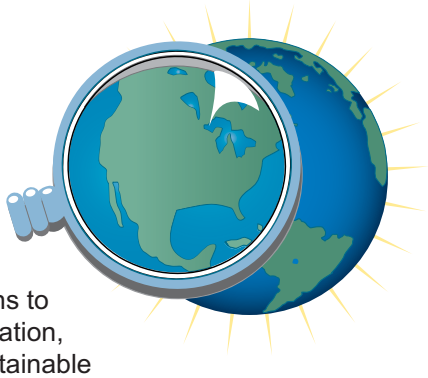
The Nile: A sustainable resource?



Investigation Overview

Students analyze data and make graphs to explore the relationship between population, water resources, water stress, and sustainable economic development. Students consider the perspectives of 10 countries within the Nile River Basin in a simulated meeting of the Nile River Basin Initiative.

Time required: One to two 45-minute sessions

Materials

Representative discussion points (one copy for each student per group per nation)
Data cards (as needed for a class of 25)
Script/briefing points
Computer with display device (optional)
Log 1: Outline map (one copy for each student)
Log 2: Water stress (one copy for each student)
Log 3: Discussion points data organizer (one copy for each student)
Figures 1-4 (overhead transparency of each)
Small paper cups
Optional: water

Content Preview

Water is a scarce commodity in northeastern Africa. Water is used for irrigated agriculture, industry, and human consumption. The Nile River is the main source of water for the nations through which it flows. The Nile does not provide sufficient quantities to meet current needs, let alone future needs as populations rise, industrial growth takes place, and more land is irrigated. When nations find themselves with less than 2000 cubic meters of renewable water supplies per person, they are water stressed. Water resources in the region have been affected by past human actions; natural factors such as evaporation present problems too. The interaction of population growth, water scarcity, and international conflict is apparent in this region. Governments in the region, particularly in Egypt, are building new irrigation projects to expand arable land. Monitoring river basins from space provides a useful and efficient way to demonstrate changes over a large area.

Geography Standards

Standard 1: The World in Spatial Terms

How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective

- Produce and interpret maps and other graphic representations to solve geographic problems.

Standard 14: Environment and Society

How human actions modify the physical environment

- Evaluate the ways in which technology has expanded the human capability to modify the physical environment.
- Develop possible solutions to scenarios of environmental change induced by human modification of the physical environment.

Standard 15: Environment and Society

How physical systems affect human systems

- Analyze examples of changes in the physical environment that have reduced the capacity of the environment to support human activity.

Geography Skills

Skill Set 3: Organize Geographic Information

- Select and design appropriate forms of graphs, diagrams, tables, and charts to organize geographic information.

Skill Set 4: Analyze Geographic Information

- Make inferences and draw conclusions from maps and other geographic representations.

Classroom Procedures

Beginning the Investigation

1. Distribute **Log 1** and ask students to follow the path of the Nile River from its origins in the highlands of Ethiopia and Burundi to its mouth in Egypt. Have them draw a boundary around the Nile River Basin. This watershed makes a functional region. Next, have students identify the 10 countries with territory in the Nile River Basin. (*Burundi, Rwanda, Tanzania, Kenya, Congo [Zaire], Uganda, Ethiopia, Eritrea, Sudan, Egypt.*) Point out to students that 40 percent of Africa's population lives in these 10 countries, which constitute only 10 percent of its landmass.

2. Divide the class into groups roughly proportional to the size of the population of each nation in the Nile River Basin. The proportions for a class of 25 are listed at right.

Country	Population	% of Total Population	# of Students
Burundi	6,064,000	2	1
Rwanda	5,184,000	2	1
Tanzania	30,026,000	11	2
Kenya	27,154,000	10	2
Congo	45,453,000	16	4
Uganda	19,689,000	7	2
Ethiopia	56,404,000	20	5
Eritrea	3,171,000	1	1
Sudan	26,707,000	9	2
Egypt	62,096,000	22	5
Total	281,948,000	100	25

   Distribute **Log 2** and the data cards for each country. Explain that students will play the role of representatives from each of the Nile River Basin nations. First, they must do some research on their nation, its water resources, and population prospects. Students use the data for their nation to graph population growth against water resource availability and determine water stress in the past, present, and future.

   Students can draw the graph by hand or use a computer-based graphing program. The left-hand scale represents population shown as bars; the right-hand scale represents the per capita water available in cubic meters shown as a line graph. Data for Burundi are graphed below as an example.

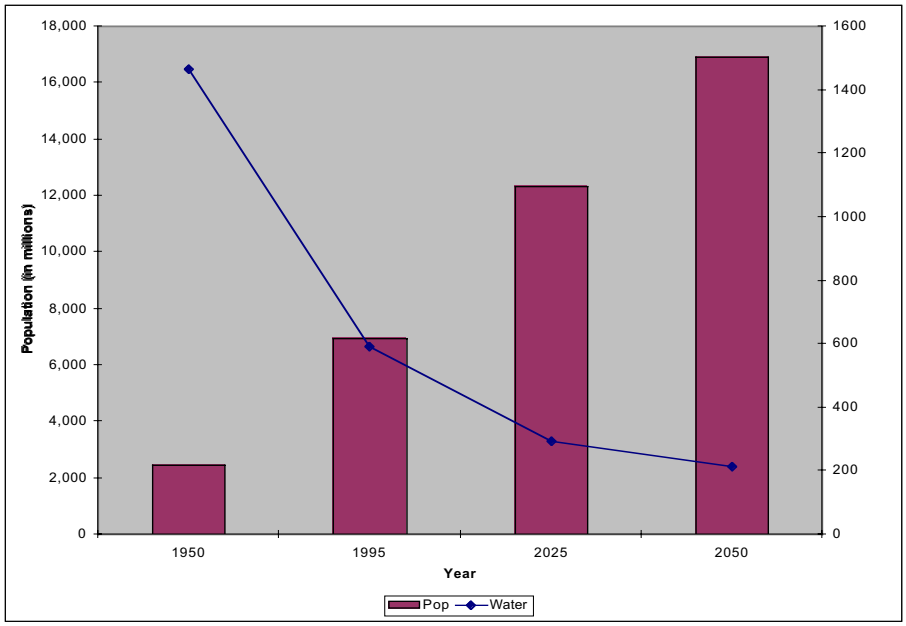
   Have students analyze their graphs and answer questions 2-4 on **Log 2**.

3. When students have completed **Log 2**, check to make sure they understand the relationship among population growth, water resource availability, and the water stress index.

Developing the Investigation

4. Group the students by nation or group of nations: Other Nile Basin Countries (Rwanda, Burundi, Tanzania, Kenya, Congo, and Uganda form one block)—6 students, Ethiopia and Eritrea—6 students, Sudan—2 students, Egypt—5 students.

Water stress in Burundi



Distribute the appropriate **Representative Discussion Points** (Educator's Guide handout) to each group. Ask students to use the Data Cards from **Log 2** to fill in the blanks in the Representative Discussion Points. Next they should create three-dimensional histograms representing the per capita water availability of their nation(s) at different periods of time with paper cups. Allow students to work out a proportion of water per cup. Identify students to play the role of representative from each nation or group of nations. Students may share the responsibility, or one student may play the position. The Representative Discussion Points contains the information they need to share. Distribute **Log 3** to all students.

5. Call a meeting of the Nile River Basin Initiative. Establish that the purpose of the meeting is to make plans to manage existing and proposed water development projects in the Basin, specifically to seek international funding to monitor the basin's water resources using remote sensing. As was clear in the previous activity, water is in short supply in the region. Following the Script/Briefing Points in this Educator's Guide, introduce the past and current situation in the region. Illustrate the presentation using **Figures 1-4**. Next, ask each representative to present the water status of each nation (or group of nations), point of view on management issues, and water resource objectives or goals. Representatives should use the histogram and graph from Log 2 to illustrate their status. Students complete **Log 3** using the information presented during the meeting.

Concluding the Investigation

6. In conclusion, ask students working alone or in groups to evaluate the geographic reasoning of each presentation and to prepare a summary to support funding to continue to monitor basin changes from space. Students should include evidence obtained in the meeting of the Nile River Basin to substantiate their request for funding, e.g., specific water stress data, current and past water projects in each country, each country's perspective on water management.

Background

The Nile is formed by three tributaries, the Blue Nile, the White Nile, and the Atbara. The White Nile begins in Burundi and flows through Lake Victoria into southern Sudan. Near the capital of Sudan, Khartoum, it meets the Blue Nile which begins in the highlands of Ethiopia. North of Khartoum the Atbara joins the river. The Nile flows north through Lake Nasser, the second largest human-made lake in the world, and the Aswan Dam, then splits into two distributaries north of Cairo, the Rosetta in the west and the Darneita to the east. The Nile has created a large delta into the Mediterranean Sea.

Additional information is included in Educator's Guide Script/Briefing Points.

Evaluation/Key

Log 2

1. Graphs will vary depending on the country.
2. Answers vary.
3. Answers vary.
4. Answers vary.

References

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Ethiopia and Eritrea

Our combined population is 59,578,171 people. We have just emerged from a long period of civil war and famine. Although Eritrea is now independent, we work closely on water resource issues. The economies of both nations are growing and developing rapidly in this period of peace. Our population is growing as well, at a rate of 3.3 percent per year. In 2025 our population is expected to be 142,792,000, and 25 years later it will be 221,540,000. In order to grow more food to feed our growing population, we must develop a large portion of land. This will take more water for irrigation.

Eighty-six percent of the Nile's water originates in our nations, yet we have not taken full advantage of our key resource and are water stressed. Ethiopia is worse off than Eritrea. In 2000 Ethiopia had ____cubic meters of water per person. In 2025 Ethiopia expects to have _____ and in 2050_____. We are in the process of constructing more than 200 small dams to use Nile water to irrigate needed cropland. But we are afraid this will anger Egypt, the most powerful nation in the region. We seek ways to peacefully share our common resource and to enhance our environment.

Egypt

Our population is 62,096,000 people and we occupy only 4 percent of Egypt's land—that strip along the Nile. For thousands of years Egyptians have relied on the Nile for almost all of our fresh water. We never worried about the supply of water. But now the nations upstream from us are using more and more Nile water. We are concerned—very concerned. This is a threat to our national security. Our population is growing at a rate of 2 percent per year. In 2025 our population is expected to be _____ , and 25 years later it will be _____ .

In 2000 we had ____cubic meters of water per person. In 2025 we expect to have _____ and in 2050_____. We are developing new water projects to accommodate our population growth. We are especially proud of a project, the New Valley Project, to pipe 5 billion cubic meters of Nile water from Lake Nasser through the Western Desert to the New Valley. Seven million people will be persuaded to move away from the Nile to live in this new agricultural area. This project is very expensive, and the Nile may not provide enough water. Although in the past Egypt's official policy was to maintain a monopoly on Nile water, today we wish to cooperate to equitably distribute the river resources to bring stability to the region and to promote economic development. We also need help in monitoring the effects of our water development projects on the environment.

Sudan

Our population is 26,707,000 people. Our nation is suffering a civil war in the south, and we are struggling economically and politically. Our population is growing at a rate of 2.2 percent per year. In 2025 our population is expected to be _____, and 25 years later it will be _____. We need to use more of our Nile water to produce food for our growing population but know that this will anger the Egyptians. In 2000 we had ____cubic meters of water per person. In 2025 we expect to have _____ and in 2050_____. We have ambitious plans for the Nile; it is our chief resource. We started a canal with money from the World Bank to increase supplies of Nile water in the 1970s; construction was halted in 1983 because of rebel action. This was a loss. We are building a dam north of our capital, Khartoum, where the Blue Nile and White Nile converge. We plan to work closely with Egypt and Ethiopia to develop the Nile in a way to help generations of peoples.

Other Nile Basin Countries

The other Nile Basin countries are Rwanda, Burundi, Tanzania, Kenya, Congo, and Uganda. Currently we use only a small proportion of the river's water. However, together our current combined population of _____ is expected to grow to _____ in 2025 and _____ in 2050.

- In 2000 in Rwanda we had ____cubic meters of water per person. In 2025 we expect to have _____ and in 2050_____. Our population growth rate is 2.3 percent per year.
- In 2000 in Burundi we had ____cubic meters of water per person. In 2025 we expect to have _____ and in 2050_____. Our population growth rate is 2.5 percent per year.
- In 2000 in Tanzania we had ____cubic meters of water per person. In 2025 we expect to have _____ and in 2050_____. Our population growth rate is 2.9 percent per year.
- In 2000 in Kenya we had ____cubic meters of water per person. In 2025 we expect to have _____ and in 2050_____. Our population growth rate is 2.1 percent per year.
- In 2000 in Congo we had ____cubic meters of water per person. In 2025 we expect to have _____ and in 2050_____. Our population growth rate is 3.2 percent per year.
- In 2000 in Uganda we had ____cubic meters of water per person. In 2025 we expect to have _____ and in 2050_____. Our population growth rate is 2.9 percent per year.

With this growth, it is inevitable that we will start to claim a larger share of the Nile's flow to meet our growing irrigation and development needs. We understand that this will not please the countries down river from us, particularly Sudan and Egypt. We are forming a joint program to develop our shared resource. But we need help to monitor our resource in all Nile Basin nations.

Burundi							
1950		2000		2025		2050	
Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)
2,456,000	1,466	6,964,000	594	12,341,000	292	16,937,000	213

Rwanda							
1950		2000		2025		2050	
Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)
2,120,000	2,972	5,184,000	1,215	12,981,000	485	16,937,000	372

Tanzania							
1950		2000		2025		2050	
Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)
7,886,000	11,286	30,026,000	2,964	62,436,000	1,425	88,963,000	1,000

Kenya							
1950		2000		2025		2050	
Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)
6,265,000	4,820	27,150,000	1,112	50,202,000	602	66,054,000	457

Congo (Zaire)							
1950		2000		2025		2050	
Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)
12,184,000	83,684	45,453,000	22,419	105,925,000	9620	164,635,000	6,189

Uganda

1950		2000		2025		2050	
Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)
4,762,000	13,860	19,689,000	3,352	44,983,000	1,467	66,305,000	995

Ethiopia

1950		2000		2025		2050	
Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)
18,434,000	5,967	56,404,000	1,950	136,288,000	807	212,732,000	517

Eritrea

1950		2000		2025		2050	
Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)
1,140,000	7,719	3,171,000	2,775	6,504,000	1,353	8,808,000	999

Sudan

1950		2000		2025		2050	
Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)
9,190,000	16,757	26,707,000	5,766	46,850,000	3,287	59,947,000	2,569

Egypt

1950		2000		2025		2050	
Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)	Population	Per Capita Water Availability (cubic meters)
21,834,000	2,661	62,096,000	936	95,766,000	607	115,480,000	503

These are the points you should make at the opening of the meeting of the Nile Basin Initiative:

- The Nile is the longest river in the world at 6601 kilometers and is the main source of water for the nations that make up the Nile watershed.

- Currently, the water provided by the system barely meets the demands of the region. In the near future it is expected that many of the nations that share the Nile's water will experience water stress.

- Access to the Nile's waters has already been defined as a vital national priority by countries in the region. As more of the countries in the region develop their economies, the need for water will increase. Although the demand for resources increases, the supply is likely to remain unchanged, increasing the chances for conflict over a scarce resource.

- Development projects that are aimed at increasing the flow of the Nile remain endangered by tension and instability in the region as well as environmental and financial concerns.

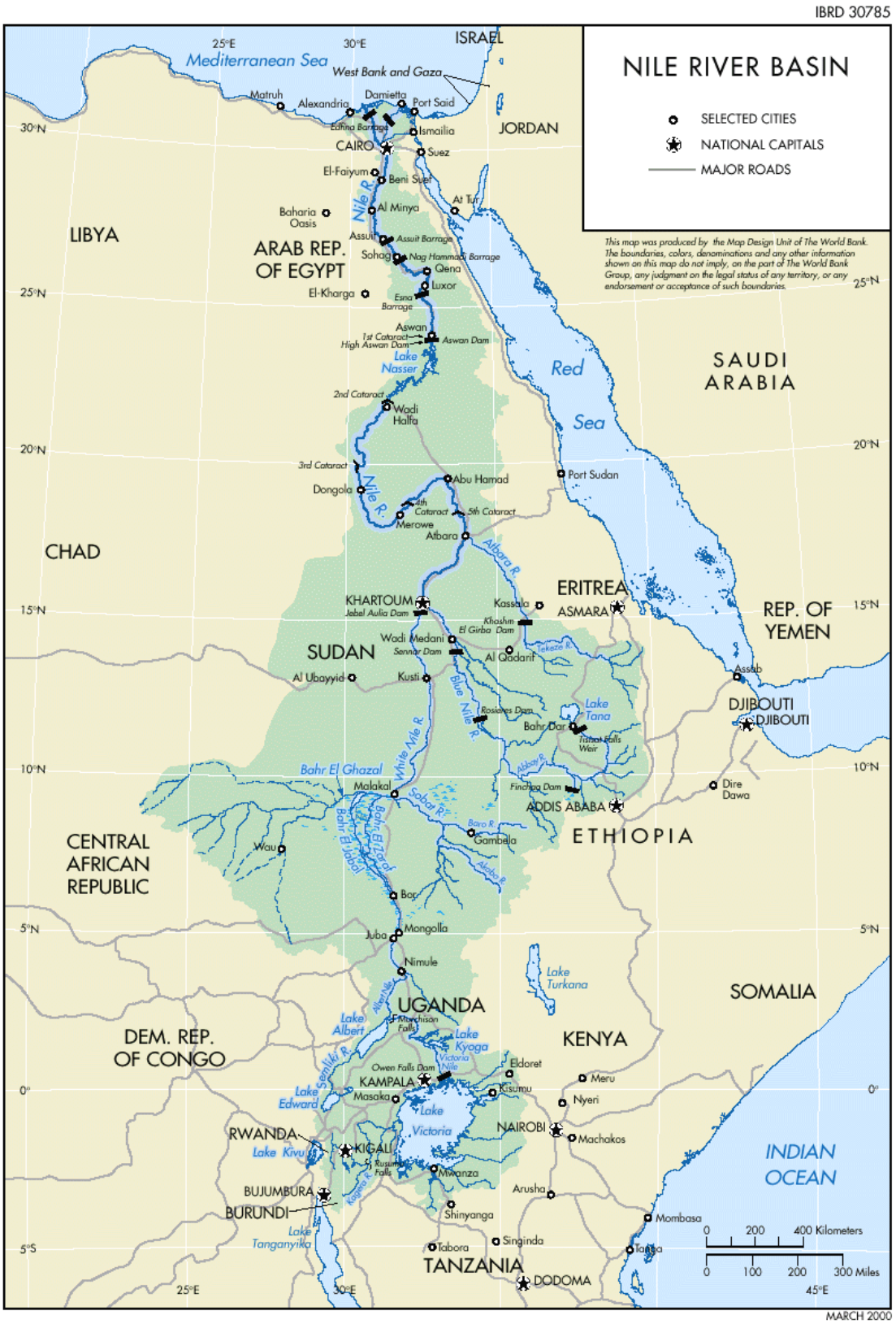
- **Figure 1.** As you can see from these figures, the Nile is in an arid region. Figure 1, a handheld Space Shuttle photograph, shows clearly the contrast in land use along the Nile. River water is used for irrigation in a narrow strip on either side of the river. Beyond is the desert. *(This bend of the river is the home of many historical points of interest—Valley of the Kings, Valley of the Queens, Temple of Luxor, the Tomb of Tutankhamen, and the Necropolis of Thebes)*.

- **Figure 2.** Figure 2 is a radar image of an area west of Cairo, Egypt, approximately 20 by 30 kilometers in size. The Nile is the dark band along the right side of the image. It flows almost due north from the lower edge of the image to the right. The boundary between dense urbanization and the desert is seen between the bright and dark areas. This boundary is the extent of the yearly Nile flooding which played an important part in determining where people lived in ancient Egypt. The pattern persists today. As the population of Egypt grows, the irrigated land along the river becomes more and more densely settled. Egypt is eager to disperse its population to newly irrigated areas.

- **Figure 3.** Figure 3 is the delta of the Nile, which contains 60 percent of Egypt's cultivated land. This figure shows again the stark contrast between desert and irrigated land along the river. Cairo is at the center of the image. The Mediterranean is to the north.

- **Figure 4.** Figure 4 shows the Nile River, the Aswan Dam, and the lake created by the dam, Lake Nasser, located in southern Egypt on the border with Sudan. Changing a significant resource in a vulnerable, dry environment can have serious consequences. The Aswan Dam, completed in 1971, provides examples of the array of potential and actual problems.
    - One major problem is that silt from the river which for thousands of years fertilized Egypt's cropland no longer flows down the river. Chemical fertilizers are needed to enrich the soil.
    - There is more erosion along the banks of the Nile which previously were replenished by the silt being carried down river.
    - Much of the delta shown in Figure 3 is being swept into the Mediterranean. If barriers near the Nile's outlet erode any more, low-lying delta land could find itself in the sea, causing a devastating loss of cultivated land.
    - The Nile is also bringing more salt to the fields of Egypt. Increased evaporation in Lake Nasser makes irrigation water more saline. The evaporation also presents a severe problem in terms of water loss.

- The Nile belongs to no one country or people. It is a shared resource.
- It is also an interconnected system—what affects one part of the system affects all parts of the system.
- It is difficult to monitor watershed changes over a large area and to communicate information to stakeholder groups, such as governments and scientists. However, remote sensing is a very effective and efficient means to accomplish this goal.
- Organizations like the Nile River Basin Initiative meet regularly to coordinate water policies, especially in relation to development needs. But there is a need for good reliable information about the entire water basin. This is especially true today as countries balance climate change, population growth, and development issues.


IBRD 30785
NILE RIVER BASIN
SELECTED CITIES
NATIONAL CAPITALS
MAJOR ROADS
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Mediterranean Sea
Red Sea
ISRAEL
West Bank and Gaza
JORDAN
LIBYA
ARAB REP. OF EGYPT
SAUDI ARABIA
CHAD
SUDAN
ERITREA
REP. OF YEMEN
DJIBOUTI
ETHIOPIA
SOMALIA
CENTRAL AFRICAN REPUBLIC
DEM. REP. OF CONGO
UGANDA
KENYA
RWANDA
BURUNDI
TANZANIA
INDIAN OCEAN
Matruh
Alexandria
Damietta
Port Said
Ismailia
CAIRO
Suez
El-Faiyum
Beni Suef
Al Minya
At Tur
Baharia Oasis
Assuit
Sohag
Qena
Luxor
El-Kharga
Aswan
Lake Nasser
Wadi Halfa
Abu Hamad
Port Sudan
Dongola
Merowe
Atbara
KHARTOUM
Kassala
ASMARA
Wadi Medani
Al Qadarif
Al Ubayyid
Kusti
Assab
DJIBOUTI
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Dire Dawa
ADDIS ABABA
Bahr El Ghazal
Malakal
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Lake Albert
Lake Kyoga
Lake Victoria
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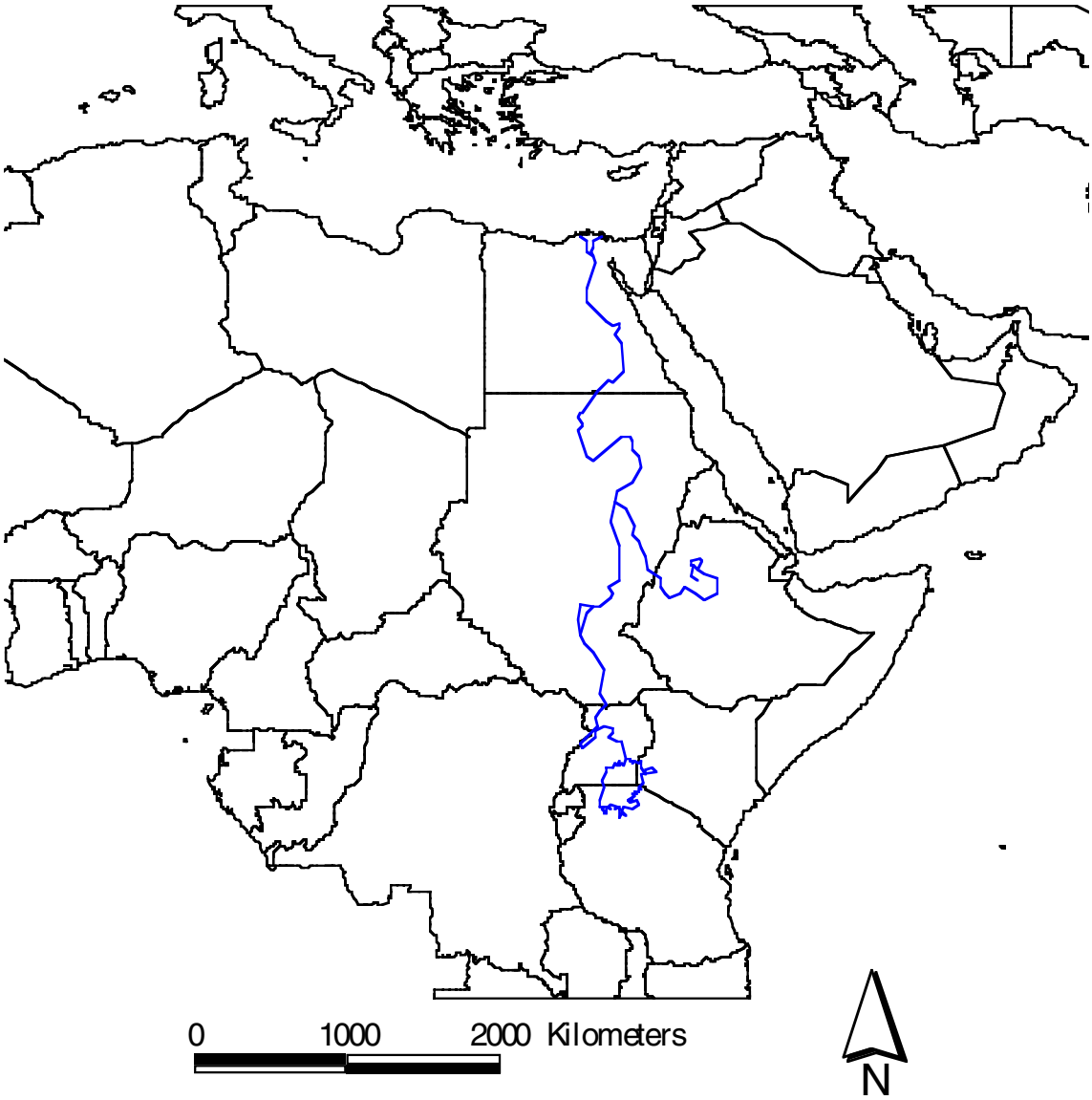
Module 1, Investigation 3: Log 1



Module 1, Investigation 3: Log 2
Water stress

Sustaining Water
Water is a scarce resource, particularly in arid regions of the world. Water is used for irrigated agriculture, industry, and human consumption. As population grows, demands on water resources grow. It is estimated that the minimum level of water needed per person for drinking, bathing, and cooking is 100 liters per day. It takes from five to 20 times this amount to meet the demands of agriculture, industry, and energy production.

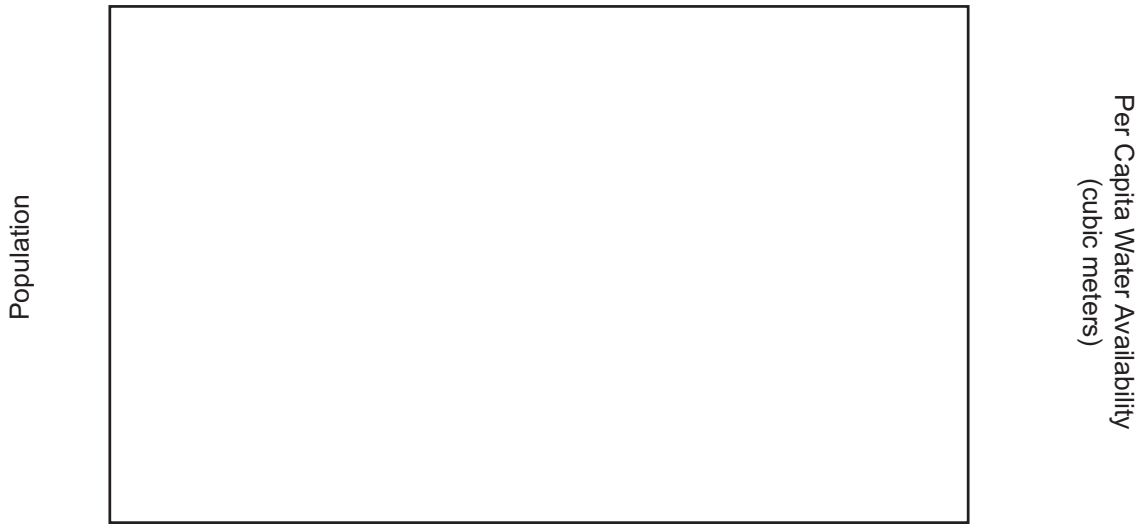
Water Stress Index
Scientists have developed ways to measure the balance between population and water supply and the onset of water stress and scarcity.

- **Adequate:** More than 1700 cubic meters of renewable fresh water per person per year. Countries with this amount of water will experience only minor water shortages.
- **Water stress:** 1000-1700 cubic meters of renewable fresh water per person per year. Countries at this level experience water stress—chronic and widespread water supply problems.
- **Severe water stress:** Below 1000 cubic meters of renewable fresh water per person per year. Water scarcity is the rule in these countries, causing economic development problems and serious environmental degradation.

Nile River Basin
Water is a scarce resource in the generally dry northeastern Africa. The Nile River is a significant source of water for this area. Some nations such as Rwanda, Uganda, Sudan, and Egypt depend on the Nile River as their primary source of water. Other countries in the Nile River Basin, such as the Congo, have additional water resources.

The region is experiencing rapid population growth. More irrigated land is needed to grow food for the growing population. In addition, the standard of living is improving among many of the people who live in the Nile Basin, placing greater demand on water resources.

Task
1. Prepare a graph presenting the data on the card for your nation. Construct and then use the left-hand scale to draw a bar graph showing population in your nation at four dates, 1950, 2000, 2025, and 2050. Construct and then use the right hand scale, to plot per capita water availability as a line graph.



Module 1, Investigation 3: Log 2
Water stress

2. **Analyze the graph**.

   Does there appear to be a relationship between population growth and per capita water availability in your nation? What is the relationship?

   What was the water stress index in your country in 1950? _____

   What was the water stress index in your country in 2000? _____

   What is the expected water stress index in your country in 2025? _____

   What is the expected water stress index in your country in 2050? _____

3. Do you think the citizens of your country should be concerned about water resources? Why or why not?

4. Based on the amount of water available, is economic development and population growth sustainable in your country? Why or why not?

Module 1, Investigation 3: Log 3

Discussion points data organizer

Nation	Population 1950	Population 2000	Population 2025	Population 2050	Water Stress 1950?	Water Stress 2000?	Water Stress 2025?	Water Stress 2050?
Key Management Issues								
Nation	**Population 1950**	**Population 2000**	**Population 2025**	**Population 2050**	**Water Stress 1950?**	**Water Stress 2000?**	**Water Stress 2025?**	**Water Stress 2050?**
Key Management Issues								
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Key Management Issues								

Module 1, Investigation 3: Log 3

Discussion points data organizer

Nation	Population 1950	Population 2000	Population 2025	Population 2050	Water Stress 1950?	Water Stress 2000?	Water Stress 2025?	Water Stress 2050?
Key Management Issues								

Nation	Population 1950	Population 2000	Population 2025	Population 2050	Water Stress 1950?	Water Stress 2000?	Water Stress 2025?	Water Stress 2050?
Key Management Issues								

Module 1, Investigation 3: Log 3

Discussion points data organizer

Nation	Population 1950	Population 2000	Population 2025	Population 2050	Water Stress 1950?	Water Stress 2000?	Water Stress 2025?	Water Stress 2050?
Key Management Issues								

Nation	Population 1950	Population 2000	Population 2025	Population 2050	Water Stress 1950?	Water Stress 2000?	Water Stress 2025?	Water Stress 2050?
Key Management Issues								

Nation	Population 1950	Population 2000	Population 2025	Population 2050	Water Stress 1950?	Water Stress 2000?	Water Stress 2025?	Water Stress 2050?
Key Management Issues								

Module 1, Investigation 3: Log 3

Discussion points data organizer

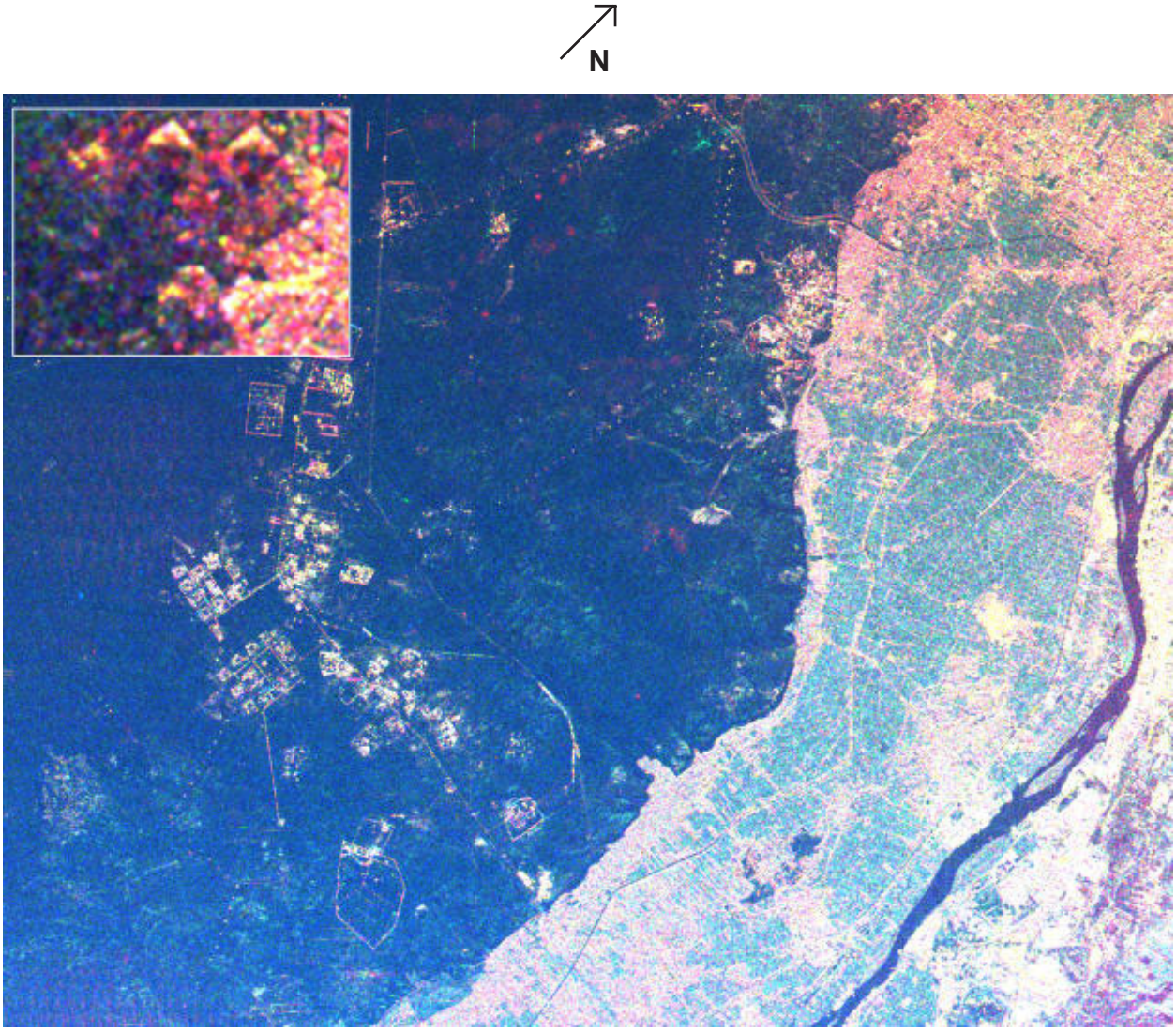
Nation	Population 1950	Population 2000	Population 2025	Population 2050	Water Stress 1950?	Water Stress 2000?	Water Stress 2025?	Water Stress 2050?
Key Management Issues								

Nation	Population 1950	Population 2000	Population 2025	Population 2050	Water Stress 1950?	Water Stress 2000?	Water Stress 2025?	Water Stress 2050?
Key Management Issues								

Module 1, Investigation 3: Figure 1

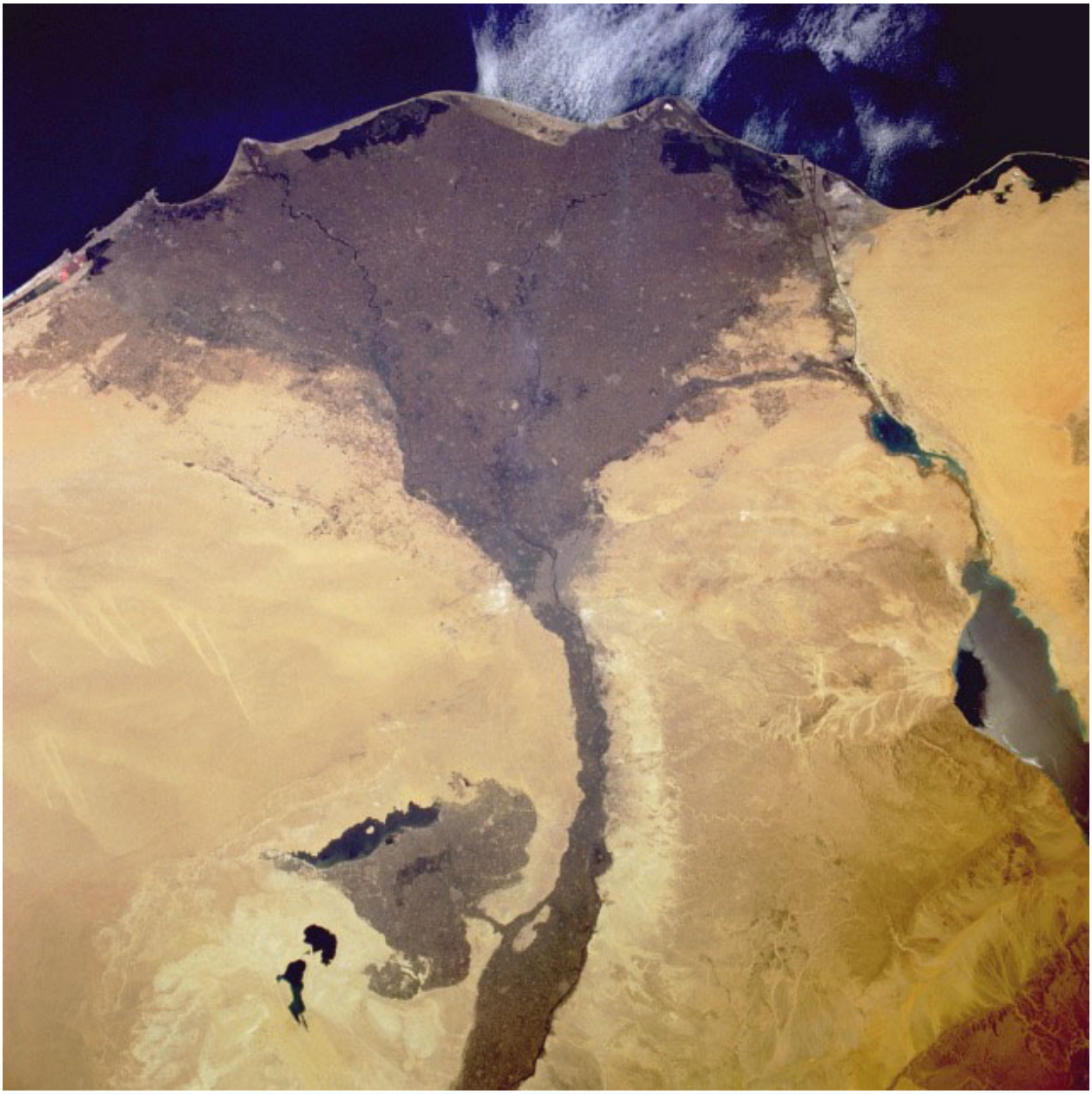
STS026-041-058 Valley of the Kings, southern Egypt, October 1988

Module 1, Investigation 3: Figure 2



SIR-C/X-SAR image, April 1994

Module 1, Investigation 3: Figure 3



STS077-710-091 Nile River Delta, Suez Canal, Egypt, May 1996

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Module 1, Investigation 3: Figure 4

STS046-075-018 Nile River and Aswan Dam, Egypt, August 1992

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