

Workplace Environmental Management

WEEK 12 – Climate Change Mitigation Measures

University: Rwanda Polytechnic – IPRC Tumba

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Objectives

At the end of this topic students will be able to:

- Understand climate change indicators
 - Understand socio-economic implication
 - Understand mitigation technologies
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12.0 Climate change at glance

- Climate change, caused primarily by human activities releasing greenhouse gases into the atmosphere, is one of the most pressing challenges facing our planet.
 - These gases trap heat, leading to rising global temperatures, changing weather patterns, and extreme weather events.
 - Mitigating climate change, or reducing the severity of its effects, requires a global effort.
 - Greenhouse gases like carbon dioxide, methane, and nitrous oxide trap heat from the sun, causing the planet to warm.
 - The burning of fossil fuels for electricity, transportation, and industrial processes is the primary source of these emissions.
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12.0 Climate change at glance cont'd

- Other human activities like deforestation and agriculture also contribute.
 - Rising sea levels: Warmer temperatures cause thermal expansion of the oceans and melting of glaciers, leading to rising sea levels that threaten coastal communities and low-lying islands.
 - Extreme weather events: Climate change is increasing the frequency and intensity of extreme weather events like heatwaves, droughts, floods, and storms, causing widespread damage and displacement.
 - Disruptions to ecosystems: Changing temperatures and weather patterns disrupt ecosystems, impacting plant and animal life, and threatening biodiversity.
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12.0 Climate change at glance cont'd

- Climate change is the long-term shift in weather patterns in a specific region or globally.
 - Unlike **global warming**, which refers to just one aspect of climate change “a rise in the surface temperature of the earth’s surface”, **Climate change** refers to changes in a regions overall weather patterns, including precipitation, temperatures, cloud cover, and so on.
 - Changes in precipitation patterns leads to shifts in the timing of seasons and thus reproductive timing of plants and animals as well as the length of the growing seasons
 - Shifts in water availability and temperatures affects species distributions, abundance due to loss or expansion suitable habitats
 - Some species may become extinct – locally or regionally
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12.1 Climate change indicators

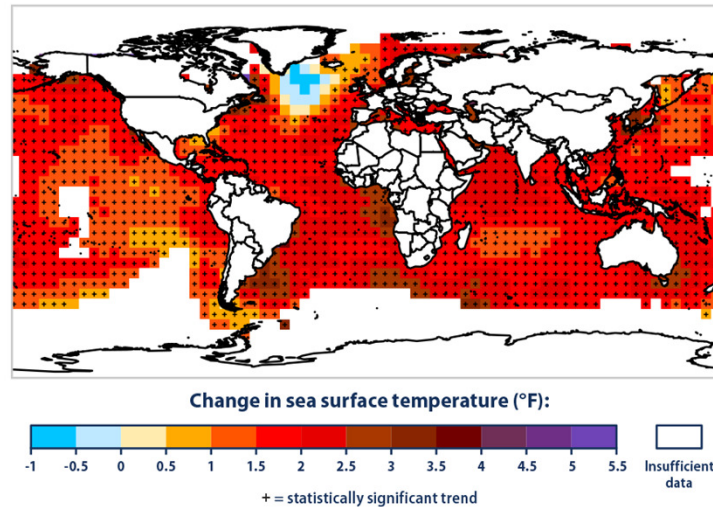
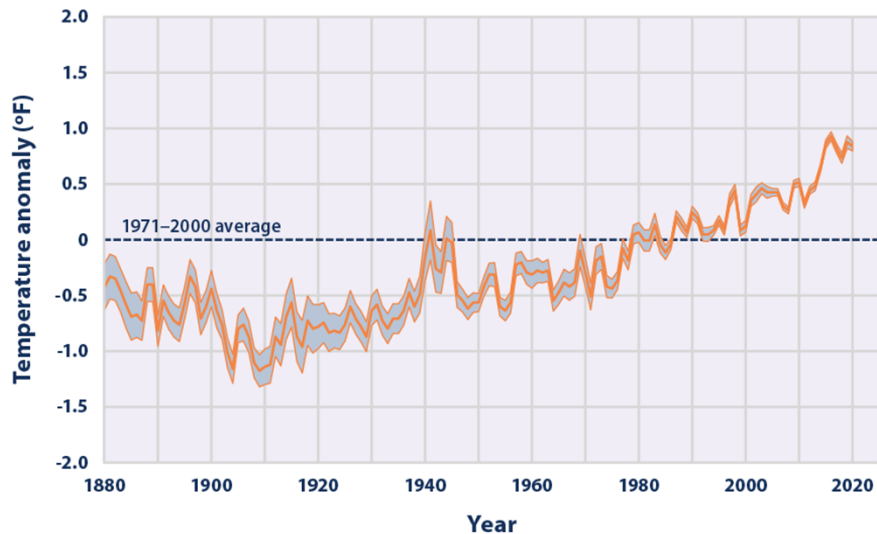
- More drought and more flooding
 - Less ice and snow
 - More extreme weather incidents
 - Rising sea level
 - **1st order impacts:** changes in temperature, rainfall, humidity, wind and sunshine hours (basic meteorological conditions). These may result into heat waves, droughts, floods, landslides etc.
 - **2nd order impacts:** These are consequences of 1st order impacts like impacts of droughts, floods on natural resources: water, soil, biodiversity, ecosystems.
 - **3rd order impacts:** These result from 2nd order impacts like crop and livestock responses and effects on production.
 - **4th order impacts:** rural economies and livelihoods – interaction with other stressors and drivers of change.
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12.1.1 Surface temperatures

- **Global Sea Surface Temperature Trends:** The average surface temperature of the world's oceans has been a critical indicator of climate change.
 - Since 1880, sea surface temperature has consistently risen, with two notable periods of increase: between 1910 and 1940, and from about 1970 to the present. Over the 20th century, the temperature rose at an average rate of 0.14°F per decade. Notably, the past three decades have seen consistently higher sea surface temperatures than any other time in recorded history.
 - **Regional Variability:** While most ocean regions have experienced rising temperatures, some areas have cooled. For instance, parts of the North Atlantic have seen cooling trends. These regional variations highlight the complexity of climate change impacts on sea surface temperature. As the oceans absorb more heat, circulation patterns shift, affecting marine ecosystems, species distribution, and harmful algal blooms.
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12.1.1 Surface temperatures cont'd

- **Importance and Implications:** Sea surface temperature influences marine life, migration patterns, and ocean ecosystems. It affects coral reefs, sensitive species, and nutrient transport. As global temperatures continue to rise, understanding these changes becomes crucial for conservation efforts and sustainable management of our oceans.



(Climate Change Indicators: Sea Surface Temperature, NOAA (National Oceanic and Atmospheric Administration), U.S. Environmental Protection Agency (EPA), 2021.)

12.1.1 Surface temperatures cont'd

- **Climate change indicators related to surface temperature in Rwanda:** Study of the spatial and temporal variations of daily maximum and minimum surface air temperatures (Tmax) & (Tmin) in Rwanda from 1961 to 2014.
 - The results indicate a significant positive trend in both Tmin and Tmax across the country during this period. Notably, Tmin increased at a faster rate than Tmax in certain regions, leading to a decrease in the diurnal temperature range (DTR). This warming trend has been observed since the early 1980s.
 - **Temperature trends:** Rwanda has experienced high temperature rising phenomena over the last decades, making it highly vulnerable to climate change.
 - An analysis of temperature measurements taken in Kanombe and Kamembe between 1971 and 2009 shows that the temperature increased by 1.2°C in Rwanda, exceeding the global average increase of 0.8°C over 150 years.
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12.1.1 Surface temperatures cont'd

- Since 1970, Rwanda has seen a temperature increase of 1.4°C, higher than the global average. By the 2030s, temperatures are expected to rise to 2.0°C from 1970 levels. (Climate Change in Rwanda: The Observed Changes in Daily Maximum and Minimum Surface Air Temperatures during 1961–2014, Jean Paul Ngarukiyimana, Yunfei Fu, Celestin Sindikubwabo, Idrissa Fabien Nkurunziza, Faustin Katchele Ogou, Floribert Vuguziga, Bob Alex Ogwang, Yuanjian Yang, *Frontiers in Earth Science*, 2021.)
 - **Mean annual temperature and precipitation:** Mean annual temperature for Rwanda is 19.1°C, with average monthly temperatures ranging between 18.5°C (July) and 19.5°C (September). Rainfall occurs throughout the year, with significant rainfall from September to May. (Climate Change Profile of Rwanda, Ministry of Natural Resources in Rwanda, Rwanda Environment Management Authority (REMA), 2011.)
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12.1.2 Greenhouse gases (GHGs)

- **GHGs concentrations:** GHGs from human activities significantly drive observed climate change. They include carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and fluorinated compounds. The U.S. EPA provides data on U.S. GHG emissions, showing a decrease of 2.3% from 1990 to 2021. CO₂ remains the largest contributor, with transportation being the primary source. Globally, net GHG emissions increased by 43% from 1990 to 2015, mainly due to energy production and use.
 - **Atmospheric concentrations:** GHGs concentrated in the atmosphere have risen since the industrial era. CO₂ levels are unprecedented in the past 800,000 years. Ice cores, tree rings, and sedimentary rocks reveal Earth's climate response to changing GHG levels. Monitoring sites worldwide track halogenated gases, providing crucial data.
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12.1.2 Greenhouse gases cont'd

- **Annual climate indicators update:** To bridge information gaps between Intergovernmental Panel on Climate Change (IPCC) reports, an annual effort compiles reliable global climate indicators. These include GHG emissions, radiative forcing, surface temperature changes, and remaining carbon budgets. The purpose is to provide updated evidence for climate negotiations and informed decision-making. (Climate Change Indicators: Greenhouse Gases, U.S. EPA.)
 - **GHG emissions in Rwanda:** According to the World Resources Institute Climate Analysis Indicators Tool (WRICAIT), Rwanda's GHG emissions in 2014 were primarily from activities in the agriculture sector (39.5%), followed by waste (24.7%), and energy (23.1%). Land-use change and forestry (LUCF) and industrial processes, (IP) contributed 11.4% (net) and 1.4% of total, emissions, respectively. (Greenhouse Gas Emissions in Rwanda, Climatelinks, 2014.)
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12.1.2 Greenhouse gases cont'd

- A repository page provides the information related to GHG emissions for various countries to help necessary comparison, the link shared herewith is for the data of Rwanda though other countries also may be selected according to the need. It shows the following:
 - **Per capita emissions**, in 2020, Rwanda's per capita CO₂ emissions were relatively low compared to many other countries.
 - **Annual CO₂ emissions**, the chart shows Rwanda's annual CO₂ emissions alone not total greenhouse gas emissions.
 - **Year-on-year change**, yearly growth in annual CO₂ emissions is indicated for Rwanda. (CO₂ Emissions Data for Rwanda, Our World in Data.)
 - Students are requested to explore much on GHG emissions from local to global contributions to understand the impacts and set individual targets and advocacy to reduce the emission for sustainable future.
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12.1.3 Ozone depletion

- **Ozone** is a form of oxygen with three atoms combined into a single molecule of ozone. It doesn't exist in lower atmosphere but in stratosphere between 20 and 50 Km above the surface. The main importance is to **filter** out the **incoming ultraviolet (UV) radiation** and thus acts as a screen against UV that can increase the occurrence of skin cancer, cataracts, and eye diseases. It also affects the body defense mechanism increasing vulnerability of infectious diseases. Increased UV seriously affect plant and fish production.
 - **Ozone depletion** refers to the wearing out or reduction of the amount of ozone in stratosphere, first identified in 1970s due to advent of supersonic aircraft, which was flying in the lower stratosphere emitting nitrogen oxides.
 - It refers to two related events; a steady lowering of about 4% in the total amount of ozone in Earth's atmosphere and a much larger springtime decreases in stratospheric ozone (the ozone layer) around Earth's polar regions, commonly known as the ozone hole.
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12.2 Socio-economic implication

- This section will discuss about the climate change implications on socio-economic development related to natural disasters and human mobility as well as environmental and health impact.
 - Those aspects are much related to the human endeavour versus the climate change in terms of sustainability of future generations.
 - The damage of infrastructure like homes, roads, bridges, and utilities which endanger the cost to repair as well as coral bleaching, and ocean acidification impact marine ecosystems and livelihoods due to sea level rise.
 - Weather events, water scarcity, and changing temperatures impact crop yields and livestock production while air pollution, and disease spread impact workforce efficiency and healthcare costs. The energy sector is affected by demand in cooling and even power generation.
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12.2.1 Natural disaster and Human mobility

- The natural disaster which can result in human mobility may originate from floods, earthquakes, volcanoes eruption, dangerous storms, landsliding, wildfires etc.
 - Rwandan soils are naturally fragile. The rainfall regime has a strong influence on the hydrological regime.
 - There are floods during the long rainy season from March to May, and they subside during the long dry season of June to September.
 - Rwanda has increasingly been experiencing long periods of drought which tend to become cyclical and persistent, particularly in the East and South-East.
 - These climatic changes may have a direct relationship with those recorded in the world due particularly to the global warming of the planet.
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12.2.1 Natural disaster and Human mobility cont'd

- Some recent effects of climate change in Rwanda: 40 families lost their houses due to high rainfall on Sunday 18/09/2011 in western Province as shown on the images, the same date in Northern Province, Burera District 6 children lost their lives due to floods and many houses were destroyed.



Photos: New Times

12.2.1 Natural disaster and Human mobility cont'd

- Landslides and floods hit several parts of Rwanda between 07 and 08 May 2016 after a period of heavy rainfall which took 49 lives and 500 houses destroyed in the district of Muhanga, Ngororero and Gakenke.
- The Prime Minister had to address to the families affected the Government support and strengthen them for the loss. (Rwanda – At Least 49 Killed in Floods and Landslides, 500 Homes Destroyed, Richard Davies, FloodList, 2016.)



Photos: Government of Rwanda

12.2.1 Natural disaster and Human mobility cont'd

- In the past years, a series of climate disasters worldwide was observed; Cyclone Idai caused loss of life and devastation in Southern Africa, Australian wildfires razed communities, Asia flood and landslide took 10 plus million lives and severe droughts in East Africa left millions in need of aid.



All Photos: Oxfam

12.2.2 Environmental and Health impacts

- As water warms it expands. Added to this, glaciers and ice sheets melt as the atmospheric temperature increases. These two factors, expanding warmer water and ice melt, result in sea level rise. Sea level rise is a challenge for low lying areas.
 - Other problems may arise: Destroy food crop → rice, wheat and corn, Affect animals → need to migrate, Encourage growth of weed and pests → may lead to diseases like dengue fever, cholera which are deadly.
 - Climate change and agriculture are interrelated processes, both of which take place on a global scale.
 - Global warming will have much impacts agriculture, including temperature carbon dioxide, glacial run-off, precipitation and the interaction of all.
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12.2.2 Environmental and Health impacts cont'd

- Climate change induced by increasing greenhouse gases is likely to affect crops differently from region to region.
 - For example, average crop yield is expected to drop down to 50% in Pakistan whereas corn production in Europe is expected to grow up to 25% in optimum hydrologic conditions. (Global Climate Change Impact on Crops Expected Within 10 Years, NASA Study Finds, Ellen Gray, NASA's Earth Science News Team, 2021.)
 - Southern Africa could lose more than 30% of its main crop, maize, by 2030.
 - In South Asia losses of many regional staples, such as rice, millet and maize could top 10%. (Climate Trends and Global Crop Production Since 1980, Lobell et al., Science, 2008.)
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12.2.2 Environmental and Health impacts cont'd

- Agriculture shall be affected much in the following aspects: productivity by quantity and quality of crops.
 - Agricultural practices, through changes of water use (irrigation) and agricultural inputs such as herbicides, insecticides and fertilizers.
 - Environmental effects, in particular in relation of frequency and intensity of soil drainage, soil erosion, reduction of crop diversity.
 - Rural space, through the loss and gain of cultivated lands, land renunciation, etc.
 - Climate change may increase the amount of farmed land in high-latitude region by reduction of the amount of frozen lands.
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12.2.2 Environmental and Health impacts cont'd

- Adaptation, organisms may become more or less competitive, as well as humans may develop urgency to develop more competitive organisms, such as flood resistant or salt resistant varieties of rice.
 - Duration of crop growth cycles: An increase in temperature will speed up development.
 - In the case of an annual crop, the duration between sowing and harvesting will shorten (for example, the duration in order to harvest corn could be within one and four weeks). The shortening of such a cycle could have an adverse effect on productivity because senescence would occur sooner.
 - Effect of elevated carbon dioxide on crops, Carbon dioxide is essential to plant growth.
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12.2.2 Environmental and Health impacts cont'd

- The region where Rwanda is located seems to surpass Asia as the most food-insecure region as Africa is much affected by pollution and the set measures are not yet enough due to non-compliance to mitigate.
 - Tanzania reported on climate change that suggested areas that usually get two rainfalls in the year will probably get more, and those that get only one rainy season will get far less resulting in an unexpected production of maize.
 - Agriculture contributes to greenhouse gas increase through land use in four main ways: CO₂ releases linked to deforestation, Methane releases from rice cultivation, Methane releases from enteric fermentation in cattle, Nitrous oxide releases from fertilizer application.
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12.2.2 Environmental and Health impacts cont'd

- Livestock and livestock-related activities such as deforestation and increasingly fuel-intensive farming practices are responsible for over 18% of human-made greenhouse gas emissions, including: 9% of global carbon dioxide emissions, 35-40% of global methane emissions (chiefly due to enteric fermentation and manure), 64% of global nitrous oxide emissions (chiefly due to fertilizer use.)
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12.2.2 Environmental and Health impacts cont'd

- **Sea level rise:** Beach erosion, coastal wetland loss, loss of low-lying territories
 - **Water resources change :** Precipitation pattern shift, increases instances of heavy precipitation, new burdens on water capture, storage and distribution system to be expected.
 - **Effects on agriculture:** Changes in the length of growing season, growth of undesirable plant species
 - **Effects on air quality:** Increase in reaction rates and concentrations of atmospheric species; increase in O₃ in urban areas, more droughts; widespread forest fire; worsen air quality, change in pollutants dispersion.
 - **Impacts on human health:** Changes in patterns of sickness and death, respiratory problems affected by air quality change
 - **Biodiversity:** Some species may grow too quick and overshoot their reproductive period (e.g. reef corals), forest could be devastated if the rate of climate change outpaced the rate at which forest species could migrate.
 - **Change in the pattern of ocean current**
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12.2.2 Environmental and Health impacts cont'd

Some likely impacts of climate change	
Change	Impacts
<i>Warm spells/heat waves frequency up on most land areas</i>	Extreme temperatures (worst in heat islands in cities); air pollution worsened. Large vulnerable population. Spread of vector-borne diseases because of increased range of insects, loss of biodiversity and species extinction
<i>Heavy precipitation events, frequency up over most areas</i>	- Floods/landslides; injuries and deaths, households losing homes, possessions, assets, livelihoods.
<i>Intense tropical cyclone activity increases</i>	- Large population displacements and disruption of city economies, transport and other infrastructure damaged. - Health services and emergency services unable to cope.
<i>Increased area affected by drought and expansion of subtropical desert</i>	Water shortages, food shortages/malnutrition because of low agri-productivity, distress migration into urban centres, hydro-electric constraints, loss of biodiversity and species extinction
<i>Increased incidence of extreme high sea level and acidification</i>	Loss of lives/biodiversity, property and livelihoods to coastal flooding, damage to tourism, damage to buildings, salinization of water and acidification of oceans creating drops in fishing yields.

Farm to Table
The Potential Interactions of Rising CO₂ and Climate Change on Food Quality and Safety



(Climate Impacts on Human Health, US EPA, Chicago Climate Change.)

12.3 Mitigation technology and practice by sector

- Transitioning to renewable energy: Replacing fossil fuels with renewable energy sources like solar, wind, geothermal, and hydropower is crucial for reducing greenhouse gas emissions.
 - Improving energy efficiency: Implementing energy-saving technologies and practices in buildings, transportation, and industrial processes can reduce significantly the energy consumption and emissions.
 - Protecting forests: Forests play a vital role in absorbing carbon dioxide from the atmosphere. Protecting existing forests and promoting reforestation efforts are essential for mitigating climate change.
 - Sustainable practices: Encouraging sustainable agriculture, waste management, and consumption patterns can further reduce GHG emissions.
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12.3 Mitigation technology and practice by sector cont'd

- **Environmental Sustainability:** By working with the natural world, we can minimize resource depletion, habitat destruction, and pollution. This ensures a healthy planet for future generations.
 - **Reduced Costs:** Understanding the environment allows for better project planning and construction. This can lead to cost savings by avoiding unforeseen challenges and minimizing the need for remediation efforts.
 - **Resilience:** A project adapted to the environment is more likely to withstand natural disasters like floods, droughts, and storms. This protects lives, property, and infrastructure.
 - **Improved Public Health:** Healthy ecosystems provide clean air and water, regulate temperature, and offer recreational opportunities. Adapting projects can enhance these benefits.
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12.3 Mitigation technology and practice by sector cont'd

- Urban Planning: Green infrastructure projects like parks, rain gardens, and bioswales can manage stormwater runoff and create urban oases.
 - Renewable Energy Siting: Careful placement of wind turbines and solar panels can minimize visual impact on landscapes and avoid disrupting bird migration patterns.
 - Sustainable Agriculture: Practices like crop rotation, cover cropping, and integrated pest management can protect soil health, water resources, and biodiversity.
 - Rwanda aimed at increasing terraces to prevent soil erosion, using economic stoves with less charcoal, Reforestation of marginal areas.
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12.3 Mitigation technology and practice by sector cont'd

- Rwanda also adopted a national human settlement policy aimed at establishing an improved rural human settlement model, grouping settlements in villages generally known as IMIDUGUDU, which meet the criteria of environmental viability through the reorganization of the national space, land reform, improved housing quality, but it is still in the progress
 - The Government also adopted the use of alternative sources of energy (biogas, solar energy, methane gas hydroelectricity,...), fuels with less impacts like that from plants, reduce the number of people involved in agriculture by creating more other jobs and make agriculture more modern with land consolidation and regionalization of crops, improve techniques for erosion control.
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12.3 Mitigation technology and practice by sector cont'd

- There is also increase researches in the fields of agriculture and Environmental protection and management, improve capacity building in those above fields.
 - There are many little things that we can do to make a difference to reduce the amount of greenhouse gases that we put into the atmosphere, many GHGs come from things we do every day such as driving a car or using electricity is not wrong.
 - We just must be smart like trying carpooling, turn off lights, the television and the computer when they are not in use, Bike, Bus and Walk- You can save energy by sometimes taking the bus, riding a bike or walking.
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12.3 Mitigation technology and practice by sector cont'd

- Read about the environment and talk to your family and friends about global warming. Let them know what you've learned.
 - Recycle to send less trash to the landfill and you help save natural resources like trees and elements such as aluminum (cans, bottles, plastic bags and newspapers, etc.)
 - Buy cool stuff that don't use as much energy, recyclable.
 - Solar energy – can be used to heat homes, buildings, water and to make electricity.
 - Use cars which can travel long distances on a small amount of fuel to reduce the amount of greenhouse gases in the air.
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12.3 Mitigation technology and practice by sector cont'd

Task 1: Prepare a scenario in your sector showing how climate change mitigation measures can be applied.

Task 2: Evaluate for continuous improvement with participation in awareness campaigns.



Thank you for your good attention
Q&A
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