Toward Sustainable Governance of Water Resources: The Case of Guanacaste, Costa Rica

by

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ABSTRACT

Research shows that many water governance regimes are failing to guide social-ecological systems away from points, beyond which, damage to social and environmental well-being will be difficult to correct. This problem is apparent in regions that face water conflicts and climate threats. There remains a need to clarify what is it about governance that people need to change in water conflict prone regions, how to collectively go about doing that, and how research can actively support this. To address these needs, here I present a collaborative research project from the dry tropics of Guanacaste Province, Costa Rica. The project addressed the overarching questions: How can water be governed sustainably in water-contested and climate-threatened regions? And, how can people transition current water governance regimes toward more sustainable ones? In pursuit of these questions, a series of individual studies were performed with many partners and collaborators. These studies included: a participatory analysis and sustainability assessment of current water governance regimes; a case analysis and comparison of water conflicts; constructing alternative governance scenarios; and, developing governance transition strategies. Results highlight the need for water governance that addresses asymmetrical knowledge gaps especially concerning groundwater resources, reconciles disenfranchised groups, and supports local leaders. Yet, actions taken based on these initial results, despite some success influencing policy, found substantial challenges confronting them. In-depth conflict investigations, for example, found that deeply rooted issues such friction between opposing local-based and national institutions were key conflict drivers in the region. To begin addressing these issues, researchers and stakeholders then constructed a set of governing alternatives and devised governance

transition strategies that could actively support people to achieve more sustainable alternatives and avoid less sustainable ones. These efforts yielded insight into the collective actions needed to implement more sustainable water governance regimes, including ways to overcoming barriers that drive harmful water conflicts. Actions based on these initial strategies yielded further opportunities, challenges, and lessons. Overall, the project addresses the research and policy gap between identifying what is sustainable water governance and understanding the strategies needed to implement it successfully in regions that experience water conflict and climate impacts.

DEDICATION

For Michelle Marie – my love, adventure partner, and best friend.

ACKNOWLEDGEMENTS

Like many good adventure stories, this dissertation started when a rebar pole violently shattered at a construction site in rural Nicaragua. As a result, a small piece of rebar from the exploded pole became permanently lodged in my left leg. A few months later in September 2009, shortly after beginning my PhD studies, Dr. Raffaele Vignola from the *Centro Agronómico Tropical de Investigación y Enseñanza* in Costa Rica called Dr. Arnim Wiek at Arizona State University to discuss an idea to start a new research project in the dry tropics of NW Costa Rica. Following that call, Dr. Wiek and I looked at a map. The proposed study area in NW Costa Rica was only hours away from where that metal shrapnel became lodged in my leg. A piece of metal from Central America was already stuck in my leg, so it made perfect sense that I would go back to work there. And, so this dissertation begins. This story illustrates something significant: A key factor in the success of this undertaking has been the confidence from Dr. Arnim Wiek that one of his new PhD students with no initial funding and with no previous history of academic achievement could do this project in a way that would require years of time on the ground in another country working in another language. And, that in the end, he would do it well. Thank you for your confidence, Arnim. I could not have done this project without the love and support of my wife, family, and friends. Who would have thought that while doing a dissertation, which has required years of living and working in difficult settings abroad, that I would find and marry the love of my life, Michelle. My Mom and Dad taught me that life is good, to see the best in people and to work hard. They are my role models. My sisters Aleecia and Joleen taught me how to keep it real when things get tough. My Grandparents taught me to be joyful. My good friends Ben Warner, Josh

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Chapter 1

Introduction: How can water be governed sustainably in water-contested and climate-threatened regions? And, how can people transition water governance regimes from current to sustainable ones in these regions?

1. The Principal Problem

Evidence shows that many socio-ecological systems could be nearing thresholds, beyond which, system damage may be irreparable (Rockström et al., 2009). Over the last two decades, research has identified key requirements and obstacles for well-designed governance regimes (i.e., Ostrom, 1990; Folke et al., 2005). The emphasis on governance represents a shift from traditional management paradigms characterized by hierarchical state-centric approaches to those with political authority distributed to multi-actor alliances and relevant actors from civil society. 'Governance' approaches suggest that the collective actions of these individuals serve as a steering or guiding function for socio-ecological systems (Nelson et al., 2005). These collective actions can guide systems in one direction (i.e., toward collective goals) or another over time (Lubell et al., 2008; Wiek & Larson, 2012). Recent research shows that many water governance regimes – in their current states - will not be able be to successfully steer societies or socio-ecological systems away from these tipping points (Vörösmarty et al., 2010; Biermann et al., 2012; Pahl-Wostl et al., 2013). In contrast, many regions now face mounting challenges related to, for example, the just distribution of water and its risks and benefits among communities, economic actors, and environments (Swatuk, 2008; Biggs et al., 2013; Gutiérrez et al., 2013).

Put simply, people must 'govern water differently' in order to collectively resolve and mitigate water problems (Wiek & Larson, 2012). Yet, water governance research to date has struggled to adequately support problem-solving efforts (Loucks, 2008; Reed & Kaspryszk, 2009; Bakker, 2012). It has generally failed to yield actionable research results that can be directly used to help resolve complex problems. These failures have led to increasing calls for a 'solution-orientation' of water governance research (Wiek & Larson, 2012; Pahl-Wostl et al., 2013; Vörösmarty et al., 2013) that, for example, engages the intended 'users' of the research throughout the research process (i.e., Lang et al. 2012); that avoids one-size fits all solutions/ recommendations for resolving complex problems (i.e., Ostrom, 2007; Meinzen-Dick, 2007); and that focuses on collaboratively constructing robust solutions to complex problems rather than only analyzing problems (i.e., Wiek et al., 2012). In spite of the growing calls for a 'solution-orientation' of water governance research, to date there remain few, if any, examples in the literature of an implemented and comprehensive solution-oriented water governance research project that researchers and practitioners can learn from. As a whole, this dissertation aims to fill that void.

The principle problem addressed by the overall dissertation is: people's failing efforts to collectively govern water sustainably and to successfully resolve complex water problems in the face of existing water scarcity, climate change, and social tension. In other words, many current water governance regimes in these contexts are not resolving complex water problems; rather, mounting evidence shows many water governance regimes are actually exacerbating these problems and placing people and environments under increasing risk (of decreased quality of life, less available water, harm, etc.). On

top of this, mounting evidence in the literature has shown that water governance research to date has not adequately supported water governance regimes to better tackle complex problems. People then, must govern water more sustainably, and research must better support people to govern water in more sustainable ways.

2. Research Objectives and Questions

The guiding research question of this dissertation is: *How can water be governed sustainably in water-contested and climate threatened regions? And, how can people transition water governance regimes from current to sustainable ones in these regions?* To answer these questions, three overarching (and overlapping) objectives are pursued. Each objective contains a set of sub-questions addressed in individual chapters. Details on individual questions and their relevance to the literature and to yielding actionable results are described within the appropriate chapter.

Objective #1: To clarify the process and design features of sustainable water governance and potential barriers to implementation, especially in the context of climate threatened, water-contested, and developing regions.

- How is water currently governed in a water-contested and climate-threatened region in the Central American dry tropics? (Chapter 2)
- How well is water currently governed in this water-contested and climate-threatened region? (Chapter 3)
- What common opportunities for advancing toward sustainable water governance might we expect to find in such regions? What common barriers might we expect to find? (Chapter 2 and 3)

- What governing actions can be implemented over time in order to overcome those barriers? (Chapter 6)

Objective #2: To specify the institutional drivers and mediators of intense and intractable water conflicts at regional scales.

- Why do some water conflicts escalate while others do not? (Chapter 4)
- What are the implications of current and alternative water governance schemes to mitigate or aggravate water conflicts in a water-contested and climate-threatened context? (Chapter 4)
- How would particular sets of institutional drivers and mediators play out in terms of their effects on conflict outcomes within alternative water governance regimes? (Chapter 5)

Objective #3: To test participatory methods and approaches for developing/ evaluating governance alternatives and policy strategies toward sustainable water governance, including mitigation of intense and intractable water conflicts in the face of climate threats.

- How can water governance analysis and appraisals best be designed to maximize their positive impacts? What are their limitations? (Chapter 2 and 3)
- How can water conflict research better align with the professional needs of decision-makers who aim to mitigate such conflicts? (Chapter 4)
- What are the strengths and limits in terms of the usability governance scenarios and governance transition strategies in collective planning processes? (Chapter 5 and 6)

3. The State of Current Knowledge

The current state of knowledge pertaining to each of the three sub-objectives is explained below. Specific contributions made to the literature/ current knowledge is stated in bullet points.

Objective #1: To clarify the process and design features of sustainable water governance and potential barriers to implementation, especially in the context of climate threatened, water-contested, and developing regions.

To understand the shortcomings and successes of water governance regimes, studies have employed common pool resource (CPR) theory - often suggesting that more polycentric governance systems (as opposed traditional management schemes) that effectively engage stakeholders are best able to achieve sustainability outcomes within highly uncertain planning contexts (Pahl-Wostl & Franz, 2010; Ostrom, 2010). Polycentric governance systems contain many (as opposed to few) centers of decision-making authority (Ostrom et al., 1961). They disperse this authority across locations and nested scales (McGinnis, 2000; Pahl-Wostl, 2009), and they allow governance actors to largely self-organize and to coordinate with each other (Ostrom, 2007). Currently, there is a need to constructively build on polycentric governance propositions using multi-scale cases within the water sector - especially from regions underrepresented in the literature (ISSC/UNESCO, 2013, p605; Neef, 2009) - to help build understanding of how, when, and under what contexts polycentric governance, and the way it is implemented, enables more effective and sustainable water governance (Molle, 2007; Marshall, 2009; Nagendra & Ostrom, 2012). Water governance cases provide the opportunity to examine polycentric governance as a more dynamic (vs. static) process, where governing actors

exercise control in different parts of water systems from sources to post-use. In Chapter 2, for example, we constructively examine potential implications for polycentric governance propositions in the rural, water-scarce context of the Central American dry tropics. This context affords a multi-scale and dynamic (i.e., changes in the governing system as water moves through the system) perspective of water governance that offers a fresh perspective and use of CPR theory.

Key dissertation contributions to the literature from meeting Objective #1

- Improved understanding of the how, when, and under what contexts polycentric-schemes of water governance promote more sustainable water governance regimes and how they cannot (Chapter 2)
- Demonstration of the potential utility and limits of integrated analytical knowledge of water governance regimes using CPR theory (Chapter 2) and normative knowledge of how sustainable water governance regimes are currently (Chapter 3).

Objective #2: To specify the institutional drivers and mediators of intense and intractable water conflicts at regional scales.

Water conflicts are approached in this dissertation from three departure points. First, I define conflict as a situation where 'two or more entities, one or more of which perceives a goal as being blocked by another entity, and power of some sort being exerted to overcome the perceived blockage' (Frey, 1993). I focus especially on actions taken against other actors with the intent to overcome or harm. Non-cooperative actors are not necessarily trying to overcome or harm others (Zeitoun & Mirumachi, 2008). Second, I view water conflict as a process that occurs with varying degrees of tension among social

actors over time (Funder et al. 2010). Many studies view conflict as a single point or measurement. A static approach does not account for the more realistic, dynamic nature of water conflicts (Sneddon et al., 2002; Böhmelt et al., 2013). Thirdly, the new approach for understanding water conflicts (in Chapter 4) aims to improve the links between research and the needs of stakeholders that face conflicts (Bakker, 2012; Pahl-Wostl et al., 2013). More intense water conflicts most often happen within sub-national regions (Postel and Wolf, 2001), yet few studies comprehensively address conflicts within at-need and at-risk regions (Scheffran et al., 2012). In contrast, many current water conflict studies examine conflicts 'from a distance' using large-n samples and with little apparent grounding in the actual regions where conflicts occur – which in turn limits the accessibility and usability of such studies for those who aim to mitigate conflicts.

Water governance studies, as noted above, increasingly use common pool resource (CPR) theory, which underpins the alternative approach to water conflicts found in this dissertation (especially Chapter 4). Polycentric systems are considered different from centralized (e.g., rigid) or fragmented (e.g., disparate) systems (Pahl-Wostl, 2009; Bakker & Cook, 2011). Fragmented systems contain limited interfaces among governance actors who operate in relative seclusion in different locations and scales (Molle, 2007; Nagendra & Ostrom, 2012). In reality, water governance often includes some polycentric aspects, but with widely varying degrees (Huitema et al., 2009). Rogers (2002) and Biswas et al., (2009) illustrate that, while water governance schemes across Latin America generally fit these three governance types, they are continuously changing due to internal and external factors. Huitema et al. (2009) point out that while polycentric prescriptions for water governance are theoretically sound and feasible, there remains a

need to clarify effective and sustainable water governance schemes for specific and urgent problems in specific places (i.e., water conflict in the dry tropics of Central America). Chapter 2 of this dissertation suggests that, in addition to clarifying governance schemes to fit problems and places, the manner in which new governing schemes are implemented over time (in order to address conflict) will also be important for effectiveness. Harmful sub-national water conflict problems however, are typically approached very generally in attempts to sort out water supply and demand. Identifying the potential of current and alternative water governance regimes that potentially aggravate or mitigate harmful water conflicts is then a key research need addressed in this dissertation that has important implications for effectively meeting the challenges faced in water-contested and climate-threatened regions.

Key dissertation contributions to the literature from meeting Objective #2

- Developing and applying fresh/ alternative concepts and tools for understanding water governance that is well-grounded to the places where water conflicts are actually experienced and thus offers improved study utility in comparison to many of current water conflict and climate change studies (Chapter 4)
- Improved understanding of the institutional mediators and drivers of water conflicts at a scale that is relevant and actionable for decision-making and collective groups (Chapter 4).
- Improved understanding of how current and alternative governance regimes might be expected to handle water conflict risk and their real-time policy implications (in terms of crafting governance strategies to better mitigate conflicts) in critically threatened regions such as the dry tropics of Central America (Chapter 4 and 5).

Objective #3: To test participatory methods and approaches for developing/ evaluating governance alternatives and policy strategies toward sustainable water governance, including mitigation of intense and intractable water conflicts in the face of climate threats.

It is now recognized that robust options for addressing complex problems (i.e., water governance challenges) cannot be deduced from only analyzing or describing those problems (Sarewitz et al., 2012; Wiek et al., 2012). This recognition has led to the formation of the new field of sustainability science (Kates et al., 2001; Kemp et al., 2005). Although still lacking agreement on some fronts the field has generally accepted a number of defining aspects. These aspects include: a focus on of the linkages among humans and nature through a coupled systems approach (Clark & Dickson, 2003; Ostrom, 2009); a focus on the long-term integrity and viability of societies and ecosystems (Jerneck et al., 2010); the explicit engagement with (as opposed to avoidance of) the normative aspects of problems and their solutions (Gibson, 2006); a recognized value of transdisciplinary research methods and of diverse research collaborations across society (Gibbons, 1999; Lang et al., 2012); and, a focus on place-based research that is grounded in real problems and oriented toward finding robust solutions rather than focused on one-size-fits all analyses and subsequent recommendations (Ostrom, 2007; Meinzen-Dick, 2007). At the core of sustainability science (which in this dissertation I will often refer to as solution-oriented water governance research) is the aim to construct actionable knowledge. However, there still remains few cases or examples in the water governance arena where research efforts analyzed problems, aimed to construct and test ways to address those problems with society, and then re-examined what worked and

what didn't in terms of producing actionable knowledge and in terms of advancing solution-oriented research theories and practices. In the water governance field, most studies tend to be based in developed regions in urban settings with relatively high quality data available from previous studies (Neef, 2009). Many of those studies though do not explicitly aim to produce and test actionable knowledge that is relevant for addressing complex water problems. This dissertation offers insights from an integrated water governance research project in a unique region that aimed to produce actionable knowledge over its 4-year and counting lifespan. Examining the failures and successes in doing this over the course of the project offers valuable insights that can help improve and advance the design and implementation of solution-oriented research efforts that aim to produce actionable knowledge that is useful for addressing complex water problems.

Key dissertation contributions to the literature from meeting Objective #3

- Demonstration that descriptive-analytical research efforts are best carefully integrated with, rather than separated from, solution-oriented research that focuses on producing actionable knowledge (Chapters 3, 5, and 7)
- Identifying the challenges and opportunities for producing actionable knowledge for sustainable water governance in a unique region and context (Chapters 6 and 7)

4. The Research Site and Its Relevance

The Central American dry tropics – featuring water scarcity, social tension, and climate impacts and threats - offer a unique and useful setting for research to address a how water can be governed more sustainably in water-contested and climate threatened regions. Guanacaste Province in the rural and dry NW of Costa Rica in particular, offers

a compelling case that is particularly well suited to addressing the three dissertation sub-objectives:

Objective #1: To clarify the process and design features of sustainable water governance and potential barriers to implementation, especially in the context of climate-threatened, water-contested, and developing regions.

The Guanacaste case allows us to constructively examine potential implications for polycentric governance propositions in the rural, water-scarce context of the Central American dry tropics. This context affords a multi-scale and dynamic (i.e., changes in the governing system as water moves through the system) perspective of water governance, while contributing to advancing more solution-oriented water governance studies (Vörösmarty et al., 2013). Very little existing knowledge of physical water systems was available for the selected site, which afforded an opportunity to learn about executing water governance analysis in ways that can support effective governing efforts despite the high uncertainty common in the broader region and beyond. Many areas in the dry tropics of Central America are subject to increasing risk of water scarcity (Anderson et al., 2008). These areas often experience uneven economic growth and expanding agricultural development, which compete for water in contexts that often include relatively weak state governments that are now seeking to expand, social injustice, and at times political instability (Booth et al., 2010; Madrigal et al., 2011). Water-related laws in Costa Rica, some of which date back several decades, generally protect the ability of people and communities to organize, including for purposes to protect, and to a limited extent to govern, resources. Several avenues for public accountability (i.e., checks and balances), and stakeholder engagement (although not always pursued) exist. Yet, below the

national-scale in the dry tropics of Guanacaste Province, governance is currently inadequate (see point about water conflicts below). The Guanacaste setting includes intense dry seasons that are expected to become drier (Anderson et al., 2008), rapid political and social change (Casas-Zamora, 2011), and typically very active rural populations (Edelman, 1999).

Objective #2: To specify the institutional drivers and mediators of intense and intractable water conflicts at regional scales.

Over a recent 10-year period, Guanacaste experienced on average one water conflict (defined by people or groups taking legal actions against others) every month and a half (Cover, 2007) – in a land area slightly smaller than Los Angeles county but with a population thirty times smaller. However, as noted in Chapter 1 and examined in-depth in Chapter 4, water conflicts have not been experienced uniformly across the region and they have played out in different processes over time from one area to another.

Objective #3: To test participatory methods and approaches for developing/ evaluating governance alternatives and policy strategies toward sustainable water governance, including mitigation of intense and intractable water conflicts in the face of climate threats.

In spite of the challenges that water governance regimes face in Guanacaste, many individuals are active in in the water sector aspire to better perform collectively as illustrated throughout the following chapters. Some of these individuals are collectively organized and eager to partner with research projects that aim to go beyond only extractive-styles of research (as illustrated throughout the following chapters). Thus, in addition to being a case that is well suited to addressing the study objectives, Guanacaste

also affords a case to implement and test new solution-oriented approaches to water governance research that aim to meaningfully involve research 'users' in an effort to produce actionable knowledge.

5. Research Approach

The project or procedural planning framework used to organize the dissertation is based on Wiek (under review) and adapted to water governance and water conflict cases (Figure 1.1). I distinguish between *analytical* and *procedural* frameworks. An analytical framework identifies the components and general relationships between these components that should be considered when analyzing problems (Ostrom, 2011). For example, the Institutional Analysis and Development (IAD) framework developed by Elinor Ostrom and colleagues and later iterations of the IAD (i.e., Ostrom, 2009; Anderies & Janssen, 2013) links governance and resource systems with resource units, governance actors, and action arenas. Two primary analytical frameworks are used in this dissertation and are described at length in the relevant chapters. Chapters 2 and 3 employ the framework for analyzing and appraising water governance regimes developed by Wiek & Larson (2012). Given the lack of attention to place-based water conflicts and little current water conflict research that yields actionable results (Scheffran et al., 2012), Chapter 4 develops an exploratory analytical tool for identifying the potential of governance regimes to aggravate or mitigate conflicts within specified contexts. However, analytical frameworks in themselves are not necessarily integrated with subsequent efforts that aim to build on gained analytical knowledge in order to, for example, examine alternative ways of governing water and craft collective governing

strategies that aim to change current water governance regimes. Integrating these efforts is supported by procedural planning frameworks (Wiek & Lang, 2014).

The procedural framework used here links three research/ knowledge domains within the dissertation (i.e., Wiek & Walter, 2009). (1) Current state analysis domain includes knowledge of, for example, how governance works (e.g., why do people do what they do with water and why, etc.) (Chapter 2), knowledge of normatively how well water governance works currently (Chapter 3), and why conflicts happen (Chapter 4). Research in this domain would utilize an appropriate analytical framework as mentioned above. The (2a) Governance alternatives domain includes knowledge of what alternative water governance regimes might look like and their social and environmental consequences. Variables, systemic relationships and key governance features from the current state analysis would support constructing robust governance alternatives (see Table 1.1). In the domain (2b) Goal identification, these governing alternatives are deliberated in order to identify what is a sustainable governance regimes and what is not. The (3) Governance transition strategies domain includes knowledge of the actions, barriers to success, and policy options that are relevant for collective efforts that aim to transition the current governance regime toward more sustainable alternatives while avoiding more detrimental and less-desirable alternatives. Developing and implementing governance transition strategies is a reflexive and anticipatory process that continuously revisits and reflects on current-state conditions, future possibilities and alternatives, implementing collective governance goals and strategies, and implementation barriers and actions that can overcome those barriers. Specific research designs and methods for each chapter are

summarized in the following section and elaborated and justified at length within each chapter.

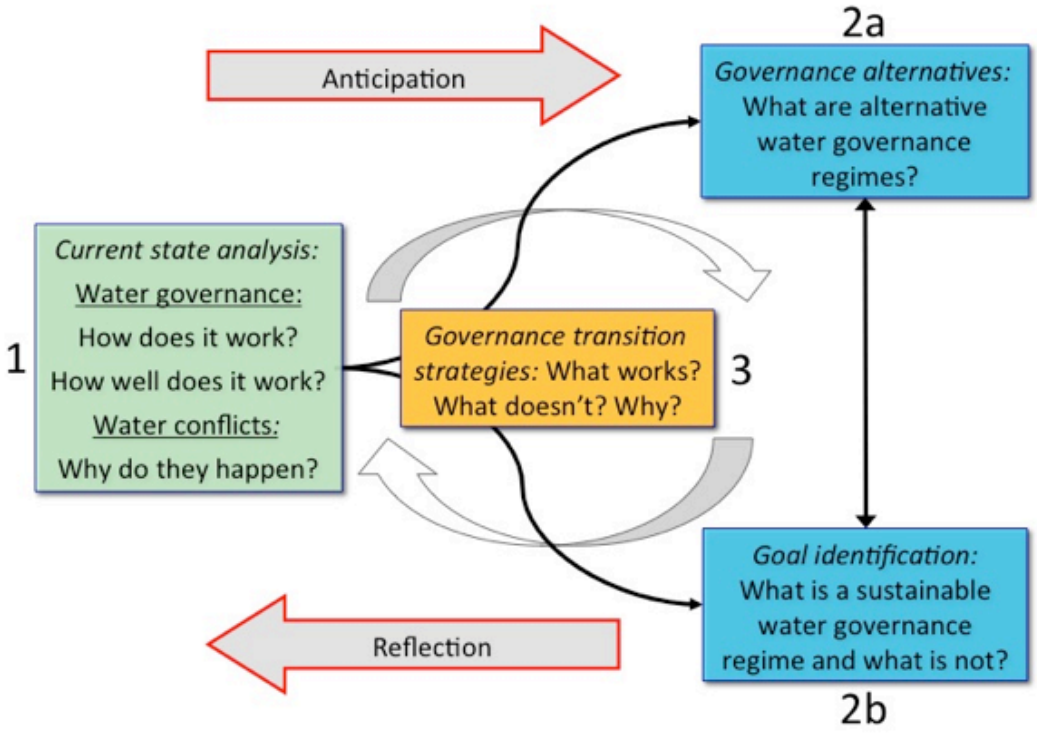

Figure 1.1 Procedural planning framework used to organize the dissertation research components. Adapted from Wiek (under review) in order to fit the water governance and conflict application.

Table 1.1

Linking and Integrating the Study Chapters

Chapter	Research Domain	Chapter summary	Link to other chapters
2	1	Analyzing a regional water governance regime in a way that is integrated with the regional	Provided a foundation for the normative governance appraisal (Chapter 3),

		water system and that involves those people that live, work, and take water-related governing actions in the system	provided a list of relevant variables needed to construct governance alternatives (Chapter 5), and offered a comparison case where no harmful water conflicts have been experienced (Chapter 4)
3	1,3	Evaluating how well a regional water governance regime operates based on a set of normative sustainability criteria and identifying initial opportunities to improve governance	Provided the normative framing to identify more and less sustainable alternatives (Chapter 5) and the appraisal process helped fortify local partnerships and collaborative relationships needed to execute subsequent chapters (Chapter 5, 6)
4	1,2a, 3	Identifying the institutional features of governance regimes that drive or help to mitigate more intense and intractable	Provided the needed insight for constructing different governance alternatives and (importantly) identifying

		water conflicts	how those alternatives would mitigate or aggravate conflicts under different climatic conditions and impacts (Chapter 5), offered insight into what collective governance strategies may be more or less feasible under different types of governance regimes (Chapter 6 and 7).
5	2a, 2b, 3	Developing and engaging a set of alternative options (via scenarios) to current water governance regimes	The alternative governance scenarios brought to life a small set of robust options that would help elaborate, deliberate and identify collective goals, sustainable water governance schemes, and un-sustainable water governance schemes (Chapter 6 and 7).
6	3, 1	Devising collective governance	Forming collective

		strategies for transitioning the current water governance regime toward more sustainable alternatives and away from less desirable/ less sustainable alternatives	governance strategies provided a means to reflect further on current conditions with an eye to transform (rather than just understand) the existing water governance regime (link back to Chapter 1,2 and 3).
7	Cross-cutting	To use insight from the real-time 'testing' of study applications and devised strategies (e.g., stakeholders taking action on study results, study application, and devised strategies) over time to initially evaluate, for example, the feasibility, the barriers, and the opportunities for people to collectively change or even begin to transform currently inadequate water governance regimes.	This concluding chapter brings together the insights from across the chapters (organized by sub-objectives 1, 2 and 3) in order to conclude (1) how water can be governed sustainably in water-contested and climate-threatened regions and (2) how research can better support this (link back to principal problem).

6. Individual Chapter Summaries

6.1 Chapter 2: Integrated and participatory analysis of regional water governance regimes: The case of Guanacaste, Costa Rica.

Water governance research provides ample evidence that many of the persistent water problems worldwide are caused by people's consumer behavior, professional practices, and collective actions. If these problems are to be resolved or mitigated, then, in simple words, people need to 'do things differently' with water. In a first step, this requires systematically mapping what people do with water, what the impacts are, and why they do what they do with water. In this Chapter, I apply a recently developed framework for such water governance analysis to Guanacaste Province, Costa Rica. Data collection included 47 semi-structured interviews and several stakeholder meetings with representatives from government agencies, non-profit organizations, businesses, and academia. Data analysis combined qualitative content analysis, quantitative network analysis, two stakeholder workshops, stakeholder mapping, and watershed-scale hydraulic modeling of precipitation-runoff processes. Results show regional water governance operates unevenly and is increasingly uncoordinated as water moves through the system. Two central actors exercise authority in separate domains of the water system with little cooperation between them. Non-state actors play a major role driving collaboration in regional Guanacaste water governance, in spite of prevailing institutions that limit their involvement in governing processes. These results suggest that water governance designs with top-down institutional hierarchies, combined with horizontally fragmented or uncoordinated administrative units, are likely to exacerbate uncertainty. Governance actors will then struggle to set shared goals and make progress toward them. Mutual accountability between hubs of

authority and active institutional leadership are two critical design features of sustainable water governance in regions that experience water scarcity and conflicts, aggravated through climate change. Based on this application, I present guidelines for solution-oriented water governance analysis, including the framing of critical analysis elements with key stakeholders; identifying and involving leaders at the science-policy interface; and positioning the analysis within larger problem-solving endeavors.

6.2 Chapter 3: Sustainability appraisal of water governance regimes: The case of Guanacaste, Costa Rica. Sustainability appraisals produce evidence for how well water governance regimes operate and where problems exist. This information is particularly relevant for regions that face water scarcity, conflicts, and climate change threats. This study presents a criteria-based and participatory sustainability appraisal of water governance in a region with such characteristics - the dry tropics of NW Costa Rica. Data collection included 47 interviews and three stakeholder workshops. The appraisal was conducted through a collaborative and iterative process between researchers and stakeholders. Out of the 25 sustainability criteria used, seven posed a significant challenge for the governance regime. We found challenges faced by the governance regime primarily clustered around: failing coordination related to the use, management, and protection of groundwater resources; and, inadequate leadership to identify collective goals and to constructively and openly deliberate alternative ways of governing water. The appraisal yielded some positive impact in the study area. Yet, its application provided only limited strategic information to support problem-solving efforts. Insights from this study suggest focal points for sustainable water governance in the Central American dry tropics, including: investing in increasingly influential

collective organizations that are already active in water governance; and leveraging policy windows that can be used to build confidence and disperse more governing authority to regional and local governing actors that are in-tune with the challenges faced in the dry tropics. We conclude the article with reflections on how to produce research results that are actionable for sustainable water governance.

6.3 Chapter 4: Identifying the potential of governance regimes to aggravate or mitigate conflicts in regions threatened by climate change. In this chapter my partners and I develop an alternative approach for understanding water conflicts. The approach identifies the potential of governance regimes to aggravate or mitigate water conflicts within specified settings. We apply the approach using five diverse cases from Costa Rica to investigate why some water conflicts escalated while others did not. The mixed methods approach included 16 ethnographic interviews, three focus groups, and a qualitative cross-case study comparison that aimed to tease out the institutional drivers and mediators of escalated conflicts in the region. We found conflicts were set off in contexts of high friction between national-scale and community-based institutions in situations with inactive regional leaders. Distrust and poor collective water system knowledge, worsened by ineffective stakeholder engagement, were important aggravating factors. Self-organized conflict mitigation efforts had difficulty dealing with unresolved tension among actors and vague resource rights and governing responsibilities. Yet, even in aggravating-contexts, successful mitigation potential existed if face-to-face cooperation venues and supportive, successful governing examples from nearby areas were accessible to local actors. The approach and case studies yielded a schematic that identifies potential conflict risks, mitigation abilities, and promising mitigation strategies

across a range of governance schemes in the dry tropical Central American context. Polycentric water governance schemes that are fitted to regional contexts, that feature enabling leadership, that fairly resolve water access issues, and that emphasize vertical accountability offer conflict mitigation potential. Centralized governance regimes that undergo institutional/ administrative fragmentation allow potential risk of aggravated conflicts in settings where power is disproportionately held and where local groups are not accounted for. Results demonstrate that water conflicts are not uniformly experienced within regions nor do conflict processes unfold in consistent manners over time - which has implications for realizing effective water governance and useful water conflict research. Knowledge transfers within regions, learning by example, and existing leaders offer promising starting points for overcoming institutional and political barriers that obstruct conflict mitigation potential.

6.4 Chapter 5: Governance scenarios for addressing water conflicts and climate change impacts. Scenarios that outline alternative governance regimes may offer one way to support positive change in regions that face persistent water problems. Here, I explore this proposition using the case of Guanacaste, Costa Rica – a region that faces water conflict and looming climate change impacts. My partners and I developed five scenarios over the course of a year using a formative and participatory approach with system, consistency, and diversity analyses, and visualization. In one scenario, water conflicts surfaced due to opaque governance schemes not accounting for communities that opposed suspect alliances of agencies, developers, and investors. In another alternative, challenging environmental and social contexts overwhelmed fragmented governance schemes causing dissent; which contrasted with another scenario where

engaged and vertically accountable governance schemes are fitted to the unique regional context and collectively mitigate problems. Governance though, in a return to historical precedent, could alternatively implement strong top-down schemes in order to safeguard rural communities and lifestyles; or, in contrast, implement more minimalist governance that fills technical roles. The scenario study provided diverse stakeholders with opportunities to share perspectives, connect with others, and to collaboratively explore and articulate alternative water governance schemes. The practical value of the scenarios, however, highly depended on efforts before and after the study and the integration of the scenarios with those efforts. Previous water governance research in the region facilitated partnership building, stakeholder trust, and active participation in the scenario building process. Timely follow-up demonstrated the real-time application of the scenarios as reference points to help craft collective governance strategies. Governance scenarios, if integrated with a broader transformational planning process, can be a constructive step toward crafting more sustainable water governance schemes. In spite of their limitations, the scenarios played a part in Guanacaste that helped revitalize coordination and encouraged experimentation with new water governance efforts in the region.

6.5 Chapter 6: Governance transition strategies for a water-contested region. Building directly on Chapter 5, here I recount the efforts of my partners and I during and after the largest stakeholder workshop for water governance in Guanacaste in recent years. 46 individuals from 18 Guanacaste communities, from all scales of water governance, worked constructively for over 7 hours to help build alternatives to the current water governance regime, to evaluate using multi-criteria analysis how sustainable or not those alternatives were, and to build collective governance strategies

that would transition the current governance regime toward more sustainable alternatives and help avoid less-sustainable alternatives. Participants worked in sub-groups to develop strategies based on the five priorities for water governance that were identified through scenario evaluation exercises at the workshop. Each sub-group presented its strategies, which identified actions to be taken, leaders, resources, and expected barriers to successfully taking action. Following the workshop, the research team and partners in the *Comisión para el Manejo de las Cuencas Potrero-Caimital* synthesized a systematic action plan embodying the strategies developed by workshop participants and the insights obtained from the group discussions that followed each strategy presentation. The action plan identifies four action items, potential barriers, and ways to overcome those barriers. I argue that Guanacaste leaders and communities are in a position now to make a unified push for national water reform that better enables sustainable water governance while simultaneously implementing actions to advance water sustainability from within the region. Progress is already being made as is demonstrated in previous dissertation chapters. Though barriers remain, Guanacaste can move forward despite the failure of national lawmakers to modify water policies in light of citizens' needs. When water reform does happen—and with enough momentum it eventually will— the action plan will position Guanacaste to capitalize on current water sustainability efforts and further accelerate sustainable water governance.

6.6 Chapter 7: Conclusion: How water can be governed sustainably in water-contested and climate-threatened regions and how people can transition water governance regimes from current to sustainable ones in these regions. This concluding chapter brings together the insights from across the chapters and re-caps the

entire dissertation organized by the sub-objectives 1, 2 and 3 in order to conclude (1) how water can be governed sustainably in water-contested and climate-threatened regions, (2) how people can transition water governance regimes from current to sustainable ones in these regions, and (3) how research can better support sustainable water governance efforts. Much of the conclusion is already stated in the individual chapters, but organized by the dissertation objectives here in the conclusion. Some readers may prefer to read the relevant chapter, while others may prefer to read here in the conclusion only the answers to some questions under certain dissertation objectives. In the conclusion, each question stated under the sub-objectives is answered; contributions to the literature are stated organized by sub-objective; a discussion and initial reflection on the evolution of the project's research and planning framework is presented in Section 4.2; and a list of practical contributions made to water governance efforts in Guanacaste. The concluding chapter also offer a glimpse into other key research activities that have occurred as a part of this broader project.

Chapter 2

Integrated and participatory analysis of regional water governance regimes - The case of Guanacaste, Costa Rica

1. Introduction

Over the last two decades, research has revealed key requirements and obstacles for well-designed governance regimes (Ostrom, 1992; Folke et al., 2005). Evidence also shows that many of our natural resource systems could be nearing points beyond which, system damage could be irreparable (Rockström et al., 2009; Galaz et al., 2012). In their current states many environmental governance regimes may not be able be to successfully steer or guide societies away from these tipping points (Bierman et al., 2012). Without significant change to how people govern resources, many social-ecological systems and the quality of services they provide are at risk of degenerating. But where do we start with the changes that are needed – what are promising intervention points? How can analyses of natural resource governance better inform or prepare for long-term efforts that seek to transform governance regimes?

People cause the majority of natural resource problems in general, and water problems in particular (Young et al., 2008; Rijke et al., 2012). Thus, people need to 'do things differently' with water, including governing water differently, in order to resolve and mitigate water problems (Pahl-Wostl, 2008; Kuzdas, 2012). Yet, water governance research often does not focus on people's water related activities, their impacts, and their drivers (Reed & Kaspryszk, 2009). It struggles to integrate water governance components beyond isolated aspects such as legal issues, infrastructure, or material flows (Loucks, 2008; Bakker, 2012). If governance research is to help people govern water

differently, we first need to know what people do with water, why they do what they do, what the impacts are, and where opportunities for change might exist (Wiek and Larson, 2012). Many current water governance regimes do not sufficiently account for people-centered aspects such as (diverging) needs, desires, and values of stakeholders; roles of leaders and mediators; incompatibilities between different political and administrative structures; imprecise or vague rules and regulations; archaic yet resilient modes of resource planning; and conflicts within fragmented governance regimes (Pahl-Wostl et al., 2012).

To deal with the shortcomings of many existing water governance regimes, the field of adaptive water governance, drawing on common pool resource theory, often suggests that polycentric governance systems that effectively engage stakeholders are best able to achieve sustainability and adaptability in the face of climate threats and high uncertainty, especially in comparison to fragmented or hierarchal governance designs (Ostrom, 2007; Pahl-Wostl & Kranz, 2010; Huntjens et al., 2012; Rijke et al., 2012). Polycentric governance systems are those systems that contain many independent centers of decision-making (Ostrom et al., 1961), that disperse decision-making authority across locations and scales (Pahl-Wostl, 2009), and where governance actors are largely self-organized and coordinated (Ostrom, 2007). However there remains a lack of diverse and broadly comparable studies in the field that adequately account for the dynamics of authority and coordination within water governance regimes, especially in understudied regions where water scarcity and conflicts already exist. The Guanacaste case also helps address current needs to build improved understanding of how, when, and under what contexts polycentric governance, and the way it is implemented, enables more effective

and sustainable water governance (Molle, 2007; Neef, 2009; Marshall, 2009; Nagendra & Ostrom, 2012). Water governance cases also provide the opportunity to examine polycentric governance as a more dynamic (vs. static) process, where governing actors exercise control in different parts of water systems from sources to post-use.

In this study, we evaluate the applicability of the polycentric governance system hypothesis in the context of developing regions that experience water scarcity, conflicts, and high risk of future climate change impacts. Water governance research in general, and especially water security research, often struggles with integrating the research process and the ensuing results with the professional needs of decision-makers and water administrators; and thus, often makes poor contributions in terms of directly aiding problem-solving efforts (Bakker, 2012). Following our analysis, we reflect on practical methodological guidelines that future water governance analyses might use to help maximize their contributions to water problem solving endeavors. In doing so, we aim to help build a solution-oriented approach to water governance analysis that considers context and place-based problems, but supports generality in terms of both content (research results) and methods.

We present and reflect on an integrated water governance analysis in three connected watersheds in Guanacaste Province, Costa Rica. We pursue four research questions:

1. Who are the key actors in the water governance regime? What do they do with water and why? (RQ.1)

2. How do the key actors in the governance regime relate to each other? In other words, what is the structure of the actor network, overall and for each water governance domain? (RQ.2)
3. How does the structure of the actor network impact coordination within the governance regime? (RQ.3)
4. What common barriers to sustainable water governance should be expected from governance regimes with similar design characteristics to Guanacaste's? Why (or not) are these expected barriers consistent with the polycentric governance system hypothesis? (RQ.4)
5. What can we learn from the Guanacaste case about conducting water governance analysis in ways that directly contribute to practical problem solving endeavors? (RQ.5)

In pursuit of these questions, we apply the framework for water governance analysis proposed by Wiek & Larson (2012), which is a place-based, activities-oriented approach for understanding regional water governance regimes. The framework structures water governance into four domains – water supply, delivery, use, and outflows – to mimic regional water systems in a way that synchronizes with daily water activities (in public, professional, and private settings). The framework is based on a mixed methodological approach (Young et al., 2008), including participatory research settings with stakeholders. In this study, we expand this framework through social network analysis and stakeholder mapping, coupled with watershed-scale hydraulic modeling of precipitation runoff processes.

2. Framework for Integrated Analysis of Water Governance

The analytical framework proposed by Wiek & Larson (2012) is mechanically similar to the Institutional Analysis and Development (IAD) framework developed by Elinor Ostrom and colleagues (see Ostrom, 2011 for a recent review) and the regime analysis framework proposed by Holtz et al. (2008). The IAD framework is widely used and has been applied previously to water management situations (Imperial, 1999). The regime analysis framework has also been applied to water management (Pahl-Wostl, 2010). Wiek & Larson (2012) take core components from those frameworks, such as institutions (rules, rights, etc.), social actors and activities, and structure those components in a way that mimics regional water systems and how they are used and governed on a day-to-day basis. Ostrom (2009) employs similar system-mimicking logic in developing an approach for analyzing general social-ecological systems that links governance systems and resource production systems with resource units and actors. Wiek & Larson (2012) translate Ostrom's (2009) approach specifically for regional water systems. By mimicking regional water systems explicitly, the framework aims to resonate with stakeholders in the regional water governance regime.

Not all water-related activities are *governing* actions. We understand governance as a set of collective actions that aim toward a common goal and that are coordinated among a diverse set of actors (Lemos & Agrawal, 2006; Lubell et al., 2008). Governance is distinct from government or management, which imply limited sets of actors dealing with water such as agencies or utilities. In contrast, water governance includes all people affecting and affected by the water system as potential governance actors who might coordinate their activities to secure water system integrity and other objectives (Ostrom,

2009). The framework aims to provide the base for assessing how the collective actions of governance guide the water system toward meeting, or not meeting, water system objectives.

Here I simplify the original Wiek & Larson (2012) framework in order to better apply to Guanacaste (specifically) and rural regions (in general), where information involving natural systems and water infrastructure tend to be more challenging to obtain or may not exist. The water system is structured along two layers (illustrated in Figure 2.1):

Framework Layer 1: Actors, institutions, & activities. This layer identifies all relevant social actors and their networks, norms, and values; and outlines what they do with water, how they interact with each other, what their mandates or intentions are, what rules govern their actions and interactions, and what systems of rights and decision-making processes are in play.

Framework Layer 2: Hydrological flows and infrastructure. This layer captures how water is entering, traveling through, and leaving the water system. This includes facilities and infrastructure involved in storage, extraction, treatment, and water transfers between basins.

The two layers interface with each other along four governance domains of regional water systems:

1. *Water Supply:* the physical water sources (the environment) that support, maintain, and protect them. In Guanacaste this includes rivers, springs, and groundwater. Also included are the social arrangements, including water rights, which govern sources.

2. *Water Delivery:* the distribution of water through infrastructure, such as wells, aqueducts, treatment facilities, and post-treatment storage tanks, and water transports or inter-basin exchanges.
3. *Water Use:* consuming and conserving water by organizations and individuals within the region, including residential and commercial, industry, agriculture, ranching, forestry, rural domestic, and commercial users.
4. *Water Outflows:* discharging wastewater that consumers have used. In Guanacaste this includes septic tanks, oxidation ponds, and run-off that flows back into the watershed and environment.

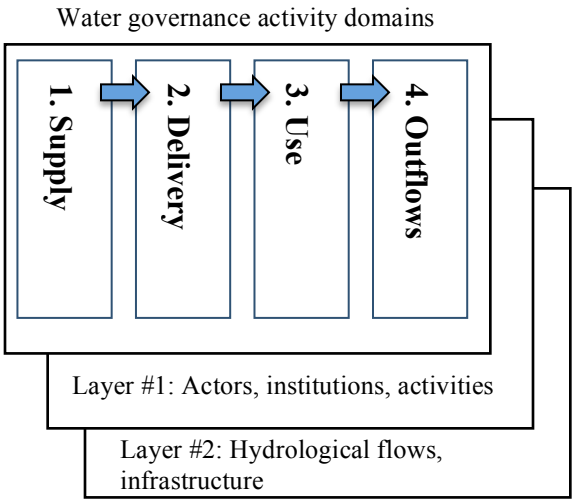

Figure 2.1 Framework for integrated analysis of regional water governance regimes in Guanacaste. Adapted from Wiek & Larson (2012).

3. Research Design

3.1 Site selection. The research site includes three sub-basins located in the Nicoya and Hojancha Counties of Guanacaste Province on the interior of the Nicoya Peninsula (illustrated in Figure 2.2): the Río Potrero, Río Caimital, and Upper Río Nosara. Regional planning documents and local stakeholders were consulted in order to

verify the extent and nature of hydrological connectivity between the watersheds. The Río Potrero and Río Caimital share the Potrero-Caimital Aquifer. The Upper Nosara typically does not flow in the dry season (December – April), so groundwater from the Caimital is transported to the town of Hojancha. The City of Nicoya receives its entire water supply from transported Río Potrero surface flows.

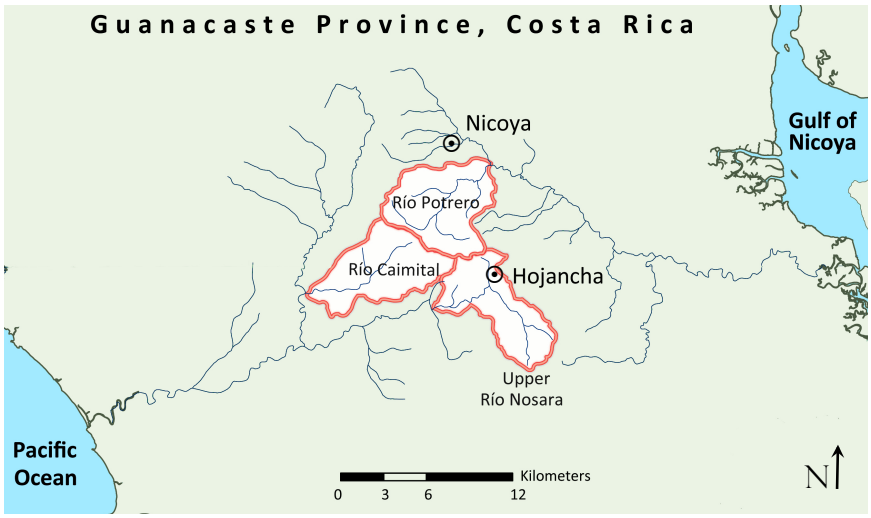

Figure 2.2 Río Potrero, Río Caimital, and Upper Río Nosara sub-basins in Guanacaste.

Collaborating researchers from the *Centro Agronómico Tropical de Investigación y Enseñanza* (CATIE) in Costa Rica and Arizona State University in the United States selected the research site after being invited to attend local and regional meetings in early 2010. CATIE has a long history of involvement in forest conservation efforts in the area and facilitated initial contact with stakeholders. The site was chosen because:

(1) Little existing knowledge of physical water supplies and predicted climate change necessitates governing water effectively in the region despite high uncertainty, which provided an opportunity to learn about conducting water governance

analysis in ways that can inform water governance effectively despite high uncertainty (Quay, 2010).

(2) Well-established conservation networks provided a known quantity of actors within the study boundaries, which facilitates accurate methods that rely heavily on the human dimensions of social-ecological systems (Ernston et al., 2010).

(3) Researchers considered the potential of using the case to learn about and inform transformative and pro-active water governance to be high. Sharp water conflicts in Guanacaste over groundwater reserves have led local and regional managers to search for ways to mitigate future conflicts (Herrera, 2009), which encouraged willingness on the part of stakeholders to participate in the research process.

(4) Like many regions in Pacific Mesoamerica and beyond, Guanacaste will be subject to increasing risk of water scarcity and climate hazards in the future (Anderson et al., 2008). Pacific Mesoamerica is an important region for global agricultural exports, is experiencing substantial growth in tourism and real estate that competes for water with agriculture, and is often challenged to deal with social inequality and political instability. Guanacaste's economic development parallels that of other Pacific Mesoamerican regions that also experience water conflicts (Booth et al., 2010; Cañada, 2010). Complex cases with such features are often not represented adequately or studied at sufficient detail by water governance scholars to allow for cross-case comparisons. The Guanacaste case affords an opportunity to examine a case that, to some degree, can serve as a general proxy for Pacific Mesoamerica. The site adds a more diverse analysis case to the water governance

field, which accounts for developing regions that experience high climate risks, high water scarcity, and existing resource conflicts and tensions.

3.2 Identification and classification of organizations (actors). Organizations were used as the units of analysis within the governance regime because they tended to embody institutions; they change relatively slowly (thus allowing for a relevant analysis for a period of time); and they are often used relevant units in a range of natural resource governance literature (Schneider et al., 2003; Ernston et al., 2010). We used three guidelines to identify relevant organizations: (1) organizations should include those affecting water governance, (2) organizations should include those affected by water governance, and (3) stakeholders should play a major role in identifying both sets of organizations. During stakeholder working groups in Nicoya and Hojancha, we asked attendees to use these guidelines to help create a list of important organizations. We also asked them to identify affiliated individuals with tenure in their respective organization, in order to help us develop an interview listing. Individuals from 45 organizations were identified as potential interview candidates (Table 2.1) for data collection. To balance the representation of organizations, we used a typology for classifying organizations relevant for study in rural areas (Agrawal, 2008). Based on this classification, we selected a mix of public organizations (local governments; government agencies), civic organizations (membership organizations; cooperatives), and private organizations (service organizations; businesses).

Table 2.1

Selected Key Organizations in the Regional Water System

Key Actor	Classification	Description
Acueductos y Alcantarillados (AyA)	Agency	National water utility mandated to supply drinking water to the population. Regional office is in Nicoya.
Ministerio de Ambiente, Energía y Telecomunicaciones (MINAET)	Agency	National environment ministry. Umbrella organization for environmental management. Nicoya and Hojancha are managed as separate sub-regions.
Área de Conservación Tempisque (ACT)	Agency	A branch of MINAET that coordinates protected area management in the region. The ACT also has an environmental education office.
Ministerio de Salud	Agency	National health ministry mandated to ensure the health of the population. Regional offices are in Hojanhca and Nicoya.
Rural aqueduct administrators (ASADAs)	Local government	Community groups that manage rural water supplies and deliveries. Granted power to set and collect water use tariffs.
Municipalities	Local	County-level government that develops

	government	land-use guidelines outside of nationally protected areas
Ministerio de Agricultura y Ganadería (MAG)	Agency	Ranching and agricultural ministry mandated to promote economic competitiveness of Costa Rican agriculture
Servicio Nacional de Aguas Subterráneas Riego y Avenamiento (SENARA)	Agency	National agency mandated to manage irrigation districts and groundwater. Main offices are in Cañas and San José.
NicoyAgua Foundation	Service organization	Non-profit water conservation group in Nicoya administered by the PCW Commission, which functions as a group promoting basin management
CooPilangosta	Cooperative	Coffee producer cooperative
Rural development associations	Membership organization	Community organizations dedicated to securing rural community well-being and financing local projects
National Training Institute	Service organization	Agricultural extension office dedicated to producer training and education
Costeña S.A.	Business	Melon producer and largest agricultural business in the area
Monte Alto Foundation	Service	Non-profit set up to finance land purchases

	organization	to protect the Upper Nosara headwaters
Ranching commissions	Membership organization	Local organizations that disseminate information to producers and promoting collective interests
Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)	Service organization	Higher education organization that administers the Finnish Forestry (FinnFor) project in Hojanhca that seeks to create biological corridors on the Nicoya Peninsula
CoopeGuanacaste	Cooperative	Regional electricity provider, administered as a cooperative which also manages retail outlets located throughout the region

3.3 Data collection. 47 semi-structured interviews were conducted with individuals representing 40 organizations. 8 additional interviews were conducted with micro-scale agricultural farms (businesses). These micro-farms were not included in the formal network analysis described below. Final interviews covered about 90% of organizations originally targeted. To ensure that as many key actors were included in the study as possible, interview participants were asked to list the two most important organizations for water governance in the region. All the resulting organizations listed as the most important for water governance in the region were interviewed. Interviews lasted an average of 75 minutes and were done face-to-face. Interviews were executed in

collaboration with the *Universidad Nacional de Costa Rica* (UNA) in Nicoya over the course of five months.

After review and pre-tests with stakeholders and prior to conducting final interviews, the initial interview protocol was modified (number and type of questions, interview length, etc.). In line with interview protocols developed by Wiek et al. (2007), interviews were structured into three parts: first, participants were asked about the water-related responsibilities, objectives, motives, mandates, and activities of the organization they represented; respondents then listed all organizations, regardless of size or type, which they interact with and described how they interact with each organization they listed. Second, respondents identified where they work and what they specifically do in the water system, using a (partly populated) water system map based on the framework that had been vetted by stakeholders. Third, respondents were asked to name the two most important regional water governance challenges and to indicate where in the system these challenges occur.

Existing and relevant hydrological information was catalogued and organized in order to determine if and how many components of the physical water system could be quantified. Existing data were collected from the *Instituto Tecnología de Costa Rica* (ITCR, 2008), the *Ministerio de Ambiente, Energía, y Telecomunicaciones* (MINAET, 2010), and the *Instituto Meteorológico Nacional* (IMN, 2009). Data included land cover and use, soil type, topography, basin size, rainfall from 1955 to 1995, and water concession registrations for individuals and organizations.

3.4 Data Analysis. We analyzed qualitative interview responses in order to determine what individual actors do concerning water and why they do what they do

(Q.1). We used thematic content analysis uncovered a range of existing water-related responsibilities, the objectives of actors, their motives, their mandates, and their water-related activities for each of the four governance domains. Data on how organizations relate to each other in the regime were first coded by the research team, which resulted in three relation-types: (i) collaboration and coordination, (ii) resource transfers, and (iii) information and knowledge exchange (Q.2). The relation types are consistent with other network-based studies of regional water governance regimes (e.g., Stein et al., 2011) and were triangulated with qualitative interview responses. The research team verified the relevance of relation types for the governance regime with key stakeholders. We only counted mutual collaborative relations between actors. Meaning, for two actors to have a collaborative relation, both actors were required to acknowledge they collaborate or coordinate with each other.

Social network analysis software UCINet/Netdraw (Borgatti et al., 2002) was used to quantitatively reconstruct the social network of the governance regime based on how actors in the regime relate to each other (RQ2) (Bodin et al., 2011). Measures from social network analysis were also used to help determine key individual actors in the regime (Q.1). These actor-level measures are: (a) *degree centrality* (number of direct links), which indicates how directly involved an actor is with other actors; and (b) *betweenness centrality* (number of times an actor lies on the shortest path between two other actors), which indicates how central an actor is based on other actors needing to 'go through' them to reach others in the network.

To analyze how the governance network responds as water flows through the system (Q.2) and to analyze the impact of these responses on the regime's coordination

(Q.3), organizations were coded, based on the mapping exercise conducted in interviews, as belonging to one or more of the governance activity domains (supply, delivery, use, or outflow). We used 2-mode network analysis (Vance-Borland and Holley, 2011) to re-construct the actor network for each of the four governance activity domains (Figure 2.3). This enables us to examine both the whole governance network, and track how the governance network and sub-sets of actors respond as water flows through the system from supply to outflows. Five basic network-level measures were used in order to help gauge and track the relative degree of coordinated functioning within the water governance regime. Measures were calculated for the entire governance network and for each of the four governance domains, which include only the actors involved in that particular domain. The five network-level measures are: (i) *number of organizations* involved in the network and in each domain; (ii) *number of ties* that actors share with each other (actor activity indicator); (iii) *density*, the proportion of all possible ties between actors in the network (network activity indicator); (iv) *centralization*, the percent of the network that corresponds to perfect centralization (e.g., one actor in the middle, other actors only connected to this actor), which indicates the extent that the network is organized around central actors; (v) *cohesion*, the extent to which the network functions as a single unit (connections vs. fragmentation).

The final data analysis step was to estimate water stocks and flows in order to quantify, to the extent possible, a systems map (Figure 2.3) and to demonstrate where key uncertainties were present. We estimated water flows and stocks using ArcGIS and HEC-HMS. Estimations for water stocks and flows were assigned a reliability score of high (more than one reliable source including our own calculations), medium (one reliable

source but no way to confirm/ triangulate), or low (the source may not be as reliable and/or information is contradictory to other observations).

3.5 Participatory process. An ongoing participatory process occurred throughout this study (see Kuzdas et al., 2014 for post-study and assessment efforts). The purpose of the participatory processes was to ensure that the analysis and subsequent assessment was grounded in the real-time governing system and that the study could over time help fortify the ability and will of those involved to address the complex water challenges that they faced in the region (Meinzen-Dick, 2007). Participatory elements included several stakeholder-working groups, with the most prominent group being the *Comisión*. At the time (2010-2012), the *Comisión* was composed of representatives from *Ministerio de Ambiente, Energía y Telecomunicaciones* (MINAET), ASADAs, *Universidad Nacional de Costa Rica* (UNA), and with some involvement with the Municipality of Nicoya. During the study design phase, several local representatives vetted the interview protocol with researchers. This afforded stakeholders and researchers a platform to communicate and align expected results (i.e., the purpose of questions), the study's potential use in the broader context, and to help establish a longer-term collaborative process. Another effort of the participatory process was building the systems map (Figure 2.3). This helped ensure the map 'skeleton' resonated with interviewees (for the third section of interviews).

To expand participation in the study, we organized two afternoon workshops in Nicoya and Hojancha in November 2010. In addition to those already engaged with the study (mentioned in the previous paragraph), the twenty workshop participants also represented community associations, agricultural producers, *Instituto Costarricense de*

Acueductos y Alcantarillados (AyA), and, *Ministerio de Agricultura y Ganadería* (MAG). Workshop participants vetted the nearly finished systems map and focused on the reliability of initial estimations of the map components. Early results of the ongoing interviews were also discussed in an open, facilitated format. Many of those attending the workshop had already participated in interviews, which afforded individuals a preview of how information provided in interviews was being used and allowed input into the direction of the longer-term project.

4. Results

4.1 The governance network of the regional water system. The governance regime (Figure 2.3) with classified actors mapped onto the regional water system based on the governance activity domains, can be characterized as a combination of top-down institutional hierarchy with a fragmented administrative scheme that is vertically responsible to a degree, yet horizontally disparate. Communications, responsibilities, and mandates originate and are dictated in top-down fashion through institutional hierarchies, which are then implemented through a set of administrative units. These units are not horizontally integrated or collaborative with each other. Outside of these administrative units, which function as hubs of authority within the governance regime, participation and engagement of stakeholders and rural communities struggle to be effective.

Administrative units of the Ministerio de Ambiente, Energía, y Telecomunicaciones (MINAET) and the Instituto Costarricense de Acueductos y Alcantarillados (AyA) each hold a large degree of influence and power, which are exercised unevenly across governance activity domains (Figure 2.4, Table 2.2). Coordinated activity significantly changes from one governance domain to the next

(shown in Figure 2.4), as these two actors exchange central roles back and forth in governing processes as water moves through the system. High levels of coordination activity among governance actors are present in the water supply domain as indicated by the network measures of the water supply domain in Table 2.2. In comparison to governance of water supplies, the water delivery and outflows domains experience drastic decreases in coordinated activity levels and the number of organizations involved, as in indicated by the collaboration/ coordination network measures of the water delivery, use and outflows domains in Table 2.2 (and graphed for comparison across domains in Figure 2.4). MINAET and AyA do not execute water-related activities jointly or plan for water resources in conjunction with each other, which is a key missing linkage between hubs of authority in the regime. Without this linkage, the regime becomes increasingly disorganized as water flows through the system, as evidenced by disparate water-use education efforts conducted by different organizations.

Strong linkages between steering actors are likely required if regional water governance is to set course on a single direction toward meeting a set of goals or objectives. There is poor knowledge of groundwater resources: Table 2.3 shows little confidence in estimates of water storage for the Potrero-Caimtial aquifer, and there is not enough information to estimate storage of any groundwater reserves in the Nosara basin. Efforts that set out to formulate collective goals, which aim to secure the long-term integrity of the region's water resources, are inhibited by low levels of participation from rural community water administrators (ASADA) and large water-users. Little knowledge of the water needs of forestry activities – the areas most important economic driver – and

the water needs (or minimum acceptable flows) of hydro-ecosystems to provide key services, pose a challenge to negotiating water allocation.

In spite of the high degree of control over water resources held by national agencies, a key role driving governance collaboration in the regime is still played by non-state actors, such as the non-profit NicoyAgua and the Potrero Caimital Watershed Commission, which is especially evident in the water supply domain. Table 4 shows NicoyAgua has more collaborative and information sharing connections than any other actor in the water supply domain. Despite prevailing institutions that formally limit what locally created organizations can do in water governance, they still play key roles, such as effectively driving cooperation, in regional water governance that are unfilled by state actors.

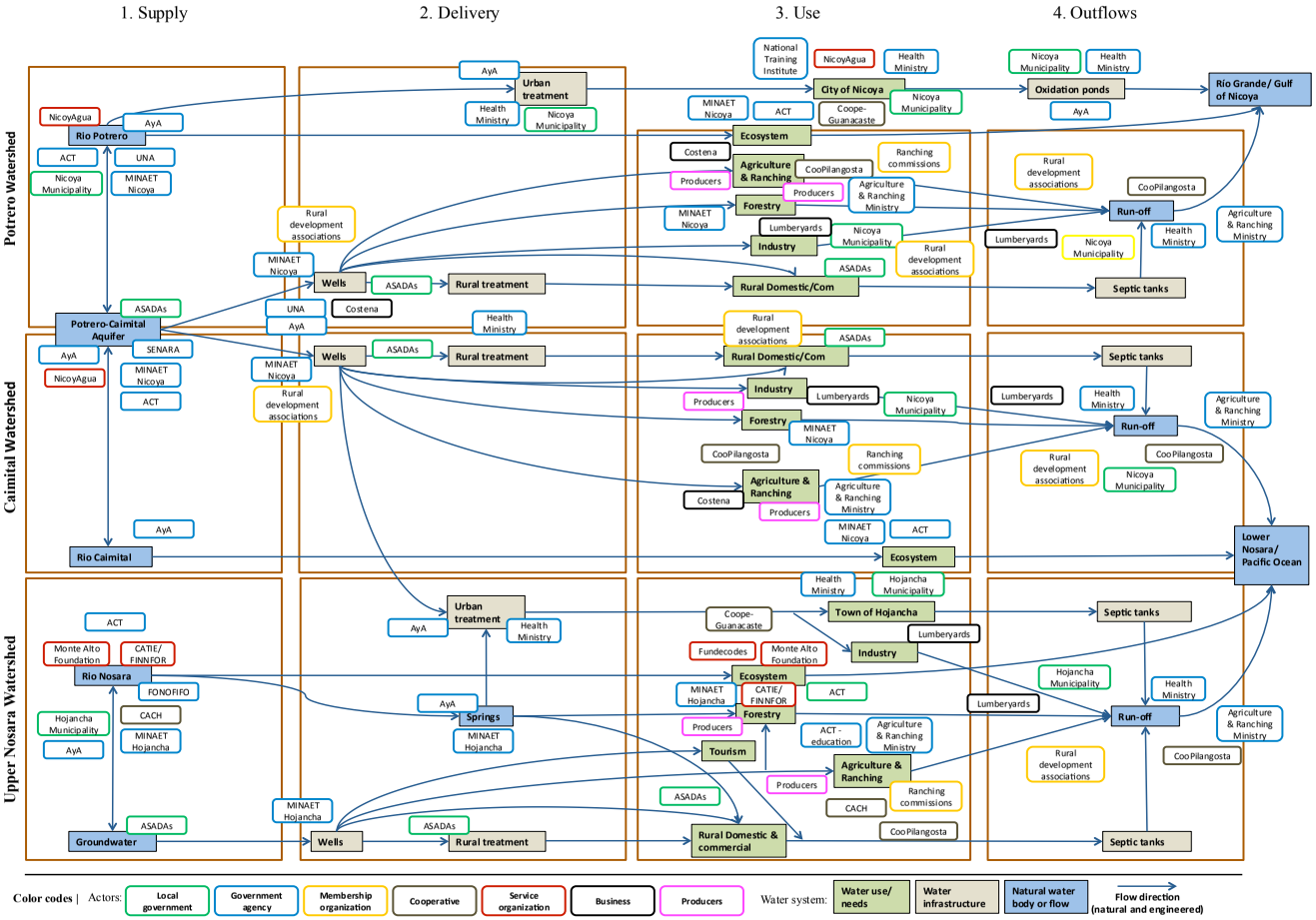

Figure 2.3 The water system and stakeholder map; classified stakeholders and physical water system components are overlaid onto the framework.

Table 2.2

Network Measures Based on the Three Relations Actors Share for the Whole Water System and for Each Domain of Water Governance. Measures in Bold and Grey Highlight are Graphed in Figure 2.4

	No. of organizations	Density	No. of ties	Centralization	Cohesion
Whole system	40				
Relation #1: Collaboration/ Coordinate		5%	84	19%	.16
Relation #2: Resource transfers		6%	100	40%	.19
Relation #3: Information exchange		18%	290	43%	.43
Domain 1: Supply	**17**				
Relation #1: Collaboration/ Coordinate		17%	**53**	**26%**	**.43**
Relation #2: Resource transfers		08%	26	27%	.16
Relation #3: Information exchange		33%	102	46%	.64
Domain 2: Delivery	**12**				
Relation #1: Collaboration/ Coordinate		7%	**9**	**12%**	**.08**
Relation #2: Resource transfers		7%	9	44%	.11
Relation #3: Information exchange		37%	49	58%	.65
Domain 3: Use	**29**				
Relation #1: Collaboration/ Coordinate		4%	**31**	**4%**	**.07**
Relation #2: Resource transfers		3%	23	3%	.04
Relation #3: Information exchange		12%	101	32%	.40

Domain 4: Outflows	**15**			
Relation #1: Collaboration/ Coordinate	3%	**6**	**21%**	**.04**
Relation #2: Resource transfers	8%	16	70%	.12
Relation #3: Information exchange	14%	29	48%	.21

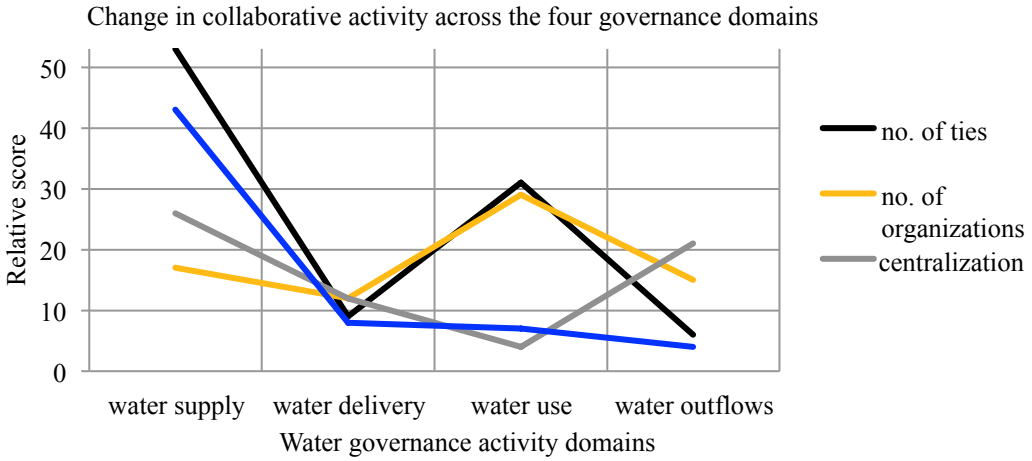

Figure 2.4 Scores for selected social network analysis measures using Relation #1: Collaboration and cooperation (y-axis) are compared across the four governance domains (x-axis). Scores are relative only to the scores of the other activity domains. Cohesion measures are converted to a 1-100 scale.

4.2. Water governance in the four activity domains. *4.2.1 Water supply.*

Ecosystem protection drives governance around water supplies, nearly always in the form of reforestation activities around rivers, springs, and recharge zones. Information regarding reforestation and resource protection is historically dictated by MINAET. The departments within MINAET are the most central actors in water supply governance processes, and record the highest betweenness centrality scores for information exchange and resource transfers with other organizations in the water supply domain of the governance regime (Table 2.4). MINAET is mandated to coordinate water related

activities across organizations; however how this plays out in regions is legally unspecified. Article 50 of Costa Rica's Constitution establishes the human right to a healthy environment. Fulfilling Article 50's mandate in watersheds falls onto branch offices of state agencies; so most water resources are held in trust and publically managed by the State. Yet institutional coordination between agencies is often ad hoc. Non-profits, such as NicoyAgua and the Monte Alto Foundation, have assumed a role that drives water supply related cooperation in the region. NicoyAgua possesses the most collaborative ties among actors present in the water supply domain (Table 2.4).

The most important water sources in the region, which supply water to the majority of the 30,000 people, are the PC aquifer and surface flows from the Río Potrero. The PC aquifer is shared by ASADA communities in Nicoya county, agricultural users, and the Town of Hojancha. Information on water stocks, flows, and quality is not widely shared or known. ASADAs who use the Potrero-Caimital (PC) aquifer do not share information or coordinate activities with each other or with private agricultural businesses that also share the PC aquifer. Water is transported to the Town of Hojanhca, which relies entirely on the PC aquifer during the dry season when the Upper Nosara runs mostly dry (as indicated by our estimates of Río Nosara surface flows in the dry season in Table 2.3). AyA is responsible to maintain supplies and monitor flows to Hojancha, but information on flow quantities are not conveyed with ASADAs or private businesses that also use the PC aquifer. There has never been a study of groundwater sources in the Upper Nosara. The City of Nicoya (pop. 20,000+/-) receives its entire water supply from the Río Potrero. Users in the region that rely on surface flows are very susceptible to water shortages if climate variability increases of if dry seasons are prolonged. Our

estimations indicate that dry season flows in rivers fluctuate near zero levels as indicated in Table 3. Although the aquifer is speculated to be one of the better groundwater sources in the region, with current information it is not yet possible to quantify recharge rates or how much water can safely be withdrawn from the aquifer.

Table 2.3

Estimations of Water Supplies Using Best Available Information (Government Data, Reports, and Our Calculations in GIS and HEC-HMS). Knowledge Gaps are Indicated by N/AoOr Low Reliability Ratings.

Supply source	Dry season stock/ flow	Wet season stock/ flow	Units	Source	Reliability
Río Potrero	0-10	60-90	m^3/s	HEC-HMS	Medium
Río Caimital	0-10	60-90	m^3/s	HEC-HMS	Medium
Potrero-Caimital Aquifer	16 x 20	25 x 20	km^2 x m (extent)	Agudelo (2008)	Medium
Upper Río Nosara	0-5	30-50	m^3/s	HEC-HMS, CORENA (1986)	High
Nosara groundwater	N/A	N/A	–	–	–

Supply transfer	Stock	Units	Source	Reliability
Rio Potrero to Nicoya City	2,522,880	m³/year (max)	MINAET, (2010); AyA	High
Potrero-Caimital Aquifer to Hojanhca	157,680 +	m³/year	MINAET, (2010)	Medium

Table 2.4

Selected Actors in Water Supply and Their Individual Degree Centrality and Betweenness Centrality Scores for Each Network Relation. Bold Highlights Indicate Highest Scores Among All Actors Involved Iin Water Supplies.

	Degree centrality			**Betweenness centrality**		
Relation	Collaborate/ coordinate	Info exchange	Recourse transfer	Collaborate/ coordinate	Info exchange	Recourse Transfer
Actors						
MINAET - Nicoya	5	20	4	12	**14**	**32**
MINAET – Hoja.	5	30	**6**	27	9	8
ACT	**7**	41	4	10	11	18
NicoyAgua	**7**	**63**	1	0	8	3

Monte Alto	3	0	3	**35**	5	1

4.2.2 Water delivery. In the water delivery domain, the number of organizations involved in governance decreases by nearly a third and the number of ties that organizations hold with other organizations in the domain decreases by about 85% when compared to the water supply domain. The involvement of non-state actors, in comparison to the water supply domain, diminishes. All actors holding key positions in Table 2.6 are government actors. Consequently coordination decreases, and the regime shifts toward a higher degree of central control over resources and information that is mostly held by AyA (Table 2.2 in the results section shows the increase in the governance network's centralization scores in the water delivery domain). AyA is legally mandated to manage all public water infrastructure. AyA constructs and maintains water distribution networks, treatment facilities, and delivery networks that bring potable water to larger population centers like the City of Nicoya and Hojancha. Cohesion measures of cooperative activity significantly drop in the water delivery domain in comparison to water supply, as illustrated in Figure 2.4, which indicate higher degrees of fragmentation at this stage of governance. This drop in cohesion is due to autonomous and disconnected ASADAs that fulfill AyA's mandate in rural communities. ASADAs treat water being delivered to the same standards as AyA, and are subject to quality monitoring by the Health Ministry. The quality of local leadership within ASADAs varies greatly. Some ASADAs regularly monitor how much water moves through their distribution networks, while others do not. The dual nature of water governance in water delivery – high

fragmentation coupled with a single actor (AyA) holding a majority of power – is common in Guanacaste.

Outside of surface flows from the Río Potrero delivered to the City of Nicoya, a majority of the water is pumped from groundwater. Most information on water quantities flowing through distribution networks is not highly reliable, as indicated in Table 2.5. Local governance efforts to organize and use estimated delivery information for management and planning are challenged in two ways. First, applications for private water concessions and monitoring of all private and public water concessions is managed by MINAET. MINAET does not relay or coordinate this information with AyA, who is responsible for day-to-day operation and maintenance of delivery networks. Thus how much water is delivered and where may significantly differ than how much water is permitted to go where. This also presents a challenge for AyA water managers to sufficiently track how much water private landowners, who obtain water concessions from shared sources, are utilizing in water systems that provide public water. Second, the fragmented nature ASADA integration in governing processes inhibits collective information sharing of how much water ASADA delivery networks are providing to rural communities. Uncertainty within the water delivery domain appears to be increased, or at least left unresolved, by governing processes that are unable to organize and share critical information among relevant units in a way that facilitates knowledge accumulation and proactive decision-making.

Table 2.5

Estimations of Water Deliveries Using Best Available Information (Government Data, Reports, and Our Calculations in GIS And HEC-HMS). Knowledge Gaps are Indicated by N/A or Low Reliability Ratings.

Delivery	Delivered quantity	Units	Source	Reliability
Potrero wells	1,466,666	m³/year	GIS	Medium
Potrero surface	2,572,392	m³/year (max)	GIS, AyA	High
Caimital wells	1,072,479	m³/year	GIS, Agudelo (2008)	High
Caimital surface	0	m³/year	GIS	Medium
Upper Nosara wells	489,754	m³/year	GIS	Medium
Upper Nosara surface	220,752	m³/year	GIS	Medium
Upper Nosara springs	82,624	m³/year	GIS	Medium
Nicoya City treatment	2,522,880	m³/year (max)	GIS, AyA	High
Potrero rural treatment	N/A	-	-	-
Caimital rural treatment	-	-	-	-
Hojanhca treatment	157,680	m³/year	MINAET	Low
Hojanhca rural treatment	N/A	-	-	-

Table 2.6

Selected Actors in Water Delivery and Their Individual Degree Centrality and Betweenness Centrality Scores for Each Network Relation. Bold Highlights Indicate Highest Scores Among All Actors Involved in Water Delivery.

	Degree centrality			**Betweenness centrality**		
Relation	Collaborate/ coordinate	Info exchange	Recourse transfer	Collaborate/ coordinate	Info exchange	Recourse Transfer
Actors						
AyA	1	0	**5**	**10**	**11**	**14**
MINAET/Nicoya	1	0	1	0	9	6
Health Ministry	1	0	1	0	9	7
ASADA 1	**2**	**2**	1	0	7	3

4.2.3 Water Use. In the water use domain the regime shifts back toward MINAET's sphere of influence. MINAET offices hold all the highest individual actors scores in the water use domain as indicated in Table 7. MINAET is legally mandated to permit, monitor, and enforce resource-use planning and policies. The number of organizations and the number of ties between organizations operating in the water use domain increase in comparison to the water deliveries domain (as indicated in Figure 2.4). Information exchange levels increase back up to levels reached in the water supply

domain, however the number of cooperative ties between organizations reach only half the levels of those found in water supplies as shown in Table 2.3. Despite increasing cooperation in comparison to the water delivery domain, the degree of fragmentation in the regime stays consistent. Large agricultural businesses, such as Costeña, hold rights to nearly two-thirds of the permitted groundwater from the Potrero-Caimital (PC) Aquifer, yet are disconnected from central decision-making actors (MINAET, AyA) and ASADA communities that share the same groundwater source.

Many residents in the region are involved in a mix of forestry, agriculture, and ranching to support themselves and their families. Along gradients, which characterize a majority of the geography, managing pastures for raising cattle in combination with growing hardwood trees (primarily teak) is common. Agencies, extension offices, and educational organizations practice consistent community engagement efforts targeting a variety of water-using activities. The engagement efforts focus on water-use education programs, producer training, and water management training programs. However, without established goals within the regime, education efforts remain uncoordinated with each other and strive for varying and sometimes contradictory objectives. Two primary sources of uncertainty that inhibit setting and meting water-use goals through education programming are (1) the virtual unknown water needs of local ecosystems or minimum flow requirements (indicated by many low reliability scores and water system components that cannot be quantified in Table 2.7), and (2) the unknown collective water needs of forestry activities (that also cannot be quantified as indicated in Table 2.9), which is the area's most important economic activity. This uncertainty poses a challenge

for negotiating new development projects and objectively evaluating water-use trade-offs in decision making and planning.

Table 2.7

Estimations of Water Use Using Best Available Information (Government Data, Reports, And Our Calculations In GIS And HEC-HMS). Knowledge Gaps Are Indicated by N/A or Low Reliability Ratings. Demand Categories Are Based on the Standard Water-Use Categories Used by MINAET.

Use	Quantity	Units	Source	Reliability
City of Nicoya	2,522,880	m^3/year	MINAET (2010)	Medium
Río Potrero				
AG & ranching	1,346,829	m^3/year	MINAET (2010)	Low
Forestry	N/A	-	-	-
Ecosystem	N/A	-	-	-
Industry	2,208	m^3/year	MINAET (2010)	Low
Rural domestic/comm.	162,410	m^3/year	MINAET (2010)	Low
Caimital				
AG & ranching	730,944	m^3/year	MINAET (2010)	Low
Forestry	N/A	-	-	-
Ecosystem	N/A	-	-	-
Rural domestic/comm.	183,855	m^3/year	MINAET (2010)	Low
Upper Nosara				
Town of Hojancha	157,680	m^3/year	MINAET (2010)	Medium
AG & ranching	13,560	m^3/year	MINAET (2010)	Low

Forestry	N/A	-	-	-
Ecosystem	N/A	-	-	-
Tourism	15,768	m³/year	MINAET (2010)	Medium
Rural domestic/comm.	763,802	m³/year	MINAET (2010)	Low

Table 2.8

Selected Actors in Water Use And Their Individual Degree Centrality and Betweenness Centrality Scores for Each Network Relation. Bold Highlights Indicate Highest Scores Among All Actors Involved in Water Use.

	Degree centrality			**Betweenness centrality**		
Relation	Collaborate/ coordinate	Info exchange	Recourse transfer	Collaborate/ coordinate	Info exchange	Recourse Transfer
Actors						
MINAET/Nicoya	4	**5**	**16**	9	**39**	**126**
MINAET/Hoja.	**5**	4	11	**15**	26	50
ACT/Education Division	2	2	7	0	0	15
MAG	4	3	6	13	19	7
Nat. Training Inst.	0	2	9	0	24	19
Costeña S.A.	0	0	2	0	0	0

4.2.4 Water Outflows. In the water outflow domain water governance shifts again toward a more centralized governing mode with under half of the actors involved in water use being involved in water outflows (indicated the organizations involved column of Table 2.2). AyA largely controls the governance regime in the water outflow domain, as indicated by its high centrality scores in Table 2.9. Compared to other domains, the lowest levels of cooperation, and activity in general, in the regime are present in the water outflows (as indicated in Figure 2.4). Incentive-based governance of outflows is often the norm in the region. AyA manages the *Bandera Azul* Program which awards communities that voluntarily clean up waterways and improve water quality with a public designation. Accountability and transparency in terms of follow up, monitoring, and compliance are often cited by citizens as major challenges for governing water outflows. Who should fill monitoring and enforcement roles in the outflows domain remain vague. MINAET is often considered responsible by small producers. However, in practice MINAET concentrates its resources in the other governance domains (i.e., supply, delivery, and use). Disputes regarding contamination, though, may go through MINAET at a national level or through citizen action groups that take legal action on behalf of local communities.

The City of Nicoya is the only population center in or near the sub-basins with centrally managed wastewater treatment facilities. Wastewater flows to oxidation ponds where it is treated and released into the Río Morote, which then flows into the Gulf of Nicoya near the mouth of the Rio Tempisque. AyA administers wastewater treatment in

the oxidation ponds. Estimates on post-use flows in the region are not available at this time.

Table 2.9

Selected Actors in Water Outflows and Their Individual Degree Centrality and Betweenness Centrality Scores for Each Network Relation. Bold Highlights Indicate Highest Scores Among All Actors Involved in Water Outflows.

	Degree centrality			**Betweenness centrality**		
Relation	Collaborate/ coordinate	Info exchange	Recourse transfer	Collaborate/ coordinate	Info exchange	Recourse Transfer
Actors						
AyA	**3**	**3**	**10**	**44**	7	16
Health Ministry	1	0	1	0	7	16
Nicoya Municipality	1	0	2	0	**9**	**55**

5. Discussion

5.1 Regional water governance in Guanacaste. The study shows that regional water governance in Guanacaste is an uneven, asymmetrical process that is difficult to fit into singular characterizations. Key actors, such as MINAET and AyA, each hold a large degree of power and influence, which is exercised irregularly across the activity domains (RQ.1). How the regime functions, especially how actors in the regime coordinate what they do with water, shifts as AyA and MINAET exchange central roles in the governing

process. MINAET and AyA do not execute water-related policy-making, planning, or management jointly with each other (RQ.2). This gap is a key void in the regime. The regime becomes disorganized as water flows through the system (from the water supply domain to water outflows), as evidenced by disparate water-use education efforts by different organizations (RQ.3). We find that strong linkages between steering actors that are prominent in each activity domain are likely required if regional water governance is to set course toward developing a set of goals and instituting processes to meet those goals over time.

In spite of the high degree of consolidated control over water resources held by national agencies, a surprising role is still played by the locally run non-profit NicoyAgua (RQ.1). Despite prevailing institutions that formally limit what locally created organizations can do in water governance, organizations like NicoyAgua can still have a profound impact on regional water governance. As a result of NicoyAgua's role driving collaboration in the water supply domain (where NicoyAgua operates) (RQ.2), governance in water supply is significantly more collaborative and more active than the three domains where NicoyAgua does not operate (delivery, use, and outflow) (RQ.3).

The study confirms the current governance regime will need to undergo substantive change if vulnerabilities to extended dry periods and potential water conflicts are to be mitigated. The consequences of the missing links between AyA and MINAET for the regime become increasingly apparent as water moves through the system. In the water delivery domain, these missing links drive uncertainty regarding quantities of water moving through distribution networks. In the water use domain, this uncertainty is compounded. Virtually no knowledge of the water needs of forestry activities – the areas

most important economic driver – and the water needs (or minimum acceptable flows) of hydro-ecosystems to provide key services, pose a key challenge to negotiating an agreed-upon balance between conservation and development. Without this knowledge, it may be difficult for managers, decision-makers, and planners to navigate climate change impacts and avoid detrimental conflicts.

The study suggests two initial intervention points may begin to spur substantive change within the regime. The first is to remedy the missing (collaborative) link between regional offices of AyA and MINAET. Non-state actors, such as NicoyAgua, might be in a role to effectively drive coordination between these two prominent actors. This is a promising first step that could give guidance toward sharing and organizing information that can be used to set collective objectives and better steer the regime jointly toward those objectives. This effort may even eliminate some degree of uncertainty to aid local managers. The second is to take initial steps in securing the highest protection levels possible for the area's groundwater reserves. Nearly everyone in the area relies directly on groundwater or indirectly on groundwater (through surface flows fed by groundwater). Yet, communities and large agricultural users who share the same groundwater reserves do not coordinate groundwater extractions. When these factors are combined with high uncertainty of how much groundwater can be safely withdrawn, the regime may be at risk.

5.2 Water governance in climate change threatened regions. The governance regime in Guanacaste can be described as a combination of top-down institutional hierarchy with a fragmented administrative scheme that is vertically responsible, yet horizontally disparate. Administrative units struggle to communicate and coordinate

within a given (horizontal) scale. This hybrid type of governance regime can be considered as generally characteristic of governance regimes in regions with recent histories of centralized resource management (thus remaining hierarchal structures) and that have recently experienced rapid population growth and economic or political change (thus facilitating a number of disconnected administrative units) (Booth et al., 2010; Ribot, 2011). Based on the Guanacaste case, we expect such types of water governance regimes to exhibit at least two significant barriers to sustainable water governance (RQ.4).

The design of such hybrid water governance regimes appears to generate, or at least exacerbate, uncertainty within the governance regime. The uncertainty generated by such designs includes aspects such as how much water is needed by communities, by economic actors, and by ecosystems; and how much water is moving through water distribution infrastructure. This lack of shared knowledge and learning can impede the successful (re-) allocation of water resources to secure community health, economic productivity, and ecosystem integrity (Huntjens et al., 2012; Wiek & Larson, 2012). Consequently, the ability of such hybrid governance regimes to identify parts of regional water systems that are at high risk of climate change threats is limited. Developing strategies for more sustainable water governance in this design context will be a challenge.

Hybrid governance regimes also appear to be prohibitive of establishing processes that negotiate and set shared goals for sustainable water governance. Rather, goals and objectives of water governance are likely to originate in top-down fashion through institutional hierarchies, which are then implemented by disparate administrative units at

local and regional scales. In this case, community and regional-level constituencies are likely unable to share their experiences and knowledge to inform the pursuit of such goals. This situation inhibits the ability of the governance regime to monitor, adjust, and respond to constituencies to meet their needs (Ostrom, 2007; Schlüter et al., 2010).

In both cases, we expect a polycentric governance system with effective stakeholder participation (Pahl-Wostl & Kranz, 2010) to be more effective at dealing with climate threats. Stakeholder participation would require effective horizontal integration at both community and regional scales, which would facilitate shared learning and knowledge accumulation that would help reduce the uncertainty generated by hybrid governance designs (Huitema et al., 2009). The Guanacaste case presents a hybrid hierarchical-fragmented governance regime, which would appear to be inferior to polycentric governance in climate change contexts. The Guanacaste case, however, affords the opportunity to clarify two additional aspects of the polycentric governance system hypothesis that appear especially critical for high competition, high scarcity, and existing conflict contexts (RQ.4).

First, the study suggests that coordination consisting of *mutual accountability* between hubs of authority within water governance regimes is important for achieving sustainability in the face of climate change threats in such contexts. In high resource competition contexts such as Guanacaste, powerful actors may already be maneuvering into positions where they can benefit in spite of climate change hazards, while others may be at disproportionate risks (Fabricus et al., 2006). The study shows how uncoordinated exercise of authority, coming from two primary hubs of powerful actors, impacts the

water governance regime. Such hubs of authority will need to coordinate effectively, but also be mutually accountable to help ensure fair and equitable adaptation and development processes and outcomes.

Second, the study suggests that *active institutional leadership* is another critical success factor of sustainable water governance in high-risk regions such as Guanacaste. Leaders, even non-state leaders such as NicoyAgua in the Guanacaste case, can help remedy many of the problems associated with inadequate or ineffective water governance designs. Many regimes are not able or equipped to adequately handle navigating climate change threats while maintaining community well being, environmental integrity, and economic vitality (Biermann et al., 2012). Such leaders not only support a 'management-as-learning' approach to water governance (Huntjens et al., 2012), but advocate and practice 'learning as doing'. If many environmental governance regimes are considered to be struggling or even failing in the face of challenges, then actions will need to be taken and leaders will need to take action. Current themes in the paradigm of adaptive water governance are structure, agency, and learning – we suggest, based on our analysis presented here, the research themes of leadership (where should we go?) and action (how do we go there?) to be critical for sustainable and adaptive water governance in climate change threatened regions that already experience scarcity and conflicts.

5.3 Insights for conducting relevant water governance analysis. The analysis presented here is part of a broader research effort searching for promising options within regional governance that might be changed. We discuss in the following a set of principles derived from this study that might guide the development and implementation of integrated water governance analysis in a way that (1) might best contribute

immediately to the practical needs of water resource managers and decision-makers, and (2) might best inform and prepare for solution-oriented endeavors.

The overarching principle that guides this reflection is how to best assimilate integrated water governance analysis into transformational sustainability research efforts that aim at generating solution options for water sustainability problems (Wiek et al., 2012). A great deal of existing literature discusses participatory research dealing with water resources; yet relatively few coherent guidelines are established for executing water governance analyses that are a part of a broader problem solving effort (Lang et al., 2012). Being part of an overarching problem solving endeavor, the present case study lends itself toward reflection on what aspects of executing the analysis facilitated assimilation within the broader effort and what aspects of the analysis could have been improved (RQ.5).

5.3.1. Frame governance study with key stakeholders. Framing the study with stakeholders at opportune moments can yield positive benefits. Critical moments suggested by this effort include: defining system boundaries and defining who participates in the study as subjects, as collaborators, or even as clients (i.e., who is going to use results). Raadgever et al. (2012) find that, while in many cases collaborative research dealing with complex water problems often does not live up to promises, very intensive collaboration under the right circumstances might produce benefits. Likewise we suggest intensive collaboration in key parts, such as framing, of analysis. Positive benefits of framing exercises can include increased and broadened ownership of analysis results and short knowledge diffusion times once results are communicated. Who participates in these exercises should be carefully considered, since power asymmetries,

which are present in many resource regimes, could skew or even derail such exercises (Voß & Bornemann, 2011).

Insights from the Guanacaste study: Key stakeholders were involved in defining components of the physical water system, determining who relevant stakeholders are, and designing some parts of data collection instruments. As a result, research findings were easily dispersed once the analysis was coupled with the ensuing assessment. The analysis process itself reinforced strong mutual trust between stakeholders and researchers. Trust was a significant success factor that led to the sustainability assessment, which is based on the analysis contained here, being directly incorporated into regional planning and policy changes shortly after researchers delivered results to the PCW Commission (Kuzdas et al., 2012).

5.3.2. Identify strategic output venues early in the process. Analyses that produces results which mesh easily with the most advantageous output venues have a much higher likelihood of generating outputs that lead to positive impacts. Desirable output venues should be negotiated early on in analysis planning procedures with key stakeholders and the broader research team to ensure realistic expectations are maintained (on the part of stakeholders) and that analysis results are salient and optimally packaged (on the part of researchers) (Stalwart et al., 2011). Outputs might be a policy memo, planning document, presentation, or simply a solid foundation for expanding collaborative research. Identifying such output venues should include key stakeholders (Krütli et al., 2010).

Insights from the Guanacaste study: Strategic output venues in the local water system were not identified in the planning stages of the analysis beyond the traditional

'report'. As a result, the sustainability assessment report that was delivered to the PCW Commission was not designed to directly sync or apply to any specific policies or procedures. Some prospects and opportunities to adjust regional policies and regulations may have been missed due to planning shortcomings on the part of the research team. The analysis framework proposed by Wiek & Larson (2012) did prove useful in terms of packaging results in a flexible way that could apply to several outputs, even though the research team did not originally plan for those outputs.

5.3.3 Adapt to leverage new opportunities during analysis. Executing analysis procedures in participatory settings is a learning process (Johnson, 2009). As knowledge of opportunities to better and broaden analysis become apparent, procedures should be flexible enough to make the most of the opportunity (Stringer et al., 2006). Opportunities may be events, the emergence of a local champion or leader, or new research alliances, which might require re-assigning research responsibilities or adjusting strategies used to execute analysis (Lang et al., 2012).

Insights from the Guanacaste study: The opportunity to execute analysis procedures in collaboration with the *Universidad Nacional* de Costa Rica (UNA) was important for building credibility, trust, and knowledge dispersion avenues. UNA holds a seat in the PCW Commission along with several other important organizations. The new alliance with UNA provided links to individual stakeholders the research team previously did not have access to and allowed for greater interview coverage (90%) of targeted actors in the system. The alliance with UNA was the most important factor that created a strong working relationship with the PCW Commission, which is a key policy advocate for water resources in the region. The PCW Commission has made several presentations

of the results from the sustainability assessment (Kuzdas et al., 2012) to government agencies, commissions, and local governments.

5.3.4. Aim for mutual understanding of analysis procedures and methods. Analysis procedures can be explicitly planed to produce, and help foster, mutual understanding between researchers and stakeholders. The analysis process is an opportunity to gain mutual understanding of the framework used, methods, or research procedures (Shaw et al., 2009). Without understanding how results were arrived at, there may be less imperative on behalf of stakeholders to trust those results. How much mutual understanding of what part of analysis is critical will vary between contexts.

Insights from the Guanacaste study: Results of the sustainability assessment, based on the analysis here, dispersed and were applied to regional institutions quickly due to the level of high mutual understanding between stakeholders and researchers. Mutual understanding was arrived by *doing* the analysis. By the end, key stakeholders understood the general methods of analysis, the goals of researchers, what to expect, and some took part in interactively creating system maps using the framework. The stakeholder mapping conducted in this project was considered to be the strongest element of the analysis by local managers, and in retrospect, was key for building quality working relationships.

5.3.5. Position analysis within broader problem-solving endeavors. Analysis is one tool available for complex problem solving endeavors. Problem solving endeavors might be local policy or program innovation processes or a solution-oriented research program. A key function of analysis in problem solving endeavors for water resources should be to act as a foundation that organizes and orients new information as it becomes available (Wiek & Larson, 2012). New information might include knowledge of how

well a water governance regime operates now or knowledge of where the regime might be headed in the future.

Insights from the Guanacaste study: The sustainability assessment, built on the analysis, which generated new normative knowledge for the region in addition to the new analytical knowledge of the water system generated in the governance analysis presented here. However, it is not yet clear if the framework and analysis will be or can be used as a foundation for increasing knowledge of regional ecosystem flows over time in the region which is critically needed. Although stakeholders reported that the analysis carried out here was the first to coherently synthesize the information it did, it will be a major challenge to continue using the framework as a means to structure new information. In public agencies dealing with path dependency and funding and personnel cuts, there is likely a low probability such frameworks will be coherently used over the long-term. Enduring leadership, long-term partnerships, and funds to operationally support such efforts are needed to overcome this challenge. However, a valuable snapshot of the system was achieved.

5.3.6. Identify and enhance leaders at the science-policy interface. In many natural resource management contexts, the space between scientific analysis and real-time planning or policy-making is already occupied by existing organizations, committees, or individuals (Young, 2008). These boundary objects, leaders, or policy entrepreneurs likely hold significant ability to translate and apply analysis results to the local system and even potentially inform next research steps (Talwar et al., 2011).

Insights from the Guanacaste study: The PCW Commission was identified and targeted as an important regional leader by researchers early on. Individual members on

the commission are often involved in both water-related scientific efforts and policy-making. The research team maneuvered into a 'partner-client' relationship with the commission and wrote the assessment results report specifically for the PCW Commission. It is not yet apparent whether the report enhanced the capacity of the Commission. However, the PCW Commission did advocate for policy changes as a result of the results document delivered by researchers, it reports that the document is often consulted with before meetings and decision-making, and it has mad several results presentations in the region.

6. Conclusions

Regional water governance operates unevenly in context-unique stakeholder landscapes, which this study captured in three rural watersheds in Guanacaste, Costa Rica using an activities-oriented water governance framework that mimics regional water systems. A large degree of authority lies within a sub-set of actors in Guanacaste. This creates problems as this set of agencies and offices struggle to coordinate their activities with each other in a way that enables collective goal setting, learning to deal with uncertainty, and implementing strategies to confront change. The general design of water governance in Guanacaste – similar to other regions with histories of central resource management and rapid population growth, economic change, or political change – consists of an institutional hierarchy combined with administrative fragmentation. This design appears to drive, or, at least, perpetuate uncertainty in regional water systems. This design also prevents or, at least, hinders governance regimes to steer collectively away from threats and toward sustainable futures. Our findings generally support the working hypothesis that polycentric governance systems with effective stakeholder

participation will be more successful at dealing with climate change threats and working toward sustainable states, rather than hierarchal or fragmented designs. However, the Guanacaste case also illustrates the importance of focusing on mutual accountability and active institutional leadership when dealing with sustainable water governance in climate change threatened regions that already experience water scarcity and conflicts.

In many parts of Guanacaste, agriculture, tourism, and real estate development are economic domains that compete for water resources. Advances in water governance, beyond the current state, will need to address this challenge. This study offers optimism that new community organizations, such as NicoyAgua and the PCW Commission, are increasingly prepared and willing to assume water governance responsibilities and fill existing gaps within governance regimes. Technical, personnel, and financial support for such organizations will be critical moving forward. Problem solving, like regional water governance itself, will be an uneven process. Our case demonstrates that with the right analysis approach, this problem solving process can be aided and even accelerated by solution-oriented water governance analyses that are explicitly designed to inform solution development and implementation efforts.

Chapter 3

Sustainability appraisal of water governance regimes – The case of Guanacaste, Costa Rica

1. Introduction

Water governance is a set of collective actions that aim toward a common goal and are coordinated among diverse stakeholder groups (Lubell et al., 2008). Sustainable water governance coordinates the supply, delivery, use, and outflows of water in a way that ensures sufficient and equitable levels of socio-economic welfare without compromising the long-term integrity of supporting ecosystems (Rogers & Hall, 2003; Langsdale et al., 2009; Wiek & Larson, 2012). Sustainable water governance should also adequately address water demand management and conservation (Brooks and Holtz, 2009). In many cases, stakeholder groups struggle to establish sustainable resource governance (Galaz et al., 2012). On the contrary, many existing governance regimes drive social-ecological systems toward points beyond which environmental or societal damage may very difficult to correct (Rockström et al., 2009). Research suggests that this is in part due to inadequate governance. Inadequate governance struggles to address conflicting needs, desires, and values of relevant stakeholders; to reconcile different political and administrative structures, with each other and with ecosystem boundaries; to simplify and enforce rules and regulations; and to employ participatory modes of resource planning and decision-making (Pahl-Wostl et al., 2012). Efforts to re-design water governance regimes are needed in order to avoid systems failures (Young et al., 2008; Biermann et al., 2012). To aid these efforts, criteria-based and participatory appraisals are needed that determine how sustainable water governance regimes operate

(Wiek et al., 2007). Such appraisals should help to clarify what features of water governance regimes deter or foster sustainability of water systems (i.e., through positive and mutually supporting sustainability effects); and in doing so, help to better align water governance research with the professional needs of decision-makers to aid problem-solving efforts (Bakker ,2012).

Considering the profound insights on resource governance through comparison of comprehensive case studies (Ostrom, 2009), there is a need for similarly comprehensive and comparable case studies on the sustainability of water governance regimes. This is especially relevant for understudied regions where climate change threats are imminent, where water conflicts occur, and where impacts from water scarcity are being felt (Pahl-Wostl & Kranz, 2010). Few studies address the sustainability of water governance regimes from a comprehensive and actor-oriented perspective (e.g., Wiek & Larson, 2012; Larson et al., 2013). Even fewer studies include such high-risk regions where there is an urgent need for water governance research that yields actionable results. In this paper, we pursue three objectives:

(1) To provide a sustainability appraisal of the water governance regime in Guanacaste, a region that experiences water conflict and scarcity and is threatened by climate change
(2) To determine the general features of governance regimes that are critical for water sustainability in regions across Pacific Mesoamerica.
(3) To reflect on potential impacts resulting from the appraisal in Guanacaste and draw conclusions for future water governance and sustainability research efforts.

1.1 Case Study Background - Guanacaste Province. Guanacaste is one of the most important agricultural regions in Costa Rica and one the more lucrative tourism markets in Central America. Agriculture and tourism are prominent economic drivers in the dry tropics of Central America. Both have expanded significantly in the last 20 years, and they continue to do so (MINAET, 2008; Booth et al., 2010). Guanacaste is a seasonally dry, predominantly rural region where virtually no rain falls half the year. Water is and will likely be much more scarce in the near future. Climate models predict the region will experience drier conditions as soon as the 2020s (Anderson et al., 2008). Water governance is challenged to provide a just and fair distribution of water to communities and economic actors, to maintain the integrity of supporting ecosystems, and to mitigate water conflicts. It has thus far struggled to meet these challenges. Cover (2007) documented at least 65 water conflicts in Guanacaste over a recent ten-year period.

During the early years of Costa Rican statehood (e.g., 1950s-1970s), the public sector substantially increased in order to meet citizen needs (Edelman, 1999, p70). During this time, many public organizations important for water management were formed such as the Environment, Energy, and Telecommunications Ministry (*Ministerio de Ambiente, Energía, y Telecomunicaciones*, MINAET), which oversees water management and conservation activities in the country. Growing populations in rural areas tested the ability of the national water utility - the Costa Rican Institute of Pipes and Sewers (*Instituto Costarricense de Acueductos y Alcantarillados*, AyA) - to meet its responsibility to deliver potable water to citizens. As a result, communities increasingly organized in the water sector, with an estimated 1,500+ rural community-run water

associations (ASADAs) now operating (Madrigal et al., 2011). ASADAs perform AyA's duties in rural areas, but are governed autonomously by community boards. Two primary pieces of legislation provide the substance current water management frameworks. Article 50 of the Constitution guarantees healthy and clean environments for citizens. The 1942 Water Law prohibits private ownership of water resources. Accordingly, the authority to govern water in Costa Rica has largely remained with state agencies that have actually expanded their administration through branch offices around the country (Rogers, 2002).

In Guanacaste, the growing public sector combined with increasing numbers of ASADAs has helped water governance become increasingly fragmented. There are variable technical, financial, administrative, and logistical capacities among actors (i.e., agency offices and ASADAs) in different places, and water-related regulations (many of which go back several decades) often do not clearly specify who is responsible to do what with water (Rogers, 2002). Yet, many individuals from a variety of organizations are active in in the water sector. Some of these individuals are collectively organized, such as the Commission for the Management of the Potrero-Caimital Watersheds (*Comisión para el Manejo de las Cuencas Potrero-Caimital*, PC Commission) in Nicoya. The PC Commission, despite having limited formal authority, aims to improve water management and conservation in the region. Like similar organizations in the region, their efforts are challenged due to, at least in part, little being systematically known about problems, potential opportunities to expand on, and where both exist in the regional water system. Thus, a water governance appraisal that elaborates criteria, helps clarify the water governance regime features that deter or that potentially could help expand the

sustainability of the water system, and that identifies where in the system those problems and opportunities exist (and who is implicated), could be a useful endeavor that we explore in this paper.

In this study, we focus on three connected sub-basins on the Nicoya Peninsula in Guanacaste: the Río Potrero, Río Caimital, and Upper Río Nosara in Nicoya and Hojancha Municipalities. The Upper Río Nosara and Río Caimital flow west to the Pacific coast. The Potrero-Caimital Aquifer is located on the alluvial plain beneath the Caimital and Potrero. During the dry season, groundwater from the Potrero-Caimital Aquifer is transported to the Town of Hojancha. The semi-urban City of Nicoya receives its entire water supply from Río Potrero surface flows. The largest agricultural producer in the region lies over a large part of the Potrero-Caimital Aquifer, upstream from where the City of Nicoya extracts surface water. About 30,000 people live in the area; most reside in the City of Nicoya (INEC, 2011). The Guanacaste case presented here affords an opportunity to appraise a water governance regime that shares many features and contexts with regions across the Central American dry tropics such as high uncertainty, complexity, and potential conflicts under changing climate conditions (Rogers, 2002; Biswas et al., 2009), which contributes to the sustainable water governance literature and supports governance efforts in arid tropical regions that experience water scarcity, conflicts, and climate change threats.

2. Framework for analyzing and appraising regional water governance regimes

A broad notion of 'who is involved' distinguishes governance from government or management, which imply limited sets of actors such as government agencies or utilities. Governance includes all people affecting and affected by the water system as

potential actors who might coordinate their activities toward collective goals (Ludwig, 2001; Ostrom, 2007). Actors include diverse sets of state, private, and civil players who are "doing things" with water, including governing water, and who hold some degree of power, rights, or resources (Rhodes, 1996; Kemp et al. 2005). This *doing* that is coordinated across groups of actors towards common or collective goals (e.g., governance) steers or guides water systems (Lubell et al., 2008). Sustainability appraisals, in a water governance context, evaluate how well governance regimes steer water systems towards a sustainability direction. This 'direction', based on the definition we use for sustainable water governance from Wiek and Larson (2012), should generally ensure '...a sufficient and equitable level of social and economic well-being without compromising the viability and integrity of the supporting hydro-ecosystems in the long term.'

In this study, we use an actor-oriented approach for analyzing and appraising regional water governance regimes proposed by Wiek & Larson (2012). The approach is composed of an analytical and a normative component. The analytical part of the approach is similar to the Institutional Analysis and Development (IAD) framework developed by Elinor Ostrom and collaborators (Ostrom (2011) offers a recent review) and the regime analysis framework proposed by Holtz et al. (2008). Both frameworks have been applied to water systems (e.g., Imperial, 1999; Pahl-Wostl et al., 2010). Wiek & Larson (2012) take components from those frameworks, such as institutions (rules, rights, and decision-making processes) and a focus on social actors and their activities, and structure those components in a way that mimics regional water systems. The purpose is to better synchronize the approach with the day-to-day operations of governance actors.

According to a simplified version of this approach, the water governance regime is structured into four activity domains:

5. *Water Supply:* the physical water sources that support, maintain, and protect. In Guanacaste this includes rivers, springs, and groundwater. Also included are the social arrangements, including water rights, which govern water sources.
6. *Water Delivery:* the distribution of water through infrastructure, like wells, aqueducts, treatment facilities, and post-treatment storage tanks.
7. *Water Use:* consuming and conserving water by organizations and individuals, including residential, commercial, industry, and agriculture.
8. *Water Outflows:* includes discharging wastewater and other post water-use sanitation related activities and governing institutions. In Guanacaste this includes septic tanks, oxidation ponds, and run-off that flows back into the watershed or water table.

Each of the activity domains contains three inter-linked components:

Actors, activities, & institutions. This component includes all relevant social actors and their networks, norms, and values; and outlines what they do with water, how they interact with each other, what their mandates or intentions are, what rules govern their actions and interactions, and what decision-making processes are in play.

Interface with the Natural Environment (hydro-ecology). Water activities rely on and impact the natural environment, including the four basic spheres of earth systems: the hydrosphere (water and precipitation), the lithosphere (land and soils), the biosphere (plants and wildlife), and the atmosphere (air and linked climatological processes). This interface captures various geological, hydrological, ecological, and other natural attributes and processes.

Interface with the Built or Engineered Environment (Infrastructure). Water activities require and involve as well as build upon and alter man-made infrastructure and facilities. We capture, among others, extraction and retention facilities linked to water supplies (e.g., dams and reservoirs); the physical system for water deliveries, along with the biological or mechanical systems (e.g., wetlands or treatment plants) for cleaning water for various purposes; infrastructure that determines various usages and rates of consumption (e.g., irrigation systems); recharge basins or other structures for managing outflows from the system or recycling wastewater for direct reuse.

The second part of the approach suggests a set of normative sustainability criteria for appraising the analyzed governance regime, which we focus on here. A range of literature details criteria for good resource governance (Ostrom 1990, Ostrom, 1992; Folke et al. 2005; Lockwood 2010) and water governance in particular (Rogers & Hall 2003; Alley & Leake 2004; Pahl-Wostl, 2008; Grigg, 2010). Criteria based on this literature were synthesized and vetted with stakeholders in this case and others (see Wiek & Larson (2012). These criteria overlap across parts of the water system. Accordingly, criteria interact with each other, which can produce either positive or negative cumulative effects on sustainability (Gibson, 2006; Larson et al., 2013). Criteria are categorized according to Gibson's (2006) set of sustainability criteria and linked to the framework's activity domains in Table 3.1.

Table 3.1

Principles and Criteria for Appraising the Sustainability of Water Governance Regimes, Adapted from Wiek & Larson (2012).

Principle	**Criteria**	**Governance**

		domain
1. Social-ecological system integrity	**1a**. Maintain minimum flows in surface water **1b**. Maintain or enhance the quality of water resources **1c**. Ensure aquifers are not over-taxed to points of instability **1d**. Recognize/ coordinate resource uses/ impact within appropriate physical units	1a. Supply 1b. All 1c. Supply 1d. Use
2. Resource efficiency and maintenance	**2a**. Reduce water-use or enhance water-use efficiency **2b**. Reuse water/ recycle wastewater for various uses **2c**. Eliminate water losses **2d**. Groundwater extraction rates should not exceed the recharge rate	2a. Use 2b. Use / Outflows 2c. Supply / Delivery 2d. Supply
3. Livelihood Sufficiency and Opportunity	**3a**. All people pursuing livelihood activities have access to sufficient quality and quantity of water **3b**. All people pursuing economic activities have access to sufficient quality and	3a. Supply / Use 3b. Supply / Use 3c. Supply / Use

	quantity of water **3c**. A fair "compensation" for affected stakeholders in case of insufficient access	
4. Socio-ecological civility and democratic governance	**4a**. Involve all groups who affect or are affected by water governance efforts in decision-making **4b**. Elicit the full array of interests and perspectives through various stages of governance **4c**. Establish collaborative water governance endeavors	4a. All 4b. All 4c. Supply / Delivery
5. Inter-generational and intra-generational equity	**5a**. Make sure all residents have access to safe water for eating, drinking and sanitation **5b**. Define/ implement a sufficient level of water needs beyond "basic needs" **5c**. Ensure fair distribution of benefits and costs among stakeholders **5d**. Facilitate involvement among diverse stakeholders **5e**. Ensure representation of future generations (e.g., via groups who consider	5a. Supply 5b. Use 5c. All 5d. All e. Use

	their interests)	
6. Interconnectivity from local to regional to global scales	**6a**. Reduce/ eliminate negative impacts on other areas **6b**. Plan within the watershed or groundwater basin context **6c**. Recognize/ coordinate between local and broader scale stakeholders	6a. Supply / Outflows 6b. Supply 6c. Supply
7. Precaution (mitigation) and adaptability	**7a**. Anticipate potential water shortages and water quality problems **7b**. Mitigate potential water shortages and water quality problems **7c**. Adapt to water shortages and water quality problems	7a. Supply 7b. All / Use 7c. All

3. Research Design

3.1 Appraisal design. The appraisal was planned in Costa Rica with collaborators from June through August 2010. This afforded stakeholders and researchers a platform to communicate, align expectations, and to establish a long-term collaborative process. During this time, a partnership was formed with the PC Commission in Nicoya, which was comprised of members from MINET, ASADAs, Nicoya Municipality, and the National University. Through several meetings with PC Commission and other stakeholders, the appraisal procedure was hashed out. This included vetting the interview

protocol, identifying participants, discussing appraisal criteria (which were under development in Wiek & Larson (2012) at the time), elaborating an initial 'skeleton' version of the water system map to be used in interviews (to ensure that it resonated with interviewees), and defining the appraisal parameters. Accordingly, a qualitative and visual procedure that used a water systems map based on the framework was formulated. The goal of the procedure was to identify how well the governance regime worked based on a normative set of criteria and to clarify where in the system problems and potential opportunities existed.

3.2 Data collection: Interviews. 47 interviews were conducted with individuals from 40 different government agencies, local governments, service organizations, cooperatives, membership organizations, and businesses (Table 3.2). Eight additional interviews were conducted with small family farms (businesses). 90% of organizations originally targeted by researchers were interviewed. Also, to help ensure all key actors were interviewed, we asked participants to list who they considered to be the two most important organizations (besides their own) for water governance in the region (i.e., Wiek et al., 2007). All of those resulting organizations were interviewed. The interviews first engaged respondents with the sustainability principles and criteria (allowing for comments and alternative suggestions). Each respondent then shared two water-related challenges they perceived to be critical for the region and located those challenges on the systems map (Figure 3.2 in the results section). Information on perceived challenges was used to derive groups of water-related challenges that actors generally saw as prominent in the region and to then to visually compare those challenges with the non-compliant

criteria in the appraisal. Interviews lasted an average of 75 minutes and were conducted face-to-face from August to December 2010.

Table 3.2

Selected Organizations Involved in the Sustainability Appraisal Study. Classifications are Based on Agrawal (2008).

Key Actors	**Description**
Agencies	
Acueductos y Alcantarillados (AyA)	National water utility mandated to supply drinking water to the population.
Ministerio de Ambiente, Energía y Telecomunicaciones (MINAET)	Environment ministry. Umbrella organization for environmental management. Nicoya and Hojancha are managed as separate sub-regions; 'Conservation Areas' branches manage protected areas. The Área de Conservación Tempisque (ACT) is the responsible Conservation Area in the study site
Ministerio de Agricultura y Ganadería (MAG)	Ranching and agricultural ministry mandated to promote economic competitiveness of Costa Rican agriculture
Local governments	
Rural water administrators	Community-run groups that manage rural water supplies and deliveries. Granted power to set and collect water use tariffs.

(ASADAs)	
Municipalities	County-level government that develops land-use guidelines outside of nationally protected areas
Service organizations	
NicoyAgua Foundation	Non-profit water conservation group in Nicoya administered by the Potrero Caimital Watershed (PCW) Commission, which promotes basin management
National Training Institute	Extension office dedicated to producer training and education
Membership organizations	
Rural development associations	Community-run groups dedicated to community well-being and financing local projects
Ranching commissions	Local organizations that disseminate information to producers and promoting collective interests
Cooperatives	
CooPilangosta	Coffee producer cooperative
CoopeGuanacaste	Regional electricity provider
Businesses	
Costeña S.A.	Primarily a melon producer and largest agricultural business in the area

3.3 Data collection and synthesis: Workshops. Three workshops informed the appraisal. The first involved mostly researchers studying water issues in Guanacaste. Researchers were from Costa Rica, Colombia, and the United States. The workshop was held in Palo Verde National Park, Guanacaste in August 2010. Nine participants represented: the Organization for Tropical Studies, *Universidad de Costa Rica*, *Centro Agronómico Tropical de Investigación y Enseñanza*, the International Union for the Conservation of Nature, and Arizona State University. Participants broadly evaluated water governance in the region using the criteria and outlined water-related challenges. The second and third workshops were held in Hojanhca and Nicoya in November 2010. The 20 participants in these two workshops represented: AyA, MINAET, ACT, ASADAs, MAG, Municipalities, PC Commission, agricultural associations, and producers. Early results of the nearly finished interviews were presented and discussed, which allowed for additional input. Nearly all workshop attendees had participated in the study interviews that had already engaged them with the water system map. This experience helped support the diverse groups to frame the water system using a similar perspective (i.e., its boundaries were defined and the governance domains were clear). In an open discussion format, participants used the criteria across the four domains of the water system to begin appraising the governance regime. The research team facilitated and participated in the discussion.

3.4 Appraisal scoring. After the workshops, the research team initially appraised the governance regime against each criterion (from Table 3.1). This first involved filling in the appraisal score sheet (e.g., Table 3.3 in the results) with evidence from the interviews, the workshops, and the parallel governance analysis research effort (of the

same system in Kuzdas et al., 2014) for each criterion. As a part of this effort, the research team also organized information from publicly available sources (i.e., reports, indicators, monitoring data, etc.) for use as additional evidence in the appraisal score sheet. To then score the appraisal, we applied a three-tier metric (denoted by asterisks), which indicates (one*) non-compliance, (two**) some compliance, or (three***) full or nearly full compliance of the governance regime with a given criterion. Relative compliance of each sustainability principle was then calculated by dividing the summed score of individual criterion within a given principle by the maximum possible score. We used the resulting average scores as a way to differentiate three groups of principles that were, relative to each other, in either high, medium, or low compliance (Figure 3.1). As specified during the appraisal-planning step, the scoring assumed that each criterion is equally important for principles, and each principle is equally important for sustainability. Averaging scores for each principle was used, despite the categorical variables, in order to provide guidance and initial differentiation among principles for targeted discussions with stakeholders on the principles/ criteria that may require more urgent attention than others. This technique supported the clear communication of appraisal results and provided a concise way to summarize the detailed qualitative information contained in the appraisal.

3.5 Mapping the appraisal. Criteria that scored as relatively non-compliant (e.g., one*) were then placed onto the finalized systems map. To place criteria onto the map, we used the framework that specifies which domain(s) each criteria is relevant, along with the detailed information found within the appraisal itself. The perceived water-related challenges (from interviews) were aggregated and grouped using content analysis

techniques. Each of those aggregated groups was then assigned a code (A-F) and paced into the part of the water system map where respondents most often mentioned the water-related challenges (that were included in the grouping) as occurring. This step provided a visual picture of the appraisal results in comparison to the perceived water-related challenges, as well as providing indications as to where in the water system both tend to cluster and which actors (already on the finished map) are implicated.

3.6 Examining problem clusters, opportunities, and finalizing results. Starting in early 2012, appraisal scoring was vetted and finalized in an iterative process with partners in the PC Commission in order to promote relevance of the results. The PC Commission reviewed a draft document describing the initial appraisal scoring. After receiving feedback on the document, we used the marked systems map to visually group the challenges and non-compliant criteria into clusters (based on the same actors involved in the same part of the water system map) in order to explore underlying problem drivers, which if corrected, could help mitigate several non-compliant criteria and water-related challenges linked to a particular cluster. Accordingly, this step afforded initial qualitative insight into the negative effects of interactions among criteria and water-related challenges within 'problem clusters' that were relevant for the regional water system. This step also provided further insight into existing opportunities that already produced positive sustainability effects (as identified in the appraisal) and could potentially be capitalized on to further increase those effects. The research team, PC Commission members, and a number of other stakeholders from civil society, agricultural businesses, and ASADAs examined and synthesized the identified clusters and opportunities in a series of meetings. This process occurred throughout March 2012 in Costa Rica. In April

2012, an executive summary and final report for the completed appraisal was distributed to stakeholders in the region.

4. Appraisal Results

4.1 Overview of appraisal scoring. Of the twenty-five criteria used to appraise the sustainability of the water governance regime, for seven criteria the regime was rated as non-compliant (*), for fifteen criteria rated as somewhat compliant (**), and for three criteria rated as compliant (***). The scoring results are illustrated in Figure 3.1 and detailed in the score sheet in Table 3.3.

The regime scored relatively low (near 50%) compliance against four principles – P1: Socio-ecological system integrity, P2: Resource efficiency and maintenance, P6: interconnectivity across scales, and P7: Precaution and adaptability (Figure 3.1).

For two principles – P3: Livelihood sufficiency and opportunity and P4: Socio-ecological civility and democratic governance – the regime received relatively medium (67%) compliance scores. By law Costa Rican citizens are entitled to basic levels of social services and well-being. Article 50 of Costa Rica's constitution guarantees clean and healthy environments for every citizen. Implementing the mandate of Article 50, however, has become a significant challenge for government agencies below the provincial-level that struggle to coordinate with each other and involve local communities in decision-making processes. Communities are increasingly seeking the power and rights to manage local and regional resources amidst a historical planning context of top-down control, which may create friction and, at times, high tension in governing processes.

For only one principle – P5: Intra and inter-generational equity – the regime earned a relatively high (73%) compliance score. Nearly all citizens have access to clean drinking water in the region. Recently formed NGOs such as NicoyAgua and other collective organizations (such as those taken by PC Commission) already collaborate with and across local branches of government agencies that typically do not coordinate with each other, which helps increase general collaborative activities in some places within the governance regime. These efforts also allow for the inclusion, although informally, of some rural community water-user associations (e.g., ASADAs) within the region that would otherwise be disconnected from the governance regime.

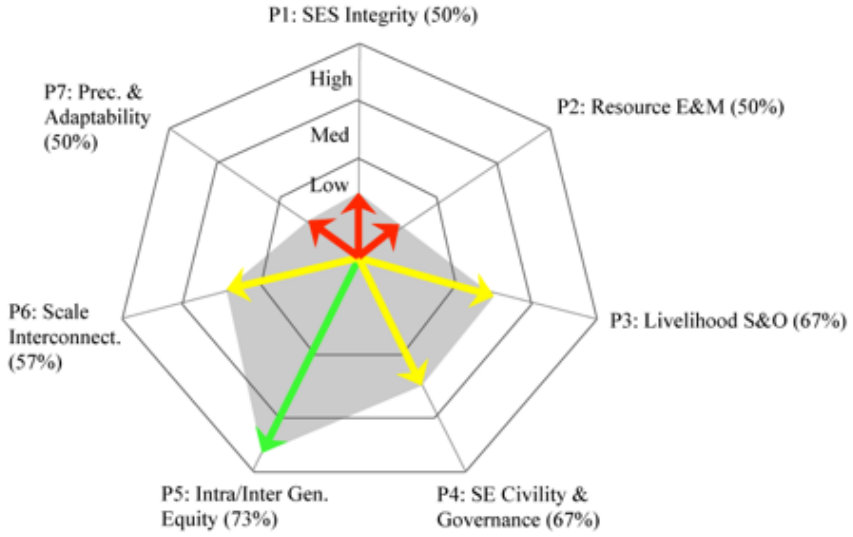

Figure 3.1 Extent of governance regime compliance with sustainability criteria. Arrows (green=high; yellow=medium; red=low) represent relative sustainability compliance of individual principles.

Table 3.3

*Compliance of Guanacaste's Water Governance Regime with Sustainability Criteria (Scoring key: *= non-compliance / **= some compliance / ***= full compliance).*

	Appraisal Criteria	Domain	Appraisal Results/ Score sheet
Principle #1: Socio-ecological system integrity | Relative appraisal score: 6 /12 – 50%			
1a	Maintain minimum surface water flows	Supply	Data are sparse, but from our initial calculations (Kuzdas et al., 2012a) it doesn't appear surface flows are currently overtaxed in the wet season. Careful study is needed of dry season flows, and supply availability in general. New mechanisms for transparently monitoring flows are also crucial. **
1b	Maintain or enhance water resource quality	Cross-cutting	Residents enjoy regular clean water. MINAET is charged with monitoring ecosystem health and integrity; however consistent ecosystem monitoring and enforcement is a challenge especially outside voluntary initiatives in the water outflows domain. **
1c	Ensure aquifers are not over-taxed	Supply	There has never been a groundwater study in the Upper Nosara. The Potrero-Caimital Aquifer was mapped for the first time in 2003 by Costeña, the largest groundwater-user in the region. This study was foundational for the subsequent 2006 and 2008 SENARA studies on aquifer vulnerability. No reliable information on stocks from an independent source exists and current protection remains inadequate. *

1d	Coordinate water uses/ impacts within appropriate units	Delivery Use	ASADAs do not coordinate groundwater extractions or water-use with each other or with Costeña and other agricultural businesses that use the same source. Current rules and regulations do not encourage coordination. No leader facilitates the accumulation of water system knowledge over time. *
Principle #2: Resource efficiency & maintenance | Relative appraisal score: 6/12 – 50%			
2a	Reduce or enhance water-use efficiency	Use	Leadership roles that guide and coordinate public and producer education efforts are missing. Fractured knowledge of water-use across groups and communities makes collective goal setting and identifying, targeting, and evaluating the effectiveness of water-use or demand reduction programs difficult. *
2b	Reuse water/ recycle wastewater	Outflow Use	Reuse and recycling projects are gaining interest, evidenced by several recent water re-use and recycling workshops. However lacking coordination and vagueness (who is responsible to do what) in the water outflows domain inhibit program implementation. **
2c	Eliminate water losses	Supply Delivery	Infrastructure is often maintained well enough; however public funds for upkeep is sparse. In the 2010 rainy season, AyA took out a large loan to fund infrastructure maintenance (Loaiza, 2010). Infrastructure problems periodically leave Hojancha without running water. **
2d	Groundwater	Supply	Although widely considered to be one of the best water resources in the region, the Potrero-Caimtial

	extractions should not exceed recharge	Delivery	Aquifer has never been sufficiently studied to identify safe-yield thresholds. Knowledge of groundwater supplies is often considered by agencies to be the major challenge for managing water in Guanacaste. *
Principle #3: Livelihood sufficiency & opportunity | Relative appraisal score: 6/9 – 67%			
3a	Everyone pursuing livelihood activities has sufficient access to water quality/ quantity	Supply Use	Those covered by AyA and ASADA delivery networks (a majority of people) are generally assured water of sufficient quality and quantity. Legally all residents have the right to drill private wells for domestic purposes. However independent rural farmers relying on private wells are assured neither quantity nor quality and are vulnerable in the dry season. **
3b	Everyone pursuing economic activities has sufficient access	Supply Use	Wait times for obtaining water permits for economic uses can be exasperating for small farmers. Illegal water extractions are common, and may be twice as many as recorded legal extractions. Ironically, weak institutions seem to be allowing equal economic opportunity at the moment. Increasing scarcity, poor knowledge of how much water people are using, and weak institutions could turn out to be a detrimental combination leading to tension in the future though. **

	to water quality/ quantity		
3c	Fair compensation for affected stakeholders in case of insufficient access	Supply Use	The Environmental Tribunal Court and pathways within MINAET resolve compensation issues for affected stakeholders and semi-public NGOs are available to take legal action on behalf of stakeholders. However case-volume in recent years and lengthy litigation processes have limited local access to Courts. Guanacaste communities are well organized and are capable of mobilizing when fair compensation is not available. Communities trust in agencies and their ability to fairly compensate affected groups has decreased in recent years. **
Principle #4: Socio-ecological civility and democratic governance | Relative appraisal score: 6/9 – 67%			
4a	All groups who affect/ are affected by water are involved in decision making	Cross-cutting	Involving rural communities and large private water-users remains a challenge. Agencies often struggle to involve each other in decision-making, which also creates difficulty in involvement of other groups outside of central government. But there are collective efforts that aim to broaden involvement in governance through the Potrero-Caimital Watershed Commission/ NicoyAgua. **
4b	Elicit full array of interests/	Cross-cutting	Despite calls in the 2004 Management Plan to integrate rural community and private sector interests, it did not develop strategies to achieve it. The Watershed Commission has broadened governance to cover

	perspectives		more interests, though this is often administered in ad hoc fashion. **
4c	Establish collaborative endeavors	Supply Delivery	Actors collaborate most effectively in the water supply domain, where civil society is most active. Community-groups have successfully partnered with businesses to purchase land for conservation. Model forest and biological corridor projects are ongoing. Collaboration however decreases in the other domains as no collective goals for the regime have been established. **
Principle #5: Inter & intra-generational equity | Relative appraisal score: 11/15 – 73%			
5a	All residents have access to potable water	Supply	Virtually all residents have access to potable water. ***
5b	Define/ implement a sufficient level of water needs beyond basic needs	Use	Agencies that are most central in the regime do not typically coordinate or share information to the extent where such levels of need could be fairly decided. Poorly organized data of how much water is going where and for what purpose, declining legitimacy of national institutions, and recent corruption in the national government is likely eroding the trust needed for effective implementation of such decisions if administered in a top-down way . *
5c	Ensure fair	Cross-	The Town of Hojanhca is charged slightly higher water use tariffs to help cover water transport costs.

	distribution of benefits/ costs among stakeholders	cutting	Accessible and clean water is an explicit human right by Costa Rican law, so in theory costs should not disproportionately burden one group over another. However regulatory and enforcement gaps in water outflows potentially allow for some communities to share disproportionate costs associated with contamination. **
5d	Facilitate involvement among diverse stakeholders	Cross-cutting	NGOs are filling roles that attempt to connect groups and communities. Continued support and leveraging these NGOs for progress toward sustainability is vital, as rural involvement in larger governing processes remains limited. **
5e	Ensure representation of future generations	Use	A large number of prominent environmental NGOs (often financed by international donors largely concerned with the survival of rare tropical dry forests) in a relatively small area who are well integrated into the public sector generally ensure future generations have a voice in governing processes. ***
Principle #6: Inter-connectivity from local to global scales | Relative appraisal score: 6/12 – 50%			
6a	Reduce negative impacts on other areas	Supply Outflow	Downstream coastal communities do not usually see negative impacts. ***

6b	Plan within the basin context	Supply	Recent uprisings in nearby rural areas over water transfers have made some planning processes more concerned with the basin context. Though water independence is considered important in Hojancha, the role of taking responsibility to achieve this remains unfilled. **
6c	Recognize/ coordinate between local and broader scale actors	Outflow Supply	Integration or coordination with broader regional water governance is non-existent and roles that effectively connect to broader scale actors are unfilled. Coastal communities rely on aquifers that are subject to increasing salinization and demand. Increased connections between local and broader scales actors, and a stronger broader regional approach, will likely be important. *
Principle #7: Precaution (mitigation) and adaptability | Relative appraisal score: 5/9 – 56%			
7a	Anticipate shortages/ quality problems	Supply	It is widely accepted that dryer or more variable climate patterns in the future will be experienced in the near future. However, procedures that attempt to use future thinking to aid planning and decision making today are often not available or not used. **
7b	Mitigate shortages/ quality problems	Cross-cutting, Use	Reforestation efforts are often implemented to mitigate water shortages and quality problems. However actors lacks strategies and a diverse portfolio of planning procedures and policies. Local management plans are not currently binding, nested into larger governing institutions, nor enforceable; which hinders

			coordinated planning that seeks to mitigate local water problems. *
7c	Adapt to water shortages/ quality problems	Cross-cutting	Mobilizing resources and responding to change is mostly effective in reforestation contexts; however less evidence indicates that quick and effective change can be implemented in other efforts related to water shortages and quality. **

4.2 Problem perceptions, locations, and clusters. In the interviews, governance actors identified a variety of water governance challenges ranging from water quality issues (contamination, monitoring, etc.) to poor aquifer protection and unjust water allocation schemes (Table 3.4). The challenges vary in public awareness (frequency of mentions in interview) as well as in location (where they occur in the system). We tabulated and grouped those perceptions and where in the system actors marked that they occur, (Table 3.4) in order to map them onto the water system map.

Table 3.4

Perceived Water Governance Challenges in the Region and Where They Occur in the Water System

	Perceived Challenge	**% Of interviews mentioned**	**In which domain mentioned most?**
A	Contamination, water quality, monitoring and enforcement	38	Outflows and Supplies (especially groundwater)
B	Unregulated demand growth & deforestation	34	Use (Ecosystem, Agriculture)
C	Climate change	9	Supplies (Potrero-Caimital Aquifer)
D	Lack of education & awareness	9	Use

E	Scarcity and drought	6	Supplies
F	Poor aquifer protection	5	Supplies
-	Distribution inequalities	1	Delivery [not mapped in Fig 3.2]

Figure 3.2 illustrates *where* in the regional water system non-compliance with criteria (from the detailed sustainability appraisal scores; Table 3.3) and the aggregated actor perceptions of water governance challenges (compiled from interviews; Table 4) occur. Based on a visual inspection of the system map in Figure 3.3, we see generally that the perceived water-related challenges (A-F) are well aligned, or at least tend to group, with the lower scoring criteria from the appraisal (1a-7c). These identified problem 'locations' or clusters helped identify not only the where, but in particular *who* is active in the part of the water system where problems or challenges tend to occur. The system non-compliance with criteria and the perceived challenges cluster around four features of the regional water governance regime (Table 3.5).

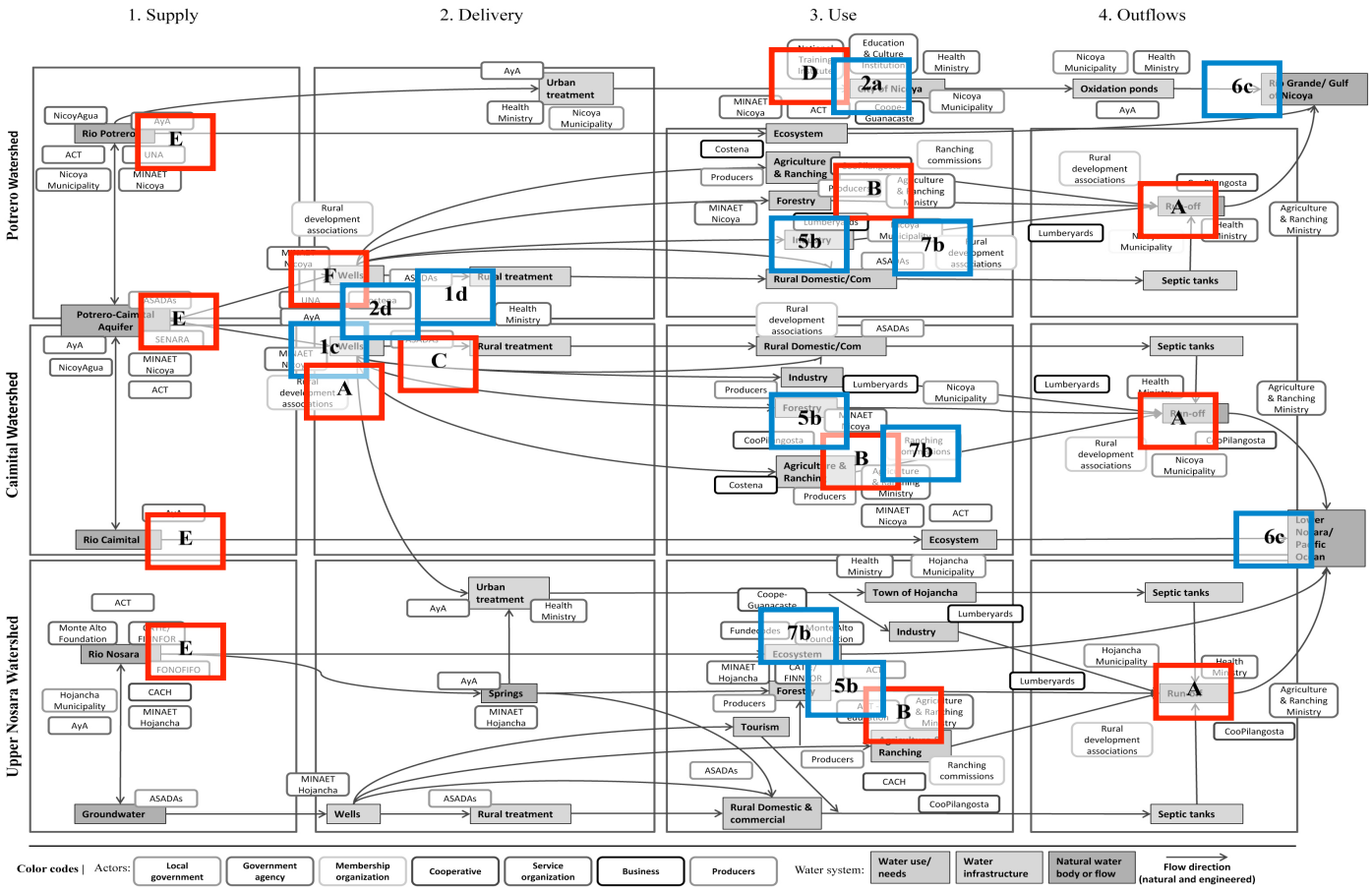

Figure 3.2 Challenges from the sustainability appraisal mapped onto the water system. Blue squares indicate non-compliant criteria from the sustainability appraisal (1a-7c). Red squares indicate major challenges perceived by actors (A-F). Grey scale water system/stakeholder map is adapted from Kuzdas et al. 2012a

Table 3.5

Problem Clusters in the Regional Water System

Problem cluster	**Appraisal criteria**	**Actor Perceptions**	**Who is implicated on the water system map?**
I. Potrero-Caimital Aquifer	1c, 1d, 2d, 7b	A, C, E, F,	MINAET, AyA, ASADAs, SENARA, Development Associations, Costeña, NicoyAgua,
II. Regulating institutions, water management frameworks	5b, 7b,	A, B	MINAET, AyA, Municipalities, ASADAs, MAG, Health Ministry, Producer Associations, Private enterprise/ agriculture
III. Institutional leadership, goal setting, water-use education	2a	D	UNA, MINAET, ACT-Education, MAG, Education and Culture Institution, National Training Institute, NGOs, NicoyAgua
IV. Downstream integration	6c	A	Rural communities, national agencies, Potrero-Caimital Aquifer users and ASADAs

We qualitatively synthesized the underlying structural and process aspects of the regional governance regime that relate to the perceived water-related challenges and non-compliant criteria that cluster in these four areas.

4.2.1 Potrero-Caimital (PC) Aquifer. The absence of management coordination and poor information sharing of water extractions among communities that share the PC Aquifer bring about several challenges. Law mandates that government agencies should coordinate with each other (in the water sector) and with local organizations, but how exactly this ought to be organized is not defined. This is a major challenge for creating a body of accessible and coherent knowledge about water quantities being stored, moved, and used in the system. Local actors indicate that the majority of problems in the region center on the PC Aquifer (Table 3.4). In the past, stakeholders have struggled to develop adequate basin scale management plans for properly managing uses of the aquifer. Levels of mutual trust between actors, which is needed to execute collaborative management plans, appear to be low. Uncertainty regarding water supply and use potentially makes reconciling mistrust and negotiation difficult.

4.2.2 Regulatory institutions / water management frameworks. Inadequate rules that regulate and monitor the system after water is used drive stakeholder concerns regarding water quality. A third of interviewees indicated that contamination/ water quality is the most important challenge facing water governance (Table 4). In the study area, all central actors are government agencies with the exception of NicoyAgua/ PC Commission. Institutional frameworks that dictate how these actors operate in relation to each other are vague. Vague rules allow for excessive overlap and repetition of the institutional responsibilities of government agency actors. As a result, many actors use

financial and personnel resources duplicating efforts such as reforestation. In Hojanhca, especially, nearly all of the environmental management activities deal with tree farming – even promoting tree farming – often without a broader understanding of the larger hydrological impacts in the region. There is no standard for cooperation between Nicoya and Hojancha, despite Hojancha relying on the PC Aquifer (in Nicoya) for water supplies during the dry season. In the study area, the first Management Plan (Morataya, 2004) aimed to create stakeholder networks – a critical task considering gaps in broader institutional frameworks. Results of the first management plan have been mixed, since such plans lack authority and are not legally enforceable.

4.2.3 Institutional leadership and goal setting. The lack of institutional leadership, which helps drive collective goal setting or visioning processes, is evident. Results highlight, for example, that the various water-use education efforts in the region lack a clear purpose and objective. No actor fills leadership roles that steer environmental education efforts in a unified direction, which is a reflection of the larger issue of unclear objectives of the governance regime. A coordinated direction for water governance requires a process to deliberate and identify collective sustainable development goals, which in turn requires extensive engagement of the various sectors involved in the regional water system. Effective engagement with stakeholders will require enduring leadership and commitment that spans institutional and administrative scales, which is currently not present. MINAET and AyA are the two organizations in the positions, at the moment, to drive goal setting in the governance regime. However, these two agencies operate in different aspects of the water governance regime and do not coordinate their activities. Having two prominent public actors that do not coordinate their primary

functions in the regime is a major obstacle for efforts that seek to develop collective objectives and implement plans to achieve those objectives.

4.2.4 Downstream and regional integration. Poor integration of downstream communities, including unclear vertical accountability mechanisms that are accessible to rural communities, is a significant challenge for the region when considering historical conflict events and potentially drier futures. There is a reasonable possibility that other communities will look for new water sources in the near future if drier or more variable climate projections come to fruition. If they do, the PC Aquifer would be an attractive prize. If the future does require deliberation processes over water transfers to other regions, downstream integration will help ensure the planning of transfers is open, civil, and participatory. At the moment, many of these processes in Guanacaste lack an adequate considerations of demand management perspectives that could in some cases provide an alternative 'soft' path to large infrastructure and transfer projects (i.e., Gleick, 2003). Such a process would stand in contrast to the traditional method of water resources planning in Guanacaste, which (as evidenced by recent conflicts) is a process that is often closed, exclusive, and seen with suspicion by many communities (Benevente, 2010). Building downstream integration, vertical accountability, and an adequate focus on demand management may help avoid future conflicts and increase sustainability compliance of the regime.

Investing in actions to address the issues found in these four clusters will likely have positive effects on compliance with several sustainability criteria.

4.3 Opportunities. The appraisal procedure also yielded four existing opportunities that already have positive sustainability effects, but could be further built on to expand those positive effects on the water system:

4.3.1 Emerging partnerships for information sharing. The will to establish venues and science-decision maker partnerships by which to formally share information on water extractions and needs is demonstrated by recent efforts by the *Universidad Nacional* in Nicoya, which has initiated work to synthesize information of water being extracted by ASADAs. UNA has also hosted recent workshops addressing water reuse and recycling potential in the region. Active institutional leadership for the region could feasibly be fostered in UNA's programs.

4.3.2 Opportunities for facilitating coordination. Grassroots NGOs, such as NicoyAgua, are well positioned to increase participation and coordination among ASADA communities – as well as strengthen ties between AyA and MINAET. NicoyAgua in this case is the only actor with connections to both MINAET and AyA. Facilitating better coordination and unified leadership between the regional offices of these two central actors at the watershed-scale would be one key objective NGOs could feasibly strive for in order to encourage the developing of collective goals, which could substantially increase sustainability compliance.

4.3.3 Transfer potential. With adequate strategic planning, the coordination by NicoyAgua and other non-state organizations could serve as a model for grassroots water governance efforts throughout Guanacaste and beyond. Aiming to be this type of model for the region could feasibly be a powerful visioning tool for water governance efforts and might inspire new and enduring leadership in the region.

4.3.4 Existing management plan as starting point. The 2004 Management Plan established the need to include all relevant actors into decision-making, including large agricultural businesses in the region. An updated Plan could feasibly be more effective and authoritative if developed in conjunction with a variety of actors. The basis of the Plan update could establish an open, transparent water governance process that seeks to build consensus over management objectives, monitors sustainability compliance, and adjusts management strategies as needed in the future.

5. Discussion

5.1 Appraisal impacts: Utility, limitations, and ways forward. There is increasing recognition that water governance research largely struggles to integrate with the needs of decision-makers and practitioners; and thus often makes little contribution in terms of directly aiding problem-solving efforts (Bakker, 2012). The Guanacaste case demonstrates that with the right local partnerships, and with the right timing, sustainability appraisals could be a promising research endeavor that can aid some problem-solving efforts. We found that the participatory step of mapping challenges onto the water system map resonated well with stakeholders. More exploration of mapping challenges, opportunities, and stakeholder groups onto water governance regimes could prove beneficial. The criteria-based appraisal was appreciated for its transparency that allowed stakeholders to engage in structured and targeted discussions of challenges and opportunities. As we discuss and illustrate below, the appraisal was usefully applied in the study area. But, its application was also limited in the face of deeply rooted, broader water governance issues. We argue below that, for research efforts to adequately address these broader issues, integration with subsequent solution-oriented research is required.

During the appraisal procedure (2010-2012), the update process to the Regulatory Plan for the Municipality of Nicoya was underway. Regulatory Plans contain legally enforceable policies and designations for land-use and development in rural and urban areas that are not nationally protected. Under the supervision of the Nicoya Regulatory Plan (NRP) Commission, the two-year update process was initially completed in February 2012 and followed by a 10-day public comment period. Local communities, frustrated by the short period to review the 600-page document, largely deemed the plan inadequate. The main point of contention was the vague rules regarding what can and cannot be done on land over groundwater resources, which many rural residents rely on for their drinking water. In response to these objections, the NRP Commission granted an additional 45-day comment period beginning in April.

During the additional comment period, the PC Commission presented the results of the appraisal (in this paper) to the NRP Commission. The focal point of the presentation was the PC Aquifer 'problem cluster' identified in the appraisal. The PC Commission argued for limiting development that utilizes water from the PC Aquifer until better coordination could be achieved and neutral studies commissioned to accurately determine water supply and needs. As a result, the new Regulatory Plan strongly limits new development (for the time being) that uses water from the PC Aquifer. The PC Commission considers this step to set the stage for collectively formulating goals and alternative ways of governing groundwater resources in the area. They are using the momentum for continuing efforts to consolidate a biological corridor in the region and to begin identifying standards (information sharing, reporting back, transparency, etc.) for future research collaborations (i.e., 'new partnerships for

information sharing' opportunity in section 4.3) in order to promote the relevance of research conducted in the region. However, core issues for water governance remain unresolved.

The root of the contentions over the Regulatory Plan update – the lack of open participation and engagement of communities in governing processes – was not resolved. Some groups and communities were not able to personally lobby the NRP Commission as the PC Commission did. One community group sent a 10-page document to the NRP Commission outlining faults within the Plan that might allow for new development that the community's sole (ground) water source could not support. Governing groundwater resources – and engaging communities in processes that determine their use, conservation, and management – remains a significant challenge after the Plan update. The Regulatory Plan update illustrates that, in spite of the moderate successes of the PC Commission to put the appraisal to use in policy making, a critical need for long-term and sustainable water governance is still missing: the need for diverse groups to constructively deliberate, devise, and implement alternative water governance schemes in the region.

The PC Commission noted that the appraisal, while providing focus for their efforts through identified challenges and opportunities, did not fully establish how they should go about those efforts. The appraisal also did not fully clarify who would need to do what, where, when, etc., in order to address problems and ultimately implement alternative ways of governing water - which would not only require normative, but *instructional/ actionable* knowledge (Wiek et al., 2012). While the need to constructively and openly deliberate alternative governing options, as mentioned in the appraisal, is now

being considered in planning that involves the PC Commission, the appraisal in itself did not automatically result in people 'governing water differently' (Wiek & Larson, 2012). Importantly though, the appraisal did allow the need for 'governing water differently' to be articulated among a variety of local groups, which offers a valuable starting point for subsequent and integrated solution-oriented water governance research (Pahl-Wostl et al., 2013).

Linking subsequent solution-oriented water governance research to current, engaged research efforts like we presented here, offers a potential path for research to better support the re-design of inadequate governance regimes. For example, the PC Commission is especially concerned with the identified problem cluster of institutional leadership. They argued AyA should lead, since it currently holds a large amount of formal legal authority. Although AyA technically holds a seat on the PC Commission, at the time of the appraisal AyA was often absent. Efforts were explored to engage with AyA in new ways; however, the PC Commission noted that the appraisal provided little guidance on how to do this or on how to identify and develop leaders. The point here is that the appraisal was limited in its ability to inspire new ways of *addressing* challenges. For example, while AyA might be the default legal choice to lead – it may not be the *best* choice. The best choice may not yet exist. How an innovative leadership scheme, which may require an alternative governance regime and other preliminary steps, could best be implemented over time is beyond the scope of an appraisal. For this, solution-oriented research would be necessary. Research has pointed out that robust options for solving or addressing complex problems cannot be deduced from only analyzing or describing complex problems (Sarewitz et al., 2012; Wiek et al., 2012). Others have concluded that

water governance research in particular would highly benefit, in terms of its impact and utility, from a solution-oriented approach (Bakker, 2012; Pahl-Wostl et al., 2013). The presented appraisal, which only evaluated the sustainability effects of a regional water governance regime, validates these perspectives. The appraisal in Guanacaste proved useful for local groups that were closely involved with the appraisal procedure. But, further solution-oriented efforts that, for example, investigate what alternative governance schemes might best address different problems and steps to implement and adjust those schemes over time could offer the actionable knowledge needed to fully address complex water problems. We conclude that descriptive-analytical research efforts are best carefully integrated with, rather than separated from, subsequent solution-oriented research (Reed & Kasprysk, 2009).

5.2 Prospects for sustainable water governance in the climate threatened Central American dry tropics. Based on our appraisal in Guanacaste, we would expect Principle #1: Social-ecological system integrity to be a focal point for sustainable water governance. Coordinating the sustainable use, management, and protection of groundwater reserves is a critical challenge for long-term sustainability in the face climate change impacts. Like Guanacaste, many parts of the dry tropics in Central America already rely on groundwater as an important water resource. Reduced precipitation that is expected in much the Central American dry tropics could severely affect these resources, while also limiting the viability of relying on alternative surface flows for water supplies. Also similar to Guanacaste, the regulatory context of the use, management, and protection of groundwater reserves is often vague (Ballestero et al., 2007). Developing and implementing fair governing processes in line with Principle #4:

Socio-ecological civility and democratic governance and that aim to sustain ground water resources will be important for the region.

Principle #4 though also presents challenges for much of Central America, and accordingly, should be a relevant focus for sustainable water governance efforts. Water governance regimes are challenged to better engage diverse stakeholders and to develop improved participatory and responsive governance schemes when planning infrastructure and deliberating alternatives. Although not accounted for in our appraisal, damming rivers and creating reservoirs for both water storage and power generation is a current coping and development strategy of Central American governments. In Guanacaste, adequately involving rural, diverse groups in governance where (1) centralized agencies are expanding their reach through additional branch offices, (2) drinking water delivery schemes are becoming more decentralized in rural areas (e.g., ASADAs), and (3) governing responsibilities are vague and local management capacity varies presented challenges (as indicated in the problem clusters). Regions in the Central American dry tropics with similar governance schemes may expect comparable challenges. For example, the poor involvement of especially rural communities in decision-making processes, especially those concerning new infrastructure, is an important factor in escalated water conflicts in the region (Paniagua and Stocks, 2008; Kuzdas, 2012). Sufficiently involving more diverse groups in these processes, in addition to helping improve compliance with Principle #4, could also allow for more serious engagement and deliberation with alternative demand management strategies that rely less on water supply enhancement (Brooks & Holtz, 2009). Such alternatives could in turn offer positive, mutually reinforcing benefits related to Principle #1: Socio-ecological system

integrity and Principle #2: Resource maintenance and efficiency considering in Guanacaste poorly managed groundwater reserves and citizen's concerns over potentially taxed water supplies and demand growth (e.g., Table 3.4).

To enhance the positive sustainability effects of water governance regimes along the lines mentioned above, many governance regimes in Central America will need to confront deep social inequalities, lingering poverty, histories of exclusive control – and in some cases histories of oppression and rebellion – that have in many areas fostered persistent feelings of disenfranchisement and mistrust toward political institutions and government agencies (Edelman, 1999; Booth et al., 2010). Strategic, multifaceted efforts that aim toward reconciliation, capacity building, and renewed investment (i.e., technical, financial, administrative) especially in rural community and regional water governing organizations offers a potential path, or at least a start, toward more sustainable water governance regimes. The Guanacaste case affords insight into two potential opportunities that are relevant for water governance regimes in the Central American dry tropics to start on this path.

While economic liberalization in the broader region has generated concerns over public sector capacity (Eakin et al., 2011), there has been a growing influence of private enterprise and civil society organizations in decision-making (Bebbington, 2005). In Guanacaste, we found that the efforts of organizations such as the PC Commission had positive sustainability impacts where public sector roles were diminished. As mentioned in the results, these roles involved driving coordination across institutional boundaries and facilitating some rural community groups to informally participate in governing processes. These actions helped make the governance regime more open, just, and

collaborative in the parts where the PC Commission was active. Grassroots organizations are common in the broader region (Booth et al., 2010), and although it should be expected that their capacities would vary, they do offer a promising investment opportunity that, combined with the right partnerships and in appropriate settings, could positively impact water governance.

The second common opportunity that we might expect are 'policy windows' that can potentially be used to distribute more authority to local, regional, and basin-level planning efforts that already occur with limited authority in many places (Rogers, 2002). Although not a silver bullet, well-designed and alternative schemes that better disperse authority could potentially allow for decision making that is more in-tune and responsive to the challenges that more rural, dry tropical regions face such as governing groundwater in a climate threatened and socially contested context. These 'windows' may come unexpectedly and seem limited, as the Regulatory Plan update process in Guanacaste illustrates, but nonetheless may be a first step. For example, the PC Commission reported its lobbying efforts during the Plan update helped increase its confidence and helped solidify its position as a respectable governance actor in the area, which it considers a positive a step toward utilizing the 'transfer potential' opportunity (Section 4.3). Other 'windows' may take on different forms. For example, Eakin & Lemos (2010) note the trend has been for smaller scale managers and administrators to experiment with new policy instruments such as 'risk atlases' and 'ecological ordinances.' Engle and Lemos (2010) find resource managers to be experimenting with integrating democratic principles into policy. Scenarios and basin-scale plans have been used in Guanacaste communities, and they could feasibly build on appraisal efforts in order to help diverse actors

constructively engage with alternative ways of governing water (Kuzdas et al., 2013). These small-scale 'policy windows' offer opportunities that could support the collective organization of local actors to more effectively confront and positively influence broader governing issues and help strengthen diverse resource planners and managers in the dry tropics.

6. Conclusion

The sustainability appraisal was a valuable tool that provided normative insight into how well water governance in Guanacaste operated. While the results suggested some well-targeted efforts could help remedy interlinked problems, the appraisal provided limited evidence-based instructions that dealt with how to go about resolving problems over time. Additional and expanded efforts are critically needed, at the provincial scale in Guanacaste, to deliberate and craft alternative ways of governing water that can overcome broader governing issues. Water governance research efforts where descriptive-analytical components, solution-oriented components, and real-time problem-solving components are well integrated are a high priority. Such integrated research efforts could well support sustainable water governance in Guanacaste and beyond. As a start for these efforts, the Guanacaste appraisal suggested two critical points for water governance in the Central American dry tropics: (1) a focus on alternative schemes to better manage groundwater; and (2) renewed efforts and investments to engage and reconcile with diverse stakeholders and rural communities. Two existing opportunities that could be capitalized on include: (1) investing in and granting more responsibility to existing grassroots organizations that are already positively impacting water governance regimes; and (2) leveraging 'policy windows' to disperse more

decision-making, planning, regulatory, monitoring, and goal-setting authority to local, regional, and basin-scale actors that are already innovating governance practices, policies, and normative principles.

Chapter 4

Identifying the potential of governance regimes to aggravate or mitigate water conflicts in regions threatened by climate change

1. Introduction

Most of the world's population faces risks to their water supplies (Vörösmarty et al., 2010). Many regions also face challenges related to the just distribution of water and its risks and benefits among communities, economic actors, and environments (Swatuk, 2008; Biggs et al., 2013; Gutiérrez et al., 2013). Fittingly, water conflicts have received increasing attention. Yet, we know little about how water governance regimes aggravate or mitigate water conflicts. In the dry tropics of Guanacaste Province, Costa Rica, dealing with water conflicts is already a challenging reality: on average, one legal water conflict every 52 days occurred over a recent 10-year period (Cover, 2007). In this paper, we ask: Why do some water conflicts escalate or remain intractable while others do not? And, what are the implications of current and alternative water governance schemes to mitigate or aggravate water conflicts? To answer these questions, we examine five diverse cases from Guanacaste in order to identify how governance regimes potentially aggravate or mitigate water conflict within the context of the Central American dry tropics.

We begin this paper from three departure points. First, we define conflict as a situation where 'two or more entities, one or more of which perceives a goal as being blocked by another entity, and power of some sort being exerted to overcome the perceived blockage' (Frey, 1993). We focus especially on actions taken against other actors with the intent to overcome or harm. Non-cooperative actors are not necessarily trying to overcome or harm others (Zeitoun & Mirumachi, 2008). Second, we view water

conflict as a process that occurs with varying degrees of tension among social actors over time (Funder et al. 2010). Many studies view conflict as a single point or measurement. A static approach does not account for the more realistic, dynamic nature of water conflicts (Sneddon et al., 2002; Böhmelt et al., 2014). Thirdly, our approach aims to improve the links between research and the needs of stakeholders that face conflicts (Bakker, 2012; Pahl-Wostl et al., 2013). More intense water conflicts most often happen within sub-national regions (Postel & Wolf, 2001), yet few studies comprehensively address conflicts in at-need and at-risk regions (Scheffran et al., 2012).

Considering the above questions and departure points, there is a deficiency of tools to support water conflict research. To carry out the study presented, we developed an analytical tool based on Ostrom's (2007; 2009) diagnostic framework for analyzing socio-ecological systems (SES Framework). The SES Framework links governance systems, resource systems, and actors to aid understanding of complex water systems (Meinzen-Dick, 2007). Complex water systems resist traditional approaches that view water systems as production systems under management control (Pahl-Wostl et al., 2007). Instead, complex water systems are seen as being governed by intricate sets of rules, rights, and decision-making processes (e.g., institutions) that involve state, private, and civil actors who operate at different scales and locations (Ostrom, 1990; Andersson and Ostrom, 2008). We define water governance as the processes and collective actions that steer water systems (Wiek & Larson, 2012).

Water governance studies increasingly use common pool resource (CPR) theory, which underpins our alternative approach to water conflicts. These studies often suggest that polycentric governance systems, as opposed to rigid or disparate management

schemes, are more effective at coping with uncertainty and change (Neef, 2009; Ostrom, 2010; Huntjens et al., 2012). Polycentric systems contain many and diverse - as opposed to one or alike - centers of decision-making authority (McGinnis, 2000). They disperse authority across nested scales and let actors organize (Marshall, 2009; Ostrom, 2012). Polycentric systems are considered different from centralized (e.g., rigid) or fragmented (e.g., disparate) systems (Pahl-Wostl, 2009; Bakker & Cook, 2011). Fragmented systems contain limited interfaces among governance actors who operate in relative seclusion (Molle, 2007; Nagendra and Ostrom, 2012). In reality, water governance often includes some polycentric aspects, but with widely varying degrees (Huitema et al., 2009). Rogers (2002) and Biswas et al., (2009) illustrate that, while water governance schemes across Latin America generally fit these three governance types, they are continuously changing due to internal and external factors. Huitema et al. (2009) point out that while polycentric prescriptions for water governance are theoretically sound and feasible, there remains a need to clarify effective water governance schemes for specific problems and places. Kuzdas et al. (2014a) suggest that, in addition to clarifying governance schemes to fit problems and places, the manner in which new governing schemes are implemented over time is also important for effectiveness. Harmful sub-national water conflict problems however, are typically approached very generally in attempts to sort out water supply and demand. Identifying the potential of current and alternative water governance regimes that potentially aggravate or mitigate harmful water conflicts is then a key research need with important implications for effectively meeting the challenges faced in water-scarce regions. The exploratory tool presented below and the case studies that follow offer and demonstrate an alternative step towards meeting these challenges.

2. Exploratory Framework for Identifying the Potential of Governance Regimes to Aggravate or Mitigate Water Conflicts

2.1 Introduction. The framework organizes a set of system components to consider when identifying governance potential to aggravate or mitigate water conflicts (Figure 3.1). It provides systematic indications for the governance features that mitigate or aggravate water conflicts within specified contexts. Accordingly, it is best understood starting with the conflict stages, then linking them to the water governance regime, and then considering the wider governing context. Conflicts move through stages of varying intensity levels over time, which is directly influenced by the governance regime. The governance regime consists of interdependent process features (decision-making, collective learning, leadership) and structural features (arrangement, integration, roles). We derived these features from the SES Framework and organized them in a way specified for water conflict studies. The governance regime influences, and is influenced by, the broader governing contexts (political economy, socio-economic, climatic and environmental). Conflicts also impact the broader governing context (i.e., environmental damage, human migration, etc.) and impact the governance regime (by changes in process and/or structure), which can then filter the effects of those governance changes back onto the broader context. Governance actors may take actions that modify governance processes and/or structures. These modifications change the governance regime's influence on conflict (i.e., reduced or increased intensity) and on the governing context.

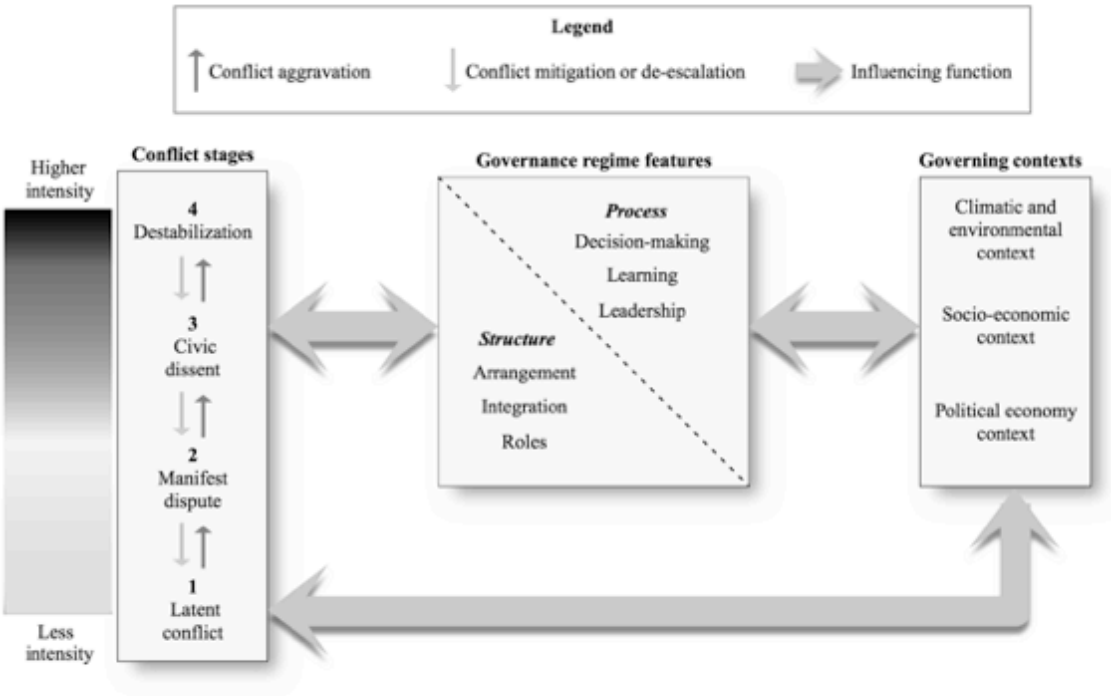

Figure 4.1 Framework to aid identifying the potential of governance regimes to aggravate or mitigate water conflicts

2.2 Components: Water conflict stages. Conflicts can move through stages of higher or lower intensity over time (Figure 3.1). These stages represent categories that reflect tension levels between actors involved (Wondolleck & Yaffee, 2000). We suggest four general categories: latent conflict, manifest dispute, civic dissent, and destabilization (i.e., Priscoli & Wolf, 2009). *Latent conflicts* include professional, normative, or other differences between actors that may or may not be visible. *Manifest disputes* occur when one actor takes action, such as political, legal, or economic actions, against one or more actors, which is often followed by a period of escalated tensions. Tensions are not violent in the manifest dispute category (Kramer, 2004). If disputes are not resolved, the situation might escalate and some actors may take actions of civic dissent. *Civic dissent* includes isolated or sporadic acts of violence, threats of harm,

protests, vandalism, or other subversive acts. If no resolution is reached, the situation may escalate toward the final stage, which we label destabilization. In *destabilization*, civic dissent increases in frequency and in intensity. Destabilization may include regular violence, routine lawlessness, prolonged states of fear, or a breakdown of governing institutions. For example, the 1999-2000 water conflicts in Cochabamba, Bolivia destabilized some parts of the country, which led the federal government to declare a state of emergency (Davis, 2005).

2.3 Components: Water governance regime features. We identified six features of water governance regimes that include three process features and three structural features (Figure 3.1). Inclusion of these features was supported by the research team's work in Guanacaste. The features account for the insights of Guanacaste water administrators while also reflecting a review of relevant water governance literature (i.e., Rogers & Hall, 2003; Wiek & Larson, 2012) and resource conflict studies (i.e., Wolf, 2007; Eriksen & Lind, 2009), which suggests the identified features are applicable in various contexts. Accordingly, a number of empirically testable propositions that are relevant for an improved understanding of water governance and conflict are articulated. These propositions are generally supported by water governance-related studies, but they often remain insufficiently explored in a diverse array of contexts and in conflict-specific cases. We address a number of these propositions in the case studies that follow.

2.3.1 Process features. *Decision-making:* Transparent, inclusive, and fair decision-making processes are commonly proposed as a conflict buffer. Internationally, disputes may result after a state takes unilateral decisions concerning internationally shared watercourses (Priscoli & Wolf, 2009). Regionally, social tension may surface

when decisions are taken without sufficient representation of local groups or economic actors, especially when decisions concern water infrastructure or water transport (Gleik, 2003). When citizens suspect decisions will divert water-related benefits for private gain or will unfairly increase risks to some, tensions may also increase (Davis, 2005; Lafragua et al., 2008). Decision-making in centralized regimes can be efficient; although if decisions are not appropriate to local contexts inefficiencies may result (Eakin et al., 2011). Inclusive decision-making may encourage social learning and allow opportunities for enabling, as opposed to controlling, leadership (Gosnell & Kelly, 2010). Decentralized regimes may make decisions less efficiently, but engagement with decision-making can potentially be broad (Brooks & Holtz, 2008). Decentralized *and well-integrated* regimes can make efficient decisions, often with opportunities for stakeholder input and participation in the decision process, although this does not necessarily guarantee that opportunities for participation in decision processes are fair (Eakin & Lemos, 2006).

Learning: Interactions among diverse actors or communities are often cited as critical for producing social learning, although those interactions must be sustained over time to be effective (Folke, 2006). Learning that is relevant for water conflicts includes capacity building to enhance mitigation abilities and awareness, information sharing practices to enhance collective knowledge of water systems, and the testing of new ideas to solve problems (Olsson et al., 2008). Shared learning processes have helped produce innovative water treaties and agreements (Wolf, 2007). Transparent and fair decision processes can encourage social learning, as can supportive leadership (Pahl-Wostl, 2009). Social learning though may only produce outcomes after considerable stakeholder

investment and commitment (van Herk et al., 2011). Decentralized structures may allow for more effective learning processes as opposed to very rigid structures, as can higher degrees of integration that facilitate knowledge exchange among actors and across scales and locations - although there likely must be multiple available avenues (including face-to-face) for such exchanges to be effective (O'Toole et al., 2009).

Leadership: Governance should lead water systems away from conflicts that cause harm, fear, injustice, or deprivation. Leadership may refer to the transformational aspects of individuals, such as motivation, inspiration, and challenging the status quo (Bass, 1999; Avolio et al., 2009). Leadership can be characterized as either controlling or enabling (Uhl-Bien & Marion, 2009). Enabling leadership can compliment and encourage social learning, both of which can be facilitated through accessible decision-making processes (Furgeson et al., 2013). Leadership may become more controlling in centralized structures, which in turn could affect outcomes on learning potential. Research has shown that in the right contexts more decentralized as opposed to more rigid structures may allow for enabling-types of leadership to grow and mature (Rijke et al., 2012).

2.3.2 Structural features. *Arrangement (networks):* Actors in water governance regimes may be arraigned or networked in a variety of ways (Lemos & Agrawal, 2006), including more centralized structures with few actors in the center and all other actors subject to the central actor(s). Such structures are common in the Central American water sector (Rogers, 2002). Centralized governance regimes may solve simple problems efficiently and may coordinate actions with some actors effectively through controlling mechanisms (Bodin & Crona, 2009). Alternatively, water governance may be structurally

more dispersed or decentralized. In these structures, there may be several hubs of highly connected actors, with less intense connections between hubs (Andersson and Ostrom, 2008). In many contexts, more decentralized arrangements are potentially positioned to account for more diverse constituencies in decision-making processes when addressing more complex problems (Carlsson & Sandström, 2008).

Integration: Structural mechanisms should allow governance at different scales or locations to address problems that surface in another location or scale (e.g., river basin, community, etc.) (Ostrom, 2010; Poteete, 2012). Integrated governance regimes allow for quick feedback from the governance actor(s) at the source of an issue, problem, or innovation to the rest of the regime; and for efficient response of other governance actors to assist with the problem or implement new ideas (Rogers & Hall, 2003). Integration may be vertical or horizontal. Vertical integration refers to the degree governance actors and institutions at different scales are accountable, coordinated, and engage in complimentary rather than contradictory governance activities. Horizontal integration refers to the degree governance actors and institutions within one scale (e.g., regional) are accountable and coordinated in their responsibilities and actions. Effective integration, although potentially difficult to achieve, can support legitimate decision-making, help prevent confusing fragmentation, and encourage mutually supportive (as opposed to divergent) governance roles (Rijke et al., 2012).

Roles: The distribution and clarity of water governance roles and responsibilities (and appropriate legal frameworks) are important to balance competing interests and for efficient and legitimate dispute resolution processes (Gleick, 1998). Poorly defined roles or responsibilities can produce contradictory governance schemes, which may generate

institutional uncertainty that allows opportunities for elite actors to unfairly dominate (Kramer, 2004). Stakeholder commitment to governing processes can support effective and mutually clear roles and governing responsibilities (Larson et al., 2009).

2.4 Tool components: Governing contexts.*Climatic and environmental context:* Studies have found that wet or dry periods may be linked to conflict (Hauge & Ellingsen, 1998; Hendrix & Salehyan, 2012) or that climate has no relation to conflict (Witsenburg & Adano, 2009). Generally, studies that examine this link are inconclusive (Fjelde & von Uexkull, 2012). However, if climate change does push governance regimes beyond environmental boundaries that have been previously experienced, the climatic and environmental context will be important for mitigation efforts (Scheffran et al., 2012).

Socio-economic context: Contexts that include populations with relatively high unemployment numbers and poverty have been speculated to be at risk of conflict, especially in settings of declining agricultural productivity (Soysa & Gleditsch, 1999; Ohlsson, 2000). In such contexts, for example, may allow for elites to disproportionately benefit from water resources while leaving others at risk (Kramer, 2004). Contexts that include sudden demographic shifts, which can quickly put pressure on resource, may also play roles in some conflicts. Rapid change from rural to urban landscapes, for example, can put pressure on maintaining quality water infrastructure to meet increasing demand.

Political economy context: The political economy context is important for contextualizing water conflict analyses, especially in areas that are dependent on global markets and commodity exports. Political economy contexts concern economic markets and their relations to laws and government (Booth et al., 2010). In Guanacaste, relevant markets for water conflict include real estate (which requires water for development and

use) and irrigated agriculture (which requires water during dry seasons). These markets are historically controlled by agencies, yet increasingly open to national and international investors, businesses, and trade. Literature that focuses on the broader political economies surrounding water conflicts in Central America includes Cover (2007), Herrera (2009), and Cruz (2009). Generally, this literature suggests that trade liberalization has weakened state agencies (i.e., fewer personnel, lower budgets), which limits the extent that agencies can manage effective programs and offices in rural areas that historically received strong, responsive pubic sector support. Edelman (1999) finds that trade liberalization in Costa Rica has fostered individual feelings of disappointment and disengagement with state agencies and politics. In the past, many residents viewed the State as supportive or even as a protectorate of rural lifestyles. This shift in citizen's attitudes, Edelman (1999) notes, was potentially the most significant driver of organized farmer resistance toward the State in the 1980s.

3. Case Background

Two primary pieces of national legislation provide the current water resources management framework in Costa Rica. Article 50 of the Constitution guarantees healthy and clean environments for all citizens. The 1942 Water Law prohibits private ownership of public water resources. Water management duties are historically performed by state agencies. Early years of Costa Rican statehood were characterized by legitimate, representative democracy and small, centrally located populations (Booth et al. 2010). By 2011, the population of rural Guanacaste increased over five fold, in comparison to 1950, to about 325,000 people (INEC, 2011). During this time, the number of public organizations also increased exponentially. For example, Edelman (1999, p.70) notes that

over a 30-year period the number of public organizations within the agricultural sector nearly tripled.

Decades of state-led neo-liberal economic reform helped facilitate a real estate boom in Guanacaste from roughly 2000 to 2008. A growing and dispersed rural population tested the ability of agencies, especially the water agency *Instituto Costarricense de Acueductos y Alcantarillados* (AyA), to fulfill social responsibilities. Communities increasingly organized in the water sector, with en estimated 1,500+ rural community-run water associations (ASADAs) now operating in the country (Madrigal et al., 2011). ASADAs are affiliated with AyA, but are governed autonomously by locally elected boards. By the year 2000, studies documented declining public trust in State institutions (Seligson, 2002). Agriculture and tourism are prominent economic drivers in Guanacaste and the Central American dry tropics. Both have expanded in contexts that often involve social inequality (Booth et al., 2010). The region is seasonally dry where little rain falls half the year. Downscaled climate models for the region predict drier and hotter climate conditions will likely continue in the near future (Anderson et al. 2008). In general, the rural dry tropics along Central America's Pacific Coast present similar institutional and environmental contexts for water management (Rogers, 2002; Biswas et al., 2009). The Guanacaste case is an important proxy for the broader region, while offering insights and potential starting points for other water-scarce or arid regions.

4. Study design

4.1 Case selection. We selected five cases (Figure 4.2) to account for variability in conflict processes and outcomes. Some cases feature escalated conflict while others feature less intense conflicts over several years. In other cases conflict mitigation has

been mostly successful or has improved over time, while in others, no conclusion was reached, or historically successful mitigating efforts are now facing conflict.

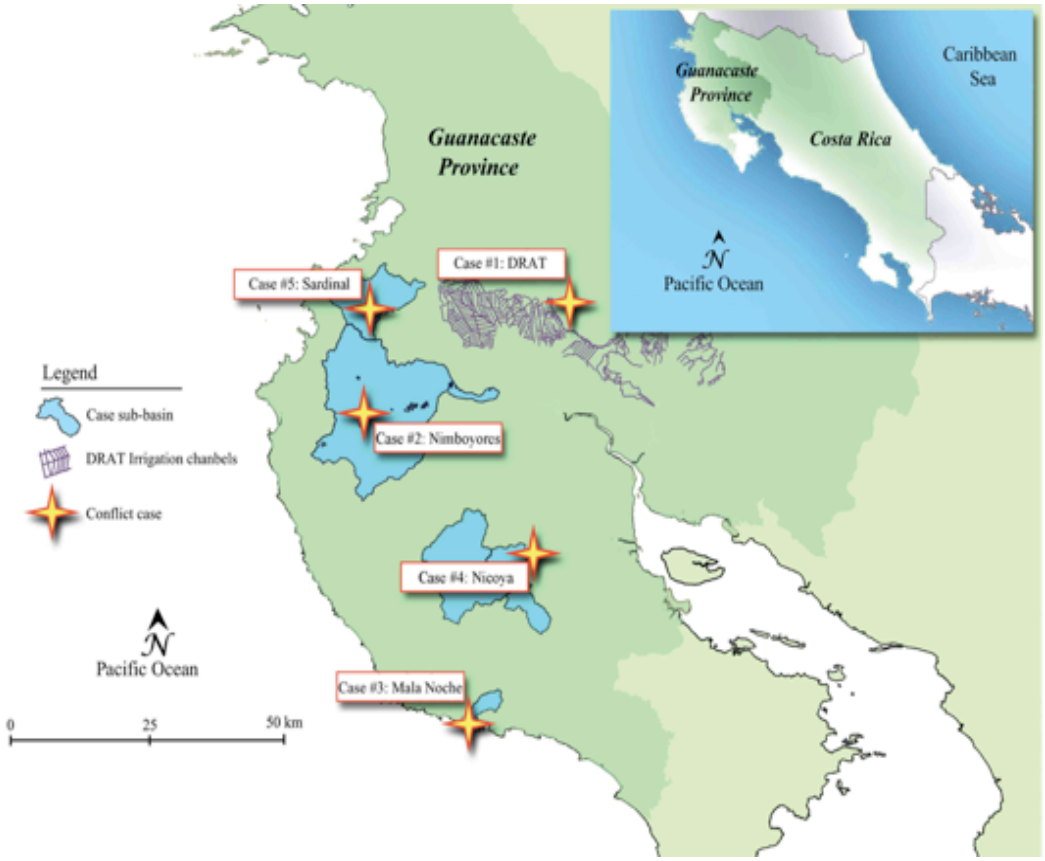

Figure 4.2 The location of the five cases in Guanacaste Province, Costa Rica

4.2 Data collection and analysis. Data collection and analyses involved multiple sources and case study methods that occurred over two years in Costa Rica (Table 4.1). We aimed to balance and validate information among the cases and across timespans of individual cases. Analysis generally followed a 'multiple case study comparison approach' (Yin, 2013). In this approach, we employed what Tortajada (2010) terms 'reverse engineering' to reconstruct each case over time based on collected information. In re-constructing cases, we primarily focused on the six governance features and how they changed over time.

Obtaining challenging information from each case (i.e., information on threats, subversive actions, and various perspectives), and piecing it together over the lifespan of each case, required a multifaceted approach. First, from 2012 to 2013 we conducted 17 ethnographic interviews based on a grounded approach (Savage, 2000). Interviews were conducted in Spanish and lasted 1-4 hours. Individuals selected for interviews were those directly involved with the cases and/ or who were experts in those cases. Interview protocols slightly differed depending on the case. For example, in cases where conflict was experienced, more-structured interviews focused on how conflict evolved over time. Questions also elicited which actors were involved, what actions were taken, and the consequences or outcomes (Lewicki et al., 2003). In cases where conflict mitigation was mostly successful, interviews protocols were flexible. We also organized four focus groups to better understand the more successful cases. These focus groups afforded a more vibrant setting (vs. a structured interview) where diverse parties (from cases where there was relatively little conflict) could relate insights that could be validated by their peers. Three focus groups for Case #1 included mostly farmers and some public sector employees. One focus group for Case #4 included the members of the collective organization the *Comisión para el Manejo de las Cuencas Potrero-Caimital*. We triangulated information obtained via interviews and focus groups with relevant case documents. Integrating this additional information, which included 'non-peer reviewed reports' (i.e., government reports) and 'other material' (i.e., meeting logs and legal documents) (Table 4.1), allowed for case enhancement and verification. Triangulation also afforded supplemental information for instances where potential informants were no longer for cases that had run their course.

Table 4.1

Information Sources Used for the Case Studies

	DRAT	**Nimboyores**	**Mala Noche**	**Nicoya**	**Sardinal**
# Of interviews	4 (Feb-April 2013)	3 (March-May 2012)	3 (March-May, 2013/ Sept. 2013)	4 (Jan-April 2013/ Aug 2013)	3 (March-May 2012)
Focus groups	3 (Feb-March 2013)	-	-	1 (Aug 2013)	-
Reports	5	17	12	10	10
Other material	11	27	20	7	5

5. Results

5.1 Case briefings. *5.1.1 Case #1: Arenal-Tempisque Irrigation District (DRAT).*

The 28,000-hectare DRAT is the largest irrigation system in Central America. It was built to improve living conditions and to increase agricultural production and regional economic output. Since 1980, a series of multi-million dollar loans have been extended to the state to build the DRAT, which provides up to 65m^3/s of water to farmers through gravity-fed irrigation channels. The responsibility to allocate water and to construct/ maintain irrigation channels falls to the Cañas branch of the National Subterranean Waters, Irrigation, and Drainage Service (*Servicio Nacional de Aguas*

Subterráneas, Riego y Avenamiento - SENARA). Larger commercial farms use irrigation water to produce export rice, sugar cane, and tilapia; and smallholder farmers grow rice, fruits, and vegetables for domestic markets and personal use. DRAT managers and farmers would seem to be at odds with organizations that aim protect the Palo Verde National Park, the first internationally recognized wetlands in Central America, which lies in the middle of the DRAT. However, beyond some contamination issues, no significant water conflicts occurred during the first two decades of the DRAT. The DRAT was designed during a period of relatively more rainfall, about 100mm (8-10%) more per year on average in comparison to 2003-13.

SENARA began operating the DRAT under water scarcity conditions for the first time in 2006. Having never experienced scarcity before, SENARA developed a new scheme to allocate limited water supplies to different user groups. The new scheme determined that each hectare of land would receive the same amount of water regardless of its ownership or usage. Different types of farmers have responded in different ways. Commercial farms have acquired smallholder farmers' land and water rights, and then re-distributed their water as needed. Farms with sufficient capital also increasingly pump water from rivers or drill unregistered wells to supplement their irrigated water. Smallholder farmers, lacking the resources to drill wells, have resorted to destroying and illegally damming irrigation infrastructure to gain access to supplies - leaving their downstream neighbors with less water. On one recent occasion, a SENARA official was intentionally injured by a farmer's moving vehicle in an altercation. Since 2006, the makeup of water-users in the DRAT has changed now favoring larger and better-resourced landholders.

5.1.2 Case #2: Nimboyores. In 1998, *Desarrollos Hoteleros de Guanacaste* (DHG) was granted permits to build four wells over the Nimboyores aquifer near the town of Lorena to supply water for tourism development 16km away on the Pacific Coast. The ASADA in Lorena and local organizations were not informed of the project. By 2001, the pipeline was halfway finished when water scarcity concerns were brought up during mass at local parishes. Community organizations responded by blocking access to the pipeline's construction site and filed formal complaints with agencies and watchdog groups. AyA and MINAET determined to resolve the issue with communities, rather than through the courts. All parties agreed to establish a steering committee that consisted of community groups, AyA, MINAET, the County, and the ASADA; and they committed to meet regularly in order to reach a resolution. Agency officials were cautious at the initial meetings, and reported being fearful of intimidating residents who carried clubs. Parties could not agree on how much groundwater could be safely withdrawn. In reaction, AyA performed a study of the aquifer and concluded that 600 l/s could be safely withdrawn. But community groups questioned whether AyA was the legitimate authority of groundwater resources. Opposition leaders approached SENARA, whose responsibility is to manage irrigation systems and their groundwater supplies, about studying the local aquifer. SENARA agreed and concluded that 170 l/s was maximum safe yield. All parties accepted SENARAs estimate and agreed the project could be completed as long as transported water was made available to coastal communities (in additional to tourism development) as well. However DHG, who was not involved in the resolution process, was no longer interested in the project and had secured water for the project on their coastal property. Following the conflict case, the

County of Santa Cruz, under an agreement with national agencies, established an ASADA coordinator position (despite not being officially responsible for ASADAs) that aimed to mediate between rural communities and broader governance actors. The coordinator position has been largely successful, although its scope is limited to within the County. And, how well ASADAs represent communities or effectively manage resources varies even within the Municipality.

5.1.3 Case #3: Río Mala Noche. Three ASADA communities – Sámara, El Torito, and Santo Domingo - share water resources in the Mala Noche. Groundwater in lower basin is the only water source for Sámara and El Torito. In the upper basin, Santo Domingo relies on springs. The ASADAs manage water in the basin with little interference or direction from national agencies. Since the 1960s, a lumber company has owned much of the land outside of townships in the Mala Noche. Santo Domingo has water rights to springs in the upper basin. Since the 1970s, Sámara has been allowed to operate wells on private land in the lower basin. El Torito though has been unable to secure access better parts of the aquifer that lie below private land in the lower basin.

Persistent conflict started in the early 2000s, when Sámara took legal action to halt a condominium project suspected of draining contaminants into the Mala Noche. Although the project proceeded, the defeat spurred Sámara's leadership to take a pro-active approach to secure its water supplies. Sámara successfully lobbied SENARA to study the Mala Noche and began attempts to gain rights to the land surrounding its well. SENARAs study, which labeled groundwater in the Mala Noche as 'extremely vulnerable, was used by Samara as a basis to legally challenge land rights in the basin and to halt development projects that infringed on the Mala Noche. A Regional court

eventually prohibited development on the private land immediately around Samara's well, although the land remained privately owned. Tensions among ASADAs surfaced when the company holding land rights in the upper basin proceeded with plans to transport water out of the upper basin. Developers agreed to share water with Santo Domingo in exchange for support, which divided ASADA interests. AyA, seeing the persistent problems in the Mala Noche, organized a committee with all ASADAs participating, but the committee quickly dissolved.

With increasing tension, an individual, targeted act of dissent disbanded Sámara's pro-active leadership. With less-visible leadership and no new projects to contest after the 2008 economic crisis, conflict cooled. In 2012, the *Municipalidad de Nicoya*, who is responsible for land-use planning in the area, updated zoning guidelines in the County. The update was challenged by Sámara, which again sought total protection of the Mala Noche. The update did not ultimately settle land rights issues, but new leadership began interacting with other water governance schemes in nearby Nicoya. Following a 2013 workshop in Nicoya where all ASADAs participated, new leaders orchestrated the first self-organized ASADA meeting to discuss improving collaboration and the potential of forming a single governing body. In this process, local managers noted that collaboration and trust increased, including with the private company in the upper basin.

5.1.4 Case #4: Nicoya. About 30,000 people use water from the Río Potrero and nearby groundwater. The City of Nicoya relies entirely on surface water; several community ASADAs pump groundwater; the largest agricultural producer in the area lies directly over groundwater (and upstream from where Nicoya takes surface water); and the Town of Hojancha uses transported groundwater. Despite seasonal scarcity and the

seeming potential for conflicts, the area has not seen any. Recognizing the potential for severe water problems in Niocya and after witnessing the conflict in nearby Nimboyores, a group of leaders from a local MINAET office, the *Universidad Nacional*, and local ASADAs drafted the first management plan for the area in 2004. The plan helped establish the *Comisión para el Manejo de las Cuencas Potrero-Caimital* and it's affiliated non-profit *NicoyAgua*. Although the *Comisión* cannot implement formal rules, its actions and its growing influence have mitigated water challenges that many other areas in Guanacaste have struggled to address: very little was known about available water supplies; mediation among actors who share groundwater resources is required at times; and engagement with surrounding rural communities disconnected from formal governing efforts can be logistically difficult.

The *Comisión* has been increasingly successful at facilitating communication among agencies that typically do not interact and has reached out to rural community groups. They have also negotiated land swaps with businesses to reforest some groundwater recharge areas. *Comisión* members, who now include a diverse set of actors, meet once a month to discuss problems and potential solutions. Current (2012-13) efforts, which grew out of a collaborative assessment effort with local and international researchers, seek to grow the *Comisión* toward a regional water management group (which in 2013 covered four sub-basins vs. one sub-basin in 2004) to secure water supplies for the future and avoid conflicts. As a part of this effort, the *Comisión* supports communities to better organize and offers education on resources that are available to help meet water challenges. In 2013, they began a new partnership to study water systems. Water governance in Nicoya has become more inclusive, better coordinated, and

the involved actors are keen to leverage collaboration to increase water system knowledge.

5.1.5 Case #5: Sardinal. By January 2008, a 23km pipeline that would transfer groundwater below the community of Sardinal to tourism development in *El Coco* on the Pacific Coast was three-quarters complete. Prior to constructing the pipeline, the developers formed Costa Rica's first public-private partnership for water resources development. The developers fronted money to construct the pipeline and planned to transfer pipeline ownership to *AyA* after it was complete. In this way, developers aimed to bypass the long wait for building new public water infrastructure while still complying with water laws. *AyA* held a public meeting in Sardinal to announce the nearly finished project and expected a positive (even thankful) reception by the local community. Instead, shocked *AyA* officials and developer representatives had to be escorted out of the contentious meeting for their safety. Concerned Sardinal residents then formed the Water Defense Committee to organize resistance. The Committee received substantial support from the *pastoral social* of the Diocese from nearby Tilaran and Liberia. These groups were involved in opposition to the Central American Free Trade Agreement (which was still being deliberated in Costa Rica at the time). In March 2008, the Committee organized two protests. The first protest was peaceful. In the more raucous second protest, riot police tear gassed the crowd of about 600 protestors. Five demonstrators were arrested and the case landed in the Constitutional Court.

The Court initially ruled that the community must be involved in the project. So *AyA* created another committee with selected representatives from the community to manage the project. No one who opposed the project was selected for the new committee,

and negotiations continued as they had before. The opposition did not trust *AyA*'s reports that concluded water supplies were sufficient for the project to proceed. *AyA* then proposed to halve the pipeline's flow rate, which the opposition deemed to be suspect since the pipeline was nearly finished. Negotiations stalled as parties awaited another Court ruling. The Court eventually ruled there was not sufficient evidence of adequate water supplies to warrant the pipeline, which seemingly ended the dispute. However, in non-typical fashion, the Court issued a series of clarifications to their initial decision, which removed legal obstacles for completing the pipeline. During an annual public holiday period, the *Municipalidad de Carrillo* quietly granted the final approval for the project to resume. However, the developer consortium had dispersed following the 2008 economic recession and the pipeline was not finished.

Table 4.2

Basic Case Information

	DRAT	**Nimboyores**	**Mala Noche**	**Nicoya**	**Sardinal**
Duration	1980-2013	2001-2006	2002-2013	2004-2013	2008-2011
Sub-basins	Tempisque/ Bebedero	Cañas/ Nimboyores	Mala Noche	Potrero, Upper Nosara, Quiriman/ Caimital	Sardinal

Municipality population, 2011	Cañas (26,201), Bagaces (19,536)	Santa Cruz (55,184)	Nicoya (50,825)	Nicoya (50,825), Hojancha (7,197)	Carrillo (37,122)

5.2 Case synthesis: Why did some conflicts escalate while others did not*?* More intense conflicts were set off in settings of high friction between agencies and disconnected community-based institutions and without active regional-scale leaders. This friction materialized through escalated conflicts when local groups aimed to influence decision-making despite limited available avenues to do so – such as in Sardinal and Nimboyores (P1 row, Table 4.3). In the DRAT case, some farmers without the means to cope with reduced water deliveries or to reach governing actors, damaged irrigation infrastructure to secure water. In contrast, well-coordinated and accessible multi-level governance with effective regional leadership supported actor's efforts to resolve or mitigate water conflicts. For example, in the Nimboyores resolution, a new municipal position was established to provide leadership and convey information to and from rural water-user groups. Learning from Nimboyores, actors in Nicoya established collective efforts that provided avenues for rural communities to access governing processes that otherwise remained unreachable. Although these avenues were largely informal since the PC Commission is not a formal decision-making organization (although it does substantially influence decisions), they did help facilitate successful conflict mitigation. In the Mala Noche, we see differing aspects of leadership. Early

leadership guided actions against private actors that sought to utilize or potentially affect poorly understood groundwater resources. More recent leadership has sought to enable cooperation in the basin in spite of historical tension and other challenges.

Table 4.3

Comparing the Governance Features and Conflict Process Across the Cases.

	#1: DRAT	#2: Nimboyores	#3: Mala Noche	#4: Nicoya	#5: Sardinal
P1: Decision-making (↑more open; ↓less open)	↓ Mostly exclusive, but decisions based on normative system of fairness	↓⋆ Community excluded initially; developer excluded during negotiations	↓ Land-use planning does not include ASADAs	↑ Many decisions are made with an aim to be inclusive	↓ Community excluded; reports of pipeline being constructed at night
P2: Learning (↑ present; ↓ not present)	↓ Some recent efforts to better monitor system, but unclear if new knowledge is acquired/ how it will be applied	↓ Uncertainty of groundwater supplies; poor ability to reach agreement	↓⋆ Little significant learning until new leadership meaningfully connects with actors outside of system	↑ Partnerships with universities help improve knowledge and ID problems	↓ Uncertainty of groundwater supplies; poor ability to reach agreement

P3: Leadership (↑more enabling; ↓ less enabling/ more controlling)	↓ Leadership from agency controls system	↓⋆ Leadership from agencies seeks to control system	↑ Early leader seeks to enable conservation amidst tension during real estate boom; later leader cooperation and new ideas	↑ Consistent and diverse group of leaders aim to enable localized problem solving	↓ Leadership from agency initially seeks to control system; no active leadership during conflict process
S1: Arrangement (↑ more dispersed/ decentralized; ↓ less dispersed/ more centralized)	↓ Agencies are central with all authority; all information goes through agencies	↓ Agency is central, with most authority	↑ Very dispersed, three autonomous ASADAs share water in same sub-basin	↑ Dispersed, connections coordinated through regular processes	↓ Agency with central, nearly all formal authority
S2: Integration (↑higher integration;	↑ Highly integrated among agencies and b/t agencies and	↓⋆ Low integration between agency and local	↓⋆ Low integration among ASADAs and b/t agency and	↑Integration and coordination increases	↓ Low integration between agency and local organizations

↓lower integration)	producers	organizations	ASADAs		
S3: Roles (↑well defined; ↓ loosely defined or missing roles)	↑ Mandates and quotas for the DRAT delineate clear roles for agencies and responsibilities	↓⋆ No mediator b/t national and local actors; vague roles related to groundwater	↓⋆ No role that coordinates local actors; roles related to defining land and water rights are contested	↑ Comisión fills mediator role between actors and encourages engagement	↓No mediator b/t national and local actors; vague roles related to groundwater
Conflict trajectory (≠Latent/ no conflict; ↑low or medium intensity; ⇑ higher intensity)	≠ ↑ ⇑ ≠ No visible conflict until supply does not meet seasonal demand; farmers damage irrigation infrastructure to take water; and one violent	↑ ≠Medium intensity initially (protest and intimidation); reduced to low intensity/ latent over years of	↑ ⇑ ≠↑≠ Low conflict for years; one violent act targets leadership; conflict fades during economic slump then resurfaces over zoning	≠ Challenges are successfully addressed to the point where they do not escalate into formal conflicts	⇑ ↑≠ Quick escalation in conflict intensity approaching violence - fear, protests w/ arrests; years of low conflict

incident against a public worker	localized negotiation	dispute; new leaders now aim for organized cooperation in basin	as negotiations stalled; court decisions required

Even in challenged settings that feature high friction between disconnected institutions that operate at different levels, the presence of individuals with the drive and will to address shortcomings of water management allowed for conflict mitigation potential (P3 row, Table 4.3). We detected a surprisingly large degree of interactions and learning among actors across some cases. Learning from leading individuals across three cases - starting with Nimboyores, to Nicoya, and then to the Mala Noche occurred. However, Table 4.3 shows the most recent Sardinal case follows a similar trajectory as Nimboyores, which occurred nearly 10 years prior. Thus some areas within Guanacaste used nearby water conflicts as learning opportunities to improve governing efforts while other areas did not. While pro-active individuals in Nicoya strengthened the *Comisión* after Nimboyores, little changed in Sardinal where unresolved friction remained a risk. Although the Sardinal case went quietly unresolved, more successful efforts in Nicoya were validated. Shortly after Sardinal, efforts in Nicoya aimed to further improve through new partnerships that assessed water governance and started building a more effective regional presence (e.g., Kuzdas et al., 2013; 2014b) that was reached by interested actors in the Mala Noche.

Distrust among actors, institutional legitimacy issues, and poor water system knowledge predicated conflict intractability in the cases (P2 row, Table 4.3). The underlying factor within these aggravating factors was often current and historically ineffective stakeholder engagement (S1, S2 P1 rows in Table 4.3). Poor engagement often coincided with legitimacy issues concerning who was responsible or had the authority to govern what (S3 row, Table 4.3). In the DRAT, a state employee was targeted during an act of dissent. In Sardinal and Nimboyores, local groups rejected water

system studies performed by national agencies. In the Nimboyores case, resolution processes advanced after parties sufficiently addressed how water-benefits would be re-distributed to communities and created a new governing role to better account for rural communities. In Nicoya, effective stakeholder engagement processes organized by a collective group (which had the backing of agencies) reached some otherwise disconnected rural communities. In the Mala Noche though, we saw self-organized basin planning by local actors had difficulty overcoming histories of tension among actors, vague resource rights, and unclear governing responsibilities. The progression of the Mala Noche conflict shows however that self-organized conflict resolution and mitigation is viable if face-to-face cooperation venues are logistically available and if supportive, successful governing examples are accessible and visible to local actors (see trajectory of Mala Noche in Table 4.3).

5.3 Governing contexts: Water scarcity, access and political economy conditions. While we do not provide in-depth analysis of the potentially wide range of governing contexts here, we do illustrate some of the linked, broader context issues we found to be relevant. Scarcity that involved water access issues closely tied to political economy conditions were important. One intense altercation involved access to limited irrigation water in the DRAT under extenuating circumstances where a smallholder farmer had no alternative access options. In the Mala Noche, the economically poorest of the three ASADAs was unable to access quality groundwater below privately held land (that was deeded prior to modern coastal development regulations implemented in the 1970s) that another, better resourced ASADA was able to secure through legal actions. Consequently, the former ASADA must rely on suspect sources and experiences seasonal

shortages. Over time, this situation increased the former ASADAs suspicion of and even animosity toward governing attempts in the basin. The former ASADA felt the latter was better able to capitalize on tourism and real estate investment in the area (which required sufficient water for development). While a vast majority of the water disputes in the Mala Noche involved ASADAs taking actions against developers, the key factor in the most escalated point in the Mala Noche conflict was this feeling of disparity among ASADAs. Generally ineffective governance combined with broader political economy trends had over time allowed increases in disparate water access and economic well-being in the area. In Sardinal, we saw another aspect of the link between scarcity, access and political economies. Here, developers attempted to access water sources used by local communities where the perceived threat of scarcity, combined with distrust, precedents of poor stakeholder engagement, and low political legitimacy contributed to the escalation of the conflicts. While features such as distrust, poor engagement, and low political legitimacy directly impacted conflict outcomes, they are also (as we noted in the case introduction - Section 3) deeply rooted in social, political, and economic trends involving weakened state governments and feelings of disenfranchisement especially within rural groups. However, water governance played a role mitigating these broader context issues in some cases. The resolution process of Nimboyores aimed to correct eroded trust and rural disenfranchisement issues present in the areas. Actors in Nicoya improved on these issues over several years through a collective organization and have yet to experience harmful conflict.

6. Discussion

6.1 Implications for current and alternative water governance regimes to aggravate or mitigate conflicts.

In Table 4.4, we use case insights to identify potential water conflict risk factors, mitigation abilities, and promising mitigation strategies within three general types of water governance regimes (centralized, polycentric, fragmented) within the context of the Central American dry tropics (left side of Table 4.4). We use the exploratory framework (Figure 4.1) and evidence from the cases to assign expected values of water governance process features (*P1-3* in Table 4.4) and structural features (*S1-3* in Table 4.4) for each hypothetical regime-type. As expected, no one case offered a perfect example of one governance scheme or another (i.e., Huitema et al., 2009). However the diversity of governance schemes within the cases, the different processes or changes experienced in each case, and the different degrees that each case exhibited fragmented, centralized, or polycentric patterns allowed for sufficient breadth of evidence within the given context. We also use insights from the cases to identify potential conflict risks, conflict mitigation abilities, and offer promising initial strategies for each hypothetical governance scheme (S1-3 and P1-3 in Table 4.4) within the defined governing context (described on left side of Table 4.4). The schematic in Table 4.4 facilitates a structured discussion of the potential implications of current and alternative water governance regimes for effectively mitigating harmful water conflict in the Central American dry tropics.

Table 4.4

Schematic that Identifies the Potential of Alternative and Hypothetical Governance Regimes to Aggravate or Mitigate Water Conflicts in the Central American Dry Tropics.

In the context of the Central American dry tropics...	**...And, with governance regimes that display these features within centralized, polycentric, or fragmented water governance...**				**...What aggravating conflict risks are potentially present?**	**...What abilities to mitigate conflicts are potentially present?**
		Process features		*Structural features*		
Water scarcity and drastic seasonal variability; high resource competition; some tensions over water are highly visible in media and society; existing water	***Centralized water governance***	*P 1* Closed decision-making	*S 1* Governing authority held by central actor(s)		Lower potential to collectively learn about complex water systems; Ineffective stakeholder/ community engagement; Decisions may not reflect important local or regional contexts	Moderate: Some capacity if sufficient political legitimacy, buy-in from constituencies, and administrative resources are present, which may be a challenge in rural areas already experiencing water conflicts
		P 2 Lower degrees of social learning	*S 2* High vertical, low horizontal integration			
		P 3 Leadership seeks to	*S 3* Clear roles and responsibilities at			

conflicts; rapid population growth; agriculture and tourism-driven economies; increasingly open to, and dependent on, global markets; citizen (often rural) dissatisfaction with national government		control	least in public sector		
		...And, what might be potential starting points for strategies that aim to mitigate harmful conflict within this governance scheme? <u>*Short-term mitigation strategies*</u>: Anti-corruption/ transparency policies, joint fact-finding over water system states. <u>*Long-term transition strategies*</u>: Measured transfers of some shared authority to regional/ community scales, legitimize basin-scale planning processes and existing leaders, ensure mechanisms that reach disconnected, rural groups are preset and effective			
	Polycentric water governance	*P1* Open and inclusive decision-making	*S1* Governing authority is dispersed across scales and locations	In areas with long histories of conflict or poorly defined land or water rights, more decentralized schemes may be ineffective at mobilizing	High: Potential of mitigating effects from mutually reinforcing relationships b/t open decision-making, social learning, and enabling leadership; requires
		P Higher	*S* Moderate vertical,		

2	degrees of social learning	*2*	moderate-high horizontal integration	sufficient resources and authority in order to initiate effective dispute resolution and mediation processes	commitment to coordination; may be difficult to implement conflict resolution processes in some very tense situations
P 3	Leadership seeks to enable	*S 3*	Mostly clear roles and responsibilities		

...And, what might be potential starting points for strategies that aim to mitigate harmful conflict within this governance scheme?

Short-term mitigation strategies: Reinforce coordination commitments and sanctioning mechanisms, ensure clearly defined resource rights, governing responsibilities, and actor expectations. *Long-term transition strategies*: Test/ refine governance processes to negotiate, monitor, and meet goals, ensure the legitimacy and accessibility of vertical accountability mechanisms,

water	*P 1*	Ad hoc decision-	*S 1*	Governing authority is	Institutional uncertainty may allow for elites to	Low: capacity to anticipate/ recognize problems and to act

	making		dispersed unevenly	gain power/ benefits at expense of others; unclear governing objectives and low coordination encourage unilateral action	appropriately in response is potentially diminished due to low degrees of coordination, accountability, and institutional clarity; innovation and collective action may make minimal impacts if power asymmetries are prevalent and acted on
P2	Potentially moderate degrees of social learning	*S2*	Low-variable vertical and horizontal integration		
P3	Leadership may be inactive or variable	*S3*	Fuzzy roles and responsibilities		

...And, what might be potential starting points for strategies that aim to mitigate harmful conflict within this governance scheme?

Short-term mitigation strategies: Invest in regional governance and leadership development; consult/ collaborate with university programs or other, more successful water governance examples within or near region; review/ adjust governance communication practices. *Long-term transition strategies*: Institute processes that build and practice coordination between scales and locations; focus on development of vertical accountability mechanisms and inclusion of potentially disconnected groups

***6.1.1 Centralized governance regimes*:** Water governance in Central America was highly centralized and many still are today (Booth et al., 2010; Rogers, 2002). We would expect such governance regimes to be at potential risk of water conflicts due to their limited ability to include diverse, especially rural, stakeholders in governance processes and their lower tendency to promote collective learning regarding water systems and the water needs of stakeholders from unique regions. Successful conflict mitigation in these contexts potentially depends on securing sufficient trust from stakeholders and the fair allocation of administrative resources that are needed to efficiently solve local problems. Relevant issues such as disenfranchised constituencies (Edelman, 1999) and corrupt and weakened states (Eakin & Lemos, 2010) may hinder conflict mitigation. Short-term mitigation strategies within centralized regimes could focus on improving transparency, encouraging joint fact-finding ventures with local stakeholders to increase collective water system knowledge, and repairing trust. Long-term success may require more shared decision-making authority to be distributed to regional-to-local levels in order to better account for unique conditions faced in the rural, dry tropics (Eakin et al., 2011).

6.1.2 Polycentric governance regimes: Polycentric water governance designs that are fitted to regional contexts, feature committed leadership, and emphasize vertical accountability offer reasonably high conflict mitigation potential. Mitigation abilities potentially benefit from mutually reinforcing processes: open decision-making, learning, and enabling leadership. Possible conflict risk may be present if historical tensions between actors and vague resource rights and governing responsibilities exist. If not

addressed, these risks may allow for some elites to gain disproportionate power if accountability mechanisms are not effective (i.e., Persha & Andersson, 2013). In some polycentric settings, self-organized actors may struggle to initiate conflict resolution and mitigation processes. Here, more centralized mechanisms and well-resourced actors may help begin effective mediation processes in some tense situations. Promising mitigation strategies for more polycentric configurations potentially include reinforcing commitments face-to-face basin planning processes that are logistically feasible (especially for governing actors that may be poorly resourced) and alignment or open discourses of actor expectations. Long-term efforts could fortify processes that elaborate collective goals, monitor progress toward goals, and ensure the continued effectiveness of stakeholder engagement.

6.1.3 Fragmented governance regimes: Lower abilities to anticipate, recognize, and coordinate diverse actions to solve problems allows risks for fragmented governance schemes. Here, little or logistically challenged communication among actors might be expected as well as unclear governing responsibilities and less-effective accountability mechanisms. These conditions potentially allow for actors to take unilateral governing actions – especially without input from disadvantaged or disconnected rural groups. Strategies might initially focus on identifying existing and securing new financial, personnel, and technical investments in regional-scale governance and securing commitments to face-to-face planning processes. Such investments and commitments may initially help build regional mediators between opposing national and community-scale institutions and discourage governance actors from taking unilateral actions or circumventing fair governing processes. Available resources for new efforts might be

found in local university programs, which were used to support good water governance in Nicoya, as in other places (i.e., Atkinson-Palombo and Gebremichael, 2012). Long-term efforts are challenged to devise feasible action plans that are amenable to diverse actors (some of whom may be benefiting from current conditions) in order to practice and legitimatize cooperation and coordination.

6.1.4 Dynamic governance regimes in the Central American dry tropics.

Guanacaste as a whole affords a proxy for centralized water governance regimes that, due in part to various pressures (i.e., from global economies, public funding cuts), are shifting towards more institutionally and administratively fragmented regimes without well-coordinated nor well-defined governing responsibilities below the national-level (Edelman, 1999; Kuzdas et al., 2014a). In Guanacaste, this hybrid water governance scheme retained some risks of centralized schemes (i.e., non-transparent, poorly fitted to local contexts) while assuming additional risks associated with more fragmented schemes. Accordingly, these change processes within governing schemes could allow for potential conflict risk in settings where power (i.e., through water allocation mandates, rights, or political access) is disproportionately held and acted on by relatively few and where local groups are not accounted for. Here, long-term strategies that aim for more responsive, vertically accountable, and polycentric governance schemes are important for mitigation efforts. Within Guanacaste, each case played out and was resolved (or not) in different fashion, so a measured and multi-faceted approach to conflict mitigation and ultimately, to changing governance regimes, rather than a one-size-fits-all approach will be important. Involving groups – especially those who are not included within current water governance regimes – will be a key logistical effort for devising and implementing

alternative governance schemes. Strategies that initially reduce governing uncertainty (i.e., who has rights to what and responsibility to do what?) and that deploy strong, legitimate leaders to potentially offset interests that are willing to use economic or political power to circumvent fair processes may be an effective first step to help re-organize institutions and actors prior to implementing or testing more polycentric schemes.

6.2 Implications for future water conflict research. In spite of tough challenges facing the region, prospects for successfully mitigating harmful water conflicts remain reasonable. Importantly, water conflicts were not uniformly experienced within the region, a number of individuals committed to solving water-related issues were active, and each case unfolded in a unique manner. Knowledge transfers within regions, learning by example, and existing leaders could offer reasonable starting points for strategies within a variety of contexts that aim to overcome institutional and political challenges that matter for successful conflict mitigation – such as better accounting for rural community interests and power imbalances that negatively affect within multi-level governance schemes. Accordingly, water conflict research that addresses problems and their potential solutions within meaningful and decision-relevant contexts offers an alternative approach to support water conflict-prone regions. This thread of research offers potentially useful and improved links to water administrators and policy makers that aim to avoid water conflicts in their professional efforts. How to do so, and clarifying what that step sequence would look like in various contexts, and learning from diverse cases, is an important future research need.

7. Conclusion

Aggravated water conflicts in Guanacaste are driven by the friction between fragmented institutions for governing water resources that operate at different – local and national – scales in the absence of effective regional-scale governance schemes. These institutional schemes have been shaped by Costa Rican political and economic trends that are increasingly oriented toward global markets and often times leaving rural groups out of key decision and planning processes. Once a conflict materializes, the mixture of citizen mistrust and the poor state of regional water system knowledge – especially concerning groundwater - is a primary aggravating factor. The common denominator in this mix of conflict aggravating factors is ineffective stakeholder and citizen engagement. Initiating basin-oriented, cooperative planning in areas that feature self-organized local actors, histories of conflict, and poorly defined land and water rights can be a significant challenge. Committed and legitimate central actors with sufficient resources may be needed to initiate cooperation and resolution processes in such cases.

Yet, even in aggravating-contexts, successful mitigation potential existed if face-to-face cooperation venues and supportive, successful governing examples from nearby areas were accessible to local actors. The approach and case studies yielded a schematic that identifies potential conflict risks, mitigation abilities, and promising mitigation strategies across a range of governance schemes in the dry tropical Central American context. Polycentric water governance schemes that are fitted to regional contexts, that feature enabling leadership, that fairly resolve water access issues, and that emphasize vertical accountability offer conflict mitigation potential. Centralized governance regimes that undergo institutional/ administrative fragmentation allow potential risk of aggravated

conflicts in settings where power is disproportionately held and where local groups are not accounted for. Results demonstrate that water conflicts are not uniformly experienced within regions nor do conflict processes unfold in consistent manners over time - which has implications for realizing effective water governance and useful water conflict research. Knowledge transfers within regions, learning by example, and existing leaders offer promising starting points for overcoming institutional and political barriers that obstruct conflict mitigation potential. Such efforts might focus on governance strategies that intentionally avoid fragmentation and institute transition processes and strategies that seek to implement more balanced, polycentric water governance designs over time. How do so, and clarifying what that step sequence would look like, in various contexts is an important research need. Such strategies will be critical for achieving sustainable water governance in conflict prone, climate threatened regions.

Chapter 5

Governance scenarios for addressing water conflicts and climate change impacts

1. Introduction

The persistence of complex water problems is often attributed to deficiencies in how water governance regimes are designed, implemented, and changed (Uhlendhal et al., 2011; Wiek & Larson, 2012; Biggs et al., 2013; Gutiérrez et al., 2013). We refer to governance as the set of collective actions that steer socio-ecological systems toward shared goals and are coordinated among diverse actors (Lubell et al., 2008). Successful steering requires, among other things, the anticipation of future developments and acting on the results of that 'anticipation' though decisions and policies (Nelson et al., 2007; Guston, 2008; Fuerth, 2009). Research often concludes that an anticipatory approach to governance is needed to adequately confront complex water challenges (Schneider & Homewood, 2013). And, scenarios are proposed as a practical tool to aid these anticipation efforts (Quay, 2010). *Governance* scenarios portray alternatives to current governance regimes and inform people about what they could do differently in governing water. Governance scenarios that are integrated within transformational planning processes (i.e., Wiek, in review) intend to support actors to positively change and improve upon inadequate governance. Yet, current water-related scenarios often do not portray alternative governance regimes nor are they integrated within such efforts (Dong et al., 2013; Haasnoot & Middelkoop, 2012). If governance scenarios are to support people to articulate and implement alternative, more sustainable governance regimes, this presumably requires them to also be well integrated within real time governing processes. Yet, there remains a lack of clarity on what scenario features facilitate or hinder their

integration into governing processes (Wright et al., 2013) and there remains few examples by which to learn about how water governance scenarios are built, applied, and fit within transformational planning processes. Such clarity and learning examples are critical if anticipatory approaches, and scenarios studies in particular, are potentially able to successfully meet their intentions to support change in untenable governance regimes (Hulme & Dessai, 2008; Wiek et al., 2006).

In this study, we developed scenarios in order to 'bring to life' alternative water governance regimes in Guanacaste, Costa Rica. The study was integrated into a broader transformational research and planning process and, accordingly, was built on previous water governance research in the region (i.e., Kuzdas, 2012; Kuzdas et al., 2014a; 2014b). Through implementing these previous studies since 2009, the need for and interest in re-imagining and re-designing water governance was established and grew with stakeholders in the region up until the scenario study we present here was initiated in 2012. This afforded the research team an opportunity to focus on how to optimally deploy alternative governance scenarios to support change towards more sustainable water governance regimes in the region. The guiding questions of the study were: What are consistent and alternative scenarios of the water governance regime in Guanacaste? And, how can scenarios support the re-design of currently unsustainable water governance schemes? What are their limitations?

The Guanacaste case offers insights into the opportunities and challenges of developing and applying anticipatory approaches in regions that experience water conflict, climate threats, and governance regimes that often fail to adequately resolve challenges. This scenario study, although tailored specifically to Guanacaste,

demonstrates how regions facing water challenges can use scenarios, in spite of their limitations and if integrated into a larger transformational planning process, as a constructive step towards sustainable water governance.

2. Study Context

Guanacaste Province is a traditionally rural region that experiences a distinct 6-month annual dry season. By 2011, Guanacaste's population increased five times, in comparison to 1950, to 325,000 people (INEC, 2011). In its early years (1950s ff.), Costa Rican democracy was known as responsive and progressive (Booth et al., 2010). During this time, the public sector substantially increased in order to meet citizen needs. For example, Edelman (1999, p.70) notes that over a 30-year period the number of public agricultural organizations nearly tripled. During this time, many public organizations important for water management were formed such as the Environment, Energy, and Telecommunications Ministry (*Ministerio de Ambiente, Energía, y Telecomunicaciones*, MINAET), which oversees general water management and conservation activities in the country. Growing populations in rural areas tested the ability of the national water utility - the Costa Rican Institute of Pipes and Sewers (*Instituto Costarricense de Acueductos y Alcantarillados*, AyA) - to meet its responsibility to deliver potable water to citizens. As a result, communities increasingly organized in the water sector, with an estimated 1,500+ rural community-run water associations (ASADAs) now operating (Madrigal et al., 2011). ASADAs perform AyA's duties in rural areas, but are governed autonomously by community boards. Two primary pieces of legislation provide the substance current water management frameworks. Article 50 of the Constitution guarantees healthy and clean environments for citizens. The 1942 Water Law prohibits

private ownership of water resources. Accordingly, water management is carried out by agencies in a context that typically protects citizen's rights to organize and to generally influence environmental management.

Decades of State-led neoliberal economic reform helped enable a real estate boom in Guanacaste from roughly 2000 to 2008. This boom stressed increasingly fragmented water governance regimes that were already struggling to meaningfully involve sub-provincial actors and rural water users. In contrast to other countries in Latin America that heavily pursued decentralization schemes in the water sector, the authority to govern water in Costa Rica has largely remained with state agencies (Rogers, 2002; Biswas et al., 2009). In Guanacaste, water governance operates as a hybrid centralized institutional scheme that is increasingly fragmented below the national-level with highly variable technical, financial, administrative, and logistical capacities among actors (i.e., agency offices and ASADAs) in different places. Edelman (1999) found that neoliberal economic reform created widespread feelings of disengagement toward agencies in rural areas. In the past, many communities viewed the State as a supporter of rural lifestyles. This shift in citizen's attitudes, Edelman (1999) notes, was an important driver of organized farmer resistance toward the State in the 1980s. Much of this resistance originated in Guanacaste, with Municipality of Nicoya (2011 population: 51,000) being a stronghold. In a similar thread, Seligson (2002) documented widespread declining trust towards public institutions, speculating that this trend could indicate "trouble in paradise."

Agriculture and tourism are both prominent economic drivers in Guanacaste that have expanded within this dynamic political-economic context that also often includes deepening social inequalities and unfair water access issues (Booth et al., 2010). Cover

(2007) identified, on average, one water conflict occurred every 52 days over a recent 10-year period in Guanacaste. Kuzdas et al. (2014c) found that more intense conflicts resulted from factors such as unmediated friction between disconnected governing scales, inactive regional leaders, distrust among actors, poor collective knowledge of water systems, and ineffective stakeholder engagement. To make matters more urgent, the region faces drier and hotter climatic conditions in the near future (Anderson et al., 2008). Accordingly, many water managers and administrators in Guanacaste consider mitigating water conflicts to be a top priority.

Despite the persistence of inadequate governance regimes in the region, many individuals from a variety of organizations are active in in the water sector. Similar to past eras of organized resistance, Nicoya remains a geographic hub for tenacious efforts that aim to govern water more effectively, collaboratively, and justly in spite of broader institutional and political barriers (Kuzdas et al., 2013). Many of these efforts are undertaken or supported by the Commission for the Management of the Potrero-Caimital Watersheds (*Comisión para el Manejo de las Cuencas Potrero-Caimital*, PC Commission) that is based in Nicoya. Because of Nicoya's historical and cultural importance in the region, its relatively easy access from a variety of areas, and the research team's track record of collaborating with Nicoya-based stakeholders, it was the primary location for the scenario building process.

3. Scenario Method

We applied formative scenario analysis (Scholz & Tietje, 2002; Wiek et al., 2006; Wiek et al., 2009) to construct alternative water governance scenarios for Guanacaste using the following steps:

3.1 Selecting system variables and performing system analysis. Previous research was used to initially narrow down potential variables relevant for water governance in the region. Researchers and partners from public agencies, local governments, civil society, and businesses selected final variables from that list and identified the impact relationships among all pairs of variables in both directions (e.g, A to B and B to A) in two working group meetings in Costa Rica in March and May 2012. In the meetings, we explicitly focused on using evidence from a recently completed water governance analysis and assessment in the region as the basis to finalize variables and assign impact relationships. These previous research results were delivered to stakeholders in April 2012 via a report designed specifically for them (Kuzdas et al., 2014a). This report helped ensure the impact relationships were assigned using a shared 'framing' of regional governance (i.e., what is the regional water governance regime? How does it work?). Participants had already engaged with previous research and seen the results that this scenario study would build on. Impact relationship types were pre-defined using a simplified scale from 0 (no impact) to 2 (strong impact) (i.e., Wiek et al., 2008). We then performed the system analysis using *Systaim* software with the 17 final variables. The analysis mathematically evaluated the impact relationships among variables and the relative strength of those relationships. The system analysis provided insight into the underlying structure comprised in the scenarios, which helped interpret scenarios in a way that ensures the scenarios represented systemically different governance alternatives (Wiek et al., 2008; 2009).

3.2 Defining future projections and consistency analysis. From March-April 2012, the research team initially determined a small range of reasonable future

projections for each variable in consultation with the aforementioned report. Consistency analysis evaluates the prospect that a pair of future projections could occur at the same time and helps identify scenarios that are without significant contradictions and more plausible e.g., "holding sufficient evidence to be considered occurable" (Wiek et al., 2013). We used a matrix approach to describe the consistency relations between future projections (Scholz & Tietje, 2002; Tietje, 2005). We assigned standardized values for the simultaneous occurrence of a pair of projections (Table 5.1) through a working-group meeting with the PC Commission in April 2012. The PC Commission has members that represent agencies, municipal governments, rural water-user associations, and businesses. It is one of the more successful grassroots water-related organizations in Guanacaste and has played an important role mitigating water conflicts in Nicoya that other areas have struggled to avoid (Kuzdas et al., 2014c). The PC Commission offered a fairly well representative but manageable group that could efficiently contribute to the consistency analysis. The filled-in consistency matrix was analyzed using consistency analysis software to help identify the most internally consistent scenarios (Tiejte, 2005).

Table 5.1

Assigned Standardized Values for the Simultaneous Occurrence of a Pair of Projections

Relation-type	**Consistency value and description**	**# of occurrences**	**% of occurrences**
Conditional	**2** – The occurrence of one projection would require or cause	34	6%

	the occurrence of another		
Supportive	**1** - The occurrence of one projection would support the occurrence of another	159	28%
Independent	**0** – The occurrence of one projection would not affect the occurrence of another	307	53%
Obstructive	**-1** - The occurrence of one projection would hinder or block the occurrence of another	76	13%
		Total: 576	Total: 100%

3.3 Diversity analysis. We then statistically grouped all scenarios that were either completely consistent or that contained one inconsistent relation in order to select the most distinctive ones. To do this, we performed a cluster analysis procedure in SPSS software up to the point where an additional 'clustering' of scenarios no longer significantly differentiated from the previous clusters. We then calculated diversity values (e.g., number of differing projections divided by overall number of projections) to ensure representative scenarios from each cluster were significantly different from each other (Wiek et al., 2009).

3.4 Scenario selection. We selected final scenarios based on the following technical criteria common to the formative scenario method :

- *Few obstructive relations*. Considering the complexity of water governance, we allowed the inclusion of one obstructive relation in eligible scenarios.
- *Sufficiently high consistency*. We defined the cut off for eligible scenarios to have a consistency value of greater than two thirds of the highest consistency value present in the set of scenarios (i.e., Consistency value>72, with the highest being Consistency value=108).
- *Sufficiently high diversity*. We defined the diversity value of an eligible scenario to be more than one third of future projections differing from other scenarios. We calculated this for each scenario in comparison to the other scenarios collectively and individually.

3.5 Scenario interpretation and validation. Interpretation and visualization are required to effectively communicate scenarios to different groups (Shaw et al., 2009). Scenario interpretation included a stakeholder workshop held in March 2013 at the *Universidad Nacional de Costa Rica* in Nicoya. In preparation, we named the scenarios, elaborated themes, developed descriptions, created newspaper front pages (dated March 2037) using the logo (obtained with permission) of a local newspaper, crafted day-in-the-life-of stories of people from government, community groups, and businesses, and located illustrative photographs for each scenario (Figure 5.1). The research team initially formulated the stories for each scenario, which were then vetted and revised by members of the PC Commission in unstructured meetings from January-March 2013.

Forty-six individuals from eighteen Guanacaste communities participated in the workshop. These individuals represented eleven rural water administrators (ASADAs), six public agencies (including representation from regional and national offices), regional

governments (e.g., Municipalities and irrigation district managers), tourism businesses, agricultural businesses, community groups, environmental groups, and the media. Participants were invited in order to ensure adequate representation from across water-use sectors, from across the public water management sector, and from organizations that have been in tension over water issues in the past. Workshop participants engaged with five scenario exhibits in order to help interpret and to validate the scenarios - and to prepare for workshop activities later in the day. At each scenario exhibit, a team member guided and documented discussions. Prior to the scenario exhibit exercise, the research team provided prep material and gave an introduction to the group. For the scenario exhibits, each scenario was presented on 2x0.8m freestanding posters (Figure 5.1). Participants placed sticky notes on designated white boards near each poster to answer prompting questions: what is missing from this scenario? And, what would make this scenario more tangible? The aim of the questions was to spur thought and discussion that would address and help improve the adequacy of the scenarios and their relevance/ meaningfulness to people. Participants also commented, critiqued, and added information to the scenario components, which was structured similarly using sticky notes and nearby whiteboards in each exhibit. Participants were free read and comment on each other's notes.

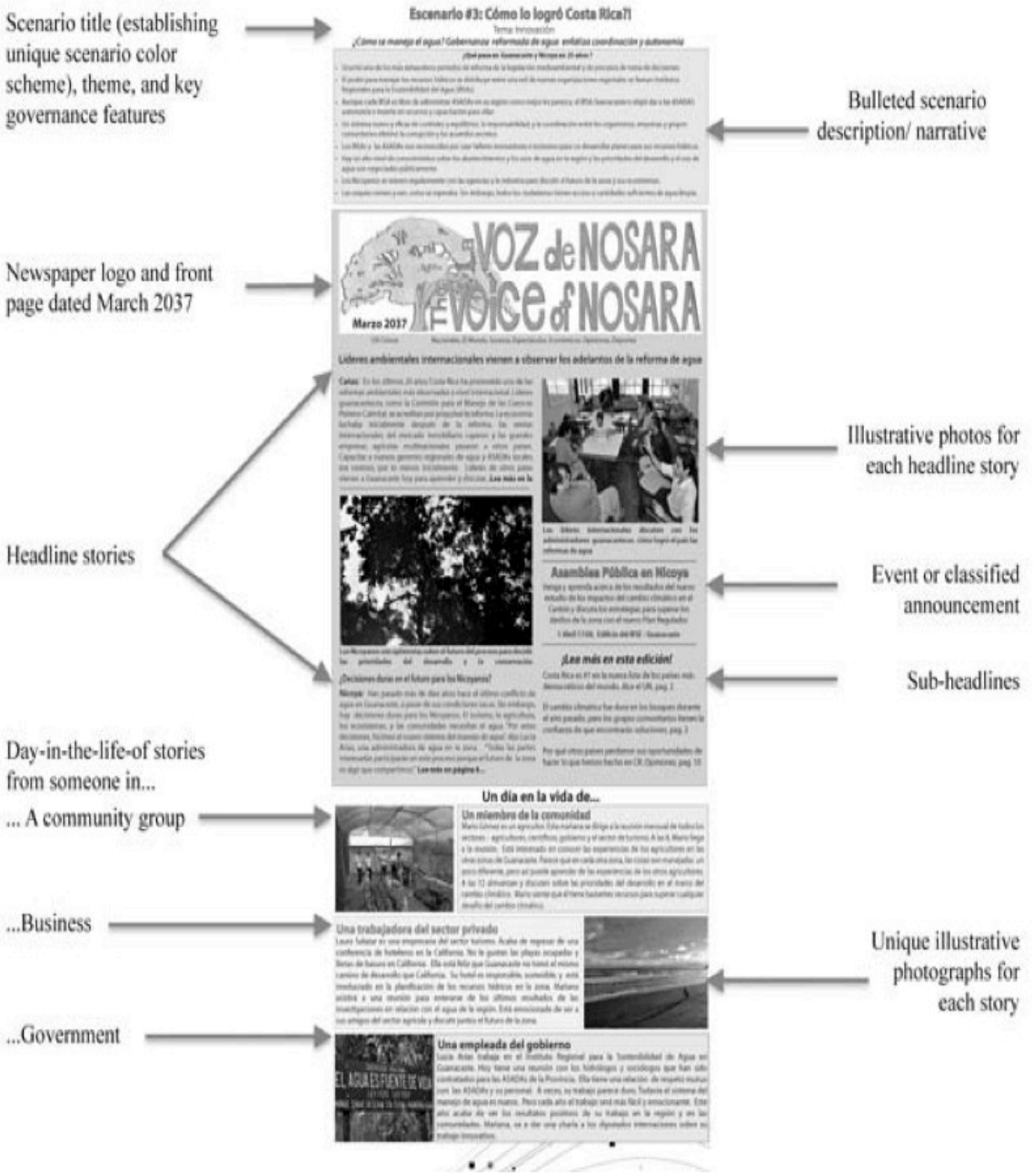

Figure 5.1 The scenarios were presented on 2x0.8m posters (like this one of Scenario #3). We structured information identically (but with unique color schemes and photos) on each poster to promote comparison and discussion of the set of scenarios. All photos on the poster were taken by Christopher Kuzdas. Newspaper logo is used with permission.

4. Results

4.1 Selected system variables, identified variable projections, and system analysis. The final variables, their descriptions, and their future projections are listed in Table 5.2. The system analysis classified the variables as governance drivers (4 variables), governance mediators (4 variables), governing context features (5 variables), and passive governing features (4 variables) (Figures 5.2 to 5.6).

Table 5.2

Selected Variables, Current State Conditions, and Their Future Projections

Selected variables, current state conditions, and their future projections

Variable	Description	Current State (2010-2013)	Future projections
1. Precipitation	Average annual rainfall in the region	Average rainfall per year in the Province is about 1000 - 1300mm (MINAET, 2008).	a. More abundant rainfall, higher mean precipitation b. Less abundant rainfall, lower mean precipitation c. Rainfall patterns are highly variable
2. Forest cover	Area of land in the region covered by natural forest	About 45% of the Province is considered "forested". Although, it is not clear to what extent monoculture tree plantations are counted in official estimates (Calvo-Alvarado et al., 2009).	a. Healthy, natural forests are widespread, covering more than 45% of the Province b. Natural forests cover less than 45% of the Province
3. Resource competition	State of competition over water resources	Many new water development and infrastructure projects are contested,	a. Competition over water resources is high

		competition is high (Cover, 2008; Kuzdas 2012).	b. Competition over water resources is mild or low
4. Dispute resolution mechanisms	Fair and clear institutional procedures are in place to resolve water disputes	Although several dispute resolution procedures exist, most are resolved through ad hoc procedures on a case-by-case basis (Kuzdas et al., 2014c).	a. Clear, effective, and fair resolution mechanisms exist b. Disputes resolution procedures are confusing, ad hoc, and/ or unfair
5. Civil democracy	Level of effective public engagement and responsiveness of government to citizens	In some cases, agencies will make concerted efforts to engage the public after a dispute manifests; historically though, government has been keen to public needs (Edelman, 1999).	a. Government is responsive and regularly engages the public b. Government often disregards public needs and desires and is generally not responsive nor engaging
6. Groundwater security	The stability of groundwater resources	Permitted groundwater allocations exceed dry season carrying capacities in some basins. In 2012, more water was allocated in the Tempisque than was available (although	a. Sustainable yield is achieved in many groundwater basins in the Province/ groundwater reserves are stable

		not all allocations were taken).	b. Sustainable yield is not achieved in many groundwater basins in the Province/ groundwater reserves are not stable
7. Regional integration	The presence of effective regional level actors or institutions that mediate between governing scales	The regional-scale of water is poorly funded and often ineffective; regional roles in water governance are most often filled by agency branch offices with some exceptions (Calvo, 1990; Kuzdas et al., 2014c).	a. Regional-scale actors/ institutions are active/ high vertical accountability b. Regional-scale actors/ institutions are inactive/ low vertical accountability in governing institutions
8. Irrigated agriculture	Extent of irrigated agriculture in the Province	Irrigated agriculture covers about 50,000 working hectares in the Province. Construction of planned canals for 8,000 additional hectares began in 2014.	a. The amount of working irrigated hectares increases b. The amount of working irrigated hectares decreases
9. Water quality	Availability and accessibility of clean, safe water for health and	Over 95% of residents have access to sufficient supplies of clean water (MINAET,	a. All residents have access to sufficient and clean water

	sanitation purposes	2008).	b. Fewer residents have access to sufficient and clean water
10. Water system knowledge	Extent of shared knowledge of regional water system quality, limits, and outcomes	A significant lack of knowledge regarding river basin and groundwater carrying capacities and the water needs of water users and environments is a major issue (Ballestero et al., 2007).	a. Improved collective knowledge of water systems b. Less collective knowledge of water systems
11. Policy innovation	The modification of existing water-related policy by actors	Modifying water policy is difficult. Most significant pieces of water-related legislation dates back half a century (Calvo, 1990; Rogers, 2002).	a. Basin-scale, community, and national actors modify water-related policies as required (possible) b. Excessive bureaucracy prevents the modification of water-related policies (difficult)
12. Population growth	The change in the number of people residing in the region	As of the 2011 census, about 325,000 people reside in Guanacaste (INEC, 2011).	a. The population is decreasing every year b. The population is increasing every year

	from year to year		
13. Leadership	Role of civil society leaders in regional water governance	Leaders from civil society are active in the region, and some play important roles in water governance (Kuzdas et al., 2014b)	a. Civil society leaders are active in water governance b. Civil society leaders are weak and/ or not active
14. Decision-making process	The open, transparent, and accessible quality of decision making processes	Many decisions regarding water resources are made behind closed doors although this varies within the Province (Kuzdas et al., 2014.c)	a. Decisions are made through transparent and open processes b. Decisions are made in closed process
15. Outcome distribution	The distribution of benefits, risks, and costs associated with water resources	Firms often buy locally owned farm businesses; real estate developers and investors receive or attempt to obtain controversial water rights (Cover, 2007).	a. Benefits, risks and costs of water resources are fairly distributed b. A few benefit while the many share disproportionate risks and/ or costs
16. Institutional	Level of citizen satisfaction and trust in	Continuing from the early 1990s, citizen trust and satisfaction in government agencies and	a. Citizens are satisfied with and trust government b. Citizens are dissatisfied with and suspicious of

legitimacy	government agencies and institutions	political institutions has declined steadily (Seligson, 2002; Booth et al., 2010).	government
17. Water infrastructure	The efficiency and quality of water storage, delivery, treatment, water-use, and post-use infrastructure	Infrastructure is mostly kept up; however at increasing costs. In 2010, the national water agency took out a large loan to cover infrastructure costs. The abilities of rural water-user associations to fund and maintain infrastructure varies (Madgrigal et al., 2011).	a. Water infrastructure is maintained for efficiency and minimum waste b. Water infrastructure falls into disrepair and water is often wasted

4.2 Selected scenarios. Of the 196,698 possible scenarios, 45 contained no obstructive consistency relationships and 69 contained one obstructive relationship. Out of these 114 (e.g., 45+69) potential scenarios, the cluster analysis five statistically different clusters. From these clusters, representative scenarios from each cluster were chosen based on their diversity values and selection criteria shown in Table 5.3. We made some justified exceptions. Scenario #4 contains one obstructive consistency relationship; yet contains unique features that were deemed important in working groups for a scenario featuring citizen apathy. For Scenario #5, we accepted two lower than optimal diversity index values in order to include a scenario featuring a large hacienda-oriented economy that is contextually relevant.

Table 5.3

S*cenario Selection Results and Criteria Values; *Indicates Non-Compliance with Selection Criteria*

	Scenario 1 (#199)	**Scenario 2 (#196,410)**	**Scenario 3 (#12)**	**Scenario 4 (#95,040)**	**Scenario 5 (#196,409)**
No. of inconsistencies	0	0	0	1	0
Diversity index value	.59	.43	.59	.40	.43
Diversity index relative to other selected scenarios	Sc2 (0.88)	Sc1 (0.88)	Sc1 (0.19)*	Sc1 (0.71)	Sc1 (1.00)
	Sc3 (0.18)*	Sc3 (0.94)	Sc2 (0.94)	Sc2 (0.35)	Sc2 (0.18)*

	Sc4 (0.71)	Sc4 (0.35)	Sc4 (0.71)	Sc3 (0.71)	Sc3 (0.88)
	Sc5 (1.00)	Sc5 (0.18)*	Sc5 (0.24)	Sc5 (0.24)*	Sc4 (0.24)*
Additive consistency	98	102	88	81	107
No. (%) of other scenarios in cluster	25 (17%)	5 (4%)	16 (14%)	46 (40%)	22 (19%)

4.3 Interpreted scenarios. ***4.3.1 Distinguishing systemic features of the scenarios.*** Table 5.4 provides the basic 'skeleton' of each scenario and shows basic differences among variables across the scenarios.

Table 5.4

*Different Values of Variables across the Five Scenarios. *Indicates Valuables that are Further Specified from Scenario Interpretation Steps*

Variables	Scenario #1: Mandated to prepare	Scenario #2: Closed-door alliances	Scenario #3: Responsive and engaged	Scenario #4: Unnoticed in the background	Scenario #5: Overwhelmed and out of touch
1. Precipitation	Wetter (or variable)	Drier	Drier (or more variable)	Variable (or wetter)	Drier (suspected to be)
2. Forest cover	More land is forested (or little change)	More land is forested (in the interior)	Less land is forested (more savannahs due to realized climate change)	Less land is forested	Less land is forested
3. Resource competition	Low competition	High competition	Low competition	Low competition	High competition

4. Dispute resolution mechanisms	Dispute resolution mechanisms are untested*	Dispute resolution mechanisms are skewed*	Dispute resolution mechanisms are effective	No dispute resolution mechanisms	No dispute resolution mechanisms
5. Civil democracy	Some engagement/ govt. is responsive*	No public engagement/ govt. is unresponsive	High engagement/ govt. is responsive	Low engagement/ govt. is mostly not responsive	Low engagement/ govt. is not responsive
6. Groundwater security	Stable groundwater reserves	Unstable groundwater reserves	Stable groundwater reserves	Some reserves are stable, some are not*	Unstable groundwater reserves
7. Regional integration	Effective, through active, strong central government	Regional-scale water governance is inactive	Active regional-scale water governance	Inactive/ weak regional-scale water governance	Inactive/ weak regional-scale water governance
8. Irrigated	Hectares decreases	Hectares decreases	Hectares slightly	Hectares increases	Hectares increases

agriculture			increases*		
9. Water quality	Most have access	Few have access	Most have access	Most have access	Few have access
10. Water system knowledge	Improved (through centralized initiatives)	Less (most water systems remain unknown)	Improved (through collective initiatives)	Less (most water systems remain unknown)	Les (decreased though unstable governance)
11. Policy innovation	Possible (water policy can be modified as required)	Difficult (water policy is circumvented)	Possible (water policy can be modified as required)	Modification of water policy is difficult (little attention is paid to it)	Modification of water policy is difficult (it is out of touch)
12. Population	Population increases	Population decreases	Populations increases	Populations increases	Population decreases

growth					
13. Leadership	Civil society leaders are replaced by agencies*	Active civil society leaders oppose alliances*	Civil society leaders often play strong roles	Civil society leaders are often not active	Civil society leaders are often not active
14. Decision-making process	Agency decisions are made in somewhat open process*	Decisions are made in closed process	Decision made though open/ transparent process	Decisions are made in closed process (due to no interest)	Decisions are made in closed process
15. Outcome distribution	Fair outcome distributions	Some benefit unfairly at the expense of most	Fair outcome distributions	Somewhat fair outcome distributions*	Some benefit unfairly at the expense of most
16. Institutional legitimacy	Citizens trust government	Citizens do not trust government	Citizens trust government	Citizens do not trust government	Citizens do not trust government
17. Water infrastructure	Infrastructure is well maintained	Infrastructure is not widely maintained (except for tourism)	Infrastructure is well maintained	Infrastructure is maintained (primarily for supply and delivery)	Infrastructure is not widely maintained (except for big AG)

Figures 5.2 to 5.7 provide illustrations of the systemic nature the scenarios. The figures include short descriptions of the variables and a brief synopsis of interpreted conflict outcomes (e.g., "water conflict?" box). Bolded-grey boxes and solid arrows indicate key aspects and unique systemic relationships used in scenario interpretation (i.e., to craft stories, etc.). Note that dotted lines in the figures indicate a systemic relationship between variables exists, but a is less prominent in its systemic composition and in terms of use in interpretation.

Scenario #1: "Mandated to prepare" shows a centrally controlled water governance scheme that aims to secure rural community well-being in the face of scarcity - although important feedbacks coming from the governing context (outcome distributions, water quality, competition, etc.) on to the decision making processes and other drivers are missing (in contrast to Scenario #3, for example (Figure 5.4). While this missing linkage potentially allows conflict risks by limiting the effectiveness and responsiveness of dispute resolution mechanisms (which we see in Scenario #2 and #5), no conflict occurs in Scenario #1. With people trusting government (i.e., high legitimacy) and little scarcity or water access issues that challenge the governance regime (i.e., less competition, water supplies are not decreasing), governance schemes are able to successfully avoid harmful conflicts. Scenario #1 allowed for weaving of stories that hailed back to the early years of Costa Rican progressive democracy (prior to the 1980s). These years saw a far-reaching presence of a highly legitimate State that sought to support rural, smallholder farmer lifestyles often through top-down mandates.

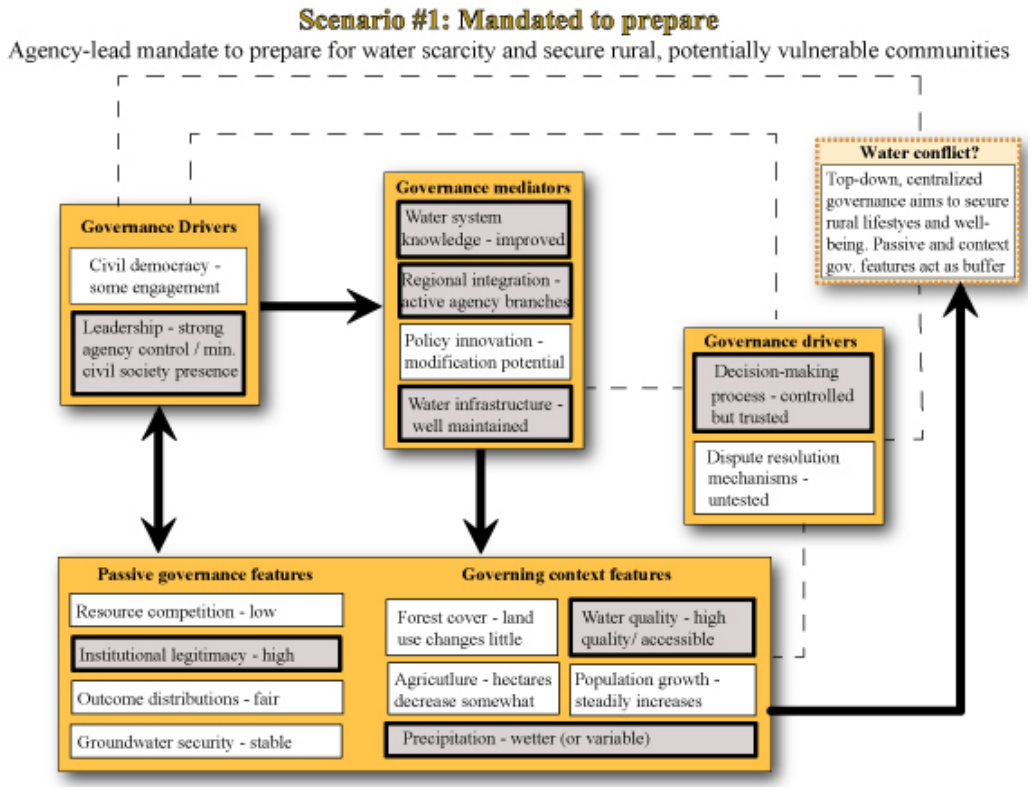

Figure 5.2

Systemic representation of Scenario #1: "Mandated preparation"

In ***Scenario #2: "Closed-door alliances"***, inadequate water governance primarily drives (as opposed to challenging contexts) conflict, environmental decline, and unfair water access, which negatively reinforces unresponsive and ineffective water governance schemes (Figure 5.3). The systemic nature of Scenario #2 is similar to Scenario #3, but with features that are negatively rather than positively reinforced. In contrast to Scenario #5, conflict outcomes in Scenario #2 stem primarily from the governance regime itself, which takes purposeful actions against the interest of rural communities. Consequently, Scenario #2 allowed for storylines of actors that deal with 'closed-door alliances' of

government agencies, developers, and investors - reminiscent of recent Guanacaste water conflicts.

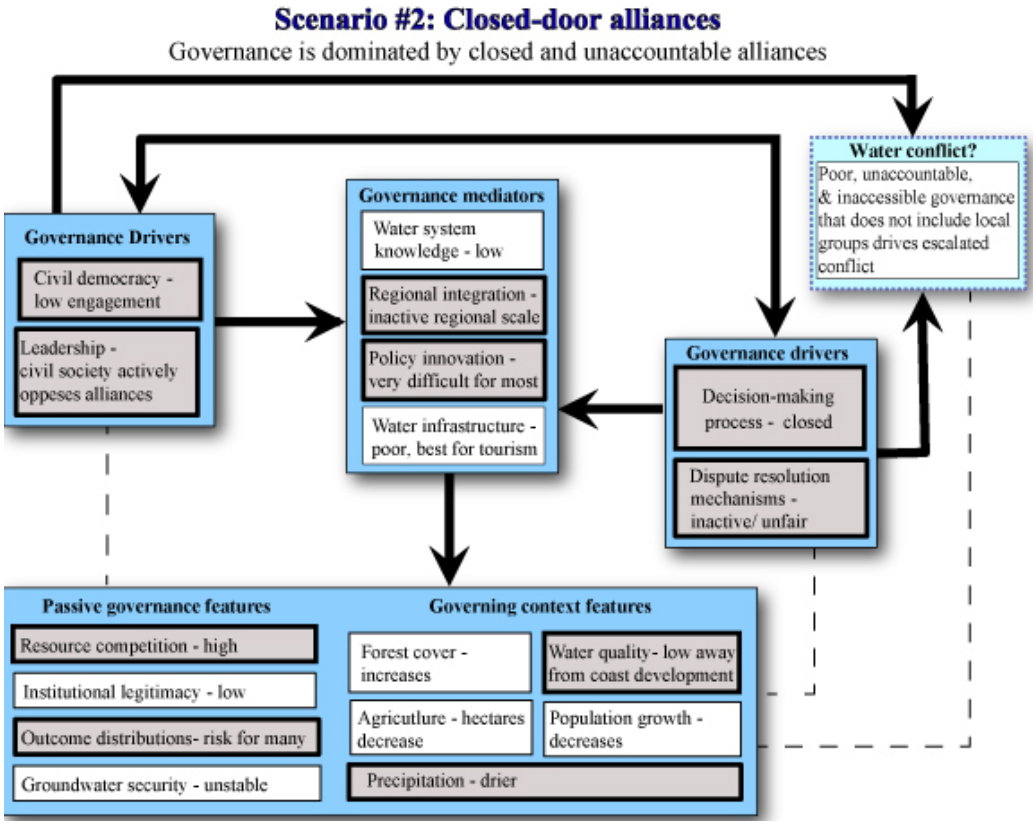

Figure 5.3

Systemic representation of Scenario #2: "Closed-door alliances"

Responsive civil democracy, active regional leadership, and open decision-making processes were most effective (in terms of positive governance outcomes) when mutually reinforced by each other and by established dispute resolution mechanisms. In ***Scenario #3: "Responsive and engaged"***, these drivers positively reinforce each other while also supporting institutional legitimacy (e.g., people trust governance) that in turn helps facilitate active regional-scale governance and vertical accountability, which are

conducive for improved collective water system knowledge and groundwater security (Figure 5.4). This distinguishing system of positively reinforcing impact relationships in Scenario #3 allows effective mitigation of water conflict in spite of challenging contexts.

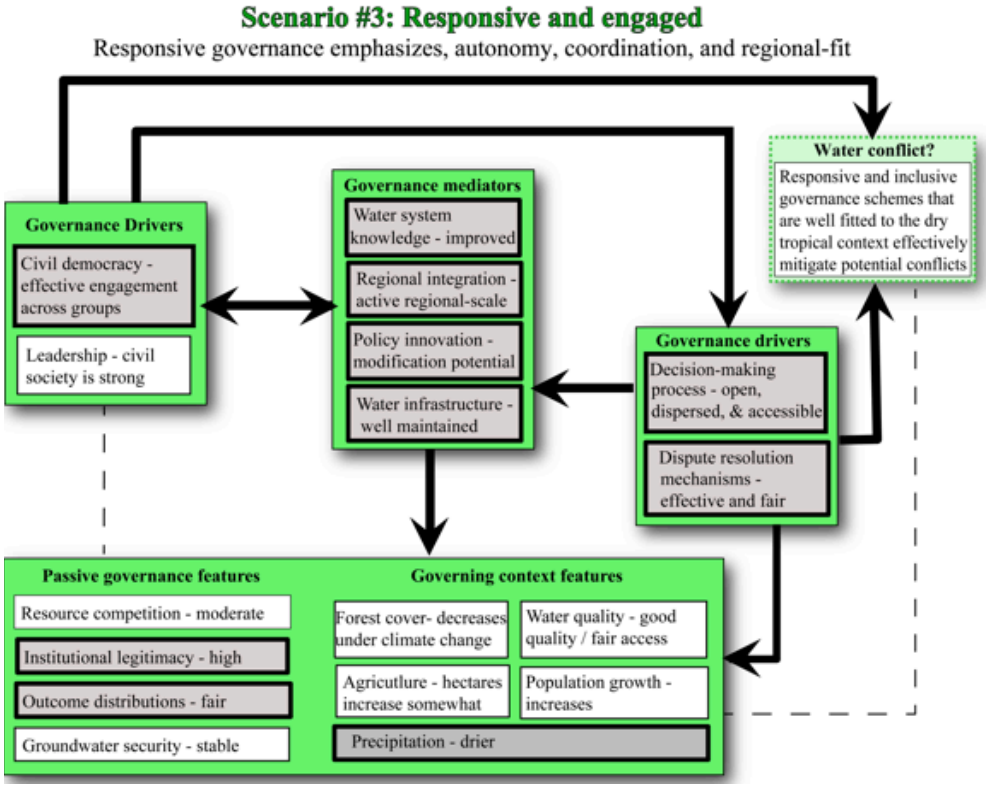

Figure 5.4

Systemic representation of Scenario #3: "Responsive and engaged"

Scenario #4: "Unnoticed in the background" demonstrates how a prominence of mediation with very efficient water infrastructure, combined with a low water-allocation priority for natural (forested) systems, allowed for rapid economic development and growth. Like Scenario #1, many important systemic feedbacks are missing which allows for risk due to low responsiveness and less accountability of the governance regime to stakeholders. These missing features would support effective conflict resolution

mechanisms, as is the case in Scenario #3. Rather, the governance scheme in Scenario #4 is similar to Scenario #5 - but with key differences being population growth (in contrast to decline), well-maintained water infrastructure, and accessible good quality water, which allows for a more economically prosperous scenario that features a decline of natural systems and a less active or more apathetic role for civil society organizations (such as the PC Commission (Figure 5.5).

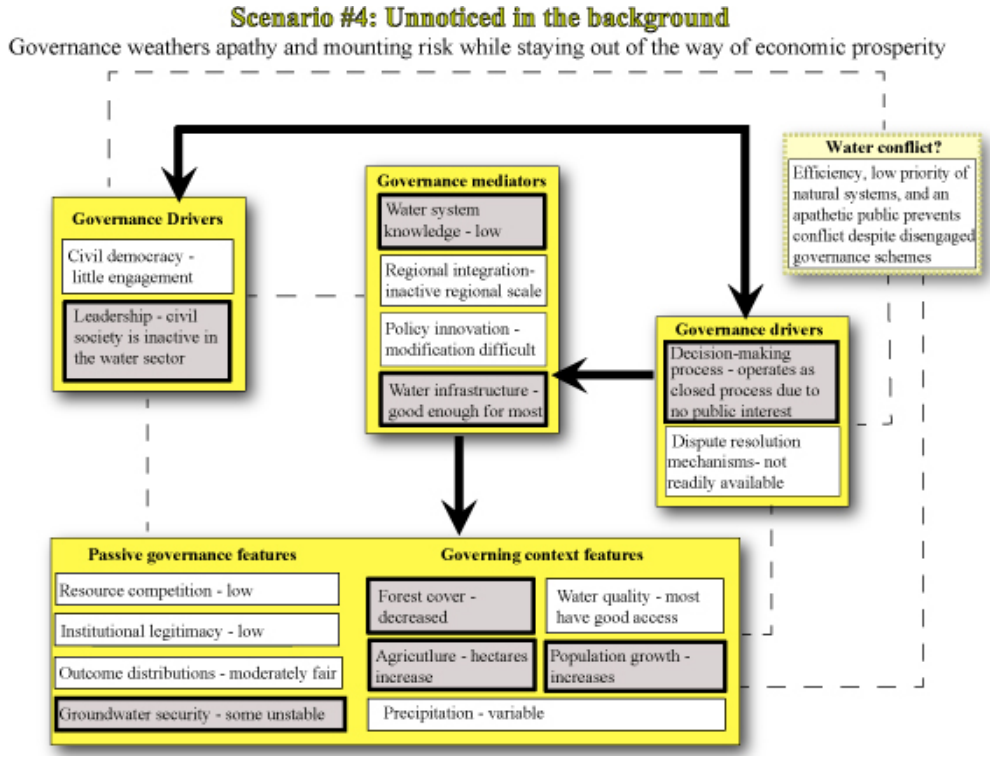

Figure 5.5

Systemic representation of Scenario #4: "Unnoticed in the background"

In ***Scenario #5: Overwhelmed and out of touch***, the governing context (i.e., poor water quality, dry conditions, etc.) overwhelms weaker governance schemes that lack active regional governance actors and institutions, accountability mechanisms, accessible decision-making, and a responsive, engaged civil democracy (Figure 5.6). This

overwhelmed situation that also features drier climates and unfair water access helps stem population growth in the region. Governance that is overwhelmed by the challenging contexts that it faces is a distinguishing systemic feature of Scenario #5.

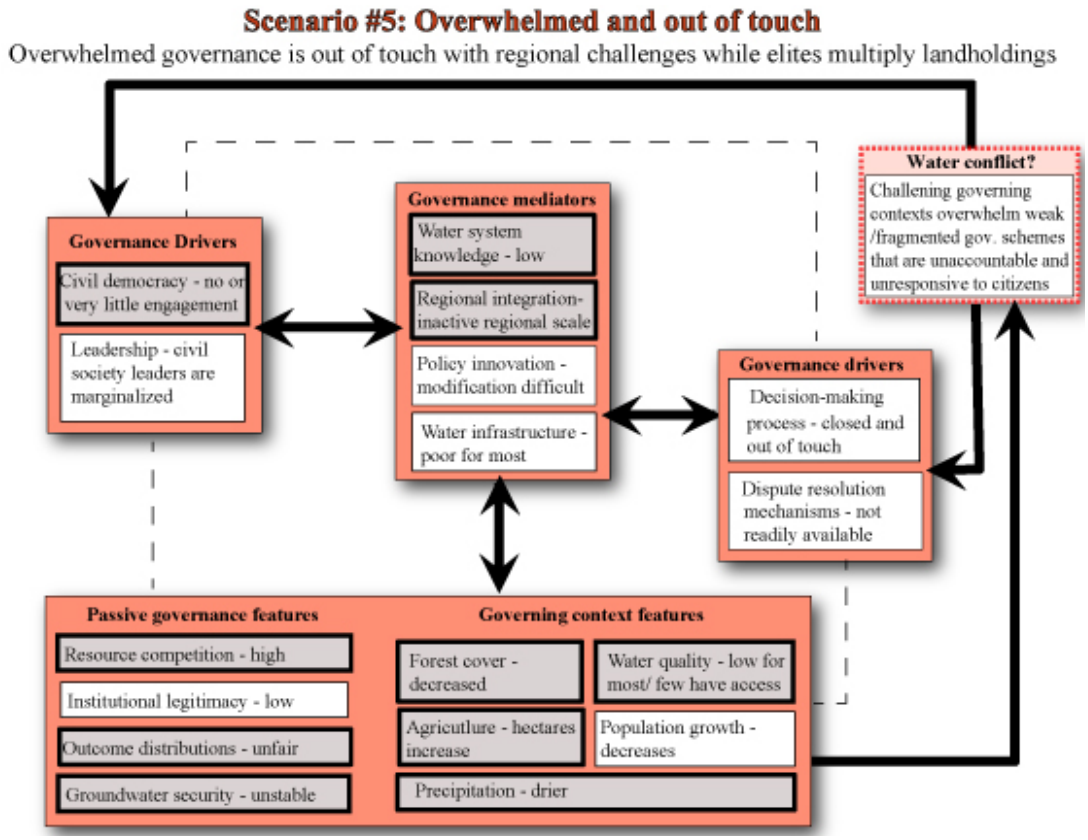

Figure 5.6

Systemic representation of Scenario #5: "Overwhelmed and out of touch"

4.3.2 Integrated scenario descriptions. The following scenario descriptions are short, integrated summaries of the story lines based on the systemic scenario structures highlighted above. The scenario descriptions and their storylines helps animate the distinguishing aspects of alternative governance regimes in a way that helped effectively communicate the scenarios to diverse groups.

Scenario #1: Mandated to prepare

Guanacaste context: Government emphasizes controlled economic sector diversification and streamlined resource management as a mitigation strategy for water scarcity. As a result, many regional and local organizations in the water sector have been consolidated in an effort to increase efficiency. Agencies focus on investments and stimulus for small to medium size farms. Consequently, the number of multinational farms has been reduced. This trend has decreased the overall hectares under irrigation in the region, and allowed water quality in many places to remain high. Water-related decisions sometimes involve actors outside of central agencies. Despite its dominating presence, there is a sense that the public sector is working for the collective good as it did during the early years of Costa Rican statehood.. Water reform remains a discussion topic; however modifying water policy is difficult if groups outside of central government propose modifications.

In Nicoya: As a part of public sector efficiency improvements, ASADAs in the area have been unified under AyA. Consequently, local water management activities must be approved by AyA if they are not specified through officially designated responsibilities. Consequently, the degree of autonomy that ASADAs had experienced in the past has been greatly reduced. To improve efficiency of water governance in rural Guanacaste, local water managers are trained in a specialized program in the Capitol. After which, they are assigned posts based on agency needs. Accordingly, the PC Commission no longer coordinates watershed management in Nicoya. With little scarcity and a large public sector that largely looks out for rural interests, local agricultural businesses are doing well and many tourists still pass through the area.

These conditions have helped water competition levels to remain low. Some retired members of the PC Commission are skeptical of the ever-present public sector's ability to keep the peace if water scarcity were to become an issue again or if agency leaders were to change priorities since accountability mechanisms are not always clear. For now, water governance is making efforts to ensure that *Nicoyanos* have their needs met.

Scenario #2: Closed-door alliances

Guanacaste context: The first 50 years of modern Costa Rican (1948-98) statehood were characterized by open democracy, strong social support, and high trust in government. However recent decades are known for unaccountable, backroom deals between alliances consisting of government, investors, and developers and the growing separation between national leadership with local communities. The real estate market in Guanacaste is booming and, as a result, residential tourism accounts for much the region's economic output which – when combined with a State that is largely unresponsive to transitionally rural communities and less rainfall – has led to a decline in agriculture in the region. Consequently, dry forest and increasingly more savannas (due to drier conditions) are taking back a good portion of the previously irrigated land and ranches. Protests over water allocations are common in Guanacaste communities, since leaders are still active, and the coast is full of pipelines transporting water to various developments. When one water source is gone more pipes are built. Like historic conflicts from the early 2000s that were considered anomalies by some, these pipes are built overnight to avoid detection by concerned citizens and other active groups.

In Nicoya: Attempts at water policy reform are made, but unresponsive and unengaged governance allows powerful interests to circumvent new initiatives. 10 years

ago the PC Commission was a leader advocating for reform, but those efforts were fruitless. Frustrated, the PC Commission now supports communities who illegally divert water from large developments and oppose closed-door alliances. To avoid potential bankruptcy due to very limited support from unreliable broader governance and the dominant agencies, ASADAs have pooled resources with other community-based groups to self-finance local water projects. Accordingly, ASADAs function as platforms for citizens to voice dissatisfaction with inaccessible decision-making processes and with the unfair allocation of water, and financial resources and infrastructure resources for regional development. As result of less irrigated agriculture and thus more natural land cover in the interior, the area still attracts many international visitors. After observing common water protests and water access issues, many of these visitors end up supporting local communities. Consequently, residents are concerned about the increasing number of national and international visitors who use the area's challenges as a platform to promote their own agendas. Citizens wonder how long the 'most peaceful country in the America's' label is going to last.

Scenario #3: Responsive and engaged

Guanacaste: 20 years ago, one of the most comprehensive and internationally-watched water reform efforts occurred in Costa Rica. *Guanacasteco* leaders are credited for pushing the reform. Over time, the authority to govern water resources in the country was gradually distributed over a network of new regional organizations called 'regional institutes for water sustainability (RIWS)' to better account for the unique challenges faced in the dry tropics. A new system of accountability and coordination among agencies, private industry, and community groups helped combat once-common

corruption. As a result, the transparency of decision-making in the Guanacaste water sector is well known - international observers come in order to take lessons back to their own countries. The reform however did come with some costs. A deeply entrenched economy struggled initially after the reform as international real estate investment fell. Initially training personnel was also costly. But the effort paid off. Climate change has required tough decisions over development priorities. But, priorities and tough decision process are conducted in open and accessible venues. Consequently, *Guanacastecos* feel like valued citizens who have respected input into governing their resources.

In Nicoya: After the period of water reform, the PC Commission members were elected to head the RIWS for Guanacaste. While each RIWS is free to govern ASADAs in their region as they see fit, the Guanacaste RIWS chose to give ASADAs large autonomy and invest heavily in their training and their start-up capital. Droughts come and go, but due to new collective initiatives there is a high level of shared water system knowledge in the region. Consequently, regional development plans, water-use, and demand management priorities are publicly negotiated. While the forests that remain in protected areas are healthy, some areas are beginning to resemble savannas due to changing climatic conditions. However, community and industry representatives meet regularly with land managers to discuss the future of the area and its ecosystems. In spite of challenges, *Nicoyanos* are confident they can handle any water-related challenge that the future might hold.

Scenario #4: Unnoticed in the background

Guanacaste context: Following an unprecedented period of economic development *Guanacastecos* are one of the most economically prosperous groups in

Central America. This period felt a lot like the real estate boom on the early 2000's, but without the persistent water conflicts. The voices and leaders of the old environmental movements that often contested new development projects have now faded. Backroom deals and corruption are no longer an issue like it was at the turn of the century because there is largely no need to be publically cautious about new, large development projects like there was in the past. Some say this change in community attitudes is due to the long period of economic prosperity in Guanacaste, which caused citizens to become apathetic to water issues. As a result of this trend, few ecosystems exist in their natural state. Water governance mostly functions as a catalyst for economic development. Water managers argue there is not enough interest from stakeholders to warrant transparency, and accordingly, water-related decisions are taken without broad input. Managers point out that if no one is talking about water, then it means they are doing their job - they just keep the faucets running.

In Nicoya: An elaborately engineered system of pipes and treatment plants is hidden from view behind the hills that surround Nicoya. Water infrastructure effectively buffers most citizens from any impacts from recent development or potential water scarcity issues. Many ASADAs were no longer able to manage the sophisticated water infrastructure needs of communities, so the Guanacaste branch of AyA assumed control of important water infrastructure in the area. Following economic catalyst mandates, ASADAs are typically left to manage the water needs of less economically important areas. Due to increasing demand and environments that have largely diminished in quality, water is increasingly expensive to treat and transport, although most residents

have regular access to clean water. How water gets to Nicoya, or where it comes from is a mystery to residents. For most residents though, the living is easy.

Scenario #5: Overwhelmed and out of touch

Guanacaste context: Years ago the State was unable to fulfill social obligations, to mediate water conflicts, or to adequately respond to citizen needs. With a weakened state and a superficially representative electorate, large agricultural producers substantially increased their holdings. Consequently, many large haciendas and their politically powerful landowners are found in the lowlands. Years ago the fragmented government and powerful few landowners in Guanacaste alarmed foreign investors, which eventually pulled their investments from the region. Accordingly, international tourism has slowed similar to the economic recession of 2008. Without competition from tourism and many communities often disconnected from confusing and water governance schemes, large landowners secured large water allocations. Over years of power politics being played on the national stage, water agencies eventually became public-private organizations, with many *Guanacasteco* elites holding large influence over them. As a result, most water infrastructure is poorly maintained for many communities without vested interests in the ruling elite. Most say the climate is drier, but no one has studied water systems in the region in many years.

In Nicoya: Similar to mobilization against trade liberalization in the 1980's, the highlands around Nicoya are a stronghold for small farmer opposition. The more rugged terrain is less conducive to effective, large hacienda-style ranches. ASADAs around Nicoya are disconnected from AyA and are consequently very poorly resourced. Consequently, ASADA water distribution networks are a patchwork of tubes and pumps

that are maintained best they can be. Numerous petitions and envoys are sent to the Capitol in attempts to bring attention to water disparities in Guanacaste. But water governance is too fragmented and out of touch with local and regional challenges for any meaningful action to be taken. Because many of Guanacaste's landowning elites have large investments in public agencies, *Nicoyanos* are doubtful that even if actions or new policies were taken, that they would effectively resolve water issues.

4.4 Validated scenarios. The newspaper front page in ***Scenario #1: "Mandated to prepare"*** told the story of a new central office for water management opening in the Capitol being the last step in the centralization of water governance. Other stories told of the high numbers of *Guanacastecos* that trust government and of a member of an ASADA doing a training rotation in the Capitol. Most participants generally commented that, although seemingly possible, it was a difficult scenario to imagine due to recent histories of disengagement between communities and agencies. On the other hand, some participants related well to this scenario as a potentially disheartening example of confusing current bureaucratic systems that some participants noted were a challenge for water managers – especially in terms of securing financial, technical, and administrative resources. Overall, a centralized yet benevolent governance system was something that participants generally found to be suspicious. Other participants pointed out that the current governance regime struggles to develop policies fit to the unique dry tropical context in Guanacaste, and that a more extremely centralized regime like the one portrayed in Scenario #1 would likely also struggle with this. Relatively few notes (16% of 191 total) placed and discussion involved Scenario #1.

Scenario #2: "Closed-door alliances" (combined with Scenario #5) accounted for nearly half (48%) of all notes placed and much discussion among participants. Both scenarios extend prominent historical and current events into the future. The newspaper headlines in Scenario #2 told the story of ASADAs organizing large protests over the allocation of water, reminiscent of recent conflicts in the region. Participants generally commented that this scenario seemed very real and that the idea of 'secret agreements' and 'closed decision-making' resonated strongly with their current experience. Similar to Scenario #5, participants were interested in building connections between the Scenario content to their personal experiences. Many participants wanted to contribute ideas to help specify why this governance regime in the Scenario #2 led to conflict. For example, an agency representative noted how the current lack of collective goals for development in the region might factor into such a scenario. Some participants were uncomfortable with Scenario #2, but many found it to be the most identifiable and some considered it eerily similar to the current state of water governance.

In contrast to Scenarios #2 and #5, ***Scenario #3: "Responsive and engaged"*** evoked fewer (16% of notes placed) but much more positive responses from participants. The headline told the story of international leaders coming to Guanacaste to observe and take lessons from its responsive, accountable, and collaborative water governance model. The day-in-the-life of stories related vignettes of citizens from different sectors and their involvement in the water governance regime. Participants generally commented that more information would be helpful in this scenario – especially regarding how change in the governance regime came about through time. Many participants were interested in exploring more about the reconciliation between communities and government agencies

that would be required in such a scenario. Other participants were interested in seeing more details on the decision-making processes and laying out how it works and who is involved and at what stage. Overall, participants were enthusiastic about Scenario #3, but wanted to see more about the roles that communities (e.g., ASADAs, community groups) and other actors would play in helping bring such a governance regime about over time.

Some participants considered ***Scenario #4: "Unnoticed in the background"*** to lack information on where the water required for the rapid development portrayed in the scenario would come from. The front-page headline in Scenario #4 told the story of controversy resulting from water agencies that suggested lowering water consumption and commercial interests in the region. Historically, *Guanacasteco* communities are environmentally active and well organized. Considering this, participants expressed interest in seeing more detail regarding the 'taming' of these communities in the scenario, specifically how a change from being active currently to being complacent came about. Some thought this scenario would fit well with a water privatization storyline, since privatization recently occurred in the energy and communications industries in Costa Rica. Yet others countered that under current constitutional laws that water privatization was unlikely and may make the scenario seem less real. Some participants saw this as a potential scenario if water education, conservation, and demand management activities were to subside and they commented that making a link between (poor) education and the outcomes in the scenario would improve the scenario's effectiveness.

Scenario #5: "Overwhelmed and out of touch", along with Scenario #2, was one of the most discussed scenarios at the workshop. The newspaper headline told of an expanding sugar cane empire in the Guanacaste lowlands and the growing social

inequalities that resulted from unjust water distributions in the face of challenging climate and environmental contexts. Participants commented that, although the outcomes in this scenario were extreme, the politics, corruption, and disconnectedness within the governance regime was reminiscent of the current politics. Some participants noted that the *Latifundio* doesn't need to necessarily return, because it still exists today in disguise in the Capitol (San José) where it is about vying for political power. Other participants thought this scenario would be a good place to describe superficial national-level political processes that fail to make decisions on water reform issues – which is often the case currently. Overall, the failed politics described in Scenario #5 struck a chord with participants – many of which (often with a sense of humor) linked the scenario to current political events and politicians.

Table 5.5

Summary of Key Scenario Differences

	Scenario #1	**Scenario #2**	**Scenario #3**	**Scenario #4**	**Scenario #5**
Quick title	Mandated to prepare	Closed-door alliances	Responsive and engaged	Unnoticed in the background	Overwhelmed and out of touch
Theme	Cautious	Deception	Innovation	Apathy	Disconnection
How water governance	Agency-led and top-down	Governance is dominated	Responsive governance	Governance weathers	Overwhelmed

operates	implemented mandate to prepare for water scarcity and secure rural, potentially vulnerable communities	by closed and unaccountable alliances and back-door dealings	emphasizes autonomy, coordination, and regional-fit	apathy and environmental risk while staying out of the way of economic prosperity	governance is out of touch with regional challenges while elites multiply landholdings
Distinguishing systemic features	A highly controlled governance schemes that has the trust of local communities avoid conflicts due to more accommodating contexts	Negative reinforcing feedback loops among governance drivers and mediating features allow for governance schemes that cater to	Positive reinforcing feedback loops between governance drivers and mediating features in spite of challenging contexts	Efficient water management buffers potential risks while less active leadership allows governance to operate without	Challenging governing contexts overwhelm governance schemes that are poorly adapted to regional contexts and disconnected from local

	where scarcity, water access, and competition are not prevalent	interest-based alliances that tend to circumvent due processes		public interest	constituencies
Interpreted scenario components	The ever present nature of central government	Organized community opposition, resistance	Problem-solving, confidence, trying new ideas	Progress, technical water management, failed demand management	The return of the *Latifundio,* power imbalances, power politics

5. Discussion

5.1 Scenario content: Measuring up to the water governance literature.

Scenario #3: "Responsive and engaged" would, in practice, be a new governance regime for Central America - and in many parts of Latin America (Rogers, 2002). In this sense, the scenario could offer the general makeup of a 'business unusual' approach to water governance that Biswas et al. (2009) call for in their review of water management in Latin America. The scheme portrayed though is not necessarily new in other regions nor is it new theoretically. Scenario #3 could be seen, on the one hand, as an approach to

governance described in Meinzen-Dick (2007) where authority and financial responsibilities are shared (e.g., co-managed) across groups. On the other hand, the scenario could be seen a polycentric approach to water governance – where authority to govern water is distributed across nested actors and scales (i.e., local, regional, and national) as described in Huitema et al. (2009) and Ostrom (2009; 2010). In theory, these types of governance schemes are often prescribed to more adequately cope with uncertainty and change (Pahl-Wostl & Kranz, 2010) in comparison to traditional water management schemes. ***Scenario #4: "Unnoticed in the background"*** portrayed a traditional management scheme that was approaching its limit and ability to cope with problems using a narrow infrastructure and technological development approach. As displayed in Scenario #4, traditional schemes allow for risk in the face of change and confronting complex 'wicked' problems (Reed & Kasprzyk, 2009) and lack effective demand management mechanisms (Brooks & Holtz, 2009).

Despite known shortcomings of traditional management schemes there remains less understanding how exactly alternative propositions - such as the polycentric and more responsive water governance prescriptions outlined in Scenario #3 - work or can be implemented (or not) in different areas and contexts to best fit to meet certain problems (Neef, 2009). Thus, since we did not focus on how each scenario came about, the challenge in devising content for Scenario #3 was to allude to a reasonably believable implementation path of such a new governance regime. We attempted to do this through highlighting the challenges faced over the years of implementation (for example, decreased foreign real estate investment and some large commercial farms moving initially) and the role ASADAs and existing leaders (i.e., the PC Commission) played in

forming the new organizations. We were moderately successful in this regard. As noted, relatively little discussion involved Scenario #3 and some participants thought the scenario was difficult to imagine. But, the quality of that discussion was generally high and not all found the scenario difficult to imagine. For example, a group of ASADA representatives identified with Scenario #3's content because they had previously discussed off and on a regional–type of ASADA leadership organization. They viewed the scenario as a helpful platform to help articulate the long-term goals of such an effort.

Scenario #3, however, did not necessarily delve into the political issues and power asymmetries (which played out in the form of corrupted alliances, protests, and marginalized communities) that are readily apparent in ***Scenario #2: "Closed-door alliances"*** and ***Scenario #5: "Overwhelmed and out of touch"***. Another major governance challenge portrayed in Scenario #2 and #5 was the lack of Guanacaste-specific water governance schemes that accounted for the unique water challenges present in a dry tropical region. Participants were also quick to point that this was a major shortcoming of the supposed benevolent governance regime portrayed in ***Scenario #1: "Mandated to prepare"***. The scenario content that highlighted these political challenges felt the most real to participants. It was also the most concerning to them. For Scenario #2 in particular, many participants affiliated with locally based organizations commented that not only did the scenario seem real or plausible, but it also had closely articulated how they personally felt about current water governance. Many examples illustrate water governance that does not account for political power, regional contexts and specific problems, and other power asymmetries in society (like the water governance portrayed in Scenario #2 and #5) will struggle to effectively mitigate complex problems and

achieve just outcomes (Swatuk, 2008; Giordano & Shah, 2014). This has important implications for the region: in order to make progress toward a more effective and just water governance regime that more resembles Scenario #3, realities that may be reminiscent to Scenarios #2 and #5 will need to be addressed and overcome. There is no quick fix that will make this change (as indicated by the vast differences among the scenarios) and making progress on this endeavor will require collective, multifaceted governance strategies and new processes. The scenario exercises in themselves did not directly address this need. It could even be argued, looking at recent water governance analyses and assessments (Kuzdas et al. 2014a; 2014b) that this key need was not newly 'discovered'. However the scenarios did offer a profound contribution and advantage: the scenario study ultimately allowed an exceptionally large and diverse group of stakeholders to collectively articulate and validate this need in an understandable (and even fun) way; and it encouraged them to continue and improve collective efforts to address this need (which many did - Section 5.3).

5.2 Strengths and limitations of the formative scenario methodology.

Flexibility was an important strength of the formative scenario methodology. It allowed the scenarios to be tailored to meet the needs of a mostly rural, developing region. Importantly, it allowed the scenarios to represent local context, challenges, and alternative governance regimes in ways that evoked meaningful responses from diverse stakeholders in order to deliberate goals and actions (in later workshop activities) without costly, unavailable computerized simulations (i.e., Sheppard et al. 2011; Gober & Kirkwood 2010). Flexibility also allowed the scenario building process and the communication of scenarios to be tailored to the needs of those involved at different

stages. For example, the research team and PC Commission negotiated the contents of the scenario posters and agreed not to include scenario system diagrams for the broader audience at the workshop – many of whom had not previously worked within such models. Additionally, pre-testing in Guanacaste with the diagrams revealed that they were most effective (in terms of communicating systemic differences) if compared directly and immediately, which the large exhibit-style event did not allow for. However, the exhibit-style event was able to effectively involve a very large number of diverse stakeholders who typically are not involved in these planning activities. Nevertheless, the system diagrams were valuable for helping construct scenario storylines that aligned logically within each scenario's underlying structure. This flexible approach to communicating scenarios to different groups worked well in Guanacaste.

Integrating thorough current state analysis and assessment of governance regimes in Guanacaste - that was already engaged and publically visible - with scenario building was beneficial. It provided a shared frame of reference for the scenario building process. In this case, this shared frame of reference was important in the consultation meetings with local partners and stakeholders during the system and consistency analyses steps. Compared to the workshop event, relatively few people participated in the system and consistency analyses steps - which is typical in these more expert-driven steps of the formative approach (Walz et al., 2013). In Guanacaste, these smaller groups were more effective in these steps than larger groups. The purpose of these smaller groups was to perform the above steps in close consultation with previous current-state research that had already engaged and involved many people from the area. In this sense, we aimed for the system and constancy analysis steps to reflect, as much as possible (given the limited

set of variables), the real-time governance system. In contrast, a purely judgment-based approach may be more appropriate in some cases or settings (von Wirth et al., 2013). In contexts like Guanacaste with heterogeneous stakeholder groups and potentially significant power imbalances within those groups, our slightly modified approach to the early steps of the formative scenario approach may be worth considering. The key success factor here is that stakeholders already trusted the results of those previous studies because they had been highly engaged with them. Tangible current state research that directly addresses real problems (that are likely highly visible in regions like Guanacaste, i.e., water conflict) offers a valuable starting point to building trust, to organizing a sufficient body of current-state evidence that is seen as valid by diverse groups, and to understanding diverse stakeholder groups – all of which were key precursors to successfully employing the formative scenario steps in Guanacaste.

In this case, having a small but diverse stakeholder group – the PC Commission – central in the scenario building process was key. Importantly, the PC Commission is highly respected in the region, and positioning them in a way where they essentially became the intended users of the scenarios helped to avoid any potential legitimacy issues with the scenarios coming into the large stakeholder workshop. With the PC Commission in a central role, stakeholders were open to discuss even controversial scenario content at the workshop. A subtle benefit of this was the willingness of the PC Commission to be a named actor in each scenario. Workshop participants knew the PC Commission, and seeing/ comparing its different roles and activities in the scenarios was an effective communication strategy. We received many comments directly mentioning the PC Commission's activities in the scenarios. Thus in the Guanacaste context, the

limited but effective participation scheme at the start of the scenario building, combined with key partnerships, and followed by a very open participation scheme towards the end seemed optimal. Other cases will require different approaches to participation at different stages that fit the context.

We did not use the method to explore development pathways, i.e., how different alternatives could happen over time, which was pointed out by workshop participants. We found that scenarios alone cannot adequately support necessary change processes and activities, which is in line with previous findings and concepts (i.e., Wiek et al., 2006). Scenarios must then be incorporated into collective strategy building activities (ideally as a part of a broader transformational planning process) in order to have practical relevance for stakeholders. We found that quickly demonstrating this application in later workshop activities with stakeholders was important. As an critical step to prime for these later 'application demonstration' activities in the workshop, deliberating scenario content in an open format with a representative and diverse group of stakeholders effectively supported people to articulate what futures were desirable (or not) as a first step to planning and taking coordinated action. In this sense, motivating workshop participants who collectively could change regional water governance was a success of the workshop that was supported by the formative scenario method that was slightly adapted to fit the Guanacaste context. The general lesson here is that engagement, commitment over a sufficient period of time, and trust matter, methods can be adapted in transparent ways to fit problems and contexts, and that in water contested-regions like Guanacaste that face urgent and complex problems, there is significant opportunity for research that does these things to make positive impacts. For scenarios specifically, a timely demonstration of

their real application for governance actors, ideally situated within a transformational planning process (i.e., Wiek, in review), can help maximize these positive impacts.

5.3 Practical use of scenarios in follow-up activities: Successes and challenges. Workshop activities that followed the scenario building and validation exercise evaluated scenarios, identified priorities, and created strategies to avoid negative futures and achieve more positive ones. These follow-up activities quickly demonstrated the practical value of the scenarios. During this latter part of the workshop, participants, many of whom had not worked together before, exchanged contact information, suggested ideas, and offered to share resources and data with those who needed them. Many collaborative invitations were extended, including one to join a new coordination platform in Nicoya. After the workshop, several new efforts aimed to improve governance cooperation within the region. Much focus is now placed on leadership development in Nicoya, with the PC Commission assuming an important role. Several ASADAs, who have experienced conflict in the past, implemented a series of meetings to address ideas to share resources and to consolidate their organizations (the same ASADAs mentioned at the end of Section 5.1 that discussed ***Scenario #3: "Responsive and engaged"***.) These ASADAs started emphasizing internal human resources development, which is a significant paradigm shift for organizations that are historically only concerned with service-area infrastructure and collecting water-use fees. The scenarios were important reference points for stakeholders around Nicoya in the several months that followed the workshop. These efforts though have encountered barriers. Political corruption, lack of transportation, and low investment in communications infrastructure are a few examples. But recognizing, locating, and defining those barriers

has been beneficial. It has allowed new leaders to begin planning how to overcome barriers. As local leadership has grown, as new actions have been taken, and barriers discovered, there is less frequent operational reliance on the scenarios (i.e., being referenced in planning meetings).

The marked deficiency of reliable and accessible hydro-climatological information (and monitoring systems) remains a substantial void for Guanacaste water governance that presents acute challenges. Yet the governance scenarios, to some extent, initially helped revitalize regional organization and coordination around Nicoya to the point where collective strategies and the re-allocation of some personnel, financial, and technical resources to address this key knowledge gap could be more efficient. In turn, once new information is obtained and processed, the improved organization of the governance regime (assuming it stays improved or keeps improving) will potentially provide opportunities to capitalize on more effective avenues to formulate and implement adapted policies that will better position the region to meet complex water challenges. In this sense, the jump-start that the governance scenarios provided to better organize a very fragmented water governance regime was their most valuable application.

6. Conclusion

In Guanacaste, we found governance scenarios were well-equipped tools to initially support the mending of the fragmented parts of a regional water governance regime. The scenarios provided a means for actors to contribute their perspectives, to connect with each other, and to collectively examine which 'direction' Guanacaste water governance could go and what that could mean for the region. Local history, context, and challenges resonated with participants in the scenarios. Engaged and linked current-state

research, the timely demonstration of scenario application (i.e., goal setting and strategy building) with stakeholders, and a constructive, participatory scenario building approach were important factors that helped boost scenario value. If many water governance regimes are proving inadequate, as they have been in Guanacaste, then understanding alternative governing options is critical. Also critical, is that people who can collectively change governance understand key needs in order to realize alternative, more just water governance schemes. In Guanacaste - a developing context featuring low data availability, high urgency, and water conflict - governance scenarios were an effective step in this direction.

Chapter 6

Governance transition strategies for a water-contested and climate-threatened region

1. Introduction

Effective and sustainable water governance is a priority for Costa Rica, and the need is most apparent in the dry tropics of Guanacaste Province. At least 65 water conflicts (defined by legal action taken by one or more parties against another party) between 1997 and 2006 were documented in Guanacaste (Ramírez, 2007)—one water conflict every 56 days in a land area only slightly smaller than Los Angeles County but with a population thirty times smaller.

Guanacaste was Costa Rica's last frontier for development. It was known for its cowboys, heat, and bumpy roads. Today, a population that has increased five-fold since 1950, an economy that is increasingly open to global markets, and the continued expansion of irrigated agriculture and tourism infrastructure have created intense competition for water resources. Guanacaste also accounts for a large amount of Costa Rica's foreign direct investment, agricultural production, and electricity generation. A more sidelined province on the national political stage (Edelman, 1999), Guanacaste may not have the influence it should with the capitol's water politics. Regardless, how water is governed in Guanacaste will play an important role that helps determine how sustainable Costa Rica's future will be.

Table 6.1

Hoping for a Water Solution in La Esperanza (Loaiza, 2013; Bran, 2013)

The rural community of La Esperanza (pop. 800) in the *Municipalidad de Nicoya* has been without running water for months. The water problem in La Esperanza illustrates the inefficiencies of water governance in Guanacaste and in Costa Rica generally. An earthquake in September 2012 damaged the community's aquifer and wells. In December, when the rains stopped, the damaged wells ran dry. Response has been slow. There is a large well nearby, but it is on private land, and the local rural water administrator (ASADA) does not have the technical or financial resources to resolve the issue. Poorly coordinated public agencies with overlapping responsibilities have been slow to find a resolution. The *Municipalidad*, under direction of the mayor, is now leading efforts with public agencies to resolve the issue, though the case is outside its responsibilities. Regional governments have been increasingly active and willing to lead resource governance, which may indicate that positive change is on the horizon.

Note: The above table appeared as an insert box in the original published article.

An institutional and regulatory framework that has not changed significantly in over half a century largely determines water governance in Costa Rica. The legal backbone of water resources management in Costa Rica, the *Ley de Agua* (Water Law*)*, has remained virtually unchanged since 1942. The *Ley de Agua* defines water as a public good and the Constitution protects citizens' rights to a healthy and clean environment. However, legal loopholes (e.g., water is not currently defined as a human right, despite being a public good), the proliferation of public organizations, confusion over agency responsibilities, and ill-defined governing roles have created a fragmented system of water governance (Ballestero et al., 2007). The system is prone to corruption, is unresponsive to citizens, and is disconnected with many basin- and community-based

water managers. These troubles combine to make the current water governance system poorly equipped to handle the urgent and multi-faceted water challenges of the twenty-first century (Calvo, 1990). Despite repeated efforts at reform in recent years, each one has stalled in the *Asamblea Legislativa*, which makes the final decision on reform proposals (Arias, 2011).

The 2008 economic recession and, the ensuing slow down of development in Guanacaste, have offered a chance to revisit and re-imagine water governance. Despite hurdles at the national level, efforts to create a new model of water governance in Guanacaste are underway. Here we recount the progress and insights from one of these efforts - a project titled: *Toward Sustainable Governance of Water Resources in Guanacaste, Costa Rica*. This project, based out of Arizona State University and in partnership with the *Comisión para el Manejo de las Cuencas Potrero-Caimital* (Potrero-Caimital Watershed Management Commission), focuses on quality water governance research that is integrated with outreach to engage citizens and decision-makers and the promotion of project findings and material for water administrators, citizens, scientists, and lawmakers. A major effort of the project was organizing and leading a collaborative workshop—one the largest events for regional water governance in recent years – to help inform a proposed action plan for sustainable water governance in Guanacaste.

2. The Collaborative Workshop

On March 14, 2013, 46 individuals from 18 Guanacaste communities participated in the first collaborative workshop for water governance in the region. Participants represented eleven rural water administrators (ASADAs), six public agencies, regional governments, tourism, agriculture, community groups, and environmental groups. The

positions that participants held in the public water sector ranged from agency directors to part-time water administrators in communities with fewer than 1,000 people. Participants worked together for over seven hours to help build five future scenarios of water governance, assess the sustainability of each, identify water governance priorities that determined whether a scenario was sustainable or not, and develop strategies to avoid negative scenarios and achieve the best outcomes.

Workshop participants agreed on five governance priorities needed to achieve water sustainability in the region. First, governance must be initially well coordinated among different local and regional actors. Second, decisions must be made in transparent and open arenas. Third, policies should be modifiable based on changing human needs and environmental conditions. Fourth, groundwater resources should be secured within natural limits. Finally, commitments must be obtained to support effective regional and basin-scale organizations. These priorities were considered key to bringing about a sustainable model of water governance in Guanacaste to support healthy communities, distribute water fairly, and help ensure ecosystem integrity and equal economic opportunity.

Table 6.2

A New Era for Cooperation in the Mala Noche?

There is nearly one autonomous rural water administrator (ASADA) for every 2000 people in Costa Rica, so cooperation among river basins can be a challenge. The 28 km^2 Mala Noche Sub-basin, located near the town of Sámara in Nicoya County on the Pacific Coast has three ASADAs, which have been in conflict with one other over

issues such as development projects, water rights, and private interests (Kuzdas, 2012). All the Mala Noche ASADAs, along with eight others, attended the workshop. The ASADA representatives exchanged contact information and a new leader volunteered to serve as the central contact for under-funded ASADAs that lack adequate communications equipment. During the workshop, the Mala Noche ASADAs were also invited to participate in the County of Nicoya's new Coordination Platform. The future looks positive for water cooperation in the Mala Noche. But the question remains: will pubic agencies and lawmakers fully commit to and invest in these grassroots water governance efforts?

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3. An Action Plan

Participants worked in sub-groups to develop strategies based on the five priorities for water governance that were identified through scenario evaluation exercises at the workshop. Each sub-group presented its strategies, which identified actions to be taken, leaders, resources, and expected barriers to successfully taking action. Following the workshop, the research team and partners in the *Comisión para el Manejo de las Cuencas Potrero-Caimital* synthesized the following systematic action plan embodying the strategies developed by workshop participants and the insights obtained from the group discussions that followed each strategy presentation. The action plan identifies four action items, potential barriers, and ways to overcome those barriers.

3.1 Investment in the human element of water governance. Progress toward sustainable and effective water governance depends on investment in *human* resources.

There are at least two opportunities for investment in the human aspect of water governance in Guanacaste. *Communications equipment:* Coordination requires effective communication. Many ASADAs in Guanacaste lack basic communication equipment. Water governance in Guanacaste would look very different if every ASADA could be reached (and reach others) through email, phone, or social media. National leadership must consider investing in communications equipment for Guanacaste ASADAs. *Cooperation venues:* Coordination requires effective cooperation, and effective cooperation requires healthy professional and working relationships. The workshop we led could be replicated for less than $1,000. The cost could be split between participating organizations and led annually by regional and community actors. The event could help participants refine water governance strategies for communication and cooperation, report on strategy implementation, and solidify working relationships.

Admittedly, use of some communications equipment, especially the Internet, email, and social media, might be a challenge for ASADA personnel who are unaccustomed to it. But effective communication is an important precursor to new cooperation venues.

One initial way to address communication barriers is to use interns as office/professional aides for ASADAs while new communications equipment is being integrated into management practices. Interns could learn valuable professional skills as well as science, and perhaps also earn class credit. Over time these internships could turn into highly competitive and desired learning opportunities for young citizens. Until a water-specific venue is institutionalized in the region, the new public sector coordination

platform in Nicoya, led by the mayor's office, could function as a cooperation venue for the water sector.

3.2 Investment in small-scale monitoring equipment. Though effectively discussing and negotiating water needs is critical for basin-scale cooperation in Guanacaste, this is very difficult to do without knowing how much water is going where and for what purpose. National and regional leadership should fund and distribute water meters for Guanacaste ASADAs and openly share information with community and regional leaders on how much water is being allocated to tourism and agriculture.

A core barrier is likely to be the weak political will of national organizations to fund monitoring equipment for small-scale water management in rural areas. The open sharing of water-use information with communities may also be seen as a political risk in light of recent conflicts between large water users and communities. Nevertheless, a unified voice from ASADAs would be politically difficult to ignore.

To initially overcome barriers related to lacking political will, regional offices of agencies often have equipment that is available for shared use. ASADAs within a basin or sub-basin could also pool resources to purchase shared water meters. Water use data for large-scale tourism and agriculture exists, but not in one place. Sharing this information in real time would require ASADAs to have access to an open database and the Internet (e.g., communications equipment). To help defray the investment in communications infrastructure, a regional task force for ASADAs could help locate new revenue opportunities, like fee or tax restructuring at the municipal level or stiffer penalties for individuals that do not pay ASADA water bills.

3.3 Legal commitment to basin-scale planning for water resources. If people in Guanacaste are to govern their water resources sustainably, they must have the legal backing and authority to do so. National leadership should embark on a transparent process that explicitly involves leaders from the Guanacaste water sector to delineate more authority and resources to basin-wide and regional water managers.

Changing laws at a national scale often requires dealing with corruption, the influence of powerful interest groups, and significant bureaucratic red tape. Also, delineating authority or power to basin-scale managers might seem threatening to special interests that benefit politically or financially from weak basin-scale management.

Municipalidades, many of which are allies with ASADAs and community groups, could modify the purpose and implementation process of regional Regulatory Plans that are already in place and undergo regular updates. Such actions could help to avoid the barriers related to national-level bureaucracy and powerful special interests. With some legal adjustments, these Plans could be used to begin laying the initial groundwork for basin-oriented water resource planning. National allies, such as the *Programa de Gestión Integral del Recurso Hídrico* have been pushing for basin-scale planning in Costa Rica and could be called upon to support these efforts in Guanacaste.

3.4 Investment in a pilot project that incorporates the above three points in Nicoya. A pilot project in Nicoya County would be inexpensive and provide valuable insight into successfully implementing these actions across Guanacaste in the most effective and feasible way.

However, a pilot project would face certain implementation barriers. Uncertainty about the ability to communicate, coordinate, and disseminate the results of such a

project could inhibit commitment from some actors who may not yet trust governing processes. Potentially divided interests within the region might also hinder the willingness of local stakeholders to invest their effort, time, and resources into these collaborative projects.

To overcome these barriers to trust and commitment, already vested communities could identify leadership teams to pool their resources. They could start small, and then develop a system of accountability and expectations, like attending meetings regularly, following through, and responsiveness, in order to secure full commitment from stakeholders. The Mayor's Office in Nicoya recently implemented a new accountability system to ensure participation in regional meetings. That could serve as a model. Investment in communications infrastructure is a key synergistic action to help improving the potential participants' trust in and commitment to new governing processes and experiments.

4. Looking Ahead

Progress is already evident in Guanacaste. Participants at the workshop, many of whom had not worked together before, exchanged contact information with each other, suggested ideas, and offered resources to those who needed them throughout the day. One regional agency offered its extra water meters to several ASADA representatives. Another group offered access to extensive studies of groundwater reserves in one particular area. A contact list of participants was distributed to those in the group. Potential new leadership for the region was identified, and one participant offered to serve as the primary point of contact for ASADAs that could not be easily reached in the region. Another participant extended invitations to the larger group to join the new

Coordination Platform in Nicoya. Nevertheless, much work remains.

Table 6.3

An Engaged and Integrated Research Approach.

Major progress has been made in recent decades to identify the common success factors of resource governance systems (Ostrom, 2009; Allen, 2012). In the water sector, decision-makers are increasingly facing daunting challenges driven by dwindling water supplies, growing demand, and highly complex institutions. As a result, research on water governance may be out of sync with the professional needs of decision-makers (2012). In Costa Rica, we found that decision-makers are enthusiastic about research results that offer actionable knowledge (Kuzdas et al., 2012). In 2012, we delivered a report to the *Comisión para el Manejo de las Cuencas Potrero-Caimital* that was used to secure some protection of a groundwater reserve in one area. But our partners in the commission reminded us that the research contained in the report, although helpful, was not necessarily informative about ways to address the more challenging water issues in the region over time. We have since integrated research on the current state (how things are), possible future states (to identify goals), and governance strategies (to help achieve goals). Our partners in the *Comisión* now model this integrated approach in their watershed planning efforts, which in 2013 will be expanded to also cover the *Río Quirimán* in Nicoya.

Note: The above table appeared as an insert box in the original published article.

Water governance is understood as the set of collective actions that aim toward a common goal and are coordinated among diverse stakeholder groups (Lubell et al.,

2008). The recent efforts in Guanacaste, then, are positive steps toward reconfiguring water governance in the region. But the broader push for water reform in Costa Rica is not yet coherent. Some reform measures compete with one other at the national level, and many of the grossly underfunded ASADAs in Guanacaste petition for various things at different times. A key step to move forward will be to unify, to some extent, the water reform efforts at both a regional (Guanacaste) and national scale. To help jumpstart this step, our team distributed a document outlining the four action items to workshop participants, to national water sector leaders, and to members of the *Asamblea Legislativa*. Our team has also distributed material based on our research to a variety of groups through fax, newspaper, radio, email, social media, and community events in close collaboration with leaders in the region. These efforts have shed light on key considerations for leadership in the region, which will take on the responsibility to:

(1) Balance the need for new organizations and institutions in an already saturated and complex public (water) sector. Creating new organizations that are effective may require an initial reduction in or a consolidation of some existing organizations.

(2) Make available processes that identify the resources (financial, personnel, and technical) that already exist in the region. Existing resources and opportunities to secure new resources must be made clear to those who are spearheading action on the items listed above.

(3) Make a joint, timely effort to push for amending the Constitution to define water as a universal human right. Defining water as an explicit human right has often been the cornerstone of water reform efforts that fall short. Thus, some preliminary steps

might be needed before such a Constitutional amendment can be successfully achieved.

(4) Establish processes to define development goals at the regional or local scale. Communities, especially those along the Pacific Coast in Guanacaste, must begin these collective discussions before the real estate market begins growing again which will put additional pressure on water governance in the region.

(5) Document, evaluate, and modify action plans and strategies as needed. Partnerships with universities will provide opportunities for action plans and strategy evaluations.

Guanacaste leaders and communities are in a position to make a unified push for national water reform while simultaneously implementing actions to advance water sustainability from within the region. Progress is already being made. Though barriers remain, Guanacaste can move forward despite the failure of national lawmakers to modify water policies in light of citizens' needs. When water reform does happen—and with enough momentum it eventually will—Guanacaste will be in a position to capitalize on current water sustainability efforts.

The path to a sustainable water future in Costa Rica therefore must go through Guanacaste. *Guanacastecos* know that. They are working to create new model of water governance. But the question still remains: when will the rest of the country—and its national leaders—realize this and get on board?

Table 6.4

A Systematic Action Plan to Advance Sustainable Water Governance in Guanacaste

Action item #1	**Action item #2**	**Action item #3**	**Action item #4**
Investment in the human element of water governance (communications equipment and cooperation venues)	Investment in small scale monitoring equipment	Legal commitment to basin-scale planning for water resources	Investment in a Pilot Project (Test #1-3) in Nicoya
Barrier(s): Low professional communication expectations; cultures of poor communication; Little experience with newer communication modes	**Barrier(s):** Low political will of national-scale funders; perception of political risk to share water-use info	**Barrier(s):** Corruption; powerful interest group influences; difficulty of penetrating national-level bureaucracies	**Barrier(s):** Potential divided interests within region and uncertainty about ability to disseminate / communicate results
To overcome barrier: ASADA	**To overcome barrier:** Allies in	**To overcome barrier:** Modify	**To overcome barrier:** Identify

internship program; regular workshops funded by participating organizations; use new Coordination Platform	agency branch offices; pooling resources; task force to define new revenue sources for ASADAs	the purpose and implementation process of regional Regulatory Plans to circumvent wait time to change national water policy	and fully commit to regional leadership team; pool resources; investment in communications equipment
Existing resources: Nicoya Coordination Platform; New ASADA leadership; Regional political allies (mayors)	**Existing resources:** University information infrastructure; development association allies	**Existing resources:** Media allies (political pressure); Regulatory Plan funds; Regional political allies (mayors); National allies	**Existing resources:** New ASADA leadership; Nicoya Coordination Platform;

Key considerations/ responsibilities for local and regional leaders to move forward

Balancing the creation of new organizations with the need to reduce institutional complexity/ consolidate
Identifying resources in the region and channeling those resources toward priority actions
Detecting the right time to push efforts that aim to explicitly define water as a Constitutional human right
Establishing processes that define and re-define goals for development at regional or smaller scales
Partnering with research organizations to document, evaluate, modify strategies in real-time

Chapter 7

Conclusion: How water can be governed sustainably in water-contested and climate-threatened regions and how people can transition water governance regimes from current to sustainable ones in these regions

1. Introduction

In this final chapter, I first (in Section 2) briefly report on other project activities and explain their role and importance in the broader project. In Section 3, I recap how the three objectives of the dissertation were met by addressing the individual sub-questions (outlined in the introduction) under each objective. This information is reported in the individual dissertation chapters, but is re-organized here for the purposes of this concluding dissertation chapter. Some readers may prefer to read the relevant chapter, while others may prefer to read here only the answers to some questions under certain dissertation objectives. Section 4 summarizes the contributions of this dissertation to the current state of knowledge following each of the three dissertation objectives. A discussion and initial reflection on the evolution of the project's research and planning framework is presented in Section 4.2. Section 5 outlines practical contributions made to water governance efforts in Guanacaste.

2. Brief Summary of Other Key Research Activities

A number of relevant research activities occurred which are not presented in full chapter detail in this dissertation. Two such activities included a multi-criteria evaluation of the sustainability of the scenarios/ alternative water governance regimes developed in Chapter 5 and the initial real-time testing of governance transition strategies that were developed and outlined in Chapter 6.

2.1 Summary of the multi criteria scenario/ governance alternative evaluation and its role. Research from Guanacaste has made it clear that current water governance regimes are not sufficiently addressing complex challenges (Chapter 2). By investigating these issues with stakeholders, efforts from project partners have attempted to re-orient governance regimes toward more sustainable pathways; and, these efforts have been met with some, but limited success (Chapter 3). Chapter 5 (partially informed by Chapter 4, i.e., how conflict could play out in alternative governance regimes) developed a coherent and consistent set of alternative water governance regimes in Guanacaste. However just developing alternatives does not necessarily place normative values on those scenarios. In other words, which scenarios should governance processes and actors aim for and which should be avoided? The multi criteria evaluation of the alternative governance scenarios addressed this question and occurred immediately after the scenario development activity with the 46 participants (divided into sub-groups) in the March 2013 workshop. The formative scenario methodology described in Chapter 5 allowed for a unique opportunity to assess the scenarios using a multi-criteria analysis approach. The approach focused on defining 'sustainability thresholds' for a small set of variables and then comparing the sustainability performances of each scenario and the current state based on 'distances' from those defined thresholds. The discussion after the evaluation activity focused on the key parts of those scenarios that systemically helped determine how far the scenarios were from those 'thresholds'. Details on the methods and procedures are contained in Appendix E. This evaluation exercise was one of the first collaborative and collective efforts in the study area to attempt to sort out goals, aspects to avoid, etc. across such a diverse group of stakeholders. Decision support tools,

including scenarios and multi criteria analysis, are often proposed by researchers to support such collective efforts. Results of these efforts though are often mixed: scenarios tend to overlook current challenges; multi criteria approaches often only include a handful of experts; and approaches that combine scenarios, multi criteria analysis, and other decision support tools often lack a strategic (e.g., how to we go that direction while avoiding those directions starting from here and right now) imperative. The largest contribution of the scenario evaluation was to support an initial identification of goals - through comparing the sustainability performances of alternative governance regime, in a novel and very strategic way. The evaluation exercise fed directly into governance transition strategy building.

2.2 Summary of further building and beginning to test strategies and their role. Governance transition strategies refer to the coordinated actions of governing actors that aim to overcome problems, to identify barriers to success, to locate and secure resources needed to act and overcome barriers, and to devise alternative courses of action as needed. Developing and, to some extent testing, governance strategies in Costa Rica found direct and indirect pathways through which diverse governance actors could over time address a politically stubborn and often-unjust water governance regime that is largely controlled by actors located away from the unique, dry tropical context of rural Guanacaste. In the March 2013 workshop, sub-groups selected a workable set of key aspects of the governance regimes (that were discussed in the previous activity as important components that determined the sustainability performances of the governance scenarios and the current state) in order to build governance transition strategies. The purpose of this activity had two parts: (1) to introduce governing actors to the

components and concept of transition strategies, and (2) to actually build transition strategies. Six sub groups worked on a large 'building a governance transition strategy template" (See Appendix F) and then presented their strategies. In doing so, leaders for the principal actions were discussed and identified, resources needed to carry out the actions were discussed and identified (and in some cases offered to others), barriers were identified and discussed, and further actions were discussed. In total, participants created six transition strategies ,which were then synthesized by researchers and partners in the PC Commission into the strategies presented in Chapter 6.

Various actors have since attempted to implement components of the strategies. Some have been successful, others have not, and others have found mixed results. For example, members of the Potrero-Caimital Watershed Management Commission (*Comisión para el Manejo de las Cuencas Potrero-Caimital,* PC Commission) were invited to contribute to water reform talks in February 2014. Attempting to engage with and contribute to currently inadequate, broader water governance schemes that negatively affect Guanacaste was an important component of the proposed transition strategies in Chapter 6. In another case, a small group of community-run drinking water associations (ASADAs) successfully implemented standing regional meetings in order to begin formation and unification of a coastal water managing body. Addressing the lack of effective regional governance, which has negative affects on water governance in Guanacaste, was an important component of the transition strategies developed in Chapter 6. These efforts by the ASADAs were successful over their first months and improved the previously poor collaboration in the area that was at least in part driving conflict. However an unexpected leadership changes in one ASADA has hampered

progress and presented new barriers concerning leadership development. Other efforts to build more effective regional scales of water governance though have moved forward, as illustrated by the recent efforts of the PC Commission which now operate and help lead the governance efforts in four watersheds near Nicoya. This real-time testing of the strategies (e.g., trying them and seeing how they work or not) has provided new insights into what it will take to actually implement successful sustainable water governance in the region. This work on testing strategies continues beyond this dissertation.

3. Meeting the Dissertation Objectives and Addressing Questions

Below I provide a recap of the answers for questions stated under each objective in the dissertation introduction. Note that this information is found in the chapters above and more detail can found in the indicated chapters.

3.1 Dissertation Objective #1. To clarify the process and design features of sustainable water governance and potential barriers to implementation, especially in the context of climate threatened, water-contested, and developing regions.

How is water currently governed in a water-contested and climate-threatened region in the Central American dry tropics? (Chapter 2)

Regional water governance in Guanacaste operates within a hybrid institutional structure that features several national agencies at higher levels, a handful of regional-scale actors, and many sub-regional to local actors that are mostly arraigned around agency offices in semi-rural areas (i.e. provincial capitols) or that are often disconnected in the more rural areas. Institutional responsibilities are dictated through formal organizational hierarchies, which are then implemented through a set of increasingly disconnected administrative units as the scale changes to more rural contexts. Nationally,

the Environment Ministry *(Ministerio de Ambiente, Energía, y Telecomunicaciones, MINAET*) MINAET and the national water agency (*Instituto Costarricense de Acueductos y Alcantarillados*, *AyA*) are legally obligated to coordinate with each other and with other agencies in order to execute broader efforts, rule making, and new water-related initiatives. Article 50 of Costa Rica's Constitution establishes citizen's rights to a healthy and clean environment. Since water sources and major infrastructure are held in trust by the State in accordance to the 1942 Water Law, fulfilling Article 50's mandate falls onto agencies. Yet, there is little institutional clarity of who should be involved with implementing, and enforcing rules at regional to local scales. Regionally, MINAET and AyA did not execute water-related activities in coordination with each other, while other water governance-related agencies (such as the *Servicio Nacional de Aguas Subterráneas Riego y Avenamiento*, SENARA) were often not present. AyA and MINAET, who hold a large degree of power through water management and allocation mandates, operated in separate governing domains (although with overlapping responsibilities). Accordingly, the characteristics of regional water governance changed significantly as AyA (mainly influencing water delivery and outflows domains) and MINAET (mainly influencing water supply and use domains) exchanged prominent positions as water governance unfolded from sourcing water to delivery, use, and post-use within the regional water system.

Notably, the actions and presence of non-state community and collective leaders increased collaborative activity within the governance regime. High levels of coordinated activity among governance actors are present in the water supply domain, where the PC Commission and its affiliate *NicoyAgua* were most active. In spite of challenges,

cooperation is still significantly boosted in comparison to the other governance domains because the presence of the PC Commission allows involvement of some rural ASADA communities in governing processes - although, ASADA involvement also depends on individual abilities, will, and operating resources.

Results in Chapter 2 show surface flows in rivers substantially fluctuate and decrease during dry seasons, indicating the importance of adequately maintaining groundwater sources – which is a notable challenge given little is known about groundwater capacity and the minimal management and use coordination. Chapter 2 also notes that collective knowledge does exist to initially estimate surface flows with moderate confidence. However, as noted in workshops, some more rural water user groups do not necessarily have access to this knowledge. Additionally, independent rural smallholder farmers who rely on springs and feeder streams often do not have the capital to drill wells, leaving them potentially vulnerable to water scarcity during dry periods. Although moderate knowledge exists regarding surface flows, we found that very little was collectively known about how much is used or needed by different economic sectors and groups and minimum needed flows for healthy ecosystems, both of which were cited by some interviewees as posing major challenges for governance to fairly negotiate just water allocations and for improving overall environmental quality.

In rural Guanacaste, the de-concentrated water administrative scheme became functionally fragmented as scale was reduced. De-concentrated refers to the physical expansion of public agencies outside of a central/ capitol location (Meinzen-Dick & Knox, 1999). Within watersheds, formal administrative units struggled to communicate across and within jurisdictions and to coordinate their localized actions. Decentralization

schemes (referring to actual transferred decision-making and financing responsibilities to local units such as ASADAs) were simultaneously present with the more centralized, de-concentrated schemes. Eakin et al. (2011) use evidence from Mexico to demonstrate that centralized water governance can struggle to make decisions that are appropriate to local contexts and needs. Similarly, here we saw that responsibilities for water governance in Guanacaste often fell on agency branches that follow directives from higher-ups in Costa Rica's capitol region, an area that faces a different set of water-related problems (i.e., urban runoff, increased diversity of users, more complex distribution and collection infrastructure) that notably involves less pronounced dry seasons and less reliance on groundwater for both domestic and economic purposes (Ballestero et al., 2007). Agency branches in Nicoya struggled to collectively organize with each other and with other groups in order to address the complex problems faced in the rural dry tropics due to, at least in part, to this structural issue (i.e., Biswas et al., 2009). For example, results illustrated the negative impacts of the uneven exercise of authority and lack of accountability between the two primary or more-central governing actors (AyA and MINAET) in the water system. Relevant issues that the current water governance regime has thus far poorly addressed include: well-coordinated groundwater management and use, low capital investment in decentralized community water-user associations, and potentially critically less available surface water for independent and small farms during dry periods.

The limited decentralized scheme within the rural drinking water sector of the governance regime did not help remedy these challenges. Decentralized rural drinking water groups (e.g. ASADAs) were often too disconnected (and often poorly resourced in

more rural areas) from the rest of the governance regime (mostly located in the city of Nicoya) to provide formal input, or in some cases, to access important information (i.e., available surface flow information) which led to asymmetrical knowledge gaps of key parts of the water system. Broader trends, such the tendencies of some Latin American states to re-centralize after past periods of compulsory decentralization (Dickovick & Eaton, 2013), are also being realized in Costa Rica's water sector as agencies have begun attempts to gain and tighten control on some rural water-user groups (Madrigal et al., 2011). Despite seemingly polycentric-inspired efforts and schemes at the national level in the Costa Rican water and environmental sectors (Calvo, 1990; Calvo-Alvarado et al., 2009), these efforts have not translated into similar water governance schemes in the rural dry tropics of Guanacaste. Indeed, it appears from the literature that the current trend is for agencies instead to seek to increase their control in the rural water sector in some places in Costa Rica (Madrigal et al., 2013) and in other areas with fewer administrative and financial resources, the rural water sector functions in a largely uncoordinated and fragmented fashion.

How well is water currently governed in this water-contested and climate-threatened region? (Chapter 3)

Out of the 25 normative sustainability criteria used to appraise the water governance regime in Guanacaste, seven were found to pose a significant challenge for the governance regime (for details on the performance of individual criteria and sustainability principles see Chapter 3). Below I recap the results via the problem clusters and opportunities identified in Chapter 3.

Potrero-Caimital (PC) Aquifer – The absence of management coordination and poor information sharing of water extractions among communities that share the PC Aquifer bring about several challenges. Law mandates that government agencies should coordinate with each other (in the water sector) and with local organizations, but how exactly this ought to be organized and who is responsible to do what is not defined. This is a challenge for creating a body of accessible and coherent knowledge about water quantities being stored, moved, and used in the system. Local actors indicated that the majority of perceived water-related challenges in the region involve the PC Aquifer. In the past, stakeholders have struggled to develop adequate basin scale management plans for properly managing groundwater use. As indicated in interviews and the appraisal (in Chapter 3) levels of mutual trust between actors (especially among rural community groups and agencies), which would be needed to execute collaborative management plans in rural areas, appear to be low. Uncertainty regarding water supply and use potentially makes reconciling mistrust and negotiation difficult as demonstrated in recent nearby water conflicts.

Regulatory institutions / water management frameworks – Inadequate rules that regulate and monitor groundwater and post water-use drive stakeholder concerns regarding water quality. A third of interviewees indicated that contamination/ water quality (especially dealing with groundwater and in the water outflows domain) is the most important water-related challenge in the region. In the study area, all actors central in the regional governance regime are national agencies with the exception of the PC Commission. Institutional frameworks that dictate how these central actors operate in relation to each other are vague in terms of specifying who is responsible to do what in

the region. This vagueness allows excessive repetition of some institutional responsibilities of agencies and leaves voids concerning others. For example, in Hojancha many actors use organizational resources duplicating efforts such as reforestation-related activities - and promoting tree farming - often without a broader understanding of its hydrological impacts in the area while few or no efforts address groundwater or relevant issues in water outflows. There is no standard for cooperation between Nicoya and Hojancha, despite Hojancha relying on the PC Aquifer (in Nicoya) for water supplies. In the study area, the first Management Plan (Morataya 2004) aimed to create stakeholder networks - a critical task considering gaps in broader institutional frameworks. Results of the first management plan have been mixed though, since such plans are not legally enforceable.

Institutional leadership and goal setting – The lack of institutional leadership, which helps drive collective goal setting and deliberation across boundaries, is evident. Results highlight, for example, that various water-use education efforts in the region lack a clear objective. No actor fills leadership roles that guide environmental education efforts in a unified direction, which is a reflection of the larger issue of unclear governing objectives. A coordinated effort for sustainable water governance would involve a constructive process to deliberate and identify collective goals and alternative ways of governing water, which in turn requires engagement of diverse stakeholder groups. Effective stakeholder engagement will require enduring leadership and commitment that spans institutional and administrative scales, which is currently not present. MINAET and AyA are the two organizations in the positions, at the moment, to drive goal setting in the governance regime. However, these two agencies operate (as mentioned in the

previous section) in different aspects of the water governance regime and do not coordinate their activities. Having two prominent public actors that do not coordinate their primary functions is an obstacle for efforts that seek to develop collective objectives and to deliberate and implement collective actions to achieve those objectives.

Downstream and regional integration – Poor integration of downstream communities, including unclear vertical accountability mechanisms that are accessible to rural communities presents challenges, especially when considering recent conflict events involving rural communities and potentially drier futures. There is a reasonable possibility that other communities will look for new water sources if drier or more variable climate projections come to fruition. If they do, the PC Aquifer would be an attractive prize. If the future does require deliberation processes over new infrastructure, downstream integration will be important for open and fair deliberation processes. At the moment, many of these processes in Guanacaste lack an adequate considerations of demand management perspectives that could in some cases provide an alternative 'soft' path to large water infrastructure and transfer projects (i.e., Gleick, 2003). Such approaches would stand in contrast to the traditional method of water resources planning in Guanacaste, which (as evidenced by recent conflicts) is a process that is often closed and seen with suspicion by many communities (Kuzdas, 2012). Building downstream integration, especially through vertical accountability and through open deliberation and testing of demand management alternatives, may help avoid future conflicts and prove important for sustainability efforts.

The appraisal procedure also yielded four existing opportunities that already have positive sustainability effects (as noted in the appraisal in Chapter 3), but could be further built on to expand those positive effects on the water system:

New partnerships for information sharing – The will to establish venues and science-decision maker partnerships by which to formally share information on, for example, water extractions and needs is demonstrated by recent efforts by the *Universidad Nacional* in Nicoya, which has initiated work to synthesize information of water being extracted by ASADAs. UNA has also hosted recent workshops addressing water reuse and recycling potential in the region. Active institutional leadership for the region could feasibly be fostered or developed in partnership with UNA's programs.

Opportunities for facilitating coordination – Grassroots efforts, such as the PC Commission and its affiliate NicoyAgua, are in a unique position to increase participation and coordination among ASADA communities – as well as strengthen ties between AyA and MINAET. The PC Commission/ NicoyAgua is the only actor in the study area with professional ties to both MINAET and AyA, and it attempts to better include more rural community groups in water governance through more informal means. Facilitating better coordination and unified leadership between the regional offices of two central actors (AyA and MINAET) would be one feasible near-term objective that collective efforts could strive for in order to encourage developing collective goals and deliberating alternative governing options, which could increase sustainability compliance on a number of fronts.

Transfer potential – With adequate strategic planning, the coordination efforts by the PC Commission, NicoyAgua and other non-state organizations could serve as a

model for grassroots water governance efforts throughout Guanacaste and beyond. Aiming to be this type of model for the region could feasibly be a powerful motivation and visioning tool for devising alternative ways of governing water. It could also function as a learning platform for water governance efforts and it might inspire new and enduring leadership in the region.

Existing management plan as starting point – The 2004 Management Plan, despite not being a legally binding document, established the need to include more diverse actors into decision-making, including large agricultural businesses. An updated Plan could feasibly be more effective and authoritative if developed in conjunction with more diverse actors. The basis of a new Plan update could establish an open, transparent governance process that formally includes rural community groups and offers them practical avenues to participate and provide input. A modified governing process established by a new Plan could also aim to build consensus through open deliberation of management objectives, to outline responsibilities to monitor system sustainability compliance, and provide the means to adjust management strategies as needed.

What common opportunities for advancing toward sustainable water governance might we expect to find in such regions? What common barriers might we expect to find? (Chapter 2 and 3)

Given the evidenced limitations of the current water governance regime in Guanacaste, governing efforts that protect or enhance already successful collectives and effective local leaders, such as the PC Commission in Nicoya, potentially offer a *initial* promising start since these organizations currently maintain the trust of and connections to rural communities that agencies and other governing actors currently do not have. Such

collective leaders were also found to be key drivers of community-agency collaborations in rural Brazil (Abers, 2007). In contrast to other rural water governance regimes, where organizational costs and activities are shared between government agencies and water-user groups (i.e., Meinzen-Dick et al., 2002), in Guanacaste we found less formal sharing among diverse groups. Consequently, as results show, rural community water providers (ASADAs) were often left out of governing processes. Meinzen-Dick et al. (2002) found in rural India that quality leadership boosted farmer's participation in water user associations and the collective activity levels of those organizations. Despite the differences in terms of how governance operates between rural Brazil, India, and Costa Rica, the positive influence of effective local leaders were evident in all cases. Overcoming formal limitations, local leaders in Guanacaste still facilitated the inclusion of some otherwise disconnected rural groups. Among other things, Chapter 2 argues that these local leaders could be promising starting points for water governance regimes to move forward in the Central American dry tropics.

Chapter 3 identified two challenges and two starting points for advancing sustainable water governance in the Central American dry tropics.

Based on the appraisal in Guanacaste, it would be expected that *Principle #1: Social-ecological system integrity* to be a focal point for sustainable water governance. Coordinating the sustainable use, management, and protection of groundwater reserves is a critical challenge for long-term sustainability in the face climate change impacts. Like Guanacaste, many parts of the dry tropics in Central America already rely on groundwater as an important water resource. Reduced precipitation that is expected in much the Central American dry tropics could severely affect these resources, while also

limiting the viability of relying on alternative surface flows for water supplies. Also similar to Guanacaste, the regulatory context of the use, management, and protection of groundwater reserves is often vague (Ballestero et al., 2007). Developing and implementing fair governing processes in line with *Principle #4: Socio-ecological civility and democratic governance* and that aim to sustain ground water resources will be important for the region.

Principle #4 though also presents challenges for much of Central America, and accordingly, should be a relevant focus for sustainable water governance efforts. Water governance regimes are challenged to better engage diverse stakeholders and to develop improved participatory and responsive governance schemes when planning infrastructure and deliberating alternatives. Although not accounted for in our appraisal, damming rivers and creating reservoirs for both water storage and power generation is a current coping and development strategy of Central American governments. In Guanacaste, adequately involving rural, diverse groups in governance where (1) centralized agencies are expanding their reach through additional branch offices, (2) drinking water delivery schemes are becoming more decentralized in rural areas (e.g., ASADAs), and (3) governing responsibilities are vague and local management capacity varies presented challenges (as indicated in the problem clusters). Regions in the Central American dry tropics with similar governance schemes may expect comparable challenges. For example, the poor involvement of especially rural communities in decision-making processes, especially those concerning new infrastructure, is an important factor in escalated water conflicts in the region (Paniagua & Stocks, 2008; Kuzdas, 2012). Sufficiently involving more diverse groups in these processes, in addition to helping

improve compliance with Principle #4, could also allow for more serious engagement and deliberation with alternative demand management strategies that rely less on water supply enhancement (Brooks and Holtz, 2009). Such alternatives could in turn offer positive, mutually reinforcing benefits related to *Principle #1: Socio-ecological system integrity* and *Principle #2: Resource maintenance and efficiency* considering in Guanacaste poorly managed groundwater reserves and citizen's concerns over potentially taxed water supplies and demand growth.

To enhance the positive sustainability effects of water governance regimes along the lines mentioned above, many governance regimes in Central America will need to confront deep social inequalities, lingering poverty, histories of exclusive control – and in some cases histories of oppression and rebellion – that have in many areas fostered persistent feelings of disenfranchisement and mistrust toward political institutions and government agencies (Edelman, 1999; Booth et al., 2010). Strategic, multifaceted efforts that aim toward reconciliation, capacity building, and renewed investment (i.e., technical, financial, administrative) especially in rural community and regional water governing organizations offers a potential path, or at least a start, toward more sustainable water governance regimes. The Guanacaste case affords insight into two potential opportunities that are relevant for water governance regimes in the Central American dry tropics to start on this path.

While economic liberalization in the broader region has generated concerns over public sector capacity (Eakin et al., 2011), there has been a growing influence of private enterprise and civil society organizations in decision-making (Bebbington, 2005). In Guanacaste, we found that the efforts of organizations such as the PC Commission had

positive sustainability impacts where public sector roles were diminished. As mentioned in the results, these roles involved driving coordination across institutional boundaries and facilitating some rural community groups to informally participate in governing processes. These actions helped make the governance regime more open, just, and collaborative in the parts where the PC Commission was active. Grassroots organizations are common in the broader region (Booth et al., 2010), and although it should be expected that their capacities would vary, they do offer a promising investment opportunity that, combined with the right partnerships and in appropriate settings, could positively impact water governance.

The second common opportunity that we might expect are 'policy windows' that can potentially be used to distribute more authority to local, regional, and basin-level planning efforts that already occur with limited authority in many places (Rogers, 2002). Although not a silver bullet, well-designed and alternative schemes that better disperse authority could potentially allow for decision making that is more in-tune and responsive to the challenges that more rural, dry tropical regions face such as governing groundwater in a climate threatened and socially contested context. These 'windows' may come unexpectedly and seem limited, as the 2012 Regulatory Plan update process in Guanacaste illustrates, but nonetheless may be a first step. For example, the PC Commission reported its lobbying efforts during the Plan update helped increase its confidence and helped solidify its position as a respectable governance actor in the area, which it considers a positive a step toward utilizing the 'transfer potential' opportunity (Section 4.3). Other 'windows' may take on different forms. For example, Eakin & Lemos (2010) note the trend has been for smaller scale managers and administrators to

experiment with new policy instruments such as 'risk atlases' and 'ecological ordinances.' Engle & Lemos (2010) find resource managers to be experimenting with integrating democratic principles into policy. Scenarios and basin-scale plans have been used in Guanacaste communities, and they could feasibly build on appraisal efforts in order to help diverse actors constructively engage with alternative ways of governing water (i.e., see Chapters 5 and 6). These small-scale 'policy windows' offer opportunities that could support the collective organization of local actors to more effectively confront and positively influence broader governing issues and help strengthen diverse resource planners and managers in the dry tropics.

What governing actions can be implemented over time in order to overcome those barriers? (Chapter 6)

(#1) Primary Action - Investment in the human element of water governance. Effectively mitigating water conflicts depends on investment in *human* resources. There are at least two opportunities for investment in the human aspect of water governance in Guanacaste. *Communications equipment:* Coordination requires effective communication. Many rural water administrators lack basic communication equipment. Water governance in Guanacaste would function very differently if every rural water administrator could be reached (and reach others) through email, phone, or social media. *Cooperation venues:* Coordination requires effective cooperation, and effective cooperation requires healthy professional and working relationships. The workshop we led could be replicated with a reasonable budget. The cost could be split between participating organizations and led annually by regional and community actors. The

event could help participants refine water governance strategies for communication and cooperation, report on strategy implementation, and solidify working relationships.

(#1) Barrier: Admittedly, use of some communications equipment, especially the Internet, email, and social media, might be a challenge for rural water administrator personnel who are unaccustomed to it. But effective communication is an important precursor to new cooperation venues.

(#1) Action to overcome barrier: One initial way to address communication barriers is to use local student interns as office/ professional aides for rural water administrators while new communications equipment is being integrated into management practices. Interns could learn valuable professional skills as well as science, and perhaps also earn class credit. Over time these internships could turn into highly competitive and desired learning opportunities for young citizens. Until a water-specific venue is institutionalized in the region, the new public sector coordination platform in Nicoya, led by the mayor's office, could function as a cooperation venue for the water sector.

(#2) Primary Action - Investment in small-scale monitoring equipment. Though effectively discussing and negotiating water needs is critical for basin-scale cooperation in Guanacaste, this is very difficult to do without knowing how much water is going where and for what purpose. National and regional leadership should fund and distribute water meters for Guanacaste rural water administrators and openly share information with community and regional leaders on how much water is being allocated to tourism and agriculture.

(#2) Barrier: A core barrier is likely to be the weak political will of national organizations to fund monitoring equipment for small-scale water management in rural areas. The open sharing of water-use information with communities may also be seen as a political risk in light of recent conflicts between large water users and communities. Nevertheless, a unified voice from Guanacaste water administrators would be politically difficult to ignore.

(#2) Action to overcome barrier: To initially overcome barriers related to lacking political will, regional offices of agencies often have equipment that is available for shared use. Rural water administrators within a basin or sub-basin could also pool resources to purchase shared water meters. Water use data for large-scale tourism and agriculture exists, but not in one place. Sharing this information in real time would require rural water administrators to have access to an open database and the Internet (e.g., communications equipment). To help defray the investment in communications infrastructure, a regional task force for rural water administrators could help locate new revenue opportunities, like fee or tax restructuring at the municipal level or stiffer penalties for individuals that do not pay water bills.

(#3) Primary Action - Secure legal commitment to basin-scale planning for water resources. If people in Guanacaste are to govern their water resources sustainably, they must have the legal backing and authority to do so. National leadership should embark on a transparent process that explicitly involves leaders from the Guanacaste water sector to delineate more authority and resources to basin-wide and regional water managers.

(#3) Barrier: Changing laws at a national scale often requires dealing with corruption, the influence of powerful interest groups, and significant bureaucratic red

tape. Also, delineating authority or power to basin-scale managers might seem threatening to special interests that benefit politically or financially from weak basin-scale management.

(#3) Action to overcome barrier: Municipalities, many of which are allies with rural water administrators and community groups, could modify the purpose and implementation process of regional Regulatory Plans that are already in place and undergo regular updates. Such actions could help to avoid the barriers related to national-level bureaucracy and powerful special interests. With some legal adjustments, these Plans could be used to begin laying the initial groundwork for basin-oriented water resource planning. National allies, such as the *Programa de Gestión Integral del Recurso Hídrico* have been pushing for basin-scale planning in Costa Rica and could be called upon to support these efforts in Guanacaste.

*(#4) Primary Action - Implement a pilot project that incorporates the above three Primary Actions***.** A pilot project in Nicoya County would be inexpensive and provide valuable insight into successfully implementing these actions across Guanacaste in the most effective and feasible way.

(#4) Barrier: However, a pilot project would face certain implementation barriers. Uncertainty about the ability to communicate, coordinate, and disseminate the results of such a project could inhibit commitment from some actors who may not yet trust governing processes. Potentially divided interests within the region might also hinder the willingness of local stakeholders to invest their effort, time, and resources into these collaborative projects.

(#4) Action to overcome barrier: To overcome these barriers to trust and commitment, already vested communities could identify leadership teams to pool their resources. They could start small, and then develop a system of accountability and expectations, like attending meetings regularly, following through, and responsiveness, in order to secure full commitment from stakeholders. The Mayor's Office in Nicoya recently implemented a new accountability system to ensure participation in regional meetings. That could serve as a model. Investment in communications infrastructure is a key synergistic action to help improving the potential participants' trust in and commitment to new governing processes and experiments.

The recent efforts to govern water more effectively and mitigate water conflicts in Guanacaste are positive steps toward reconfiguring water governance in the region. But the broader push for water reform in Costa Rica – which we found to be ultimately needed if local and regional actors are to access the resources needed to mitigate water conflict - is not yet coherent. Some reform measures compete with one other at the national level, and many of the grossly underfunded water administrators in Guanacaste petition for various things at different times.

We found that a key step to move forward with water conflict mitigation strategies will be to unify, to some extent, the water reform efforts at both a regional (Guanacaste) and national scale. To help jumpstart this step, our team distributed a document outlining the above four action items to workshop participants, to national water sector leaders, and to members of the *Asamblea Legislativa* (national congress). Our team has also distributed material based on our research to a variety of groups through fax, newspaper, radio, email, social media, and community events in close collaboration with leaders in

the region. These efforts have shed light on key considerations for leadership in the region, which will take on the responsibility to:

(6) Balance the need for new organizations and institutions in an already saturated and complex public (water) sector. Creating new organizations that are effective may require an initial reduction in or a consolidation of some existing organizations.

(7) Make available processes that identify the resources (financial, personnel, and technical) that already exist in the region. Existing resources and opportunities to secure new resources must be made clear to those who are spearheading action on the items listed above.

(8) Make a joint, timely effort to push for amending the Constitution to define water as a universal human right. Defining water as an explicit human right has often been the cornerstone of water reform efforts that fall short. Thus, some preliminary steps might be needed before such a Constitutional amendment can be successfully achieved.

(9) Establish processes to define development goals at the regional or local scale. Communities, especially those along the Pacific Coast in Guanacaste, must begin these collective discussions before the real estate market begins growing again which will put additional pressure on water governance in the region.

(10) Document, evaluate, and modify action plans and strategies as needed. Partnerships with universities will provide opportunities for action plans and strategy evaluations.

Guanacaste leaders and communities are in a position to make a unified push for national water reform while simultaneously implementing actions to advance water sustainability from within the region. Progress is already being made. Though barriers remain,

Guanacaste can move forward despite the failure of national lawmakers to modify water policies in light of citizens' needs.

3.2 Dissertation objective #2. To specify the institutional drivers and mediators of intense and intractable water conflicts at regional scales.

Why do some water conflicts escalate while others do not? (Chapter 4)

More intense conflicts were often in cases of high friction between agencies and disconnected community-based institutions and without active regional-scale leaders. This friction materialized through escalated conflicts when local groups aimed to influence decision-making despite limited available avenues to do so – such as in the Sardinal and Nimboyores conflict cases. In the DRAT case, those farmers without the means to cope with reduced water deliveries or to reach governing actors, damaged irrigation infrastructure to secure water. In contrast, well-coordinated and accessible multi-level governance with effective regional leadership supported actor's efforts to resolve or mitigate water conflicts. For example, in the Nimboyores resolution, a new municipal position was established to provide leadership and convey information to and from rural water-user groups. Learning from Nimboyores, actors in Nicoya established collective efforts that provided avenues for rural communities to access governing processes that otherwise remained unreachable. Although these avenues were largely informal since the PC Commission is not a formal decision-making organization (although it does substantially influence decisions), they did help facilitate successful conflict mitigation. In the Mala Noche, we see differing aspects of leadership. Early leadership guided actions against private actors that sought to utilize or potentially affect

poorly understood groundwater resources. More recent leadership sought to enable cooperation in the basin in spite of historical tension and other challenged.

Even in challenged settings that feature high friction between disconnected institutions that operate at different levels, the presence of individuals with the drive and will to address shortcomings of water management allowed for conflict mitigation potential. We detected a surprisingly large degree of interactions and learning among actors across some cases. Learning from leading individuals across three cases - starting with Nimboyores, to Nicoya, and then to the Mala Noche occurred. However, the most recent conflict case in Sardinal follows a similar trajectory as Nimboyores, which occurred nearly 10 years prior. Thus some areas within Guanacaste used nearby water conflicts as learning opportunities to improve governing efforts while other areas did not. While pro-active individuals in Nicoya strengthened the PC Commission after Nimboyores, little changed in Sardinal where unresolved friction remained a risk. Although the Sardinal case went quietly unresolved, more successful efforts in Nicoya were validated. Shortly after Sardinal, efforts in Nicoya aimed to further improve through new partnerships that assessed water governance and started building a more effective regional presence (e.g., Kuzdas et al., 2013; 2014a) that was reached by interested actors in the Mala Noche.

Distrust among actors, institutional legitimacy issues, and poor water system knowledge predicated conflict intractability in the cases. The underlying issue within these aggravating factors was often current and historically ineffective stakeholder engagement. Poor engagement often coincided with legitimacy issues concerning who was responsible or had the authority to govern what. In the DRAT case for example, a

state employee was targeted during an act of dissent. In Sardinal and Nimboyores, local groups rejected water system studies performed by national agencies. In the Nimboyores case, resolution processes only advanced after parties sufficiently addressed how water-benefits would be re-distributed to communities and created a new governing role to better account for rural communities. In Nicoya, effective stakeholder engagement processes organized by a collective group (which had the backing of agencies) reached some otherwise disconnected rural communities. In the Mala Noche though, we saw self-organized basin planning by local actors had difficulty overcoming histories of tension among actors, vague resource rights, and unclear governing responsibilities. The progression of the Mala Noche conflict shows however that self-organized conflict resolution and mitigation is viable if face-to-face cooperation venues are logistically available and if supportive, successful governing examples are accessible and visible to local actors.

While the dissertation does not provide in-depth analysis of the potentially wide range of governing contexts that are relevant for water conflicts here, it does illustrate some of the linked, broader context issues found to be relevant for identifying the potential of governance regimes to aggravate or mitigate water conflicts. Scarcity that involved water access issues closely tied to political economy conditions were important. For example, one intense altercation involved access to limited irrigation water in the DRAT under extenuating circumstances where a smallholder farmer had no alternative access options. In the Mala Noche, the economically poorest of the three ASADAs was unable to access quality groundwater below privately held land (that was deeded prior to modern coastal development regulations implemented in the 1970s) that another, better

resourced ASADA was able to secure through legal actions. Consequently, the former ASADA must rely on suspect sources and experiences seasonal shortages. Over time, this situation increased the former ASADAs suspicion of and even animosity toward governing attempts in the basin. The former ASADA felt the latter was better able to capitalize on tourism and real estate investment in the area (which required sufficient water for development). While a vast majority of the water disputes in the Mala Noche involved ASADAs taking actions against developers, the key factor in the most escalated point in the Mala Noche conflict was this feeling of disparity among ASADAs. Generally ineffective governance combined with broader political economy trends had over time allowed increases in disparate water access and economic well-being in the area. In Sardinal, we saw another aspect of the link between scarcity, access and political economies. Here, developers attempted to access water sources used by local communities where the perceived threat of scarcity, combined with distrust, precedents of poor stakeholder engagement, and low political legitimacy contributed to the escalation of the conflicts. While features such as distrust, poor engagement, and low political legitimacy directly impacted conflict outcomes, they are also (as we noted in the case introduction - Section 3) deeply rooted in social, political, and economic trends involving weakened state governments and feelings of disenfranchisement especially within rural groups. However, water governance played a role mitigating these broader context issues in some cases. The resolution process of Nimboyores aimed to correct eroded trust and rural disenfranchisement issues present in the areas. Actors in Nicoya improved on these issues over several years through a collective organization and have yet to experience harmful conflict.

What are the implications of current and alternative water governance schemes to mitigate or aggravate water conflicts in a water-contested and climate-threatened context? (Chapter 4)

This dissertation used case insights to identify potential water conflict risk factors, mitigation abilities, and promising mitigation strategies within three general types of water governance regimes (centralized, polycentric, fragmented) within the context of the Central American dry tropics. The framework in Chapter 5 and evidence from the cases were used to assign expected values of water governance components for each hypothetical regime-type. As expected, no one case offered a perfect example of any one governance scheme (i.e., Huitema et al., 2009). However the diversity of governance schemes within the cases, the different processes or changes experienced in each case, and the different degrees that each case exhibited fragmented, centralized, or polycentric patterns allowed for sufficient breadth of evidence within the given dry tropical context. The dissertation also used insights from the cases to identify potential conflict risks, conflict mitigation abilities, and offered promising initial strategies for each hypothetical governance scheme within the defined governing context. The resulting schematic facilitates a structured discussion of the potential implications of current and alternative water governance regimes for effectively mitigating harmful water conflict in the Central American dry tropics.

Centralized governance regimes: Water governance in Central America was highly centralized and many still are today (Booth et al., 2010; Rogers, 2002). It could be expected that such governance regimes to be at potential risk of water conflicts due to

their limited ability to include diverse, especially rural, stakeholders in governance processes and their lower tendency to promote collective learning regarding water systems and the water needs of stakeholders from unique regions. Successful conflict mitigation in these contexts depend on securing sufficient trust from stakeholders and the fair allocation of administrative resources that are needed to efficiently solve local problems. Relevant issues such as disenfranchised constituencies (Edelman, 1999) and corrupt and weakened States (Eakin and Lemos, 2010) may hinder conflict mitigation. Short-term mitigation strategies within centralized regimes could focus on improving transparency, encouraging joint fact-finding ventures with local stakeholders to increase collective water system knowledge, and repairing trust. Long-term success may require more shared decision-making authority to be distributed to regional-to-local levels in order to better account for unique conditions faced in the rural, dry tropics (Eakin et al., 2011).

Polycentric governance regimes: Polycentric water governance designs that are fitted to regional contexts, feature committed leadership, and emphasize vertical accountability offer reasonably high conflict mitigation potential. Mitigation abilities may benefit from mutually reinforcing processes: open decision-making, learning, and enabling leadership. Possible conflict risk may be present if historical tensions between actors and vague resource rights and governing responsibilities. If not addressed, these risks may allow for some elites to gain disproportionate power if accountability mechanisms are not effective (i.e., Persha and Andersson, 2013). In some polycentric settings, self-organized actors may struggle to initiate conflict resolution and mitigation processes. Here, more centralized mechanisms and well-resourced actors may help begin

effective mediation processes in some tense situations. Promising mitigation strategies for more polycentric configurations include reinforcing commitments, basin planning, that involves face-to-face processes that are logistically feasible (especially for governing actors that may be poorly resourced) and alignment or open discourses of actor expectations. Long-term efforts could fortify processes that elaborate collective goals, monitor progress toward goals, and ensure the continued effectiveness of stakeholder engagement.

Fragmented governance regimes: Lower abilities to anticipate, recognize, and coordinate diverse actions to solve problems allows risks for fragmented governance schemes. Here, little or logistically challenged communication among actors might be expected as well as unclear governing responsibilities and less-effective accountability mechanisms. These conditions potentially allow for actors to take unilateral governing actions – especially without input from disadvantaged or disconnected rural groups. Strategies may initially focus on identifying existing and securing new financial, personnel, and technical investments in regional-scale governance and securing commitments to face-to-face planning processes. Such investments and commitments may initially help build regional mediators between opposing national and community-scale institutions and discourage governance actors from taking unilateral actions or circumventing fair governing processes. Available resources for new efforts might be found in local university programs, which were used to support good water governance in Nicoya, as in other places (i.e., Atkinson-Palombo and Gebremichael, 2012). Long-term efforts are challenged to devise feasible action plans that are amenable to diverse actors

(some of whom may be benefiting from current conditions) in order to practice and legitimatize cooperation and coordination.

Guanacaste as a whole affords a proxy for centralized water governance regimes that, due in part to various pressures (i.e., from global economies, public funding cuts), are shifting towards more institutionally and administratively fragmented regimes without well-coordinated nor well-defined governing responsibilities below the national-level (Edelman, 1999; Kuzdas et al., 2014b). In Guanacaste, this hybrid water governance scheme retained some risks of centralized schemes (i.e., non-transparent, poorly fitted to local contexts) while assuming additional risks associated with more fragmented schemes. Accordingly, these change processes within governing schemes could allow for potential conflict risk in settings where power, given through water allocation mandates, rights, or political access, is disproportionately held and acted on by relatively few and where local groups are not accounted for. Here, long-term strategies that aim for more responsive, vertically accountable, and polycentric governance schemes are important for mitigation efforts. Within Guanacaste, each case played out and was resolved (or not) in different fashion, so a measured and multi-faceted approach to conflict mitigation and ultimately, to changing governance regimes, rather than a one-size-fits-all approach is important. Involving groups – especially those who are not included within current water governance regimes – will be a key logistical effort for devising and implementing alternative governance schemes. Strategies that initially reduce governing uncertainty (i.e., who has rights to what and responsibility to do what?) and that deploy strong, legitimate leaders to potentially offset interests that are willing to use economic or political power to circumvent fair processes may be an effective first step to help re-

organize institutions and actors prior to implementing or testing more polycentric schemes.

How would particular sets of institutional drivers and mediators play out in terms of their effects on conflict outcomes within alternative water governance regimes? (Chapter 5)

Alternative water governance regimes in the dissertation were developed and engaged with as a set of five scenarios.

Scenario #1: "Mandated to prepare" shows a centrally controlled water governance scheme that aims to secure rural community well-being in the face of scarcity - although important feedbacks coming from the governing context (outcome distributions, water quality, competition, etc.) on to the decision making processes and other drivers are missing (in contrast to Scenario #3, for example). While this missing linkage potentially allows conflict risks by limiting the effectiveness and responsiveness of dispute resolution mechanisms (which we see in Scenario #2 and #5), no conflict occurs in Scenario #1. With people trusting government (i.e., high legitimacy) and little scarcity or water access issues that challenge the governance regime (i.e., less competition, water supplies are not decreasing), governance schemes are able to successfully avoid harmful conflicts. Scenario #1 allowed for weaving of stories that hailed back to the early years of Costa Rican progressive democracy (prior to the 1980s). These years saw a far-reaching presence of a highly legitimate State that sought to support rural, smallholder farmer lifestyles often through top-down mandates.

In Scenario #2: "Closed-door alliances", inadequate water governance primarily drives (as opposed to challenging contexts) conflict, environmental decline, and unfair

water access, which negatively reinforces unresponsive and ineffective water governance schemes. The systemic nature of Scenario #2 is similar to Scenario #3, but with features that are negatively rather than positively reinforced. In contrast to Scenario #5, conflict outcomes in Scenario #2 stem primarily from the governance regime itself, which takes purposeful actions against the interest of rural communities. Consequently, Scenario #2 allowed for storylines of actors that deal with 'closed-door alliances' of government agencies, developers, and investors - reminiscent of recent Guanacaste water conflicts.

Responsive civil democracy, active regional leadership, and open decision-making processes were most effective (in terms of positive governance outcomes) when mutually reinforced by each other and by established dispute resolution mechanisms. In Scenario #3: "Responsive and engaged", these drivers positively reinforce each other while also supporting institutional legitimacy (e.g., people trust governance) that in turn helps facilitate active regional-scale governance and vertical accountability, which are conducive for improved collective water system knowledge and groundwater security. This distinguishing system of positively reinforcing impact relationships in Scenario #3 allows effective mitigation of water conflict in spite of challenging contexts.

Scenario #4: "Unnoticed in the background" demonstrates how a prominence of mediation with very efficient water infrastructure, combined with a low water-allocation priority for natural (forested) systems, allowed for rapid economic development and growth. Like Scenario #1, many important systemic feedbacks are missing which allows for risk due to low responsiveness and less accountability of the governance regime to stakeholders. These missing features would support effective conflict resolution mechanisms, as is the case in Scenario #3. Rather, the governance scheme in Scenario #4

is similar to Scenario #5 - but with key differences being population growth (in contrast to decline), well-maintained water infrastructure, and accessible good quality water, which allows for a more economically prosperous scenario that features a decline of natural systems and a less active or more apathetic role for civil society organizations (such as the PC Commission).

In Scenario #5: Overwhelmed and out of touch, the governing context (i.e., poor water quality, dry conditions, etc.) overwhelms weaker governance schemes that lack active regional governance actors and institutions, accountability mechanisms, accessible decision-making, and a responsive, engaged civil democracy. This overwhelmed situation that also features drier climates and unfair water access helps stem population growth in the region. Governance that is overwhelmed by the challenging contexts that it faces is a distinguishing systemic feature of Scenario #5.

3.3 Dissertation objective #3: To test participatory methods and approaches for developing/ evaluating governance alternatives and policy strategies toward sustainable water governance, including mitigation of intense and intractable water conflicts in the face of climate threats.

How can water governance analysis and appraisals best be designed to maximize their positive impacts? What are their limitations? (Chapter 2 and 3)

The overarching principle that guides this reflection is how to best assimilate integrated water governance analysis into transformational sustainability research efforts that aim at generating solution options for water sustainability problems (Wiek et al., 2012). A great deal of existing literature discusses participatory research dealing with water resources; yet relatively few coherent guidelines are established for executing

water governance analyses that are a part of a broader problem solving effort (Lang et al. 2012). Being part of an overarching problem solving endeavor, the Guanacaste water governance analysis lends itself toward reflection on what aspects of executing the analysis facilitated assimilation within the broader effort and what aspects of the analysis could have been improved. More details and explanation on the points in italics below is found in Chapter 2.

1. Frame the governance study with key stakeholders. Insights from the Guanacaste study: Key stakeholders were involved in defining components of the physical water system, determining who relevant stakeholders are, and designing some parts of data collection instruments. As a result, research findings were easily dispersed once the analysis was coupled with the ensuing assessment. The analysis process itself reinforced strong mutual trust between stakeholders and researchers. Trust was a significant success factor that led to the sustainability assessment, which is based on the analysis contained here, being directly incorporated into regional planning and policy changes shortly after researchers delivered results to the PCW Commission (Kuzdas et al. 2012).

2. Identify strategic output venues early in the process. Insights from the Guanacaste study: Strategic output venues in the local water system were not identified in the planning stages of the analysis beyond the traditional 'report'. As a result, the sustainability assessment report that was delivered to the PCW Commission was not designed to directly sync or apply to any specific policies or procedures. Some prospects and opportunities to adjust regional policies and regulations may have been missed due to planning shortcomings on the part of the research team. The analysis framework

proposed by Wiek and Larson (2012) did prove useful in terms of packaging results in a flexible way that could apply to several outputs, even though the research team did not originally plan for those outputs.

3. Adapt to leverage new opportunities during analysis. Insights from the Guanacaste study: The opportunity to execute analysis procedures in collaboration with the *Universidad Nacional* de Costa Rica (UNA) was important for building credibility, trust, and knowledge dispersion avenues. UNA holds a seat in the PCW Commission along with several other important organizations. The new alliance with UNA provided links to individual stakeholders the research team previously did not have access to and allowed for greater interview coverage (90%) of targeted actors in the system. The alliance with UNA was the most important factor that created a strong working relationship with the PCW Commission, which is a key policy advocate for water resources in the region. The PCW Commission has made several presentations of the results from the sustainability assessment (in Chapter 3) to government agencies, commissions, and local governments.

4. Aim for mutual understanding of analysis procedures and methods. Insights from the Guanacaste study: Results of the sustainability assessment, based on the analysis here, dispersed and were applied to regional institutions quickly due to the level of high mutual understanding between stakeholders and researchers. Mutual understanding was arrived by *doing* the analysis. By the end, key stakeholders understood the general methods of analysis, the goals of researchers, what to expect, and some took part in interactively creating system maps using the framework. The stakeholder mapping

conducted in this project was considered to be the strongest element of the analysis by local managers, and in retrospect, was key for building quality working relationships.

5. Position analysis within broader problem-solving endeavors. Insights from the Guanacaste study: The sustainability assessment, built on the analysis, which generated new normative knowledge for the region in addition to the new analytical knowledge of the water system generated in the governance analysis presented here. However, it is not yet clear if the framework and analysis will be or can be used as a foundation for increasing knowledge of regional ecosystem flows over time in the region which is critically needed. Although stakeholders reported that the analysis carried out here was the first to coherently synthesize the information it did, it will be a major challenge to continue using the framework as a means to structure new information. In public agencies dealing with path dependency and funding and personnel cuts, there is likely a low probability such frameworks will be coherently used over the long-term. Enduring leadership, long-term partnerships, and funds to operationally support such efforts are needed to overcome this challenge. However, a valuable snapshot of the system was achieved.

6. Identify and leaders at the science-policy interface. Insights from the Guanacaste study: The PC Commission was identified and targeted as an important regional leader by researchers early on. Individual members on the commission are often involved in both water-related scientific efforts and policy-making. The research team maneuvered into a 'partner-client' relationship with the commission and wrote the assessment results report specifically for the PC Commission.

In Chapter 3, the sustainability appraisal was a valuable tool that provided normative insight into how well water governance in Guanacaste operated. While the results suggested some well-targeted efforts could help remedy interlinked problems, the appraisal provided limited evidence-based instructions that dealt with how to go about resolving problems over time. Additional and expanded efforts are critically needed, at the provincial scale in Guanacaste, to deliberate and craft alternative ways of governing water that can overcome broader governing issues. Water governance research efforts where descriptive-analytical components, solution-oriented components, and real-time problem-solving components are well integrated are a high priority. Such integrated research efforts could well support sustainable water governance in Guanacaste and beyond.

On the one hand, Chapter 3 offers encouragement that the sustainability effects of water governance regimes can be reasonably monitored even in contexts that exhibit high uncertainty and low information/data availability such as Guanacaste. Even in these contexts, appraisal efforts can have a role that may help increase compliance under the right conditions. On the other hand, the appraisal demonstrates room for improvement. An important future research endeavor will involve establishing far better means to communicate and measure impacts from actually doing the appraisal and other subsequent research efforts. The appraisal method and criteria used, for example, do not easily capture potential context-unique trade-offs that may be critical to deliberate and negotiate in order to make progress toward sustainable water governance alternatives.

Also in Chapter 3, the principles we use, although synthesized from several relevant streams of literature and confirmed by stakeholders, largely suffer from poor or

vague operational distinctions between the *practices* of sustainable water governance and the *goals* of sustainable water governance. Practices would include operational aspects such as deliberation, negotiation, or monitoring. Goals would include objectives such as equity, self-sufficiency, or sustainable yield. Distinguishing practice criteria and goal criteria, while utilizing a system mapping activity in appraisal procedures like we develop here, may be a promising way to improve the effectiveness of future sustainability appraisals and better integrate governance appraisals with problem-solving and solution-research. This distinction would potentially yield a clearer picture of what operational practices of governance regimes are deficient and which are compliant (and where in water systems they occur), which could better set up and integrate with problem-solving efforts and solution-oriented research that ultimately seeks to address options and strategies for governing water resources differently – and more sustainably – than is done currently.

How can water conflict research better align with the professional needs of decision-makers who aim to mitigate such conflicts? (Chapter 4)

To align with the professional needs of decision makers who aim to mitigate conflicts, research must address the conflicts that matter to people, it must address conflicts within a scale that is usable for mitigating conflicts, and it must address the conflicts that have real/ felt negative impacts on people and environments. In cases such as the Central American dry tropics where very little existing knowledge exists surrounding water conflicts, research required an intimate and place-based approach that involved months and even years of living and working in the region. The variability of conflict events and the differences in the specific places where they occurred – including

even significant differences in how conflict events played out over time - within regions (that was illustrated in this dissertation) would support this perspective. In other words, one conflict event in even a small area like Guanacaste could not be accurately considered 'representative' of Guanacaste or Costa Rica. In contrast, research that seeks generalities of the link between climate change and water conflict across even multiple continents with no apparent engagement of those who aim to mitigate water conflicts in any particular region have so far proven to yield little knowledge that can be acted on within a given context. This issue is pointed out in a variety of relevant literature (Reed & Kaspryzk, 2009; Funder et al., 2010; Bakker, 2012; Pahl-Wostl et al., 2013). Also key for water conflict research that aims to better sync with the needs of decision-makers, is locating and identifying the number of active individuals within regions that are committed to solving water-related issues. These individuals highly influenced knowledge transfers concerning water conflict mitigation within Guanacaste, they encouraged learning by example, and they have helped developing leaders. All of these aspects were found to be conflict-mitigating factors. These individuals could offer reasonable starting points for further building relevant water conflict research and strategies within a variety of contexts that aim to overcome institutional and political challenges that matter for successful conflict mitigation. Accordingly, water conflict research that addresses problems and their potential solutions within tangible, meaningful and decision-relevant context offers an alternative approach to support water conflict-prone regions. This thread of research offers useful and improved links to water administrators and policy makers that aim in their professional activities to avoid water conflicts.

What are the strengths and limits in terms of the usability governance scenarios and governance transition strategies in collective planning processes? (Chapter 5 and 6)

Flexibility was an important strength of the formative scenario methodology. It allowed the scenarios to be tailored to meet the needs of a mostly rural, developing region. Importantly, it allowed the scenarios to represent local context, challenges, and alternative governance regimes in ways that evoked meaningful responses from diverse stakeholders in order to deliberate goals and actions (in later workshop activities) without costly, unavailable computerized simulations (i.e., Sheppard et al., 2011; Gober & Kirkwood, 2010). Flexibility also allowed the scenario building process and the communication of scenarios to be tailored to the needs of those involved at different stages. For example, the research team and PC Commission negotiated the contents of the scenario posters and agreed not to include scenario system diagrams for the broader audience at the workshop – many of whom had not previously worked within such models. Additionally, pre-testing in Guanacaste with the diagrams revealed that they were most effective (in terms of communicating systemic differences) if compared directly and immediately, which the large exhibit-style event did not allow for. However, the exhibit-style event was able to effectively involve a very large number of diverse stakeholders who typically are not involved in these planning activities. Nevertheless, the system diagrams were valuable for helping construct scenario storylines that aligned logically within each scenario's underlying structure. This flexible approach to communicating scenarios to different groups worked well in Guanacaste.

Integrating thorough current state analysis and assessment of governance regimes in Guanacaste - that was already engaged and publically visible - with scenario building

was beneficial. It provided a shared frame of reference for the scenario building process. In this case, this shared frame of reference was important in the consultation meetings with local partners and stakeholders during the system and consistency analyses steps. Compared to the workshop event, relatively few people participated in the system and consistency analyses steps - which is typical in these more expert-driven steps of the formative approach (Walz et al., 2013). In Guanacaste, these smaller groups were more effective in these steps than larger groups. The purpose of these smaller groups was to perform the above steps in close consultation with previous current-state research that had already engaged and involved many people from the area. In this sense, we aimed for the system and constancy analysis steps to reflect, as much as possible (given the limited set of variables), the real-time governance system. In contrast, a purely judgment-based approach may be more appropriate in some cases or settings (von Wirth et al., 2013). In contexts like Guanacaste with heterogeneous stakeholder groups and potentially significant power imbalances within those groups, our slightly modified approach to the early steps of the formative scenario approach may be worth considering. The key success factor here is that stakeholders already trusted the results of those previous studies because they had been highly engaged with them. Tangible current state research that directly addresses real problems (that are likely highly visible in regions like Guanacaste, i.e., water conflict) offers a valuable starting point to building trust, to organizing a sufficient body of current-state evidence that is seen as valid by diverse groups, and to understanding diverse stakeholder groups – all of which were key precursors to successfully employing the formative scenario steps in Guanacaste.

In this case, having a small but diverse stakeholder group – the PC Commission – central in the scenario building process was key. Importantly, the PC Commission is highly respected in the region, and positioning them in a way where they essentially became the intended users of the scenarios helped to avoid any potential legitimacy issues with the scenarios coming into the large stakeholder workshop. With the PC Commission in a central role, stakeholders were open to discuss even controversial scenario content at the workshop. A subtle benefit of this was the willingness of the PC Commission to be a named actor in each scenario. Workshop participants knew the PC Commission, and seeing/ comparing its different roles and activities in the scenarios was an effective communication strategy. We received many comments directly mentioning the PC Commission's activities in the scenarios. Thus in the Guanacaste context, the limited but effective participation scheme at the start of the scenario building, combined with key partnerships, and followed by a very open participation scheme towards the end seemed optimal. Other cases will require different approaches to participation at different stages that fit the context.

We did not use the method to explore development pathways, i.e., how different alternatives could happen over time, which was pointed out by workshop participants. We found that scenarios alone cannot adequately support necessary change processes and activities, which is in line with previous findings and concepts (i.e., Wiek et al., 2006). Scenarios must then be incorporated into collective strategy building activities (ideally as a part of a broader transformational planning process) in order to have practical relevance for stakeholders. We found that quickly demonstrating this application in later workshop activities with stakeholders was important. As an critical step to prime for these later

'application demonstration' activities in the workshop, deliberating scenario content in an open format with a representative and diverse group of stakeholders effectively supported people to articulate what futures were desirable (or not) as a first step to planning and taking coordinated action. In this sense, motivating workshop participants who collectively could change regional water governance was a success of the workshop that was supported by the formative scenario method that was slightly adapted to fit the Guanacaste context. The general lesson here is that engagement, commitment over a sufficient period of time, and trust matter, methods can be adapted in transparent ways to fit problems and contexts, and that in water contested-regions like Guanacaste that face urgent and complex problems, there is significant opportunity for research that does these things to make positive impacts. For scenarios specifically, a timely demonstration of their real application for governance actors, ideally situated within a transformational planning process (i.e., Wiek, in review), can help maximize these positive impacts.

Workshop activities that followed the scenario building and validation exercise evaluated scenarios, identified priorities, and created strategies to avoid negative futures and achieve more positive ones. These follow-up activities quickly demonstrated the practical value of the scenarios. During this latter part of the workshop, participants, many of whom had not worked together before, exchanged contact information, suggested ideas, and offered to share resources and data with those who needed them. Many collaborative invitations were extended, including one to join a new coordination platform in Nicoya. After the workshop, several new efforts aimed to improve governance cooperation within the region. Much focus is now placed on leadership development in Nicoya, with the PC Commission assuming an important role. Several

ASADAs, who have experienced conflict in the past, implemented a series of meetings to address ideas to share resources and to consolidate their organizations (the same ASADAs mentioned at the end of Section 5.1 that discussed ***Scenario #3: "Responsive and engaged"***.) These ASADAs started emphasizing internal human resources development, which is a significant paradigm shift for organizations that are historically only concerned with service-area infrastructure and collecting water-use fees. The scenarios were important reference points for stakeholders around Nicoya in the several months that followed the workshop. These efforts though have encountered barriers. Political corruption, lack of transportation, and low investment in communications infrastructure are a few examples. But recognizing, locating, and defining those barriers has been beneficial. It has allowed new leaders to begin planning how to overcome barriers. As local leadership has grown, as new actions have been taken, and barriers discovered, there is less frequent operational reliance on the scenarios (i.e., being referenced in planning meetings).

The marked deficiency of reliable and accessible hydro-climatological information (and monitoring systems) remains a substantial void for Guanacaste water governance that presents acute challenges. Yet the governance scenarios, to some extent, initially helped revitalize regional organization and coordination around Nicoya to the point where collective strategies and the re-allocation of some personnel, financial, and technical resources to address this key knowledge gap could be more efficient. In turn, once new information is obtained and processed, the improved organization of the governance regime (assuming it stays improved or keeps improving) will potentially provide opportunities to capitalize on more effective avenues to formulate and implement

adapted policies that will better position the region to meet complex water challenges. In this sense, the jump-start that the governance scenarios provided to better organize a very fragmented water governance regime was their most valuable application.

4. Contributions to the State of Current Knowledge

The current state of knowledge pertaining to each of the three sub-objectives is explained below. Specific contributions made to the literature/ current knowledge is stated in bullet points.

Objective #1: To clarify the process and design features of sustainable water governance and potential barriers to implementation, especially in the context of climate threatened, water-contested, and developing regions.

Results suggest that superior and more sustainable alternatives to water governance in the Central American dry tropics would: be fitted to the social and hydrological dynamics of regional water systems (from supplies to post-use); address asymmetrical and collective knowledge gaps in those dynamic water systems; reconcile disenfranchised rural groups and governing agencies; and, operationally support currently effective local leaders. Yet in terms of abilities to address these specific aspects, e.g., implement them, in the given context, we saw that many deeply rooted uncertainties and complexities inhibit and complicate implementation pathways. Implementation of improved governance design features becomes even less straightforward when considering current water-related conflicts in the broader region, water scarcity, and climate change impacts. The dissertation demonstrates the practical value of more intimate, multi-faceted water governance analysis within critically challenged regions. Yet, it also demonstrates that within critically challenged regions such as the Central

American dry tropics, getting started on advancing toward more sustainable alternatives is urgent. Here, only identifying or specifying the key features of superior or alternative governance regimes cannot remedy the complex challenges facing the region. To remedy these challenges would require developing and testing governance strategies that aim to, over time, transition currently inadequate governance regimes toward alternative, more sustainable ones. This presents a significant contribution to the literature which, to this point, has most often only identified and success factors of resource governance regimes with little focus on how to actually implement these factors in exceptionally challenging cases where change is urgently needed. Illustrating this disconnect in both analysis (Chapter 2) and in normative assessment (Chapter 3) and highlighting a potential way forward by developing governance transition strategies (Chapter 6), offers an important contribution to the literature concerned with resource governance, common pool resources, and collective actions.

Objective #2: To specify the institutional drivers and mediators of intense and intractable water conflicts at regional scales.

The dissertation developed and applied fresh/ alternative concepts and tools for understanding water governance that are well-grounded to the places where water conflicts are actually experienced and where people seek to mitigate them; and, thus offers improved utility in comparison to many of current water conflict and climate change studies. The framework proposed in Chapter 5 is unique in the literature that deals with water conflicts. Much of the literature that deals with water conflicts, up to this point, is largely detached from the places of interest with no visible connections to those who could actually take action to mitigate those water conflicts. The current

literature also is still largely focused on approaching conflicts by sorting out supply and demand, which this dissertation (Chapter 4) demonstrates does not adequately explain why conflicts occur in climate-threatened and water-contested regions. Accordingly, the dissertation offers Improved understanding of the institutional mediators and drivers of water conflicts at a scale that is relevant and actionable for decision-making and collective actions. In addition, the dissertation clarifies how current and alternative governance regimes might be expected to handle water conflict risk and their real-time policy implications (in terms of crafting governance strategies to better mitigate conflicts) in critically threatened regions such as the dry tropics of Central America (Chapter 4 and 5). Results demonstrate that water conflicts are not uniformly experienced within regions nor do conflict processes unfold in consistent manners over time - which has critical implications for realizing effective water governance and useful water conflict research. Knowledge transfers within regions, learning by example, and existing leaders offer promising starting points for overcoming institutional and political barriers that obstruct conflict mitigation potential. Such efforts might focus on governance strategies that intentionally avoid fragmentation and institute transition processes and strategies that seek to implement more balanced, polycentric water governance designs over time. How do so, and clarifying what that step sequence would look like, in various contexts is an important research need. Such strategies will be critical for achieving sustainable water governance in conflict prone, climate threatened regions.

Objective #3: To test participatory methods and approaches for developing/ evaluating governance alternatives and policy strategies toward sustainable water

governance, including mitigation of intense and intractable water conflicts in the face of climate threats.

In Guanacaste, we found governance scenarios were well-equipped tools to initially support the mending of the fragmented parts of a regional water governance regime. The scenarios provided a means for actors to contribute their perspectives, to connect with each other, and to collectively examine which 'direction' Guanacaste water governance could go and what that could mean for the region. Local history, context, and challenges resonated with participants in the scenarios. Engaged and linked current-state research, the timely demonstration of scenario application (i.e., goal setting and strategy building) with stakeholders, and a constructive, participatory scenario building approach were important factors that helped boost scenario value. If many water governance regimes are proving inadequate, as they have been in Guanacaste, then understanding alternative governing options is critical. Also critical, is that people who can collectively change governance understand key needs in order to realize alternative, more just water governance schemes. In Guanacaste - a developing context featuring low data availability, high urgency, and water conflict - governance scenarios were an effective step in this direction.

Among other things, the Guanacaste case demonstrates that to develop, to deliberate, to test, and to implement governance transition strategies demands a focused - even distinctive - research effort with certain logistical needs and challenges. This new type of research stands in contrast to strategies or policy prescriptions that only result from descriptions or analyses of current water problems. We argue and demonstrate that a solution-orientation of water governance studies can be fittingly organized in

comprehensive research projects. To help maximize impact, these projects can consider using a transformational planning approach that aims to integrate research on current water problems with the collective governance strategies that are needed to overcome those problems over time. Results highlight the need for governance that fits dynamic water systems; addresses asymmetrical knowledge gaps; reconciles disenfranchised groups; and, supports currently effective local leaders. To move forward though, research and policy-making must address how to implement/ test governing alternatives in ways that account for multiple institutions, actors, challenges, and opportunities in addition to deliberating what alternatives to aim for and which to avoid.

In spite of tough challenges facing the region, prospects for successfully mitigating harmful water conflicts remain reasonable. Importantly, water conflicts were not uniformly experienced within the region, a number of individuals committed to solving water-related issues were active, and each case unfolded in a unique manner. Knowledge transfers within regions, learning by example, and existing leaders could offer reasonable starting points for strategies within a variety of contexts that aim to overcome institutional and political challenges that matter for successful conflict mitigation – such as better accounting for rural community interests and power imbalances (especially in terms of allocating water and land rights) within multi-level governance schemes. Accordingly, water conflict research that addresses problems and their potential solutions within meaningful and decision-relevant contexts offers an alternative approach to support water conflict-prone regions. This thread of research offers potentially useful and improved links to water administrators and policy makers that aim to avoid water conflicts in their professional efforts. How to do so, and clarifying

what that step sequence would look like in various contexts, and learning from diverse cases, is an important future research need.

The regional and local orientation of this project produced useful information to improve water governance and management schemes. We found that focused investments in the human resources of water administering organizations - including communications equipment, professional development, civic space, and means of transportation - to be key initial steps to help mitigate future water conflicts. Other management priorities include securing small-scale water monitoring equipment and legal commitments for legitimate basin-scale planning processes. We found that a promising way forward to effectively mitigating water conflicts to be a constructive process of identifying collaborative actions for water governance, selecting leaders, identifying existing resources, recognizing barriers to success, and deriving other actions to overcome those barriers. Results offer insight for other researchers, decision-makers, and development practitioners in other regions (that also face current resource conflict and climate threats) who are interested in understanding how water conflicts might best be mitigated.

4.1 Evolution of the project's research and planning frameworks and lessons learned from their application. Figure 7.1-3 demonstrates how this project's organizing research and planning framework has evolved, and how the research team has learned, over the last five years. Figure 7.1 was the original research and planning framework used to organize research activities starting in 2009 (based on Wiek & Lang, 2011 and Wiek & Walter, 2009). Figure 7.2 (described in this dissertation's introduction), was developed starting late 2012 to better reflect the issues being addressed by the project (namely conflict and a focus on governing alternatives rather than

scenarios directly informed by broader climate change scenarios). Figure 7.3 utilizes insights from the whole dissertation project in order to reflect on another related perspective for organizing research and governance efforts that aim to realize transitions toward sustainable water governance from current conditions. The main difference in Figure 7.3 is that actions, and consequently learning from those actions, occurs in an explicitly organic process that is not necessarily structured or conceptualized in a linear fashion. Notably, not all important and useful actions are transformational in nature (e.g., resulting directly from developed governance transition strategies), but these actions nonetheless play a role informing other knowledge domains and potentially making some changes in the current state (this is illustrated from the Guanacaste experience after the Figures below). This further conceptualization of research and planning approaches still maintains the original ideas that each knowledge domain (1-3) should be integrated with the others (i.e., Wiek & Walter, 2009; Wiek & Lang, 2011). Figures 7.1-3 all communicate that research and planning should address the need for current water governance regimes to ultimately transition toward more sustainable alternatives, i.e., Wiek et al., 2012). Key insights, differences, and lessons are explained below.

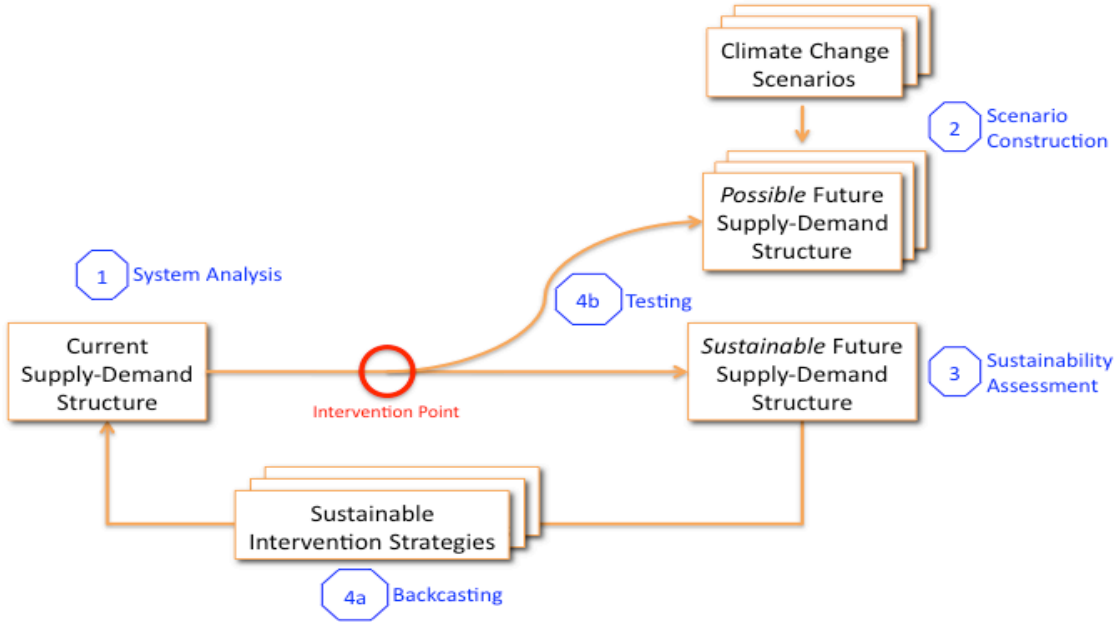

Figure 7.1

The initial project research and planning framework from 2009. Adapted from Wiek & Lang (2011) and Wiek & Walter (2009).

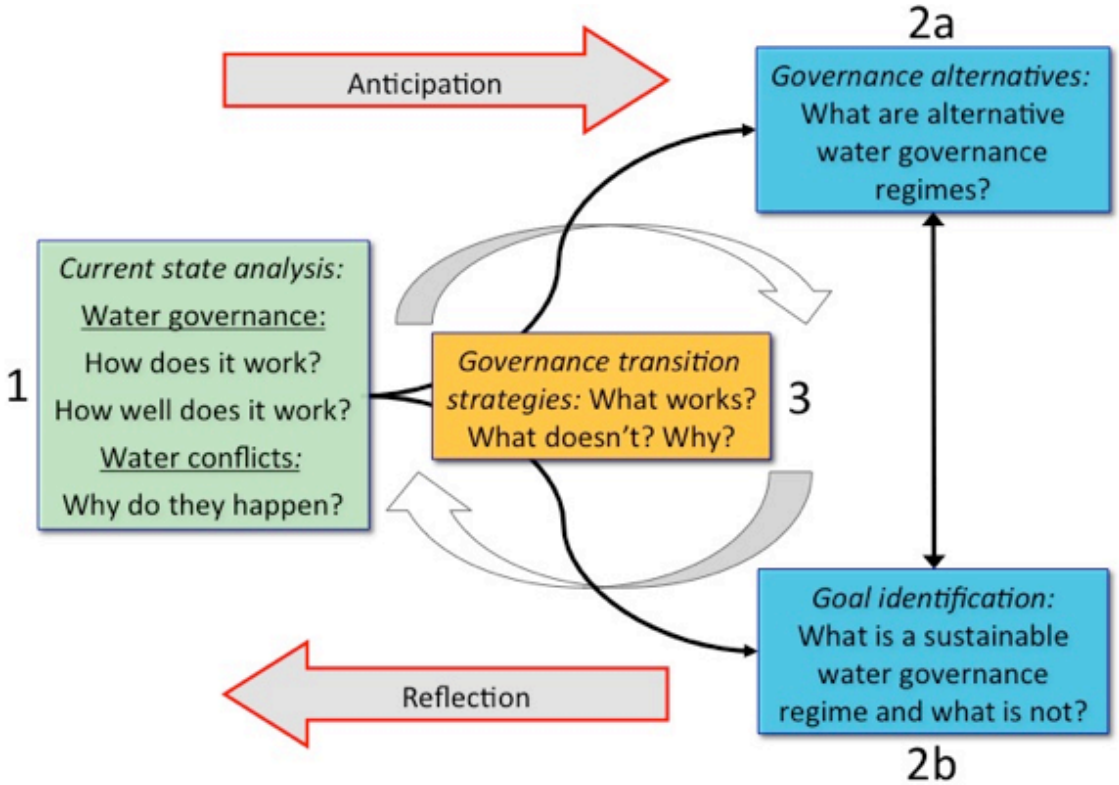

Figure 7.2

Project research and planning framework developed in late 2012. Adapted from Wiek (under review)

The main advancements from Figure 7.1 to Figure 7.2 are more content-related. These content related shifts offer important lessons for research that aims to produce actionable knowledge for regions that face climate-threats and sharp water completion. Once the research team began this project, and especially dug into the water conflict cases, it was apparent that water conflicts were not merely the result of governance regimes poor attempts to sort out or match water demands with available and/or expected water supplies – as is illustrated at length in Chapter 4. Consequently we concluded that it would be unlikely that domains/ parts 2,3, and 4 in Figure 7.1 would adequately support governance transition strategies if based on such content in Guanacaste. The original idea in Figure 7.1 was (I state this very simply here) to essentially create a system model that mimicked the current system, to then incorporate a range of plausible climate impacts derived from broader climate change scenarios on that system, and – largely based on balances between supply and demand – to then assess the sustainability effects of those options and craft transition strategies. While this would potentially work and be very beneficial in other places, the Guanacaste case required different content in order to develop actionable knowledge and, especially, meaningful transition strategies. The way forward that we took in Guanacaste was to instead developing governance alternatives – that captured a range of more sustainable to less sustainable alternative governance regimes - that were first and foremost based on how water conflicts played out across a range of institutional schemes. We mostly dropped the explicit focus on climate change

'possibilities' and rather assumed that climate change impacts were largely happening or were going to happen in the near future. Our initial calculations of unpublished rainfall data from government agencies found that the last 10 years in Guanacaste have averaged about 8-10% less annual rainfall than the previous year average of the last fifty years or so. And, considering virtually no rain falls in much of the Province for six months a year anyway - which already often results in a number of scarcity issues (see for example the story of the community of La Esperanza in Chapter 6) – it is reasonable to assume that responding to current and climate impacts involving reduced precipitation would be a wise thing to do right now. Indeed, partners in the PC Commission are already taking actions based on less rainfall (as illustrated in Chapter 3). This slightly adjusted approach to the scenarios – which is reflected in the change from Figure 7.1 to 7.2 - proved to be an interesting discussion topic among researchers and some stakeholders in the scenario development. Ultimately no 'climate utopia' scenario, i.e., plenty of rainfall every year and water supplies for people and environments are never taxed, was developed although the extent of climate change impacts varies within the scenarios. Initially, some stakeholders (notably this included stakeholders from San José and not any stakeholders working on a daily basis in Guanacaste) deemed the lack of a climate utopian scenario to be a negative aspect of the scenarios. However after the scenario event, these stakeholders agreed on the value of scenario set, especially discussing an alternative scenario such as Scenario 3: Responsive and Engaged which portrayed tradeoffs that occurred as climate dried, and how open and fair decision processes responded and mitigated conflict. This adjustment in the research and planning approach highlights the

increasing recognition gained over the course of the project that people will ultimately need to transition governance regimes from the current state to more sustainable ones.

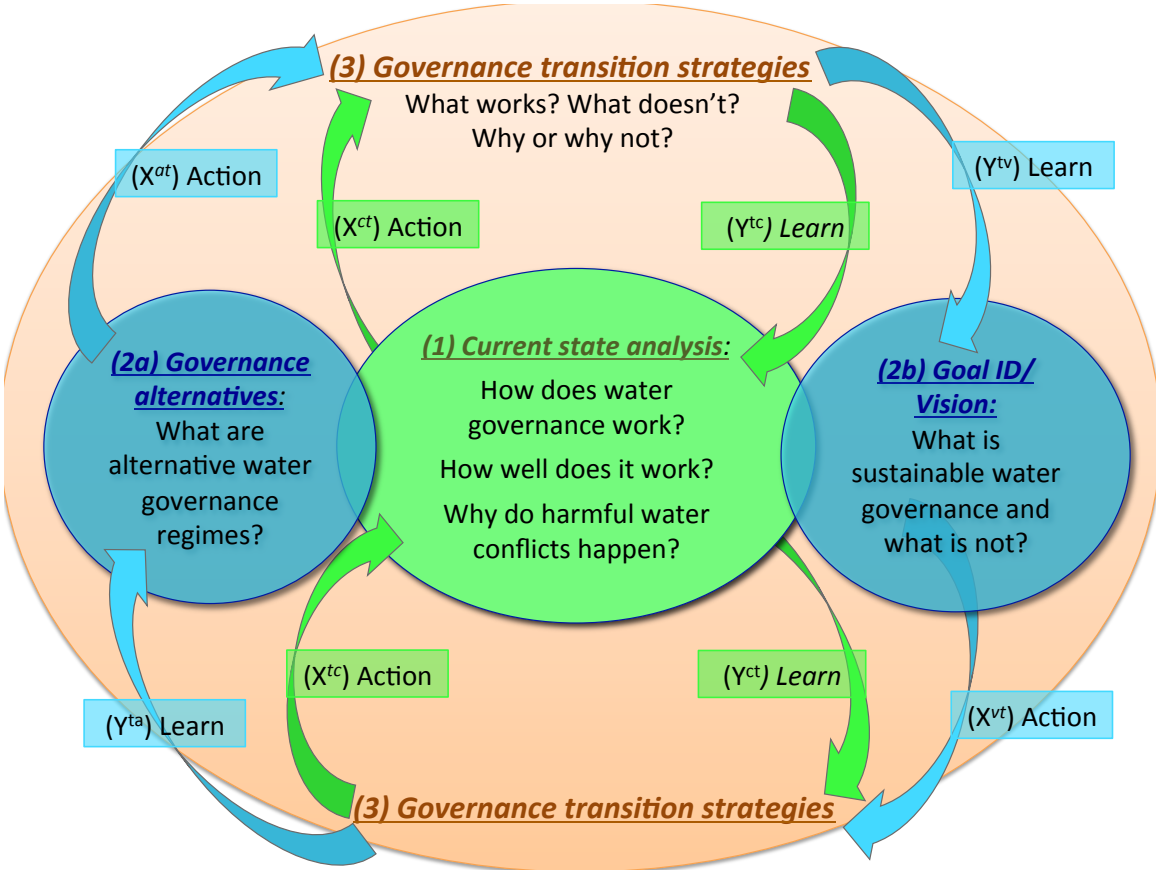

Figure 7.3

An illustration of ideas and potential future concepts for the next iterations of integrated research and planning approaches for transforming water governance regimes.

The baseline assumption in all three diagrams is that the efforts of the research project or program are embedded in a transformational planning approach (i.e., Wiek et al., 2012; Wiek, under review). This approach requires, among other things, the close integration of governance and research efforts (which then requires collaboration, participation, etc.). In this sense, here I am discussing approaches that *start* with this underpinning and advance from there.

A significant take away from Figure 7.3 - in comparison to Figures 7.1 and 7.2 - is the explicit focus and differentiation of actions being taken and, as a result of those actions, lessons being learnt and consequential adjustments taken in the water governance system or in other research and planning domains. These actions (*X* functions), and the learning (*Y* functions) that results from their implementation, affects and is affected by all of the domains in the framework (e.g., current state analysis, governing alternatives/ goal ID/ Vision, and governance transition strategies). Figure 7.3 also significantly puts the domains of current state analysis and governance alternatives/ goal ID and vision squarely within the overarching domain of governance transition strategies. The explicit assumption here is to highlight that all research and planning efforts should ultimately contribute to fundamentally changing current governance regimes to more sustainable regimes in urgently challenged regions like Guanacaste. For example, in this project actions were taken at different stages/ domains regardless of whether transition strategies had been developed or not. Even having discussions and reporting (see last section of Appendix C) to stakeholders on *potential* or initial starting points for governance strategies (that result from current state analysis) proved to be a key factor that helped build a high quality partnership between researchers and stakeholders. The point here is that stakeholders in Guanacaste wanted to see how research, regardless of its domain, could ultimately support their governing actions. This didn't need to be a direct link in all cases, but it needed to be somehow linked to informing their actions in some way. Ideally and in retrospect, research and planning within the governance transition strategies domain would occur simultaneously with current state research in research projects and programs.

In this project, the research team, for a number of practical reasons, started with only current state research as illustrated in Figure 7.1 and Figure 7.2. This resulted in a number of important lessons and insights that are communicated through Figure 7.3.

X^{tc} Actions (in Figure 7.3) are taken in the current state based on developed transition strategies. For example, a major component of the developed transition strategies in this dissertation were actions toward reconciliation between national agencies and community interests and their opposing institutions. This gap between agencies and communities was found to be a problem that led to fragmented water governance schemes that were often unresponsive to the needs of rural and local communities in Guanacaste (Chapter 2). It was found to have negative sustainability effects in the region (Chapter 3), and it was found to be an important driver of escalated water conflicts (Chapter 4). An example of an *X^{tc} Action* taken within this project would be the PC Commission's actions to engage with national level water governance and politics and positioning itself in a way to be invited to contribute to national water reform meetings. *X^{tc} Actions* would aim to systemically address the underlying causal structures and mechanisms of complex problems over time. Other examples of *X^{tc} Actions* include new collaborative efforts (as of 2014) by the PC Commission that aim to completely alter the economic and agricultural landscape on the Nicoya Peninsula. These efforts are building new private sector partnerships in order to experiment and implement new crops and alternative agricultural schemes that do not rely on mass wood-producing tree farms. The clear cutting of large tree plot every 10-20 years has seriously damaged environments and water sources. The PC Commission argues that clear-cutting in the

near future, when combined with increasing impacts from climate change, presents high risk of socio-ecological damage that must be mitigated.

In contrast, $\underline{X^{ct}\ Actions}$ (in Figure 7.3) are taken only based on current state research. While the lessons learned from taking these actions can inform governance transition strategies, these actions are not in themselves the result of a governance transition strategy. For example, as described in Chapter 3 the PC Commission used the results of the sustainability appraisal (which would be in the current-state analysis domain in Figure 7.3) to successfully secure some degree of protection of a local groundwater resource through a local Regulatory Plan update. However, the same Regulatory Plan update process that the PC Commission was able to utilize for positive gain also demonstrated the deeper underlying issues of water governance in the region. Local ASADAs from other areas in Nicoya voiced significant concern over the Regulatory Plan update process, which did not include any insight from local communities who sought to protect their groundwater resources. This issue had critical implications for many coastal communities that struggled to manage limited groundwater reserves in spite of poor broader level, official protection of those reserves. From the experiences of this dissertation, the success of $\underline{X^{ct}\ Actions}$ would seem to be limited to the immediate area where partnerships, collaborations, and other research collaborations are immediately based (i.e., Nicoya). However, those $\underline{X^{tc}\ Actions}$ taken by the PC Commission resulted in important lessons about what the research team would need to do in order to build governance transition strategies, namely who (i.e., more ASADAs and organizations that have experienced water conflicts) needed to be in the same room in order to do this.

Other components and the content of Figure 7.3 is essentially the same as Figure 7.2 with a few exceptions. One minor content adjustment is the specification of *harmful* water conflicts. *Harmful* implies the normative stance that people should not be personally harmed (i.e., become injured, become fearful, receive threats, etc.). These are the types of conflicts that this dissertation engaged with, which is very different from most of the water conflict literature and it described at length in Chapter 4. This framing attempts to intentionally leave the door open for further water conflict research that follows these types of transformational planning frameworks: what is the potential role of organized social opposition in water governance transition strategies? When are these types of strategies needed and how can research integrate with these strategies? To what extent and how severely should opposition measures proceed? The history of Guanacaste shows that organized opposition against unsuitable governing institutions is undertaken in intense cases and even in less intense cases. Challenging question remain here for sustainability-oriented research that seeks to address real conflicts: If governance regimes must change in order to resolve complex problems, who is likely to lose along the way of doing this? Who *should* or who *must* lose for these changes to happen (and what are the alternatives) – are academic institutions prepared to address these questions and perhaps even help make these judgments via professional outputs? And, what would be the consequences of research doing this?

The other exception regarding the content of Figure 7.3 vs. Figure 7.2 is the more explicit inclusion of complementary research and planning that constructs a comprehensive vision (as a part of domain 2b in Figure 7.3) for water governance in regions, or perhaps more appropriately, for several different parts of regions (i.e., a vision

for the DRAT in Guanacaste would not be a readily applicable planning tool for the small coastal town of Sámara). In this project, we elaborated goals for water governance, but did not fully construct a vision for water governance. In some cases during the project, a vision seemed like it would have been a potentially fruitful research endeavor – as indicated by some stakeholder's comments regarding the explicit lack of a purely utopian-climate scenario or even pure utopian-type of governing alternative. On the other hand, in climate-threatened and water-contested regions with logistical constraints and other challenges on organizing collaborative events and processes, using such rare events to achieve the highest need at that time for the region is required. In this sense, elaborating initial goals for water governance based on comparing alternative governance regimes - and discussing what about the governance regime brought about sustainable outcomes or not – offered a feasible alternative method that sufficiently set up the development of governance transition strategies. Ultimately the development, application, and learning from governance transition strategies is needed. Applying, testing, and comparing the lessons and outcomes of these types of research and planning frameworks in different cases offers much to learn about actively transitioning water governance regimes toward more sustainable alternatives. The key is that we now start from this point: in order to resolve complex water problems in challenged regions like Guanacaste, people need to transition current water governance regimes toward more sustainable alternatives. This dissertation offers a first step on how to go about doing that and how research can actively contribute to these efforts.

5. Practical Contributions and Efforts for Advancing Toward Sustainable Water Governance in Guanacaste

A number of practical contributions and efforts were made for advancing toward sustainable water governance on the ground in Guanacaste. Some of these include:

(1) The PC Commission is now experimenting with assuming a role as a regional water governance organization. They aim to expand their role beyond a river basin organization in order to be a model for good regional water governance in Guanacaste that can mediate between national and local/ community scale water governance which this project found to be a key structural issue in the region.

(2) 150+ individuals were directly engaged in project activities (interviews, workshops, working groups, meetings). Many more people were exposed to project to the through newspaper, social media, and radio programs.

(3) Starting in 2013, several autonomous rural water administrators along the coast near Nicoya are meeting regularly in a new process to begin laying the groundwork to combine resources/ unite into a better-coordinated regional water administrative organization. Although these efforts have encountered hurdles (i.e., leadership changes), many of these organizations now focus on human resource development. This is a major paradigm shift in organizations that are typically only concerned with delivering water to users in their service area.

(4) Governing processes in many parts of the region are using a planning model similar to the one employed in the project (Current State Analysis – Future State/ Alternative State Analysis – Strategy Development). A new 'Science Committee' was formed in Nicoya to help train others on this process and to ensure that

relationships with future research teams productive and yield usable results.

(5) Local actors in Nicoya regularly used the scenarios in planning efforts immediately after the March 2013 workshop. Since then, however, efforts have shifted toward strategy development and testing with less reliance on the scenarios.

(6) Local water managers are building a 'resource map' to continue work that identifies human, technical, and financial resources that are dispersed in various organizations in the region

(7) Local actors and organizations are using the results to advocate to national organizations and politicians on behalf of under funded rural water administrators to secure financial, technical, and communications resources that are key to help mitigate future water conflict in the region. Members of the PC Commission were invited to participate in water reform talks in San José in February 2014.

(8) Two important organizations for water governance in the Nicoya zone – the Environment Ministry and the Water Agency - now attempt to coordinate with each other. An official from AyA now regularly attends PC Commission monthly meetings.

(9) A major effort to understand and quantify water resource availability in the area is now building on the work presented in this dissertation in cooperation with the PC Commission.

(10) In 2012, the report presented in Appendix C was used by the PC Commission during a Municipal Regulatory Plan update process to secure some protection (via land-use and development guidelines and zoning) of a nearby groundwater reserve.

(11) Chapter 6 of this dissertation was published online in the journal *Solutions* in

English and Spanish. The Spanish version was distributed to a wide range of stakeholders and people involved in water governance in Costa Rica. Some of these groups include: workshop/ study participants, to water law reform groups, agency directors, congressmen, and other decision-makers.

(12) The report contained in Appendix D was distributed to workshop participants, local and regional decision makers, community groups, and environmental groups via e-mail and in-person hard copies. Many recipients stated that they had never received the results of such scientific studies before. Efforts were made a to deliver the report to underfunded rural water administrators in Guanacaste that could not be contacted by email.

(13) In November 2012, the research team wrote a guest editorial on water conflicts in the Monthly newspaper *Voz de Nosara* (now called *Voz de Guanacaste*). The article focuses on water conflict cases. The newspaper article is available freely online and was distributed in print around Guanacaste Province. The article was picked up and re-published by three other news outlets including the national Costa Rican newspaper *El Día*.

(14) On March 14, 2013, 46 individuals from 18 Guanacaste communities participated in the first collaborative workshop for water governance in the region. Participants represented eleven rural water administrators (ASADAs), six public agencies, regional governments, tourism, agriculture, community groups, and environmental groups. The positions that participants held in the public water sector ranged from agency directors to part-time water administrators in communities with fewer than 1,000 people. Participants worked together for over seven hours. The workshop was

a significant research activity (i.e., data collection, some data analysis with participants, validating data/ results), but it also served as a major outreach activity in the sense that it dramatically increased the visibility of the project and that it included many people who have not been exposed to or been involved with such a project before. Many people have requested results from the workshop – even those who did not attend the workshop. Many of the rural water administrators who attended had never been involved with a research project before.

(15) In late March 2013, the *Voz de Nosara* published an article on the March 2013 workshop. A reporter was invited to participate and write an article on the workshop. The article is available freely online and was distributed in print around the Province of Guanacaste.

(16) On March 22, 2013, the research team was invited by the *Comisión para el Manejo de las Cuencas Potrero-Caimital* to participate in a community event commemorating World Water Day in the City of Nicoya. Hundreds of people from the City came and heard a summary of the research activities and results. The research team was invited to join a radio program and discuss the project and water governance and water conflict in general in Guanacaste. The research team was also invited to the 2014 event.

(17) Also in March 2013, the research drafted an initial 2-page summary of key results and action items for water governance. The PC Commission reviewed the 2-page summary. The PC Commission presented the summary at the March 22nd World Water Day event and asked people from the community to sign the summery in order to send the summery to politician and law makers. The summary was also

distributed in hard copy form to interested people at the event in Nicoya. The copy with the signatures was delivered to the Mayor's Office, to over 50 national politicians via email and social media, and to rural water administrators in either hard copy or via fax. The purpose of sending the a copy to the rural water administrators was to assist in any outreach or advocacy activities concerning water reform.

(18) In early 2014, SENARA began re-doing the rural development plan for the DRAT and has asked the research team to support assessment effort to ensure fair and just water allocations across groups of farmers

(19) The PC Commission asked for and received from the research team a draft an outline of key lessons for doing collaborative research in the region. This document's purpose was to be the basis for a new Science Committee in the area around Nicoya. The PC Commission views the project as a model of collaboration with researchers, of results dissemination, and of communication with stakeholders – and wanted a document to guide them in their future relationship with other researchers.

The contributions and efforts listed above should not be taken as a 'work finished' section. On the contrary, they should be taken as a start that – in close collaboration with many other researchers and local partners - has helped modestly contribute to building some initial momentum for sustainable water governance in a small part of Guanacaste. As I write these last paragraphs of the dissertation, in rural Guanacaste, it is apparent that much more work remains. For example: A few weeks ago (in February 2014) another escalated water conflict occurred in Playa Potrero (north of Nicoya). Shortly after that event, 11 people were violently arrested in a demonstration for the support of proposed

legislation that would distribute more governing authority of land and water resources to coastal communities. This last event has since prompted an investigation by a human rights watchdog group into the police actions and arrests. And, since the dry season started here, a strange amount of calcium and other minerals is constantly clogging my shower and sink. We receive water from a small ASADA who cannot figure out what is going on with the groundwater that supplies our neighborhood. Which, accordingly, has prompted my wife and I to stop drinking from the tap. Much work remains in Guanacaste and in other climate-threatened and water-contested regions. In the last two years, the literature on water governance has begun to take a major shift in its paradigm and perspective towards solution-oriented water governance studies. This shift is highlighted and engaged with in a variety of ways in all of the dissertation chapters. This shift has resulted in a number of recent academic papers calling for more solution-oriented water governance studies that aim to yield actionable knowledge for critical regions. Yet, there are currently few examples available where we can learn about how exactly to do this type of research and what the opportunities and challenges are. This dissertation provides an early example to learn about the opportunities and challenges of doing such use-inspired research that is well integrated across its research components and in the place where research is being conducted. The presented project ultimately offers the insights and lessons – from its successes and failures - for designing and implementing several aspects of solution-oriented water governance research that is coupled with real-time efforts that, simultaneously with research efforts, take actions in attempts to advance toward sustainable water governance.

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APPENDIX A

PERMISSION OF CO-AUTHORS TO PUBLISH WORK IN DISSERTATION

Arnim Wiek, Benjamin Warner, Raffaele Vignola, Mariel Yglesias, Ricardo Morataya, and Alonso Ramírez-Cover give permission to publish co-authored work in this dissertation.

APPENDIX B

INSTITUTIONAL REVIEW BOARD RESEARCH APPROVALS

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Arnim Wiek GIOS Build
From:	Mark Roosa, Chair SM Soc Beh IRB
Date:	10/20/2010
Committee Action:	**Exemption Granted**
IRB Action Date:	10/20/2010
IRB Protocol #:	1010005570
Study Title:	Water Governance in Guanacaste, Costa Rica

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Arnim Wiek GIOS Build
From:	Mark Roosa, Chair Soc Beh IRB
Date:	01/26/2011
Committee Action:	**Exemption Granted**
IRB Action Date:	01/26/2011
IRB Protocol #:	1101005892
Study Title:	Community visioning and Strategy Building for Sustainable Water Governance in Guancaste, Costa Rica

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Arnim Wiek GIOS Build
From:	Mark Roosa, Chair Soc Beh IRB
Date:	05/30/2012
Committee Action:	**Exemption Granted**
IRB Action Date:	05/30/2012
IRB Protocol #:	1205007880
Study Title:	Water governance and water disputes in Guanacaste, Costa Rica

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

APPENDIX C

2012 PROJECT EXECUTIVE SUMMARY AND REPORT FOR STAKEHOLDERS

(SPANISH)

NOTE: DESIGNS AND LAYOUT IN THE FOLLOWING REPORT WERE ALTERED FROM THE ORIGINAL IN ORDER TO FIT DISSERTATION FORMAT REQUIREMENTS. SOME IMAGES FROM THE OIGINAL REPORTS HAVE BEEN ALTERED OR REMOVED IN ORDER TO REDUCE DOMEUNT SIZE.

Evaluación de Sostenibilidad del Sistema Hídrico Regional y el Manejo de Agua en las Sub-Cuencas Potrero, Caimital, y Nosara Alta

Nicoya, Guanacaste, Costa Rica
Abril 2012

Preparado para:
La Comisión para el Manejo de las Sub-Cuencas Potrero-Caimital

Informe de Proyecto 1 de 3:
Hacia el Manejo Sostenible de los Recursos Hídricos en Guanacaste, Costa Rica

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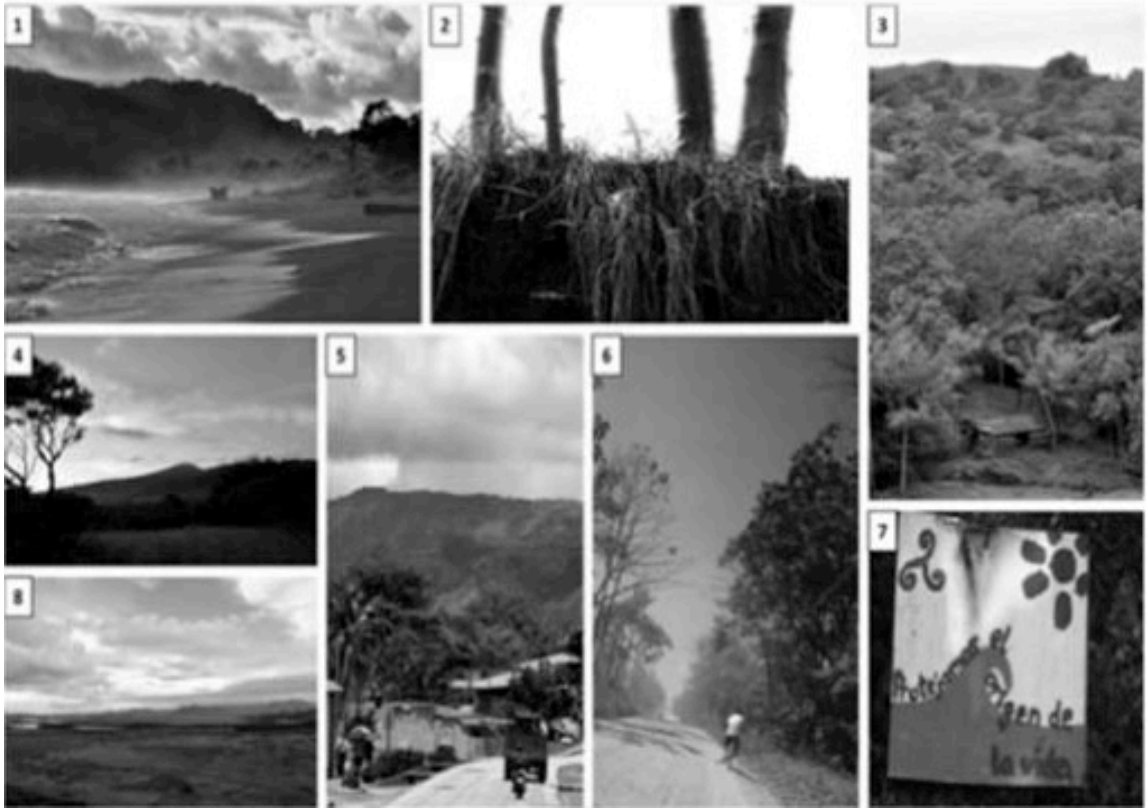
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El contexto y antecedentes del estudio

El estudio abordado en este informe es el primero de tres estudios que forman parte del proyecto titulado: "Hacia el Manejo Sostenible de los Recursos Hídricos en Guanacaste, Costa Rica." El proyecto se inició en el año 2010 a través de un esfuerzo conjunto entre el Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), en Turrialba, Costa Rica y la Facultad de Sostenibilidad de la Universidad Estatal de Arizona. El trabajo de campo y recopilación de datos para este informe se realizaron durante seis meses, desde septiembre del 2010 hasta febrero del 2011.

En el transcurso del 2011, los datos recopilados se sintetizaron y analizaron en la Universidad Estatal de Arizona. Los resultados de este estudio se utilizarán como base para el diseño de los próximos dos estudios que se iniciarán a mediados del 2012. Los tres estudios del proyecto, "Hacia el Manejo Sostenible de los Recursos Hídricos en Guanacaste, Costa Rica," se resumen a continuación:

Estudio # 1: El objetivo del primer estudio, el cual es abordado en este informe, es comprender ¿qué tan bien está siendo manejada el agua en la actualidad? La gravedad de los agentes estresores en los sistemas hídricos, desde el cambio climático hasta las disputas social-ambientales, está determinada por lo bien que funciona el manejo regional del agua. Por lo tanto, antes de anticipar los impactos futuros y las consecuencias para el sistema de agua, identificamos cómo funciona su manejo regional actualmente. Adicionalmente, en este estudio también se describen los criterios generales de sostenibilidad, los cuales se utilizarán en los tres estudios.

Estudios Futuros (2012 - 2013)

Estudio # 2: El objetivo del segundo estudio es crear escenarios para anticipar la dinámica del sistema hídrico y sus estados del manejo a un plazo de 20 años. Los escenarios futuros incluirán evaluaciones del cumplimiento de los criterios de sostenibilidad. Asimismo, incluirán las evaluaciones de dónde y cómo las disputas de recursos podrían surgir en el sistema hídrico. Los escenarios serán evaluados con los miembros de la Comisión y las partes interesadas para avanzar en la determinación de una visión compartida de sostenibilidad.

Estudio # 3: El objetivo del tercer estudio es trabajar en estrecha colaboración con las partes interesadas para descubrir cuáles acciones viables, si se ejecutan hoy en día, aumentarían la capacidad del manejo regional de agua para mitigar y evitar los impactos negativos de los factores de estrés como cambio climático. Este paso incluye reforzar las funciones importantes que ya existen en el manejo regional de agua y la identificación de

funciones que todavía no existen pero que pero que serán importante en el futuro para mitigar las disputas social-ambientales y evitar estados futuros no deseados o no sostenibles del sistema hídrico regional.

Resumen ejecutivo

El manejo sostenible de agua involucra a todas las partes interesadas en la coordinación del abastecimiento, la distribución, el uso, y la salida de agua de una manera tal que garantice un nivel suficiente y equitativo de bienestar socioeconómico, sin comprometer la integridad de los ecosistemas de apoyo a través del tiempo.

Los esfuerzos para lograr un manejo sostenible del agua en Nicoya y Hojancha, Guanacaste, Costa Rica, se enfrentan a obstáculos significativos. Estos obstáculos incluyen impactos esperados del cambio climático en un futuro próximo; posiblemente menos precipitación y, potencialmente, disputas perturbadoras de agua. La capacidad para una adaptación con éxito a los impactos climáticos y una mitigación de las disputas de agua depende de qué tan bien - o qué tan sostenible - los recursos hídricos están siendo manejados.

Los objetivos de este informe son (1) establecer los criterios de sostenibilidad con el fin de evaluar el sistema hídrico regional , (2) identificar las áreas críticas de desafío en el sistema hídrico donde la sostenibilidad se ve afectada negativamente, (3) explorar por qué estos desafíos existen en el sistema en estos momentos. Además, (4) presentamos una vista previa de las oportunidades y las estrategias de manejo de agua que potencialmente podrían remediar estos desafíos. El desarrollo y evaluación de las estrategias de manejo sostenible de agua para la región se llevará a cabo con mucho más detalle a través de esfuerzos de investigación conjunta en las investigaciones #2 y #3, las cuales se llevarán a cabo en el periodo 2012-2013.

Los resultados de la evaluación de sostenibilidad del sistema se triangularon con las percepciones de los agentes clave sobre los retos de manejo del agua en la región. Posteriormente, los retos fueron localizados en el sistema de agua a través de la elaboración de un mapa y revelaron **cuatro áreas críticas** que agrupan desafíos en el sistema de agua:

- Falta de coordinación e intercambio de información entre comunidades sobre las extracciones de agua en el acuífero Potrero-Caimital.

- Poca integración de las comunidades de la cuenca media y baja en la toma de decisiones regional, especialmente en el área de la costa Pacifica.

- Ausencia de liderazgo institucional que coordine actividades para la educación del uso de agua y ausencia de un norte común en los esfuerzos de manejo.

- Reglas inadecuadas de regulación y monitoreo del uso del agua, especialmente después de que el agua ya ha sido utilizada. Tales reglas contribuyen a que exista un vacío de información compartida entre organizaciones clave en cuanto a la oferta y demanda de agua en la región.

Los resultados también revelan componentes que potenciales soluciones podrían aprovechar para acelerar el proceso hacia una manejo sostenible:

- La voluntad para establecer plataformas y alianzas transversales que permitan intercambiar información sobre las extracciones de agua. La importancia de tal componente está demostrada por los esfuerzos de la Universidad Nacional en Nicoya (UNA). UNA ha iniciado trabajo para organizar la información del agua extraída (del acuífero Potrero-Caimital) por parte de las ASADAs. La oportunidad ya existe para usar y organizar cursos y grupos estudiantiles de trabajo los cuales podrán trabajar cerca de la Comisión para ejecutar proyectos que permitan avanzar hacia la sostenibilidad regional de agua.

- Las organizaciones de base, como NicoyAgua, están bien posicionadas para aprovechar y aumentar la participación y colaboración de las comunidades y las ASADAs, así como estrechar las alianzas con el Instituto Costarricense de Aceuductos y Alcanterillados (AyA) y Minesterio de Ambiente, Energía, y Telecomunicaciones (MINAET) en Hojancha y Nicoya. Aprovechar las organizaciones de base en los esfuerzos de manejo de agua a largo plazo, establecer metas, y tomar decisiones a nivel local es promisorio para lograr un manejo sostenible del agua.

- Con un adecuado planeamiento estratégico, la coordinación y colaboración que solamente NicoyAgua y otras organizaciones de base pueden proveer, podría ser un modelo para organizaciones base de manejo de agua a través de la provincia de Guanacaste. Apuntar a este modelo de organización podría constituir una importante herramienta de visualización para esfuerzos de manejo locales y regionales. Los esfuerzos actuales para consolidar corredores biológicos son asimismo una plataforma que puede utilizarse para la cooperación en el manejo del agua y en el establecimiento de metas conjuntas.

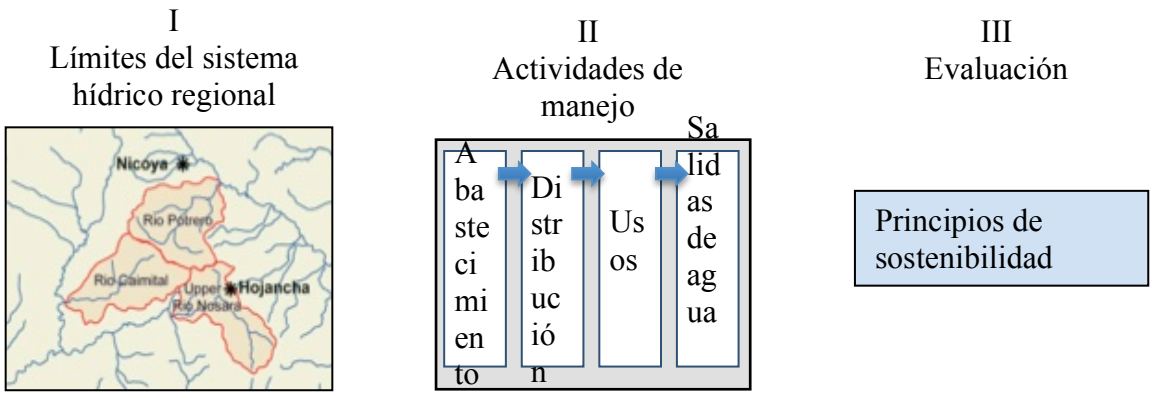
- El Plan de Manejo 2004 de la Cuenca Potrero-Caimital (Morataya 2004) ha establecido la necesidad de involucrar a todos los actores relevantes en el proceso de toma de decisiones, incluyendo al gran productor agrícola de la región. Una

vez reconocida la necesidad de un manejo participativo, se abre la oportunidad para formalmente desarrollar un proceso regional que se enfoque al consenso de objetivos de manejo, al monitoreo del progreso regional hacia el manejo sostenible del agua y al ajuste de estructuras de manejo a medida que sea necesario en el futuro.

Informe

1. Diseño del estudio[1]

El enfoque utilizado en este estudio para asesorar el sistema hídrico es un enfoque orientado hacia las actividades que llevan a cabo los diferentes actores del sistema. Principalmente nos interesa lo que las personas *hacen* dentro del sistema de agua, y como resultado de estas actividades, cómo entra el agua al sistema, cómo viaja a través, y cómo sale de la región. Se utiliza el término *hacer,* el cual involucra la extracción, distribución, uso y recarga del agua así como actividades que tengan influencia sobre el sistema, las cuales incluyen planificación, investigación, monitoreo, reportes y debates, promoción, regulación, advocación , entre otros. *Hacer* y *manejar* están estrechamente relacionados en este enfoque, al utilizar *manejo de agua* para indicar la inclusión y responsabilidad de todos los actores y las personas que están siendo afectadas por las decisiones y resultados dentro del sistema de agua.



[1] La material la que está presentada en Section 1 y 2 es replicada y adaptada de: Wiek A, Larson KL (under review) Water systems, people, and sustainability – a framework for analyzing and assessing water governance regimes. *Water Resources Management*

Figura 1.1: Los tres pasos llevados a cabo para desarrollar la evaluación de sostenibilidad de Potrero, Caimital, y la Cuenca Alta del Nosara. Los (I) límites que delinean el sistema hídrico regional, el cual es posteriormente definido a través de (II) actividades de manejo. (III) Seguidamente los principios de la sostenibilidad son aplicados para evaluar y describir el estado actual del sistema hídrico regional.

Analizando el sistema desde esta perpectiva, no se busca proveer un modelo perfecto de sistema hídrico . Por el contrario, el estudio está estructurado de manera que la evaluación de sostenibilidad permita identificar potenciales puntos de intervención para mejorar el manejo regional del agua.

I Límites del Sistema Hídrico Regional

Los sistemas hídricos regionales son sistemas socio-ecológicos multi-dimensionales, los cuales pueden ser delineados de diversas maneras al identificar el área geográfica de interés. De esta manera, el enfoque podría ser un sistema socio-político particular como una ciudad, un área metropolitana o un estado. Alternativamente, los sistemas hídricos pueden definirse utilizando criterios biofísicos como cuencas hidrográficas. En este caso definimos los límites del sistema hídrico regional como Potrero, Caimital y la subcuenca alta del Nosara

II Actividades de manejo

Las actividades delinean los aspectos básicos de lo que las personas *hacen* con el agua. En este caso, el enfoque de tales actividades son las acciones y decisiones relacionadas con los recursos hídricos. Las cuatro actividades definidas se exponen a continuación:

Abastecimiento de Agua

Este ámbito de actividades incluye de dónde viene el agua, cómo se adquiere, acceso y maneja. Algunos ejemplos incluyen:

- La búsqueda y extracción de los acuíferos y la construcción y mantenimiento de pozos.
- El almacenamiento de agua, así como la construcción y mantenimiento de infraestructuras de almacenamiento.

- Recarga de acuíferos.

- Distribución y administración de derechos y acceso a fuentes de agua, ya sea de manera legal o a través de redes sociales informales.

- Evaluación , asesoramiento y planificación para las fuentes de abastecimiento de agua, incluyendo el monitoreo de niveles de agua y contaminantes, la anticipación de perturbaciones que afecten el abastecimiento y el manejo de estas fuentes.

Distribución del agua

Estas actividades incluyen la distribución de agua a los usuarios a través de sistemas que facilitan su consumo. Algunos ejemplos:

- El bombeo y transporte del agua a través de estructuras como canales y tuberías, así como a través de estructuras naturales como canales de ríos. Se incluye la construcción y modificación de infraestructura y la alteración de estructuras naturales con el propósito de distribución.

- La distribución y administración de derechos para suministrar agua, ya sean de manera legal o a través de redes sociales informales.

- El tratamiento de agua con el fin de hacerla potable o permitir usos para el agua no potable (ver salidas del agua)

- El monitoreo y manejo de la calidad tanto del agua distribuida así como de la infraestructura utilizada para tal distribución.

Usos del agua

Este ámbito de actividades incluye cómo las personas utilizan, consumen y conservan el agua para distintos propósitos de naturaleza humana, económica y ecológica, como por ejemplo:

- El uso de agua para actividades agrícolas, residenciales y del hogar, industriales, comerciales y de uso público (por ejemplo producción y procesos industriales, agricultura, consumo del sector empresarial, saneamiento), así como construcción, mantenimiento y alteración de pozos e infraestructura para esto.

- El uso de agua para propósitos ecológicos como flujos utilizados para pesca y vida silvestre, así como las demandas climáticas de evaporación.

- La conservación de agua por medio de la reducción del consumo y el aumento de la eficiencia de uso de agua a través de innovación tecnológica, cambio de actitudes y otros mecanismos.

- El monitoreo, promoción, coordinación y regulación de los usos del agua, incluyendo la conservación del recurso y la instalación de tecnología e infraestructura que mejore la eficiencia de uso del agua.

Salidas de agua

Estas actividades incluyen el tratamiento del agua después de que ésta ha sido utilizada, y cómo se utilizan y manejan las aguas residuales y efluentes. Algunos ejemplos son:

- Transporte y manipulación segura de aguas residuales , así como la construcción, mantenimiento y alteración de pozos y e infraestructura para el transporte.

- El tratamiento de aguas residuales (mecánico o biológico) , así como la construcción, mantenimiento y alteración los pozos y la infraestructura para el tratamiento.

- La descarga de aguas residuales que han sido utilizadas al sistema hidro-ecológico (para la reutilización y la recarga hídrica).

- Actividades que influyen sobre aquellas mencionadas anteriormente, como planeamiento, investigación, monitoreo, reporte y debate, negociación, promoción, advocación, regulación, entre otras.

Actividades transversales

Hay factores que influyen en varias de las actividades mencionadas anteriormente a través de:

- Planificación, manejo, regulación, incentivos y control (políticas y administración).

- Negociación y consideración de opciones (participación y compromisos)

- Estudios, monitoreo, evaluación y suministro de información (investigación y evaluación).

- Promoción y advocación

Tabla 1.2: Organizaciones entrevistadas en el estudio

Organización clave entrevistada	Descripción
Instituto Costarricense de Acueductos y Alcantarillados (AyA)	Agencia nacional de agua cuyo objetivo es abastecer a la población de agua potable. La oficina regional está localizada en Nicoya.
Ministerio de Ambiente, Energía y Telecomunicaciones (MINAET)	Ministerio Nacional de Ambiente. Es una organización sombrilla para el manejo del medio ambiente. Nicoya y Hojancha son manejadas como sub-regiones separadas. El departamento de agua se encuentra localizado en San José.
Sistema Nacional de Aéreas de Conservación, Área de Conservación Tempisque (ACT)	Las áreas protegidas son manejadas por el ACT, un brazo descentralizado de la división de ambiente de MINAET. El ACT también tiene una oficina de educación ambiental.
Ministerio de Salud	El ministerio nacional tiene el objetivo de proteger la salud de la población. Las oficinas regionales se localizan en Nicoya y Hojancha.
Asociaciones Administradoras de Acueductos y Alcantarillados (ASADAs)	Grupo de comunidades rurales que manejan el abastecimiento y distribución de agua. Tienen el poder de establecer y colectar tarifas de uso de agua.
Municipalidades (Nicoya y Hojancha)	Gobierno municipal encargado de establecer y revisar los estándares y planes de desarrollo.
Ministerio de Agricultura y Ganadería (MAG)	Agencia nacional encargada de promover la competitividad del sector agrícola costarricense. Las oficinas regionales se localizan en Hojancha y Nicoya.
Servicio Nacional de Aguas Subterráneas, Riego y Avenamiento (SENARA)	Agencia nacional que tiene el objetivo de manejar aguas subterráneas e irrigación. Maneja grandes distritos de riego en el país. Las oficinas están localizadas en San José.
Fundación NicoyAgua / Comisión del Manejo de Río Potrero	Agrupación sin fines de lucro encargada de administrar la Comisión de Manejo de Cuenca Potrero-Caimital. Es a menudo la cara pública de la Comisión de Manejo.
CoopePilangosta	Cooperativa de productores de café
Asociaciones de desarrollo rurales	Organizaciones dedicadas al bienestar de las comunidades rurales
Instituto Nacional de Aprendizaje	Oficina de extensión agrícola encargada de educación y asistencia técnica.
Costeña S.A.	Melonera y negocio agrícola más grande del area.

Universidad Nacional de Costa Rica (UNA) (Sede Chorotega)	Universidad Nacional con un campus localizado en Nicoya. Tiene unidades de investigación de recursos hídricos y bosque seco tropical y desarrollo.
Fundación Monte Alto	Fundación sin fines de lucro cuyo objetivo es financiar la compra de tierras y proteger la Cuenca alta del Río Nosara Alta
Comisiones Ganaderas	Organizaciones dedicadas a la difusión de información y asistencia técnica y la promoción de intereses colectivos entre productores afiliados.
Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)	Centro de educación superior con un brazo de investigación ubicado en Hojancha. Su objetivo en el area es consolidar los corredores biológicos de la Península de Nicoya.
CoopeGuanacaste	Proveedor regional de electricidad, administrado como una cooperativa que también maneja negocios localizados a lo largo de región.

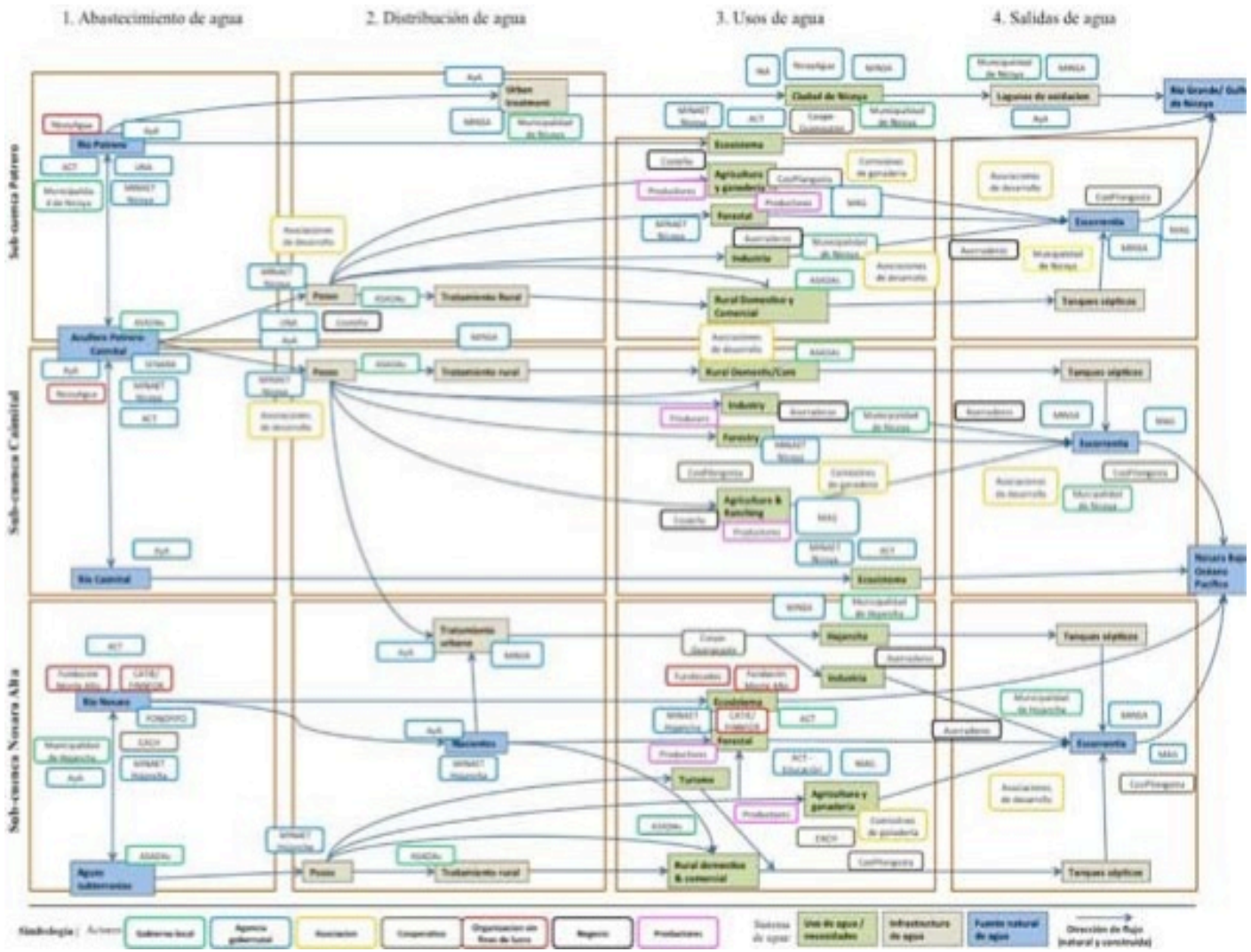


Figura 1.2 Organizaciónes en el manejo regional de agua

2. Principios de Sostenibilidad

El tercer paso es la evaluación del sistema hídrico regional desde la perspectiva de la sostenibilidad. La pregunta guía es: ¿qué tan sostenible es el actual régimen de manejo del agua? Definimos el manejo sostenible del agua como el proceso que involucra a todos las partes interesadas en la coordinación del abastecimiento, distribución, uso y salidas de agua de manera que garantice un nivel de bienestar social y económico suficiente y equitativo sin comprometer la viabilidad y la integridad de los hidro-ecosistemas a largo plazo (Rogers y Hall, 2003; Langsdale et al 2009; Reed y Kaspryzk de 2009). Para llevar a cabo dicha evaluación, desarrollamos un conjunto de principios de gobernanza sostenible con los que puede evaluarse el régimen actual.

Nuestra recopilación se basa en el conjunto de criterios generales de sostenibilidad propuestos por Gibson (2006) así como en la integración de propuestas de sostenibilidad de agua (por ejemplo, Newman, 2001; Alley y Leake 2004), manejo del agua (por ejemplo, Larsen y Gujer 1997, Pahl Wostl 2008; Muelle de 2010; Grigg 2010) y manejo de los recursos naturales (por ejemplo, Lockwood 2010). Adicionalmente, el desarrollo de estos principios fue acompañado por entrevistas conducidas durante el estudio.

Los 7 principios son explicados a continuación:

1. La integridad del sistema socio-ecológico.

Este principio exige equilibrar las necesidades de los residentes locales, agricultura, industria y otros usuarios del agua tomando en cuenta la viabilidad de los ecosistemas de soporte. Durante las últimas dos décadas, ha surgido el consenso de que el concepto convencional de caudal ecológico no es suficiente para un régimen de manejo de agua cuyo objetivo sea garantizar la viabilidad de los hidro-ecosistemas. Como resume Sophocleous (2000:41): "en el pasado, el volumen de recarga de un acuífero fue aceptado como la cantidad de agua que podría extraerse sobre una base sostenible, el llamado caudal ecológico. Ahora entendemos que para el rendimiento sostenible de un acuífero, la extracción debe ser considerablemente menor que la recarga,

El principio de integridad del sistema socio-ecológico puede definirse en 4 partes:

a. El mantenimiento de flujos mínimos de aguas superficiales para fauna y ecosistemas, así como recreación , educación y otros objetivos antropocéntricos.

b. El mantenimiento o aumento de la calidad de los recursos hídricos a través de la eliminación, reducción o mitigación de la contaminación en cuerpos de agua.

c. Garantizar que los acuíferos no se sobrecarguen hasta puntos de inestabilidad, por ejemplo, creando fisuras y hundimientos del suelo debido al agotamiento de las aguas subterráneas o reduciendo corrientes de agua conectadas a aguas superficiales.

d. Reconocer los límites naturales de la cuenca, coordinar la utilización de recursos hídricos y evaluar impactos tomando en cuenta las conexiones de agua subterránea y superficial a fin de asegurar la integridad del sistema socio-ecológico.

2. Eficiencia y mantenimiento de recursos

El principio de eficiencia y mantenimiento de recursos se especifica a continuación:

a. Reducir el consumo de agua o mejorar la eficiencia del uso de agua en prácticas agrícolas, industriales, comerciales y residenciales. Puntos de referencia comunes para este principio incluyen las tasas de consumo de agua per cápita, especialmente para el sector municipal, además del rendimientos de cultivos por cantidad de agua utilizada.

b. Reutilizar agua o reciclar las aguas residuales para usos diversos, incluyendo el tratamiento para usos no potables como la irrigación.

c. Eliminar la pérdida de agua del sistema debida a demandas climáticas y fugas en la infraestructura.

d. La tasa de extracción de aguas subterráneas no debe exceder la tasa de recarga y regeneración de las aguas subterráneas a largo plazo (comúnmente conocido como "caudal ecológico"), a fin de mantener los niveles del acuífero. El cumplimiento de este principio requiere aumentar la conservación, reducir las tasas de consumo y reutilizar el agua para múltiples propósitos a fin de reducir las exigencias sobre los recursos hídricos. Aunque la recarga de acuíferos con otras fuentes de agua es una opción, los crecientes costos económicos, políticos y ambientales de la adquisición de suministros de agua para hacerlo a menudo constituyen una limitación.

3. Oportunidad y suficiencia de medios de vida

Este principio asegura el acceso equitativo a suficiente cantidad y calidad del agua para las personas que dependen de ella para su subsistencia y actividades económicas.

Un manejo adecuado del agua debe específicamente asegurar:

a. El acceso al agua en suficiente cantidad y calidad para actividades que sostienen los medios de vida de las personas y garantizan su bienestar.

b. El acceso al agua en suficiente cantidad y calidad con el fin de perseguir oportunidades económicas. Por ejemplo agricultura, procesamiento de alimentos y turismo. Este sub-principio es contingente con el mencionado anteriormente.

c. Una compensación para las partes afectadas en caso de tener un acceso insuficiente (e.g; agua contaminada, infraestructura deficiente).

4. Civilidad socio-ecológica y el manejo democrático

Este principio exige la participación y la colaboración entre todos los interesados en la toma de decisiones, considerando los intereses, necesidades y perspectivas de los actores locales y los que están conectados a los recursos a través de redes sociales y ambientales más amplias (como cuencas hidrográficas). Este principio alienta a los usuarios del agua, los reguladores, los administradores, y otros a desarrollar un entendimiento compartido y preciso del sistema regional de agua, reconociendo y respetando las funciones y perspectivas de los diversos actores del sistema. Exige también que todas las partes interesadas desarrollen responsabilidad personal e institucional para las prácticas sostenibles de agua.

El principio de civilidad y manejo democrático se especifica a continuación:

a. Involucrar a todas las personas o grupos que afectan o son afectados por los esfuerzos de manejo de agua, incluidos los usuarios del agua, proveedores, reguladores, gerentes, planificadores, científicos y ambientalistas en la toma de decisiones sobre cuestiones relativas al agua en la región (Ostrom, 2009).

b. Considerar la completa gama de intereses y perspectivas a través de las diferentes etapas del manejo. Este proceso incluye desde debates y estudios hasta la toma de decisiones y su evaluación, así como una documentación transparente de cómo tales intereses y perspectivas están siendo integradas o ignoradas en la toma de decisiones.

c. Establecer esfuerzos colaborativos para el manejo de agua más allá de los límites físicos y políticos del sistema.

5. Equidad inter e intrageneracional

El principio asegura un acceso equitativo a la suficiente cantidad y calidad de agua para los residentes actuales y futuros. Esto implica proveer a las generaciones futuras con las mismas oportunidades que se brinda a la población actual, tanto en términos de actividades antropocéntricas y como del ecosistema. Generalmente, se hace hincapié en dos formas de equidad: justicia de distribución, donde se destaca una distribución justa de los impactos, beneficios y costos, y la justicia participativa, que hace hincapié en la participación equitativa de todas las partes en toma de decisiones.

Este principio se define seguidamente:

a. Asegurar el acceso al agua potable por parte de todos los residentes para fines de alimentación y saneamiento, es decir, como una necesidad humana básica y por lo tanto, un derecho humano.

b. Definir e implementar un nivel suficiente de necesidades de agua más allá de "necesidades básicas", dando prioridad a las disputas entre partes interesadas .

c. Asegurar una distribución justa de los beneficios y los costos entre todos los actores y los actores involucrados en el uso y manejo del agua.

d. Facilitar participación entre diversas partes, las cuales deben ser representativas de todos los sectores interesados de la población.

e. Asegurar la representación de las generaciones futuras en los procesos de manejo del agua.

6. Interconectividad de escala local a global

El principio asegura la asignación y manejo de los recursos hídricos en regiones ascendentes y descendentes de las cuencas hidrológicas. En otras palabras, porque el agua está conectada en la unidad biofísica de la cuencas, deben considerarse las decisiones tomadas en todas las unidades sociales o políticas involucradas y los efectos nocivos a otros deben mitigarse o ser compensados.

Este principio se define a continuación:

a. Reducir o eliminar los efectos negativos (de extracción de agua, contaminación, etc.) en otras regiones, incluidas las comunidades de origen de extracción del agua y sus posteriores usuarios o actores.

b. Planear el manejo de los recursos dentro de los límites del acuífero o cuenca hidrográfica.

c. Reconocer y coordinar entre los actores locales y las partes interesadas a mayor escala, por ejemplo, el co-manejo de recursos a través de las cuencas transfronterizas y la negociación de tratados internacionales de agua.

7. Precaución (mitigación) y adaptabilidad

El manejo sostenible del agua requiere la anticipación de posibles problemas y la capacidad para mitigar así como responder a los impactos negativos sobre el sistema de agua. Se toman en cuenta tres ámbitos:

a. Anticipación. Se prevé la posible escasez de agua y problemas de calidad, por lo que se desarrollan estrategias proactivas para evitarlos y administrarlos. Los factores estresores incluyen el clima y la variabilidad hidrológica, así como los cambios socioeconómicos, entre otros. Actividades clave de anticipación incluyen: monitoreo de condiciones hidrológicas y ambientales, del uso de agua y otros parámetros; y construir modelos dinámicos, escenarios futuros y estrategias de mitigación y adaptación.

b. Mitigación. Implementación de planes y adopción de prácticas de manejo de agua que a largo plazo reducen la complejidad de los sistemas, aumentan la resiliencia y promueven la conservación del agua. Estas prácticas incluyen la prevención de perturbaciones por medio de la mitigación de estresores.

c. Adaptación. En caso del fracaso de los esfuerzos de mitigación, adaptarse a las condiciones y necesidades cambiantes, asegurando que los actores involucrados son conscientes y capaces de tomar las medidas requeridas para la sostenibilidad. Esto exige flexibilidad para permitir el aprendizaje, la renegociación de los objetivos y modificación de estrategias según sea necesario.

Table 2.1: Resumen de los criterios de sostenibilidad; cada criterio corresponde a actividades de manejo

Principio de Sostenibilidad	Componentes Clave	Actividades de manejo
1. La integridad del sistema socio-ecológico	a. Mantener flujos mínimos en las aguas superficiales b. Mantener o aumentar la calidad de los recursos hídricos c. Asegurar que los acuíferos no sean sobrecargados hasta puntos de inestabilidad d. Reconocer y coordinar el uso de recursos y su impacto dentro de los límites del sistema hídrico	Abastecimiento Transversal Abastecimiento Uso
2. Eficiencia y mantenimiento de recursos	a. Reducir el uso de agua o incrementar la eficiencia de uso b. Reusar agua o reciclar agua residual para usos varios c. Eliminar la pérdida de agua d. La extracción de agua subterránea no debe exceder la regeneración y tasa de recarga	Uso Uso / Salidas de agua Abastecimiento/ Distribución Abastecimiento
3. Oportunidad y suficiencia de medios de vida	a. Todas las personas deben tener acceso a suficiente calidad y cantidad de agua para sus medios de vida b. Todas las personas deben tener acceso a suficiente calidad y cantidad de agua para sus actividades económicas c. Una compensación justa para los actores que no tienen suficiente acceso	Abastecimiento / Uso Abastecimiento / Uso Abastecimiento/ Uso
4. Civilidad socio-ecológica y manejo democrático	a. Involucrar a todas las partes que afectan o se ven afectadas por la toma de decisiones de manejo de agua b. Considerar toda la gama de intereses y percepciones de en las diversas etapas del proceso de manejo c. Establecer alianzas colaborativas para el manejo de agua	Transversal Transversal Abastecimiento / Distribución
5. Equidad inter e intra-generacional	a. Asegurar que todos los residentes tienen acceso a agua potable para alimentación y para propósitos de saneamiento b. Definir e implementar un nivel suficiente de agua más allá de las	Abastecimiento Uso Transversal

	necesidades básicas c. Asegurar una distribución justa de costos y beneficios con las partes interesadas d. Facilitar la participación entre diversas partes interesadas (dentro de la región) e. Incluir la representación de futuras generaciones	Transversal Uso
6. Interconectividad de escala local a global	a. Reducir o eliminar impactos negativos sobre otras regiones b. Planear el manejo de los recursos dentro de los límites del acuífero o cuenca hidrográfica c. Reconocer y coordinar con actores locales y otras partes interesadas a mayor escala	Abastecimiento/ Salida de agua Abastecimiento Abastecimiento
7. Precaución (mitigación) y adaptabilidad	a. Anticipar potencial escasez de agua y problemas de calidad b. Mitigar potencial escasez de agua y problemas de calidad c. Adaptarse a la escasez de agua y problemas de calidad	Abastecimiento Transversal / Uso Transversal

3. Resultados de la Evaluación de Sostenibilidad

	Principios de sostenibilidad	Actividad	Resultados | *=Incumle el principio / **= Incumple el principio, pero hay avances hacia la sostenibilidad / ***=cumple con los requerimientos del principio
1. La integridad del sistema socio-ecológico			
a	Mantener flujo mínimo de agua superficial	Abastecimiento	Aunque los datos son escasos, basado en cálculos iniciales en este esfuerzo de investigación (no presentados en este informe) no parece que el flujo de agua superficial está sobrecargado en la época lluviosa. Es urgente un estudio más cuidadoso de las corrientes de la estación seca y disponibilidad de suministro. **
b	Mantenimiento o incremento de la calidad de los recursos hídricos	Transversal	AyA y el Ministerio de salud monitorean regularmente la calidad del agua para el consumo humano. MINAET está encargado de vigilar la salud e integridad del ecosistema, sin embargo el monitoreo consistente de ecosistemas es un desafío prácticamente inexistente fuera de iniciativas voluntarias (como el programa de bandera azul). **
c	Asegurar que los acuíferos no se sobrecargu en hasta el punto de inestabilidad	Abastecimiento	No existe un estudio de las aguas subterráneas en la parte superior del Nosara. El acuífero de Potrero Caimital fue localizado en un mapa por primera vez en el 2003 por Costeña, el mayor usuario de aguas subterráneas en la región. Este estudio fue fundamental para los estudios posteriores de SENARA 2006 y 2008 sobre la vulnerabilidad de acuífero. Existe muy poca información fiable sobre el abastecimiento del recursos. *
d	Reconocer/ coordinar los usos e impactos dentro del sistema de agua	Distribución Uso	Las ASADAs no coordinan las extracciones del acuífero con Costeña u otras entidades que utilizan la misma fuente. Ningún actor juega el papel de facilitar el intercambio de información sobre el uso del agua entre comunidades o entre sectores que comparten la misma fuente. Las normas y reglamentos actuales no fomentan la coordinación e incluso obstaculizan la acumulación de información coherente de oferta/demanda. *
2. Eficiencia y mantenimiento de recursos			
a	Reducir el uso de agua o incrementar la eficiencia	Uso	Hay pocos esfuerzos de coordinación pública y educación. La ruptura de conocimiento entre grupos y comunidades convierte el establecimiento de un norte común, la cooperación, el monitoreo e identificación de objetivos en tareas difíciles. *

	de uso		
b	Reusar agua o reciclar agua residual para usos varios	Salida de agua Uso	Los proyectos de reutilización y reciclaje están ganando interés, lo cual ha sido demostrado por talleres recientes realizados por UNA. Sin embargo la falta de coordinación y los vacíos (quién es responsable de hacer qué) han impedido la ejecución de los programas y obstaculizado esfuerzos de financiamiento. **
c	Eliminación de la pérdida de agua	Supply Delivery	La infraestructura generalmente tiene un mantenimiento adecuado por parte del AyA. Sin embargo, el financiamiento público se ha vuelto escaso. En la época lluviosa 2010 AyA enfrentó problemas de bajo presupuesto para dar mantenimiento, por lo que tuvo que optar por un préstamo. Los problemas de infraestructura periódicamente dejan a Hojancha sin agua potable tanto en época seca como lluviosa. **
d	La tasa de extracción de agua subterránea no debe exceder la tasa de recarga	Abastecimiento Distribución	El conocimiento de reservas de suministro de acuífero es considerado por el gobierno uno de los problemas principales para la Provincia Guanacaste. A pesar de ser uno de los mejores recursos de agua dulce en la región, el Acuífero Potrero-Caimtial nunca ha sido suficientemente estudiado para identificar umbrales de caudal ecológico. *
3. Oportunidad y suficiencia de medios de vida			
a	Todas las personas deben tener acceso a suficiente calidad y cantidad de agua para sus medios de vida	Abastecimiento Uso	Generalmente las redes de distribución de AyA y ASADAs (la mayoría) aseguran cantidad y calidad de suficientes. Legalmente todos los residentes tienen derecho a perforar pozos privados para fines domésticos. Sin embargo, los campesinos que dependen de pozos privados no tienen asegurada cantidad ni en calidad de agua y están vulnerables en la estación seca. **
b	Todas las personas deben tener acceso a suficiente calidad y cantidad de agua para sus	Abastecimiento Uso	El tiempo de espera para la obtención de permisos de aprovechamiento puede ser exasperante. Como resultado, la extracción ilegal de agua es muy común y se especula que ocurre a menudo. Sin embargo, la creciente escasez, el poco conocimiento de cuánta agua está siendo utilizada y la debilidad institucional es una condición que puede potencialmente llevar a la disputa de recursos. **

	actividades económicas		
c	Una compensación justa para los actores que no tienen suficiente acceso	Abastecimiento Uso	El Tribunal Ambiental resuelve la compensación de partes afectadas. Sin embargo, el volumen de casos en los últimos años y la lentitud de los procesos ha limitado el acceso local a la corte. Las comunidades de Guanacaste se relacionan estrechamente y tienen la capacidad de movilizarse cuando la compensación no está disponible y afecta los objetivos de la comunidad. Sin embargo, en el futuro ésto podría tener impactos negativos en las comunidades. **
4. Civilidad socio-ecológica y manejo democrático			
a	Involucrar a todas las partes que afectan o se ven afectadas por la toma de decisiones de manejo de agua	Transversal	Todos los sectores y grupos tienen la oportunidad de participar en el manejo. La inclusión de comunidades rurales y los usuarios grandes de agua es un desafío, sin embargo existen esfuerzos por parte de organizaciones de base para ampliar la participación de todos los actores. **
b	Considerar toda la gama de intereses y percepciones en las diversas etapas del proceso de manejo	Transversal	Es necesario que las ASADAs participen en el manejo regional del agua- en realidad su acción está limitada al trabajo con asociaciones de desarrollo para buscar fondos y apoyo. A pesar de evidenciarse la necesidad de la incluir alas ASADAs y al sector privado en la elaboración del Plan de Manejo 2004, no se desarrollaron estrategias para lograr esto. Sin embargo, las organizaciones de base han ampliado el manejo para cubrir más intereses y perspectivas- aunque esto no está documentado. **
c	Establecer alianzas colaborativas para el manejo de agua	Abastecimiento Distribución	La conectividad facilita la colaboración del sector ambiental, ampliamente motivado por la reforestación (i.e.: los proyectos de Corredor Biológico y Bosque Modelo). Sin embargo, la homogeneidad de sub-grupos y sectores interesados puede dificultar la inclusión de nuevas perspectivas, lo cual es crítico para desarrollar conocimiento necesario para tiempos de cambio. **
5. Equidad inter e intrageneracional			
a	Asegurar que todos los	Abastecimien	Todos los residentes tienen acceso a agua potable para tomar. ***

	residentes tienen acceso a agua potable para alimentación y para propósitos de saneamiento	to	
b	Definir e implementar un nivel suficiente de agua más allá de las necesidades básicas	Uso	Los actores centrales de toma de decisiones están en una posición para ser capaces de definir las necesidades de agua más allá de aquellas que son básicas. Sin embargo, datos mal organizados de cuánta agua va adónde y para qué objetivo y la corrupción reciente del gobierno para asignar permisos de desarrollo en la costa Pacífica (es decir, el caso de Papagayo) podría erosionar la legitimidad necesaria para una implementación eficaz. *
c	Asegurar una distribución justa de costos y beneficios con las partes interesadas	Transversal	Hojancha cobra tarifas de uso de agua ligeramente superiores para ayudar a cubrir los costos de transporte de agua. El acceso a agua potable es un derecho humano explícito en la ley costarricense, por lo que en teoría los costos no deberían sobrecargar a algunos grupos sobre otros. Sin embargo, las actuales leyes y regulaciones sobre salidas de agua permiten que algunas comunidades compartan costos desproporcionadamente en relación a su contaminación agrícola. **
d	Facilitar la participación entre diversas partes interesadas (dentro de la región)	Transversal	Las organizaciones de base han surgido en los últimos años facilitando la colaboración grupos y comunidades. Aprovechar estas organizaciones para fomentar el progreso hacia la sostenibilidad es vital, ya que la participación rural en procesos de manejo se encuentra limitada en otros espacios. **
e	Incluir la representación de futuras generaciones	Uso	Un gran número de importantes organizaciones de base relacionadas a medio ambiente (financiadas por donantes internacionales en gran medida preocupados con la supervivencia de los bosques secos),en un área relativamente pequeña, que están bien integradas en el sector público en general velan porque las generaciones futuras tengan voz en los procesos de manejo. ***
6. Interconectividad de escala local a global			

a	Reducir o eliminar impactos negativos sobre otras regiones	Abastecimiento Salidas de agua	Fuera de las fuertes lluvias que durante la época lluviosa llenan los ríos que van hacia el océano, haciendo del nado una actividad poco salubre para turistas, las comunidades de las cuencas media y baja usualmente no observan impactos negativos. ***
b	Planear el manejo de los recursos dentro de los límites del acuífero o cuenca hidrográfica	Abastecimiento	Aunque la independencia de agua sigue siendo una prioridad en Hojancha, hay un vacío de liderazgo para direccionar esfuerzos de sostenibilidad en este sector , tomar decisiones y crear estrategias de implementación **
c	Reconocer y coordinar con actores locales y otras partes interesadas a mayor escala	Salidas de agua Abastecimiento	La integración del manejo de aguas costeras y de la cuenca baja es inexistente. Existe un vacío de roles de manejo que permitan la conexión con otras regiones. Las comunidades costeras dependen de grandes acuíferos costeros que están sujetos a aumentos de salinización, demanda por parte de la población y un futuro aumento del nivel del mar. En el futuro será más eficiente el transporte de agua del interior que llevar a cabo procesos de desalinización, lo que hace de éste un sector crítico para la sostenibilidad. *
7. Precaución (mitigación) y adaptabilidad			
a	Anticipar potencial escasez de agua y problemas de calidad	Abastecimiento	El manejo del agua es un proceso de mucha conexión e intercambio de información entre los actores. En este caso, la información sobre el sector forestal es la más prominente. El vacío de información de otros sectores (tales como abastecimiento de agua y demanda) limita la capacidad para anticipar y prepararse para futuros escenarios. **
b	Mitigar potencial escasez de agua y problemas de calidad	Transversal Uso	Los planes de manejo de agua elaborados por actores locales están diseñados para ayudar a mitigar la escasez de agua, pero no son vinculantes y no están conectados directamente con grandes marcos reguladores de agua. Los planes de manejo de agua no se utilizan para organizar nueva información sobre los sistemas de agua a medida que ésta es producida. *
c	Adaptarse a la escasez de agua y problemas de calidad	Transversal	Alta densidad y cohesión en el suministro de agua permiten movilizar recursos y responder efectivamente al cambio en en contextos de reforestación. ***

Table 3.2 Percepción de desafíos en el manejo y su ubicación en el sistema de agua por parte de los actores.

Cuáles son los mayores desafíos percibidos para el manejo de agua y dónde ocurren?			
Desafíos		% Mencionado (n=96)	Dónde?
A	Contaminación, calidad de agua, monitoreo y aplicación	38	Salidas de agua
B	Demanda, crecimiento y deforestación sin regulaciones	34	Uso (Ecosistema, Agricultura)
C	Cambio climático	9	Abastecimiento (Acuífero Potrero-Caimital)
D	Falta de educación y conciencia	9	Uso
E	Escasez y sequía	6	Abastecimiento
F	Insuficiente protección de acuíferos	5	Abastecimiento
-	Inequidades de distribución	1	Distribución (no incluido en el mapa abajo)

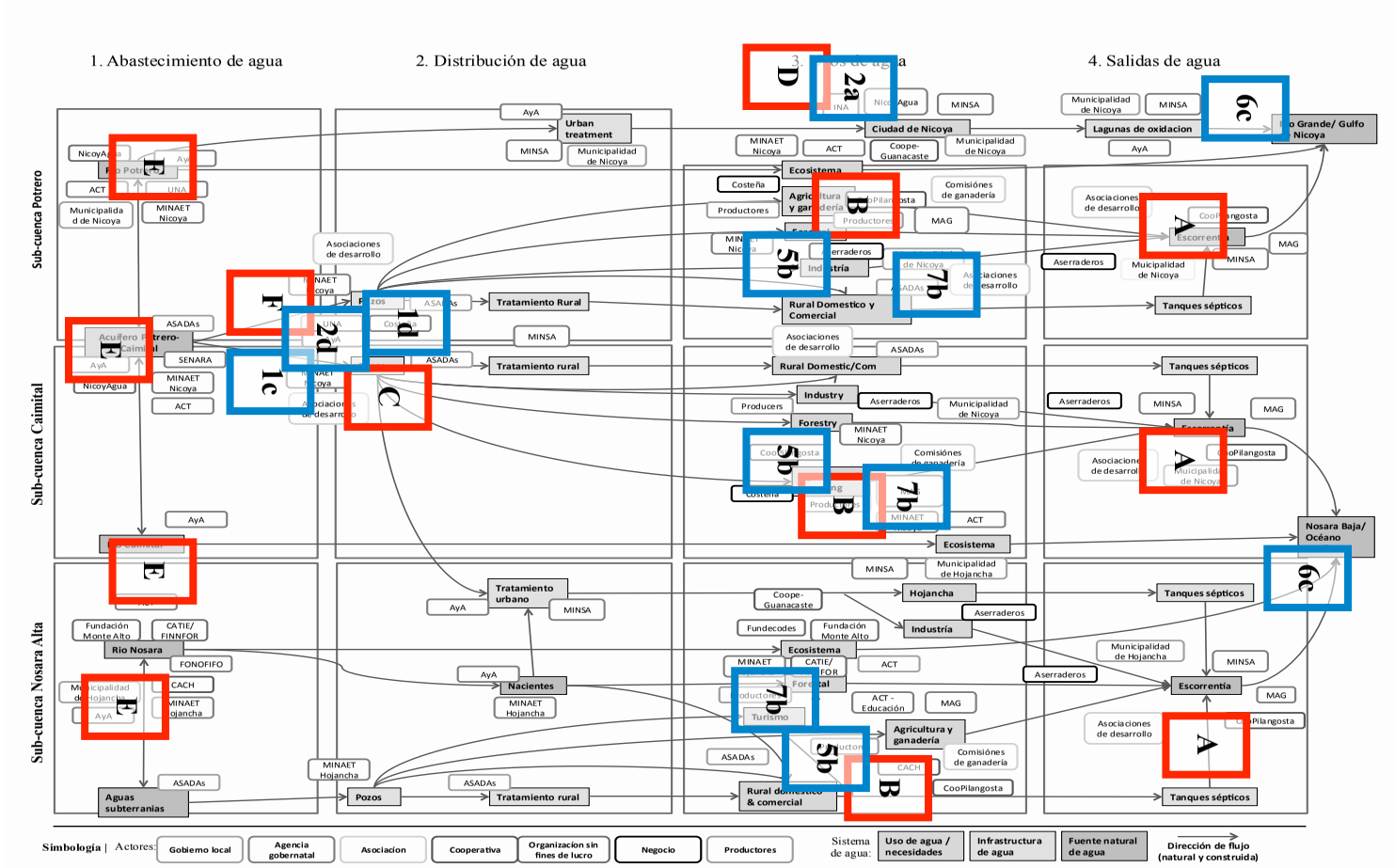


Figura 3.1: Desafíos críticos para la sostenibilidad. Los cuadros azules indican desafíos de la evaluación de sostenibilidad. Los cuadros rojos indican dónde ocurren los mayores desafíos percibidos

Table 3.3 Agrupaciones de desafíos para la sostenibilidad en el sistema de agua**.**

Agrupación de desafíos	Evaluación de desafíos	Percepciones de actores	Implicados
Acuífero Potrero-Caimital	1c, 2d, 1d , 7b	E,F,C	MINAET, AyA, ASADAs, SENARA, ACT, Dasociaciones de desarrollo, Costeña, NicoyAgua
Instituciones reguladoras, marcos de manejo de agua	5b, 7b,	B, A	MINAET, AyA, Municipalidades, ASADAs, MAG, Ministerio de Salud, asociaciones de productores, empresas privadas (Costeña, CoopePilangosta)
Educación de uso de agua/ establecimiento de objetivos	2a	D	UNA, MINAET, ACT-Educación, MAG, INA, NGOs, NicoyAgua
Integración de la cenca media y baja	6c	A	Comunidades costeras, actores a nivel nacional, usuarios del acuífero Potrero-Caimital

Acuífero Potrero-Caimital

La ley obliga a los organismos nacionales a coordinar, pero ésto ocurre de manera indefinida a nivel de cuencas hidrográficas. Esto constituye un reto para los esfuerzos que pretenden crear un cuerpo de conocimiento accesible y coherente sobre las cantidades de agua que se almacena, mueve y usa en el sistema. Sin este conocimiento base, autoridades y actores ven obstaculizado el desarrollo de planes de manejo adecuados. En la práctica, los esfuerzos del gobierno local no están estructurados según o sujetos a un modelo de manejo singular. Aunque esto proporciona oportunidades para las iniciativas innovadoras de manejo local, aún no se ha desarrollado un acuerdo de manejo vinculante para todas las partes. En consecuencia, no se está produciendo la acumulación sistemática del conocimiento de sistemas físicos de agua y nuevas estrategias para un manejo adecuado. Esto es especialmente crítico sobre el acuífero de Potrero-Caimital. Todo el conocimiento existente sobre este acuífero está basado en una encuesta privada que se realizó sobre las aguas subterráneas en el 2003.

La participación de ASADAs y la conexión con procesos de manejo más amplios fuera de las respectivas comunidades son muy limitadas. ASADAs y asociaciones de desarrollo históricamente han jugado un papel fundamental, actuando como centros de acción colectiva rural y manifestándose cuando se perciben amenazas sobre los suministros. Una mejor incorporación de las ASADAs en el manejo permitirá ampliar las capacidades para la mitigación de conflictos.

Integración de la Cuenca Media y Baja

Los esfuerzos de mitigación se verán impulsados al integrar en los procesos de manejo a las comunidades de la cuenca media y baja. Eventualmente el transporte del agua hacia esta zona sera más rentable que resolver los problemas de salinización de la costa. Existe una posibilidad razonable de que en un futuro cercano las comunidades costeras busquen abastecerse con agua del interior. Si lo hacen, el acuífero de Potrero-Caimital sería una fuente atractiva.

Instituciones reguladoras / Marcos de manejo de agua

En el área de estudio, los actores centrales son organismos del Gobierno nacional, con la excepción de NicoyAgua. Los marcos institucionales y jurídicos que determinan cómo estos actores manejan el agua son muy vagos. Asimismo, las reglas permiten un traslape excesivo y la repetición de las responsabilidades de agencias gubernamentales. Como resultado, muchos actores gastan recursos haciendo cosas similares, tales como la reforestación. Sin embargo, cuando el agua sale del sistema, los actores carecen de recursos operativos para supervisar, monitorear y controlar la contaminación y la escorrentía en arroyos y ríos.

En estas subcuencas de Guanacaste, el Plan de Manejo local está dirigido esencialmente a crear redes de actores, una tarea crítica, teniendo en cuenta los vacíos y traslapes en el sistema. NicoyAgua es el mejor vínculo en el régimen de comunidades ASADA. El aprovechamiento de esta organización constituye un inicio prometedor para la integración y la coordinación necesaria para el manejo del agua a pesar de fallas institucionales a nivel nacional.

Establecimiento participativo de un norte común/ Educación de uso de agua

Los resultados muestran una ausencia de coordinación directa entre el sector educación (muy vagamente definido), el departamento de educación del ACT, la educación y asistencia técnica del MAG y otros esfuerzos de educación del uso del agua. Ningún actor tiene un papel de liderazgo para guiar los esfuerzos de educación pública hacia una dirección o conectando actores y sus respectivas actividades. Es necesario que el liderazgo provenga de las organizaciones comunales locales. Sin una visión clara para la administración de agua regional acordada por las diversas partes interesadas, es difícil coordinar todos las diversos y pertinentes programas de educación pública.

MINAET es el actor principal en el sector del medio ambiente y controla los flujos y dispersión de información en el sistema de manejo. AyA coopera con MINAET en proyectos de reforestación periódicamente, pero mantiene una posición independiente y

está más enfocado en las entregas de agua y proyectos de infraestructura. Fuera de la reforestación y la protección de cuencas hidrográficas, casi todas las actividades conexas al manejo se relacionan con la supervisión de calidad de agua por parte del Ministerio de salud, mientras que las ASADAs y asociaciones de desarrollo rural permanecen en la periferia. Además de conectar a las ASADAs con actores dentro de MINAET, las organizaciones no gubernamentales como NicoyAgua también son un vínculo entre AyA y MINAET. Permitir una mejor coordinación entre estos dos actores centrales a nivel de cuenca, podría ser un objetivo potencial de NicoyAgua con el fin de solventar los desafíos de la sostenibilidad.

4. Estrategias de Manejo Potenciales

El equipo de investigación considera las siguientes estrategias como posibles opciones estratégicas que aumentarían el cumplimiento de los principios de sostenibilidad. Los próximos pasos de la investigación (estudios 2 y 3) incluirán estrategias de desarrollo y evauación más detalladas- en conjunto con los actores locales y tomadores de decisiones. Las estrategias presentadas a continuación son una revisión de potenciales opciones que han surgido a partir de esta evaluación de sostenibilidad. Existen muchas más que deben descubrirse, aplicarse y evaluarse.

Abastecimiento y distribución de agua

Estrategia 1: Implementar procesos que tengan el objetivo de establecer un comité local que supervise el agua subterránea, contando con autoridad legal, con miembros de comunidades y corporaciones que compartan el acuífero Potrero-Caimital. Un sistema de reporte de extracciones de agua, conducido a partir de una alianza con la Universidad Nacional de Costa Rica, podría permitir la acumulación de conocimiento sobre cuánta agua para abastecimiento hay en el acuífero

Estrategia 2: Desarrollar un plan a largo plazo que incluya a las ASADAs de Nicoya y Hojancha en los procesos de toma de decisiones. En un plazo de 10 años, este plan podría ser la base para establecer programas de construcción de capacidades, los cuales serían llevados a cabo en conjunto con las ASADAs de la región. Actualmente, NicoyAgua\la Comisión se encuentra en la mejor posición para coordinar con las comunidades ASADA.

Uso de Agua

Estrategia 3: Esfuerzos regulares de visualización con organizaciones y comunidades locales incrementarán la oportunidad de tener usos deseados para el agua en la región.

Esfuerzos de visualización colaborativos e inclusivos serán de utilidad para la priorización y la toma de decisiones.

Salidas de agua

Estrategia 4. La integración de las comunidades de las cuencas media y baja- especialmente aquellas en la costa Pacífica- en los procesos de manejo locales permitirá mitigar potenciales disputas a medida que los acuíferos costeros experimentan salinización.

Transversal

Estrategia 5. Aprovechar organizaciones de base como NicoyAgua es un inicio para la integración y coordinación del manejo de agua en la región. Asimismo, los esfuerzos para consolidar corredores biológicos podrían constituir una plataforma para el manejo. NicoyAgua actúa como un Puente entre AyA y MINAET. Facilitar la coordinación entre estos dos actores centrales a escala regional (Nicoya y Hojancha) podría ser un objetivo clave para organizaciones de base. Con un apropiado planeamiento estratégico la colaboración que NicoyAgua está en posición de liderar podría ser un modelo para otras organizaciones de base en Guanacaste.

Agradecimientos

Los autores agradecen a 54 personas que colaboraron con su tiempo y esfuerzo en entrevistas y grupos de trabajo. Especialmente agradecemos a Heiner Rosales y Gabriela Morera por su apoyo durante las entrevistas, Ariel Amoroso, Gabriela Barrantes, Jorge Vásquez, Xinia Campos, David Morales Hidalgo, Adriana Baltodano, Grendis Lozano y Michael Bauman por sus comentarios y apoyo. Este trabajo fue posible gracias al apoyo económico de la Organización para Estudios Tropicales a través del programa *International Research Experience for Graduate Student's Fellowship.*

Los resultados presentados en este reporte son responsabilidad de los autores y no representan la posición de la Comision u organizaciones mencionadas. Más detalles técnicos e información en relación al enfoque, los principios de sostenibilidad, y los métodos pueden encontrarse en Wiek A, Larson KL (under review) Water systems, people, and sustainability – a framework for analyzing and assessing water governance regimes: Forthcoming in *Water Resources Management.* Los principios para reproducir y adaptar el contenido de este artículo para el presente reporte han sido obtenidos de los autores originales.

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APPENDIX D

2013 PROJECT EXECUTIVE SUMMARY AND REPORT FOR STAKEHOLDERS (SPANISH)

NOTE: DESIGNS AND LAYOUT IN THE FOLLOWING REPORT WERE ALTERED FROM THE ORIGINAL IN ORDER TO FIT DISSERTATION FORMAT REQUIREMENTS. SOME IMAGES FROM THE OIGINAL REPORTS HAVE BEEN ALTERED OR REMOVED IN ORDER TO REDUCE DOMEUNT SIZE.

La Gobernanza Sostenible de Agua en Guanacaste: Los Escenarios Futuros y las Estrategias

Nicoya, Guanacaste, Costa Rica
Octubre 2013

Preparado para:
La Comisión para el Manejo de las Sub-Cuencas Potrero-Caimital y las ASADAs Guanacastecas

Informe de Proyecto:
Hacia el Manejo Sostenible de los Recursos Hídricos en Guanacaste, Costa Rica

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ASU SCHOOL of SUSTAINABILITY
ARIZONA STATE UNIVERSITY

Comisión para el manejo de las Cuencas Potrero-Caimital
"una gota de agua, pero constante, hace diferente a la piedra"

Índice General

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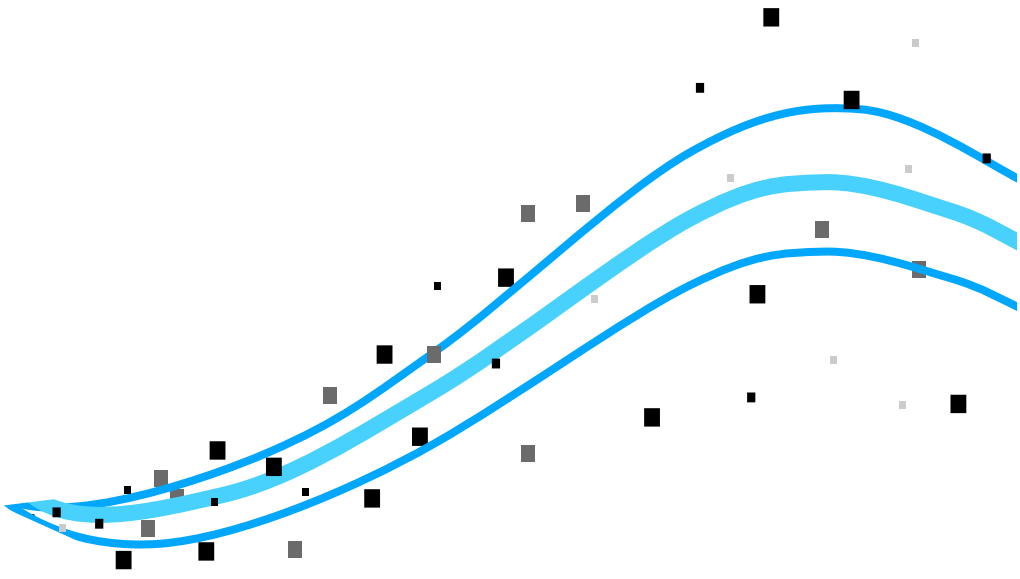

El contexto y antecedentes del estudio

El estudio abordado en este documento forma parte del proyecto titulado: "Hacia el Manejo Sostenible de los Recursos Hídricos en Guanacaste, Costa Rica." El proyecto se inició en el año 2010 a través de un esfuerzo conjunto entre el Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), en Turrialba, Costa Rica y la Facultad de Sostenibilidad de la Universidad Estatal de Arizona. En 2012 el equipo del trabajo creció para incluir a la Comisión para el Manejo de las Cuencas Potrero-Caimital en Nicoya y la Universidad Nacional de Costa Rica en Nicoya.

En 2013, este equipo realizó el primer taller colaborativo para la gobernanza sostenible de agua en Guanacaste. 46 participantes de 18 comunidades de Guanacaste participaron en el primer taller colaborativo de agua en la región. Los participantes incluyeron once administradores de acueductos rurales (ASADAS), seis organismos públicos, gobiernos regionales, el sector turismo, el sector agricultura, grupos comunitarios y grupos ecologistas. Las posiciones que los participantes sostuvieron en el sector público incluyeron desde directores de agencias hasta administradores del agua (a tiempo parcial) en sus comunidades con menos de 1.000 personas. Los participantes trabajaron juntos durante más de siete horas para construir cinco escenarios de futuro de la gobernanza del agua, evaluar la sostenibilidad de cada uno, determinar las prioridades de gobernanza del agua con el fin de determinar si un escenario es sostenible o no, y desarrollar estrategias para lograr los resultados deseados. Después del taller, el equipo de investigación comenzó a trabajar explorando diferentes estrategias para la efectiva y sostenible gobernanza de agua en la región. Este informe incluye los resultados y las conclusiones de este taller y el trabajo que ha seguido el taller.

Estamos muy agradecidos por su participación en este trabajo y esperamos que usted encuentre los contenidos de este informe útiles. Por favor, póngase en contacto con nosotros si tiene alguna pregunta.

Sinceramente,

Christopher Kuzdas Mariel Yglesias

Fotos arriba: Alrededor de Guanacaste. Hacia la derecha a partir de la parte superior izquierda: (1) Estación seca cerca del Parque Nacional Palo Verde; (2) la estación lluviosa en el Parque Nacional Palo Verde; (3) campos irrigados de arroz en el Distrito de Riego Arenal-Temipisque; (4) Guanacaste es reconocida por sus hermosas playas; (5) invernadero gestionado por estudiantes de secundaria – las comunidades Guanacastecas son conocidas por ser activas en su protección al medio ambiente.

Resumen Ejecutivo

La gobernanza sostenible de agua involucra a todas las partes interesadas en la coordinación del abastecimiento, la distribución, el uso, y la salida de agua de una manera tal que garantice un nivel suficiente y equitativo de bienestar socioeconómico, sin comprometer la integridad de los ecosistemas a través del tiempo. Los esfuerzos para lograr una gobernanza sostenible del agua en Guanacaste, Costa Rica, se enfrentan a obstáculos significativos. Estos obstáculos incluyen impactos esperados del cambio climático en un futuro próximo; posiblemente menos precipitación y, potencialmente, disputas perturbadoras de agua. Afrontar con éxito los impactos climáticos y lograr una mitigación de las disputas de agua depende de qué tan bien - o qué tan sostenible - los recursos hídricos están siendo gobernados.

El taller fue un esfuerzo para apoyar los procesos de la gobernanza sostenible de agua en Guanacaste. Este taller fue un ejercicio en el proceso de planificación participativa que se llama 'Planificación Transformativa (Wiek y Lang 2011).' La idea de este proceso es identificar los futuros o escenarios diferentes, para seleccionar los futuros más sostenibles o los objetivos, y elaborar estrategias para lograr los futuros más optimistas y para evitar los futuros menos optimistas. Ocho conclusiones importantes del taller y del trabajo de investigación reciente se presentan abajo:

1. Los participantes (y las partes interesadas en general) favorecen abrumadoramente los escenarios futuros de la gobernanza *policéntrica* del agua en Guanacaste. La gobernanza policéntrica es un tipo de gobernanza que está bien coordinado entre las organizaciones relevantes que trabajan a escala local, regional y nacional. Sin embargo, la gobernanza actual del agua en Guanacaste es *fragmentada* - lo que significa que hay mucho margen para mejorar en cuanto a la coordinación, la cooperación, y la comunicación. Específicamente, hay una necesidad de fuertes líderes regionales y las organizaciones regionales capaces y motivadas en la provincia. La Comisión Potrero-Caimital, que ahora se está expandiendo para incluir el Rio Quirimán, puede ser un modelo de liderazgo regional en Guanacaste. Las ASADAs en la Mala Noche también podrían considerar algún tipo de comisión regional, así que también podrían ser un modelo en la provincia.

2. Las partes coincidieron en cuanto a algunos de los fines que deberían tener la sostenibilidad y la gobernanza de agua (como la gobernanza bien coordinada y la apertura de tomar de decisiones). También, hubo acuerdo sobre las situaciones que la gobernabilidad de agua en Guanacaste debe evitar - como esos futuros retratados en el Escenario 5 y el Escenario 2 (descripciones de escenarios se encuentran en la

Sección 2 de este informe). El estado actual de la gobernanza de agua se percibe como mediocre en términos de preferencia (en comparación con la gobernabilidad del agua en los escenarios) cuando se evaluó utilizando los mismos parámetros que los participantes utilizan para evaluar los escenarios. Esto indica que hay una necesidad de implementar estrategias y procesos concretos para mover el estado actual de la gobernanza de agua hacía condiciones más deseables y sostenibles y evitar activamente las características negativas que se encuentran en algunos de los escenarios. Ahora es la oportunidad de tomar acción.

3. Hay una necesidad de una visión clara por la gobernanza de agua en Guanacaste que se comparta entre ASADAs, gobiernos regionales, las agencias nacionales y las comunidades - ¿Cómo se ve el desarrollo en el futuro? ¿Para que debería ser utilizada el agua o cuáles son las prioridades? La evaluación de los escenarios en el taller fue un inicio, pero se necesitan procesos continuos para especificar metas y los fines para la gobernanza de agua en la región - y para monitorear cómo se están realizando progresos hacia esos fines sobre el tiempo y para informar sobre los progresos en una manera abierta.

4. Muchos de los recursos que se necesitan para inicialmente implementar estrategias ya están disponibles en las comunidades y las organizaciones en Guanacaste. Tomará un poco de la creatividad, formar nuevas alianzas y utilizar las conexiones de diferentes organizaciones y de diferentes sectores para obtener estos recursos, si no es que están disponibles. En el largo plazo, más recursos técnicos, financieros, y humanos se necesitarán, pero con el aumento de la coordinación y colaboración entre las organizaciones locales y regionales en la gobernanza de agua Guanacaste, los administradores locales podrían estar en posición de asegurar estos recursos de los organismos nacionales en San José en el futuro próximo.

5. Había un fuerte consenso entre los participantes en el taller sobre la falta de un fuerte liderazgo regional y la falta de organización de los recursos a nivel regional. Una mejor coordinación y organización de la gobernanza de agua a un nivel regional será un esfuerzo importante y valioso para la buena gobernanza de agua en el futuro. Será importante que cualquier nueva institución regional tenga la autoridad para aplicar y hacer cumplir las leyes y reglamentos. ¿Cómo construir esa institución? Esta pregunta puede ser el objeto de futuras deliberaciones en los procesos de la gobernanza de agua en Guanacaste.

6. Hubo consenso que en cuanto a la falta de conexión entre la gobernanza de agua en Guanacaste y la gobernanza de agua a una escala nacional - y que esta falta de conexión hace que la implementación de una buena gobernanza de agua en

Guanacaste sea un desafío. Las estrategias clave en el futuro tendrán que afrontar cómo Guanacaste puede tener un mejor acceso y ser involucrado con la toma de decisiones sobre los recursos hídricos a nivel nacional (incluyendo las decisiones sobre la distribución de los recursos financieros, equipo, y los recursos humanos). Estas estrategias y los esfuerzos deberán ir más allá de la retórica política e ir hacia el diálogo constructivo y procesos entre los líderes nacionales y los líderes Guanacastecos.

7. Las estrategias deben ser monitoreada y probadas si van a tener éxito. Las reuniones y los eventos regulares (por ejemplo, un taller anual) ofrecen a los participantes la oportunidad de informar y reportar sobre cómo está sucediendo la implementación de las estrategias, lo que ha funcionado, lo que no ha funcionado, etc. La implementación de las estrategias, la evaluación de las estrategias, y el cambio de estrategias para satisfacer las condiciones cambiantes será un proceso importante que ayudará a la gobernanza de agua en Guanacaste a avanzar en el tiempo.

8. Debería haber más eventos regulares donde los ciudadanos que trabajan en el sector del agua pueden reunirse y compartir experiencias. Estos tipos de eventos, como talleres bien organizados, son valiosos y promueven el aprendizaje compartido a través de fronteras políticas y geográficas. Se necesita liderazgo para organizar estos eventos.

Foto arriba: Miembros del sector agua de Guanacaste participan en las actividades del taller

1. Introducción

La gobernanza efectiva y sostenible de agua es una prioridad para Costa Rica, y la necesidad se hace aún más aparente en la zona del trópico seco de la provincia de Guanacaste. Al menos 65 conflictos de agua (definidos por medio de acciones legales tomadas por una o más partes involucradas) entre 1997 y 2006 fueron documentados en Guanacaste (Ramírez 2008) — un conflicto por agua cada 56 días.

Un marco institucional y normativo que no ha cambiado significativamente en más de medio siglo determina en gran medida la gestión del agua en Costa Rica. La columna vertebral legal de la gestión de los recursos hídricos, la Ley de Aguas, se ha mantenido prácticamente sin cambios desde 1942. Esta Ley define el agua como un bien público y la Constitución protege los derechos de los ciudadanos a un medio ambiente sano y limpio. Sin embargo, las portillos legales (por ejemplo, el agua no se define como un derecho humano, a pesar de ser un bien público), la proliferación de organismos públicos, la confusión sobre las responsabilidades de las agencias, y sus roles mal definidos han creado un sistema fragmentado de gobernanza del agua. (Ballestero et al. 2007). El sistema es propenso a la corrupción, no responde a los ciudadanos y tiene una desconexión con los administradores de recursos hídricos a nivel de cuenca y comunidad. Estos problemas se combinan para hacer que el sistema actual de gobernanza del agua esté pobremente equipado para manejar los desafíos urgentes y de múltiples facetas del siglo 21 (Calvo 1990; Kuzdas 2012). A pesar de los reiterados intentos de reforma en los últimos años, cada uno de ellos se ha estancado en la Asamblea Legislativa, quien toma las decisiones finales sobre los proyectos de reforma (Arias 2011).

Los esfuerzos para ayudar a crear un nuevo modelo de gobernanza del agua en Guanacaste están en marcha. A lo largo de este documento, presentamos los avances y perspectivas de uno de estos esfuerzos - un proyecto titulado: Hacia la gestión sostenible de los recursos hídricos en Guanacaste, Costa Rica. Este proyecto es administrado entre una colaboración con la Comisión para el Manejo de las Cuencas Potrero-Caimital y el Centro Agronómico Tropical de Investigación y Enseñanza se centra en la investigación de una gestión del agua que integre los ciudadanos y tomadores de decisiones y en la promoción de los resultados y el material para los administradores del agua, ciudadanos, científicos y legisladores del proyecto. Un esfuerzo importante del proyecto fue organizar y dirigir el primer taller colaborativo para ayudar a informar acciones con miras a la gobernabilidad sostenible del agua en Guanacaste.

El 14 de Marzo, 2013, 46 participantes de 18 comunidades de Guanacaste participaron en el primer taller colaborativo de agua en la región. Los participantes incluyeron once administradores de acueductos rurales (ASADAS), seis organismos públicos, gobiernos regionales, el sector turismo, el sector agricultura, grupos comunitarios y grupos ecologistas. Las posiciones que los participantes sostuvieron en el sector público incluyeron desde directores de agencias hasta administradores del agua (a tiempo parcial) en sus comunidades con menos de 1.000 personas. Los participantes trabajaron juntos durante más de siete horas para construir cinco escenarios de futuro de la gobernanza del agua, evaluar la sostenibilidad de cada uno determinar las prioridades de gobernanza del agua con el fin de determinar si un escenario es sostenible o no, y desarrollar estrategias para lograr los resultados deseados.

Foto Arriba: Miembros de varias ASADAs discuten uno de los escenarios de gobernanza en el taller

2. Los escenarios

Los participantes colocaron notas adhesivas sobre pizarras blancas junto a cada póster de los escenarios para responder a las preguntas: ¿Qué falta en este escenario, e.g., otras historias, ideas, aspectos, etc.? Y, qué hace este escenario más tangible? Los participantes también utilizaron las notas adhesivas para comentar, criticar y añadir información a las partes diferentes de los pósteres de los escenarios - descripciones de escenarios, las páginas de los periódicos, y las historias "el día en la vida de..." Los escenarios que fueron presentados en el taller se desarrollaron a lo largo de un año, y se basan en un extenso análisis de la gobernanza de agua en Guanacaste (Kuzdas et al. 2012) y sigue una método se llama la *construcción formalizada de escenarios* (Wiek et al. 2009; Wiek y Walter 2009). Los escenarios fueron construidos inicialmente en colaboración con la Comisión para las Cuencas Potrero-Caimital y otras partes interesadas de la región antes de ser presentados en el taller. Para más detalles sobre cómo inicialmente se construyeron los escenarios (o si querría recibir los originales posters de los escenarios) por favor mande un correo electrónico a: ckuzdas@asu.edu y mariel_yglesias@yahoo.es.

El objetivo de esta primera actividad en el taller era desafiar a los participantes para considerar y pensar lo que el futuro de la gobernanza de agua en Guanacaste puede ser y

cómo los tipos diferentes de gobernanza pueden resultar en futuros diferentes en la región. Esta actividad sentó las bases para la identificación de objetivos para la gobernanza de agua en la región. Los escenarios se presentan a continuación.

*** Los siguientes escenarios son descripciones de estados futuros alternativos en el año 2037 - no son predicciones. En su conjunto los escenarios ofrecen una serie de opciones distintas de lo que el futuro pueda ser. El objetivo de estos escenarios es apoyar los procesos de planificación para la gobernanza de agua sostenible en Guanacaste e identificar - e iniciar las deliberaciones sobre - lo que la gente en Guanacaste quiere en el futuro y lo que la gente en Guanacaste no quiere que en el futuro ***

Escenario #1: Mandato para prepararse para la escasez de agua *– año 2037*
Tema de Escenario #1: Cautela
Gobernanza centralizada de agua y mitigación de arriba abajo

> "*Este (Escenario 1) no es un scenario deseable- ya hay suficiente burocracia en la gobernanza nacional de agua* – Comentario de un participante del taller

Contexto Guanacasteco (Escenario 1): En los últimos 20 años, el gobierno ha enfatizado una diversificación económica muy controlada. Además se ha dado una agilización de la gestión de los recursos públicos como una estrategia para mitigar la escasez de agua prevista. Las organizaciones regionales y locales en el sector del agua, tales como las comisiones de cuencas y las ASADAs, se han unido en un esfuerzo para reducir la duplicación de responsabilidades y aumentar la eficiencia y control de gestión . Ahora el gobierno centra sus inversiones y estímulos económicos en fincas pequeñas y medianas, lo que ha provocado que muchas fincas grandes multinacionales salgan. Esta tendencia ha disminuido las hectáreas de riego totales en la región, y permitió que la calidad del agua se mantenga alta. Las decisiones de agua a veces involucran a los sectores fuera del gobierno. A veces hay participación de los ciudadanos y de los grupos comunitarios, y las decisiones a veces implican sectores fuera del gobierno. A pesar de la presencia dominante del sector público en todos los aspectos de los recursos naturales (incluso en la vida), hay un sentir que el sector público está trabajando por el bien colectivo. No hay escasez de agua suficiente para probar los mecanismos de resolución de disputas de agua, pero la mayoría de la gente ya no considera la mitigación de conflictos del agua una prioridad. La reforma del agua sigue

> "Es difícil pensar cómo un gobierno tan centralizado *(como el Escenario 1) podría beneficiar comunidades locales*" – Comentario de un participante del taller

siendo un tópico de discusión, sin embargo la modificación de las políticas de agua puede ser un proceso lento si se inicia por los grupos fuera del sector público.

La gobernanza de agua en Nicoya (Escenario 1) : Las ASADAs en la zona se han unificado bajo la estrecha supervisión de la oficina regional de AyA, que está dirigida por la Oficina del Valle Central de AyA. Todas las actividades locales de manejo del agua deben ser aprobadas por la oficina regional, quien debe obtener la aprobación de la oficina nacional si la actividad propuesta no está incluida en el ámbito legal de trabajo. La acción de trabajo dice - en detalle muy exacto - las pocas decisiones que los administradores locales y regionales de recursos naturales pueden tomar con autonomía. Los administradores del agua están entrenados , comenzando después de la escuela, en un programa especializado en San José. Los administradores de agua son capacitados, comenzando después de la escuela secundaria, en un programa especializado en San José. Después del programa, se asignan posiciones en el país en base de las necesidades de la agencia. La agricultura local se está yendo bien._Muchas turistas todavía pasan por la zona. Ha cambiado poco el uso de la tierra alrededor de Nicoya. La competencia por el agua ha permanecido mayormente baja. Sin embargo, algunos miembros de la comunidad son escépticos en cuanto a la capacidad y la voluntad del siempre-presente sector público para mantener la paz si la escasez de agua se convierte de nuevo en un problema. El sector público parece estar haciendo esfuerzos para asegurar que Nicoyanos tengan sus necesidades satisfechas.

Escenario #2: Acuerdos a puerta cerrada *– año 2037*
Tema de Escenario #2: Engaño
Manejo de agua sin rendición de cuentas por parte de alianzas de intereses

> "*Este escenario (Escenario 2) ya parece real – es algo para evitar*" – Comentario de un participante del taller

Contexto Guanacaste (Escenario 2) : Los primeros 50 años del estado moderno costarricense se caracterizaron por la democracia abierta, apoyo social fuerte, y alta confianza en el gobierno. Sin embargo, los próximos 50 años son más conocidos por acuerdos secretos entre las alianzas de gobierno, inversionistas y desarrolladores y una completa desconexión entre el liderazgo nacional, la política y las agencias con las comunidades locales, gobiernos locales, y gerentes regionales de recursos. El mercado inmobiliario en Guanacaste está floreciendo' y el turismo residencial es un gran parte de la producción económica en la región. La agricultura ya no es de gran importancia política en la región. Una buena parte de la tierra de riego está vacante y se está convirtiendo de nuevo en bosques secos y sabanas, lo que en realidad aumenta el atractivo de la región para los desarrolladores inmobiliarios y los

inversionistas. Las protestas sobre la distribución de agua son comunes en las comunidades de Guanacaste. La zona costera está atravesada por tuberías que transportan agua a varios desarrollos. Cuando una fuente de agua se va, más tubos se construyen, a menudo bajo el manto de la oscuridad para evitar ser detectados por las comunidades preocupadas

> *"Ya no puede haber más acuerdos secretos sobre la distribución y alocación de agua en Guanacaste "* – Comentario de un participante del taller

La gobernanza de agua en Nicoya (Escenario 2) : Los intentos de reforma de la política del agua pasan a veces, pero las nuevas iniciativas siempre son bloqueadas por los intereses más poderosos. Hace 10 años la Comisión para el Manejo de Cuencas las Potrero-Caimital era líder abogando por la reforma. Pero esos intentos de reforma fueron infructuosos. Miembros de la comunidad se han involucrado cada vez más con el apoyo a las comunidades que ilegalmente desvían el agua de los grandes proyectos de desarrollo. Con el fin de evitar la quiebra, ASADAs en la zona se han integrado con otros grupos comunitarios para aunar recursos y financiar proyectos de agua en la comunidad. Las ASADAs funcionan como "las plataformas de protesta", las que usan los ciudadanos para expresar insatisfacción de cómo se toman decisiones sobre los recursos naturales, la distribución injusta de agua, y el mal estado de la infraestructura de agua en las comunidades. El aumento de la cubierta forestal natural en el interior atrae a muchos visitantes quienes, después de observar las protestas de agua en la zona, apoyan a las comunidades locales con recursos personales, técnicos, y financieros para continuar la oposición. Los residentes están preocupados por el número creciente de los visitantes nacionales e internacionales que utilizan el área como una plataforma para promover sus propias prioridades políticas y radicales.

Escenario #3: Cómo lo logró Costa Rica?! *– año 2037*
Tema de Escenario #3: Innovación
<u>Gobernanza de agua enfatiza autonomía y coordinación</u>

> *"Este es el escenario* (Escenario 3) *por el que deberíamos estar trabajando"* – Comentarios de un participante del taller

Contexto Guanacaste (Escenario 3): Hace 20 años, uno de los más exhaustivos - e internacionalmente observados- períodos de reforma de la legislación medioambiental y de procesos de toma de decisiones ocurrió en Costa Rica. Líderes guanacastecos, como la Comisión Potrero-Caimital, se acreditan por propulsar la reforma. La autoridad para regular los recursos hídricos en el país se distribuyó gradualmente entre una red de

nuevas organizaciones regionales de manejo del agua que se llaman "Institutos Regionales para la Sostenibilidad del Agua (IRSA), a través de enmiendas constitucionales. Un sistema nuevo y eficaz de controles y equilibrios, la responsabilidad, y la coordinación entre los organismos, empresas y grupos comunitarios eliminó la corrupción y los acuerdos secretos que eran comunes en los principios del siglo. La transparencia en la toma de decisiones en el sector de agua en Guanacaste es muy conocida. Expertos de todo el mundo vienen a observar y tomar lecciones para sus países. Sin embargo, la reforma llegó con algún costo: la economía luchaba inicialmente después de la reforma, las ventas internacionales de inmobiliario cayeron y las grandes empresas agrícolas multinacionales pasaron a otros países. Capacitar a nuevos gerentes regionales de agua y ASADAs locales era costoso, por lo menos inicialmente. Pero las reformas valieron la pena. Recientemente el cambio climático ha obligado a tomar decisiones difíciles con respecto a las prioridades de desarrollo. Sin embargo tener varios centros del manejo de agua y difundir el poder de dirigir recursos a través de los grupos locales y regionales, ha dado lugar a decisiones que se toman en forma conjunta en todos los sectores y de una manera abierta. La agricultura y el desarrollo responsable del turismo siguen ocurriendo. Los Guanacastecos son ciudadanos sanos, felices y valorados ya que tienen poder real para manejar sus recursos.

> *"La reconciliación y recuperación de la confianza entre comunidades y agencias será importante para que este escenario ocurra"* – Comentario de un participante del taller

La gobernanza de agua en Nicoya (Escenario 3) : Después del período de la reforma del agua, la Comisión para el Manejo de las Cuencas Potrero-Caimital fue elegida para dirigir y desarrollar el Instituto Regional para la Sostenibilidad del Agua (IRSA) para Guanacaste. Aunque cada IRSA en Costa Rica es libre de administrar ASADAs locales en su región como mejor le parezca, el IRSA en Guanacaste eligió dar a las ASADAS autonomía e invertir en recursos y capacitación para ellas. Todos los ciudadanos tienen acceso a cantidades suficientes de agua limpia. Hay un alto nivel de conocimientos sobre los abastecimientos y los usos de agua en la región y las prioridades del desarrollo y el uso de agua han sido negociadas públicamente. Mientras los bosques que están en las áreas protegidas son saludables, algunas áreas alrededor de Nicoya están empezando parecerse a sabanas o bosques templados más debido a las condiciones climáticas que están cambiando. Sin embargo los ciudadanos - involucrados y empoderados - se reúnen regularmente con las agencias y la industria para discutir el futuro de la zona y sus ecosistemas. Los agricultores tienen acceso fácil a la ciencia y a mejores prácticas, los líderes locales a menudo son consultados por los políticos electos, y los representantes de desarrolladoras consultan primero con líderes locales y regionales para considerar nuevos

proyectos. Los Nicoyanos son muy saludables, felices, dispuestos a colaborar con otros, y están seguros que superarán cualquier desafío de agua o sostenibilidad que lleva el futuro.

Escenario #4: Prosperidad económica y riesgo ambiental *- 2037*
Tema de Escenario #4: Apatía
La gobernanza de agua se mantiene fuera del camino del desarrollo económico

> *"Poca educación ambiental y conciencia pueden ser la causa de que este escenario suceda"* – Comentario de un participante del taller

Contexto Guanacaste (Escenario 4) : ha estado siguiendo un modelo de competitividad económica, mercados abiertos, y el desarrollo con una velocidad vertiginosa durante más de veinte años. Los Guanacastecos son uno de los grupos más prósperos económicamente y ricos en Centroamérica. Las voces y los líderes de los movimientos ambientalistas viejos desaparecieron hace 10 años. La economía nacional disfruta alto crecimiento durante un período de tiempo sin precedentes. Acuerdos a puertas cerradas, la corrupción y la destrucción ambiental ilegal ya no son un problema como lo fueron en el cambio del siglo. Sin embargo, algunos dicen que el largo período de prosperidad económica en Guanacaste ha causado que los ciudadanos sean apáticos a los problemas del agua y del medio ambiente. Existen pocos ecosistemas en sus estados naturales en la región, pero los residentes son felices. El manejo del agua en Guanacaste principalmente funciona porque es un catalizador para el desarrollo económico. Las decisiones sobre los recursos hídricos se hacen sin la participación de los ciudadanos o las partes interesadas. Sin embargo, los administradores de agua argumentan que no hay suficiente interés de los ciudadanos para justificar la transparencia o la participación. Los administradores del agua dicen que si nadie está hablando sobre agua, significa entonces que ellos están haciendo su trabajo. Simplemente hay que mantener los grifos funcionando.

> *"¿Cómo "domesticaron" a las comunidades de este? No es un scenario deseable*" – Comentario de un participante del taller

La gobernanza de agua en Nicoya (Escenario 4) : Un sistema fue elaborado y diseñado para que las tuberías de agua y las plantas de tratamiento estén ocultos desde la vista detrás de los cerros que rodean la comunidad de Nicoya. El sistema complejo de la infraestructura de agua protege a la mayoría de los ciudadanos de las consecuencias de las pocas regulaciones y rápido crecimiento económico. Hace diez años, muchas ASADAs ya no eran capaces manejar las necesidades de la infraestructura de agua cada vez más sofisticadas en la zona de Nicoya. La sucursal de AyA en Guanacaste asumió el control de toda la

infraestructura importante de agua en la zona. Las ASADAs se enfocan en dirigir el agua a zonas menos importantes por la economía, que se encuentran en las tierras altas en la Península. Los bosques son pocos y distantes entre sí. El agua es cada vez más costosa de tratar, aunque la mayoría de los residentes tienen acceso regular al agua potable. Pocos residentes se recrean en el aire libre o están interesados en las áreas naturales. Mientras que muchos ciudadanos en los sectores de los servicios, la agricultura y profesionales son relativamente ricos, no todos se han beneficiado económicamente de la máquina económica de Guanacaste. Cómo el agua llega a Nicoya, o de dónde viene, es un misterio para los residentes. Sin embargo, para la mayoría de los residentes la vida es fácil.

Escenario #5: El regreso del latifundio *– año 2037*
Tema de Escenario #5: Desconexión
La gobernanza fragmentada de agua permite el ascenso de una élite

Contexto Guanacaste (Escenario 5): Muchas de las grandes haciendas y sus propietarios poderosos se encuentran en las tierras bajas. El estado era incapaz de cumplir con las obligaciones sociales, para mediar en conflictos por el agua, o para responder adecuadamente a las necesidades de los ciudadanos. Con un estado debilitado y un sistema electoral representativo superficial, los grandes productores agrícolas fueron capaces de aumentar considerablemente sus tenencias y recursos. Un gobierno fragmentado y los propietarios de élites muy poderosas en Guanacaste alarmaron a los inversionistas extranjeros y desarrolladores, que finalmente sacaron sus inversiones en la región. El turismo se ha reducido al mínimo. Sin competencia por el abandono del turismo, los grandes propietarios de tierra en Guanacaste pueden obtener grandes asignaciones de agua. AyA y SENARA ahora son organizaciones públicas-privadas, y muchas élites Guanacastecas tienen participación mayoritaria en ellas. La infraestructura está mal mantenida fuera del centro de las tierras bajas de Guanacaste. Algunos dicen que el clima es mucho más seco de lo normal, pero nadie ha estudiado los sistemas de agua o los ecosistemas de la región en mucho tiempo.

> "*Este escenario* (escenario 5) *debería discutir cómo la reforma de agua se discute de forma superficial en la Asamblea – como hoy. No podemos permitir que este escenario ocurra" –* Comentario de un participante del taller

> *"El latinfundio actual no es de tierra; es sobre poder. Todavpia existe disfrazado en el Capitolio*" – Comentario de uno de los participantes del taller

La gobernanza de agua en Nicoya (Escenario 5): Las tierras altas alrededor de Nicoya son un bastión de la oposición de los pequeños agricultores. ASADAs alrededor de Nicoya

están completamente fragmentadas del AyA. Las redes de distribución de agua que pertenecen a las ASADAs son un mosaico de tubos y bombas que se mantienen lo mejor que se puede. Numerosas peticiones han sido enviados a San José en un intento de llamar la atención de la desigualdad de la distribución del agua en Guanacaste. Pero el sistema del manejo de agua está demasiado fragmentado para sean tomadas acciones significativas. Muchas de las élites de tierra en Guanacaste tienen grandes inversiones en el sector público. Por lo tanto, los Nicoyanos dudan de que, incluso si las acciones o políticas nuevas se tomen, resolverían efectivamente los problemas del agua en la zona.

Los Comentarios de los Participantes sobre los Escenarios

La portada de periódico en el **escenario # 1** contó la historia de una nueva torre de la oficina central para la apertura de la gestión del agua en el Capitolio. El nuevo edificio representa el último paso en la centralización del régimen futuro de la gobernanza del agua. Las historias sub-título contaron, por ejemplo, que un gran número de guanacastecos confían en el gobierno. Los participantes en el taller general comentó que, a pesar de este escenario parecía posible, era difícil de imaginar, debido a las recientes tendencias históricas de la desconexión entre las comunidades y los organismos nacionales. Un sistema de gobierno centralizado pero benevolente resultó ser sospechoso para los participantes y debe ser evitado.

El **escenario # 2** y el **escenario # 5** representaron gran parte de la discusión entre los participantes. Ambos escenarios extienden acontecimientos históricos y actuales importantes hacia el futuro. Los titulares de los periódicos en el escenario # 2 contaban la historia de ASADAs en la región de Nicoya que organizan grandes protestas por la distribución del agua, lo que recuerda a muchos conflictos recientes, como Sardinal. En general los participantes comentaron que esta situación parecía muy real. El titular de un periódico de escenario # 5 habló de un imperio en expansión de caña de azúcar en las tierras bajas de Guanacaste y las desigualdades sociales crecientes que resultan de distribuciones de agua injustas. Los participantes comentaron que, si bien los resultados de este escenario fueron extremas, la política, la corrupción y la falta de conexión en el régimen de gobierno de hoy era una reminiscencia de la esfera política. No todos los participantes se sentían cómodos con escenario # 2, pero algunos lo encontraron identificable (basado en sus experiencias) y algunos consideraban que era retratar de cerca el estado actual de la gobernanza del agua en Guanacaste. Todos los participantes coincidieron en que tanto escenario # 2 y # 5 debían ser evitados.

El **escenario # 3** obtuvo respuestas positivas de los participantes. El título cuenta la historia de los líderes internacionales que vienen a Guanacaste para observar y tomar

lecciones de su modelo bien coordinado y de colaboración en la gobernabilidad del agua. Muchos de los participantes se mostraron interesados en la reconciliación y la construcción de confianza entre las comunidades y los organismos gubernamentales que se requieren en este escenario. Otros participantes se mostraron interesados en ver más detalles de un régimen de gobierno, tales como la definición de los procesos de toma de decisiones y la disposición de cómo funciona y quiénes están involucrados en qué momento.

En general los participantes consideraron que el **escenario # 4** tenía falta de información con respecto al lugar de donde el agua necesaria para el desarrollo del escenario vendría. El titular de primera plana en el Escenario # 4 contó la historia de tensión entre las agencias de agua que sugirieron reducir el consumo de agua y de los intereses comerciales de la región. Históricamente, las comunidades guanacastecas han sido ambientalmente activsa y bien organizadas. Los participantes expresaron su interés en ver más detalles acerca de la "domesticación" de estas comunidades en el escenario, específicamente se produjo el cambio de ser activos para luego volverse "domesticados".

En la siguiente tabla se destacan algunos de los comentarios de los participantes para cada uno de los cinco escenarios:

Escenario #1	Escenario #2	Escenario #3	Escenario #4	Escenario #5
Específicamente aborda el nivel de motivación de las comunidades	Qué pasaría con los precios de la comida sin agricultura irrigada?	Un buen escenario –pero necesita más detalles de cómo las comunidades están empoderadas	Abordar de dónde viene el agua de los desarrollos	Agregar una historia de un productor que encuentra su pozo seco a causa de una finca industrial
Cómo puede una gobernanza muy centralizada corrsponder a las necesidades de diferentes zonas?	Un escenario por evitar- necesitamos evitar que el sector privado domine el manejo de agua	Reconciliación y recuperación de la confianza entre comunidades y agencias	Hablar de las diferencias de clases sociales	Hablar de cómo este escenario puede ser el resultado de la manera en que se maneja la política hoy
El gobierno actual no tendría que cambiar tanto para ser tan centralizado y no ser corrupto	La actual falta de claridad sobre los objetivos de desarrollo contribuye a que nos acerquemos a este escenario	Más descripción del proceso de toma de decisiones, quién está involucrado y cómo funciona	Describir más cómo las comunidades fueron "domesticadas" en este escenario	La finca grande de este escenario debería pertenecer a Pedro Arias (hermano del ex-presidente Oscar Arias)

Este escenario parece fuera de contacto con la realidad– las agencias a menudo no apoyan a las comunidades	Conversar sobre la historia de un hogar en este escenario, cómo obtienen su agua? Explicar sus dificultades	Más detalles en la creación de una base sostenible para la región	Agregar una historia en el periódico de cómo el agua es un negocio	Debemos mejorar nuestros esfuerzos para que esto no suceda
Cómo utiliza la gente el agua en este escenario?		Ser #1 en democracia debe ser un objetivo explícito	Hablar se cómo la poca educación se relaciona con un futiro como este	

3. Evaluación de los Escenarios

Después de revisar los escenarios, los participantes se dividieron en 7 grupos para evaluar la forma "sostenible" y deseable de cada escenario. Esta actividad fue diseñada para permitir a los participantes la oportunidad de analizar cada situación en un entorno con otros profesionales de diferentes sectores. El objetivo de esta actividad era utilizar los escenarios para identificar un conjunto de objetivos para la gestión del agua en la región, y para iniciar las discusiones sobre lo que un futuro sostenible para la gobernanza del agua en Guanacaste se vería y cómo se vería futuro insostenible de Guanacaste.

Los participantes recibieron primero un conjunto de 15 indicadores (que corresponden a los principios de la gobernanza sostenible del agua - ver Anexo 1) para clasificar por orden de importancia para el logro de la gobernabilidad sostenible del agua en la región. Los participantes del taller coincidieron en cinco prioridades principales para lograr la sustentabilidad del agua en la región: la gobernanza debe estar bien coordinado entre los diferentes actores locales y regionales, las decisiones deben tomarse en arenas transparentes y abiertas, las políticas deben ser modificables según el cambio de las necesidades humanas y las condiciones ambientales, los recursos de agua subterránea deben asegurarse dentro de los límites naturales, y se necesitan compromisos de parte de organizaciones regionales a escala de cuenca. Estas prioridades se consideraron clave para lograr un modelo sostenible de gestión del agua en Guanacaste que apoye a las comunidades saludables, distribuya el agua con justicia, y ayuda a asegurar la integridad de los ecosistemas y la igualdad de oportunidades económicas.

La posición final de los indicadores está abajo. El promedio (la columna en el extremo derecho) es la suma de la posición de cada uno de los 46 participantes, luego se divide por el número de participantes. Valores más bajos (más cerca de ser el número 1) indica

mayor importancia para lograr una gobernanza sostenible del agua en Guanacaste de acuerdo con los participantes del taller.

Indicador	Posición	Promedio
La coordinación de la gestión y la planificación de los recursos hídricos	#1	3.44
La apertura y la transparencia de la toma de decisiones para los recursos hídricos	#2	4.00
Balanza de extracción de aguas subterráneas y la recarga	#3	4.23
La facilidad de modificar las políticas de agua y el proceso de planificación para satisfacer las necesidades y las prioridades que cambian	#4	5.64
La efectividad y la pertinencia de la escala de cuenca y la escala regional para la gobernanza de agua	#5	6.14
Condición del hábitat terrestre (% de cobertura forestal nativa)	#6	7.19
Condición del hábitat acuático y las especies acuáticas	#7	8.06
Los riesgos para la calidad del agua	#8	8.26
La distribución de los beneficios, costos, y riesgos entre de los partes interesadas	#9	8.65
Las decisiones se toman basado en el largo plazo (20+ años)	#10	9.08
La eficiencia de todas de las tipas de infraestructura de agua	#10	9.08
Mezcla de fincas pequeñas y grandes (industrial)	#12	10.76
Hectáreas de la agricultura de riego	#13	10.88
Una economía basada en turismo	#14	12.40
El mercado del inmobiliario turístico	#15	12.71

Luego, los participantes deliberaron en grupos sobre los valores actuales y los deseados (sostenibles) para cada uno de los 15 indicadores. El objetivo de este ejercicio era facilitar el debate entre los diferentes sectores y grupos de interés sobre lo que los objetivos que deben ser priorizados para la gobernabilidad sostenible del agua en Guanacaste, qué tan cerca o lejos está la gobernabilidad del agua de alcanzar esos objetivos, y para comenzar las discusiones sobre qué tan deseable era cada uno de los escenarios.

A continuación hemos resumido lo que los participantes ven como "sostenible" o el valor deseable (o nivel) de cada uno de los 15 indicadores:

Indicador	Objetivo sostenible
#1 - La coordinación de la gestión y la planificación de los recursos hídricos	Policéntrica
#2 - La apertura y la transparencia de la toma de decisiones para los recursos hídricos	Abierto

#3 - Balanza de extracción de aguas subterráneas y la recarga	Recarga excede la extracción
#4 - La facilidad de modificar las políticas de agua y el proceso de planificación para satisfacer las necesidades y las prioridades que cambian	Bastante fácil
#5 - La efectividad y la pertinencia de la escala de cuenca y la escala regional para la gobernanza de agua	Efectivo
#6 - Condición del hábitat terrestre (% de cobertura forestal nativa)	Alrededor del 50%
#7 - Condición del hábitat acuático y las especies acuáticas	Saludables o Muy Saludables
#8 - Los riesgos para la calidad del agua	Bajo riesgo
#9 - La distribución de los beneficios, costos, y riesgos entre de los partes interesadas	Justa
#10 - Las decisiones se toman basado en el largo plazo (20+ años)	Muchas decisiones
#11 - La eficiencia de todas de las tipas de infraestructura de agua	Muy eficiente / mínimo desperdicio
#12 - Mezcla de fincas pequeñas y grandes (industrial)	Más fincas pequeñas que grandes/ buen balance
#13 - Hectáreas de la agricultura de riego	---
#14 - Una economía basada en turismo	Importante para una economía diversa
#15 - El mercado del inmobiliario turístico	---

Hemos dejado # 13 y # 15 en blanco - el objetivo de deliberar sobre qué 'objetivos' podría haber para las hectáreas de riego y venta de bienes raíces era desafiar a los participantes a pensar en lo que el futuro podría ser si alguno de estos indicadores tuviera valores diferentes. Se necesitará más deliberación abierta y trabajo para definir metas para estos indicadores y medir su desempeño a través del tiempo.

Utilizando el rango de los indicadores y las metas de sostenibilidad, el equipo de investigación calculó la preferencia general de cada uno de los escenarios después del taller. El objetivo de este cálculo fue identificar cómo los participantes del taller (en su conjunto) vieron cada escenario en términos de su conveniencia y sostenibilidad. Aunque no hubo un escenario perfecto, el Escenario # 3 obtuvo el puntaje más alto en términos de preferencia y la sostenibilidad. A continuación se muestra un resumen de la calificación de cada escenario. Cuanto mayor sea el valor el escenario fue más deseable para los participantes del taller en comparación con los otros escenarios (los valores oscilan entre 0 y 1).

Posición	Escenario	Calificación
#1	Escenario 3: Cómo lo logró Costa Rica?!	.62
#2	Escenario 1: Mandato para prepararse para la escasez de agua	.52
#3	Escenario 4: Prosperidad económica y riesgo ambiental	.29
#4	Escenario 2: Acuerdos a puerta cerrada	.22
#5	Escenario 5: El regreso del latifundio	.10

Con base en los análisis anteriores de la gobernabilidad del agua en Guanacaste, el equipo de investigación llevó a cabo la misma evaluación del estado actual de la gobernabilidad del agua en Guanacaste. Se utilizaron los mismos 15 indicadores y valores asignados de los indicadores, evaluados en la actualidad, basado en amplios análisis de la gobernabilidad del agua en la región. A continuación se muestra la calificación del estado actual (hoy) de la gobernabilidad del agua en comparación con los cinco escenarios:

Estado Actual de la Gobernanza de Agua	**Calificación: .29**

La puntuación de la situación actual de la gestión del agua (0,29) pondría el actual estado en el medio de los cinco escenarios (el estado actual de la gobernabilidad del agua actual obtuvo la misma calificación (0,29) que el escenario 4). Este resultado demuestra que:

1) Hubo algunos objetivos claros, metas de sostenibilidad y futuros hacia los que la gobernabilidad del agua debe trabajar (en especial algunas de esas características en el escenario 3, como gobernanza policéntrica, bien coordinada y toma de decisiones abierta para la gestión del agua);

2) Había cosas claras que la gobernabilidad del agua en Guanacaste debe evitar - como esos futuros retratados en el escenario 5 o en el escenario 2; y

3) El estado actual de la gestión del agua es mediocre en términos de rendimiento (con respecto a la gestión del agua en los escenarios) cuando se evaluó utilizando los mismos parámetros de evaluación que los participantes utilizan para evaluar los escenarios en el taller. Esto indica que hay una fuerte necesidad de implementar estrategias y procesos concretos de moverse activamente y deliberadamente hacia condiciones más deseables y sostenibles (como el escenario 3), y de manera activa y deliberadamente evitar las características que se encuentran en escenarios negativos (como los escenarios 2 y 5).

Foto arriba: Participantes del taller traban en grupos inicialmete para evaluar los escenarios

Este tipo de evaluación puede ayudar a manejadores a identificar recursos para trabajar hacia ciertas metas y evitar ciertas otras cuando se regula el agua en Guanacaste. Esta evaluación también puede ayudar a iniciar - y ser una base - para proseguir los debates y colaboraciones para ayudar a la gobernabilidad del agua a movilizarse hacia un futuro más sostenible. Esto fue sólo un primer paso - aún queda mucho trabajo para identificar aún más, medir y evaluar los indicadores que los administradores del agua y otros pueden utilizar en Guanacaste.

Lecciones claves del desarrollo y la evaluación de los escenarios:

1. Estos cinco escenarios podrían ser utilizados para futuras actividades de planificación de base comunitaria en Guanacaste - especialmente con ASADAs que comparten las mismas cuencas. Estos escenarios pueden ayudar a gestores del agua y políticos a identificar las metas locales y fomentar la colaboración a través de fronteras políticas. Las comunidades y otras partes interesadas deberían modificar los escenarios como mejor les parezca con el tiempo.

2. Hay una necesidad de una clara visión y metas en Guanacaste que se compartan entre ASADAs locales, gobiernos regionales, los organismos y las comunidades – cómo se ve el desarrollo en el futuro? Cuáles son las prioridades de uso de agua? La evaluación de escenario fue un comienzo, pero se necesitan más esfuerzos para especificar metas y objetivos para la gestión del agua en la región - y para monitorear cómo se están haciendo progresos hacia esas metas en el tiempo.

3. Deben ser programados con mayor regularidad eventos donde los ciudadanos que trabajan en el sector del agua pueden reunirse y compartir experiencias. Tales eventos como este taller son valiosos y fomentan el aprendizaje compartido a través de fronteras políticas y geográficas. Se necesita liderazgo para ayudar a organizar estos eventos.

4. Los participantes estuvieron a favor de los futuros escenarios de la gobernanza del agua policéntrica en Guanacaste. La gobernanza policéntrica es un tipo de gobierno que está bien coordinado entre las organizaciones que trabajan a escala local, regional y nacional. Sin embargo, el gobierno actual del agua en Guanacaste es fragmentado - lo que significa que hay mucho margen de mejora en cuanto a la coordinación. En concreto, hay una necesidad de fuertes líderes regionales y organizaciones regionales capaces en la Provincia. La Comisión Potrero-Caimital, que ahora se está expandiendo para incluir el Rio Quiriman, podría tratar de convertirse en un modelo de liderazgo regional para la gobernabilidad del agua en Guanacaste. Los ASADAs en la Mala Noche podrían considerar algún tipo de comité o de la comisión regional.

5. Los 15 indicadores podrían ser un punto de partida para que los líderes locales y regionales evalúen regularmente qué tan bien va la gobernabilidad del agua en Guanacaste, en Nicoya, o en sus cuencas. Definición de objetivos, evaluación de los progresos y la aplicación de estrategias para alcanzar las metas debe ser un proceso continuo que está abierto a todos los interesados en la región. Nicoya podría ser modelo de buena gobernanza del agua para otras zonas de Guanacaste.

6. Los escenarios no representan necesariamente la visión. Una visión es un escenario o futuro, que es el mejor de los casos, el más sostenible, el más positivo. Un ejercicio útil en el futuro, podría ser el desarrollo de una visión coherente para la gobernanza del agua en Guanacaste. Esto ayudaría aún más a las metas articuladas para la gobernabilidad sostenible del agua en la región.

4. Las Estrategias

Hemos explorado diferentes opciones de cómo el futuro se podría ver (en el ejercicio para desarrollar los escenarios) y hemos evaluado cuáles de esos futuros son los más sostenibles y cuáles de los fines para la gobernanza de agua son las claves para llegar a un futuro sostenible. Ahora, comenzamos trabajar en la elaboración de estrategias con el

fin de movilizar la gobernanza de agua en Guanacaste hacia estos escenarios deseables y evitar los escenarios negativos.

Los participantes en el taller trabajaron en grupos para elaborar estrategias a base de los 5 indicadores prioritarios de la actividad de evaluación de escenarios. Los participantes fueron instruidos para elaborar una estrategia que ayude a mover el indicador de su estado actual al estado más sostenible en el tiempo. Los cinco indicadores, sus estados actuales, y sus valores sostenibles (los fines) son los siguientes:

Indicador	**Objetivo sostenible**
#1 - La coordinación de la gestión y la planificación de los recursos hídricos	Policéntrica
#2 - La apertura y la transparencia de la toma de decisiones para los recursos hídricos	Abierto
#3 - Balanza de extracción de aguas subterráneas y la recarga	Recarga excede la extracción
#4 - La facilidad de modificar las políticas de agua y el proceso de planificación para satisfacer las necesidades y las prioridades que cambian	Bastante fácil
#5 - La efectividad y la pertinencia de la escala de cuenca y la escala regional para la gobernanza de agua	Efectivo
#6 - Condición del hábitat terrestre (% de cobertura forestal nativa)	Alrededor del 50%
#7 - Condición del hábitat acuático y las especies acuáticas	Saludables o Muy Saludables
#8 - Los riesgos para la calidad del agua	Bajo riesgo
#9 - La distribución de los beneficios, costos, y riesgos entre de los partes interesadas	Justa
#10 - Las decisiones se toman basado en el largo plazo (20+ años)	Muchas decisiones
#11 - La eficiencia de todas de las tipas de infraestructura de agua	Muy eficiente / mínimo desperdicio
#12 - Mezcla de fincas pequeñas y grandes (industrial)	Más fincas pequeñas que grandes/ buen balance
#13 - Hectáreas de la agricultura de riego	---
#14 - Una economía basada en turismo	Importante para una economía diversa
#15 - El mercado del inmobiliario turístico	---

El objetivo del ejercicio de crear estrategias fue explorar cómo el proceso de elaboración de estrategias puede funcionar en Guanacaste. La actividad fue preliminar y queda mucho trabajo por hacer en la elaboración de estrategias para lograr la gobernabilidad sostenible del agua en Guanacaste.

Fotos arriba: Participantes presentan y discuten sus estrategias en el taller

En la página siguiente, se resumen las seis estrategias que los participantes desarrollaron en este parte del taller. La estructura de las estrategias y las preguntas en la parte izquierda de la tabla pueden ser utilizados como un guía para elaborar otras estrategias o para cambiar estrategias sobre tiempo. Mande un correo electrónico a ckuzdas@asu.edu para recibir la plantilla que se utilizó para elaborar estrategias el taller.

	Estrategia #1	Estrategia #2
¿Cuál es el nombre de su estrategia?	Tomar de decisiones participativas e integradas (con información científica)	El plan regional para el abastecimiento sostenible de agua
Describa la acción(es) principal por tomar	1.) Talleres técnicos y científicos para informar a todos los interesados en el proceso de toma de decisiones 2.) Talleres para la toma de decisiones y la búsqueda de acuerdos que son vinculantes para con el gobierno regional 3.) Comité eficiente para el mandato de establecer las prioridades para el gobierno 4.) Establecer un presupuesto para garantizar el seguimiento a través de las decisiones participativas 5.) Mantener un sistema de auto-evaluación, seguimiento y retroalimentación de las partes interesadas 6.) Incorporar este tema en la educación formal e informal	Recopilar y sistematizar la información (las extracciones; la cantidad de lluvia; las concesiones; la balanza de agua); identificar la información faltante; crear un inventario del estado de los suministros de agua (calidad y cantidad). Crear un instituto regional de agua para Guanacaste (el líder). La capacitación (para iniciar cambios radicales en la cultura con respecto al uso del agua)
¿Quién debe ser el líder y ser responsable para tomar esta acción?	Las organizaciones civiles con el poder para auditar y las organizaciones públicas y privadas	Una versión ampliada de la CCCI (Las ASADAs deberían ser representadas). MIDEPLAN (Ministerio de Desarrollo y Planificación)
¿Cuáles recursos necesitan para tomar esta acción (personales, técnicos, financieros, otros)?	Financieros, técnicos, personales, y transporte	Recursos humanos especializados que son permanentes (toma de decisiones, análisis de los datos, y el monitoreo), computadoras, equipo de monitoreo (estaciones meteorológicas, medidores de caudal de los ríos, y el equipo de la calidad de agua)
¿Están disponibles estos recursos ahora?	Sí, pero algunos de los recursos existentes están limitados	Sí
¿Si 'sí', quién tiene los recursos y cuáles acciones tomarían para obtenerlos?	Los gobiernos locales y las instituciones públicas y privadas	SENARA, AyA, MAG, ICE, MINAET, MEP - sector privado (desarrolladores, hoteles, el sector agrícola); solicitar préstamos que pueden ser pagados con los impuestos / cargos agua (canon hídrico), el apoyo de las organizaciones internacionales y el sector privado
¿Si 'no', cuales acciones deben ser tomadas – y de quién – para crear estos recursos?		
Ahora, está listo para implementar su estrategia 'jalar.' ¿Cuáles obstáculos espera?	Alguna resistencia natural de las partes interesadas cuando las decisiones afectan potencialmente los intereses políticos y privados; la burocracia	Resistencia a aplicar restricciones o medidas correctivas, el choque cultural

¿Cuáles acciones adicionales deben ser tomadas para superar los obstáculos mencionados arriba?	Informar a (por ejemplo, talleres educativos) las partes interesadas sobre los cambios necesarios para el desarrollo sostenible local y regional, con énfasis en los sacrificios y beneficios ('trade-offs')	Incluir todos los sectores para crear dicho Plan, educación, campañas, conferencias, estudios
¿Quién(es) debe tomar las acciones mencionadas arriba y cuáles recursos necesitan para ser exitosos?	Los gobiernos locales por decretos, y la creación de un auditor autónomo regional que coordina y supervisa las acciones de la gobernanza. El auditor deberá no ser político	El CCCI / MIDEPLAN; también tiene que haber un compromiso por parte de los recursos humanos, cada institución debe establecer las tareas que contribuyen a objetivos más grandes para la región

	Estrategia #3	**Estrategia #4**	**Estrategia #5**	**Estrategia #6**
¿Cuál es el nombre de su estrategia?	Tomar de decisiones que beneficia la comunidad en general	Apoyar la administración de las ASADAs	La promoción de participación activa y mejorar la accesibilidad de los procesos de tomar decisiones para recursos hídricos	El manejo integral de agua
Describa la acción(es) principal para tomar	Reuniones con la comunidad para informar decisiones de la gobernanza de agua; crear una nueva comisión que monitorea el uso de agua en la zona; obtener mejor equipo para controlar y monitorear niveles de los pozos	Crear las herramientas apoyadas por los aspectos legales, técnicos, y administrativos de las ASADAs; crear un nuevo Ministerio de Agua Regional para Guanacaste que tiene la autoridad y la autonomía adecuadas para supervisar el manejo de agua en las zonas de Guanacaste	Coordinar la participación de las partes interesadas en los procesos diferentes de la gobernanza de agua en la zona; elaborar planes para la participación de los sectores diferentes de modo que pueden ser informados sobre cambios, políticos, condiciones naturales, suministros de agua etc.	1. Los procesos de coordinación; 2. La capacitación; 3. Definir y elaborar los fines y los objetivos; 4. Crear un plan de trabajo – todo de esto es un proceso permanente
¿Quién debe ser el líder y ser responsable para tomar esta acción?	Los presidentes de las ASADAs y las juntas directivas de las ASADAs	El Ministerio de Agua (mencionado arriba)	El Comité de Agua (que aún se necesita ser creado) incluye AyA, las ASADAs, SENARA, las Universidades, ICE y MINAET	Una nueva comisión que está formada por los sectores involucradas en la gobernanza de agua en Guanacaste (el gobierno, las empresas, y las comunidades)

¿Cuáles recursos necesita para tomar esta acción (personales, técnicos, financieros, otros)?	Recursos financieros, un electricista, y un fontanero	La elaboración de las leyes nuevas para mejorar el sistema de manejo regional de las ASADAs y la estructura del apoyo de las ASADAs	Recursos humanos – se necesita un equipo de apoyo; se necesitan recursos técnicos y financieros que se dan por todas las organizaciones involucradas	Recursos humanos, técnicos, y financieros – pero cada organización necesita considerar primero cómo obtener estos recursos de sus propios presupuestos
¿Están disponibles estos recursos ahora?	Sí	Sí – los recursos están disponibles de AyA, MINAET, y la Asamblea	Sí	Sí
¿Si 'sí', quién tiene los recursos y cuáles acciones tomarían para obtenerlos?	Las ASADAs en Guanacaste deben ser pagadas por los servicios de agua; también las ASADAs necesitan formas de pago eficientes	Los recursos están definidos por ley, entonces necesitamos obtener los recursos por el nuevo ministerio de agua en Guanacaste (mencionado en las cajas arribas)	Las universidades, AyA, SENARA, MINAET, ASADAs, Municipalidades, Comunidades, ICE. Necesita una nueva forma ágil para comunicar las necesidades de recursos entre las organizaciones y la obtención de autorizaciones para distribuirlos	Los recursos humanos ya existen y están en cada organización involucrada
¿Si 'no', cuales acciones deben ser tomadas – y de quién – para crear estos recursos?				No hay muchos recursos financieros, entonces cada organización tiene que contribuir
Ahora, está listo para implementar su estrategia. ¿Cuáles obstáculos espera?	Gente que no paga a las ASADAs por los servicios de agua; y la buena administración de los recursos financieros en la parte de las ASADAs	La voluntad política y la Asamblea Nacional	La voluntad política; los compromisos de las partes interesadas; recursos técnicos están limitados ahora	Los intereses especiales y políticos son obstáculos
¿Cuáles acciones adicionales deben ser tomadas para superar los obstáculos mencionados	Mantener el servicio de agua eficiente, buscar financiación con otras instituciones como IMAS; hacer nuevas asociaciones	Las ASADAs y las comunidades pueden aplicar la presión política; continuar con los procesos de capacitación para aplicar mas presión	La sensibilización de las partes involucradas; enfocarse en hacer que las partes interesadas se relacionen más con el problema de agua	Segura participación ciudadana y procesos transparentes

arriba?			en Guanacaste	
¿Quién(es) debe tomar las acciones mencionadas arriba y cuáles recursos necesitan para ser exitosos?	La junta directiva de las ASADAs, líderes de las comunidades, líderes de otras organizaciones involucradas; ellos necesitan apoyo y financiamiento	Movimiento de base – las comunidades, las ASADAs, grupos ambientales, las universidades	El nuevo comité regional de agua (mencionado en las cajas arriba)	La capacitación y los recursos financieros en los procesos mencionados en las cajas arriba; y también la infraestructura

Lecciones claves de la Actividad de las Estrategias

1. Muchos de los recursos que se necesitan para probar e implementar las estrategias con éxito ya están disponibles en las comunidades de Guanacaste y en las organizaciones que trabajan en Guanacaste. Puede tomar un poco de la creatividad, la creación de asociaciones nuevas, y la utilización de conexiones en diferentes organizaciones y en diferentes sectores - pero muchos recursos ya están disponibles para el uso por administradores de recursos hídricos. En el largo plazo, más recursos técnicos, financieros y de personal se necesitarán. Con el aumento de la coordinación y la colaboración entre la gobernanza local y regional de agua en Guanacaste – los administradores locales pueden estar en una posición para asegurar estos recursos de los organismos nacionales en San José, en un futuro.

2. Hubo un fuerte consenso entre los participantes durante la actividad de estrategias que había una falta de un fuerte liderazgo regional y una falta de la organización social a nivel regional. Una mejor coordinación y organización de la gobernanza del agua regional será un esfuerzo importante para una eficiente y buena gobernanza de agua en el futuro. Muchos de los participantes estuvieron de acuerdo que necesitan una nueva organización regional para la gobernanza de agua en Guanacaste. Será importante que cualquier nueva institución regional tenga la autoridad para aplicar y hacer cumplir las leyes y reglamentos. Cómo construir esa institución sobre tiempo - podría ser un objeto de deliberaciones futuras por la gobernanza de agua Guanacaste.

3. También hubo consenso en cuanto de la falta de conexión entre la gobernanza de agua en la región de Guanacaste y la gobernanza de agua en la escala nacional, y que esta desconexión hace que el logro de una buena gobernanza de agua en Guanacaste sea un desafío. Las estrategias claves en el futuro se necesitarán para hacer frente a cómo Guanacaste puede accesar e involucrarse en la toma de decisiones sobre los recursos hídricos a nivel nacional. Dichas estrategias y esfuerzos deberán ir más allá de la retórica política e ir hacia el diálogo constructivo y procesos abiertos entre los líderes a nivel nacional y Guanacaste.

4. Las estrategias deben ser monitoreados y 'probadas' para tener éxito. Debe haber reuniones regulares y eventos (por ejemplo, un taller anual) que ofrecen a los participantes información sobre cómo está sucediendo la implementación de las estrategias, lo que ha funcionado, y lo qué no ha funcionado, etc. La implementación de las estrategias, la evaluación de las estrategias, y su cambio sobre tiempo para satisfacer condiciones cambiantes serán procesos importantes que ayudan a avanzar la gobernanza de agua en Guanacaste.

5. Un plan de acción

Este sección fue publicada originalmente por Kuzdas et al. (2013). Haga clic el link en Las Referencias para leer el original (en español y ingles)

Después del taller, el equipo de investigación y los socios de la Comisión para el Manejo de las Cuencas Potrero-Caimital sintetizaron el siguiente plan de acción sistemático que incorpora las estrategias desarrolladas por los participantes del taller y los conocimientos obtenidos a partir de las discusiones del grupo que siguieron a cada presentación de la estrategia. El Plan de Acción identifica cuatro elementos de acción, las barreras potenciales y las formas de superar esas barreras.

Foto arriba: La coordinadora del proyecto Mariel Yglesias habla por el radio en Nicoya durante el Día Mundial de Agua (22 de Marzo 2013) sobre el plan de acción presentado a continuación abajo. El equipo de proyecto coleccionó firmas durante el Día Mundial de Agua y luego mandó el plan y las firmas a los políticos y tomadores de decisión nacionales. Para obtener una copia de lo que fue mandado, escriba un correo electrónico a ckuzdas@asu.edu y mariel_yglesias@yahoo.es.

(1) La inversión en el capital humano alrededor de la gobernabilidad del agua. El progreso hacia la gestión del agua sostenible y eficaz depende de la inversión en recursos humanos. Hay por lo menos dos oportunidades de inversión en el aspecto humano de la gobernabilidad del agua en Guanacaste. Equipo de comunicaciones: La coordinación requiere una comunicación efectiva. Muchas ASADAs carecen de equipos de comunicación básica en Guanacaste. La gobernabilidad del agua en Guanacaste sería muy diferente si cada ASADA pudiera contactar (y ser contactada) a través de correo electrónico, teléfono, o medios de comunicación social. El liderazgo nacional debe considerar la inversión en equipos de comunicación para ASADAs en Guanacaste. Espacios de cooperación: La coordinación requiere una cooperación efectiva y la cooperación efectiva requiere relaciones profesionales y de trabajo saludables. El taller que se realizó podría ser replicado por menos de $ 1,000. El costo podría ser dividido entre las organizaciones participantes y llevarse a cabo anualmente por los actores regionales y la comunidad. El evento podría ayudar a los participantes a perfeccionar las estrategias de comunicación y la cooperación, informar sobre la implementación de la estrategia, y solidificar las relaciones de trabajo.

Ciertamente el uso de algunos equipos de comunicaciones, en particular Internet, correo electrónico y redes sociales puede ser un reto para el personal de la ASADA que no está acostumbrado a ello. Pero la comunicación efectiva es un importante precursor de nuevos espacios de cooperación.

Un inicio para abordar las barreras de comunicación puede ser, por ejemplo, el uso de pasantes para la oficina / asistentes profesionales para las ASADAs mientras que el nuevo equipo de comunicaciones se integra en las prácticas de gestión. Los pasantes podrían aprender valiosas habilidades profesionales, así como ciencia, y quizás también ganar créditos de clase. Con el tiempo estas prácticas pueden convertirse en oportunidades de aprendizaje altamente competitivas y deseadas por los ciudadanos jóvenes. Hasta que una plataforma específica haya sido institucionalizada para el manejo de agua en la región, la nueva plataforma de coordinación del sector público en Nicoya, liderada por la oficina del alcalde, podría funcionar como un espacio de cooperación para este sector.

(2) La inversión en equipos de monitoreo de pequeña escala. A pesar de que discutir y negociar con eficacia las necesidades de agua es fundamental para la cooperación a escala de la cuenca en Guanacaste, esto es muy difícil de hacer sin saber cuánta agua va adónde y con qué propósito. El liderazgo nacional y regional debe financiar y distribuir medidores de agua para ASADAs y abiertamente compartir información con la comunidad y los líderes regionales sobre la cantidad de agua que se está destinado al turismo y la agricultura.

Un obstáculo fundamental es probablemente una débil voluntad política en las organizaciones nacionales para financiar los equipos de monitoreo de la gestión del agua a pequeña escala en las zonas rurales. El intercambio abierto de información del uso del agua con comunidades puede también ser visto como un riesgo político a la luz de los recientes conflictos entre los grandes usuarios del agua y de las comunidades. Sin embargo, una voz unificada de ASADAs sería políticamente difícil de ignorar.

Inicialmente, para superar los obstáculos relacionados con la falta de voluntad política, las oficinas regionales a menudo tienen equipos que están disponibles para uso compartido. Asimismo, las ASADAs dentro de una cuenca o sub-cuenca podrían juntar recursos para comprar medidores de agua compartidos. Datos sobre el uso del agua para el turismo a gran escala y la agricultura existen, pero no en un solo lugar. Compartir esta información en tiempo real requeriría que las ASADAs tengan acceso a una base de datos abierta y a Internet. Para ayudar a sufragar la inversión en infraestructura de comunicaciones, un grupo de trabajo regional podría ayudar a localizar nuevas oportunidades de ingresos, como reestructuración de los impuestos a nivel municipal o penas más severas para las personas que no pagan las facturas de agua.

(3) Compromiso legal para la planificación de recursos hídricos a escala de cuenca. Si la gente en Guanacaste gobierna sus recursos hídricos de manera sostenible, deben tener el respaldo legal y la autoridad para hacerlo. El liderazgo nacional debe embarcarse en un proceso transparente que involucre explícitamente a líderes del sector del agua en Guanacaste con el fin de delinear más autoridad y recursos para los gestores del agua a escala regional y de cuenca.

Un cambio de leyes a escala nacional con frecuencia requiere tratar con corrupción, la influencia de poderosos grupos de interés, y un papeleo burocrático significativo. Asimismo, delinear autoridad o figuras de poder a escala cuenca puede parecer una amenaza para aquellos que se benefician políticamente o económicamente de gestión débil nivel de cuenca.

Las municipalidades, muchas veces aliadas con ASADAs y grupos comunitarios, podrían modificar el objetivo y el proceso de ejecución de los planes reguladores regionales que

ya están operando y someterlos a actualizaciones periódicas. Tales acciones podrían ayudar a evitar los obstáculos relacionados con la burocracia a nivel nacional y poderosos intereses políticos. Con algunas adaptaciones legales, estos planes podrían utilizarse para comenzar a sentar las bases iniciales para la planificación de los recursos hídricos a escala de cuenca. Aliados nacionales, como el Programa de Gestión Integral del Recurso Hídrico, han estado presionando para la planificación a escala de cuenca en Costa Rica y podrían ser llamados a apoyar estos esfuerzos en Guanacaste.

(4) La inversión en un proyecto piloto que incorpora los tres puntos ya mencionados en Nicoya. Un proyecto piloto en Nicoya sería barato y proporcionaría información valiosa sobre la implementación exitosa de estas acciones en Guanacaste.

Sin embargo, un proyecto piloto que se enfrentaría a ciertas barreras de implementación. La incertidumbre acerca de la capacidad de comunicar, coordinar y difundir los resultados de este proyecto podría inhibir el compromiso de algunos actores que todavía no pueden confiar en los procesos de gobierno. Intereses potencialmente divididos dentro de la región también podrían menoscabar la voluntad de los actores locales a invertir su esfuerzo, tiempo y recursos en estos proyectos de colaboración.

Para superar estas barreras a la confianza y el compromiso, las comunidades podrían identificar los equipos de liderazgo para unir sus recursos. Podrían empezar poco a poco, y luego desarrollar un sistema de rendición de cuentas y expectativas, como asistir a las reuniones con regularidad, cumplir con los compromisos adquiridos, y ver la capacidad de respuesta, con el fin de garantizar el pleno compromiso de las partes interesadas. La Alcaldía de Nicoya recientemente implementó un nuevo sistema de rendición de cuentas para asegurar la participación en las reuniones regionales. Esto podría servir de modelo. La inversión en infraestructura de comunicaciones es una acción sinérgica clave para ayudar a mejorar la confianza de los potenciales participantes y el compromiso con los procesos que rigen nuevos y experimentos.

El progreso es ya evidente en Guanacaste. Los recientes esfuerzos en Guanacaste son pasos positivos hacia la reconfiguración de la gobernanza del agua en la región. Sin embargo, aún queda mucho trabajo y la iniciativa de presión para la reforma del agua en Costa Rica aún no es coherente. Algunas medidas de reforma compiten entre sí en el ámbito nacional, y muchas de las ASADAS altamente desfinanciadas abogan por diferentes cosas en diferentes momentos. Un paso clave para avanzar será el de unificar, en cierta medida, los esfuerzos de la reforma del agua, tanto a escala regional (Guanacaste) y nacional.

Para ayudar a impulsar este paso, nuestro equipo distribuyó un documento que resume los

cuatro elementos de acción a los participantes del taller, a los líderes nacionales del sector del agua, y a los miembros de la Asamblea Legislativa. Nuestro equipo también ha distribuido material basado en nuestra investigación a una variedad de grupos a través de fax, periódico, radio, correo electrónico, redes sociales y eventos en la comunidad, en estrecha colaboración con los líderes de la región. Estos esfuerzos han arrojado luz sobre las consideraciones clave para el liderazgo en la región, que tendrá la responsabilidad de:

(1) Balancear la necesidad de crear nuevas organizaciones e instituciones en un sector público ya saturado y complejo. La creación de nuevas organizaciones que sean eficaces puede requerir una reducción inicial o una consolidación de algunas organizaciones existentes.

(2) Asegurar procesos que identifiquen los recursos (financieros, de personal y técnicos) ya existentes en la región. Los recursos existentes y las oportunidades para asegurar nuevos recursos deben quedar claras para aquellos encabezando la acción sobre las cuestiones antes mencionadas.

(3) Hacer un esfuerzo conjunto para presionar por una reforma de la Constitución que defina el agua como un derecho humano universal. Definir el agua como un derecho humano de manera explícita a menudo ha sido la piedra angular de los esfuerzos de reforma de agua que no prosperan. Por lo tanto, son necesarios pasos preliminares antes de que una enmienda constitucional se pueda lograr con éxito.

(4) Establecer procesos para definir los objetivos de desarrollo a escala regional o local. Las comunidades, especialmente aquellas a lo largo de la costa del Pacífico en Guanacaste, deben comenzar debates colectivos antes que el mercado inmobiliario comience a crecer de nuevo y ponga una presión adicional sobre la gobernanza del agua en la región.

(5) Documentar, evaluar y modificar los planes y estrategias de acción, según sea necesario. Asociaciones con universidades pueden potencialmente proveer oportunidades para desarrollar planes de acción y evaluar estrategias.

Los líderes de Guanacaste y las comunidades están en condiciones de hacer un esfuerzo unificado para la reforma nacional del agua, mientras a la vez se da la implementación de medidas para promover la sostenibilidad del agua desde el interior de la región. Aunque todavía existen barreras, Guanacaste puede avanzar a pesar de la inhabilidad de los legisladores nacionales para modificar las políticas del agua en función de las necesidades de los ciudadanos. Cuando la reforma del agua ocurra-y una vez que haya

suficiente impulso-Guanacaste estará en condiciones de capitalizar los actuales esfuerzos para la sostenibilidad del agua.

Se resumen el Plan de Acción:

Acción #1	**Acción #2**	**Acción #3**	**Acción #4**
La inversión en el elemento humano de la gobernanza (equipo de comunicaciones y espacios de cooperación) de agua	La inversión en equipos de monitoreo pequeña escala	Compromiso legal de planificación a escala de cuenca	La inversión en un proyecto piloto (evaluar # 1-3) en Nicoya
Barrera: Bajas expectativas profesionales de comunicación; cultura de falta de comunicación, poca experiencia con modos de comunicación más recientes	**Barrera:** Poca voluntad política para financiamiento, la percepción de riesgo político al compartir la información del uso de agua	**Barrera:** Corrupción; poderosas influencias de grupos de interés, dificultad de penetrar burocracias a nivel nacional	**Barrera:** Intereses divididos dentro de la región y la incertidumbre acerca de la capacidad de difundir / comunicar los resultados
Para superar barrera: Programa de pasantías de ASADA, talleres regulares financiados por las organizaciones participantes, el uso de una nueva Plataforma de Coordinación	**Para superar barrera:** Aliados en las sucursales de la agencia; agrupación de recursos; grupo de trabajo para definir nuevas fuentes de ingresos para ASADAs	**Para superar barrera:** Modificar el propósito y proceso de implementación de Planes Reguladores regionales para eludir el tiempo de espera mientras cambia la política nacional del agua	**Para superar barrera:** Identificar y comprometerse plenamente con el equipo de liderazgo regional; aunar recursos, invertir en equipos de comunicaciones
Recursos existentes: Plataforma de Coordinación Nicoya, Nueva liderazgo ASADAs, aliados políticos regionales (alcaldes)	**Recursos existentes:** Infraestructura de información de la Universidad, los aliados de la Asociación de Desarrollo	**Recursos existentes:** Aliados en medios de comunicación (presión política), el financiamiento de planes reguladores, aliados políticos regionales (alcaldes), aliados nacionales	**Recursos existentes:** La nuevo liderazgo de ASADA, Plataforma de Coordinación Nicoya

Consideraciones claves/ responsabilidades para líderes locales y regionales

- Equilibrar la creación de nuevas organizaciones con la necesidad de reducir/ consolidar la complejidad institucional
- Identificar los recursos de la región y canalizar esos recursos hacia actividades prioritarias
- Detectar el momento adecuado para impulsar los esfuerzos que tienen como objetivo definir explícitamente el agua como un derecho humano Constitucional
- Establecer procesos que definen y redefinen las metas para el desarrollo a escala regional

- La asociación con organizaciones de investigación para documentar, evaluar, modificar las estrategias en tiempo real

Apéndice 1 –Principios para la Gobernanza Sostenible de Agua

El manejo sostenible de agua se define como el proceso que involucra a todas las partes en la coordinación del abastecimiento, distribución, uso y salidas de agua de manera que se garantice el bienestar que no comprometa la integridad de los hidro-sistemas en el futuro (Wiek y Larson 2012). Para evaluar el sistema de agua actual establecimos una serie de principios de sostenibilidad basado en varios autores y en entrevistas con actores clave del sistema en Guanacaste. Estos mismos principios son los que serán utilizados para evaluar los escenarios a futuro en el taller y son importantes para la gobernanza sostenible de agua en Guanacaste. A continuación se presentan los principios:

#1. La integridad del sistema socio-ecológico: Exige equilibrar las necesidades de los residentes locales, agricultura, industria y otros usuarios del agua tomando en cuenta la viabilidad de los ecosistemas de soporte

#2. Eficiencia y manejo de los recursos: Exige reducir consumo de agua, mejorar eficiencia, reutilizar agua, eliminar fugas, que la tasa de extracción no supere la tasa de recarga

#3. Oportunidad y suficiencia de medios de vida: Implica acceso equitativo a suficiente calidad y cantidad de agua para las personas que dependen de ella para su subsistencia y actividades económicas

#4. Civilidad socio-ecológica y manejo democrático: Es la participación y colaboración de los interesados en la toma de decisiones tomando en cuenta a todos los que están conectados con el recurso

#5. Equidad Inter e Intra-generacional: Es el acceso equitativo a suficiente cantidad de agua para residentes actuales y futuros

#6. Interconectividad de escala local a global: Es asegurar la asignación y el manejo de los recursos en regiones ascendentes y descendentes de las cuencas hidrográficas

#7. Precaución (mitigación) y adaptabilidad: El manejo sostenible de agua requiere la anticipación de posibles problemas y la capacidad de mitigar así como de responder a impactos negativos

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APPENDIX E

SCENARIO MULTI CRITERIA EVALUATION ACTIVITY SUMMARY – IDENTIFYING SUSTAINABLE ALTERNATIVES, LESS SUSTAINABLE ALTERANTIVES, AND INITIAL GOALS IN GUANACASTE

Scenario Multi Criteria Evaluation Methods and Activity Summary

The purpose of this appendix is to provide the reader with further details on some activities involved in the overall project in Guanacaste that played a role in meeting dissertation objectives. Accordingly, research efforts that identify and distinguish sustainable alternatives to current water governance in a participatory way played a key role. This role supported collective efforts to develop transition strategies to 'go' one direction and avoid other, less sustainable alternatives.

Integration of the scenario evaluation with the overall project

The scenario/ alternative water governance evaluation forms part of the integrated research to understanding and transforming water governance regimes that struggle to address complex sustainability problems including harmful water conflicts. According to the dissertation introduction, the project has focused on systematizing new knowledge across three temporal domains: current-state, alternative states, and developing transition (Wiek, under review). In this dissertation, we developed a small set of alternative governance scenarios (detailed in Chapter 5) based on extensive current-state analyses of water governance in the region (Chapter 2-4). This current-state work included, for example, a sustainability appraisal of the water governance regime (Chapter 3), which determined qualitatively how well current water governance complied with agreed-upon sustainability criteria. This normative current-state assessment emphasized stakeholder participation and the communication of results to a variety of groups, which afforded a large degree of familiarity and broad interaction with the process described below.

Current-state research, especially the sustainability appraisal, streamlined the selection of an understandable set of indicators (below) that would form the basis for scenario evaluation. Note these variables are different from the variables used to construct the scenarios (in Chapter 4). Members of the *Comisión para el Manejo de las Cuencas Potrero-Caimital* (e.g., PC Commission) were already familiar (and using) the general set of sustainable governance principles, which greatly facilitated the process. With the analytical scenarios mostly constructed (with narratives, illustrative photos, newspaper stories, and day in the life of stories), the iterative process of assigning indicator values between researchers and the PC Commission that reflected each scenario's unique content was straightforward. For example, discussions addressed questions such as, 'in this scenario a reasonable or expected value of indicator 1A would be *w* while in Scenarios 3,4,and 5 due to these conditions it would by *x,y*, and *z*." The previous analytical scenario development process utilized a constructive approach that emphasized systemic accuracy and consistency. Thus, having analytical scenarios already virtually built, increased the reliability that indicator values assigned to each scenario

correctly reflect what was actually happening and were consistent with the systemic features of those scenarios (Wiek et al., 2009; Chapter 5). We note that, while there is overlap with the variable used to build the scenarios and variables used to evaluate the scenarios, the variable sets are distinct from each other. The variables used in the evaluation are necessarily more precise and their selection was meant to elicit substantive discussion and deliberation over sustainability thresholds and levels of a variety of relevant features.

Indicator selection and specification across the scenarios

The research team and members of the PC Commission identified and justified 15 indicators for water governance in Guanacaste and linked each indicator to general principles for sustainable water governance (same principles used in Chapter 3) through two working group meetings in early 2013. The guiding sustainability principles, developed in Wiek and Larson (2012), were already employed to assess the current state of water governance in the Nicoya region of Guanacaste (Kuzdas et al., 2014). Importantly, the normative principles also facilitated the initial identification of the 'best' or most sustainable value for each indicator. The indicators were important 'information points' that helped to communicate the scenarios and ensured that each scenario was specified to the point where they could be collectively evaluated in a workshop setting. Indicator values for each scenario and the current-state were also assigned in the iterative process with the PC Commission. This was important to help compare, in a very streamlined way, how current water governance in the region lined up with the scenarios, which is an important link between the integrated scenario evaluation and strategy crafting process that immediately followed the evaluation.

Multi criteria analysis

The multi criteria analysis (MCA) approach that I employed evaluates how well each alternative state performs based on 'distances' between ideal indicator values, which I term sustainability thresholds, and the indicators actual performance in a given (alternative or current) state. We use the term sustainability threshold to refer to a point, beyond which, could be considered a 'sustainable state' in Guanacaste based on evidence accumulated in the project activities since 2009, sustainability principles, and stakeholder preferences. We found this framing to help facilitate discussions among diverse groups of where water governance *should* be headed and the sustainability effects of alternative water governance schemes. MCA methods that are based on compromise programing algorithms assume that preferences for a given state are determined by distances from the most ideal values of a set of indicators. The resulting utility scores of the evaluation then reflect how close each alternative state is to a set of ideal or sustainable indicator values.

This suite of MCA techniques is well suited for a sustainability evaluation. It potentially allows for relatively simple visual comparison of evaluated scenarios (which was important for participatory processes), and it couples well with crafting governing strategies that seek to transition governance regimes toward alternative, more sustainable futures while avoiding others.

We used the MCA equation developed by Straton et al. (2011) who slightly modified another compromise programming algorithm from Zeleny (1973), so that a resulting utility score closer to 1 indicates better performance (with closer to 0 indicating worse performance). The MCA equation from Straton et al. (2011) is:

$$u_j = \left[\sum_{i-1}^{m} wi\left(1 - \frac{f_i^+ - f_{ij}}{f_i^+ - f_i^-}\right)^c\right]^{1/c}$$

Where,
fij is the value of indicator *i* in alternative *j*;

f_i^+ is the best value (or sustainability threshold) for indicator *i*;

f_i^- is the worst (or value farthest from the sustainability threshold) for indicator *i*;

wi is the weight for indicator *i* and is based on rank of indicator importance, highest possible weight (dependent on the number of indicators being used) and a normalized value of *c;*

m is the number of indicators;

c is a parameter that reflects the importance of the distance from the sustainability threshold (which in this case we left at 1 for all indicators, so that all deviations from the most sustainable values are weighted equally); and

u_j is the resulting utility score of an alternative state *j*

Participatory evaluation process

In March 2013, 46 participants convened for a workshop in Nicoya, Guanacaste. Participants represented local governments, national agencies, agriculture, tourism,

universities, community groups, and environmental groups. Over 30 organizations and 18 Guanacaste communities were represented at the workshop. Participants were invited in order to account for the fragmented parts of the current regional water governance regime and to include organizations that had been involved in conflicts with each other. The all-day workshop was organized into three modules that fed into one another. The interactive modules were designed to mirror potential collaborative governing processes in the region. The first module developed and refined the set of systemic water governance scenarios in order to identify where Guanacaste water governance *could* be headed (Chapter 5). The second module, which I very briefly explore here, evaluated those scenarios in order to deliberate and identify where Guanacaste water governance *should* be headed and began framing a process to craft transition strategies to get there over time. The third module implemented and tested a collective process of crafting governance strategies to get to where the group determined water governance in Guanacaste should go and avoid where it should not go. The first module, where participants interacted with 'scenario stations' to contribute to scenario content and design, prompted participants to begin thinking about water governance alternatives and what the consequences of those alternatives could be for the region. The format of the first module allowed participants to meet each other (many of whom had not worked with each other before) and become accustomed to the deliberative and constructive nature of the workshop prior to the (second) evaluation module.

As a first step in the evaluation module, workshop participants individually ranked the set of indicators based on their perceived importance for sustainable water governance in Guanacaste. Although many participants were familiar with the broader project and its results, at the beginning of the workshop the research team took the time to review the concept and definition of sustainable water governance that was being used in the broader project and during the workshop. The rich concept of sustainable water governance is defined at length in Chapter 3 of this dissertation.

The resulting average rank helped determine the weight of each indicator in the evaluation. This step occurred immediately after the first module so that the alternative governance scenarios and their similarities and differences were fresh in participant's minds.

While rankings were being tabulated, participants broke up into seven sub-groups of 6-7 people in order to identify and justify the sustainability thresholds of each indicator. Participants were divided into sub-groups in order to ensure maximum diversity. A facilitator and note-taker led each group, while two additional facilitators roamed and offered support when needed. The sub-groups also discussed and modified the initial list of indicator values and justifications for the current state of water

governance in Guanacaste. While some MCA studies focus on exploring differences in the weighting of indicators (and how this effects utility scores of alternatives), in this study we focused more on identifying the sustainability thresholds in a broad participatory setting, which afforded a more goal-oriented approach to the MCA used in the workshop. We chose this approach due to, among other determinants, the large number of workshop participants that included very diverse groups (comparing weights typically occurs in a smaller, expert-driven setting due to the technical requirements) and the extremely early stage at which collaborative water resource (or even development in general) planning is at in Guanacaste. Allowing such a large group to participate in the evaluation (and overall workshop) was deemed critical by the *Comisión* and the research team in light of recent conflicts over water that often involve marginalized groups and stakeholders who are left out (sometimes intentionally) of planning processes for water resources. In this sense, this study offers a unique perspective on an MCA approach that effectively involved a large number of diverse participants.

Following small group work, the larger group re-convened to discuss, identify, and justify the sustainability thresholds to be used in the evaluation. The average rankings of the indicators were then presented to the larger group, followed by additional discussion and finalization of the indicator rank – focusing on the top five indicators. After a break, the evaluated scenarios – including the 'evaluated' current state - were presented to the group using a simple visualization tool that facilitated comparing alternatives. Here we explored the sustainability of each scenario (and how they compare to the current state) and identified key aspects of the governance regime that systemically influenced whether or not alternative states met sustainability thresholds or not. The second module was concluded by initially exploring and discussing a process to craft governance strategies utilizing the evaluation results. The module after the evaluation exercises tested that process to craft governing strategies.

Selected indicators and their ranking

Final indicators (Table 1 in this appendix) and their assigned values for each scenario (Table 2 in this appendix) aim to adequately capture the complexity of water governance in Guanacaste while still maintaining their accessibility to the diverse stakeholder groups involved in the early stages of organized and participatory planning for water resources. The set of indicators accounts for the general condition(s) of water governance and its outcomes in Guanacaste as a Province, rather than one specific area (important considering the diversity of groups and communities represented at the workshop).

Table 1 (APPENDIX E): Sustainability principles, associated indicators, their definitions, and value ranges. Primary sources/ previous use of each indicator are indicated by a + (formative scenario building in Chapter 5); * (sustainability appraisal of water governance in the Nicoya region Chapter 3); and a ^ (analyses of water conflict cases in Guanacaste in Chapter 4).

Principle	Indicator		Range of indicator values
Principle #1 Socio-ecological system integrity	**1 A**	Condition and quality of freshwater habitat and species*^	1 to 5 (5=unaltered; 3= healthy; 1= completely degraded)
	1 B	Condition and quality of terrestrial habitat (% native forest cover)+*	1 - 100% of land covered by natural forest
	1 C	Risks to water quantity and quality+*^	1 to 3 (1 =low risk, 2=medium risk, 3=high risk)
Principle #2: Resource efficiency and maintenance	**2 A**	Efficiency of water infrastructure+*	1 to 5 (5 = most efficient, 1 = least efficient)
	2 B	Balance of extraction and recharge of groundwater+*	1 to 3 (3 = recharge exceeds extraction; 2 = extraction exceeds recharge; 1 = unknown)
Principle #3: Livelihood sufficiency and opportunity	**3 A**	Hectares of irrigated agriculture+^	0 – 100,000 Ha
	3 B	Mix of small and large (industrial) farms*^	1 to 4 (4 = balanced and competitive mix; 3 = substantially more small farms than large or industrial farms; 2 = mixed, but small farms find it difficult to compete with larger farms; 1 = nearly all farms are large or industrial)
	3 C	State of tourism real estate market^	0 - $100 million in foreign real estate purchases (residential tourism only)
	3 D	An economy based on tourism^	1 to 3 (3 = important for a diverse economy; 2 = very important, the economy is dependent on tourism; 1 = not important)
Principle #4: Socio-ecological	**4 A**	The accessibility and transparency of decision-making for	1 to 3 (3 = open; 2 = sometimes open; 1 = closed)

civility and democratic governance		water resources+*^	
	4 B	The extent of coordination in the management and planning of water resources+*^	1 to 3 (3 = polycentric; 2 = centralized; 1 = fragmented)
Principle #5 Inter/ intra-generational equity	**5 A**	The distribution of benefits, costs, and risks among stakeholders+*^	1 a 3 (3 = fair, 2 = sometimes fair; 1 = unfair)
Principle #6: Interconnectivity from local to global scales	**6 A**	The effectiveness and legitimacy of the basin and regional scale of water governance+*^	1 a 3 (3 = effective; 2 = somewhat effective; 1 = ineffective)
Principle #7: Precaution (mitigation) and adaptability	**7 A**	Decisions based on long-term (20+ years) planning horizons*^	1 a 3 (3 = Many decisions; 2 = some decisions; 1 = no decisions)
	7 B	The ease of modifying water policy and planning processes to meet changing needs and priorities+*^	1 a 5 (5 = very easy 1 = nearly impossible)

Table 2 (APPENDIX E): Assigned indicator values in each scenario and summary of key differences between scenario (from Chapter 5)

	Scenario #1	**Scenario #2**	**Scenario #3:**	**Scenario #4**	**Scenario #5**
Scenario title	Mandated to prepare	Closed-door alliances	Responsive and engaged	Unnoticed in the background	Overwhelmed and out of touch
Scenario theme	Cautious	Deception	Innovation	Apathy	Disconnection
How water governance operates	Agency-led and top-down implemented mandate to	Governance is dominated by closed and unaccountabl	Responsive governance emphasizes autonomy,	Governance weathers apathy and environmenta	Overwhelmed governance is out of touch with

	prepare for water scarcity and secure rural, potentially vulnerable communities	e alliances and back-door dealings	coordination, and regional-fit	l risk while staying out of the way of economic prosperity	regional challenges while elites multiply landholdings
Distinguishing systemic features	A highly controlled governance schemes that has the trust of local communities avoid conflicts due to more accommodating contexts where scarcity, water access, and competition are not prevalent	Negative reinforcing feedback loops among governance drivers and mediating features allow for governance schemes that cater to interest-based alliances that tend to circumvent due processes	Positive reinforcing feedback loops between governance drivers and mediating features in spite of challenging contexts	Efficient water management buffers potential risks while less active leadership allows governance to operate without public interest	Challenging governing contexts overwhelm governance schemes that are poorly adapted to regional contexts and disconnected from local constituencies
Interpreted scenario components	The ever present nature of central government	Organized community opposition, resistance	Problem-solving, confidence, trying new ideas	Progress, technical water management, failed demand management	The return of the *Latifundio,* power imbalances, power politics
Indicators					
1A	4 (very healthy)	2 (degraded)	3 (healthy)	2 (degraded)	2 (degraded)
1B	30% natural forest cover	40% natural forest cover	30% natural forest cover	20% natural forest cover	10% natural forest cover
1C	1 (low risk)	2 (medium risk)	1 (low risk)	2 (medium risk)	3 (high risk)
2A	4 (very efficient)	2 (inefficient for many)	3 (efficient)	4 (very efficient)	2 (inefficient for many)
2B	3 (recharge exceeds extraction)	1 (unknown)	3 (recharge exceeds extraction)	2 (extraction exceeds recharge)	2 (extraction exceeds recharge)
3A	40,000 Ha	35,000 Ha	50,000 Ha	70,000 Ha	90,000 Ha
3B	4 (balanced mix)	3 (more small farms than industrial farms)	4 (balanced mix)	2 (mixed, but small farms find it difficult to	1 (nearly all farms are industrial farms)

				compete)	
3C	$35 million	$80 million	$25 million	$40 million	$7 million
3D	3 (important for a diverse economy)	2 (the economy depends on tourism)	3 (important for a diverse economy)	3 (important for a diverse economy)	1 (tourism is not important)
4A	2 (sometimes open)	1 (closed)	3 (open)	2 (sometimes open)	1 (closed)
4B	2 (centralized)	2 (centralized)	3 (polycentric)	1 (fragmented)	1 (fragmented)
5A	3 (fair)	1 (unfair)	3 (fair)	2 (sometimes fair)	1 (unfair)
6A	2 (somewhat effective)	1 (ineffective)	3 (effective)	2 (somewhat effective)	1 (ineffective)
7A	3 (many decisions)	1 (no decisions)	3 (many decisions)	1 (no decisions)	1 (no decisions)
7B	3 (somewhat easy for some)	2 (difficult)	4 (easy enough)	2 (difficult)	1 (nearly impossible)

For Principle #1: Socio-ecological system integrity, three indicators (1A-1C) were selected that capture the general quality of natural systems and acceptable risks to the well being of those systems. The ability to easily compare forestation levels (Indicator 1C) in the scenarios was deemed important for the evaluation process by local administrators. Forest cover is a historically major environmental concern for the Province. All indicators in Principle #3: Livelihood sufficiency and opportunity, address agriculture and tourism – the two most important economic drivers in Guanacaste. After debate, Indicators 3A – 3D were determined to best represent the general composition of agriculture and tourism in the Province in an understandable way (that easily compared across scenarios) and that would spur deliberation about what Guanacaste *should* look like in a workshop setting that aimed to promote learning and interaction. Principle #2: Resource efficiency and maintenance included indicators (2A-2B) related to the efficiency of water infrastructure and the quality of groundwater reserves. Both measures are high priorities for Guanacaste water managers that often face poorly maintained infrastructure and have access to very limited groundwater monitoring resources. Principle #4: Socio-ecological civility and democratic governance includes two indicators (4A-4B) related to open, accessible decision-making processes and coordination. Water allocation decisions made without community input are often the norm in Guanacaste, which has spurred intense water conflicts and eroded community trust in prevailing political institutions. Coordination is a major concern for water managers who are helping lead very new organized efforts to collaboratively manage water resources. Principle #5: Inter/ intra-generational equity includes an indicator of the fairness in the distribution benefits, risks, and costs of water allocation and use. Developing mediators between community-scale actors and national agencies is an important recent effort in the region, thus one indicator in Principle #6: Interconnectivity from local to global scales focuses on the effectiveness and legitimacy of this mediating regional or basin-scale role. Principle #7: Precaution (mitigation) and adaptation include two indicators that relevant to recent efforts in Guanacaste. Long-term planning (Indicator 7A) is still a very new practice (or it is not practiced) in the Province, and is a current focus (and thus very relevant for mitigation capacities of regional water governance) of new leaders in the region. Many current decisions do not factor in long-term considerations, especially considerations related to development impacts on hydro-ecosystems. Many new water governing efforts in Guanacaste (such as promoting long-term planning practices) have found that modifying water policy can be impossibly difficult. Thus Indicator 7B was chosen as a relevant and understandable gauge that helps reflect the collective ability to adapt to meet changing conditions and needs.

Table 3 (APPENDIX E) Descriptive results from the indicator ranking activity

Indicator	Rank	Weight (w_i)	Mean rank	Standard deviation	Median
1A: Condition and quality of freshwater habitat and species	9	0.037	8.06	3.73	9
1B: Condition and quality of terrestrial habitat (% native forest cover)	6	0.042	7.19	3.28	7.5
1C: Risks to water quantity and quality	7	0.036	8.26	4.45	7.5
2A: Efficiency of water infrastructure	10	0.033	9.08	3.56	9.5
2B: Balance of extraction and recharge of groundwater	3	0.071	4.23	3.53	3
3A: Hectares of irrigated agriculture	13	0.028	10.88	2.88	11
3B: Mix of small and large (industrial) farms	12	0.028	10.76	3.05	12
3C: State of tourism real estate market	15	0.024	12.71	3.20	15
3D: An economy based on tourism	14	0.024	12.40	2.42	13
4A: The accessibility and transparency of decision-making for water resources	2	0.075	4.00	3.10	3
4B: The extent of coordination in the management and planning of water resources	1	0.087	3.44	2.76	2.5
5A: The distribution of benefits, costs, and risks among stakeholders	8	0.035	8.65	3.07	9.5
6A: The effectiveness and legitimacy of the basin and regional scale of water governance	5	0.049	6.14	2.75	6
7A: Decisions based on long-term (20+ years) planning horizons	10	0.033	9.08	4.04	10
7B: The ease of modifying water policy and planning processes to meet changing needs and priorities	4	0.053	5.64	3.64	5

Identified sustainability thresholds

For some indicators, there was little disagreement within or between groups on the identified sustainability thresholds although justifications varied slightly depending on the composition of the group. For other 'more difficult' indicators that were purposely selected to challenge participants, there was much more discussion. This discussion was an important primer for deliberations on what different levels of some indicators might mean for the region. For example, some participants (starting with the scenarios) discussed what Guanacaste might look like with a certain amount of irrigation or level of tourism, then discussed the regional implications, made a judgment on those regional implications (using the evaluation criteria), and then identified a sustainability threshold. Table 4 in this appendix compares the identified sustainability thresholds with the values of indicators in the current state.

Table 4 (APPENDIX E): Synthesis of current state values and sustainability thresholds identified at the workshop

Indicator	Current-state	Sustainability threshold	Summary of justifications from the workshop activity
1A: Condition and quality of freshwater habitat and species	Degraded in many places; healthy in others (2 or 3)	Healthy (3)	Freshwater ecosystems must be healthy in order to provide a sufficient quality and quantity of water. Many places in Guanacaste are still recovering from virtually complete deforestation in past decades
1B: Condition and quality of terrestrial habitat (% native forest cover)	25% (officially protected areas)	40%	25% of the province is currently under official protection; but there is still a significant lack of protection for known groundwater reserves
1C: Risks to water quantity and quality	Medium risk (2)	Low risk (1)	High risks to water quality could have negative impacts on the health of people and ecosystems
2A: Efficiency of water infrastructure	Some efficiency (2)	Very efficient (4)	More efficient infrastructure allows for less water that is lost or wasted during sourcing, delivery, use, and post-use
2B: Balance of extraction and recharge of groundwater	Unknown in many places (1)	Recharge exceeds extraction (3)	Stable groundwater reserves are important for maintaining sufficient levels of water security, health, and quality environments
3A: Hectares of irrigated agriculture	40,000 Ha (DRAT + Filadelfia + a little more)	35,000 Ha	In December 2012, the irrigation system in the DRAT (28,000 Hectares) demand exceeded delivery capacity. No further hectares could be serviced. Conflicts and tension resulted.
3B: Mix of small and large (industrial) farms	Mixed, but small farms cannot compete (2)	Substantially more small farms than large or industrial farms (3)	A balanced mix of small, medium, and large farms allow economic opportunities for diverse people. Culturally, agricultural landscapes that contain substantially more small farms are preferred by most residents. The original purpose of the DRAT was to promote small farmer livelihoods and economic opportunity

3C: State of tourism real estate market	$50 million in foreign real estate purchases (2005)	No more than $25 million in foreign real estate purchases	2005 was during the real estate boom in Guanacaste, during which many water conflicts occurred. Residential tourism is not the preferred tourism of many local communities, although it has been promoted by the national government.
3D: An economy based on tourism	Very important, many Guanacaste economies depend on it (2)	Important for a diverse economy (3)	An economy that is entirely based on one sector could prove vulnerable to shocks. Coastal areas that depended heavily on visitor and residential tourism felt very difficult economic impacts during the 2008 collapse of the real estate market. Situations like that should be avoided in the future.
4A: The accessibility and transparency of decision-making for water resources	Sometimes open, but often closed (2)	Open (3)	An open process that is used to take decisions (and accordingly is accessible to rural communities and attentive to their needs) is a necessary part of governance that can help to avoid water conflicts and to create collective goals for water governance and sustainable development in the region.
4B: The extent of coordination in the management and planning of water resources	Centralized and often fragmented (2)	Polycentric (3)	Multi-level, multi-sector, and multi-organization coordination within water resources planning and management can play a role in allowing different stakeholders in different places to provide meaningful input (i.e., monitoring, info sharing, perspective sharing into governing processes
5A: The distribution of benefits, costs, and risks among stakeholders	Sometimes just, sometimes not (2)	Just (3)	A few people should not benefit at the cost of many without fair and just compensation and processes to determine appropriate risks, compensation, and benefit distribution
6A: The effectiveness and legitimacy of the basin and regional scale of water governance	Some effectiveness (2)	Effective (3)	Different places, such as basins and regions, require different governance focuses and efforts that are based on local needs and conditions. This is especially important in unique tropical dry regions that lie outside the experiences of prevailing governing institutions.

7A: Decisions based on long-term (20+ years) planning horizons	Some decisions (2)	Many decisions (3)	Decisions that anticipate future opportunities and impacts could support collective efforts to avoid negative un-sustainable water resource development and make progress toward more sustainable futures. This approach is important considering the high uncertainty and potential for high impact climate change in the region.
7B: The ease of modifying water policy and planning processes to meet changing needs and priorities	Difficult (2)	Easy enough (4)	If the climate or other conditions/ contexts (i.e., political economy) changes, new water policies could be required to meet community needs and secure environmental quality

Sustainability performance of evaluated alternatives

Below shows visually the differences of governance alternatives in terms of their evaluated sustainability effects/ performances. In this short appendix, I do not discuss each evaluated alternative and do not go into detail of the evaluation results. The only purpose here in this appendix is to show how the project evaluated alternatives (and compared them with the current state) in order to identify sustainable water governance alternatives and less sustainable alternatives. This was a key step for developing the governance transition strategies (using the base template in Appendix F) presented in Chapter 6 in the sense that participants collectively understood (1) what the transition strategies were meant to achieve; (2) what the transition strategies were meant to avoid; and, (3) where these strategies needed to start from (e.g., current state).

Table 5 (APPENDIX E): Resulting utility scores of water governance scenarios/ alternatives and the current state of water governance in Guanacaste from the multi criteria evaluation

Position	**Scenario/ Governance Alternative**	**Utility score**
#1	Scenario 3: Responsive and engaged	.62
#2	Scenario 1: Mandated to prepare	.52
#3	Scenario 4: Unnoticed in the background	.29
#4	Scenario 2: Closed-door alliances	.22
#5	Scenario 5: Overwhelmed and out of touch	.10
Current state of water governance	**Score: .29**	

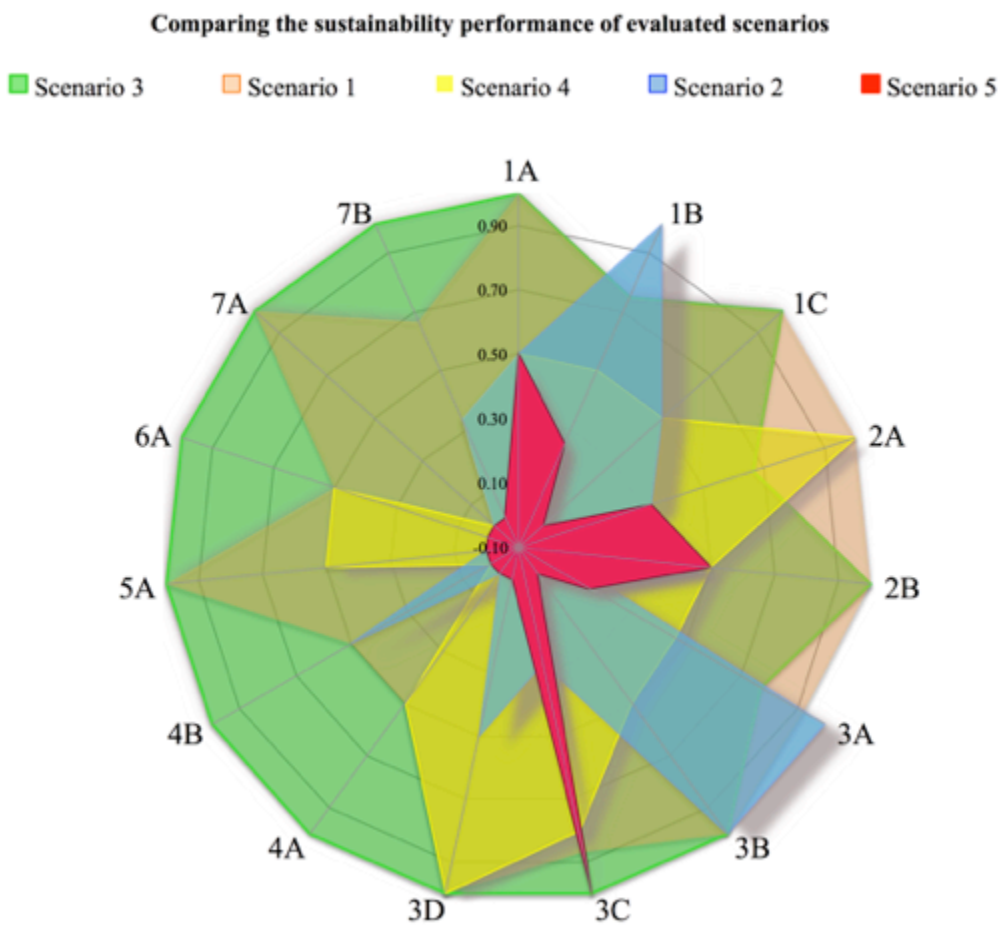

Figure 1 (APPENDIX E): Visualization of the evaluated scenarios, based on measured distance from identified sustainability thresholds. Scale (-0.10 to 1.00) indicates relative distance from identified sustainability threshold for each criterion (1A to 7B). Note: I include the value -0.10 in order to display values that would be equivalent to zero, which would otherwise not be visible in the diagram.

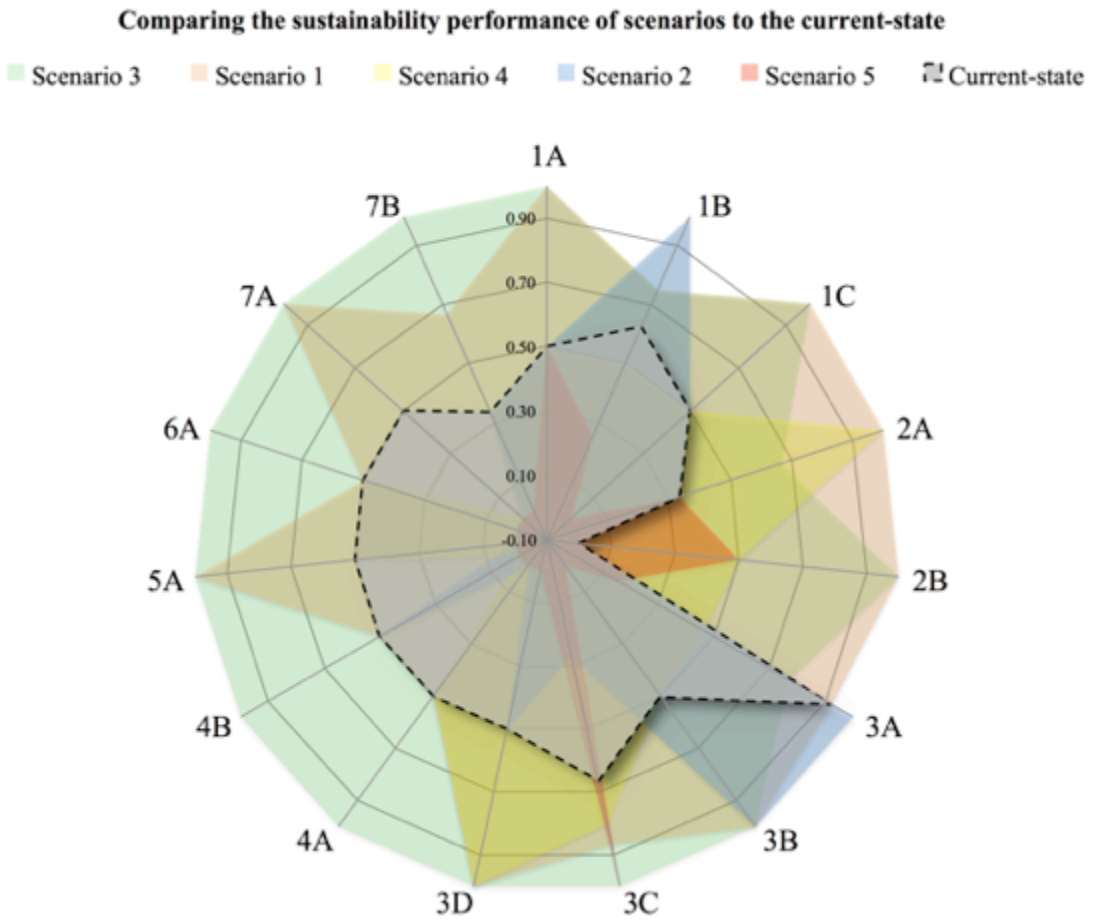

Figure 2 (APPENDIX E): Comparing the evaluated performance of the current-state with the performance of the evaluated scenarios. Scale (-0.10 to 1.00) is the same as Fig. 2 and indicates the relative distance from sustainability threshold for each criterion (1A to 7B) in comparison to the evaluated current state.

References (Appendix E)

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APPENDIX F

TEMPLATE FOR INITIALLY BUILDING A GOVERNANCE TRANSITION STRATEGY (SPANISH AND ENGLISH)

NOTE: FOR HIGH RESOLTUION 42X36 INCH POSTER IMAGES OF THE FOLLOWING TEMPLATES THAT ARE SUITABLE FOR PRINTING PLEASE SEND EMAIL TO: CHRISOPHER.KUZDAS@GMAIL.COM

Estrategia 'halar'

¿Cuales el nombre de su estrategia?

La acción principal para tomar (puede enumerar varias acciónes, pero rodear la acción más importante para continuar con esta actividad). Tambien, indicar el tiempo que necesita para la implementación.

¿Quien debe ser el lidier y estar responsible para tomar esta acción?

¿Cuales recursos necesita para tomar esta acción (personales, técnicos, financieros, otros)?

¿Están disponibles estos recursos ahora?

¿Si 'sí, quien tiene los recursos y cuales acciónes tomarian para obtenerlos?	¿Si 'no', cuales acciónes deben ser tomado – y de quien – para crear estos recursos?

Ahora, está listo para implementar su estrategia 'halar.' ¿Cuales obstáclulos expecta?

¿Cuales acciónes adicionales deben ser tomado para superar los obstáculos arriba?

¿Quien(es) debe tomar los acciónes arriba y cuales recursos están necesitados para ser exitosos?

¿Cuándo expecto el proceso de tomar este estrategia 'halar' será terminada (2020, 2025, etc.)? ¿Qué en el estado actual cambiará esta estrategia? ¿Cómo cambiará el criterio?

Estrategia 'empujar'

¿Cuales el nombre de su estrategia?

La acción principal para tomar (puede enumerar varias acciónes, pero rodear la acción más importante para continuar con esta actividad). Tambien, indicar el tiempo que necesita para la implementación.

¿Quien debe ser el lidier y estar responsible para tomar esta acción?

¿Cuales recursos necesita para tomar esta acción (personales, técnicos, financieros, otros)?

¿Están disponibles estos recursos ahora?

¿Si 'sí, quien tiene los recursos y cuales acciónes tomarian para obtenerlos?	¿Si 'no', cuales acciónes deben ser tomado – y de quien – para crear estos recursos?

Ahora, está listo para implementar su estrategia 'empujar.' ¿Cuales obstáclulos expecta?

¿Cuales acciónes adicionales deben ser tomado para superar los obstáculos arriba?

¿Quien(es) debe tomar los acciónes arriba y cuales recursos están necesitados para ser exitosos?

¿Cuándo expecto el proceso de tomar este estrategia 'halar' será terminada (2020, 2025, etc.)? ¿Qué en el estado actual cambiará esta estrategia? ¿Cómo cambiará el criterio?

Criteria: _____

Pull Strategy	Name of your 'pull' strategy?	Push Strategy	Name of your 'push' strategy?
Primary action to take (you may list several actions, but circle the most important to continue with the exercise). Also, estimate a timeframe that		Primary action to take (you may list several actions, but circle the most important to continue with the exercise). You may build on your 'pull' strategy!	
Who should lead and be responsible for taking this action?		Who should lead and be responsible for taking this action?	
What resources will be needed in order to take this action (personnel, financial, technical, other)?		What resources will be needed in order to take this action (personnel, financial, technical, other)?	
Are these resources currently available?		Are these resources currently available?	
If yes, who has those resources and what actions would need to be taken to obtain them ?	If no, what actions need to be taken – and by whom – to create these resources?	If yes, who has those resources and what actions would need to be taken to obtain them ?	If no, what actions need to be taken – and by whom – to create these resources?
Now you are ready to implement your 'pull' strategy – what implementation barriers do you expect?		Now you are ready to implement your 'push' strategy – what implementation barriers do you expect?	
What actions will need to be taken to overcome the barrier(s) above?		What actions will need to be taken to overcome the barrier(s) above?	
Who will need to take those actions and what resources will they need to be successful?		Who will need to take those actions and what resources will they need to be successful?	
Now imagine it is the year 20 and your 5-year strategy has worked! Refer back to the sustainability criteria above that this strategy targets, estimate how it has changed since 2012.		Now imagine it is the year 2027 and your 15-year strategy has worked! Refer back to the sustainability criteria above that this strategy targets, estimate how it has changed since 2017.	