

Fulbright-Hays Curriculum Project

WATER:

Playing a Major Role in the
Development and Demise of
Civilizations

Upper Elementary (4-6th)
Integrated Science and Social Studies Unit

By
Jody K. Geitz
Consolidated Community School District 15
Palatine, Illinois

"On The Footsteps of the Mayan and Inca Peoples"
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Unit Summary

Water—a substance composed of the chemical elements hydrogen and oxygen and existing in gaseous, liquid, and solid states. Water is one of the most plentiful and essential compounds found on Earth. It is vital to life, participating in virtually every process that occurs in plants and animals. An abundant supply of fresh water has been one of the essential factors in the development of all civilizations. This integrated social studies/science curriculum unit explores the ancient Maya civilization's management of water resources and introduces students to basic scientific concepts fundamental to the discussion of management of water resources in society. Students will explore the Maya sites of Uxmal and Palenque searching for an understanding of how these ancient civilizations grew, prospered, and ultimately were abandoned. With each Maya site of study, complementary science concepts will be developed through additional discussion and experimentation. The unit terminates by comparing Uxmal and Palenque, allowing students the opportunity to develop perspective on the Maya Civilization and to interpret how water possibly played a fundamental role in this civilization. This unit is designed to complement the 5/6 grade social studies and science curriculum. If executed within a typical public school framework, it would take approximately four weeks to complete. It is suggested that the introductory activities be completed first, laying a framework for the subsequent lessons.

Essential Questions

1. Does availability of fresh water determine the settlement patterns of a civilization?
2. How has man controlled or managed water resources?
3. Could depletion of this valuable resource cause the demise of a civilization?
4. Does the Maya civilization have lessons to teach us today regarding water management?
5. How can we better preserve and manage water for future generations?



Illinois State Goals & District Learner Statements

Language Arts:	
State Goal 1	Read with understanding and fluency.
District	Use information to form and refine questions and predictions.
State Goal 5	Use the language arts to acquire, assess, and communicate information.
District	Apply acquired information, concepts, and ideas to communicate in a variety of formats.
Science:	
State Goal 12	Understand the fundamental concepts, principles, and interconnections of the life, physical, and earth/space sciences.
District	Know and apply concepts that describe how living things interact with each other and with their environment.
State Goal 13	Understand the relationships among science, technology, and society in historical and contemporary contexts.
District	Understand that the introduction of a new technology can affect human activities worldwide.
Social Science:	
State Goal 17	Understand world geography and the effects of geography on society.
District	Understand relationships between geographic factors and society.

Introductory Lessons

A. Opening Discussion Questions: Use the following questionnaire to initiate a discussion of water in our world. This activity is designed to aid students in recognizing how they use water and to determine what background knowledge they bring to the subject. Revisit this questionnaire at the end of unit to determine if students have altered their understanding of the topic.

B. The Water Cycle: To help students understand the water cycle, complete the following activities.

1. **Readers' Theater:** The Water Cycle Adventure [available at: <http://www.enchantedlearning.com/rt/weather/watercycle.shtml>]. Using 19 readers, enjoy this 10 minute script that covers the never-ending story of the water cycle. It does not require props or scenery and is easy to perform. It would be useful to identify all the different places indicated in the script. The script is provided by Enchanted Learning, © 2001-2008.

2. **The Water Cycle Diagram:** Color and label the diagram to have a quick visual presentation of the water cycle.

C. The Geography of Mexico: Identify important physical features and sites in Mexico.

1. Using a classroom world map, locate Mexico. Identify major cities, bodies of water and physical landforms.



2. Using the Maya World Map, identify the location of Uxmal and Palenque. Compare the present day Mexico map to the Maya World Map. Locate nearest sources of water for these settlements. Predict how these communities supplied and used water.

D. Maya Civilization: Read the Encarta® Online Encyclopedia article and create a timeline to compare the Maya civilization to the following significant civilizations and events in history; Egyptian Empire, Roman Empire, Discovery of America by Christopher Columbus, Discovery of Mexico by Hernando Cortez.

Water Questionnaire

1. How did you use water this morning before coming to school?
2. How does your mother use water every day?
3. Where does the water in your home come from?
4. How is water used for recreation?
5. Have you ever lived a day without water coming to your home? What was it like?
6. Are there important sources of water in your region? What are they?
7. Are there places in the world where water is scarce? Where?
8. How do people waste water?
9. What can you do to preserve and protect our water supply?
10. Does everyone in the world have safe clean drinking water? Is this question important? Why or why not?

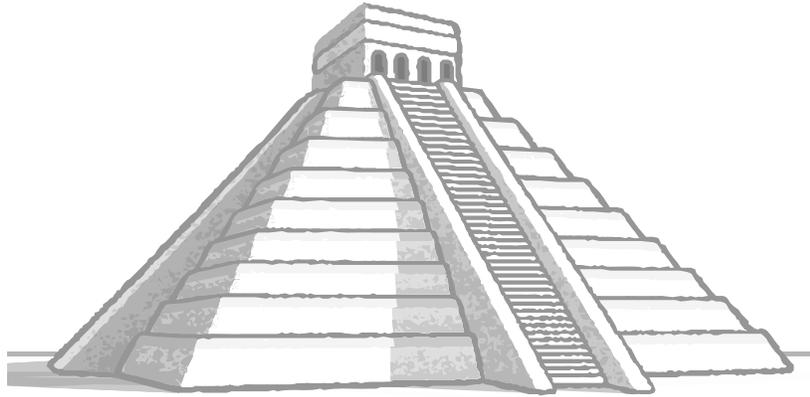
The Water Cycle

Read the text below and label the diagram with the underlined words.



The sun's heat makes water evaporate from streams, lakes, rivers, and oceans. The water vapor rises. When it reaches cooler air, it condenses to form clouds. When the clouds are full of water, or saturated, they release some of the water as rain.

Maya Civilization



I. Introduction

Maya Civilization, an ancient Native American culture that represented one of the most advanced civilizations in the western hemisphere before the arrival of Europeans. The people known as the Maya lived in the region that is now eastern and southern Mexico, Guatemala, Belize, El Salvador, and western Honduras. They thrived for more than 2,000 years. The Maya built massive stone pyramids, temples, and sculpture; developed a system of writing using hieroglyphs; and recorded their achievements in mathematics and astronomy. Archaeologists long believed that Maya culture reached its highest development from about A.D. 300 to 900, during what is known as the Classic period. Recent discoveries in northern Guatemala, however, have challenged that assumption. There, archaeologists have found highly developed cities, sophisticated art, and examples of Maya writing that date from as early as 600 years before the Classic period began.

After 900 the Maya mysteriously declined in the southern lowlands of Guatemala. They later revived in the north on the Yucatán Peninsula and continued to dominate the area until the Spanish conquest in the 16th century. Descendants of the Maya still form a large part of the population of the region. Although many have adopted Spanish ways, a significant number of modern Maya maintain traditional cultural practices.

Reviewed By: William R. Fowler, B.A., M.A., Ph.D., Associate Professor of Anthropology and Latin American Studies, Vanderbilt University. Author of *El Salvador: Antiguas Civilizaciones*. Editor of *Ancient Mesoamerica*.

"Maya Civilization," Microsoft® Encarta® Online Encyclopedia 2008
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Uxmal - "Thrice-Built"

Uxmal (oosh-mawl) is an ancient city in the north Yucatán peninsula of Mexico. A Late Classic period Maya center, Uxmal flourished between 600 and 900. The name Uxmal means "thrice-built" in Mayan, referring to the construction of its highest structure, the Pyramid of the Magician. The site has several fine examples of Mayan architecture, including the Nunnery, with elaborate stone mosaic friezes; the Governor's Palace, with some 20,000 carved stone elements; and the Pyramid of the Magician. The Maya abandoned Uxmal shortly after 950.

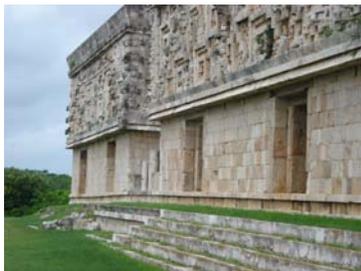


Uxmal was one of the greatest Maya cities. The city was built sometime during the 5th or 6th centuries but archaeological evidence suggests that the area had been inhabited as a farming center since as far back as 800 B.C.

The grandest structure of the site is the Pyramid of the Magician. Though not a true pyramid (it is elliptical, not square), the pyramid stands 38 meters tall with a staircase at a steep angle. At 90 feet tall, this nine-level pyramid is the largest structure at Uxmal. It is decorated with fancy carvings of masks, birds, and flowers.



The Nunnery is thought to have been a school

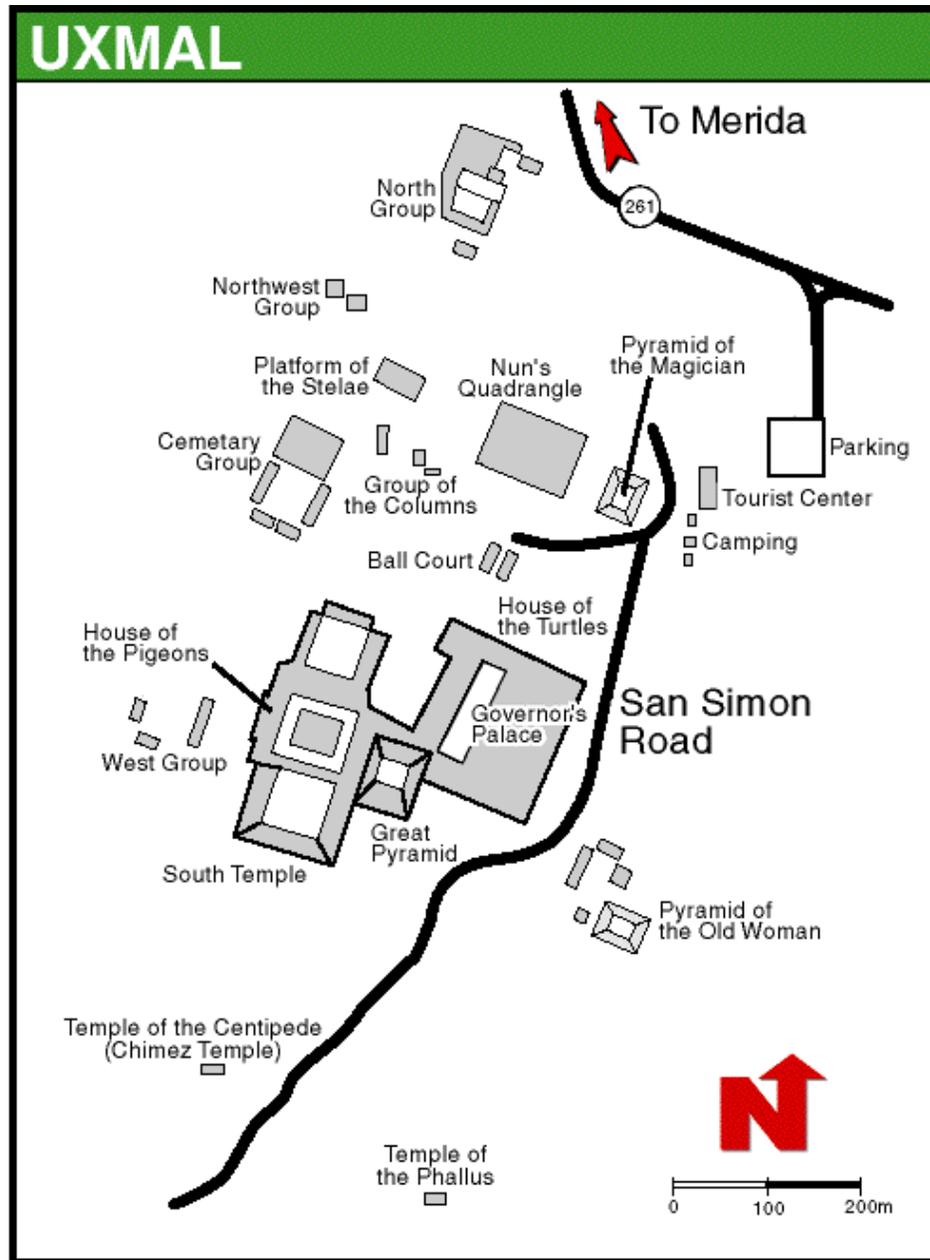


of some sort, either for the military or the children of the elite classes. Southwest of the pyramid is the Governor's Palace, the largest and fanciest structure in Uxmal. The intricate stonework and the 320-foot long mosaic facade of the palace make the building the most beautiful at Uxmal. The Palace's main door was placed in perfect alignment with the planet Venus. Like many of the other ruins in Mexico, Uxmal has a restored ball court.

There are huge cisterns which supplied the city with water; the city built these cisterns to capture rain. That's why the rain god, Chaac, was the most worshipped in Uxmal.

This article is adapted from Mayan Kids, © 2008:
<http://www.mayankids.com/mmkplaces/mkuxmal.htm>

Activity: Use this map to identify the structures mentioned in *Uxmal - "Thrice-Built."*



Chultuns of Uxmal

In Uxmal (approximately 500 A.D. to 1200 A.D.), the Ancient Maya of the Yucatán Peninsula began carving out underground storage facilities called *chultuns* or cisterns. These chambers were carved out of the relatively soft limestone bedrock, then often plastered with a thick coating of lime stucco. The exact purpose of these extremely common storage chambers still eludes archaeologists. Most were probably used to collect and store rain water. The northern portion of the Yucatán Peninsula has a marked dry season, and portions have a quite meager rainy season. The water that does fall sinks into the limestone bedrock almost immediately and joins with the groundwater in the immense systems of caves which riddle the peninsula. Consequently, surface water is scarce, and *chultuns* were positioned in sculpted plazas and side yards which would drain the precious fluid into the narrow openings for storage. There was evidence of a great hydraulic engineering system used to collect rain water in the *chultuns*, which held 20-35 thousand liters of water each. Over 150 of these *chultuns* have been found in the center of Uxmal alone. It is also possible that the *chultuns* were used to store other goods and seal them away from pests. In many cases this can be ruled out due to the amount of water which would have collected in these chambers and quickly rotted any dry food-stuffs.



This article is adapted from Mesoamerican Photo Archives, owned and maintained by David R. Hixson at the Department of Anthropology, Tulane University, © 1997-2001, <http://www.mesoamerican-archives.com/>

Activity: Use the Uxmal Map and indicate where 50 cisterns could be located. Explain your choice of sites.

Chaak

Chaac, Dios del Agua

Chac, The Rain God

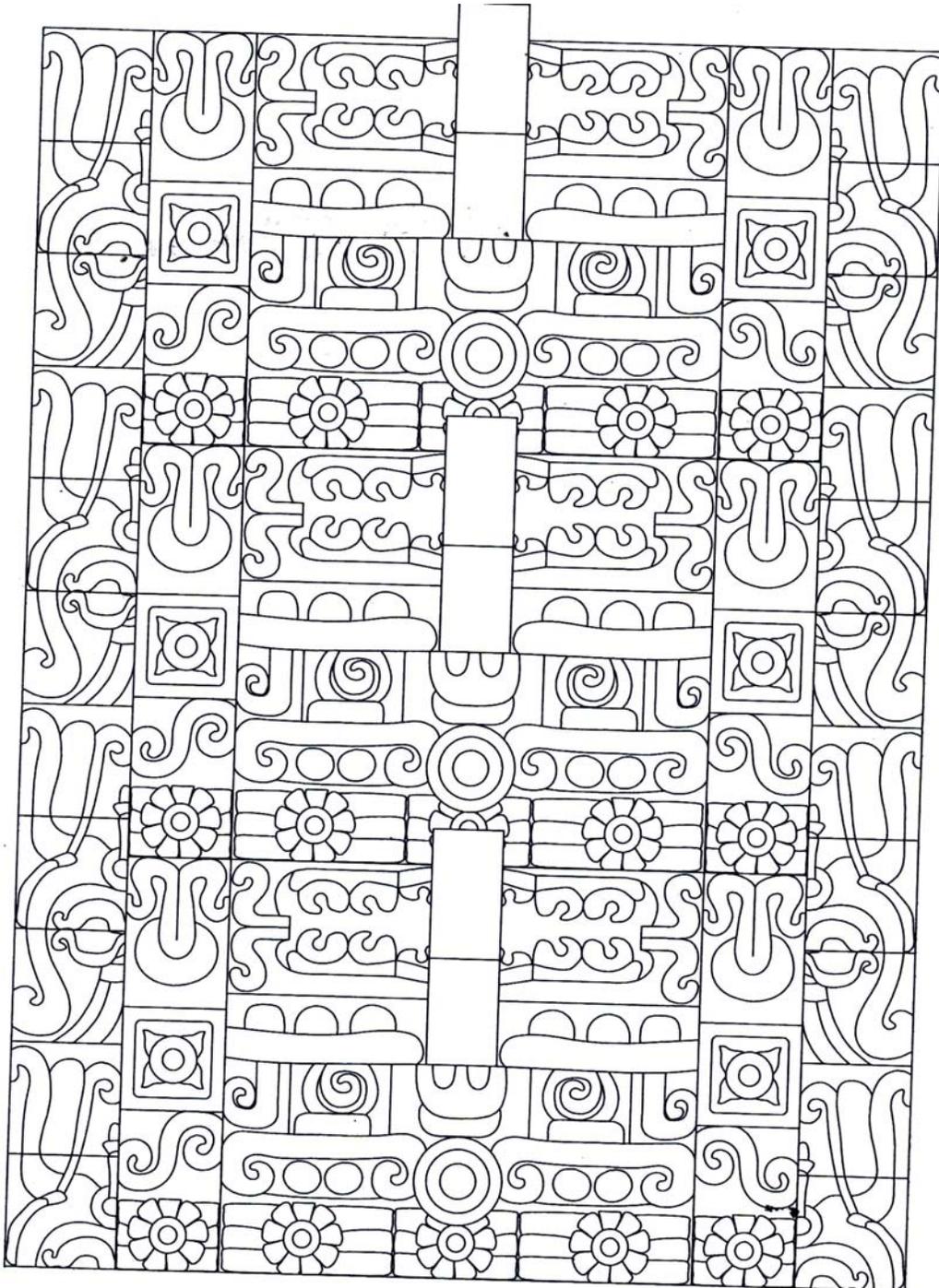
Uxmal had no water—no rivers, lakes, streams, or even cenotes. It's not surprising that the Mayas of Uxmal depended on their rain god, Chaak, to bring them life-giving rain to collect in their cisterns, and to provide run-off to nourish their crops. Rituals and offerings were and still are made to the great god Chaak, especially before planting and to ensure the coming of the rainy season. Chaak's physical appearances were varied: catfish whiskers, down-turning reptilian snout, body scales, and bound hair. He is often shown with an axe or serpent indicating his status as god of lightning. In his most benevolent form, he was associated with agriculture and fertility. What Chaak provided, however, he could also withhold or supply in disastrous abundance. In his most malevolent aspect, Chaak could bring drought or hurricanes.

Article adapted from Instituto Cultural Quetzalcoatl,
www.samaelgnosis.net/.../mayas/dioses/chaac.htm



Activity: Identify the three faces of Chac on the following drawing. Color this reconstructive drawing of Chac masks which are displayed on the west building of the Nunnery at Uxmal.

Chaak
Chaac, Dios del Agua
Chac, The Rain God



Science focus: Rainwater Harvesting

Rainwater harvesting is an ancient technique enjoying a revival in popularity due to the inherent quality of rainwater and interest in reducing consumption of treated water.

Advantages and benefits of rainwater harvesting are numerous.

- The water is free; the only cost is for collection and use.
- The end use of harvested water is located close to the source, eliminating the need for complex and costly distribution systems.
- Rainwater provides a water source when groundwater is unacceptable or unavailable, or it can augment limited groundwater supplies.
- Rainwater is sodium-free, important for persons on low-sodium diets.
- Rainwater harvesting reduces consumers' utility bills.

Source: The Texas Manual on Rainwater Harvesting,
http://www.twdb.state.tx.us/publications/reports/RainwaterHarvestingManual_3rdedition.pdf

Activity: Consider whether harvesting rainwater would be a good idea for your community. Consult local weather Internet sites to determine average patterns of rain fall in your area. Design a system to harvest rainwater. Determine how the water will be collected and stored. Draw a diagram and fully explain the system. Finally, determine what might be the best uses for the water collected in this system.



Palenque



Lakam Ha' - "Big Waters"



Palenque is a ruin city that is part of the Maya civilization that dates back to 100 B.C. to its fall around 800 A.D. It is located on the western edge of the Maya empire near the present-day city of Chiapas, Mexico. The ruins left behind are very well preserved and maintained

by local people as well as anthropologists. Currently, it is one of the most popular ruins for tourists from around the world to visit.

Palenque is located at slightly less than 3000 meters above sea level overlooking the lower coastal plain stretching to the Gulf of Mexico about 80 miles to the north. The ruins can be found throughout a thick forest of mahogany, cedar, and sapodilla trees, which in turn kept the ruins hidden for many years until they were discovered by the Spaniards in the mid to late eighteenth century. In early morning hours the ruins are often covered in a blanket of fog. The fog, combined with the sun and trees, produces one of the most aesthetically grand ruins ever visited. The site of Palenque stays at an average temperature of 79 degrees Fahrenheit and remains humid with an average precipitation per year of 85 inches of rain.

Although Palenque originated at about 100 B.C., it did not become a major population with importance in the Maya culture until 600 A.D. At this time their greatest ruler,



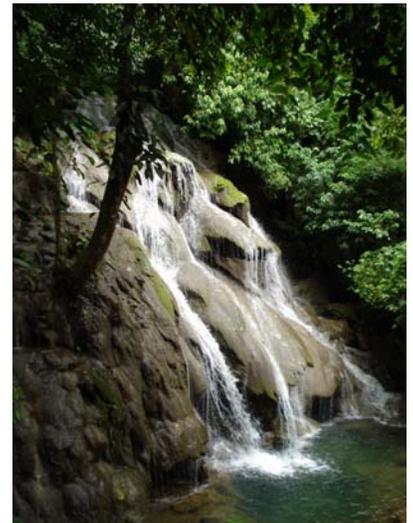
Pacal, assumed power. Pacal took power in 603 A.D. and ruled for 68 years. During his rule, he emphasized the construction of grand buildings to reflect his power. One of his great structures was the



Ancient Mayan toilet

Palace. The Palace was made with mansard-type roofs and the walls were covered with priceless stucco carvings of rulers, gods, and ceremonies that took place. On the inside of the palace were a plethora of rooms with interior courts that overlooked a four-story square tower that may have served as both lookout and observatory for the people of that time. Underneath the palace and through a long, corbel-vaulted tunnel, a stream ran through carrying a constant supply of running water. Flowing water through a monumental structure like that was a feat of engineering genius. Some say the Palace may not have been lived in because of the cold dampness of the rooms and no sign of people living there.

The Maya were an incredible civilization and nobody knows exactly why the empire fell. Some people believe it was from disease, famine, or civil war. Someday we may know more of the secrets of Palenque because archaeological excavations are ongoing at the site. With time, hopefully all the mysteries of Palenque will be revealed.



Article adapted from: Minnesota State University Mankato, EMuseum,
http://www.mnsu.edu/emuseum/archaeology/sites/meso_america/palenque.html

Palenque FEATURES

Palenque Means Big Water

By Kirk D. French

From an article in *Mundo Maya*

Riding in the back of an old pickup truck into the misty jungle-covered hills of Chiapas, Mexico, the anticipation of seeing my first major Maya city was almost more than I could handle. The road was narrow and curvy, but we finally arrived.

As we topped the hill and drove through the gate, the jungle opened up, I was overcome with amazement. It was early in the morning and the fog was just beginning to part ways with the 1500-year-old stone structures.

The awe I felt at that moment when I first caught a glimpse of Palenque is what has fueled my fire as an archaeologist. So in the fall of 1997 I was fortunately chosen to work in Palenque on a three year mapping project. The Pre-Columbian Art Research Institute (PARI) Palenque Mapping Project (PMP) is made possible by The Foundation for the Advancement of Mesoamerican Studies, Inc. (FAMSI).

As a member of the PMP my goal is not only to help finish the first complete map of Palenque, but also to provide an understanding of the complex water management



systems that have not yet been brought to light.

The name Palenque in all actuality is a Spanish word meaning “palisade or stockade of wood.” An early archaeologist at Palenque, Miguel Angel Fernandez, commented “the natives of the area referred to Palenque by the name of Otolum,” a Chol Maya word meaning “strong house land,” or “fortified place.”

It was suggested that Fray Pedro Lorenzo de la Nada, who discovered the ruins in 1567, understood the meaning of the Chol word “Otolum,” and searching for a Spanish word with similar meaning chose the name “Palenque.”

The Maya that built and occupied this ancient city called it Lakam Ha, which translates as “Big Water.” The fact that the area in which the city was built is saturated with numerous springs, arroyos, creeks, and streams is enough to justify its ancient name.

The people of Palenque dealt with many of the same issues that face our modern cities of today. One such issue is water

management. In our societies of the 21st century, city planners must deal with how to move water from its source to desired destinations in a convenient, sophisticated, and practical way. Palenque, because of its abundance of water and steep topography, presented quite a challenge in terms of land management.

Having many small water sources, the ancient Maya of Palenque had more water management options than other contemporary cities. Many other sites throughout Mesoamerica deal with water management in different ways than Palenque. Some were forced to focus on large-scale reservoir systems, Tikal being a case in point. Reservoirs filled during the rainy season were essential to Tikal's survival through the four-month dry season.

These reservoirs, located in many Maya lowland centers, were unnecessary at Palenque. Surrounded by waterfalls and underground springs, Palenque's inhabitants had flowing water year round, even in the dry months.

The problem that Palenque faced was not storing water, but rather what to do with the abundance of water. The types of water management Palenque decided



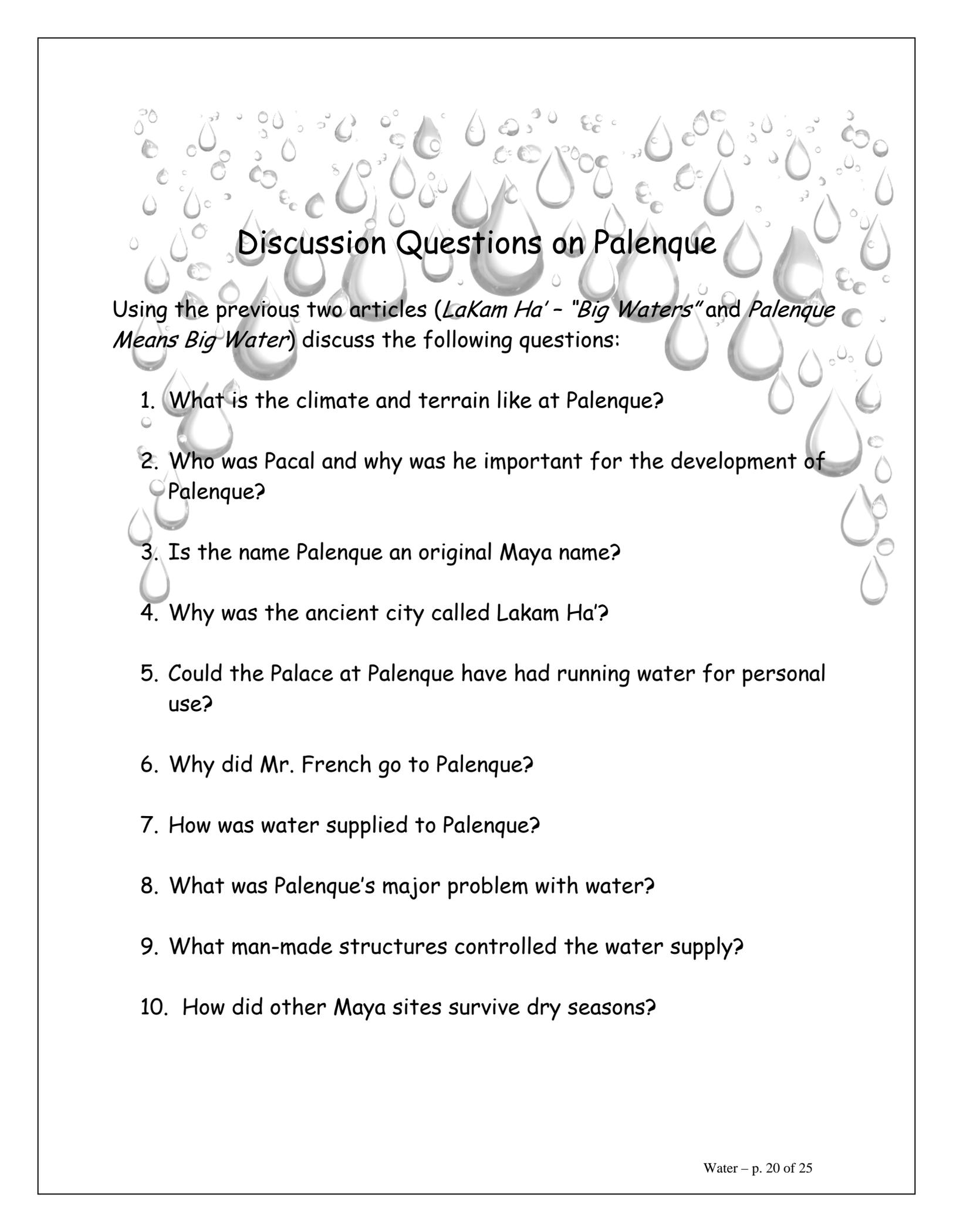
upon were of elaborate canal and aqueduct systems that were used to control the delivery and disposal of water. They channeled water throughout most of the entire city, including residential areas.

Some of the aqueduct channels are still functioning and many others have collapsed exposing their interior architecture. A few of those exposed aqueducts were dug 1–1.5 meters beneath the surface, similar to pipe systems found in modern cities of today.

One of the most accessible aqueducts for tourists at the ruins runs along the east edge of the Palace. Elaborately vaulted and 2.5 meters in height, this centrally located aqueduct is a must see for anyone visiting the site for the very first time.

The high level of architectural sophistication at Palenque has been known and respected for many years. Through the completion of the first topographic map of the ruins and the subsequent creation of a new understanding of its extensive water management system, we are now adding a new chapter to the history of Palenque.

Source: Mesoweb, An Exploration of Mesoamerican Cultures,
<http://www.mesoweb.com/palenque/features/bigwater.html>



Discussion Questions on Palenque

Using the previous two articles (*LaKam Ha' - "Big Waters"* and *Palenque Means Big Water*) discuss the following questions:

1. What is the climate and terrain like at Palenque?
2. Who was Pacal and why was he important for the development of Palenque?
3. Is the name Palenque an original Maya name?
4. Why was the ancient city called Lakam Ha'?
5. Could the Palace at Palenque have had running water for personal use?
6. Why did Mr. French go to Palenque?
7. How was water supplied to Palenque?
8. What was Palenque's major problem with water?
9. What man-made structures controlled the water supply?
10. How did other Maya sites survive dry seasons?

Science Focus:

Where does your drinking water come from? Using the U.S. government's Environmental Protection Agency's The Water Sourcebook, complete the science activities WATER GOES AROUND AND COMES AROUND and READ YOUR METER [available at: <http://www.epa.gov/safewater/kids/wsb/pdfs/352.pdf>].

The following is the introduction to these activities. Please download the file for the complete activity.

WATER GOES AROUND AND COMES AROUND OBJECTIVES

The student will do the following:

1. Build a model of a water system from the source to users.
2. Learn to read and interpret a water meter.
3. Plan ways of water conservation at the community level.

SUBJECTS:

Science, Social Studies, Math

TIME:

120 minutes

MATERIALS:

large piece of cardboard
paper towel or bathroom tissue tubes
straws
different sizes of pasta (spaghetti, manicotti, etc.)
glue
paste or glue sticks
small boxes (matchboxes, small milk cartons)
markers
construction paper
student sheets (included on Web site)
teacher sheet (included on Web site)

BACKGROUND INFORMATION

It has been determined that each person in the United States uses about 150 gallons of water a day. Experts add the number of people who live in a city, town, or community, and multiply that number by 150 to determine how much water is used daily by that community.



People use water for drinking, cooking, bathing, flushing the toilet, laundry, washing cars, and watering lawns. Factories, farms, stores, public utilities, and homes use millions of gallons of water daily. It is a big job for water treatment facilities to supply clean drinkable water to a town, city, or community.

After the water treatment plant cleans the water, it sends it out to the users. As the water travels through a distribution system, it is diverted down different pathways to homes and businesses. The diameter of a pipe determines the quantity of water the pipe can hold and determines the rate the water can travel through the pipe. The volume of water needed for homes or businesses represents a small portion of the volume leaving the water plant. Therefore, smaller pipes are needed near the point of distribution, whereas larger pipes are needed near the treatment plant.

Water treatment plants pump water from a source (lake, river, or groundwater), treat the water, and pump it to holding tanks or water towers. If the water goes to a water tower, it flows by gravitational force from the water tower throughout the distribution system. Otherwise, water distribution is driven by motorized pumps.

Drinkable water is not free. Water treatment facilities and the distribution of drinking water are costly. Customers are charged according to the amount of water they use. A water meter is used to measure how many gallons (liters) or cubic feet (cubic meters) a household or business uses.

Because users pay for water and because there is only so much fresh water available for use, we must conserve our supplies, using them as wisely and efficiently as possible. We must not use water wastefully.

Final Assessment:

Comparison of Uxmal and Palenque

1. Complete this chart.

Comparison Component	Uxmal Chac, the Rain God 	Palenque Pacal the Great 
Location		
Climate		
Physical Geography		
Estimated Time Period		
Primary Constructions		
Secondary Constructions		
Man-made structures to control water		
Site names and meanings		

Water Resources

Here are four resources that I found to be quite interesting while completing my research on water. JKGeitz

The Texas Manual on Rainwater Harvesting.

Texas Water Development Board, Third Edition. Austin, TX: 2005.

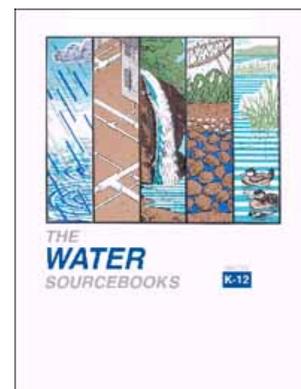
http://www.twdb.state.tx.us/publications/reports/RainwaterHarvestingManual_3rdedition.pdf

The Water Sourcebooks

The Water Sourcebooks contain 324 activities for grades K-12 divided into four sections: K-2, 3-5, 5-8, and 9-12. Each section is divided into five chapters: Introduction to Water, Drinking Water and Wastewater Treatment, Surface Water Resources, Ground Water Resources, and Wetlands and Coastal Waters.

This environmental education program explains the water management cycle using a balanced approach showing how it affects all aspects of the environment. All activities contain hands-on investigations, fact sheets, reference materials, and a glossary of terms. Activities are organized by objectives, materials needed, background information, advance preparation, procedures, and resources.

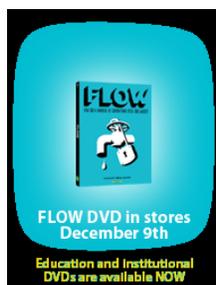
<http://www.epa.gov/OGWDW/kids/wsb/>



The End of the Pipe

Produced by *Chicago Matters* on Tuesday, August 05, 2008 Chicago Public Radio. Millions of gallons of fresh water are flowing under Chicago right now. And as our region grows, more and more people want to divert some their way. As part of *Chicago Matters: Growing Forward* we bring you the documentary *The End of the Pipe*, by independent producers Laura Starecheski and Gregory Warner. Come along on the near-epic journey of our water as it moves from Lake Michigan, into the city and beyond to the suburbs.

<http://www.wbez.org/Biography.aspx?bio=cmbaseline>



Flow: For Love of Water

A 2008 documentary film directed by Irena Salina, produced by Steven Starr. The film concentrates on the big business of privatization of water, which prioritizes profits over the availability of clean water for people and the environment.