Development of a Public Education Website:

Building Bridges over Water

A Senior Project

Presented to

the Faculty of the Agricultural Education and Communication Department

California Polytechnic State University, San Luis Obispo

In Partial Fulfillment

of the Requirements for the Degree

Bachelor of Science

By

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Abstract

Website created by Angelina McKee to educate the public about water resource issues. Water is the basic unit of life, water resources are the basis for what societies and ecosystems are founded upon. Water shortages and droughts are more prevalent in our ever-changing world. It is no shock that there are discrepancies between various stockholders on either sides of the dry riverbed. This senior project resulted in the development of a website that addresses global water resources, water use in California, water conservation, and water allocation. The website informs the public on water resources and related issues and will hopefully change behavior and attitudes toward the valuable resource. The information is located at: http://buildingbridgesoverwater.weebly.com/.

Acknowledgements

I would like to acknowledge my wonderful instructors at California Polytechnic State University, San Luis Obispo for their insight, enthusiasm, and lasting contributions to my education. In particular I would like to thank Dr. Robert Flores, my senior project advisor, Dr. Sarah Bisbing for her appreciation for the natural world, Dr. Michael Jenks for his tutelage in water law and issues with water quality and quantity, as well as the multitude professors within the BioResource and Agricultural Engineering Department who furthered my education in agricultural water use.

Aside from my academic life, I would like to acknowledge my parents, Jeff and Kea McKee, for teaching me the true meanings in life and showing me all that it has to offer. I would especially like to thank my wonderful husband, Joseph Rice, for his continuing support. Lastly, I would like to thank my son, Charlie, for giving me the strength and focus to try and make the world a better place for our future generations. You all mean the world to me and I greatly appreciate all of your advice, education, support, and love!

Table of Contents

Chapter One

Introduction

Water is one of our most precious and valuable resources. Water resources are often only appreciated when there isn't enough to go around. Droughts and water shortages are times of high concern, interest, and misinformation. Not only mankind, but society as a whole depends upon water for survival. Humans have "tacitly assumed over the centuries that water is readily available, inexpensive and plentiful," presently however, the "abundance of clean, unlimited supplies of inexpensive water is quickly becoming a myth." With costs rising, supplies drying up, tensions growing and pressure mounting, it is important to not only understand where our water comes from, how it is divided among users, how the users use, conserve and can improve their water use. Policy makers, voters, and water users – everyone needs to be better educated on water, as their lives do in fact depend upon it. This chapter will cover the statement of the problem, the importance, purpose, objective, benefits, and summary of the overall report on Building Bridges over Water.

Statement of the Problem

Water resources are becoming increasingly important, as many sources are limited. Without proper education, water resources can be mismanaged or misappropriated. An educated public is more likely to value and respect their precious resources when they understand the importance of the resources. In times of major ongoing drought, it is vital that the public has access to information about how they can help conserve water and respect the way water is used.

The Importance of the Project

In these times of serious drought, an educated public is vital to the survival of the society as a whole. Water is often what societies are based around; water it is a vital part of every day life. Water sources, water destinations and water uses need to be understood so that it is used wisely and will be available in the near future and for future generations to come.

Besides educating on the level of the individual, the public is often an integral part of law and policy making of society as a whole. Society's decision makers are not informed enough to draft and implement appropriate regulation about water law, if they are not properly educated about water resources. The coverage of water resources is vital to the public as a whole, as all life depends upon it. There is also a lack of communication between different water users, specifically between urban and agricultural water resource users. It is unfortunate that lawmakers and the majority of voters often do not understand agricultural water user's needs, however they are the one's deciding restrictions for quantity and use for their operations. Proper knowledge, education, and understanding of water resources are vital in an every expanding population with pressures for food availability with limited water resource availability. The education of water resources is vital to the successful continuation of society as a whole.

Purpose of the Project

The purpose of the project is to inform the public about many facets of water resources so that they may not only understand and make informed decisions involving water resources, but they might also conserve and learn to respect the privileges that come along with having them. By distributing a pamphlet to a sample group of water users, they will become better informed

and thus make educated decisions on their water use and potential water policies as well as the water that is allocated to other users.

Objectives of the Project

Objectives include researching and compiling water resource data, fact and pertinent sources to form a bank of information. Draw from the bank of information to compile a website that will educate the public about water resources. The website will be posted on the internet so that water resources users may learn about daily measures they can partake in, as well as information they can use to make educated decisions, and potentially policy decisions involving water resources. The overall outcome is to design and construct a website with water resource information for the public to be able to search and use.

Definition of Important Terms

Agriculture: the food and fiber industry that is responsible for feeding, clothing, and providing materials including shelter, paper, and tree products to the worlds' population.

Brackish: water that is a mixture of freshwater and salt water, usually in an estuary, delta, or bay, which typically hosts a high diversity of life.

Desalination: typically referred to as 'ocean desalination', is the process that occurs when ocean or briny water is processed to create purified water and a concentrated briny solution. Desalination is very expensive to operate and results in a high water cost.

Desertification: the process where a landscape turns into a desert, usually due to mismanagement of the landscape, a removal of a key species in the trophic cascade (also called the food web or food chain), reduced rainfall, or a combination of the preceding.

Environment: the natural world, which includes the land, air and water that all animal and plant species, including mankind, live in. The environment also provides important ecosystem services such as the water cycle, nutrient cycle, pollination, oxygen exchange, and many other services that are taken for granted, but to which all of life depends upon.

Intrusion: referred to as 'salt water intrusion', occurs when ground water sources are drained or diminished and oceanic water is drawn through the soil into the fresh water aquifers, thereby contaminating the freshwater sources.

Tail-water return system: A system that can be used in surface irrigation (typically field or row-crop irrigation) to collect the 'tail-water' at the end of the field for storage or to be reused in irrigation.

Precipitation: rainfall, snow, or sleet.

Urban: areas including and surrounding towns or cities, where concentrations of people reside.

Water wheeling: a figurative term used to describe water distribution and transport.

Summary

The quality and quantity of water resources are limited, in California especially. Mark Twain once said, "Whiskey is for drinking, water is for fighting," which still holds true today, as ever. California has suffered through severe droughts and society across the globe depends on water, public education of water resources is increasingly important. Additionally, the majority of voters are not educated to make uninformed decisions that affect other water users. With the public's strong dependence on clean and reliable sources of water, the objectives of this report will hopefully bridge the gap in knowledge to grant better use, conservation, understanding and policy making for water resources.

Chapter Two

Review of Literature

Water is one of our most precious resources, and we must better understand the resource to conserve and protect the resource. Water resources are not alike and require different conservation and management plans. Water is collected, distributed, reallocated, and often times stored for later use. The following information has been compiled to emphasize global water resources, water allocation, and the conservation and use of water in agricultural and urban areas.

Global Resources

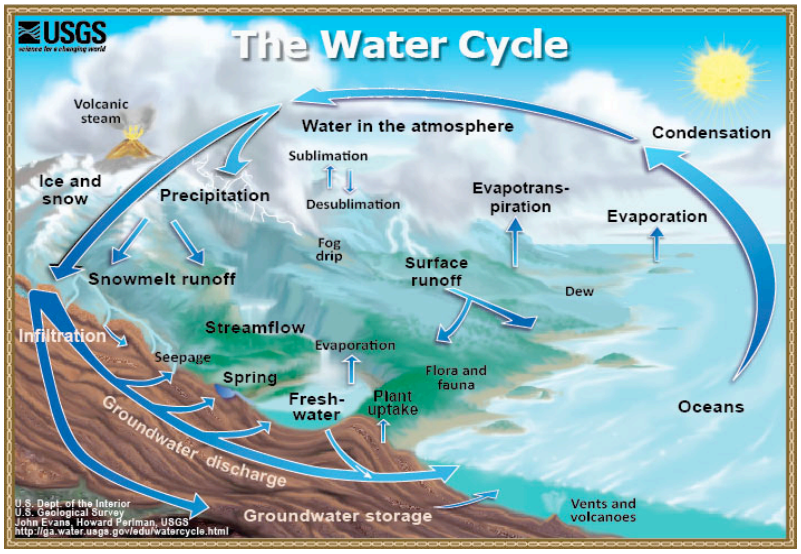


Figure 1. The Water Cycle. (The Water Cycle, 2014)

The natural water cycle, also called the hydrologic cycle, (The USGS Water Science School, 2014) is a cylindrical process in which water changes between solid, liquid and gas, which we refer to as ice, water, and water vapor (The USGS Water Science School, 2014). The Hydrologic cycle, as seen below in Figure 1, helps depict the endless changes between physical

states, above, below and within the Earth's surface and illustrates the complex relationship that is the water cycle. (The USGS Water Science School, 2014).

The distribution of the water on Earth is far more complex that it appears from the surface. While water covers 71% of the planet's surface (How much water is there on, in, and above the Earth?, 2014), approximately 96.5% of that water is ocean water (The World's Water, 2014), which is undrinkable without costly desalination treatment. Of the remaining freshwater most make up glaciers and ice caps underground reservoirs, with less than .7% of the total Earth's freshwater remaining surface water and groundwater, which are sources of water that we are available for storage and potential use. (The World's Water, 2014) Please view Figure 2, Distribution of Earth's Water, for a better illustration of Earth's water.

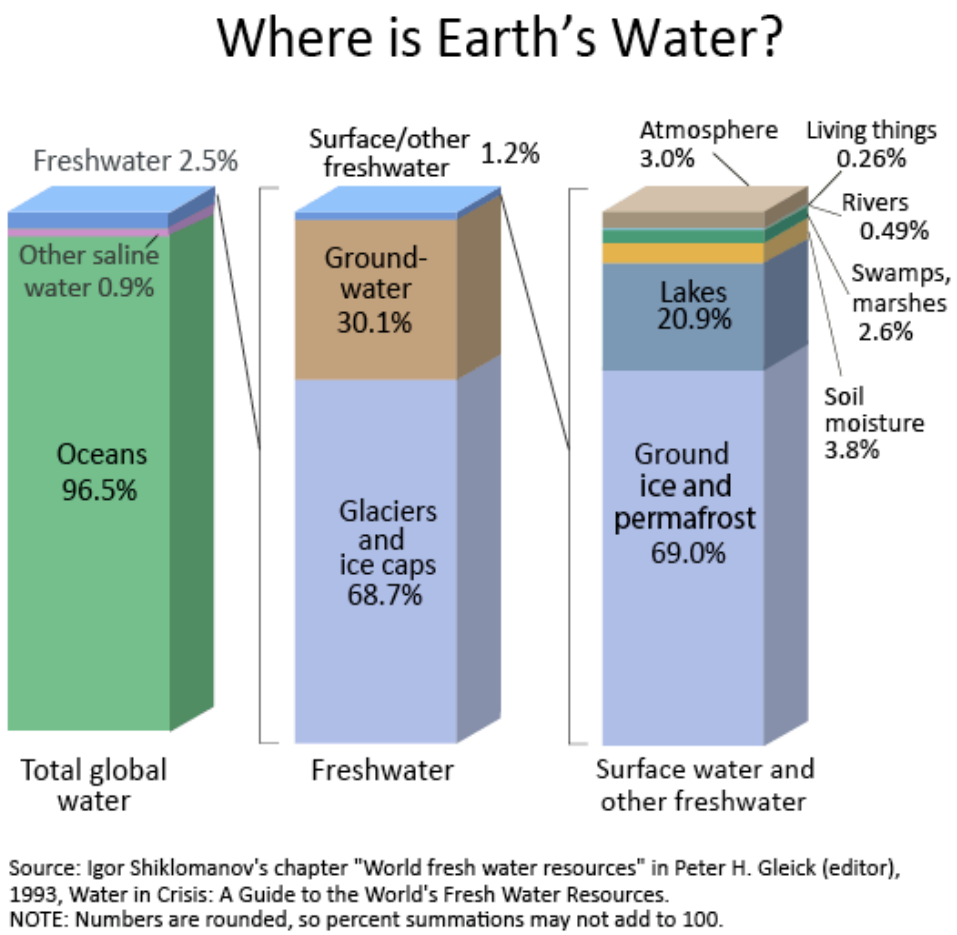


Figure 2. Distribution of Earth's Water. (The World's Water, 2014)

The Earth is very large, and while over the surface is predominantly covered with water, it is surprising how little water there is to go around. The Earth's water, if compared in size to the earth, would equate to a sphere approximately 860 miles in diameter, the liquid fresh water including ground water, lakes, swamps, and rivers would comprise a sphere of 169.5 mile diameter, and the fresh water contained in lakes and rivers would create a sphere with a 34.9 mile diameter (The World's Water, 2014). An illustrated version of these spheres can be seen in Figure 3 below. The planet is surprisingly dry in comparison to the typical perception of the 'blue planet'. (Where is Earth's Water Located?, 2013) There are a few accessible sources of water including precipitation, surface water, and groundwater.

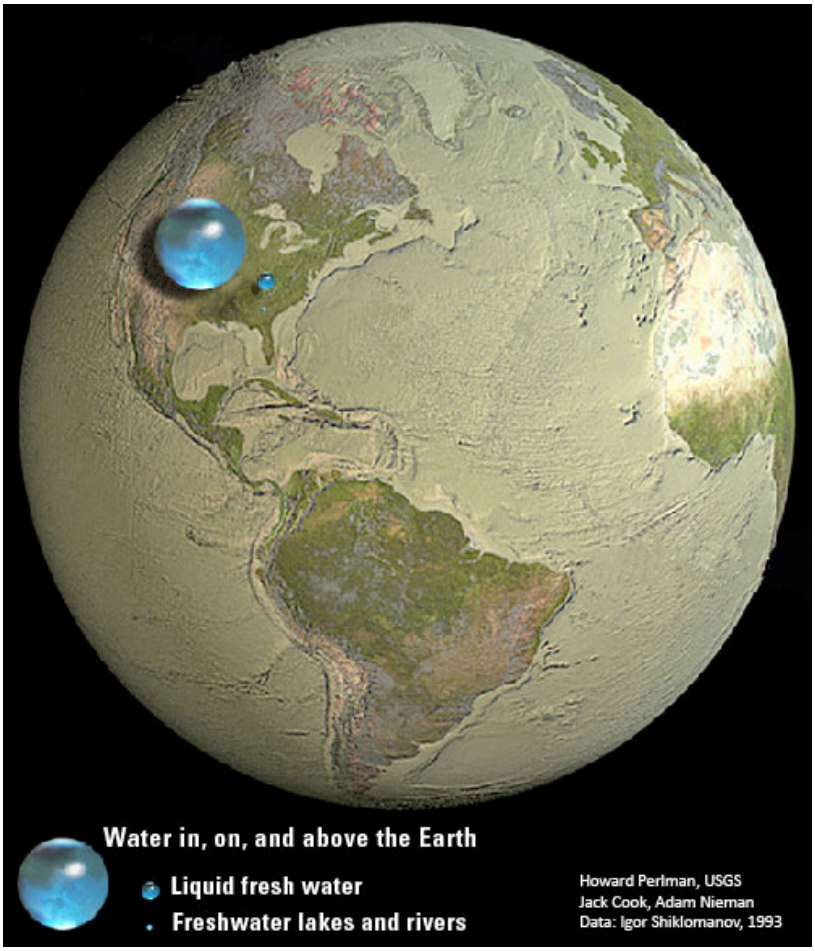


Figure 3. Volume of Earth's Water Compared to Volume of the Earth. (The World's Water, 2014)

Precipitation is the product of water vapor falling to the Earth in the form of rain, sleet, snow, or hail. (Precipitation: The Water Cycle, 2014) Precipitation is one of the primary connections in the water cycle that delivers atmospheric water to the earth, as seen previously in Figure 1. (Precipitation: The Water Cycle, 2014) Precipitation in the form of snow can be very important to ecosystems that experience dry summers. (Precipitation: The Water Cycle, 2014) In areas with little precipitation during summer, snowmelt during the spring recharges depleted groundwater and streams that are very important for water supply to the environment, the agricultural industry, and for urban and industrial use. (Precipitation: The Water Cycle, 2014)

Surface water can be considered as any body of water, which includes fresh and saltwater bodies, like oceans, seas, lakes, rivers, and streams. (The USGS Water Science School, 2014) Dammed lakes and reservoirs allow for storage, timely water delivery, flood control, potential hydroelectric generation, and fire suppression. (Why do people build dams?, 2014) Surface water is often artificially created by the damming of rivers and streams, which alters the natural ecosystem, segments the river, and often times inhibits native fish migration. (Perrine, 2013) Surface water is prone to evaporation losses, "sometimes exceeding 20 percent of the average annual runoff" evaporation losses can be even greater if the "width of the impounded valley is considerable, and induces a larger open water area." (Conjunctive use of surface and groundwater, 1993) This form of water storage may not be suitable for all locations, especially when compared to the potential for ground water storage.

Groundwater is one of our many precious resources, unfortunately, groundwater is not only neglected, and it is also taken for granted. Groundwater is recharged by stream flow, rain, and permeated surface water. (Groundwater, 2014) Pollutants can also contaminate groundwater, which is a very serious issue for potable drinking water. (Groundwater, 2014) If

groundwater is pumped more than it is replenished, it can lead to lower water tables and possibly land subsidence depending on the aquifer system and rock structure below. (The Science of Groundwater Studies, 2012)

Precipitation, surface water, and groundwater are the predominant sources of easily accessible water, however, traditional sources are expanding to include alternative sources of water. Storm water runoff and wastewater effluent can be collected and used for groundwater recharge or for non-potable uses such as stream flow, wildlife habitat, landscaping, and irrigation. (Wastewater Treatment Water Use, 2014) Other sources, such as salt or ocean water can be processed through ocean desalination and used; however desalination plants are expensive to operate and power. (Saline water: Desalination, 2014) Advancements in technology and innovative methods are key in conserving and stretching out every drop of water, especially in dry times and periods of drought. The year 2014 marks the end of the third year of ongoing drought, with calendar year 2013 marking one of the driest years in recorded history for many places throughout California. (One of California's Driest Years, 2014)

Local Resources and Allocation

The most recent Californian state of emergency declared by Governor Jerry Brown was on January 17, 2014 due to the sever drought. (Drought 2014: What You Need to Know, 2014) In wet and dry years alike, it is important to know about your sources of water including but not limited to: safety, sustainability, and management practices and development. According to the Huston Museum of Natural Science, "areas with very little rainfall usually turn into deserts" and some of these desert areas include North Africa, the Middle East, western North America, and Central Asia. (World Rainfall Map, 2012). In California, there are many urban populations that

are situated in desert areas, or areas that are experiencing increasingly less water. It is a major challenge to make an oasis out of a desert landscape, creating a huge pressure on water from other locations.

To 'wheel water' means to distribute and transfer water to meet demands of urban, industrial, and agricultural water users. Water sources and water requirements often don't match up, which is why large networks of water delivery systems have been built across many parts of the world, such as California and the Western United States. According to the Association of California Water Agencies (ACWA), in California, approximately 75% of the precipitation occurs in the North and 75% of the need is in the Southern part of the state. (California's Water: California Water Systems, 2014) With this large disparity, California has developed a large and extensive network of water storage and delivery systems to bridge the ongoing gap between water sources and water demands. It is widely assumed that a family of four will use 1 acre-foot of water per year, which is equivalent to 325,851 gallons. Major projects in California include the Central Valley Project with 7 million acre-feet (MAF) per year, the State Water Project with 2.3 million a (MAF) / year, the All-American Canal with 3 MAF/year, the Colorado River Aqueduct with 1.2 MAF/year, the Los Angeles Aqueduct with 200,000 AF/year, the Mokelumne Aqueduct with 364,000 AF/year, and the San Francisco Hetch Hetchy Project with 330,000 AF/year. (California's Water: California Water Systems, 2014)

Water is a scarcity in California. With finite resources, the division of between water users can be very controversial in dry years. Water in California can be divided into three main groups: environmental requirements, urban uses, and agricultural demands. Urban water uses include indoor and outdoor uses, as well as industrial and manufacturing water used. (Let's Examine the Issues: Water Quantity and Quality, 2008) Agricultural water uses in California

include uses such as irrigation of the variety of more than 250 crops, which “leads the nation in production of 75 commodities” (Let's Examine the Issues: Water Quantity and Quality, 2008). Environmental water uses “include wild and scenic river flows, required Delta outflow, and wetland water and is crucial for maintaining intact marine ecosystems” (Let's Examine the Issues: Water Quantity and Quality, 2008). The distribution of these three groups can be seen in Figure 4 below, the distribution of water during an average year is approximately 11% urban, 42% agricultural, and 47% environmental. (Let's Examine the Issues: Water Quantity and Quality, 2008)

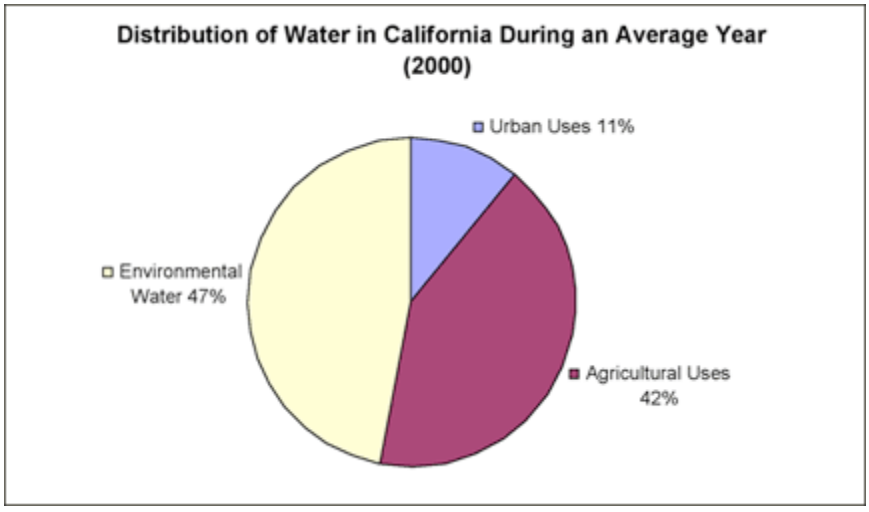


Figure 4. Distribution of Water in California During an Average Year. (Let's Examine the Issues: Water Quantity and Quality, 2008)

Every continent across the globe is suffering from population increases that put demand on all resources, however water resources can be the most difficult to quantify and indicate issues with overuse. Groundwater tables lowering, land subsidence, desertification, and rivers running dry are all indicators that freshwater resources are not being managed properly. According to the National Geographic Society, there are eight major rivers across the world that no longer reach the ocean and have run dry from overuse due to agriculture, industry, and municipal uses. The rivers they list include the Colorado River in western North America, the

Indus River in Pakistan, the Amu Darya River in Central Asia, the Syr Darya River in Central Asia, the Rio Grande River in central North America, the Yellow River in China, the Teesta River in India, and the Murray River in Australia. (8 Mighty Rivers Run Dry from Overuse, 2014). When rivers run dry it completely changes the ecosystem at the confluence of the oceans, destroys brackish and estuarine ecosystems, and can greatly impact local fisheries. It is important to use water resources responsibly so that all users, agricultural, environmental, and municipal alike, may benefit. Limited water affects everyone, especially those downstream.

Water Use and Conservation

Water is one of the key elements that we all need in order to survive and often taken for granted. There are many ways to conserve water in both urban and agricultural areas. In urban and industrial areas, conservation can happen in several ways including, but not limited to: grey water reuse for landscaping, high efficiency irrigation methods and upkeep of the equipment, low flow fixtures at home, high efficiency appliances, smart water saving techniques and overall water use consciousness, being aware of your water use and impacts, reducing losses through evaporation, leaks, and contamination, planting native and low-water use landscapes, turf replacement, low-water landscape transition, reuse of process water during production, and using less water overall in processing. (Water Use Calculator, 2014) In agriculture, mainly conservation through irrigation and a better understanding of the land can include, but is not limited to: high efficiency irrigation methods, laser leveling for more level ground, dry land farming, partial root drying, deficit irrigation, modifying irrigation schedule according to weather, allowing for groundwater recharge, use of cover crops, tail water collection and reuse, and planting crops better adapted to local climate. It should be noted that agricultural irrigation

uses include evaporation, transpiration, and return flows may be recoverable depending on local conditions (Perry et al., 2009), but are nonetheless kept within the water cycle and may contribute to environmental water available. Agriculture is crucial to our food and fiber industries and urban water use is inevitable, but with proper upkeep of infrastructure and education everyone can do their part to conserve water in a multitude of ways.

Aside from conservation of water resources, there are potential water issues that can occur. Urban and industrial water use issues include, but are not limited to: pollutants being introduced into groundwater, streams, and the ocean, chemical spills introduced during industrial operations, pathogenic organism introduced via contaminated water, prescription drugs and heavy metals introduced into wastewater and therefore wastewater effluent and reclaimed water, fertilizers, herbicides and pesticides being applied improperly in the garden, potable water quality issues, sewage spills, septic tank leaks, and leach lines and groundwater contamination. (Groundwater Quality, 2014) Potential water issues involving agriculture include salt water intrusion from pumping groundwater near the coast, reduced river flows affecting riparian and aquatic life, pumping impacts on groundwater including compaction of aquifer systems and subsidence, soil erosion from irrigation on bare soils, leeching of nutrients into ground water and rivers or streams, salt accumulation in soil from deficit irrigation without periodic leaching, fertilizers introduced to surrounding environment if applied incorrectly or carelessly, and runoff from irrigation as a pesticide or fertilizer introduction. (Groundwater Quality, 2014) Education can make a difference by reducing water consumption, educating voters, and making conservation of resources a priority for future generations to come. (California Water: Is Your City Planning for the Future?, 2014) Water awareness and education leads to wiser choices and improved resource conservation.

Summary

Accessible fresh water resources are very small in comparison to the total volume of water on Earth. The water cycle connects all of the various states of water to the earth. Accessible sources of water include precipitation, surface water, groundwater, and alternative sources such as reclaimed water and water from ocean desalination. Local resource management is vital to the future of a community in dry and wet years alike. The year 2013 marked the third year of drought in California and in many places through California, the driest year in recorded history. (One of California's Driest Years, 2014) Wheeling water, or distributing water, is a way to meet sources of water with its environmental, agricultural, and urban demands. California has an extensive system of waterways to convey water to bridge the ongoing gap between water sources and demands. There are potential water use issues in both agriculture and with urban and industrial water uses; as well as conservation measurements and areas to improve upon. Water awareness and water education lead to wiser conservation for future resources.

Chapter Three

Methods and Materials

Creating a website for the public requires many considerations about the information presented, the media it is presented with, the design and functionality of the site, the conveyance of the material to the public, and the perception and communication of the information to the public. Materials for this website included gathering information from various sources, developing the website using a computer and a website builder, consideration of the site in regards to design, navigation, and presentation, consulting with advisors to review website information and possible perceptions of the public, and curtailing the finished product using advisors comments.

Gathering Information

Information gathered for the website information and compilation included gathering background information concerning water resources, learning principles of design, learning website design and functionality as it applies to public use.

In order for the author to develop an understanding of the need for this public website development concerning water resources, they took many classes at multiple institutions. Classes in natural water resources included environmental management, dendrology, natural resource ecology and habitat management, wildlife conservation biology, and water law and policy. Classes in agricultural and landscape water applications and irrigation included principles of irrigation, irrigation theory, drip/microirrigation, hydraulics, irrigation water management, environmental horticulture, horticulture and crop science, and fruit growing. Urban and industrial

water use classes water distribution systems and water law and policy. The author completed an internship at county public works department in the water resources and hydraulic planning units and attended meetings including, but not limited to Water Resources Advisory Committee meetings, the California Irrigation Institute Annual 2010 Conference: California Water Supply: Running on Empty, Thinking Outside the Tank, and has been members of the United States Committee on Irrigation and Drainage, and an Honorary 2010 student member of the California Agricultural Irrigation Association. Knowledge obtained during these classes, positions, meetings, and memberships will be used in combination with other researched material for population of the website content.

Website Development and Design

The website was developed using Weebly, which is a web-hosting service that allows users functionality to design, build, and maintain websites. This site assists the site owners create a widget-based site that operates in a web browser. (Weebly, 2014) The process Weebly has set up for the site owners involves planning, creating, publishing, and growing the site. (Weebly, 2014) The site builder also allows you to create your own domain name. (Weebly, 2014) The author purchased the professional plan in order to utilize more multimedia functions to create a more interactive website.

In addition to content, design, layout, and organization are very important considerations for multimedia like websites. The communication medium is important for the audience, because it is the channel that links the source to the receiver. (Bradley, 2014) The medium, which in this case is a website, can either attract or distract the audience based on mental and physical interferences individuals may have. (Bradley, 2014) The design and layout of a website can also

capture the audiences attention or cause them to become easily disinterested in the message. Graphic communication is very important in multimedia messages and interactive media channels like websites. Organization of the information and ease of movement through the website is very important and must be given great consideration during the design and layout of the site.

Consulting with Advisors

When publishing a website that the public can access, it is important for the communicator to provide information that is both fair and balanced. The author took great care and consideration to consult with advisors from various backgrounds to provide insight into the complicated issue that relates to water resources. Advisors include: Dr. Robert Flores (primary advisor), who is a professor in the Agricultural Education and Communication Department, Professor Ivan Bradley (graphic communications advisor), who is a professor in the Graphic Communications Department, and Dr. Sarah Bisbing (natural resources advisor), who is a professor in the Natural Resources Management and Environmental Sciences Department. Using these advisors to accurately portray the information in a fair and balanced way is key to the goal of accurately informing the public; water resources are the subject to a very complicated stigma that must be overcome in order to be effective. Using these various advisors will help maintain the importance of environmental, agricultural and urban water resources, utilization, and conservation while attempting to remove any potential biases around the subjects that may create mental interference for the audience. It is also important to receive feedback on a quality product in terms for collaboration of ideas and balance of information.

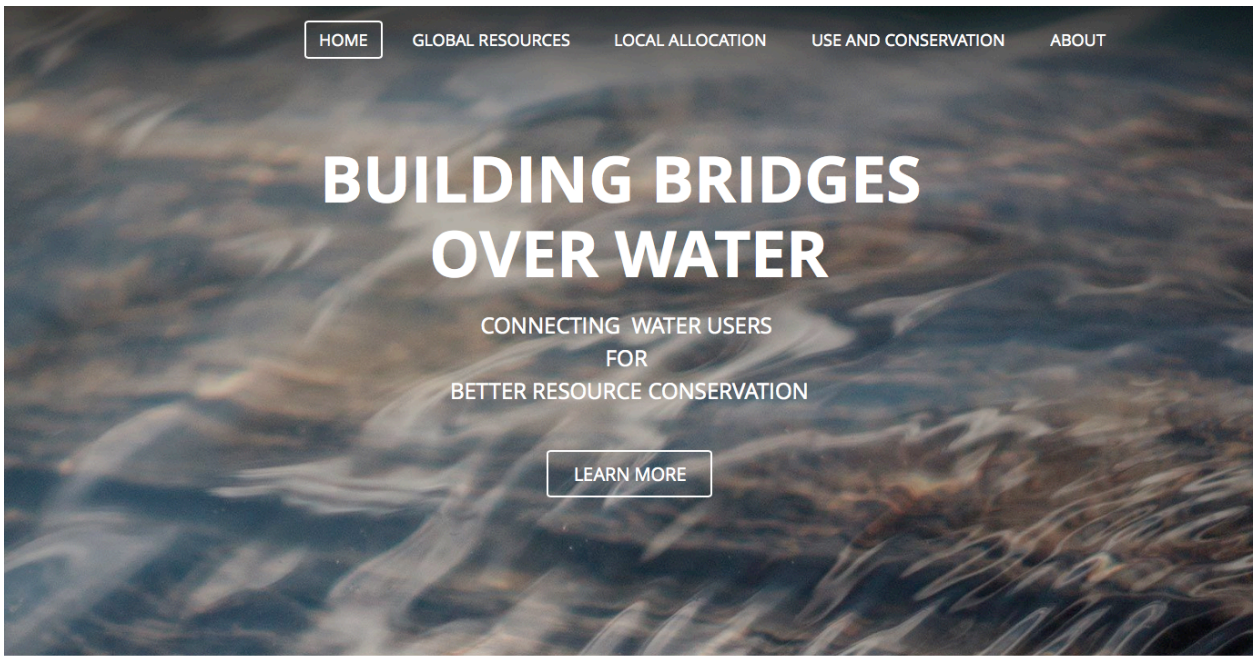
Conclusion

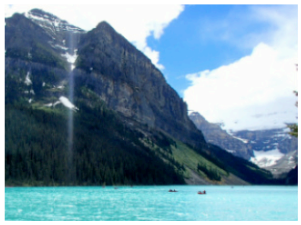
The creation and population of a website involves many integrated parts. Gathering information is the basis for the start of the project. Creation and development of a website needs to include design and organization considerations for navigation through the site and understanding of the material. Feedback and recommendations from advisors and peers is also important to ensure you have a quality product for public viewing. Website design and publication is not a formidable task, however it does entail a great amount of time and energy.

Chapter Four

Results

The purpose of this senior project was to develop a website to educate the public and promote water conservation, a better understanding of resource allocation, and water resources education. The following pages consist of screenshots of the website that was developed and is located at http://buildingbridgesoverwater.weebly.com/. The figures included are the following website pages in their respective order:





GLOBAL RESOURCES

Water is one of our most precious resources. It is important to understand where our water comes from because different water sources require different conservation and management plans.

LOCAL ALLOCATION

Water is distributed, or reallocated to different places, and then stored for later use. It is important to know where your water is coming from and how it is being managed. Find out where your water comes from!

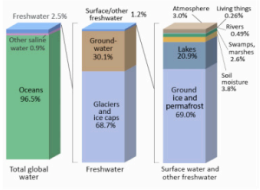
USE AND CONSERVATION

We all need to do our part to conserve water and use it wisely. Water conservation means reducing our water consumption so that everyone has access to a clean and sustainable source of water.

When the well is dry, we learn the worth of water.
- Benjamin Franklin

GLOBAL RESOURCES

WATER DISTRIBUTED ON EARTH

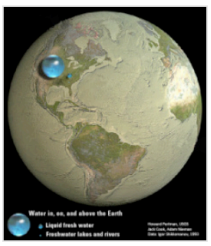


Source: Water Cycle. 2014. USGS.

VARIOUS WATER SOURCES

Water sources are present in many different forms, of which can be both natural and man-made. Rain water, or precipitation, oceans, rivers, lakes, streams, ponds, springs, and groundwater are all examples of natural sources of water. Dams, wells, canals, reservoirs, storage ponds, ocean desalination, and others are examples of man-made sources of water. Often times sources of water are a complex combination of these systems.

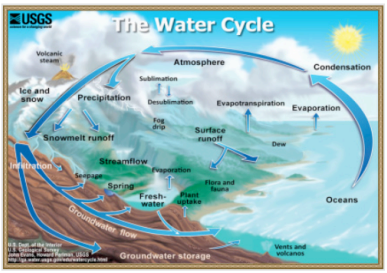
FRESH WATER SIZE COMPARISON



Source: The World's Water. 2014. USGS.

THE WATER CYCLE

The natural water cycle, also called the hydrologic cycle, is a cylindrical process where water changes between the solid, liquid, and gas physical states. These physical states for water are referred to as ice, water, and water vapor. The Hydrologic cycle, as seen to the right, is a simplified version of the various parts of the water cycle that are constantly naturally occurring; the graphic helps depict the endless changes between physical states, above, below and ontop of the Earth's surface and hints at the complicated interconnections between each part of the cycle that makes up the whole.



Source: Water Cycle. 2014. US Geological Survey.

ACCESSIBLE SOURCES OF WATER

PRECIPITATION

Precipitation, in the form of rain, sleet, snow, or hail, is the process where evaporated water vapor condenses in the atmosphere and falls to the earth. Precipitation is one of the primary connections in the water cycle that delivers atmospheric water to the Earth. Precipitation in the form of snow is crucial to many ecosystems, because as the snow melts throughout the year, it provides fresh water. The fresh snowmelt is very important to riparian habitats because it provides water to rivers and streams through the warm summer months when precipitation may not normally occur.

PRECIPITATION

SURFACE WATER

Surface water is any body of water that can include fresh and salt water bodies, like oceans, seas, lakes, rivers, and streams. Dammed lakes and reservoirs allow for storage, timely water delivery, flood control, potential hydroelectric power generation, and fire suppression. Surface water is often artificially created by the damming of rivers and streams which alters the natural ecosystem, segments the river, and often times inhibits native fish migration. Surface water is also very prone to evaporation losses, which is why this form of water storage may not be suitable for all locations.

SURFACE DISADVANTAGES

GROUNDWATER

Groundwater is one of our most precious resources. Unfortunately, our groundwater is not only neglected, but it is also taken for granted. Groundwater is recharged by stream flow, rain, and permeated surface water. Groundwater can also become contaminated by pollutants, which is a very serious issue surrounding drinking sources. If groundwater is pumped more than it is replenished, it can lead to lower water tables and possibly land subsidence in susceptible areas depending on the aquifer system and rock structure.

LAND SUBSIDENCE

ALTERNATIVE SOURCES

With so many technological advances, we are able to harness water previously considered unusable. Innovative processes allow us to expand our list of resources, including salt-water treatment plants that create potable water from the ocean. There are also reclamation facilities that take wastewater effluent and storm runoff and treat it to become non-potable water for environmental or agricultural uses such as fisheries, stream flow, wildlife habitats, landscaping and irrigation.

WASTEWATER TREATMENT

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DISTRIBUTION: WATER WHEELING

To 'wheel water' means to transfer water to meet demands of urban, industrial, and agricultural water users. Water sources and water requirements don't always match up.

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CA WATER DISTRIBUTION

LIMITED WATER AFFECTS EVERYONE

According to the Huston Museum of Natural Science, "areas with very little rainfall usually turn into deserts" and some of these desert areas include North Africa, the Middle East, western North America, and Central Asia. In California, there are many urban populations that are situated in desert areas, or areas that are experiencing increasingly less water. It is a major challenge to make an oasis out of a desert landscape, creating a huge pressure on water from other locations.

Every continent across the globe is suffering from population increases that put demand on all resources, however water resources can be the most difficult to quantify and indicate issues with overuse. Groundwater tables lowering, land subsidence, desertification, and rivers running dry are all indicators that freshwater resources are not being managed properly.

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Note: Planners typically assume that a family of four will use 1 acre-foot of water per year, which is equivalent to 325,851 gallons.

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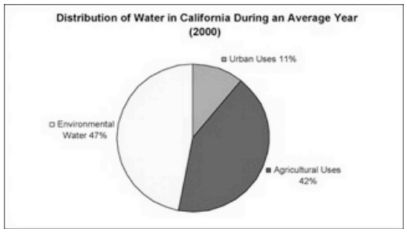

HOME | GLOBAL RESOURCES | LOCAL ALLOCATION | USE AND CONSERVATION | ABOUT

WATER USE AND CONSERVATION

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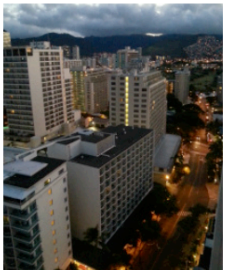
Below are lists of issues and ways to conserve water. A few of the topics may be of particular interest to you or the area where you live. Educate yourself and see how you can make a difference by reducing your water consumption, becoming a more educated voter, and conserving our resources for future generations to come!



POTENTIAL ISSUES IN WATER USE

AGRICULTURE

- Salt water intrusion from overpumping near coast
- Reduced river flows affect riparian flora and fauna
- Pumping impacts on groundwater; subsidence
- Soil erosion from irrigation on bare soils
- Leeching of nutrients into groundwater, streams
- Salt accumulation in soil from deficit irrigation
- Fertilizers introduced into surrounding environment
- Irrigation runoff as source of pesticide or fertilizer

URBAN / INDUSTRIAL

- Pollutants introduced into groundwater, streams, and the ocean
- Chemical spills introduced by industrial operations
- Pathogenic organisms in contaminated water
- Prescription drugs and heavy metals introduced into waste water- an issue with reclaimed water
- Potable water quality issues
- Sewage spills, septic tanks, leech lines

WATER CONSERVATION

AGRICULTURAL

- High efficiency irrigation methods
- Laser leveling for more level ground
- Dry land farming
- Partial root drying
- Deficit irrigation
- Modifying irrigation schedule according to weather
- Groundwater recharge
- Cover crops
- Tail water collection and reuse
- Planting crops better adapted to local climate

URBAN / INDUSTRIAL

- Grey water reuse for landscaping
- High efficiency irrigation methods and upkeep
- Low flow fixtures at home
- High efficiency appliances
- Smart water saving techniques
- Being aware of your water use and impacts
- Reducing losses- evaporation, leaks, contamination
- Planting native and low-water use landscapes
- Reuse of process water during production
- Turf replacement, low-water landscape transition

CALCULATE YOUR WATER USE

ABOUT THE AUTHOR

Angelina McKee is from a small town on the Central Coast of California, where she lives with her husband Joseph, and son Charlie. Once this project is completed, Angelina received her undergraduate degree with honors from Cal Poly, San Luis Obispo. In her time at Cal Poly, Angelina studied Agricultural Engineering, Water Engineering Science and Irrigation, Forestry, and Natural Resources.

This website was created in partial fulfillment of the requirement for a Bachelor's of Science in Agricultural Science from Cal Poly State University, San Luis Obispo. The website, research, synthesis of the project, and final report fulfills the capstone curicullum requirements. Angelina McKee designed and created this website to promote water conservation, resource use, and allocation, and a better understanding of water resources.

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Chapter Five

Summary, Recommendations, and Conclusions

Summary

Water is one of our most valuable resources. How water resources are managed, utilized, conserved, and stored are crucial for all that use it. Everyone needs to be more educated and aware about how their water use affects others and how it will affect future use. With limited resources, bridging the gap between different water users will allow more effective management, informed voter decisions, and a more sustainable use of resources. This website is for the purpose of bridging the gap between water users, increasing water resource awareness, and allowing the public as a whole to make more informed decisions on their water use and potential water policies.

Recommendations

Compiling information for the public and building a website can be very time consuming and involves a lot of care and consideration. Making information that can potentially reach millions of viewers should be thorough, balanced, and factual. There are many ways to create websites and that decision depends greatly on the amount of time and experience of the website creators.

It is recommended that when starting a project, like a website, background information be compiled beforehand, so that the design and population of the information on the website is a more straightforward task. When creating and populating a website, it is recommended to have several advisors to critique your design, functionality, and information presented to insure the convenience for the public user, as well as potential reactions that the public site may receive.

Based on personal website experiences, either writing code or using a website builder with “drag and drop” functionality, for those inexperienced it would be recommend using a builder that has “drag and drop” functionality. It reduces the amount of work, provides designs and layouts that are simple to choose from, and takes the difficulty of writing code out of the equation. For those that enjoy a challenge, or are very computer savvy, writing code would be the other more complicated option.

Conclusions

Completion of the compilation of the website for water awareness and water resource user education was a success because it met the objectives established in the beginning of the project. The website is able to reach a wide array of viewers because it is available to everyone with a computer and Internet across the world.

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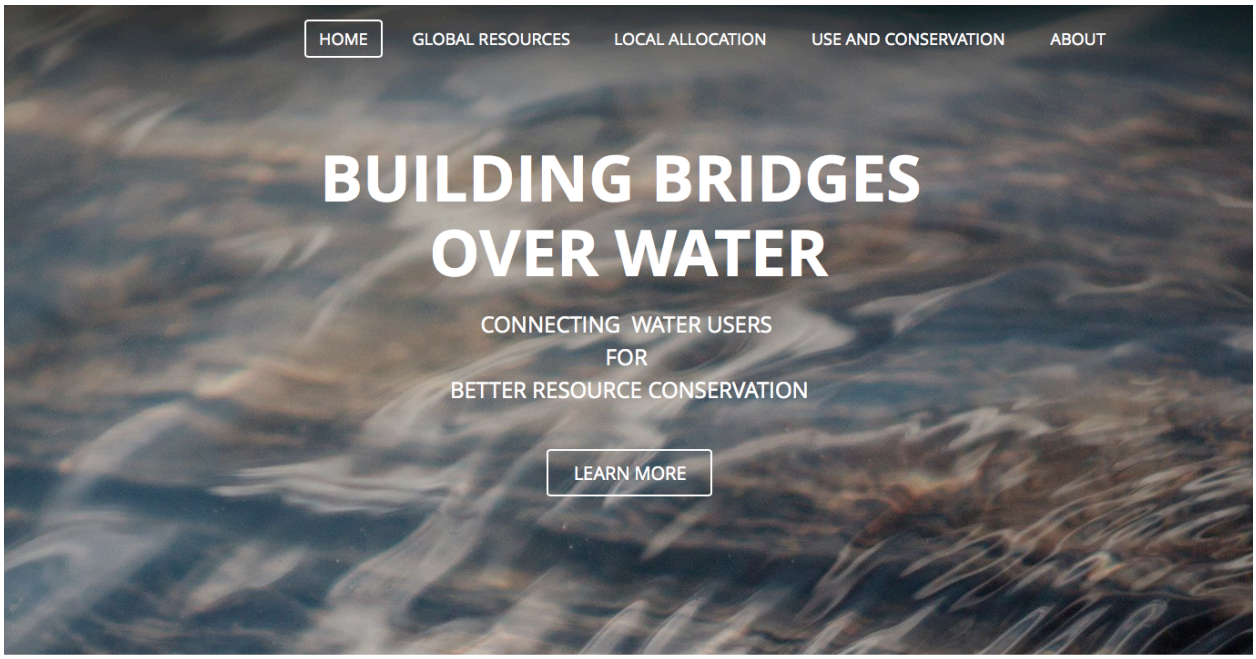
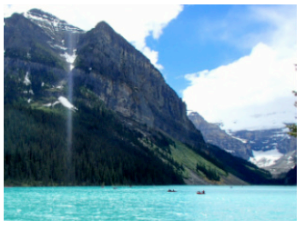




GLOBAL RESOURCES

Water is one of our most precious resources. It is important to understand where our water comes from because different water sources require different conservation and management plans.

LOCAL ALLOCATION

Water is distributed, or reallocated to different places, and then stored for later use. It is important to know where your water is coming from and how it is being managed. Find out where your water comes from!

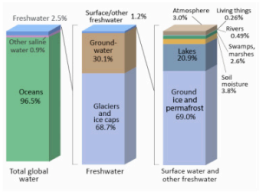
USE AND CONSERVATION

We all need to do our part to conserve water and use it wisely. Water conservation means reducing our water consumption so that everyone has access to a clean and sustainable source of water.

When the well is dry, we learn the worth of water.
- Benjamin Franklin

GLOBAL RESOURCES

WATER DISTRIBUTED ON EARTH

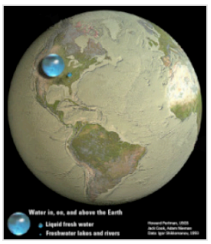


Source: Water Cycle. 2014. USGS.

VARIOUS WATER SOURCES

Water sources are present in many different forms, of which can be both natural and man-made. Rain water, or precipitation, oceans, rivers, lakes, streams, ponds, springs, and groundwater are all examples of natural sources of water. Dams, wells, canals, reservoirs, storage ponds, ocean desalination, and others are examples of man-made sources of water. Often times sources of water are a complex combination of these systems.

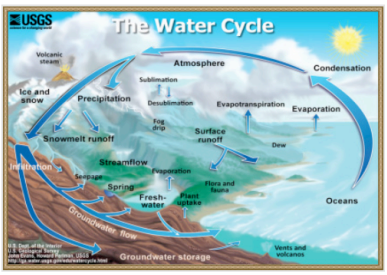
FRESH WATER SIZE COMPARISON



Source: The World's Water. 2014. USGS.

THE WATER CYCLE

The natural water cycle, also called the hydrologic cycle, is a cylindrical process where water changes between the solid, liquid, and gas physical states. These physical states for water are referred to as ice, water, and water vapor. The Hydrologic cycle, as seen to the right, is a simplified version of the various parts of the water cycle that are constantly naturally occurring; the graphic helps depict the endless changes between physical states, above, below and ontop of the Earth's surface and hints at the complicated interconnections between each part of the cycle that makes up the whole.



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ACCESSIBLE SOURCES OF WATER

PRECIPITATION

Precipitation, in the form of rain, sleet, snow, or hail, is the process where evaporated water vapor condenses in the atmosphere and falls to the earth. Precipitation is one of the primary connections in the water cycle that delivers atmospheric water to the Earth. Precipitation in the form of snow is crucial to many ecosystems, because as the snow melts throughout the year, it provides fresh water. The fresh snowmelt is very important to riparian habitats because it provides water to rivers and streams through the warm summer months when precipitation may not normally occur.

PRECIPITATION

SURFACE WATER

Surface water is any body of water that can include fresh and salt water bodies, like oceans, seas, lakes, rivers, and streams. Dammed lakes and reservoirs allow for storage, timely water delivery, flood control, potential hydroelectric power generation, and fire suppression. Surface water is often artificially created by the damming of rivers and streams which alters the natural ecosystem, segments the river, and often times inhibits native fish migration. Surface water is also very prone to evaporation losses, which is why this form of water storage may not be suitable for all locations.

SURFACE DISADVANTAGES

GROUNDWATER

Groundwater is one of our most precious resources. Unfortunately, our groundwater is not only neglected, but it is also taken for granted. Groundwater is recharged by stream flow, rain, and permeated surface water. Groundwater can also become contaminated by pollutants, which is a very serious issue surrounding drinking sources. If groundwater is pumped more than it is replenished, it can lead to lower water tables and possibly land subsidence in susceptible areas depending on the aquifer system and rock structure.

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ALTERNATIVE SOURCES

With so many technological advances, we are able to harness water previously considered unusable. Innovative processes allow us to expand our list of resources, including salt-water treatment plants that create potable water from the ocean. There are also reclamation facilities that take wastewater effluent and storm runoff and treat it to become non-potable water for environmental or agricultural uses such as fisheries, stream flow, wildlife habitats, landscaping and irrigation.

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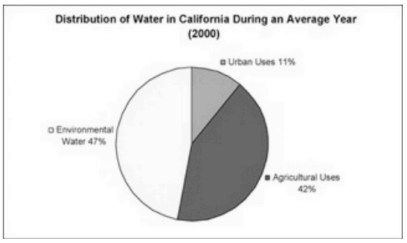

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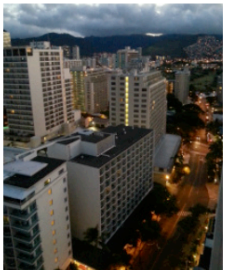

POTENTIAL ISSUES IN WATER USE

AGRICULTURE

- Salt water intrusion from overpumping near coast
- Reduced river flows affect riparian flora and fauna
- Pumping impacts on groundwater; subsidence
- Soil erosion from irrigation on bare soils
- Leeching of nutrients into groundwater, streams
- Salt accumulation in soil from deficit irrigation
- Fertilizers introduced into surrounding environment
- Irrigation runoff as source of pesticide or fertilizer

URBAN / INDUSTRIAL

- Pollutants introduced into groundwater, streams, and the ocean
- Chemical spills introduced by industrial operations
- Pathogenic organisms in contaminated water
- Prescription drugs and heavy metals introduced into waste water- an issue with reclaimed water
- Potable water quality issues
- Sewage spills, septic tanks, leech lines

WATER CONSERVATION

AGRICULTURAL

- High efficiency irrigation methods
- Laser leveling for more level ground
- Dry land farming
- Partial root drying
- Deficit irrigation
- Modifying irrigation schedule according to weather
- Groundwater recharge
- Cover crops
- Tail water collection and reuse
- Planting crops better adapted to local climate

URBAN / INDUSTRIAL

- Grey water reuse for landscaping
- High efficiency irrigation methods and upkeep
- Low flow fixtures at home
- High efficiency appliances
- Smart water saving techniques
- Being aware of your water use and impacts
- Reducing losses- evaporation, leaks, contamination
- Planting native and low-water use landscapes
- Reuse of process water during production
- Turf replacement, low-water landscape transition

CALCULATE YOUR WATER USE

ABOUT THE AUTHOR

Angelina McKee is from a small town on the Central Coast of California, where she lives with her husband Joseph, and son Charlie. Once this project is completed, Angelina received her undergraduate degree with honors from Cal Poly, San Luis Obispo. In her time at Cal Poly, Angelina studied Agricultural Engineering, Water Engineering Science and Irrigation, Forestry, and Natural Resources.

This website was created in partial fulfillment of the requirement for a Bachelor's of Science in Agricultural Science from Cal Poly State University, San Luis Obispo. The website, research, synthesis of the project, and final report fulfills the capstone curicullum requirements. Angelina McKee designed and created this website to promote water conservation, resource use, and allocation, and a better understanding of water resources.

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