INVESTIGATION - LEARNING MODULE

Sea snots and finding possible solutions

Istanbul, The Marmara Sea, Turkey

A thick, slimy layer of so-called "sea snot" is spreading in Turkey's Sea of Marmara to the south of Istanbul, posing a threat to marine life and the fishing industry. Scientists say climate change and pollution have contributed to the proliferation of the organic matter, also known as marine mucilage, which contains a wide variety of microorganisms and can flourish when nutrient-rich sewage flows into seawater (Ref: Reuters).

Please watch the movie on [Turkey's 'sea snot' problem](#)

Introduction

Pollution is the entrance of harmful materials, called pollutants, into the environment. Pollutants, natural such as volcanic ashes or human-made such as trash, damage the quality of air, water, and land.

Most pollution in our landscapes is anthropogenic, which means human induced. Human activities, including car driving, heating and cooling, production of industrial materials or agriculture, all produce pollution on air, land or water to some degree. This pollution is also a serious threat to other living

organisms, including microorganisms and the largest animals, whose life depends on the quality of Earth's supply of air, land and water.

Pollution is a global problem. While the human dominated places, such as large cities, are polluted directly by human activities, pollution can spread to other places where no people live by means of air and water currents. For example, pesticides and other chemicals that are used in agriculture in rural areas have been found in the Antarctic ice sheet. Microscopic plastic particles have been carried by ocean currents and migrating fish to the middle of the northern Pacific Ocean. Winds can pick up radioactive material or fossil fuel residues far and away and scatter it around the world.

Land and air pollution can be more visible to the human eye, yet the impact of pollution on water landscapes is severe. Water is considered as the source of life; where life begins and proliferates first. But, water is also crucial for the continuation of life on Earth. Scientists estimate that 50-80% of the oxygen production on Earth comes from the ocean. Like animals on land, marine animals depend on oxygen to breathe, and both plants and animals in water use oxygen for cellular respiration. Water and weather, the delicate balance between evaporation and precipitation, is the primary cycle of Earth's climate. Water can absorb large amounts of heat energy before it begins to get hot and releases energy slowly when situations cause it to cool. This helps moderate the Earth's climate and helps organisms regulate their body temperature. Water is a universal solvent and is able to dissolve a large number of different chemical compounds. This feature also enables water to carry solvent nutrients in runoff, infiltration, groundwater flow and living organisms. After all, water covers 75% of the earth's surface.

The changes on water landscapes have drastic effects. For example, climate change manifests itself primarily through changes in the water cycle. As climate changes, droughts, floods, melting glaciers, sea-level rise and storms intensify or alter, often with severe consequences. Considering only 3% of the planet's water is freshwater, and of this, two-thirds is captured in glaciers and polar ice, the Intergovernmental Panel on Climate Change (IPCC) alerted the global community to the great vulnerability of freshwater resources as a result of climate change. Polluted water is a source of harmful chemicals that threatens both marine life and life on land. The fish that are caught in a polluted river often have high levels of chemical toxins in their flesh. People and animals absorb these toxins as they eat the fish.The fish are forced to migrate from their natural habitat due to the invasion of harmful algae. Aquatic creatures are sensitive to changes in temperature. Some fish, for example, can only live in cold water. Warmer river temperatures prevent fish eggs from hatching. Warmer river water also contributes to harmful algal bloom. Chemicals in runoff can create a toxic environment for aquatic life but can also help create a fertile environment for a harmful algal bloom. Harmful algal blooms prevent organisms such as plants and fish from living in the water, creating "dead zones" in the lakes and rivers, places where no other or little life exists below surface water.

One such pollution has been seen in Marmara Sea, which is an inland sea located between and connects the Black Sea to the Aegean Sea. The sea takes its name from Marmara Island, which is rich in sources of marble, from the Greek μάρμᾰρον (mármaron) "marble." Sea snot (the white substance that can be seen on the surface of the water in the cover photo) is spreading over the Marmara Sea as a symptom of marine pollution, and is threatening life both under and above water.

Also called marine mucilage, sea snot is essentially a mass of microorganisms enriched by components of excessive nutrients from untreated waste discharged into the sea. According to scientists, the increase in sea snot is due to the large increase of phosphorus (three to four times higher than previous year) and other excessive nutrients combined with drought conditions and with prolonged warm temperatures and calm weather. Scientists say climate change and pollution have contributed to the proliferation of the organic matter, which contains a wide variety of microorganisms and can flourish when nutrient-rich sewage flows into seawater.

In this investigation, the aim is to understand the impact of pollution on water landscapes by examining different parameters over a timescale.

Research Questions
1. What is the current situation for "Harmful Algae Bloom (HAB)" in the nearest water landscape (sea or river) to your location?
2. What is the current situation for "Chlorophyll-a" in the nearest water landscape to your location?
3. What is the current situation for "Surface temperature" in the nearest water landscape to your location?
4. What could be an action plan for reducing or mitigating the impact of pollution on the water landscape you selected to do research?

The investigation stage can be implemented by following steps:

1) **Planning**
   In Planning, students and teachers design their investigation activities on landscape, for instance they decide what to do, how to do it, when to do it, where to do it.
   According to the topic or issue chosen for investigation, the class will need to identify what kind of actions to undertake in terms of literature review, hands-on research activities, and it will identify the most suitable methods and list the needed materials to gather the necessary information.
   Expert stakeholders from local research centres, universities and local authorities can be contacted as a valuable opportunity to access up-to-date knowledge and to make use of scientific equipment.

2) **Performing**
   In Performing the investigation, the class implements the devised plan, and follows the steps of action along the project timeline. Data collection can regard environmental data during a field trip, a survey on the perceptions and views of the local community, or investigations on historical and artistic documents regarding the landscape of interest. Specific materials, equipment and worksheets can be used, allowing students to approach methods and software of common use in research. Experiments can be performed to understand the reason for certain phenomena.

3) **Data analysis and interpretation**

In Data analysis and interpretation, the collected data are analysed and interpreted in order to understand the extent of the issue (generating new knowledge) and the relations between the factors and variables that are involved in the investigation.

Objectives of the Investigation

To learn about:

- ✔ Current situation for water quality in the sea.
- ✔ Detecting Harmful Algae Bloom (HAB), Chlorophyll-a and surface temperature using UNESCO-IHP IIWQ World Water Quality Portal
- ✔ Possible protection ways to make sea clean and fresh for life

To be able to:

- ✔ Work in groups
- ✔ Exercise online research skills and develop field research and interview skills
- ✔ Develop analytical skills and exercise in teamwork and collaborative techniques
- ✔ Develop skills in using AR and GIS software in order to visualize and communicate spatial information
- ✔ Enhance their awareness and attitudes regarding active citizenship and civic democracy.

HOW TO INVESTIGATE

When: After the Conceptualization Phase (Step 2)
Time estimated: Maximum 5 teaching sessions (at least 1 hours in total), depending on the investigation activities to be implemented
Where the activity takes place: in the classroom, computer lab and outdoors
Method (how the students have to work): group-work

Art activity - in every step of investigation students are invited to produce an artistic product inspired by their investigations: texts, photos, drawing, videos, music or sound, meme (https://en.wikipedia.org/wiki/Meme), patchwork/collage, theatrical performances.

In the classroom, the students are divided into groups. The teacher/facilitator could follow the steps suggested in the table below:

https://www.eomap.com/world-water-quality/about-iiwq-portal/
http://sdg6-hydrology-tep.eu/

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Planning	Remind students that in this investigation, the aim is to understand the impact of pollution on water landscapes by examining different parameters over a timescale, and develop an action plan for reducing or mitigating the impact of pollution on the nearest water landscape to their location. As a preparation for investigation, students first will examine the parameters that are measured to determine the level of the pollution on water landscapes. Worksheet 1 can be used for this investigation. After completing the work, identify the nearest water landscape to the school location and ask students "How would you determine the causes and level of pollution on this water landscape?" Students may begin with formulating hypotheses based on the above exercise and plan a method investigating their hypothesis. Encourage students to use different investigation techniques, i.e. use of satellite images, historical review of the water landscape, field visit, interview with an expert (a planner, landscape architect or local authority official), interview or survey with locals (i.e. their parents, local businesses, etc.). Give the student groups 20 minutes to generate an investigation plan each. In their investigation plan, students need to: ● Decide which parameters they will measure to determine the level of pollution or the causes of the pollution ● Plan how to perform the investigation (techniques, equipment needed, materials). ● Create a timetable where they set the order of the investigation activities. The groups present their investigation plans and reach an agreement for the most reliable and feasible. It could be a combination of the plans presented. The teacher may then offer feedback, proposing alternatives or adjustments to the investigation plan proposed by the students. The feedback should aim at making the plan feasible and concrete in terms of time management, access to proposed resources and availability of the persons to be interviewed/consulted. The outcome should be an investigation plan complete with the activities to be implemented, the timetable for implementing them, the groups/persons responsible for implementing them, the necessary

	equipment and software, and the communication and info sharing arrangements.

Performing	The investigation plan can be implemented on the basis of the following activities:
	✔ Online research: The students may perform an online research regarding the history of the water landscape, the human activities that are related to the water landscape, satellite images, photos or videos that document the change of the water landscape selected through time and level of integration in the city.
	✔ Field visit: The students can visit the water landscape and observe and document the main probable causes for pollution around the water landscape, safely have a sample of the water to examine experimentally for the parameters. Students will collect documentation material, i.e. photos and/or videos, to support their findings. Duration: 45 minutes.
	✔ Survey/ Interview: The students may perform a survey regarding the views of locals (citizens, businesses, visitors) or the experts (a planner, landscape architect or local authority official) on the water landscape selected and ask about the issues associated with the pollution in the water landscape. This activity can be combined with the Field visit activity. Duration: 60 minutes.

Data analysis and interpretation	In the school computer lab or at home, students proceed to the analysis of the data collected and report the main findings. Students may use Worksheet 2 for this stage. The analysis should focus on developing an action plan for reducing or mitigating the pollution in the water landscape. Students may prepare a presentation, an infographic or a poster to present their action plan.

WORKSHEET 1

In this investigation, the aim is to understand the impact of pollution on water landscapes by examining different parameters over a timescale. Please enter http://sdg6-hydrology-tep.eu/ for the map and select a region for investigation.

1- Internet search

Make an internet search (http://sdg6-hydrology-tep.eu/) for the region you selected.Below you can find an example from Germany (Image 1). Please try to understand the geographical region and the properties of the water landscape. You may extend your search to include the dynamics in and around the water landscape, such as in and around water living organisms, water landscape as an economic resource, and the human activities around the water landscape.
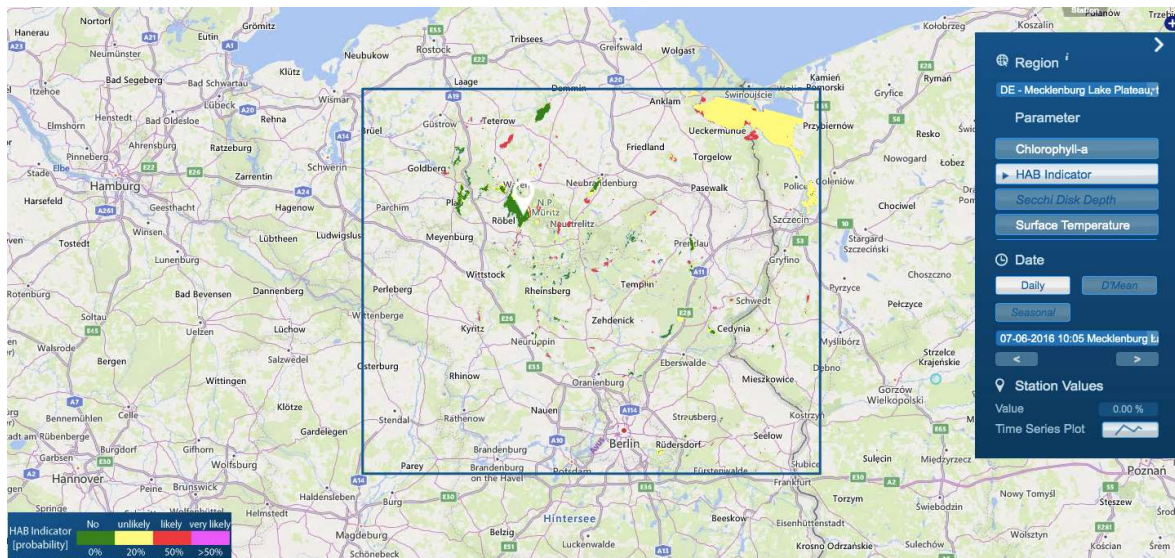

Image 1. HAB Indicator for the selected region in Germany

2- Data collection and analysis

Please select a timescale to see the change in parameters. Record each parameter for the selected time scale to the table below. Please take note of the observed changes in the water landscape for each parameter.

Table 1. The impact of pollution on …. (the name of the water landscape)

Time Span (from ….. to …..)/ Parameters	Time 1 Date: …….	Time 2 Date: …….	Time 3 Date: …….	Time 4 Date: …….	Time 5 Date: …….	Observed changes (color/size/ etc.)

Chlorophyll-a Values:						
HAB Indicator Values:						
Surface Temperature						
Total Suspended Matter						
Turbidity						
Water Storage						

Please select a parameter that shows the most drastic changes and draw a time series plot to see the change on a graph.

Make an interpretation about the relationship between the parameters and polluted water landscape.

WORKSHEET 2

1. Conclusion

In light of the research, investigation and expert/local interview, please write your comments about the impact of pollution on the water landscape.

2. Action plan

Please prepare a digital infographic, poster, or presentation to post and share on social media about the impact of pollution on the water landscape and the action plan you have developed in your group. You can use the free infographic maker websites such as www.canva.com, www.infograpify.com, www.visme.co or create your own template.

Your action plan may include the following:
- The main human activities that do or may cause pollution on the water landscape
- The summary of the findings of your investigation
- The suggestions to reduce or mitigate the pollution in and around the water landscape.

Each group will present the action plan to other groups and comment on others' work.