WaterWorks4All: A Groundwater Reporting and Monitoring App

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Executive Summary

Groundwater is the life blood of the earth. It is the most precious natural resource we have, and we cannot survive or thrive without it. Access to secure water supplies is essential. There are millions of groundwater wells worldwide affected by intensive groundwater pumping. WaterWorks4All can help solve the over pumping of renewable groundwater in communities effected by water uncertainty and scarcity.

Renewable groundwater pumping in the US is significant, rated second in the world. Countries pumping the highest quantities of groundwater per capita are located in arid zones, where surface water is scarce and unreliable and where agricultural irrigation is well developed. Furthermore, groundwater is a common pool and there is little awareness of the cumulative implications of intensive groundwater pumping can do to a community's water supply, leading to an unsustainable water supply.

New Mexico has been experiencing water supply diminishment leading to uncertainty in water supplies due to worldwide, regional and local atmospheric climate changes caused by rising greenhouse gases. There is strong scientific evidence that the current long-term drying trend, driven by warming and precipitation deficits, could worsen for years or decades into the future causing water scarcity and uncertainty (Udall, 2017). There is an urgent need for more groundwater management interventions. WaterWorks4All, is a groundwater well monitoring and usage reporting mobile application (App) to assist in increasing longevity of declining groundwater resources by stopping wastage, encouraging efficiency and providing self-governed conservation behaviors in the Middle Rio Grande. This solution takes an adaptation practical approach to water planning and management by providing a water management tool for users who rely on groundwater for agricultural crop production and domestic use well sharing. WaterWorks4All begins as a pilot project in collaboration with the Middle Rio Grande Conservancy District (MRGCD) (MRGCD, 2020), focused on a select group of users dependent on groundwater wells. During the pilot the App will be analyzed, designed, developed, and tested in a real world setting before it can be made available to thousands of water users.

Introduction

This project concept began as an idea to make water planning effective by offering a suite of computer access tools for water managers and users to help manage an uncertain water supply. Supporting research identified an urgent need for intervention to curtail the over pumping of ground water. Although there are a number of viable interventions that have been effective, such as changing or implementing public groundwater policies, this concept idea proposes using Smart App technology to modernize water management by addressing the most critical need; monitoring and reporting on water usage.

There are about 16 million groundwater wells in the United States effected by intensive groundwater pumping (Mandler, 2017). The impacts from climate change such as droughts and population growth have led to the mismanagement of groundwater and therefore a growing need for more resources and management interventions to help curtail the over pumping. Water management experts are asking for governments and water agencies to act: "Governments and water management agencies should identify and monitor the unsustainably exploited water resources within the territory of their mandates and prepare to replace them in due course with alternative water sources or, if these are not available, to reform water use practices. The latter may require a transition to a completely different regional economy, much less dependent on water. This constitutes a major challenge in regions where the economy is dominated by irrigated agriculture that is largely based on non-sustainable exploitation of groundwater resources, such as on the Highland Plains in the USA or in many regions in the Middle East" (Margat, 2013).

The use of Smart App technology can help solve the over pumping of fresh groundwater by stopping wastage, encouraging efficiency and providing self-governed conservation behaviors. Furthermore, this leadership solution takes an adaptation practical approach to water planning and management by providing a tool to help with monitoring and usage reporting for water well users who rely on groundwater for agricultural crop production, and domestic use well sharing in rural communities.

WaterWorks4All begins as a pilot and will be implemented in a region known as the Middle Rio Grande Basin in the State of New Mexico (Appendix1.). The Middle Rio Grande geologic basin covers 3,060 square miles in central New Mexico, the most populous encompassing seven counties. In 1995, the New Mexico Office of the State Engineer (OSE) declared the Middle

Rio Grande Basin a “critical basin”. “The ground-water basin is faced with rapid economic and population growth for where there is less than adequate technical information about the available water supply” (ISC, 2019).

In addition to improving and strengthening water planning and management practices in the region, this project will also help make groundwater measurement and accountability a priority for State agencies, water managers and the end user by introducing App technology as a way forward to replace a paper reporting system. This project, instituted as a pilot, is asking the OSE and Interstate Stream Commission (ISC, 2019) to put in the hands of the user an easy to use mobile App serving as a tool to help monitor and report usage while at the same time improving water management.

This paper outlines the water supply problems New Mexico is facing, how to take a leadership approach to the problems, what was discovered and why these discoveries are important in addressing our current and future water supply in a sustainable way. As outlined the projects pilot will analyze, design, develop, test and implement the mobile App. The intended outcome being; stopping wastage, encouraging efficiency, encourage water sharing, improve conservation behaviors, and minimize water needed to meet beneficial water rights, in the Middle Rio Grande Basin.

The Desirable Results

The desirable results from implementing this pilot project is to curtail groundwater pumping by putting into motion a solution that is, readily transferable, uses practical science and technology to reliably help water users to report and monitor their usage on a voluntary basis. This project makes the assumption that water users, if given effective tools, will have a better understanding of their usage thereby encouraging water conservation and efficiency. Center to the project involves using the act of citizen science to help define and measure sustainable groundwater levels.

This project can lay some foundational work to determine if New Mexico needs a Groundwater Sustainability Plan with goals for each basin and if the State needs a mandatory metering and reporting policy. The projects outcomes can also help State agencies account for uncertainty by developing a suite of modernized proactive responses to help improve supply and demand and help define measurable and quantitative objectives to determine undesirable

results such as; the chronic lowering of groundwater levels and other ecological and sociological impacts to the river basin. Finally, help develop warning triggers to ensure the threshold is not crossed. The key goal in this project will help create an understanding of water usage in order to then effectively manage groundwater usage to avoid undesirable results and achieve sustainable yields.

And lastly, this paper outlines the water supply problems New Mexico is facing, how to take a leadership approach using citizen science to help solve the problems, what was discovered and why these discoveries are important in addressing our current and future water supply in a sustainable way.

Water Planning, Management and Sustainability

With climate change looming over our communities and dismal water supply projections over the long term, the timing was perfect to find solutions to complicated environmental problems like water scarcity and the management of uncertainly. To address some of these problems, water planning becomes essential to help protect water resources and plan ahead as the state prepares for water shortages. While the most visible signs of drought in New Mexico are dwindling snowpack, a dry riverbed and depleted reservoirs, some of the state's serious water supply issues are hidden from view. An over reliance on underground aquifers for agriculture and private wells in the state has led to concerns that New Mexico will deplete our groundwater, causing a cascade of long term environmental, economic and social concerns. There is also the failed public's view that water supply has no limits. Without planning, our water resources are at risk at being depleted.

Every few years the ISC, a State agency, conducts a statewide water planning effort for 16 regions (OSE, 2018). Each region has the opportunity to come together to plan for their water. However helpful in bringing communities together to share solutions, the plans are difficult to implement in a holistic way for each region because each region has its own unique challenges. One such challenge is the Rio Grande Compact compliance in the Middle Rio Grande (Otowi Gage to Elephant Butte Dam) to deliver water to Texas. If the delivery is not met, this could result in millions of dollars in fines to the State of New Mexico. Yet another challenge is posing a threat to water supply; the unsustainable groundwater depletions in many areas of the state; and New Mexico's key water management agencies not having enough financial resources to protect

our water supply.

Water management in New Mexico has always been a challenge. New Mexico has the fifth largest landmass in the United States with the least amount of available surface water. Adding to this problem, surface water supplies are fully allocated making water planning a challenge when it comes to supply and demand. Over pumping is a grave concern, without any end user accountability and concern that groundwater could be depleted. New Mexico's water supply is dependent on mountain snowpack, spring runoff and summer monsoons to supply its needs. Climate change will make available water supply vary from year to year causing uncertainty. Furthermore, wildfires, forest dieback, aquifer decline, and other stresses are degrading ecosystem services and hence the sustainability of water supply. Water planning and the strategies that come from water planning consist of many thought processes and ideas requiring collaboration between government agencies, water managers and irrigators. The intended purpose of the water plans creates a pathway to act and succeed at the desired strategies. Statewide and Regional water planning efforts are helpful in identifying a suite of strategies for implementation but without action and the necessary resources to implement the ideas, the water plans stay idol. There is consensus among water planers that the existing updated water plans are not sufficient to meet the demands of a diminished water supply into the future (MRGWA, 2018).

This project came about from reviewing the Middle Rio Grande State Water Plan (OSE, 2018), asking for improved water monitoring and measurement (OSE, 2018) and feedback from a group of water planners who made recommendations to the ISC on ways to make water planning effective (MRGWA, 2018). The state water plan for the Middle Rio Grande states: "Unmeasured water is seen to be a major encouragement to casual or excessive water use. The recommendation is that all uses of water in the region be measured and reported at the single user level. Measuring only particular types of users or particular individual users is publicly seen to be unfair. The recommendation is to establish the measuring program immediately for all new uses, and as a gradual retrofit to existing uses, as soon as possible. This recommendation is for local and state governments to implement incentive, regulatory, and/or public education policies so as to stimulate the prompt installation of appropriate retrofit measurement devices. Besides the direct benefit of water savings, this recommendation will enable much more incisive and efficient management of our surface-water and ground-water supplies. This will entail costs, and

the appropriate bodies should consider how these costs would most fairly be borne" (OSE, 2018).

Supporting Research

Water scarcity affects more than 40 % of the global population and is projected to rise (United Nations, 2015). Relevant to New Mexico: "Over 1.7 billion people are currently living in river basins where water use exceeds recharge" (United Nations, 2017). Groundwater pumping for irrigation is one of the main causes for water depletions here in New Mexico.

The countries with the largest extent of areas equipped for irrigation with groundwater, in absolute terms, are India (39 million ha), China (19 million ha) and the USA (17 million ha) (Siebert, 2010). Groundwater use in irrigation is increasing both in absolute terms and in percentage of total irrigation, leading in places to concentrations of users exploiting groundwater storage at rates above groundwater recharge (Siebert, 2010). Here in New Mexico agriculture irrigation represents 76% of total water usage, both groundwater and surface water (OSE, 2015), above the National average of 65% (American Geosciences Institute, 2017) and 69% worldwide (Kresic, 2009).

Water resources refers to underground aquifers (layer of rock and sand that is saturated with water) and surface water (rivers, lakes, and streams). Groundwater is predominantly a renewable resource which, when managed properly, ensures a long-term supply that can help meeting the increasing demands and mitigate the impacts of anticipated climate change (Kresic, 2009). To better understand this, we begin by asking what is sustainable water management? It refers to a complex interactive process that considers societal, economic, and environmental values, and the respective consequences of different water management decisions (Kresic, 2009). In theory, groundwater use can be sustained if the amount of water removed is equal to recharge commonly referred to the concept of "safe yield". But this is a myth. There is no volume of groundwater use that can be truly free of any adverse consequence on a complex and dynamic system. Water must have a source from where it comes from like rain or snowpack and it falsely assumes that there will be no effects on other elements of the overall water budget and natural system. What's most important when implementing water management strategies is developing a common understanding of how changes in one portion of the system will ultimately affect its other parts as well (Kresic, 2019).

Due to climate change, climate scientists are saying our state will see a 35% or more reduction in water supply effecting the states stream flow quantity and aquifer recharge (Udall. 2018). This means less water flowing down the river for our agriculture, businesses, urban and rural communities and wildlife. This means we will face water shortages in certain areas of the state. Is New Mexico prepared to deal with these challenges? How will businesses, government and individuals alike cope with a limited water supply? What will this mean for future generations? These questions and many others are the reason why we need effective water management, planning and governance.

There is much information and research on climate change and how it will affect water resources. Research conducted by the EPA's Office of Research and Development stated essential and innovative science and engineering was needed to address climate change and improve air and water quality. The research says, "Climate change poses unique challenges for protecting environmental resources upon which our society depends. Adapting to changing climate hinges on knowing the regional and local vulnerabilities and impacts to water resources and ecosystem services. Determining social and ecological risk is a major challenge because of insufficient data, knowledge and models, including uncertainties about the regional and seasonal nature of changing climate and how water, watersheds and associated ecosystem services respond to interacting biological and physical stressors" (Beedlow, 2019).

The concept of sustainability means; meeting today's needs without jeopardizing the ability of future generations to meet their needs. It also means; addressing the balance between environmental, social and economic concerns. Understanding science and research will help determine what sustainability means at a local level so to avoid undesirable results. The State of New Mexico does not have a technical definition for sustainability. This proposes challenges for most communities who have water shortages because more than likely they do not have the resources to find solutions or implement solutions documented in the State water plan. The importance here being; sustainability should connect long-term environmental and social challenges with economic priorities. Through Statewide water planning efforts, sustainability will more than likely be defined by the range of community members, experts and non-experts who work together to develop a vision for the future.

SWOT Analysis

This project applied a SWOT (sSWOT) analysis to identify undesirable threats and opportunities in the Middle Rio Grande Basin (sSWOT appendix 1). The World Resources Institute (WRI) created the sustainability SWOT (sSWOT) to help organizations take action on environmental challenges (Mitzer, 2012). SWOT stands for; strengths, weaknesses, opportunities, and threats. It serves as a guide and framework to put forth a process to help motivate, engage and identify and communicate new insights to decision makers within any kind of organization. The SWOT approach is designed to help drive action as an end goal.

This project identifies the over pumping of groundwater as the key challenge effecting communities long term water supply. The SWOT is useful in helping explore what's at risk, identify possible opportunities and solutions and how to prioritize to take action.

Identifying Threats

Threats mean consequences for communities affecting everyone in the State of New Mexico, including wildlife. The SWOT analysis for the Middle Rio Grande Basin determined several key important threat multipliers this project seeks to address. Climate change poses a serious threat and has become one of the most significant and fastest growing threats to people and their cultural heritage worldwide (ICOMOS, 19GA 2017/30). All credible projections of 21st century climate call for continued warming in the decades to come. Numerous assessments of groundwater vulnerability to a warming climate project that groundwater resources will be adversely affected by even small increases in temperature, regardless of changes in rainfall (Chermak, 2015). What are the impacts?

- Earlier springs, hotter summers, and milder winters pose a threat, especially to a desert Southwest. This impact will greatly affect agriculture in all parts of the State. Research is showing that up to 29% reduction in runoff is forecasted by 2080 (Hurd, 2007) causing a cascade of water shortages, economic and social consequences.
- Precipitation patterns have also changed, with more intense droughts and storms and a greater percentage of overall precipitation falling as rain rather than snow (Udall, B. 2017). These changes have led to lighter snowpack and earlier

snowmelt, which contribute to lower steam flows and reduced water availability during the summer (Udall, B. 2017). Flash floods will be a common occurrence during the summer and fall, effecting infrastructure, rivers and streams, impacting the quality of water.

- Droughts are complex causing a cascade of occurrences that have economic, social and environmental impacts (NDMC, 2019). Extended, severe drought significantly affects both surface water and groundwater supplies by disrupting the balance between precipitation and evapotranspiration in the hydrologic cycle (Chermak, 2015). The most significant adverse effects that severe drought and a warming climate have on groundwater resources are: (1) reducing the availability and distribution of groundwater recharge; (2) compounding groundwater depletions with additional pumping; and (3) intensifying groundwater declines that result in a permanent loss of groundwater storage (Chermak, 2015).
- New Mexico is home to well-known cultural heritage sites, objects and practices going back thousands of years. Loss of ancient cultural Acequia's that has sustained our agricultural cultural identity and ways of knowing for hundreds of years will be felt (NMSU, 2017).
- State financial support for water planning has been consistently far less than in neighboring states. Funding, staffing, water resources data collection, and the capacity of agencies to deal with New Mexico's water problems are all currently diminished from previously inadequate levels, while, at the same time, our water supplies are facing increasing pressures due to climate change.
- Finally, one other affected issue in the Basin is meeting the Rio Grande Compact compliance in the Middle Rio Grande (Otowi Gage to Elephant Butte Dam) to deliver water to Texas. If not met; this could result in millions of dollars in legal fines the State of New Mexico will have to pay.

Weaknesses and Strengths

The SWOT analysis identified several weaknesses affecting water planning efforts in the region that could pose a threat to a sustained water supply. One such weakness is a lack of State funding to support water planning activities coupled with lack of State agency personal to aid in

implementation of water planning is undermining water planning efforts in the regions. Other weaknesses such as the over allocation of water use and over pumping will have a negative impact on current and future water supplies.

The SWOT analysis identified three key areas that could strengthen water planning efforts in the Basin. The two key agencies, the ISC and the MRGCD are best positioned to create opportunities for collaboration that could support water conservation efforts. Secondly, the newly formed Water Data Act of 2019, will provide reliable data to improve water management and planning efforts (NMBGMR, 2020) and serve as a key resource for the pilot. Finally, there is robust advocacy coming from the Middle Rio Grande Basin's region who are motivated to see improved water planning efforts.

Identified Opportunities

The whole notion of having many water users with competing interests such as, irrigators, cities, industries and wildlife, presents opportunities to explore collaborations, innovation and conservation efforts so that when water is scarce those efforts are helping everyone. The SWOT analysis identified four key opportunities. One such opportunity is the forging of partnerships and collaborations among key water managers and advocates. To create the opportunities, you need partners and collaborations. For example, Audubon effort to partner with the State Engineer, recently secured important water rights that supports birds and people (Audubon, 2019). This newly signed permit by the State Engineer gives water right holders the option to use their water for the protection of stream flow. "In-stream-flow water rights allow water right holders to leave their water in the river channel while still retaining its status as legally protected property. Through this permit, New Mexico has recognized in-stream flow as a beneficial use, establishing this important tool for improving ecologic and economic resiliency" (Audubon, 2019). More water flowing down stream means habitat protection for birds and native riparian habitat. Like the Audubon case, you need ideas and you need partners. "Consider the strengths you can add and share through partnerships which can break down seemingly insurmountable barriers. One company cannot transform an industry by itself. It will need supporting partners, like customers, suppliers, or supporting infrastructure and policies" (Mitzer, 2012).

The second opportunity is the efforts to improve and integrate water resources and water

use monitoring, data collection and data availability to support water planning and management. The Water Data Act is the vehicle to help with this effort, led by the Bureau of Geology and Mineral Resources (NMBGMR, 2020). There efforts are credited for taking the leadership role in laying the foundation for water data modernization. Without their efforts the pilot would have a difficult time succeeding.

App Technology as a Conservation Tool

The use of technology to support water management challenges is not a new concept. In 2000 BC the Romans developed cement pipes to ensure that irrigation water could be delivered cleaner and more efficiently and the Greeks are credited by developing filter and rainwater harvesting systems to improve their water supplies (Global Water Forum, 2015).

Water management over the last few decades reflect a shift away from infrastructure management to Integrated Water Resources Management (IWRM) concepts of social equality, economic efficiency and ecological sustainability. IWRM has been defined by the Global Water Partnership (GWP) as a "process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP, 2019). IWRM is now the dominant paradigm for managing water resources worldwide. Technologies available for supporting IWRM now include the use of mobile phone and internet applications. The availability of mobile phones is ubiquitous worldwide, easy to use, affordable, and able to transmit a variety of information such as text, spatial information and photographs rapidly over long distances.

To improve implementation of IWRM, a mobile application will build the capacity of individuals, communities, or institutions in at least one of the six capacity categories; institutional, human resources, technical, financial, stakeholder and social linkages and information management (appendix 2). The capabilities of mobile applications align closely with the communication and participation focus of IWRM (Global Water Forum, 2015). This project can help improve IWRM all six capacity categories.

Research conducted on mobile application development for water management found App development has been focused on water supply and sanitation such as remote and participatory monitoring, payment of water bills, and communication between users and water

utilities (Global Water Forum, 2015) and not enough of a focus on a broader scale of water management challenges such as, flood warning systems through GPS tracking. Applications supporting technical and information management capacities dominate the market today. For example, collection and distribution of information on water quality or the condition of water supply infrastructure.

The range of App's in the marketplace rely on capturing photos, some do calculations for you, and others are made specifically for monitoring instruments. For example, the University of Nebraska developed one of the earliest App's for irrigation management. The main function is to estimate soil water status based on soil matric potential sensors installed at soil depths of 1, 2, 3 or 4 feet (Irmak, 2006). The App uses the algorithms and procedures researched and published by Irmak et al. (2006; 2010). With these sensor readings, the App estimates the crop water used as well as what available soil water is remaining in the profile for typical 8 different soil types. The user can also see historic sensor readings and graph the data and pin his/her GPS locations.

Some Apps's register water variables by taking a picture with a smartphone. The App will measure a water level in a river or canal, ground water level, gate position, discharge or water quality variable. The picture is then automatically uploaded to the database/Water Information System and proprietary pattern recognition software reads the water variable from the picture. In contrast to professional Apps for users Mobile Water Management App, uses citizen science to collect local data for global precipitation monitoring. For example, the iRain Mobile App is designed to facilitate citizens' involvement in collecting local data for global precipitation monitoring (UNESCO, 2019). It allows users to visualize real-time global satellite precipitation observations, track extreme precipitation events worldwide, and report local rainfall information using crowd-sourcing functionality of the App to supplement the data (UNESCO, 2019). The key benefits are used to inform emergency planning and management of risks, such as floods, droughts, and extreme weather events.

Currently the OSE requires meter reporting for only new domestic and non-domestic well use. This leaves thousands of wells users not reporting usage. This could represent irrigators, domestic, commercial and/or industrial usage. Well usage must be reported on a form (WR-26) manually and then emailed on a quarterly or monthly basis depending on the type of user (appendix 4). This suggests an opportunity to move toward an App to report usage. This project

would replace the current time-consuming handwritten reporting system with a user-friendly App as a first step toward modernizing the reporting system.

Irrigated agriculture accounts for 76.30% of New Mexico's total water use coming from a mix of surface water and ground water (OSE, 2015) suggesting that a mobile app developed for irrigators and well users makes the most sense to help conserve water use. The Rio Grande Basin is the most populous region at 1,532,954 people and accounts for 46% of the total surface and groundwater supply in the State (OSE, 2015).

Smart technology is not new to the OSE. Available through the OSE is the New Mexico Landscape Irrigation Smart Calculator, available only web based. The second water measurement program is the Real-Tim Water Management Information System. This allows the State Engineer to actively manage the state's limited water resources while administering water rights and interstate compacts throughout the state. In order to do this, the OSE/ISC maintains a network of stream, acequia, ditch's and well monitoring sites that electronically transmits data values via radio and satellite telemetry and stores the data in a database. This data collection primary intention is to collect data and not intended for the end user to help conserve water use. This project is proposing to change this scenario in a number of different ways. Firstly, to allow the water user to participate in reporting of water usage through a mobile App and secondly, to allow water users to monitor their own water usage to encourage water conservation.

Mobile applications can incorporate the GIS (Geographic Information System). The GIS is a framework for gathering, managing, analyzing data and communicating in a real-world setting. It analyzes spatial location and organizes layers of information into visualizations using maps and 3D scenes. By utilizing this technology, you can map out a story about our water supply and its users and build deeper insights using water data and relating that to situations, helping users make smarter water management decisions. For example, this would be great for farmers who want to understand they're water usage to conserve water.

Target Audiences

The target audience will be water users who use ground water wells. The pilot project will be two groups. The first group of 10 will be domestic ground water users who share a well. The second group of 10 are ground water users who irrigate and may or may not have a meter.

To make this leadership project feasible, a partnership with the MRGCD, the OSE and the ISC is essential. Going it alone is not a good idea, as most projects require some kind of collaboration or partnership to achieve any kind of success. The MRGCD maintains and manages irrigation, drainage, and river flood control in the Middle Rio Grande Valley (MRGCD, 2020). They serve to promote efficient and responsible water management, protect the environment, wildlife and endangered species in cooperation with other local, state and federal agencies, and provides multi-use recreational opportunities within the Middle Rio Grande Valley. The MRGCD will serve as the pilot host and funder. Funding sources would come from non-profits and organizations who share the same conservation goals.

Building the Project

The overarching vision is to analyze, design, develop and test a mobile App for water users and managers. This project will address unsustainable ground water supply draws by putting in the hands of water users a tool to help monitor water in times of drought and supply uncertainty and serve as a reporting tool to help understand usage.

Building the project will happen in phases beginning with the selection of the two pilot groups of 10 each. The two groups would be involved in a needs assessment to determine what user-friendly features of the App are needed. This project is calling for a water usage and monitoring App that would allow the user to report their water usage to the OSE while at the same time monitoring their water usage. It would replace their existing paper reporting system required by the OSE. Building the project would take six months and testing the App in the field would take from 3 to 6 months.

After the pilot has been successfully completed the App is ready to scale up to all well users. The scaling up could be implemented in phases as more resources become available. The OSE and the ISC would be responsible for the implementation and ownership of the project with collaboration from the MRGCD. The ISC or OSE would act as the hub to maintain the App, requiring a staff person to manage the data collection and monitoring.

Other App opportunities that could arise from the pilot is the addition of a feature to implement Water Banking. “Water Banking is used to promote the beneficial use of water for agriculture, protect water rights and water supply, ensure adequate carriage water, and support aquifer recharge. The Water Bank enables irrigation of productive lands with leased water when

water supply is sufficient to serve all lands within the MRGCD. When water supply is insufficient for all lands, Water Bank leases may be curtailed to protect water rights of other land within the District. The Water Bank supports the intent of the MRGCD that as many irrigable acres as possible remain in agricultural production" (MRGCD, 2020). With the App feature, the water rights owners will be encouraged to apply for Water Banking and if leasing water from the Water Bank can be notified when they will receive water for their most productive lands during curtailment periods.

This project is asking for a change in the way water usage is accounted for and a shared place of understanding of how water is valued. Those are two different tasks. Water is a shared natural resource necessary for our survival and assumed it should be an easy topic for most audiences to relate to. But when it relates to the failed public view that water supply has no limits, it requires changing the public view. To make any kind of change happen, the goal will be to make the audience become the "hero" (Duarte, 2013). Helping the public understand where our water comes from, how much supply we have at different times of the year and how to value conservation as a self-governed action to benefit the common good is the first step toward a sustainable water supply. The second task is asking for the OSE and ISC to make necessary changes to the way water is accounted for by modernizing the reporting system with Smart App technology; the pilot will serve as a learning process to guide changes in governance.

Creating a Work Breakout Schedule (Gantt Chart)

This activity will help organize the projects duties and activities in three phases (Appendix 3). The Gantt chart helps both the team and people outside the team to understand the major activities of the project and their progression in time (Tate, 2010). Phase I of the project involved defining the project, its goals and identifying collaborators. Phase II involved researching the project features, identifying a developer, making presentations to stakeholders and defining the App development process. The final phase is the implementation of the pilot project.

Conclusion

In conclusion, sometimes sustainability initiatives are not always clearly defined in the beginning. This was true for this leadership journey. But taking an initiative like this pilot to

work with stakeholders in a more direct and personal collaborative way, helps to define the scope of the problems and have a better understanding of how the problems can affect their neighbor, thereby affecting a whole community. It is the journey and process of defining the needs that will have an effect on actions taken. Lastly, putting a tool in the hands of the users such as, WaterWorks4All is so important to help encourage self-governed conservation behaviors. It is the collaborations and the tools created from those efforts that will guide us towards sustainability.

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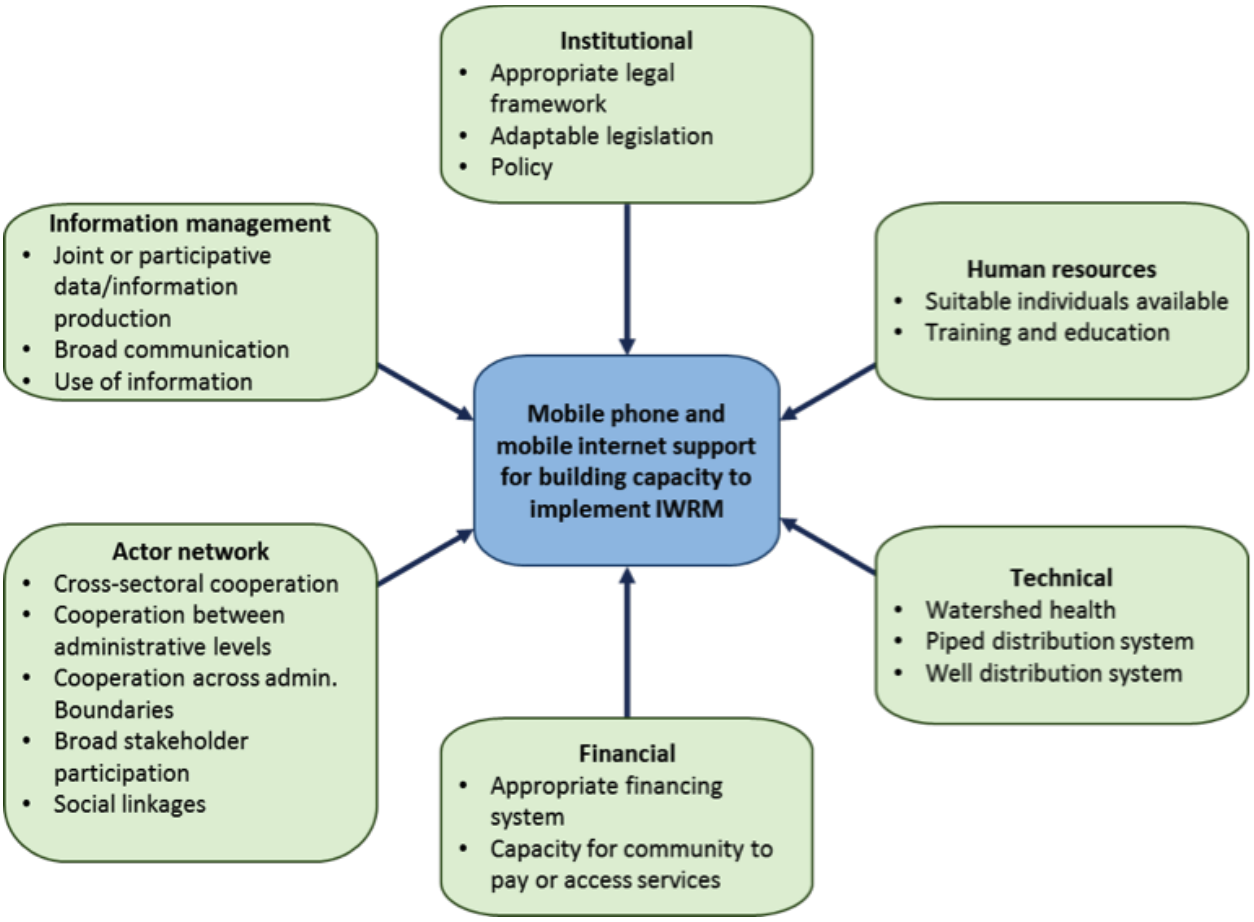
New Mexico's Middle Rio Grande Basin
Abiquiu Reservoir
Rio Chama
Rio Grande
Rio Chama Acequia Association
Espanola
NM Upper Rio Grande Basin
Buckman Direct Diversion
NM Middle Rio Grande Basin
Cochiti Lake
Cochiti Dam
Santa Fe
Pecos
Cochiti Reach
Angostura Diversion Dam
Pecos River
Bluewater Lake
Rio Rancho
Bernalillo
Corrales
ABCWUA Diversion Dam
Milan
Grants
Albuquerque
Albuquerque Reach
Moriarty
Isleta Diversion Dam
Middle Rio Grande Conservancy District
Bosque Farms
Los Lunas
Belen
Estancia
Laguna del Perro
Isleta Reach
Salina Lake
Mountainair
SEVILLETA NATIONAL WILDLIFE REFUGE
San Acacia Diversion Dam
Socorro
San Acacia Reach
BOSQUE DEL APACHE NATIONAL WILDLIFE REFUGE
Carrizozo
Capitan
Rio Grande
Elephant Butte Reservoir
Ruidoso
Ruidoso
Miles
0 5 10 20
ELEPHANT BUTTE DAM
Las Cruces
Consequences
Big Salt Lake
Tularosa
Caballo Reservoir
Interstate Stream Commission

Appendix 1.


Institutional
Appropriate legal framework
Adaptable legislation
Policy
Information management
Joint or participative data/information production
Broad communication
Use of information
Human resources
Suitable individuals available
Training and education
Mobile phone and mobile internet support for building capacity to implement IWRM
Actor network
Cross-sectoral cooperation
Cooperation between administrative levels
Cooperation across admin. Boundaries
Broad stakeholder participation
Social linkages
Technical
Watershed health
Piped distribution system
Well distribution system
Financial
Appropriate financing system
Capacity for community to pay or access services

Appendix 2

Addressing Groundwater Sustainability: A Pilot: WaterWorks4All: Using Mobil Applications To Manage Groundwater Depletions						
	Notes	Risks	Partners	Contact	Finish Date	%complete
Phase I						
Identify project name and description	Name Change				2/20/20	100%
Identify Funder		Maybe won't fund	Interstate Stream Commission and the Middle Rio Grande Conservancy District			100%%
Key Stakeholder Identified		Could be other stakeholders critical to the project success.	Interstate Stream Commission			100%%
Secondary Stakeholders Identified	Secondary Stakeholder		Hydrogeology Program at the Bureau of Geology and Mineral Resources			100%
	Secondary Stakeholder		Middle Rio Grande Conservancy District			100%%
	Secondary Stakeholder		Middle Rio Grande Water Advocates			100%%
Phase II						
Make Face to Face Project Concept Presentation to Stakeholders			Interstate Stream Commission	Director Rolf Schmidt	March 2020	
			Hydrogeology Program at the Bureau of Geology and Mineral Resources	Stacy Timmons	February 2020	100%%
			Middle Rio Grande Water Advocates	Norm Gaume	December 2019	100%%
			Middle Rio Grande Conservancy District	Mike Hammon	December 2019	100%%
Work with Noventum Software Development to create App	Create project architecture: needs assessment by working with Bureau of Geology and Mineral Resources. I don't need Noventum to propose this project.	Noventum might not be the selected developer because of State purchasing regulations.	Noventum Software Development		March 2020	100%%
Write project proposal that will guide my paper and spark talk.	This would be the design, build and implementation guidelines and phases.		Presented to my key stakeholder.		February 2020	100%
Backcasting -	Research the California Ground Water New Legislation. Include in presentation. Research the web site of the Water Data Act				February 2020	100%
Make Second More Detailed Project Presentation to Stakeholders			Interstate Stream Commission, Bureau of Geology & Mineral Resources, Middle Rio Grande Water Advocates & Middle Rio Grande Conservancy District		March	90%
Create Spark Talk	Work on images and script				March 2020	100%%
Final paper	Needs editting				March 2020	90%%
Present Spark Talk	Revise spark talk after presentations.		Interestate Stream Commission		Mar-20	
Phase III						
Implementation	Implemented by the Interestate Stream Commission; Water Planning Department				unknown	
Project Funded		Dependent on State funding			unknown	

Appendix 3