

WATER AVAILABILITY CASE

Lesson 1, Detailed Plan

Prior to teaching

Refer to the *Teacher Overview* document, page 1

Introduce; Whole Class

20 minutes

- Referencing the *Welcome Letter*, explain the context: students role-play as data analysts. Their goal is to develop the best possible argument for 1 country and make an objective evaluation of all arguments.
- Assign students to country teams (groups of 3). Multiple teams will study the same country.
- Distribute the *Analyst's Guide* (required pages or the entire document).
 - Optional*: can distribute the *Glossary* to each group
 - Optional*: can provide the maps, one for the class or for each group
- Play the *WWRB Video* for the whole class. Instruct students to complete Getting Information on page 1. It is not essential that students capture all the information.
 - Optional*: Groups can review the video segment related to their country.
- Verify what they learned from the video. Points to emphasize:
 - All 3 countries need more water.
 - The countries have access to saltwater seas, but saltwater is not drinkable.
 - Issues around water scarcity are complex. This case study is a simplified version.

Hypothesize; Whole Class

5 minutes

- Discuss responses to the *Reflection Boxes*.

Investigate; Small Group

25 minutes

- Give a copy of the *WWRB Data Table* to each group.
 - The UK & London are provided for comparison only, and will not get aid.
 - Optional*: can provide groups the electronic datasheet to have them work in Excel

WWRB Data Table						
Prepared by: WWRB Applications Processing Unit						
	Unit	ALGERIA ¹	JORDAN ¹	TURKEY ¹	UK ²	LONDON ²
Total Population	millions	31	5	70	53	8
Total Area	thousand square kilometres	2,382	92	781	245	2
Total Water Available	billion cubic metres	12	1	214	147	Not available

DEFINITIONS:

Total Population Everyone living in a country.

Total Area The amount of land in a country.

Total Water Available The amount of water in a country in a year. This includes rivers, rain, and other water sources.

Square Kilometre A square measuring one kilometre on each side.

Cubic Metre A container measuring one metre in length, width and depth.

¹ ACTUAL SOURCE OF DATA: AQUASTAT online database of the Food and Agriculture Organization of the United Nations, <https://www.fao.org/aquastat/country/details/uk/en>

² ACTUAL SOURCE OF DATA: WIKIPEDIA, <https://en.wikipedia.org/wiki/London>

WATER AVAILABILITY CASE

Lesson 1, Detailed Plan

8. Groups complete *Understanding the Data* on pages 2-3. Monitor student understanding:
 - o Using data is a quantitative way to characterize a country's water situation.
 - o The country with the largest area does not have the highest population.
 - o Population (people) is the important consideration for water needs.
 - o A compound measure will allow for a more fair comparison. (Question 7 is foreshadows this for the next lesson.)
 - o Check that reasoning in question 6 matches the logic of their answer in question 7.

Reflect; Whole Class **10 minutes**

9. Using the *Reflection Boxes*, compare student ideas from the beginning of the class to now.
10. Assign the *Making the Headlines* homework.
 - o Emphasize that an accurate headline is more important than selecting a photo.
 - o Students select from the pictures printed from the *Gallery.ppt* document
 - o OR, for the electronic option:
 - Provide students a copy of *WWRB Gallery.ppt*.
 - Distribute the file *Headlines.doc* electronically.

UNDERSTANDING THE DATA

Part 1: Understanding the Measures in the WWRB Data Table

1. Review the WWRB Data Table. Which country has the largest?

	POPULATION	LAND AREA	WATER AVAILABILITY
ALGERIA			
JORDAN			
TURKEY			

2. Write a sentence to describe the water situation in each of the 3 countries. Include information from the WWRB data table.

ALGERIA	
JORDAN	
TURKEY	

3. How does population size impact a country's water situation?

4. How does a country's total area impact their water situation?

5. How can you use the data water availability to describe any country's water situation?

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Part 2: Using Data to Characterize the Water Situation

6. Imagine being a person living in each country: Algeria, Jordan and Turkey. In which country would you have the **best** water? Give reasons why. Show relevant calculations.

COUNTRY: _____

REASON & CALCULATIONS: _____

7. Two other WWRB analysts are arguing about a different pair of countries.

Clifford: "Vietnam needs more water than Thailand. It has close to twice the water as Thailand, but its population is twice the size too."

Alexander: "Oh, but Thailand has twice the area of Vietnam. So Thailand needs more water."

Who do you agree with? What calculations would you do?

NAME OF SCRIPTURE: _____

CALCULATION: _____

REFLECTION: Based on all that you learned today, which country do you think has the strongest argument for greatest need for water? Why?

Which country do you think has the weakest argument for greatest need for water? Why?

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HOMEWORK
MAKING THE HEADLINES

The WWRB Gazette is looking to feature a country in its next issue. Use the information and data you just learned about any of the 3 countries to make an objective assessment of their water situation. Make a single news flash to show how the people in Algeria, Jordan OR Turkey are affected by their water situation.

WWRB The WWRB Gazette

Four major graph here:

Headline 1: _____

Headline 2: _____

Headline 3: _____

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Prior to teaching

Refer to the *Teacher Overview* document, page 2

Introduce; Whole Class

10 minutes

1. Plenary: selected groups present their headlines. Compare headlines for the same country and/or across the 3 countries. Transition to *Points to Ponder* on page 5.
2. Present the *Letter about Applications* from JT Smith.
3. Emphasize that (a) the data comes from the *WWRB Data Table* (provided in Lesson 1), and (b) each country used a different measure. The WWRB needs to use the same measure to make a fair comparison.

Hypothesize; Small Group

15 minutes

4. Provide a copy of the appropriate country application to each group. Instruct them to complete *Evaluating the Application* on page 5.
 - o *Optional:* Can provide students with the excel sheet that shows the calculations and graphs used in the country applications. Note that each country calculation and graph is found in its own tab.
5. Probes for monitoring understanding:
 - o Have you identified the data used?
 - o Is the measure in the application logical? Is it appropriate for determining water needs?
 - o Is the argument logical? Does the argument make sense for determining water needs?
6. Guidance for struggling groups:
 - o Algeria: Land is not as appropriate a measure as population in this case study. Also, much of the land in Algeria is not populated.
 - o Jordan: water \times population is mathematically correct but not logical in this context.
 - o Turkey: The measure does not include water. That is, Turkey may need more water than the other countries (we can't tell from the data), but they may already have all the water they need

Applications submitted to the WWRB

Each applicant country has prepared an application that contains an argument for why they have the greatest need for water. They made use of the same data presented in our WWRB Data Table. Furthermore, they created different **emphasized measures** by applying mathematical operations on the existing data measured in the table.

Each country presents a seemingly rational argument using different measures. What the WWRB needs is a single measure that will ensure a **FAIR** comparison.

As a WWRB Analyst, your goal is to make an objective evaluation on their use of the data and the logic of their argument. I trust you will do a fine job.

JT Smith
WWRB Director

MAKING A FAIR COMPARISON

POINTS TO PONDER

1. In general, which of the 3 measures contained in the WWRB data table can describe a country's water situation best?
2. Data analysis operations create **emphasized measures** by combining 2 or more measures mathematically. Can you think of possible compound measures we could use?

Part 3. Evaluating the Application of...

1. In your own words, what rationale is given in your assigned country's application?
2. How did they use the data to support their argument? Specify the measure and mathematical procedure used.
3. What units did they use (liters, miles per gallon)?
4. Is this measure appropriate for making an argument about water needs? Justify your answer.
5. Does this measure allow us to make a fair comparison of the 3 countries?

ANALYST'S GUIDE 2.0

WWRB Application for Financial Aid
(rev. 2008)

COUNTRY: ALGERIA

I. DATA TABLE

Population	31 million
Area	2,367 thousand square kilometers
Water Available	12 billion cubic meters

II. RATIONALE FOR APPLICATION

When you divide our total water available by our total area, we have the LEAST water per land area.

Algeria is dry. We have so much more land than other countries so we need more water. This chart illustrates that Algeria clearly has less water per square kilometer of land area. The Algerian people clearly deserve land that is as lush as our good friends in Jordan and Turkey.

WWRB Application for Financial Aid
(rev. 2008)

COUNTRY: JORDAN

I. DATA TABLE

Population	5 million
Area	92 thousand square kilometers
Water Available	1 billion cubic meters

II. RATIONALE FOR APPLICATION

We have by far the smallest water-population product (water available \div population).

Jordan has a much smaller water-population product than our friendly neighbors in Turkey and Algeria. Because water and people are both precious, this water-population-product measure was developed by our accountants as a way to measure a country's most valuable resource. Clearly Jordan must deserve the WWRB aid!

Investigate; Small Group

30 minutes

7. Groups complete *Using Compound Measures* on pages 6-7. If they don't finish, it can be completed as homework.
 - *Optional:* Provide access to *WWRB Datasheet.xls* and Excel
8. Downplay the computation of the numbers and stimulate critical thinking.
 - Some measures make mathematical sense but are not sensible in the real world, e.g., population × area.
 - Emphasize the logic behind the resulting units. For example, “people — square kilometers” [people minus sq. km] is not a mathematically sensible unit.
 - Consider modeling one nonsensical or inappropriate compound measure for the whole class.
9. Inform the class about relevant compound measures: *per capita* and *population density*. *Per capita* = per person, similar to per cent = per 100.

Reflect; Whole Class

5 minutes


10. Discuss.
 - What measures make mathematical sense? E.g., what are the units if you subtract area from population?
 - What measures make sense in the real world?
 - What measures are appropriate for describing a country's water needs? E.g., population density (people/area) is a common compound measure, but it is not the best measure for a country's water needs.

WWRB Application for Financial Aid
(rev. 2008)

COUNTRY: **TURKEY**

I. DATA TABLE

Population	70 million
Area	781 thousand square kilometers
Water Available	214 billion cubic metres



II. RATIONALE FOR APPLICATION

When you divide the number of people by the amount of land, we have most people per land area.



This chart clearly shows that Turkey's population must fit into relatively less space than our good friends in Jordan and Algeria. Because we must live closer together, we need more water to maintain proper sanitation and health.

*1000 litres of water per person per day.

Part II: Using Compound Measures

6. Use the WWRB Datasheet to explore possible compound measures. Create at least 4 of your own.

COUNTRY ASSIGNED TO YOU:	SET VARIABLE 1	OPERATION	SET VARIABLE 2	UNIT	IS THIS A SENSIBLE MEASURE?	IS THIS AN APPROPRIATE MEASURE OF WATER NEEDS?
Example 1: Population	+	Area	million people	people km	NO	NO
Example 2: Population	÷	Area	people per square km	people km ²	YES	NO
Measure and Application:						

7. Without computing the actual numbers, which compound measure that you created in the table above (question #6) could be used to describe a country's water needs? Explain how you might use this or provide a fictional argument that uses this compound measure.

Example: Both people and plants need water to survive. By adding population to area, we are able to find the cumulative need for water in the country.

8. Add to the WWRB data table below so that it includes at least 1 sensible and appropriate compound measure. Compute the data for all countries.

	UNIT	ALGERIA	JORDAN	TURKEY
Total Population	billions	31	6	70
Total Area	thousand square kilometers	2,382	32	781
Total Water Available	billion cubic metres	32	1	214
New measure:				
Explanation:				

9. Which measure makes the most sense for making a **FAIR** comparison of the 3 countries? Why?

MEASURE:

REASON:

WATER AVAILABILITY CASE

Lesson 3, Detailed Plan

Prior to teaching

Refer to the *Teacher Overview* document, page 3

Introduce; Whole Class

5 minutes

1. If needed, give students additional time to complete *Using Compound Measures* on pages 6-7.
2. Remind groups that they will create an argument for their assigned country only. However, they will evaluate the arguments for all countries during the plenary.
3. Emphasize the text in Your Goal as well as the reminder from JT Smith on page 8. Points to highlight:
 - o All 3 countries can make an argument for needing more water since it is the "most water scarce region in the world."
 - o Their role is not to win the case for their country but rather to understand and use the data to craft the best possible argument.

Hypothesize; Individual or Whole Class

5 minutes

4. Students answer question 1 on page 8.
 - o Check or briefly discuss responses to question 1.

Investigate; Small Group

45 minutes

5. Instruct students to complete *Developing an Argument* on pages 8-9. Explain that the worksheet is designed to help them think through the data and guide them in developing their argument.
6. Introduce the poster. Present the sample poster provided, emphasizing the listed success criteria. (This may also be done as a whole class activity.)
 - o Encourage creativity but emphasize that students should concentrate on the logic rather than the aesthetics.
 - o Reiterate that best possible does not mean "winning" argument. This will be especially challenging for the team assigned to Turkey.

DEVELOPING AN ARGUMENT

YOUR GOAL:
Use the data as your evidence to support the best possible argument for the country assigned to you.

1. Review the table you made in *Using Compound Measures* on pages 6-7. Based on the compound measure you created, which would be the strongest argument? Why?

NOTE: As WISE analysts, your job is to make an OBJECTIVE assessment and FAIR comparison using the data available. No country could use aid to get more water; however, some need more than others. Your job is to evaluate the data and make the best possible argument for the country assigned to you.

At the end of our session, analysts will gather at an event to evaluate all the arguments and vote on which one presents the most objective and fair argument.

2. Use data to describe how your assigned country compares the other applicants.

POPULATION	
AREA	
WATER AVAILABILITY	
COMPOUND MEASURE	

POINT TO PONDER

1. Of the comparisons you made, which data could you use to make the **best possible** argument about the need for water in the country assigned to you? Why?

2. In a few words, write an argument that uses this data to support the best possible argument for the country assigned to you.

3. What general information about your assigned country can you include to emphasize your argument?

You are ready to create your own poster. Get poster materials from your teacher.

ANALYST'S GUIDE 3.0

WATER SAMPLE POSTER

SUCCESS CRITERIA:

- 1) Calculated measures must be mathematically correct - both the numbers and units!
- 2) Data must be appropriate for making an argument on each nation (population, area, water availability) - it must be appropriate for making an argument!
- 3) The argument must be logical and articulated clearly so that others can understand and evaluate it.
- 4) All supporting data should be included - any additional data - not from the Analyst's Guide - should also be included.

United Kingdom

Population & Area: The UK has a population of 63 million and an area of 244,820 sq km. This gives a population density of 258 people per sq km.

Water Availability: The UK has 11,000 km³ of water available per year. This gives a water availability of 174 litres per person per year.

Compound Measure: The UK has the highest population density in the world. This means that there are more people in every square km of the UK than anywhere else in the world.

Conclusion: The UK has the highest population density in the world. This means that there are more people in every square km of the UK than anywhere else in the world.

What's the argument for the UK?

Who are the other countries?

Who are the other countries?

Who are the other countries?

- Remind students of the coming plenary where they will evaluate the arguments for other countries. They will be allowed to vote on the country that needs water the most, and they may find that they do not want to vote for their own country.

Reflect; Individual Homework **5 minutes**

- Assign *Reviewing Your Work* on page 10 as individual homework. Students should articulate what s/he learned and express independent/ dissenting opinions regarding the group's argument, if any.
- The *Point to Ponder* box on page 10 aims to elicit students' insights regarding the relevance of the case to maths class.



Prior to teaching

Refer to the *Teacher Overview* document, page 4

Introduce; Whole Class & Small Group

5 minutes

1. Ask each country team to hang their poster on the wall. Ensure that there is enough space for students to gather around and read each poster.
2. Remind students that the more posters they are able to read, the more informed their vote will be. At the minimum, they should review at least 1 poster from every country.
 - o Provide students with stickies (or small pieces of paper with tape) so they can post comments or questions on the posters.
 - o Groups may want to divide & conquer so that every poster is read by at least 1 group member.

Investigate; Individual

10 minutes

3. Instruct students to complete the Poster Walk Table on page 11 as they are reviewing posters. Remind students that they will not be able to review all posters in this short time. Things to think about:
 - o Does the argument make sense?
 - o Is it supported by the data?
 - o Are they making a FAIR comparison?
 - o Are the calculations mathematically correct?
 - o Are the units appropriate?

Reflect; Whole class

15 minutes

4. Debrief with the class on their insights during the poster walk. Address common questions raised as well as particularly insightful questions or comments. Consider the following questions:
 - o What data was used as evidence?
 - o What were some of the approaches used in developing the argument?
5. Process the groups assigned to Turkey, which was the obvious "loser." Elicit reactions from the group as well as other students.
6. Reflect on the process of evaluating the work of peers.

WWS

You've done a splendid job studying the data and preparing a case for your assigned country. Now you have the final responsibility of evaluating the arguments of each group.

Enjoy reading the arguments of other groups during the Poster Walk. For each poster, consider these two questions: **Does their argument make sense? Is it supported by the data?** You can make notes in the table below.

J.P. Smith
WWS Director for Case Studies

POSTER WALK

COUNTRY	ARGUMENT	DATA USED AS EVIDENCE	NOTES or QUESTIONS

ANALYTE'S GUIDE 3.0
Page 11

WATER AVAILABILITY CASE

Lesson 4, Detailed Plan

Investigate; Individual 5 minutes

7. Provide each student with only 1 sticky (or small paper with tape) of a different color so that they can vote for the argument that best illustrates that the country has the greatest need for water. (A show of hands will also suffice.)
8. Encourage students to vote based on the argument; they do not need to vote for their own poster. Remind them of the success criteria:
 - o Data (simple and/or compound measures) must be relevant to their argument.
 - o Calculated measures must be mathematically correct – both the numbers and units.
 - o Data must be appropriate for making an argument on water needs. (Example, population density is valid but by itself it is inappropriate for arguing on water needs.
 - o The argument must be logical and articulated clearly so that others can understand their case.
 - o All supporting data should be included. Any additional data – not from the Analyst's Guide – should include the source.

Reflect; Whole Class

25 minutes

9. How has your thinking changed/ developed since lesson 1? Elicit the following points:
 - o Data as objective evidence.
 - o Data lends itself to making mathematical explorations for more complex investigations.
 - o Data can be manipulated in a way that distrorts reality/ truth.
10. What is their biggest takeaway from the experience?
11. Why do this case in maths? How is this relevant to maths? Key connections to look for:
 - o The case provides an opportunity to better understand large numbers.
 - o Maths (the data) lends itself to making fair comparison.
 - o Maths allows us to go beyond the data and calculate compound measures.
 - o Maths is key in creating the best argument that is supported by data.
 - o Maths is a key part of evaluating the best argument.

WWF

You've done a splendid job studying the data and preparing a case for your assigned country. Now you have the final responsibility of evaluating all the arguments presented by each group.

- 1 Information Gathering
- 2 Making a FAIR Comparison
- 3 Preparing an Argument
- 4 Plenary and Evaluation

YOUR GOAL:
To identify the argument that best uses the data to present the strongest possible case for the country's need for water.

Enjoy reading the arguments of other groups during the Poster Walk. Remember to always consider these 2 important questions as you read each poster: **Does their argument make sense? Is it supported by the data?**

In the end, all analysts will vote on which country made the strongest argument for receiving WWF aid. Think critically and carefully. The WWF aid should go to the country that needs it the most.

Congratulations on a job well done!

Dr. Smith
WWF Director