

Linking Science, Social Studies, and Sustainability through NSF Research on Mediterranean Landscapes



Mediterranean Landscape Dynamics Project Overview

- The Medland Project was developed by an interdisciplinary team of scientists at ASU and other universities worldwide to better understand the changes people make to the landscape
- It is funded by a grant from the National Science Foundation
- A portion of this grant was used to fund an Educational Outreach component in which the Medlands data is used to construct lessons about landscape change and sustainability

Landscape Differences



Landscapes that were once forested, have changed over time to sparsely wooded or almost completely cleared

How Could This Have Happened?



Hypothesis: Over time, farming and grazing have had a huge impact on the land that wasn't immediately noticeable

When did
people first
start making
major
changes to
the
landscape?

Neolithic!



What do you know
about the Neolithic
and the start of farming?



The Neolithic Revolution: 8,000 BCE



- Farming = Surplus food
- People “settle down”
- Populations grow and disease spreads
- Creation of “jobs” and social inequality
- Long distance trade
- Warfare
- New technology- invention of pottery



Neolithic Package



Sheep



Goats



Lentils



Chickpeas

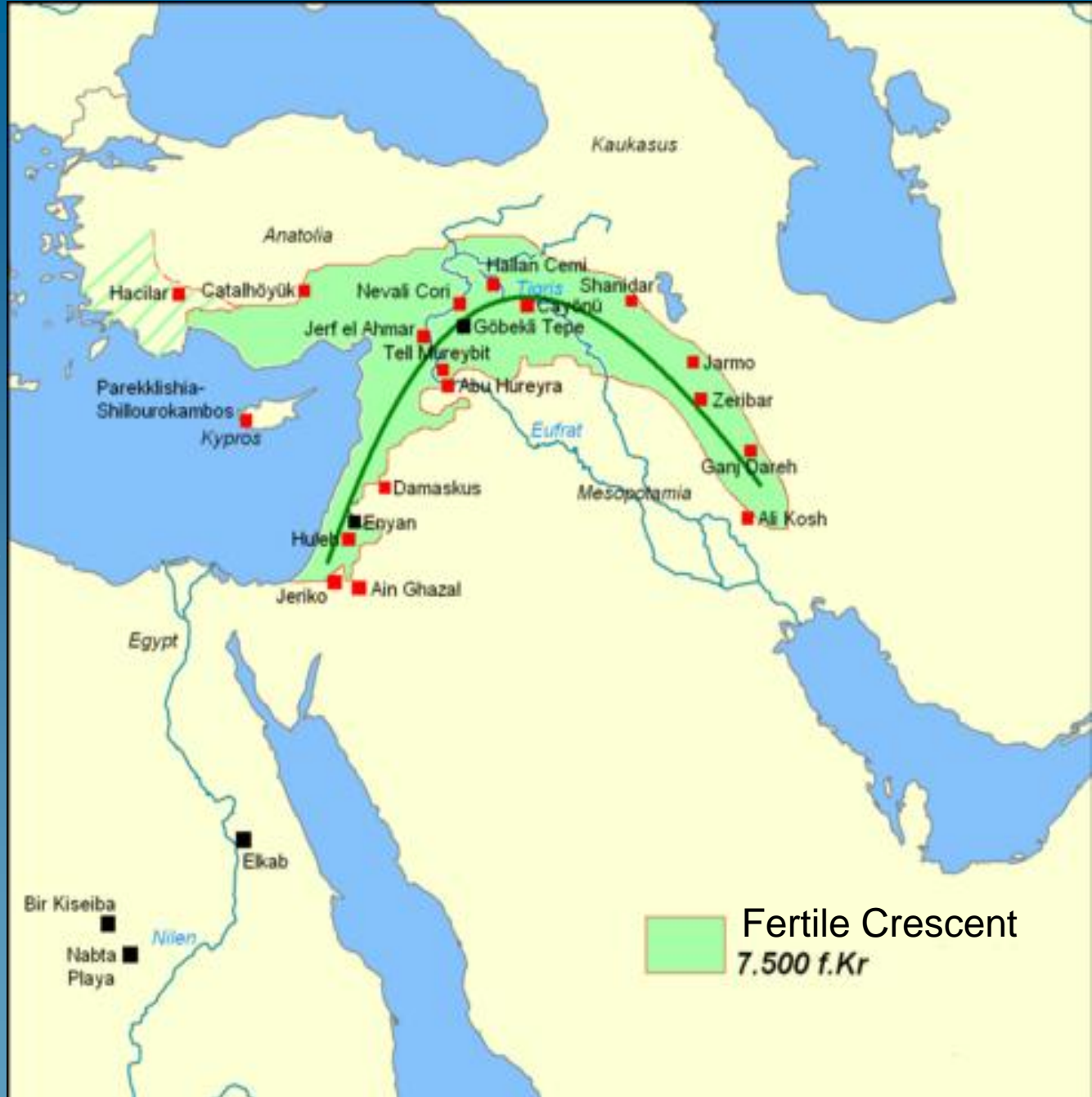


Barley



Emmer Wheat

Origins of Agriculture

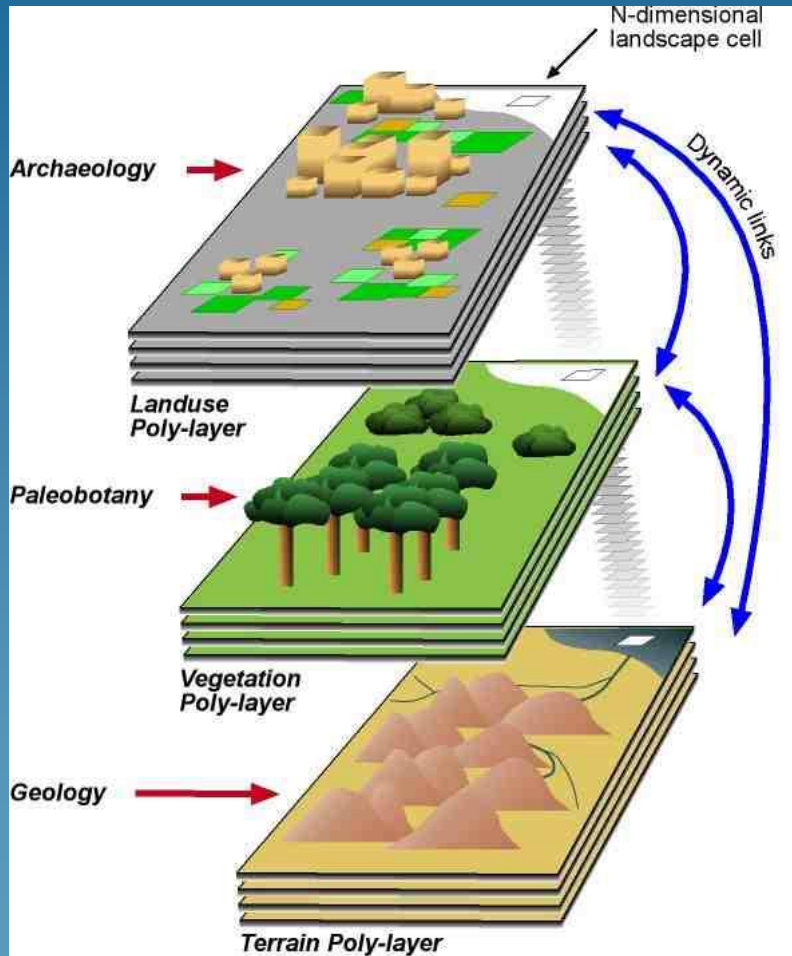


Mediterranean Landscape Dynamics (Medland)

Main questions: How did the decisions made by Neolithic farmers change the Mediterranean landscape? How does that affect our future decisions?

Experiment: the Medlands team collected data from the study areas and used it to create an agent-based computer model that simulates the decisions made by Neolithic farmers and the changes they made to the environment.

The Medland Model

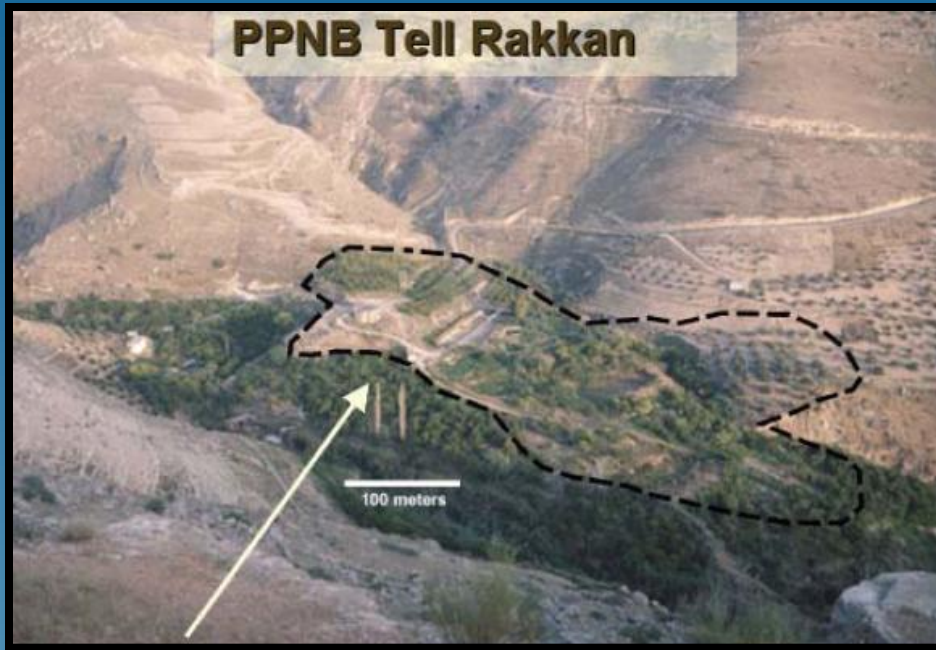


Agent model captures human social structure



Landscape model captures climate, landforms, surface processes (erosion), and vegetation

Case Study



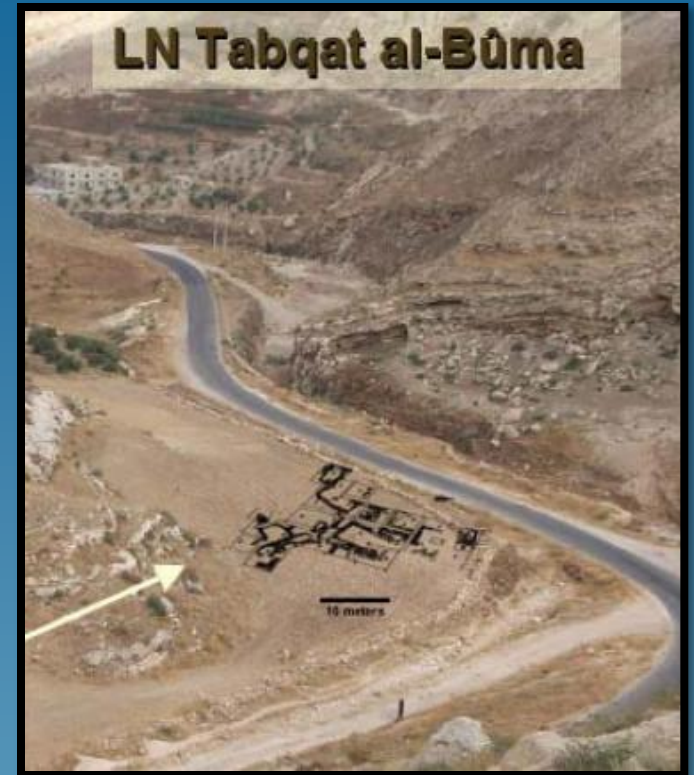
Medium sized village

100 people

On hillside

Heavy rains

(limited excavations)



Small farmstead

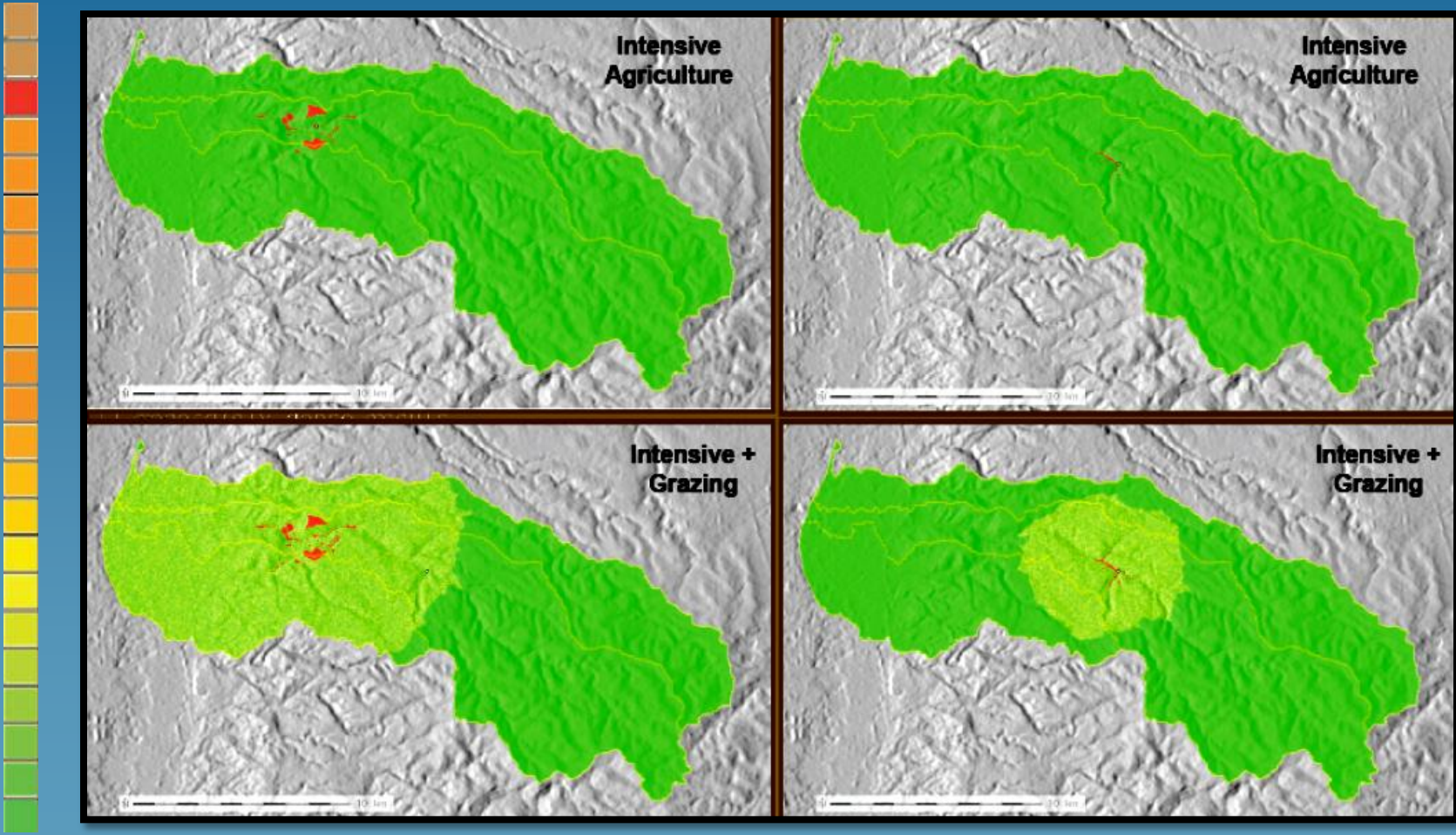
20 people

Flatter land

(fully excavated)

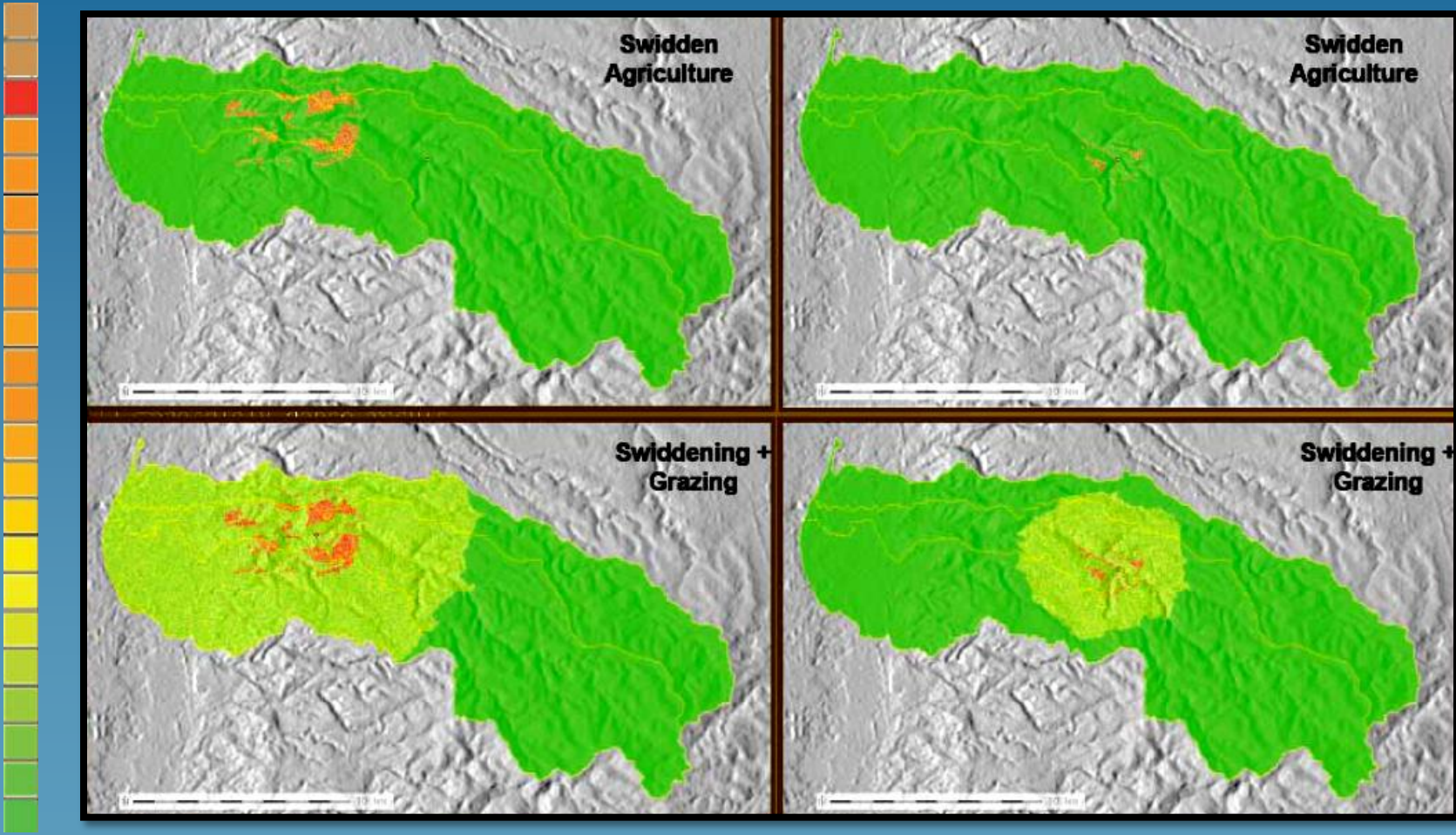
Tell Rakkan

Tabqat al-Bûma

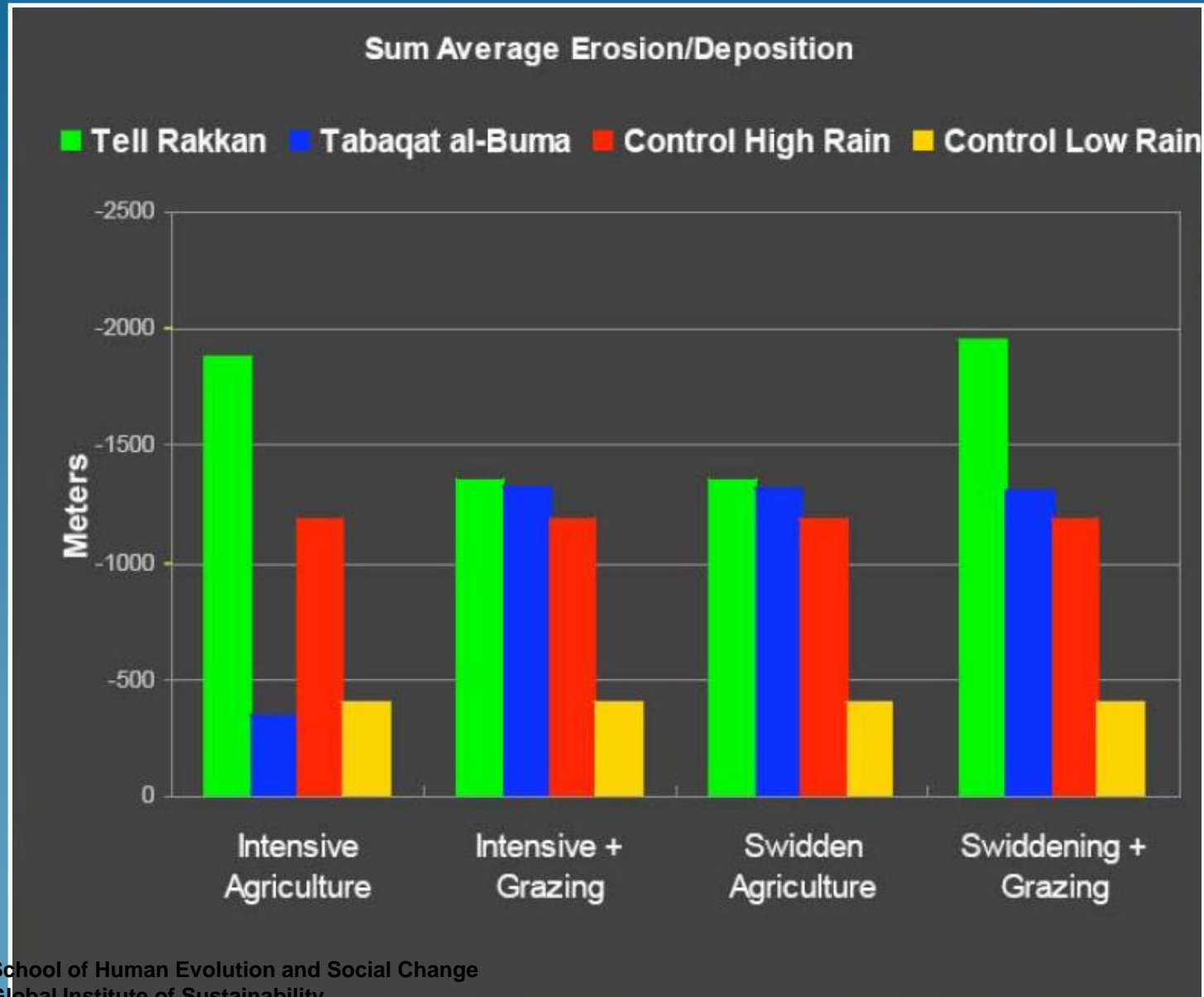


Tell Rakkan

Tabqat al-Bûma



Surface Processes Summary



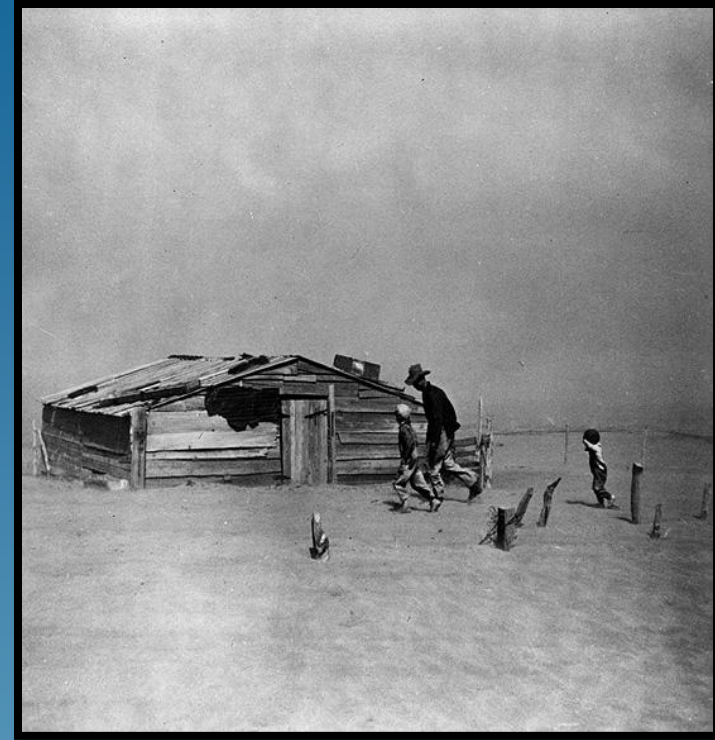
Conclusions

- Ancient land-use practices had impacts on the environment.
- Soil erosion from farming and grazing changed some landscapes from fertile to sterile.
- Allowing grazing on fallowed areas in a Swidden catchment increased recovery time.
- Increased rain causes more erosion, probably explaining the dispersal to small farmsteads.
- Some decisions were better than others, but were specific to location and population size. No “one size fits all rule”.

Why should people today care about Neolithic farmers?

- We continue to change landscapes today
 - Farming is still the #1 cause of these changes
 - Urban growth, development of marginal lands, introduction of non-native plants, addition of water
- These changes are affecting our sustainability and have great impacts on the way we live and the decisions we make
 - The Medlands model can be used to simulate changes in landscapes today

When farming decisions go bad!



The Dust Bowl occurred in the 1920-30's in Colorado, Kansas, Oklahoma, New Mexico & Texas.

It is considered the worst ecological disaster in human history! Some areas never recovered.

The Global Problem



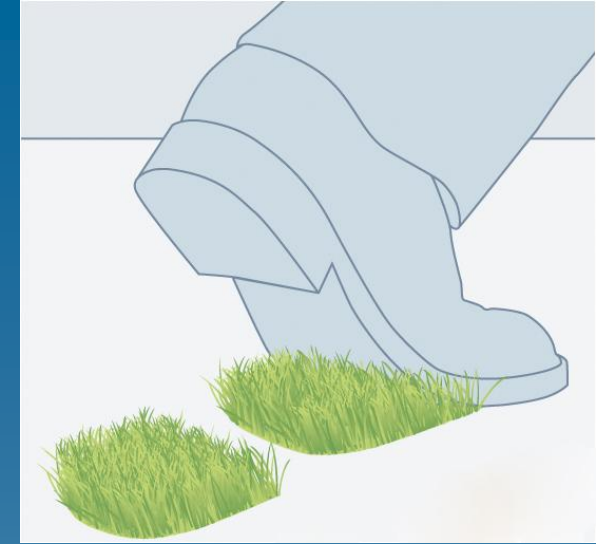
China

What are other effects of soil erosion?

- Loss of farm land through desertification
- Pollution of rivers with silt
- Algae build-up in lakes
- Contaminated drinking water
- Global climate change
- Air pollution



China's Yangtze River 1.6 billion tons of sediment is washed away each year



Teaching Students about Sustainability using the Medlands Project



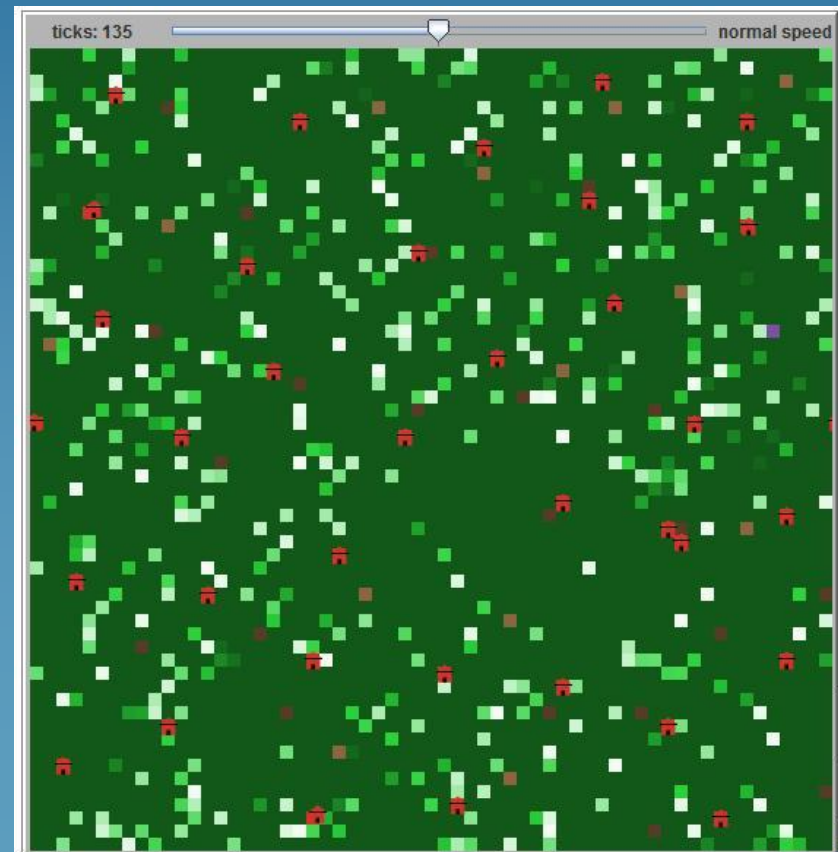
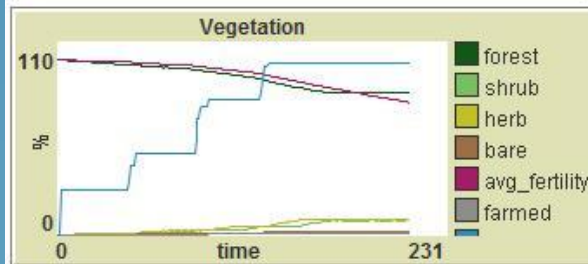
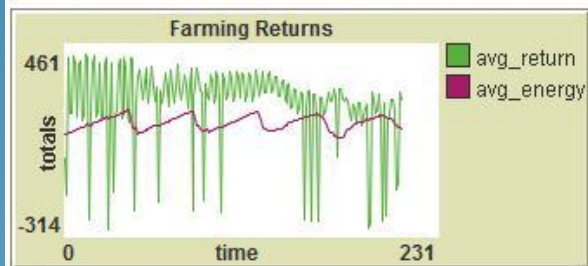
Construct Your Own Conceptual Model



- 1. Work with a partner to construct a conceptual model of landscape change.**
- 2. Share your model.**
- 3. Find similarities and differences between your model and the Swidden Model.**

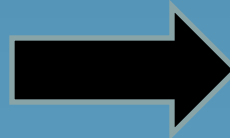
Computer Modeling in the Classroom

- 1 day, Social Studies, Science or Technology class
- Students use the Medlands model to see the effects of Neolithic farmers on the landscape.
- Graphs show households growing and shrinking and changes in the biodiversity of the land.



Changing Landscapes: Arizona through Time

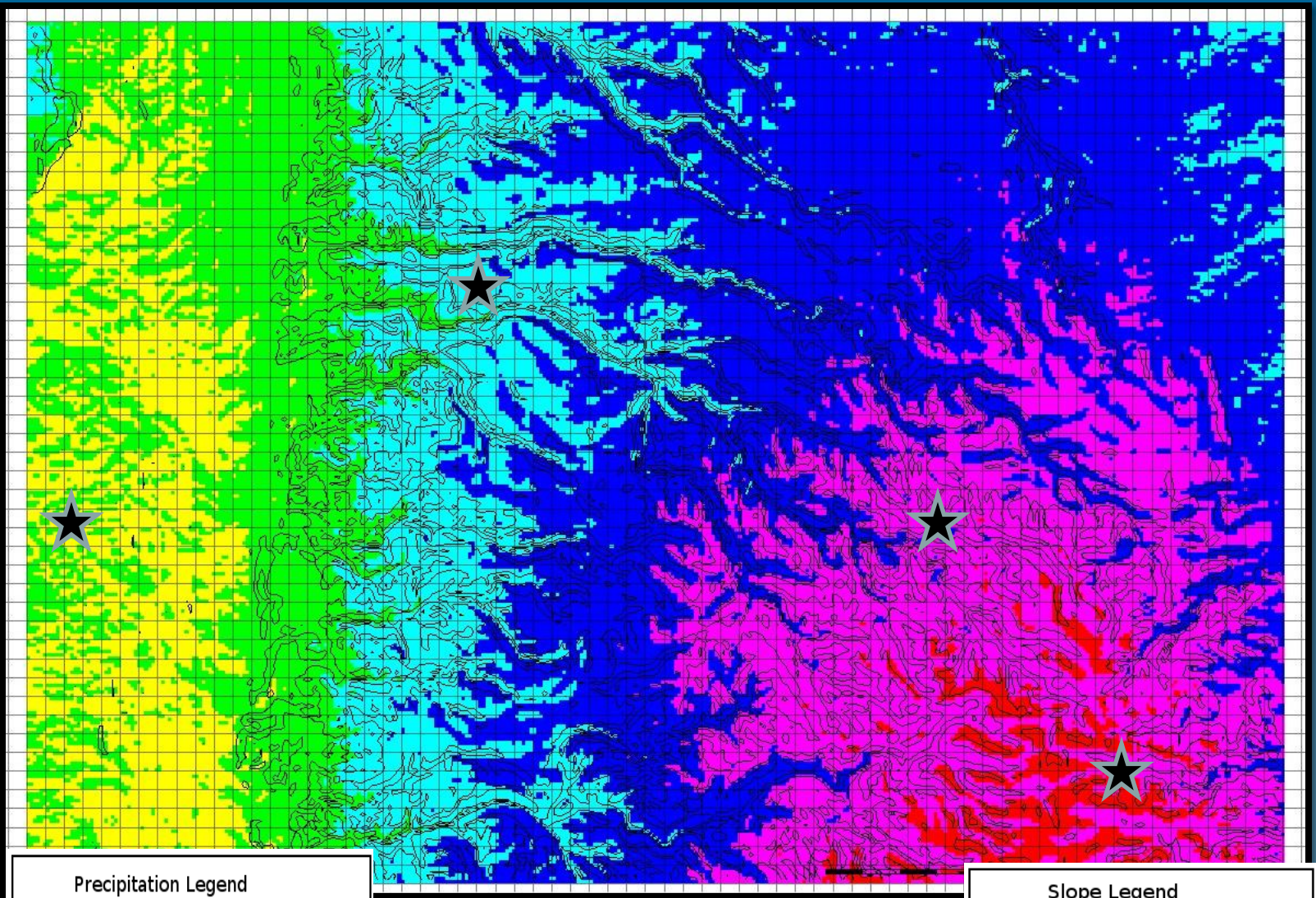
- 1 day or 2, Social Studies/Geography class
- The history of Arizona is used to teach students about people's choices and landscape changes.
- Students fill out a timeline from information given in stories.
- Students can also read the article provided about the pros and cons of farming in Arizona today and debate the issue in their own classroom.



Universal Soil Erosion Equation

- 1 day, Science, Math or Social Studies
- Students replace variables in equation with numbers provided in lesson for different geographic areas.
- Information is used to find archaeological sites on GIS maps created by the Medlands team and on Google Earth to see what the actual landforms look like.

Soil loss= (Soil erodibility factor)(Rainfall)(Slope)(Crop Management)



Precipitation Legend

- 200-299 mm rainfall annually
- 300-399 mm rainfall annually
- 400-499 mm rainfall annually

- 500-599 mm rainfall annually
- 600-699 mm rainfall annually
- 700-799 mm rainfall annually

Slope Legend

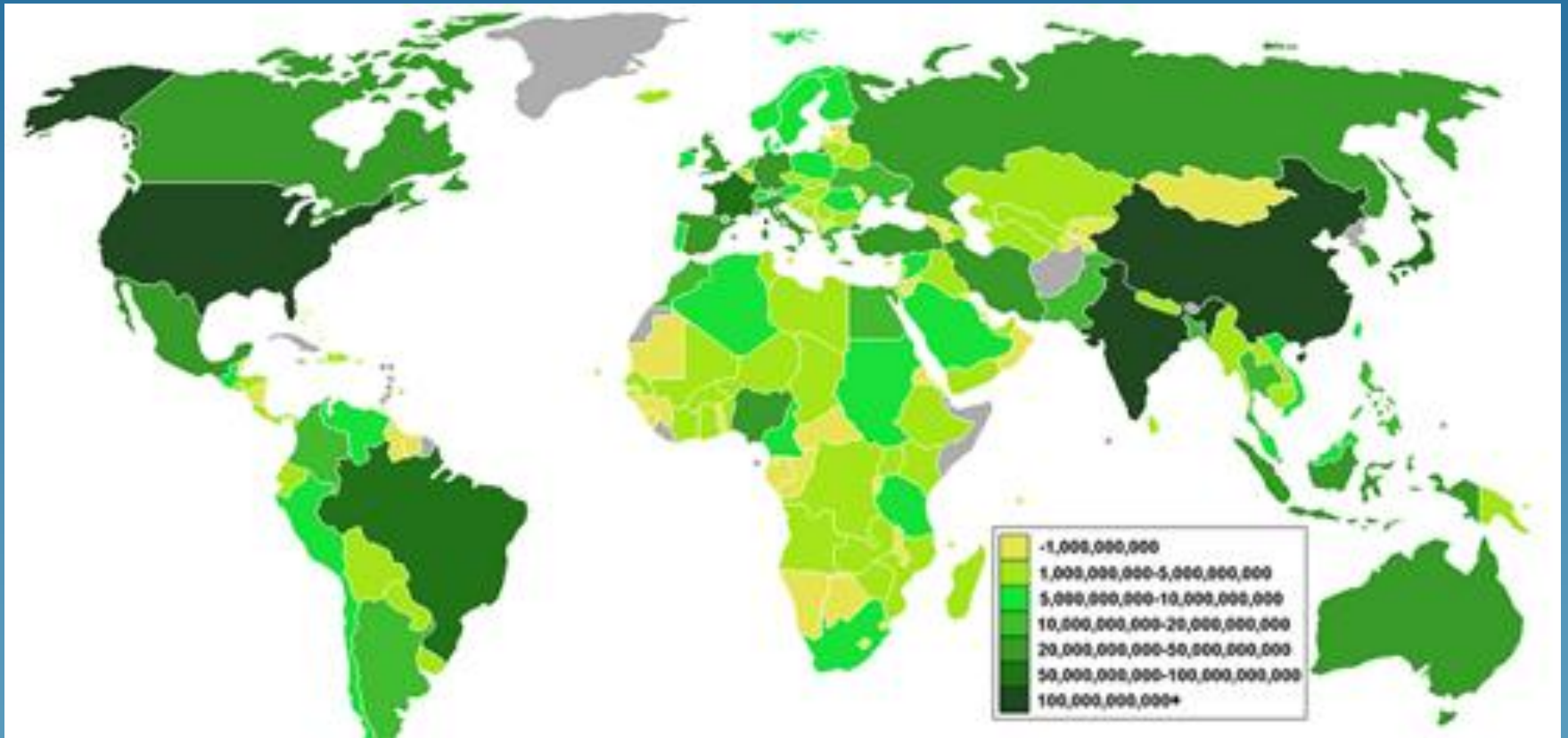
- 0-9.9 degrees
- 10-19.9 degrees
- 20 and higher degrees

Human Decisions and Landscape Change

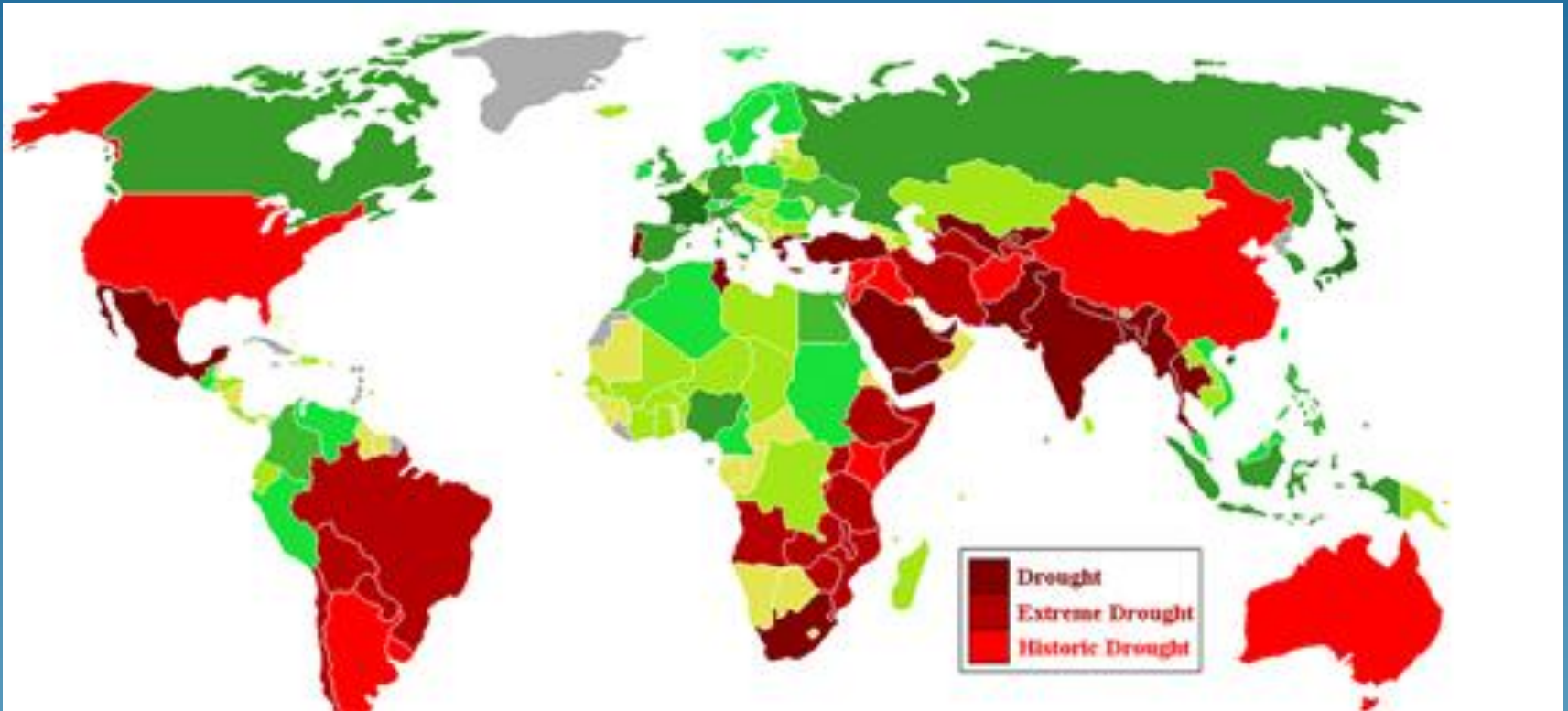
- 2 days, Social Studies or Science classes
- Students match information from different global locations to pictures; learning how peoples' decisions affect the environment and food sources.
 - Students will use world maps and maps of Maricopa County to see land-use changes over time where they live.



Agricultural Value in U.S. Dollars

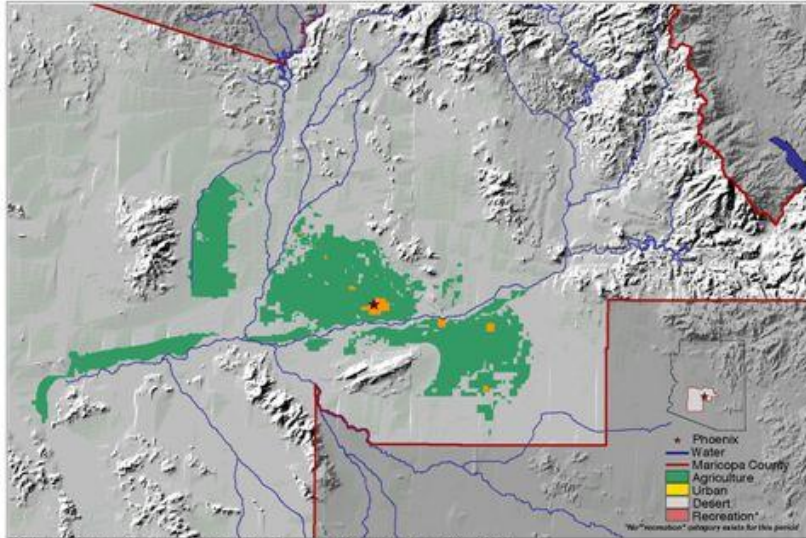


Worldwide Drought

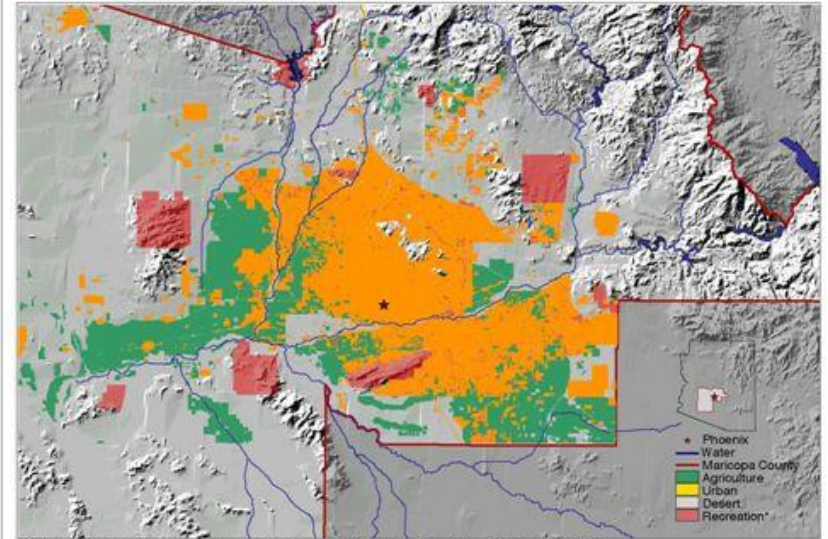


Changes in Land Use in Arizona

Central Arizona Phoenix Historic Landuse - 1912

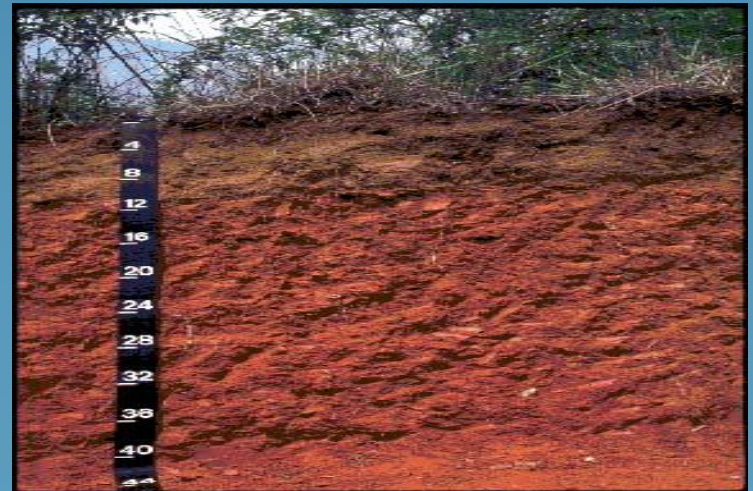


Central Arizona Phoenix Historic Landuse - 1995



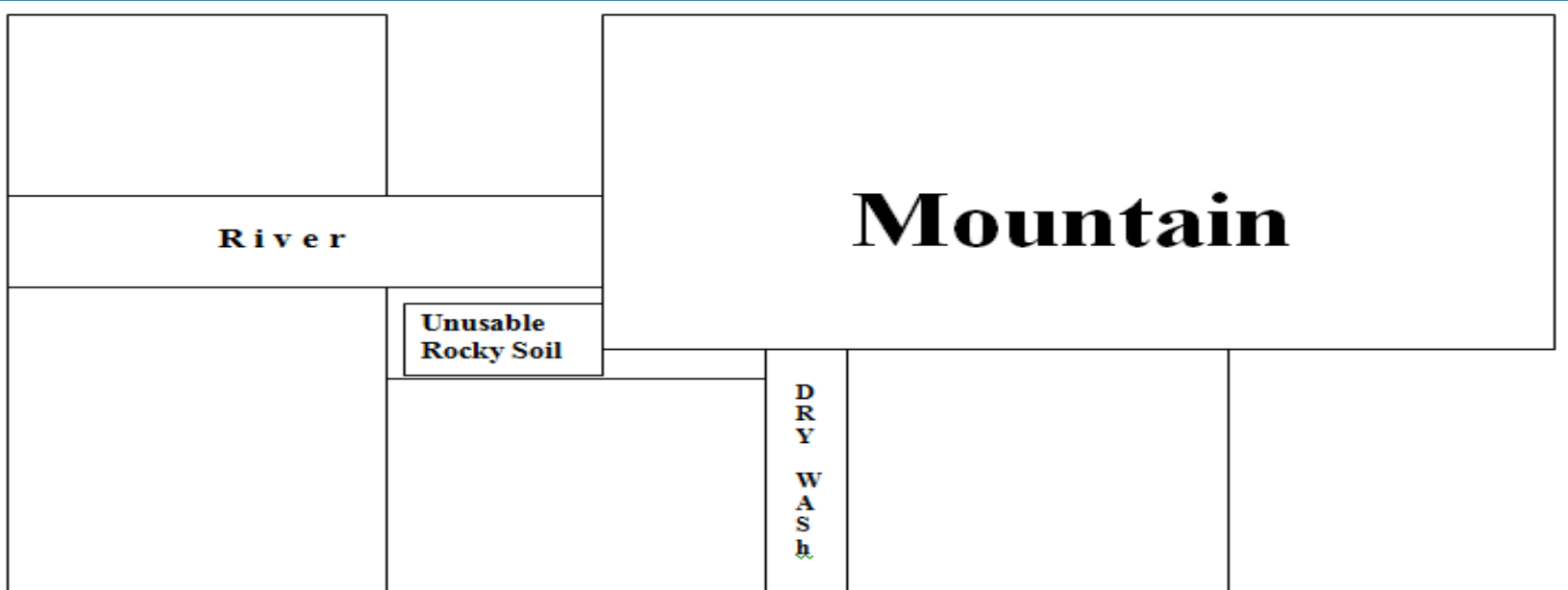
Mapping Activity

- The red clay of this area is one of the most startling and memorable sights for visitors.
- Historically, however, Piedmont land was among the richest in North America covered by six feet or more of black, rich topsoil.
- Today a farmer is exceptionally lucky if he has any land with SIX INCHES of fertile soil above the clay.
- Amazingly, less than 300 years of intensive corn and cotton farming had eliminated tens of thousands of years' worth of natural soil building.
- This region of the United States borders both the Gulf of Mexico and the North Atlantic Ocean.



Neolithic Settlement Activity

- 2-3 days, Social Studies and Math classes
 - Day 1, Social Studies
- Students will re-enact how Neolithic people chose geographic areas for their settlements based on a map created by the teacher.
- Each student will fulfill a role within a “tribe” and facilitate communication between other “tribes” to sustain their populations.



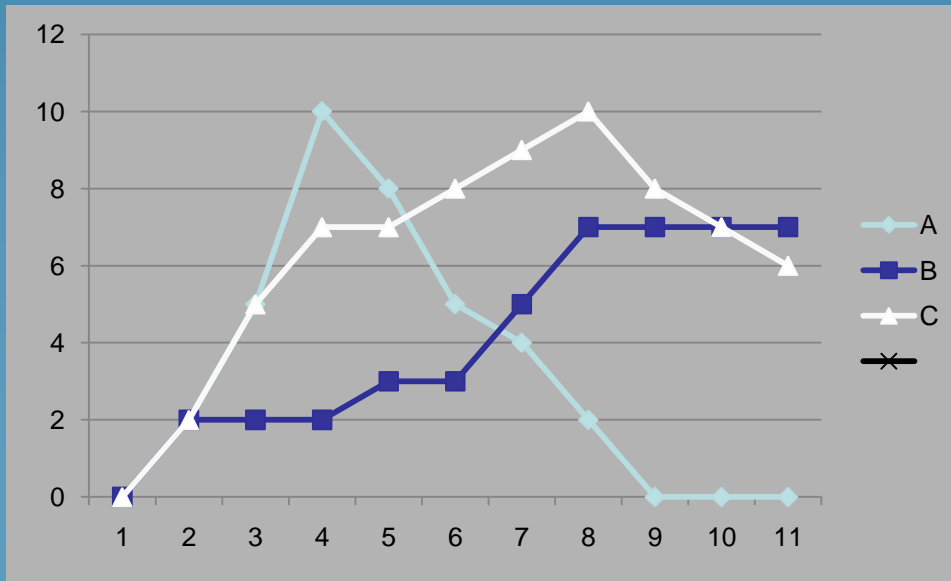
Neolithic Settlement Activity

- Day 2, Math class

- Students measure the plots created on day 1 and calculate how to obtain the least area of land based on the amount needed for farming, grazing goats and housing.
- They will also graph the plot of land they created.

Neolithic Survivor

- 3 days, Science or Social Studies classes
- Students play a game outside that simulates the computer model developed by Medlands. They are the Neolithic farmers and must make sustainable decisions!
- Students will choose their locations, collect “food” and finally graph their population numbers through time to see which group made the most sustainable decisions.



Neolithic Survivor Board Game

- 1 day, Science or Social Studies classes
- Each group of students is given a game board that represents plots of land on different types of terrain that can produce more food every year, every other year, or every 3rd year.
- Dice are rolled to determine the number of people that can be fed by the amount of food produced on the land for that year.
- Plots will turn fallow and chance cards introduce helpful and harmful environmental and technological changes.
 - Students will graph results and compare and contrast population trends on each type of terrain.



FALLOW



FARMED

Teacher Evaluations

- **Most teachers had not taught the content presented by Medlands, but intended to include it in their classrooms!**
- **Teachers like the computer model and thought it was useful**
 - **Teachers have suggested introducing computer models to students through some of the other Netlogo models building up to the Medlands model.**
 - **Teachers said they would use the Survivor Game if they could not get access to computers.**
- **Connections to Arizona history: “Nice to see change in our area over time. A must for Social Studies. Good for critical thinking.”**
- **“Good way to show human-environmental interaction especially the Human Impacts and Environmental Change lesson.”**

Testing Medlands Lessons

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<http://ecologyexplorers.asu.edu>

<http://www.asu.edu/clas/shesc/projects/medland/>

THANK YOU!!!!

Tell Us What You Think!

**Please fill out an
evaluation form**

