

Egypt's FiNile Solution: A Case Study

Authors: Hoda Mostafa, Mahmoud Shaltout, Sherif Osman and Tamer Shoeib



Egypt's FiNile Solution: Socio-Environmental Influences on the Nile Delta Region

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Introduction:

The importance of the Nile Delta to Egypt cannot be quantified. Not only did it provide the key to Egyptology (the Rosetta stone), it is an agricultural gold mine essential to Egypt's millennia-long survival, and home to Egypt's most densely populated cities: Cairo, Alexandria, Port Said, Mansoura, Zagazig and Tanta - over a half of Egypt's 85.7 M¹ population. This case study, intended for introductory science undergraduate level courses, aims to enhance students' analytical thinking and quantitative literacy skills by examining major threats to the Nile Delta. Including the large output of wastes from increased agricultural demands, water scarcity and access, loss of agricultural land and wastewater drainage from the Greater Cairo area^{1,2,3,4,5}. This poses several chemical and biological risks (pH, contaminants, oxygen levels, solids, coliforms)^{1,2,3,4,5} which in turn affect the quality of both the ecosystem and human life. Second is the loss of agricultural land^{4,6} due to expanding cities and the need to meet an ever-increasing population. Students will examine and identify the interactions between the various natural and social components, requirements and usage of Delta lands from a systems perspective. Students will also learn how to interpret quantitative data and collaboratively work in formulating a multidisciplinary approach to this challenge.

Key Questions: Does Egypt have a scarcity probably or not? What are the potential solutions? Political implications? Re-evaluation of usage? Is there really a problem? How can a socio-environmental synthesis approach inform our decision making?

Estimated time frame:

4 Class Periods of 80 minutes

Has this been tested in the classroom:

Not yet (*to be piloted February 2017 in Scientific Thinking (Science for Non-Science Majors) / freshman multi section course, each section has up to 30 students*)

Course and Class Size:

Undergraduate-Lower level. Non-Science and Science Majors

"This work was supported by the National Socio-Environmental Synthesis Center (SESYNC) under funding received from the National Science Foundation DBI-1052875".



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SESYNC Learning Goals:

- Clearly focuses on a socio-environmental problem or issue, including its social, political, and historical context.
- Illustrates the coupled nature of S-E systems including systems feedbacks. (e.g. illustrates interactions between humans and the environment).
- Highlights importance of interdisciplinary or transdisciplinary understanding of the problem.
- Requires students to use data and ideas (e.g. frameworks or models) from both natural and social sciences.
- Highlights importance of interdisciplinary or transdisciplinary understanding of the problem.

Resource Files:

Section	Resource Files	URLs
Teaching Notes	Teacher guides for classes 1-4 act a walkthrough for each class, including teacher tips for class preparation and facilitation	Class 1 Teaching Notes Class 2 Teaching Notes Class 3+4 Teaching Notes
Class Slides	In-class presentation materials for classes 1-4. Teaching notes contain guidance on using these.	Class 1 Slides Class 2 Slides Class 3+4 Slides
Student Handouts	Worksheets and assignment prompts that will be given to students through the case study. Teaching notes contain guidance on when these are to be used.	Class 1 Worksheet Handouts Class 3 Worksheet Handouts
Assessment Rubrics	Rubrics that will be used to assess the four deliverables of this case study. Rubrics should be discussed with students prior to beginning an assignment to ensure they fully understand the instructor's expectations	Rubric Individual Systems Map Rubric Number of the day Rubric Reflection on the Comic Rubric Science Citizen Article
Comics	A two part comic was specifically designed for the purposes of this case study. It will be the initial activity to prompt the discussion on the topic and provide the background and context to students.	Comic part 1 Comic part 2

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Grade Breakdown:

Assessment	Percentage from Total	Points
Comic Reflection	10%	50
Individual Systems Map	35%	50
Number of the Day	20%	50
Citizen Science Article	35%	50

Timeline:

References:

1. State information Service
<http://www.sis.gov.eg/En/Templates/Articles/tmpArticles.aspx?CatID=19#.V2wBi7h97IU> (2014)
2. WATER QUALITY MANAGEMENT SCENARIOS IN ROSETTA RIVER NILE BRANCH, EGYPT Hussein A. El Gammal and Hesham S. El Shazely. Central Water Quality Management Unit, Ministry of Water Resources and Irrigation, Giza, Egypt. Twelfth International Water Technology Conference, IWTC12 2008 Alexandria, Egypt 1
3. Water quality of Rosetta branch in Nile delta, Egypt. Mohamed M. El Bouraie, Eman A. Motawea, Gehad G. Mohamed & Mohamed M. Yehia. *Suoseura — Finnish Peatland Society Helsinki 2011 Suo 62(1): 31–37*
4. WATER QUALITY DETERIORATION OF MIDDLE NILE DELTA DUE TO URBANIZATIONS EXPANSION, EGYPT S. S. Zaghloul and Hussein Elwan. Fifteenth International Water Technology Conference, IWTC-15 2011, Alexandria, Egypt.
5. Water pollution in the Middle Nile Delta, Egypt: An environmental study. [Samy I. El-Kowrany](#), [Enas A. El-Zamarany](#), [Kholoud A. El-Nouby](#), [Dalia A. El-Mehy](#), [Ehab A. Abo Ali](#), [Ahmad A. Othman](#), [Wesam Salah](#), [Ahmad A. El-Ebiary](#). *Journal of Advanced Research* Available online 7 December 2015.
6. Monitoring urban growth and land use change detection with GIS and remote sensing techniques in Daqahlia governorate Egypt. [Ibrahim Rizk Hegazy](#), [Mosbeh Rashed Kaloop](#). *International Journal of Sustainable Built Environment Volume 4, Issue 1, June 2015, Pages 117–12.*



Comic Activity: Pre-Case Preparatory Activity

Time needed: 45 minutes

Grade: 50 points

Aims of Activity:

1. Students will read a short comic story on the Nile Delta which will introduce them to the Nile Delta issue.
2. Students will recognise the socio-environmental nature of the Nile Delta issue as well as the social, political and cultural significance of the Nile.
3. As a result, students will write a short graded reflection on the topic, which they will be required to hand in at the start of class 1.

S-E Learning Outcomes:

- Clearly focuses on a socio-environmental problem or issue, including its social, political, and historical context.
- Illustrates the coupled nature of S-E systems including systems feedbacks.

Case Specific Learning Outcomes:

- Identify the key stakeholders or “nile citizens” affected by threats to the river Nile
- Dissect and identify patterns or connections within a system

Description: This activity is designed to prepare students for the case “The FiNile Solution”. Students are expected to read the comic and write a short, graded reflection. Students will use this reflection as a “ticket” into class (optional).

Summary: The comic consists of 7 pages. The story begins in 2050, where we see an image of the Nile Delta. A large part of the Delta is now submerged and the city of Damansour lies on the Mediterranean coast. The comic also shows another city Banha, where the Nile has shrunk, has turned green due to algal blooms and is being polluted by effluent from nearby residential areas. Also farmland has shrunk and residential areas have been built instead.

The comic then shifts to the present day, where four film students are attending a course on the Nile/Nile Delta and its’ significance to Egypt. It highlights the use of the Nile and specifically the Delta since ancient times for food, crops, defence and industry/economy and some recent threats to Nile quality (the local and regional dams specifically). This lecture inspires the students to use the Nile and the Delta as the subject of their final film project. The students then make use of their inter-semester break to travel to Aswan and sail downstream to the Mediterranean, filming the scenery and interviewing a felluca sailor whose livelihood depends on the Nile. On their journey, they pass by the sailor’s hometown of Banha where he shows them the city and also a plot of farmland he recently bought with his savings, to be used later for farming and for building homes for

his grown up children to start families. The finished project is so good that the professor submits their film to a regional short film festival, which they go on to win.

The final part of the comic goes back to the future (2050). One of the four film students went on to become a successful film director and is now a film professor at the same university. She gives the students a film project and promises to submit the best entry to the same regional film festival her film was once submitted to. The comic ends with her showing her own movie, filmed 43 years earlier, to the class as an example of a film project.

This 7 page comic is an introductory reading **to be completed before the first session** devoted to the case study. This comic aims to:

1. **Familiarise students with the area of focus**, the Nile- specifically the Nile Delta. This is done through the history given in the lecture the four students are attending. This is also conveyed by showing maps of the Nile (in its' entirety, as well as in Egypt).
2. **Visually relay the changing nature of the Nile Delta** by presenting a possible future. This is done in the first page which shows the changes to the Nile Delta. It is visually and not verbally stated, thus students' observational skills are employed here. The Banha panels are drawn exactly the same, with the evident changes in the future (the water colour, amount, shrinking farmlands, runoff).
3. **Convey the importance of the Nile to livelihoods** (tourism, agriculture, residential). This is done through the conversation with the felluca sailor, who made his entire living off of tourism and on the felluca and who is using his land in Banha for agricultural and residential purposes. Also, indirectly, the Nile is what drove the students to film their project, and in a way helped pave the path to the successful film career of one of those students.
4. **To present the issue in an interesting and relatable way** to undergraduate students. This is done by presenting the project in the context of an undergraduate lecture and a film project.

Assignment: As a ticket into class, students will be required to submit a written reflection (*See 'Rubric- Reflection on Comic Reading' for assessment*) on the comic story, guided in part by the following questions:

- What differences do you see between modern day and 2050 Egypt?
- List some of the issues you see in the comic?
- How does modern day Egypt tie in 2050 Egypt in the comic?
- What are some of the pressing environmental concerns that you can foresee in Egypt's future?
- What are some of the social concerns that Egypt may face by 2050?

Class 1: “Is there a water crisis in Egypt... is Egypt in DeNILE?”

Exploring the Data Activity

Time needed: 80 minutes

Assignments due before Class 1:

As a ticket into class, students will have read the short comic story and prepared a written reflection. This reflection will be submitted as students enter the class.

Aims of Class:

1. Students will explore and familiarize themselves with the Nile Valley and Nile Delta geography.
2. Students will be exploring, in groups, 5 sets of data divided by theme (5)
3. As a product of this activity students will begin to explore the relationships between various stakeholders and themes.
4. As a class, students will build a systems map together: Each group will contribute to a class systems map building connections between key factors contributing to the Nile Delta crisis.

S-E Learning Outcomes:

- Focuses on a socio-environmental problem or issue.
- Highlights importance of interdisciplinary or transdisciplinary understanding of the problem.
- Illustrates the coupled nature of socio-environmental systems (e.g. illustrates interactions between humans and the environment).
- Requires students to use data and ideas (e.g. frameworks or models) from both natural and social sciences.

Case Specific Learning Outcomes:

- Identify the key stakeholders or “Nile citizens” affected by threats to the river Nile
- Dissect and identify patterns or connections within a system
- Examine a complex socio-environmental issues from multiple lenses.
- Visually represent a system, identifying connections and feedbacks

Before Class:

- Print out five copies of the ‘Pin the Tail on the Continent’ activity sheet.
- Make sure to have on hand material suited for making a class systems map. This may be solely in the form of different coloured markers in the event of using a blackboard. Alternatively, you can use sticky notes which can be moved around easily.
- Have on hand an electronic photography device (phone, camera) to use in class to photograph the student product (systems map) at the end of class.
- Have the lecture 1 Powerpoint slides ready for use.

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Description: This activity is designed to allow students to appreciate the complexities of the Nile Delta ecosystem by exploring various datasets highlighting the different sub-themes. Students will be placed in five groups (of 3 to 4) and will complete two activities. The first activity, occupying the first 15-20 minutes, is entitled 'Pin the Tail on the Continent (for international students)/Country (for Egyptian students)', whereby students (in groups) will attempt to name all the countries of the Nile Basin and also to name the various governorates and cities within the Nile Delta. The second activity will be an examination by the students (in groups) of various worksheets provided using guided questions to help them interpreting the data at hand. Finally, students will work as a class, guided by the instructor and attempt to create a large systems map (as an entire class) highlighting the interdisciplinary nature of the Nile Delta crisis.

Summary:

- **Beginning of class:** The link between the comic and class one should be made. Start the class by engaging students in a small discussion regarding the comic content, particularly focusing on the identification of visual differences between the Nile Delta panels of 2017 and those of 2050. Also allow students to explore and voice why these differences may exist.
- A. **'Pin the Tail on the Continent/Country':** In groups, students will first explore the various countries comprising the Nile Basin and also examine the cities and Governorates that make up the Nile Delta. Each group shall be presented with two sheets (printed before class), one with an empty Nile Basin map, the other with an empty Nile Delta map. Students will fill out both maps without any technological help or the comic (which already maps out various Delta cities). Following student attempts, the instructor shall present the complete versions of the Nile Basin and Delta maps.

Tips to Teacher:

- **Prior to activity:** Start by asking students how many other countries share the Nile with Egypt? What water bodies are sources of the Nile?
- **Remind students** that a few Delta cities were already labelled in the comic.
- B. **Examining Data Sets:** The second activity will have each group examining one of five different worksheets. Each worksheet highlights a different area of the five focus areas of the Nile Delta crisis by presenting several quantitative datasets. The teacher may choose to replace or add to the existing datasets or focus areas. Listed below are the five worksheets/focus areas and their constituent datasets.



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Group 1 Worksheet: Water Access

- *A breakdown of Egypt's water supply*
- *Average annual rainfall on the Nile Countries*
- *Percentage of total water used for irrigation*
- *Competing water uses for main income groups of countries.*
- *FAO Map of Current Sites of Physical and Economic Water Scarcity*

Group 2 Worksheet: Water Quality

- *Capacity of Nile Delta Waste Water Treatment Plants (2000)*
- *Water Quality Indicators at three drains in the Nile Delta from 2000-8*
- *Concentrations of heavy metals recorded along the Nile in Egypt (from 2010)*

Group 3 Worksheet: Population (growth, distribution)

- *Egyptian Population Centers and Density*
- *Egypt Population (2016 and historical)*
- *Egyptian Population Versus Time*
- *Egyptian Population Pyramids of 2016 and 2050*

Group 4 Worksheet: Land Usage

- *Summarized Results of Vulnerability in the Delta Region.*
- *Urbanization rate in the Nile Delta*
- *Assessment of urban sprawl on agricultural soil of northern Nile Delta of Egypt using RS and GIS*
- *Amount and percentage loss of agricultural lands in the northern Nile Delta in 2060*

Group 5 Worksheet: Climate

- *Sea level rise maps and impact on delta*
- *Economic losses to Egypt through climate change*
- *Estimated economic losses for various sectors in 2030 and 2050.*

Each worksheet will contain the following three questions asking students to (a) interpret the given data (b) relate it to the short story comic, and (c) draw connections between the data sets

- 1. Describe what you are seeing in the data/graphs/visualization. What is the data telling you? Make a table with your answers. Can you identify trends or relationships?**
- 2. How does your dataset relate to the story in the comic?**
- 3. Can you see connections/relationships within the data sets provided? If so, describe or draw these connections.**



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- C. Systems Map In-Class Generation:** Groups shall use (a) the data sheet given to them, as well as (b) their answers to the three questions in building a class systems map to highlight the interdisciplinary nature of the Nile Delta crisis. Initially, each group will work on their own section within the systems map, and then they will examine the systems map as a whole and try to build connections. This should be followed by an in-class discussion, focusing primarily on the interdisciplinary nature of this issue, and also on the various stakeholders involved.

[If you are unfamiliar with systems maps, there are some great resources and tutorials on the SESYNC website]

Tips to Teacher:

- During generation, if there is an obvious link which students have not explored, try to direct students to this issue in the form of a question.
- Alternatively, if any student points out a previously unforeseen link, this should be noted and added.

Post-class/ Pre assignment:

- **Make sure** that students have access to :
 - a) A photograph or a visual/digital documentation of the class systems map generated earlier
 - b) All five data sheets (basically everything given to all groups)

Description: During class 1, students will have been introduced to the concept of stakeholders as a diverse body with complex interrelated connections. At home, students will:

- **Review the class systems map created in Class 1.** This resource can be found online in the class 1 resource folder. (Teacher should either take a picture of board map OR create a digital version using mindomo, C-MAP, Mental Modeler, mindmaple or Poplet)
- **Create an individual systems map** using data sets from all 5 worksheets. Additional resources may be included. Students should refine and build on the work they did in class as a group. Resources for creating systems maps include: mindomo, mindmaple or Poplet. Students should also find three data sources not covered in class to incorporate into their systems map. **This modified individual systems map will be due at the end of class 3.**
- **Prepare answers** to the following questions:
 - Who are the stakeholders (individuals, systems) you have identified in your systems map (at least 3). *Note: Teachers should take time in class to discuss the variety of stakeholders, people, places, systems, agencies etc.*
 - Describe the connections can you see between the nodes of your map, and consider both positive and negative, amplifying and detrimental etc synergistic and antagonistic.
 - What are the key elements that you have identified and how are they related ?
 - We have identified 5 areas for exploration in order to create your system map. Can you identify an additional area ?
- **Prepare a short narrative** explaining their individual map and describing the relationships between the various nodes on their individual map.



Class 2: “Is there a water crisis in Egypt?”

Fake the Facts: Two Truths and Lie

Time needed: 80 minutes

Assignments due before class 2:

Although no assignments are due in class 2, students should have a working draft of their systems map as a ticket into class.

Aims of Class:

1. Students will continue to **explore**, in groups, the five sets of data divided by theme.
2. As a product of this activity students will **design statements relating to the data** provided in the worksheets. Two of these statements should accurately reflect the data and synthesize information from multiple data sets (minimum 2 data sets).
3. Students will be introduced to **various ‘social snapshots’** of the Nile Delta crisis which highlights the social aspects of a shared Nile river, a growing crisis problem, and the role of the Nile in the arts.
4. Students will be **introduced to various systems maps*** building on their last class activity, and working towards a final individual systems map.

*** Instructors should select appropriate examples that better demonstrate the type of systems maps they want their students to create.**

S-E Learning Goals:

- Focuses on a socio-environmental problem or issue.
- Highlights importance of interdisciplinary or transdisciplinary understanding of the problem.
- Illustrates the coupled nature of socio-environmental systems (e.g. illustrates interactions between humans and the environment).
- Requires students to use data and ideas (e.g. frameworks or models) from both natural and social sciences.

Case Specific Learning Outcomes:

- Select data from the datasets provided and synthesize statements relevant to the system at hand
- Evaluate the complex socio-environmental issue from multiple lenses. **
- Identifying connections and articulate these connections to their peers

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Before Class:

- Have the following ready for use:
 - a. Class 2 powerpoint slides
 - b. Examples of statements for 'Fake the Facts' activity
 - c. YouTube videos to be shown 'Social Snapshots' activity
 - d. Sample systems maps chosen to show to class (optional)

Description: This activity is designed to allow students to apply basic quantitative reasoning approaches in critically evaluating the data provided in the case. Students should be familiar with the five datasets which explore the complexities of the Nile Delta ecosystem. Students will have completed a class systems map and will be working towards the completion of their individual systems map. This class consists of four distinct sections. First is 'Fake the Facts: Two Truths and a Lie', which involves students using quantitative datasets to formulate true or false statements. This is followed by 'Social Snapshots', presenting the students with several Youtube segments highlighting the importance of the Nile to not just Egypt but the Nile Basin countries, followed by a discussion on the aforementioned videos. The instructor will then elaborate the concept of a systems map by showing students a variety of existing systems maps to help them in their own systems map assignment. Finally, the instructor will introduce the second major assignment of the case study; a 'Number of the Day' activity designed to raise public awareness of the Nile crisis.

Summary:

- A. Fake the Facts: Two truths and a lie (20 min):** This exercise will have students working in five groups of 3-4 each. Students will work individually at first, and then in pairs
- The instructor will introduce the assignment with a sample collection of three statements supported by data, two being true and one being false. Two examples may be:

The governorates with the highest density of population are

- a. Cairo (TRUE)
- b. As Suways (Suez) (FALSE)
- c. Al Minufiyah (TRUE)

With respect to Egyptian populations

- a. Fertility rate has consistently declined from 1955 to 2016 (FALSE)
- b. The highest density of the population lies along the Nile Valley (TRUE)
- c. Egypt ranks as one of the twenty most populous countries on Earth (TRUE)

- **First ten minutes (individually):** Each student will prepare a series of three statements, two of which are supported by the data and one which lacks support.
- **Second ten minutes (in pairs):** Students will pair up and exchange questions. Students then respond to their partners' three questions and try to identify the supported versus unsupported.



Once students have completed this phase of the activity, the instructor lead a discussion to debrief and highlight interesting findings. Students are also asked to share with their colleagues any additional data sets they found during their research.

Tips to teacher:

- **Before class:** make sure to prepare a sample of true/false statements, more than one.
- B. **Introducing Social Snapshots(25-30 min) and Group Discussion (10 min):** This section aims at introducing students to the social and cultural side to the Nile. As well as introducing the Nile's importance through small news segments highlighting current trends/impacts of the crisis, but also aims at using art and culture to transmit the importance of the Nile, as well as students' sense of Nile citizenry. This is also aimed at making students feel empowered in contributing to the Nile, regardless of their discipline (even art can help/send the message). Below is a list of links that teachers may find useful. Teachers are not obligated to show the entire list.
 - **Nile Project Conversations (12 min):** <https://youtu.be/Wj4OqEAK7aY> : An introduction to the Nile Project, a collaborative effort from artists and musicians of different Nile Basin countries to promote communication, musical and cultural understanding between these nations. This is in response to the building of the Grand Renaissance Dam in Ethiopia, which has created tension between those countries that share the Nile.
 - **Projected population growth (4 min):** <https://youtu.be/YJz7LVVl8c> : This video describes data used to project population of nations in 2050. This video places Egypt as one of the top 20 most populous nations and forecasts a population growth trend in an already overpopulated nation.
 - **Water crisis in egypt: water poverty (5 min):** <https://youtu.be/hRHv7b-xTGY>: An introduction to Egypt's water crisis, setting the problem in the context of population and dated treaties. Also investigated is how water is used in irrigation and some of the techniques used by farmers in alleviating water pressure, as 80% of water is used for irrigation purposes.
 - **Nile's drying waterways stall Egypt's growth (3 min):** <https://youtu.be/niP7VyTepD4> Egypt's drying canals - often used as rubbish dumps by local communities - are the theme of this video, presenting a shortage, garbage and public health issue combined.
 - **Is the Nile Running Dry (17 min):** <https://youtu.be/QkDf9ybQkGk> A comprehensive look at the Nile crisis in Egypt, describing the current situation in detail as well as Egypt's geography. Also discussed are previous efforts of the Egyptian state to produce fertile land and curb this crisis. The video also highlights the problems faced by Nile dwellers in rural villages.
 - **The Eternal River (16 min):** <https://www.youtube.com/watch?v=ukSxrJI-gRs> The Eternal River (النهر الخالد) is a song originally written and sung by Egyptian singing great Mohammed Abdel Wahab about the Nile.
 - **The opening of the locks (4 min):** <https://www.youtube.com/watch?v=vtUbCwchf4E> The importance of water to Egyptian farmers and livelihoods is shown in this dramatic and iconic scene from the Egyptian classic film 'A Kind of Fear' (1969) (شيء من الخوف) where in defiance against orders to shut the locks, one woman is brave enough to open the locks.

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- **Sailing down the Nile (5 min):** <https://www.youtube.com/watch?v=jjdOlv82kPE> beautifully shot video of a trip down the Nile, showing its' various uses and how people live and interact with it. Reminiscent of the video the students will produce in the comic story presented in this case.

This should be followed by a 10 minute discussion on video content. Questions to probe the students include

- Can you make any links between the previous videos?
- How are science and scientific thinking important in tackling this issue? Elaborate.
- How can the arts play a role in addressing this crisis?

C. **Systems Map Generation:** The next section involves introducing students to existing systems maps to help them with their own ongoing systems map assignment. Several existing systems maps are available below. The teacher may also use their own systems maps if available.

- <http://blog.waterdiplomacy.org/2015/10/coping-with-uncertainty-and-feedback-in-the-nile-basin/> : This link presents a systems map entitled 'Total Nile Flow', displaying the volume of water entering and leaving the entire Nile system, as well as average monthly flow throughout the year.
- https://en.wikipedia.org/wiki/Aswan_Dam#/media/File:NileCanals.JPG or http://www.fao.org/nr/water/aquastat/countries_regions/EGY/Figure_1.png : A simple systems map detailing the main irrigation offshoots and canals of the Egyptian branch of the Nile.
- http://www.venturariver.org/2010_05_01_archive.html: This link, despite not being about the Nile, provides a few systems maps pertaining to the Ventura River in the United States. These systems maps display the interaction of governmental sectors in river governance, as well as social processes.
- <http://rs.resalliance.org/2011/10/06/5120/>: This link provides several introductory maps relating to social ecological systems.

D. **Introducing Second assignment (Number of the Day):** This assignment aims at making students actively involved in communicating and raising awareness of the Nile crisis to the public, by producing a coherent and easily transmitted media message. This message can be in the form of a 'Number of the Day' activity, wherein the students present a number/statistic they have obtained from the data examined, and present it in a single sentence or two in an appealing and creative way. This can also be a post to a TAcKK page, facebook page, or any popular social media forum. This way, students could surpass classroom settings and actually transmit to the public as well as make a difference. (Adapted from <http://www.baseera.com.eg/>)

[Refer to 'Rubric-Number of the day' for assessment]



Class 3-4: Evidence-Based Decision Making Activity

Time Needed: 160 minutes (80 min/ class)

Assignments due before class 3:

On the day, students should come to class with three tickets into class:

1. **Number of the day activity** and accompanying 150-300 word **reflection piece**.
2. **A copy of the group systems map** generated at the end of class one, which should have been photographed or documented and given to them and their working draft of individual systems map.

Aims of Activity:

1. Students will (in groups) **explore one or more existing solutions** to the Nile crisis.
2. Students will then use elements of the socio-environmental framework to **critique these solutions**, using existing assessment techniques (The 6 Thinking Hats[®]).

S-E Learning Outcomes:

- Focuses on a socio-environmental problem or issue.
- Highlights importance of interdisciplinary or transdisciplinary understanding of the problem.
- Illustrates the coupled nature of socio-environmental systems (e.g. illustrates interactions between humans and the environment).
- Requires students to use data and ideas (e.g. frameworks or models) from both natural and social sciences.

Case Specific Learning Outcomes:

- Apply socio-ecological frameworks to assess solutions to the Nile crisis. .
- Evaluate and critique existing solutions to the Nile crisis.
- Identifying connections and articulate these connections to their peers

Before Class:

- Have the following ready for use
 - a) Class 3 powerpoint slides
 - b) Worksheets detailing the solutions to the Nile crisis
 - c) Multicolored pens
 - d) Inform students that they **MUST** bring their laptops/tablets and listening devices (headphones) for activity.

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Description: This class is aimed at examining existing solutions to the Nile crisis. The basis of class 3 shall be the systems maps generated in both class one (the large systems map), and those that students have completed individually and are submitting. In groups, students will use these socio-environmental frameworks to assess and critique a specific Nile crisis solution.

Summary:

- A. Intro to Solutions (15-20 minutes):** The students here are introduced briefly to several different solutions to the Nile Water crisis. Also covered should be assessment techniques. For the purposes of this exercise, this assessment technique used will be Edward De Bono's Six Thinking Hats[®] (http://www.debonogroup.com/six_thinking_hats.php) which is used in many disciplines to evaluate decisions regardless of scale. The activity requires students to wear different 'hats' representing different lenses of looking at data through different hats; emotion, cautious, information, structure, creativity and optimism.
- Guidelines to facilitating Six Thinking Hats[®] activity can be found at the following sites:
 - <http://study.com/academy/lesson/de-bonos-six-thinking-hats-summary-examples.html>
 - <http://www.acced-i.org/files/Handouts/The%20Six%20Thinking%20Hats.pdf>
 - <https://www.miun.se/siteassets/fakulteter/nmt/summer-university/bonopdf>
 - <http://www.is-toolkit.com/workshops/hats/ChangeManagement6ThinkingHats.pdf>
 - <https://www.adb.org/sites/default/files/publication/27648/wearing-six-thinking-hats.pdf>
 - Guiding questions

Blue Hat (focus statement): <ul style="list-style-type: none">Scan the current problem. What problem(s) are your assigned solutions addressing?
White Hat: <ul style="list-style-type: none">What is the current/existing information about the problem? About these solutions?What information is missing? How do we go about finding this information?
Red Hat: <ul style="list-style-type: none">Based on your own experience, how would these solutions be perceived by all stakeholders in the ecosystem (both positive and negative)? How will they feel about it, and why?What would be possible gut feeling responses from stakeholders involved?
Yellow Hat: <ul style="list-style-type: none">What are the potential benefits of these solutions? And why?
Black Hat: <ul style="list-style-type: none">What are the potential disadvantages of these solutions? And why?
Green Hat: <ul style="list-style-type: none">How can the disadvantages of these solutions be bypassed?Any alternative ideas/recommendations/suggestions/modifications that you can add to the solutions?
Blue Hat <ul style="list-style-type: none">Looking at the big picture, what can we conclude about the solutions?Any other elements that should be considered when implementing these solutions?



- B. Group analysis of a single solution (50-60 minutes):** Each group of students looks at one (or more) solution(s) and use their understanding of the system to critique the solution in groups. Students will be required to examine various sources relating to the solutions (listed below). They will use internet resources in investigating further. Students will then use the assessment techniques to create a group chart detailing the Six Thinking Hats process on their respective solution, which will be due at the end of class. Students are addressing solutions to the key questions posed in this case study.
- C. Worksheets:** Sources for each of the worksheets are listed below however students should be encouraged to explore additional resources prompted by the suggested resources.

Reuse of Wastewater:

- Direct students to the following link to the academic paper ‘Reuse of Wastewater In Mediterranean Region, Egyptian Experience’
http://www.academia.edu/332059/Reuse_of_Wastewater_In_Mediterranean_Region_Egyptian_Experience .
The paper discusses the reuse of wastewater treatment. **Refer students specifically to the later sections, notably section 6.2**, entitled ‘Major Use of Wastewater in Egypt’. It covers the history of wastewater re-use in Egypt, and current efforts and practices (both direct and indirect). It also presents a case study of El Salam Canal, an example of the usage of drainage water from the Damietta branch of the Delta as well as wastewater drains to irrigate lands in the North Sinai Peninsula and how the water is treated en route from several pollutants. Furthermore, it highlights efforts in using wastewater to cultivate forests (Forest Plantation) and to provide newly erected desert towns and cities with much needed urban greenland.
- Also, show students the following viral news video from a popular Egyptian news website posted earlier in 2016,
<http://www.cairoscene.com/Buzz/Video-Through-Miracle-Technology-Egypt-is-Growing-Forests-In-The-Desert-Using-Sewage-Water> . This details how wastewater deemed unfit for irrigation has been channelled into cultivating a forest in a desert near Ismailia, just outside of the Nile Delta.
- The academic paper ‘Urban Water Cycles in Egypt: Current Situation and project Examples’
http://www.academia.edu/1493592/Urban_Water_Cycles_in_Egypt_Current_situation_and_project_examples includes a section (4a) describing the wastewater treatment process at the Gabal El Asfar Waste Water Treatment Plant (WWTP) which treats Cairo’s waste water.

Water desalination projects:

- The first link is an academic paper from 2007, http://www.iwtc.info/2007_pdf/4-5.pdf about the water desalination industry in Egypt. Have students read specifically from page 4 of the 13 page document (page 340 on the sheet). The following sections describe the suitability of agricultural drainage water for desalination, as well as desalination techniques, environmental impact and policy.
- The next link is from a 2015 news article
<http://www.scidev.net/global/water/news/egyptian-filters-seawater-environment.html>. This

article discusses the efforts of students at Alexandria University at creating a cost-effective desalination technique relying on short time and no electricity.

- Also direct students to the Egyptian Desalination Research Center which details all the projects undertaken to advance desalination efforts, <http://edrc.gov.eg/>.
- Also useful is a 2016 news article detailing how Egypt is planning on constructing a large desalination plant to supply Sinai with water, with the help of a Kuwaiti firm <http://constructionreviewonline.com/2016/06/egypt-set-to-construct-a-98-6m-desalination-plant/>.
- Two web pages on the American University in Cairo's website. The first, <http://schools.aucegypt.edu/Sustainability/CSD/Pages/Desalination.aspx> highlights the Water Energy Food Nexus lab which uses solar energy to desalinate water. The second page, <http://schools.aucegypt.edu/newsatauc/Pages/story.aspx?eid=1089> describes the benefits of desalination and the University's research into the use of nanotechnology in developing more efficient membranes in the desalination process (also includes a link to a 2 minute video).

Increasing Water Delivery and Irrigation Systems (quantity and quality):

- The first link <http://ressources.ciheam.org/om/pdf/b52/05002250.pdf> is an academic paper 'Irrigation Systems in Egypt' which defines and assesses water irrigation systems' efficiency. Of particular significance to the groups is the section 'Improvement of the water distribution system' (page 93-94) which describes several solutions to improving water delivery, such as telemetry and automation.
- The academic paper 'Urban Water Cycles in Egypt: Current Situation and project Examples' http://www.academia.edu/1493592/Urban_Water_Cycles_in_Egypt_Current_situation_and_project_examples includes a section (5) on recommendations and solutions to ensure efficient transmission of higher quality water for irrigation.
- <https://www.youtube.com/watch?v=kJs3aahOhJE> This 2016 news segment covers a novel irrigation technique (raised bed farming) using new tractors to increase wheat yield while reducing water usage - thereby solving both water shortage and food insecurity.
- <https://www.youtube.com/watch?v=y8smq20wNw0> This two minute video introduces a new irrigation technique, a mobile solar irrigation pump, which has been placed into effect in the Nile valley in the Sohag, Egypt.

Urban Water Sustainability/ Consumer Awareness:

- The first link <http://www.sciencedirect.com/science/article/pii/S0959652610000478> (or https://www.researchgate.net/publication/223448217_Towards_sustainability_in_urban_water_A_life_cycle_analysis_of_the_urban_water_system_of_Alexandria_City_Egypt alternatively) is a 2010 research paper examining the environmental impact of the urban water system in Alexandria, with all the potential hazards of the pollutants found within the system. Also highlighted are solutions for sustainable water use, whereby the authors provide several scenarios for improvement (see section 3.5).
- The Australian government's official website provides a guideline to citizens on how to successfully manage and reduce their domestic water demands

The FiNile Solution (Case Study)

Authors: Hoda Mostafa, Mahmoud Shaltout, Sherif Osman and Tamer Shoeib



<http://www.yourhome.gov.au/water/reducing-water-demand> to lessen water taxes as well as environmental impact.

- <https://www.youtube.com/watch?v=jOQEZrxaGBc> A youtube video produced in India, another developing country which highlights how an average person wastes water doing simple home chores.
- <https://www.youtube.com/watch?v=gtcZbN0Z08c> The use of media messages is a powerful tool in changing habits, particularly in children's programming (in this case, *Sesame Street*)

Increasing Efficient Stormwater Use:

- The academic paper 'Urban Water Cycles in Egypt: Current Situation and project Examples' http://www.academia.edu/1493592/Urban_Water_Cycles_in_Egypt_Current_situation_and_project_examples includes a section (4b) on rainwater harvesting in the Northwestern Governorate of Matruh.
- The 2004 academic journal article 'Optimizing Use of Rainfall Water in East Desert of Egypt' http://www.iwtc.info/2004_pdf/01-5.pdf describes practices including detention basins, ponds and wetlands. Of particular importance is a small section near the end, proposed management (p.81) in which the authors suggest recommendations for improved stormwater management.
- <https://www.epa.gov/greeningepa/epa-facility-stormwater-management> The EPA's website provides a helpful overview of Stormwater Management, and introduces the concept of green infrastructure. Links to existing projects in the States are also found.

Third Assignment: Nile Citizen Report

Students will work on writing a short citizen-science news article communicating a data-backed solution to a selected problem. This should follow the standard word count of any online news article - around 500 to 750 words. This will be due after Class 4. [Refer to 'Rubric-Short Article' for assessment rubric]

Students will submit this assignment the following class. Guiding questions to this activity include :

- **What is the problem** that the article/post addresses?
- **Why is this issue important ?**
- **Identify the target audience.** Why this issue is relevant to them?
- **Know your audience.** What background/knowledge do they have about both problems and solutions?
- **How will your article/post help** in both understanding and solving the issue?

Class discussion:

Should occur after the students have submitted their individual systems maps and short articles, students can share their insights on their synthesis and solutions. The instructor can use this discussion to tie up any loose ends and clarify misconceptions and generic feedback.

