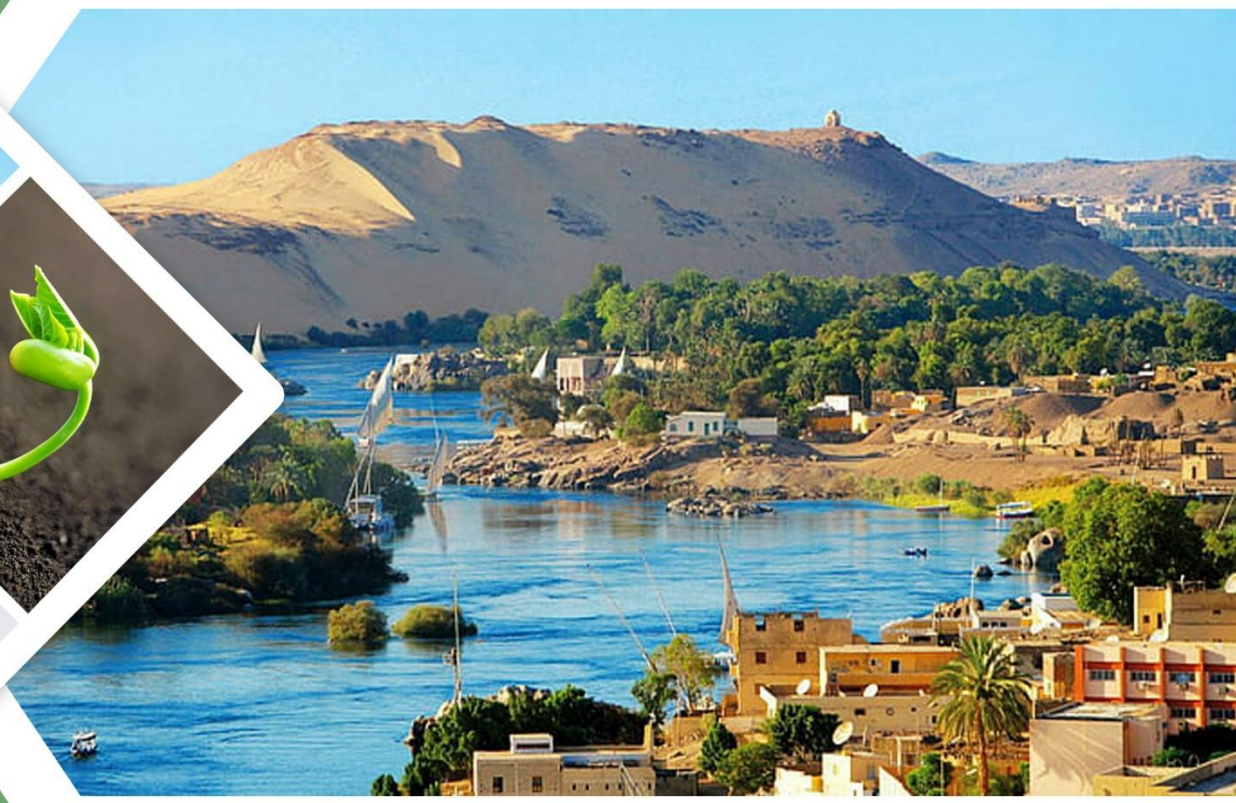
CB3

Report 2021



Education Package for Environmental Sustainability

Pre-university Education

Forward by H.E. Minister of Environment

The educational system with all its components is one of the pillars of achieving the transformation of the green economy, because the formation of personality and awareness is the driving force and capable of bringing about change in the patterns of sustainable production and consumption and creating cadres in all disciplines with values, ethical and scientific foundations that qualify them to protect and efficiently manage the available natural resources through modern technologies and tools based on the minds and national capabilities.

The partnership between the Ministry of Environment and the Ministry of Education and Technical Education in Egypt, especially in the field of environmental work, is extremely important, which the whole world has realized that natural resources and life on planet Earth will not be preserved without paying attention to the role of society, especially young people, so that future generations can deal with that complex and intertwined relationship between human activities and nature.

There are many new terms that have appeared on the scene during the past few years, such as the green economy, climate change and biodiversity, all of which refer to achieving the national goals of sustainable development, taking into account the rights of future generations to natural resources and ensuring the sustainability of their provision of the same environmental services. It is simplified and easy for students to realize the importance of preserving them. It also required the Ministry of Education to develop educational curricula and systems to keep pace with global developments and national challenges through a student who understands these issues and their repercussions and effects on his life and the importance of his role in addressing these issues and the impact of each behavior he follows on the sustainability of life.

I expressed my happiness in producing such educational packages, which will greatly contribute to the development of environmental affiliation in the hearts and minds of new generations, and I would like to thank the Center for the Development of Educational Curricula, which has adopted this topic since its inception.

Her Excellency Dr. Yasmine Fouad

Minister of Environment

Forward by H.E. Minister of Education and Technical Education

The Ministry of Education and Technical Education is constantly striving towards developing education in Egypt and providing distinguished community services in all aspects of the basic education system, including students, teachers, supporting bodies, principals and classes. The ministry also aspires to create an enabling environment for students and teachers that allows them an update about the latest developments in international, regional and national issues and participate in confronting them.

Environmental issues are at the forefront of these issues, especially the problems related to climate change, biodiversity and desertification. Fruitful cooperation with the Ministry of Environment culminating in the production of three educational packages that address the teachers and provide them with basic information, extracurricular activities, community based messages, and illustrations, including videos, articles, and power-point presentations with audio recordings regarding the aforementioned issues.

We hope, through such effort, to achieve the desired goals of boosting awareness of teachers and students about environmental problems and their solutions, and providing information based on comprehension rather than memorizing. We hope that this will be reflected into change in societal behavior towards preserving natural resources, reducing pollution, and working to conserve the nature that God has endowed us with.

With my sincere thanks to everyone who contributed to these outcomes, and my best wishes for a better future for our dear country and our great peoples.

His Excellency Professor Tarek Shawky

Minister of Education and Technical Education

Preface

For the sake of a new generation that has the right to a decent life,
For a new generation having the right to a fair share of the its country's natural resources,
For a new generation having the right to be secured against hunger, poverty, illiteracy and illness,
For the sake of a new generation that has the right to breathe clean air and enjoy a clean environment,
For new generations that will pay dues of coexisting with the thoughtlessness of previous generation,
For raising generations that will adopt the concepts of rational use of the natural resources that God has blessed us with, and
In support for enhancing our level of compliance with multi-lateral environmental agreements,

The Capacity Building Project (CB3) executed by the Ministry of Environment, and supported by the Global Environment Facility (GEF) and the United Nations Development Program (UNDP), presents this effort to enhance the capabilities of our teachers and provide them with further sources of knowledge and basic information regarding environmental issues, especially climate change, conservation of biological diversity, combating desertification and achieving environmental sustainability.

We are pleased to contribute to the efforts to establish environmental awareness and belief within the personality of school students under prospective of green transformation within the Egyptian society.

May God protect our country, and may God bless us all.

Ahmad Wagdy

Prof. of Hydrology, Engineering, CU
Project Manager, CB3

Educational Package
for
Environmental Sustainability

This package is developed by
the Center for Applied Research on the Environment & Sustainability – CARES
at the American University in Cairo as part of the outputs of the project:

"Enhancing National Capacities for Improved Public Participation for Implementing Rio Conventions (CB3)"

funded by the Global Environment Facility (GEF) / United Nations Development Program (UNDP) and implemented by Ministry of Environment

Citation: El-Awamri, Y. [1], Maher, L. [1], Tamer, N. [1], Omara, M. [1], Wagdy, A. [2.3], Saleh, S. [3], Omar, K. [3], and Sayed, A. [3] (2021). Educational Package for Environmental Sustainability. Enhancing National Capacities for Improved Public Participation for Implementing Rio Conventions Project (CB3)". Global Environment Facility (GEF) / United Nations Development Program (UNDP) and Ministry of Environment. Report 202113ES, English version, 196 pp.

[1] the Center for Applied Research on the Environment & Sustainability – CARES
[2] Cairo University, Faculty of Engineering
[3] CB3 Project, Ministry of Environment

Table of Contents

Message #1: Overpopulation & Sustainable Development

1. Design Map:

Activity Code	S.1
Activity Title	Overpopulation: A blessing or a curse?
Activity Type	Debate - Video watching - Group work
Activity Location	Computer Lab / Classroom
Duration	120 Minutes
Optimum no. / grouping	40 Learners / Groups of 5
Prerequisites	None
Short description	Learners will watch a video about overpopulation then reflect on the reasons for overpopulation and its consequences.
Learning outcomes	1. Learners will be able to explore the impact of overpopulation on the quality of life. 2. Learners will link between overpopulation and the lack of a healthy, sustainable, and stable life. 3. Learners will be able to explore the relationship between high population levels and consumption levels.
Skills	Teamwork, communication, negotiation, and critical thinking skills.
Values	Understanding, Responsibility, Self-confidence, Justice, Standing up for the truth, being Pro-active, Collective responsibility, Open mindedness and ability to think logically, Sensitivity to social issues in the community
Keywords	Grade 6-9, Overpopulation, Birth Rates, Consequences, Quality of life.
Necessary Materials	Whiteboard, markers, video material, data Show, charts, copies of why-why-why chain, and the consequences model templates.
Assessment method	Reflection, Evaluation Rubric
Link to MOE's cur.:	Social Studies, developed and developing countries Science, Preventive Health
References	(Why-why-why chain, 2020), (Overpopulation - Definition, Effects, Causes and Solutions | Biology, 2019). Biology Dictionary. 2019. *Overpopulation - Definition, Effects, Causes, and Solutions | Biology*. [online] Available at: <https://biologydictionary.net/overpopulation/>. YouTube. 2019.Overpopulation *& Africa*. [online] Available at: <https://youtu.be/NMo3nZHVrZ4>.

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Onboarding	25 Min.	● Divide the learners into groups of 5. ● Ask the learners to guess the meaning of overpopulation (definitions are placed into bubbles on the whiteboard). ● Ask a question to lead to the video topic "is overpopulation good or bad for us and our country?". The definition can be found in annex S.1.1.	Whiteboard and markers. "Annex S.1.1"
Explore the relationship between high population levels and consumption levels	8 min.	● Learners watch the video on the data show. ● Recap after the video using the Background information for post video discussion at annex S.1.1 ● Ask the learners if they are with or against controlling birth rates and find solutions to limit overpopulation growth? "Don't force them towards a certain answer. Encourage them to express their opinions and challenge others if they have different one in a progressive discussion"	Video in annex S.1.1 & data show.
Explore the impact of overpopulation on the quality of life	30 min.	● Use the why why why chain to identify the reasons behind overpopulation in Africa. "The why why why template can be found in annex S.1.2."	why why why chain template and guide "annex S.1.2."
Assessment of learning	50 min.	● Ask learners to brainstorm effective campaigns to raise awareness of the dangers of overpopulation and its impact on people, the whole country, and the environment. ● Learners work in groups to come up with campaigns and present it to the class.	Paper and pen
Final reflection & closing note	7 min.	● Learners are encouraged to share their thoughts and opinions. ● Teacher refers to further learning resources they can go over at home as seen in annex S.1.3	annex S.1.3

3. Assessment
   - Ask learners to brainstorm an awareness campaign idea in groups.
   - Give each group 5 minutes to present their idea.
   - Ask the class then to anonymously vote for the best idea.
   - Encourage learners to combine ideas and develop them further.
   - Ask follow-up questions to assess learning using the below rubric for grading.
   - Evaluate learners per group, individuals will get the same grade as their group.
   - The activity grade will be out of 20 points.

Criteria	**Advanced (5)**	**Developed (4)**	**Limited (3)**
Presentation	Clear, detailed, and well-delivered presentation	Missing 1-2 details but was clear and well delivered	Presentation missing more than a few details and the delivery was mediocre
Teamwork	The whole team collaborated on the idea	1-2 people were not involved and were silent observers	The team was not fully able to collaborate, but they delivered the work nonetheless
Time Frame	Was able to deliver the presentation within the 5 minutes	Delivered the presentation but went overtime by 1-2 minutes	Learners were unable to manage their time or sequence of presenting
Innovation	Came up with an innovative campaign that can be implemented	Came up with an innovative idea but needs a lot of work to be implemented	Used an existing idea without tweaking it or trying to get creative

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

Learners are encouraged to read more on overpopulation and its impact and look into volunteering in awareness campaigns in Egypt. They are also directed to some websites and resources that may be useful to learn more about overpopulation. These resources can be found in annex S.1.3.

5. Possible adaptation

This message can be easily adapted to accommodate younger and older ages.

Older age groups: would require a more detailed campaign and a template for campaign designing. The rubric of grading for older ages will also be more detailed accordingly.

Younger age groups: The message can be delivered to younger age groups by presenting role-play scenarios where the learners represent the people in a country and the piece of land in different areas in the classroom. They can see the effects of having a large number of people in a small space, and they are given roles like in a play. They are instructed to do whatever they see fit to feel comfortable and survive. They are given limited resources as well to see how they will be able to use them. Will they choose themselves? Fight over resources? Collaborate to preserve and increase the resources somehow?

Annex “Teacher’s Background Information”

S.1.1. Overpopulation:

- Definition of overpopulation:
  Overpopulation refers to a population that exceeds its sustainable size within a particular environment or habitat. Overpopulation results from an increased birth rate, decreased death rate, immigration to a new ecological niche with fewer predators, or a sudden decline in available resources. Therefore, overpopulation describes a situation in which a population in a given ecosystem limit the resources available for survival.
  Source:
  Biology Dictionary. 2019. *Overpopulation - Definition, Effects, Causes, and Solutions | Biology*. [online] Available at: <https://biologydictionary.net/overpopulation/>.

- Possible questions for onboarding:
  - How many of you know the number of brothers and sisters your grandparents had? “Expected: 6-8 siblings”
  - How many brothers and sisters your parents have? “Expected 3-6 siblings”
  - How many brothers and sisters you personally have? “Expected 2-4 siblings”
  - So do you think generations are having more or less children as time passes by?
  - Why do you think this is so?
  - What does population growth mean? “Might be mass migration- overcrowded slums – diseases and pollution- chaos and violence over energy, water and food”
  - Is population growth a good thing or a bad thing?

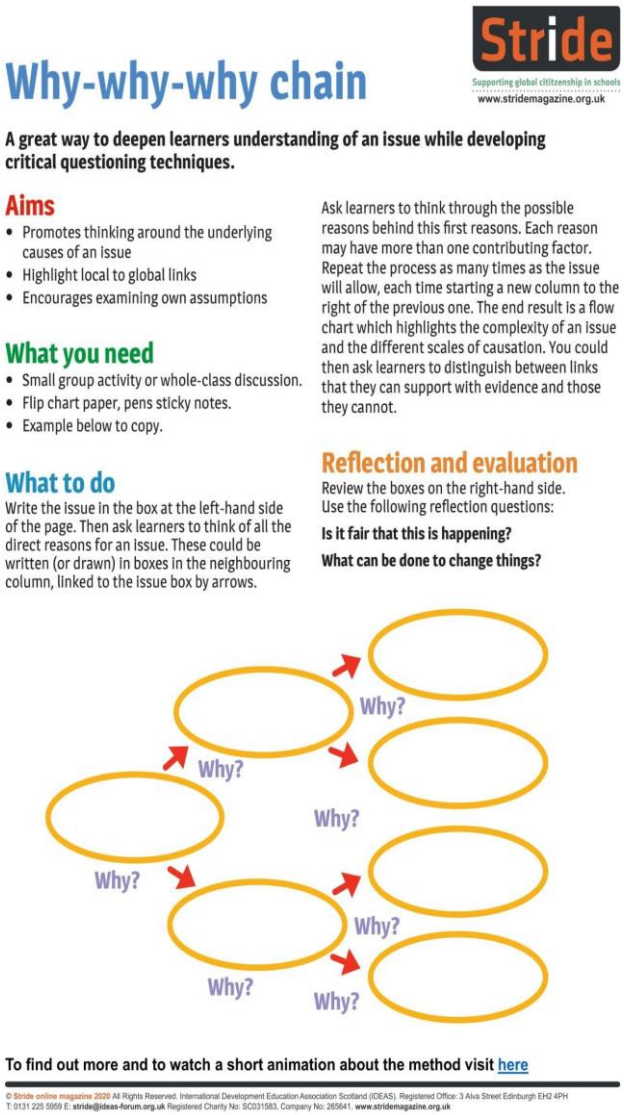
- Link to video on overpopulation:
  Youtube. 2019. *Overpopulation & Africa*. [online] Available at: <https://youtu.be/NMo3nZHVrZ4>.

  Background information for post video discussion:

  more and more countries went through the four stages. First, many births and many deaths due to bad living conditions. Second, better living conditions leading to fewer deaths and a population explosion. Third, fewer deaths resulting in fewer births, and population growth came to an end. But if birth rates have dropped so much, why is the population still growing so fast? Well, the children born in the population explosion of the 70s and 80s are having kids themselves now. Leading to a noticeable spike in overall population. But they are having far fewer children on average than their parents. The average today is 2.5, it was 5, 40 years ago. So as this generation gets older, and fertility declines further, the rate of population growth will keep on slowing. This is true for every country. In the west, we tend to overlook progress in other regions of the world. But actually, most of the world's countries have made it to the fourth stage. Just look at Bangladesh. In 1971, the average woman had 7 kids, but 25% of them would die before the age of 5. In 2015, the mortality rate was down to 3.8% and women had only 2.2 kids on average. This is the rule, not an exception, we're not special, we just had a head start. It took developed countries about 80 years to reduce fertility from more than 6 children, to less than 3. Others are catching up fast. Malaysia and South Africa did it in only 34 years; Bangladesh took just 20. Iran managed it in 10 years. All these countries that are catching up didn't have to start from scratch and the more support they get, the faster they catch up. This is why programs that help lower child mortality or help poor nations develop, are so important, no matter what your motivation is, whether you dream of a world where all people live in freedom and wealth, or you just want fewer refugees coming into your country, The simple truth is, that it's beneficial to you personally if people on the other side of the globe can live a good life. And we are getting there, the percentage of people living in extreme poverty has never been as low as today. So, the future of global population growth

is not an apocalyptic prophecy, it's a promise! Population growth will come to an end. The UN forecasts that the 12th billionth human will never be born at all. And as the development level of the world rises, the number of people a higher education will increase tenfold. Countries who used to be a need, will help advance development instead. More people are going to mean more people able to advance our species.

S.1.2. Why why why activity template and guidelines:



Why-why-why chain

Stride
Supporting global cititzenship in schools
www.stridemagazine.org.uk

A great way to deepen learners understanding of an issue while developing critical questioning techniques.

Aims

- Promotes thinking around the underlying causes of an issue
- Highlight local to global links
- Encourages examining own assumptions

What you need

- Small group activity or whole-class discussion.
- Flip chart paper, pens sticky notes.
- Example below to copy.

What to do

Write the issue in the box at the left-hand side of the page. Then ask learners to think of all the direct reasons for an issue. These could be written (or drawn) in boxes in the neighbouring column, linked to the issue box by arrows.

Ask learners to think through the possible reasons behind this first reasons. Each reason may have more than one contributing factor. Repeat the process as many times as the issue will allow, each time starting a new column to the right of the previous one. The end result is a flow chart which highlights the complexity of an issue and the different scales of causation. You could then ask learners to distinguish between links that they can support with evidence and those they cannot.

Reflection and evaluation

Review the boxes on the right-hand side. Use the following reflection questions:

Is it fair that this is happening?

What can be done to change things?

To find out more and to watch a short animation about the method visit here

2020. *Why-why-why chain*. [PDF] Edinburgh: Stride online magazine, p.1. Available at: <http://www.stridemagazine.org.uk/images/winter-2020/activity-why-why-why.pdf>
https://wosdec.org.uk/methodologies/why-why-why-chains/

S.1.3. Useful resources:

Volunteering in Egypt: http://www.oneworld365.org/volunteer/egypt

Overpopulation - The human explosion explained

صندوق الأمم المتحدة للسكان

Counter argument: Overpopulation is not the problem it once was

Message #2: Sustainable Development Vs. Economic Development

1. Design Map:

Activity Code	S.2
Activity Title	Mindful Economy
Activity Type	Group project
Activity Location	School yard, Outdoors
Duration	290 Min / divided on 2 days
Optimum no. / grouping	40 Learners / Groups of 5
Prerequisites	None
Short description	Learners will be divided into groups to work in a small business project then they will evaluate how successful their project was not just economically but also in terms of the environmental and social impact
Learning outcomes	1. Learners differentiate between economic development and sustainable development. 2. Learners understand the direct effects of focusing only on the economy with no regard to the environment and society.
Skills	Leadership, Interpersonal, Communication, Creative Thinking, Team Work, Problem Solving
Values	Empathy, Responsibility, Self-confidence, admitting one's mistake, Adherence to time, Responsibility, Trustworthiness, Collective responsibility, Helping one another, Open mindedness and ability to think logically, Sensitivity to social issues in the community
Keywords	#Grades: 6 to 9, Sustainable development, GDP
Necessary Materials	Seed funding envelopes, ecodesign cards “see annex 1.2.2”, Internet access
Assessment method	Observation, Oral discussion, Self-assessment
Link to MOE’s cur.:	Social science, economy
References	14ideas. (2017, April 1). Every Business Should Be a Sustainable Business. Medium. https://medium.com/@14ideas/every-business-should-be-a-sustainable-business-48ccf91ae386. YouTube. (2015). Macroeconomics: Crash Course Economics #5. YouTube. https://www.youtube.com/watch?v=d8uTB5XorBw. Haanaes, K. (2018, August 16). Why all businesses must embrace sustainability and lead the way. IMD business school. https://www.imd.org/research-knowledge/articles/why-all-businesses-should-embrace-sustainability/. YouTube. (2016). Little Green Bags: True Business Sustainability. YouTube. https://www.youtube.com/watch?v=AEFqUh4PMmI. SwitchMed. (n.d.). SwitchMed. https://2014-2019.switchmed.eu/en/corners/start-up/Porlets/training-materials.html.

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Onboarding	"Day 1" 70 Min.	● Divide the learners into groups of 5 ● Ask the learners to search for the meaning of GDP and how to measure it. ● Ask each group of the learners to do a quick 3 minutes demonstration about GDP and how to measure it "they can present, act or use any tool during the demonstration" ● Lead a discussion about the GDP. "See annex S.2.1"	Internet access / computer devices
Experience starting a business	"Day 1" 150 Min	● Give each group an envelope with a seed funding of 100 EGP ● Instruct the learners to use this 100 EGP to start a business project and make as much money as possible within 24 Hrs. by providing a product or service that counts towards GDP. They will have one day only to do their project. ● Inform the learners that they will be competing to achieve the highest profit. However, this will not be the only criteria and the other factors won't be announced to them at this stage. ● The learners can do the business project activity in the school yard during the school break, during school event or outdoors.	Seed funding envelopes
Evaluating business sustainability	"Day 2" 30 Min	● After the activity, check the progress of each team. Write each team name, revenue and profit on the board. Learners must return the seed fund and keep the profit for themselves ● Give each group of learners eco design cards "see annex S.2.2" and ask them to answer the questions mentioned based on their business and give 1 grade for each yes.	eco-design cards "annex 1.2.2"
Reflect on how sustainability can make the business flourish	"Day 2" 20 Min	● Lead a discussion about why economic growth is not enough. "See annex 1.2.3"	"Annex 1.2.3"
Assessment of learning	"Day 2" 20 Min	● Ask every student to share an idea that can make the business more sustainable "more conscious for environmental and social aspects"	Non

3. Assessment

- Assess learners' demonstration and interactions in the activities
- Ask every student to share an idea that can make the business more sustainable "more conscious for environmental and social aspects"
- Ask follow-up questions that challenge their understanding.
- Self-assessment using the eco-design cards

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

Create a list of simple sustainable economic activities that learners can do at home while creating a positive environmental and social impact as well. The economic activities should capitalize on adding value or solving a problem, saving resources and creating revenue. Then ask each student to choose one of the activities to do at home. You might create a social media group “i.e., WhatsApp” where learners can share their experience, progress, challenges and what worked well while doing the sustainable economic activity of their choice.

Example for the economic activities:

- ecommerce platform on social media
- Handicrafts
- Services “Accessibility, pet keeping, commission-based services, etc.”
- Art and media “photography, drawing, editing, etc.”
- Programming
- etc.

5. Possible adaptation

This activity can be done without giving the learners seed fund at all. This will be challenging. However, it will foster their innovation and creativity. For younger learners you can hold a business day at school with coordination with the school administration. Where the learners in their teams do a business project and sell to their peers. This way it will be much easier and safer to reach potential customers.

Annex “Teacher’s Background Information”

1.2.1. What is GDP?

The most important measure of an economy is Gross Domestic Product or GDP. GDP is the value of all final goods and services produced within a country's border in a specific period of time, usually a year. Now there are some details worth mentioning. GDP doesn't include every transaction that's in the economy. For example, if you buy a used domestic car, it doesn't count towards GDP because nothing new was produced. Now that same logic applies to buying financial assets like stocks, or when one company buys another company, for example when Google bought YouTube. Those don't count towards GDP because no new goods or services were produced. Also, GDP often doesn't include illegal activity, since drug dealers don't usually report their sales to the government, or non-traditional economic activity like household production. For example, if a plumber charges someone $100 to fix their hot water heater, that counts towards GDP, when he fixes his own water heater, that doesn't count towards GDP. GDP is measured in dollars, not in the raw number of things produced. If we analyzed just the raw number, then a country that produced five million thumbtacks would look like they're doing just as well as a country that produced five million cars, but there's also a problem with using the dollar only as a reference. However, learners can work on their own later to investigate that.

Source: Macroeconomics: Crash Course Economics #5

1.2.2. Eco-Design Cards

Location of Sources: 1. Are all the materials I need common & easy to find in my region?
Recycled content and recyclability: 1. Is my product completely made of recycled content? 2. Is my product made of fully recyclable materials?
Renewability and composability 1. Does my product use compostable or biodegradable organic materials? 2. Did I choose a renewable* organic material? (*the extraction speed of the material is much slower than nature needs for regenerating it) 3. Farming, harvesting and treatment is performed with no toxics, banned or unknown chemicals. Is this statement true?
Energy management 1. ‘Most of the energy (at least 75%) needed come from renewable sources’ is this statement true? 2. Do I estimate the energy consumption per manufactured unit? 3. ‘I cannot further improve the efficiency of my production system, I’m already using the latest technology’. Is this statement true?
Water management

1. Do I estimate the water consumption per manufactured unit? 2. 'I am sure that there are no uncontrolled flows or leaks along the processes. Is this statement true? 3. 'My water supply and discharge is not damaging or changing the local environment'. Is this statement true?
Waste management 1. 'My production is not generating waste and most of my product is reused and refurbished inside the workshop'. Is this statement true? 2. I cannot reduce further waste generation, and waste is managed by an authorized organization within regulations, is that true? 3. 'I promoted a quality management policy that has reduced at the minimum discarded products and unconformities. Is this statement true?
Processes & technology 1. 'I cannot further minimize the number of steps in the production' is this statement true? 2. Have I chosen to use an easy to repair, maintain and use safe process technology? 3. 'I adapt the production to the market demand, avoiding large stocks of products' is this statement true?
Package materials 1. 'I choose a renewable material for one-use packaging applications' is this statement true or I choose a resistant, highly recyclable material for multiple uses and returnable systems. Is this statement true? 2. 'In any case, I cannot make the packaging simpler, with fewer elements, fewer materials types' is this statement true? 3. 'In any case, I cannot make the packaging lighter' is this statement true?
Means of transport 1. 'To receive the raw materials and distribute the product, I use mostly human power (foot & bikes), transoceanic ships or electric vehicles' is this statement true? 2. Do I choose mostly very new efficient vehicles, big trucks (40ton) or scooters to deliver my product? 3. Do I take advantage of the return-journeys to transport other things?

Source: ecodesign cards are retrieved from The Workbook for Green Entrepreneurs in the Mediterranean by Switchmed

1.2.3. Why isn't economic growth enough?

Our planet isn't in good shape. Currently we are using the resources of one and a half planets. Make that two and a half if everyone was living by European standards, for if we were all Americans and even worse. Studies conclude that we've crossed several of nine planetary boundaries that are necessary for a safe and sustainable life.

We want to ask how companies and corporations can foster sustainable development. What is true business sustainability that helps overcome society's long-term problems. Business and sustainability don't go together; yep, that's what the traditional economic paradigm preaches the business of business is business. The American economist Milton Friedman once said only economic concerns like turnover profit, market share or shareholder value matter. Societal or ecological concerns mustn't distract private companies, that's what the

government is for. We call this approach business sustainability zero point O. Jack Welch was a prominent advocate of this traditional model as CEO of General Electric he measured everything in terms of shareholder value. Neutron jack laid off tens of thousands of employees and was widely admired and celebrated for his economic success. So, how does sustainability enter the world of business? What role does it play there? In the first phase of business sustainability, companies react to social and ecological concerns. Economic objectives however remain the only priority. They just recognized that sustainability management may help them save costs, reduce risks, improve their attractiveness as an employer and differentiate themselves from their nasty competitors. Sustainability management is all about managing the chances and risks that stem from economic, ecological and social chances issues and yes that's where most companies are today on the level of business sustainability. One point out also called a refined shareholder value management sustainability as a means to an end. The end being economic success. A good example for this is Walmart, the world's largest retailer. Its sustainability strategy focuses on reducing things, energy, water, packaging materials and transport routes. Which fits perfectly well into Walmart strategy everyday low prices. In the second phase of sustainability management, companies rethink their one-sided goal of profit maximization and pursue a triple bottom line approach. Value creation now goes beyond shareholders. Business is not only about economics, but also about environmental and social goals, in order to achieve these goals, organizations implement sustainability strategies and plans using sustainability management systems and proper reporting. This is business sustainability. To point out, the organization embeds the triple bottom line in its structure and defines and implements responsibilities and programs, accordingly, for example in 2010 Unilever a fast-moving consumer goods giant launched its sustainable living plan. Its ambitious goals for 2020 include doubling of sales while cutting its environmental footprint in half and improving living conditions of millions of people along its supply chains.

Time for a quick recap. There are three levels of business sustainability: traditional management does not include social and economic sustainability, it's all about the shareholders in business sustainability, 1.0 social and environmental concerns are means to an end. Business sustainability 2.0 takes it up a notch by assuming a triple bottom line that includes not only economic but also environmental and social goals. All three approaches share an inside-out view on how companies can avoid negative side effects. Of course, this is important, yet, it doesn't go far enough. True business sustainability 3.0 isn't about reducing negative effects, but about creating positive ones. It is about active contributions to the world sustainability problems, which requires shifting from inside out to outside in thinking. First, look at the challenges out there and then start addressing them using your own resources. Particularly, startups and social businesses see these challenges as opportunities. They address societal and ecological issues without forgetting that at some point they have to become profitable and self-sufficient among the bigger and more established companies. Only a few companies have renewed their business models by shifting from inside out to outside in thinking. one example is SV group, a provider of catering services for companies in Switzerland. Together with a worldwide fund it has recently launched “one two we”, a new food program that helps clients provide healthy food to their employees and reduce their carbon footprint at the same time. With this program SV group directly addresses the sustainability issue climate change by making it an integral part of its offering. A second example is IKEA, a Swedish furniture giant through its foundation and in collaboration with the United Nations High Commissioner for Refugees, it has developed an emergency refugee shelter that costs only one thousand euros per piece, weighs one hundred kilograms, and provides shelter for five people on 17.5 square meters. It is foldable, easy to transport, and already in use in Iraq, Ethiopia, Syria, and parts of Europe. The challenges society faces are manifold and span across many fields; nutrition, energy, mobility, economy, and agriculture. To name a few, solution driven approaches not only require different business models, but also new forms of collaboration. Collaboration within supply chains across industries, between private, public and non-governmental actors, ultimately transforming the rules of the game. It may come as a surprise but true business sustainability isn't such a new idea. Management guru Peter Drucker pointed out every single social and global issue of our day is a business opportunity in disguise. Let's have a look at history corporations like Nestle or Unilever. Only came into existence because their founders set out to address pressing societal

matters, such as infant mortality in Switzerland and hygienic problems in Victorian England. Which is why returning to the original purpose of business wouldn't hurt. We must directly link the sustainability goals of companies with the sustainability challenges of the world then we'll be talking about true business sustainability.

Written by Thomas Dyllick, Professor of Sustainability Management at the University of St.Gallen

Source: Little Green Bags: True Business Sustainability

1.2.4. Useful links

- Every Business Should Be a Sustainable Business
- Little Green Bags: True Business Sustainability
- Why all businesses should embrace sustainability
- Tina Seelig: Classroom Experiments in Entrepreneurship
- Macroeconomics: Crash Course Economics #5

Message #3: Unlimited Needs, Limited Resources/ Green Economy, Circular Economy

1. Design Map:

Activity Code	S.3
Activity Title	Sustaining Life
Activity Type	Game, Group discussion
Activity Location	Classroom / School yard / Outdoor
Duration	75 Min
Optimum no. / grouping	40 Learners / Groups of 8
Prerequisites	None
Short description	Learners engage in a game where different groups, at staggered times, have to find a set number of 'resources' "sticky dot yellow labels" in different locations around the classroom or School yard. The task becomes more challenging for each group as there are less and less resources to find. This game portrays how unsustainable use of resources results in its depletion and thus we should be conscious about the impact of our actions on the world. Also highlighting the circular economy as a powerful intervention for sustainability.
Learning Outcomes	1. Learners explore how unsustainable behavior could impact the availability of resources in the world now and in the future. 2. Learners develop an understanding of concepts such as green and circular economies
Skills	Interpersonal, Intrapersonal, Communication, Critical Thinking, Team Work, Problem Solving
Values	Compassion, Generosity, Respect for others, Respect for individual rights, Adherence to time, Value self-respect, Just, Freedom within the law, Responsibility, Collective responsibility, Gratefulness, Open mindedness and ability to think logically, Sensitivity to social issues in the community
Keywords	#Grades: 6 to 9, Sustainable Development, Resources, Circular economy, Green economy
Necessary Materials	Data show, 80 sticky dot yellow labels "See annex S.3.1", Papers, Pens
Assessment method	Observation, Oral Discussion, Group Work
Link to MOE's cur.:	Subjects: Arabic, religion and social science, Topics: Environment protection
References	Ludwig, V. (2021, March 5). How can an individual contribute to a circular economy? - EPALE - European Commission. EPALE. https://epale.ec.europa.eu/en/blog/wie-kann-jede-und-jeder-zu-einer-kreislaufwirtschaft-beitragen. Jones, K. (2021, February 10). Why the Circular Economy is Important to Everyone. Medium. https://medium.com/climate-conscious/why-the-circular-economy-is-important-to-everyone-1e18664ab0e3. YouTube. (2018). What is the circular economy? | Cnbc Explains. YouTube. https://www.youtube.com/watch?v=__0Spwj8DkM.

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Activity Setup	10 Min	● Prior to the lesson, prepare 80 sticky dot yellow labels "See annex S.3.1". These dot labels represent resources, which can be energy, water, food products, land availability, etc. ● Before the learners arrive at the activity location, place these objects in different locations throughout the room "or at the area where the lesson is taking place". Try to ensure that some of them are not immediately obvious to the learners with some being in obscure places, i.e., on top of blackboard, under chairs, on windowsill, on the door frame and so on.	80 sticky dot yellow labels
Onboarding	10 Min	● Engage the learners by telling them they will participate in a challenging activity and will reflect upon later. ● Divide the learners into groups of 8. Each group is given a number, i.e., group 1, group 2, etc.	None
Experiencing unconscious consumption	10 Min	● Inform the learners that there are objects hidden around the classroom and show them sample of the object "sticky dot yellow label" ● Tell learners that each group will be called on by number. When the group is called, they will have 20 seconds to collect as many objects as possible. ● Start to call the 1st group and give them 20 seconds to collect the objects then ask them to return to their places and keep the objects. ● Do the same with all the groups consecutively ● Ask each group to count the number of objects they have collected and write these numbers on a board if possible. Obviously the first few groups should have the highest number and the number collected by each subsequent group should decrease.	Small box for each group to keep their yellow label gathering
Reflect on how unsustainable behavior could impact the availability of resources in the world now and in the future	15 Min	● Lead a discussion and ask learners to consider the following questions in their groups: ▪ What could the objects used in this game represent in the world? ▪ Why did it become more difficult to find the objects as the activity progressed?	see possible answers "annex S.3.2"

		▪ If we added another 5 groups. Would they find objects “resources” left? ▪ Do you have an idea who group 1 represents, who group 2 represents, etc.? ▪ What does this activity portray in relation to the use of resources by each generation? ▪ How the game could have been changed to be fair for all groups. ▪ Ask learners to suggest ways in which this theory could be applied to our world today	
Interpret the positive impact of circular economy and illustrate how can products	30 Min	● Tell the learners that one of the ways to preserve the resources is by moving from liner economy to circular economy. ● Let the learners know that they will work on their groups to come up with an example for a product life cycle that applies the philosophy of circular economy. But first they will watch a video explaining what a circular economy is. ● Lead a discussion to make sure that all the learners understand the meaning and importance of circular economy ● Ask the learners to start working on group to imagine and draw an illustration for a product life cycle of their choice in a circular economy ● Let each group draw and illustrate the product life cycle on the board and illustrate it to the class	Video “annex S.3.3”

3. Assessment

- Assess learners' responses to the group task and discussion where they explore the impact of unsustainable behavior on the world.
- Assess learners' contributions to the discussion on sustainable development, whether they can provide an explanation for what is meant by circular economy after watching the video and reflecting on the activity.
- Observe the level of communication skills shown by learners during the activity, i.e., do they engage in the class discussion, do they listen to each other.

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

Inspire learners to contribute to circular economy by:

- Consume less, like using cloth bags when shopping, choose products that will last or can be repaired, buy only what you really need and be creative with reusing products
- Consume better, like choosing versions of products that have been produced in more sustainable ways or that can be recycled. It can also mean changing what we consume, for instance avoiding purchasing altogether and shifting to circular models such as sharing platforms like carpooling.

Note: A good approach is to brainstorm ideas with the learners to contribute to the circular economy then together agree on one action that you will be doing for the upcoming month to build a habit. You can also follow up weekly with the group or use a scoreboard for motivation. The scoring can be each learner log one point for each day of doing the determined action and share the sum of the group score weekly.

5. Possible adaptation

This activity can be executed in class or outdoors. In the case of holding outdoor activities, watching a video before the discussion can be replaced by reading an article about circular economy. Also, make sure when playing the video to activate the subtitles, increase the font size to make it large enough for everyone.

Annex “Teacher’s Background Information”

S.3.1. Example for sticky dot yellow labels

Diameter ~ 1 cm

S.3.2. Possible Answers:

- What could the objects used in this game represent in the world?
  Possible answer: These objects could represent the resources we have in the world. This could be the forms of energy, the availability of freshwater, the sources of food we can use, the area of inhabitable land
- Why did it become more difficult to find the objects/resources as the activity progressed?
  Possible answer: The first group had more objects/resources to choose from. The number of objects was higher and the objects/resources were more available to the first few groups. As the game progressed, the earlier groups took as many objects as they could which made it more difficult for the remaining groups to get as many objects as there were fewer objects left for other groups. This is unsustainable as eventually the number of resources ran out which meant that the last group had none or very few objects.
- Who could group 1 represent, who group 2 represents, etc.?
  Group 1 represents the people of today (or previous generations), group 2 represents the next generation (our children), group 3 represents the generation after that (our grandchildren) and so on.
- What does the activity portray in relation to the use of these resources by each generation?
  Possible answer: The activity shows the difficulties that would be created if the current generation uses the resources we currently have in any way that they want and without thinking about the next generation. If the current generation uses the resources (water, food, energy, land etc.) without thinking of how they can make them last, there will be fewer of such resources for future generations. This means that aspects of life could be more difficult for future generations i.e., the availability of fresh water to the world’s population could become even more difficult than it is now.

S.3.3. Video: What is the circular economy? | CNBC Explains

S.3.4. Circular economy:

The circular economy is primarily focused on systemic change: tackling problems of overuse and waste at the source, instead of at the end of life. The agents for these changes are: governments (to set the rules and frameworks), industry (to implement the changes), and academia (to test new ideas and evaluate progress). However, I’m a big believer of the idea that the circular economy also has a lot to offer individuals: you, me and everyone else. Circularity can help guide us in the things we buy, how we use them, and how we dispose of them.

- What is the Circular Economy?
  First, a definition. The Circular Economy is most commonly defined with three principles:
  - Keep products and materials in use;
  - Design out waste and pollution; and
  - Regenerate natural systems.

  In the following sections, for each of the circular principles, I’ll explain why they are important to each of us and how we can use them to live more sustainably and help our planet.
  Where the circular economy is about re-designing systems and businesses, think about this approach as re-designing our lives to use things better, create less waste, and help the environment.

- Keep Products and Materials in Use
  What’s it Mean?

One of the key ways we can reform our throwaway society is to use things for as long as possible. For manufacturers, that means using more durable materials, designing easily repairable items, and designing components so they can be reused or repurposed.

How can WE apply it?

We can use this principle to inform our purchasing decisions: from clothing to kitchenware, from electronics to gardening equipment. Prince Charles' mantra is "buy once, buy well", and it's something we could all do to remember. We used to buy stuff that lasted, and look after it, but we've lost sight of that in recent times. We used to value our possessions. We should be willing, where we can afford it, to pay more for something that is well made and that will last. We must ask ourselves if an item can be repaired if it breaks or if the components degrade.

Look at the companies we buy from. Do they operate from circular principles? It is not always easy to find out, but we can look for their policies on repair and refurbishment. Ask what their position is and also how they are ensuring their products last a long time.

Are there alternatives to our regular purchases that make more responsible use of resources? Our local zero waste shop can be a great place to start for this and to help us avoid single-use items.

Make use of local community services. Two that are particularly relevant to the circular economy are libraries of things and repair shops. A library of things is a place where we can borrow household or garden appliances. Staff at the libraries can often provide knowledgeable instruction and advice.

Repair shops are increasingly common; they give us a way to extend our product lives. They also can serve as valuable community hubs, giving vulnerable or lonely people a place to meet, exchange skills and learn.

Key questions to ask:

Some of the key questions to ask ourselves when looking to apply this principle are:

- Will this material or product last?
- Can this product be repaired?
- Can I borrow or rent this item instead of buying it?
- Does this company have a circular philosophy?

- Design Out Waste and Pollution

  What's it mean?

  Everything we throw away has to be replaced. The mining or farming of new materials and subsequent fabrication into products is energy-intensive.

  Recycling isn't much better. It's difficult to create material of "as new" quality from old materials, as well as being energy-intensive. Though it's become an easy way for companies to demonstrate their environmental credentials, it's better to reduce or avoid recycling altogether.

  In industrial terms, we want to minimize the energy we use, and so opt for lower-energy processes such as reuse, refurbishment and remanufacture. We also want to minimize the harmful byproducts and emissions associated with extraction and manufacture.

  How can WE apply it?

  When we dispose of something, we must try to save that item from the waste bin or the recycling. The best thing we can do is not create the waste in the first place. The key thing to remember is that, because of the energy requirements, recycling should always be the last resort.

  We should strive for multiple-use. It's important to note that it isn't only plastic items that can be single-use. Everything that goes in one of those bins is single-use, whether it is ultimately recycled, land-filled, or incinerated. Aluminum foil, cardboard, glass, etc. — we need to manage it all.

  Consider the mantra: Everything saved from the bin is a win.

  Whilst on the topic of single-use: we should avoid fast fashion. Never buy something just for one wear. Buy adaptable and versatile clothing that will last. Buy clothing made from natural materials rather than synthetic ones. Synthetic materials break down and shed plastic fibers that end up in our environment.

We must think about reducing the pollution we create, from plastic fibers, yes, but also the emissions associated with the products we buy: those associated with extraction and manufacture, but also, crucially, transportation. If in doubt, it's always better to buy local, and pre-owned, refurbished or up-cycled.

Make fewer journeys by car and replace them where possible with more sustainable alternatives (public transport, walk or cycle). Fly less, if not at all.

Key questions to ask:

- Can this item be reused or repurposed?
- Can I avoid disposing of this item?
- Can I get this product from a local source?
- Will I use this more than once?

- Regenerate Natural Systems

  What it means:

  Minimizing the harm done to the natural environment is not enough; we must aim to maintain and even improve it. For businesses, this means offsetting the damage they cause and using byproducts in creative ways to help restore natural environments.

  How can WE apply it?

  We need to stop and think before destroying anything in the natural environment. If our purpose is to maximize the good, we do, then to minimize the bad we do seems like an obvious place to start. Whether a regular task or a one-off, we must ask if there's an alternative to clearing, trimming or mowing.

  If we have land, we can consider giving some of it back to nature. Let the grass grow as it will, or plant wildflowers. If we haven't got land, we can do the same on a small scale with a window box or flower pots.

  Use leftover food scraps to feed the birds or other local wildlife. This can be particularly important to make up for winter shortfalls caused by loss of habitats.

  Finally, we can look to our local communities. Are there initiatives that we can support or help to improve, such as nature gardens or wildlife areas? If not, can we set one up?

  Key questions to ask:

  - Does this action harm or help the environment?
  - Can I help this environment grow and thrive?
  - What does this ecosystem need from me?

  Source: Why the Circular Economy is Important to Everyone

S.2.5. Useful links

- How can an individual contribute to a circular economy?
- Why the Circular Economy is Important to Everyone?

Message #4: Water Scarcity & Virtual Water

1. Design Map:

Activity Code	W.4
Activity Title	Our Water
Activity Type	Debate
Activity Location	Classroom
Duration	100 Minutes
Optimum no. / grouping	40 learners / 4 groups, 10 learners/group.
Prerequisites	None
Short description	Teacher reviews with learners some important facts about water scarcity, water pricing, virtual water, and water footprint. They are then able to debate and create links between these concepts and their relationship to poverty.
Learning objectives	1. Learners will be able to form a real understanding of the status of water scarcity in the world, and in Egypt. 2. Learners will be able to differentiate between different new concepts such as water pricing, virtual water, water footprint.
Skills	Discussion and dialogue skills, Critical, holistic, and analytical thinking, problem-solving skills.
Values	Compassion, Responsibility, Self-confidence, Politeness, Respect for others, Respect for individual rights, Value self-respect, Just, Braveness, Tolerance, Gratefulness, Open mindedness and ability to think logically, Sensitivity to social issues in the community
Keywords	#Grades: 6 to 9 Water scarcity, causality/effect relationship, Water pricing, water poverty line, virtual water.
Necessary Materials	A model of the cause-effect matrix, pens, and paper, whiteboard, and markers.
Assessment method	Matrix completion.
Link to MOE's cur.:	subject: Social Studies, Topics: The link between water scarcity and poverty, water pricing.
References	(Water Footprint Comparisons by Country, 2017), (Srinivas, n.d.), EDUCAMP Kit 3 level 3.

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
On Boarding	20 min.	● Divide the learners into groups of 10. ● Introduce learners to the main definitions: Water scarcity, Virtual water. “See annex W.4.1” ● Explain to the learners the definitions of water footprint and virtual water and the difference between them “see annex W.4.1”	White board, markers, annex W.4.1
Explore and get sense of the water footprint concept	15 min.	● Get each group to assume the water footprint of 5 items from the ones in annex “see annex W.4.1”. ● Go over each estimated number and ask questions on why they choose that number specifically. ● Show them the actual water footprint for the products they were assigned.	Pens, paper and annex W.4.1.
Water pricing	20 min.	● Introduce what water and wastewater tariffs are and why they are used. ● Let the learners brainstorm the advantages and disadvantages to water tariffs. “See annex W.4.2.”	annex W.4.2.
Water pricing activity	35 min.	● Each group is asked to use the given data on water pricing and come up with an opinion “with/against water pricing” and why? And how can we fix the current issues associated with water pricing. ● 2 groups are with and 2 are against. The groups take turns stating their opinion and presenting their argument. ● The final solutions are concluded and presented.	Pens and paper.
Final reflection and conclusion	10 min.	● Present The table on the water consumption per country so the learners understand that on a global level the consumption levels are high and water tariffs are necessary for the increasing demand. ● Each learner has the opportunity to ask questions, express their feelings and say their final notes.	Annex W.4.3

3. Assessment

Learners will be assessed based on their engagement and contribution during the group activities. Make sure to involve the full group through instruction and asking them questions to ensure that they are all involved. Each activity will be graded out of 5 with the following rubric:

- 2 points on teamwork.
- 2 points on solid discussion points.
- 1 point on the feasibility of proposed solutions.

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

The learners are urged to monitor their water consumption at home and research and use an online water footprint calculator, to calculate the water footprint for their daily used items/food, etc. They can also monitor the amount of money paid per month for water bills and see how they can reduce it through reduced water use.

Online water footprint calculator: https://www.watercalculator.org/wfc2/q/household/

5. Possible adaptation

- Younger age groups: The solutions for increased water use activity can be a great activity for younger groups, they tend to be very creative and it will get them to discuss together. However, for younger age groups smaller groups of 5/group would be more appropriate.
- Older age groups: The water footprint activity can be of increased complexity if they are asked to do the actual calculation through a case study where they are provided with water utilized per phase of production.

Annex “Teacher’s Background Information”

W.4.1.

- Virtual water
  Virtual water is the amount of water that is embedded in food or other products needed for its production. Trade-in virtual water allows water-scarce countries to import high water-consuming products while exporting low water-consuming products and, in this way, making water available for other purposes [World Water Council].

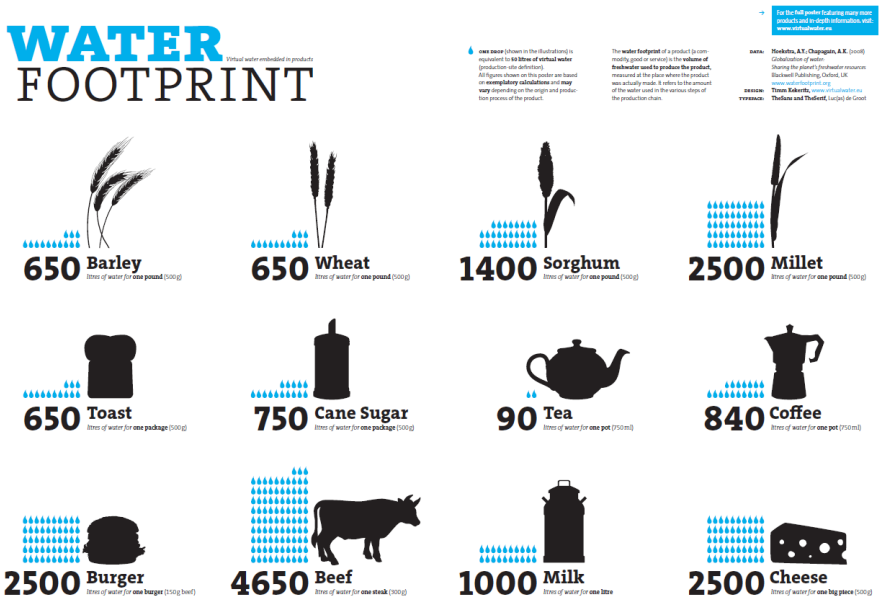
- The water footprint

  Water footprint is the volume of water used, at the individual level, this is expressed in liters. But at the national level, this becomes complex - The water footprint of a nation = the use of domestic water resources- the virtual water export flows + the virtual water import flows.

  The total ‘water footprint’ of a nation is a useful indicator of a nation’s call on global water resources. The water footprint of a nation is related to the dietary habits of people. High consumption of meat brings along a large water footprint. Also, the more food originates from irrigated land, the larger is the water footprint. Finally, nations in warm climate zones have relatively high-water consumption for their domestic food production resulting in a larger water footprint. At an individual level, it is useful to show the footprint as a function of food diet and consumption patterns.

Source: Srinivas, H., n.d. Water Footprints and Virtual Water. [online] Gdrc.org. Available at:

https://www.gdrc.org/uem/footprints/water-footprint.html .



Water Footprints of our everyday products. Source: The Water Footprint Network

W.4.2 Water and wastewater tariff:

- A water tariff

  Water tariff is a price assigned to water supplied by a public utility generally for both freshwater supply and wastewater treatment. The term is also often applied to wastewater tariffs. Water and wastewater tariffs determine the conditions of service and the monthly bills for water users in various categories and classes. Tariffs are often set by a regulatory agency for the appropriate catchment, purification, and distribution of freshwater, and the subsequent collection, treatment, and discharge of wastewater.
- Should there be a tariff on water?

  Often, consumers pay too little for the water and sanitation services they get. People are not aware of the real costs of providing water and sanitation services because these have been historically heavily subsidized by governments. This is because water is a social good and it was considered a cheap and abundant resource. However, with population growth and much larger communities requiring access to water services, the availability of fresh water is decreasing dramatically in many regions of the world.
- Water tariffs are economic instruments that help to tackle both challenges of providing water and sanitation services to all citizens at an affordable price and the conservation of water resources.

Find below the advantages and disadvantages of water and wastewater tariffs.

Advantages	**Disadvantages**
Provide incentives for efficient water use and for water quality protection.	There is disagreement over the objectives of water pricing and tariff design.
Charges send appropriate price signals to users about the relationship between water use and water scarcity.	Tariff setting is a political process rife with controversy.
Pricing water provides funds for necessary infrastructure development and expansion.	The tariff setting process is often not transparent.
Water pricing ensures in the medium-long term that water services can be provided to all citizens at an affordable price.	Tariff design is a complex process that needs a high volume of data.
	Water tariffs are often difficult to understand for consumers.

Source: EDUCAMP Kit 3 level 3

W.4.3. Water Usage (gallons/person/day)

Country	Water Usage (gallons/person/day)
United Arab Emirates (UAE)	2,270
United States of America (USA)	2,200
Canada	1,687
Brazil	1,466
Russian Federation	1,341
Denmark	1,183
Australia	1,156
Germany	1,032
Dominican Republic	1,014
Colombia	995
Egypt	971
United Kingdom	910
Republic of South Africa	908
China	775
Bangladesh	557

Source: Waterfootprint.org. 2017. *Water Footprint Comparisons by Country*. [online] Available at: <https://waterfootprint.org/en/>.

W.4.4 Useful links:

https://www.watercalculator.org/

https://www.youtube.com/watch?v=Wpm7cvGqI8g

Message #5: Water Pollution

1. Design Map:

Activity Code	W.5
Activity Title	Water pollution
Activity Type	Experiment
Activity Location	Classroom and Science Lab
Duration	80 minutes - follow the plant for two weeks (5 mins every day)
Optimum no. / grouping	40 Learners / 5 Groups of 8.
Prerequisites	None
Short description	In this activity, learners will do an experiment in the lab to find out the impact of acid rain on the pollution of water resources, and thus the growth and vitality of plants. Learners follow the growth of plants watered with water similar to acid rain and compare them to other plants watered with normal, uncontaminated water, comparing the results.
Learning outcomes	1. Understand the sources of water pollution and how they can contribute to alleviating this problem 2. Be able to understand the seriousness of climate change on water and sea level rise and suggest solutions to mitigate the climate change phenomenon. 3. Discuss how water moves through the layers of underground water, understand how human activity can cause ground water pollution and reflect on ways to reduce it.
Skills	Teamwork, presentation and public speaking, research skills, and direct scientific observation.
Values	Adherence to time, Responsibility, Personal cleanliness, Environmental cleanliness, Trustworthiness, being Pro-active, Collective responsibility, patience, Open mindedness and ability to think logically, Sensitivity to social issues in the community
Keywords	Grades 6 to 9, Water pollution, Acid rain, sunflower leaves, acid, alkaline, aquifer
Necessary Materials	Data show, five pre-planted sunflower plant pots of the same size and state, 4-liter tank containers, a bottle of vinegar, pen and papers, and labels.
Assessment method	Observation, Written
Link to MOE's cur.:	Acid rain and water pollution.
References	(Using the Scientific Method Science Experiment Form, n.d.), (What is Acid Rain? | Acid Rain | Video for Kids, 2021),(Water pollution | Water Contamination | Video for kids, 2018). Lesson plans. Wisconsin Geological Natural History Survey. (n.d.). https://wgnhs.wisc.edu/education-resources/lesson-plans/.

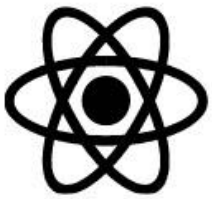
2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Introduction	–	● A couple of weeks before the activity, ask group of learners to volunteer to participate in doing a project of building a model for the groundwater and present it to their classmates later. “You just need 3 volunteers to work on the project, if more learners volunteered you can create groups of 3 where each group work on a model” ● Meet those who had volunteered after class and let them know that they will build a model that shows how water enters “infiltrates” an aquifer and how water moves “percolates” through an aquifer. ● Prepare and give the learners an instruction sheet and share with them the guiding video “see Annex W.5.4 for the instructions and video link” “This model will be used later during the activity day. Make sure it will be ready at the class by the time”	Annex W.5.4
Onboarding	15 min.	● Ask the learners about the meaning of water pollution and its causes and solutions to this problem ● The learners are urged to watch a video about this topic and take notes “video link is at annex W.5.1.” ● Divide the learners into 5 groups of 8 learners each. ● Manage that the learners take turns mentioning some of the causes and solutions proposed in the video to ensure they understood the information.	Annex W.5.1 and data show.
Acid rain and water pollution	20 min.	● Show the learners a video about acid rain so that they learn how it is formed and what causes it. Also, the adverse effects of acid rain on water pollution, climate change, and aquatic life. “See annex W.5.2.” ● Ask the learners to take notes on what they learned from the video, to refer to it later. ● Let the group / groups that built Groundwater model demonstrate how water enters “infiltrates” an aquifer and how water moves “percolates” through an aquifer. ● Let all the learners reflect on this demo. The main point is that groundwater and surface water are connected. Over-pumping groundwater can dry up surface water and polluted surface water pollutes groundwater reserve. “See annex W.5.5”	Annex W.5.2 and data show.
Experiment	30 min.	● Assign each group of learners a number and ask them to take the materials placed on the lab desk.	5 tanks, 5 sunflower plant

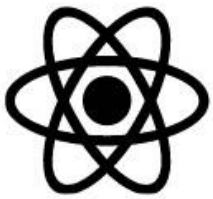
		The materials are divided as follows: groups 1 & 2 “fills one tank with 3.8 liters of tap water and labels it tap water”, groups 3 & 4 “adds 0.5 liters of vinegar to 3.3 liters of water in a tank and labels it acidic” and group 5 “adds 0.9 liters of vinegar to 2.9 liters of water in a tank and labels it highly acidic”. ● The learners use the tank to water 5 pre-planted sunflower plant pots of the same size and condition and nature every 2-4 days and all plant pots are placed in the same area that is well ventilated with sunlight “all pots must be under the same exact conditions to test the variable efficiently”. ● The learners are asked to water and monitor the plants for a period of 2 weeks and take pictures and note down changes for each observation.	pots, water, vinegar, labels, and pen.
Monitoring and observation the effect of polluted water on plants	5 min.	● The learners will then submit their observations and conclusions after the two weeks in a report “one report per group” and they will also submit the answered question sheet that “see annex W.5.3”	annex W.5.3
understand the importance of preserving the purity of the water to minimize the negative impact on the environment	10 min.	● The learners are asked to reflect on what they learned and what they expect will happen to each sample and the final hypothesis is written down to come back to it after the 2 weeks. ● Give the learners a take home activity to find links between climate change and water pollution. How they affect one another. Is increasing global temperature led to excess increase in the growth of some spices and extinction of others. Can this imbalance lead to water pollution? You can then hold a discussion about the topic in the next class.	none

3. Assessment

The learners are asked to fill out the below observation form and answer the questions that can be found in annex W.5.3.



Using the Scientific Method
Science Experiment Form



Name/s_____

Title of Project_____

QUESTION: What do you want to find out?

_____

_____

_____

_____

HYPOTHESIS: What do you think will happen and why?

_____

_____

_____

_____

MATERIALS: List all materials you will be using.

_____

_____

_____

_____

_____

_____

PROCEDURE: List step by step, what you will do.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

RESULTS: What actually happened?

_____

_____

_____

_____

CONCLUSION: Is your hypothesis correct or incorrect based on your results? Explain why. What did you learn?

_____

_____

_____

_____

_____

_____

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

This activity extends for a 2-week period so the learners will be engaged for a while. Learners are also urged to try other activities related to planting and practicing sustainable habits to decrease water pollution.

5. Possible adaptation

- The same activity can be adapted to younger groups by using this video instead for water pollution. They can also use this video for acid rain.
- The experiment can be demonstrated by the teacher to smaller age groups and the learners can observe and take notes.

Annex “Teacher’s Background Information”

W.5.1. Video on Water pollution definition, causes, and solutions.

Water Pollution

W.5.2. Video on Acid rain formation causes effects and solutions.

Acid rain

W.5.3.

Answer each question after each observation and add pictures if possible (observe every 2-4 days, 2-3 observations)

- Has plant color changed? Did its leaves fall? Does it look fresh and healthy?
- Compare the state of the plant before and after the experiment.
- Write down your conclusion on how acid rain affects plants and how water quality is important for our life on earth.

W.5.4. Groundwater Model

Building Groundwater model instructions:

Guiding video: Shoebox Groundwater Model

- Fill half of the shoebox with sand and gravel.
- Make sure that the top of the sand is sloped and has a depression in one corner (for a lake). This represents the land surface sloping toward a lake.
- Place a plastic house, animal, etc. on the “land surface.” This makes the shoebox into a “model.”
- Poke many small holes into the bottom and sides of the plastic cup and mark rings inside the cup about ½ inch apart.
- Scoop a small depression in the gravel and place the cup into the gravel to nearly the bottom of the box. This cup is going to represent a high-capacity water-supply well.
- Use your burette with baster to sprinkle water on the surface, representing rainfall. Then, add more water (with the baster) near the hill. Water sprinkled on the surface models precipitation, the source of groundwater.
- Slowly fill the shoebox and gravel with water until the lake in the opposite corner starts to fill. Be careful not to pour water too quickly! Sometimes it takes a long time for water to move through the gravel to the other side of the shoebox. When water moves down into the gravel from above, this is infiltration. When water moves sideways to fill up the gravel in the shoebox, this is called percolation. Groundwater often moves very slowly.
- Mark the side of the box at the top of the lake and mark the other side at the top of the water in the sand and gravel (the water table). Look into the well (plastic cup) and mark the water level on the inside of the well.
- Refill the burette with baster and then add that water to the “hill side” of the shoebox to simulate recharge of the aquifer. Note what happens to the water level in the lake and in the well.
- Use your burette with baster to remove more water from the plastic cup than you added in step 9. This step represents what happens when you pump water out of the aquifer. Watch and note what happens to the water level in the lake and in the well.

Required Materials:

- One 5 liter plastic shoebox or other large rectangular plastic container
- Coarse-grained sand and fine gravel to fill about half of the plastic box (AQUIFER). Aquarium gravel works well. A 10 k bag is enough for three models.
- One 5-oz plastic cup (WELL)
- Small plastic toy people, houses, cars
- A burette with baster (PUMP)

Activity resource: Shoebox Groundwater Model

W.5.5. Groundwater Model discussion points

This activity demonstrates several key concepts about how water moves into and through aquifers. Learners should now understand that water enters the ground, and ultimately the aquifer, from the surface. The source of water entering the ground could be rainfall, represented in this model by water being sprinkled on the surface or poured onto the hillside. Through the force of gravity, water moves through the aquifer. The learners should have observed this when they watched the water move from the side where they poured water onto the gravel, to the dry gravel and the depression (lake) on the other side of the shoebox. The groundwater and the surface water are connected. Pumping removes water from the aquifer and can lower the water level in nearby lakes and streams.

Big ideas

- Groundwater comes from precipitation.
- Groundwater moves through the spaces between the sand grains (pore space). No underground streams or underground lakes are needed for groundwater flow.
- Groundwater and surface water are connected. Over-pumping groundwater can dry up surface water.

Message #6: Water Desalination

1. Design Map:

Activity Code	W.6
Activity Title	Water desalination
Activity Type	Experiment
Activity Location	Classroom / Schoolyard
Duration	90 Min
Optimum no. / grouping	40 Learners, 4 groups of 10 learners
Prerequisites	Messages W.1 and W.2
Short description	With the teacher's help, learners will carry out an experiment that proves that heating water through sunlight helps separate salt from water.
Learning outcomes	1. Learners understand the water desalination process and its importance.
Skills	Direct observation, teamwork.
Values	Adherence to time, Responsibility, Personal cleanliness, Environmental cleanliness, Trustworthiness, being Pro-active, Collective responsibility, patience, Open mindedness and ability to think logically, Sensitivity to social issues in the community
Keywords	#Grades: 6 to 9, Desalination, vapor, condensation, freshwater, saltwater.
Necessary Materials	Data show, Cooking salt, 4 large plastic pots, 4 glasses, transparent plastic cover, 4 tomatoes, a ¼ kg of rocks, food coloring.
Assessment method	The accuracy of the model and observations recorded.
Link to MOE's cur.:	• Science • Seawater desalination
References	Veolia Water Technologies. (2015). *What does desalination mean?* [DVD]. United Kingdom., Coral Walker & Melissa Christensen. (2012). [Ebook] (pp. 1-3). Retrieved from http://josephminato.com/sci580/lesson-plans/earth--space-science/ desalination.pdf., *All Laboratory Water Is Initially Sourced From A Potable - Natural Water Cycle Diagram*. [Image]. Retrieved from <ahref="https://www.nicepng.com/ourpic/u2q8u2t4t4q8q8e6_all-laboratory-water-is-initially-sourced-from-a/" target="_blank">All Laboratory Water Is Initially Sourced From A Potable - Natural Water Cycle Diagram @nicepng.com

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Introduction	15 Min	● Begin the lesson with a quick review of the water cycle by presenting the illustration of the water cycle in nature in Figure 1 in annex W.6.1, with an emphasis on the important role of evaporation in the water cycle, which results from the rising temperature of the sun.	Data shows & annex W.6.1.
Onboarding	15 Min	● Review the important definitions that can be found in annex W.6.2.	Annex W.6.2
Desalination	30 Min	● Tell the learners that in the cycle of water, they noted that saltwater turned into drinkable freshwater at a stage of the water cycle and this is part of desalination, which refers to any of the many processes that remove an amount of salt and other minerals from saltwater for the production of freshwater which is suitable for development, consumption or irrigation.	Annex W.6.1
Experiment the water desalination process and its importance	30 Min	● Divide learners into 4 groups of 10 each. Then explain to each group the steps they will carry out "see the experiment steps in annex W.6.3." ● The next day. Ask each group to present the results before the chapter, and explain what has happened? "Is the water in the cup safe to drink and use? Was the water affected by the tomato pieces and food colors?"	Cooking salt, 4 large plastic pots, 4 glasses, transparent plastic cover, 4 tomatoes, a ¼ kg of rocks, food coloring.
Exploring water desalination methods	15 Min	● Show the learners a video about desalination "see annex W.6.1" then lead a discussion about water desalination methods and types "see annex W.6.4"	none

3. Assessment

Assess the accuracy of implementing the model, taking notes and present them to other learners. You can use an evaluation rubric.

4. Suggestions for extended activities at home

Water is scarce source. Also, water desalination takes effort, energy and costs money. Inspire the learners to build the following habits to save resources.

1. Be aware and spread awareness
2. Close the taps while brushing teeth
3. Take quick showers
4. Fix any leaky taps at home
5. Use one utensil for drinking water
6. Don’t pour excess drinking water in the sink
7. Wash fruits in a bowl of water

5. Suggestions for extended activities at home

You can replace watching the video with older students by researching different methods of desalination, examples of successful desalination projects, and suggesting ways to implement such projects in Egypt. In addition, they can research how to make the water purification process sustainable and what desalination methods do not waste a lot of energy.

Annex “Teacher’s Background Information”

W.6.1.

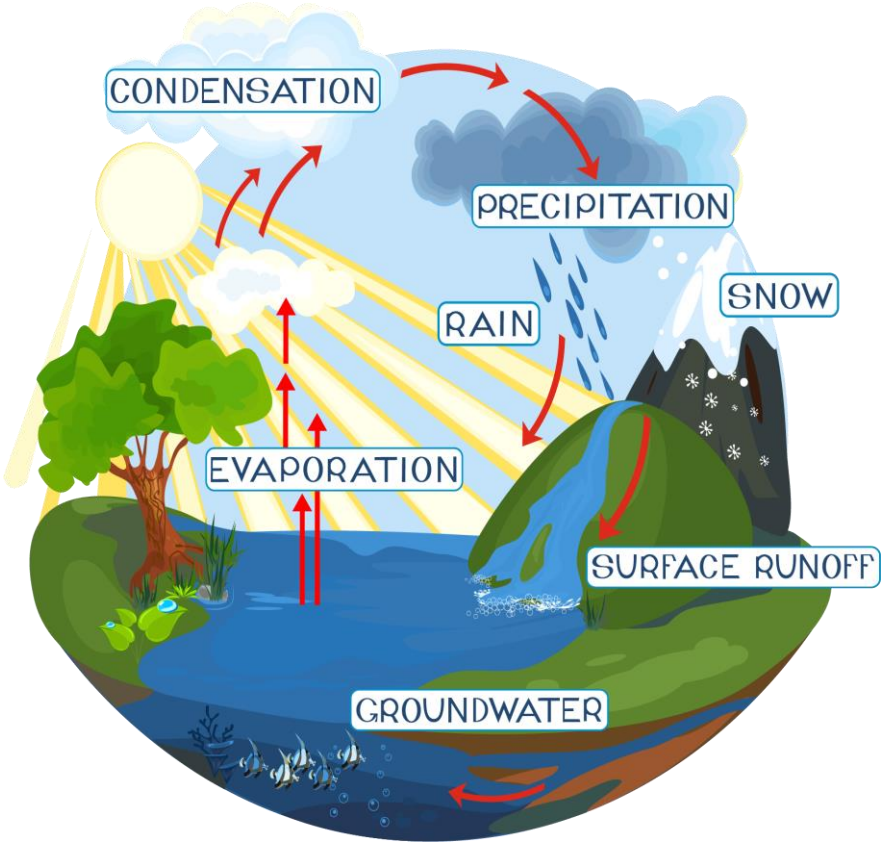


Figure 1: water cycle in nature

Video on desalination animation:

[What does desalination mean?]

W.6.2. Important Definitions

Evaporation:

Water transforms from a liquid to a gaseous state as it moves from the earth or water bodies to the overlying atmosphere. The sun is a source of evaporation energy.

Transpiration:

Is the emission of water vapor from plants and soil into the air. Where, water vapor is a gas that cannot be seen in the atmosphere.

Condensation:

Transformation of the water vapor into liquid water droplets in the air, creating clouds and fog.

Precipitation:

Condensed water vapor falling on the surface of the earth. Most precipitation occurs as rainfall, but precipitation also includes snow, fog, and frost.

W.6.3. Experiment steps:

- Give each group a pot in which they put water about 3cm high from the bottom of the pot with groups as follows:
  - The first group puts a small amount of salt on the water and flips it in the pot.
  - The second group puts a variety of food colors on the water.

- The third group puts tomato pieces in water.
- The fourth group puts more salt than the first group.

- When all groups do their work, put the glass cup in the middle of each pot and cover the container with transparent plastic tightly and put the stone in the middle of the plastic to represent a heavy pressure that allows the drop of water to condense - when heated in the cup in the middle of the pot.
- Let each group place the pot in a place where the sun is directly focused on it. Ask learners to follow the three pots the next day as the water heating and evaporation through sunlight takes some time.

What happened?

When the water is heated by the sunlight passing through the translucent plastic, which is similar to the greenhouse effect, it turns into vapor that sticks to the transparent plastic, which is colder because of its contact with the outside air. The process of condensation occurs and when the droplets adjacent to the plastic become heavy, they fall into the cup and become pure drinking water free of salts or odors.

W.6.4. Background information

Water desalination methods:

The methods used to desalinate the water currently revolve around two perspectives:

- Using membranes, sometimes called Reverse Osmosis, and it is electrically operated.
- Using heat vaporization and this method is known as distillation.

Using membranes

In the desalination process, a semi-permeable membrane known as reverse osmosis membrane is used. This membrane allows fresh water to pass in the direction of low pressure and prevents the passage of salt and bacteria through it. This requires increased pressure on the side of the membrane which is filled with seawater, and this pressure is about 70 bars (70 air pressure). This pressure usually produced through electrically operated pumps. Other membranes are also used in this process like electrophoresis. Other types are being researched such as anterior osmosis, nano filter and desalination membrane. However, most of the existing research focuses on finding better and more effective membranes. Desalination is expected to be used in many places over the next 25 years.

Distillation

This process involves raising the temperature of saltwater to the boiling point and forming water vapor, which is then condensed so that distilled water is free of salt. This distilled water has no taste and is then treated with additives to become good water for drinking or irrigation. This technique is often used when it is necessary to treat water that is semi-free from salts for industrial, chemical, biological, etc. applications.

The thermal energy used may be produced through natural gas, coal, or a nuclear reactor, and is also used for the process of evaporation.

Types of water desalination:

- Normal distillation:

  Salt water is boiled in a water tank without pressure. The water vapor rises to the top of the tank and exits through a conductor path to the condenser, which condenses the water vapor, and turns into water droplets that are collected in the distilled water tank. This method is used in desalination plants with small production capacity.

- Multi-stage flash distillation:

  Depending on the fact that the boiling point of liquids is directly proportional to the pressure on it, the lower the pressure on the liquid, the lower the boiling point. In this way, the saline water passes through heating into low-pressure rooms that turn water into vapor that is condensed on cold surfaces and collected and processed in drinkable quantities. This method is used in desalination plants with a large production capacity (30000 cubic meters or about 8 million gallons of water per day).

- Multi-stage distillation (Multiple Effect Distillation):
  Multi-phase distillers take advantage of the vapors from the first condenser for condensation in the second evaporator. The condensate heat is used to boil the salty water in the second evaporator, so the second evaporator acts as a condenser for the vapors from the first evaporator, and the fumes in the second vaporizer acts as the heating steam in the first evaporator. Similarly, the third evaporator acts as a condenser for the second evaporator, and so each evaporator in that chain is called the effect.
- Solar distillation:
  This method uses solar energy to heat saline water up to evaporation rate and is then condensed on cold surfaces and collected in pipes.

Source: https://www.lenntech.com/processes/desalination/general/desalination-key-issue.htm

Useful resources W.6.5.

Websites

- ’تحلية المياه.. حل أم مشكلة؟‘
- Sustainability in Desalination
- Towards sustainable desalination

Videos

- What does desalination mean?
- Can desalination solve the global water crisis?
- Making Desalination More Sustainable

Message #7: Renewable vs Non-Renewable Energy Sources

1. Design Map:

Activity Code	E.7
Activity Title	The energy seminar
Activity Type	Socratic seminar
Activity Location	Classroom / Multipurpose Room “Socratic seminar setup see annex E.7.1”
Duration	80 Min
Optimum no. / grouping	40 Learners / 2 Teams of 6 / The rest of learners forms the audience
Prerequisites	Learners do research about renewable and non-renewable energy sources to study different opinions and rationale against and pro non-renewable energy sources.
Short description	Through this activity learners’ will get aware about renewable and non-renewable sources of energy and also compare the advantages and disadvantages of each through a classroom dialogue that triggers their competitive skills and enthusiasm.
Learning objectives	Learners identify different sources of energy and compare between the advantages and disadvantages of renewable and non-renewable energy sources
Skills	Interpersonal, Intrapersonal, Communication, Team Work, Critical thinking
Values	Compassion, Understanding, Self-confidence, Politeness, admitting one's mistake, Respect for others, Value self-respect, Just, Stand up for the truth, Open mindedness and ability to think logically, Sensitivity to social issues in the community
Keywords	#Grades: 6 to 9, Energy, Renewable energy, Non-renewable energy
Necessary Materials	Chairs for the Socratic seminar setup, papers, paper holder for each learner “preferred”
Assessment method	Observation, Oral
Link to MOE’s cur.:	Science, Energy resources
References	Davenport, M. (2016, September 22). Socratic Seminars: Building a Culture of Learner-Led Discussion. Edutopia. https://www.edutopia.org/blog/socratic-seminars-culture-learner-led-discussion-mary-davenport. Ritchie, H. (n.d.). Energy mix. Our World in Data. https://ourworldindata.org/energy-mix.

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Preparation	15 Min	● A week prior to the activity, ask the learners if they know the difference between renewable and non-renewable energy sources. Then let them know that they will have a dialogue between those who agree or disagree with this statement: Renewable energy cannot replace fossil fuels ● Explain to the learners that this dialogue will be through a Socratic seminar then explain to the learners what is Socratic seminar "annex E.7.2" ● Assign roles and set expectations. Learners will be getting reading to prepare for the seminar. They can study one agree/disagree opinion only from the reading "annex E.7.3" ● Convert the reading "annex E.7.3" to a PDF file and share it with the learners to study and prepare for the activity and also let them know that they are free to collect data from the Internet about the dialogue topic Energy Sources.	PDF print of the reading "annex E.7.3"
Onboarding	15 Min	● Make sure that the learners are prepared ● You might like to create two teams, each consisting of six members. The two teams are: an affirmative team supporting the usage of renewable sources of energy and a challenging one supporting fossil fuel usage and forming the inner circle. The rest of the learners form the audience, they can coach and guide the inner circle through passing notes, make comments on debaters' constructive and rebuttal speeches, give their opinions on the presented issues, their own views on the arguments offered, etc.	Socratic seminar setup see annex E.7.1
Compare between the advantages and disadvantages of renewable and non-renewable energy sources through a dialogue	50 Min	● Run the dialogue and make sure that everyone is participating. You can use the info. In "annex E.7.2" to manage a successful discussion	papers, paper holder for each learner "preferred"

3. Assessment

- Use the discussion to observe and assess learners' deep understanding of the different energy resources and the challenges for using sustainable renewable energy sources.
- Establish clear metrics for success (e.g., using and explaining quotes, expanding on a peer’s idea, asking questions that keep the conversation going) and make sure the class is aware of them.

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

After the Socratic seminar activity, ask the learners if it is doable to replace the current non-renewable electricity source that supplies their homes with a renewable one and save money at the same time. Let them share their ideas then suggest solar energy panels as a renewable and clean source for electricity.

Challenge the learners to find the story behind Solarize Egypt. Solarize Egypt is an Egyptian company that provides a cheaper and cleaner alternative to conventional energy. Also, challenge them to come with ideas next week to help individuals replace non-renewable energy sources with renewable ones.

Solarize website

Solarize intro

5. Possible adaptation

For younger learners you can summarize and simplify the reading or look for other visual resources such as videos “see annex E.7.4”

Annex “Teacher’s Background Information”

E.7.1. Socratic seminar setup

Figure 1

Socratic Seminar

Note. "Socratic Seminar - FUHS Ms. Alexander's Room at Lunch 1-12-11" by slimlibrary is licensed under CC BY-NC-SA 2.0

E.7.2. Socratic seminar

- Rationale:

  In a Socratic Seminar activity, learners help one another understand the ideas, issues, and values reflected in a text through a group discussion format. Learners are responsible for facilitating their group discussion around the ideas in the text; they shouldn’t use the discussion to assert their opinions or prove an argument. Through this type of discussion, learners practice how to listen to one another, make meaning, and find common ground while participating in a conversation.

- Procedure:

  1. Select an Appropriate Text

     The Socratic Seminar strategy is based on close textual analysis, so it is important to select a text that provides ample avenues for interpretation and discussion. If you choose a simple text where the meaning is fairly straightforward, there won’t be much for learners to discuss. Also, the text should not be too long to read closely in the allotted amount of time. Often, teachers select a text ranging from one paragraph to one page.

2. Give Learners Time to Prepare

   Before beginning the seminar, it is essential that learners have time to prepare ideas. Learners should annotate the text before the start of the class discussion. Teachers often lead or assign a discussion leader who generates a few open-ended questions that can be used to begin the seminar.

3. Develop a Classroom Contract These seminars have rules that may not apply to other forms of discussion, so before beginning the seminar, it is important that everyone is aware of the norms. Below are typical rules used to structure a Socratic Seminar activity. Of course, you can adapt these to fit the needs of your learners.

   - Talk to each other, not just to the discussion leader or teacher.
   - Refer to evidence from the text to support your ideas.
   - Ask questions if you do not understand what someone has said, or you can paraphrase what another learner has said for clarification ("I think you said this; is that right?").
   - You do not need to raise your hand to speak, but please pay attention to your "airtime"—how much you have spoken in relation to other learners.
   - Don't interrupt.
   - Don't "put down" the ideas of another learner. Without judging the learner you disagree with, state your alternate interpretation or ask a follow-up question to help probe or clarify an idea.
   - Common statements or questions used during a Socratic Seminar activity include:
     - Where does that idea come from in the text?
     - What does this word or phrase mean?
     - Can you say that in another way?
     - Is this what you mean to say...?
     - What do you think the author is trying to say?
     - What else could that mean?
     - Who was the audience for this text? How does that shape our interpretation of these words?
     - Who was the author of this text? What do we know about him/her? How does that shape our understanding of these words?
   - Before beginning the seminar, it is also important to remind learners that the purpose of the seminar is not to debate or prove a point but to more deeply understand what the author was trying to express in the text. If you have never done a Socratic Seminar activity with your learners before, you might spend a few moments brainstorming the qualities that would make for a great seminar. These qualities or criteria can be explained on a rubric and used to evaluate the seminar at the end of the class period. Criteria you might use to evaluate a Socratic Seminar activity include engagement (everyone listening and sharing), respect (no interruptions or put-downs), meaning-making (learners understand the text more deeply at the end of the seminar), and use of evidence (comments always refer back to the text).

4. The Socratic Seminar

   A Socratic Seminar activity often begins with the discussion leader, a learner or the teacher, asking an open-ended question. A typical opening prompt is: What do you think this text means? Silence is fine. It may take a few minutes for learners to warm up. A Socratic seminar is best done in a circle, where learners are equal to the facilitator on the outside. There are two ways to do that based on the class size and dynamics: one giant circle for all learners, or fishbowl style (where the participants in an inner circle have a discussion and the participants in an outer circle coach the inner circle). At least 15 minutes should be allotted to the activity, and it can often last 30 minutes or more. As learners become more familiar with the Socratic Seminar format, they will be able to discuss a text for longer periods of time without teacher intervention.

5. Reflect and Evaluate

   After the Socratic Seminar activity, give learners the opportunity to evaluate the process in general and their own performance specifically. Reflecting on the seminar process helps learners improve their ability to participate in future discussions. Here are some questions you might discuss or have learners write about when reflecting on the seminar:

   - At any point, did the seminar revert to something other than a dialogue? If so, how did the group handle this?
   - What evidence did you see of people actively listening and building on others' ideas?
   - How has your understanding of this text been affected by the ideas explored in this seminar?
   - What parts of the discussion did you find most interesting? In what parts were you least engaged?
   - What would you like to do differently as a participant the next time you are in a seminar?

Source: Socratic Seminar

E.7.3. The energy debate: Challenge: Renewable energy cannot replace fossil fuels

Fossil Fuels (coal, oil, petroleum, and natural gas) are originally formed from plants and animals that lived hundreds of millions of years ago and became buried deep beneath the Earth's surface. These then collectively transformed into the combustible materials that we use today for fuel. The earliest known fossil fuel deposits are from about 500 million years ago, when most of the major groups of animals first appeared on Earth. The later fossil fuels, such as peat or lignite coal (soft coal), began forming about five million years ago.

Currently, we are over-dependent on fossil fuels to heat our homes, run our cars, power our offices, industry and manufacturing, and respond to our insatiable desire to power all of our electrical goods. Nearly all of the energy needed to meet our demands – 80 percent of global energy – comes from burning fossil fuels. At the current rate of global energy demands, fossil fuels cannot replenish fast enough to meet these growing needs. The over-consumption of these non-renewable fuels has been linked to the emission of greenhouse gases and pollutants into the atmosphere – the leading cause of global warming and climate change.

- Renewables

  Renewable energy is energy that is derived from natural processes (e.g., sunlight and wind). Solar, wind, geothermal, hydropower, bioenergy and ocean power are sources of renewable energy. Currently, renewables are utilized in the electricity, heating and cooling and transport sectors. Renewable energy collectively provides only about 11.41 percent of the world's energy needs. This means that fossil fuels, along with nuclear energy — a non-renewable energy source — are supplying 88.59% of the world's energy resources. Nuclear energy (a controversial energy source among public opinion) currently provides 4.27% of the world's energy supplies.

- The issues

  "Models predict that Earth will warm between 2 and 6 degrees Celsius in the next century. When global warming has happened at various times in the past two million years, it has taken the planet about 5,000 years to warm 5 degrees. The predicted rate of warming for the next century is at least 20 times faster. This rate of change is extremely unusual." – NASA Earth observatory

  Burning fossil fuels creates carbon dioxide, the main greenhouse gas emitter that contributes to global warming, which hit its peak in 2012. In the last 30 years, temperatures have risen to the warmest since records began. If we continue to pump greenhouse gases into our environment the average global temperature could increase by 1°C to 4°C by 2100. Even if we changed today to using more renewable resources instead of fossil fuels for example, increases could be between 1 to 2.5°C.

  The 20th century saw the most prolific population growth and industrial development, which was and remains totally dependent on the use of fossil fuel for energy.

  Estimates for fossil fuel reserves depletion range from between 50-120 years. None of these projections are very appealing for a global community that is so heavily dependent on energy to meet even our basic human needs – needs that keep growing.

  Scientists maintain that the impact of global warming on the environment is widespread. In the Arctic and Antarctica, warmer temperatures are melting ice, which leads to increases in sea levels and alters the composition of the surrounding sea water. Rising sea levels impacts on settlements, agriculture and fishing both commercially and recreationally. Air pollution is also a direct result of the use of fossil fuels, resulting in smog, and the degradation of human health and plant growth. There is the negative impact on natural ecosystems that result from collecting fossil fuels, particularly coal and oil. There is also the continuing threat of oil spills that devastate ecosystems and the impact of mining on land vitality.

- The future

  The discussions around climate change and energy problems today center around the potential for technical solutions to energy demands that are cost effective. So far, the alternative to fossil fuels has been around

renewable energy sources, which are expected to play an increasingly vital role in the mix of power generation over the next century. The demands on these alternative energy sources are inordinate – they will need to not only keep up with the increasing population growth, but also go beyond these demands by contributing to the replacement of fossil fuel energy production in order to meet future energy needs and consider the natural environment.

However, the argument from governments, oil, coal and natural gas companies is that until renewable energy sources become more viable as major energy providers, the only alternative in meeting the increasing demands for energy from a growing global population that requires more and more energy, is to continue to extract fossil fuel reserves.

- **Challenge for discussion: Renewable energy cannot replace fossil fuels**

AGREE 1: Switching to renewable energy is not as simple as it is being made out to be. Quite the opposite.

"It is commonly assumed that greenhouse gas and energy problems can be solved by switching from fossil fuel sources of energy to renewables. However, little attention has been given to exploring the limits to renewable energy. Unfortunately, people working on renewable energy technologies tend not to throw critical light on the difficulties and limits. They typically make enthusiastic claims regarding the potential of their specific technologies." (Alex Epstein)

The idea of drawing our energy from sources that are renewable, independent of foreign nations, and do not emit greenhouse gases has powerful appeal. But capturing these resources is expensive, and many are intermittent, which complicates using them on a large scale. Furthermore, it takes time and money to change distribution and consumption of energy, meaning we will be dependent on fossil fuels until we can afford this switch. Finally, bringing new renewable energy technologies to market causes problems both in regard to cost and convenience, meaning a switch from fossil fuels to renewable energy is not a simple task.

"It would be difficult to find a more taken for granted, unquestioned assumption than that it will be possible to substitute renewable energy sources for fossil fuels, while consumer-capitalist society continues on its merry pursuit of limitless affluence and growth. There is a strong case that this assumption is seriously mistaken." (Ted Trainer)

AGREE 2: Renewables cannot provide the required amount of energy to supply demand (Intermittency)

Renewables, after 50 years of subsidies, produce less than 11.4 percent of the world's energy—and, because renewables provide only intermittent energy, continue to require fossil fuel backups.

The issue of intermittency from solar and wind means that it is difficult to get reliable power from either as it is weather dependent – which, particularly in many places in the world is unpredictable. This creates a need

for energy storage (which is currently not efficient enough to be cost effective) or needs traditional fossil fuels or nuclear power to supplement.

> "As you look at the jagged and woefully insufficient bursts of electricity from solar and wind, remember this: some reliable source of energy needed to do the heavy lifting. In the case of Germany, much of that energy is coal. As Germany has paid tens of billions of dollars to subsidize solar panels and windmills, fossil fuel capacity, especially coal, has not been shut down—it has increased. Why? Because Germans need more energy, and they cannot rely on renewables." (Alex Epstein)

> "It is concluded that although the foregoing figures are not precise or confident, their magnitudes indicate that it will not be possible to meet a 1000 EJ/yr energy target for 2050 from alternative energy sources, within safe greenhouse gas emission levels. Such a goal could not be achieved without radical change in social, economic, political and cultural systems." (Ted Trainer)

Much of the debate around renewables is in reference to the 'present' energy demands, where the anticipated demand for energy in the future is expected to double by 2050. "The crucial question is can renewables meet the future demand for energy in a society that is fiercely and blindly committed to limitless increases in "living standards" and economic output. The absurdity of this commitment is easily shown. If 9 billion people were to rise to the "living standards" we in rich countries will have in 2070 given 3% p.a. economic growth, then total world economic output would be 60 times as great as it is now! It is concluded that the investment cost that would be involved in deriving total world energy supply from renewable sources would be unaffordable. Full dependence on renewable energy can only be done if we move to lifestyles and systems that require only a small fraction of the present rich world's per capita energy consumption.

Renewables could provide around of 25% of energy needs in some countries, but much of the generating capacity would have to be duplicated in the form of fossil or nuclear plant for use when there is little sun or wind; and the amount of coal use that will continue to be required would continue to exceed safe greenhouse gas emission limits." see Ted Trainer, The Simpler Way

As discussed above, Renewable Energies have limitations, but these are varied based on the type of renewable energy being discussed. Here are the specific limitations of each.

Solar Power

> Photovoltaic solar electricity (or PV) is intermittent. Its potential contribution to providing widespread renewable energy is limited without the capacity for very large-scale storage. Even if it became cheaper than fossil fuels, its major limitation is that it can't power anything for about 16 hours a day, or in the case of consecutive cloudy days. It can feed surpluses from house roofs etc., into a grid running on coal (although this is expensive), while drawing power from that grid at night. But this only works when a lot of coal or nuclear power plants are running all the time to act as a giant "battery" into which PV can send surpluses.

Solar thermal plants – need to be located in the Sahara region. While they can store energy as heat to generate and transmit electricity when it is needed, their biggest limitation is the significant transmission losses and the magnitude of the potential of this type of renewable energy is uncertain, and especially doubtful in winter, where output is generally about 20% of summer output. This means that solar thermal systems will need to be located in the world's hottest regions, and will need to supply major demand centres by long transmission lines, and will not be able to make a large contribution in winter.

Biomass

For very large scale biomass production, each person in the world would need about 2.6 hectares of land growing only biomass to provide for their liquid and gas consumption (in the form of ethanol net, not primary energy amount.) To provide the anticipated 9 billion people on earth by 2060 we would need 24 billion hectares of biomass plantations.

The world's total land area is 13 billion hectares, and the total forest, cropland and pasture adds to only about 8 billion hectares, just about all heavily overused already. If we vary the above assumptions there is no possibility of explaining how all people could ever have something like the present rich world's liquid fuel consumption from biomass.

AGREE 3: Renewable energy is not cost effective

Renewable energies in their current supply are either not cost effective without heavy government subsidies, use tremendous amounts of land, or they harm the environment in some way. (Quora.com)

Calculating the cost of electricity from renewable energy sources is quite difficult. It depends on the fuel used, the cost of capital (power plants take years to build and last for decades), how much of the time a plant operates, and whether it generates power at times of peak demand. In measuring the costs economists use "levelized costs"(the net present value of all costs – capital and operating – of a generating unit over its life cycle, divided by the number of megawatt-hours of electricity it is expected to supply). What levelized costing doesn't take into account is the issue of intermittency – wind power isn't generated on a calm day, or solar power at night, resulting in the need for conventional power plants to be kept on standby.

Electricity demand varies during the day in ways that the supply from wind and solar generation may not match, so even if renewable forms of energy have the same levelized cost as conventional ones, the value of the power they produce may be lower.

Another way to measure the costs is through a 'cost-benefit analysis' which looks at the benefits of renewable energy including the value of the fuel that would have been used if coal or gas-fired plants had produced the same amount of electricity and the number of carbon-dioxide emissions that they avoid. According to this

calculation, wind and solar power appear to be far more expensive than if calculated on the basis of levelized costs.

To determine the overall cost or benefit, the cost of the fossil-fuel plants that need to continue to be on stand-by for the intermittency problem, needs to be factored in. For example, solar farms run at only about 15% of capacity, so they can replace even less. Seven solar plants or four wind farms would be needed to produce the same amount of electricity over time as a similar-sized coal-fired plant. And all that extra solar and wind capacity is expensive.

In Europe, rather than seeking to increase the availability of low-cost electricity, governments enforce scarcity by manipulating the factors influencing electricity prices such as "regulatory structures—including taxes and other user fees, investment in renewable energy technologies, and the mix and cost of fuels."

In the EU governments interfere with electricity markets, and enforce the use of inferior electricity sources such as wind and solar, resulting in subsidies, taxes, feed-in tariffs, materials and labor, forcing the consumer to pay the ultimate costs. Rather than seeking to increase the availability of low-cost electricity, governments enforce scarcity by manipulating the factors influencing electricity prices such as regulatory structures—including taxes and other user fees, investment in renewable energy technologies, and the mix and cost of fuels. In Germany for example,

"Taxes and levies account for about half of retail electricity prices, [and] transmission system operators charge residential consumers a renewable energy levy that is used to subsidize certain renewable generation facilities.". This is in addition to policies which penalize coal and nuclear electricity generators. (Alex Epstein)

AGREE 4: Renewable energy utilizes too much land, meaning problems in scalability and storage.

A problem with solar and wind energy is the sheer scale of land that is required to obtain as much energy as even a small coal fire power plant can produce. Storing renewable energy more effectively and inexpensive energy from wind or solar could become much more viable than they are currently. However right now, no cost-effective forms of energy storage exist, and are not foreseen.

The area of productive land required to provide for one Australian is over 7 hectares per person. The US figure is closer to 12 hectares. However, the amount of productive land per person on the planet is about 1.3 hectares and by the time we reach 9 billion it will be close to 0.8 hectares. In other words, Australians have a footprint about 10 times greater than all could share.

> "Renewables are so much less energy dense than conventional generation, meaning so much more land is required. The British economist David McKay estimated that to meet the UK's electricity needs from offshore wind would require 44,000 3MW turbines in a 4km wide band around the entire 3,000km coastline of the country. And if the wind stops, well..." (Ted Trainer)

The best option is to use electricity to pump water up into dams, then generate with this later. This works well, but the capacity is very limited. World hydro generating capacity is about 7 – 10% of electricity demand, so there would often be times when it could not come anywhere near topping up supply. Hydroelectric power is cost effective and does not suffer from intermittency, but has been linked to impacting on the ecosystems in which they are installed and affecting settlements and livelihoods.

Very large-scale production of renewable energy, especially via solar thermal and PV farms located at the most favorable regions, will involve long distance transmission. European supply from solar thermal fields will probably have to be via several thousand-kilometer long HVDC (high-voltage, direct current) lines from North Africa and the Middle East. Expected power losses from long distance plus local distribution are predicted to be around 15 percent. This makes it different from coal, natural gas, and nuclear, and in some senses worse. It means that it can't supply 100 percent of our needs, and intermittency needs to be factored into any electricity system design. An intelligently designed energy system using very basic "smart grid" technology could easily support up to 25 percent production from intermittent renewables without significant strain on resources.

AGREE 5: Demand is increasing globally

The total world energy demand is for about 400 quadrillion British Thermal Units (BTUs) annually. One 'BTU' is about the energy and heat generated by a match. Oil, coal and natural gas supply about 350 quadrillion BTUs. Oil provides most of this, around 41 percent of the world's total energy supplies (164 quadrillion BTUs). Coal provides 24 percent (96 quadrillion BTUs), and natural gas provides the remaining 22 percent (88 quadrillion BTUs).

By the year 2020, world energy consumption is projected to increase by around 50 percent – an additional 207 quadrillion BTUs. As outlined in previous points, renewable energies would not be able to meet this increasing demand.

DISAGREE 1: Leaving fossil fuels in the ground is good for everyone

"To deliver a 50% probability (which is not exactly reassuring) of no more than 2C of warming this century, the world would have to leave two-thirds of its fossil fuel reserves unexploited. I should point out that reserves are just a small fraction of resources (which means all the minerals in the Earth's crust). The reserve is that proportion of a mineral resource which has been discovered, quantified and is viable to exploit in current conditions: in other words, that's good to go…. a third of the world's oil reserves, half its gas reserves and 80% of its coal reserves must be left untouched to avert extremely dangerous levels of global warming. 2C is dangerous enough; at present we are on course for around 5C by the time the century ends, with no obvious end in sight beyond 2100." (George Monbiot, The Guardian, 2015)

[and]

“The major thrust of climate-change claims is that man is destroying the planet. There is much evidence to show that we are the greatest burden that Earth has to bear. To simply rape the earth of all its fossil-fuels would be gross folly.” (Dr. Peter Langdon)

Fossil fuels are not renewable, they can’t be made again. Once they are gone, they’re gone.

DISAGREE 2: Renewable energy can meet energy needs in a safe and reliable way

“…The key is to have a mix of sources spread over a wide area: solar and wind power, biogas, biomass and geothermal sources. In the future, ocean energy can contribute. Intelligent technologies can track and manage energy use patterns, provide flexible power that follows demand through the day, use better storage options and group producers together to form virtual power plants. With all these solutions we can secure the renewable energy future needed. We just need smart grids to put it all together and effectively ‘keep the lights on’”. (Greenpeace.org 2014)

[and]

“There’s no shortage of renewable energy from the sun, wind and water and even stuff usually thought of as garbage — dead trees, tree branches, yard clippings, left-over crops, sawdust, even livestock manure, can produce electricity and fuels — resources collectively called ‘biomass’… The sunlight … in one day contains more than twice the energy we consume in an entire year. … Clean energy sources can be harnessed to produce electricity, process heat, fuel and valuable chemicals with less impact on the environment.” (California Energy Commission 2006)

Continued research has made renewable energy more affordable today than 25 years ago. The cost of wind energy has declined from 40 cents per kilowatt-hour to less than 5 cents. The cost of electricity from the sun, through photovoltaics (literally meaning “light-electricity”) has dropped from more than $1/kilowatt-hour in 1980 to nearly 20cents/kilowatt-hour today. And ethanol fuel costs have plummeted from $4 per gallon in the early 1980s to $1.20 today.

The amount of energy used in Irish homes has decreased by 32 per cent since 1990 despite a 50 per cent increase in the average floor area of residential properties. Renewable energy last year accounted for 21% of the amount used in the electricity sector, 5.7% of the amount used for heat and 4.9 per cent of that used in transport.

By 2050 almost all of global energy needs can be met with renewable energy share: 41 percent by 2030 and 82 percent by 2050. That would be the global electricity supply- energy used in buildings and industry, would come from renewable energy sources. The transport sector, in particular aviation and shipping, would be the last sector to become fossil fuel free.

Already many countries throughout the world are committing to a future that will be powered by renewables. For example:

– Germany, currently generates 25 percent of its electricity from renewables and is aiming for 80 percent by 2050

– Spain's top source of electricity in 2013 was wind power, ahead of nuclear, coal and gas. Renewables supplied 42 percent of mainland Spain's electricity in the same year

– In 2012 China's wind power generation increased more than generation from coal

– The Philippines produces 29 percent of its electricity with renewables, targeting 40 percent by 2020

– Denmark is aiming to produce 100 percent of its heat and power with renewable energy by 2035 and all energy by 2050.

– Emerging economies like South Africa, China and Brazil are setting the pace for renewable energies. Investments in renewables from these economies was US$112 billion in 2012, which is close to the US$132 billion that developed countries invested.

Emerging economies do not need to go down a path of relying on fossil fuels. Just as many developing countries skipped landlines and went straight to cellular telephones, these countries can leapfrog right to affordable clean energy. Many have already taken advantage of the benefits of renewable energy and recognised the long-term benefits. For example, in Uganda less than 15% of a total population of 38 million people, have access to electricity. The majority of the population is dependent on kerosene or charcoal for their energy and light, both of which are expensive and environmentally damaging. Yet, the population is embracing the potential for clean energy alternatives being promoted within the country.

Intermittency is an issue at the moment as the technology is expanding, but it can be managed by thinking about the overall energy system. Over reliance on one renewable technology could result both in massive variability in output over short time periods and in severe risk of big gaps in generation.

The way round this is:

a) a dispersed portfolio of generation connected by a wide grid and

b) clean gas on standby

DISAGREE 3: Fossil Fuel energy costs do not factor in all the 'hidden' costs

"Investing in clean energy is not only good for economic growth, it is good for people. The unfortunate reality is that those in the poorest countries are often the most vulnerable to climate change — whether from rising seas that threaten homes and water supplies or droughts that drive up food prices. This is the human cost of fossil fuels that often goes unmentioned in balance sheets and gross domestic product statistics."

If the full cost of fossil fuel generation (including climate impact) were included then the costs would be comparable.

“Typically, the ones who claim that wind and solar will bring trouble to the grid are the old players, who failed to take renewable energy seriously and over-invested in fossil fuel capacities instead. Renewable energy is now eating their profits and making their old business models out-of-date” (Greenpeace.de)

“Those who argue that wind is expensive and unnecessary are quite simply wrong. Because Ireland has such a good wind energy resource, we can get cheap clean electricity from it. Making comparisons with other countries about wind effectiveness is not always valid. Ireland has a uniquely strong resource. We have one of the lowest support regimes and wind is not raising electricity prices.”(Sustainable Energy Authority of Ireland 2014)

Ireland is highly dependent on imported fossil fuels – for 89 per cent of its energy, spending €6.5 billion per year on imports – just over half of this on transport. In the past five years renewable energy has saved over €1 billion in fossil fuel imports; has reduced CO2 emissions by 12 million tonnes and has not added to consumers’ bills. The potential for wind and others provides the opportunity for greater energy independence, reducing carbon footprint, national competitiveness leading to greater control over energy prices.

Growing our use of renewable energy is also vital for our national competitiveness, giving us greater control over our energy prices.

“Less reliance on fossil fuels gives us greater certainty on our energy prices, rather than leaving us at the mercy of international commodity price rises. It also helps attract foreign investment, as more global companies seek access to clean energy as part of their location decisions.” (SEAI 2014)

The costs of some renewable energy inputs such as Photovoltaic solar panels have halved in price since 2008 and the capital cost of a solar-power plant—of which panels account for slightly under half—fell by 22 percent between 2010 and 2013. In a few sunny places, solar power is providing electricity to the grid as cheaply as conventional coal- or gas-fired power plants.

As the large utilities’ fossil and nuclear plants become more expensive and alternatives become cheaper, savvy consumers are looking to decrease their dependence on the utilities’ power supply. To cope, the utilities are trying to decouple their increasing costs from the amount of electricity they sell, further increasing the cost advantages of renewables and other alternatives. Renewables, with zero-marginal-costs, helped push down wholesale prices to 8-year lows in 2013.

Most sources of electricity, including coal, natural gas, and nuclear are and have historically been subsidized with both implicit and explicit subsidies, including the same types of tax credits afforded to wind and solar. For example:

Explicit subsidies: Nuclear receives a Production Tax Credit, similar to Wind. Natural Gas gets access to the Oil and Gas Exploration & Development Expensing subsidy.

Implicit subsidies through the taxpayer for example in the US, subsidies cover the costs of catastrophic insurance for nuclear plants, because there is no way their owners could afford to clean up after a Fukushima-style disaster. And, of course, the ultimate implicit subsidy – the cost of environmental damage due to pollution and CO2 production, for which we all pay and will continue to pay for generations.

Also hidden costs such as bonus payouts to CEOs of the top 5 oil companies estimated at US$1tn (£650bn or €888bn) for fossil fuel exploration and extraction over nine years, reflecting the confidence of top oil companies that demand will remain high for decades to come.

The combined 2014 upstream (Upstream operations deal primarily with the exploration stages of the oil and gas industry, with upstream firms taking the first steps to first locate, test and drill for oil and gas. Later, once reserves are proven, upstream firms will extract any oil and gas from the reserve) capital spending bill for the big five is three and a half times the sum devoted to research and development by the world's five biggest-spending drug firms. It is also equivalent to more than 14% of the combined stock market value of Exxon Mobil, Shell, Chevron, Total and BP.

Currently, renewables are more expensive than fossil fuels. But this is changing rapidly. There are various types of renewables – onshore wind is the most cost competitive and offshore wind is heading that way but will likely remain more expensive; the large-scale solar power costs are rapidly reducing, hydro power – marine, tidal stream, dams, run-of-river – are currently more expensive but some large-scale projects such as the Severn Barrage in the UK are competitive.

Given the interest in the private sector for renewable energy – it must be big business, with giants like Wal-Mart, Google and General Electric that have been increasing in clean energy investments. Billionaire Warren Buffett recently spent US$5.6 billion for a renewable energy company in Nevada and a US$2.4 billion investment in a wind farm in California. Many oil companies are involved in the development of more reliable renewable energy technologies. Already for example, BP has become one of the world's leading providers of solar energy through its BP Solar division. Dong Energy and EDP have built up balanced energy portfolios which include higher shares of renewables. Their renewable assets are making more profits than their thermal ones.

Fossil fuel companies are benefiting from global subsidies of US$5.3tn (£3.4tn) a year, equivalent to US$10m a minute every day. This subsidy estimated for 2015 is greater than the total health spending of all the world's governments and 6.5% of global GDP. The vast sum is largely due to polluters not paying the costs imposed on governments by the burning of coal, oil and gas. These include the harm caused to local populations by air pollution as well as to people across the globe affected by the floods, droughts and storms being driven by climate change.

“This very important analysis shatters the myth that fossil fuels are cheap by showing just how huge their real costs are. There is no justification for these enormous subsidies for fossil fuels, which distort markets and damage economies, particularly in poorer countries… A more complete estimate of the costs due to climate change would show the implicit subsidies for fossil fuels are much bigger even than this report suggests.” (IMF 2015)

The need for subsidies for renewable energy –$120bn a year – would disappear if fossil fuel prices reflected the full cost of their impacts.

DISAGREE 4: Many renewable technologies are scalable, and perceived problems regarding land, noise and animal welfare can be overcome.

Many renewable technologies are very scalable. The much hyped DeserTec project pointed to a new model for electricity generation for Europe with massive PV arrays in North Africa. Difficult, expensive… but do-able.

All of the scalability problems are surmountable. Doing so requires a new, far more complex, energy system with new technologies and new policy tools.

“The really fun bit will come when electric vehicles and demand-side-management become a mainstream reality. Finally, we would have the beginnings of a sustainable energy system.”

Land use: The land used for renewable energy projects, like wind farms, can still be used for farming and cattle grazing. International experience has shown that livestock are completely unaffected by the presence of wind farms and will often graze right up to the base of wind turbines.

Noise: Studies have shown that noise complaints, especially those related to wind farms, are often unrelated to actual noise. In most cases it was found that people were actually opposed to the farms on aesthetic grounds – which would be the same with coal or nuclear plants. It was also found that ‘noise’ complaints dropped off rapidly when local communities derived income from the renewable energy projects in question.

Birds and bats: A common argument against wind farms is that they kill birds and bats. However, if environmental impact assessments are conducted and migratory and local bird population patterns are assessed before construction, this is avoided completely. It is vital that these assessments are made to ensure the safety of birds and bats, as with any development project.

DISAGREE 5: Demand is decreasing in significant parts of the world, for example the European Union

Total and peak electricity demand in the European Union started to slow in the 1990s, and have been falling since 2007 (with the exception of in 2009). Total demand in the EU-27 fell by around 2.5% from 2007 to 2012. Demand also fell in several large national markets: by 7.5% in the UK, 4.3% in Italy, 3.4% in Spain and 3.2% in Germany. In the first 11 months of 2013, demand fell by a further 2.6% in Spain and 3.5% in Italy (where Enel,

the country's major electricity producer, reported an even larger drop in its nine-month report); in the first nine months of 2013, demand in Germany fell by1.1 percent.

Europe today has about twice as much installed generation capacity as peak demand would warrant.

Source: The energy debate: Renewable energy cannot replace fossil fuels

States were edited reference to: Energy mix, Our world in data

E.7.4. Useful links

The Engineering Challenges of Renewable Energy

http://simplicityinstitute.org/ted-trainer

Message #8: Clean Energy Sources

1. Design Map:

Activity Code	E.8.
Activity Title	Energy from waste
Activity Type	Group Work, Experiment
Activity Location	Lab
Duration	75 Min
Optimum no. / grouping	50 learners / Groups of 6
Prerequisites	None
Short description	Each learners' team receives an envelope containing cards for some stages of converting solar/wind/hydro energy into electrical energy. Learners work in groups to put the stages in order. Then explore how certain forms of garbage (biomass) could be used as a source of energy, through an experiment that shows which forms of biomass produce the most gas– that could then be used as an alternative form of renewable energy.
Learning Outcomes	1. Learners explain key stages involved in converting solar/wind/hydroelectric/ biomass energy into electrical energy. 2. Learners discuss the benefits of clean/renewable energy sources. 3. Learners explore how to extract energy from common forms of household waste (i.e., food scraps, grass cuttings, leaves).
Skills	Leadership, Interpersonal, Communication, Analytical Thinking, Team Work
Values	Adherence to time, Responsibility, Personal cleanliness, Environmental cleanliness, Trustworthiness, being Pro-active, Collective responsibility, patience, Open mindedness and ability to think logically, Sensitivity to social issues in the community
Keywords	#Grades: 6 to 9, Energy, Biomass, Energy transformation
Necessary Materials	Presentation tools & slides, Energy Transformation cards "annex E.8.1", Plastic bottles, food scraps, grass cuttings, leaves, animal manure
Assessment method	Observation, Oral
Link to MOE's cur.:	Geography, Agriculture
References	Benefits of Renewable Energy Use. Union of Concerned Scientists. (2017). https://www.ucsusa.org/resources/benefits-renewable-energy-use. National Geographic Society. (2012, November 14). biomass energy. National Geographic Society. https://www.nationalgeographic.org/encyclopedia/biomass-energy/.

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Preparation	10 Min	● Prepare the Energy Transformation cards “see annex E.8.1”	Sets of Energy cards for each group
Explain key stages involved in converting solar/wind/hydroelectric/ biomass energy into electrical energy	15 Min	● Divide learners into groups of six ● Give each group the three sets of cards solar, wind and hydroelectric ● Ask the learners to work in groups to put the stages of energy conversion in order so that it clearly shows the stages of energy transformation from different formats into electric energy. ● Call on one group at a time to provide one stage. Once a group suggests the next stage, ask the rest of the class whether they agree or not and if they placed it differently so that the entire class works together to complete the task. ● Lead a discussion to encourage learners to think of the benefits of renewable energy “see annex E.8.2”	Presentation
Onboarding	10 Min	● Invite learners to consider the following questions either individually or in small groups and then ask learners to share their answers with the entire class. Write the core ideas on the board. • How much garbage do you throw out at home? • What kind of stuff do you throw out? • Could any of these materials be used in some way to create energy? • Are there other waste products that you would use as a form of energy? For example, from the garden? (Grass cuttings, wood, leaves, etc.) “The core idea is to get learners to identify those certain forms of organic waste could be used as a source of energy”	Presentation
Reflect on what the biomass is?		● Invites suggestions from learners on what they think biomass is, then introduce the meaning of biomass to them “annex E.8.3”	none

Explore how to extract energy from common forms of household waste (i.e., food scraps, grass cuttings, leaves).	40 Min	● Inform learners that they will be testing different types of garbage to see which produces the most biogas and therefore which would be best to use as a source of energy. ● Inform learners that they will have the following materials to conduct the experiment: plastic bottles, balloons, and various forms of garbage (leaves, cut grass, various forms of food scraps). ● Give learners five minutes to figure out how they should conduct the experiment and why, then ask the groups to provide their suggestions. ● Ask learners to place different forms of garbage into each bottle (have one bottle for each type of garbage you are using). One control bottle with nothing inside should also be included. ● Each bottle should be labelled with the appropriate label stating what is inside the bottle. ● Balloons are placed on the top of each bottle and are sealed to ensure that no gas can get in or out. This experiment works best within an anaerobic environment, which means without oxygen, therefore the less oxygen that is in the bottle or can get into the bottle the better. ● The bottles are left for several days or a week and are checked by learners each day. Differences in the bottles and/or balloons are noted. Some of the balloons will be inflated while others will not (i.e., the control bottle). ● Invite learners to make suggestions about what has happened and why have some balloons inflated. “Bacteria have broken down the biomass into gas. This gas is called methane and can be referred to as biogas. This has happened within an anaerobic environment - which means that there was not any oxygen” ● Based on the results (which balloons had most gas in it) learners are encouraged to decide which forms of garbage would provide the best form of energy (biomass). The more energy a sample of garbage has, the greater the volume of gas released and, in turn, the bigger the inflation of the corresponding balloon. ● Lead discussion to insure understanding	Plastic bottles, food scraps, grass cuttings, leaves, animal manure

3. Assessment

- Call on groups to explain the stages involved in converting solar, wind, and hydroelectric energy into electrical energy.
- Observe the level of participation of learners in the group activities.
- Complete a self-assessment sheet regarding the level of team work in their groups.
- Assess learners' ability to plan, conduct and draw conclusions from the experiment.
    - Conduction of the experiment: Did learners control the variables? – e.g., use the same amount of garbage in each bottle, leave all bottles for the same amount of time, etc.
    - Conclusion: The best energy source would have inflated its balloon more than the others.
- Ask learners to explain what is meant by biomass.

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

Inspire learners to work with their families to donate the used oil instead of throwing it away. Some companies like Green Pan help people dispose of their used oil where they recycle the oil to produce biofuel and other products like soap.

Green Pan: https://www.facebook.com/Greenpan.service/

5. Possible adaptation

In order to speed the process up, the teacher could set up the bottles with their content needed for this experiment a week or two before conducting it with learners. Then after getting learners to conduct the experiment themselves, use the bottles that were prepared a few weeks before to show the results/ outcomes. This would mean that the entire experiment can be completed during one session/ day rather than over a few weeks.

Annex “Teacher’s Background Information”

E.8.1. Energy transformation cards “Each table is to be cut into a number of separate cards forming a set”

Solar Energy	The sun produces energy.	Sunlight is composed of photons which strike the solar panels (photovoltaic cells) and are absorbed.
The structure of electrodes in the PV Cell allows these electrons to flow to the load.	The sun’s rays reach the Earth.	The photons free electrons in the PV Cell.
Electricity is produced.		

Wind Energy	The sun produces energy.	Air above land heats up quicker than air over water.
Wind strikes the wind turbines.	The sun’s rays reach the Earth.	The warmer air over land expands and rises and the cooler air over water moves in
The wind flows over the blades of the turbines creating lift which causes them to turn.	The blades are connected to a drive shaft that turns an electric generator.	Electricity is produced.

Hydroelectric Energy	The sun produces energy.	Energy from the sun heats water causing it to evaporate.
In a hydroelectric dam, the water flows through pipes onto turbines.	The sun’s rays reach the Earth.	Water vapor condenses into clouds and falls back onto Earth as rain.
The water pushes against and turns the blades of the turbine.	When the blades move a generator spins.	Electricity is produced.

E.8.2. Benefits of renewable energy use

- Less global warming

  Human activity is overloading our atmosphere with carbon dioxide and other global warming emissions. These gases act like a blanket, trapping heat. The result is a web of significant and harmful impacts, from stronger, more frequent storms, to drought, sea level rise, and extinction.

- Improved public health

  The air and water pollution emitted by coal and natural gas plants is linked with breathing problems, neurological damage, heart attacks, cancer, premature death, and a host of other serious problems.

- Inexhaustible energy

  Strong winds, sunny skies, abundant plant matter, heat from the earth, and fast-moving water can each provide a vast and constantly replenished supply of energy.

- Jobs and other economic benefits

  Compared with fossil fuel technologies, which are typically mechanized and capital intensive, the renewable energy industry is more labor intensive. Solar panels need humans to install them; wind farms need technicians for maintenance.

- Stable energy prices

  Renewable energy is providing affordable electricity across the country right now, and can help stabilize energy prices in the future. Although renewable facilities require upfront investments to build, they can then operate at very low cost (for most clean energy technologies, the “fuel” is free). As a result, renewable energy prices can be very stable over time.

- Reliability and resilience

  Wind and solar are less prone to large-scale failure because they are distributed and modular. Distributed systems are spread out over a large geographical area, so a severe weather event in one location will not cut off power to an entire region. Modular systems are composed of numerous individual wind turbines or solar arrays. Even if some of the equipment in the system is damaged, the rest can typically continue to operate.

  Source: Benefits of Renewable Energy Use

E.8.3. Biomass

Biomass is a living material that comes from plants and animals, such as wood, dried vegetation, cow manure and food scraps. Biomass contains stored energy from the Sun. Plants absorb the Sun's energy during photosynthesis, which converts the solar energy into chemical energy. When the plants die, the chemical energy is trapped inside and can be released by burning. This chemical energy in biomass is released in the form of heat. This kind of renewable energy that is created through biomass is called bioenergy.

People have used biomass energy—energy from living things—since the earliest "cave men" first made wood fires for cooking or keeping warm. Biomass is organic, meaning it is made of material that comes from living organisms, such as plants and animals. The most common biomass materials used for energy are plants, wood, and waste. These are called biomass feedstocks. Biomass energy can also be a non-renewable energy source. Biomass contains energy first derived from the sun: Plants absorb the sun's energy through photosynthesis, and convert carbon dioxide and water into nutrients (carbohydrates). The energy from these organisms can be transformed into usable energy through direct and indirect means. Biomass can be burned to create heat (direct), converted into electricity (direct), or processed into biofuel (indirect).

Source: Biomass energy

E.8.4. Useful links

What Is Biomass?

Message #9: Energy Efficiency & Conservation

1. Design Map:

Activity Code	E.9
Activity Title	Energy wasters
Activity Type	Group Work
Activity Location	Classroom
Duration	65 Min
Optimum no. / grouping	40 Learners / Groups of 5
Prerequisites	Understand some basic concepts about energy like energy conversion
Short description	Learners discuss their daily habits when using energy resources and reflect on some of the actions that don't utilize the use of energy and result in waste.
Learning outcomes	1. Learners identify all the different ways in which energy is being wasted. 2. Learners reflect on their own behavior and level of energy usage. 3. Learners develop an appreciation of energy conservation by outlining key changes they can make to their own level of energy usage.
Skills	Interpersonal, Intrapersonal, Communication, Team Work, Observation, Analytical Thinking
Values	Generosity, Self-confidence, admitting one's mistake, Just, Responsibility, Collective responsibility
Keywords	#Grades: 6 to 9, Energy, Waste
Necessary Materials	Flip chart, post-it notes, tack-it
Assessment method	Observation, Written, Oral
Link to MOE's cur.:	Religion, Conservation of the Environment
References	Brasler, K. (2021, March 16). Perspective | 15 painless ways to reduce your home's energy use. The Washington Post. https://www.washingtonpost.com/business/2021/03/22/15-painless-ways-reduce-your-homes-energy-use/.

3. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Preparation	10 Min	● Divide the learners into groups of five ● Give each group post-it notes block, flip chart papers, tack-it	None
Reflect on one's behavior in terms of energy usage	40 Min	● Hold a brainstorming session. Where each learner in their group has to reflect on their previous day about their energy usage and discuss with the group if there was an unnecessary waste in energy consumption. ● Assign one member of each group as the note taker. This person must ensure that the key points from the group discussion are recorded accurately using the energy usage tracking table "see annex E.9.1". Discussion should be about how much time they spent using energy, what they were doing, and if possible, what is the source of energy used. The group can use the reflective questions "see annex E.9.1" ● Ask each group to write every way they wasted energy on a post-it note and stick it on the flip chart paper ● Finally ask each group to hang the flip chart and start presenting all the ways that they think was a waste for energy to the class	Flip chart, post-it notes, tack-it
Develop an appreciation for energy conservation by outlining key changes they can make to their own level of energy usage.	15 Min	● Lead a group discussion about how the ways of wasting energy are much more than we think "annex E.9.2" ▪ What waste happen when we through the food leftovers ▪ What waste happens when we rely on products from abroad. Very far from where we live	None

4. Assessment

- Review each group's sheet and discuss it with them
- Make sure that the class or groups advise five actions they can take to reduce their level of energy usage. To be written on a poster/board and revisited by the teacher during the coming weeks.
- Assess learners' interaction during the group discussion and presentation

5. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

Guide the entire class or the groups to outline key actions they can adopt as a result of the lessons' findings (this can be completed as a whole class activity or else working in the same groups again). Are there changes they can make in their use of energy in the future? What would they be prepared to do to reduce the amount of energy they use?

6. Possible adaptation

For younger learners, the table can be replaced by an image. Where learners either work alone or in groups to identify all the examples of energy wasting in the picture.

Annex “Teacher’s Background Information”

E.9.1. Energy usage tracking

#	Activity Type	Energy Source	Duration	Was there waste
1	i.e., Watching T.V.	Electric Energy	50 Minutes	Yes. Wasn’t really watching, was on my phone
2				
3				
..				
30				

Reflective questions

- Are there aspects of the table that the group had in common, i.e. did you use energy for the same things?
- Are there aspects of the table that were different amongst the group members? (Did some use a lot less energy?
- Who used the most energy? Why did they use the most?
- Extent to which you actually needed to use a lot of the energy you did, i.e. could you have done without some activities?
- How many of the energy sources that you used were non-renewable? Were any renewable (that you are aware of)?
- Do you think that you wasted energy? Could you cut down on the amount of energy used if you were to do this table again?
- Do you think the amount of energy you used could have led to an increase in pollution levels?

E.9.2. Surprising energy wasters

We are an energy-hungry species, and when it comes to meeting tomorrow’s demands we tend to focus on things like more fuel, new technologies, and better energy efficiency. But we don’t think about this. About 40% of the food in the United States is never eaten, it skips our dinner table and goes straight in the trash can. Along with it, we throw away a quarter of our freshwater, a third of our fertilizer, and along with all the transportation, packaging, and processing at every step, a total of 2% of the total energy we consume. The walk from your fridge to the couch isn’t very far, but the average American meal travels 1500 miles to reach

our plates. The calories we throw out translates to $600 per family per year. That's a lotta money. We plant too much, leave food in the field, and who really understands what that date on the milk carton means anyway? But 60% of our food waste happens at the last step: when we don't consume it. Energy waste is a big problem, and it's not limited to food. More than half of the energy we produce is wasted thanks to inefficiencies. Some are inevitable thanks to our pesky friend entropy, but many could be avoided. Everything from power plants to light bulbs gives off heat that usually isn't put to any use. And have you ever looked at the buildings in your city at night? Didn't your mother teach you to turn the lights off? 40% of our energy goes to transportation, usually as fossil fuels, and a whopping 75% of that is wasted, right out the tailpipe. Burning gasoline to move around big hunks of metal holding one person turns out to be a pretty inefficient way to get around. Planes and ships aren't much better. It takes a lot of energy to keep a metal tube flying through the sky, and one container ship is as fuel hungry as 50 million cars. Water is an energy catch-22 all its own. It takes energy to get water, but we need water to make energy. H2O is used in mining and fracking, to cool reactors, to make steam, to grow crops for biofuels, and to just turn turbines. Power plants alone account for about 3% of total water consumption in the U.S. Only 2.5% of Earth's water is fresh, and even less is accessible in lakes and rivers. Water, water everywhere, and not a drop to turn into a kilowatt-hour. Americans use 13% of their energy to clean water and move it from place to place. The largest electrical consumer in thirsty California? The California Aqueduct. Unfortunately, pumping billions of gallons of water over 700 miles from the mountains to Los Angeles is still cheaper than making the ocean drinkable. So what can we do? A million things, but here's a few ideas: Engineers are researching ways to turn waste heat from cars and power plants back into electricity. And if we're going to keep throwing things away, we should harness landfill gas and turn it back into usable energy. Make buildings more intelligent so they use energy when and where it's needed. And maybe we could turn off some lights. We need to change the way we produce and distribute food and water. Educate people on making smart food choices, so we throw away less and eat more, from closer to home. And of course, turn off the water when you're brushing your teeth. If you've got more ideas, leave them in the comments. Or better yet, go out and invent it. We're a thirsty species, and a hungry one too. For our future, let's waste not, and want less.

Written by: Joe Hanson, Ph.D.

Source: [The Surprising Places We Waste Energy]

E.9.3. Painless ways to reduce your home's energy use

- Check for leaks

  Start by assessing how your home passively wastes energy. Most homes have holes, cracks and gaps that let cold air in and warm air out in the winter — and do the reverse in the summer.
- Lose inefficient lighting

  Using efficient LED or CFL lights instead of incandescent will save on average 35 percent off the lighting costs each year.
- Pull some plugs

Most plugged-in devices consume electricity even when not in use.

- Replace HVAC filters

  A dirty filter makes your system work harder than it should, reducing performance and energy efficiency. Plus it could spread dust.

- Get rid of extra fridges and freezers
- Turn out the lights!

  You can install motion-detecting switches that automatically turn off lights when no one is in the room — or if you sit still for too long. Occupancy sensors are less frustrating: They turn on lights when someone enters and then off again when they leave.

- Wash clothes in cold water

  According to Energy Star, as much as 90 percent of the energy used to wash clothes comes from heating water. In Consumer Reports' tests, cold water sufficiently cleans most loads.

- Do dishes wisely

Source: 15 painless ways to reduce your home's energy use

S.2.4. Useful links

https://www.dw.com/ar/%D8%A7%D9%84%D8%B7%D8%A7%D9%82%D8%A9-%D8%A7%D9%84%D9%85%D8%AA%D8%AC%D8%AF%D8%AF%D8%A9-%D9%87%D8%AF%D9%8A%D8%A9-%D9%85%D9%86-%D8%A7%D9%84%D8%B7%D8%A8%D9%8A%D8%B9%D8%A9-%D9%88%D9%81%D8%B1%D8%B5%D8%A9-%D9%84%D8%AD%D9%8A%D8%A7%D8%A9-%D8%A3%D9%81%D8%B6%D9%84/a-1796571

https://www.dw.com/ar/%D9%86%D8%B5%D8%A7%D8%A6%D8%AD-%D9%85%D8%B6%D9%85%D9%88%D9%86%D8%A9-%D9%84%D8%AA%D9%88%D9%81%D9%8A%D8%B1-%D8%A7%D8%B3%D8%AA%D9%87%D9%84%D8%A7%D9%83-%D8%A7%D9%84%D8%B7%D8%A7%D9%82%D8%A9-%D9%81%D9%8A-%D8%A7%D9%84%D9%85%D9%86%D8%A7%D8%B2%D9%84/a-18454484

https://www.youtube.com/watch?v=1wrnQsqbSig

Message #10: Desertification: Soil degradation

1. Design Map:

Activity Code	D.10
Activity Title	Egypt Soils
Activity Type	Discussion and Experiment
Activity Location	Classroom / Science lab
Duration	120 Minutes
Optimum no. / grouping	40 Learners / Groups of 6
Prerequisites	Soil types lesson, Ministry of Education Curriculum
Short description	Learners will learn about different types of soil, the value of each and their distribution in Egypt then they will determine what is the best soil for agriculture through experiments and hands-on activity.
Learning outcomes	1. Learners examine, analyze, and recognize different kinds of soil, describe their properties and textures, and water holding capacity. 2. Learners will learn about which plants are suitable for each kind of soil. 3. Learners will be able to link between overpopulation in Egypt and the stress on the agricultural lands. 4. Learners will be able to explore the relationship between high population levels and consumption levels.
Skills	Teamwork, communication, observation, examination, and critical thinking skills
Values	Responsibility, Self-confidence, Adherence to time, Value self-respect, Personal cleanliness, Environmental cleanliness, Being Pro-active, Gratefulness, Open mindedness and ability to think logically, Sensitivity to social issues in the community
Keywords	Desertification, Soil, Agriculture
Necessary Materials	3 Containers each contain different soil type “Sandy, clay, and silt soil” for each group, 6 Jars for each group; One large Map of Egypt, a photo of soil texture triangle for each group; filter paper or Coffee filter; watercress seeds; pots or other planting containers
Assessment method	Observation, short written piece
Link to MOE’s cur.:	Social Studies: Population distribution in Egypt. Science: Soil types
References	Jar Test: https://growitbuildit.com/mason-jar-soil-test-clay-sand-silt/

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Preparations	–	● Prepare 3 soil samples, 6 jars, 3 filter papers, and a photo of the soil texture triangle "see annex S.2.1". A large physical map of Egypt needs to be hung up in the classroom	3 soil samples, 6 jars, 3 filter papers, a copy of the soil texture triangle "see annex S.2.1", a large physical map of Egypt
Onboarding	15 Min.	● Divide the learners into groups of 5. ● Ask the learners reflect on the school curriculum's "soil types" lessons or their previous information about soils ● Write the learners answers' keywords on the board	board, board pens
Examine, analyze, and recognize different kinds of soil	30 Min.	● Ask learners to touch the different soil types and describe its feeling, color, texture, and particle size ● Make a table of 3 columns for each soil type on the whiteboard and write the learner's insights. ● From learners' reflections differentiate between the 3 types.	3 Soil types Sample
Observe water holding capacity of each soil and link this criterion to the soil composition	30 Min.	● Ask the learner what soil type do they think will hold the most amount of water? ● Then, ask learners to do a water holding capacity test "The 3 soil types should each be put in a filter paper above an empty glass and the same amount of water should be poured over them" The test is to show that the sandy soil keeps less water than the other soils. ● After that, ask learners to do a soil component test (Jar test). "The jar test explanation is in the annex D.10.2" ● Link between (jar test) results and soil texture triangle. "Annex D.10.1 and D.10.2"	6 Jars for each group; Filter paper; Water
Map different types of soil location on Egypt's map link between overpopulation in Egypt and the stress on the agricultural lands	15 Min.	● Ask the learners to use the map of Egypt to search for desert lands, the Nile delta and agricultural land beside the Nile. They then relate these parts to the soil samples. The conclusion might be that presently, in order to grow food, the suitable area is too small to feed all 100 million people, so it is necessary to transform parts of the desert into green land.	Egypt Map "map should show natural resources as well as some demographics like population"

		● Finally, point to a region in Egypt, e.g., the delta and ask the learners which crops grow there. Collect the answers on the whiteboard. Do the same with the Nile valley, Sinai, and the oasis. Examples for the crops in each region: ▪ Delta Black Soil: rice, cotton ▪ Oases Mainly Sandy Soil: dates, liquorice, potatoes, turnips ▪ Cultivated land Yellow Soil: vegetables, fruits	
Explore how soil type affect crops growth rate	30 Min	● Guide the learners to prepare the 3 types of soil ▪ Salty soil "this can be achieved by adding salt to the sand or Over chemical fertilizing which increases soil salinity" ▪ Normal soil ▪ Quality compost soil: Adding compost to the soil ● Watercress seeds should be planted in the three types of soil and the learners should come up with assumptions on the outcome of the test and observe it for the upcoming weeks	Salt; Compost; water cress seeds; Planting pots

3. Assessment

Evaluate learners' engagement in class and in their discussions. Assign them to write a brief piece about what they have observed during the experiments and what they learned.

4. Suggestions for extended activities at home

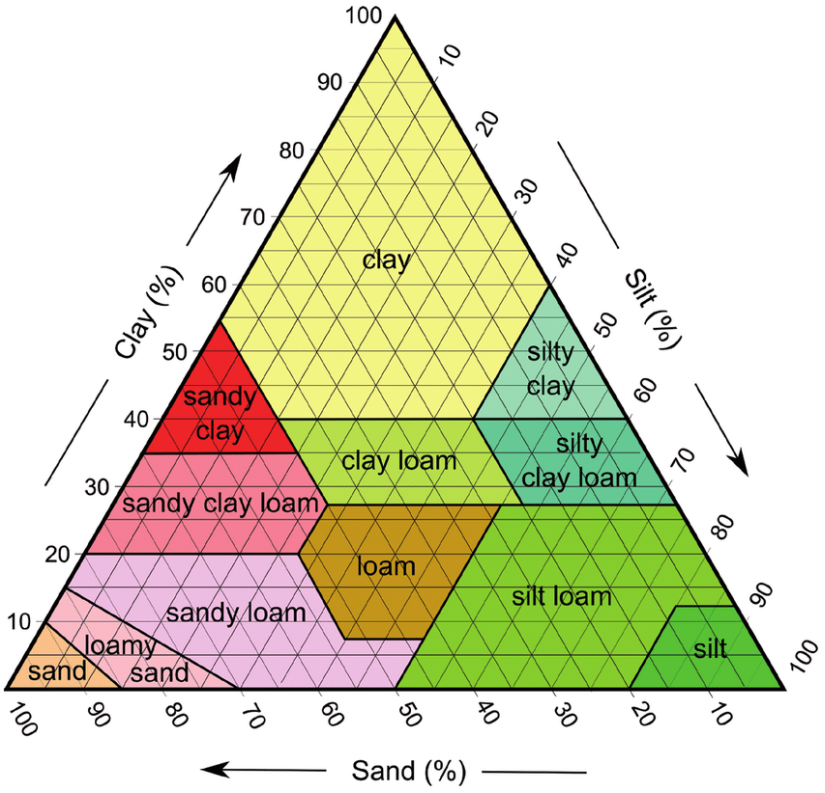
Learners create a suitable soil pot at home and start planting some seeds. After that, the plant can be moved to the home garden or schoolyard with the addition of compost to help the soil.

5. Possible adaptation

You can divide the learners into groups so that each group focuses on a specific type of soil. After doing some research, each group makes a presentation about their soil type. Where is it located? What kind of biodiversity does it live in? What are its basic characteristics? If you find this soil in their area they may bring a sample for display with their presentation.

Annex “Teacher’s Background Information”

D.10.1 Soil texture triangle



Rhodes, C. (n.d.). A soil texture diagram soil types according to their clay silt and sand composition. Research Gate. https://www.researchgate.net/profile/Christopher-Rhodes-5/publication/235884102/figure/fig2/AS:601683109351428@1520463840129/A-soil-texture-diagram-soil-types-according-to-their-clay-silt-and-sand-composition-as.png .

D.10.2. Soil texture test (Jar test):

Steps to conduct the ‘jar test’ for soil texture

1. Gather Materials

Obtain the following materials before starting. You will need a glass jar with straight sides, a ruler, black marker, and granular dishwasher detergent. And, dig your soil.

For digging your soil, ensure you take a cross section of at least six inches depth (15 cm). Don’t just scrape the surface, as you want to get a complete picture of your soil.

2. Sift the soil

Place a kitchen strainer or sieve over a bucket and push the soil through. This will help break up the particles and remove any larger rocks or roots and other organic matter. (to get accurate results take the time to sift the soil!)

3. Add soil, water, and detergent to jar

Fill the glass jar to approximately 1/3 full with the finely sifted soil. Add 1 tablespoon of granular dishwashing detergent. Then fill the jar with water to almost the top, leaving a gap.

4. Shake the jar

Secure the lid to the jar tightly. Then shake up the mixture until the mixture becomes uniform and slimey.

Then set the jar on a flat surface to rest

5. Mark the Sand Layer

After the mixture has set for one minute, mark the side of the jar with a black marker. This represents the sand component.

6. Mark the silt layer

After the mixture has set for two hours, mark the side of the jar. This represents the silt layer.

7. Mark the clay layer

After the mixture has set for 2-3 days and the water is clear, mark the final layer. This is the clay layer.

Interestingly enough the soil sample on the right has no identifiable clay layer. Even though it was taken only about 15 feet away from the sample on the left. Also note the difference in sand particle size

8. Determine the amounts of sand, silt, and clay.

Use your ruler to determine the total height of soil. But also record the individual heights of each layer.

Then, to calculate the proportions (percentages) of sand, silt, and clay use the formulas below. Additionally, I would like to point out that the 'total' height of mixture is the same as the clay layer.

% Sand = (height of sand) / (total height of mixture)

% Silt = [(height of silt) – (height of sand)] / (total height of mixture)

% Clay = 1 – %Sand – %Silt

9. Determine the soil type using the Soil texture triangle

You can use the USDA soil texture calculator to determine your exact soil classification.

Source: Testing Soil Texture – The Mason Jar Test

What does Soil Texture mean?

The soil is made up of 3 inorganic components, sand, silt, and clay. Knowing the proportions of each component can greatly aid you in optimizing your soil for vegetable production or adding amendments.

Any combination of these three elements that falls into the 'loam' category is considered a good base for a successful garden.

Sand

Sand is the largest particle size for soil components (0.10 to 2.0 mm). Pure sand will drain water and not hold nutrients. Just think of how little plant life you find on a beach! Sandy soil will be prone to drought and hold little in the way of nutrients.

Silt

The next smallest soil particles are considered silt, and are between 0.002-0.05 mm diameter. Silt is generally silica, rock or some other small inorganic particle. Silt will hold nutrients and water quite well, but still drain.

Clay

Clay is the smallest of soil particle sizes, coming in at anything less than 0.002 mm. Clay will compact quite easily and prevent water drainage. On the flip side though, it holds water and nutrients quite well.

D.10.3. Useful links:

Soil Jar test video

Alternative video in Arabic

https://www.nationalgeographic.com/culture/article/141205-world-soil-day-soil-agriculture-environment-ngfood

Message #11: Sustainable Farming / reforestation

1. Design Map:

Activity Code	D.11.
Activity Title	My Lovely Tree
Activity Type	Discussion / Planting project
Activity Location	Classroom / Computer lab / School yard
Duration	175 Min
Optimum no. / grouping	Whole class / Groups of 6 learners
Prerequisites	Learners should know the impact of tree planting in reducing the effects of climate change and its implications for water resources
Short description	Learners will learn about the trees and their importance for humans, biodiversity, and the whole planet through discussions and practical activities
Learning outcomes	1. Learners understand the impact of cutting down trees and deforestation on living things. 2. Learners identify all the factors that a tree needs to live and flourish. 3. Learners explore all the different plants and animals that depend on the trees for their survival. 4. Learners participate in campaigns to plant trees and contribute to reducing the negative impacts of climate change in their community.
Skills	Communication / Teamwork / Observation
Values	Compassion, Responsibility, Self-confidence, Respect for individual rights, Value self-respect, Personal cleanliness, Environmental cleanliness, Being Pro-active, Collective responsibility, Helping one another, Gratefulness, Sensitivity to social issues in the community
Keywords	Trees, biodiversity, animals, climate change, planting.
Necessary Materials	Sticky notes, 2 printed tree drawings on A3 paper for each group, 1 tree seedling for each group, planting tools
Assessment method	Observation, evaluation
Link to MOE's cur.:	Science, Plants
References	Parts of a tree and their functions. Science Facts. (2020, July 3). https://www.sciencefacts.net/parts-of-a-tree.html. What Makes Plants Grow: Plant Growing Needs. gardening know how. (n.d.). https://www.gardeningknowhow.com/special/children/how-plants-grow.htm. YouTube. (2020). YouTube. https://www.youtube.com/watch?v=lOy5wh9Ul40. Kerr, J. (2019, November 22). The Parts of Trees and Their Functions. Sciencing. https://sciencing.com/spanish-moss-poisonous-5717155.html.

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Onboarding	25 Min.	● Divide the learners into groups of 6 ● Lead a discussion about what are the main parts of any tree "Roots, trunk, leaves, flowers, and fruits) and the elements trees need to grow (Sun, temperature, soil, water, fertilizer, Air (O_2 + Co_2)"	none
To know the importance of the trees for humans, biodiversity, and the planet	40 Min	● Give each group two A3 printed tree drawings and sticky notes "see annex D.11.2" ● Ask learners to write as many names as they can for any creature "animal or insect" that they saw before on post it notes and stick them on one of their tree drawings. ● Ask learners to reflect on what we get from the trees (Benefits of the trees), write each benefit on post it note and stick them on the other tree ● Count the benefits each group added to the tree in the winning group is that who wrote the max number. ● Ask learners to hang the two winning paintings on the class wall ● Reflect on learners' answers with 2 videos: ▪ Who lives in trees? "see annex D.11.3" ▪ The Importance of trees "see annex D.11.3"	A3 Printed tree drawing, post it notes, projector and computer
Understand the impact of the cutting down trees and deforestation on living things	30 Min	● Play the What will happen if we cut all the trees down video "annex D.11.3 what will happen if we cut all the trees down video" ● Lead a discussion about the learners reflection on deforestation	Projector and pc
Take action towards deforestation "preparation for the activity"	20 Min	● Tell the learners that they will work together in a project to plant trees in the school area ● Assign the learners in their groups the following tasks: ▪ Determine the best location to plant the trees. And handle the planting day. ▪ With the support of the agriculture teacher, prepare logistics (Trees and planting tools which are compost, axe, shovel, gloves) ▪ Getting clearance from the school headmaster, telling the nearby neighbors about the activity, and asking them to take care of the trees "like watering them frequently". "Before communicating the tasks to the learners, you can engage them in thinking about the tasks that they need	None

		to do to execute the project. This will help them practice planning, then put the tasks in order and add any missing task"	
Take action towards deforestation "Main activity"	60 Min	● In the same learners group, the learners will implement the planting activity with science, social studies and agriculture teachers' support. ● Ask learners to give names to the trees they have planted and take care of them.	Plant seedlings, Planting tools
participate in campaigns to plant trees and contribute to reducing the negative impacts of climate change in their community	Next week	● Ask the learners to do research about Jadav Paying. And use their findings from the research and other resources to do an inspiring campaign to plant trees and contribute to reducing the negative impacts of climate change in their community. ● Follow up with the learners' groups their progress after a week	None

3. Assessment

- Assess the learners’ reflection of each group on what they have learned and the importance of the trees
- Observe the learners’ interaction in the activities and their project compilation
- Use an evaluation rubric to assess the learners' awareness campaign. Evaluation criteria might include finding reliable information, campaign design, execution, campaign reach and engagement and team work.

“Jadav Paying is an Indian man who was 16 years old when a series of floods followed by a severe drought in 1979 occurred in his hometown of Majuli (the largest river island in the world) in Assam, India. The devastation around him affected his feelings, leading him to vow to himself to plant a tree every day, and his forest today, after 39 years, is 1,360 acres, larger than New York's Central Park, which is 840 acres.”

for more info about Jadav Paying “see 1.2.3.”

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

Ask learners to tell their families about what they have learned and the importance of the trees, also encourage them to plant trees in the area of their homes.

They can also work together to create a social media campaign about deforestation threats. Let them be creative and use whatever technology tool to spread their message. This can include any type of media i.e., images, memes and comics, videos, podcasts, etc. and any social media platform, WhatsApp, Facebook, Tiktok, etc.

You can also make the social media campaign as a competition between learners' groups. Where the points are gained based on the engagement with the campaign i.e., "Share: 4 points, Comment: 3 points, Reaction: 2 points, View 1 point"

5. Possible adaptation

Older learners can go with their teachers outside the school yet in its outer premises. While younger learners can do the activity inside the school to plant trees beside the walls and the school buildings

Annex “Teacher’s Background Information”

1.2.1. Tree Parts:

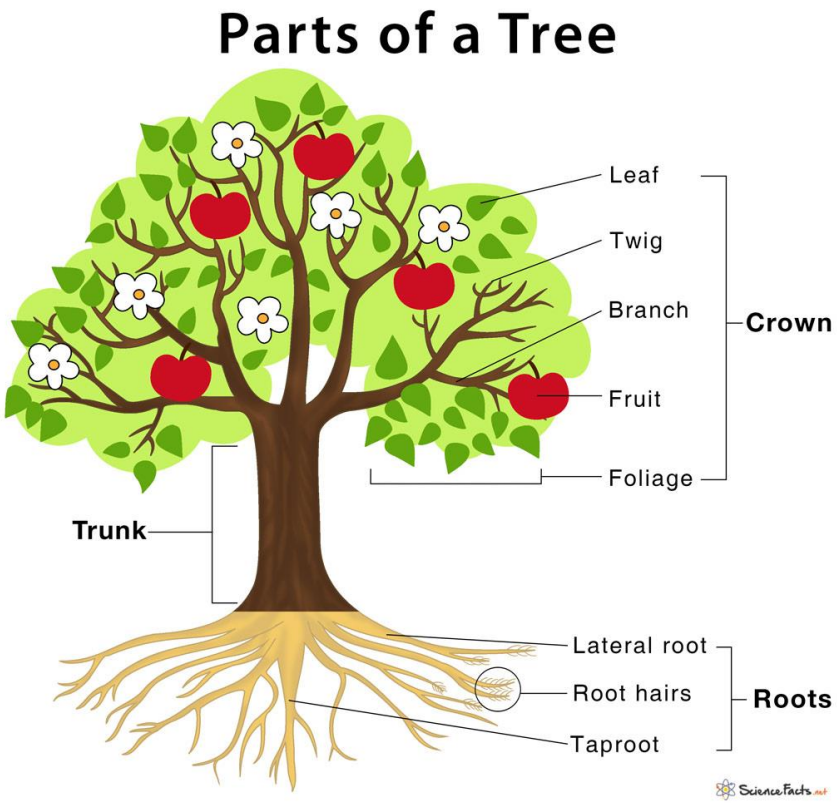


Image Source: https://www.sciencefacts.net/parts-of-a-tree.html

All trees share these three basic parts, no matter what type of tree you're examining. From palm trees with their expansive, shallow fibrous root system to giant redwoods hundreds of feet tall, every tree has the same three elements: the root system, a trunk and a crown. Most trees begin with a taproot system and develop a fibrous root system as they grow. There are also wide variations in the type of leaves, from simple to scale-like to needles. Within each of the three parts there are variations, but these three essential elements exist no matter what size the tree is or which climate it resides in.

- Roots

  A tree's root system pulls nutrients and water from the soil and carries it to the trunk for distribution through the tree. A tree that grows tall and thick like a redwood needs a root system that grows thick and deep to anchor it. Trees that grow in desert climates tend to have long, tendril-like roots that stay near the surface of the soil to catch rain more easily. Roots tend to grow to the size and depth needed to adapt to water levels in the soil. When a seedling forms a taproot grows straight down and sub-roots grow off it. As the tree develops a number of central taproots grow and the root system becomes a fibrous root system with many branches supporting and feeding the tree.

- Trunk

  Once the water and minerals pass through the roots and reach the trunk, they're carried up through the outer layers of the tree just below the bark. The trunk doesn't just transport water and minerals up from the ground, it also carries sugars from the leaves down to the roots to support and feed the root system. The trunk is the central support system for everything that happens in the tree. It's also the part of the tree that's harvested for lumber and to make paper.

  The four layers

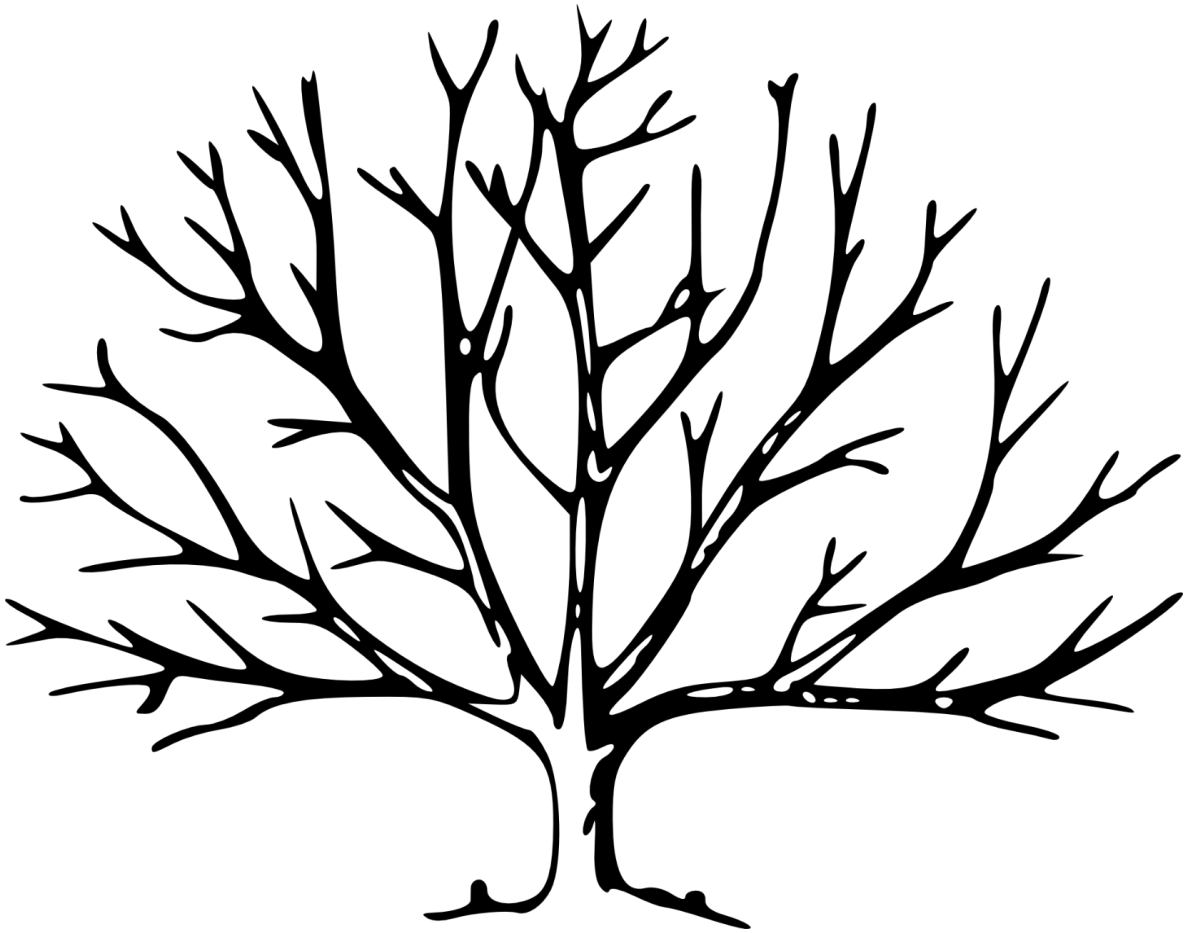
  Within the trunk there are four layers. Starting from the center there's heartwood, xylem, cambium and phloem. The heartwood is a hard core of old xylem layers that have died and become compressed by the newer outer layers. The xylem is also called sapwood and carries water and minerals up the trunk. The cambium is a thin layer where new cells develop to either become xylem, phloem or more cambium. A cambium layer is turned into xylem once per year and this creates an annual ring around the trunk. Just outside the cambium, the phloem transports sugars from the leaves down to the roots and as it dies it forms the bark.

- Crown

  Above the trunk is the crown. The crown is all the branches and leaves on the tree. The crown is the powerhouse of the tree. The leaves take in sunlight which reacts with the green chlorophyll to transform light into sugars. The process is called photosynthesis and the byproduct is oxygen released into the air. Photosynthesis occurs whether the leaves are broad and flat like a simple leaf or thin and pointed like needles. Leaves vary widely, but they all perform photosynthesis to feed the tree. Not only does the crown produce the sugars the tree needs to survive, it also filters dust from the air and protects the soil below from excessive erosion from rainfall.

Source: https://sciencing.com/spanish-moss-poisonous-5717155.html

1.2.2. Tree painting for printing https://www.pngwing.com/en/free-png-ikkpc



1.2.3. Useful links:

- Who Lives in/on Trees:
  https://www.youtube.com/watch?v=lOy5wh9Ul40
- The importance of Trees:
  English Video: https://www.youtube.com/watch?v=vu97CRuXI9c
  Arabic Video: https://www.youtube.com/watch?v=_LZLoNvpyMQ
- What will happen if we cut all the trees down:
  https://www.youtube.com/watch?v=nUstYj4o2VQ
  https://www.youtube.com/watch?v=Nc7f5563azs
- How to plant a tree:
  https://www.youtube.com/watch?v=PQwuog7_wmg
- Jadav Paying story:
  Article Jadav Paying
  https://www.youtube.com/watch?v=zGStrdQ5odo
  https://www.youtube.com/watch?v=HkZDSqyE1do

Message #12: Sustainable Land Use

1. Design Map:

Activity Code	D.12
Activity Title	Environmental Journalism
Activity Type	Discussion / Debate
Activity Location	Classroom / computer lab
Duration	140 Min
Optimum no. / grouping	40 Learners / Groups of 5
Prerequisites	Non
Short description	Learners will be divided into groups to work on an environmental Interview about unsustainable land use
Learning outcomes	1. Learners state the role and contribution of individuals and governments to achieve sustainable use of land. 2. Learners recognize and appreciate the importance of sustainable land use.
Skills	Communication, Creative Thinking, Team Work, Negotiation Skills
Values	Compassion, Empathy, Responsibility, Self-confidence, Adherence to time, Value self-respect, Courage, Being pro-active, Helping one another, Sensitivity to social issues in the community
Keywords	Unsustainable, Deforestation, Desertification, Climate Change, Water Scarcity
Necessary Materials	Printed information cards
Assessment method	Evaluation rubric
Link to MOE's cur.:	Social Studies
References	YouTube. (2018). Journey 2050: Land Use. YouTube. https://www.youtube.com/watch?v=RMu7NtScdhU. Climate change: The biggest human rights violation in history? Climate Change | Amnesty International. (n.d.). https://www.amnesty.org/en/what-we-do/climate-change/?utm_source=google&utm_medium=cpc&gclid=CjwKCAiAv4n9BRA9EiwA30WND6rv. YouTube. (2017). Causes and Effects of Climate Change | National Geographic. YouTube. https://www.youtube.com/watch?v=G4H1N_yXBiA. Soil, land and climate change. European Environment Agency. (2021, May 11). https://www.eea.europa.eu/signals/signals-2019-content-list/articles/soil-land-and-climate-change. Nunez, C. (2021, May 3). Desertification facts and information. National Geographic. https://www.nationalgeographic.com/environment/article/desertification. Encyclopædia Britannica, inc. (n.d.). deforestation. Encyclopædia Britannica. https://kids.britannica.com/kids/article/deforestation/443116. Sustainable development and challenging deforestation in the Brazilian Amazon: the good, the bad and the ugly. FAO. (n.d.). http://www.fao.org/3/i0440e/i0440e03.htm.

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Onboarding	20 Min.	● Divide learners into groups of 5 ● Let the learners know that they will watch a video about land use and discuss it afterwards “Annex D.12.2”	Presentation tools
Determine the importance of the land	20 Min	● Ask learners What is the importance of the land? Collect main answers and write them on the board ● Ask Learners about their opinions on unsustainable land use. Collect main answers and write them on the whiteboard	Board, board markers
Recognize and appreciate the importance of sustainable land use	80 Min	● Assign the following 5 characters for 8 groups: ▪ Environmental Journalist ▪ Policy Maker ▪ Scientist ▪ Influencer (Actor, sportsman, etc.) ▪ Egyptian Citizen ● Assign the following topic to the groups: ▪ Group A & B: Climate change ▪ Group C & D: Desertification ▪ Group E & F: Deforestation ● Ask Learners to create a TV interview script by the help of the information cards (they have to make a full script contains the five characters. (30 Min) “Annex D.12.1” ● Ask learners to implement the interview script in front of another class. (5 Min for each group) ● Evaluate each group and ask the best group to do the interview on the school radio.	None
Final reflection	10 Min	● In 10 minutes reflect with learners on each topic impact on land use. “Annex D.12.3”	None
state the role and contribution of individuals and governments to achieve sustainable use of land	10 Min	● Learners brainstorm ways where individuals can contribute to land preservation, protection and development	None

3. Assessment

- Use the below table to evaluate the learner's work

Evaluation Criteria

	All characters involved in the interview			The script covered all topic points and subtitles			Interview conducted in a creative way			Total
	Yes (3)	Somehow (2)	No (1)	Yes (3)	Somehow (2)	No (1)	Yes (3)	Somehow (2)	No (1)	
Group A										
Group B										
Group C										
Group D										
Group E										
Group F										
Group G										
Group H										

The winning team, the team will get the highest score

- Ask the learners to present the improvements they would make to their town to improve its sustainability (having acted like town planners). Their peers evaluate these suggestions on the basis of

  1) possible positive impact on community in terms of sustainability

  2) feasibility

  3) longevity (how long would it be likely to last/work. As a result of this evaluation the top suggestions are acknowledged and discussed by the class.

4. Suggestions for extended activities at home

Ask the learners to use internet search engines or google maps images to get satellite photos for Egypt governorates. Specially places that suffered from a land abuse and unsustainable land use. Then they can work in small groups to create a social media awareness campaign using the before and after satellite images and information about how such practices can negatively affect people's lives now and in the future.

5. Possible adaptation

For younger learners. You can ask them to explore non-sustainable behaviors of land use and discuss their impact on people, animals, plants, economy, environment, agriculture and energy consumption. The roles practiced within the group can be: group leader, note-taker, time-keeper, and spokesperson. Give each community a number of pictures showing various unsustainable behaviors of land and resources use. Then, ask them to identify these behaviors and write down their own comments and opinions on the board. Ask them to imagine that each group works as a newspaper editorial board. The board has to agree on one picture that represents the worst of the non-sustainable behaviors to use as a front-page picture for their newspaper. Let each group/community hold a discussion on the procedures they will adopt and decisions they will make to confront this emergency. In conclusion, each group gets to share their ideas in an open discussion with the whole class.

© wikimedia

© wikimedia

© wikimedia

© wikimedia

Annex “Teacher’s Background Information”

D.12.1. Information Cards:

A. Climate Change:

What is climate change?

The planet's climate has constantly been changing over geological time, with significant fluctuations of global average temperatures.

However, this current period of warming is occurring more rapidly than any past events. It has become clear that humanity has caused most of the last century’s warming by releasing heat-trapping gases—commonly referred to as greenhouse gases—to power our modern lives. We are doing this through burning fossil fuels, agriculture and land-use and other activities that drive climate change. Greenhouse gases are at the highest levels they have ever been over the last 800,000 years. This rapid rise is a problem because it’s changing our climate at a rate that is too fast for living things to adapt to.

Climate change involves not only rising temperatures, but also extreme weather events, rising sea levels, shifting wildlife populations and habitats, and a range of other impacts.

Researchers can already see the effects of climate change globally and in European soil. For example, according to the EEA’s most recent report on climate change, impacts and vulnerability in Europe, soil moisture has significantly decreased in the Mediterranean region and increased in parts of northern Europe since the 1950s. The report projects similar effects for the coming decades, as the rise in average temperatures continues and rainfall patterns change.

Continuing declines in soil moisture can increase the need for irrigation in agriculture and lead to smaller yields and even desertification, with potentially dramatic impacts on food production. A total of 13 EU Member States have declared that they are affected by desertification. Despite this acknowledgement, a recent report by the European Court of Auditors concluded that Europe does not have a clear picture of the challenges linked to desertification and land degradation and that the steps taken to combat desertification lack coherence.

Changes in seasonal temperatures can also shift the annual cycles of plants and animals, resulting in lower yields. For example, spring can arrive earlier and trees can blossom before their pollinators have hatched. With the expected population growth, world food production needs to increase rather than decrease. This hinges largely on maintaining healthy soil and managing agricultural areas sustainably. At the same time, there is a growing demand for biofuels and other plant-based products, driven by the urgent need to replace fossil fuels and prevent greenhouse gas emissions.

The EEA report on impacts and vulnerability also highlights other impacts on soil related to climate change, including erosion, which can be accelerated by extreme climate events, such as intense rain, drought, heat waves and storms. In addition to causing the loss of areas of land, rising sea levels may change soil in coastal areas or bring contaminants,

including salt, from the sea. In relation to land use, climate change may make some agricultural areas, mainly in the south, unusable or less productive while possibly opening up new possibilities further north. In forestry, the decline in economically valuable tree species might cut the value of forest land in Europe by between 14 and 50 % by 2100. A recent EEA report on climate change adaptation and agriculture highlights that the overall impacts of climate change could produce a significant loss for the European agricultural sector: up to 16 % loss in EU agriculture income by 2050, with large regional variations.

Yet perhaps the biggest climate concern linked to soil is the carbon dioxide and methane stored in permafrost in boreal regions, mainly in Siberia. As the global temperatures increase, the permafrost melts. This thawing causes the organic material trapped in the frozen soil to disintegrate, which can lead to the release of massive amounts of greenhouse gases into the atmosphere, which could hence lead to the accelerating of global warming far beyond people's control.

Resources:

https://www.eea.europa.eu/signals/signals-2019-content-list/articles/soil-land-and-climate-change

https://www.amnesty.org/en/what-we-do/climate-change/?utm_source=google&utm_medium=cpc&gclid=CjwKCAiAv4n9BRA9EiwA30WND6rv

https://www.youtube.com/watch?v=G4H1N_yXBiA

B. Desertification

As global temperatures rise and the human population expands, more of the planet is vulnerable to desertification, the permanent degradation of land that was once arable.

While interpretations of the term desertification vary, the concern centers on human-caused land degradation in areas with low or variable rainfall known as drylands: arid, semi-arid, and sub-humid lands. These drylands account for more than 40 percent of the world's terrestrial surface area.

While land degradation has occurred throughout history, the pace has accelerated, reaching 30 to 35 times the historical rate, according to the United Nations. This degradation tends to be driven by a number of factors, including urbanization, mining, farming, and ranching. In the course of these activities, trees and other vegetation are cleared away, animal hooves pound the dirt, and crops deplete nutrients in the soil. Climate change also plays a significant role, increasing the risk of drought.

All of this contributes to soil erosion and an inability for the land to retain water or regrow plants. About 2 billion people live on the drylands that are vulnerable to desertification, which could displace an estimated 50 million people by 2030.

Where is desertification happening, and why?

The risk of desertification is widespread and spans more than 100 countries, hitting some of the poorest and most vulnerable populations the hardest, since subsistence farming is common across many of the affected regions.

More than 75 percent of Earth's land area is already degraded, according to the European Commission's World Atlas of Desertification, and more than 90 percent could become degraded by 2050. The commission's Joint Research Centre found that a total area half of the size of the European Union (1.61 million square miles, or 4.18 million square kilometers) is degraded annually, with Africa and Asia being the most affected.

The drivers of land degradation vary with different locations, and causes often overlap with each other. In the regions of Uzbekistan and Kazakhstan surrounding the Aral Sea, excessive use of water for agricultural irrigation has been a primary culprit in causing the sea to shrink, leaving behind a saline desert. And in Africa's Sahel region, bordered by the Sahara Desert to the north and savannas to the south, population growth has caused an increase in wood harvesting, illegal farming, and land-clearing for housing, among other changes.

The prospect of climate change and warmer average temperatures could amplify these effects. The Mediterranean region would experience a drastic transformation with warming of 2 degrees Celsius, according to one study, with all of southern Spain becoming desert. Another recent study found that the same level of warming would result in "aridification," or drying out, of up to 30 percent of Earth's land surface.

When land becomes desert, its ability to support surrounding populations of people and animals declines sharply. Food often doesn't grow, water can't be collected, and habitats shift. This often produces several human health problems that range from malnutrition, respiratory disease caused by dusty air, and other diseases stemming from a lack of clean water.

Desertification solutions

In 1994, the United Nations established the Convention to Combat Desertification (UNCCD), through which 122 countries have committed to Land Degradation Neutrality targets, similar to the way countries in the climate Paris Agreement have agreed to targets for reducing carbon pollution. These efforts involve working with farmers to safeguard arable land, repairing degraded land, and managing water supplies more effectively.

The UNCCD has also promoted the Great Green Wall Initiative, an effort to restore 386,000 square miles (100 million hectares) across 20 countries in Africa by 2030. A similar effort is underway in northern China, with the government planting trees along the border of the Gobi desert to prevent it from expanding as farming, livestock grazing, and urbanization, along with climate change, removed buffering vegetation.

However, the results for these types of restoration efforts so far have been mixed. One type of mesquite tree planted in East Africa to buffer against desertification has proved to be invasive and problematic. The Great Green Wall initiative in Africa has evolved away from the idea of simply planting trees and toward the idea of "re-greening," or supporting

small farmers in managing land to maximize water harvesting (via stone barriers that decrease water runoff, for example) and nurture natural regrowth of trees and vegetation.

"The absolute number of farmers in these [at-risk rural] regions is so large that even simple and inexpensive interventions can have regional impacts," write the authors of the World Atlas of Desertification, noting that more than 80 percent of the world's farms are managed by individual households, primarily in Africa and Asia. "Smallholders are now seen as part of the solution of land degradation rather than a main problem, which was a prevailing view of the past."

Resources:

(https://www.nationalgeographic.com/environment/article/desertification)

C. Deforestation:

Introduction:

Deforestation is the clearing, or cutting down, of forests. The word is normally used to describe the actions of humans in removing forests from the planet, rather than destruction caused by such natural events as hurricanes.

People have been cutting down trees for thousands of years. In recent times, however, the number of forests being lost through deforestation has grown enormously. This is seen as a great problem that affects the environment in many important ways.

Experts estimate that about 500,000 square miles (1.3 million square kilometers) of land is deforested every 10 years. Half of that is primary forest, which means it has never been cut down before. The largest amount of deforestation is happening in tropical areas, where rainforests are being cut down. Most deforestation is permanent. Some areas do recover from this damage, but it can take many years.

Reasons for Deforestation:

Trees are cut down so their wood can be burned or used to make things, such as buildings, furniture, or paper. Large areas of trees are removed so that the land can be used to grow crops or to provide places where farm animals can graze. Most of the planet's croplands were once forests, which would have covered 4.2 million square miles (11 million square kilometers). In tropical areas large areas of forest are cleared in order to plant such crops as coffee, rubber trees, or palm trees. These crops are grown on large farms called plantations. The people who grow them make a great deal of money selling the coffee beans, sap from the rubber trees, and oil from the palm trees. Deforestation also takes place when people want to clear an area to build new settlements.

How Forests Are Cut Down

Slash and Burn: In some countries, especially in tropical areas and in Southeast Asia, farmers cut down large trees and then set fire to areas of a forest to kill off all the animals and plants living there. The ash from the fire helps to fertilize the land, and crops can be grown for a few years before the land becomes useless. The farmers then leave the area and move to a new place. This traditional method of deforestation is called slash and burn.

Forest plants and animals may return to the land, but it takes many years. Some places never recover.

Logging: Large areas of forest are cut down by a process called logging. Machines or humans fell hundreds, or sometimes thousands, of trees and remove them for use as lumber.

Problems Caused by Deforestation

Trees and other green plants produce oxygen, the gas needed by humans and other animals to live. When trees are cut down, less oxygen is released into the atmosphere.

Trees also capture carbon dioxide, one of the gases that contribute to a problem known as global warming. When they are burned, trees release carbon dioxide back into the atmosphere.

Erosion: Deforestation on steep mountain hillsides can lead to erosion. The land can get worn away because the trees are not there to hold the soil together. Heavy rains in such areas can wash the land down the slopes in disastrous landslides that destroy fields, homes, and human lives.

Habitat Loss: Many forests are peaceful, quiet places where people can rest or play. When trees are cut down, this recreational use of forests is lost.

Forests are home to an enormous range of living things. When an area is deforested, many plants and animals are killed. Others lose their habitats. Some types of living things become extinct because of deforestation, especially those that live in tropical rainforests. The traditional way of life for rainforest peoples can be greatly affected by deforestation.

Resources

(https://kids.britannica.com/kids/article/deforestation/443116)

http://www.fao.org/3/i0440e/i0440e03.htm

D.12.2. Videos:

Land Use: https://www.youtube.com/watch?v=RMu7NtScdhU

D.12.3. useful links:

Climate change impact on land use:

Video: https://www.youtube.com/watch?v=G4H1N_yXBiA

Water scarcity impacts:

Video: https://www.youtube.com/watch?v=J5WMyD9-CHs

Article: https://www.worldwildlife.org/threats/water-scarcity

When waters run dry, people can't get enough to drink, wash, or feed crops, and economic decline may occur. In addition, inadequate sanitation—a problem for 2.4 billion people—can lead to deadly diarrheal diseases, including cholera and typhoid fever, and other water-borne illnesses.

https://www.youtube.com/watch?v=q94Lm79nrds

Message #13: Endangered Species

1. Design Map:

Activity Code	B.13
Activity Title	Endangered Animals
Activity Type	Group Work, Game
Activity Location	Classroom
Duration	60 Min
Optimum no. / grouping	40 Learners / Groups of 6
Prerequisites	None
Short description	There are a number of endangered animals clinging to survival, including the gray wolf, sharks, whales and elephants. Placing an animal on the list brings attention to the species plight and can lessen the likelihood of it being poached and its habitat destroyed. Through the interactive game of charades, learners will be taught about endangered species in order to help them understand how human actions effect the environment, and the importance of achieving population balance in individual habitats. The activity focuses on recent specimens that became/are close to extinction.
Learning outcomes	1. Learners relate the survival or extinction of species to variation in physical/behavioral characteristics in a population and reproductive success in a changing environment. 2. Learners reflect on how human behavior impacts the environment; humans, plants, animals, and their ecosystem.
Skills	Leadership, Interpersonal, Communication, Analytical Thinking
Values	Empathy, Responsibility, Self-confidence, admitting one's mistake, Stand up for the truth, Environmental cleanliness, Collective responsibility, Tolerance, Gratefulness, Sensitivity to social issues in the community
Keywords	#Grades: 6 to 9, Biodiversity, Endangered, Species, Ecology
Necessary Materials	Endangered Animals Info Cards
Assessment method	Assignment
Link to MOE's cur.:	Science, Living Organisms
References	Glenn, C. R. 2006. "Earth's Endangered Creatures" (Online). Accessed 7/13/2021 at http://earthsendangered.com. National Geographic. (n.d.). https://www.nationalgeographic.com/.

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Relate the survival or extinction of species to variation in physical/behavioral characteristics in a population and reproductive success in a changing environment	40 Min	● Begin this activity by introducing the topic of extinct animals. Point out that this topic is very important and has been given wide international recognition. A list called the Red List has been compiled where endangered animals are placed in special categories according to species and region. ● Prepare a list of recently extinct animals - or animals on the red list close to extinction, create info card about them then place the cards deck face down "see annex B.13.1 for a sample info cards". Better add image of the animal to each card. Info cards should include the following: ▪ Background info and description ▪ Habitat ▪ Range ▪ Ecology ▪ Reasons for being endangered or vulnerable ● Divide the class into groups of 6. Give each group an info card and ask them to study it well then use the jigsaw technique to form new groups and make sure all the learners know about all the animals "see annex B.13.2" ● Write the type of each endangered animal that you selected earlier on a small piece of paper ● Ask a learner from each group to pick a piece of paper and improvise the animal written on it to the class and the learners will try by their turn to guess what the animal is.	Info cards
Reflect on how human behavior impacts the environment; humans, plants, animals, and their ecosystem.	20 Min	● Manage a brief discussion follows where the learners are asked to think about some reasons behind the extinction of some species. They are encouraged to look for particular links with human actions. "E.g., Some animals have been caught by humans, in order to be used as pets or for hunting. Poaching and secondary damage are other causes of extinction caused by humans"	

3. Assessment

Learners are instructed to visit the IUCN website that provides the list of endangered species “the Red List”. Their task is to find out why such species have been included in the Red List – they can work on different categories of species, e.g., animals “birds, mammals, insect, etc.”, plants, and so on. They write a report based on their findings that is evaluated by the teacher.

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

Share with the learners some acts that will help saving endangered species. Some of the acts might be:

- Recycle and buy sustainable products.

  Buy recycled paper, sustainable products like bamboo and Forest Stewardship Council wood products to protect forest species. Never buy furniture made from wood from rainforests. Recycle your cell phones, because a mineral used in cell phones and other electronics is mined in gorilla habitat. Minimize your use of palm oil because forests where tigers live are being cut down to plant palm plantations.

- Never purchase products made from threatened or endangered species.

  Overseas trips can be exciting and fun, and everyone wants a souvenir. But sometimes the souvenirs are made from species nearing extinction. Avoid supporting the market in illegal wildlife including: tortoise-shell, ivory, coral. Also, be careful of products including fur from tigers, polar bears, sea otters and other endangered wildlife, crocodile skin, live monkeys or apes, most live birds including parrots, macaws, cockatoos and finches, some live snakes, turtles and lizards, some orchids, cacti and cycads, medicinal products made from rhinos, tiger or Asiatic black bear.

The above two actions are retrieved from: https://www.endangered.org/. For more insights about acts to save endangered species check 10 Easy Things You Can Do To Save Endangered Species

5. Possible adaptation

This activity can be implemented on plants as well. Also pictures of animals could be used for demonstrations and to introduce to learners the Classification of Animals based on endangerment, which can be divided into different categories.

Annex “Teacher’s Background Information”

B.13.1. Animal information cards

- Card 1: Barbary Sheep

  The Barbary sheep (Ammotragus lervia), also known as aoudad is a species of caprid native to rocky mountains in North Africa. Six subspecies have been described. Although it is rare in its native North Africa, it has been introduced to North America, southern Europe, and elsewhere. It is also known in the Berber language as waddan or arwi, and in former French territories as the moufflon.

  - Description

    Barbary sheep stand 60 to 90 cm tall at the shoulder, with a length around 1.5 m, and weigh 40 to 140 kg. They are sandy-brown, darkening with age, with a slightly lighter underbelly and a darker line along the back. Upper parts and the outer parts of the legs are a uniform reddish- or grayish-brown. Some shaggy hair is on the throat (extending down to the chest in males) with a sparse mane. Their horns have a triangular cross-section. The horns curve outward, backward, then inward, and can exceed 76 cm (30 in) in length. The horns are fairly smooth, with slight wrinkles evident at the base as the animal matures.

  - Range

    Barbary sheep naturally occur in northern Africa in Algeria, Tunisia, northern Chad, Egypt, Libya, northern Mali, Mauritania, Morocco, Niger, and Sudan (west of the Nile, and in the Red Sea Hills east of the Nile

  - Habitats

    Barbary sheep are found in arid mountainous areas where they graze and browse grasses, bushes, and lichens. They are able to obtain all their metabolic water from food, but if liquid water is available, they drink and wallow in it. Barbary sheep are crepuscular - active in the early morning and late afternoon and rest in the heat of the day. They are very agile and can achieve a standing jump over 2 meters. They are well adapted to their habitat, which consist of steep, Rocky Mountains and canyons. They often flee at the first sign of danger, typically running uphill. They are extremely nomadic and travel constantly via mountain ranges. Their main predators in North Africa were the Barbary leopard, the Barbary lion, and caracal, but now only humans threaten their populations.

  Source: Barbary Sheep

- Card 2: Arabian Gazelle

  The Arabian gazelle, or mountain gazelle has a wide range throughout the Middle East, but is listed and protected in the Arabian Peninsula, Palestine, and Sinai. This species has a slender build with a proportionally long neck and long hind legs. It has a dark brown coat, white underparts and a black, short, and bushy tail. Both male and female gazelles have horns and their ears are relatively short. Adults weigh up to 51 lbs on average and females are smaller than males. Arabian gazelles are excellent runners and can reach speeds of 80 km per hour. They have excellent vision, hearing, and a good sense of smell to help detect predators and to find food. The Arabian gazelle prefers mountainous and hilly habitat consisting of light forests, fields, or desert plateaus. Days are usually spent in the hills and at night or in the early morning they come down to forage. They prefer to eat grasses, herbs, and shrubs but can eat other varieties of food, depending on what is available in their habitat. Groups consist of three to eight gazelles, and males are territorial preferring one or more females in the group and their young. Mating occurs mainly in the early winter, but can take place year-round if food is not scarce. The female gives birth to only one calf after a gestation period of 180 days. Males may leave after about six months, but females may remain with their mother for life. The main threats to the species is habitat loss. Also hunting and collecting, trade, alien invasive species, and hybridizers threaten the Arabian gazelle population. Strict laws are currently in place and have helped to prevent poaching of the species, but habitat loss and exploitation continue to be a threat.

  Source: Arabian Gazelle

- Card 3: Egyptian Tortoise

  Kleinmann's tortoise (Testudo kleinmanni), also called commonly the Egyptian tortoise, Leith's tortoise, and the Negev tortoise, is a critically endangered species of neck-hiding tortoise in the family Testudinidae. The species is native to Egypt, Libya, and Palestine. The species was once more widespread, but its numbers are now dwindling. The species is nearly extinct in Egypt, and complete extinction in the wild is a looming threat unless more actions are taken to protect this species.

  - Description

    Kleinmann's tortoise is the smallest tortoise in the Northern Hemisphere. Female tortoises are larger than the males; males are slenderer and have a longer tail. The plastron has a high dome, and ranges in color from ivory to pale gold to dark brown to pink or dull yellow. This coloring strongly follows Gloger's rule, as it helps to regulate the impact of sunlight. This allows the paler tortoise to stay in the desert heat for longer. It is also an effective camouflage in the desert. The carapace is light yellow, often with two dark triangles on each abdominal scute. The tortoise's scutes have dark edgings that fade with age. The head and limbs are a very pale ivory-yellow to yellowish-brown color.

  - Habitat and Ecology

    Kleinmann's tortoise lives in deserts and seHabitat and Ecology Kleinmann's tortoise lives in deserts and semiarid habitats, usually with compact sand and gravel plains, scattered rocks, shallow, sandy wadis, dry woodlands, shrubby areas, and coastal salt marsh habitats. In captivity, it eats grasses, fruits, and vegetables, but the diet of T. kleinmanni in the wild is unknown. It is least active when the weather is very cold or very hot. During the colder months, it is out most during midday. During the warm season, it is active in the mornings and evenings. The rest of the day is spent under bushes or in rodent burrows.miarid habitats, usually with compact sand and gravel plains, scattered rocks, shallow, sandy wadis, dry woodlands, shrubby areas, and coastal salt marsh habitats. In captivity, it eats grasses, fruits, and vegetables, but the diet of T. kleinmanni in the wild is unknown.It is least active when the weather is very cold or very hot. During the colder months, it is out most during midday. During the warm season, it is active in the mornings and evenings. The rest of the day is spent under bushes or in rodent burrows.

  Source: Egyptian Tortoise

- Card 4: Four-toed jerboa
  - Physical appearance:

    Similar to the other jerboas in the genus Allactaga, the four-toed jerboa are small hopping rodents with large ears and a long tail with a black band near the white, feathery tip. The tail assists and serves as support when the jerboa is standing upright. They have long hind feet and short forelegs. The pelt of the four-toed jerboa is velvety in texture and the upper-parts are speckled black and orange, the rump orange, and the sides gray. The four-toed jerboa hind-limbs have an extra digit compared to other jerboas in the genus Allactaga. The extra digit is smaller in size and nonfunctional compared to the other three digits.
  - Geographic Range

    This jerboa species is found in coastal areas of Egypt and eastern Libya. It is confined to a northern coastal strip approximately 200 km wide and of less than 100 km inland (Abu Baker and Patterson 2010).
  - Habitat

    Allactaga tetradactyla is found on salt marshes and clay desert areas of coastal plains. They are nocturnal rodents spending most of the daylight hours in underground burrows and emerging at night to forage.
  - Nutrition

    Emerging at night, the four-toed jerboa eats grass, leaves, and soft seeds. The low crown molars and soft palates help the Four-toed Jerboa chew plant material and seeds. The Four-toed jerboa is a host of the Acanthocephalan intestinal parasite Moniliformis aegyptiacus.

    Source: Four-toed jerboa

- Card 5: Nubian Ibex

  The Nubian ibex (Capra nubiana) is a desert-dwelling goat species found in mountainous areas of northern and northeast Africa, and the Middle East. It was historically considered to be a subspecies of the Alpine ibex (C. ibex), but is now considered a distinct species. The wild population is estimated at 1,200 individuals.

  - Description

    Nubian ibexes stand around 65–75 cm (2.1–2.6 ft) tall at the shoulder and weigh around 50 kg (110 lb). They are a light tan color, with a white underbelly; males also have a dark brown stripe down their backs. Nubian ibexes have long, thin horns that extend up and then backwards and down. In males, these reach around 1 m in length, while in females they are much smaller (around 30 cm (12 in)).

  - Distribution and habitat

    Its range is within Egypt, Palestine, Jordan, Oman, Palestine, Saudi Arabia, Sudan, and Yemen. It is extirpated in Lebanon. Its presence is uncertain in Ethiopia and Eritrea. It has also been reintroduced to Syria.

  - Ecology

    Nubian ibexes live in rough, dry, mountainous terrain, where they eat mainly grasses and leaves and are preyed upon by leopards, wolves, common foxes, eagles, and bearded vultures. They are social and herds tend to consist of females, young, and males up to the age of about three years. The males are solitary or form more transitory bands of up to eight individuals. During the breeding season, males join the female-based herds for the six- to eight-week rut. Large males then do battle with much clashing of horns. Nubian ibexes are diurnal, meaning they are active during the day, and rest at night. On 16 March 1959, the British established the Yob Wildlife Reserve in northern Eritrea specifically to protect significant populations of Nubian ibex in the area.

  - Status

    The International Union for Conservation of Nature has classified the Nubian ibex as "vulnerable" on the basis that fewer than 10,000 mature individuals remain and the population is declining. Threats faced by the animal include competition with livestock for water and fodder, hunting pressure, and habitat destruction.

    Source: Nubian Ibex

- Card 6: Giant Devil ray

  The devil fish or giant devil ray (Mobula mobular) is a species of ray in the family Mobulidae. It is currently listed as endangered, mostly due to bycatch mortality in unrelated fisheries.

  - Description

    The devil fish is larger than its close relative the lesser devil ray. It grows to a length of disk 3.5 meters, making it one of the largest rays. It possesses a spiny tail. The devil fish is the third largest species in the genus Mobula, after the oceanic and reef manta rays. It is the only mobulid species that lives in the Mediterranean Sea. The species has been observed to have a maximum recorded length of disk width of 5.2 meters. However, those data are unreliable and are allegedly misunderstood as Giant oceanic Manta Rays that have strayed into the Mediterranean. It is also considered to be the only Devil fish with a tail spin. The species is also considered endangered given its decreasing population density.

  - Distribution and habitat

    Devil fish are most common in the Mediterranean Sea and can be found elsewhere in the Eastern Atlantic Ocean, off the southwest coast of Ireland and south of Portugal, and possibly in the northwest Atlantic. The species has been recorded in a number of Mediterranean countries such as Croatia, Greece, Italy, and Turkey, which shows that the species has a basin-wide distribution. They predominantly prefer deep waters. Devil fish inhabit offshore areas to the neritic zone, their range as deep as several thousand meters. They are typically observed in small clusters, and may occasionally form larger groups. Giant devil rays are usually seen in deep coastal waters but are occasionally seen in shallow waters. In a tagging experiment conducted by the Italian National Institute for Environmental Protection and Research (ISPRA), three giant devil rays were tagged and their depth was observed throughout different times of the day. The rays reached a maximum depth of 600–700 meters but mostly spent their time between 0 and 50 meters; they prefer warmer waters with a temperature between 20 °C and 29 °C. The giant devil rays also deep dive at random times, instances not correlated to the time of day unlike how other species deep dive at specific times of day. In other observations studying ray abundance and habitat, giant devil rays were observed alone and occasionally in groups with a maximum of 18 rays. The same study also emphasizes that the rays undergo a species migration across the Mediterranean Sea with the seasons, taking advantage of warm, highly productive waters.

  - Ecology

    The average lifespan of a giant devil ray is 20 years. It is an epipelagic species. It has a very low reproductive capacity. This means that the species gives birth to a single offspring at unknown intervals. The species is ovoviviparous: the young hatch from their eggs inside the mother's body and emerge later when they are more fully grown. It can be predicted that at the rate that its population is declining now, the population will decline by at least 50% in the next 60 years. This is due to a number of threats including the poor likelihood of recovering from declining populations. Devil rays feed on planktonic crustaceans and small schooling fish, which are trapped using the modified gill covers (branchial plates) responsible for its "devil-like" silhouette. It mostly eats euphausiid shrimp (Meganyctiphanes norvegica) and small mesopelagic and clupeid fishes.

    Source: Giant Devil ray

B.13.2. Jigsaw learning technique

The jigsaw classroom is a research-based cooperative learning technique. To manage a jigsaw activity follow the following steps:

1- Divide learners into 5- or 6-person jigsaw groups. The groups should be diverse in terms of gender, ethnicity, race, and ability.
2- Appoint one student from each group as the leader. Initially, this person should be the most mature student in the group.
3- Divide the day's lesson into 5-6 segments. For example, if you want history learners to learn about Eleanor Roosevelt, you might divide a short biography of her into stand-alone segments on: (1) Her childhood, (2) Her family life with Franklin and their children, (3) Her life after Franklin contracted polio, (4) Her work in the White House as First Lady, and (5) Her life and work after Franklin's death.
4- Assign each student to learn one segment. Make sure learners have direct access only to their own segment.
5- Give learners time to read over their segment at least twice and become familiar with it. There is no need for them to memorize it.
6- Form temporary "expert groups" by having one student from each jigsaw group join other learners assigned to the same segment. Give learners in these expert groups time to discuss the main points of their segment and to rehearse the presentations they will make to their jigsaw group.
7- Bring the learners back into their jigsaw groups.
8- Ask each student to present her or his segment to the group. Encourage others in the group to ask questions for clarification.
9- Float from group to group, observing the process. If any group is having trouble (e.g., a member is dominating or disruptive), make an appropriate intervention. Eventually, it's best for the group leader to handle this task. Leaders can be trained by whispering an instruction on how to intervene, until the leader gets the hang of it.
10- At the end of the session, give a quiz on the material. Learners quickly come to realize that these sessions are not just fun and games but really count.

Source: THE JIGSAW CLASSROOM

B.13.3. Background information

Species are classified by the International Union for Conservation of Nature (IUCN) Red List into nine groups, set through criteria such as rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation.

In biology and ecology, extinction is the end of an organism or of a group of organisms (taxon), normally a species. The moment of extinction is generally considered to be the death of the last individual of the species,

although the capacity to breed and recover may have been lost before this point. Because a species' potential range may be very large, determining this moment is difficult, and is usually done retrospectively. This difficulty leads to phenomena such as Lazarus Taxa, where a species presumed to be extinct abruptly "re-appears" (typically in the fossil record) after a period of apparent absence.

Extinct in the Wild (EW) is a conservation status assigned to species or lower taxa, the only known living members of which are being kept in captivity or as a naturalized population outside its historic range.

Critically Endangered is the highest risk category assigned by the IUCN Red List for wild species. Critically Endangered species are those that are either facing an extremely high risk of extinction, or have numbers which decreased, or will decrease, by 80% within three generations.

An Endangered Species is a population of organisms facing a high risk of becoming extinct because it is either few in numbers, or threatened by changing environmental or predation parameters. IUCN has calculated the percentage of endangered species.

A Vulnerable Species is one which has been categorized by the IUCN as likely to become Endangered unless the circumstances threatening its survival and reproduction improve. Vulnerability is mainly caused by habitat loss or destruction. Vulnerable species are monitored. However, some species listed as "vulnerable" may in fact be quite abundant in captivity, examples being the blue poison dart frog.

Conservation Dependent (LR/CD) was an IUCN category assigned to species or lower taxa which were dependent on conservation efforts to prevent the tax on becoming threatened with extinction. Such taxa must be the focus of a continuing taxon-specific or habitat-specific conservation program targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories within a period of five years.

Near Threatened (NT) is a conservation status assigned to species or lower taxa that may be considered threatened with extinction in the near future, although it does not currently qualify for the threatened status.

Least Concern (LC) is an IUCN category assigned to extant species or lower taxa which have been evaluated but do not qualify for any other category. As such they do not qualify as Threatened, Near Threatened, or (prior to 2001) Conservation Dependent.

Data Deficient (DD) is a category applied by the IUCN to a species when the available information is not sufficient for a proper assessment of conservation status to be made. This does not necessarily indicate that the species has not been extensively studied; but it does indicate that little or no information is available on the abundance and distribution of the species.

Not Evaluated (NE) is a category applied by the IUCN to a species when they have not been studied by the IUCN Red List of Threatened Species.

Source: Educamp I

B.13.4. Useful links

https://www.iucn.org/regions/mediterranean

Message #14: Human Impact on Ozone Layer

1. Design Map:

Activity Code	B.14.
Activity Title	The ozone and us
Activity Type	Research activity
Activity Location	Computer lab
Duration	120 Min
Optimum no. / grouping	25 Learners / Groups of 5
Prerequisites	Study atmosphere layers
Short description	In this activity, learners should do an online research on ozone hole, under the supervision of the teacher, to know about its causes, damages and possible solutions to mitigate this issue.
Learning outcomes	1. Learners recognize the importance of atmosphere 2. Learners appreciate the importance of ozone layer in protecting all organisms on Earth 3. Learners realize the impact of human activities on the ozone layer
Skills	Interpersonal, Communication, Creative Thinking, Team Work
Values	Adherence to time, Being pro-active, Collective responsibility, Sensitivity to social issues in the community
Keywords	#Grades: 6 to 9, Biodiversity, Ozone depletion, Ozone hole.
Necessary Materials	Computers, Internet access, A0 paper per group, white cloth, torch
Assessment method	Observation, Oral discussion, Presentation
Link to MOE's cur.:	Science, Layers of Atmosphere
References	Ozone and You. Ozone and You | Ozone Secretariat. (n.d.). https://ozone.unep.org/ozone-and-you.

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Onboarding	10 Min	● Ask the learners: What is the atmosphere and its layers and what are the gases percentages at the atmosphere? And write the final answers on the table “see annex B.14.1.”	none
Reflect and recognize the importance of atmosphere	30 Min	● Bring a white cloth and ask two of the learners to hold it, keep it straight and horizontal then raise it. ● Tell the learners that this white cloth represents one of the atmosphere layers “Ozone layer” that surrounds Earth ● Ask one of the learners to hold a torch, turn it on and direct it to the upper side of the white cloth. Tells the learner that sunray falls on Earth similar to how the torch light falls on the cloth that represents the ozone layer of the atmosphere. ● Using screwdriver make a hole at the bottom of the cloth, not from the side of the torch light. ● Asks the learners to observe the torch light that passes through the holes of cloth and tells them that this is similar to what is happening in reality. ● Explains to the learners that the atmosphere contains ozone layer, which prevents ultraviolet radiations from reaching Earth. Ultraviolet radiations are very harmful to all living organisms. Unfortunately, there is a hole in the ozone layer that causes ultraviolet radiation to reach our planet. ● Tell the learners that in the next activity they will search for the reasons behind the formation of ozone hole.	White cloth, torch
Realize the impact of human activities on the ozone layer	50 Min	● Divide the learners into 5 groups of 5 ● Ask each group to use a computer with internet access to search for the topics assigned to them. ▪ Group 1 (Industry role in ozone hole phenomenon) ▪ Group 2 (Agriculture role in ozone hole phenomenon) ▪ Group 3 (Daily and household habits role in ozone hole phenomenon)	A0 Paper size per group, Computers, Internet access

		▪ Group 4 (Transportation role in ozone hole phenomenon) ▪ Group 5 (Volcanoes and natural phenomena role in ozone hole phenomenon) ● Ask the learners to record the data that they will get and create an infographic poster to be presented it in front of their colleagues	
Appreciate the importance of ozone layer in protecting all organisms on Earth	30 Min	● Give each group 5 Minutes to present their findings using the infographic poster ● Lead a discussion with the learners about how to mitigate the risk of ozone hole “see annex B.14.2.”	none

3. Assessment

- Assess learners' interaction in the class discussion
- Assess groups presentation and infographic posters

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

Asks learners to raise awareness of their family and their community about the risks of ozone hole and the precautions that can be taken to mitigate ozone hole phenomenon.

5. Possible adaptation

You can replace the cloth demonstration by presenting a short cartoon film, then follow up with class reflection about the atmosphere layers, ozone layer and its importance, how is ozone produced and destroyed in the stratosphere, UV radiations and its harms, etc.

Suggested video link: Ozzy Ozone

Annex “Teacher’s Background Information”

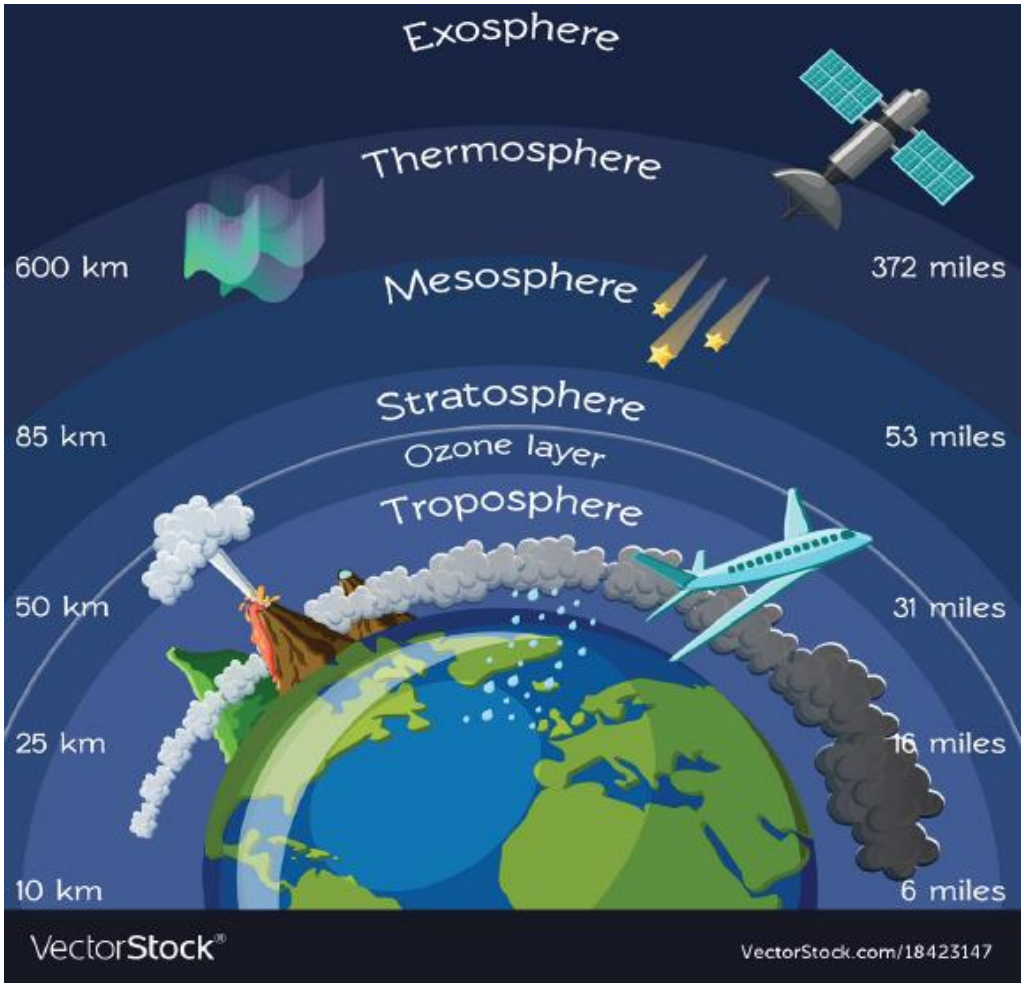
B.14.1. The atmosphere

The atmosphere is a collection of gases which surrounds earth in form of an envelope rotating with the earth around its axis and it extends about 1000 Km above the sea level The most important components of the atmosphere: - Nitrogen (N2) and almost 78%. - Oxygen (O2) and almost 21%. - Inert gases such as Argon, Neon, Helium of 0.9% - Carbon dioxide and almost 0.03% - Ozone - Methane - Sulfur oxides - Hydrogen - Nitrogen Oxides - Water vapor

Atmosphere layers:

Troposphere, stratosphere, mesosphere, thermosphere.

The ozone layer in the stratosphere plays a significant role in protecting all organisms on Earth from the harmful solar ultraviolet radiations, which can burn the skin and cause, at some cases, skin cancer and eye cataract.



B.14.2. Some reasons behind ozone hole formation:

- Some airplanes release NOx emissions such as nitrogen dioxide and nitrogen oxide
- Global warming
- Some types of pesticides
- Nuclear tests
- Volcanic eruptions as it plays a significant role in causing ozone hole
- Air pollution due to burning processes, factory wastes, and fumes released by factories, cars and laboratories, etc.

How to protect ozone layer:

- Raising awareness about the importance of preserving the ozone layer
- Reducing industrial activities that harm the ozone layer
- Stopping use of pesticides that contain chlorofluorocarbon and adopt bio-agriculture that does not depend on pesticides
- Reducing production of chlorofluorocarbon gas and ban it worldwide
- Using ozone layer and environmentally friendly air fresheners and stop using sprays that contain harmful substances
- Avoid purchasing of freezers and air-conditioners that contain harmful gases to the ozone layer
- Avoid discharging of fire extinguishers unless it is required for some reason.
- Ensuring regular maintenance of appliances that contain harmful compounds to ozone layer.

B.2.3. Useful links:

Ozone and You

Ozone depletion, explained

The Ozone Hole

Message #15: Environmental Balance, the Carbon Cycle

1. Design Map:

Activity Code	B.15.
Activity Title	Carbon Cycle Game
Activity Type	Game
Activity Location	Classroom, School yard, Outdoors
Duration	60 Min
Optimum no. / grouping	40 Learners / Groups of 10
Prerequisites	Prior knowledge on the carbon cycle.
Short description	In this interactive game, learners assume the identity of carbon atoms that are released into the atmosphere when fossil fuels are burned. The learners travel the carbon cycle, visiting the different reservoirs where carbon is stored. The objective is to get to all the places where carbon is stored along the cycle and learn more about them.
Learning outcomes	1. Learners understand that carbon cycles move naturally through living and non-living parts of the Earth system in a complex and nonlinear manner. 2. Learners understand that burning fossil fuel adds carbon to the cycle. 3. Learners explore the impact of additional carbon dioxide on global warming. 4. Learners learn that carbon is essential for living things.
Skills	Communication, Creative Thinking, Team Work, Observation, Analytical Thinking
Values	Responsibility, Adherence to time, Value self-respect, Collective responsibility, Helping one another, Gratefulness, Open mindedness and ability to think logically, Sensitivity to social issues in the community
Keywords	#Grades: 6 to 9, Biodiversity, Atmosphere, carbon atom, oxygen atom, surface ocean, marine life, deep ocean, soil nutrients
Necessary Materials	Flash cards with information and instructions “see annex”
Assessment method	Written
Link to MOE’s cur.:	Science
References	National Geographic Society. (2019, October 29). The carbon cycle. National Geographic Society. https://www.nationalgeographic.org/encyclopedia/carbon-cycle/. The activity is inspired from: Climate Heroes Lesson Plan. BC Teachers' Federation. (n.d.). https://bctf.ca/.

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Preparation	–	● Prior to the game, prepare the game plan, set up 6 stations representing the carbon reservoirs. These are: atmosphere, plants, soils, shallow water, deep ocean, and marine life. Each station holds 3 sets of cards: ▪ Options for the carbon cycle: 2 possible cycles are presented in this game. "See annex B.15.1." ▪ Carbon reservoir questions: questions about a particular carbon reservoir for learners to gain deeper knowledge on each. "See annex B.15.2" ▪ Answers to the questions "See annex B.15.3"	Sets of cards
understand that carbon cycles move naturally through living and non-living parts of the Earth system in a complex and nonlinear manner.	40 Min	● Begin the game by briefly introducing the topic of carbon cycle and explaining the rules of the game. You may wish to review the characteristics of the carbon reservoirs before learners begin playing the game. "See annex B.15.2, B.15.3." ● Split learners into groups of two or three where they go from station to another "depending on which of the two cycles they choose to follow" learning about each carbon reservoir in the process by taking a card with the questions "annex B.15.2" and attempt to answer as many of them as they can before reaching for the Answers card "annex B.15.3". They decide which station to go next and they pick the appropriate card and so on till they complete all the cards "annex B.15.1." (Learners keep all the cards they picked up in order to be able to recreate their journeys later on "see Assessment." ● Instruct the learners to begin either at the atmosphere, marine life or deep ocean stations and follow the cycle. "If they start at the atmosphere, they get to choose which of the two cycles they want to follow". As they travel through the cycle, they should try to think how much time the carbon spends in each of the reservoirs.	none
Explore the impact of additional carbon dioxide on	20 Min	● At the end of the designated time initiate a small discussion to find out how many learners enjoyed the game and what they gained from it.	none

global warming and carbon importance for living things.			

3. Assessment

- Ask learners to write a paragraph about their trip through the carbon cycle. In their paragraph they should include information about (1) where they went, and (2) how they got to each destination.
- Guide learners to create a “map” documenting their journey through the carbon cycle identifying what causes the increase of carbon in the cycle, and the consequences of the excess of carbon.

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

Carry out the following activity with the learners to change their habits and use the accompanying daily habit tracker to monitor their progress outside of the classroom. "see annex B.15.4"

1. Brainstorm a list of decisions that learners make daily that affect the welfare of the environment. Below are some examples:
   - Every recycled bottle is worth 0.5kg carbon saved.
   - Do not forget the power on = 30kg carbon saved. "per …. Day/hour/…."
   - Switch your use to recycled paper = 2.300kg carbon saved. "per …. Day/week/…."
   - Think of how much impact you have on the earth; how many earths are needed to sustain your lifestyle?
   - Every cup you boil is 25 cups more carbon, just boil what you need.
   - One year's driving = 5000kg carbon used.
   - Every time you throw a bag of trash out = 20kg carbon used.
   - 1 kg of beef = 5 kg carbon equivalent used.
   - 1 flight Cairo – Aswan = 900kg carbon used.

2. Categorize these as being either harmful or helpful. Add more actions on the same line.
3. Trace local actions to distant consequences. Ask learners how our decisions at home affect the people in their country? Or the generations to come? How do their decisions affect us? Discuss our role as consumers and how that affects how resources are used around the world.
   A. Do we intend to find solutions? Below are some examples:
      - Take shorter showers because showers account for 2/3 of all water heating costs;
      - Use cold water to wash your clothes – reduces the carbon footprint by 226 kg a year;
      - Plant a tree because trees use up carbon dioxide and make clean air for us to breathe;
      - Buy products with less packaging and recycle paper, plastic and glass – this can reduce our garbage by 10% and our carbon footprint by 544 kg a year;
      - Buy local products and reduce the amount of energy required to ship the products to our stores;
      - Car pool, use public transportation or drive a fuel efficient car – this reduces the carbon footprint by 0.5kg for every 2km not driven;
      - Wash only a full load of clothes to save water and energy;
      - Keep the water heater insulated and the thermostat no higher than 50C;
      - Clean or replace dirty air conditioning filters as recommended;
      - Use a low-flow showerhead because the less water used, the less energy required to heat the water – this reduces the carbon footprint by thousands of kg a year;
      - Eat organic food because the chemicals used in modern agriculture pollute the water supply and require energy to produce.
   B. Go from the bigger actions to the day-to-day negative habits, following the Daily habits sheet below. Learners can do this individually or in groups "the size of which is determined by the teacher".
   C. Create a list of resources in school/ home and add suggestions on how to decrease their consumption. Share the list with the class.

Daily habits sheet

What are my negative habits? Why should I change them?

Now let's start a new day in our lives. Here is what you could do to kick the habit… Let's start from the moment you wake up:

7:00 am: In the bathroom

How much water do you use?

5 minute shower (not strong water) 35 liters

5 minutes shower (strong water) 90 liters

Brushing teeth with tap off 1 liter/min

Brushing teeth with tap running 6 liters/min

One toilet flush 9 liters

You see how much water is wasted?!

What can you do?

- Keep washing time to a minimum. Use water-saver showerhead.
- Recycle empty shampoo bottles and other containers found in the bathroom.
- Place a sand bottle inside your flush.
- Do not leave the tap running when you clean your teeth.
- If you have not got a toilet with a water economy flush, put an empty water bottle filled with sand in the cistern.

8:00 am: Having your breakfast

- Cut down on packaging, especially the many plastic bags we tend to use.
- Try to buy fair-trade1 products
- Choose organic food
- Choose cafes and restaurants that provide recycled packaging.
- Do not throw the wrapping (of sandwiches or snacks) on the ground.
- Instead of buying pre-packed sandwiches, biscuits, or chips make your own.
- Buy food produced locally, to reduce the need for long distance food transport.

8:30 am: Going to school/ work

- Take a bus or car pool.
- Do not accelerate or brake too harshly.
- Switch off the engine when you are going to be stationary for some time (for example as on 6th of October bridge!).
- Empty the junk from the boot–the more load in your car, the more gas is needed.
- Put a small basket in your car for your rubbish.
- Do not throw your food wraps or rubbish off the window.
- One bus holds the same number of people as 10 fully occupied cars. The bus takes up seven times less road space than the cars.

- There are more than 400 million cars and light trucks on the world's roads today. These are
- responsible for producing huge amount of greenhouse gas.

10:00 am: Attending the morning classes/ checking your emails

- If you are buying a new computer, use the most energy efficient machines (carrying the energy star logo).
- A laptop is better than a PC.
- Donate your old computer to NGOs and orphanages in Upper Egypt.
- Do not leave your computer running for 24 hours. Shut it down instead of putting it on STANDBY.
- Switch off the monitor. "You could print 800 pages with the energy you waste by leaving on a computer monitor overnight"

12:00 pm: Having your lunch

- Take your own bag to put your snack for lunch.
- Put your rubbish in a recyclable bin3.
- Do not throw your trash in the school's yard or leave it on your desk. "More than half the plastic waste generated every year is from packaging. This includes: potato chips packaging, sandwich wraps and boxes, supermarket rubbish of large boxes"

1:00 pm: Making a phone call

- Note: in 2006, worldwide sales of new mobiles topped 1 billion.
- What is inside your mobile?!
    - Cadmium (in the mobile's old battery) Can contaminate 600,000 litres of water
    - Tantalum (in electric circuit boards of the phone) Damages the environment
    - The plastic cover of the phone This lasts for hundreds of years in landfill
- What could you do then?
    - Donate or sell your mobile plastic covers to a recycling NGO.
    - Do not leave your phone charger switched on. Even when not connected to a phone the charger continues to draw electricity.
    - Laptops are more environmentally friendly than desktops. They consume five times less electricity.
    - If you do not have a recycling system at school or in your office, why not start one?! All it takes is some extra bins and talking to your peers and colleagues.

4:00 pm: Doing your homework/ revising final reports

- Try to practice the 3Rs:
    - Reduce the amount of paper you use.
    - Reuse both sides of the paper.
    - Recycle all of your waste paper.
- Buy recycled paper. "Each ton of recycled paper can save 17 trees and around 32,000 litres of water"

6:00 pm: Back home and enjoying your free time

- Always switch off TV, music player, satellite decoder and other electronic equipment when
- not in use. DO NOT just put them on stand-by.
- Some new models could be energy efficient, look for those when you are buying a new one.
- Do not talk over the phone for hours while leaving the TV on when you are not watching it.
- Avoid leaving one room's lights on when you are sitting in another room.
- Buy energy saving bulbs.

10:00 pm: Going to bed

- Do not leave on any lights overnight (unless you absolutely have to).
- In winter use a hot-water bottle with a wool pyjama to keep warm.
  In summer try to use a fan instead of the AC.

5. Possible adaptation

For younger learners you can use one of the videos in “annex B.15.4.” and then guide the learners to answer the questions “annex B.15.2” in groups

Annex “Teacher’s Background Information”

Note:

It is important to remind the learners that all carbon, even the carbon sequestered deep underground in limestone rocks, coal, and fossil fuels, is part of the carbon cycle. These reservoirs, often known as deep carbon sinks, remove carbon from circulation through other parts of the carbon cycle for such long amounts of time that they are sometimes considered an extension of the carbon cycle called the slow carbon cycle. For simplicity, the deep carbon sinks have been omitted from this activity, however they are a very important part of the long-term cycle. While it may only take your learners 10-20 minutes to complete their journey as a carbon atom, it can take actual carbon atoms millions of years to make it to all the reservoirs in the carbon cycle.

B.15.1. **Options for the Carbon Cycle:**

- **First Cycle:**

Once the carbon atoms reach the surface ocean from the atmosphere or marine life or deep ocean the learners find a card explaining the cycle they just followed. These cards should be collected to reflect the different paths once the game ends.

From Atmosphere, Marine Life or Deep Ocean to Surface Ocean:

Either you got here by diffusing from the atmosphere, or by decomposing of marine life, or from circulating water from the deep ocean. The ocean absorbs more carbon dioxide from the atmosphere than the land does. The surface ocean takes in approximately 90 Gigatons of carbon per year. Cold water absorbs carbon faster than warm water.

From Surface Ocean to Marine Life:

Tiny marine organisms called phytoplankton take in carbon to make the nutrition they need through a process called photosynthesis. The phytoplankton are eaten by larger marine life. Marine life cannot survive without carbon, but high levels of carbon dissolved in ocean waters are harmful to marine organisms such as algae, mollusks and corals.

From Marine Life to Deep Ocean:

The deep ocean gets carbon from circulation with the surface ocean and dead and decaying marine life. When carbon gets to the deep ocean, it usually stays there for hundreds of years before moving on. The deep ocean holds more than 65% of the Earth’s carbon.

- **Second Cycle:**

From Atmosphere to Land Plants:

You have been taken out of the atmosphere by a plant as it used the Sun’s energy to make the nutrition it needs (a process called photosynthesis). You are now one of the building blocks that make up a plant. As more carbon dioxide is added to our atmosphere, plants will be able to grow faster. Plants also release carbon back to the atmosphere by respiration.

From Land Plants to Soil:

We are afraid to say that the plant you were in has died. The good news is that, you are now a part of the soil called detritus, which is decomposing plants and animals. Soil is also made of inorganic parts such as sand, silt, and clay. Soils store about 3% of Earth’s carbon. As bacteria and fungi breakdown the detritus, carbon is sent into the atmosphere.

B.15.2. **Carbon Reservoir Questions:**

Choose your path and answer the questions below as you get to each destination. It does not have to be the same order as the questions.

Fossil Fuels

1. Where were you for the past few millions of years?
2. How were you released into the atmosphere?
3. What is the objective of the Carbon Cycle game?

Atmosphere

4. What atoms are you stuck to here?
5. What were you called when you were in this form?
6. Is there a little or a lot of carbon dioxide in the atmosphere?
7. What caused the amount of carbon dioxide to increase in the past 150 years?
8. What kind of problem can this cause?
9. Where did you travel to next?

Marine Life

1. Why would phytoplankton need to be green like land plants?
2. How does phytoplankton remove carbon from the atmosphere? What process does it use?
3. One the carbon is inside the cells of the phytoplankton; how does larger marine life (like fish) get the carbon from the phytoplankton?
1. If carbon is good for marine life, is more carbon better?
2. What are phytoplankton?

Soil

1. The plant you were in just _____. Where are you now?
2. What is detritus?
3. What else, besides detritus, is soil made of?
4. How much carbon is stored in soil?
5. Bacteria and fungi "eat" detritus…. Which means they are eating you (the carbon atom). How is it that their act of eating you (the carbon atom) would release you (the carbon atom) back into the atmosphere?

Surface Oceans

1. How did you get here?
2. What ocean might absorb carbon faster? … The Arctic Ocean or the South Pacific?

Deep Ocean

1. In what two ways does the deep ocean get carbon?
2. What happens to the carbon in the deep ocean?
3. Which process holds the most of the Earth's carbon?

Land Plants

1. How did you get out of the atmosphere?
2. What energy source was used to get you out of the atmosphere?
3. Where exactly are you now?
4. Why can plants grow faster if more carbon dioxide is added to the atmosphere?
5. As a plant you not only "suck up" carbon dioxide, but you also do what with some of it?

B.15.3. **Carbon Reservoir Answers:**

For millions of years, you were underground in fossil fuels. Now, you have been released into the atmosphere as humans burn fuels. Did you know that 5000 megatons of carbon are released into the atmosphere as fossil fuels are burned each year?

Welcome to the Atmosphere

While you are here, little carbon atom, you will be stuck to two atoms of oxygen in a greenhouse gas called carbon dioxide. Only a small amount (0.04%) of the atmosphere is made of carbon dioxide. Because of burning fossil fuels, the amount has increased 30% in the past 150 years. More carbon dioxide in our atmosphere makes our planet warmer.

Welcome to Land Plants

You have been taken out of the atmosphere by a plant as it used the Sun's energy to make the nutrition it needs "a process called photosynthesis". You are now one of the building blocks that make up a plant. As more carbon dioxide is added to our atmosphere, plants will be able to grow faster. Plants also release carbon back to the atmosphere by respiration.

Welcome to the Soil

We are sorry to say that the plant you were in has died. The good news is that you are now a part of the soil called detritus, which is decomposing plants and animals. Soil is also made of inorganic parts such as sand, silt, and clay. Soils store about 3% of Earth's carbon. As bacteria and fungi breakdown the detritus, carbon is sent into the atmosphere.

True or False: When plants die and decay, they bring carbon into soil.

True! The carbon that was in a plant becomes part of the soil when the plant dies and decomposes.

Welcome to the Surface Ocean

Either you got here by diffusing from the atmosphere, by decomposing marine life, or from circulating water from the deep ocean. The ocean absorbs more carbon dioxide from the atmosphere than the land does. The surface ocean takes in approximately 90 Gigatons of carbon per year. Cold water absorbs carbon faster than warm water.

What percent of the atmosphere is carbon dioxide?

Carbon atoms are part of a greenhouse gas called carbon dioxide. Carbon dioxide is made of one

carbon atom attached to two oxygen atoms.

Welcome to Marine Life

Tiny marine organisms called phytoplankton take in carbon to make the nutrition they need through a process called photosynthesis. The phytoplankton are eaten by larger marine life. Marine life cannot survive without carbon, but high levels of carbon dissolved in ocean waters are harmful to marine organisms such as algae, mollusks and corals.

Phytoplankton are tiny plants and algae that float in the ocean and take up carbon dioxide as they grow.

True! Phytoplankton do the process of photosynthesis, just like plants on land.

Welcome to the Deep Ocean

The deep ocean gets carbon from circulation with the surface ocean and from dead and decaying marine life. When carbon gets to the deep ocean, it usually stays there for hundreds of years before moving on. The deep ocean holds more than 65% of the Earth's carbon.

B.15.4. Useful Resources:

The carbon cycle, Arabic video

The carbon cycle

The Carbon Cycle Process

Simples how explains the Carbon Footprint

The Best Ways to Reduce Your Carbon Footprint | Hot Mess

Three Steps to Cut Your Carbon Footprint 60% Today | Jackson Carpenter | TEDxAsheville

Carbon Footprint Calculator:

D. https://www.conservation.org/carbon-footprint-calculator
E. https://footprint.wwf.org.uk/#/
F. https://www.carbonfootprint.com/calculator.aspx

Carbon dioxide (CO2) provides the bubble in your soda pop and the “rise” in your baked goods. But it is also a very significant greenhouse gas. Carbon dioxide is important in maintaining the earth’s average temperature of about 15 C (59 F). It traps infrared energy emitted from the earth’s surface and warms the atmosphere. Without CO2, water vapor, and methane (the three most important naturally produced greenhouse gases), the earth’s surface temperature would have been about -18 ℃ (0 F).

At this temperature, it is doubtful that complex life as we know it would ever have evolved. Where does CO2 come from? Plants and animals give it off when they extract energy from their food during cellular respiration. Carbon dioxide bubbles out of the earth in soda springs, explodes out of volcanoes, and is released when organic matter burns (such as during forest fires).

- Anything that releases CO2 into the atmosphere (living, dead, or non-living) is considered a source.
- Anything that absorbs and holds CO2 from the air or water is considered a sink (because, like a sink in your home, it acts as a “holding reservoir”).
- Over geologic time, sources and sinks generally balance. In today’s atmosphere, however, levels are climbing in a dramatic and easily measurable fashion, providing evidence that there are now more sources than sinks.
- What are the sources for this ‘extra’? Human activities are thought to be primarily responsible for the observed increases. Of these human sources:
- Fossil fuel combustion accounts for 65%.
- Deforestation (released from trees that are cut and burned or left to decay) accounts for 33%.
- The by-products of cement production account for more than 10%.

Greenhouse Gases:

A greenhouse gas (sometimes abbreviated GHG) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in the Earth’s atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. In the Solar System, the atmospheres of Venus, Mars, and Titan also contain gases that cause greenhouse effects. Greenhouse gases greatly affect the temperature of the Earth; without them, the Earth’s surface would be on average about 33 ℃(59 F) colder than at present.

Greenhouse Effect:

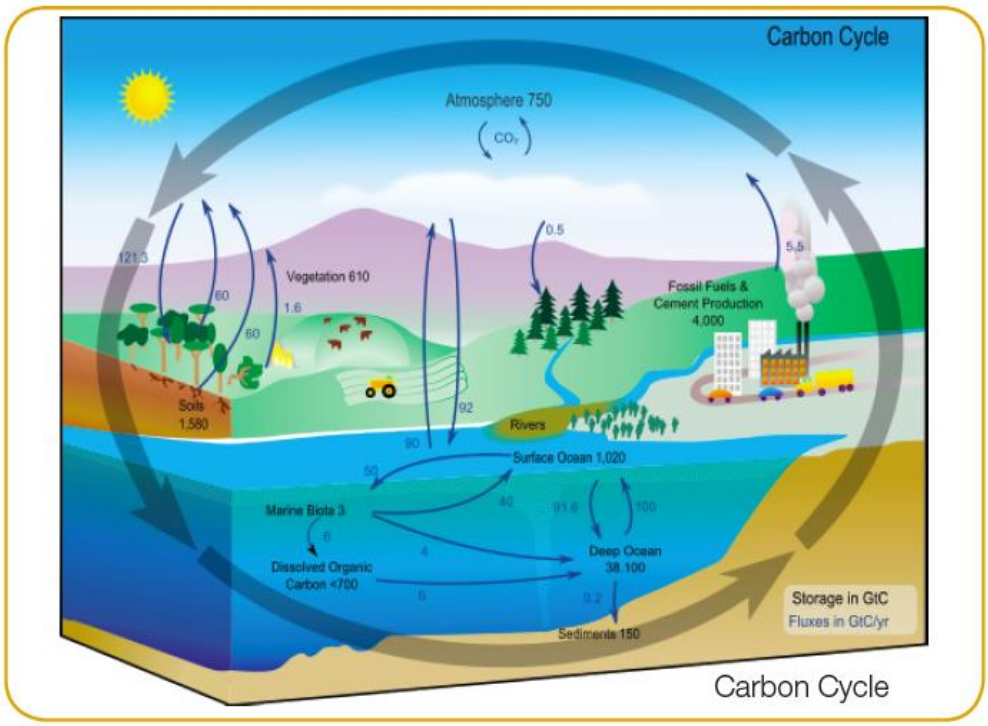
- The greenhouse effect is a process by which thermal radiation from a planetary surface is absorbed by atmospheric greenhouse gases and is re-radiated in all directions. Since part of this re-radiation is back towards the surface, energy is transferred to the surface and the lower atmosphere. As a result, the temperature there is higher than it would be if direct heating by solar radiation were the only warming mechanism.
- There are natural sources of CO2 as well. Plants and animals emit it while alive and respiring and when dead and decaying (bacteria that consume the dead bodies respire too, after all). Carbonate rocks

contain CO_2 that can be released by exposure to acid and/or weathering. Certain naturally carbonated spring waters (for example, Perrier water) contain CO_2 because the water has passed though carbonate rocks on its way to the surface. Volcanoes are also a source of CO_2. However, these geological sources are insignificant when compared to the human sources.

- Plants (both terrestrial plants and marine phytoplankton) are the most important carbon sinks, taking up vast quantities of CO_2 through the process of photosynthesis. Atmospheric CO_2 can also be dissolved directly into ocean waters and thereby be removed from the atmosphere. While plants also release CO_2 through the process of respiration, the CO_2 released from human activities is truly the 'extra'.
- Scientists typically monitor the concentration of CO_2 in atmospheric samples by using sensitive devices called infrared gas analyzers. These devices pass a beam of infrared (IR) light through a sample of gas. The amount of IR that reaches a detector on the other side can be used to determine the amount of CO_2 in the sample. A worldwide network of monitoring stations currently tracks the earth's rising levels.
- Carbon dioxide has another characteristic that enables learners to detect CO_2 themselves. When dissolved in water, carbon dioxide forms a weak acid, called carbonic acid. The chemical bromothymol blue (BTB) is a sensitive indicator of the presence of acid. When gas containing CO_2 is bubbled through a BTB solution, carbonic acid forms and the indicator turns from dark blue to green, yellow, or very pale yellow depending on the concentration (lighter colors mean higher concentrations).
- Carbon is the 12th element in the periodic table. It is able to combine with a large variety of other elements and as such it is found in some very different places within the Earth system. Living things, including plants and animals, are made of carbon and they depend on carbon for nutrition. Carbon is also an important component in bones, seashells, and chemical sedimentary rocks like limestone. It can dissolve in water. In the atmosphere, carbon forms a greenhouse gas called carbon dioxide. Carbon continually moves through these parts of the Earth system. This is called the Carbon cycle.

- The carbon cycle is one of the biogeochemical cycles. Other biogeochemical cycles include the water cycle and the nitrogen cycle. In biogeochemical cycles, elements are transported between the atmosphere, biosphere (living things), hydrosphere (water) and geosphere (rocks, minerals, and soils). Thus, these cycles are excellent examples for teaching about Earth as a system. The basic construction of these cycles allows middle school learners to explore the connections between living and non-living

parts of the Earth system. Please note that in-depth understanding of these cycles will require understanding of chemistry and is more appropriate at the high school level.



© wikimedia

Message #16: Water in Agriculture

1. Design Map:

Activity Code	W.16.
Activity Title	Less water, more crops
Activity Type	Discussion, Research, Debate
Activity Location	Computer lab
Duration	120 Min
Optimum no. / grouping	20 Learners / Groups of 5
Prerequisites	Do activity #D.12
Short description	This activity aims to introduce different irrigation systems to learners using research and debate activities
Learning outcomes	1. Learners will be able to identify different sources of water (such as rainwater collection, qanats, efficient irrigation, etc.). 2. Learners will be able to identify sustainable sources of water for agriculture. 3. They will be able to define irrigation and recognize its different types.
Skills	Research, Debate, Discussion, Analytical skills
Values	Understanding, Self-confidence, Politeness, admitting one's mistake, Respect for others, Respect for individual rights, Adherence to time, Tolerance, Gratefulness, Open mindedness and ability to think logically, Sensitivity to social issues in the community
Keywords	Water, Irrigation
Necessary Materials	Computers
Assessment method	Observation, Reflection
Link to MOE's cur.:	Social studies, Agriculture
References	M.H. Ali / Agricultural Engineering Division/ Bangladesh Institute of Nuclear Agriculture www.fao.org

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Onboarding	30 Min.	● Divide the learners into 4 groups ● Ask learners about the water resources in Egypt they have studied in message #D.12. Also discuss with them which resources are considered sustainable and which is not ● Ask learners if they know other water resources ● Lead a discussion about which sector consume the most of Egypt's water, and comment on their answer that the percentage of the agriculture sector consumes the most "about 70% of Egypt's water" ● Brainstorm with the learners some possible solutions to reduce this percentage	None
Define irrigation and recognize different types of it	70 Min	● Assign a type of irrigation for three of the four groups. "Group A, B and C" ● Ask each of the three groups to search the internet for information about the topic where they will have a debate with the other groups. ● The 3 groups will be assigned the following topics: ▪ Group A: Surface irrigation ▪ Group B: Sprinkler irrigation ▪ Group C: Drip irrigation ▪ The last group "D" can do a free search about all the topics as they will later do an organizational role in the debate Search keywords are: ▪ Definition ▪ Advantages ▪ Disadvantages ▪ Types ▪ The best crops for each ▪ The efficiency ● From the remaining group "Group D", select 2 learners to moderate the debate, and ask the other 3 to write the highlights and summary of the debate. ● Help in facilitating the discussion where the 3 learners share the highlights and other learners decide which type of irrigation is better. "Annexes from W.16.1 to W.16.4 can provide you with the needed information"	Computers, Internet access
Reflection	20 Min	● Show the learners one of the videos on "annex W.16.5"	

		● Conclude the session by summarizing all the facts learned about water “Water scarcity, Egypt water resources, Main water consumer sector, Irrigation definition and types, why we must replace surface irrigation to modern irrigation systems”	

3. Assessment

- Assess learners' interaction during the activities and challenge their understanding by asking them follow-up questions.

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

Send the homemade drip irrigation video link “annex W.16.5 - E” to learners, and ask them - with the help of their parents - to make one and use it for the plant they have planted in message D.10

5. Possible adaptation

For younger learners, you can provide printed sheets with written and pictorial information on the different types of irrigation and their effect on water conservation.

Annex “Teacher’s Background Information”

W.16.1. What is Irrigation?

It is an artificial application of water to the soil through various systems of tubes, pumps, and sprays. Irrigation is normally used in areas where rainfall is inconsistent or dry conditions or drought is expected.

An adequate water supply is important for plant growth. When rainfall is not sufficient, the plants must receive additional water from irrigation. Various methods can be used to supply irrigation water to the plants. Each method has its advantages and disadvantages. These should be taken into account when choosing the method which is best suited to the local circumstances.

A simple irrigation method is to bring water from the source of supply, e.g., a well, to each plant with a bucket or a watering can.

W.16.2. Surface Irrigation:

Surface irrigation is the application of water by gravity flow to the surface of the field. Either the entire field is flooded (basin irrigation) or the water is fed into small channels (furrows) or strips of land (borders).

Types of surface irrigation

1. **BASIN IRRIGATION**: Basins are flat areas of land, surrounded by low bunds. The bunds prevent the water from flowing to the adjacent fields. Basin irrigation is commonly used for rice grown on flat lands or in terraces on hillsides. Trees can also be grown in basins, where one tree is usually located in the middle of a small basin. In general, the basin method is suitable for crops that are unaffected by standing in water for long periods.
2. **FURROW IRRIGATION**: Furrows are small channels, which carry water down the land slope between the crop rows. Water infiltrates into the soil as it moves along the slope. The crop is usually grown on the ridges between the furrows. This method is suitable for all row crops and for crops that cannot stand in water for long periods.
3. **BORDER IRRIGATION**: Borders are long, sloping strips of land separated by bunds. They are sometimes called border strips. Irrigation water can be fed to the border in several ways: opening up the channel bank, using small outlets or gates, or by means of siphons or spiles. A sheet of water flows down the slope of the border, guided by the bunds on either side.

Suitable crops for surface irrigation: Surface irrigation is suitable for many field crops. Paddy rice grows best when its roots are submerged in water and so basin irrigation is the best method to use for this crop. Other crops include: pastures, e.g., alfalfa, clover; trees, e.g., citrus, banana; crops which are broadcast, such as cereals; to some extent row crops such as tobacco.

Suitable soils for surface irrigation: Which soils are suitable for basin irrigation depends on the crop grown. A distinction has to be made between rice and non-rice or other crops. Paddy rice is best grown on clayey soils which are almost impermeable as percolation losses are low. Rice could also be grown on sandy soils but percolation losses will be high unless a high-water table can be maintained. Such conditions sometimes occur in valley bottoms. Although most other crops can be grown on clays, loamy soils are preferred for basin irrigation so that water logging (permanent saturation of the soil) can be avoided. Coarse sands are not recommended for basin irrigation as, due to the high infiltration rate, percolation losses can be high. Also soils which form a hard crust when dry (capping) are not suitable.

W.16.3. Drib Irrigation

With drip irrigation, water is conveyed under pressure through a pipe system to the fields, where it drips slowly onto the soil through emitters or drippers which are located close to the plants. Only the immediate root zone of each plant is wetted. Therefore, this can be a very efficient method of irrigation. Drip irrigation is sometimes called trickle irrigation.

Types of drib irrigation:

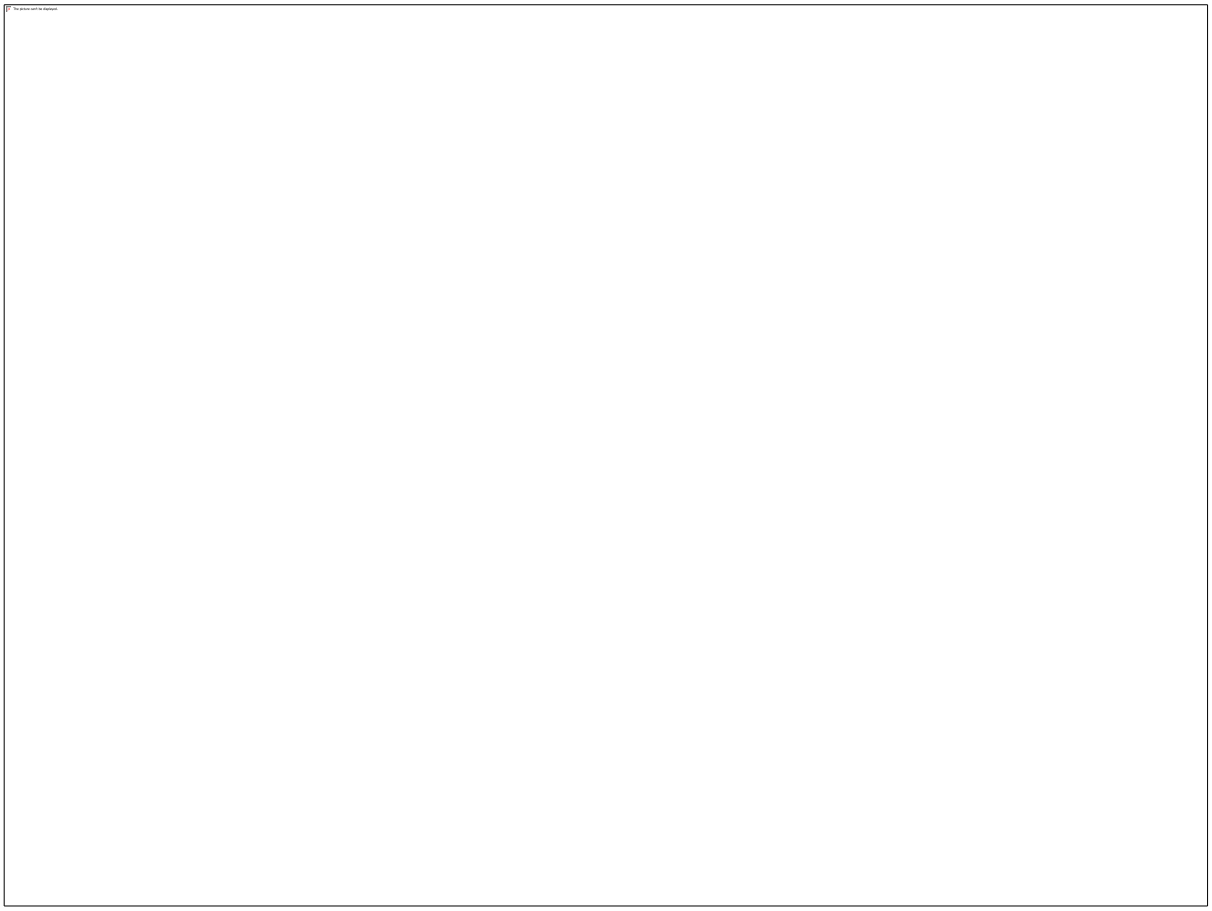
Suitable crops for Drib Irrigation: Drip irrigation is most suitable for row crops (vegetables, soft fruit), tree and vine crops where one or more emitters can be provided for each plant. Generally, only high value crops are considered because of the high capital costs of installing a drip system

Suitable soils for Drib Irrigation: Drip irrigation is suitable for most soils. On clay soils water must be applied slowly to avoid surface water ponding and runoff. On sandy soils higher emitter discharge rates will be needed to ensure adequate lateral wetting of the soil.

W.16.4. Sprinkler Irrigation

It is similar to natural rainfall. Water is pumped through a pipe system and then sprayed onto the crops through rotating sprinkler heads.

Types of sprinkler irrigation



Suitable crops for Sprinkler Irrigation: Sprinkler irrigation is suited for most row, field and tree crops and water can be sprayed over or under the crop canopy. However, large sprinklers are not recommended for irrigation of delicate crops such as lettuce because the large water drops produced by the sprinklers may damage the crop.

Suitable soils for Sprinkler Irrigation: Sprinklers are best suited to sandy soils with high infiltration rates although they are adaptable to most soils. The average application rate from the sprinklers (in mm/hour) is always chosen to be less than the basic infiltration rate of the soil so that surface ponding and runoff can be

avoided. Sprinklers are not suitable for soils which easily form a crust. If sprinkler irrigation is the only method available, then light fine sprays should be used. The larger sprinklers producing larger water droplets are to be avoided.

W.16.5. Useful links:

Videos:

A. Let's use Drip Irrigation to conserve water: https://www.youtube.com/watch?v=6tPzlh2CjWc
B. What is irrigation? https://www.youtube.com/watch?v=amrCMakolKA
C. Irrigation systems: https://www.youtube.com/watch?v=rXT5HwH-l9w
D. Modern methods of irrigation: https://www.youtube.com/watch?v=xi_CMzBQtY4
E. Home Task - bottle drip irrigation: https://www.youtube.com/watch?v=RGG3jVTWYm4

Websites:

https://medium.com/@hmkrishna/efficient-and-water-saving-irrigation-methods-for-2020-b49efe9d2e88

Message #17: Title Role of Protected Areas in Biodiversity

1. Design Map:

Activity Code	B.17.
Activity Title	Fellow creatures: Saving endangered species
Activity Type	Research, Group Work, Presentation
Activity Location	Classroom, Computer Lab
Duration	100 Min
Optimum no. / grouping	40 Learners / Groups of 5
Prerequisites	It's better if the learners studied topics related to living organisms' classification and species taxonomy
Short description	Learners work in groups, where each group will do a research about an endangered species and present how this might affect the environment and the food web and accordingly make negative effects on economy, society and human well-being
Learning outcomes	1. Learners get introduced to the International Convention on Biological Diversity and its plans for the future of biological diversity. 2. Learners discuss ways of biodiversity conservation and the role of protected areas.
Skills	Interpersonal, Intrapersonal, Communication, Team Work, Observation, Analytical Thinking, Research
Values	Empathy, Responsibility, Self-confidence, admitting one's mistake, Stand up for the truth, Environmental cleanliness, Collective responsibility, Tolerance, Gratefulness, Sensitivity to social issues in the community
Keywords	#Grades: 6 to 9, Biodiversity, Endangered species, Food Web, Autotrophs, Biomass
Necessary Materials	Secure a stable internet access
Assessment method	Observation, Evaluation Rubric
Link to MOE's cur.:	Biology, Species
References	National Geographic Society. (2012, October 9). Food Web. National Geographic Society. https://www.nationalgeographic.org/encyclopedia/food-web/7th-grade/. National Geographic Society. (2019, June 5). Biodiversity. National Geographic Society. https://www.nationalgeographic.org/encyclopedia/biodiversity/. United Nations. (n.d.). *Convention on biodiversity*. United Nations. https://www.un.org/en/observances/biological-diversity-day/convention.

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Onboarding	15 Min	● Ask the learners what do they know about biodiversity. Then explain to them what the International Convention on Biological Diversity is. See Annex B.17.3 ● Have learners brainstorm causes of biodiversity loss “e.g. habitat destruction to construct new homes and businesses; habitat changes due to climate change” and ways to mitigate biodiversity loss “e.g. government creates new protected areas; citizens plant local species in private and community gardens” and write the discussion conclusion on the board. “see annex B.17.1. and B.17.2.”	Board
Discuss ways of biodiversity conservation	85 Min	● Divide the learners into groups of 5 ● Ask each group to choose an endangered creature “animal, plant, insect, etc.” and do a research that covers the following: “see annex B.17.3.” ▪ Animal taxonomy “kingdom, class, etc.” ▪ Characteristics of the animal “diet – habitat – reproduction - the countries and continents in which it lives” ▪ Population and history. How long has this animal become endangered? ▪ Factors that will lead to extinction ▪ How can the extinction of this animal affect the environment and food web leading to reflections on economy, society, and human well-being ▪ Possible preventive actions by individuals, governments and society ▪ The current international convention and interventions to protect this animal now and on the future ● Instruct each group to create a 5 minutes presentation to share their findings with the rest of the class ● Lead a 3 minutes class discussion after each presentation for learners’ reflection.	Internet access

3. Assessment

- Observe learners' interaction while working on their research and presentation. Make sure the work is distributed among all the members of the team.
- Use the evaluation rubric below to evaluate the learners' presentations

	4—Excellent	3—Good	2—Fair	1—Needs Improvement
Delivery	• Holds attention of entire audience with the use of direct eye contact, seldom looking at notes • Speaks with fluctuation in volume and inflection to maintain audience interest and emphasize key points	• Consistent use of direct eye contact with audience, but still returns to notes • Speaks with satisfactory variation of volume and inflection	• Displays minimal eye contact with audience, while reading mostly from the notes • Speaks in uneven volume with little or no inflection	• Holds no eye contact with audience, as entire report is read from notes • Speaks in low volume and/ or monotonous tone, which causes audience to disengage
Content/ Org.	• Demonstrates full knowledge by answering all class questions with explanations and elaboration • Provides clear purpose and subject; pertinent examples, facts, and/or statistics; supports conclusions/ideas with evidence	• Is at ease with expected answers to all questions, without elaboration • Has somewhat clear purpose and subject; some examples, facts, and/or statistics that support the subject; includes some data or evidence that supports conclusions	• Is uncomfortable with information and is able to answer only rudimentary questions • Attempts to define purpose and subject; provides weak examples, facts, and/ or statistics, which do not adequately support the subject; includes very thin data or evidence	• Does not have grasp of information and cannot answer questions about subject • Does not clearly define subject and purpose; provides weak or no support of subject; gives insufficient supp
Enthusiasm/ Audience Awareness	• Demonstrates strong enthusiasm about topic during entire presentation • Significantly increases audience understanding and knowledge of topic; convinces an audience to recognize the validity and importance of the subject	• Shows some enthusiastic feelings about topic • Raises audience understanding and awareness of most points	• Shows little or mixed feelings about the topic being presented • Raises audience understanding and knowledge of some points	• Shows no interest in topic presented • Fails to increase audience understanding of knowledge of topic
Comments				

Evaluation Rubric Source: https://www.readwritethink.org

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

Have learners write a letter to their government representative and/or the Minister of Environment informing him or her about how they feel about biodiversity, its relevance to their lives and their opinion on the role of the government in biodiversity issues. This letter can be shared through the official social media pages of the institution or individual.

5. Possible adaptation

For younger learners you can provide info sheets about some endangered creatures to help them with their research

Annex “Teacher’s Background Information”

B.17.1. Food Web

A food web consists of all the food chains in a single ecosystem. Each living thing in an ecosystem is part of multiple food chains. Each food chain is one possible path that energy and nutrients may take as they move through the ecosystem. All of the interconnected and overlapping food chains in an ecosystem make up a food web.

- Trophic Levels

  Organisms in food webs are grouped into categories called trophic levels. Roughly speaking, these levels are divided into producers “first trophic level”, consumers, and decomposers “last trophic level”.

  - Producers

    Producers make up the first trophic level. Producers, also known as autotrophs, make their own food and do not depend on any other organism for nutrition. Most autotrophs use a process called photosynthesis to create food (a nutrient called glucose) from sunlight, carbon dioxide, and water.

    Plants are the most familiar type of autotroph, but there are many other kinds. Algae, whose larger forms are known as seaweed, are autotrophic. Phytoplankton, tiny organisms that live in the ocean, are also autotrophs. Some types of bacteria are autotrophs. For example, bacteria living in active volcanoes use sulfur, not carbon dioxide, to produce their own food. This process is called chemosynthesis.

  - Consumers

    The next trophic level includes animals that eat producers. These organisms are called consumers. Consumers can be carnivores “animals that eat other animals” or omnivores “animals that eat both plants and animals”. Omnivores, like people, consume many types of foods. People eat plants, such as vegetables and fruits. We also eat animals and animal products, such as meat, milk, and eggs. We eat fungi, such as mushrooms, and also algae, in edible seaweeds like nori ”used to wrap sushi rolls” and sea lettuce ”used in salads”. Bears are omnivores, too, because they eat berries and mushrooms as well as animals such as salmon and deer. While the primary consumers are called herbivores. They eat plants, algae, and other producers. They are at the second trophic level.

    In a grassland ecosystem, deer, mice, and even elephants are herbivores. They eat grasses, shrubs, and trees. In a desert ecosystem, a mouse that eats seeds and fruits is a primary consumer. In an ocean ecosystem, many types of fish and turtles are herbivores that eat algae and seagrass. In kelp forests, seaweeds known as giant kelp provide shelter and food for an entire ecosystem. Sea urchins are powerful primary consumers in kelp forests. These small herbivores eat dozens of kilograms of giant kelp every day.

    Secondary consumers eat herbivores. They are at the third trophic level. In a desert ecosystem,

a secondary consumer may be a snake that eats a mouse. In the kelp forest, sea otters are secondary consumers that hunt sea urchins.

Tertiary consumers eat the secondary consumers and are at the fourth trophic level. In the desert ecosystem, an owl or eagle may prey on a snake.

There may be more levels of consumers before a chain finally reaches its top predator. Top predators, also called apex predators, eat other consumers. They may be at the fourth or fifth trophic level and have no natural enemies except humans. Lions are apex predators in the grassland ecosystem. In the ocean, fish such as the great white shark are apex predators. In the desert, bobcats and mountain lions are top predators.

- Detritivores and Decomposers

Detritivores and decomposers make up the last part of food chains. Detritivores are organisms that eat non living plant and animal remains. For example, scavengers such as vultures eat dead animals while dung beetles eat animal feces. Decomposers, like fungi and bacteria, complete the food chain by turning organic wastes, such as decaying plants, into inorganic materials, such as nutrient-rich soil. They complete the cycle of life, returning nutrients to the soil or oceans for use by autotrophs. This starts a new series of food chains.

- Food Chains

Food webs connect many different food chains, and many different trophic levels. Food webs can support food chains that are either long and complicated or very short.

For example, grass in a forest clearing produces its own food through photosynthesis. A rabbit eats the grass, and then a fox eats the rabbit. When the fox dies, decomposers such as worms and mushrooms break down its body, returning it to the soil where it provides nutrients for plants like grass.

This short food chain is one part of the forest's food web. Another food chain in the same ecosystem might involve completely different organisms. A caterpillar may eat the leaves of a tree in the forest. A bird such as a sparrow may eat the caterpillar, and a snake may then prey on the sparrow. An eagle, an apex predator, may prey on the snake. Yet another bird, a vulture, consumes the body of the dead eagle. Finally, bacteria in the soil decompose the remains. Algae and plankton are the main producers in marine ecosystems. Tiny shrimp called krill eat the microscopic plankton. The largest animal on Earth, the blue whale, preys on thousands of tons of krill every day. Apex predators such as orcas prey on blue whales. As the bodies of large animals such as whales sink to the seafloor, detritivores such as worms break down the material. The nutrients released by the decaying flesh provide chemicals for algae and plankton to start a new series of food chains.

- Biomass

  Food webs are defined by their biomass—the energy in living organisms. Autotrophs, the producers in a food web, convert the sun's energy into biomass. Biomass decreases with each trophic level. There is always more biomass in lower trophic levels than in higher ones.

  Because biomass decreases with each trophic level, there are always more autotrophs than herbivores in a healthy food web. There are more herbivores than carnivores. An ecosystem cannot support a large number of omnivores without supporting an even larger number of herbivores, and an even larger number of autotrophs.

  A healthy food web has an abundance of autotrophs, many herbivores, and relatively few carnivores and omnivores. This balance helps the ecosystem maintain and recycle biomass. Every link in a food web is connected to at least two others. The biomass of an ecosystem depends on how balanced and connected its food web is. When one link in the food web is threatened, some or all of the links are weakened or stressed, and the ecosystems biomass declines.

  The loss of plant life usually leads to a decline in the herbivore population, for instance. Plant life can decline due to drought, disease or human activity. Forests are cut down to provide lumber for construction. Grasslands are paved over for shopping malls or parking lots. The loss of biomass on the second or third trophic level can also put a food web out of balance. Consider what may happen if a salmon run—a river where salmon swim—is diverted. Salmon runs can be diverted by landslides and earthquakes, as well as the construction of dams and levees.

  Biomass is lost as salmon are cut out of the rivers. Unable to eat salmon, omnivores like bears are forced to rely more heavily on other food sources, such as ants. The area's ant population shrinks. Ants are usually scavengers and detritivores, so fewer nutrients are broken down in the soil. The soil is unable to support as many autotrophs, so biomass is lost. Salmon themselves are predators of insect larvae and smaller fish. Without salmon to keep their population in check, aquatic insects may devastate local plant communities. Fewer plants survive, and biomass is lost.

  A loss of organisms on higher trophic levels, such as carnivores, can also disrupt a food chain. In kelp forests, sea urchins are the primary consumer of kelp, and sea otters' prey on urchins. If the sea otter population shrinks due to disease or hunting, urchins devastate the kelp forest. Lacking a community of producers, biomass plummets. The entire kelp forest disappears. Such areas are called urchin barrens. Human activity can reduce the number of predators. In 1986, officials in Venezuela dammed the Caroni River, creating an enormous lake about twice the size of Rhode Island. Hundreds of hilltops turned into islands in this lake. With their habitats reduced to tiny islands, many terrestrial predators weren't able to find enough food. As a result, prey animals like howler monkeys, leaf-cutter ants, and iguanas flourished. The ants became so numerous

that they destroyed the rainforest, killing all the trees and other plants. The food web surrounding the Caroni River was destroyed.

- Bioaccumulation

  Biomass declines as you move up through the trophic levels. However, some types of materials, especially toxic chemicals, increase with each trophic level in the food web, and usually collect in the fat of animals.

  When an herbivore eats a plant or other autotroph that is covered in pesticides, for example, those pesticides are stored in the animal's fat. When a carnivore eats several of these herbivores, it takes in the pesticide chemicals stored in its prey. This process is called bioaccumulation. Bioaccumulation happens in aquatic ecosystems too. Runoff from urban areas or farms can be full of pollutants. Tiny producers such as algae, bacteria, and seagrass absorb minute amounts of these pollutants. Primary consumers, such as sea turtles and fish, eat the seagrass. They use the energy and nutrients provided by the plants, but store the chemicals in their fatty tissue. Predators on the third trophic level, such as sharks or tuna, eat the fish. By the time the tuna is consumed by people, it may be storing a remarkable amount of bioaccumulated toxins. Because of bioaccumulation, organisms in some polluted ecosystems are unsafe to eat and not allowed to be harvested. Oysters in the harbor of the United States' New York City, for instance, are unsafe to eat. The pollutants in the harbor accumulate in its oysters, a filter feeder. In the 1940s and 1950s, a pesticide called DDT ”dichloro-diphenyl-trichloroethane” was widely used to kill insects that spread diseases. During World War II, the Allies used DDT to eliminate typhus in Europe and control malaria in the South Pacific. Scientists believed they had discovered a miracle drug. DDT was largely responsible for eliminating malaria in places like Taiwan, the Caribbean, and the Balkans. Sadly, DDT bioaccumulates in an ecosystem and causes damage to the environment. DDT accumulates in soil and water, and some forms of DDT decompose slowly. Worms, grasses, algae, and fish accumulate DDT. Apex predators, such as eagles, had high amounts of DDT in their bodies, accumulated from the fish and small mammals they prey on.

  Birds with high amounts of DDT in their bodies lay eggs with extremely thin shells. These shells would often break before the baby birds were ready to hatch. DDT was a major reason for the decline of the bald eagle, an apex predator that feeds primarily on fish and small rodents. Today, the use of DDT has been restricted. The food webs of which it is a part have recovered in most parts of the country.

Source: Food Web

B.17.2. Biodiversity

Biodiversity refers to the variety of living species on Earth, including plants, animals, bacteria, and fungi. While Earth’s biodiversity is so rich that many species have yet to be discovered, many species are being threatened with extinction due to human activities, putting the Earth’s magnificent biodiversity at risk.

Biodiversity is a term used to describe the enormous variety of life on Earth. It can be used more specifically to refer to all of the species in one region or ecosystem. Biodiversity refers to every living thing, including plants, bacteria, animals, and humans. Scientists have estimated that there are around 8.7 million species of plants and animals in existence. However, only around 1.2 million species have been identified and described so far, most of which are insects. This means that millions of other organisms remain a complete mystery.

Over generations, all of the species that are currently alive today have evolved unique traits that make them distinct from other species. These differences are what scientists use to tell one species from another. Organisms that have evolved to be so different from one another that they can no longer reproduce with each other are considered different species. All organisms that can reproduce with each other fall into one species.

Scientists are interested in how much biodiversity there is on a global scale, given that there is still so much biodiversity to discover. They also study how many species exist in single ecosystems, such as a forest, grassland, tundra, or lake. A single grassland can contain a wide range of species, from beetles to snakes to antelopes. Ecosystems that host the most biodiversity tend to have ideal environmental conditions for plant growth, like the warm and wet climate of tropical regions. Ecosystems can also contain species too small to see with the naked eye. Looking at samples of soil or water through a microscope reveals a whole world of bacteria and other tiny organisms.

Some areas in the world, such as areas of Mexico, South Africa, Brazil, the southwestern United States, and Madagascar, have more biodiversity than others. Areas with extremely high levels of biodiversity are called hotspots. Endemic species—species that are only found in one particular location—are also found in hotspots.

All of the Earth's species work together to survive and maintain their ecosystems. For example, the grass in pastures feeds cattle. Cattle then produce manure that returns nutrients to the soil, which helps to grow more grass. This manure can also be used to fertilize cropland. Many species provide important benefits to humans, including food, clothing, and medicine.

Much of the Earth's biodiversity, however, is in jeopardy due to human consumption and other activities that disturb and even destroy ecosystems. Pollution, climate change, and population growth are all threats to biodiversity. These threats have caused an unprecedented rise in the rate of species extinction. Some scientists estimate that half of all species on Earth will be wiped out within the next century. Conservation efforts are necessary to preserve biodiversity and protect endangered species and their habitats.

B.17.3 The Convention on Biological Diversity (CBD)

is the international legal instrument for "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources" that has been ratified by 196 nations. Its overall objective is to encourage actions, which will lead to a sustainable future.

The conservation of biodiversity is a common concern of humankind. The Convention on Biological Diversity covers biodiversity at all levels: ecosystems, species and genetic resources. It also covers biotechnology, including through the Cartagena Protocol on Biosafety. In fact, it covers all possible domains that are directly

or indirectly related to biodiversity and its role in development, ranging from science, politics and education to agriculture, business, culture and much more.

The CBD's governing body is the Conference of the Parties (COP). This ultimate authority of all governments (or Parties) that have ratified the treaty meets every two years to review progress, set priorities and commit to work plans.

The Secretariat of the Convention on Biological Diversity (SCBD) is based in Montreal, Canada. Its main function is to assist governments in the implementation of the CBD and its programmes of work, to organize meetings, draft documents, and coordinate with other international organizations and collect and spread information. The Executive Secretary is the head of the Secretariat.

B.17.4. Useful links for the research activity

- Endangered Species
- 70 species threatened with extinction in Egypt
- https://a-z-animals.com/
- https://animalia.bio/

Message #18: Climate Resilience

1. Design Map:

Activity Code	C.18
Activity Title	Climate resilient cities
Activity Type	Game, Group discussion
Activity Location	Classroom
Duration	80 Min
Optimum no. / grouping	40 Learners / Groups of 5
Prerequisites	None
Short description	A simulation game and reflection where learners will be the leaders, citizens, policymakers, business leaders, nonprofit leaders, and researchers of a coastal city that is facing challenges related to climate change and think of ways to make cities more resilient
Learning outcomes	1. Learners explore different means of adapting to climate change and how cities can become more resilient
Skills	Interpersonal, Intrapersonal, Communication, Problem Solving, Adaptability, Analytical Thinking
Values	Compassion, Responsibility, admitting one's mistake, Adherence to time, Just, Freedom within the law, Environmental cleanliness, Being pro-active, Collective responsibility, Tolerance, Gratefulness, Open mindedness and ability to think logically, Sensitivity to social issues in the community
Keywords	#Grades: 6 to 9, Climate change, Resilient cities
Necessary Materials	See annex C.18.2
Assessment method	Observation, Oral, Self-assessment
Link to MOE's cur.:	Geography, Weather and Climate
References	YouTube. (2020). Adaptation and Mitigation | Climate Wisconsin. YouTube. https://www.youtube.com/watch?v=fmBDZKOdbkY. US Department of Commerce, N. O. and A. A. (2018, January 25). Beat the Uncertainty: Planning Climate-Resilient Cities: Games@NOAA. https://games.noaa.gov/beat-the-uncertainty/welcome.html.

2. Lesson Plan:

Activity Objective	Est. Dur.	Instructions	Needed Resources / Tools
Preparation	–	● You will lead a game "Beat the Uncertainty: Planning Climate-Resilient Cities". See annex C.18.2 for setup and materials	annex C.18.2
Define climate change and interpret how cities can be resilient	10 Min	● Onboard learners by asking curiosity questions then lead the discussion. Possible Questions: ▪ What is climate change? ▪ Why is it important to track changes in climate? ▪ How can we adapt to such changes? ▪ What do we mean by resilient cities? ▪ What are the interventions that we can do to make our cities more resilient for climate change?	None
explore different means of adapting to climate change and how cities can become more resilient	60 Min	● Illustrate to the learners that they will be playing a simulation game where they will be the leaders, citizens, policymakers, business leaders, nonprofit leaders, and researchers of a coastal city. ● Divide the class into teams of 5 ● Explain to the learners that the scenario is as follows: You are excited about the potential to make the city a better place, but you are also facing many challenges. One of these is climate change. One impact of climate change is rising sea level, which puts your city at risk of more flooding and of saltwater getting into your soil and freshwater supply. Other effects of climate change in this city include more severe hurricanes, more heat waves, and heavier rainfall in the rainy season. Your job is to make smart decisions that will increase the city's resilience to climate change. The problem? You do not know exactly what impacts climate change will have on your city, how severe they will be, or when they will occur. ● Run the activity. See annex C.18.2 for understand the game overview, how to play and how to win	See annex C.18.2
Reflection	10 Min	● Lead a discussion for learners to share their reflections and assess their understanding. Visit the background data on "annex C.18.1." and the debrief section on "annex C.18.1."	None

3. Assessment

- Assess the teams' choices and rationale behind it on the Resilience Measure Checklist.
- Learners' Self-assessment using the resilience measure in the booklet
- Assess the learners' interactions and understanding for the main concepts through the reflection discussion

4. Suggestions for extended activities at home

to change perceptions and attitudes on the long term

Green roofs are gaining interest as nature-based solutions (NBS) to counteract several environmental and socio-economic problems associated with urban sprawl and climate change. Encourage learners to try planting some parts of their rooftops gradually taking advantage of the existing space in the top of the buildings, since the integration of green roofs can support cities' transition towards circularity and resilience.

They might look for information and ideas on the internet about planting roof tops. They might also check Shagrha. Shagrha is an Egyptian startup that aims to promote sustainability through planting and agriculture.

5. Possible adaptation

Instead of using the marbles and the container you can use a scoring board. However, using the regular setup is more entertaining and engaging.

Annex “Teacher’s Background Information”

C.18.1. Adaptation and Mitigation

Have you noticed our climate is changing? And when we say climate, we're not referring to day-to-day changes in weather. We're talking long-term trends, changes that you can only see over a long period of time, like shorter ice cover on lakes, warmer average winter temperatures, longer summers, more frequent heat waves, and flooding from severe storms. These changes in climate can be difficult to see as we go about our daily lives, but they are important because they impact our communities, economy, and culture. The way we live is based on the climate we live in. Warmer winters means less ice fishing, snowmobiling, and cross-country skiing, all vital parts of our culture and economy. Longer summers mean farmers have a longer growing season, but more bugs and diseases to deal with. Heat waves may be nice if you're on the beach, but they can harm vulnerable people like the elderly and young, or those who don't have access to cooler places. And flooding from heavy rain can destroy homes, roads, and crops. As our climate continues to change, impacts are becoming more and more serious. And even if climate change is not impacting your community now, it will soon. But how and when we react, though, is up to us. We can adapt, which means we change the way we live based on how our communities are being impacted. If flooding is a problem, we can redesign storm water systems to handle more water, and we can plant trees and crops suited for longer, warmer growing seasons. We can plant vegetation to provide more shade for cold water trout streams, keeping the water temperatures down, and we can develop heat emergency action plans to assist vulnerable people during heat waves. "Adaptation," identifying and preparing for the impacts of climate change, helps in the short run and can save property, money, lives, and even wildlife. But in the long run, if we are to slow climate change, we have to curb emissions of carbon dioxide and other heat-trapping gases in an effort to reduce global warming. This is called mitigation. Small steps like driving and flying less, decreasing energy use, or reducing consumption are all examples of mitigation. But if mitigation of climate change is to be effective, it has to be on a large scale, which means we have to reduce harmful emissions as individuals, as communities, as businesses, as states, as countries and, collectively, as a world.

Source: Adaptation and Mitigation

C.18.2. Beat the Uncertainty: Planning Climate-Resilient Cities

- Background

  This simulation was adapted from an original activity by Tarlise Townsend and Astrid Kause and was later adapted to a coastal version for Vietnamese audiences with Peg Steffen, NOAA National Ocean Service, Dinh Thai Hung, Thanh Ngo Duc, and Vinh Nguyen Le Ai. In 2015 it was adapted for an American audience with the assistance of Susan Fox at NOAA’s Office of Coastal Management.

- Materials

  The following are the materials needed for one station. Up to five players can use one station, although the game probably works best with three or four players per station. The stations are independent of one another, so any number of stations can be used. Each station needs:

  - One Resilience Measure Checklist “see below”
  - One Climate Events Booklet “see below”
  - One medium- or large-sized plastic food storage container.
  - One smaller plastic container that sits upright, floats, and fits inside the vase. This is your “boat”. A small condiment container works well.
  - Enough water to fill the plastic container halfway. This is your sea. It will change levels to represent sea level rise.
  - Blue and green food coloring to dye your seawater if desired.
  - Craft materials for decorating the sides of the large container to represent your city’s “coastline” (i.e., crepe paper, glue, and scissors). You can also print out a strip of coastline using Clip Art and tape it onto the side of the container.
  - About fifteen glass floral beads with flat bottoms. These will be gradually placed into the boat when players make decisions that are not resilient to climate change impacts. The flat bottoms will prevent the shifting.
  - Two six-sided dice.

- Setup

  - Decorate the outside of each large container to represent the city “coastline”. The bottoms of the buildings should be in a straight line, about an inch above the container’s midline. Instructors can do this in advance or players can create their own coastlines.
  - Add water to the large container until it is about an inch below the coastline, i.e. about halfway full.
  - Add food coloring to the water to create the desired “seawater” color.
  - Run through the game to ensure that the boats will float when up to 12 marbles are added. When more than 12-15 marbles are in the boat, the boat should sink. Calibrate as needed. 5. Place the Resilience Measure Checklist and booklet at the station. Ensure that players keep the booklet closed until after they have made their resilience decisions!

- Overview

  Each station represents a coastal city that is vulnerable to climate change. The players at that station are the city’s decision makers—citizens, policymakers, businesses, civil society, and researchers—who together are responsible for making their city resilient to climate change. First, they will work together to decide how to spend their limited funds available for this purpose. Then they will put those decisions to the test!

- How to play:
  - Design your own climate-resilient city.

    Each team should examine the Resilience Measure Checklist. 70 million credits available to spend on resilience measures. What combination of measures will best protect your city from adverse impacts of climate change?

    Each team should take up to ten to fifteen minutes to discuss the strategies and write their selections on the checklist. Remember, the total cost of resilience measures cannot be more than 70 million credits!

    Depending on the background and age group of the learners, instructors can decide whether to provide some additional explanation of each measure at this point or whether to save instructor input for the debrief session.
  - Find out: how resilient is your city?

    Roll the dice, and then open up the Booklet to the climate threat corresponding to the number rolled. For instance, if you rolled two fours, you would open the booklet to the number eight: "Flooding" (normal severity).

    Now, look at the resilience measures listed on that page. Under "The Good" are measures you might have taken that would make your city more resilient to this climate impact. Some pages also have a category called "The Bad". These measures would actually make your city less resilient to the climate impact you rolled!

    Which of the listed resilience measures did your city select? Check them off in the booklet. If you only selected "soft coastal barrier" and "allowing coastal building", you would check those boxes and leave the others blank.

    In the space provided, write the number of "good" measures that you selected. Place the corresponding number of marbles into your boat. In our example, you would put five marbles into the boat because you only selected one good resilience measure. Finally, add another marble if you selected a "bad" resilience measure.

    As you add marbles, notice that your boat displaces more water, causing the boat to sink and the sea level to rise slightly—inching closer to your city's coastline. This represents a growing threat of climate change! This is not because your less resilient decisions actually cause climate change—but rather because they make your city less able to withstand its impacts. Notice that the more "good" resilience measures you select, the fewer marbles you have to add.

    Roll the dice again and repeat! Keep playing until your boat sinks.
- How to Win

  How many climate change events (dice rolls) until your boat sank?
    - More than 12 rolls: You are Masters of Resilience!
    - 10-12 rolls: You designed a very resilient city—next time I bet you'll be Masters!
    - 7-9 rolls: Your city withstood some climate impacts but not others. Where could you have improved your decisions?

- 4-6 rolls: Your city was very vulnerable to climate change. Why do you think that happened?
- 1-3 rolls: Are you just trying to splash in the water?

Beat the Uncertainty: Planning Climate-Resilient Cities

Resilience Measure Checklist

Your community has 70 million credits for climate change resilience strategies. Discuss with your team mates and make your choices below to prepare for the simulation.

#	Adaptation Strategy	Cost	Your Selection
A OR B	Develop a soft coastline (e.g. using carefully managed wetlands) for protecting against the effects of storms and sea level rise.	25M	
	Build a hard coastline (e.g. using levees) for protecting against the effects of storms and sea level rise.	20M	
C	Increase the amount of green space in the city to serve as (a) heat absorption/reduction of urban heat island effect, (b) water absorption to reduce flooding (c) carbon sequestration.	10M	
D	Require that new city sidewalks and pavements be made from permeable materials, in order to absorb stormwater.	5M	
E	Create early warning systems to warn citizens of impending hazards.	10M	
F	Complete evacuation and preparedness plans for responding to extreme events. Run drills and make sure the public knows the plan.	10M	
G	Build buildings that are more flood- and storm resilient, e.g. that are raised so water can flow underneath.	15M	
H OR I	Allow building in coastal areas that are rarely affected by floods now but may be in coming decades, in order to strengthen the economy in preparation for climate change impacts.	10M Rebate !	
	Devise policies to discourage building around coastal areas and prevent development in flood-prone areas.	5M	
J	When updating the storm drains, sewers, and drainage ditches, add some wiggle room in how much water they'll tolerate—in order to prepare for unpredictable increases in stormwater runoff.	5M	
K	Build water reservoirs that are protected from saltwater intrusion, since sea level rise threatens saltwater intrusion into underground aquifers.	20M	
L	Subsidize bottled water for citizens whose water comes from aquifers vulnerable to saltwater intrusion. This will get them in the habit of drinking it now.	5M	
	Total (Do Not Exceed 70 Million credits)		

Booklet

Page	Dice Score	Title	Situation	Action
1	2	Green Growth	Your community has embraced green growth, so resilience policies are easier and cheaper to pass and implement	Subtract 2!
2	3	Saltwater Intrusion	Rising sea levels and high freshwater consumption have allowed Saltwater into groundwater	The Good K: Protected reservoirs o: +3 marbles 1: +1 marble The Bad (+1 marble) L: Subsidize bottled water consumption
3	4	Good Conditions Several years of fewer coastal extremes	Your population is less vulnerable to extreme weather, and your government has saved resources to deal with future extremes	Subtract 2!
4	5	Storm Surge	Extreme severity. - levees are breached, and damage to the city is great	The Good A: Soft coastal barrier C: Green space D: Permeable streets E & F: Early warning and evacuation plan U G: Resilient buildings I: Discourage coastal building J: Margins on drainage Total 0-1: + 5 marbles 2-3: + 4 marble 4-5: + 3 marbles 6-7: + 2 marbles The Bad (+1 marble) H: Allow coastal building
5	6	Loss of Fisheries	Runoff from more rain and mountain melting has created a dead zone, harming fisheries important to the economy	The Good C: Green space D: Permeable streets J: Margins on drainage 0: + 3 marbles 1-2: + 2 marble 3: + 1 marbles
6	7	Storm Surge	Normal severity. Levees not breached	The Good A: Soft coastal barrier B: Hard coastal harrier C: Green space D: Permeable streets E: Early warning G: Resilient buildings I: Discourage coastal building J: Margins on drainage Total 0-2: + 4 marbles 3-5: + 3 marble 6-7: + 2 marbles 8: + 1 marbles The Bad (+1 marble) H: Allow coastal building

7	8	Flooding	Normal severity'- a result of sea level rise combined with moderately heavy rainfall	The Good A: Soft coastal barrier B: Hard coastal barrier C: Green space D: Permeable streets E: Early warning G: Resilient buildings I: Discourage coastal building J: Margins on drainage Total 0-1: + 5 marbles 2-3: + 4 marble 4-5: + 2 marbles 6-8: + 0 marbles The Bad (+1 marble) H: Allow coastal building
8	9	Erosion	A result of sea level rise combined with coastal storms, - damages Coastal property and businesses	The Good A: Soft coastal barrier Total 0: + 1 marbles 1: + 0 marble The Bad (+1 marble) B: Hard coastal barrier
9	10	Flooding	Extreme; a result of rising sea levels combined with extreme rainfall	The Good A: Soft coastal barrier C: Green space D: Permeable streets E & F: Early warning and evacuation plan G: Resilient buildings I: Discourage coastal building J: Margins on drainage Total 0-1: + 5 marbles 2-3.- + 4 marble 4-5: + 2 marbles 6—7: + 0 marbles The Bad (+1 marble) H: Allow coastal building
10	11	Heat wave	Increased heat stroke	The Good A: Soft coastal barrier C: Green space E: Early warning Total 0-1: + 2 marble 2-3: + 1 marble
11	12	Climate Literacy	Citizens make more informed decisions, helping to protect the community	Subtract 2!

- Debrief

1. What does this uncertainty have to do with climate change?

In this game, you did not know exactly what climate events your city would experience at any given time. If it was your first time playing, you did not even know how likely any given event was. The impacts of climate change in the real world will be similarly uncertain. Not only can we not predict with certainty what climate event will occur when, and with what severity, in any given location; we cannot even assign exact probabilities to different possible events. We call this "uncertainty", and distinguish it from "risk". With risk, we can calculate the probabilities of different outcomes.

Insurance companies regularly calculate the probability of a person getting into a car accident. They use extensive data on past events to predict the future. Climate change is taking the climate system into new territory, so that what happened in the past does not necessarily predict the future. Probabilities are much harder to obtain, and so we face more uncertainty than before. Since they cannot assume the future will look like the past, scientists plug their understanding of the climate into models, which then make predictions about future events and trends. The problem is there a good deal of uncertainty in those models as well.

Traditional approaches to risk management often involve a cost-benefit analysis, weighing the probabilities and costs of different outcomes in order to calculate the safest best. With climate change, though, we usually cannot quantify those probabilities—there might be a wide range of plausible outcomes, and it is not obvious which one we should prepare for.

This has all kinds of implications for cities. How high should we build the levees if we do not know what floods will look like in the coming decades? Will sea level rise really be bad enough to merit retreating from the coast? Should we invest in an expensive infrastructure project that would protect against extreme weather events? Decision strategies that require quantified risk are often insufficient to answer these questions. Instead, we need strategies that are flexible to the uncertainties. The game challenged you to think about what those strategies are.

2. What might be some strategies for dealing with the uncertainty in climate impacts?
    - No-regrets strategies: Choose strategies that prepare for the available forecasts, but that offer benefits even if an event forecast or predicted timeline proves inaccurate. For example, limiting building in flood-prone areas would reduce damages in the current climate—and would be all the more beneficial in the case of sea level rise. For example, resilience measure C offers a variety of benefits. Green space absorbs more water than typical impermeable concrete or paved surfaces, which can help to assuage flood events. It also reduces the urban heat island effect that causes a city to heat up more than non-urban areas. It helps with carbon sequestration, helping to mitigate climate change, and offers citizens a place for recreation, access to nature, and a break from the busy city. So even if flooding due to climate change isn't ultimately severe in the city, the green space provides a number of other important benefits. Resilience measures A and D are other great examples of no-regrets strategies.
    - Flexible and reversible strategies: Decisions that can be adapted or reversed as the available information evolves are more climate resilient than those that cannot. Resilience measures H and I demonstrate this distinction. Both have advantages and disadvantages: developing in areas that may become more flood prone due to climate change has short-term economic benefits but, in the long term, economic and health risks. Discouraging development means losing out on the short-term benefits but reducing climate change vulnerability. Since the future climate impacts are uncertain, choosing the reversible path may be best: reversing the decision not to develop is much easier that reversing the decision to develop.
    - Safety-margin strategies: Incorporating more room for error into an urban planning project can be a cheap way to add resilience to the system. Resilience measure J is an example of a safety-margin strategy. Incorporating more room for error into an urban planning project can be a cheap way to add resilience to the system. Resilience measure J is an example of a safety-margin strategy. In a city

expected to experience more flooding due to sea level rise or increased rainfall, the amount of water flowing into the drainage infrastructure may sometimes be higher than predicted. Adding a safety margin helps to prepare for this uncertainty.

3. In the real world, there are many factors at play beyond the immediate expense and climate vulnerability. Can you think of some others that would likely influence the resilience measures a city decides to take?
    - Economic incentives: Green space offers a wide variety of benefits for a city, as discussed above. A large park may occupy prime real estate, and developers might pay a lot of money for building there. Decision makers and citizens may believe that allowing this would bring needed resources to surrounding neighborhoods and the city overall.
    - Competing interests: In every city, there are more challenges than there are resources. While some groups may be greatly concerned about climate change impacts, others may believe that other issues are more important and deserve greater attention. Each may advocate their position to decision makers. Deciding how to allocate the funds, time, energy, and expertise across myriad issues is a continual process.
    - Psychological biases: Many factors influence our response to climate change. For instance, the fact that many of its impacts will occur over a span of decades activates present bias. Present bias occurs when we overvalue the present (or short-term) compared to the future (or long-term). For instance, we may choose to avoid the inconvenience of creating climate resilience societies now, even though it would likely entail very large benefits in the future—and even though the benefits would probably be larger than the costs.
    - Status quo bias is also at play in climate change decision making. In status quo bias, people prefer the status quo over change, even when the status quo is objectively inferior. This may partly explain why it has been so difficult to motivate behavioral change in the face of climate change.
    - Individuals also experience ambiguity aversion, in which they prefer known risks to uncertainty—even if the known risks are not in their favor. This game aims to make players aware of uncertainty and to provide strategies for dealing with it, in the hope that this can help combat ambiguity aversion in the context of climate change.
4. Are the dice the best analogy for climate uncertainty? Why or why not?

    Since you can actually calculate the probability of any particular dice roll, the dice do not perfectly represent climate change uncertainty if you know which climate event corresponds to each number rolled. This is why it was important that you not look at the climate events booklet before choosing your resilience measures! Not knowing the probability of each event forced you to select measures that would be resilient to a variety of possible outcomes.

    Discussion Notes after the first simulation. After discussion, try the simulation again with different coastal strategies.
5. Discussion Notes after the first simulation. After discussion, try the simulation again with different coastal strategies.

    A) Develop a soft coastline (e.g. using carefully managed wetlands) for protecting against the effects of storms and sea level rise. Wetlands offer flood and storm protection, erosion control, and carbon sequestration. They also serve as habitat for wildlife, provide recreation area for local citizens, and help to filter contaminants out of water before flowing into the ocean.

    B) Build a hard coastline (e.g. using dams, seawalls, and levees) for protecting against the effects of storms and sea level rise. Hard coastlines also offer flood and storm protection. However, they have fewer co-benefits than soft coastline—and can actually worsen coastal erosion. A hard coastline may also be less resilient to uncertainty. It may protect the city up to a certain point, but then fail if, for instance, storm surge exceeds that level. Once a breach occurs, a hard coastal barrier may actually impede outflow of water from the city.

    C) Increase amount of green space in the city to serve as (a) heat absorption/reduction of urban heat island effect, (b) water absorption to reduce flooding (c) carbon sequestration. This measure not only increases resilience to climate change, but it also aids in climate change mitigation efforts by storing carbon—not to mention the benefits to citizens of having park space for exercise and recreation.

    D) Require that construction of new city sidewalks and pavements use permeable materials in order to absorb stormwater. Traditional concrete and asphalt absorb very little water. When it rains heavily

or floods due to sea level rise, the water runs off these surfaces and into the city's drainage system. Introducing permeable surfaces into cities helps to reduce the burden on the drainage system, making flooding less likely or severe. By allowing water to seep into the ground, permeable surfaces also reduce city temperatures, decrease pollutant transport (via filtration in the earth), and aid irrigation of surrounding land.

E) Create early warning systems to warn citizens of impending hazards. This measure highlights the fact that reducing vulnerability to climate change is about more than a city's physical resilience; it is also a social phenomenon. The ability of citizens to respond to an impending hazard is just one example of social resilience. Others include increasing the ability of the health system to manage the fallout of an extreme event, and improving the overall health, education level, and economic stability of the population.

F) Complete evacuation and preparedness plans for responding to extreme events. Run drills and make sure the public knows the plan. In this game, the benefits of resilience measure E occur if players did not also select measure F. If citizens receive a warning about the hazard but cannot effectively evacuate or respond to it, the warning does little good. This was included to emphasize the importance of planning for an entire chain of events—rather than just one addressing one link in the chain.

G) Build buildings that are more flood- and storm resilient, e.g. buildings are raised so water can flow underneath. Such buildings can reduce damage due to floods. However, this measure will not protect existing buildings and it has fewer co-benefits than some of the other strategies.

H) Allow building in coastal areas that rarely flood now but may be in coming decades, in order to strengthen the economy in preparation for climate change impacts. This has economic benefits that could be used to invest in other resilience measures. However, it will also increase vulnerability to climate change by putting individuals' homes and businesses at risk of flooding. Decision makers must weigh the advantages against the disadvantages.

I) Devise policies to discourage building around coastal areas and prevent development in flood-prone areas. This is, in effect, the opposite of measure H. These measures raise awareness of the economic tradeoffs when investing in resilience, and the difficulty of comparing short- and long-term outcomes.

J) When updating the storm drains, sewers, and drainage ditches, add some wiggle room in how much water they'll tolerate—in order to prepare for unpredictable increases in stormwater runoff. An unexpected increase in heavy rainfall could overwhelm the systems that manage the stormwater flowing on city surfaces, thereby increasing the likelihood of flooding. In a city where rainfall and/or sea level rise increases the flow into this system, its capacity should be increased. Including "wiggle room" can help a city deal with the uncertainty about exactly how large that increase will be.

K) Build water reservoirs that are protected from saltwater intrusion, since sea level rise threatens saltwater intrusion into underground aquifers. As sea levels rise, seawater can infiltrate the aquifers that store freshwater underground, threatening the water resources needed for drinking and agriculture. One solution is to store freshwater in more protected reservoirs. However, this measure is expensive and may not be optimal.

L) Subsidize bottled water for citizens whose water comes from aquifers vulnerable to saltwater intrusion. This will get them in the habit of drinking it now. This is not an optimal resilience measure. Rather than working to prevent saltwater from infiltrating drinking water sources, it assumes the aquifers will be affected and offers an unsustainable solution to that challenge. Producing bottled water itself uses a good deal of water, thereby putting more pressure on the earth's already scarce freshwater resources.

Source: Beat the Uncertainty: Planning Climate-Resilient Cities

Together we protect our environment and save our lives with our own hands

Enhancing National Capacities for Improved Public Participation for Implementing Rio Conventions Project – CB3

CB3 project is initiated to address the critical priority capacity needs required to increase the participation of stake-holders in fulfilling the obligations of multi-lateral environmental agreements (MEAs) as committed by the govern-ment of Egypt (GoE). Three main agree-ments are of prime concern, these are:
i) The UNFCCC (related to climate change),
ii) The CBD (related to conservation of biodiversity), and
iii) The UNCCD (related to combating desertification).

The objective of the project is "to strengthen the participation of Stake-holders in the implementation of MEAs in Egypt". The CB3 Project will engage a large number of government officials, universities, representatives of line ministries, and registered NGOs to build partnerships to ensure mutual knowl-edge transfer and learning.

CB3 Team

Dr. Ahmed Wagdy
General Manger

Eng. Samah Saleh
National Director

Dr. Karim Omar
Technical Officer

Mr. Ahmed Sayed
Accountant

15B- 106 Street - Maadi - Cairo

CB3.EGYPT@gmail.com