Class 1 Student Handouts

Worksheet 1: Water Quality

Examine the data sets below in your group.

Explore and address the following questions:

1. Describe what you are seeing in the data/graphs/visualization
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.

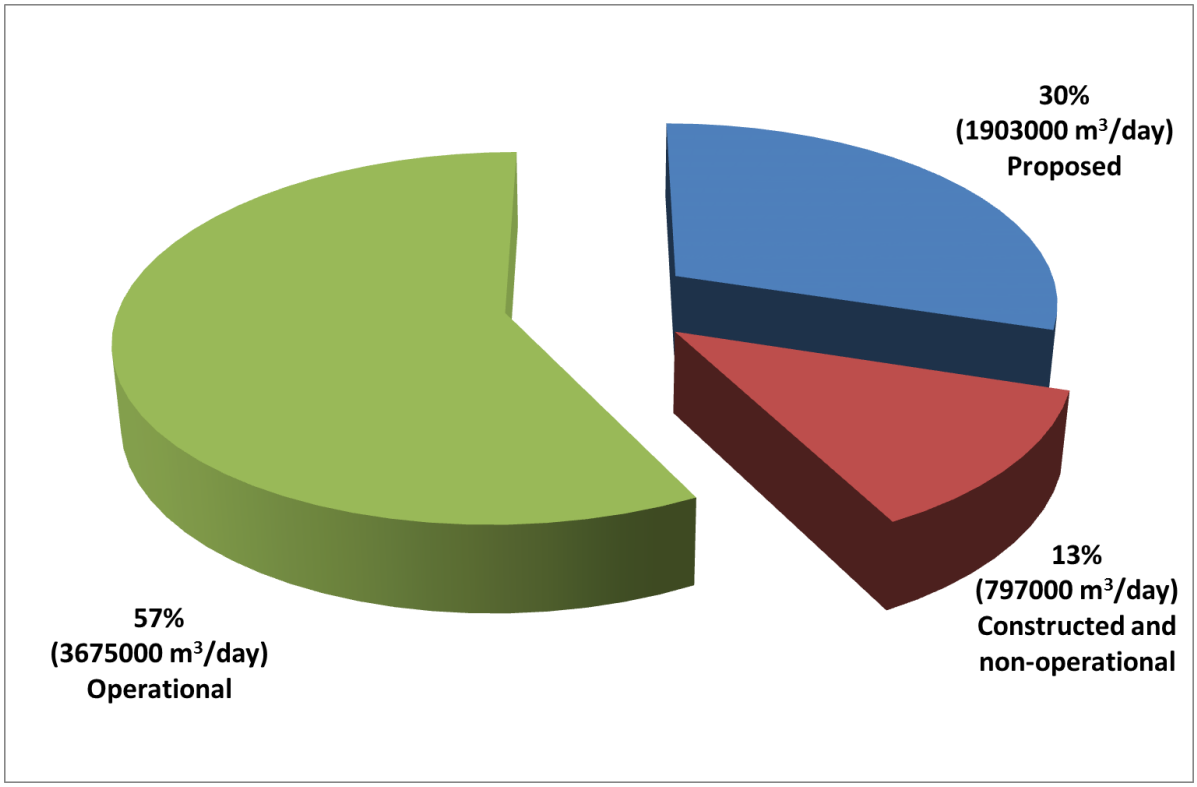


Figure 1: Capacity of Nile Delta Wastewater Treatment Plants (Yr 2000). In the Delta Region there are 18 plants constructed and non-operational as well as 94 plants proposed. Currently there is no treatment of municipal wastewater in numerous drain catchment areas throughout the Delta. Adapted from http://pdf.usaid.gov/pdf_docs/Pnads248.pdf

Table 1: Water quality indicators at three drains in the Nile Delta from 2000-2008.

Parameter	Description	Permissible Limits Law48/1982	WQI* weight (Total = 1)	Gharbia Drain 2000-8	Omar Bek Drain 2000-8	Sabal Drain 2000-8
Dissolved oxygen	It measures the amount of life sustaining oxygen dissolved in the water.	5 mg/l	0.17	2.23-2.97	0.74 - 2.58	1.84 - 5.34
Fecal coliforms	This is a form of bacteria found in human and animal waste.	2000 cfu/100	0.16	104535 - 4201839	54217 – 3830500	3208 – 1350833
pH values	It is a measure of the acid or alkaline content in water (alkaline>7 >acidic).	7 - 8.5/std units	0.11	7.24-7.56	7.78 -7.29	7.75-7.19
Biochemical Oxygen Demand	It is a measurement of the amount of food for bacteria that is found in water.	10 mg/l	0.11	23.8 - 63.23	26 - 63.9	16.17 - 89
Temperature change	It is very important, as many of the physical, biological, and chemical characteristics of water are directly affected by temperature.	5 °C over normal.	0.10	21 and 24°C.	21 and 24°C.	21 and 24°C.
Total phosphate	Phosphates are chemical compounds made from the elements phosphorous and oxygen.	1 mg/l	0.101	0.47 - 1.23	0.55 - 1.68	0.66 - 0.97
Nitrates	Nitrates are a measurement of oxidized form of nitrogen and are an essential macronutrient in aquatic environments.	45 mg/l	0.10	1.33 - 20.67	1.46 - 21.27	0.43 - 37.22
Turbidity	Turbidity is a measure of the dispersion of light in a column of water due to suspended matter. High levels of turbidity can come from urban runoff, wastewater	100 NTU	0.08	56.58 - 85.62	21.42 - 87.09	26.42 - 93.5
Total solids	It is the sum of dissolved and suspended solids materials in water includes salts, some organic materials, and a wide range of nutrients and toxic materials.	500 mg/l	0.07	1384 - 1748	609 - 955	668 - 967

* (water Quality Index), **Nephelometric Turbidity units . Adapted from http://iwtc.info/wp-content/uploads/2011/07/G40.pdf

Table 2. Mean and SD of the concentrations of the selected heavy metals of the sediment samples collected from six sites along the whole course of the river Nile from its spring at Aswan to its estuary at Damietta and Rosetta branches.

Locality / Metal	Aswan	Kena	Assiut	Beni-Suef	Damietta	Rosetta	Permissible limit*
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Pb (mg/kg)	3.1 ± 2.619	3.1 ± 2.342	4.4 ± 2.402	11.5 ± 11.518	6.9 ± 4.864	46.9 ± 23.509	35
Cd (mg/kg)	0.4 ± 0.256	0.5 ± 0.232	0.6 ± 0.354	0.6 ± 0.256	0.7 ± 0.414	0.7 ± 0.502	0.6
Zn (mg/kg)	101.1 ± 58.2	91.5 ± 27.77	100.2 ± 37.58	126.6 ± 32.73	179.8 ± 76.2	307 ± 99.19	123
Cu (mg/kg)	0.030 ± 0.027	0.024 ± 0.024	0.030 ± 0.0261	0.027 ± 0.0282	0.032 ± 0.0321	0.054 ± 0.0278	35.7
Cr (mg/kg)	8.8 ± 1.564	11.1 ± 14.417	17.6 ± 24.931	10.3 ± 10.342	9.1 ± 11.549	8.7 ± 8.438	37.3
Fe (mg/kg)	397.053 ± 291.9	379.44 ± 238.63	496.55 ± 333.45	536.483 ± 351.21	632.133 ± 393.87	698.74 ± 287.17	-
Hg (mg/kg)	0.0000 ± 0.001	0.0004 ± 0.0004	0.0009 ± 0.001	0.0010 ± 0.001	0.0020 ± 0.001	0.0033 ± 0.001	0.17
Mn (mg/kg)	210.36 ± 151.86	159.84 ± 122.70	273.35 ± 261.033	221.72 ± 198.72	351.79 ± 299.66	269.96 ± 204.093	-

*Canadian Environmental Quality Guidelines

Source: Water Quality and Heavy Metal Monitoring in Water, Sediments, and Tissues of the African Catfish Clarias gariepinus (Burchell, 1822) from the River Nile, Egypt, Alaa G. M. Osman, Werner Kloas, Journal of Environmental Protection, 2010, 1, 389-400

Worksheet 2: Population

Examine the data sets below in your group.

Explore and address the following questions:

1. Describe what you are seeing in the data/graphs/visualization
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.

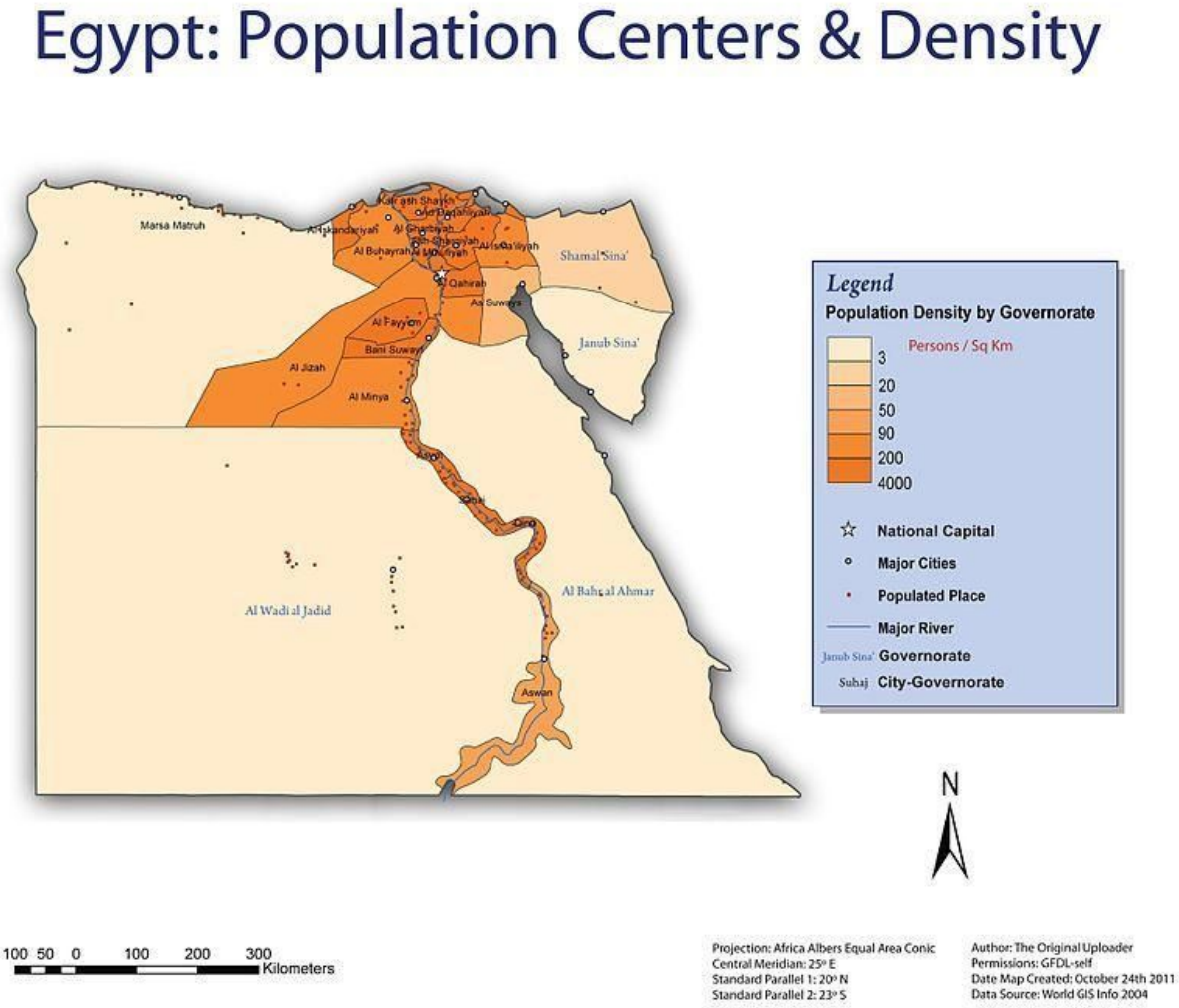


Figure 1: Egyptian Population centers and Density. Source: Anshar, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=17455836

Population of Egypt (2016 and historical)

Year	Population	Yearly % Change	Yearly Change	Migrants (net)	Median Age	Fertility Rate	Density (P/Km²)	Urban Pop %	Urban Population	Country's Share of World Pop	World Population	Egypt Global Rank
2016	**93,383,574**	2.05 %	1,875,490	-43,136	24.8	3.33	94	39.8 %	37,175,090	1.26 %	7,432,663,275	15
2015	**91,508,084**	2.21 %	1,893,418	-43,100	25	3.38	92	39.9 %	36,537,834	1.25 %	7,349,472,099	15
2010	**82,040,994**	1.83 %	1,419,776	-55,800	24	2.98	82	40.9 %	33,587,708	1.18 %	6,929,725,043	15
2005	**74,942,115**	1.86 %	1,321,442	-13,500	23	3.15	75	41.2 %	30,883,800	1.15 %	6,519,635,850	16
2000	**68,334,905**	1.82 %	1,180,076	-40,800	21	3.41	69	41.4 %	28,304,150	1.12 %	6,126,622,121	15
1995	**62,434,527**	2.05 %	1,207,451	-90,500	20	4.12	63	41.9 %	26,188,469	1.09 %	5,735,123,084	15
1990	**56,397,273**	2.7 %	1,404,693	-41,100	20	5.15	57	43.4 %	24,493,933	1.06 %	5,309,667,699	19
1985	**49,373,806**	2.63 %	1,200,851	-78,000	20	5.49	50	44.8 %	22,121,201	1.02 %	4,852,540,569	20
1980	**43,369,552**	2.34 %	949,028	-112,700	20	5.6	44	45.4 %	19,706,161	0.98 %	4,439,632,465	21
1975	**38,624,410**	2.1 %	763,162	-109,400	20	5.7	39	45.2 %	17,471,660	0.95 %	4,061,399,228	21
1970	**34,808,599**	2.43 %	787,123	-47,900	19	6.2	35	43.3 %	15,073,608	0.95 %	3,682,487,691	20
1965	**30,872,982**	2.66 %	760,117	-10,000	21	6.62	24	41.2 %	12,732,784	0.93 %	3,322,495,121	22
1960	**27,072,397**	2.73 %	683,236	-10,000	20	6.65	27	39.2 %	10,600,966	0.9 %	3,018,343,828	22
1955	**23,656,216**	2.51 %	551,796	-10,000	21	6.62	24	35.9 %	8,495,623	0.86 %	2,758,314,525	22

Source: **Worldometers** (www.Worldometers.info)
Elaboration of data by United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2015 Revision. (Medium-fertility variant).

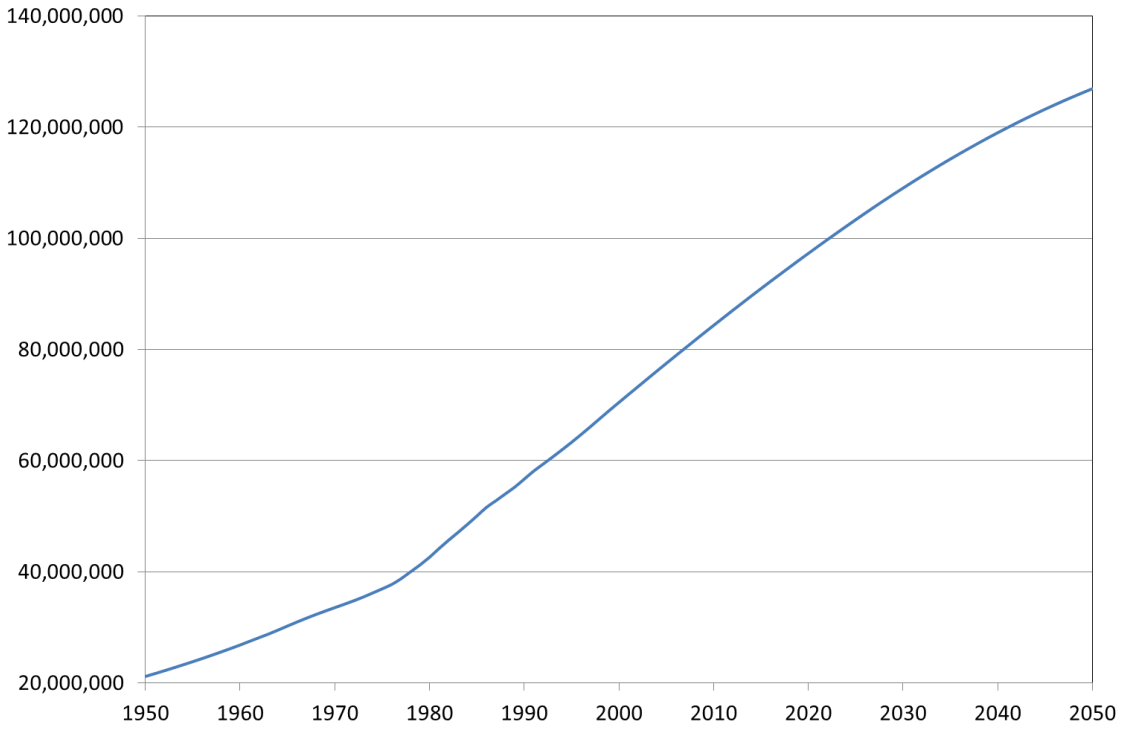
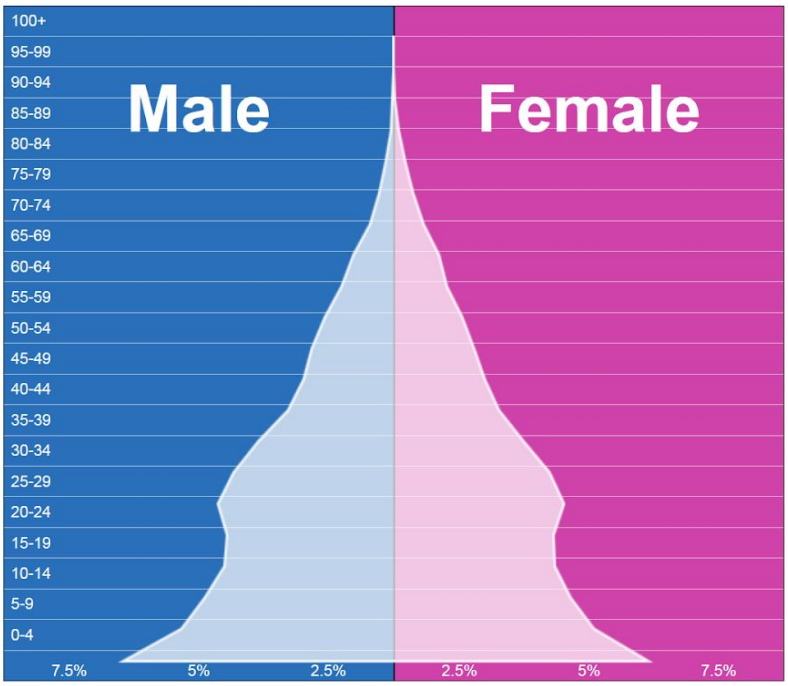


Figure 2: Egyptian Population versus time. Data from the U.S. Census Bureau
Source: http://www.data360.org/dsg.aspx?Data_Set_Group_Id=205

A



B

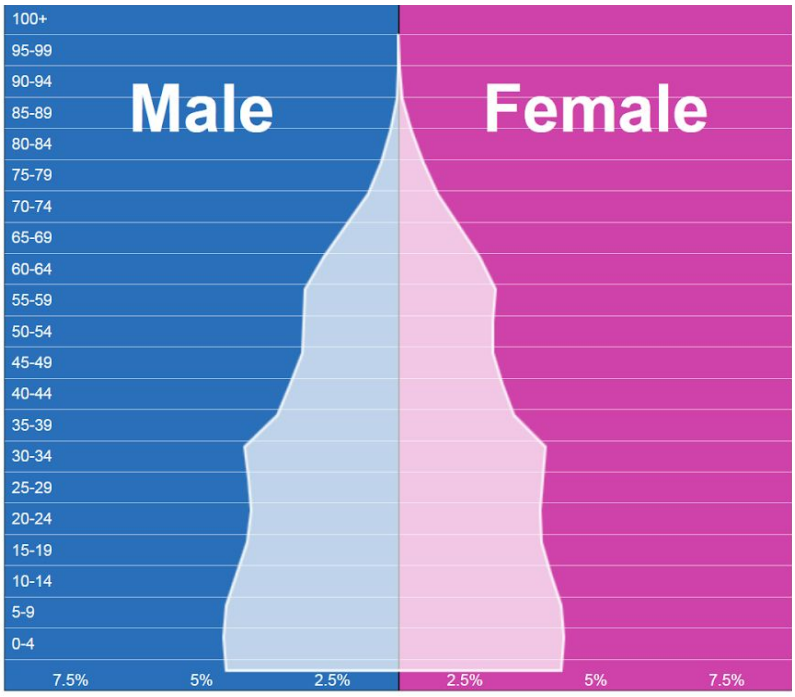


Figure 3: Panel A: 2016 Population Pyramid of Egypt and Panel B: 2050 Projected Population Pyramid of Egypt. Data from United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2015 Revision.

Worksheet 3: Land Loss

Examine the data sets below in your group.

Explore and address the following questions:

1. Describe what you are seeing in the data/graphs/visualization
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.

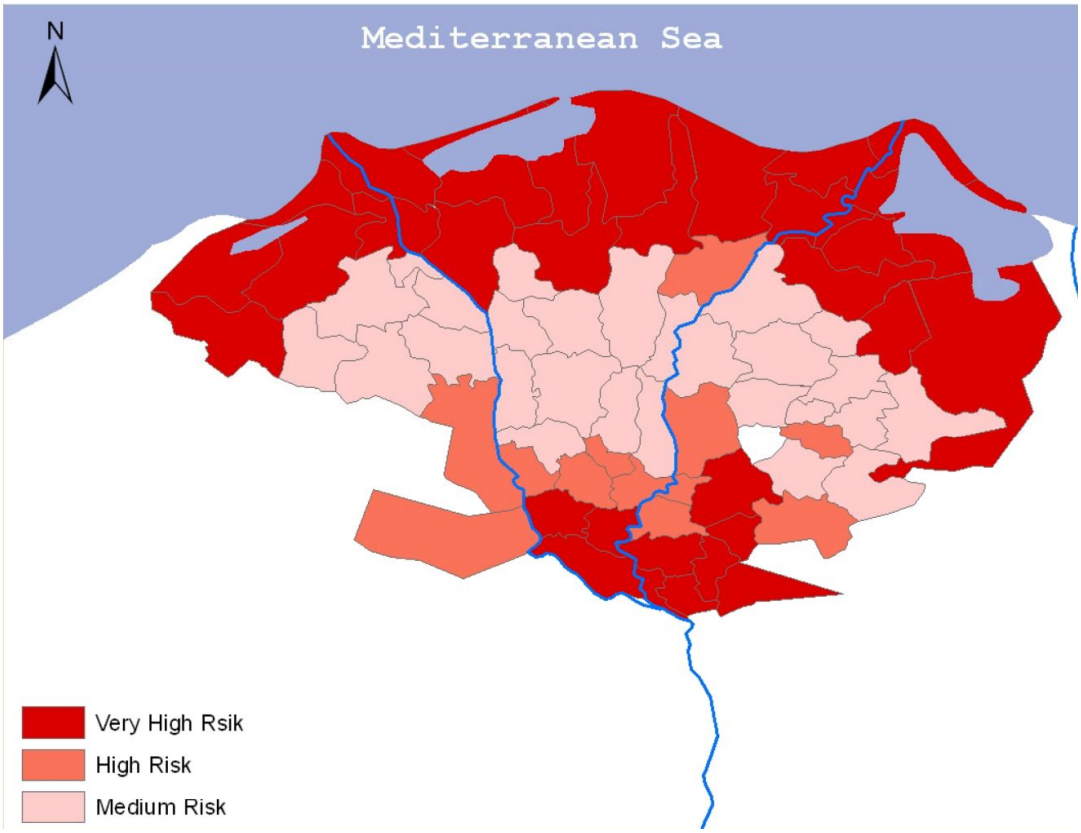


Figure 1: Summarized Results of Vulnerability in the Delta Region. North Delta: Land degradation due to soil salinity and continued increase in water table. Middle Delta: High water table, Limited and inflexible crop pattern. South Delta: Land degradation due to urbanization. (Adapted from: Land-use change and adaptation in the Nile Delta region, Mahmoud Medany, Samar Attaher, Ayman F. Abou-Hadid, regional assessment of the FP6 project: Adaptation of agriculture in European Regions at Environmental Risk Under Climate Change)

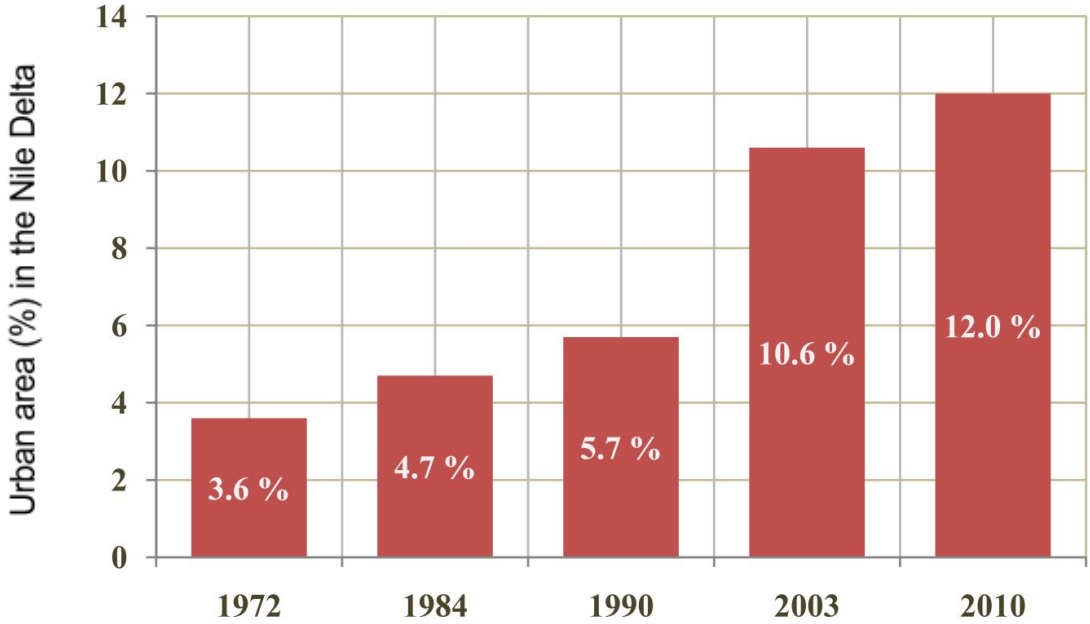


Figure 2: Urbanization rate in the Nile Delta. (Adapted from: Land-use change and adaptation in the Nile Delta region, Mahmoud Medany, Samar Attaher, Ayman F. Abou-Hadid, regional assessment of the FP6 project: Adaptation of agriculture in European Regions at Environmental Risk Under Climate Change)

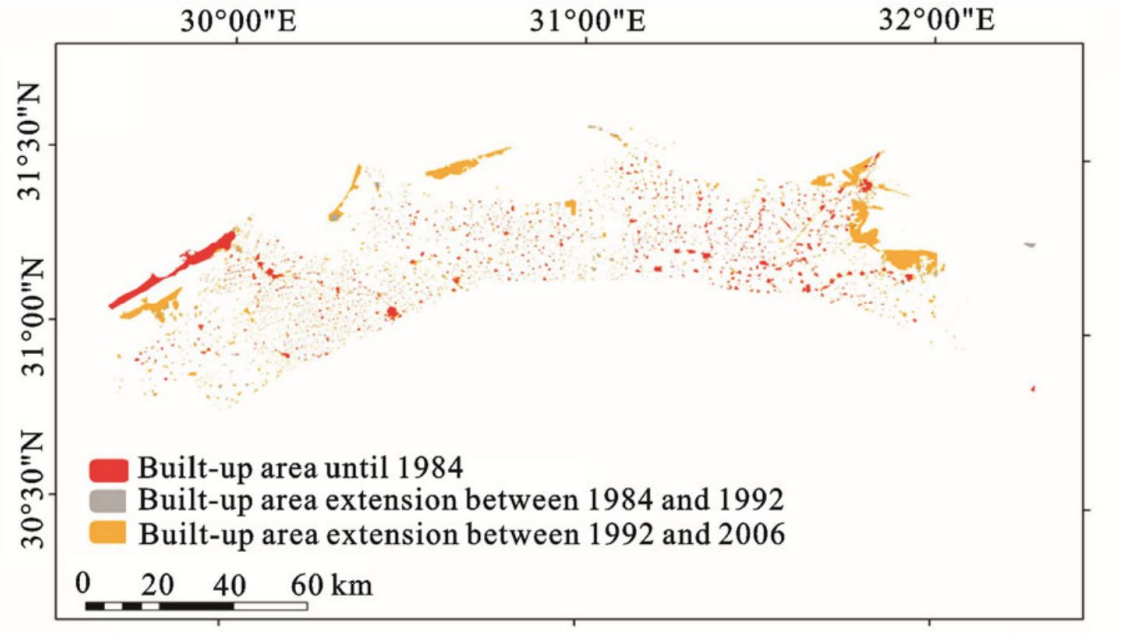


Figure 3: Assessment of urban sprawl on agricultural soil of northern Nile Delta of Egypt using RS and GIS; Adel Shalaby, Farahat Saad Moghanm, Chinese Geographical Science, 2015, Volume 25, Issue 3, pp 274–282

Table 1: Amount and percentage loss of agricultural lands in the northern Nile Delta in 2060

	Northeast Nile Delta		North-Middle Nile Delta		West Nile Delta	
Climate scenarios for SLR	**km^2**	**%**	**km^2**	**%**	**km^2**	**%**
High SLR 2060 protected	25.8	1.8	137.2	2.7	15.0	0.3
High SLR 2060 unprotected	774.3	52.7	523.9	10.4	625.6	13.2
Low SLR 2060 protected	4.8	0.4	31.2	0.6	0.0	0.0
Low SLR 2060 unprotected	449.3	30.6	129.5	2.5	10.6	0.2

Source: Potential Impacts of Climate Change on the Egyptian Economy, Joel Smith, Leland Deck, Stratus Consulting Inc., Bruce McCarl, Paul Kirshen, James Malley, Mohamed Abdrabo, 2013, United Nations Development Programme Report, Cairo, Egypt

Worksheet 4: Water Access

Examine the data sets below in your group.

Explore and address the following questions:

1. Describe what you are seeing in the data/graphs/visualization
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.

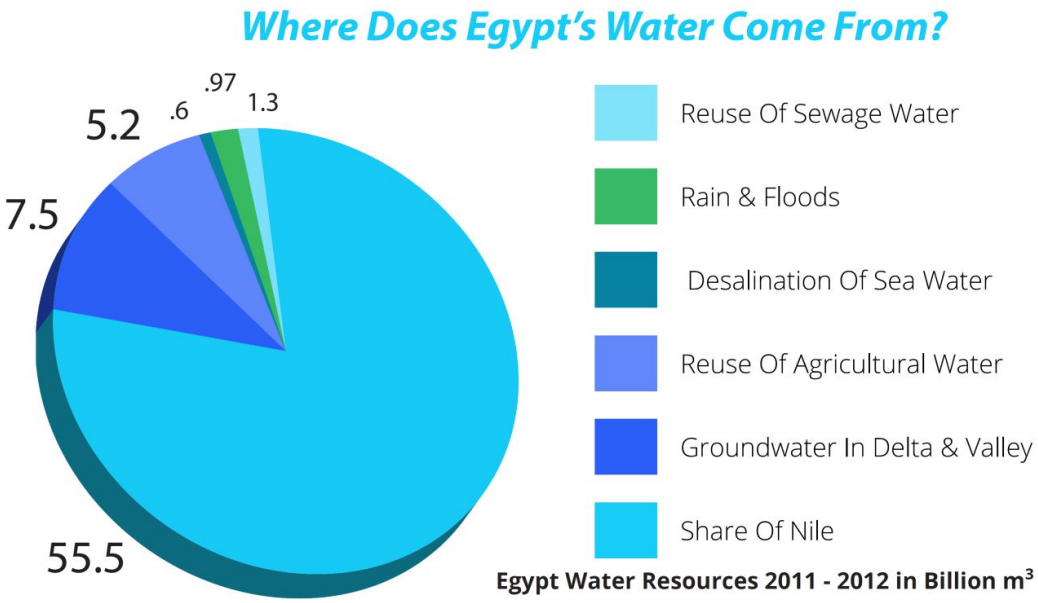


Figure 1: A breakdown of Egypt's water supply. Data from Egyptian Center for Economic & Social Rights Environmental Justice Programme, Isabel Bottoms, March 2014.

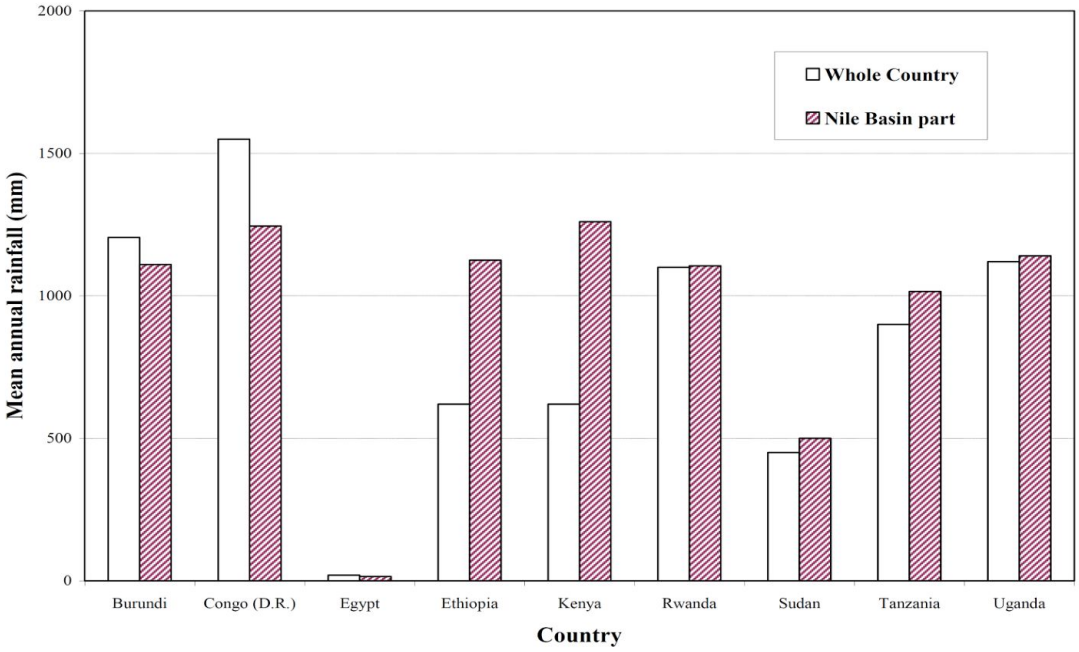


Figure 2: Average annual rainfall on the Nile Countries (Source FAO, 1995)

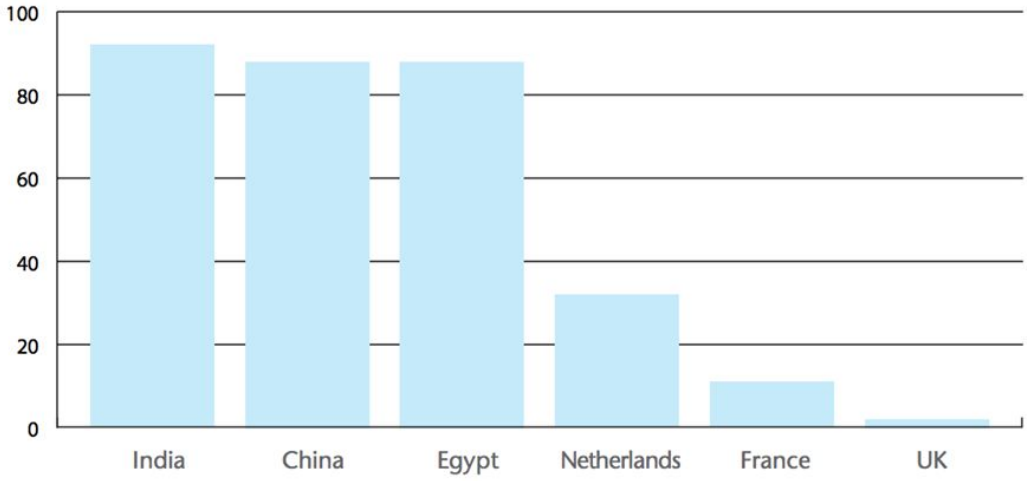


Figure 3: Percentage of total water used for irrigation. Data from Global Water Crisis, the Major Issue of the 21st Century, Saeijs, H.F.L.; Van Berkel, M.J., European Water Pollution Control, 1995, Vol. 5.4, pp.26-40.

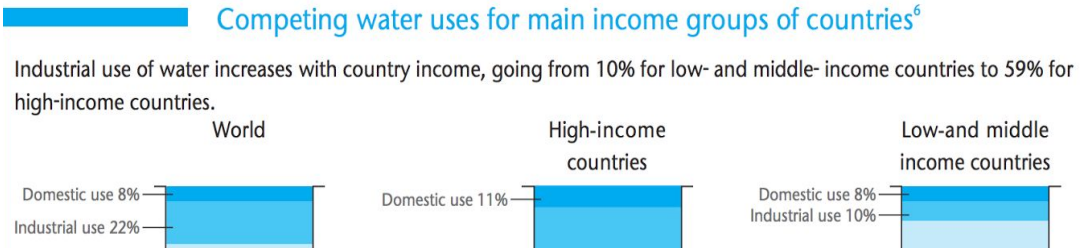


Figure 4: Competing water uses for main income groups of countries. Source: Water for People, Water for Life. United Nations World Water Development Report, UNESCO, 2003.

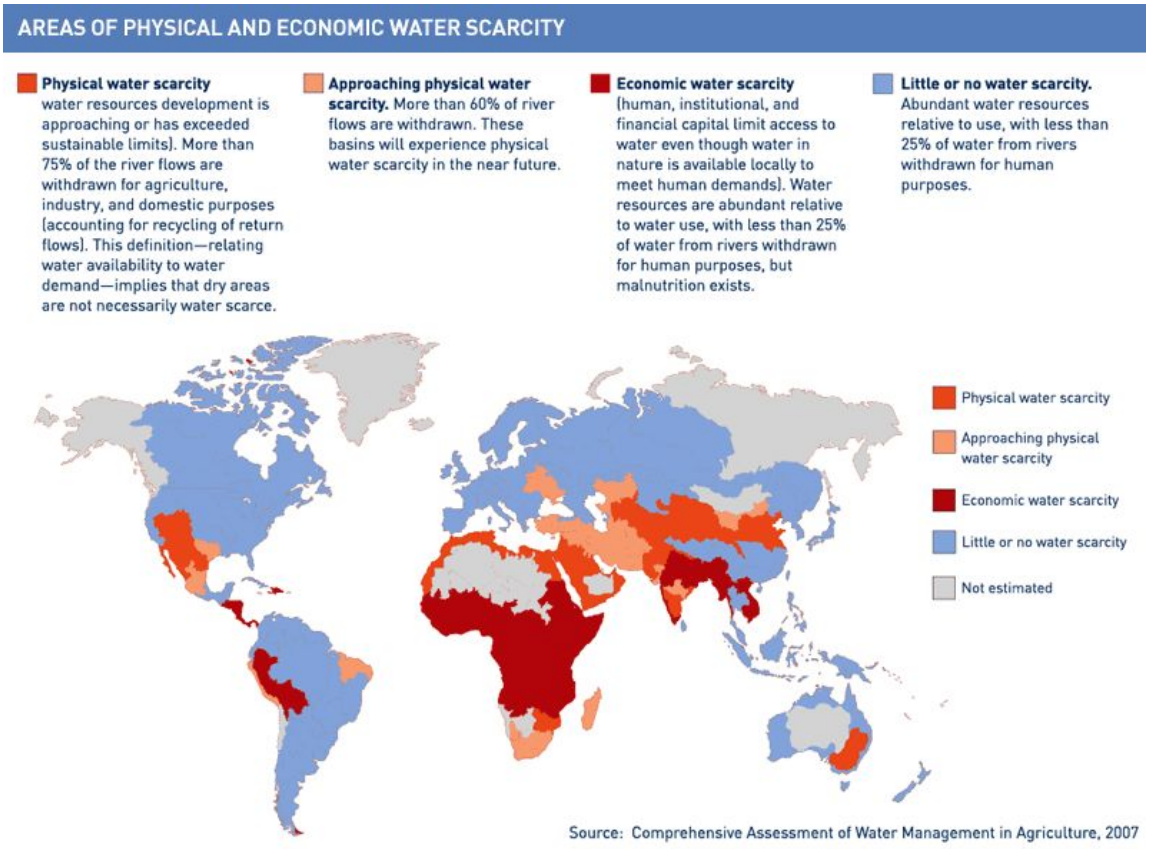


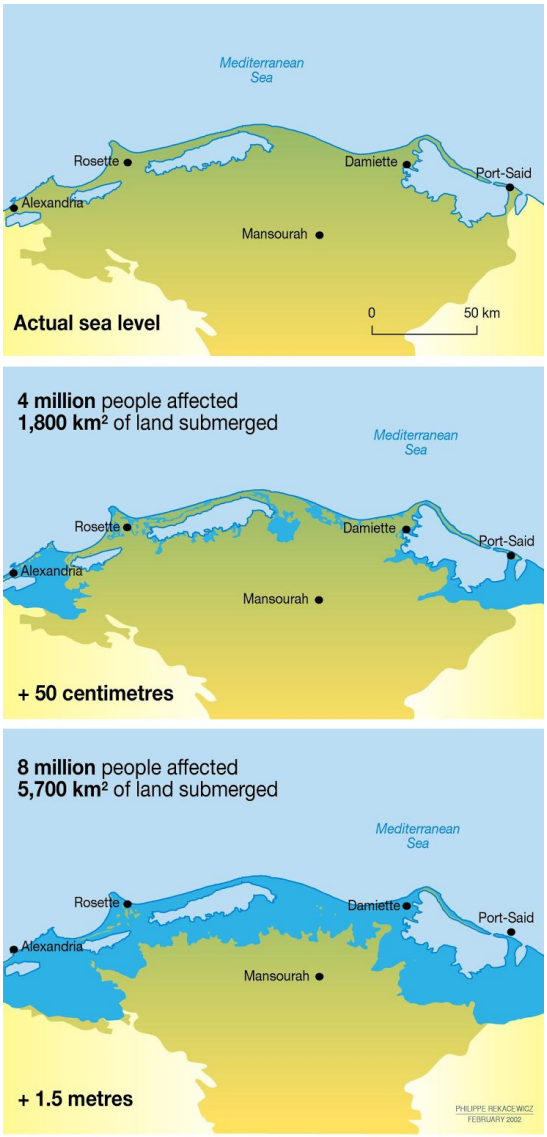
Figure 5: FAO Map of Current Sites of Physical and Economic Water Scarcity

Worksheet 5: Climate Change

Examine the data sets below in your group.

Explore and address the following questions:

1. Describe what you are seeing in the data/graphs/visualization
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.



Sources: The Sea elevation model has been calculated by Otto Simonett (UNEP/GRID, Arendal and Nairobi) at the beginning of the 1990s.
See also http://blog.mondediplo.net/2008-01-22-Le-delta-du-Nil-menace-par-les-eaux

Figure 1 Assessment of Sea Rise Impact on coastal land loss and population affected; **VITAL WATER GRAPHICS:** An Overview of the State of the World's Fresh and Marine Waters - 2nd Edition - 2008. http://www.unep.org/dewa/vitalwater/jpg/0405-Nil-EN.jpg

Table S.9. Estimated impacts of climate change on Egyptian agriculture (cont.)

Socioeconomic scenario	Baseline value (2060)	Pessimistic	Pessimistic	Pessimistic	Optimistic[a]
Nile flow	55 BCM	Small decreased flow (49)	Large decreased flow (35)	Increased flow (71)	Small decreased flow (49)
SRES (SLR + crops)		A1	A1	A1	A1
Protection from SLR		Unprotected	Unprotected	Unprotected	Unprotected
Agriculture results for 2060 (expressed as % change from base 2060)					
Production	Pessimistic: 374 Optimistic: 205 (billion EGP)	-27	-47	-8	-20
Agriculture consumption by consumers		-15	-30	-5	-7
Agriculture GDP	Pessimistic: 374 Optimistic: 205 (billion EGP)	15.6	9.0	13.8	14.1
Consumer prices (optimistic prices are 39% lower than pessimistic)		41	68	16	32
Change in welfare	Pessimistic: 1,845 Optimistic: 1,237 (billion EGP)	-112	-234	-38	-41
Agriculture labor hours	Pessimistic: 3.2 Optimistic: 2.8 (billion)	-20.1	-39.2	3.1	-5.4

SRES: Special Report on Emissions Scenarios.

a. Optimistic change is relative to optimistic baseline values.

Table 1 Estimated Impacts of climate change on Egyptian agriculture. Potential Impacts of Climate Change on the Egyptian Economy, 2013. Smith J, Deck L, McCarl B, Kirshen P, Malley J, Abdrabo M, United Nations Development Programme. http://www.eeaa.gov.eg/portals/0/eeaaReports/CCRMP/6.%20Potential%20Impact%20of%20Climate%20Change%20on%20the%20Egyptian%20Economy/Potential%20Impact%20of%20CC%20on%20the%20Egyptian%20Economy%20English.pdf

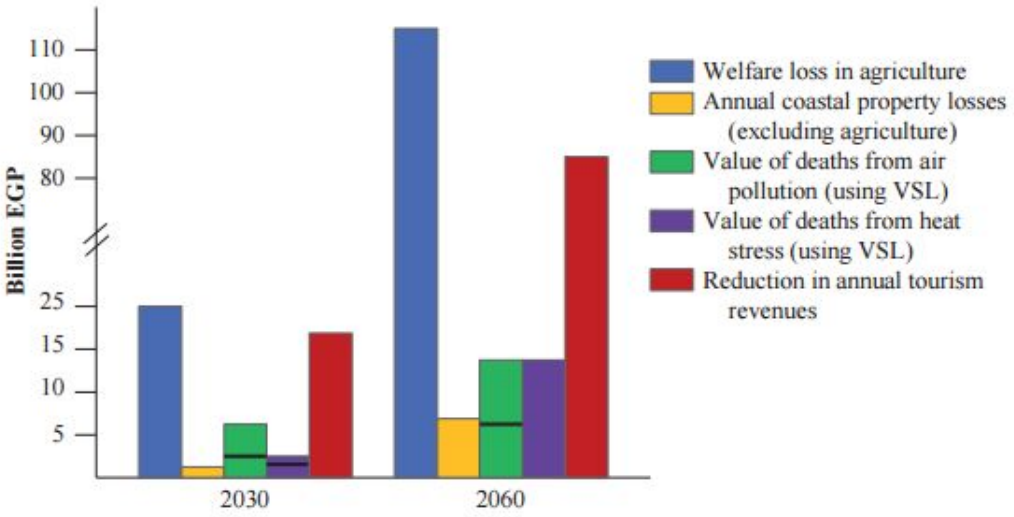


Figure 2 Estimated economic impacts by sector in 2030 and 2060 assuming low reduction in Nile flow, a pessimistic socioeconomic scenario, unprotected coastal areas and high Sea Level Rise (SLR). Potential Impacts of Climate Change on the Egyptian Economy, 2013. Smith J, Deck L, McCarl B, Kirshen P, Malley J, Abdrabo M, United Nations Development Programme. http://www.eeaa.gov.eg/portals/0/eeaaReports/CCRMP/6.%20Potential%20Impact%20of%20Climate%20Change%20on%20the%20Egyptian%20Economy/Potential%20Impact%20of%20CC%20on%20the%20Egyptian%20Economy%20English.pdf

City	Scenario	2030	2060
Port Said	Low SLR	18.12	64.3
	High SLR	27.9	109.6
Al-Burullus	Low SLR	8.75	32.25
	High SLR	14.75	60.3
Alexandria	Low SLR	7.0	27.0
	High SLR	13.0	55.0

Table 2: Sea Level Rise (SLR) (cm) scenarios used in this study relative to 2000. Potential Impacts of Climate Change on the Egyptian Economy, 2013. Smith J, Deck L, McCarl B, Kirshen P, Malley J, Abdrabo M, United Nations Development Programme. http://www.eeaa.gov.eg/portals/0/eeaaReports/CCRMP/6.%20Potential%20Impact%20of%20Climate%20Change%20on%20the%20Egyptian%20Economy/Potential%20Impact%20of%20CC%20on%20the%20Egyptian%20Economy%20English.pdf

Class 3 Student Handouts

Worksheet 1: Reuse of Wastewater

Examine the links below in your group:

- http://www.academia.edu/332059/Reuse_of_Wastewater_In_Mediterranean_Region_Egyptian_Experience
- http://www.cairoscene.com/Buzz/Video-Through-Miracle-Technology-Egypt-is-Growing-Forests-In-The-Desert-Using-Sewage-Water
- http://www.academia.edu/1493592/Urban_Water_Cycles_in_Egypt_Current_situation_and_project_examples

Using the above links, as well as your systems maps, critique the following solutions using the Six Thinking Hats ® technique.

Blue Hat (focus statement): ● *Scan the current problem. What problem(s) are your assigned solutions addressing?*
White Hat: ● *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: ● *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: ● *What are the potential benefits of these solutions? And why?*
Black Hat: ● *What are the potential disadvantages of these solutions? And why?*
Green Hat: ● *How can the disadvantages of these solutions be bypassed?* ● *Any alternative ideas/recommendations/suggestions/modifications that you can add to the solutions ?*
Blue Hat ● *Looking at the big picture, what can we conclude about the solutions ?* ● *Any other elements that should be considered when implementing these solutions?*

Worksheet 2: Water Desalination Plants

Examine the links below in your group.

- http://www.iwtc.info/2007_pdf/4-5.pdf
- http://www.scidev.net/global/water/news/egyptian-filters-seawater-environment.html
- http://edrc.gov.eg/.
- http://constructionreviewonline.com/2016/06/egypt-set-to-construct-a-98-6m-desalination-plant/ .
- http://schools.aucegypt.edu/Sustainability/CSD/Pages/Desalination.aspx\
- http://schools.aucegypt.edu/newsatauc/Pages/story.aspx?eid=1089

Using the above links, as well as your systems maps, critique the following solutions using the Six Thinking Hats ® technique.

White Hat: • *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: • *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: • *What are the potential benefits of these solutions? And why?*
Black Hat: • *What are the potential disadvantages of these solutions? And why?*
Green Hat: • *How can the disadvantages of these solutions be bypassed?* • *Any alternative ideas/recommendations/suggestions/modifications that you can add to the solutions ?*
Blue Hat • *Looking at the big picture, what can we conclude about the solutions ?* • *Any other elements that should be considered when implementing these solutions?*

Worksheet 3: Increasing Water Delivery and Desalination Plants

Examine the links below in your group.

- http://ressources.ciheam.org/om/pdf/b52/05002250.pdf
- http://www.academia.edu/1493592/Urban_Water_Cycles_in_Egypt_Current_situation_and_project_examples.
- https://www.youtube.com/watch?v=kJs3aahOhJE
- https://www.youtube.com/watch?v=y8smq20wNw0

Using the above links, as well as your systems maps, critique the following solutions using the Six Thinking Hats ® technique.

White Hat: ● *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: ● *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: ● *What are the potential benefits of these solutions? And why?*
Black Hat: ● *What are the potential disadvantages of these solutions? And why?*
Green Hat: ● *How can the disadvantages of these solutions be bypassed?* ● *Any alternative ideas/recommendations/suggestions/modifications that you can add to the solutions ?*
Blue Hat ● *Looking at the big picture, what can we conclude about the solutions ?* ● *Any other elements that should be considered when implementing these solutions?*

Worksheet 4: Urban Water Sustainability

Examine the links below in your group.

- http://www.sciencedirect.com/science/article/pii/S0959652610000478
- https://www.researchgate.net/publication/223448217_Towards_sustainability_in_urban_water_A_life_cycle_analysis_of_the_urban_water_system_of_Alexandria_City_Egypt
- http://www.yourhome.gov.au/water/reducing-water-demand
- https://www.youtube.com/watch?v=jOQEZrxaGBc
- https://www.youtube.com/watch?v=gtcZbN0Z08c

Using the above links, as well as your systems maps, critique the following solutions using the Six Thinking Hats ® technique.

White Hat: • *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: • *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: • *What are the potential benefits of these solutions? And why?*
Black Hat: • *What are the potential disadvantages of these solutions? And why?*
Green Hat: • *How can the disadvantages of these solutions be bypassed?* • *Any alternative ideas/recommendations/suggestions/modifications that you can add to the solutions ?*
Blue Hat • *Looking at the big picture, what can we conclude about the solutions ?* • *Any other elements that should be considered when implementing these solutions?*

Worksheet 5: Increasing Efficient Stormwater Use

Examine the links below in your group.

- http://www.academia.edu/1493592/Urban_Water_Cycles_in_Egypt_Current_situation_and_project_examples
- http://www.iwtc.info/2004_pdf/01-5.pdf
- https://www.epa.gov/greeningepa/epa-facility-stormwater-management

Using the above links, as well as your systems maps, critique the following solutions using the Six Thinking Hats ® technique.

White Hat: ● *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: ● *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: ● *What are the potential benefits of these solutions? And why?*
Black Hat: ● *What are the potential disadvantages of these solutions? And why?*
Green Hat: ● *How can the disadvantages of these solutions be bypassed?* ● *Any alternative ideas/recommendations/suggestions/modifications that you can add to the solutions ?*
Blue Hat ● *Looking at the big picture, what can we conclude about the solutions ?* ● *Any other elements that should be considered when implementing these solutions?*