S E A M E O

Integrating Climate Change Issues in Southeast Asian Schools

A Teachers' Guidebook

Edited by
Azian T.S. Abdullah
SEAMEO RECSAM

Southeast Asian Ministers of Education Organization
2010

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FOREWORD

"The countries of the world must act now, act together and act differently on climate change," **said World Bank President Robert B. Zoellick.**

As part of the world community, the Southeast Asian Ministers of Education Organisation (SEAMEO) has come a long way to promote meaningful cooperation in education, science and culture. With eleven (11) Member Countries, eight (8) Associate Members, three (3) Affiliate Members and nineteen (19) specialist institutions with interdisciplinary fields of expertise, SEAMEO as with the rest of the world is committed to attend to the emerging concerns on climate change and to support climate change education in the region and beyond.

Integrating Climate Change Issues in Southeast Asian Schools Teacher's Guidebook is an initiative by SEAMEO to provide teachers with useful initial resources to facilitate the capacity building of young people on the issues. This guidebook, which covers a range of related climate change concerns such as poverty, health and nutrition, and food security, would be particularly helpful to assist teachers to prepare our young generation in experiencing and dealing with the effects of climate change.

This guidebook, which is produced through a collaborative effort of experts from eight SEAMEO Regional Centres, namely SEAMEO RECSAM, SEAMEO SPAFA, SEAMEO INNOTECH, SEAMEO SEARCA, SEAMEO SEAMOLEC, SEAMEO BIOTROP and the SEAMEO TROPMED Centres in Indonesia and the Philippines, will be shared with all the Ministries of Education of SEAMEO and Associate Member Countries.

Led by SEAMEO RECSAM, experts from the eight SEAMEO Regional Centres effortlessly and painstakingly worked on planning and developing the integrative learning framework and selected the most appropriate materials including providing some lesson exemplars. For greater impact, it is our hope that this guidebook will be used extensively in schools in the region to enhance teachers' competencies to create effective learning experiences for the young people not only on the issues and impact of climate change but also on how these should be addressed.

I wish to congratulate SEAMEO RECSAM for leading the initiative, and SEAMEO SPAFA, SEAMEO INNOTECH, SEAMEO SEARCA, SEAMEO SEAMOLEC, SEAMEO BIOTROP and the SEAMEO TROPMED Centres in Indonesia and the Philippines for the collaboration and hard work of putting together the guidebook.

Dato' Dr. Ahamad bin Sipon
Director
SEAMEO Secretariat Bangkok

PREFACE

The Southeast Asian Ministers of Education Organisation (SEAMEO) was established on 30 November 1965 as a chartered international organisation whose purpose is to promote cooperation in education, science and culture in the Southeast Asian region.

SEAMEO's mission is "*to enhance regional understanding and cooperation and unity of purpose among SEAMEO Member Countries and achieve a better quality of life* through (a) the establishment of networks and partnerships, (b) the provision of an intellectual forum for policy makers and experts, and (c) the promotion of sustainable human resource development.

Eight SEAMEO Regional Centres, namely; RECSAM, BIOTROP, SPAFA, SEARCA, SEAMOLEC, TROPMED Philippines, TROPMED Indonesia, and INNOTECH embarked on a collaboration to publish this **Teachers' Guidebook** to address the impact of climate change in Southeast Asia. The publication of this **guidebook** aims to raise the awareness level of our future citizens in Southeast Asia with their teachers' guidance and help; so that they will take positive actions for a better quality of life on our planet.

This **Teachers' Guidebook** is intended for use by educators, teachers, curriculum developers, and instructional administrators responsible for connecting academic concepts with climate change issues in their respective schools and communities across Southeast Asian countries. It was developed by a multidisciplinary team from the different SEAMEO Centers using an interdisciplinary approach.

This guidebook contains the various issues that result from climate change and describes the integration process in developing the adaptive capacity of the people of Southeast Asia through formal and non-formal education. It provides basic information on the causes of global warming that triggers climate change. It also presents lesson exemplars using climate change issues and other environment-oriented or eco-friendly activities as learning context. Moreover, it describes strategies to integrate climate change issues and adaptation concepts in classroom teaching as well as how to assess the effectiveness of such an integrated learning system.

The learning activities are not exhaustive but they serve as a practical guide for honing the teacher's creativity as a learning facilitator. Maximum utilisation of this guidebook will help teachers learn more about the implications of climate change to the environment, its natural resources and human lives as well. To ensure success in adopting the prototype lesson plans, it would require teacher training to assist them in preparing lesson plans that integrate climate change issues in the basic education curriculum. The chapters and accompanying lesson plans can be used as "stand alone" teaching and learning materials but it would be more useful if the teacher thoroughly reads and understands the Introduction section first.

Looking forward, this guidebook hopes to operationalise the objectives of *Agenda 21* by focusing and aligning education efforts towards sustainable development. *Agenda 21* will be successful if our teachers could effectively increase young people's awareness of environmental and climate change issues, and develop their resilience and adaptive capacity. May this guidebook lead us towards a more sustainable living and learning for our children's children.

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TEACHER'S GUIDEBOOK ON CLIMATE CHANGE

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ACRONYMS

ADB	Asian Development Bank
BIOTROP	Regional Centre for Tropical Biology
IFAD	International Fund for Agricultural Development
IIED	International Institute for Environment and Development
INNOTECH	Regional Centre for Educational Innovation and Technology
ILO	International Labour Organisation
IPCC	Intergovernmental Panel on Climate Change
IRRI	International Rice Research Institute
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GNH	Gross National Happiness
NGO	Non-Government Organisation
RECSAM	Regional Centre for Education in Science and Mathematics
SEAMEO	Southeast Asian Ministers of Education Organisation
SEAMOLEC	Regional Open Learning Centre
SEARCA	Regional Centre for Graduate Study and Research in Agriculture
SPAFA	Regional Centre for Archaeology and Fine Arts
TROPMED (Indonesia)	Regional Centre for Community Nutrition
TROPMED (Philippines)	Regional Centre for Public Health, Hospital Administration, Environmental and Occupational Health
UNCBD	United Nations Convention on Biological Diversity
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund Agency
UNICEF	United Nations Children's Education Fund
WB	World Bank
WHO-SEARO	World Health Organisation Southeast Asia Regional Office
WWF	World Wildlife Fund

GLOSSARY of TERMS

Adaptation
Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Adaptive capacity
The ability of a system (e.g., ecosystem) to adapt to climate change or other environmental disturbances. This may mean moderating potential damages, taking advantage of opportunities or coping with the consequences. In discussions on global warming adaptive capacity often refers to a country. In this case it is currently much lower in developing countries, consequential to poverty.

Aerosol
A collection of airborne solid or liquid particles, with a typical size between 0.01 and 10 micrometers (μm) and residing in the atmosphere for at least several hours. Aerosols may influence climate in two ways: directly through scattering and absorbing radiation, and indirectly through acting as condensation nuclei for cloud formation or modifying the optical properties and lifetime of clouds. The term has also come to be associated, erroneously, with the propellant used in "aerosol sprays."

Alternative Energy
Energy derived from nontraditional sources (e.g., solar, hydroelectric, wind, wave, tidal, biomass and geothermal)

Anthropogenic
Made by people or resulting from human activities. Usually used in the context of emissions that is produced as a result of human activities

Atmosphere
The gaseous envelope surrounding the Earth. The dry atmosphere consists almost entirely of nitrogen (78.1% volume mixing ratio) and oxygen (20.9% volume mixing ratio), together with a number of trace gases, such as argon (0.93% volume mixing ratio), helium, radiatively active greenhouse gases such as carbon dioxide (0.035% volume mixing ratio), and ozone. In addition the atmosphere contains water vapour, whose amount is highly variable but typically 1% volume mixing ratio. The atmosphere also contains clouds and aerosols.

Biodiversity
Life in all its forms, essential to maintain functioning ecosystems that provide services essential for human survival and quality of life.

Biogeochemical Cycle
Movements through the Earth system of key chemical constituents essential to life, such as carbon, nitrogen, oxygen, and phosphorus.

Biomass
Total dry weight of all living organisms that can be supported at each tropic level in a food chain. Also, materials that are biological in origin, including organic material (both living and dead) from above and below ground, for example, trees, crops, grasses, tree litter, roots, and animals and animal waste.

Biosphere
The part of the Earth system comprising all ecosystems and living organisms, in the atmosphere, on land (terrestrial biosphere) or in the oceans (marine biosphere), including derived dead organic matter, such as litter, soil organic matter and oceanic detritus.

Carbon Cycle
All parts (reservoirs) and fluxes of carbon. The cycle is usually thought of as four main reservoirs of carbon interconnected by pathways of exchange. The reservoirs are the atmosphere, terrestrial biosphere (usually includes freshwater systems), oceans, and sediments (includes fossil fuels). The annual movements of carbon, the carbon exchanges between reservoirs, occur because of various chemical, physical, geological, and biological processes. The ocean contains the largest pool of carbon near the surface of the Earth, but most of that pool is not involved with rapid exchange with the atmosphere.

Carbon Dioxide
A naturally occurring gas, and also a by-product of burning fossil fuels and biomass, as well as land-use changes and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance. It is the reference gas against which other greenhouse gases are measured and therefore has a Global Warming Potential of 1. See Global Warming Potential.

Carbon Footprint
It is an estimate of how much carbon dioxide is produced to support your lifestyle. It is a measure of your impact on the climate based on how much carbon dioxide you produce. Factors that contribute to your carbon footprint include your travel methods and general home energy usage.

Chlorofluorocarbons
Greenhouse gases covered under the 1987 Montreal Protocol and used for refrigeration, air conditioning, packaging, insulation, solvents, or aerosol propellants. Since they are not destroyed in the lower atmosphere, CFCs drift into the upper atmosphere where, given suitable conditions, they break down ozone. These gases are being replaced by other compounds, including hydrochlorofluorocarbons and hydrofluorocarbons, which are greenhouse gases covered under the Kyoto Protocol.

Climate
Climate in a narrow sense is usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands of years. The classical period is three decades, as defined by the World Meteorological Organisation (WMO). These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. A simple way of remembering the difference is that climate is what you expect (e.g., cold winters) and 'weather' is what you get (e.g., a blizzard).

Climate Change
Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from:

- natural factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun;
- natural processes within the climate system (e.g., changes in ocean circulation); and
- human activities that change the atmosphere's composition (e.g., through burning fossil fuels) and the land surface (e.g., deforestation, reforestation, urbanisation, desertification, etc.)

Climate (change) scenario
A climate scenario consists of projections of possible climate futures, containing developments of driving forces, greenhouse gas emissions, temperature change and sea level rise and their key relationships. A climate change scenario is the difference between a climate scenario and the current climate.

Climate projection
A projection of the response of the climate system to emission or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations by climate models. Climate projections are distinguished from climate predictions in order to emphasise that climate projections depend upon the emission/concentration/ radiative forcing scenario used, which are based on assumptions, concerning, e.g., future socio-economic and technological developments, that may or may not be realised, and are therefore subject to substantial uncertainty.

Climate System (or Earth System)
The five physical components (atmosphere, hydrosphere, cryosphere, lithosphere, and biosphere) that are responsible for the climate and its variations.

Deforestation
Those practices or processes that result in the conversion of forested lands for non-forest uses. This is often cited as one of the major causes of the enhanced greenhouse effect for two reasons: 1) the burning or decomposition of the wood releases carbon dioxide; and 2) trees that once removed carbon dioxide from the atmosphere in the process of photosynthesis are no longer present.

Drought
A period of abnormally dry weather long enough to cause serious shortages of water for agriculture and other needs in the affected area.

Ecosystem
Any natural unit or entity including living and non-living parts that interact to produce a stable system through cyclic exchange of materials.

El Niño
El Niño, in its original sense, is a warm water current that periodically flows along the coast of Ecuador and Peru, disrupting the local fishery. This oceanic event is associated with a fluctuation of the intertropical surface pressure pattern and circulation in the Indian and Pacific Oceans, called the Southern Oscillation. This coupled atmosphere-ocean phenomenon is collectively known as El Niño-Southern Oscillation. During an El Niño event, the prevailing trade winds weaken and the equatorial countercurrent strengthens, causing warm surface waters in the Indonesian area to flow eastward to overlie the cold waters of the Peru current. This

event has great impact on the wind, sea surface temperature, and precipitation patterns in the tropical Pacific. It has climatic effects throughout the Pacific region and in many other parts of the world. The opposite of an El Niño event is called La Niña.

Environment
The complex physical, chemical, and biotic factors (as climate, soil, and living things) that act upon an organism (a living thing) or an ecological community (a collection of living things) and ultimately determine its form and survival. The circumstances, objects, and conditions that surround each of us.

Evapotranspiration
The combined process of evaporation from the Earth's surface and transpiration from vegetation.

Extreme weather event
An extreme weather event is an event that is rare within its statistical reference distribution at a particular place. Definitions of "rare" vary, but an extreme weather event would normally be as rare as or rarer than the 10^{th} or 90^{th} percentile. By definition, the characteristics of what is called extreme weather may vary from place to place. An extreme climate event is an average of a number of weather events over a certain period of time, an average which is itself extreme (e.g., rainfall over a season).

Fluorocarbons
Carbon-fluorine compounds that often contain other elements such as hydrogen, chlorine, or bromine. Common fluorocarbons include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

Geosphere
The soils, sediments, and rock layers of the Earth's crust, both continental and beneath the ocean floors.

Glacier
A multi-year surplus accumulation of snowfall in excess of snowmelt on land and resulting in a mass of ice at least 0.1 km^2 in area that shows some evidence of movement in response to gravity. A glacier may terminate on land or in water. Glacier ice is the largest reservoir of fresh water on Earth, and second only to the oceans as the largest reservoir of total water. Glaciers are found on every continent except Australia.

Global Warming
Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities.

Global Warming Potential (GWP)
Global Warming Potential (GWP) is defined as the cumulative radiative forcing effects of a gas over a specified time horizon resulting from the emission of a unit mass of gas relative to a reference gas. The GWP-weighted emissions of direct greenhouse gases in the U.S. Inventory are presented in terms of equivalent emissions of carbon dioxide (CO2), using units of teragrams of carbon dioxide equivalents (Tg CO2 Eq.).

Greenhouse Effect
Trapping and build-up of heat in the atmosphere (troposphere) near the Earth's surface. Some of the heat flowing back toward space from the Earth's surface is absorbed by water vapour, carbon dioxide, ozone, and several other gases in the atmosphere and then reradiated back toward the Earth's surface. If the atmospheric concentrations of these greenhouse gases rise, the average temperature of the lower atmosphere will gradually increase.

Greenhouse Gas (GHG)
Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, but are not limited to, water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), ozone (O_3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

Greenhouse pollution
Pollution of the Earth's atmosphere by excessive emissions of greenhouse gases by humans. This increases the volume of gases in the atmosphere, traps more solar radiation and leads to global warming.

Heat Stress
A variety of problems associated with very warm temperatures and high humidity. Heat exhaustion is a condition marked by weakness, nausea, dizziness, and profuse sweating that results from physical exertion in a hot environment. Heat stroke is a condition marked especially by cessation of sweating, extremely high body temperature, and collapse that results from prolonged exposure to high temperature.

Hydrocarbons
Substances containing only hydrogen and carbon. Fossil fuels are made up of hydrocarbons.

Hydrologic Cycle
The process of evaporation, vertical and horizontal transport of vapor, condensation, precipitation, and the flow of water from continents to oceans. It is a major factor in determining climate through its influence on surface vegetation, the clouds, snow and ice, and soil moisture. The hydrologic cycle is responsible for 25% to 30% of the mid-latitudes' heat transport from the equatorial to polar regions.

Hydrosphere
The component of the climate system comprising liquid surface and subterranean water, such as oceans, seas, rivers, fresh water lakes and underground water etc.

Intergovernmental Panel on Climate Change (IPCC)
The IPCC was established jointly by the United Nations Environment Programme and the World Meteorological Organisation in 1988. The purpose of the IPCC is to assess information in the scientific and technical literature related to all significant components of the issue of climate change. The IPCC draws upon hundreds of the world's expert scientists as authors and thousands as expert reviewers. Leading experts on climate change and environmental, social, and economic sciences from some 60 nations have helped the IPCC to prepare periodic assessments of the scientific underpinnings for understanding global climate change and its consequences. With its capacity for reporting on climate change, its consequences, and the viability of adaptation and mitigation measures, the IPCC is also looked to as the official advisory body to the world's governments on the state of the science of the climate change issue. For example, the IPCC organised the development of internationally accepted methods for conducting national greenhouse gas emission inventories.

Methane (CH_4)
A hydrocarbon that is a greenhouse gas with a global warming potential most recently estimated at 23 times that of carbon dioxide (CO_2). Methane is produced through anaerobic (without oxygen) decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion.

Mitigation
A human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Mitigation of global warming
Any actions to reduce or avoid greenhouse gas emissions (in order to avoid global warming).

Natural Gas
Underground deposits of gases consisting of 50% to 90% methane (CH_4) and small amounts of heavier gaseous hydrocarbon compounds such as propane (C_3H_8) and butane (C_4H_{10}).

Nitrogen Oxides (NOx)
Gases consisting of one molecule of nitrogen and varying numbers of oxygen molecules. Nitrogen oxides are produced in the emissions of vehicle exhausts and from power stations. In the atmosphere, nitrogen oxides can contribute to formation of photochemical ozone (smog), can impair visibility, and have health consequences; they are thus considered pollutants.

Nitrous Oxide (N_2O)
A powerful greenhouse gas with a global warming potential of 296 times that of carbon dioxide (CO_2). Major sources of nitrous oxide include soil cultivation practices, especially the use of commercial and organic fertilisers, fossil fuel combustion, nitric acid production, and biomass burning. The GWP is from the IPCC's Third Assessment Report (TAR).

Ozone (O_3)
Ozone, the triatomic form of oxygen (O_3), is a gaseous atmospheric constituent. In the troposphere, it is created both naturally and by photochemical reactions involving gases resulting from human activities (photochemical smog). In high concentrations, tropospheric ozone can be harmful to a wide range of living organisms. Tropospheric ozone acts as a greenhouse gas. In the stratosphere, ozone is created by the interaction between solar ultraviolet radiation and molecular oxygen (O_2). Stratospheric ozone plays a decisive role in the stratospheric radiative balance. Depletion of stratospheric ozone, due to chemical reactions that may be enhanced by climate change, results in an increased ground-level flux of ultraviolet (UV-) B radiation.

Ozone Layer
The layer of ozone that begins approximately 15 km above Earth and thins to an almost negligible amount at about 50 km, shields the Earth from harmful ultraviolet radiation from the sun. The highest natural concentration of ozone (approximately 10 parts per million by volume) occurs in the stratosphere at approximately 25 km above Earth. The stratospheric ozone concentration changes throughout the year as stratospheric circulation changes with the seasons. Natural events such as volcanoes and solar flares can produce changes in ozone concentration, but man-made changes are of the greatest concern.

Photosynthesis
The process by which plants take CO_2 from the air (or bicarbonate in water) to build carbohydrates, releasing O_2 in the process. There are several pathways of photosynthesis with different responses to atmospheric CO_2 concentrations.

Precipitation
Rain, hail, mist, sleet, snow or any other moisture that falls to the Earth.

Radiation
Energy transfer in the form of electromagnetic waves or particles that release energy when absorbed by an object.

Recycling
Collecting and reprocessing a resource so it can be used again. An example is collecting aluminum cans, melting them down, and using the aluminum to make new cans or other aluminum products.

Reforestation
Planting of forests on lands that have previously contained forests but that have been converted to some other use.

Solar Radiation
Radiation emitted by the Sun. It is also referred to as short-wave radiation. Solar radiation has a distinctive range of wavelengths (spectrum) determined by the temperature of the Sun.

Stratosphere
Region of the atmosphere between the troposphere and mesosphere, having a lower boundary of approximately 8 km at the poles to 15 km at the equator and an upper boundary of approximately 50 km. Depending upon latitude and season, the

temperature in the lower stratosphere can increase, be isothermal, or even decrease with altitude, but the temperature in the upper stratosphere generally increases with height due to absorption of solar radiation by ozone.

Stream flow
The volume of water that moves over a designated point over a fixed period of time. It is often expressed as cubic feet per second (ft^3/sec).

Troposphere
The lowest part of the atmosphere from the surface to about 10 km in altitude in mid-latitudes (ranging from 9 km in high latitudes to 16 km in the tropics on average) where clouds and "weather" phenomena occur. In the troposphere temperatures generally decrease with height.

United Nations Framework Convention on Climate Change (UNFCCC)
The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognises that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, with 189 countries having ratified. Under the Convention, governments:

- gather and share information on greenhouse gas emissions, national policies and best practices
- launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries
- cooperate in preparing for adaptation to the impacts of climate change

The Convention entered into force on 21 March 1994.

Vulnerability
It is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Wastewater
Water that has been used and contains dissolved or suspended waste materials.

Water Vapour
The most abundant greenhouse gas, it is the water present in the atmosphere in gaseous form. Water vapour is an important part of the natural greenhouse effect. While humans are not significantly increasing its concentration, it contributes to the enhanced greenhouse effect because the warming influence of greenhouse gases leads to a positive water vapour feedback. In addition to its role as a natural greenhouse gas, water vapour plays an important role in regulating the temperature of the planet because clouds form when excess water vapour in the atmosphere condenses to form ice and water droplets and precipitation.

Weather
Atmospheric condition at any given time or place. It is measured in terms of for e.g., wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. In most places, weather can change from hour-to-hour, day-to-day, and season-to-season.

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INTRODUCTION

[SEAMEO RECSAM]

Once upon a Time, Earth was Healthy

A healthy earth ages ago had naturally existing greenhouse gases (GHGs), and warming the earth enough for its inhabitants to live comfortably. These naturally occurring gases trap the heat from the sun as its rays deliver the heat over 150 million kilometers away. Its rays enter our atmosphere and warm our planet. About one third of this solar energy is reflected back into the universe by shimmering glaciers, water and other bright surfaces. Two thirds, however, are absorbed by the Earth, thus warming lands, oceans, and atmosphere.

What are these gases? Water vapour, carbon dioxide (CO_2), methane (CH_4), hexafluoroethane (C_2F_6), carbon monoxide (CO), and nitrous oxide (N_2O) are some examples of GHGs (ELC, n.d.). Without these naturally occurring gases, the earth will be too cold to live for humans, animals, and plants (***Figure 1***).

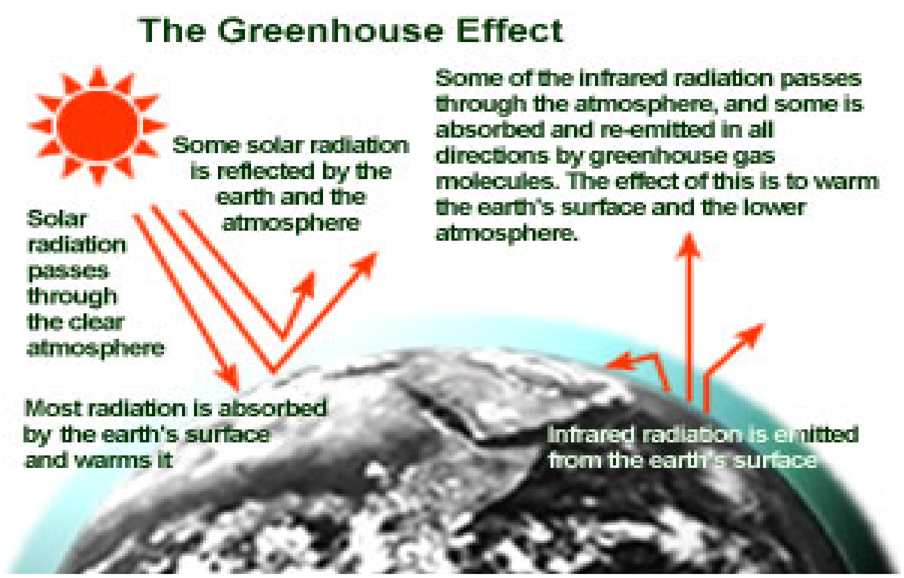

Figure 1 The Greenhouse Effect
Source: U.S EPA (n.d.)

Earth Having Fever?

A healthy human body records a temperature of 36.5^0 Celsius. An increase in body temperature of one degree or more leaves the body feeling feverish or cold. The earth too is experiencing fever as it either becomes so hot in some parts, or so cold in other parts.

What makes the earth feverish? While there are naturally existing GHGs, there are also those which are derived from human activities. This means that the sun's heat is being trapped and stays inside the GHGs and cannot anymore reflect back to the outer spaces, thus increasing the Earth's temperature. When too much heat is being trapped, the planet gets warm (in some parts) or cold (in other parts) beyond its natural capacity and this leads to what we call *Global Climate Change*.

Making More Money

Buying and selling are key words that fuel the economy. However, before you can buy anything, somebody has to produce something to sell. Human societies, through the years, have moved from household consumption to commercial production patterns which heavily extract from earth's resources.

Due of this, people have used more litres of petrol, diesel fuel, oil to fly planes, run factories and related machines (this is burning fossil fuels: coal, natural gas, oil, and petrol) to complete the cycle of producing and selling things in large quantities.

The processes in producing goods and selling goods and running machines as shown in ***Figure 2*** have indeed increased carbon dioxide and other GHGs, like methane and make the earth hotter each day (U.S. EPA, n.d.).

Figure 2 Carbon Emitting Industry
Source: FotoSearch (n.d.)

Power, land use, transport, and agriculture—they all contribute to GHG emissions. ***Figure 3*** shows how much each sector contributes GHGs in 2000 by source (Chevalier, 2009).

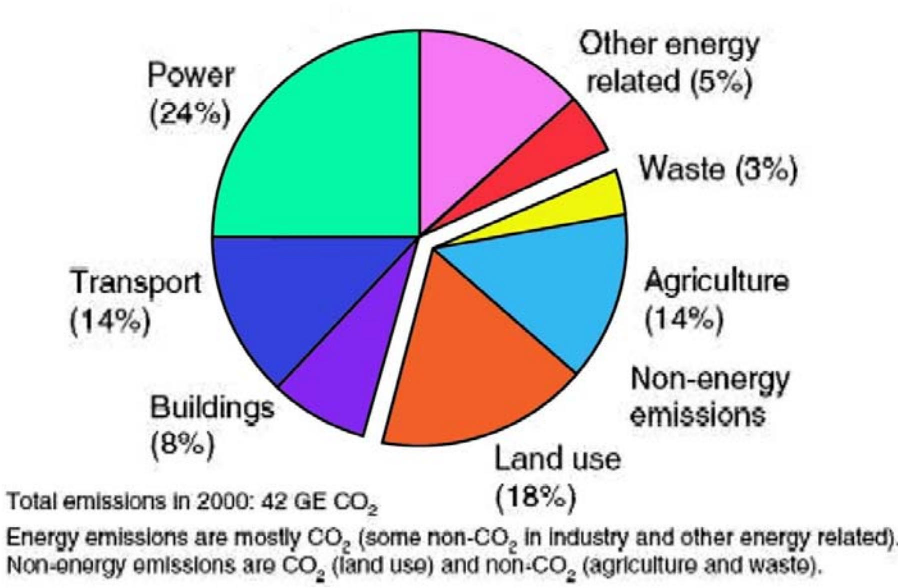

Figure 3 Greenhouse Gas Emissions in 2000 by source

What energy sources do we have?

Southeast Asian countries use fossil fuels, and a mix of oil, natural gas and coal. In 2007, this energy mix collectively accounted for 73% of total demand. Biomass and waste resources, such as wood and agricultural residues, also represent important sources of energy and met 23% of demand in 2007. Within the same period, carbon dioxide (CO_2) emissions increased sharply as countries switched from biomass to fossil fuels. ***Table 1*** shows the energy sector for ASEAN countries (IEA, 2009).

According to some country leaders, the future of our energy supply is not good. If we do not reduce the energy we use daily, in the coming years, our energy supply will fail and our environment will experience a lot of disasters (IEA, 2006).

Are We in Serious Trouble? How?

What would you do if one day you wake up surrounded with flood waters and the water keeps on rising?

If you live in Southeast Asia, your country may be in trouble or may be vulnerable. Accelerated climate change brings in floods, fire risks, typhoon, tropical storms, and landslides, and aggressive vector-borne diseases that infect humans, animals, and crops.

	Overview
Brunei Darussalam	Oil and gas have been the backbone of the economy since their discovery in 1929. Today, it is the third-largest oil producer in ASEAN and ninth-largest Liquefied Natural Gas (LNG) exporter in the world. Diversifying the economy to reduce reliance on oil and gas export earnings is a key priority.
Cambodia	Energy infrastructure remains damaged by decades of civil war. Increasing the rate of electrification is one of the main priorities. Exploitation of offshore oil and gas resources discovered in 2005 could jump-start economic development.
Indonesia	The world’s fourth most-populous country, it is the world’s leading steam coal exporter, third-largest LNG exporter, and until 2004, a net exporter of oil. Increasing energy investment will be essential for its economic development.
Laos	It has significant hydropower potential and export of hydroelectricity is one of the main sources of export earnings. As access to modern energy services remains limited, rural electrification is one of the major priorities.
Malaysia	It heavily depends on fossil fuels. It has significant oil and gas resources and is the world’s second-largest exporter of LNG. A key challenge will be to diversify the power-generation mix to meet the increase in demand for electricity.
Myanmar	The bulk of the population lives in rural areas and depends heavily on traditional energy, such as fuel wood, charcoal and biomass. Rural electrification is a priority, as is the development of the country’s hydropower resources and offshore gas deposits, which could play a key role in fostering economic development.
Philippines	Its reliance on imported energy is high and it faces serious challenges in attracting investment to overcome electricity shortages. It is pushing to reduce imports by developing renewable, including geothermal – of which it is already the world’s second-largest producer.
Singapore	It is the world’s third-largest oil trading and refining hub. Due to its small size and low energy resource endowments, it is heavily dependent on imported energy and is currently constructing an LNG import terminal to improve diversity of supply.
Thailand	It is the second-largest energy consumer in ASEAN and is heavily dependent on imports- particularly oil but also natural gas, coal and electricity. A key challenge will be to meet growing demand for electricity, including through expanding imports, while diversifying the generation mix.
Vietnam	It is rich in coal, oil and hydropower and has been a net energy exporter since 1990. Domestic energy demand is growing rapidly and reliance on traditional biomass remains high in rural areas. The government is currently pursuing policies to increase rural electrification and the use of renewable energy.

Table 1 Energy Sector Overview for ASEAN by Country
Source: IEA (2009)

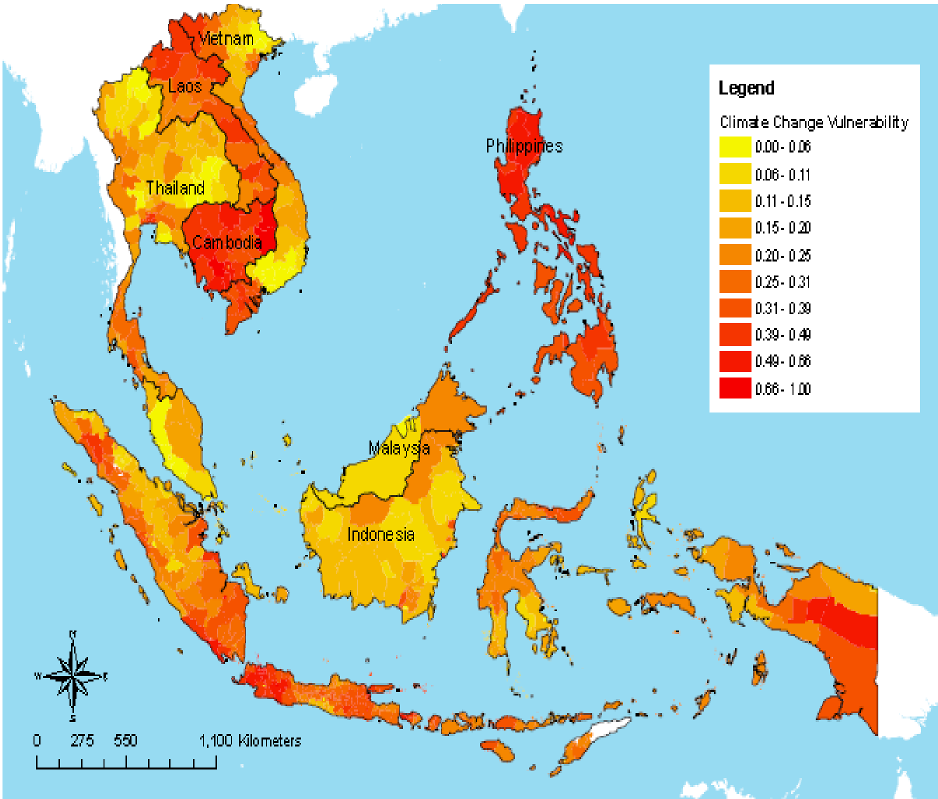

Figure 4 Climate Change Vulnerability Map of Southeast Asia
Source: Yusuf and Francisco (2009)

If we look at ***Figure 4***, it shows how vulnerable each country is to climate change. In the map, seven countries are most vulnerable or the least able to cope with the destructive impact of climate change. The Philippines, the Mekong River Delta region of Vietnam; almost all the regions of Cambodia; North and East Lao PDR; the Bangkok region of Thailand; the west and south of Sumatra, and western and eastern Java in Indonesia are countries that are vulnerable (Yusuf and Francisco, 2009).

The Philippines, unlike other countries in Southeast Asia, is not only exposed to tropical cyclones, especially in the northern and eastern parts of the country, but also to many other climate-related hazards like floods (such as in central Luzon and Southern Mindanao), landslides (due to the terrain of the country), and droughts. In Malaysia, the most vulnerable regions are the states of Kelantan and Sabah. Cambodia, however, becomes highly vulnerable since it is sharing borders with the Mekong River Delta in northern Vietnam which is susceptible to flooding and sea level rise.

Drought and Flooding, a Water Seesaw

Drought and flooding are like two persons, each sitting at either end of a seesaw, and their weights move their ends of the board up and down causing the other end of the board to move. Like a seesaw, some countries experience drought, while others, flooding.

In both cases, water, a basic resource is affected. Where there is drought, plants die. Likewise, so much water also drowns the plants. In the end, we will have no harvest for rice, corn, vegetables, and many others. No harvest means no food on the table. Our farmers, housewives, and all our communities, regardless of which part of Southeast Asia we come from, will have a real problem, if water supply is badly affected.

We get sick too

Warmer climate and rainfall combined provide a conducive surrounding for mosquitoes carrying malaria to breed much faster. In addition to scientific explanations, there are many related factors creating conditions for an increase in malaria and other diseases.

Operation Rescue!

Operation rescue of earth takes two faces: mitigate and adapt. To mitigate means to reduce carbon dioxide and other GHG emissions. Why do we mitigate? We mitigate because we want to rescue earth from further self destruction. If earth is overheated, we lose our home, and we end up being destroyed as well.

How do we mitigate or reduce carbon dioxide in the environment? A common practice is to reduce the "amount of Earth's resources that we use." We can reuse (Reduce Reuse Recyle, n.d.) by not storing our things and giving them to others who can still make use of them, or earn from them by having a garage sale. We can recycle by making old materials into new useful ones. For example, you can use old glasses and jars to store many small stuff or turn them into pretty vases.

How about adapting? How do we adapt? Each country has what we call an "adaptive capacity." Adaptive capacity simply means our ability to cope with or respond to the damages of climate change (IPCC, 2001). Do we have the technology or enough money to build strong houses, roads, and bridges that are able to stand firm during floods and storms?

Figure 5 shows the *Adaptive Capacity Index* of the different countries in Southeast Asia. The map reveals that Lao PDR and Cambodia have very low adaptive capacity index while Thailand, Malaysia and Vietnam have relatively high adaptive capacity indices.

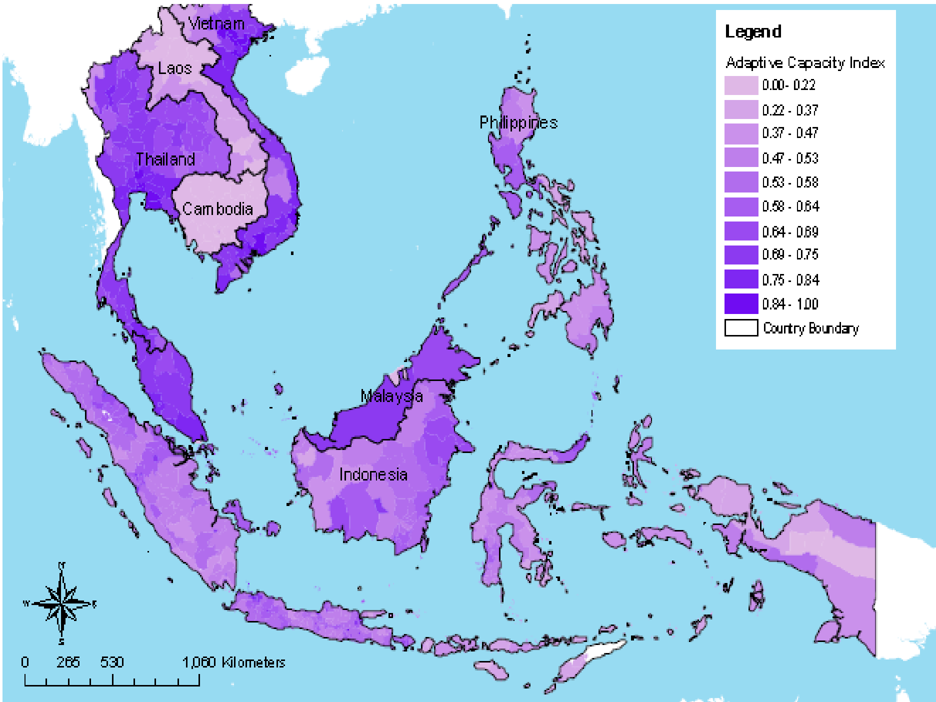

Figure 5 Adaptive Capacity Map of Southeast Asia
Source: Yusuf & Francisco (2009)

We increase our adaptive capacity if we have the right education, enough income, technical skills, disaster preparedness and management; and health care systems, especially when we need to relocate communities affected by storms, flooding, sea-level rise and many others.

Best of all, we can increase our adaptive capacity by educating our young people and the rest of the public on how to prepare for upcoming disasters.

What is our Response?

We, the SEAMEO community, being one of the movers of education in Southeast Asia, take this initiative to develop a Guidebook for Teachers. This guidebook, designed for teachers, aims to facilitate learning on climate change in classrooms and engage students through the exemplars given.

Eight chapters that reflect and elaborate concepts on climate change and its accompanying negative impacts and effects on all forms of life are presented in the concept map *(Refer to Appendix on last page of book).*

Chapters 1 to 4, respectively, present the natural resources and how climate change affects them. Security in terms of biodiversity, freshwater, sea water, and energy is the keyword for sustainability both for the environment and for the people.

Chapters 5 to 8 look at human-based needs being shaped and/or affected by climate change. The connection between climate change and food security is discussed in Chapter 5. This Chapter explains that as the temperature increases, the frequency and intensity of severe-weather events around the world also increase. Droughts, flooding, tropical cyclones have greatly reduced production of crops, fish, and forest harvests; thus, our food security is threatened.

Not only are food resources reduced by these extreme weather events, they also impact on the health and nutrition of people where mostly, the poor ones are greatly affected. Chapter 6 discusses how climate change increases mortality in terms of the resulting heat- and cold-related illnesses and death, as well as, the widening range of resistance of infective vectors which carry bacteria, viruses, and parasites.

These weather events are indeed making the poor, much poorer.

Climate change not only affects food resources and good health, but also has an impact on our land, trees, rivers, coastlines, fishes, and many others. The loss of resources causes poverty. The connection between climate change and poverty is discussed in Chapter 7. This Chapter explains that extreme weather events causing loss of lives, properties, farms, etc., severely damage the resources of the poor and are indeed making them much poorer.

As the tension of having very little or badly damaged resources increases, competition over these resources grows more intense. And as people grow in number, they would end up competing or fighting over resources that are getting fewer. This competition over resources could lead to ‘Conflict’ and discussed in Chapter 8. The book ends up with a brief Conclusion that gives some key issues of climate change and what we can do about it.

“As the world becomes increasingly interdependent and fragile, we must recognise that in the midst of diversity of cultures and life forms we are one Earth community with a common destiny. We must join together to bring forth a sustainable global society founded on respect for nature, universal human rights and a culture of peace”. (Ikeda, 2002, pp. 2)

We must also not forget that each and everyone must be responsible for whatever happens to Mother Earth. The three quotes below should also be constantly used to remind everyone of that responsibility.

> *"The earth, water and the air are* not a gift from our parents, but a *loan from our children that we must pay back".* – An old Indian saying

> *"We cannot command Nature except by obeying her".* – Francis Bacon (1561-1626)

> *"Only when the last tree has died, the last river has been poisoned and the last fish has been caught, will we realise that we cannot eat money".* – Cree Proverb

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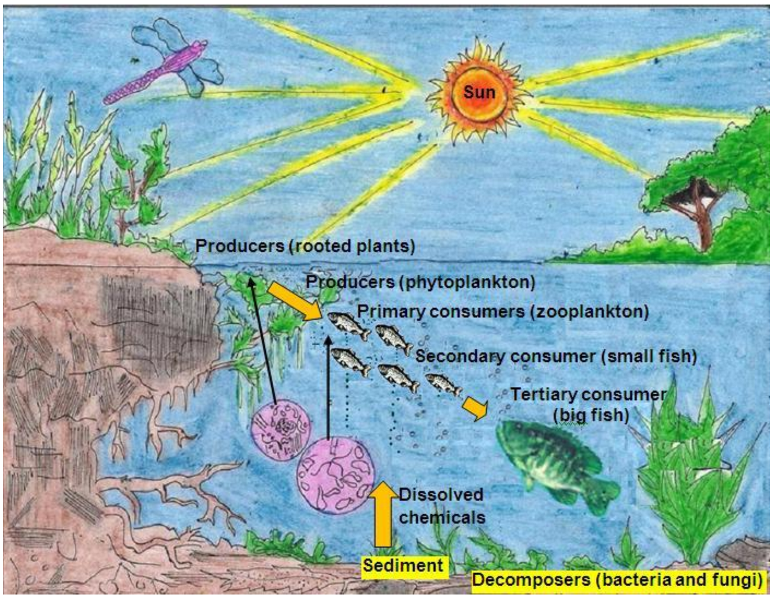
CHAPTER I: Impact of Climate Change on BIODIVERSITY and ECOSYSTEM

[SEAMEO BIOTROP and SEAMEO RECSAM]

The Ecosystem

An ***ecosystem*** is an interdependent, functioning system of plants, animals and microorganisms (***Figure 1.1***). The Intergovernmental Panel on Climate Change (IPCC, 2002) defines ecosystem as a system of dynamic and interacting living organisms (plant fungus, animal, and microorganism) together with their physical environment.



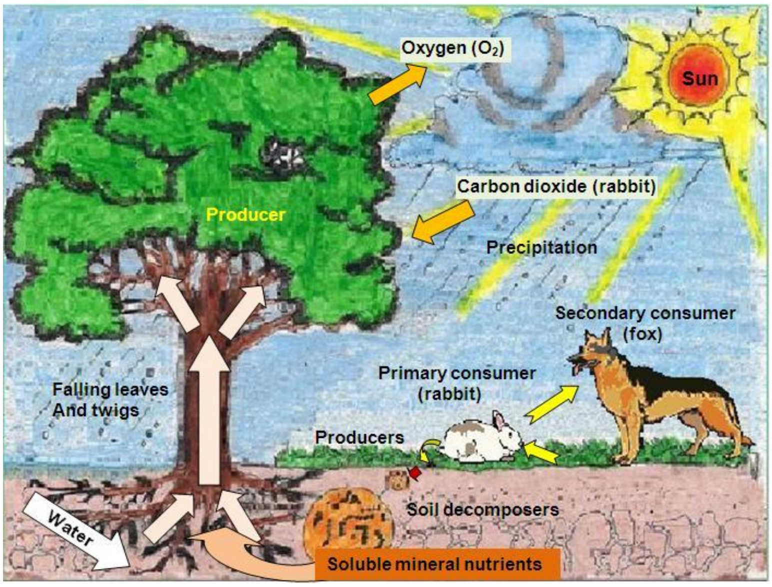


Figure 1.1 A marine ecosystem (1st photo) and terrestrial ecosystem (2nd photo)
Source: SEAMEO RECSAM (2010)

Figure 1.1 shows an example of two types of ecosystem: a marine (ocean) and a terrestrial (land) ecosystem. If you look at the two photos, you can see various organisms. This variety of organisms and their various roles, we call ***biodiversity***, is very important to make an ecosystem function well. Let's use the photo on marine ecosystem to explain what we mean by biodiversity.

Marine ecosystem. The plants underwater are called phytoplankton (producers). They are very small and cannot be seen by the naked eye. As plants, they use carbon dioxide during photosynthesis and provide food and oxygen to all the consumers, like the zooplankton (tiny shrimp, eggs of sea animals, baby sea animals or primary consumers; Gjerde, 2006).

The zooplankton is eaten by fishes (secondary consumers); and turtles (tertiary consumers) feed on fishes. When they defecate or they die, there is another set of organisms; we call them the decomposers (microorganisms) or the army of bacteria and fungi.

We can also call them nature's recyclers because as they eat the dead bodies for their energy, they recycle the nutrients coming from the consumers back to the soil which in turn is taken in by the roots of the plants to make them grow and produce food and oxygen. Without them, earth will be covered with lots of dead bodies which are still intact. All life forms would not survive without the support of other organisms within their own ecosystem (Lyons, Dunworth, Tilbury & Johnston, 2010).

Functions of Biodiversity and Ecosystem

Biodiversity makes the earth liveable. The photos that we explained earlier showcase what biodiversity is: the variety of organisms, their genetic make-up, and their respective roles in the communities where they live (Thompson, 2007). Because of biodiversity, we have air (a product of photosynthesis by green plants) to breathe.

Insects, worms, bacteria, and other tiny organisms break down wastes and aid in decomposing dead plants and animals to enrich the soils.

Figure 1.2 Biodiversity

More than 90% of our food is produced from 80 plant species and almost 30% of our medicines come from plants and animals (Thompson, 2007).

The United Nations Convention on Biological Diversity (UNCBD) defines **biodiversity** as the variability among living organisms from all sources like land, marine, and other aquatic ecosystems and the ecological complexes of which they are part of. Like a washing machine that has various parts to make it function well, biodiversity too makes the earth function smoothly. The diversity of genes, species and ecosystems make us survive on planet earth (UNCBD, 2002).

Ecosystems make humans survive. We depend on ecosystems for the natural, cultural, spiritual, recreational and aesthetic resources they provide. Ecosystem services are the ecosystem processes or functions that have value to individuals or society. The Millennium Ecosystem Assessment (MEA, 2005) describes five major categories of ecosystem services as shown in ***Figure 1.3*** below:

1) *provisioning,* such as the production of food and water;
2) *regulating,* such as the control of climate and disease;
3) *supporting,* such as nutrient cycles and crop pollination;
4) *cultural,* such as spiritual and recreational benefits; and
5) *preserving,* such as the maintenance of diversity.

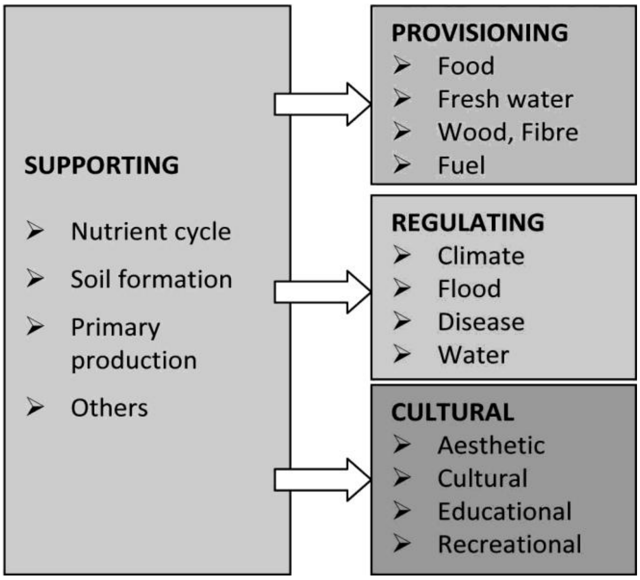


Figure 1.3 Diagram of Ecosystem Services
Source: MEA (2005)

How does Climate Change Affect Biodiversity and Ecosystem?

Biodiversity loss. The life of plants, animals, and microorganisms is affected by climate factors. When the climate is drastically altered, the ability of plants and animals to live, produce, and adapt to their environment is disrupted. Those organisms with very narrow tolerance to climate changes disappear. We call this as biodiversity loss.

The higher the number of plants and animals being lost because of drastic changes in climate, the higher the threat to human security. Many plants in the forest have been reported to have high medicinal values which are endangered because they may not be able to cope with extreme low or high temperatures, flooding and drought which have lately become unpredictable.

Climate controls the vegetation structure, productivity, and plant and animal species composition. Many plants can successfully reproduce and grow only within a specific range of temperatures and respond to specific amounts and seasonal patterns of rainfall. They may be displaced by competition from other plants or may fail to survive if climate changes. Animals also have distinct temperature and/or precipitation ranges and are also dependent on the ongoing persistence of their food species. For example, one or two degree temperature increase will push the fish to migrate to cooler waters, if not, will cause them to die.

Over the course of history, ecosystems have always had to adapt to changing climatic conditions. The current rate of climate change, however, is higher than that recorded in the past years. According to IPCC (2007), scientists have observed evidences that the composition of the atmosphere is changing, such as the earth's climate.

The increasing atmospheric concentrations of greenhouse gases from fossil fuel burning, as shown in ***Figure 1.5***, have increased Earth's temperature which caused extreme climatic events including heat waves, heavy precipitation, and droughts. The IPCC states that the recent observed rate of warming, an increase of 0.6°C in average annual temperature during the 20th century, is faster than those temperatures recorded at any other time in the past 1000 years (Houghton, Ding, Griggs, Noguer, van der Linden, Dai, Maskell & Johnson, 2001).

Figure 1.5 Carbon emitting industry
Source: Wikipedia (2010)

Many regions across the world have already been affected by changes in climate. Specifically, the growth and behaviour of plants and animals, their population and age structure have shown some changes. Climate change also directly affects the ecosystem structure and function (e.g. decomposition, nutrient cycling, water flows, and species composition and interactions). Seasonal patterns like hot and rainy seasons used to be very definite in the past. Now, we cannot anymore determine whether our coming days would be very hot or very wet.

Because of the change in seasonal patterns, the ecosystem structure and function, and the biodiversity of earth are also affected. Climate change alters directly all living organisms, their populations and species, and their reproduction, fecundity, establishment, and dispersal (Gayton, 2008).

Phenology such as flowering, breeding, and migration, growth rates, and mortality; length of growing or their biologically active season; geographic distribution, population size, and response to disturbance are all influenced by climate change. Simply stated, species can respond to altered climate in four different ways: they can adapt to the new conditions, evolve, migrate to areas of more suitable climate, or go extinct (Gitay, Brown, Easterling & Jallow, 2001).

Species most vulnerable to extinction will be those with small populations, slow rates of dispersal, restrictive elevation, climate requirements, and/or those whose habitat is limited or occurs in patches.

Migratory species face particular extinction risk, since they require multiple habitats in a particular seasonal order; thus, increasing the probability of climate change-induced disruption of their habitat requirements. Also at risk are endemics, or species with narrow elevational ranges, and species with limited dispersal ability or those with long reproductive cycles (Dunlop & Howden, 2001; Hannah, Lovejoy & Schneider, 2005).

In summary, climate change is likely to induce the following:

- Large-scale biome, ecosystem, and species shifts;
- A breakdown and re-sorting of current plant communities and ecosystems;
- A general expansion of species ranges northwards and upslope *(note that for alpine and boreal species, this will mean range contractions);*
- Loss of ecosystems, including some wetland and alpine areas;
- Changes in habitat quality and availability;
- Changes in synchrony between species — *for example*, the timing of predator/prey or flower/ pollinator interaction;
- Differential range shifting—*for example*, when a pollinator insect experiences a range expansion but its host plant does not.

Examples of the urban impacts of such species changes are:

- Loss of trees in streets, gardens and parks, as changing temperatures add stress and reduce their resilience to pests and diseases;

- Loss of species and damage of *(municipal)* forests, reducing economic gains as well as recreational values;

- Risk of collapsing waste water treatment systems as micro-organisms are vulnerable to temperature differences;
- Damages to flora and fauna through the immigrating of *(alien)* species;
- Risks to human health through the immigration of disease carrying insects such as mosquitoes.

Biodiversity and What Can Countries Do?

There are many ways that countries can slow down loss of biodiversity. The following tips are recommended by the Global Change Project (2010):

1. Create protected areas. For example, establish Ecological Parks where trees and wildlife are preserved, and people's entry to cut trees are prevented. Countries can also designate marine protected sanctuaries to nurture baby fishes and protect overfishing activities.

2. Create policies that will prevent entry of foreign plants and animals. Many times, introduced species can disturb the natural growth and reproduction of endemic plants and animals because they have the tendency to grow, multiply, and eat up food resources much faster than the naturally existing species.

3. Inform, communicate, and educate all people, young and old alike, on the importance of biodiversity, and what people can do to prevent loss of biodiversity.

Biodiversity and What You Can Do?

Biodiversity is threatened by the combined actions of our society by just going about our day-to-day business. Here are ten simple things that will help reduce your own environmental impact, and thereby your adverse impact on biodiversity. Many of them help in multiple ways (Hooper, 2009).

Habitat

1. Reduce use of pesticides and fertilisers in the farmland and backyard gardens. These often contaminate adjacent lakes and streams with adverse effects for the plants and animals living there.

2. Get involved with ecological restoration in your area. Most areas have groups active in restoration. By volunteering, you can help restore habitat for native species and eliminate invasive species, all the while learning something about your local plants and animals and getting active out in the fresh air.

Waste stream

3. Reduce, reuse, and recycle, with an emphasis on the first one. The more you can each reduce your demand for new resources, the less habitat conversion will be necessary to get those resources or the energy to make the products you demand, and the less waste goes into the landfill.

4. Composting both reduces the overall waste stream and thereby the need for landfill space, and it provides natural slow-release fertiliser for your flower or vegetable garden.

5. Use environmentally friendly products for cleaning. This reduces chemical contamination of habitats both during manufacturing and when those chemicals go down the drain.

Food choices

6. Buy organic foods. This helps reduce inputs of fertilisers and pesticides into the environment, which in turn reduces negative impacts on nearby beneficial insects (for pollination and pest control) and adjacent aquatic biodiversity. Organic foods are increasingly available, even in regular supermarkets. Your favourite place to shop doesn't offer any? Start requesting it!

7. Buy sustainably harvested seafood. Many seafood, though delicious, are not harvested sustainably–either for the individual species itself or for those species that are unlucky enough to be ensnared as "by catch". Some trawlers destroy extensive seafloor habitat in the process of catching fish; many shrimp farms destroy mangrove forests which serve as nurseries for wild fish species.

Energy use - By reducing your energy demand, you reduce both carbon dioxide release into the atmosphere, which contributes to global warming, and the need to disturb habitat for fossil fuel prospecting and extraction. Save energy and save something for the future.

8. Aim for energy conservation in your home. Home energy audits are often available from your local power companies. They know that it's more economical to conserve than having to build new power plants. Check out some energy conservation websites in Southeast Asia;

   (i) http://www.monstersandcritics.com/lifestyle/life/news/article_1521312.php/Singapore-experiments-with-energy-saving-home-for-the-tropics.

   (ii) http://www.edalight.net/

9. Reduce single-person car use. Each litre of petrol burned, releases 2.7 kilograms of the greenhouse gas CO_2. Car pooling, public transport, walking, and bicycling are often options. If you need to drive, look into the growing

number of fuel efficient vehicles, either gas efficient or turbo diesel (tdi) models. If you use 100% biodiesel, you can even make your driving “carbon neutral” – no more CO_2 released into the atmosphere from your vehicle than was taken up by photosynthesis by the plants used to make your fuel.

10. Incorporate renewable energy and/or energy efficiency into your next home. Thinking about building a new home or remodelling? With some careful thought about your region, your site, and your needs, you can drastically reduce your own energy consumption and still have a beautiful, comfortable home. While you are at it, think about some of the many alternative building and “green landscaping” materials out there. See some web sites in Southeast Asia with recent article on Designing a "Green" Building.

    (i) http://asia.cnet.com/crave/2009/10/27/singapore-showcases-its-first-zero-energy-building/

    (ii) http://www.mgbc.org.my/aboutus.htm

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Lesson 1

CLIMATE CHANGE, A MIXED BLESSING

(Effects of Climate Change on the Interdependence of Living Things)

GRADE LEVEL: High School

SUBJECT: Biology

TOPIC: Life Energy, Photosynthesis and Respiration

PREREQUISITES

- Students should have prior knowledge about the nature and requirements of photosynthesis and cellular respiration.
- Prior to this lesson, ask the students to conduct a research on the positive and negative effects of high concentration of CO_2 in the atmosphere on living things.

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: At the end of this lesson, the students should be able to:

- explain the relationship between the processes of photosynthesis and respiration;
- explain the equation showing the opposite reaction in the photosynthesis and respiration processes; and
- cite the importance of interdependence of living things based on the oxygen-carbon dioxide cycle.

Climate Change Objectives:

- explain the factors (e.g., CO_2, light intensity and temperature) which can be attributed to climate change that affect the photosynthesis process;
- discuss what will happen to plants and its dependents when photosynthesis rapidly increases; and
- identify ways to mitigate the effects of climate change on biodiversity and ecosystem.

MAIN CONCEPTS AND SKILLS

- The production of food from carbon dioxide and water in the presence of chlorophyll utilising light energy and releasing oxygen is called **photosynthesis.** Plants produce food in the form of simple sugars *(carbohydrate).* In order for photosynthesis to occur, sunlight and chlorophyll must be present. The chemical reaction involved in photosynthesis is: $6CO_2 + 6H_2O$ *(+ light energy)* $\rightarrow C_6H_{12}O_6 + 6O_2$. This is the source of oxygen *(O_2)* that human and animals breathe.

- Photosynthesis and **respiration** are reversible chemical reactions, meaning that the products of one process are the exact reactants for the opposite process. Both are processes that involve electron transport chains and affect the concentrations of carbon dioxide and oxygen in the atmosphere. They are the main source of energy in all living things and hence provide power for different cellular activities.

- Below are the photosynthesis and respiration equations. The products from respiration, six carbon dioxide molecules and six water molecules are the exact reactants and the correct number of molecules to start the photosynthesis equation. This clearly demonstrates the balance of life on earth and the interdependence of all life on other organisms.

$$36\,ADP + 36\,P_i \longrightarrow 36\,ATP$$

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$$

$$\text{Glucose} + \text{Oxygen} \longrightarrow \text{Carbon dioxide} + \text{Water}$$

Equation 1) Cellular Respiration

$$6CO_2 + 12\,H_2O + \text{Light energy} \longrightarrow C_6H_{12}O_6 + 6H_2O + 6O_2$$

Equation 2) Photosynthesis

- The increase in atmospheric CO_2 levels resulting from fossil fuel combustion has a fertilizing effect on most plants since CO_2 is needed for photosynthesis (the biochemical mechanism of plant growth). Photosynthesis converts carbon dioxide and water into the simple sugar (glucose) and emits oxygen, making it possible for animals to live on Earth. **Sunlight** is the energy that powers this reaction.

- Extreme heat and extreme cold **temperatures** are not suitable for the photosynthesis process, because the photosynthetic reactions are controlled by the enzyme activity. Very high temperatures lead to denatured enzymes, which in turn leads to lowering of the rate of photosynthesis. The ideal temperature for enzyme activity ranges from

25°C to 35°C. Enzymes play an important role, as it is required in both stages of photosynthesis.

- If the concentration of CO_2 increases, the rate at which sugars are made by the light-independent reactions will also increase. The enzyme has a binding affinity for both CO_2 and oxygen in the presence of light in independent reactions. If the concentration of CO_2 is high, the enzyme has greater affinity to bind with CO_2, but if the CO_2 concentration is low, it will bind/fix oxygen instead. This phenomenon, called **photorespiration,** uses energy but does not make sugars.

- However, very high concentrations of CO_2 could be toxic to the plants. Generally, the increase in CO_2 concentration will make crops more productive, but the quality of the crops may be degraded.

MATERIALS NEEDED

- Oxygen-Carbon Dioxide Cycle Chart
- *Elodea* or other aquatic plant that does not have needle-like leaves
- Light source
- Bromothymol blue and drinking straws
- Five 25 ml graduated cylinders and rubber stoppers
- Flip charts and marker pens for presentation

PRESENTATION OF LESSON

Scenario

The teacher will show this phrase to the class *"Climate Change: a Mixed Blessing"* and will ask for the students to give their reactions and comments on this phrase. Based on their prior research activity, ask the students to identify the positive and negative effects of climate change particularly on the high concentration of carbon dioxide in the atmosphere and its impact on living things.

Ask the following guide questions:

1. Why do you say that "Climate Change is a Mixed Blessing"?
2. What are the positive effects of having a high concentration of CO_2 in the atmosphere on plants?
3. What are the negative effects of having a high concentration of CO_2 in the atmosphere on plants?
4. What is the effect of high concentration of CO_2 in the atmosphere on the rate of photosynthesis?

Student Activities

The students will demonstrate how photosynthesis and respiration work through a simple experiment. They will carefully read and follow the procedure based on the given *Student Worksheet*. Working together in groups, they will analyse the relationship between the processes of photosynthesis and respiration.

Process Guide for Teachers

1. After the brief discussion about the issue of "climate change and its mixed blessing" particularly on plants, conduct a short review about the nature and requirements of photosynthesis and respiration.

2. Prepare the class for the group activity. Divide the class into working groups and distribute the required materials and activity sheets. Brief the students about the proper handling of chemicals as a precaution. For this activity, students will use Bromothymol blue (BTB) as an indicator. This is a substance that changes colour as the pH of a solution changes. BTB stains hands and clothes hence, you must instruct the students to wear goggles and to follow the safety precautions when using the BTB solution.

3. The reactions for Step No. 5 as prescribed in the *Student Worksheet* ***(Attachment 1.1.1)*** will take place for twenty four (24) hours. Hence, ensure that you have prepared a ready set-up prior to this lesson activity so that the students can already make an observation during the activity.

4. Move from one group to another and observe how the students perform the experiment. Use a performance rubric to assess the level participation of each group in this activity.

5. After the laboratory work, instruct each group to prepare for a plenary presentation. Ask two to three representatives from each group to present the results of their investigation. At the end of all the presentations, discuss the chemical equations for both processes of photosynthesis and respiration.

6. Conduct a reflection of the students' learning experiences using the following guide questions;

   a. Which parts of the activity represent the processes of photosynthesis and respiration?

   b. What are the factors that affect the processes of photosynthesis and respiration?

   c. Explain why photosynthesis and respiration are called reversible chemical reactions.

d. What is the importance of maintaining balance on the amount of carbon dioxide and oxygen in the atmosphere particularly on living things and the ecosystem?

e. How does climate change affect the processes of photosynthesis and respiration?

f. What are some ways to mitigate the effect of climate change on biodiversity and ecosystem?

Achieving the Objectives

Objective	This is achieved by
Explain the relationship between the processes of photosynthesis and respiration.	Conducting an experiment about photosynthesis and respiration. Students' interaction during the activity proper and output presentation.
Explain the equation showing the opposite reaction in the photosynthesis and respiration.	Teacher and students' discussion and interaction based on the guide questions from the Students' Worksheet.
Cite the importance of interdependence of living things based on the oxygen-carbon dioxide cycle.	Processing the learning experiences of the students during and after the experiment on photosynthesis and respiration.
Explain the factors which can be attributed to climate change that affect photosynthesis process.	Students' interaction and discussion ideas about photosynthesis in relation to climate change after the group presentation.
Cite ways to mitigate the effect of climate change to biodiversity and ecosystem.	Integrating the overall learning experiences of the students in relation to climate change mitigation and adaptation.

Assessment

- Skills assessment will be conducted during the performance of the assigned activity. The teacher will utilise a group performance rubric upon completion of their experiment and group presentation *(**Attachment 1.1.2**)*.

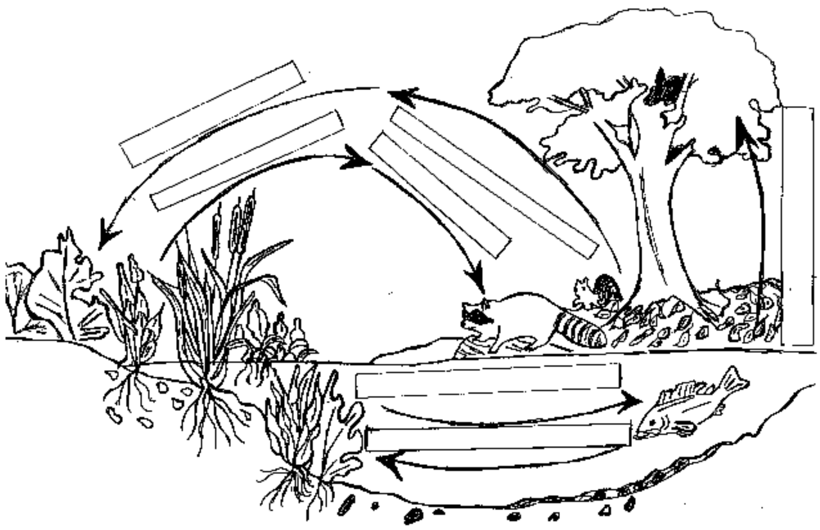
- The formative assessment will be done through a *"Picture Analysis"*. Ask the students to carefully read, analyse and fill in the correct information to complete the Carbon-Oxygen Cycle given in the figure below:

Carbon dioxide used by plants	Carbon dioxide given off by animals
Oxygen given off by plants	Oxygen used by animals

Oxygen from photosynthesis available to animals

Carbon dioxide from respiration available to plants

Carbon dioxide given off by decaying organic matter



Source:
http://www.esrl.noaa.gov/gmd/outreach/lesson_plans/The%20Carbon%20Dioxide-%20Oxygen%20Cycle.pdf

Closure Activity

1) Reiterate to the students the concept of exchange of gases and how humans and plants live together in a mutual relationship through the processes of photosynthesis and respiration. Also, connect these processes to climate change issues and mitigation measures. Say something like this:

    Without plants, humans would not have oxygen and without humans, plants would have no carbon dioxide. Through photosynthesis, plants produce food for themselves and other living organisms. When animals eat plants they too are eating the food that the plants produced.

    Climate is an integral part of ecosystems and organisms have adapted to their regional climate over time. Climatic factors affect plant and animal productivity and other ecosystem functions. The concentration of CO_2 in the atmosphere affects the rate and efficiencies of both photosynthesis and water use, thus can affect both the productivity of plants and other ecosystem processes. *Climate change* is a factor that has the potential to alter ecosystems and the many resources and services they provide to each other and to society.

    The effects of climate change on biodiversity are aggravated by the loss of forests, which serve as carbon sinks and watersheds. Trees need carbon dioxide to form chlorophyll. But, with half of the Earth's forests gone, this gas goes straight to the atmosphere.

2) Summarise the ideas of student about the mitigation measures that they can take which may include the following ways:

    "Keep plants in your home, and school to freshen the air. Plants absorb CO_2 and releases O_2. Include landscaping with native and indigenous plants; support organic farming; start urban farming; find your local watershed and woodland and adopt it; be involved in protecting and/or rehabilitating denuded forests and watershed; plant a tree at least once a year and regularly maintain it; give your family and friends the gift of planting a tree in their name; support local restaurants that use organically grown food derived less than 100 miles away and learn more about the benefits of eating locally…"(Earth Day Network Philippines, 2010)

Assignment

Option 1) Ask the students to conduct a research about *CO_2* fertilisation and will be guided by the following:

- Use a consequence map to show its advantages and disadvantages.
- Make a chart of the carbon-oxygen cycle using poster paper and coloured paper. Write a brief explanation about the carbon-oxygen cycle.

Option 2) Ask students to conduct a research project on "What are the implications to the ecosystem and biodiversity if photosynthesis advances or slows down?''.

RESOURCES

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Attachment 1.1.1
Student's Worksheet

DEMYSTIFYING THE RELATIONSHIP OF PHOTOSYNTHESIS AND RESPIRATION

Objectives

By the end of this activity, you will:

- demonstrate how photosynthesis and respiration work; and
- explain the relationship between the processes of photosynthesis and respiration.

Materials

- *Elodea* or other aquatic plant that does not have needle-like leaves
- Light source, Bromothymol Blue and drinking straws
- Five 25 ml Graduated Cylinders and rubber stoppers

Safety Precaution!

Bromothymol blue *(BTB)* is a substance that changes colour as the pH of a solution changes. *BTB* stains hands and clothes. Always wear goggles and follow the safety precautions when using the *BTB* solution.

Procedure

1. Mix two one (1) or two (2) drops of bromothymol blue to 15ml of water in a 25 ml graduated cylinder. Using a drinking straw, gently blow into the graduated cylinder until the solution changes its colour to yellow.

2. Place a piece of *Elodea* in the 25ml graduated cylinder with the yellow solution and insert a cork stopper in the beak of the cylinder. Expose the cylinder to sunlight for twenty (20) minutes.

3. Using another cylinder, add 1-2 drops of bromothymol blue to water and gently blow with a straw until the solution changes its colour. Without *Elodea*, plug the top of the cylinder with a stopper and place it under the sunlight for 20 minutes.

4. Prepare another cylinder in the same manner as the previous one (Step 3), but do not expose it to sunlight. Wait for twenty (20) minutes.

5. Again, place an *Elodea* plant, bromothymol blue and water in the cylinder and leave it in a dark place for twenty four (24) hours. *Note:* Since the reactions for this procedure will take place for a while, your teacher will present to the class a ready set-up which was prepared a day before your activity so that you can already make your observations.

Guide Questions

1. What causes the change in colour after blowing into the solution?

____

2. What happens when the *Elodea* plant was placed in a yellow solution and also exposed to sunlight?

____

3. What happens when the *Elodea* plant and the yellow solution was left in the dark for twenty four (24) hours?

____

4. Which parts of the activity represent the photosynthesis and respiration processes? Why?

____

5. What factors both affect the processes of photosynthesis and respiration? How?

____

Attachment 1.1.2
Sample Performance Rubric

EXPERIMENT ON

PHOTOSYNTHESIS AND RESPIRATION

Area	Criteria for Assessment	Possible Points	Points Earned	Remarks
Data/Observations Recorded	• Variables are labelled • Measurements use appropriate units • Data/observations are logical and organised	30		
Analysis/ Conclusion	• Data support the conclusion • Conclusion addresses hypothesis • Analysis is logical • Includes possible sources of error • Includes ways to improve design	40		
Presentation	• Visual aid is logical and neat • Visuals are clearly displayed • All members participate in designing and/or conducting the experiment • All members participate in actual presentation • Shows good planning and organisation	30		

Lesson 2

CLIMATE CHANGE: THREAT TO BIODIVERSITY

GRADE LEVEL: High School

SUBJECTS: Biology/Environmental Science

TOPIC: Diversity and Stability of Ecological Community

PREREQUISITES

- Students should have prior knowledge on the components of an ecosystem and the different types of ecosystem.
- Student should also have prior knowledge about ecological population and communities.

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: At the end of this lesson, students should be able to:

- differentiate species diversity and stability;
- explain the changes that take place in an ecological community; and
- determine the factors that affect the diversity of species in a community.

Climate Change Objectives

- explain how climate change affects the diversity of species and the stability of an ecological community; and
- suggest ways to mitigate the impact of climate change on species' diversity and stability of an ecological community.

MAIN CONCEPTS AND SKILLS

- *Species diversity* refers to the total number of species of plants and animals in an ecological community. It is also known as "species richness".
- A *diverse community* is one having a large variety of organisms. Specific diversity is affected by several factors such as geological history, climatic stability, and productivity, diversity of resources, and predation and competition.
- *Stability* refers to the ability of a community to maintain its normal conditions despite changes in the conditions of the environment. It also includes the

ability of the organism to recover and return to its original condition after some disturbances. Stability is influenced by two factors: growth and reduction. *Growth factors* increase the population size while *reduction factors* decrease the population size.

- There are two kinds of extinction or disappearance of certain species: natural and human induced extinction. *Natural extinction* results from physical and biological changes in the environment. Physical changes are the effects of events such as natural calamities (earthquakes, volcanic eruptions, typhoons) or natural geological changes (gradual sinking of an island, gradual soil erosion). Biological changes may be the result of natural processes occurring among species like predation and competition.

- Rising temperatures over time can lead to an increase in dry, desert-like conditions, which will affect not only the survival of particular species, but also the natural resources they have adapted to use in their natural environment. Species are thus forced to move elsewhere to find places to live and food to eat.

MATERIALS NEEDED

- Pictures of forest and grassland ecosystems
- Locally produced video presentation on biodiversity
- Notebook for field investigation
- Hand lens and pen marker
- Flip chart/sheets for nature mapping

PRESENTATION OF LESSON

Scenario

Present a picture of a forest, grassland and desert ecosystems to the class. Allow students to visualise, imagine and briefly share their own personal experience (for e.g., hiking) in one of these ecosystems. Listen to individual stories and facilitate the class discussion using the following guide questions:

1. Have you ever hiked through a forest or grassland?
2. What did you observe during your hike?
3. How many organisms of plants and animals did you see during the hike?
4. How does the diversity of species in the forest or grassland affect the stability of the community?

Student Activities

Students will create a “Nature Map” by preparing an inventory of plants and animals living in the ecosystems around the school or the immediate community. The students will also create a “scrapbook” of the wildlife and habitats around the school or their immediate community.

Process Guide for Teachers

1. Conduct a short lecture about the biodiversity of your immediate community or your country. If the school has a provision for video presentation, allow the students to watch a locally produced video about the country’s biodiversity.

2. After the brief lecture or video presentation, divide the class into working groups. Explain to the class that they will conduct a field investigation. Each group will prepare a “nature map” of the school-community which contains a list of plants and animals living in the ecosystem.

   Notes: The field observation and investigation will take one whole session. The teacher will have to decide on the format or template to be used for nature mapping.

3. Discuss something about Nature Mapping:

   > “Nature Mapping is a process of data collection about the number of animals that live in different areas. Using this data, interested individuals like scientists, environmental professionals and students can determine what animals are common and share the same habitats in an area. They can also see which places are more diverse, so that these areas can be protected” (Netting, 2007).

4. After the field work, instruct the students to prepare a poster showing the results of their nature mapping. The poster will be presented through gallery viewing. Ask the students to move around the class and observe the results of nature mapping. Instruct the students to take notes on diversity of species in the community and the factors that might affect the stability of the ecological community.

5. After the gallery viewing and class interaction, process the students’ learning experiences using guide questions below:

   a. What do you observe about the nature maps presented by all groups? Does your community have biodiversity? Why did you say that?

   b. What changes are taking place in your community which might affect the species diversity and community’s stability?

   c. What are the human-induced activities which contribute to the reduction and later on extinction of species?

d. How does species diversity affect ecological stability?

e. How does climate change affect the species diversity and ecological stability?

f. How can we mitigate the effects of climate change on biodiversity?

Achieving the Objectives

Objective	This is achieved by
Differentiate species diversity and stability.	Review of ecosystem and brief lecture on biodiversity; class discussion and students-teacher interaction on these two concepts.
Explain the changes that take place in an ecological community.	Nature mapping and class interaction between students and teacher.
Cite the factors that affect species diversity in a community.	Processing of students' learning experiences on nature mapping.
Explain how climate change affects species diversity and the stability of ecological community.	Students-teacher interaction and group discussion during the "gallery viewing of posters on nature maps".
Cite ways to mitigate the effect of climate change on species diversity and stability of ecological community.	Integrating students' learning experiences in real life; raising their awareness on climate change and its impact on diversity and stability of eco-communities; and, challenging them to act and be involved in climate change mitigation and adaptation.

Assessment

- This will be conducted during the performance of the assigned activity. The teacher will utilise a rubric to assess the presence of teamwork and cooperation among working groups and the quality of posters produced by each group *(See **Attachments 1.2.1 and 1.2.2**).*

- In a clean sheet of paper, the students will answer the following questions:

  1. What is the difference between species diversity and ecological stability?
  2. How do changes in the ecological community affect the species diversity and stability?

3. What factors affect the species diversity in a community?
4. How does climate change affect the species diversity in a community?
5. As a student, what common activities can you do to help mitigate the effects of climate change on biodiversity in your community?

Closure Activity

Identify which of the following human-induced activities are contributing to the extinction of some species in your community which in the long run will affect its biodiversity. Then, discuss briefly on what you can do to prevent the extinction of some species.

1. Destructing the natural ecosystems for the purpose of progress and development (e.g. conversion of rice fields into subdivisions)
2. Constructing dams which flood certain areas and drain others.
3. Polluting the air, water, and land.
4. Overgrazing of fields by livestock-raising.
5. Extinction of predators.

Assignment

1. Create a"“scrapbook” of the wildlife and their habitats around your community.
2. Conduct an “action research” on the endangered species in your country.
3. Draw a “before and after” scenario of your immediate community. Describe your community ten (10) years ago and at present. Highlight the plants and animals that were present ten years ago which are no longer around due to industrial progress and development.

RESOURCES

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Attachment 1.2.1
Teamwork and Cooperation Rubric

Criteria	4 points	3 points	2 points	1 points
Focus on Tasks **(25%)**	Stays on task all of the time without reminders.	Stays on task most of the time. Group members can count on this person.	Stays on task some of the time. Group members must sometimes remind this person to do the work.	Hardly ever stays on task. Lets others do the work.
Work Habits **(25%)**	Completes all assigned tasks and does not depend on others to do the work.	Completes most assigned tasks.	Does not follow through on most tasks and sometimes counts on others to do the work	Does not complete tasks. Depends on others to do all the tasks.
Group Interaction **(50%)**	Respectfully listens, discusses, asks questions and helps direct the group in solving problems or completing the tasks. Shares useful ideas for discussions. All information fits the group's goals	Respectfully listens, discusses and asks questions. Usually provides useful information and ideas for discussion.	Has trouble listening with respect, and takes over discussions without letting other people have a turn. Sometimes does not interact with the group. Sometimes provides useful information and ideas for discussion.	Does not listen with respect, argues with teammates, and does not consider other ideas. Blocks the group from reaching agreement. Almost never provides useful information or ideas for discussion.

Attachment 1.2.2
Poster Rubric

Group Name ____

CATEGORY	4	3	2	1
Required Elements	The poster includes all required elements as well as additional information.	All required elements are included in the poster.	All but one of the required elements are included in the poster.	Several required elements were missing.
Labels	All items of importance on the poster are clearly labelled that can be read from at least one metre away.	Almost all items of importance on the poster are clearly labelled that can be read from at least one metre away.	Many items of importance on the poster are clearly labelled that can be read from at least one metre away.	Labels are too small to view OR no important items were labelled.
Relevance of Graphics	All graphics are related to the topic and make it easier to understand. All borrowed graphics have a source citation.	All graphics are related to the topic and most are easy to understand. Some borrowed graphics have a source citation.	All graphics relate to the topic. One or two borrowed graphics have a source citation.	Graphics do not relate to the topic OR several borrowed graphics do not have a source citation.
Attractiveness	The poster is exceptionally attractive in terms of design, layout, and neatness.	The poster is attractive in terms of design, layout and neatness.	The poster is acceptably attractive though it may be a bit messy.	The poster is distractingly messy or very poorly designed. It is not attractive.
Grammar	There are no grammatical/ mechanical mistakes in the poster.	There are 1-2 grammatical/ mechanical mistakes in the poster.	There are 3-4 grammatical/ mechanical mistakes in the poster.	There are more than 4 grammatical/ mechanical mistakes in the poster.

Source:
http://www.teacherweb.com/ME/JALeonardMiddleSchoolOldTown/Ecologywebquest/page3.htm,2003-07-28

Lesson 3

INTERESTING INSECTS

(Effect of Temperature on Insect Behaviour)

GRADE LEVEL: High School

SUBJECT: Biology

TOPIC: Organisation in Living Systems, Phylum Arthropod, Class Insecta

PREREQUISITE

- Students should have prior knowledge about the biological classification of organisms.

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: At the end of this lesson, the students should be able to:

- identify the characteristics of arthropods; and
- describe the effects of temperature on cold-blooded insects.

Climate Change Objectives

- describe the effect of higher temperature on the behaviour, distribution, development, survival, and reproduction of insects;
- explain the effect of climate change on biodiversity; and
- cite practical measures to help farmers reduce the potential impacts of global warming on agricultural crops and pest infestation.

MAIN CONCEPTS AND SKILLS

- **Arthropods** include insects, spiders and other arachnids, crustaceans (such as lobsters), millipedes, centipedes and other animals with exoskeletons. Other than exoskeleton, segmented body and multiple pairs of legs, the general characteristics of arthropods include the dorsal heart, hemocoelic body cavity and a nervous system comprising of the dorsal brain and ventral nerve chord. On the basis of the physical characteristics of arthropods, they can be divided into five major classes - *Arachnida, Crustacea, Diplopoda, Chilopoda, and Hexapoda.*

- **Insects** are cold-blooded organisms - the temperature of their bodies is approximately the same as that of the environment. Therefore, temperature is probably the single most important environmental factor influencing insect behaviour, distribution, development, survival, and reproduction.

- The body temperatures of insects are highly influenced by their environments. If the weather is warm, their body temperatures are warm. If the weather is cold, so are they. When their bodies become cold, they slow down and may even stop.

- Insect life stage predictions are most often calculated using accumulated degree days from a base temperature and biofix point. Some researchers believe that the effect of temperature on insects largely overwhelms the effects of other environmental factors (Bale et al., 2002).

- It has been estimated that with a 2^0C temperature increase insects might experience one to five additional life cycles per season (Yamamura & Kiritani, 1998). Other researchers have found that moisture and CO_2 effects on insects can be potentially important considerations in a global climate change setting. Climate change resulting in increased temperature could impact on crop pest and insect populations in several complex ways. Although some climate change temperature effects might tend to depress insect populations, most researchers seem to agree that warmer temperatures in temperate climates will result in more types and higher populations of insects.

- 15% - 20% of greenhouse gases (GHG) is generated from intensive use of agro chemicals (e.g., pesticides) and fertilisers and methane gas from livestock production. Using organic farming, farmers can help reduce the potential impacts of global warming on agricultural crops and pest/insect infestation.

MATERIALS NEEDED

- News article about insect infestation in farms *(preferably the news articles should be sourced from a local news paper or magazines)*
- Insect net, tall clear plastic cup, thermometer, mesh
- Paper and pencil

PRESENTATION OF THE LESSON

Scenario

Distribute copies of the news article about insect infestation in a farming community. Provide ample time for the students to read and understand the article. Facilitate the class discussion based on the following guide questions:

1. What facts in this article caught your attention?
2. What causes the insect infestation?

3. What factors have contributed to increase the population of insects that attacked the farm crops?
4. How does the insect's behaviour relate to the environment in which it lives?

Student Activities

Students will carry out an experiment to study the "insect response (behaviour) to a certain stimuli". Based on the given *Student Worksheet,* they will investigate the possible effects of temperature on cold-blooded insects like a "bug" *(See **Attachment 1.3.1**).*

Process Guide for Teachers

1. Use the class discussion on the news article as a spring board to explain the nature and characteristics of the "phylum arthropods".
2. Divide the class into working groups. Give each group a set of materials and a worksheet for the experiment. Provide precautionary measures particularly in the proper handling of insects.
3. Also, explain the difference between temperature maintenance in warm- versus cold-blooded organisms.
4. In groups, ask the students to design and perform a short activity about the effect of temperature on cold-blooded insects. *Refer to the Student's Worksheet.*
5. Monitor the students while working in groups and assess their level of participation using a performance rubric.
6. Upon completion of the assigned tasks, give time for each group to present the results of their experiment.
7. Debrief the learning experiences of the students using the following guide questions:
    a. How does the temperature of the environment affect the behaviour of arthropods such as insects?
    b. What is the difference between warm-blooded and cold-blooded organisms?
    c. Does temperature affect the population growth of organisms?
    d. What other stimulus may affect the behaviour of insects?
    e. How does an extreme change in the global temperature (brought about by climate change) affect the population of insects and other organisms?

8. What are the effects of the change in insect population in your community's biodiversity?
9. As a responsible student and citizen, what common activities can you do to help mitigate the effects of climate change on crop pest/insects in your community?

Achieving the Objectives

Objective	This is achieved by
Identify the characteristics of arthropods.	Class discussion on news article on insect infestation and brief lecture on arthropods.
Describe the effects of temperature on cold-blooded insects.	Conducting a simple experiment (hands-on activity) on cold-blooded insects.
Describe the effect of higher temperature on the behaviour of insects.	Group presentation of outputs; Students and teacher interaction on climate change impact on biodiversity.
Explain the effect of climate change on biodiversity.	Processing students' learning experiences through integration of climate change impact on phylum arthropods' population growth.
Cite practical measures to help farmers reduce the potential impacts of global warming on agricultural crops and pest infestation.	Encouraging students to think of possible measures to help farmers mitigate climate change impact on proliferation of unwanted or harmful insects (e.g., organic farming to protect crops from insect infestation)

Assessment

Arthropods Quiz: Fill-in the missing word to complete each sentence.

1. Arthropods are _________________.
2. Certain types of ________________include exoskeletons.
3. Arthropods have ________________bodies.
4. Arthropods have ___________pairs of legs.
5. Arthropods have ___________that pumps blood through the whole body.
6. Insects are cold-blooded organisms, the ____________of their bodies are approximately the same as that of the environment.

Answer Key: 1. crustaceans
2. arthropods

3. segmented
4. multiple
5. hearts
6. temperatures

Thought Questions for Today

- How does the insect's behaviour relate to the environment in which it lives?
- Does climate change (rise in temperature) also affect the population growth of insects? What can farmers do to mitigate the impact of climate change on crop pest and insect infestation?

Closure

Discuss how the rising temperature affects the behaviour of insects. Read the news article in ***Attachment 1.3.2***. Tell them that "climate change resulting in increased temperature could impact on crop pest (insect) populations because warmer temperatures in climates will result in more types and higher populations of insects."

Farmers can adopt a number of strategies to reduce the potential negative impacts and to take advantage of possible benefits of global warming such as the following: *(*Source:http://www.climatehotmap.org/impacts/agriculture.html)

- change sowing dates to exploit a lengthening of the growing seasons and to avoid excessive heat stress during dry season (summer);
- adopt different cropping systems that take advantage of warmer climates;
- adopt new crop varieties better suited to warmer temperatures, increased water stresses, etc., as they become available through either genetic engineering or standard plant breeding techniques;
- increase the use of conservation tillage to better retain soil organic matter during high temperatures and increased flooding;
- implement the use of short-term climate prediction to reduce losses due to weather variability.

Assignment

Option 1) Interview some farmers about their observations on the behaviour of insects when the temperature in the farm is high. Determine how this impact to their crops or animals and what practical and simple measures they adopt in mitigating climate change.

Option 2) Based on what you have learned about the behaviour of insects on increasing temperature, design an experiment to show the effects of another stimulus on the behaviour of insects.

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Attachment 1.3.1
Student's Worksheet

A COLD-BLOODED BUG's LIFE

Objective

By the end of this activity, you will describe the effect of temperature on a cold-blooded insect like a bug.

Materials

- Insect net, tall clear plastic cup, thermometer, mesh (plastic lid), paper pen and pencil

Procedure

1. Catch a "bug" using the insect net.
2. Place the insect in a tall clear plastic cup. Place a thermometer in the cup, and cover the cup with mesh.
3. Record the temperature, and observe the movement of the insect.
4. Place the cup inside the refrigerator until the thermometer reads at five degrees Celsius. Observe the behaviour of the "bug". Has the insect changed?
5. Repeat the entire process at a temperature of 10^0C.
6. Place the insect back into its home environment.
7. Take out the cover mesh (plastic lid). Observe how long it takes for the insect to leave the cup.

Guide Questions

- Based on the activity, do bugs like a hot or cold environment?
- How does the temperature of the environment affect the behaviour of the "bug"?

Attachment 1.3.2
Sample News Article

Black bugs attack Albay rice farms
By Mar S. Arguelles, Rey M. Nasol
Philippine Daily Inquirer
September 30, 2010

LEGAZPI CITY, Philippines -- Black bugs have already destroyed rice plants in close to a thousand hectares of farm lands in Albay, causing an estimated damage of P16.7 million, the Provincial Agriculture Office said Thursday.

Ruben Limos, PAO chief, said the rice black bug (*Scotinophara coarctata*) is a sap-feeding insect and is one of the most difficult agricultural pests to eradicate.

Locally known as “itim na atangya,” the rice black bug (RBB) attacks rice plants in irrigated areas at almost all stages of the plants' growth, particularly from maximum tillering to ripening stage.

The insect infests the base stem of a rice plant, drains it of sap and causes it to eventually wither (bug burn) and die.

He said they were continuously assessing the extent of damage brought by the RBB in areas affected and they are conducting continuous information drive on RBB management.

He said they had already distributed metharhizium anasopliae, a biological control insecticide, to stop the spread of the pest.

Albay Gov. Joey Salceda said the province's food security program is being threatened by the pest infestation, which he said is presently destroying 975 hectares of rice lands in the towns of Guinobatan, Oas and Polangui and in Ligao City in the third district, considered as the rice granary of the province.

Salceda in a text message said, “It’s the first major incident of that magnitude in my memory, being a 49-year-old resident of Polangui where the black bug infestations are completely colossal. All signs lead to El Niño and climate change as the culprits.”

He said he had asked the Department of Agriculture for assistance and directed the Albay Public Safety and Emergency and Management Office and the Provincial Agriculture Services Office to draw up emergency measures to curb the negative effects of the pest infestation in the province's agriculture sector.

The RBB infestation was first reported in April this year, with close to 1,000 hectares of rice lands affected in 48 villages from two towns and a city in the third district of the province.

Limos said the RBBs are fast affecting the rice farms during the night, especially when the moon is out.

"They also travel during the night, following the lights of trucks, sea craft and the moon; that is why they have reached us here although these pests came from the southern provinces of the Philippines," he said.

Limos said RBB prefers marshy and wetland environments. The main habitat of this pest is the base of the rice plant.

“Also, the bugs can live on the leaves of other plants like taro, corn and weeds. At daytime, RBBs can be seen at the base of the plant and move up to the panicle at night,” he added.

Limos said he would recommend the declaration of a state of calamity in the affected towns, depending on the extent of damages to the areas under investigation.

Meanwhile, the DA Bicol office reported that aside from Albay, the RBB has also attacked the provinces of Camarines Sur, Sorsogon and Catanduanes.

CHAPTER II:
Climate Change and FRESHWATER RESOURCES

[SEAMEO SEAMOLEC and SEAMEO RECSAM]

What Are Freshwater Resources?

When we say freshwater resources, we mean two things: groundwater and surface water (***Figure 2.1***). Groundwater consists of aquifers and underground streams which give us fresh water to drink and to grow our crops and animals. People living in the desert and urban areas rely mainly on the groundwater as their only source of freshwater (Stone, n.d.). Freshwater supplies water for drinking, agriculture, sanitation, transport and many others.

Freshwater also creates ecological or environmental area for a various range of animals and plants in all over the worlds. Major facts of freshwater nowadays are as follows (Hinrichsen, Robey & Upadhyay, 1998).

- Around 70% of the Earth's surface is covered with oceans and account for 97% of its water.
- Approximately 3% of all water on Earth is fresh water and most of it is frozen in the polar ice caps.
- Only about 1% of all water found on this planet is easily accessible for human use.

Surface water, on the other hand, consists of rivers, lakes, streams, wetland, ponds, etc. Lakes and rivers provide habitat for all the plants, fishes, and other organisms that live in them.

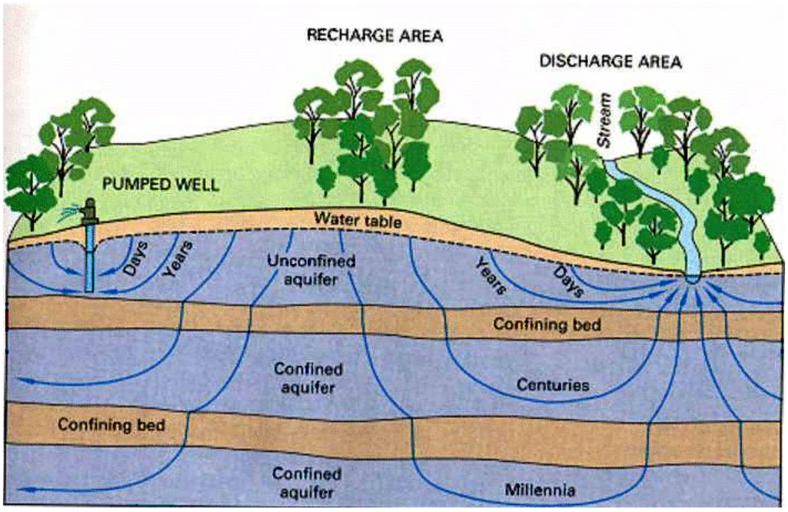

Figure 2.1 Groundwater and surface water
Source: Wikipedia (2010)

A very significant freshwater resource in Southeast Asia is the Mekong River. It provides food and income to millions of peoples from China, Myanmar, Laos, Thailand, Cambodia, and Vietnam (International Rivers, n.d.). The Mekong River is home to giant fishes, like the giant freshwater stingray ***(Figure 2.2)*** and the Mekong giant catfish ***(Figure 2.3)***.

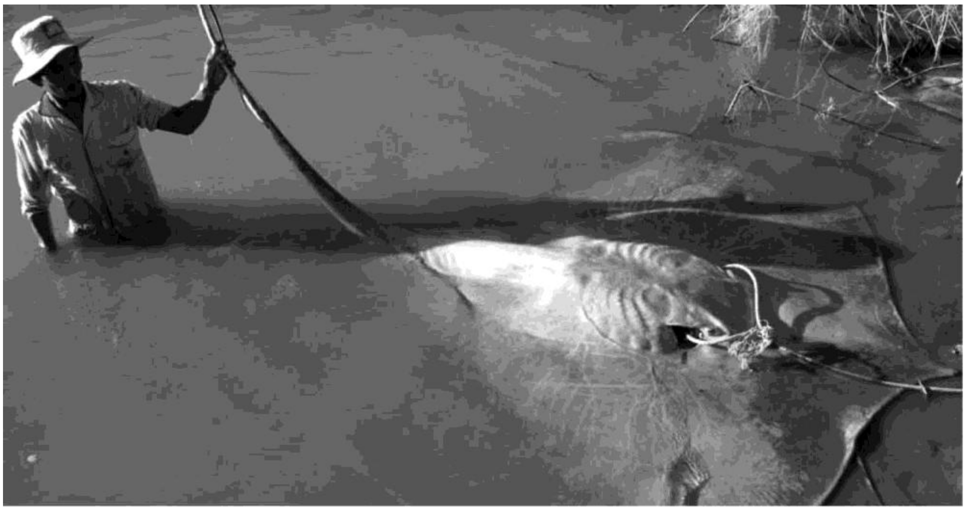

Figure 2.2. Giant fresh water stingray. (Maximum Size: 600kg, 500cm length, 240cm disc width)
Source: Hogan (2010)

Figure 2.3 Giant catfish in Mekong river (Maximum size: 300kg, 300cm)
Source: Kritsanavarin (2005)

How Does Climate Change Affect Our Freshwater Resources?

Drought

Less water. As the temperature gets warmer, the productivity of our freshwater resources will likely be reduced. When drought occurs, we will have lesser drinking water supply (***Figure 2.4***). Water in the lakes and rivers will be warmer and endanger the lives of the fishes and the plants with which they feed on.

Decreased water oxygen. The rise in water temperatures corresponding increases microbial populations in water, which negatively affects to all life forms. More microbes in the water means lesser dissolved oxygen. When water warms, its ability to hold oxygen decreases (Curseu, Popa & Sirbu, 2009). Decreased oxygen in water endangers the lives of fishes and freshwater plants.

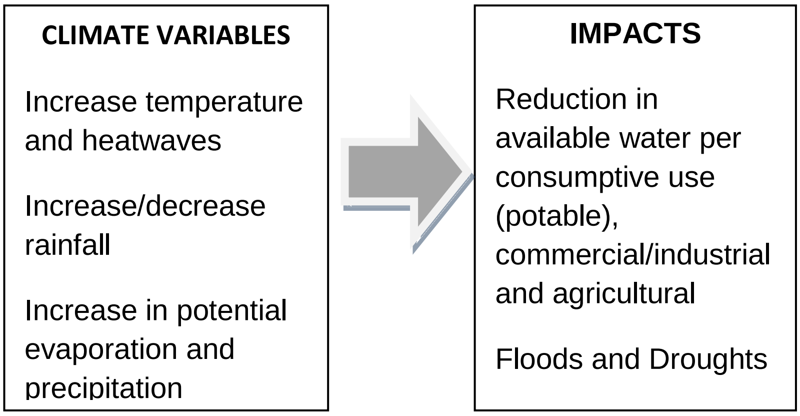

Figure 2.4 Impact of Changes in Climatic Variables to Water in Major SEA Countries

Fishes and plants die. Warm water temperatures affect fishes because they do not have the ability to adjust their bodies to external temperature like humans do, any sharp increase or decrease in water temperature will either kill them or push them to look for other lakes with temperatures more suitable for them. This is currently happening in the Mekong Delta. A number of fishes have not been seen in recent years because of the increase in temperature. As fishes disappear, farmers's income will correspondingly decrease.

Figure 2.5 Jakarta Floods 2007
Source: Flickr.com (n.d.)

Flooding

Contaminated water. On the other hand, flooding can contaminate our drinking water supply because of the microbes (Curseu et al., 2009) and other pollutants it brings. These are mixed into our public water supply (MSDH, n.d.). When we drink polluted water, we are prone to intestinal infections.

Flooding occurred in Indonesia on February 2, 2007 (***Figure 2.5***). This affected 80 districts (WHO, 2007).

What Can We Do To Save Our Freshwater Resources?

Educating people. To strengthen the desire of people to preserve their environments, habitats and ecosystems from destructive actions, they would need to be exposed constantly with lessons which explain or remind them of interconnectedness of human based activities with the environment and its vulnerability to climate change.

Expectedly, with critical and participative environmental education actions, tackling cross-sectoral and interdisciplinary subjects can motivate a responsible attitude in young people with regard to face the global socio-environmental challenges (The Charter of Human Responsibilities, 2010).

Developing Policies. At the regional level, Southeast Asian countries can join together in protecting our freshwater resources by developing and strictly implementing the following sustainable land and water policies:

- Implementing reforestation of mountains and along rivers, lakes and all water bodies
- Promoting the use of organic fertilisers to reduce use of harmful substances in the farms
- Practising proper solid waste management
- Banning the use of harmful and/or poisonous substances to catch fish
- Regulating the permits to extract ground water with the use of electric pumps
- Collecting rain water and storing this for multiple purposes (industry, agriculture, etc.)

Other measures to mitigate the impacts of climate changes on the availability of fresh water (Wilk & Wittgren, 2009) include:

1. Increasing water supply by:
    - expanding rainwater collection system and filter it to provide water and groundwater recharge
    - building water storage facilities

2. Increasing water-use efficiency and decreasing demand by:
    - water recycling to improve water-use efficiency
    - spreading of drought-resistant crops
    - improving irrigated agriculture management (e.g., changing the cropping calendar, irrigation method, crop mix, repair and maintenance of irrigation infrastructure, etc)
    - providing benefits and/or economic incentives to encourage water conservation
    - improving urban water and sanitation infrastructure

3. Improving flood protection by:

    - restoring and maintaining wetlands
    - improving flood forecasting
    - expanding river areas
    - constructing flood protection infrastructure

4. Reducing pollution reduction by:

    - using renewable and/or alternative energy sources that are environmentally friendly (e.g. use of biofuel);
    - recycling all materials that can be reused;
    - Conserving energy and contributing to keep the air clean (not using aerosol sprays, putting off equipment like computers when not using them etc).

5. Applying integrated and holistic watershed management system by:

    - developing springs (accumulate the flowing water underground to protect it from surface contamination)
    - implementing integrated and appropriate land use planning
    - implementing appropriate conservation techniques (terracing, mulching, ridge, furrow planting, and contour planting);
    - implementing conservation farming systems (strip cropping, multiple crops farming systems including fish and/or livestock);
    - employing proper soil management techniques (contour planting, contour tillage);
    - building grass waterways, drainage ditch, diversion ditch, efficient irrigation systems and building of check dams/water entrapment structures at proper sites.

Conclusion

Conserving the security of water resources is a primary issue for the Southeast Asian countries especially for the rural population. Climate change has worsened and accelerated water shortage by extreme events such as droughts which threaten food security and extreme rainfall conditions which cause flooding.

Some regions relying on limited groundwater and rainfall collection have already encountered water stress. To handle water stress, Southeast Asian countries need to aggressively restore groundwater and surface water resources. This can be done by continuously educating communities to enable them to fully understand the impacts of climate change.

Education cannot stand alone. Southeast Asian countries must develop and implement policies on sustainable management and rehabilitation of freshwater resources. Strict implementation of these policies will ensure sustainable freshwater supply for all the countries of Southeast Asia.

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Lesson 1

THIRST FOR MORE!

(Impact of Climate Change on Freshwater Availability and Accessibility)

GRADE LEVEL: Second Year High School (14-16 years old)

SUBJECT: Mathematics

TOPIC: Direct and Inverse Variations

PREREQUISITE

Students should have enough background on linear equations and quadratic equations and prior knowledge on linear relationships and ratios.

DURATION: 1 session

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this lesson, the students should be able to:

- differentiate direct variation from inverse variation;
- solve problems on direct and inverse variations; and
- determine relationships that exist between the following paired quantities:
  - temperature level and amount of available freshwater resources
  - amount of precipitation and the amount of water supplies in a certain area

Climate Change Objectives

- explain how climate change affects water resources in terms of quality, quantity and availability; and
- identify ways and means on how to help save water especially during dry seasons.

MAIN CONCEPTS AND SKILLS

- Direct variation is a relationship of two quantities *x* and *y* such that *y* varies directly as *x*. In symbol, $y = kx$, where *k* is the constant of variation
- Inverse variation is a relationship between two quantities *x* and *y* such that *y* varies inversely as *x*. In symbol, y= k/x where *k* is the constant of variation.
- The higher the temperature, the greater the amount of water that is lost from the earth's surface and returned to the atmosphere through evaporation and transpiration, collectively known as ***evapotranspiration.***

- Climate change will lead to more precipitation but could also lead to more evaporation.
- Precipitation greatly influences the amount of water flowing through the water cycle and, consequently, water availability. Changes in rainfall patterns are likely to lead to severe water shortage and/or flooding. Generally, the higher the precipitation, the more water is available. On the other hand, low precipitation and drought reduce water supply.
- The relationship existing between variables can be better understood by differentiating inverse variation from direct variation
- The analysis and proper interpretation of data on water consumption could help raise the awareness of the local community on the current state of freshwater resources in the community.
- There are various ways and means to help save water.

MATERIALS NEEDED

- Pictures of dams during rainy season and during dry season, pictures showing flood and drought
- Local data on water consumption per household for a year
- Water bill per student, if available and worksheets

PRESENTATION OF THE LESSON

Scenario

The teacher will show two main pictures. The first is a picture showing a dam during rainy season where the water level is at its maximum. Then show another picture showing the same dam but during dry season or during drought where the water level is very low. In addition, the teacher will show new set of pictures depicting flood and drought. After posting the pictures, the students will be asked to answer the following:

1. What facts do we know about the first picture? The second and third pictures?
2. What seems to be the main difference from the three pictures? What is common?
3. What do you think are some factors that cause the water level of the dam to decrease?
4. What will happen to the water level in the dam as the number of days without rain increases?
5. What do you observe during a drought?

6. What do you think will happen to the quality of water when there is flood in the area?
7. Can you give some phenomena where you can point out some of its possible causes?

Discussion Notes

- The countries in Southeast Asia are already facing water stress, and most areas in this region are often dependent upon limited groundwater and rainfall collection. Climate change will further aggravate water shortage by extreme events such as droughts which undermine food security, or extreme rainfall events which increase the risk of flooding.

8. Identify two quantities showing the following relationships:
   a. When one increases, the other also increases.
   b. When one decreases, the other increases.

Student Activities

There are many things in the real world that may vary or change which depend on its relationship to other things. In Mathematics we call this variation. In this lesson, the students will undergo three group activities to gain better understanding and appreciation of direct and inverse variations. First, they will analyse the water consumption of their family using their monthly water bills. Secondly, they will determine the amount of water usage of a certain population (community) and, lastly, the water levels of a certain dam after 24 days of drought. In each of the activities, they will describe the relationships of the two variables using the equation form and by graph. They will analyse the constant of variation *k* in each of the activities. The students' worksheet will be provided to guide the students. ***(See Attachment 2.1.1)***

Process Guide for the Teacher

a. Assign two or three groups to present and discuss their answers together with the rest of the class for 3 minutes per group.
b. Discuss some other relationships of two quantities showing direct variation and inverse variation.
c. Provide coaching to students in determining the constant of variation *k* in each of the activities.
d. Allow each group to present the results of the activity. They will also discuss their answers to the guide questions as provided on the students' worksheet.

e. Facilitate the class discussion by asking a few more questions that will help them connect the concept of variation in relation to water consumption or water resource utilisation.

- Where does your community get your water supply for drinking? Do you think it will last for many more years?
- List down how you utilise your water and estimate the amount of water used in each using cubic meter.

f. In each activity, ask the students to identify the variables that show inverse relationship and variables that show direct relationship. Then show them how to solve for the constant of variation.

Example of Direct Variation: Activity 2

As *x* increases, the value of *y* also increases. To solve for the constant of variation: $k = \frac{y_2 - y_1}{x_2 - x_1}$

$$k = \frac{4800 - 3600}{4 - 3} = 1200$$

The equation is *y* = 1200*x*.

Example of Inverse Variation: Activity 3

As *x* increases, the value of *y* decreases. The product of x and y is a constant. To solve for the constant of variation: ***k = xy***

Thus, equation is $y = \frac{k}{x}$.

Therefore, the equation of the relationship of the water level (*y*) and the number of days (*x*) is given by the equation,

$$y = \frac{1152}{x}.$$

Achieving the Objectives

Objective	This is achieved by
To differentiate direct variation from inverse variation.	Students will analyse the water consumption of their family using the monthly water bills; they will determine the amount of water usage of a certain population and the water levels of a certain dam after 24 days of drought.
To solve problems on direct and inverse variations	Students will solve problems on variations by finding the constant of variation and writing the equation.

Objective	This is achieved by
To identify the kind of relationships existing between two quantities.	In Activities 1 & 2, they will describe the relationships of the two variables using the equation form and by graphing and finding the constant of variation *k*.
To identify ways and means on how to help save water especially during dry season.	Students will identify some water phenomena that affect its quality, quantity and accessibility. They will list down some of its possible causes and identify ways to use water wisely.

Assessment

Instruction: In each of the following,

1. Identify the kind of variation
2. Find the constant of variation
3. Write the equation representing the relationship of x and y
4. Fill up the remaining entries in each table:

a)

x	7	6	5		8
y	21	18	15	9	

b)

x	2	4	8	9	11
y	26	13	6.5		

5. Solve the following:

   a) If y varies as x, $y = 1$ when $x = 3$, and $y = 4$ when $x = 12$. Find y when x is 18.

b) If y varies inversely as the square of x and $y = 1$ when $x = 2$, and $y = 4$ when $x = 1$. Find x when y is 9.

Assignment

Identify some activities in your community that may help conserve water. Interview at least five (5) people and ask them some of the activities that they do to minimise shortage of potable water.

Closure Activity

- Provide a short summary of the lesson on variation by asking the students to differentiate inverse variation from direct variation. Make copies of ***Attachment 2.1.2*** for the students.
- Ask the students to make a poster that will help people to be aware of climate change and how it affects the quality, quantity, and accessibility of water supply. On their posters, they will list down some innovative activities that may minimise the impact of climate change on water quality, quantity and accessibility.

DISCUSSION POINTS

Impact of Climate Change on Quantity of Water

For many regions of the globe, future climate change will be characterised by less rainfall and increasing temperatures. This has severely reduced the availability of water for drinking, household use, agriculture, and industry. Unfortunately, many of these areas also include the world's poorest countries, which already struggle under existing water stress.

Impact of Climate Change on Quality of Water

Changes in the amounts or patterns of precipitation will change the route/residence time of water in the watershed, thereby affecting its quality. As a result, regardless of quantity, water could become unsuitable as a resource. Higher ocean levels will lead to salt water intrusion in groundwater supplies, threatening the quality and quantity of freshwater access to large populations.

Impact of Climate Change on Accessibility of Water

As water quantities and quality decrease, competition for available resources will intensify. Agriculture has always been the dominant end-use of diverted water; this will only intensify with increasing needs for irrigation brought on by higher temperatures and reduced precipitation, coupled with increasing populations. Meanwhile, demands of industry are expected to become a greater issue in the competition for dwindling resources, since industrial water supplies are generally extracted from groundwater. In the event of decreasing water tables, industrial needs will be forced to compete with agricultural and domestic water supply sources, and could lead to conflict.

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Attachment 2.1.1
Students' Worksheet

WATER METRICS

Activity 1: THE WATER BILLS

Instruction: Compare the water consumptions using the monthly water bills of your respective families. Record the average monthly consumption in cubic meters in each family and the number of members in the family using the following table:

	Family 1	*Family 2*	*Family 3*	*Family 4*	*Family 5*	*Family 6*
No. of Family Members						
Monthly water consumption in cubic meters *(m^3)*						

Guide Questions:

1. What do you notice about the monthly consumption and the number of members in the family?
2. Identify some reasons why there are some families with equal number of members but different amount of water consumption. List possible ways in which each family is using the water.
3. Graph the water consumption in relation to the number of members in the family. Describe the graph.
4. In general, how does the number of members in the family relate to the amount water consumption per month?

Activity 2: THE WATER USERS

Suppose that in a certain city, the following data is obtained showing its population in thousand and its corresponding amount of water usage, in cubic per meter per day.

Population in thousands (x)	3	4	7	12
Amount of potable water needed in cubic meters (m^3) per day (y)	3600	4800	8400	?

Guide Questions:

1. Describe the relationship of the two quantities *x* and *y* in words.
2. How much water is needed for twelve (12) thousand people?
3. Write the relationship of *x* and *y* in equation form.
4. Draw its graph. What do you observe about the graph as the values of *x* increases?
5. Using the graph, can you predict the amount of water needed in 20 years?

Activity 3: THE DAM LEVELS

Suppose that the following table shows the water levels of the dam as recorded in interval number of days during months of drought in 2010.

No of days from January 31, 2010 (*x*)	8	12	18	24
Water Level in Meters (*y*)	144	96	64	?

Guide Questions:

1. Describe the relationship of the two quantities *x* and *y* in words.
2. What is the water level after 24 days? Show your solution.
3. Write the relationship of *x* and *y* in equation form.
4. Draw the graph. What do you observe about the graph as the values of *x* become larger?

Attachment 2.1.2

THINGS I KNOW TO BE TRUE

(Direct and Inverse Variations)

Name ____ Date __________

- **These Things I Know to be True… about Direct Variations**

____

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- **These Things I Know to be True… about Inverse Variations**

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- **These Things I Know to be True… about Climate Change and its Impact on Water Resources**

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Lesson 2

FRESHWATER AT RISK!

(Impact of Climate Change on Water Quality)

GRADE LEVEL: High School (16-18 years old)

SUBJECT(S): Physical Science, Chemistry

TOPIC: Separating Mixtures

PREREQUISITE

- Students should have prior knowledge about the difference between elements, compound and mixture. They can differentiate a solute from a solvent.
- Before conducting this lesson, the teacher will collect freshwater samples from nearby water sources (e.g., river, stream and lake)

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objective: By the end of this lesson, students should be able to:

- describe and explain the different techniques in separating mixtures.
- cite the importance of these techniques in purifying water.

Climate Change Objectives

- explain how climate change affects the freshwater resources.
- demonstrate different measures to maintain quality of freshwater resources.

MAIN CONCEPTS AND SKILLS

- Water shortage is one of the effects of climate change. The distribution of precipitation in different areas will become very uneven, leading to tremendous disproportion in water supply.
- Climate change affects the rate of evaporation which impacts the amount of water available to replenish groundwater supplies. The combination of shorter duration but more intense rainfall (meaning more runoff and less infiltration) combined with increased "**evapotranspiration"** (the sum of evaporation and plant transpiration from the earth's land surface to atmosphere) and increased irrigation is expected to lead to groundwater depletion.
- Natural freshwater sources have very limited capacity to process the pollution coming from expanding urban, industrial and agricultural uses. In effect, the degradation of the quality of fresh water can be a major source of water shortage.

- Water quality degradation can be reduced through the separation of mixtures of nutrients, pathogens and pollutants that are present in a polluted or contaminated water.

- Students can create a model for separating mixtures using various techniques and thereby learn how to improve water quality.

MATERIALS NEEDED

- fresh water samples, filter paper, 100 ml beakers, evaporating dish, alcohol lamp
- funnel, iron ring with stand, glass tube, ethyl alcohol, stirring-rod, condenser
- simple distillation set-up, activated charcoal, student's worksheet
- surface run-off and infiltration poster (see Fig. A on page 72)

PRESENTATION OF LESSON

Scenario

The teacher will obtain a glass of tap water, show it to the class, and then ask the students the following questions.

1. What qualities do you expect in a drinking water?
2. Why is it important to have safe tap water?
3. What common problems do you observe from the sources of freshwater in our school, at home and in the community?
4. What causes the degradation of water quality?
5. How can we possibly eliminate the presence of contaminants in freshwater?

The teacher will take note of the responses to be given by the students on the board and summarise the discussion using these concepts:

1. Water quality refers to how appropriate a particular ecosystem's water is for some "use," whether biological or economic. Many fish species, for instance, have narrow habitat quality preferences for dissolved oxygen, water temperature, dissolved sediment, and acidity/pH. Humans generally avoid freshwater for drinking or cooking if it has excessive levels of dissolved minerals or has a very high or low acidity/pH.
2. Water is indispensable for all forms of life. It is needed in almost all human activities. Access to safe freshwater is now regarded as a universal human right and the Millennium Development Goals include the extended access to safe drinking water and sanitation.

3. Some of the common problems we have are: decreasing freshwater quality, contaminated drinking water, and freshwater scarcity.
4. Some reasons for the decline in water quality are: An increase in precipitation carries with it higher levels of nutrients, pathogens and pollutants. These contaminants were originally stored in the groundwater reserves but the increase in precipitation flushes them out into the discharged water. Water quality degradation can be a major cause of freshwater scarcity.
5. There are different methods that people can apply to separate the contaminants in water. Hence, this lesson focuses on knowing how to separate mixtures.

Student Activities

The students will use the different techniques in separating mixtures using the fresh water samples from the different bodies of water in the community. See student's worksheet ***(Attachment 2.2.1)*** for details. (*Note:* Use a group performance rubric to assess the groups' output)

- Each group will be given a chance to present their findings for class discussion.

Process Guide for Teachers

1. Conduct a brief explanation on the following techniques in separating mixtures.

- **Evaporation –** a process in which surface molecules in liquid phase becomes gas molecules *(water becomes water vapour).* The process takes place faster when heat is absorbed by the liquid molecules.

- **Filtration –** a process of separating the solid and liquid components of a mixture. This is accomplished by the use of porous medium of the desired porosity so that the solid or precipitate is retained in the porous medium while the liquid filtrate passes through the pores of the medium.

- **Decantation** - is a process for the separation of mixture. This is achieved by carefully pouring a solution from a container in order to leave the precipitate sediments at the bottom of the original container. A small amount of solution must be left in the container, and care must be taken to prevent a small amount of precipitate from flowing with the solution out of the container. It is generally used to separate a liquid from an insoluble solid.

- **Distillation –** the process of separating substances of different boiling points from one another by vapourisation and condensation, usually done to separate solute from solvent.

2. Present the freshwater samples collected from the different bodies of water in the nearby area.
3. Allow the students to observe the given water samples focusing on quality of water particularly the odour and appearance.
4. Distribute the student's worksheet and present the pre-cautionary measures in separating mixtures.
5. Divide the students into working groups to perform the different techniques in separating mixtures using the freshwater samples.
6. Supervise the students during the activity. Ask the group leaders to evaluate the performance of the members using a performance rubric.
7. After the group activity, the class will have a plenary presentation of the outputs. A representative from each group will present the results.
8. Lead the discussion to the answers given by the students at the start of the lesson. The focus of the discussion should be on water safety, water sources and the effects of climate change on water supply.

Guide Questions

a. What causes the shortage of freshwater supply?
b. How can the people mitigate the effects of climate change on freshwater resources?

Discussion Points

a. Changes in water supply include changes in precipitation, increased flooding, and sea-level rise, higher temperatures, due to global climate change, negatively impact the amount of total water in the hydrologic system and, thereof, reusable water. Evaporation, the process by which water goes into the air, is increasingly becoming a major factor in potable water loss. Simply, if water is not on the ground in liquid form it cannot be used for drinking. Its change affects freshwater quantity and quality with respect to both mean states and variability (e.g., water availability as well as floods and droughts).

b. Some of the approaches to mitigate the impact of climate change on the availability of fresh water.

- Increasing water supply and ecosystem services.
- Decreasing water demand and increasing use/efficiency.
- Improving flood protection.
- Reducing pollution using alternative, renewable, and environmentally friendly energy sources whenever possible, recycling all appropriate materials that can be reused, and conserving energy and taking steps to keep the air clean.

- Applying integrated and holistic watershed management system.

9. Present the surface run-off and infiltration poster to the class to guide them in understanding how climate change affects the supply of freshwater.

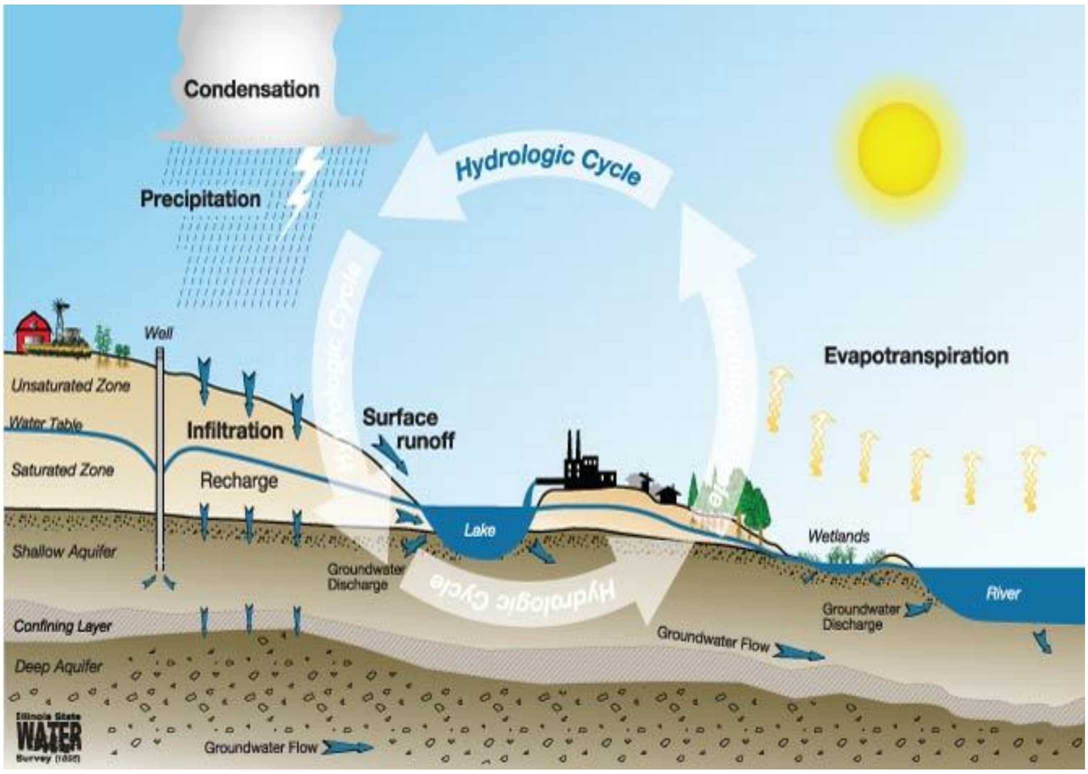


Figure A Surface Run-off and Infiltration Diagram
Source: http://www.isws.illinois.edu/docs/watercycle/images/hcycle.jpg

Discussion Notes

- Groundwater plays a central role in all the changes of the earth system and in the impacts of climate change on the various sectors of activity. This century, annual runoff and water availability are projected to increase at high latitudes by 10–30% but decrease by 10–30% at mid-latitudes and in the dry tropics.

- Drought-affected areas will likely increase in extent. Poor communities will be especially vulnerable because they are more dependent on climate-sensitive resources.

Achieving the Objectives

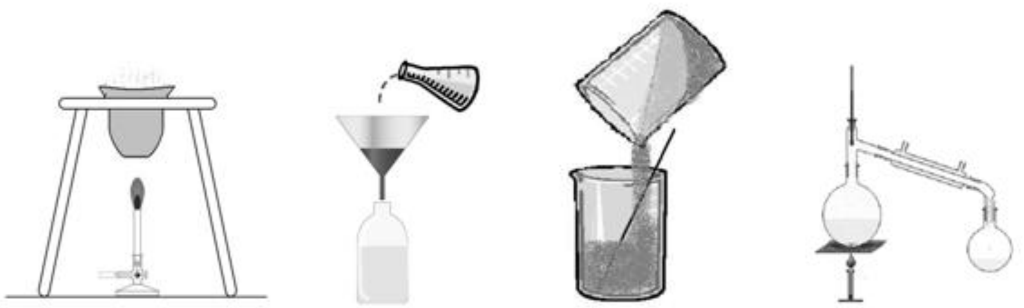
Objective	This is achieved by
Describe and explain different techniques in separating mixtures.	Students' interaction within the group during the conduct of the hands-on activity. Students' presentation of the different techniques in separating mixtures.
Cite the importance of these techniques in purifying water.	Students presenting their outputs in front of the class.
Explain how climate change affects the freshwater resources.	Sharing of students' experiences during the class discussion on shortage of freshwater supply and climate change.

Assessment

- Performance assessment: This will be conducted during the performance of the assigned activity. The teacher will utilise a performance rubric.

- Formative assessment: In a clean sheet of paper, the students will do the following:

a. Label each of the figures with the corresponding technique used. Describe and explain the physical properties illustrated by each technique:



1. Evaporation 2. Filtration 3. Decantation 4. Distillation

b. Write 3 measures that will help mitigate the effects of climate change on the quality of fresh water supply.

Closure Activity

To emphasise the key learning points, and as a means to check whether the students gave the correct answers on the assessment test, the teacher will pose the questions:

- How is drinking water treated to make it safe?
- Why is it important to maintain water quality at all times?
- In our own little way, how can we help in mitigating the effects of climate change on freshwater resources?

RESOURCES

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Attachment 2.2.1
Student's Worksheet

TECHNIQUES IN SEPARATING MIXTURES

- DECANTATION

  1) Allow the mixture to stand for sometime and wait for the sediments to settle. See ***Figure a***.
  2) Slowly pour the liquid into the other container.

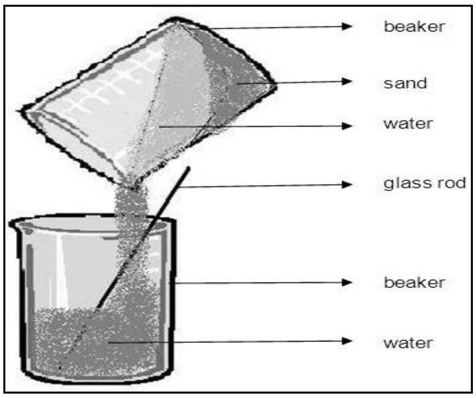


Figure a Decantation

- EVAPORATION

  1) Pour the sample mixture to the evaporating basin or beaker. See ***Figure b***.
  2) Heat the mixture until all the liquid components evaporate.

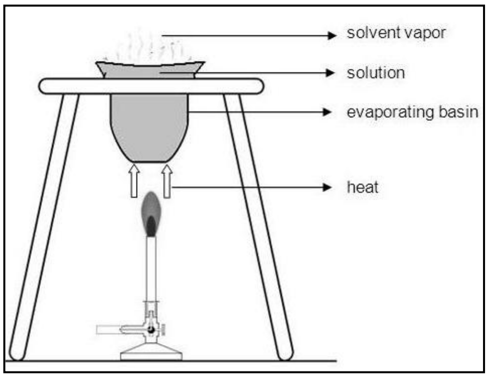


Figure b Evaporation
Source: Polimerek (2005)

- FILTRATION

  1) Set-up a funnel lined with filter paper on a stand. See ***Figure c***.
  2) Pour the mixture through the filter funnel. The filter will trap the insoluble substances. The liquid passes through the filter paper and collected in another container.

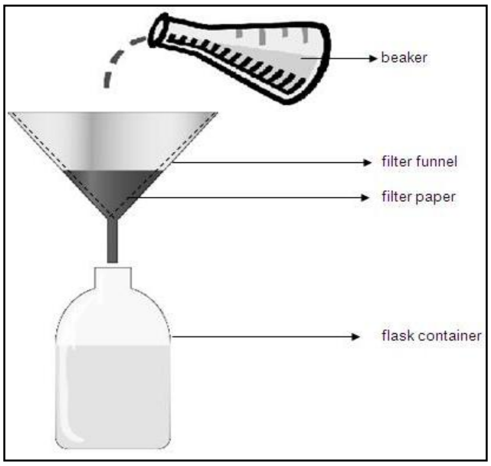


Figure c Filtration
Source: Chansigaud (2005)

3) Layers of gravel, sand, cotton wool and activated charcoal can also be used as the filter.

- SIMPLE DISTILLATION

1) Fill the distillation flask. See ***Figure d**.* The flask should be no more than two thirds full to have a sufficient clearance above the surface of the liquid so that when boiling commences the liquid is not propelled into the condenser.

2) Heat the distillation flask slowly until the liquid begins to boil. Vapours will begin to rise through the neck of the distillation flask. As the vapours pass through the condenser, they will condense and drip into the collection receiver.

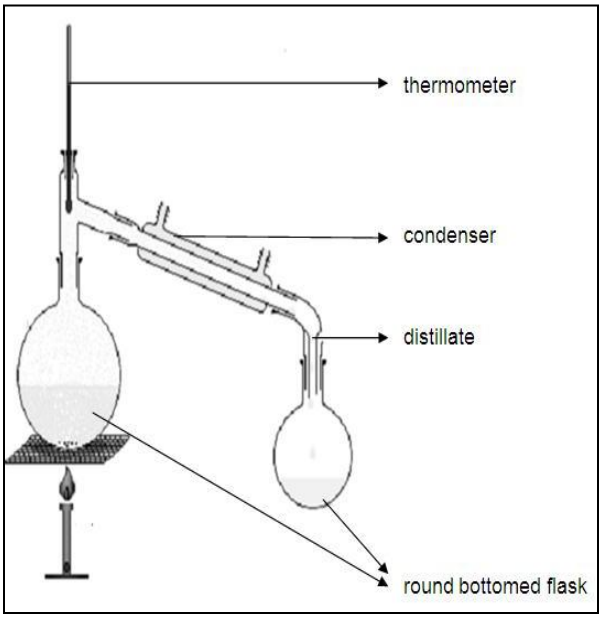


Figure d Sample distillation
Source: Padleckas (2005)

Lesson 3

WANTED: SAFE DRINKING WATER

(Impact of Climate Change on Water Quality)

GRADE LEVEL: High School (15-18 years old)

SUBJECT(S): Earth and Environmental Science

TOPIC: Groundwater and Aquifer

PREREQUISITE

- Students should have prior knowledge about the hydrologic cycle and the different processes involved in the cycle.

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this lesson, students should be able to:

- identify the major components of an aquifer
- discuss the movement of water through an aquifer
- explain how water storage in an aquifer changes over time

Climate Change Objectives

- appreciate the importance of water cycle on earth
- explain how climate change affects the freshwater resources
- demonstrate different measures to maintain quality of freshwater resources

MAIN CONCEPTS AND SKILLS

- Water permeates life on Earth. Water is essential as an enabler and sustainer both of life such as plants, animals, and humans, and of human civilization. One of the conclusions after NASA's Mission on Mars was the urgent need to pay increased interest on the importance of "water cycle for life on Earth" the only planet where water can exist in liquid form.

- An aquifer is an underground storage of water that people use as a fresh water drinking supply. The water in an aquifer is stored in geologic formations. Rocks which are porous can hold water much like a sponge holds water. Aquifers have different zones: for collecting water, for water entering the ground, and sometimes, for confining water.

- Ground water *is found in aquifers*. Aquifers can be either unconfined or confined. Unconfined (open) aquifers are "connected" to the surface above. Confined (closed) aquifers are sandwiched in between dense impermeable layers of earth material called an *aquiclude (aquitard)*. Ground *water is* replenished by percolation of water from the zone of aeration downward to the zone of saturation, or in the recharge zone of a confined aquifer.

- Aquifers replenish their supply of water very slowly. The rate of ground water flow depends on the permeability of the aquifer and the hydraulic gradient. *Permeability* is affected by the size and connectivity of pore spaces while hydraulic gradient is the difference in elevation between two points on the water table divided by the horizontal distance between them.

- Changes in precipitation, increased flooding, and sea-level rise could decrease *freshwater quality* and potentially *contaminate fresh water* (drinking water). Water quality degradation can be a major cause of freshwater scarcity.

- Longer periods of drought deplete groundwater reserves. The residual water that remains is often of inferior quality. Similarly the decrease precipitation and runoff results in a concentration of pollution in the water, which leads to an increased load of microbes in waterways and drinking-water reservoirs.

- Agricultural water use grew twice as rapidly as total water use and "there is widespread over-exploitation of aquifers from irrigation; and over irrigated agriculture are depleting groundwater resources beyond natural recharge rates in Asia and "competition for water resources is also acute".

- Environmental impacts of water pollution are predicted to increase in most trans-boundary water regions based on studies of *Global International Waters Assessment* (GIWA 2007). If this will continue, the world is threatened by a "hydrocide," a circumstance in which the water accessible in rivers is no longer fit for use. The Living Planet Index indicates that in a mere 30 years, aquatic ecosystems have lost 50% (largest) of their biodiversity.

- Disposal of wastewater, which is untreated in many parts of the world, has resulted in considerable negative impacts on aquatic ecosystems. A rapid industrial growth in semiarid regions (where the dilution effect is limited during the dry season) is particularly problematic because relatively large volumes of water are required, and the volume of effluents is correspondingly large.

MATERIALS NEEDED

- large plastic cup per group and measuring cup
- one (1) plastic cup of small gravel and 1 small cup of dry sand
- modelling clay and pitcher of water
- student's worksheet *(See **Attachment 2.3.1**)*, pictures of aquifer and permanent markers

PRESENTATION OF LESSON

Scenario

The teacher will ask the students: "*Why do people buy bottled water despite its relatively high cost compared to tap water?"*

Make a list of answers given by the students. Highlight the answers which are related to water quality and water safety. Then ask these follow up questions:

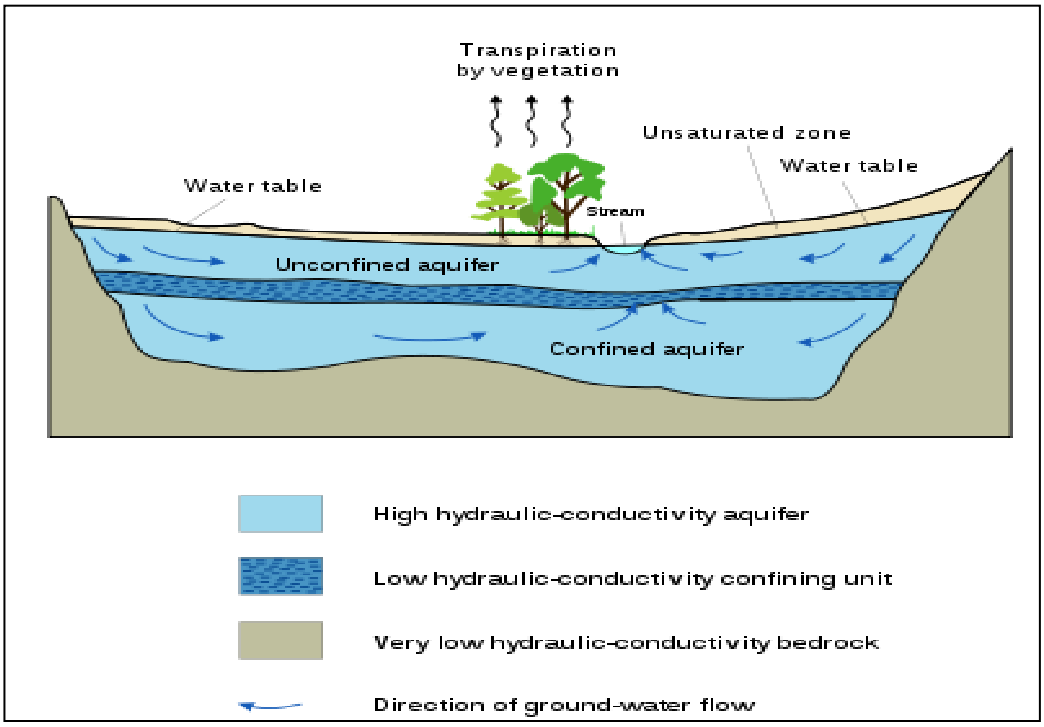
- Where does drinking water come from?
- What are the most common sources of drinking water?
- Do you think that our tap water is safe for drinking?

Students' Activities

The students will design a model that shows how an aquifer works using the given materials. Each group will conduct a gallery presentation and explain their aquifer model. The teacher will use a group performance rubric to assess their outputs. *(See **Attachment 2.3.2**)*

Process Guide for Teachers

1. Distribute pictures of a typical aquifer to the students. Ask them to study the sample picture below and analyse the direction of the groundwater flow.



Source: http://en.wikipedia.org/wiki/File:Aquifer_en.svg

2. Conduct a brief presentation about the different parts of an aquifer. Relate the discussion on the relevance of aquifer as a major source of groundwater/freshwater resources.

3. Divide the class into working groups and distribute the student's worksheets and other materials. Instruct the group to brainstorm on a model of aquifer out of the given materials. Ask the group to make a simple sketch of their model.

4. Before trying the actual model the group must present a sketch to their teacher for comment and advice.

5. After preparing the aquifer models, the class will conduct a gallery presentation. Each group will showcase their model aquifer. There should be at least two students per group who will act as the leaders of the group. The students will move around the class to observe the gallery and interact with their fellow students by giving feedback and/or ask for clarification about the model aquifer.

6. After the gallery viewing, convene the class into a single group and ask for student's reaction about the different models of aquifer. (*Note:* the teacher may use an Aquifer Model Rubric to grade the groups' output. *(See **Attachment 2.3.3**)*

   a. Which group has the best model of aquifer?

   b. Why did you say it is the best model?

   c. What components are present in the best model? What are missing from the rest of the models?

7. Process the students' learning experiences using the guide questions below:

   a. How does water move through an aquifer?

   b. How does an aquifer recharge its supply of water?

   c. Is there a possibility that aquifers may be contaminated?

   d. How can human activities seriously affect water quality in aquifers?

   e. How does the aquifer react to climatic changes?

   Discussion Notes:

   - Remember, everything (contaminants) that ends up on the ground could end up in your drinking water - so be careful!
   - Whatever products you use, follow the directions and dispose of leftovers properly.

Achieving the Objectives

Objective	This is achieved by
Identify the major components of an aquifer.	Class discussion about the components of aquifer.
Discuss the movement of water through an aquifer.	Creating/developing aquifer models.
Explain how water storage in an aquifer changes over time.	Student's interaction during the gallery presentation and processing of learning experiences.
Explain how climate change affects the freshwater resources.	Class interaction and processing of learning experiences.
Demonstrate different measures to maintain quality of freshwater resources.	Poster making about safe drinking water

Assessment

- Performance assessment: This will be conducted during the assigned group activity. The teacher will utilise the group performance and aquifer model rubric.
- Formative assessment (*Essay Questions):* In a clean sheet of paper, the students will answer the following questions:
  1. What are the major components of an aquifer?
  2. How does water move through an aquifer?
  3. What causes the depletion of groundwater in the aquifer?
  4. Cite at least two measures which can mitigate the effect of climate change on the quality of our drinking water.

Assignment

- Design a poster or project that will launch a campaign on safe drinking water and the protection of surface and ground water as a source of potable water for the community.

- Look through your home and garage or shed for the inescapable assortment of cans and bottles and boxes of leftover household cleaners, paints, stain removal products, and automotive fluids of all sorts. If used in any other way than for what they were intended, they are considered hazardous materials, and could harm our drinking water supply. Follow the directions and dispose them properly.

Closure Activity

- Using the aquifer models, present a simple demonstration about ground water contamination such as seepage of water contaminants coming from domestic and industrial sources.
- Search for the source of your home's drinking water. Then answer these questions.
    1. What type of water system services your home?
    2. What is the primary source of that water system?
    3. What can you say about the quality of that system's drinking water?

DISCUSSION POINTS

Adaptation and Mitigation to Climate Change

- Most climate change impacts will be hitting society through altered water-related phenomena. As such, water plays a crucial role in the adaptation efforts of the various socioeconomic sectors, in terms of managing altered water availability, altered water demands, and increased water variability. Increased rain variability is noted in many Southeast Asian countries and seen as one of the signs of ongoing climate change. Improved ability to cope with water variability will in fact be a key to successful adaptation to the unavoidable impacts of climate change.

- Some of the mitigation measures to save our freshwater resources that we can take are as follows:
    - Septic system maintenance
    - Proper contaminant disposal and improving waste disposal techniques
    - Private well monitoring
    - Planting trees and protecting watersheds
    - Wise gardening practices such as:
        - Using organic fertilisers that release nutrients slowly.
        - Skipping fertilising altogether, or apply smaller amounts throughout the year instead of one large application once a year.
        - Planting less lawn area and introduce more planting beds for trees, shrubs, groundcovers and/or perennials.

- Increasing the organic matter in your soil. This will help to hold water longer, reducing the need to water so frequently, which can lead to over watering and leaching. A rule of-thumb for watering is: ½ inch or less per hour to avoid runoff.
- Not using chemicals near open water such as streams, rivers or lakes.
- Reducing runoff to storm drains by not watering impermeable surfaces such as concrete, asphalt or compacted ground.
- Keeping your plants healthy and avoid by planting disease and pest resistant varieties.
- Using mulch or fabric covers to prevent weeds.
- Match plants with growing conditions by choosing plants adapted to this climate (i.e. 18"+ precipitation per year) and shade tolerant plants for shady areas.
- Using chemical methods as a last resort, and then choose the least toxic compounds such as horticultural oils, soaps and botanical insecticides.
- Installing drip irrigation to save water and save money.

➢ For the sake of our children and grandchildren, take sustainable development seriously, by calling the attention of all sectors on the following development policies.

- Pollution must be stopped to secure usable raw water sources and protect biodiversity of aquatic ecosystems, in the long term moving toward a water pollution veto.
- Awareness of depletive water use involved in plant production is essential, therefore water resources planning and management approaches need to incorporate green water resources (soil moisture) and green water use (evaporation).
- Groundwater has to be incorporated into water resources planning and management because of its link to river flow.
- Water conservation (e.g., fix leaking pipes or toilets right away, use a glass when brushing teeth instead of keeping the taps open)
- Water recycling (use treated wastewater for other uses such as flushing the toilets.
- Keep rivers, lakes, and seas clean and safe for humans and other organisms
- Promote sustainable use and protection of water resources to support continued food production and quality of life for humans, domestic animals, and wildlife through innovative approaches to assessing the

vulnerability of the environment to management practices that involve renewable resources considerations.

- Build stronger practical country-level NGO networks that represent the wider water sector.
- Promote greater accountability in the water sector institutions.

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Attachment 2.3.1
Student's Worksheet

THE MODEL AQUIFER

Objectives

By working in groups, you will:

- design a model of an aquifer using the given materials;
- discuss and share your ideas with the entire class during the gallery presentation.

Materials

- large plastic cup per group, measuring cup, 1 plastic cup of small gravel
- 1 small cup of dry sand, modelling clay, pitcher of water
- masking tape and permanent markers

Procedure

1. Brainstorm on how you can use the following materials to demonstrate how an aquifer works.
2. Draw a simple model of your aquifer. Include the appropriate labels.
3. Ask your teacher to check your model.
4. Execute your design using the given materials.
5. Prepare for a gallery presentation. Assign at least two students who will act as lead of your group. The assigned leader will explain to the audience how the model aquifer works.
6. After the gallery presentation, prepare for a plenary discussion.
7. At the end of the gallery presentation the class will select the best model.

Guide Questions

1. How does water move through an aquifer?
2. How does the aquifer recharge its supply of water?
3. Is there a possibility that aquifers may be contaminated?
4. What are the human activities that affect the quality of water in aquifers?
5. How does climate change affects the depleting groundwater in the aquifers?

Attachment 2.3.2

Group Performance Rubric

CRITERIA	4 points	3 points	2 points	1 point
Focus on the task	Stays on task all of the time without reminders.	Stays on task most of the time. Group members can count on this person.	Stays on task some of the time. Group members must at times remind this person to do the work.	Hardly ever stays on task. Let others do the work.
Work Habits	Completes assigned all tasks and does not depend on others to do the work.	Completes most assigned tasks.	Does not follow through on most tasks and counts on others to do the work.	Does not complete tasks. Depends on others to do all of the work.
Group interaction	Respectfully listens, discusses, asks questions and helps direct the group in solving problems or completing the tasks. Shares useful ideas for discussions. All information fits the group's goals.	Respectfully listens, Discusses, and asks questions. Usually provides useful information and ideas for discussion.	Has trouble listening with respect, and takes over discussions without letting other people have a turn. Sometimes does not interact with the group. Sometimes provides useful Information and ideas for discussion.	Does not listen with respect, argues with teammates, and does not consider other ideas. Blocks group from reaching agreement. Almost never provides useful information or ideas for discussion.

Attachment 2.3.3

Aquifer Model Rubric

CRITERIA	4 Excellent	3 Emerging	2 Developing	1 Needs Improvement
Design for aquifer meets these criteria: • Uses prescribed materials • Sketch of design clear and neat • Design includes list of materials • Appropriate labels are present	4 of 4 items present	3 of 4 items present	2 of 4 items present	1 of 4 items present
Model constructed as designed	Model follows design perfectly	Only very minor design flaws	Several design flaws	Many design flaws
Demonstrated and described the flow of water into the aquifer	Demonstrated and describe fully the flow of water into the aquifer	Demonstrated but failed to fully describe the flow of water into the aquifer	Demonstrated but failed to describe the flow of water into the aquifer	Does note demonstrate and describe the flow of water into the aquifer

Source: Walker & Wood, 2008

CHAPTER III: Impact of Climate Change on RISING SEA LEVEL AND SEA TEMPERATURE

[SEAMEO BIOTROP, SEAMEO SPAFA and SEAMEO RECSAM]

Introduction

Until fairly recently the terms climate change and global warming were both used interchangeably as having the same meaning. This is no longer the case. We use the term climate change to indicate that there are other changes like precipitation or wind taking place in addition to rising global temperatures. Rising temperatures or global warming is one key component or factor amongst many that collectively constitute climate change which is caused by both natural and man-induced factors. For e.g., GHGs are both natural as well as industrial gases. They trap heat from the earth and warm the surface resulting in a rise in temperature, known as the greenhouse effect. The consequences of a warming world are shown ***Figure 3.1.***

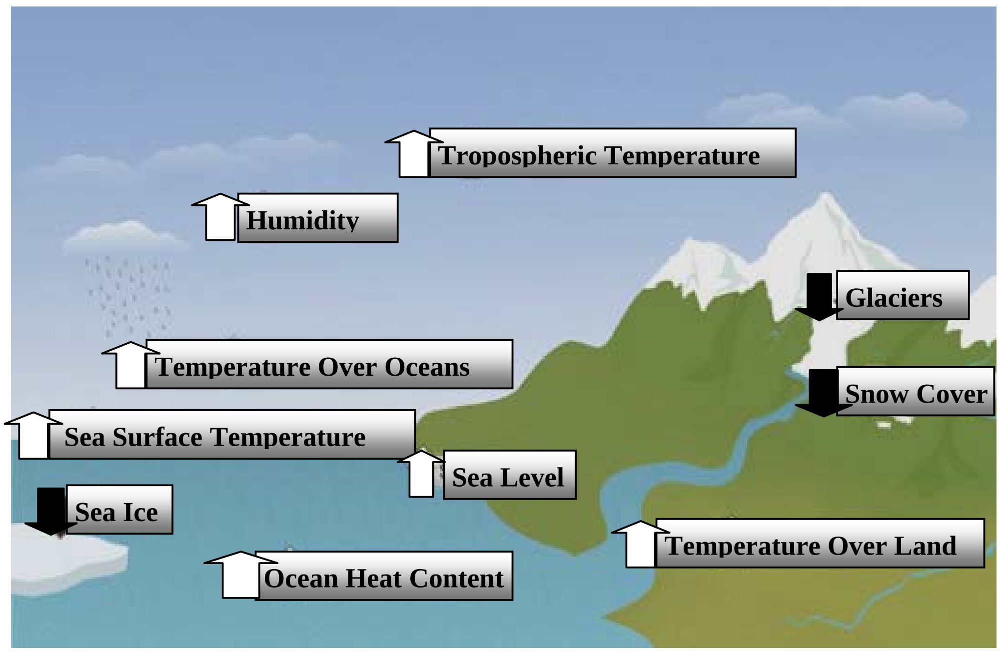

Figure 3.1 Ten Indicators for a Warming World, Past Decade Warmest on Record According to Scientists
Source: NOAA (2010)

There are 10 indicators of which three would decrease – glaciers, snow cover, and sea ice. Seven would increase which means an expected rise in sea surface temperatures as well as temperatures over land and oceans, in ocean heat content, in humidity and tropospheric temperatures. (The troposphere is the lowest portion of Earth's atmosphere containing about 75% of the atmosphere's mass) (NOAA, 2010).

Figure 3.2 shows how global warming will have significant impacts on nature and people and the interconnected cause/effect relationships. The largest impact will be on many natural ecosystems and on people who live in developing countries and have few resources and little ability to adapt. The impact on the oceans not only include rising sea levels and warming sea temperatures but also sea acidification and changing sea currents. All these will lead to major shifts in the diversity and abundance of life in the ocean. How serious are the impacts of global warming on rising sea levels and sea temperatures, and what can we do?

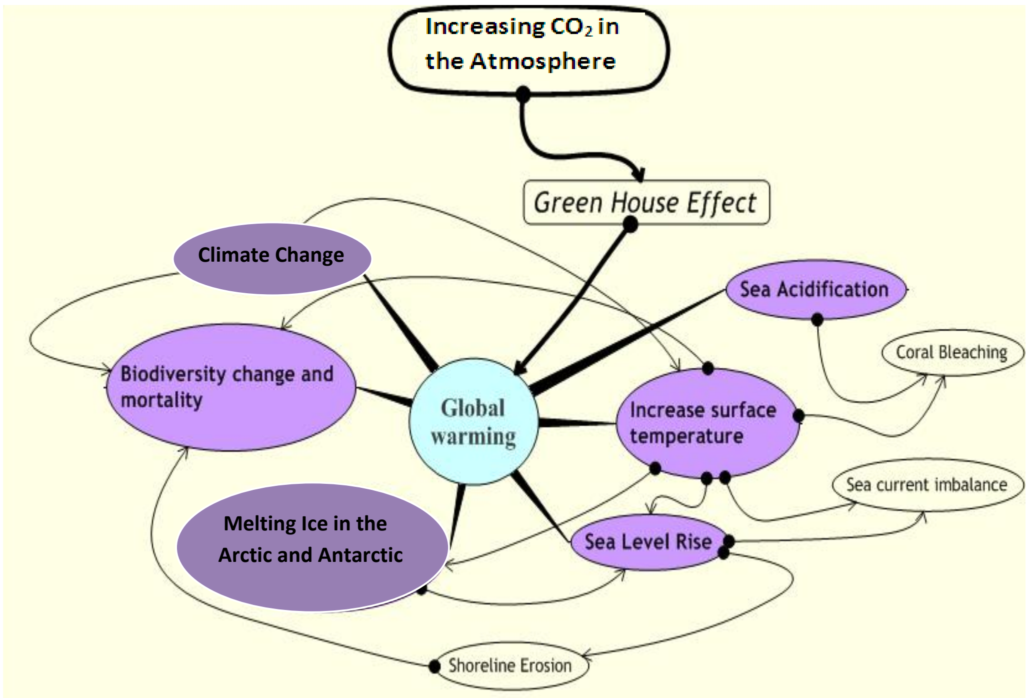

Figure 3.2 An overview of Impact of Global Warming on Rising Sea Level and Temperature

Rising Sea Levels

Sea levels have already risen due to warming and the projection is that it will rise much more in the future. Although global warming has caused significant polar ice melting over the past few decades, it is a mistake to think that sea levels only rise when the polar ice caps melt. Water expands when heated and so other factors play their part in contributing to rising sea levels. Of course as glaciers melt and when land-based ice melts, the water runs to the sea and increases its level. If there is any significant melting of the polar ice sheets, the additional rise in sea level would be enormous. The combination of rising global temperatures with melting Arctic and Greenland sea- ice equals sea level rises. Every centimeter of sea level rise covers about 2.4-4.8 metres of beach. If the ice keeps melting, the global sea level could rise more than 6 metres. That would put a lot of coastlines under water, and whole islands could disappear (Weart, 2003).

The map below (***Figure 3.3***) is designed to emphasise portions of Southeast Asia that are near sea level and hence could potentially be vulnerable to sea level rise.

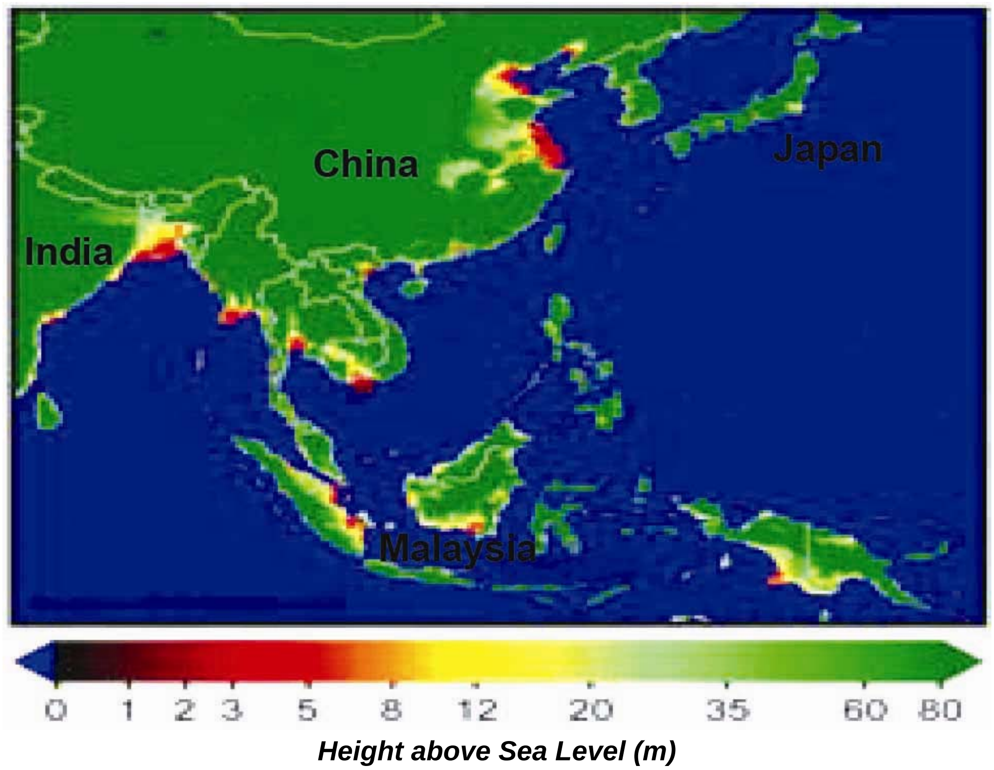

Figure 3.3 Sea level risks in Southeast Asia
Source: Rohde (2009)

The dramatic impact of a projected sea level rise of 5 m for Southeast Asia and Northern Australia would put 183.4 million people at risk in the inundated areas is shown in ***Figure 3.4***.

Effects of Rising Sea Levels

The subsequent increases in sea level have an effect on coastal ecosystems and the species that depend on these habitats to live. Most coastal areas contain ecologically and economically important habitats such as tidal wetlands, and sea grass beds, which may also be at risk from sea-level rise. Sea-level rise contributes to coastal erosion and inundation of coastal regions as well as leading to saline intrusion into coastal land and waterways. These impacts can be exaggerated by local land motions, for e.g., the compaction of sediments following the extraction of ground water which is very intense in the coastal area, or exploitation of petroleum and gas. Sea-level rise impacts on the coasts will be felt most severely during storm surges and storm wave events and at times of high tides.

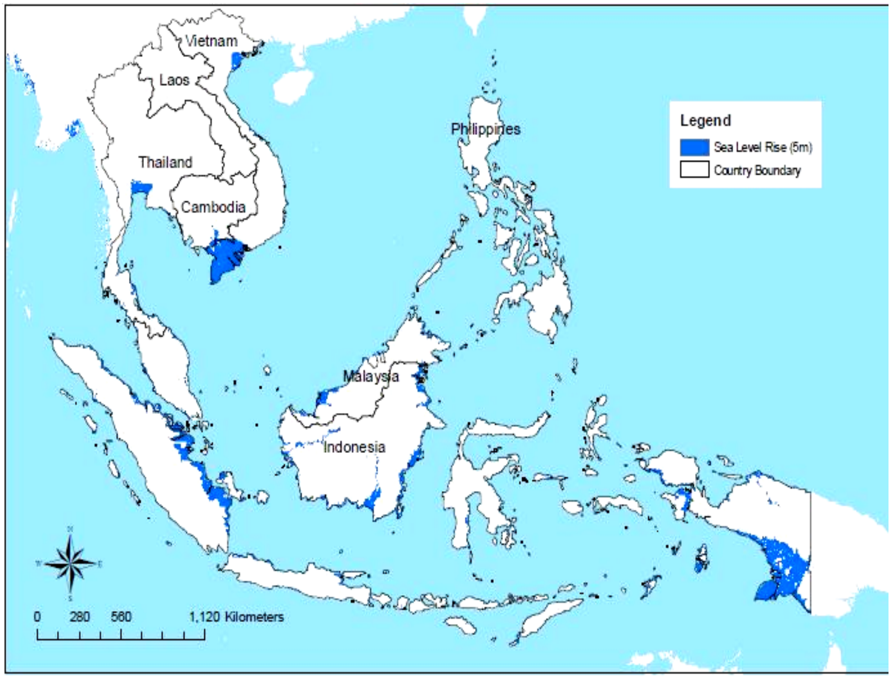

Figure 3.4 Sea level rise Map of Southeast Asia (5m)
Source: Yusuf & Francisco (2009)

Thousands of small islands are threatened by the projected sea-level rise for the 21st Century, as are low-lying coastal areas such as in Indonesia and other places. According to oceanologists, more than 2000 small islands in Indonesia alone will sink and wash off in the next decade, due to the rising sea level. The Mekong Delta is an area of particular concern. In his article, published in *The Bangkok Post*, journalist Jeff Hodson (2009), notes that:

> *"It's not hard to imagine the Mekong Delta under water. The fertile rice fields are flat as a table top except for the odd limestone mountain and stretch as far as the eye can see. Much of the region lies barely a meter above sea level. According to some projections, nearly half of the Delta's farmland could be destroyed from rising sea levels due to global warming."*

He also notes that in addition to the rising ocean levels due to water expanding as it warms, and because glaciers and ice sheets are melting, that…

> *"…other factors compound the effect, including erosion and the loss of mangrove forests. Many cities in Southeast Asia, like Bangkok, are sinking into soft clay soils faster than the seas are rising."*

A World Bank report projects that Vietnam, with more than 3,000 km of coastline, will be one of the five most affected countries in the world. Likewise, Thailand with 2,600km of coastline is increasingly vulnerable to flooding and coastal erosion. The report warns that in the worst case scenario that the entire southern tip of Vietnam, an area of roughly 40,000sq km, could be inundated (Dasgupta, S., Laplante, B., Meisner, C., Wheeler, D., & Yan, J., 2007).

Rising Sea Temperature

Earth's climate has changed naturally throughout time as shown in ***Figure 3.5***, but the current rate of change due to human activity is unprecedented. The projected range of temperature rise is wide because it includes a variety of possible future conditions, such as whether or not we control greenhouse gas emissions and different ways the climate system might respond. Temperatures over land areas closer to the poles are projected to warm faster than those nearer the equator.

Surface water temperature had risen by about one degree Celsius over the past century and is expected to increase by up to another three degrees in the next 100 years if emissions continue at current rates.

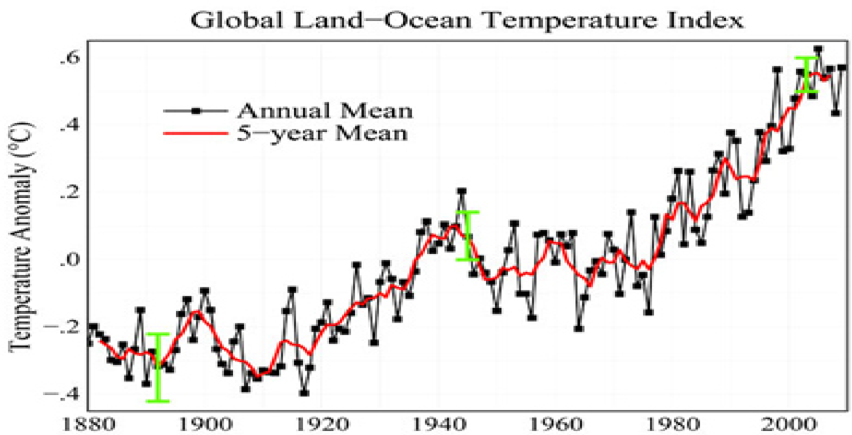

Figure 3.5 The Change in Global Surface Temperature From Years 1880-2000 Average Temperatures (NASA/GISS)
Source: NASA (2009)

Rising air temperatures affect the physical nature of our seas. As air temperatures rise, water becomes less dense and separates from a nutrient-filled cold layer below. This is the basis for a chain effect that has an impact on all marine life that relies on these nutrients for survival. There are two general physical effects of sea warming on the marine population that are crucial to consider namely- changes in natural habitats and food supply, and changing sea chemistry or ocean acidification.

Rising sea temperatures influence all kinds of sea conditions, including sea levels, critical to the survival of microscopic phytoplankton, the base of the food web. Phytoplanktons are one-celled plants that live at the ocean surface and use photosynthesis for nutrient fulfillment. Photosynthesis is a process that removes carbon dioxide from the atmosphere and converts it into organic carbon and oxygen that feeds almost every ecosystem. According to a recent NASA study as cited by Lindell (2008), phytoplankton is more likely to thrive in cooler oceans. Similarly, an algae, a plant that produces food for other marine life through photosynthesis, is vanishing due to sea warming. Since seas are warmer, nutrients are blocked from travelling upward to these suppliers that are limited to a small surface layer and therefore cannot supplement marine life with necessary organic carbon and oxygen. Natural ecosystems such as coral reefs, sea grass and mangrove swamps, are especially vulnerable to global warming and may disappear entirely in some areas. The International Union for the Conservation of Nature (IUCN) 2010, reported that in India and Southeast Asia, 80% of all mangrove area have been lost over the past 60 years.

Effects of Rising Sea Temperature

One of the most visually dramatic effects of increasing sea temperature is coral bleaching, a stress response caused by high water temperatures. Corals are animals, related to anemones and jellyfish. Corals consist of a limestone structure filled with thousands of small animals called polyps. Each polyp has a skeleton cup, tentacles with stinging cells, a mouth and a stomach. The tiny tentacles snatch at passing plankton for food (Nova Science in the News, 2003).

Coral reefs are extremely important for biodiversity, providing a home to over 25% of all marine life, and are also vital for people. They provide nurseries for many species of commercially important fish, protection of coastal areas from storm waves, and are a significant attraction for the tourism industry. However, coral reefs are very fragile and sensitive ecosystems that can only tolerate a narrow temperature range.

Rising water temperatures block the photosynthetic reaction that converts carbon dioxide into sugar. This results in a build-up of products that poison the algae. To save itself, the corals spit out the algae but in the process some of its own tissue too leaving the coral bleached white. If temperatures remain too high for too long and bleaching persists, the corals die. The bleached corals can recover, but only if cooler water temperatures return and the algae are able to grow again. If not, the corals slowly starve to death. That is happening around the world, according to the report as cited by Lobe, (2010), and he further said that in 1998, the hottest year in at least six centuries, corals suffered the most extensive damage with severe bleaching and subsequent mortality as shown in ***Figure 3.6.***

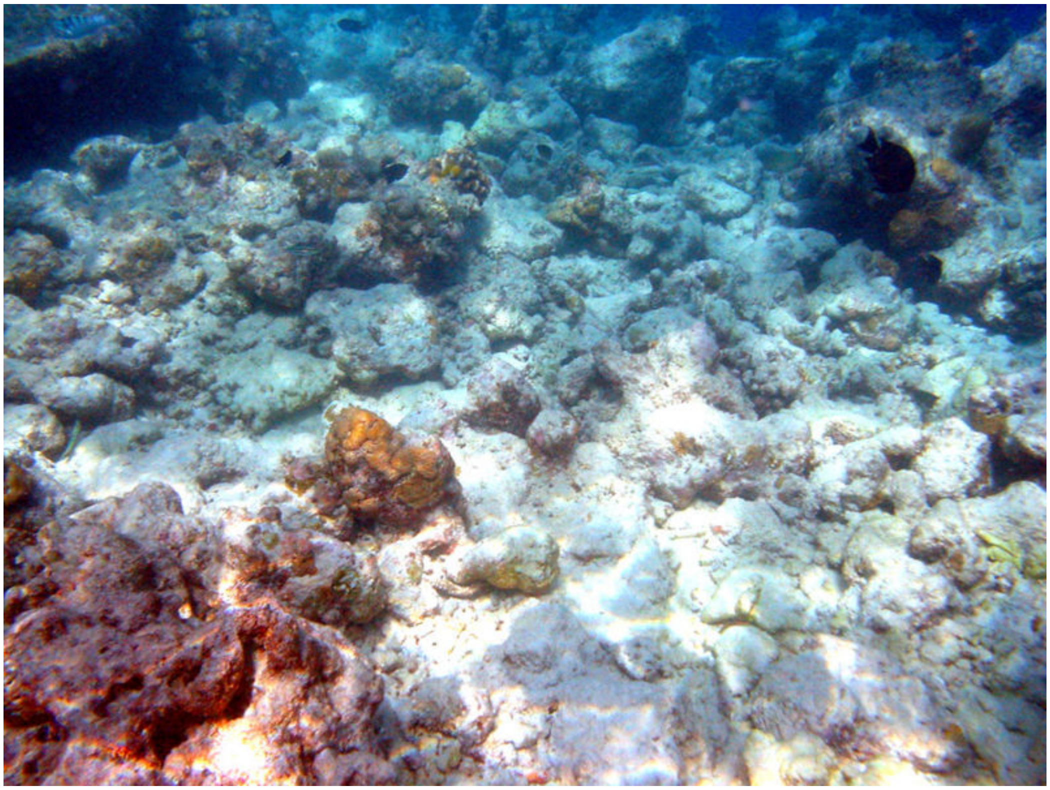

Figure 3.6 Bleached Coral due to Increase of Sea Water Temperature
Source: Wikipedia, (n. d.)

Ocean Acidification

Emissions of CO_2 arise mainly from fossil-fuel combustion, land-use practices, and concrete production. These emissions first enter the atmosphere, but a large proportion of them are then absorbed into the ocean by physical and biological processes that are normal parts of the natural carbon cycle. As CO_2 is being released into the ocean, the ocean chemistry drastically changes. Greater CO_2 concentrations released into oceans create increased ocean acidity. Ocean acidification describes the relative decrease in seawater pH that is caused by oceanic uptake of specific compounds from the atmosphere, where CO_2 forms a weak acid *(carbonic acid)* making sea more acid (Howard et al. 2009). As sea acidity increases, phytoplankton is reduced. This results in less sea plants able to uptake greenhouse gases. Also, increased sea acidity threatens marine life, such as corals and shellfish, which may become extinct later this century from the chemical effects of CO_2. As CO_2 increases in the atmosphere, the sea acidification is increased and the carbonate ions from corals will vanish. This results in lower extension rates or weaker skeletons in most corals.

According to the National Oceanic and Atmospheric Administration, at least 19% of the world's coral reefs are already gone. An additional 15% could be gone within 20 years and, if global warming continues unchecked, all corals could be extinct within 100 years. The fish that we eat make their homes around the coral reefs. With dead reefs, experts say, hunger, poverty and political instability could follow. Some types of coral and marine species that rely on reefs are being used by the pharmaceutical industry to develop possible cures for cancer, arthritis and other diseases. Hence, people all over the world could pay the price if reefs were to disappear.

What to do?

Climate change action will require the concerted effort of government and their partners (private sector, non-government organisations, communities, development partners) to manage and adapt to change in a more invasive environment. As such, we need to strengthen school community relationships, establish strong networking or partnerships between schools and government and non-government organisations. To arrest rising sea temperatures and ocean acidification, we must reduce carbon (GHG) releases through mitigation measures. At the same time, we must reduce our risk by adaptation. Some measures includes cutting on carbon, declaring some reefs off limits to fishing and diving, planting mangrove trees and controlling coastal development and pollution.

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Lesson 1

SAVING THE MARINES

GRADE LEVEL: High School

SUBJECT: Biology

TOPIC: Interaction between Biotic and Abiotic Components in a Marine Ecosystem

PREREQUISITE: Before the laboratory work, the students should have:

- prior knowledge about the biotic and abiotic factors in an ecosystem;
- familiarity with proper care and maintenance of fish; and
- knowledge on the difference between temperature maintenance in warm-blooded versus cold-blooded organisms.

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: By end of session, students should be able to:

- explain the interaction between the biotic and abiotic factors in a marine ecosystem; and
- relate climate and abiotic components of ecosystems.

Climate Change Objectives

- demonstrate the effect of rising sea level on coastal erosion and inundation or salt water intrusion to groundwater or impact to low-lying coastal and agricultural land; and
- explain the cause and effect of rising sea temperature on fish physiology and behaviour.

MAIN CONCEPTS AND SKILLS

- *Abiotic factors* are essentially non-living components that affect the living organisms of the freshwater and seawater community. When an ecosystem is barren and unoccupied, new organisms colonising the environment rely on favourable environmental conditions in the area to allow them to successfully live and reproduce. These environmental factors are abiotic factors. When a variety of species are present in such an ecosystem, the consequent actions of these species can affect the lives of fellow species in the area, these factors are deemed *biotic factors*.
- The biotic and abiotic factors combine to create an ecosystem. An ecosystem is a community of living and non-living things considered as a unit. If a single factor is changed (such as temperature), perhaps by pollution or natural phenomenon, the whole system could be altered.
- Human beings may alter the environment through farming or irrigating. While we usually cannot see what we are doing to various ecosystems, the impact

is being felt all over. For example, climate change causes sea temperature to rise in some regions and has resulted in the decline of fish species and population.

- Rising air temperatures affect the physical nature of our seas. As air temperatures rise, water becomes less dense and separates from a nutrient-filled cold layer below. This is the basis for a chain effect that impacts all marine life who counts on these nutrients for survival. There are two general physical effects of sea warming on marine populations that are crucial to consider, namely: *change in natural habitats and food supply, and change in sea chemistry such as acidification.*
- Most aquatic animals need to obtain O_2 from the surrounding water in order to carry on cellular respiration. *The amount of O_2 in water is limited, and both O_2 solubility and demand are correlated with temperature.* At most, there is only about 15 mg of O_2 per liter of water. In order to carry out the chemical reactions needed to maintain life and to reproduce, aquatic organisms must be able to efficiently extract that 15 mg of O_2 from the water.
- High water temperature would cause oxygen to leave the water. Consequently, the fish and other organisms would lack oxygen and suffocate. All aquatic life are ectotherms, meaning their body temperature varies directly with its environment.

MATERIALS NEEDED

- pictures of a fish-kill incident in your immediate community
- beakers or large bowls, warm and cold water, aquarium fish, thermometers, plastic cups, timing device
- student worksheet

PRESENTATION OF LESSON

The world's climate is constantly changing. How will these changes impact natural systems, especially ecosystems? How will humans and other living things be affected? This lesson provides the basis to start exploring possible answers to these questions by understanding the interactions between abiotic and biotic components of ecosystems and relating these to a changing climate.

Scenario: **"The Fish Kill"**

Present a recent photo of a fish kill incident in your community. Ask for students' reactions on the photograph.

- What do you notice about this photo?
- What caught your attention about this photo?
- What facts do you know about this situation?

Ask them about the possible causes of this incident. Students may give several reasons for the fish-kill. Hence, highlight only those that are directly connected to climate change particularly on the rising sea temperature.

Guide Questions

- What were the possible factors that caused the fish-kill?

- What was altered in the ecosystem that caused this incident?
- How are these factors related to climate change?

Student Activity: **"Simple Experiment on Fish Respiration"**

- Allow students to observe and analyse how a change in water temperature can affect the behaviour of fish in an experiment which they will themselves design and execute.

Process Guide for Teachers

1. After the initial class discussion about the fish-kill incident, conduct a short discussion about the biotic and abiotic factors in an ecosystem. Discuss the interaction between the two factors. Also, together with the students, review the differences between temperature maintenance in warm-versus cold-blooded organisms.

2. Divide the class into working groups. Give each group a set of materials and worksheet needed in the activity. Provide precautionary measures particularly on proper handling and maintenance of the fish.

3. In groups, ask the students to design and perform a brief experiment to determine how water temperature affects fish respiration. *Refer to the attached Student's Worksheet 1**(Attachment 3.1.1).*** The students will undergo a semi-guided science inquiry activity.

4. Monitor the students while working in groups. Use the attached sample rubric of Experimental Design for the performance rubric ***(Attachment 3.1.2).***

5. After the group activity, ask each group to present the results of their work.

6. Debrief students on their learning experiences by asking the following guide questions:

   a. How does fish respiration change with severe temperature change?
   b. Why do the fish require a constant supply of fresh water over their gills?
   c. Aside from respiration, what other physiological factors are affected by water temperature change?
   d. What are the limiting factors which affect the balance in a water ecosystem?
   e. What is the impact of sea temperature change in the population of aquatic organisms?
   f. What day-to-day activities can cause imbalance in our ecosystem?
   g. How does climate change affect the balance in our ecosystem?

Achieving the Objectives

Objective	This is achieved by
Explain the interaction between the biotic and abiotic factors in an ecosystem.	Group interaction during the conduct of the group activity. Presenting the results of the activity in the class.
Demonstrate the effects of rising sea temperature on fish physiology and behaviour.	Designing and performing a simple activity on the effects of water temperature change on fish respiration.
Explain the cause and effect of rising sea level and temperature.	Processing the student's learning during class discussion and interaction.

Assessment: "Sketching Task"

Ask students to draw an ecosystem that highlights three (3) biotic and 3 abiotic components.

1. Write a short narrative to explain the 3 possible interactions between abiotic and biotic components in normal conditions.
2. What will happen to the interactions if changes such as rise of temperature are observed? Draw a diagram to describe the new phenomenon.

Closure: "Concept Mapping"

Students will create a concept map illustrating the connections between abiotic and biotic components in an ecosystem and climate change and its potential impact on the ecosystem. Use the attached concept map rubric ***(Attachment 3.1.3)*** to assess student's output.

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Attachment 3.1.1
Student's Worksheet

SIMPLE EXPERIMENT ON FISH RESPIRATION

Objectives

- Observe fish respiration by watching a fish's mouth or gill movement.
- Determine the rate of fish respiration using water of varying temperatures.

Materials

Preferably, use aquarium pet gold fish
Beakers or large bowls, warm and cold water, aquarium fish, thermometers, plastic cups, timing device

Research Question

- How water of varying temperatures affect fish respiration?

Parameters for Temperature and Circulation

- The fish in this activity must stay alive.
- The fish can stay out of the water for a maximum of 30 seconds.
- The fish must have at least four minutes of recovery time in its normal water temperature before it is used again in another trial.
- The water temperatures can range from 15 to 30^{o} C.

Procedure

1. Plan a simple experiment to answer the research question.
2. Write the complete procedures of the experiment before conducting the actual experiment.

   Guide questions in formulating the procedures

   - How will you keep track of individual fish?
   - How will you change the temperature of the water?
   - How will you ensure the fish gets 4 minutes of rest between trials?

3. Record your observation and data using the Record Sheet below:

Record Sheet of the Experiment on Fish Respiration

Fish Number	**Water Temperature in degree Celsius**	**Respiration Rate in Minutes**	**Observations**

4. Prepare for a class presentation. It must include an introduction, hypothesis, procedures, data and results, and conclusion.

   Sample guide question for discussion during your presentation:

   - What have you observed based on data and results?
   - What happened to the fish when the water temperature changes? Why?

     (Use your information about temperature homeostasis for warm- and cold-blooded animals)

Analysis and Conclusion

- address your hypothesis

Attachment 3.1.2
Performance Rubric

EXPERIMENTAL DESIGN

Area	Criteria for Assessment	Possible Points	Points Earned	Remarks
Experimental Design	• Lists materials, uses proper amounts • Procedure written clearly; can replicate • Procedure in logical order • Identifies variables • Includes repetitions, if applicable	25		
Data Recorded	• Variables are labelled • Measurements use appropriate units • Chart/table is logical and organised	20		
Analysis/ Conclusion	• Data support the conclusion • Conclusion addresses hypothesis • Analysis is logical • Includes possible sources of error • Includes ways to improve design	30		
Presentation	• Poster is logical and neat • Visuals are clearly displayed • All members participate in designing and conducting the experiment • All members participate in actual presentation • Shows good planning and organisation	25		

Attachment 3.1.3
Concept Map Rubric

CRITERIA	Not Satisfactory Level 1	Satisfactory Level 2	Good Level 3	Excellent Level 4
Concepts	• Bare minimum number of concepts selected relating to topic • Arrangement of concepts illustrates basic understanding of relationships between them	• Acceptable number of concepts selected, with some relationships to topic • Arrangement of concepts demonstrates understanding of relationship between them	• Most concepts relating to topic were selected • Arrangement of concepts demonstrates a complete understanding of relationship between them	• Most concepts and all significant concepts selected and they clearly relate to the topic • Arrangement of concepts demonstrates complete and insightful understanding of relationship between them
Hierarchical Structure	• Some sense of hierarchical structure.	• Hierarchical structure used, but still some inconsistency.	• Most concepts connected in a hierarchical structure moving from major ideas to minor ideas.	• All concepts connected in a hierarchical structure leading to specific concepts.
Linkages	• Few relationships indicated by connecting lines • Few lines labelled with linking words • Linking words are simple and repetitive	• Some relationships indicated by connecting lines • Some lines labelled with linking words • Linking words show variety	• Most relationships indicated by connecting lines • Most lines labeled with linking words • Linking words are accurate and varied	• All relationships indicated by a connecting line • All lines labelled with linking words • Linking words are expressive and purposeful
Cross Links	• Cross links not used	• Few cross links are used to illustrate minimal connections	• Cross links used to reflect straightforward connections	• Cross links show complex relationships between two or more distinct segments of the concept map

Lesson 2

ACID OCEAN ALERT!

GRADE LEVEL: High School

SUBJECT: Physical Science (Chemistry)

TOPIC: Acid, Base and pH Scale

PREREQUISITE:

- Before the laboratory work, the students should already know the difference between acid and base and their characteristics.

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: By end of session, students should be able to:

- determine common acids and bases using a pH paper or pH meter; and
- explain the relationship between pH and the strength of an acid and a base.

Climate Change Objectives:

- explain the cause of rising sea water acidity due to climate change;
- describe ways marine organisms (e.g., corals) are affected by sea/ocean acidification; and
- design an experiment on coral bleaching as it affects the food chain.

MAIN CONCEPTS AND SKILLS

- The ocean dominates the earth's carbon cycle. Half the primary productivity on Earth takes place in the sunlit layers of the ocean and the ocean absorbs roughly half of all carbon dioxide added to the atmosphere.
- The ocean has had, and will continue to have, a significant influence on climate change by absorbing, storing, and moving heat, carbon, and water.
- The analogy between pH in the ocean and CO_2 helps explain that rising atmospheric CO_2 concentration leads to the lowering of pH in the ocean. Carbon dioxide from the atmosphere can cause a liquid to become more acidic. Hence, it is possible to acidify the ocean.
- The pH is a measure of acidity. Acids are characterised by their ability to give off H^+ ions in aqueous solutions. pH is a mathematical function that indicates the amount of H^+ present in the water. The smaller the pH value, the more acidic the sample. Acids have pH from 1 to 7, 7 is neutral, and bases have pH from 7 to 14.

- The *strength* of an acid or base is confused with its *concentration*. Dilute and concentrated are terms used to indicate the concentration of a solution. The concentration of the acid or base refers to the amount of acid or base dissolved in a solution. On the other hand, s*trong or weak* refers to the ease with which an acid or base forms ions in solution.

- Emissions of CO_2 arise mainly from fossil-fuel combustion, land-use practices, and concrete production since the industrial revolution. These emissions first enter the atmosphere, but a large proportion of them are then absorbed into the ocean by physical and biological processes that are normal parts of the natural carbon cycle. As carbon dioxide is being released into the ocean, the ocean chemistry drastically changes.

- Greater CO_2 concentrations released into oceans create increased ocean acidity. Surface ocean pH has become more acidic by approximately 0.1 units since pre-industrial times. Ocean acidification describes the relative decrease in seawater pH that is caused by oceanic uptake of specific compounds from the atmosphere, where CO_2 forms a weak acid *(carbonic acid)* making sea more acid. Ocean acidification affects calcium carbonate saturation in ocean waters, thereby making this building block of shells and skeletons less available which affects the health of corals and other marine organisms (e.g., crabs and clams). As sea acidity increases, phytoplankton is reduced. This results in less sea plants able to uptake greenhouse gases. Also, increased sea acidity threatens marine life, such as corals and shellfish, which may become extinct later this century from the chemical effects of CO_2.

- The oceans are more acidic as a result of CO_2 emissions associated with human activity. Humans affect the ocean in a variety of ways. Laws, regulations, and resource management affect what is taken out and put back into the ocean. Human development and activity lead to pollution and physical modifications (changes to beaches, shoals, and rivers) and removed most of the large vertebrates from the ocean.

- Everyone is responsible in caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage the aquatic resources for all.

MATERIALS NEEDED

- common samples of acids and bases, pH paper or pH meter;
- pH indicator solution *(ready-made or improvised like the red cabbage indicator),* before doing this lesson the teacher may conduct a test if the red cabbage pH indicator may be used;
- samples of seawater, brackish water, or freshwater and coral skeleton; and
- student's worksheet

PRESENTATION OF LESSON

Prerequisite: Prior to the conduct of the lesson, the teacher will conduct a research on a news article about the effects of rising sea acidity on aquatic organisms and their habitat which was published in a local newspaper. If this is not available visit this website *www.oceana.org* and download the ACID TEST report.

Scenario:

Distribute copies of the news article on ocean acidification to students. Give the students sufficient time to read the article. Afterwards, they have to answer the following questions:

- What is ocean acidification?
- What causes it?
- Who does it affect?
- Why should it be studied and/or monitored?

Student Activities

- **Activity A:** The students will conduct an acid and base test using pH paper or pH meter. They will use this test to determine the pH level of common household acids and bases. Various solutions may include: vinegar, hydrogen peroxide, lemon juice, household cleaner such as muriatic acid, soda.
- **Activity B:** In addition, the students will determine the pH level of water samples from nearby bodies of water such as fresh water, salt water. In this experiment, the student will determine whether the water is still suitable for aquatic organisms such as fish.
- **Activity C:** In order to see how the dissolution of CO_2 in water affects the pH, the students blow bubbles into a solution of water and pH indicator solution. As the bubbles of CO_2 are introduced to the solution, pH drops. The simple analogy between pH in the ocean and CO_2 helps students understand that rising atmospheric CO_2 concentration leads to the lowering of pH in the ocean.
- **Activity D:** Students will design an experiment on coral bleaching using a solution.

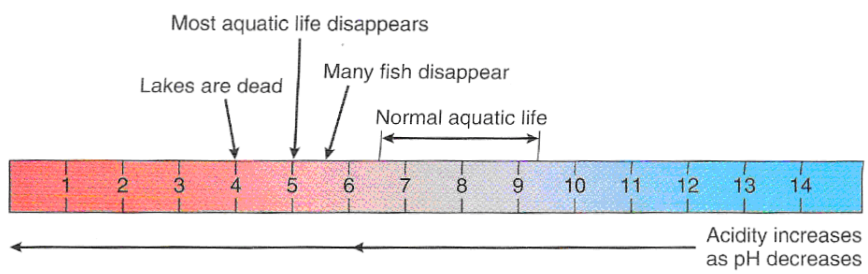
Process Guide for Teachers

1. After doing the opening activity about the news article, conduct a short review about the characteristics of acid and base. Relate this short review to the news article presented earlier. Give emphasis to the effects of rising seawater acidity on the overall aquatic ecosystem. Extend the discussion up to the corrosive effect of seawater to shellfish and coral reefs.

2. Introduce the use of pH paper and pH meter. Share with your students some precautionary measures to observe while conducting the activity. Also present the pH scale poster to determine the strength of an acid or base. Differentiate acid strength from acid concentration.

3. Divide the class into four (4) working groups. Each group will perform two acid- and base-tests using pH indicator (pH paper or pH meter). Activity A is about determining the pH of common household acids and bases. While Activity B is about determining the pH of sample seawater, brackish water, or freshwater gathered within the local community. Activity C is about Blowing Bubbles. Remind the students **not to accidentally sip up the solution**, and exhale very **slowly.** For Activity D, the students will design an experiment that will make a piece of coral skeleton disappear using a solution.

   Refer to the pH scale below to determine the quality of water samples from freshwater sources.



4. Ask each group to present their data about the pH level of the samples tested in Activity A, Activity B, Activity C and Activity D.

5. After the group presentations, discuss what the students thought was interesting about their results. Lead a brainstorming session about what they think happened to the pH of the solution. Also, ask the follow up questions.

   a. What determines the strength of an acid or base?
   b. What does the pH measures?

6. Ask the student's insights about the activities. Refer to the following guide questions.

   a. What causes the continuous rise in seawater acidity?
   b. What are the major effects of this activity to marine and terrestrial lives?
   c. How does acid rain contribute to the rising water acidity especially in freshwater sources like lakes and streams?
   d. What will happen to coral reefs and shellfish if seawater becomes corrosive?
   e. How can people mitigate the impact of rising seawater acidity?

Achieving the Objectives

Objective	This is achieved by
Determine common acids and bases using a pH paper or pH meter.	Actual pH test of common household acids and bases
Explain the relationship between pH and the strength of an acid and a base.	Actual pH test and during classroom discussion.
Design an experiment on coral bleaching.	Actual pH test on coral bleaching
Explain the cause of rising sea water acidity due to climate change.	Analysing the news article about seawater acidity. Interaction and discussion with group mates.
Discuss the effects of rising sea water acidity to aquatic organisms and their habitat.	Class discussion and group activity.

Assessment

Performance assessment: This will be conducted during the performance of the assigned activity. The teacher will utilise a performance rubric (Experimental Design) used in the previous lesson. ***(Attachment 3.1.2)***

- Formative assessment: In a clean sheet of paper, the students will answer the following questions:
    1. The aromas of many fish are caused by compounds called amines. If the pH of a dilute solution of an amine is 11.4, infer whether the amine is an acid or a base.
    2. What determines the strength of acid or base?
    3. What does the pH of each of the solutions indicate about the solutions?
        - Rainwater, 5.9
        - Soda water, 3.0
        - Drain cleaner, 14.0
        - Seawater, 8.9
        - Pure water, 7.0
    4. Draw a concept map on the impact of coral bleaching to our marine ecosystem and its impact to food chain and eventually to food security.

Closure Activity

- Option1) Tell the students to draw a concept map of pH values. They may start with three boxes labelled acidic, neutral and basic and indicate the pH range of each box. Below each box, they will give some examples of solutions that belong in each pH range.

- Option 2) Ask students to draw a poster showing the effects of rising seawater acidity to marine life particularly the fish population and coral reefs and shellfish. In groups, they will bring their posters to a particular community (chosen by your group) especially those located near water sources e.g. fishing village. They have to show the posters to the community, and ask permission from local authorities to post it in strategic places for public awareness and information dissemination.

RESOURCES

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Conrad, L.S., Eubank, L. P., Middlecamp, C. H., Pienta, N. J. & Stratton, W. (2003). Chemistry in Context: Applying Chemistry to Society. 4th Edition. Mc Graw Hill Companies.

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Attachment 3.2.1
Student's Worksheet

DETERMINING WATER ACIDITY

Objectives:

- Determine common acids and bases using a pH paper or pH meter.
- Determine whether the different water samples are suitable for aquatic organisms.
- Observe how the dissolution of carbon dioxide in water affects the pH through blowing of bubbles.
- Explain the relationship between pH and the strength of an acid and a base.

Procedure:

- This laboratory activity is divided into three parts.

Activity A: First you will determine the pH level of common household acids and bases. Tabulate the results of your investigation.

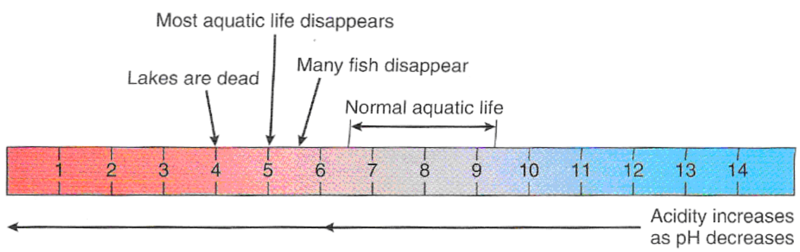
Name of Common Household Solutions	Acid or Base	pH Level

Activity B: In this activity you will determine the pH of fresh water sample, a brackish water sample, and a sea water sample. Tabulate the results and determine whether the water from these sources is still suitable for aquatic organism

Water Sample	Acidic or Basic	pH Level

Guide Question:

- Using the pH scale below, which of the samples is suitable for aquatic organism?



Activity C: Blowing Bubbles

Materials:

- Coral or shells
- 50 ml water, beaker or clear plastic cup
- Drinking straw,
- pH indicator solution

Procedure:

1. Pour 50 ml water into beaker
2. Add 15 drops of pH indicator solution to the water in the beaker/cup and mix it with the straw
   a. Record colour of solution
   b. Record pH
3. Exhale **SLOWLY** into the water through the straw and record your observations.
   c. Record colour of solution
   d. Record pH

   Guide Questions:
   1. What gas are you exhaling into the solution?
   2. What is happening to the pH of the solution?
4. Add some crushed coral or shells to the solution.

   Guide Question: What happens to the pH of the solution?

Activity D: Coral Bleaching

Materials:

- Piece of coral skeleton
- Solution of your choice

Instructions:

1. Design an experiment that will make a piece of coral skeleton disappear using the solution of your choice. Have your procedure approved by your teacher.

2. Write your hypothesis.

3. Write a clear, step by step procedure for your experiment.

4. Identify the independent and dependent variables.

Lesson 3

LET'S MEASURE IT!

GRADE LEVEL: Grade 7 (First Year High School)

SUBJECT: Mathematics

PREREQUISITE: Students should have prior knowledge on the concept of volume and temperature.

DURATION: 1 session

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this lesson, students should be able to:

- measure water displacement using different measuring devices;
- measure heat using thermometer properly; and
- identify change in volume and change in temperature using appropriate mathematical operation.

Climate Change Related Objectives

- discuss the causes and increase rate of sea temperature and sea level;
- explain the significant effect of increasing sea level at 1mm per year by the year 2030; and
- explain the effects of rising sea temperature on coral reefs and the depending biodiversity in marine ecosystem.

MAIN CONCEPTS AND SKILLS

- Sea level rise is caused by melting of ice glaciers *(a perennial mass of ice which moves over land)* due to global warming over centuries and expansion of sea water.
- The effects of rising sea level are erosion of coastline, coastal inundation, increase loss of wetlands and coastal habitats, change in surface water quality and ground water characteristics, and decrease in soil and water quality, flooding, an entry of seawater into freshwater areas and intrusion to groundwater.
- The impact of sea temperature rise also include: uneven storms, cyclones, migration of aquatic organisms, etc. High sea levels would submerge some coastal cities, small island nations, and other inhabited regions.
- Through global warming, the surface waters of the oceans could become warmer, increasing the stress on marine ecosystems, such as coral reefs. High water temperatures can cause a damaging process called coral bleaching. When corals bleach, they expel the algae that give them their colour and nourishment. The corals turn white and, unless the water

temperature cools, they die. Added warmth also helps spread diseases that affect sea creatures.

- Ice already in the oceans does not contribute to sea level rise but ice formations on land will cause a rise in sea level when they melt. Ice is less dense than water. Ice displaces water equal to the mass of the ice. Displacement is the forced relocation of water due to a submerged or partially submerged object occupying fluid space.

MATERIALS NEEDED

- Recent data on the coral reef ecosystem locally, nationally and globally
- Video showing melting of ice in the North Pole or in the Antarctic (http://www.youtube.com/watch?v=t7T7beACtQs)
- Student's Worksheet
- Ice Cubes
- Reading thermometer
- 150 ml beaker or graduated cylinder

PRESENTATION OF THE LESSON

Scenario:

Have a review about global climate change and its impact on sea level rise. Ask students where there is a lot of ice in the world. Is the ice on land or water? Does it matter whether the ice is on land or water? Will one or both cause sea level to rise when they melt?

Allow the students to watch a movie clip or a video that shows melting of ice glaciers in the North Pole. The teacher will ask the students the following questions:

- What did you observe as the ice melts?
- Why might we be concerned about sea level rise?
- What does this mean for our future?

Briefly connect the cause of sea level rise to global climate change and discuss the effects of rising sea level such as - coastal areas will be flooded, people will lose their homes, some fresh water resources will become too salty to use and habitat loss will occur.

Student Activities

Students will explore how melting ice impacts sea level. This activity will help students see the application of measurement in sea level rise and sea temperature. In groups, the students will measure the temperature of the water with ice in the beaker and record it. For the second trial, the students will expose the water and ice in the beaker to the sunlight. The students will record their measurements and write down their observations and results. They will include the answers to the guide questions in their conclusions on the worksheet.

In this exercise, students will be able to visualise differences in water volume and temperature and relate this to potential consequences of increased glacial melting.

Process Guide for Teachers

a. Use the information in the chapter introduction section to help students understand the results of their activity. Guide the students to see the relationship of temperature and the melting of ice which in turn increases the level of water in a particular container. The same is true to the environment. The increase in temperature due to global warming can cause the ice in the North Pole to melt, thus increasing the sea water level.

b. Connect the discussion about global climate change by asking the students:
   - Why might we be concerned about sea level rise and sea temperature?
   - Why do you think this phenomenon happened?

c. The teacher will get some pictures showing increase in water level temperature and will ask students to identify the consequences of an increased in sea water level and sea temperature to the coral reefs, freshwater, beaches, and even to small islands in the Mekong Delta in Vietnam, Bangladesh and small islands in the Pacific.

Achieving the Objectives

Objective	This is achieved by
Measure water displacement using different measuring devices Measure heat using thermometer properly Identify change in volume and change in temperature using appropriate mathematical operation	Performing the activity with the guide of the teacher. Group discussion on the guide questions for lesson activity.
Discuss the causes and increase rate of sea temperature and sea level	Sharing of reactions and insights on the movie clip or video on melting of ice in the North Pole.
Explain the significant effect of increasing sea level at 1mm per year by the year 2030 Explain the effects of rising sea temperature on coral reefs and the depending biodiversity in marine ecosystem.	Class discussion

Assessment

- Provide a short summary of the lesson by asking the students how to measure volume of water, irregular solids, and temperature.
- Ask the students to work in groups and ask them to answer the following:

  1. What causes the increase of temperature in the environment?
  2. What causes the rise in sea water level?
  3. What are the consequences of an increase in sea water level and temperature?
  4. Draw a concept map or diagram or caricatures or cartoons showing the amount of sea level increase and its impact to the coastal areas, low-lying areas and small islands in the pacific.

Closure Activity

- Ask the students to make a poster that will help make people informed about climate change and how it affects the rise in sea water level and temperature and its consequences to people.

- Ask the students to list down some activities that may minimise the impact of climate change on sea water level and temperature.
  - ➢ What can we do to help slow down the process of sea level rise and sea temperature?

    (*Examples:* Take public transportation instead of driving, eat local foods, turn off lights and electrical equipment when not in use, plant a tree, reduce, reuse and recycle.)

  - ➢ What can we do to reduce our risk by adaptation?

    (Examples: knowing that typhoons will be stronger than before, we should revise our building code such that we build our homes strong enough to withstand winds of certain kilometers per hour. Those living in low-lying areas must be moved to higher and safer grounds such that hazards (e.g., excessive rainfall and sea level rise) do not become major disasters.

RESOURCES

Anytime Lesson Plan: Global Climate Change and Sea Level Rise**.** (n.d). Retrieved from http://www.calacademy.org/teachers/resources/lessons/global-climate-change-and-sea-level-rise/

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Gozun, E. (July 2010). Global Warning on Global Warming. *Kerygma Magazine*. No. 242, Vol. 20.

Yee, L. P. (2008). *Teaching secondary school mathematics.* Singapore. M Graw-Hill Education (Asia).

You Tube video on ice melting. (http://www.youtube.com/watch?v=t7T7beACtQs)

Attachment 3.3.1
Student's Worksheet

MEASURING WATER RISE AND TEMPERATURE

Objective:

Students will apply their skills in measurement using the concepts of sea level rise and sea temperature.

Materials:

- Laboratory apparatus (150 ml beaker, thermometer)
- Ice cubes

Procedure:

a. Put a 150 ml of water in a beaker.

b. Put a small cube of ice in the water and observe.

c. Using the thermometer, measure the temperature of the water in the beaker and record it.

d. Measure the volume of the water in beaker.

e. This time, expose the beaker to the sunlight and wait for a few minutes.

f. Using the same thermometer, measure the temperature of the water in the beaker after exposing to heat.

g. Again, measure the volume of the water in beaker.

	Temperature	*Volume*	*Observation*
Without sunlight			
With sunlight			

Conclusion: *Guide Questions:*

- What happens to the ice?
- What happens to the level of water in the beaker?
- How does the melting of ice affect the volume of the water in the beaker?
- By how much does the volume change?
- By how much does it change its temperature?
- Can you estimate the volume of the ice? How?
- In which "situation" did the water level rise more?
- How do the results compare with the phenomenon on sea level rise and sea temperature?

CHAPTER IV:
Climate Change and ENERGY EFFICIENCY

[SEAMEO RECSAM]

What is Energy?

Energy plays important roles in our lives. It is an essential input to a nation's economic growth and development. Over the last 50 years, consumption of energy has increased from year to year due to its demand where the trend has shown a substantial growth of fossil fuel consumption (BP, 2009). ***Figure 4.1*** shows the world's energy consumption by types of fuel from 1965 to 2006, where oil remains the world's dominant fuel.

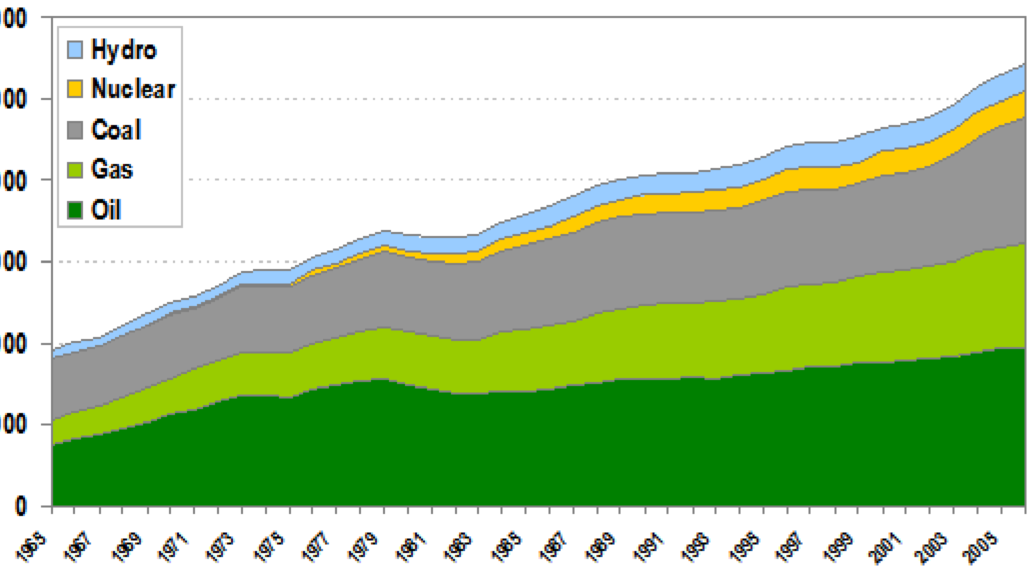

Figure 4.1 World energy consumption by types of fuel from 1965 to 2006
Source: BP Statistical Research of World Energy (2009)

Electricity is a secondary energy source which is generated by burning fossil fuels such as oil, coal and natural gas, which are non-renewable primary sources of energy. For its graphical illustration, see ***Figure 4.2.*** It is an extremely flexible form of energy, and has been adapted to a huge, and growing, number of uses (Wald, 1990). The burning of these fuels however produces pollutants and greenhouse gases which are often associated with greenhouse effect and climate change, an example of which is shown in ***Figure 4.3.***

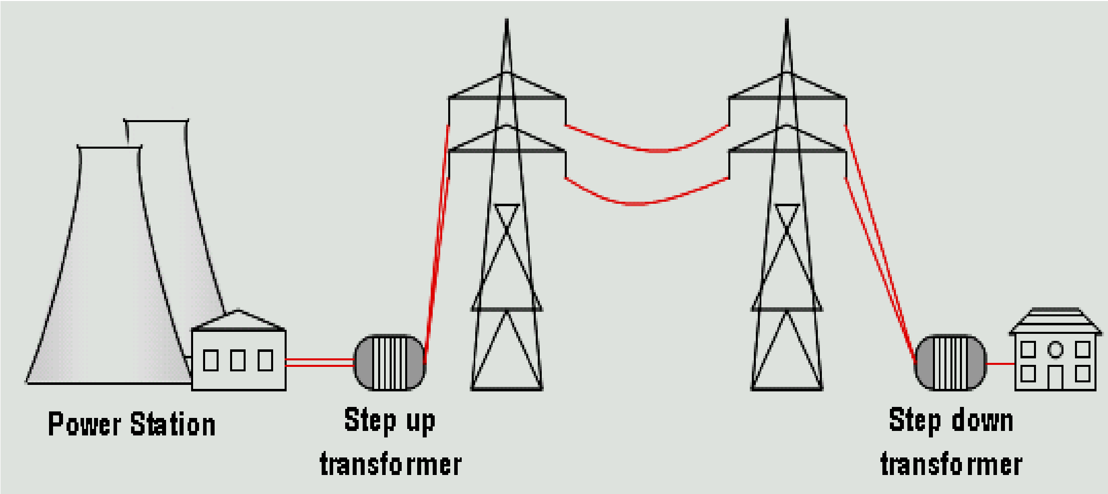

Figure 4.2 A scheme of electricity generation, supply and distribution
Source: Wikipedia (2006)

Figure 4.3 Emission of Smoke by a Coal-fired Power Station
Source: MyEcoProject (2009)

What is the Greenhouse Effect?

Greenhouse gases (GHGs) are natural gases that keep the earth warm by trapping heat in the earth's atmosphere. The main greenhouse gases in the earth's atmosphere are water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). GHGs are present in the atmosphere, and help stabilise our climate. The Greenhouse Effect is the natural process of the atmosphere letting in some of the energy we receive from the sun (e.g., ultraviolet and visible light), and stopping it from being transmitted back out into space (i.e., infrared radiation or heat). This makes the earth warm enough to support life.

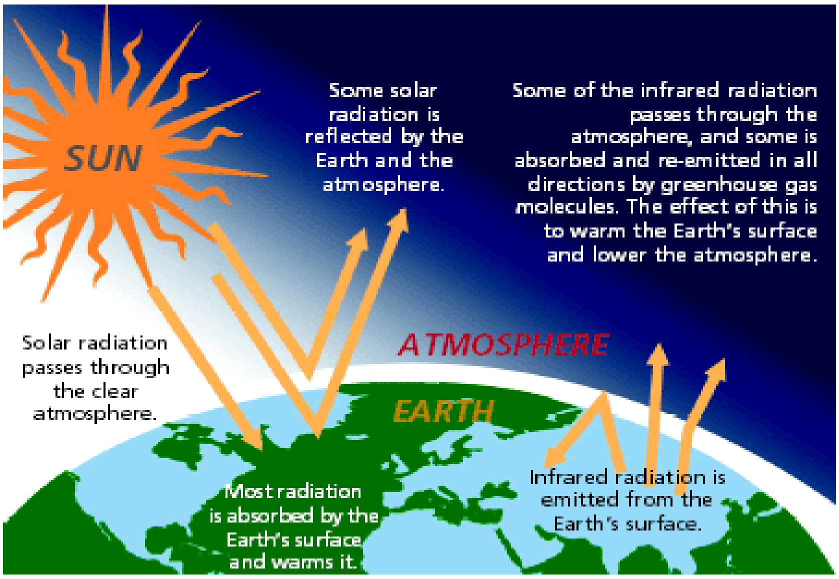

Figure 4.4 The Greenhouse Effect
Source: WHO (2010)

However, during the past century, humans have substantially added to the amount of greenhouse gases in the atmosphere by burning fossil fuels to produce energy for our use. The added gases, primarily CO_2 and CH_4, are enhancing the natural greenhouse effect, and likely contributing to an increase in global average temperature and related climate changes (EPA, 2009).

The United Nations Intergovernmental Panel on Climate Change (IPCC, 2007) reported that there has been an increase in GHGs in the earth's atmosphere since 1970. This is shown in ***Figure 4.5.*** CO_2, the most important GHG besides water vapour, is marked in red. Carbon dioxide emissions have nearly doubled from 15 Gigatons (GT) per year in 1970 to about 30 GT per year in 2004. The biggest chunk of CO_2 emissions comes from the widespread use of fossil fuels. CH_4 and N_2O emissions from agriculture have risen as well.

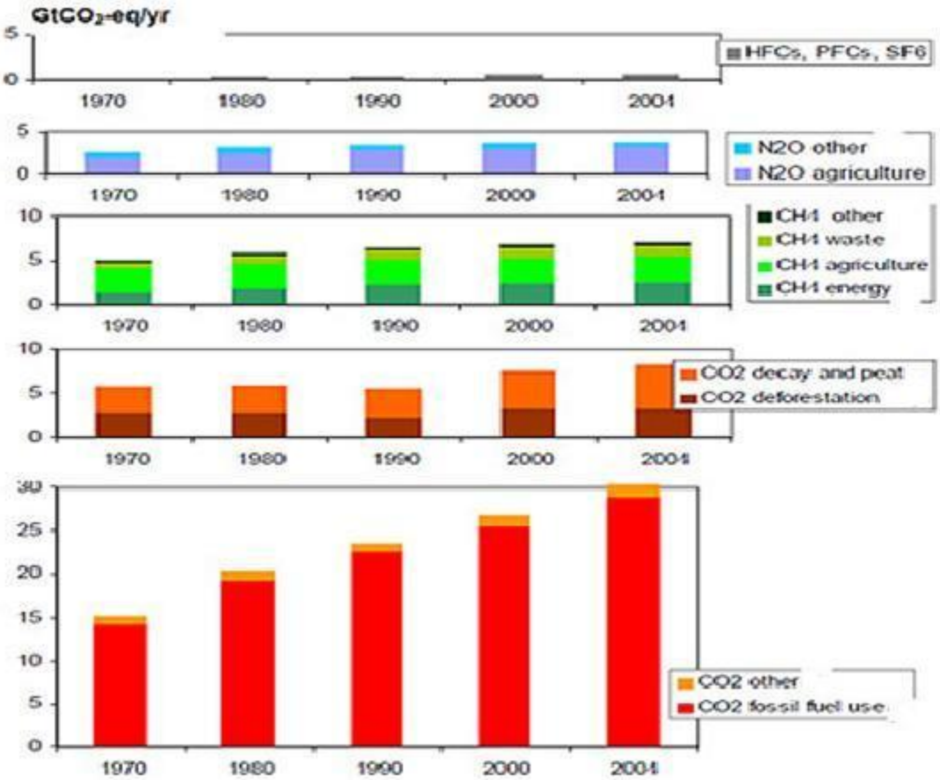

Figure 4.5 Increase in Greenhouse Gases from 1970 - 2001
Source: IPPC (2007)

The greenhouse effect is a natural process that plays a major part in shaping the earth's climate. It produces the relatively warm and hospitable environment near the earth's surface where humans and other life-forms have been able to develop and prosper. It is one of a large number of physical, chemical and biological processes that combine and interact to determine the earth's climate.

The Greenhouse Effect and Climate Change

The relationship between the enhanced greenhouse effect and global climate change is far from simple. Not only do increased concentrations of GHGs affect the atmosphere, but also the oceans, soil and biosphere. These effects are still not completely understood.

Any changes in the relative mix and atmospheric concentration of GHGs, whether natural or human-induced, will lead to changes in the radiative balance of the atmosphere, and hence the level of greenhouse warming. Studies on global climate models have drawn clear links between increased concentrations of GHGs and large-scale surface warming and other changes of climate. Serious concern at the prospect of irreversible changes to climate as a result of human activities was found on two closely linked considerations;

- the expectation that the burning of fossil fuels since the Industrial Revolution would eventually lead to significant build-up of CO_2 in the atmosphere; and

- simple physical arguments which suggest that the greater the concentration of CO_2 in the atmosphere, the greater the surface warming.

As such, climate change will mean warmer temperatures that will change rainfall patterns, causes snow and ice to melt and affect the intensity of extreme weather such as storms and heat waves. We have already begun to experience some of these impacts and many other knock-on effects to the world (Met Office, 2009).

However, there are many approaches that can be taken to mitigate climate changes. With regards to energy consumption, renewable energy (RE) and energy efficiency (EE) are the potential approaches to contribute to a better environment that we live in.

What is Renewable Energy (RE)?

RE is energy which comes from natural resources which are naturally replenished (renewable) and cannot be depleted as compared to fossil fuels sources of energy (non-renewable). Non-renewable energy sources are depleted and cannot be recreated in a short period of time.

RE can be used repeatedly without depletion. It has no polluting emissions hence it does not contribute to climate change. Above all, RE has a much lower environmental impact than the conventional sources of energy. RE is an alternative source of energy. The sources of RE include the sun, wind, tidal, wave, geothermal and biomass.

Sun

The **sun's** warmth and light produce solar energy. Passive use of solar energy involves directly capturing its warmth and light through building design. Active use happens by using technology to transform the sun's energy into electricity. Photovoltaic cells or solar panels and solar hot water systems are examples of active use. ***Figure 4.6*** shows the method of transforming sun light into electricity using solar panels.

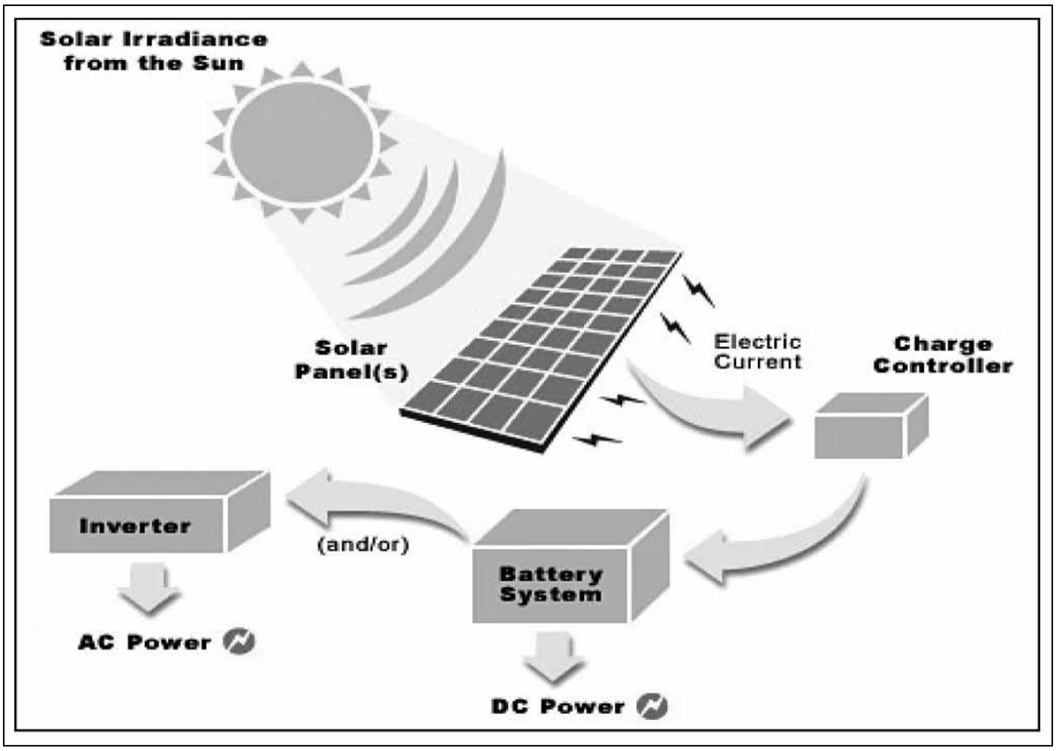

Figure 4.6 Conversion of sun light into electricity
Source: Partha Das Sharma (2009)

Wind

Wind energy is the world's fastest-growing energy source. It is a form of solar energy as weather processes that are influenced by the sun cause wind. Windmills have been used for hundreds of years. Large and small wind turbines in many countries now generate electricity for industry, homes and remote dwellings and villages. Wind turbines can be situated on land or off-shore. ***Figure 4.7*** shows the conversion system of wind energy into electricity.

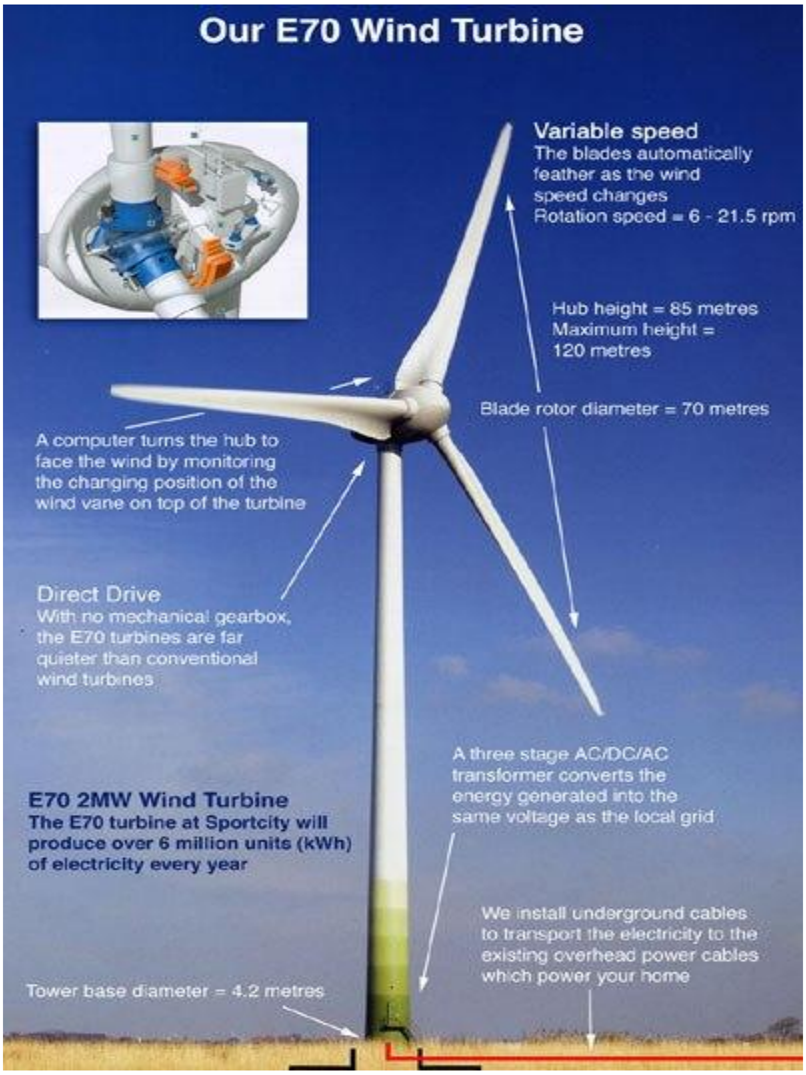

Figure 4.7 Wind energy system
Source: MyEcoProject (2009)

Wave

Wave energy is essentially stored, concentrated wind energy. The waves are created by the progressive transfer of energy from the wind as it blows over the surface of the water. The wave can then be used to create electricity applying one of the methods as shown in ***Figure 4.8.***

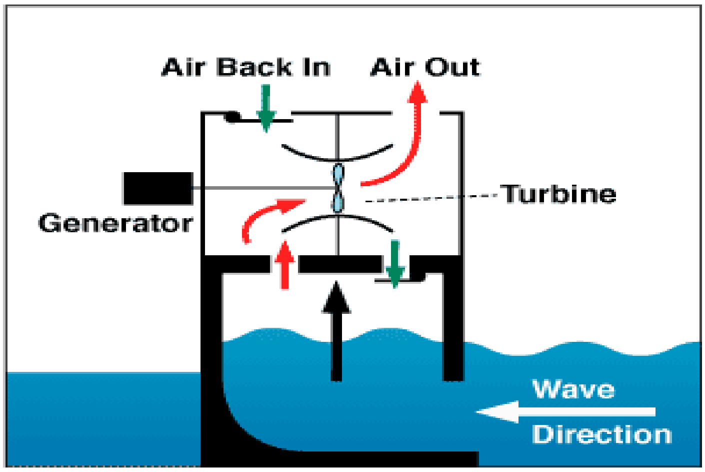

Figure 4.8 System for utilisation of wave energy to produce electricity
Source: California Energy Commission (2006)

Tidal

Tidal energy is energy that can be obtained from the changing sea levels. The tidal process utilises the natural motion of the tides to fill reservoirs, which are then slowly discharged through electricity-producing turbines. This is shown in ***Figure 4.9.***

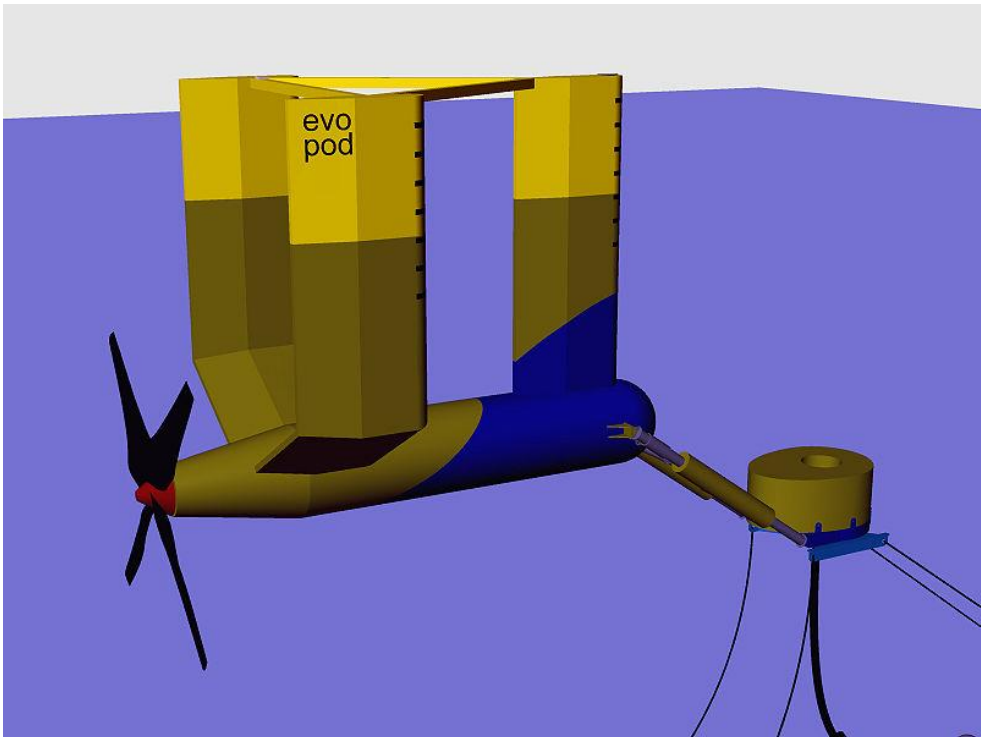

Figure 4.9 Production of tidal energy
Source: Wikipedia (2009)

Biomass

Biomass is biological material derived from living organisms. There are many sources of biomass, including:

- Agricultural crops (*e.g.,* sugar cane, corn and rapeseed)
- Agricultural residue
- Paper mill residue
- Urban wood waste
- Forest residue
- Animal waste and sewage

These sources of energy are renewable as their replacement is rapid compared to that of fossil fuels. ***Figure 4.10*** shows a simple diagram which summarises the electricity generated from biomass.

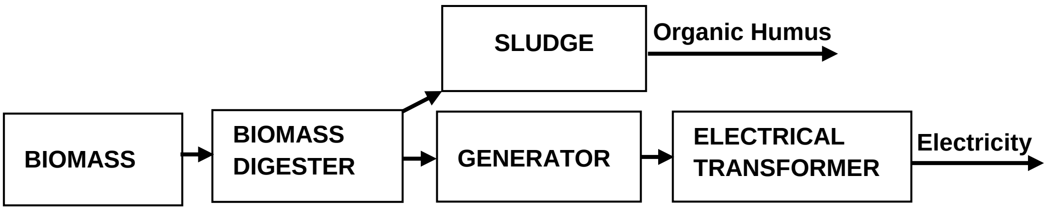

Figure 4.10 Electricity generation from biomass

Geothermal

Geothermal energy is another kind of renewable energy. It is derived from heat that is stored deep in the Earth's crust. Where this heat rises to the near-surface and heats groundwater, hot water and steam are produced. It can be directly used for domestic heating or for generation of electricity. ***Figure 4.11*** shows the use of geothermal energy to generate electricity.

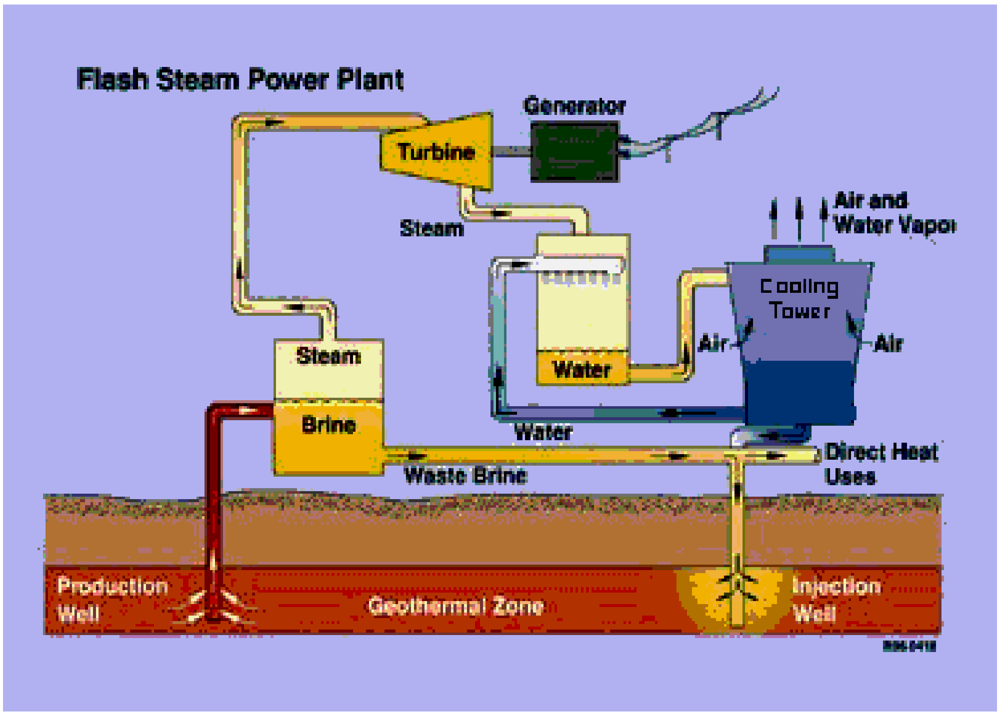

Figure 4.11 Conversion system of geothermal energy into electricity
Source: MyEcoProject (2009)

Clean Energy Generation of Thailand (A Case Study)

"Our outreach efforts have led to at least 3 Mega Watts (MW) of additional planned installations in Thailand - enough electricity for 12,000 homes," says Palang Thai's Chris Greacen. "USAID's support throughout has been essential to our efforts."

Figure 4.12 Small hydroelectric power generation
Source: USAID (2009)

Small-scale producers in Thailand are tapping alternative energy sources, including water, to reduce air pollution and decrease the country's reliance on energy imports.

Challenge

Thailand currently relies on imports, mainly crude oil, to satisfy about half of its energy needs. With a view to reducing pollution and strengthening energy security and competitiveness, the country is increasingly exploring ways to meet growing consumer and industrial needs with domestic renewable resources. Water, solar, wind, biomass and biogas generation are economically viable and could meet more than a tenth of Thailand's demand. Adopting these technologies, however, has been limited by various obstacles, including a lack of support for small-scale renewable energy producers, who were not allowed to sell electricity to utilities due to concerns about safety and compatibility.

Initiative

With assistance from USAID, a group of volunteers drafted the legislation in 2002 to allow small community- or entrepreneur-owned renewable energy generators to connect to the grid and sell excess electricity to utilities. Due in part to dialogue sparked by a USAID-sponsored study tour to the United States and training course in Bangkok for government representatives, the new regulations were approved later that year. USAID helped supply expertise and guidance through a partnership with California-based utilities with substantial experience in small-scale renewable energy. USAID also supported the organization Palang Thai in ensuring smooth implementation of the new regulations by supplying energy experts to work with the government on policy, and helping small-scale generators resolve technical and contractual barriers.

Results

The new legislation has encouraged the development of clean energy resources while improving Thailand's environment, building local economies and reducing reliance on imported fuels. Eight small-scale generators have started to sell power to the national grid, while more than 40 others, with a combined generating capacity of over 6 MW, have been given permission to connect to it. With this steady increase in renewable energy sources coming on line, the Thai government is now expanding the regulations to include larger renewable energy generators that can produce up to 5 MW (USAID, 2009).

What is Energy Efficiency (EE)?

EE or energy efficiency use means using less energy to provide the same level of energy service. In other words, EE is the practice of reducing the amount of energy used without reducing the end-use benefits enabled by that energy *(EPRI, 2010).* In terms of electricity energy use, it means using electricity wisely in order to accomplish the same task whether at home or at the workplace. EE can also be defined as lesser energy we use to generate at power plants, which reduces GHGs emission and improves the quality of our air (Energy Star, 2010).

Conclusion

Our world is experiencing climate change. One of the main causes for this is the burning of fossil fuels to produce energy for our use. Efforts should be made to mitigate this issue such as the use of RE as an alternative to non-renewable energy and EE practices. RE contributes to less dependency on fossil fuels energy sources while EE contributes to less consumption of energy to achieve the same level of quality of life. Both contribute to a better environment that we live in.

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Lesson 1

CHOOSING A GREENER ENERGY

GRADE LEVEL: High School

SUBJECT(S): Integrated Science (General Science)

TOPIC: Renewable and Non-Renewable Energy

PREREQUISITE

- Students should have prior knowledge about the forms of energy and sources of energy.
- Three days before the actual session, ask the students to search for news articles and write-ups about the different energy sources available in their community/country. Articles which are published online may also be used.

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this session, students should be able to:

- differentiate renewable from non-renewable energy sources;
- classify the sources of energy into renewable and non-renewable energy group; and
- give practical ways to conserve energy.

Climate Change Objectives:

- discuss how the massive production of greenhouse gases from fossil fuels can cause global warming and climate change; and
- cite practical measures to reduce the production of greenhouse gases which cause global warming and climate change.

MAIN CONCEPTS AND SKILLS

- Renewable energy is energy which is generated from natural sources like the sun, wind, rain, tides and can be generated again and again as and when needed. They are available in abundance and by far the cleanest sources of energy available.

- Non-renewable energy is energy which is taken from sources that are available on the earth in limited quantity. Non-renewable sources are not environment-friendly and can have serious effects on living organisms. These are called non-renewable because they can be re-generated within a short span of time. These sources of energy exist in the form of fossil fuels, natural gas, oil and coal.

- Greenhouse gases (GHGs) are natural gases that keep the earth warm by trapping heat in the earth's atmosphere. The main greenhouse gases in the earth's atmosphere are water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3).

- GHGs are present in the atmosphere, and help stabilise our climate. *Greenhouse effect* is a natural process in the atmosphere. It makes the earth warm enough to support life by letting in some of the energy in the form of ultraviolet and visible light we receive from the sun and by stopping the infrared radiation/heat from being transmitted back out into space.

- Global warming is the increase of Earth's average surface temperature due to the effect of GHGs, such as CO_2 emissions from burning fossil fuels or from deforestation, which trap heat that would otherwise escape from Earth.

- Using text-analysis and consequence map, students could differentiate and classify the energy sources into renewable and non-renewable.

MATERIALS NEEDED

- Poster on global warming or a video on global warming
- News articles and write-ups about energy sources
- Flip chart sheets or kraft paper (Mahjong paper) and marker

PRESENTATION OF LESSON

Scenario

The teacher will present a poster on global warming or if available a video on global warming. After the presentation, the teacher will lead the students' reflection on what they have observed and allow them to discuss the causes of global warming. Highlight the excessive production of GHGs as the main cause of global warming.

Guide Questions:

1. What caught your attention about this poster or video? What facts do we know about this situation?
2. What seems the most critical part of the poster or video?
3. Which parts depicted global warming? What causes global warming?

4. What is greenhouse effect? And, what are greenhouse gases?
5. What human activities contribute to the excessive production of greenhouse gases?
6. Do you think that the sources of energy that we used to run our industries and to provide comfort to our home and/or in the workplace also contribute to the excessive production of greenhouse gases?
7. Is it possible to reverse global warming? Why?
8. Are there ways to lessen the production of greenhouse gases?

Student Activities

For this lesson, the teacher may choose to implement any of the following activities depending on the level of abilities of the students.

Option 1) Develop a *consequence map* of the different sources of energy which are renewable and non-renewable.

Option 2) Organise a *debate* about the advantages and disadvantages of using alternative sources of energy.

Option 3) Draw a *comic strip* about the advantages of renewable energy sources compared to non-renewable energy.

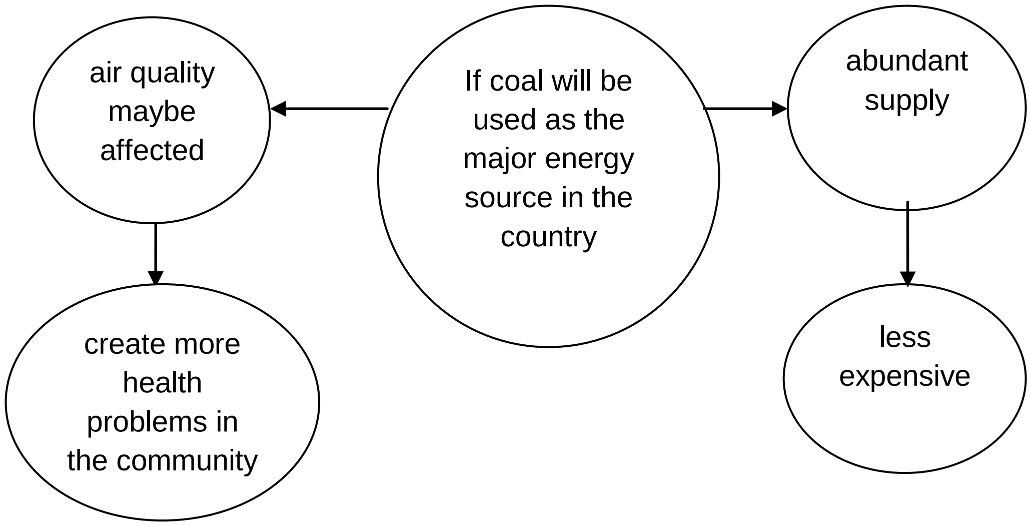
Process Guide for Teachers

1. During class discussion about global warming and excessive production of GHGs, capture the students' responses which may lead them in understanding the energy sources. Ask the students to mention the sources of energy that the country depends on to support industries and the communities. Take note of these energy sources because these will be the information materials that the students will work on in their group activity.

2. Organise the class into working groups and assign one source of energy for each group.

3. Explain how to develop a *Consequence Map* by presenting the sample diagram below:

Risks or Disadvantages **Benefits or Advantages**



4. Distribute copies of the news articles and write-ups about the different energy sources. These articles and write-ups will help the group in developing their consequence map. Guide each group as they work on the map. Assess the group's process using the attached Performance Rubric in ***Attachment 4.1.1.***

5. Advise the class that after the completion of the consequence map, there will be a plenary presentation of all the outputs. Assess the group's output using the Performance Rubric.

6. After the presentation, ask the students to classify the energy sources into two groups by utilising the information about energy sources.

7. Check how the students classify the energy sources and provide comments if necessary.

8. Introduce the terms *renewable energy* and *non-renewable energy.* Ask the students why the first group is called renewable and the other non-renewable.

9. Process the students' learning experiences using the following guide questions:

   a. What is the difference between renewable and non-renewable sources of energy?

   b. Which energy source generates lesser hazardous impact in our environment?

   c. What are the possible ways that we can adopt to effectively utilise the available energy sources in our country?

   d. Do you think it's about time for our country to explore alternative energy sources? Why or why not?

e. What can alternative energy sources do to mitigate or alleviate (ease) the effects of global warming and climate change?

Closure

- Summarise the students' learning insights by presenting a concept map about energy sources.

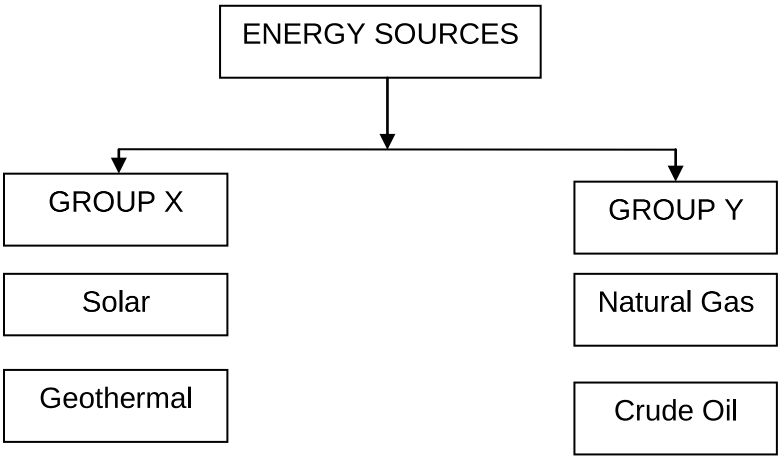
Achieving the Objectives

Objective	**This is achieved by**
Differentiate renewable from non-renewable sources of energy.	Students' participation in the preparation of consequence map on the different sources of energy and in the group presentation.
Classify the sources of energy into renewable and non-renewable energy group.	Students' interaction during the preparation of consequence map and in the group presentation.
Give practical ways to conserve energy.	Students' participation in class discussion and group activity.
Discuss how massive production of greenhouse gases from fossil fuels can cause global warming and climate change.	Reflection of students on human activities and industries that contribute to excessive production of greenhouse gases in the scenario presentation.
Cite practical measures to reduce the production of greenhouse gases which causes global warming and climate change.	Sharing of students' daily experiences and ideas on the practical methods of efficient use of energy during the scenario presentation (e.g., energy saving bulbs, hybrid car).

Assessment

1. The teacher will utilise a performance rubric during the assigned activity.

2. In a clean sheet of paper, the students will study the diagram below and answer the following questions:



Guide Questions

1. Which group will have a lesser impact on our environment?
2. In which group would you place wind? Explain your answer.
3. Which group has a limited amount of supply?
4. Which group can be utilised over and over again?
5. Give the suitable heading for Group X and Group Y.

Assignment

- Encourage the students to be actively involved in eco-friendly activities:

  1) Organise an eco-club and choose a name for their club (e.g., “Environmental Watch”, “Energy Savers”, “Green Energy Club”)

  2) Launch a school-community campaign that will advocate the usage of renewable energy. They may use video clips, skits, brochures, compose a poem or song, sponsor a mini-seminar and invite resource speakers or any creative approach to raise people’s awareness on energy conservation.

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Attachment 4.1.1
Group Performance Rubric

Subject/Topic:____

Project/ActivityTitle:____

Date:____

Group Name:____

Team Members:____

Group Process	**Below Average**	**Satisfactory**	**Excellent**
1. Has clear objective of final output	1, 2, 3	4, 5, 6	7, 8, 9
2. Properly organised to complete the task	1, 2, 3	4, 5, 6	7, 8, 9
3. Managed time wisely	1, 2, 3	4, 5, 6	7, 8, 9
4. Acquired needed information and knowledge base	1, 2, 3	4, 5, 6	7, 8, 9
5. Communicated efforts with teacher	1, 2, 3	4, 5, 6	7, 8, 9
Group Output	**Below Average**	**Satisfactory**	**Excellent**
1. Format of Output Presentation	1, 2, 3	4, 5, 6	7, 8, 9
2. Manner of communicating the output (i.e., speaking and writing)	1, 2, 3	4, 5, 6	7, 8, 9
3. Data organisation and structure	1, 2, 3	4, 5, 6	7, 8, 9
4. Creativity	1, 2, 3	4, 5, 6	7, 8, 9
5. Demonstrates knowledge on renewable and non-renewable energy sources	1, 2, 3	4, 5, 6	7, 8, 9, 10
6. Integrates concepts of renewable & non-renewable energy with climate change.	1, 2, 3	4, 5, 6	7, 8, 9

Source: http://www.teach-nology.com/cgi-bin/project_rub.cgi

Lesson 2

SAVE ENERGY, SAVE THE EARTH

GRADE LEVEL: High School

SUBJECT: Physics

TOPIC: Measuring Electrical Energy

PREREQUISITE

- Students should have prior knowledge about the concept of work, power and energy.
- They should also know how to measure current, voltage and resistance and apply Ohm's law.

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this lesson, the students should be able to:

- explain the concept of electric power;
- calculate electrical energy; and
- identify common household electrical devices that consume a lot of electricity.

Climate Change Objectives

- cite ways to conserve electrical energy; and
- explain how consumption of energy can affect climate change.

MAIN CONCEPTS AND SKILLS

- Electric power is the rate of consuming energy. The unit of power is *Watt (W)*. One watt is the *Power (P)* generated by a current of 1 *Ampere (A)* flowing due to a potential difference of *1 Volt (V).*

Power = Voltage x Current ***P = VI***

- Electrical energy is sold in kilowatt-hours *(kWh).* The amount of electrical energy consumed is equal to the power used multiply by the time it is used. Note that electrical energy can also be expressed in Joule *(kJ)*

Energy = Power x Time ***Energy (kWh) = (VI) t***

- All electrical devices or appliances are usually marked to show the amount of power they consume and their operating voltage.

- The electrical energy consumption of common household appliances or devices like light bulbs can be measured using the Brightness Meter or Data Logger.

MATERIALS NEEDED

- Power pack, connecting wires, bulb holder, 3 different light bulbs (for each group)
- Flip chart sheets (Mahjong paper), marker pens (different colors)
- Concept Cartoon sheets,
- Brightness Meter or Data Logger*[optional]*
- If the school has no Brightness Meters or Data Loggers, the teacher may provide the brightness meter readings and change the instruction on the Activity Worksheet.

PRESENTATION OF LESSON

Scenario

- The teacher will present a video on the celebration of the "**Earth Hour"**. For more information about the "**Earth Hour"** visit this website: http://www.earthhour.org/
- After the presentation of the video, ask the following questions.
  1. What important events did you see?
  2. What is the purpose of this world-wide project?
  3. What form of energy is involved in this project?
  4. Will this project help mitigate the effects of climate change? Why?

Student Activities

- Students will actively participate in a hands-on group activity to measure electrical energy using commercial light bulbs. They will analyse and present the results of this group work.

Process Guide for Teachers

1. Present a brief discussion about the concepts of electric power and electrical energy and review the concepts of current, voltage and resistance.

2. Divide the class into working groups. Explain the procedure of the activity and distribute the *Students Worksheet* to the students. ***(Attachment 4.2.1)*** You can modify the Activity Worksheet based on classroom preference and requirement.

3. While the students are working in groups, walk around to clarify possible queries from the students to facilitate the activity.

4. Upon work completion, ask each group to present the results of their activity. Provide comments on the quality of their outputs after each presentation.

5. Present ways to evaluate possible savings from changing the types of lamps used. The efficiency of industrial lights varies based on how much light they give off (in lumens) in relation to how much energy they consume (in watts). The efficiency of lights range from under 20 lumens per watt for incandescent lamps up to 185 lumens per watt for low pressure sodium lamps.

6. Distribute the *Assessment Worksheet* to students.(See ***Attachment 4.2.2***)

7. Draw the connection between wastage of energy and climate change and discuss its relationship using the ***Concept Cartoons***. (***Attachment 4.2.3***)

Closure

1. Discuss with the students the connection between wastage of energy and climate change by using the *Concept Cartoon Sheet.* Reiterate that most power plants generate electricity by burning coal and other fossil fuels and thus contribute to greenhouse gases. Emphasise the values and importance of saving energy.

2. Connect the concept of conserving electrical energy to mitigate the effects of climate change as shown below:

Less usage of energy → Less generation of energy → Less emission of CO_2 → Reduce Global Warming

3. Ask for suggestions from students on how to possibly reduce our GHG releases. *Examples:*

   - Energy conservation (e.g., unplug appliances when not in use, do not overcharge your mobile phones).
   - Improve energy efficiency (e.g., shift from incandescent bulbs to compact fluorescent lights or better yet, shift to Light Emitting Diodes [LED]).
   - Promote and shift to alternative, renewable fuel (non-fossil fuel such as wind, solar and biomass).
   - Control urban sprawl (minimise dependence on motorised transport to move people, services and products).
   - Improve mass transport system.

Achieving the Objectives

Objective	This is achieved by
Explain the concept of electric power.	Students' interaction during class discussion and performance in group activity.
Calculate electrical energy.	Observing and collecting information about the various light bulbs. Students calculate power using the formula: *E = Power x Time*
Identify common household electrical devices that consume a lot of electricity.	Students answer the Assessment Worksheet.
Explain how consumption of energy can affect climate change.	Students justify their ideas, in group discussion and student-teacher interaction.
Cite ways to conserve electrical energy.	Brainstorming for new possibilities, organising and launching a community-based "Earth Hour" project.

Assessment

1) During the lesson process:
   - Observe how the students carry out the task in the ***Student's Worksheet (Attachment 4.2.1)***, i.e., collection of information, discussion and debate. Use the *group activity rubric* to evaluate their performance.
   - Check on the calculation of electrical energy using the three different light bulbs.
   - Assess the groups' presentation and justification of their choice of light bulb. Use the *group presentation rubric* to assess their performance.
2) After the lesson, review the students' responses from the Assessment Worksheet.

Assignment

- Ask the students to organise and launch a community-based **Earth Hour** project. They will conduct an inventory of the amount of electrical energy saved during the event.

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Attachment 4.2.1
Student's Worksheet

THE ENERGY SAVING BULB

Instructions:

1. Turn on the switch and observe the brightness of each bulb as shown below.
2. Use a *Brightness Meter* and record the brightness of the bulbs.
3. Gather some data about each bulb by inspecting the information on the respective light boxes.

BULB A	BULB B	BULB C



Sources: RTCNCA (2010)   Armin Kübelbeck (2007)   Adamantios (2007)



Using the Brightness Meter or Data Logger, measure the brightness of each bulb and record your readings in **Table A** below.

Table A

Type of Light Bulb	Brightness	Power	*Energy Consumed after 1 hour (Energy = Power x Time)	Cost of Usage at 10 cents per kJ
A		100 W		
B		20W		
C		18W		

* *Note*: kilowatt-hour (kWh) may also be used as a unit of measure.

5. Refer to the packaging boxes of the bulbs. Record the power for each bulb in Table A above. Then calculate the energy consumed by each bulb.

   a. Which bulb consumes the highest energy?
   ………………………………………………………………………………………
   ……………………………………………………………………………

   b. What do you notice about the brightness of the bulbs?
   ………………………………………………………………………………………
   ……………………………………………………………………………

   c. Which bulb is energy saving?

   ………………………………………………………………………………………
   ……………………………………………………………………………

6. Use the information in **Table B** and answer the following questions. This is just a sample data. You may use the actual data available in your community.

Table B

Type of Light Bulb	**Feature**	***Price per Unit** (Convert currency unit if necessary)	**Life Span**
A	Soft white	RM 1.70	150 hours
B	White	RM 12.90	8000 hours
C	White	RM 13.93	5500 hours

Guide Questions

a. Which light bulb is the cheapest? ……………………….

b. Which light bulb has the longest life span? ……………………….

c. Which light bulb will you choose? Why? Explain. ……………..……

Attachment 4.2.2
Assessment Worksheet

Direction: Answer all the questions.

1. Calculate the amount of energy consumed by an electric light bulb of 200W if switched on for one (1) hour.

2. Name 3 electrical appliances that may consume a lot of energy.

3. List 3 ways of conserving energy.

4. State 3 reasons why we must conserve energy.

5. How does conserving energy relate to climate change?

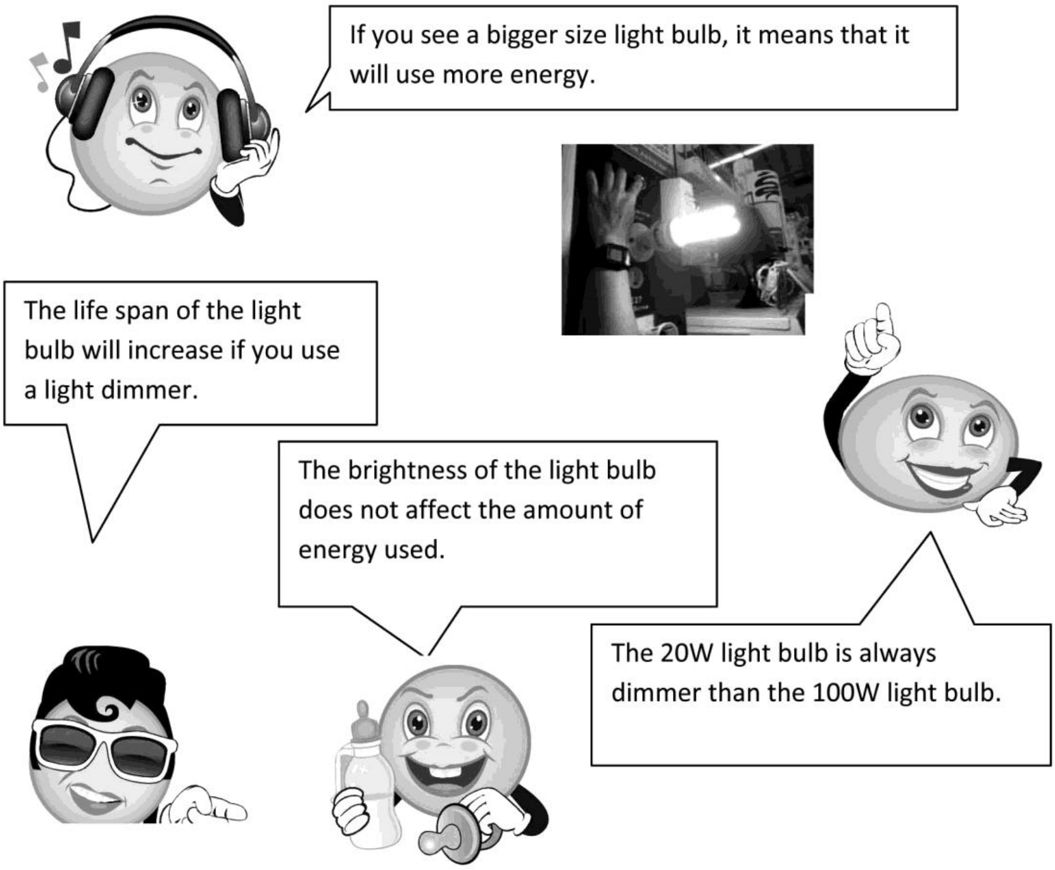
Attachment 4.2.3
The Concept Cartoon

WHAT DO YOU THINK?

Direction: Read the cartoon script carefully and answer the following guide questions:

Guide Question:

1. Does the size of the bulb determine the amount of energy it uses?
2. Does making the light dimmer prolong the life of a light bulb?
3. Do all bulbs of the same brightness use the same amount of energy?
4. Does a low wattage bulb give dimmer light?



Attachment 4.2.4
Answers to Activity Worksheet

Instructions

a) Using the Brightness Meter, measure the brightness of each bulb and record your readings in **Table A** below.

Table A

Type of Light Bulb	Brightness	Power	Energy Consumed after 1 hour (Energy = Power x time)	Cost of Usage at 10 cents per kJ
A	*1000 Lux*	100 W	*100 x 60 x 60 = 360 kJ*	*RM 36.00*
B	*1000 Lux*	20W	*20 x 60 x 60 = 72 kJ*	*RM 7.20*
C	*1000 Lux*	18W	*18 x 60 x 60 = 64.8 kJ*	*RM 6.48*

b) Refer to the packaging boxes of the bulbs. Record the power for each bulb in **Table A** above. Then calculate the energy consumed by each bulb.

i) Which bulb consumes the highest energy? *Bulb A*

ii) What do you notice about the brightness of the bulbs? *Same brightness*

iii) Which bulb is energy saving? *Bulb C*

c) Use the information in **Table B** below, and answer the following questions.

Type of Light Bulb	Feature	Price per Unit	Life Span
A	Soft white	RM1.70	150 hours
B	White	RM 12.90	8000 hours
C	White	RM 13.93	5500 hours

i) Which light bulb is the cheapest? *Bulb A*

ii) Which light bulb has the longest life span? *Bulb B*

iii) Which light bulb will you choose and why? Discuss. *Choice depends on energy consumed, cost of energy used, price and life span of bulb.*

Attachment 4.2.5
Answers to Assessment Worksheet

1. What is the principle of conservation of energy?

    - <u>In a closed system energy cannot be created nor be destroyed. It can be transformed into different forms.</u>

2. Calculate the amount of energy used when an electric light bulb of 200W is switched on for 1hour.

    - <u>200 x 60 x 60 = 720 000 J (720 kJ)</u>

3. Name 3 electrical appliances that may consume a lot of energy.

    - <u>Example: water heater, oven, electric kettle, hot plate, air conditioner</u>

4. List 3 ways of conserving energy.

    <u>i) Switch off the electrical appliance when not in use</u>

    <u>ii) Use renewable energy such as solar energy</u>

    <u>iii) Buy energy conserving electrical appliances</u>

5. State 3 reasons why we must conserve energy.

    <u>i) Save money</u>

    <u>ii) Reduce emission of CO_2</u>

    <u>iii) Reduce green house effect</u>

6. How does conserving energy relate to climate change?

Less usage of energy → Less generation of energy → Less emission of CO_2 → Reduce Global Warming

Resources

Lesson 3

ELECTRICAL ENERGY AND CARBON FOOTPRINT: WHICH FITS BEST?

GRADE LEVEL: Fourth Year High School (Grades 10 to 11)

SUBJECT: Advanced Mathematics, Statistics

TOPIC: Measures of Central Tendency and Line of Best Fit

PREREQUISITE

1. Students should have good background knowledge on Mean, Median, and Mode.
2. Knowledge on how to draw a graph given a table of values using graphing paper and using MS Excel.
3. Students should be given time to watch the Hollywood movie "2012'' prior to the lesson.

DURATION: 2 to 3 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this lesson, students should be able to:

- identify the best measures of central tendency (i.e., mean, median, and mode) that can be utilised to analyse a given data;
- calculate the appropriate measures of central tendency given a set of data;
- plot the line of best fit and calculate its slope (gradient) and give its interpretation;
- apply the concept of equation of straight lines through extrapolation and use it to predict possible temperature change in the future; and
- use the line of best fit to predict the amount of money the school has to pay for energy consumption per month or per annum.

Climate Change Objectives:

- identify the implications of a general increase in temperature over a period of years;
- determine the factors to consider when the earth's temperature is rising by a certain amount of degrees using gradient (or slope) obtained;

- relate the increase in annual energy consumption with the general increase in atmospheric temperature;
- suggest ways to reduce energy consumption thus, reducing the carbon footprint; and
- take the initiative to reduce the energy consumption through sustainable practices.

MAIN CONCEPTS AND SKILLS

- Extreme weather will cause higher consumption and production of energy, whereby energy use with emission of gases e.g., CO_2 will contribute to greenhouse effect with subsequent impact on global warming and climate change.
- The earth's temperature rises by a certain amount of degrees using gradient (or slope) obtained. This is decided based on two (2) important data obtained:
  a) The change in temperature colour shows an increase in temperature;
  b) The straight line graph plotted by the students or from the Excel files shows an average increase in temperature.
- The students will experience firsthand application of statistics by studying the temperature data.
  - ➢ The students will analyse and interpret the amount of electricity used by the school for the past three years (e.g., 2007, 2008 and 2009). Using the line of best fit, they will estimate the future energy consumption of the school.
  - ➢ The slope or gradient in the equation which represents the data determines how much is the increase on a given time interval.
  - ➢ The Mean, Median, and Mode are important measures of central tendency that can be used to interpret data. The **mean**, shows what is "typical" to the data; the median gives the information on **median** value and; the **mode** gives the information on how much is the largest value.
- Using their skills in interpreting graphs and presentation, the students will be aware of their role and contribution in reducing electrical consumption in their school and homes.

MATERIALS NEEDED

- white board, laptop and LCD for presentation
- three years monthly electric bills of the school
- temperature data from meteorological department/government agency (See the **URL** below)

(i). http://www.TuTiempo.net
(ii) http://www.fightglobalwarming.com/carboncalculator.cfm
(iii) http://www.enviroduck.com/carbon_footprint_calculations.php

PRESENTATION OF THE LESSON

Scenario

Allow the class to view a portion of the Hollywood movie entitled "2012" which shows the damages after the catastrophe. After the video presentation, ask the students to recall the movie by answering the following questions:

- What scenes caught your attention?
- What do you think are the events that caused great damage to the environment? Do you think it will happen in real life? Will it happen to Earth in the future? Why or why not?
- What could be the possible causes of these catastrophes in the movie?
- What will you do differently to prevent those great catastrophes to happen?

For the initial discussion, the students should be able to identify climate change as one of the key reasons for the changes on earth's temperature and to connect this phenomenon to energy consumption and the greenhouse effect. The teacher will then lead the students to understand and see the importance of data in relation to energy consumption and rising of Earths' surface temperature.

In this lesson, the students will use the school data on monthly electric consumption for two or three consecutive years to predict how much energy can be consumed in the next few years using the line of best fit. The line of best fit can be generated using MS-EXCEL.

Student Activities

- In this lesson, students will undergo three activities. Initially, they will study a given graph that depicts the variations of the earth's surface temperature and estimate the amount of "departure" (increase or decrease) in temperature. Using these estimated values, they will identify the mean, median, and mode and create their own "scatter plot" graph using MS EXCEL.

- For the second activity, students will analyse another graph and identify the given equations. Using the values behind the equation, they will determine the average amount of change in temperature by year 2000. They will have to explain how they arrive at their answer.

- On the third activity, students will be given copies of the school's electric bill consumption for the past three (3) consecutive years. If this is not available, the teacher may ask the students to bring their home electric consumption bill for the past two to three consecutive years. Using the given worksheet, students will analyse the pattern of electric consumption and make a conclusion in relation to temperature. They will also brainstorm on how to possibly reduce the consumption of electricity in relation to carbon footprint

Process Guide for Teachers

a. Show to the students a presentation related to change in climate which will affect human lives and environment.

b. Organise the students in groups of five and ask the students to appoint a leader for better coordination. Distribute the worksheet to each group. ***(Attachment 4.3.1)***

c. Seek the help of students in calculating the appropriate average and input data to get an overall picture of temperature change.

d. Allow the students to interpret the data and answer the questions from the worksheet.

e. Guide the students to the part in the worksheet which shows the school's monthly electricity bills collected over a three-year period. Ask the students to present the data and then interpret it.

f. Show to the students the correct data using the computer *(Spreadsheet)* for their reference and discuss the issues (e.g., how to plot the line of best fit, calculate the slope and interpret data).

g. Tell them to answer the questions in the worksheet in relation to electric consumption and to suggest ways to reduce the electric bills/consumption.

h. Ask the students why electric consumption is related to carbon footprint.

i. Explain what carbon footprint is, if the students are not familiar with the terminology.

j. Solicit ideas from students in finding ways to reduce electric energy usage.

k. Encourage students to make resolutions to become more responsible global citizens and students of the school.

Closure (optional)

Allow each group to discuss among themselves for a few minutes and to present their resolutions and summaries on what was learned in a creative way (e.g., poem, song, chant or slogan, others).

Achieving the Objectives

Objective	This is achieved by
Identify the implications of a general increase in temperature over a period of years.	Group discussion among students to identify change in temperature distribution over the years from cool blue to firefly red patches and by looking at the line graphs which give a positive slope.
Determine the factors to consider when the earth's temperature is rising by a certain amount of degrees using gradient (or slope) obtained.	Using the spreadsheet, the students look for the equation of the trend line which is a linear graph. The gradient is a positive value and it shows the amount of average increase in temperature per year.
Apply the concept of equation of straight lines through extrapolation and use it to predict possible temperature change in the future.	Using the concept of extrapolation with the condition that all events and variables remain the same, the students can predict the possible temperature in the next few years.
Use the line of best fit to predict the amount of money the school has to pay for energy consumption per month or per annum.	Drawing a bar chart which shows the gradual increase in electric consumption. The students can predict the amount by looking at the formula of the trend lines in the spreadsheet and through simple calculation to arrive at the amount to be paid in 2020.
Relate the increase in annual energy consumption with the general increase in atmospheric temperature.	Actual observation will help students realise that an increase in temperature of the surroundings would trigger them to use the electric fans and air-conditioners more often. This is further verified by the data of the school electric bills per month particularly during hotter days/months.
Suggest ways to reduce energy consumption thus, reducing the carbon footprint.	Group discussion and sharing in class to come-up with new possibilities to reduce electricity consumption and thereby reduce the release of CO_2 gases causing green house effect.
Take the initiative to reduce the energy consumption through sustainable practices.	Allowing students to summarise what they have learned and to share how they can make a difference through adoption of practical energy saving measures. Students make resolutions to help reduce electricity consumption through energy conservation and commitment to be more civic and environmental conscious.

Assessment

Students are assessed using a performance rubric that captures the following dimensions:

1. Accuracy of answers provided in the worksheet.
2. Level of enthusiasm on group presentation and sharing of outputs.
3. Level of participation in group/class discussion.
4. Resolutions/suggestions are relevant, rational, logical and up to date.
5. Correct and logical interpretation of graphs and data.
6. Use of appropriate measures of central tendency to interpret the given data.
7. Use of critical thinking based on the following criteria:
   - suggestions to reduce electric energy usage are logical/sensible and are parallel to what the government is doing;
   - non-compromised idea yet diplomatic enough to be carried out in school to indirectly contribute to the reduction of carbon footprint and to work on resolutions towards reducing the electricity consumption in school and at home (e.g., air conditioning, and electric fans);
   - ideas are acceptable to all school stakeholders and are sustainable (e.g., planting more trees – green project, organising talks to promote awareness of climate change and energy conservations);
   - able to carry out healthy debates and work together with school authorities to achieve common goals;
   - able to predict sensibly and logically the future scenario based on the mathematical and statistical data or graph plotted.

Assignment

Students will choose any of the following resolutions to address the impact of climate change on energy efficiency:

- design a poster of awareness and/or school website
- write a suggestion or appeal letter to the school principal
- present their ideas to reduce electric consumption and other energy saving measures in a forthcoming school assembly (e.g., flag ceremony, school programmes/special affairs)

Additional Notes

- Suggested Enrichment and Integration
  - ✓ Introduce the concept of dispersion and how it reflects the data.

- ✓ Use graphing calculators, Geometer's Sketchpad Software, etc. instead of Microsoft EXCEL.
- ✓ Set-up a student website/webpage on climate change and energy to enable them to apply what they have learned.
- ✓ Use games to stimulate generation of ideas in energy conservation practices.
- ✓ Set-up an environment group to reduce the carbon footprint of the school and initiate an energy saving campaign in school and the community.
- ✓ Integrate the concepts of climate change and energy in other subjects like English, Geography, History, Moral Education, Civics, Chemistry and Biology.

- ➢ The average temperature of the years listed in the EXCEL files are not at regular intervals because the temperatures of certain years are not complete or not available.
- ➢ The temperature colour using the conditional format in EXCEL needs to be changed in accordance to specifications used by each country.
- ➢ On the consumption of electricity, instead of using the amount of money paid monthly by the school, another option would be to calculate the amount of electricity based on the amount of wattage used monthly by the school.
- ➢ The conditional format used in the module is Microsoft EXCEL 2003 and may not show the same results as intended in Microsoft EXCEL 2007 *(Compatibility is not guaranteed).*

RESOURCES

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Attachment 4.3.1
Student's Worksheet

Activity 1) Instruction: Study the given graph below and answer the guide questions.

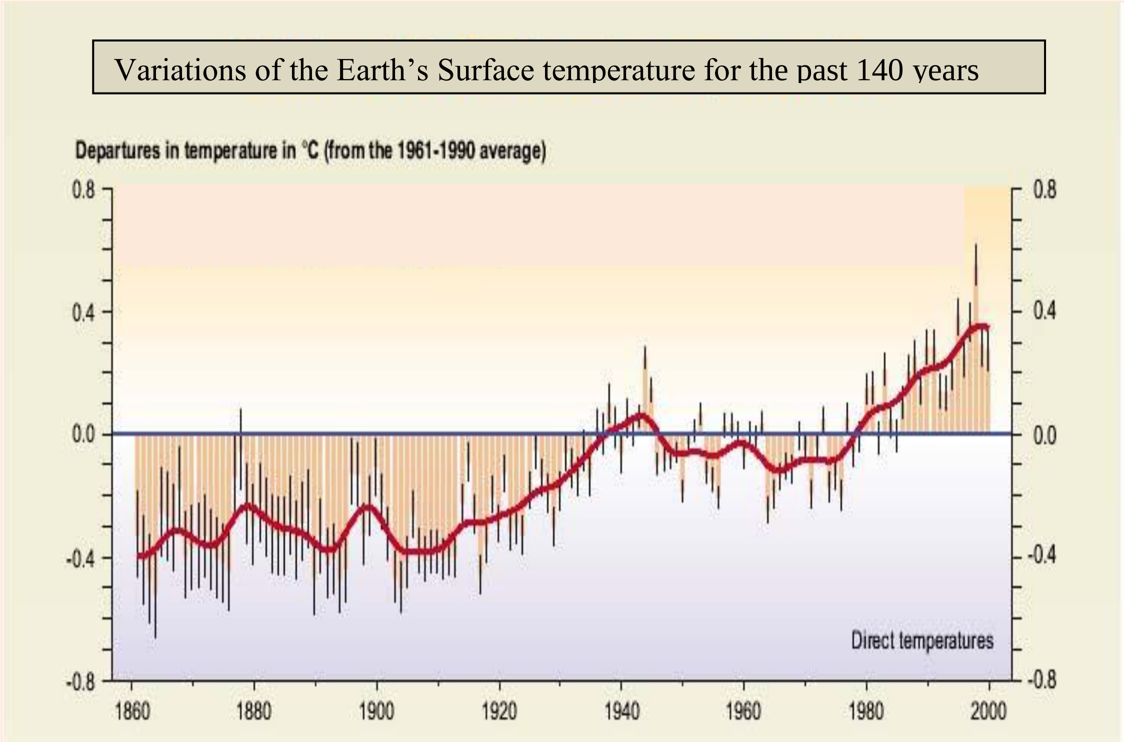

Figure 1 Chart of Variations in the Earth's Surface Temperature
Source: BBC/OU Open2.net-The World Around Climate Change, www.open2.net/coast/introducingclimate change.html

Guide Questions:

- What information can be obtained from the graph?
- In what year does the temperature start to increase?
- Estimate the amount of increase or decrease of temperature for each year and in between years. Make a table of values showing the years and amount of "departure" in temperature.
- Identify the median, mean and mode of the data. Discuss with your group mates.
- Using MS-EXCEL, generate your own a graph using "scatter plot" and compare with the graph above.

Activity 2) Instruction: Study the graph below and answer the following questions.

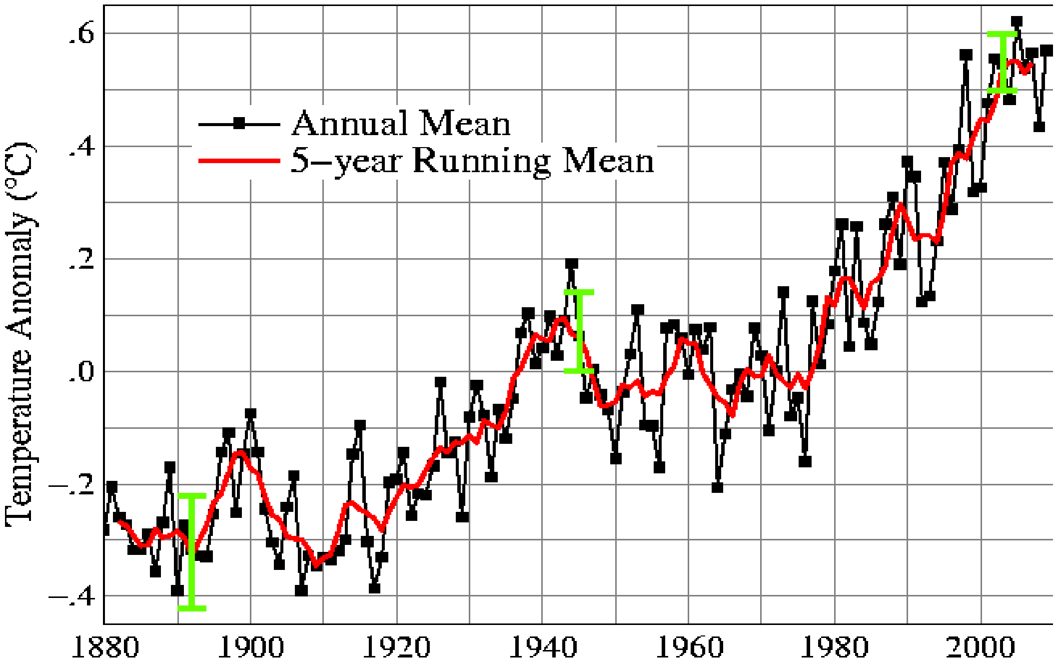

Figure 2 The Change in Global Surface Temperature From Years 1880-2000 Average Temperatures
Source:
http://en.wikipedia.org/wiki/File:NASA_global_temperature_since_1880.gif

Guide Questions:

- What information can be obtained in the graph above?
- Can you determine the average amount of change in temperature after the year 2000? How?

Activity 3) Instruction

- Draw a graph based on the school electric bills collected over the past 3 years.
- Answer the following questions:
  a. Which year has the biggest consumption of electricity? Discuss why.
  b. What do you observe? What pattern do you see?
  c. What can be concluded about electricity consumption in relation to the temperature?
  d. How is electricity consumption related to carbon footprint?
- Identify new possibilities to reduce the consumption of electricity and/or carbon footprint.

CHAPTER V: Impact of Climate Change on FOOD SECURITY

[SEAMEO SEARCA]

Introduction

Will climate change wipe out our food supply and create an irreversible hunger among all peoples of the earth? How much havoc will earth warming bring on our food resources: crops, livestock, trees, and fishes? What are our chances of surviving in a changing climate hostile to the ecosystems that host our crops, livestock, trees, and fishes? This chapter makes a connection between climate change and food shortage by discussing first and foremost, the basic principles that enable the environment to nurture life. It explains how climate change disrupts the environment's natural cycles and hinders the ecosystem's capacity to grow food resources.
However, amidst the ill impacts of changing climate on food resources, this chapter also paints a picture of hope by educating young minds on how to make earth a friendly and food-secure place to live.

Basic Environmental Principles

Seven environmental principles govern the health and sustainability of our earth and its resources (PEMSEA, 2010). These include: (1) Nature knows best; (2) All forms of life are important; (3) Everything is interconnected to everything else; (4) Everything changes; (5) Everything must go somewhere; (6) Ours is a finite earth; and (7) We are stewards of this earth.

In order for us to understand better the link between climate change and food production, we discuss only two environmental principles that will explain the close connection between them.

Nature knows best. This is one of the basic environmental principles governing planet Earth. For centuries, earth has hosted and sustained all living organisms through the natural processes that occur above and down below its surface. These natural processes transfer energy, chemical elements (nutrients), and water to support all life forms. Examples of the natural processes occurring continuously are the water, carbon, nitrogen, sulfur, and phosphorus cycles, (see ***Figure 5.1***) which are generally lumped as the biogeochemical cycle (California State University Monterey Bay [CSUMB], n. d.).

Everything is interconnected. This principle explains why climate change endangers the supply of food and fishes. To be able to reproduce, plants, animals, and fishes need to thrive in a balanced ecosystem. In a balanced ecosystem, natural processes such as the water, carbon, nitrogen, and phosphorus cycles (Green Facts, n. d.) (or the nutrients' cycle) seamlessly occur to deliver the nutrients living organisms need for them to grow and reproduce. The balance in the ecosystem is called **homeostasis** or the ability of the communities to interlink with each other, whether plant or animal communities, to perform their roles and functions in a given niche; while simultaneously adjusting either internally or externally with the changes in the climate patterns, food availability, and many others in the environment (Morning Earth, n. d.). Carbon and water are key elements needed by farmers to grow our food resources.

Carbon Cycle. Under the "*Nature knows Best" principle*, we focus our attention on the carbon cycle (***Figure 5.1***) and the water cycle (***Figure 5.2***) Carbon forms the backbone of all organic molecules. Our genetic material (DNA and RNA) and proteins, which are vital for life, are made up of carbon. Aside from being an essential element, carbon is also special because it can bond to almost any other molecule. It is the major element within our bodies (Oracle ThinkQuest, n. d.). Carbon, the key element of all life on earth, has a complex biogeochemical cycle that is greatly important to global climate change. Plants continuously remove carbon from the atmosphere and use it to create carbohydrates and sugars to build up their tissues through the process of photosynthesis (Life and Biogeochemical cycle, n. d.).

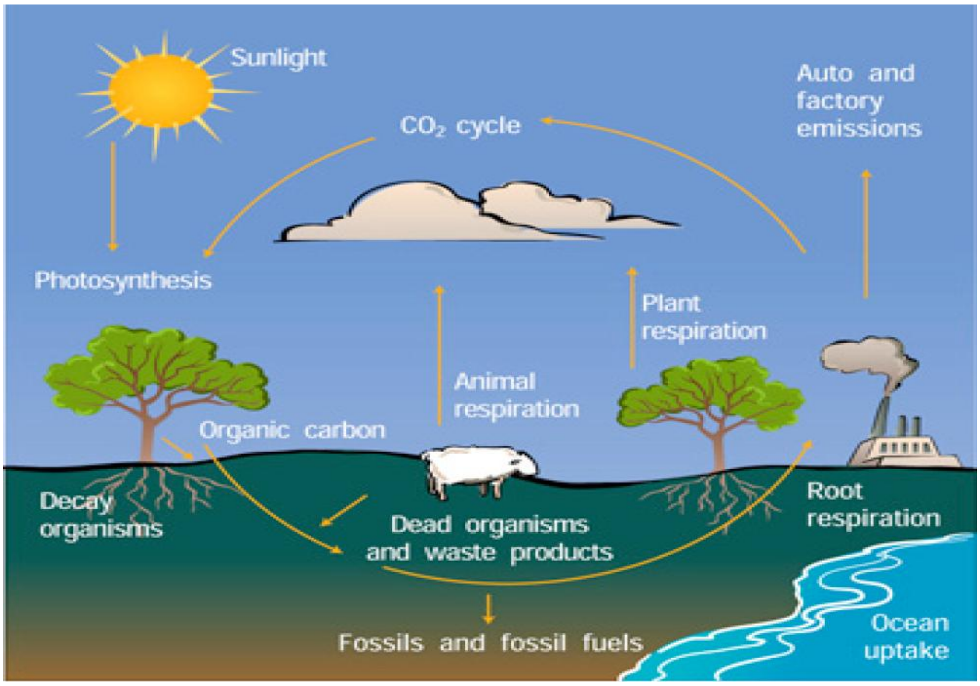

Figure 5.1 Carbon Cycle.
Source: Windows to the Universe (2010)

From the air, carbon is moved to the plants through photosynthesis (Farabee, 2006) which enables the plants to produce food for the plants to grow. O_2, the byproduct of this process, is released to the environment. By extracting CO_2 to perform photosynthesis and releasing O_2 as a byproduct, the plants both purify and cool the environment.

After the plant has fixed the carbon, it transfers from the plants to animals through ingestion. As animals consume the plants, they obtain carbon from their food as well. The next destination for carbon is the soil—this time, when plants and animals die, their bodies, wood, and leaves decay leaving carbon buried under the ground. After millions of years, this carbon will turn into fossil fuels.

CO_2 is a greenhouse gas and locks in heat in the atmosphere. Its absence and the absence of other greenhouse gases will make the earth frozen. But humans have burned so much fuel already. Today, there is about 30% more CO_2 in the air than there was about 150 years ago. The atmosphere has not held this much carbon for at least 420,000 years according to data from ice cores. The recent increase in the amounts of greenhouse gases such as CO_2 significantly affects the warming of our planet.

***Water Cycle*.** One of the natural cycles that keeps the temperature of the earth, as well as the growth and reproduction of plants and animals, is the water cycle, also known as the *hydrologic cycle*. It is the constant movement of water on, above, and below the surface of the earth (Wikipedia, n. d.). At different stages in the cycle, water can change into liquid, vapour, or ice.

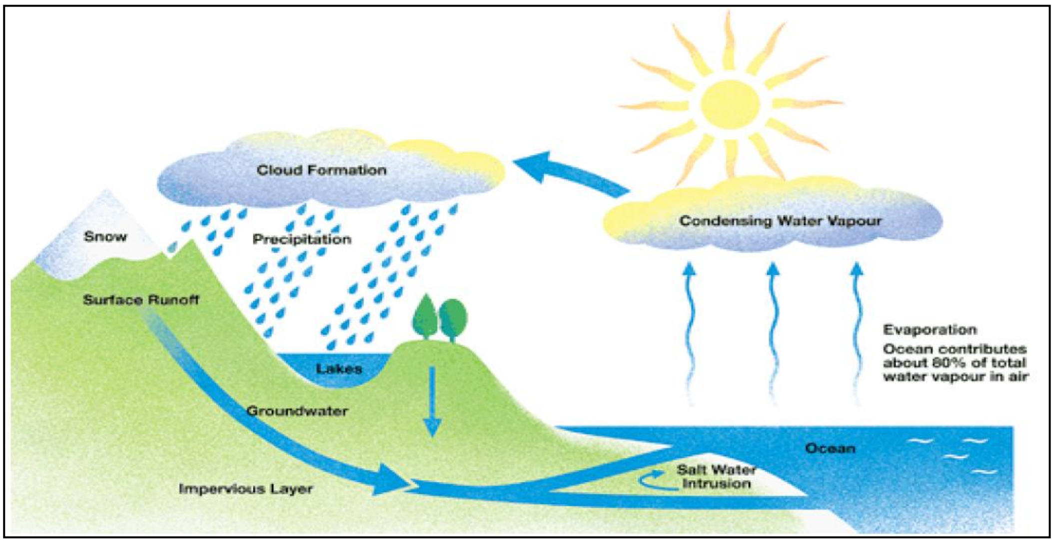

Figure 5.2. Water or Hydrologic Cycle
Source: SA Water (2010)

Imagine for a moment the breadth, the length, and the height that water has to travel from sky to land, and back and forth in a timeless dimension. What energy drives the water to revolve back and forth from sky to land? It is the heat of the sun, which makes the water evaporate from oceans, lakes, and plants. Water vapour condenses and forms tiny droplets in the clouds. When the clouds meet cool air over land, rain, sleet, or snow, precipitation occurs. With precipitation, water returns to the land or sea again (Enchanted Learning, n. d.).

As the water journeys from sky to land and back again, it brings forth life to all organisms because they use water as a vital component to perform their bodily functions. Take away water, and all of these food-producing organisms on earth will perish. However, natural water cycling is disrupted because of many development/ man-made activities. What are the causes of water cycle disruptions?

Disruptions of Carbon and Water Cycles

Carbon Cycle Disruption. Burning of fossil fuels resulting in excessive CO_2 tops the list of man-made activities that disrupt carbon cycle. As CO_2 is released daily into the atmosphere, it accelerates the occurrence of climate change because of the overall greenhouse or warming effect (Sacramento Municipal Utility, 2004). Burning of fossil fuel by man alters the natural balance of carbon because "trapped" carbon (unused and stored beneath the ground, seas, oceans, and rivers) is being released.

In addition to burning of fossil fuels, agricultural activities, such as rice cultivation and animal raising (enteric fermentation in livestock and manure management), result in the production of significant quantities of methane (CH_4). It is estimated that over 60% of global methane emissions are related to human-related activities. Natural sources of methane include wetlands, non-wetland soils, gas hydrates, permafrost, oceans, freshwater bodies, termites, and other sources such as wildfires (IPCC, 2001).

Water Cycle Disruption. Forests serve as sink for CO_2. Hence, more trees would mean greater sink area; cleaner and cooler environment; more stable water supply in the watershed areas; firmer soils where the roots of these trees are anchored; and less occurrence of soil erosion and water runoff. In contrast, fewer trees would result in higher volume of CO_2, more air pollution, more intense heat, and higher chances of water runoff and soil erosion.

Deforestation. It disrupts the water cycle, which could bring about flooding and drought to communities. The forest is like a sponge. It soaks up rainfall carried by tropical storms while anchoring soils and regularly releasing water. This regulating feature of tropical rainforests can help control destructive flood and drought cycles that can take place when forests are cleared (Mongabay.Com, 2010). Deforestation upsets the water cycle by altering weather patterns, which may trigger excess rainfall in one area of the world, or drought in another.

Business Creation**.** Converting forests and agricultural lands into commercial centres surrounded with completely cemented roads increases runoff. Runoff consists of precipitation (all forms of water that fall from the sky) that does not evaporate, transpire, or penetrate the surface to become groundwater. Even the smallest streams are connected to larger rivers that transport billions of litres of water into oceans worldwide.

Excess runoff can cause flooding, which occurs when there is too much precipitation (University of Illinois, 2010). Thus, instead of rainfall being stored underneath the ground (aquifer), this rainfall directly flows to the rivers and seas causing an overflow of water (flooding) in areas near these bodies of water. In contrast, drought in some areas occurs because runoff prevents water from being stored in the aquifers. Empty underground aquifers cannot provide the water needs of humans, plants, and animals.

Since "everything is interconnected", deforestation in the uplands disrupts the water cycle, which also leads to a negative impact on the water supply, i.e., some areas with drought and other areas with flooding. Drought or flooding disrupts the nutrient cycle from sky, land, and sea, and hinders this natural process in delivering the right chemical elements essential for the growth of living organisms. Thus, an imbalance or a deterioration of the system occurs (PEMSEA, 2010).

Climate Change and Food Security

In Asian, African, and Latin American countries, well over 500 million people are living in what the World Bank calls "absolute poverty." Yearly, 15 million children die of hunger (Oracle ThinkQuest, 2010). A majority of those who will go to bed hungry will comprise the farmers' and fishermen's families who live in marginal lands that are fragile, with low rainfall, sloping terrains, and poor market access.

With extreme temperature stress on crops and fishes as a result of climate change, more people are expected to be underfed or not fed at all. In essence, climate change directly threatens agricultural productivity and food security. It disrupts the following:

- *Growing Patterns of Crops*. Crop maturity and bearing of fruits are either hastened or delayed. Increase in temperature will lengthen the growing season in areas where agricultural potential is currently limited by cold temperature stress (Abrol & Ingram, 1996).
- *Availability of Water*. There will be more intense rainfall or absence of rainfall for long periods of time. Livestock will be affected, as the grassland productivity will be reduced due to increase in temperature. Increased desertification due to lack of water will correspondingly decrease livestock population.
- *Soil Fertility*. More soil will be eroded during times of heavy rains and flooding (EPA, 2010).
- *Pests and Diseases*. More crops and trees will be damaged due to increased outbreak and damaging effects of pests, plant pathogens and parasites, and weeds (invasive species). Increase in soil moisture will increase soil-borne diseases and nematodes (Pulhin, 2009).

According to the International Rice Research Institute (IRRI) crop modeller John Sheehy (IRRI, 2007), as a general rule, for every 75 ppm (parts per million) rise in CO_2 concentration, rice yield will increase by 0.5 ton per hectare. However, food crops will decrease in yield by 0.6 ton per hectare for every 1°C increase in temperature. The weather extremes climate change brings directly affect the agriculture sector and put farm productivity at risk. While ample carbon dioxide contributes to greater crop productivity through photosynthesis, its contribution to increasing global heat, (which would translate to more floods, droughts, and heat waves) bring serious problems to farmers and fishermen.

The Intergovernmental Panel on Climate Change (IPCC, 2007) as cited in the United States Environmental Agency (EPA), 2010 states that: "Recent studies indicate that increased frequency of heat stress, droughts and floods negatively affect crop yields and livestock beyond the impacts of mean climate change, creating the possibility for surprises, with impacts that are larger, and occurring earlier than predicted using changes in mean variables alone. This is especially the case for subsistence sectors at low latitudes. Climate variability and change also modify the risks of fires, pest and pathogen outbreak, negatively affecting food, fiber and forestry."

Fishes at Risk

Some 42 million people work directly in the fishery sector, and the great majority, are in developing countries. This sector, adding those who work in associated processing, marketing, distribution, and supply industries, supports several hundred million livelihoods (FAO, 2008).

Aquatic foods have high nutritional quality. It contributes 20% or more of average per capita animal protein intake for over 2.8 billion people, again mostly in developing countries. Fish is also the world's most widely traded foodstuff. Additionally, it is a major source of export earnings for many poorer countries.

In coastal waters, the increase in temperature caused by El Niño after the explanation will hurt the corals and the sea grasses and their corresponding fish borders. The ongoing warming of the world's oceans is likely to continue, but with geographical differences and some variability by the decade. Changes in fish distribution in response to climate variations have already been observed. Such changes generally involve pole-ward *expansions of warmer-water species* and pole-ward *contractions of colder-water species.*

In addition to increasing seawater temperature, which the fishes have to contend with to survive, they also have to adjust to the change in salinity. Other seawater areas that receive melted snow water and/or high precipitation have also changes in their salinity.

How Can Farmers Boost Food Production?

Farmers need to learn how to use sustainable land and water management technologies and combine these with green innovative agricultural technologies so they could adapt to climate change impacts (Dar, 2009).

Green agricultural technologies include using adaptive plant breeding, pest forecasting, rainwater harvesting, and fertiliser micro dosing (giving small amounts of fertiliser to each seed). Planting dates can be revised and be timed with the delayed onset of rainy or hot seasons, longer dry spells, and earlier plant maturity that are already being observed in Africa and Asia. Many more technologies can be explored to help crops and animals cope with the extreme temperature and water stresses brought about by climate change.

What Can Farmers Do to Create a More Climate-Friendly Environment?

Farmers can create a friendlier environment by doing the following:

- recycle, reuse, and reduce agricultural wastes;
- save electricity in the farm by turning off equipment when not in use;
- save water;
- plant trees;
- help arrest deforestation;
- avoid burning of farm wastes (e.g., dry leaves), plastics, and wastes;
- minimise wasting feed and food;
- educate themselves on how they can contribute to community-wide climate change-related activities.

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Lesson 1

WE'RE MESSING UP THE FOOD CHAIN!

GRADE LEVEL: High School

SUBJECTS: Biology and Environmental Science

TOPIC: Food Chains and Food Web

PREREQUISITE

- Students should have prior knowledge about the biotic and abiotic components of the ecosystem.

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this lesson, students should be able to:

- describe a food chain and a food web; and
- explain the energy relationship among organisms in an ecosystem.

Climate Change Objectives

- explain how climate change affects the food chain and food web; and
- cite specific ways to minimise carbon emission on food production activities and to prevent greenhouse gases (GHGs) build up in the atmosphere which lead to global warming.

MAIN CONCEPTS AND SKILLS

- Food chain can be shown by a sequence of organisms, whereby, one organism feeds on the one preceding it. It begins with a producer and ends with a decomposer.

- A food chain is one way of showing the energy relationships among organisms in an ecosystem. The energy transferred from one *trophic level* to the next is decreasing. As the energy goes farther from the producer, the organism receives lesser energy. In most cases, humans occupy the last trophic level in a food chain.

- Food web consists of several food chains joined together. Realistically, most organisms depend on more than one species for food. Many species occupy more trophic levels in a food web.

- Climate change modifies temperature and precipitation patterns. These both affect crop production and irrigation water availability. Livestock are also directly and indirectly affected by climate modification. Abnormal increases in temperature affect the metabolism of animals. Likewise, extreme weather conditions are threats to their lives.

- The direct and indirect effect of climate change on agriculture play out through the economic system through altering prices, food production and productivity. Climate change affects food demand, food consumption and ultimately the human well-being.

- Chemical fertilisers and toxic pesticides contribute about 15-20 % of GHGs.

MATERIALS NEEDED

- downloaded from the internet or cut-out pictures of plants, animals, long line people lining-up buying, art materials and tools, old issues of magazines about nature or ecosystem, pens and markers.

PRESENTATION OF LESSON

Scenario

1. The teacher will show several pictures of people lining-up to receive rations. These pictures will be the springboard of class discussion about the scarcity of food particularly in the poor and economically depressed areas or sector in your community and how climate change affects the human food chain.

   (*Note:* Preferably the pictures must be taken from your community or a familiar place in your country.)

2. Ask the following guide questions:

   - What do you see in the pictures?
   - What do you think causes these events?
   - What do think will happen if the food supplies continue to decrease?
   - What are the factors that affect the supplies of food in your community?

Student Activities

- Students to visit a school garden or a pond. They will identify the organisms living in it and they will construct a food chain that contains all these organisms. (Note: This depends on the availability of the garden or a pond.)
- The students will create their own posters of food chains and food webs.
- They will analyse how climate change affects the food chain and food web

Process Guide for Teachers

1. (Optional) After the students have analysed the pictures, conduct a short review of the biotic and abiotic components in an ecosystem. Ask the students to (a) explain the interaction between these two components and (b) predict what will happen when the temperature increases?
2. Teacher divides the class into working groups and orients the groups about the task that they are going to perform (e.g., field visit to an ecosystem and creating a poster).
3. Teacher presents the guidelines to create posters of a food chain and a food web out of the given materials. The food chain and food web should include human beings as one of the consumers.

Box 5.1.1
Guidelines in Creating the Food Chain and Food Web

- Use some old issues of magazines about nature.
- Cut-out 9 to 10 pictures of plants, animals, and or decomposers that could be living together in one ecosystem. *(If the pictures of decomposers are not available, make your own drawing)*
- Paste the pictures on a sheet of poster paper. Draw arrows connecting the plants and animals to show feeding relationships. Be sure your arrows are pointing in the direction of the energy flow.
- Label each organism as a producer, herbivore, carnivore, or omnivore

4. Supervise each working group during the activity.
5. Ask each group to present their posters in front of the class.
6. During the presentation and class discussion, inject issues related to climate change and its impact to the human food web.
7. Process the students' learning experiences. Ask the following guide questions:
   - ➢ What is the difference between the food chain and food web?
   - ➢ What happens to the energy possessed by an organism from one trophic level to another?
   - ➢ Which organism in the food chain receives the greatest and the least amount of energy?
   - ➢ What other external factors can affect the food chain? (e.g., increase in temperature and CO_2 may impact on climate change and affect human activities)
   - ➢ How does climate change affect the food chain and food web?

- What are some activities that might lessen the impact of climate change on food production and security? (e.g., avoid burning of farm wastes, avoid use of toxic pesticides and fertilisers which contribute about 15-20% of GHGs)

Closure

- Rat infestation in farms and households are common occurrence in most urban and rural communities. Explain this event in connection with breaking the food chain and endangering the organisms that interplay on it.

Achieving the Objectives

Objective	This is achieved by
Describe a food chain and food web.	Creating a poster and conducting a presentation in front of the class.
Explain the energy relationship among organisms in an ecosystem.	Class discussion and interaction between students and teacher during the presentation of the food chain and food web posters.
Explain how climate change affects the food chain and food web.	Using the poster as a medium to explain the externals factors (i.e., climate change) that affect the food chain and food web.
Cite ways how to minimise carbon emission on food production and how to prevent GHGs build up in the atmosphere which lead to global warming.	Class discussion on how to maintain a climate-friendly environment.

Assessment

- The teacher will utilise an oral presentation rubric ***(Attachment 5.1.1)*** and a poster (food chain and food web) rubric ***(Attachment 5.1.2)*** to assess student's performance.
- On a clean sheet of paper, ask the students to answer the following questions:
    - What is a food chain? What is a food web?
    - Why do you think producers receive the greatest amount of energy?
    - Explain why an organism that occupies the last trophic level receives the least amount of energy?

- How does climate change affect the feeding relationship in an ecosystem?
- What possible measures should be done to mitigate the effects of climate change on food production and security?

Assignment

- If the school has provision for computer and Internet connection, ask the students to log on to *www.myfootprint.org.* Advise them to take the *Ecological Footprint Quiz*, and to relate the results of their quiz to the domino effect that happens when organisms are endangered in the food chain due to massive utilisation of the earth's natural resources.

RESOURCES

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Attachment 5.1.1
Oral Presentation Rubric

Traits Presented		**4 Exceeds Standard**	**3 Meets Standard**	**2 Progressing to Standard**	**1 Below Standard**
Content	*Focus*	Purpose of presentation is clear. Supporting ideas maintain exceptional focus on the topic	Topic of the presentation is clear. Content consistently supports the purpose.	Presentation lacks clear direction.	No clear focus.
	Organisa-tion	Information/ ideas are presented in a consistently logical sequence. Transition/ connections are eloquent. A strong sense of wholeness is conveyed. Conclusion leaves the audience with a strong sense of closure.	Important ideas and information are identified for the audience. Information/ ideas are presented in a logical sequence with few lapses. Transitions and connections are made. Closing effectively summarises the presentation.	Irrelevant, unnecessary information detracts. Big ideas are not specifically identified. There are significant lapses in the order of ideas. Transitions are inconsistent and weak or missing. Closing demonstrates an attempt to summarise.	No clear organisation. Ideas do not connect with one another. There are no clear transitions. No closing is evident.
Presen-tation	*Question & Answer*	Speaker expands upon previous statements. Cites additional examples to answer question.	Thoughtful, concise response. Conveys knowledge of subject.	Response not clear or did not add to comprehen-sion of the listener.	Could not answer questions or answers are irrelevant.

Attachment 5.1.2
Food Chain and Food Web Rubric

CATEGORY	4	3	2	1
Characters(Role of organism)	All organisms are described appropriately in the food chain and food web.	Most organisms are described appropriately in the food chain and food web.	Some organisms are described appropriately in the food chain and food web.	Organisms are not described appropriately in the food chain and food web.
Neatness and Attractiveness	Exceptionally well designed, neat, and attractive. Colours that go well together are used to make the posters more legible.	Neat and relatively attractive.	Characters are neatly arranged or drawn but the poster appears quite plain.	Appears messy and "thrown together" in a hurry.
Accuracy of Presentation(Sequence of feeding relationship)	All organisms are positioned correctly and noted on the food chain and food web. Direct connections and flow are easily seen.	All organisms are positioned correctly and noted on the food chain. Connections and flow of poster is easily legible.	All organisms are positioned correctly and noted on the food chain and food web.	No organisms are positioned correctly or noted for a food chain and food web.

Source: http://www.beverlyschools.org/schools/exploringecosystems

Lesson 2

SAVE OUR FOREST AND WATER AREAS

GRADE LEVEL: High School

SUBJECT: Mathematics

TOPIC: Direct Variations

DURATION: 1 session

PREREQUISITE: Basic knowledge of ratio and proportion

LEARNING OBJECTIVES :

Subject Matter Objective: By the end of this lesson, the students should be able to:

- translate statements that describe direct relationships between two quantities into mathematical equations;
- find the unknown value in a direct relationship; and
- relate environmental problems to natural events in describing direct relationships in mathematics.

Climate Change Objectives

- realise that the degradation and reduction of protected water areas will lead to a decrease in fish production and thus, reduce the amount of food supply; and
- identify practical and specific ways to protect the forest and water areas.

MAIN CONCEPTS AND SKILLS

- Direct variation is a relation which is described by the equation $y=kx$ where k (the constant of variation) is a non-zero constant. It implies that an increase in one variable causes an increase in other variable or a decrease in one variable causes a decrease in other variable.

  Example of Direct Variation Statement:

  The rising temperature increasingly affects water areas/bodies which will lead to increase (massive) fish losses and thus increase the food crisis.

- To better understand the relationship of climate change to natural disasters, the students should have the ability to describe the direct relationship of two variables (quantities) accurately.

MATERIALS NEEDED

- video footage of the effects of global warming *(global 101 video from* www.youtube.com/watch?v=oJAbATJCugs)
- powerpoint slides on direct variation

PRESENTATION OF THE LESSON

A. (Optional) Conduct a review of ratio & proportion.

We have discussed about ratio and proportion and on how to find the unknown term in a proportion. Let us have a review of the concepts of ratio and proportion.

1. *What is a ratio?*
   - A ratio is the comparison of two quantities.
2. *Can you give examples of ratio?*
   - The ratio of boys to girls in a classroom *(e.g., 20:21)*
   - The ratio of books to magazine in a shelf *(e.g., 15:4)*
3. *How about a proportion, what is a proportion?*
   - Proportion is the equality of two ratios.
4. *Can you give examples of proportions?*
   - 1:2 = 5:10; 3:4 = 12:16; 4:1 = 20:5

B. Board Exercise: Ask the students to solve for the missing term on the board.

- *How about if we have this proportion, 2:7 = x:21 what is the value of x?*
- Answer : x = 6

Scenario

Show a video footage of the effects of global warming to the class.

Student Activities

The students will analyse the video presented in the scenario. They will perform an activity on *Protected Fishing Areas* after a lecture on direct variation.

Activity 1. Video Footage Analysis

1. *What natural phenomena did you observe?*

   Phenomena: drought, increase in temperature, strong typhoons, fish kills, pollution, forest denudation.

2. *Can you see any relationship among these phenomena? (i.e., environmental*

reaction to human activities-anthropogenic)

Relationships involve:

- an increase of temperature will also increase the amount of rainfall and drought;
- incidences of fish kills will increase when water temperature increases;
- water pollution will result in health hazards for humans (e.g., illnesses);
- an increase in the use of chlorofluorocarbon *(CFC)* will also hasten the destruction of the ozone layer;
- an increase of temperature in the bodies of water will increase the risk of fish losses, thus will increase the incidence of food shortage;
- as the population increases, the amount of food supply also increases hence, the incidence of food shortage will dramatically increase.

Activity 2. Protected Fishing Areas

1. Students will perform the activity and answer the questions in the worksheet ***(Attachment 5.2.1)***.
2. Each group will present their answers in front of the class and discuss their conclusion.
3. Class discussion will follow as the groups present their observations and analysis.

Process Guide for Teachers

1. Teacher shows video footage of the effects of global warming and conducts video analyses after viewing.
2. Teacher discusses direct variation through PowerPoint presentation.
3. Direct variation means that if one value increases, the other value will also increase, or if one variable decreases, then the other will also decrease.

   Give examples of direct variation using what you have observed in the video.

   - An increase in temperature will also increase forest denudation and drought.
   - Fish kills will also increase if water temperature increases.
   - An increase in the use of CFCs will also hasten the destruction of the ozone layer.

   From the examples given, can you give your own definition of direct variation?

Mathematically, if ***y*** varies directly as ***x***, then $y = kx$ where k is the constant of variation. Another way of writing it is $k = y/x$. This formula is used in finding the constant of variation

- *Going back to the examples that you cited a while ago, which of those exhibit direct variation?*

4. Teacher facilitates group activity and provides the following instructions.

   - You will be divided into four (4) groups. Each group will be given a worksheet (See ***Attachment 5.2.1)***. Answer the questions in the activity sheet and generate your conclusion.

5. Facilitate the processing of students' learning experiences and discoveries.

   - Let us apply the principle of direct variation in the real world. *Can you give examples of direct variations that are actually happening in our environment?*

   Examples of Direct Variation:

   - Increase in population will increase the food consumption.
   - Higher temperatures will result in more droughts in the rice fields and cornfields, which will eventually result in food shortage.
   - A decrease in rainfall will result to decrease in the amount of water reserved.

   Imagine what will happen to our Mother Earth if we are not going to take care of it. So let us start saving our earth. *As a student, what can you do to save our environment?*

   Things we can do to save the environment:

   - Learn how to segregate garbage.
   - Stop using products with CFC.
   - Be disciplined.
   - Join in the campaign of saving mother earth and be vigilant.
   - Save electricity.

Achieving the Objectives

Objective	This is achieved by
To translate statements that describe direct relationships between two quantities into mathematical equations	Discussion on direct variation through PowerPoint presentation about direct variation
To find the unknown value in a direct relationship	Discussion on direct variation through PowerPoint presentation
To relate environmental problems to natural events in describing direct relationships in mathematics	Analysis of the video footage presentation
To realise that the degradation and reduction of protected areas will lead to a decrease in fish production and thus reduce the amount of food supply	Performing the activity on *Protected Fishing Areas*
To identify practical and specific ways to protect the forest and water areas	Performing the activity on *Protected Fishing Areas*

Assessment

1) The following table shows the relationship between the number of protected water areas and the number of species of fish living in that area. Solve for ***k*** and complete the table.

Number of protected water areas by hectare *(x)*	4		10		15
Number of species of fish *(y)*	32	50		76	

2) Develop a concept map on the direct relationship of increasing temperature to flooding (La Niña) and drought (El Niño).

Assignment

The students will be asked to conduct an experiment on the mortality rate of fish living in two different conditions: one living under high temperature (exposed to sunlight) and the other in normal conditions.

RESOURCE

Global Warming 101. Retrieved on 30 November 2010 from www.youtube.com/watch?v=oJAbATJCugs

Attachment 5.2.1
Student's Worksheet

PROTECTED FISHING AREAS

Name: ____

Grade Level and Section: _________________________________

Topic: *Direct Variation*

1. The table below shows the relationship between the number of protected water areas and the number of species of fish living in that area. Based on the data given, solve for **k**.

Number of protected water areas by hectare *(x)*	2		5		10
Number of species of fish *(y)*	16	20		56	

2. Observations and Analysis

   - What is the constant of variation?

     ____
     ____

   - How did you obtain the constant of variation?

     ____
     ____

3. Conclusion/Integration to Real Life

   - As a student, what should you do to help lessen the impact of climate change?

     ____
     ____
     ____

   - With the observed changes in our environment, what do you think will happen in the next ten years if people will not protect the bodies of water?

     ____
     ____
     ____

Lesson 3

MEA CULPA, MOTHER EARTH

GRADE LEVEL: High School

SUBJECT: English, Values Education

TOPIC: Perceiving Relationships/ Cause-Effect Relationships

PREREQUISITE

- Knowledge of prevailing conditions in the local community brought about by accelerated climate change. It may include records of previous weather conditions that brought calamities or drastic changes in the community.

Pre-activity:

A day before this lesson, the teacher should have done the following:

- Assigned the class to read the article: "Mea Culpa, Mother Earth" adapted from "A Day for Mother Earth "by Jamil Flores, Philippine Panorama, April 2, 1990 ***(Attachment 5.3.1).***

- Group the students (maximum of 6 per group). Random selection of group members is encouraged to give more opportunities for spontaneous exchange of ideas.

DURATION: 1 to 2 sessions

LEARNING OBJECTIVES

Subject Matter and Climate Change Objectives: At the end of this lesson, students should be able to:

- determine the effects of accelerated climate change on the supply of rice, other agricultural products, fisheries, and forest resources;
- build their vocabulary of ecological terms using context clues;
- exchange views with other members of the class on local issues regarding climate change;
- describe the role played by man in accelerating climate change;.
- identify common practices that contribute to the production of greenhouse gases (GHG), pollution, and other environmental problems; and
- suggest specific ways on how each individual could help lessen the negative effects of accelerated climate change.

MAIN CONCEPTS AND SKILLS

- The Earth's average global temperature has increased by 0.6 ^{0}C in the past 100 years. Four main factors are believed to have affected the processes that can affect the Earth's climate. Two of these, small aerosol particles from volcanic eruptions and changes in solar luminosity, occur naturally. The other two, namely, sulfate aerosols and greenhouse gases (e.g. carbon dioxide) are due to increasing industrialisation, particularly the burning of forests and fossil fuels (coal, oil and natural gas).

- It is during this time in human history that people are changing Earth's climate rapidly through the emission of the so-called greenhouse gases (GHGs) brought about by the dramatic increase in the use of fossil fuels since the Industrial Revolution. The more we produce and consume, the more we affect the environment around us. We are creating environmental problems that are not only local but also global. One of these global environmental problems is human induced man-made climate change, an offshoot of global warming.

- Climate change occurs because of increased CO_2 emissions. Researches show that increase in CO_2 in the environment favors plants because they are able to yield more. But while increased CO_2 emissions favour food crop yields, its presence in large quantities, together with other GHGs in the atmosphere, trap more heat from the sun, which correspondingly increases global temperature. Consequently, this increased global temperature alters climate patterns and results in weather extremes, such as droughts, floods, and severe storms. These weather conditions directly affect the agricultural sector and put farm productivity at risk. While ample CO_2 contributes to greater crop productivity through photosynthesis, its contribution to increasing global heat, which translates to more droughts, floods, and heat waves, brings in more serious problems to farmers.

- In essence, agricultural productivity and food security are directly threatened by changing climate because it disrupts the following:
  - *Growing patterns of crops* – by hastening or delaying crop maturity and bearing of fruits.
  - *Availability of water* – more intense rainfall and increased drought
  - *Soil fertility* – more soil erosion occurring during times of heavy rains and flooding

- As responsible citizens of the Earth, the students should develop the abilities to discuss relevant issues about climate change; discern, analyse, and evaluate common practices that lead to accelerated climate change; and offer and execute solutions to problems brought about by climate change in the community.

MATERIALS NEEDED

- *Student Worksheets A, B, C, D, E*
- pictures, broad sheets of paper, meta cards, pentel pens, scotch tape
- scissors, ruler
- *if available:* LCD projector, computer laptop

PRESENTATION OF THE LESSON

Scenario

- Students will view these two pictures carefully. Use the following guide questions for discussion:
  1. What specific differences do you see between the two pictures?
  2. Which picture shows an industrial site? An agricultural site?
  3. Cite some specific examples of places you know of that are undergoing the same changes as shown in the pictures.

A. Pre-industrial revolution
Source: Kartapranata (2010)

B. Industrial revolution
Source: http://myecoproject.org

Student Activities

- Students will have a group activity as described in Worksheets A, B, C, D, E. (Note: the Teacher may divide the tasks into two sessions if it is not manageable in one session.)

Process Guide for Teachers

1. Distribute *Student Worksheet A (Eco-Vocabulary).* Allow the students to analyse the sentences and pick the word/s or phrase/s that gives the clues to the meaning of the italicised word. Answers may be given orally or written.

2. Divide the class into 4 groups with 5-8 members each. Using the article “Mea Culpa, Mother Earth” as basis for discussion, each group will be assigned to do particular activities, as follows:
   - Group 1 - Concept Mapping
   - Group 2 - Cause and Effect Chart
   - Group 3 - Graphic Organiser
   - Group 4 - Bubble Making

3. Each group will think of a name that will represent them. The teacher should provide a sheet of paper large enough for the whole group to write their outputs.

4. Each group will present their output in class in the most creative way that they could think of. Examples of presentations are news reporting, role-playing, pantomime, panel discussion etc. As each group share their ideas, the teacher will post on the board the rubric on their presentation.

Closure

Ask the students to formulate a one-sentence generalisation of the things they learned in the session. The students will orally recite their generalisations. The teacher will then give a summary of the discussions and inject some values on the importance of protecting Mother Earth.

Achieving the Objectives

Objective	This is achieved by
Describe the role played by man in accelerating climate change.	Discussion of the article “Mea Culpa Mother Earth”
Identify common practices that contribute to production of GHGs pollution, and other environmental problems.	Enumeration of what could be observed as common practices.
Determine the effects of accelerated climate change on the supply of rice and other agricultural products.	Students perform activities in Worksheet B and C.
Suggest specific ways of how each individual could help lessen the negative effects of accelerated climate change.	Students perform activities in Worksheet D and E.
Define vocabulary of ecological	Students perform group activity in

Objective	This is achieved by
terms using context clues.	Worksheet A.
Exchange views with other members of the class about local issues involving accelerated climate change.	Students perform activities in Worksheets B and E.

Assessment

A. Open-Ended Assessment

Instruction: Complete the open-ended statements.

1. I am concerned with our environment because___________________
2. Climate change can affect food supply if _______________________
3. Our forest resources such as _______________________________ will also be affected by climate change.
4. Climate change will also affect our fisheries if bodies of water will ____
5. I can protect Mother Earth by ________________________________
6. We need to act now because ________________________________
7. I can give my share for our continued existence by _______________

B. Performance-based Assessment

Student' performance will be assessed using the rubrics ***(Attachment 5.3.7)*** and ***(Attachment 5.3.8)***.

Assignment

The students will be given a take home exercise. They will be asked to express their thoughts on the phrase "*Think Globally, Act Locally,*" in whatever creative forms they like such as: write a one-page essay or poem, compose a song, do a poster, among others.

RESOURCES

ESPERE-ENC. (2010). Man-made Climate Change. Retrieved on 30 October 2010 from http://www.atmosphere.mpg.de/enid/basics/1__Man-made_climate_change__1od.html

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Attachment 5.3.1

MEA CULPA, MOTHER EARTH

Adapted from "A Day for Mother Earth" by Jamil Flores
Philippine Panorama, April 2, 1990

On the third planet from the sun, the largest of the inner planets of the solar system, human life has found a cozy home. That home, in which man has emerged as the most successful species of fauna for 2 or 3 million years now, is composed of an atmosphere, a hydrosphere and a lithosphere. Air, oceans and terra firma – all of them are heavily polluted in the course of man's inexorable conquest and ruthless exploitation of his environment. That is the reason the earth is an endangered planet. Its most successful tenant seems determined to destroy it and destroy himself as well.

How has man endangered the earth on which he lives? By sheer fecundity, in the first place. There are over 5.1 billion human beings on earth today (most of them in Asia) all of them in need of food and shelter that are often extracted directly from nature, all of them producing waste and garbage every day.

For about 200 years now, chimneys of industry have been sending up billowing clouds of toxic gases into the atmosphere while pouring noxious effluents into rivers, lakes and marine shores that are already poisoned by the fertilizers and pesticides of agriculture. That is perhaps why red tide blooms are more frequent, more virulent and more toxic than they have ever been – a super abundance of nutrients that find their way into the oceans. Whole forests, the lungs of the earth, that produce the oxygen without which human lives would not be possible, have been obliterated in the name of progress. That is why this country's mountain ranges are badly eroded, and aquifers here run dry. For the past several decades, the human race has been sending up chlorofluorocarbons (CFCs) out of spray cans, refrigerators, air conditioners, and hamburger boxes into the atmosphere where they attack the only defense that the earth has against the sun's ultraviolet bombardment – layer of ozone cells 10 to 30 miles up in the atmosphere. Without that defense, we get a lot of problems: skin cancers, eye cataract effect, the heating of the earth that could melt the polar caps and drown whole coastal cities and many more social ills.

How much more abuse can the earth take? No scientist in the world today will claim that he knows, but reason says that, in spite of the Ecclesiastes, given man's constant assaults against it, the earth cannot abide forever. During an earlier age, the land, the sea and the air had an effective defense against man – their sublime immensity. Man looks puny in the bowels of the jungle; adrift at sea, he is but a dot in eternity of marine and sky blue. But today, against 5.1 billion human beings that are reproducing at a tremendous velocity, a jungle is less awesome, and the sea becomes vulnerable. Forests are burned and converted into something else (agricultural land, industrial plan sites, for example) at the rate of an area the size of a football field per second. And whole oceans are smothering in the garbage and oil spillages of human civilization. There are, indeed, big patches of dead coastal waters in various parts of the world, incapable of supporting marine life.

No. The earth does not abide forever. And the only way for her to abide a bit longer is for man to convert from being her attacker into being her protector.

Attachment 5.3.2
Student Worksheet A

ECO-VOCABULARY

Name: ____

Grade and Section: ______________________________________

Instruction: Read and analyse the sentences carefully. Choose the meaning of *italicised* words. Answers may be given orally or in written form.

1. The planet is now heavily polluted because of man's *ruthless exploitation* of his environment.

   a. cruel utilisation   c. useless production
   b. crude transformation   d. careless habitation

2. With 5.1 billion human beings on earth today, man has endangered this planet through sheer *fecundity.*

   a. passion   c. fertility
   b. habit   d. sterility

3. Forests have been *obliterated* in the name of progress. Thus, we have constant erosions and floods.

   a. neglected   c. purchases
   b. destroyed   d. forgotten

4. Oceans are *smothering* in the garbage and oil spillages of human civilization.

   a. shining   c. roaring
   b. shivering   d. dying

5. With constant assault against earth, it cannot *abide* forever.

   a. wait   c. exist
   b. move   d. obey

6. Chimneys of industry poured noxious *effluents* into rivers, lakes and marine shores.

   a. liquid waste   c. poisonous waste
   b. harmful waste   d. solid waste

Attachment 5.3.3
Student Worksheet B

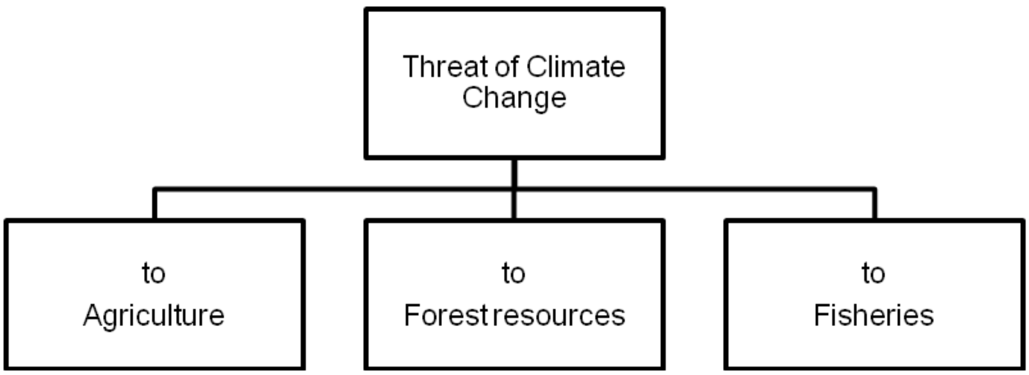
GROUP 1: CONCEPT MAP CREATOR

Instruction: From the issues presented in the article "Mea Culpa, Mother Earth," fill in the concept map below.

a. Cite practices mentioned in the article that your group consider as causes of climate change. Your group may identify other causes not mentioned in the article.

b. Enumerate the impacts of climate change to agriculture, forest resources, and fisheries that were cited in the article.

c. Your group could still cite other effects not included in the article. You may include the observations from your own community.



Concept Map on Climate Change Impact to the Rural Community

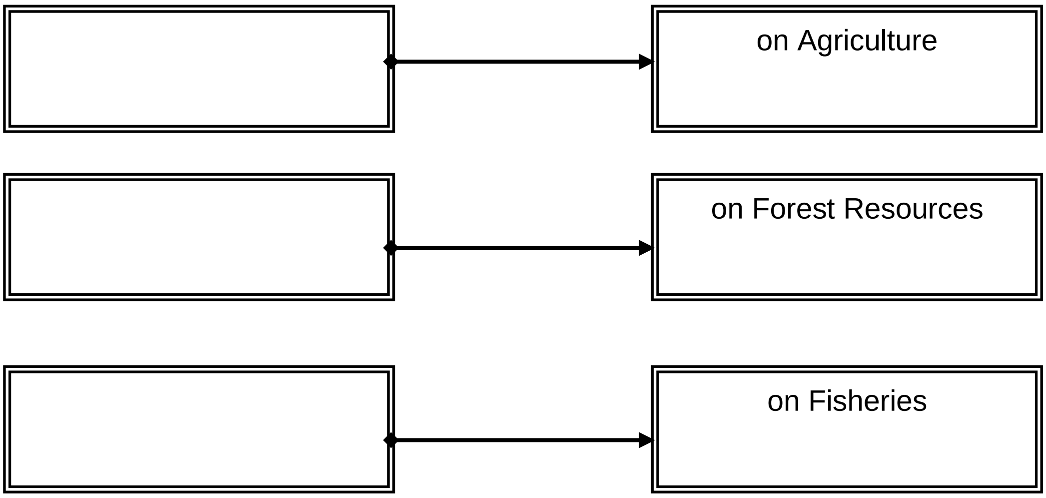
Attachment 5.3.4
Student Worksheet C

GROUP 2: CAUSE AND EFFECT ANALYST

Instruction:

- Work on the **Cause and Effect Chart** below.
- Boxes on the left should contain the causes of climate change, while boxes on the right should contain the corresponding effects of climate change on agriculture, forest resources and fisheries.

CAUSES **EFFECTS**



Cause and Effect Chart of Climate Change on Food Resources

Attachment 5.3.5
Student Worksheet D

GROUP 3: THE GRAPHIC ORGANISER

Instruction: Do the Graphic Organiser by coming up with suggestions and recommendations on how to mitigate and lessen the adverse effects of accelerated climate change on agriculture, forest resources and fisheries.

Climate Change Mitigation Measures

ADVERSE EFFECTS OF CLIMATE CHANGE	RECOMMENDATIONS (Individual Level)
1. On Agriculture	
2. On Forest Resources	
3. On Fisheries	

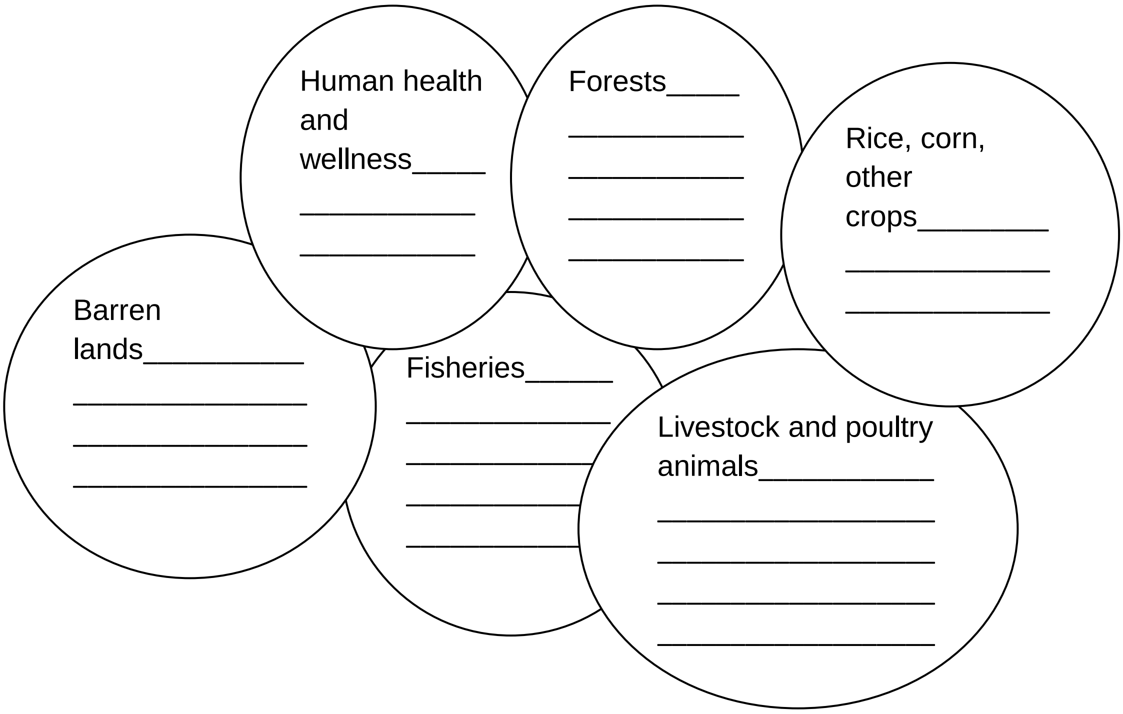
Attachment 5.3.6
Student Worksheet E

GROUP 4: THE BUBBLE MAKER

Instruction:

- Do the Bubble Making. Inside the bubbles are different elements being affected by the accelerated climate change.
- Write down suggestions on how you can lessen or mitigate the adverse effects of climate change on each of the elements inside the bubble. Your suggestions should be directed at the community level.

The Bubble Map



Attachment 5.3.7
Sample Rubric on Group Performance Output

Subject/Topic:____

Project/ActivityTitle:____

Date:____

Group Name:____

Team Members:____

Group Output	Below Average	Satisfactory	Excellent
1. Grammatically correct	1, 2, 3	4, 5, 6	7, 8, 9
2. Concise	1, 2, 3	4, 5, 6	7, 8, 9
3. Clear	1, 2, 3	4, 5, 6	7, 8, 9
4. Relevant	1, 2, 3	4, 5, 6	7, 8, 9
5. Effective	1, 2, 3	4, 5, 6	7, 8, 9

(Adapted from http://www.teach-nology.com/cgi-bin/project_rub.cgi)

Attachment 5.3.8
Sample Rubric on Group Presentation

Subject/Topic:____
Project/ActivityTitle:____
Date:____
Group Name:____
Team Members:____

Indicators	5	4	3	**2**	**1**
1. All group members contributed.					
2. Ideas were well-organised.					
3. Materials used were attractive.					
4. Group finished the task on time.					
5. Group presented with confidence.					

Use Rating Scale of 1 to 5 where:

- 5 - all five conditions were met
- 4 – four conditions were met
- 3 – three conditions were met
- 2 – two conditions were met
- 1 – only one condition was met

Lesson 4

UTILISING AGRICULTURAL WASTE

GRADE LEVEL: High School Third Year Level

SUBJECT: Science, Technology and Livelihood Education

TOPIC: Recycling Agricultural Wastes

PREREQUISITE: Students should have clear understanding of the basic principles of nutrient cycling and agriculture

DURATION: 1 to 2 sessions

LEARNING OBJECTIVES

Subject Matter and Climate Change Objectives: By the end of this lesson, students should be able to:

1. recognise how various farm wastes contribute to the production of greenhouse gases (GHGs) in the atmosphere;

2. identify technologies that may be used to prevent massive build up of agricultural waste;

3. analyse how each identified technology can recycle or reuse agricultural waste; and

4. evaluate which among the technologies discussed could best address the local farm waste situation.

MAIN CONCEPTS & SKILLS

- Human activities produce gases or air pollutants, which cause the atmospheric temperature to increase greenhouse effect. Air pollutants that cause greenhouse effect are also called “green house gases” or GHGs. The increase in surface temperature triggers the melting of ice glaciers in most temperate regions of the world leading to a drastic increase in water level, especially in regions with lower elevation. These series of disturbance in our environment is what causes our climate pattern to change, thus the term “climate change”.

- Agriculture contributes 13% of the global GHG emissions in 2008. In the Philippines, agriculture landed second at 29% preceded by the energy sector at 55% *(Pulhin, 2009. Seminar-Workshop on How Climate Change Threatens Food Supply).*

- *Vermicomposting* is a technology that utilizes agricultural (i.e. crop waste and animal manure) and kitchen wastes (i.e. spoiled food) as substrate for earthworms. Earthworm castings are then dried and used as soil conditioner and fertiliser in crop production. Earthworms produced in vermicomposting are also used as vermimeal in aquaculture. Vermimeal consist of sun dried chips of earthworm that offers a good protein source for aquaculture.
- *Biodynamic agriculture* is an advanced practice of organic farming wherein it looks upon the farm elements as living entity. For a soil (a major component of crop production) to become productive for generations, there is a need to treat its maintenance as a basic necessity. Therefore, agricultural practices that will be applied to the soil should allow it to regain the resources lost during crop production.
- *Fuel and Charcoal Briquettes* are blocks of compressed materials suitable for burning. Materials used for making briquettes may cost little or nothing at all because it only requires partially decomposed plant wastes as materials for pressing and molasses, starch or manure as binders. The only requirement is that materials should have the capability to burn for a longer period. Lastly, briquettes are very cost effective compared to ordinary charcoal or firewood especially for industrial operation since it produces higher heat level and longer heat duration (heat efficiency).
- *Biogas Production* pertains to manufacturing biofuel through anaerobic decomposition of organic matter. Anaerobic decomposition happens when organic matter decays with the help of microorganisms in an oxygen-free environment. Gas produced has relatively low carbon output making it a better substitute for fossil fuel as energy source for combustion and transport.
- Students need to appreciate how agricultural technologies could help recycle or reuse farm wastes and determine the cost-effectiveness of different technologies.

MATERIALS NEEDED

- Websites, articles, research publications, video clips of various farms and their waste products
- Posters and meta cards
- Links to websites
  - www.agricultureinformation.com
  - www.biodynamics.com
  - www.osist.dost.gov.ph/technologies/overview/9/3
  - www.villagevolunteers.org
  - http://www.biodynamics.com/biodynamics.html

PRESENTATION OF THE LESSON

Scenario

- Cite statistical data showing the contribution of agricultural sector on GHG emissions.

Student Activities

- Students will enumerate possible agricultural technologies that may utilise farm by-products and discuss the key components of each technology and its underlying principles.

Guide Questions:

1. How do farms and other methods of agricultural practices increase the production of GHGs?
2. Which of the technologies described may be used to lessen these adverse effects?
3. Enumerate the agricultural commodities being produced in your locality/community.
   a. What are the agricultural wastes brought about by these productions?
   b. Given the local agricultural condition, which is most appropriate technology to use that will make use of the wastes?
   c. Why do you think this is the most appropriate technology?

Process Guide for Teachers:

1. The whole class will be divided into groups, each group with at least 4 members. Each group will discuss a given agricultural/farming technology. They will answer the following guide questions for discussion.
   - How does the technology make use of agricultural waste?
   - How efficient is the technology in recycling or reusing the waste?
   - Which technology will be most appropriate to use in your locality?
   - Assess the technology as to its cost effectiveness and possibility of commercial production.
2. Each group will present the result of their discussions. Other members of the class will ask questions after each presentation.

Achieving the Objectives

Objective	This is achieved by
To create awareness on the adverse impact of various farm waste in the environment.	Websites, articles, research publications or video clips of various farms and their waste products
To identify technologies that may be used to prevent massive build up of agricultural waste.	Students discuss about the various technologies available that may be used to recycle or reuse agricultural waste products.
To analyse how each identified technology can solve the issues related to agricultural waste.	Students do group activity focusing on the need for technological gadgets, machineries in order to solve the problem of agricultural wastes.
To evaluate which among the technologies discussed could best address the local farm waste situation.	Students compose a write-up containing their analysis and recommendations of the best technology to use to address the problem.

Assessment

Use the attached rubric to assess the oral presentation of each group *(**Attachment 5.4.1**).*

Assignment: (Extension Ideas)

Make a case study of your own community. You may conduct interviews with farmers or even visit their farms which revolve around the following issues:

1. What are the farm products in your community or the locality nearest to your place?
2. How are these products used? What are the wastes produced by these products?
3. How are theses wastes being disposed?
4. Which among the discussed technologies will you recommend to the farmers or the users of the farm products?
5. Give some suggestions on how income could be generated further from the wastes that could be recycled or reused.
6. Submit the results of your case study.

RESOURCES

Agricultural Training Institute. Biogas Production: Alternative Pig Waste Management System. Video Presentation.

Pulhin, J. M. (2009). Seminar-workshop on how climate change threatens food supply: Agriculture and forestry sector. UPLB:SEARCA.

SRA-La Granja Research and Extension Center. Vermicomposting sugarcane trashes. Leaflet.

TESDA. Charcoal Briquetting. Video Presentation

TESDA. Vermiculture and Vermicompost Production. Video Presentation

Attachment 5.4.1
Oral Presentation Rubric

Traits Presented		4 Exceeds Standard	3 Meets Standard	2 Progressing to Standard	1 Below Standard
Content	*Opening*	Opening captivates the audience with interest and/or intrigue.	Interesting opening; engages audience.	Opening is minimally engaging.	Opening is not engaging.
	Focus	Purpose of presentation is clear. Supporting ideas maintain exceptional focus on the topic	Topic of the presentation is clear. Content consistently supports the purpose.	Presentation lacks clear direction.	No clear focus.
	Organisa-tion	Information/ ideas are presented in a consistently logical sequence. Transition/ connections are eloquent. A strong sense of wholeness is conveyed. Conclusion leaves the audience with a strong sense of closure.	Important ideas and information are identified for the audience. Information/ ideas are presented in a logical sequence with few lapses. Transitions and connections are made. Closing effectively summarises the presentation.	Irrelevant, unnecessary information detracts. Big ideas are not specifically identified. There are significant lapses in the order of ideas. Transitions are inconsistent and weak or missing. Closing demonstrates an attempt to summarise.	No clear organisation. Ideas do not connect with one another. There are no clear transitions. No closing is evident.

Traits Presented		4 Exceeds Standard	3 Meets Standard	2 Progressing to Standard	1 Below Standard
Presen-tation	*Speech*	Commands audience politely using eye contact, making sure audience is ready. Can be heard by all members of audience without assistance. Uses visual aid as guide or outline for speaking. Consistently maintains eye contact.	Makes sure audience is ready before starting. May need reminders from audience to speak up; generally consistent, maintains eye contact, minimises reliance on notes.	Makes occasional eye contact, makes few attempts to command audience; may start speaking before audience is ready. Needs reminders from audience to speak up. Mostly reads from notes.	Audience hears with great difficulty. Reads notes and seldom establishes eye contact.
	Visual Aid	Visual aid can be seen and attractive from all parts of the room. Graphic is clear and professional looking, enhancing the message.	Visual aid can be seen from all parts of the room. Graphic is neat. Appropriate subject chosen to depict message.	Visual aid is not completely accessible to all audience members. Graphic may be messy. Visual may not be most appropriate to support presentation.	Visual aid undecipher-able. Graphic detracts from message. Messy or inappro-priate visual.
	Question & Answer	Speaker expands upon previous statements. Cites additional examples to answer question.	Thoughtful, concise response. Conveys knowledge of subject.	Response not clear or did not add to comprehension of the listener.	Could not answer questions or answers are irrelevant.

CHAPTER VI: Impact of Climate Change on HEALTH AND NUTRITION

[SEAMEO TROPMED Philippines, SEAMEO TROPMED Indonesia and SEAMEO RECSAM]

INTRODUCTION

Extreme weather events causing destructive floods and droughts never before experienced in the past years provide telling evidence of climate change. The poor almost always bear the brunt of the impact to health and safety of climate change by virtue of their very limited access to economic and social capital such as education, private savings and mobility.

The effect of climate change on health can be direct or indirect. ***Figure 6.1*** shows these effects.

Ways in which climate change can affect human and health

MEDIATING PROCESS		HEALTH OUTCOMES
DIRECT EFFECTS		
Exposure to thermal extremes	→	Heat and cold-related illness and death
Altered frequency and /or intensity of other weather extremes	→	Deaths, injuries, and psychological disorders, damage to public health infrastructure
INDIRECT EFFECTS		
Effects on range and activity of vectors and infective parasites	→	Changes in geographic ranges and incidence of vector-borne diseases
Altered local ecology of water-borne and food borne infective agents	→	Changes in incidence of diarrhoeal and certain other infectious diseases
Altered food productivity due to changes in climate, weather, pests and diseases	→	Regional malnutrition and hunger, consequent impairment of growth and development
Sea level rise: with population displacement and damage to infrastructure	→	Injuries, increased risks of various infectious diseases, psychological disorders
Air pollution: including pollen and spores	→	Asthma, allergic disorders: other acute and chronic respiratory disorders and deaths
Social, economic and demographic disturbance	→	Wide range of public health consequences (e.g., civil strife, nutritional impairment) economic, and demographic disturbance

Figure 6.1 Ways in which Climate Change can Affect Human Health
Source: McMichael et al (1995)

Thermal extremes such as heat waves and extremely cold spells have caused huge mortalities and casualties among the poor, the homeless, the elderly, infants and those in ill health. The frequency and intensity of extreme weather events such as super typhoons alternating with prolonged periods of drought do not only leave people dead and injured but also permanently scar survivors psychologically and emotionally. In addition, these cause population displacements creating conditions that favour epidemics.

The relationship between climate change and human health involves multiple pathways and their relationship is schematically presented in *Figure 6.2* below:

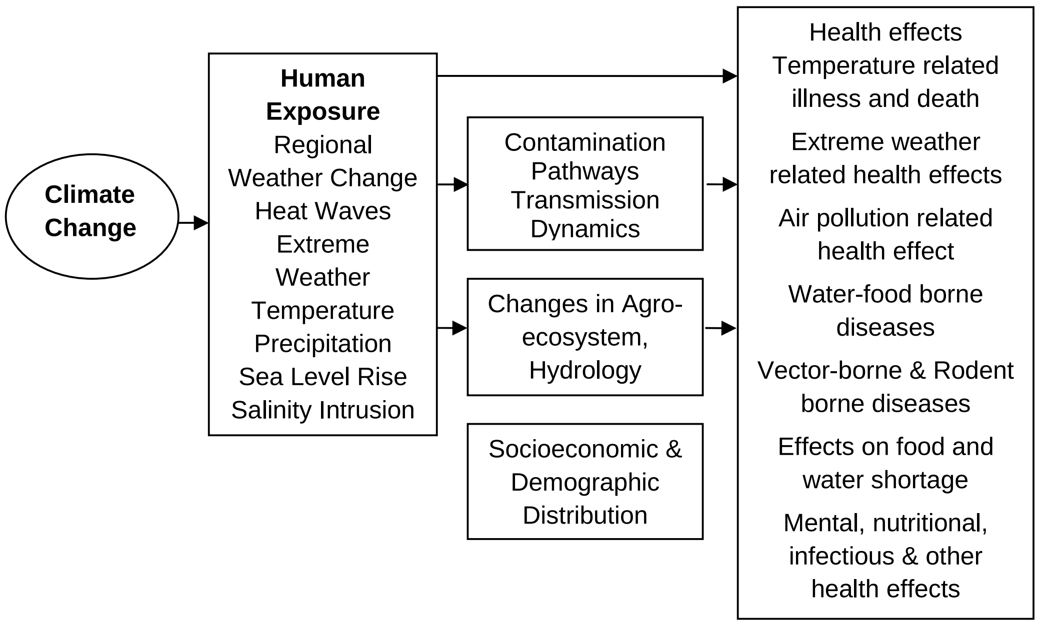


Figure 6.2 Relationship between Climate Change and Human Health
Source: WHO (2003) in Rahman (2008)

Published evidences so far indicate that:

- climate change is affecting the seasonality of some allergenic species as well as the seasonal activity and distribution of some disease vectors;
- climate plays an important role in the seasonal pattern or temporal distribution of malaria, dengue, tick-borne diseases, cholera and some other diarrhoeal diseases;
- heat waves and flooding can have severe and long-lasting effects.

Influence of Climate Change on Disease Triad

Diseases in the human hosts result when a specific agent, such as persistent unfavourable environmental conditions (e.g., climate change) or the activity of a pathogen disrupts physiological functions causing the human to deviate from normal behaviour. The word “persistent” is used to distinguish a *disease* which develops over time from an *injury* which usually occurs instantaneously.

Noninfectious diseases, more appropriately called *disorders*, do not spread from person to person. Disorders often result from the host's exposure to environmental factors such as unfavourable weather due to high temperature (heat wave) or extreme low temperature and, undernourishment.
An infectious disease results when a microbial *pathogen* lives in close association with the host (e.g., human). The pathogen functions as a parasite as this relationship usually benefits the pathogen at the host's expense.

Three critical factors must be present for a disease and/or disorder to occur:

- Pathogen
- Vulnerable Host (e.g., human), and
- Environment (e.g., climate change)

Humans are vulnerable to disease if factors such as these are present: insufficient or improper nutrition, inaccessible clean water due to flooding, the strain of the pathogen is virulent and favourable environmental factors (climate change i.e.; high temperature and flooding) that enhance the growth and propagation of the pathogen but which may be detrimental to the host (human). The disease triad concept as shown in *Figure 6.3* helps us understand how a particular disease develops and it explains the factors affecting its development.

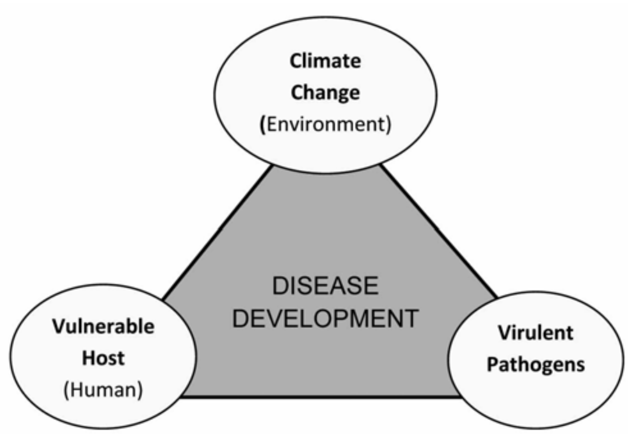


Figure 6.3 Disease Triad Concept

Vector-Borne Diseases

The indirect effects are seen on vector-borne diseases such as malaria, dengue, filariasis and schistosomiasis which are jointly affected not only by climatic conditions but also by population movement, forest clearance, land-use pattern, biodiversity losses, freshwater surface configuration and human population density. Changing weather patterns may favour the ecology of mosquito or snail vectors of malaria/filariasis and schistosomiasis, respectively and expand the range of distribution of these diseases. Movement of environmental refugees from endemic to non-endemic areas could spread these diseases too. The loss of forests, improper land use patterns and biodiversity losses could destroy natural habitats of vectors forcing them to seek other favourable places in the process of spreading the diseases.

Gubler, Reiter, Ebi, Yap, Nasci & Patz (2001) proposed the following association between climate change and transmission pattern of vector- and rodent-borne diseases.

Climate change (natural and human-caused) →regional weather changes (temperature, precipitation and humidity) →vector longevity, vector development, pathogen development, natural vertebrate host distribution and abundance, vector and rodent habitat → disease transmission dynamics →altered length of transmission season, altered intensity of transmission, altered distribution of diseases and increased or decreased disease risk(disease-specific).

The worldwide effect of climate change is expected to lead to increased latitudinal and altitudinal warming. Given this, Githeko (2009) warned that Southern Africa will be more suitable for malaria transmission and the east African highlands will become warmer thus intensifying malaria transmission. In Australia, although malaria was eradicated in 1981, the mosquito vector was not. Increase in temperature and precipitation may favour conditions for breeding of the malaria vector increasing the populations of the vector. GIS surveillance of schistosomiasis in China showed the slow northward expansion of the disease as the temperature and precipitation increase in this part of the country.

The two destructive typhoons that inundated Metro Manila in September 2009 resulted in an outbreak of leptospirosis, a disease spread through contact with water contaminated with urine of rats, dogs and other animals. With 160,000 people living in unhygienic conditions in evacuation centres and 1.4 million people living in flooded suburbs, the inevitable results were 175 deaths from the disease and 2000 showing symptoms of the disease.

The Third Assessment Report of the Intergovernmental Panel on Climate Change in 2001 as cited by WHO (2003) stated that “overall, climate change is projected to increase threats to human health, particularly in lower income populations, predominantly within tropical/subtropical countries.” The vulnerability of these populations depend on such factors as population density, level of economic development, food availability, income level and distribution, local environmental conditions, pre-existing health status and quality and availability of public health care.

Waterborne Diseases

Waterborne diseases are illnesses brought about by drinking water contaminated by human and animal faeces which may contain microorganisms that can cause disease. In developing countries, several diseases are brought by contaminated water and diarrhoea is the leading cause of illness and death among children.

What Impact Will Climate Change Have On Water Quality?

Climate change is expected to increase the severity of weather. This means that some regions will experience an increase in rainfall and flood risk, while regions that are prone to droughts may experience more extreme droughts. Warmer temperatures and increased precipitation will raise the risk of flooding. Floods cause sewage and drinking water to mix and if that water is ingested, the risk of contracting diarrhoea is great. The lack of sanitation in developing countries will even make the problem worse.

IPCC (2007) predicted an increase in illnesses and deaths in Southeast Asia due to diarrhoeal diseases, primarily associated with climate change. The occurrence of water-borne diseases in the region is likely to increase with global warming due to precipitation changes, contamination of fresh water supplies, and sea level intrusion into freshwater areas. Floods contaminate shallow groundwater and stream waters, which in some areas are the main source of drinking water. During drought periods, sea water advances inland, which leads to contamination of groundwater resources.

McMichael (2004) commented that the risk of deaths and illnesses due to climate change (attributable to diarrhoea and malnutrition) in some parts of Southeast Asia is already the largest in the world. He further predicts that this would remain so up to 2030. Flooding and rising sea levels could result in poor water quality leading to more water-related infectious diseases such as gastrointestinal diseases. Examples of gastrointestinal epidemic diseases that could be transmitted by poor sanitation and contaminated water supplies are amoebiasis, cholera, giardia, shigellosis, and typhoid fever. Pascual, Bouma & Dobson (2002) found that phytoplankton blooms are excellent habitats of infectious bacterial diseases such as cholera. These phytoplankton blooms are projected to benefit from warmer sea surface temperatures along the coastlines of Southeast Asian countries.

Several incidents were documented showing the effect of climate change (excessive precipitation) on water quality leading to cases of waterborne diseases. The outbreak of *E. coli* in Walkerton, Ontario, Canada is a good example of how excessive precipitation can increase the probability of water contamination. On May 8, 2000, a heavy rainfall began in Walkerton. On each of the first four days, the community received 10 to 20 millimeters of rainfall. On May 12, 70 millimeters of rain fell. This amount of rainfall was unusual, and could be expected once every 60 years. It is believed that the heavy rain overburdened the groundwater aquifers, and, through runoff, animal wastes contaminated the water supply with the *E. coli* bacteria. Aside from *E. coli*, there are other waterborne microorganisms that cause diarrhoea such as vibrio cholera, campylobacter, amoeba, hepatitis and salmonella, salmonella, rotavirus and norovirus. Several incidents like what happened to Canada also happened in several Southeast Asian countries (IPCC 2007).

From the World Health Organisation (WHO-SEARO, 2008.), ***Figure 6.4*** shows that diarrhoeal diseases contribute the largest fraction in the total burden of world diseases.

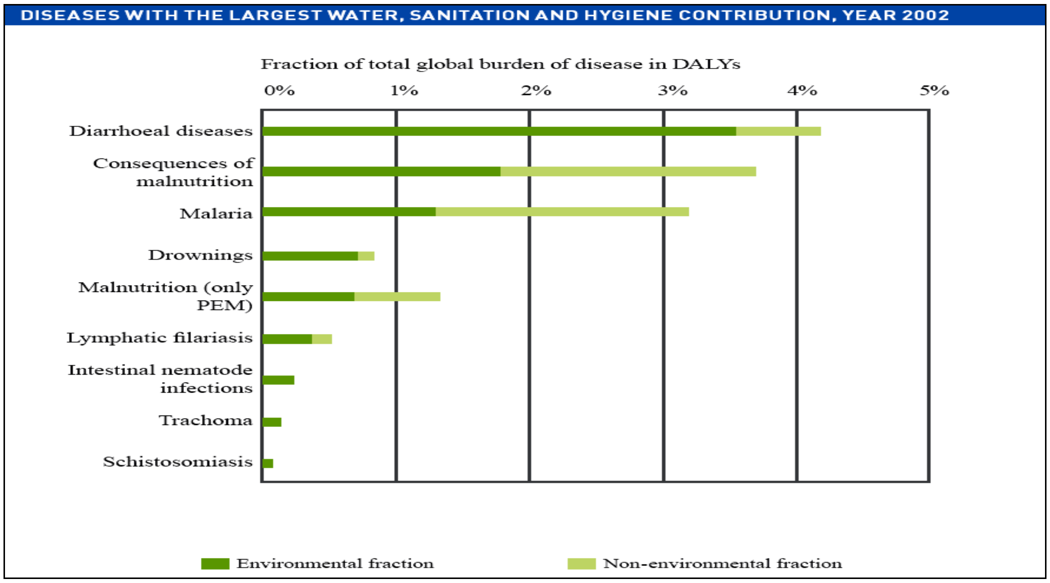


Figure 6.4 Diseases with the Largest Water, Sanitation and Hygiene Contribution
Source: WHO-SEARO (2008)

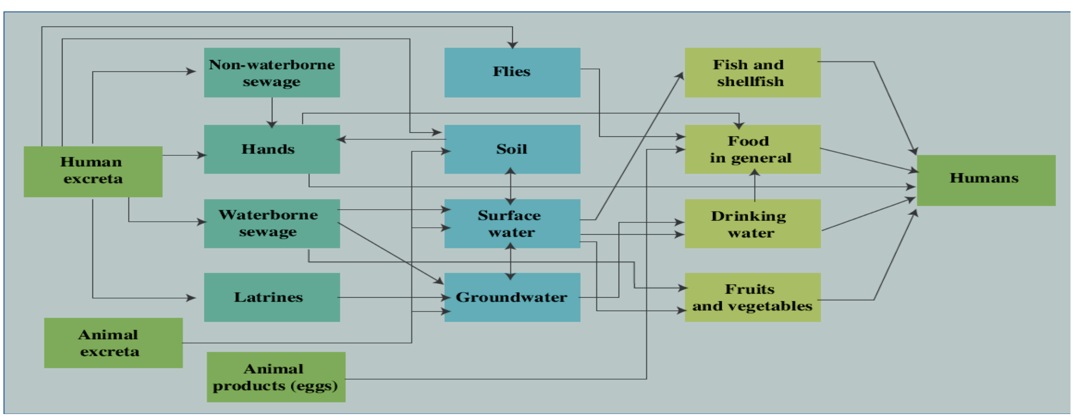


Figure 6.5 Link between a climate signal and diseases
Source: WHO-SEARO (2008)

The impact of climate change in the occurrence of diarrhoeal diseases is best understood if the disease pathway is presented. The diarrhoeal disease pathway is best exemplified by ***Figure 6.5****.* This flow chart from WHO-SEARO (2008) illustrates the points that provide the link between a climate signal and a disease. While we are interested in the human health end points (at the far right of the chart), many of these diarrhoeal diseases are zoonotic (transmitted from animals) and, therefore, transmission pathways must include both human and animal contamination. The pathogens can be transmitted from person to person (in some cases), or indirectly through contamination of food products, groundwater, and surface water.

What are the Impacts of Climate Change on Nutrition?

Climate change will definitely have impacts on our nutrition as shown in ***Figure 6.6****.* A change in climate may increase undernutrition cases which may result from improper or inadequate consumption, poor absorption or excessive loss of nutrients from the body (WHO-SEARO, 2008).

Hidden Hunger is micronutrient malnutrition. It is called “hidden hunger” because it is not readily apparent from clinical signs of a body. Even if a person consumes enough calories, this does not guarantee adequate intake of essential micronutrients (vitamins, minerals and trace elements such as vitamin A, iron, zinc, iodine, calcium, etc). This condition may happen due to low quality of food consumed. Micronutrient deficiency can have far greater consequences than insufficient macronutrient intake, as follows (Cohen, Tirado, Noora & Thompson, 2008):

- Iron deficiency can lead to anaemia which may have impact to maternal mortality during childbirth delivery. Anaemic mothers are more likely to deliver prematurely, low birth weight baby and to have babies who die as newborns. Anaemia among children can impair health and development, limit learning capacity, and impair immune systems. Iron deficiency in adult can reduce work performance.
- Lack of adequate iodine in maternal diets can lead to spontaneous abortion and stillbirths. Children who have iodine deficiency could have cretinism and retardation.
- Insufficient vitamin A intake among children causes blindness and impairs immune system which contributes to infections and death.
- Inadequate dietary zinc can lead to stunting (i.e., lower than expected height for one’s age) and greater susceptibility to infections.
- Deficiency in calcium intake increases the risk of osteoporosis and bone deformities occurrence during growth years.

Main source of iron comes from meat; vitamin A source food is liver, carrot, etc.; zinc can be taken from seafood; iodine usually from iodine fortified-salt; source of calcium are milk and milk products, egg yolks, grains, legumes, nuts, and green vegetables. Reduction in livestock production, food crops yield, and higher food prices due to food scarcity as a result of climate change could worsen the existing hidden hunger in communities because there will be decline in the availability and accessibility to food rich in iron, zinc, vitamin A, iodine, calcium, etc. that makes people consume less micronutrient (Cohen et al., 2008).

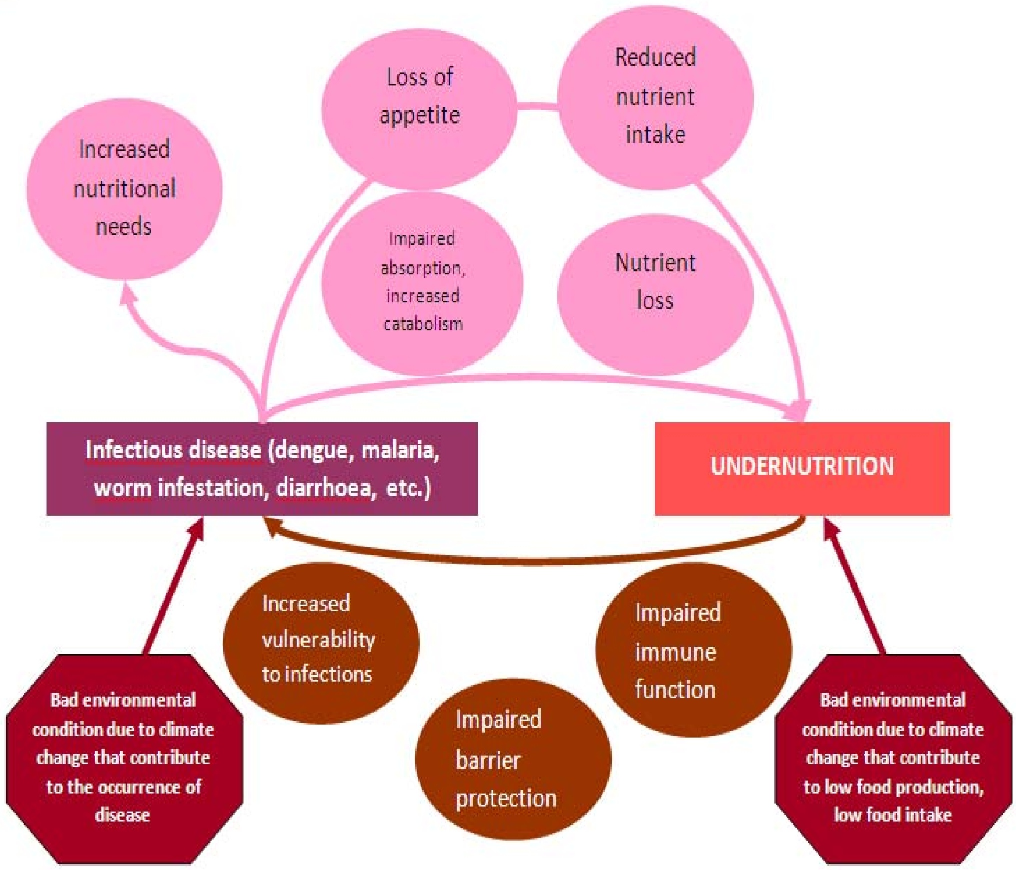


Figure 6.6 Impacts of climate change on nutrition

1. Starvation and hunger

An increase in temperature and reduced rainfall may lead to water shortages (drought). Climate change will also make crop pests thrive thereby disturbing the growth of cereal crops (WHO-SEARO, 2008). We must realise that cereal crops, the source of carbohydrate and our energy, are the staple food among the Southeast Asian population.

Droughts also have an impact on the decrease in food production from livestock (Bartlett, 2008) which will have consequences for the availability of meat and dairy products (Back & Cameron, 2008), and also affect fisheries which will decrease the supply of animal-protein source food (WHO-SEARO, 2008) and increase micronutrients deficiency problem (Cohen et al., 2008). During food shortages people will suffer from starvation and hunger (WHO-SEARO, 2008) due to inadequate food consumption that would lead to widespread undernutrition *(*UNICEF, 2007 & 2008).

2. Low nutritional status

Studies show that children born during drought years are significantly more likely to be stunted (Bartlett, 2008; UNICEF, 2008) while children exposed to floods also experience interruption in linear growth and remain shorter than the children unexposed to floods (Yoko, Goodman & Parker, 2009). When children are raised in dirty flood surroundings, calories that should go for their growth are spent instead of supporting their challenged immune systems (Bartlett, 2008).

3. Undernutrition due to diseases

Many important diseases are very sensitive to changing temperatures and precipitation caused by climate change. These include common diseases such as malaria, dengue fever, worm infestation, diarrhoea, water and sanitation related illnesses, and other communicable and non communicable disease (WHO-SEARO, 2008; Bartlett, 2008).

The relationship between nutrition and diseases is bi-directional, not only does disease bring undernutrition, but undernutrition also predisposes its sufferers to diseases. In other words, people who have disease may become undernourished even when there is sufficient food intake. When they are undernourished, their vulnerability to infections is increased (UNICEF, 2008).

People, who suffer from diseases, have increased caloric demand and metabolic requirements. While their nutritional needs increase during illness, on the other hand they cannot fulfill their nutrient requirement. For example, people who are chronically ill from parasitic infections such as worm infestations are unable to absorb nutrients, because the nutrients were taken by the parasites. Or, people who suffer from frequent , may restrict food intake because they are losing appetite, and they also experience impair nutrient absorption and nutrient losses during diarrhoea (Bartlett, 2008).

Diseases may also impair nutrient transport to target tissues which then will lower the body's capacity to utilise food effectively. At the end, people will end up in undernourished condition (Yoko et.al., 2009).

Undernourished condition, especially in infants and young children, makes infections worse and more frequent because undernourished people have low protection to disease. Inadequate food consumption also heightens vulnerability to infectious diseases because of the impaired immune function (Cohen et al., 2008).

Food Contamination

Heavy precipitation events and intense tropical cyclone will raise the risk of flooding. Flood water can be contaminated by pathogenic microorganisms derived from human or animal faeces, and runoff from fields (pesticides), septic fields, gutter, residential and industrial waste. Flood water may wash away or drown the facility in the house such as stove, cooking fuel, eating utensils, cooking utensils, including clean water to be cooked. These hamper people to prepare and store food hygienically and force people to drink unsafe water. In this dirty environment and minimised-facility, the risk of food contamination increases (WHO-SEARO, 2008). When drought occurs, water shortage increases. Children's bodies, food, eating utensils, floors, cooking surfaces are all less likely to be kept clean when water supplies are inadequate and difficult to reach. When water supplies become scarce and difficult to access, families are more likely to store their water, a practice that greatly increases the potential for drinking water contamination. For instance, contamination can take place through children's grubby hands reaching into pails for drinking water. People may be touching food without previously washing their hands since there is no water or they try to lessen the use of water. These conditions may contribute to diarrhoea disease outbreaks that may lead to undernutrition (Bartlett, 2008).

Climate change and variability also influences food contamination with non-infectious hazards such as biotoxins (e.g. mycotoxins or marine toxins) and chemicals, which may have an impact on food utilisation. Chemical food contamination may lead to recommendations to limit consumption of locally produced food in order to protect human health, thus reducing the dietary options and compromising people traditional diets. For example, high contamination with dioxins associated with severe droughts has led to recommendations that poor rural communities limit the consumption of locally produced foods. Higher ocean temperatures are leading to increased levels of methyl mercury in fish and marine mammals, prompting recommendations to limit the intake of fish and marine fats by pregnant women and indigenous people (Cohen et al., 2008).

Nutrition and Quality of Caring Practices

Intense weather events (cyclones, storms), sea level rise and coastal storms cause loss of life, injuries, life-long handicaps, and loss of property and land that will force massive migration and displacement. Migrated families will face hunger, unemployment, insecurity and famine. These will bring about psychosocial stress which causes potential social conflict that will affect mental health (WHO-SEARO, 2008).

The burdens faced by caregivers become more challenging. Overstretched and exhausted caregivers are more likely to leave children unsupervised and to cut corners in all the chores that are necessary for healthy living (Bartlett, 2008).

During crisis and emergency situation when health and nutrition of mother are usually diminished, the production of breast-milk will be disturbed. Therefore, mothers will provide the children with other food which need further preparation as substitutes for the breast milk. But the preparation and storage of the food, especially in unsanitary environments can present real health risks to children, since there is opportunity for food contamination. Mothers may also be unaware about the quantities to be mixed in the food, which may place children at risk of undernourishment because of the lack of nutrients in their food (Bartlett, 2008; Yoko et al., 2009).

What Needs To Be Done?

How great the health impacts will be are strongly dependent on local environmental conditions and socio-economic circumstances and the range of social, institutional, technological, and behavioural adaptations taken to reduce the full range of threats to health. Every system has a particular adaptive capacity which is its ability to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities or to cope with consequences.

What is seen as the "most important, cost-effective and urgently needed" adaptation strategy is the rebuilding and maintaining of public health infrastructure. This includes public health training, more effective surveillance and emergency response systems, and sustainable prevention and control programmes.

While it is incumbent upon vulnerable populations to put in place the above adaptation strategy to cushion the impact of climate change, the need for education of the population especially the youth whose future is severely compromised by the effects of climate change cannot be overemphasised. As early as elementary school, children should be taught in simple terms and mechanisms the whys and the hows of climate change and how this could be abated or how its impact could be mitigated. By the time these students enter high school, they are prepared to take on certain responsibilities and better still stand side by side with adults in the crusade against activities that aggravate climate change. There are no better spokespersons than the group whose future is endangered by the very activities of adults who profess to protect their welfare and future.

What can the students do to make a difference?

- Balanced diet, in variation and proportion, and no excess consumption. Reduce average daily meat consumption but may increase meat consumption accordingly for those under- consumers.
- Take exchangeable food in one category (staple food: rice, cassava, corn, etc)
- Local food utilisation, cheap but nutritious. It will lessen the GHG emissions caused by transportation.
- School gardening activities.
- Promote exclusive breastfeeding. Mothers are encouraged to continue breastfeeding even while their supplies are depleted in order to maintain and stimulate their supply.

- Promote healthy lifestyles. Use public transportation, ask parents to leave the car at home or share car journey with friends. For short trips and local shopping, try walking or use a bicycle. It will encourage physical exercise and thus reduce obesity. It keeps you fit and is fun too!
- Build anti-hunger alliances or join an environmental groups, express your concerns and solutions and stay informed
- Create, write, and disseminate information related to mitigating impact of climate change on health and nutrition to your friends, families, and communities.
- Prevent and prepare for emergency situations
- AND TAKE ACTION NOW!!!!!

To raise students' awareness and develop their resiliency to climate change impact on health and nutrition, this chapter includes exemplars on vector-borne diseases (e.g., filariasis and dengue infections) and water-borne diseases (e.g., cholera) to show the effects of climate change on human health and nutrition.

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Lesson 1

CONTAMINATED WATER AND WATERBORNE DISEASES

GRADE LEVEL: High School

SUBJECT: Biology

TOPIC: Diarrhoea as a Digestive Disorder

PREREQUISITE

- Students should have prior knowledge about the parts and functions of the digestive system and how the digestive system works.

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objective: By the end of this lesson, students should be able to:

- explain how waterborne diseases (e.g., cholera) can affect the human digestive system.

Climate Change Objectives

- discuss how diarrhoea becomes virulent as influenced by climate change such as high temperature and flooding;
- explain how humans become vulnerable to infectious disease when there is drastic change in the environment such as temperature and climate; and undernourishment;
- analyse how climate change affects the spread of waterborne diseases like diarrhoea through the environment; and
- cite different measures to prevent the spread of waterborne diseases.

MAIN CONCEPTS AND SKILLS

- Three critical factors must be present for a disease and/ or disorder to occur namely, *pathogen* (e.g., virus, bacteria, protozoa, fungi); *vulnerable host* (e.g., human); and *environment* (e.g., climate change). Humans are vulnerable to disease due to improper/insufficient nutrition; contaminated water due to flooding; virulent strain of the pathogen; and unfavourable environmental factors (e.g., climate change such as high temperature and flooding) that enhance the growth and propagation of pathogens which may be detrimental to the host (human).

- Due to climate change, warmer temperatures and increased precipitation will raise the risk of flooding. Floods cause sewage and drinking water to mix and if contaminated water is ingested; the risk of contracting waterborne diseases (e.g., cholera) is more likely. The lack of sanitation will even make the problem worse.

- An infected person or animal may pass pathogens through waste into the water supply. Some microorganisms (e.g., bacteria) are indigenous to water environments and are naturally occurring in some bodies of water. These cannot be seen, smelled, or tasted. Hence, contaminated water often appears fresh and clear.
- Waterborne diseases like diarrhoea occurs because more fluid passes through the large intestine (colon) than the organ can absorb. Rapid transit of stool is one of the most common causes of diarrhoea. For stool to have normal consistency, it must remain in the large intestine for a certain amount of time. Stool that leaves the large intestine too quickly is watery due to waterborne disease.
- Alternative energy production, carbon sequestration, water reuse, and recycling are some of the mitigation and adaptation options that could have the greatest implications for human health. Increased hydroelectric power generation will have significant impact on local ecologies where dams are built, often resulting in increased or decreased incidence of waterborne disease. Shifting to wind and solar power will reduce demand on surface waters and therefore, limit impacts on local water ecosystems and potentially reduce risks of waterborne diseases.
- Adaptation strategies such as protecting wetlands to reduce damage from severe storms have beneficial impact on water quality and on the ecology of waterborne infectious disease. Also, for any novel mitigation technology, thorough health and environmental impact assessments are necessary prior to its implementation and widespread adoption.

MATERIALS NEEDED

- Recent picture of flooding incident in the area.
- Pictures taken from magazines, newspapers and the internet showing ill-effects of flooding on human health
- Newspaper clips or videos emphasising climate change effects on human health
- Recent data/statistics on burden of waterborne diseases with emphasis on diarrhoeal diseases
- Visual aid on “Disease Triad Concept”
- Art materials to be used in developing the comic strip.

PRESENTATION OF LESSON

Scenario

The teacher will present any recent pictures of a flooding incident in the community and then ask the class to mention the effects of this incident in the community. Take note of the different responses provided by the students and highlight those that are related to health issues particularly on waterborne diseases.

Guide Questions:

1. What struck you most in these pictures?
2. What are the possible effects of flooding in our community?
3. What do you think will happen if flooding incidents will occur more often in our place?
4. What are the possible health problems due to frequent flooding?

Student Activities

1. The student will develop a comic strip about the causes of diarrhoea as a waterborne disease and its effects in the digestive system.
2. Make a research on why severe flooding in Pakistan had caused the mass death of children from July to August 2010 (i.e. due to cholera, dehydration and malnutrition).

Process Guide for Teachers

1. Conduct a short review on how the digestive system works. Use a digestive system poster.
2. Present a short lecture about waterborne diseases and some related digestive disorder like diarrhoea.
3. Divide the class into groups. Distribute the information materials about climate change and waterborne diseases and the art materials. If the classroom has access to computer with internet connection, provide a list of websites pertaining to climate change and its effect to human health particularly on waterborne diseases.
4. Present a scoring rubric for the comic strip ***(Attachment 6.1.1)*** and group presentation rubric ***(Attachment 6.1.2)*** before the activity starts to guide the students on how they will perform their project/activity properly.
5. Conduct a comic strip presentation.
6. Process student's learning experiences in doing their research project. Solicit insights about the impact of climate change on human health particularly the spread of diarrhoea as a waterborne disease.

Guide questions

1. How does diarrhoea become virulent as a result of climate change?
2. Why do people become vulnerable to infectious disease when there is a drastic change in the environment (e.g., temperature, climate) and undernourishment?
3. How do waterborne diseases like diarrhoea affect the welfare of the community particularly those living in depressed areas?
4. What measures can we do to mitigate the effects of climate change on our health condition?

Discussion Points

Floods contaminate shallow groundwater and stream waters, which in some areas are the main source of drinking water. During drought periods, sea water advances inland, which leads to contamination of groundwater resources. The risk of deaths and illnesses due to climate change (attributable to diarrhoea and malnutrition) in some parts of Southeast Asia is already the largest in the world and this would remain to up to 2030 (McMichael 2004).

Flooding and rising sea levels could result in poor water quality leading to more water-related infectious diseases such as gastrointestinal diseases. Examples of gastrointestinal epidemic diseases that could be transmitted by poor sanitation and contaminated water supplies are amoebiasis, cholera, giardia, shigellosis, and typhoid fever.

Pascual, Bourna, and Dobson (2002) found that phytoplankton blooms are excellent habitats of infectious bacterial diseases such as cholera. These phytoplankton blooms are projected to benefit from warmer sea surface temperatures along the coastlines of Southeast Asian countries.

Achieving the Objectives

Objective	This is achieved by
Explain how waterborne diseases like cholera affect the human digestive system	Developing comic strip about waterborne diseases and digestive system.
Discuss how diarrhoea becomes virulent as influenced by climate change such as high temperature and flooding	Group presentation of comic strip in class.

Objective	This is achieved by
Explain how humans become vulnerable to infectious disease when there is a drastic change in the environment such as temperature, climate, and undernourishment	Presentation of research findings on Pakistan flooding Students' interaction while working in groups and during the class presentation.
Analyse how climate change affects the spread of waterborne diseases like diarrhoea through the environment	Class discussion about their learning experiences and insights.
Cite different measures to prevent the spread of waterborne diseases	Class discussion on mitigating the effects of climate change.

Assessment

- Performance assessment: This will be conducted during the performance of the assigned activity. The teacher will utilise a performance rubric.

- Formative assessment: In a clean sheet of paper, the students will answer the following questions.
  1. How is diarrhoea affecting the human digestive system?
  2. Explain how climate change contributes to the spread of waterborne diseases?
  3. List at least two ways to mitigate the effects of climate change on waterborne diseases which could endanger human health.

Closure

1. To provide a brief summary of the lesson, the teacher will present the following schematic diagram which describes the effects of climate change on human health.

Schematic diagram pathways by which climate change affects health

Climate change
- Gradual change
  - Global warming
  - Change in rainfalls
- Extreme events
  - Storms and floods

Affected factors
- Contamination of water and foods by bacteria
- Increase in number and activation of mosquitoes
- Expansion of infected areas

Project effects
- Increase in water-borne diseases
- Increase and expansion of vector-borne diseases

Source: Climate Change and Human Health - Risks and Responses (WHO, 2002)

Increases in water temperature, precipitation frequency and severity, evaporation-transpiration rates, and changes in coastal ecosystem health could increase the incidence of water contamination with harmful pathogens and chemicals, resulting in increased human exposure. Hence, mitigation studies and measures should focus on understanding where changes in water flow will occur, how water will interact with sewage in surface and underground water supplies as well as drinking water distribution systems, what food sources may become contaminated, and how to better predict and prevent human exposure to waterborne and ocean-related pathogens and biotoxins.

2. To integrate the lesson in real life, ask the students to reflect on the following guide questions:

   ➢ What is the importance of maintaining proper sanitation in our school, at home and in the community?

   ➢ In our own way, how can we help mitigate the effects of climate change on water-borne diseases that could severely affect human health?

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Attachment 6.1.1
Sample Comic Strip Rubric

Criteria	4 Exemplary	3 Proficient	2 Needs Improvement	1 Incomplete
Content of the Story	A full story of the causes of waterborne diseases and how it affects the human digestive system is given. All topics are addressed.	A full story of the causes of waterborne diseases and how it affects the human digestive system is given. Not all topics are addressed.	Two or more topics were not addressed. The story is not complete.	Story has little or nothing to do with the main topic. All the topics are not addressed.
Captions	Captions are related to the scenes, and the connections are easy to understand.	Captions are related to the scenes, and most connections are easy to understand.	Captions are related to the scenes, but the connections are less obvious.	Captions do not relate well to the scenes. There seems to be no connection or connections are very general.
Character	The main characters are clearly identified, and their actions and dialogue are well-suited for the story.	The main characters are clearly identified, and their actions and dialogue suit the story.	The main characters are identified, but actions and dialogue are too general to show their relationship to the story.	It is hard to tell who the main characters are.
Scenery	Scenes are directly related to the story and enhance the reader's understanding of the topic.	Scenes are directly related to the story.	Scenes are generally related to the story.	Scenes seem randomly chosen and sometimes distract the reader.

Attachment 6.1.2
Sample Rubric for Group Presentation

Criteria	4 Exceeds Standard	3 Meets Standard	2 Progressing to Standard	1 Below Standard
Opening	Opening captivates the audience with interest and/or intrigue.	Interesting opening; engages audience.	Opening is minimally engaging.	Opening is not engaging.
Focus	Purpose of presentation is clear. Supporting ideas maintain exceptional focus on the topic	Topic of the presentation is clear. Content consistently supports the purpose.	Presentation lacks clear direction.	No clear focus.
Organisation	Information/ ideas are presented in a consistently logical sequence. Transitions and connections are eloquent. A strong sense of wholeness is conveyed.	Important ideas and information are identified for the audience. Information/ ideas are presented in a logical sequence with few lapses. Transitions and connections are made. Closing effectively summarises the presentation.	Irrelevant, unnecessary information detracts. Big ideas are not specifically identified. There are significant lapses in the order of ideas. Transitions are inconsistent and weak or missing. Closing demonstrates an attempt to summarise.	No clear organisation. Ideas do not connect with one another. There are no clear transitions. No closing is evident.

Lesson 2

LET'S FIGHT DENGUE!

GRADE LEVEL: High School

SUBJECT: Biology

TOPIC: Dengue Hemorrhagic Fever: How it affects the Circulatory System?

PREREQUISITES

- Students should have prior knowledge on blood circulatory system, water cycles, and insects.
- Search for locally produced short film or video documentary in your country about climate change and vector-borne diseases prior to the lesson proper.

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this lesson, students should be able to:

- identify which part of the circulatory system is affected by dengue; and
- explain how dengue hemorrhagic fever affects the human circulatory system.

Climate Change Objectives

- discuss how dengue vectors become active as influenced by climate change such as high temperature and more rains;
- analyse how humans become vulnerable to infectious diseases when there is a drastic change of environment such as temperature and climate; and undernourishment; and
- identify different measures to prevent the spread of vector-borne diseases.

MAIN CONCEPTS AND SKILLS

- Dengue fever is caused by a type of arthropod-borne virus (*arbovirus).* The virus is carried by a mosquito named *"Aedes aegypti"* which transmits the virus to humans through its bite. The virus travels in the blood stream and then starts multiplying itself in the whole body. *Aedes aegypti* works as a vector for transmitting the disease. Disease risk may increase as a result of climate change due to related expansions in vector ranges, shortening of pathogen incubation periods, and disruption and relocation of large human populations.

- The dengue virus' main effect is on the platelet production. Normally the platelets in our body last for about 4 days and the body replenishes them when required. This virus destroys the body's capacity to produce new platelets. A fall in platelet count prevents the formation of clots and may lead to hemorrhage which results into both internal and external bleeding.

- Climate change mitigation strategies focused on alternative energy sources such as nuclear power may influence local ecologies by increasing water demands, temperature, and currents. This, in turn, might alter the life cycles of certain mosquitoes. Increased reliance on hydroelectric power, which typically requires construction of dams, also may change local vector-borne disease ecologies and alter transmission cycles.

- Mitigation activities focused on preservation of forests and wetlands are likely to reduce the incidence of these vector-borne diseases. For instance, changes to wetlands may affect mosquito burden in certain areas by altering the breeding area size and the incidence of malaria, dengue, or other mosquito-borne diseases.

MATERIALS NEEDED

- Video presentation of a locally produced short film or video documentary in your country about climate change and vector-borne diseases.
- Visual Aid on Disease Triad Concept
- Information materials about dengue hemorrhagic fever.
- If the classroom has access to computer with internet connection, provide a list of websites pertaining to climate change and vector-borne diseases such as dengue.
- Writing materials and instruments
- Art materials for poster making

PRESENTATION OF LESSON

Scenario

The teacher will present a short film or a video documentary about climate change and the spread of vector-borne diseases particularly dengue. After viewing, the teacher will ask the students to share their personal experiences or stories about dengue and how it affects human health.

Student Activities

1. Construct a *graphic organiser* about the different parts and function of the human blood.

2. Conduct a *walk tour* of the school campus to investigate possible breeding ground of mosquitoes carrying the dengue virus. They will conduct a *clean-up drive* around the school campus for dengue prevention.
3. Develop an *information poster* about the effects of the dengue virus to the human circulatory system.

Process Guide for Teachers

1. Assign the students into their respective working groups.
2. Provide each group the *Information Sheet* about the parts and functions of blood.
3. Instruct the group to create a graphic organiser about the parts and function of blood. Utilise computer with Internet connection, if available.
4. Determine how much time is needed to develop the graphic organiser. When all the groups are ready, tell them to post their work in a designated area. Allow them to spend some minutes for gallery viewing.
5. Discuss with the students the importance of maintaining a healthy circulatory system. Ask them about the possible external threats to a healthy circulatory system. Based on their responses, lead the discussion on vector-borne diseases such as dengue.
6. Conduct a short lecture about vector-borne diseases. Discuss how climate change contributes to the worsening cases of vector-borne diseases especially dengue in Southeast Asia.
7. Allow students to return to their respective groups and ask them to develop a plan for a *walk tour* and *clean-up drive* around the school campus. They will conduct an area survey of possible breeding ground of mosquitoes and a clean-up drive around the campus.
8. Reconvene the class to discuss the students' learning experiences and insights.

Achieving the Objectives

Objective	This is achieved by
Discuss how dengue vectors become active as influenced by climate change such as high temperature and more rains.	Film show or video presentation and analysis.
Analyse how humans become vulnerable to infectious diseases when there is a drastic change of environment such as temperature and climate; and undernourishment	Class discussion after the short lecture on vector-borne diseases.

Objective	This is achieved by
Identify which part of the circulatory system is affected by dengue	Interaction among students during gallery viewing of graphic organisers about the parts and functions of the blood.
Explain how dengue hemorrhagic fever affects the human circulatory system.	Students' interaction while working in groups.
Cite different measures to prevent the spread of vector-borne diseases.	Walk tour around the school campus to investigate possible breeding ground of mosquitoes and conducting a clean-up drive. Developing information posters about the effects of dengue and mitigating climate change impact on human health.

Assessment

- Conduct a performance based assessment for the following activities:
  - Developing a graphic organiser
  - Planning a walk tour within the school campus
  - Developing an information poster
- Formative assessment: Identification of terms

  ______1. It is the protein in the blood the carries oxygen.

  ______2. It is the component of blood that fights diseases that enters the blood stream.

  ______3. When blood is exposed to air, this blood component become sticky and form internal and external "scabs" to catch the blood cells and plasma, thereby stopping bleeding.

  ______4. It serves as the main transportation component in the body since it is the liquid part of the blood.

  ______5. It is the component of the blood that is adversely affected by the dengue virus.

Closure Activity

1. Ask the students to develop an *Information Poster* about the effects of the dengue virus to the human circulatory system.

Firming-up Questions:

- How does dengue virus affect the human circulatory system?
- In our own way, how can we help in mitigating the effects of climate change on vector-borne diseases that can cause danger to human health?

2. Provide the students some practical tips to fight dengue. The acronym "DENGUE" would help them easily remember the steps to monitor the disease. (Source: http://www.abs-cbnnews.com)

D- daily monitoring of patient's status
E- encourage intake of oral fluids
N- note for any warnings or signals *(persistent vomiting, severe abdominal pain, restlessness, irritability, platelet count, bloated abdomen)*
G- give paracetamol to bring down fever (avoid aspirin)
U- use bed/mosquito screens, insect sprays, repellant
E- early consultation is advised if you have doubts

Homework/Assignment

- Ask students to conduct an action research on how unpredicted rainfall creates more favourable environment to the vectors and to determine its impact on human health. (Note: install a rain gauge to monitor rainfall in the school grounds).

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Lesson 3

UNDERSTANDING FILARIASIS

GRADE LEVEL: High School

SUBJECT: Biology

TOPIC: Phylum Nematoda (*Filarial Parasitic Worm*)

PREREQUISITE

- Students should have prior knowledge on the classification of organisms and organ system.
- Before the conduct of this session, the teacher must prepare information sheets about phylum Nematoda and filaria for distribution to students.

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this lesson, the students should be able to:

- discuss the characteristics of nematodes;
- explain the life cycle of nematodes particularly the filarial parasites; and
- explain the effects of filarial parasites to the human organ system.

Climate Change Objectives

- analyse how nematode vectors become active as influenced by climate change such as high temperature and flooding;
- analyse how humans become vulnerable to infectious diseases when there is a drastic change of environment such as temperature and climate; and undernourishment; and
- identify different measures to prevent the spread of the filariasis disease.

MAIN CONCEPTS AND SKILLS

- *Nematodes* (filarial parasitic worm) are the most speciose phylum after the arthropods. A handful of soil can contain up to thousands of microscopic worms which range from 0.3 mm to 8 meters in size. They have digestive, nervous, excretory, and reproductive systems but do not have a respiratory system.

- Nematodes are the most abundant multi-cellular animal on earth. They live in a vast variety of habitats except in dry places. They can be divided into *free living* forms and *parasitic* forms. Free living forms have a simple life cycle involving four (4) juvenile *instars* (developmental stages) on the path from egg to adult.

- Parasitic worms are parasitic to insects, plants, and animals. They have developed a wide range of variations i.e., whether there is a *secondary host*, the *amount of time* spent in one or either hosts and *the way that they move* from one host species to another. Thus, many species lay eggs that pass out of the primary host with the faeces where they are eaten by the secondary host which gets eaten in turn by the primary host after the nematodes have developed. Because it is not totally reliable that the secondary host will be eaten just as the nematode larvae have developed into the *infective stage* (penetrates human skin & causes infection) many species have the ability to *encyst (*enclose*)* themselves in the muscle/cuticle of their secondary hosts.

- The life cycle of filarial worms start with an infected fly or mosquito - it bites a human and deposits larvae of the filarial worm into the feeding site. The larvae reach adulthood, mate, and the females produce offspring. The young worms, called *microfilariae*, reside in the bloodstream during peak times for human-biting insect activity. At this stage, they may be consumed when a mosquito or fly lands and feeds. The cycle continues as the insect lands on a new human host and transmits the larvae. It may be several months and often years before an individual exhibits symptoms of having been infected with filarial worm larvae.

- There are eight known species of filarial worms that infect humans which is divided into three categories: worms that *invade tissue and skin*, those that *reside in the lymphatic system* and those that *thrive in areas around the stomach, lungs, and heart*.

- Transmission of vector-borne diseases can be reduced by avoiding mosquito bites in endemic areas through personal protective measures like repellents, use of bed nets and insecticides. Mosquito vectors often breed in stagnating polluted water bodies, such as blocked drains and sewers. Aside from drug administration, good sanitation and rigorous hygiene practices are essential to reduce mosquito breeding places.

MATERIALS NEEDED

- Visual Aid on Disease Triad Concept
- Pictures of the effects of filarial worm in human health (e.g., elephantiasis)
- Information materials about phylum Nematoda and filariasis.
- If the classroom has access to computer with Internet connection, provide a list of websites pertaining to climate change and vector-borne diseases like Filariasis.
- Writing materials and instruments
- Drawing materials

PRESENTATION OF LESSON

Scenario

- Show pictures of filariasis cases in human beings to students and ask them about the possible causes of this disease.

- Show pictures of how vectors and pathogens move in flooded water and how the nematode vectors migrate from unsuitable habitat and increase its population because the natural enemies of the nematode vectors are gone.

Guide Questions:

1. How can human beings contract the filariasis disease?
2. What do you think are the possible causes of filariasis?
3. What are the environmental problems which may lead to the spread of filariasis?

Student Activities

- Students will create a poster showing the characteristics of nematodes and their life cycle. The students will differentiate different kinds of nematodes.
- Students will develop a concept map showing how the nematode vectors move over flooded water or migrate due to unsuitable habitat wherein they spread the disease in the process.
- They will develop an information brochure about filariasis.

Process Guide for Teachers

1. Conduct a short review about the concept and classification of organisms.
2. Present a short lecture about phylum Nematoda.
3. Divide the class into working groups, and then pass out the prepared information sheets about phylum Nematoda and filaria (as shown in the main concepts)
4. Instruct the students to develop a poster depicting the characteristics of organisms under phylum Nematoda.
5. Each group will present their poster for critiquing. If there is time constraint, the class may opt to conduct a gallery viewing of all posters inside the classroom. Facilitate the class discussion on nematodes using the guide questions below:
   - What are the characteristics of nematodes?
   - How do they survive?
   - How do nematodes affect human beings like us?

6. Ask students to draw a *concept map* showing how the vectors move over flooded water or migrate due to unsuitable habitat wherein they spread the disease in the process.

7. Present and discuss the filariasis poster to the class as shown in the sample below. Ask the students to identify various types of nematodes

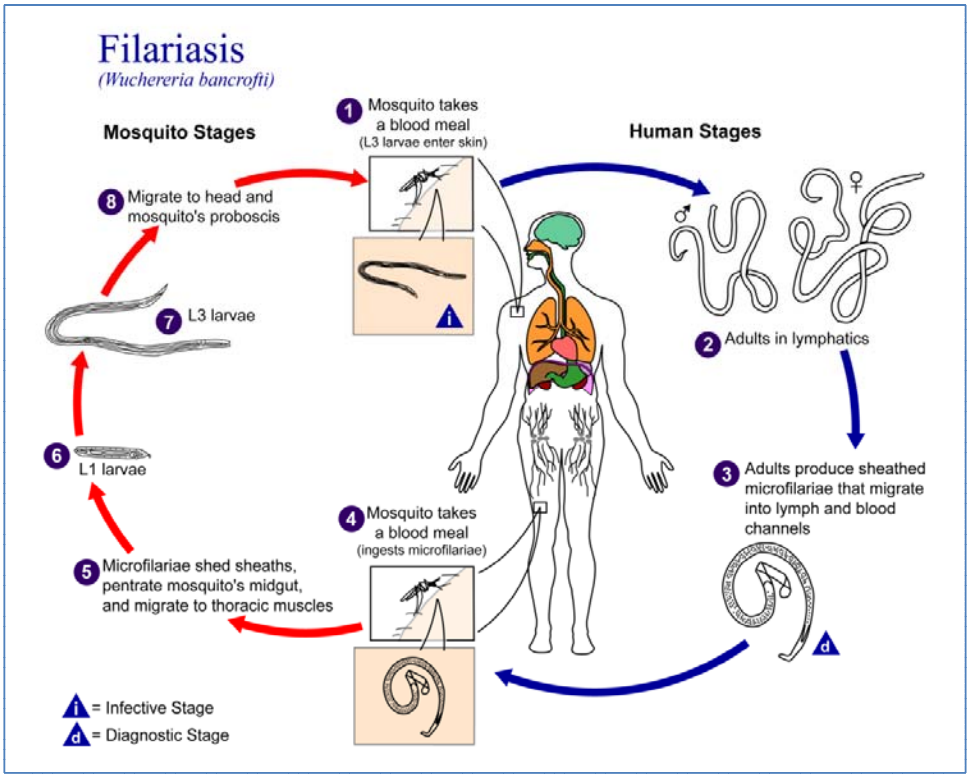

Figure 1 Filariasis Poster
Source: *http://commons.wikimedia.org/wiki/File:Filariasis_01.png*

8. Discuss the relationship between climate change and filariasis. Ask the students this question: "What stage within the life cycle of nematodes is affected by climate change?"

9. Advise the students to return to their respective working groups and instruct them to develop a *brochure* about filariasis and climate change.

Achieving the Objectives

Objective	This is achieved by
Discuss the characteristics of nematodes. Explain the life cycle of nematodes	Group interaction during the development of poster. Exchanging ideas during the Gallery viewing of posters.
Explain the effects of nematode parasite to the human organ system	Class discussion and short lecture.
Analyse how the nematodes become active as influenced by climate change such as high temperature and flooding;	Presentation of concept map on vector transmission as a result of climate change Presentation of posters on filariasis and students' interaction.
Analyse how humans become vulnerable to infectious diseases when there is a drastic change of environment such as temperature and climate, and undernourishment.	Sharing of learning experiences and insights on the effects of climate change to infectious diseases.
Cite different measures to prevent the spread of filariasis disease.	Developing a brochure to describe the effects of climate change in the spread of filariasis and the mitigation measures.

Assessment

A. Using rubrics, ***(Attachment 6.3.1 & 6.3.2)*** conduct performance-based assessment among students for the following activities:

- Developing a poster and group presentation.
- Developing a concept map on vector transmission/migration.
- Developing a brochure about filariasis.

B. Conduct formative assessment through Multiple Choice:

1. Which of the following are NOT characteristic of nematodes?

   a. unicellular
   b. no circulatory system
   c. free living form and parasitic
   d. unsegmented

2. Nematodes feeds on

   a. bacteria
   b. fungi
   c. other nematodes
   d. all of them

3. Filariasis is a

   a. vector-borne disease | c. air-borne disease

   b. water-borne disease | d. communicable disease

4. Which of the following transmits the filarial larvae to a human host?

   a. rodents | c. worms

   b. mosquitoes | d. snail

5. Nematode-parasites can live only in human and animal hosts?

   Give your reasons.

Closure Activity

Draw out the students' overall learning insights on phylum Nematoda in relation to climate change using the following guide questions:

1. What is the importance of phylum Nematoda in understanding, treating and preventing parasitic diseases like filariasis?

2. In our own way, how can we help in mitigating the effects of climate change on filarial parasitic diseases which could threaten human health?

RESOURCES

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Ramel, G. (n.d.) Phylum nematoda. Retrieved on 30 October 2010 from http://www.earthlife.net/inverts/nematoda.html

Attachment 6.3.1
Sample Brochure Rubric

Group Name____

CRITERIA	4	3	2	1	VALUE
Display	All parts are not clearly labeled.	Some parts are clearly labeled.	Many parts are clearly labeled.	All parts are clearly-labeled.	10
Mechanics and Spelling	There are many mistakes in mechanics and/or spelling.	There are several mistakes in mechanics and/or spelling.	There are minor mistakes in mechanics and/or spelling that do not detract from the presentation	There are no mistakes in mechanics/or spelling.	30
Presentation	The brochure is presented as difficult for the audience to hear and little or no eye contact is made.	The brochure is presented with a choppy voice, and an attempt is made to make eye contact.	The brochure is presented with a fluent voice, and occasional eye contact.	The brochure is presented with an expressive and fluent voice and good eye contact.	25
Layout	Layout is confusing. Components are inconsistent and information is missing.	Layout is somewhat organised. Most of the components are not consistent. Partial information can be located.	Layout is organised. Most components are consistent within the publication. Information can be located.	Layout is well organised. There is consistency in its components that allows the reader to easily locate information.	35
TOTAL					100

Source: http://www.makeworksheets.com/samples/rubrics/brochure.html)

Attachment 6.3.2
Sample Poster Rubric

Group Name:____

Category	4	3	2	1	Value
Required Elements	The poster includes all required elements as well as additional information.	All required elements are included on the poster.	All but 1 of the required elements are included on the poster.	Several required elements were missing.	10
Labels	All items of importance on the poster are clearly labelled that can be read from at least 1 m away.	Almost all items of importance on the poster are clearly labelled that can be read from at least 1 m away.	Many items of importance on the poster are clearly labelled that can be read from at least 1 m away.	Labels are too small to view OR no important items were labelled.	30
Relevance of Graphics	All graphics are related to the topic and easier to understand. All borrowed graphics have a source citation.	All graphics are related to the topic and most are easy to understand. Some borrowed graphics have a source citation.	All graphics relate to the topic. One or two borrowed graphics have a source citation.	Graphics do not relate to the topic OR several borrowed graphics do not have a source citation.	25
Attractive-ness Grammar	The poster is exceptionally attractive in terms of design, layout, and neatness. There are no grammatical/ mechanical mistakes on the poster.	The poster is attractive in terms of design, layout and neatness There are 1-2 grammatical/ mechanical mistakes on the poster.	The poster is acceptably attractive though it may be a bit messy. There are 3-4 grammatical/ mechanical mistakes on the poster.	The poster is distractingly messy or very poorly designed. It is not attractive. There are more than 4 grammatical/ mechanical mistakes on the poster.	35
Total					100

Source:
http://www.teacherweb.com/ME/JALeonardMiddleSchoolOldTown/Ecologywebquest/page3.htm,2003-07-28

CHAPTER VII: Impact of Climate Change on POVERTY

[SEAMEO SPAFA]

Introduction

In Southeast Asia, poverty incidence remains high. As of 2005, about 93 million or 18.8% of Southeast Asians lived below the USD1.25-a-day poverty line and 221 million (44.6%) below the USD2-a-day-poverty line. For this large group of people, poverty means lack of access to food, housing, education, health care and basic human rights. So it is not just about economics. Whether we talk about USD1.25 or USD2 per day, it is important to ask if this is enough for survival or not. Overall, being poor means a poor state of well-being.

Poverty is also relative. "In wealthy societies, the concept of poverty is relative. People feel poor because many of the good things they see advertised on television are beyond their budget, but they do have a television (TV). In the United States, 97% of those classified by the Census Bureau as poor own a coloured TV. Three quarters of them own cars, have air-conditioning, a VCD or DVD player. All have access to healthcare" (Singer, 2009).

What is Poverty?

Extreme or *absolute poverty* indicates deprivation that kills and this affects 1.4 billion people around the world. This means that nearly 30,000 people die every day, that is, one death every 3 seconds.

Absolute Poverty means not having enough income to meet the most basic human needs for adequate food, water, shelter, clothing, sanitation, health care, and education (The World Bank, n.d.)

However, one does not have to die to be poor. How can one person be poor? The most commonly used way to measure poverty is based on standard of living and incomes. A person whose income level falls below the poverty line or some minimum level necessary to meet basic needs is considered poor. What is necessary to satisfy basic needs varies across time and societies. Therefore, poverty lines vary in time and place, and each country uses lines which are appropriate to its level of development, societal norms and values (The World Bank, n.d.).

The Story of Teacher Nongkraan provides a clear picture of what poverty is:

NONGKRAAN'S STORY…

Nongkraan teaches in a two-room preschool on the corner of Bangkok's major garbage dump. The students are mostly children of garbage pickers and factory workers. Nongkraan says she took in about 20 new students last year who migrated with parents from northern areas where farming had become too costly and who came to Bangkok looking for factory jobs.

At the end of the day, she sends a container of milk home with each child. She fears it may be the only thing a few of them will consume that evening. Lately, some students have not been coming to class because they don't have the 10 baht (USD0.36) daily school fee. Nongkraan also thinks not having 5 baht for an ice cream from the trolley that rolls to a stop in front of the bright blue preschool around 2:00 pm might be keeping some students away. Not being able to buy what others can, makes them "feel different, unequal," she says. And if they don't come to preschool, she worries they will go out into Bangkok's streets to pick-up garbage. Also, if they miss preschool, they will find it more difficult to succeed in primary school classes.

What is the Relationship between Climate Change and Poverty?

Climate Change affects everyone everywhere. Two of the most urgent crises facing the world, **climate change and extreme poverty** do offer an example of interconnectedness. By understanding how the two crises and the people they affect are connected, we can begin to understand how and what actions we need to take to deal with these crises.

Climate change and poverty are connected in many ways. For example, as temperature changes, the frequency and intensity of severe-weather events around the world, also increases. The poor countries which often lack infrastructural needs like storm walls and water-storage facilities will divert resources (e.g., people and money) away from fighting poverty in order to respond to immediate disasters.

Warmer climates will also increase the spread of diseases like malaria and make it more difficult for poor countries to respond adequately. Perhaps most severely, changed rain patterns will increase the prevalence of droughts and floods leaving populations without food or enough food. The links between these issues are shown in ***Figure 7.1***.

Severe Weather

- More Frequent and intense floods
- Rising sea levels
- More frequent and intense storms/cyclones /typhoons
- More frequent and intense droughts

Outcomes

- Less land to use
- Loss of coastlines
- Loss of delta areas which are major sources of food production
- Spread of disease
- Increase in migration (population movement)

Impact on Poverty

Increase in poverty because there will be:

- Less food & less safe water
- Less land for living & agriculture
- Loss of livelihoods
- Decline in health
- Diversion of resources (e.g., people and money) away from fighting poverty to respond to disasters

Figure 7.1 The Impact of Climate Change on Poverty

Just as climate change will contribute to make poverty worse, poverty is also contributing to climate change. Most poor people around the world lack access to reliable energy sources and through necessity are forced to mainly use oil, coal and wood. These significantly increase the world's greenhouse emissions. These greenhouse gases (GHGs) are the natural and industrial gases that trap heat from the earth and warm the surface. Experts believe that the steady rise in global average temperatures in recent decades, known as g*lobal warming***,** is one aspect of climate change.

In fighting poverty, we can at the same time address climate change issues because the two are linked. For example, less dependence on oil, coal and wood will help reduce GHGs. Biofuel, which is a fuel derived from renewable, biological sources, including crops such as maize and sugar cane, and some forms of waste can be used instead. This will reduce GHG emissions while helping to reduce poverty because it provides a reliable renewable energy option. Bio-fuel energy production from coconut shells in the Philippines is a good example that provides cost effective access to an energy source that reduces GHG emissions.

The link between climate change and poverty effectively shows that the solutions to address both of them can be the same. The story below depicts that the struggles against poverty and climate change are inseparable and inextricably linked (Kumi, 2009).

AN UNUSUAL STORY

In November 2009, **Kumi Naidoo**, a life-long human rights activist, became the International Executive Director of Greenpeace.
In South Africa he was involved with the liberation struggle against white supremacy rule until 1987 when he had to flee the country.
He returned after the release of Nelson Mandela. In 2003, he was one of the founders of the "*Make Poverty History"* campaign.
He explains why becoming head of Greenpeace is not such a strange or unusual move to make:

I see a need to bring together the poverty movement and the environmental movement as we face up to the greatest challenge of our time - **Climate Change**

Climate change is real and happening now.
It already accounts for over 300,000 deaths throughout the world each year, according to the Global Humanitarian Forum.
Whilst some may wonder what a 'poverty activist' is doing, moving to an environmental organisation, I do not view my role at Greenpeace as an abrupt detour. I believe the struggles against poverty and climate change are inextricably linked, while the solutions are the same.

Climate Change and Poverty in Southeast Asia

Southeast Asia is widely considered one of the world's most vulnerable areas to climate change. By vulnerable we mean being less able to anticipate or predict, cope with, resist, and recover from, a climate change induced impact.

Southeast Asia is home to 563 million people. The population is rising almost two percent annually, compared with the global average of 1.4%. It has long coastlines with high concentrations of population and economic activities in coastal areas. Indeed, about 80% of the population lives within 100 kilometers (km) off the coast - leading to an over-concentration of economic activity and livelihoods in coastal mega cities. There is heavy reliance on agriculture for providing livelihoods especially those at/or below the poverty lines and a high dependence on natural resources and forestry in many of its countries.

Climate change is already affecting Southeast Asia and impacting many sectors. It has affected the quantity and quality of water resources. Extreme weather events such as droughts, flooding, and tropical cyclones are increasing in frequency and intensity, and have contributed to a decline in the production of grains and industrial crops, fish supply, and forest harvests.

The region is struggling against the loss of its arable lands and coastal areas due to a rise in sea levels, more frequent storm surges, heightened coastal erosion, and *soil salinisation*. A significant proportion of the population has been affected by the outbreak of malaria and dengue. All these impacts are predicted to worsen due to increased warming, changes in precipitation patterns, and sea level rise.

Soil Salinisation – where by the soil becomes highly concentrated in salt and thus unusable for crops.

It is the poor who are affected most by climate change and many of the region's poor live in coastal areas and in the low-lying deltas. Most often, these are smallholder farmers, fishermen, and poor households that are most vulnerable to risk of climate change as their marginal income provides little or no access at all to health services or other safety nets to protect them against the threats posed by changing conditions.

We can see that for Southeast Asia, climate change and poverty are linked by the issue of vulnerability. Geographically, climate change impacts on the region because of its long coastlines and dependence on agriculture amongst other factors; and with the high incidence of poverty of the people living in these areas working as farmers or fishermen, they are made more vulnerable to the impacts of climate change. Moreover, it becomes more difficult for people to escape what is known as the 'poverty trap' when they are caught up in the 'poverty cycle'.

The Poverty Cycle

The poverty cycle can be described as a continuing situation whereby poor families become trapped in poverty for generations. The limited access to essential resources, such as education, means that the family's children will remain poor because they are unable to improve their skills and thus lose the opportunity to make a better life.

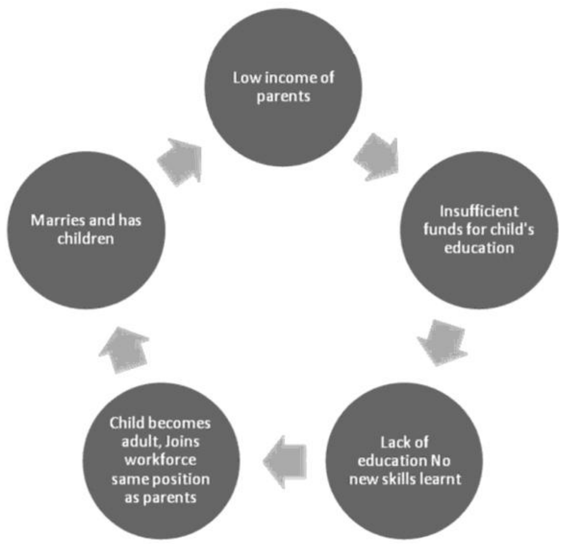

Figure 7.2 The Stages of Poverty Cycle

The simplistic diagram ***(Figure 7.2)*** above illustrates the 'cyclical' effect of the poverty trap. This is an inter-generational cycle showing parental poverty that leads to the childhood poverty of their offspring and so on. In this example, lack of education is shown as the driver in continuing the cycle. But other factors such as lack of access to clean water and enough food that in turn can lead to malnutrition and disease could also be a cycle. In fact, there are many cycles that are happening at the same time and indeed overlap and contribute to each other.

People living in poverty often show incredible courage and work long hours day after day on inadequate diets. As a result, some suffer indignity and a loss of self-worth. Feelings of inadequacy and failure can cause severe psychological damage. So when we talk of the poverty cycle, in fact, there are many cycles and it is important to note that they are not all based on economics. We must also consider how people feel and value themselves and their ability to provide for their families and contribute to their communities. When they feel a sense of helplessness, they are less able to help themselves. This is a very real feeling as people living in poverty are marginalised and more often than not are not listened to. Their ability to express their needs through local government channels is limited.

A Summary on Continuing Poverty

Many things contribute to make poverty worse and climate change is one factor among many others. It is difficult to lift oneself out of poverty because its causes and effects are also interlinked. For example:

- People living in poverty do not have enough food to eat. Without a good diet, people suffer malnutrition and are weak.
- When people are weak they are more likely to become sick.
- Sick people do not have the energy to work well or to seek help.
- People living in poverty are also unable to afford medical care and so their poor health will continue to worsen. This is because they are already living in poor quality housing that more than likely lacks adequate access to safe clean water, disposal of sewerage, electricity supply. What little savings a family has may be spent, and as a result they are more at risk if there is a disaster.
- People living in poverty are primarily found in remote rural areas or in slums on the outskirts of big cities. This contributes to continuing poverty because the people are isolated and not so easy to reach for help re: basic social services. The people have limited access to basic services to enable them to help themselves. For instance, lack of transportation service makes movement of people and goods difficult, lack of jobs where they are living results in little or no income, lack of medical services, lack of education opportunities.
- The areas where people are living in poverty, especially the rural and coastal areas, are more at risk from severe weather conditions as a result of climate change. The resources to deal with possible disasters like flooding or drought are lacking and the impacts of such disasters (e.g., loss of arable land, destroyed crops etc.,) make an already bad situation much worse as people have to try and survive with even less than they had before.

Because of all these factors, people living in poverty are described as being vulnerable or the most easily and immediately affected group of people that will suffer the most from the impacts of climate change. Their vulnerability and isolation lead to a sense of powerlessness or helplessness i.e., they feel as if everything is beyond their control and that they are indeed trapped or unable to improve their circumstances and living conditions as described in the following quote from a woman farmer:

> *"Every day I feel as if there is a water buffalo standing in front of me. The future feels dark and hopeless and I have no alternative, I just have to keep going day in day out".*

Climate Change, Poverty, and Women

The poor are the most affected by climate change and as many as 70 per cent of these poor people are women. This means that the worst impacts of climate change will affect poor women and children the most.

Not only will climate change affect women the most because there are more poor women than poor men but as the quote from WHO shows, women are also most vulnerable because of gender issues.

> "Women and men's vulnerability to the impact of extreme climate events is determined by differences in their social roles and responsibilities. Among women, an expectation that they fulfill their roles and responsibilities as carers of their families often places extra burdens on them during extreme climate events.
>
> For men, their expected role as the economic provider of the family often places extra burdens on them in the aftermath of such events. As women constitute the largest percentage of the world's poorest people, they are most affected by these changes. Children and youth – especially girls – and elderly women, are often the most vulnerable" (World Health Organisation).

Gender refers to the socially constructed norms, roles and relations that a given society considers appropriate for men and women. Gender determines what is expected, permitted and valued in a woman or a man in a determined context (World Health Organisation, n.d.).

Therefore, the role of women - as generally assigned by society as a whole, shapes what is expected of them and how they should behave.

A report from the United Nations Population Fund (UNFPA, 2009) affirms that:

- Women are indeed among the most vulnerable to climate change, partly because in many countries they make up a larger share of the agricultural workforce and they tend to have lesser access to income-earning opportunities than men.

- Women manage households and care for family members, which often limits their mobility and increases their vulnerability to sudden weather-related natural disasters.
- Drought and erratic rainfall force women to work harder to secure food, water and energy for their homes.
- Girls drop out of school to help their mothers with these tasks.
- The report refers to this as a "cycle of deprivation, poverty and inequality" which undermines the social capital needed to deal effectively with climate change.

In addition, women also:

- Have less access to resources and services.
- Have less liberty of migration.
- Suffer low visibility, especially in any decision-making

We can conclude from this information that women suffer disproportionately as a consequence of climate change and that we must address gender issues in climate change adaptation and mitigation strategies if they are to be successful.

We need women to participate if the efforts made to combat climate change are to be effective and sustainable and so women's knowledge, priorities and strategies have to be integrated in climate change *adaptation, mitigation* and *disaster management*. This will enable them to fully contribute to all three areas as well as *build resilience* to climate change.

Climate Adaptation refers to the ability to adjust to climate change to moderate/limit potential damage, to take advantage of opportunities, or to cope with the consequences.

Climate Mitigation is any action taken to permanently eliminate or reduce the long-term risk and hazards of climate change to human life and property (e.g., reduce carbon emissions)

Disaster Management means having a plan to deal with and minimise the impact of natural disasters e.g., flooding, drought, tsunami. The purpose of the plan is to coordinate the actions of the government, local leaders and the people to:

a. prepare in advance;
b. know what to do during a disaster;
c. manage the situation after a disaster.

Build Resilience means to strengthen or to make less vulnerable.

In most Southeast Asian countries, efforts in this area are taking place. For example, in addressing the issue of climate change, the Indonesian government has been conducting gender mainstreaming strategies in relation to the environment, disaster relief, and social conflict supported by running gender-responsive programs. Women's and environmental NGOs in Indonesia have also been working together in facilitating women to manage local resources in their regions by providing technical assistance.

Breaking the Poverty Cycle

There are three dimensions of poverty that can be summed up as lack of **income,** lack of **access,** and lack of **power**. Understanding what the consequences of these three "Lacks", helps identify where interventions must be made to break the cycle of poverty.

Table 7.1 shows what the lack of income, access, and power, results in.

Lack of Income	Limited and inadequate availability of food, land, housing
Lack of Access	Limited or no access to education, health, safe water, credit
Lack of Power	Limited or no participation in decision-making, loss of dignity and respect

Table 7.1 Outcomes Resulting from Lack of Income, Access, and Power

Intervention in the areas of food, housing, education, basic health, agricultural inputs, safe water, transport and communications, and credit, are clearly seen as necessary. But there are other issues, namely gender inequality, that need to be addressed within all three areas of *income, access*, and *power.*

Changing unequal gender relations to increase ownership and control of property and women's effective participation in community management is cited as a key strategy by the International Fund for Agricultural Development (IFAD, n.d.) to help reduce and break the cycle of poverty. However, strategies will have to vary according to the differences in the degree of dependency on agriculture. The International Labour Organisation (ILO, n.d.) estimates that the percentage of women workers in agriculture in Malaysia is 15%, whereas in Thailand and Indonesia it is between 50-60%.

According to the World Bank (n.d.), "the region accounts for approximately half of the world's poor", the possibilities for intervention and action are numerous. Southeast Asia also has one of the *highest illiteracy rates* in the world, and so, reducing illiteracy would be a strategy to help lift people out of poverty as literate people have more opportunities to improve their lives.

There are many ways in which interventions have been made on poverty alleviation and as a result families have successfully risen above the poverty level. Some examples include:

1. Education of girls and boys

   Where girls have completed their education alongside boys there have been dramatic improvements in health and well being of communities. Girls marry later, have smaller families and this means that there is more food to go around and there are resources to treat diseases. Educated girls also provide good role models for the next generation as they encourage their children to study hard and attend school regularly.

2. Availability of micro credit loans

   A small loan enables the poor to take an initiative e.g., buying an extra chicken and selling surplus eggs in markets and reinvesting profits. This leads to greater access to basic needs such as food. Provided that the interest rates are small, loans may be paid back easily.

3. Literacy and numeracy education of adults (especially women) linked to business

   This strategy is especially effective if literacy and numeracy classes are linked to real world activities such as:

   - formation of small local cooperatives to share smallest surpluses;
   - basic accounting and management of small loans.

4. Access to medicine and medical care

   Many common infections can be treated with the right medicines, as long as they are available. This can save lives, keep people working productively and strengthen the local economy. Thousands of cataract operations have been performed at little or no cost to the poor in Southeast Asia and this has meant that family members become independent and productive again.

Cataract is a film which grows over the eye lens and causes blindness.

Our Future

It is often said that children are our future and their welfare is a major key to breaking the poverty cycle, as noted by Emmons (2009):

> *"When children begin and end their day without proper nutrition, or miss vital vaccinations, or are taken out of school to work, or cannot afford the books and pencils or even the ride to school, their long-term potential, as well as their country's economic and social development, suffers."*

Climate change induced disasters force people further into poverty and poverty forces people to exploit the environment even further. For example, illegal logging causes the loss of forest, its animals and birds and increased soil erosion. This inseparable and inextricable link between climate change and poverty means that the measures needed to combat both are thus the same.

Addressing the issues of poverty and climate change is urgent and concerns all of us. The lesson plans that follow are designed for you, the teacher, to raise awareness in your classroom about climate change, poverty and environment-friendly ways of living. Educated on these issues, the youth of Southeast Asia can make a valuable contribution now and in the future. By advocating environment-friendly projects, they will be more informed and able to make a significant difference to make our world clean and green once again.

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Lesson 1

A LIFE BEHIND EVERY STATISTIC

GRADE LEVEL: 16 to 17 years of age (Grades 10 to 11)

SUBJECT: Mathematics, Social Science

TOPIC: Data Collection, Organisation and Interpretation

PREREQUISITE

- Students should have prior knowledge on graphing by plotting points.
- ***Pre-assigned Activity:*** Prior to this lesson, students will conduct a survey in their community to gather basic information on the socio-economic situation which may include: total population, number of males, number of females, number of households, average annual income of households, number of population who are of school age, number of out-of-school youth, working population (labour force), number of unemployed and underemployed, number of older people who need care and support, number of people living below poverty line, etc.

DURATION: 2 to 3 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this session, students should be able to:

- gather, organise, and present data systematically;
- use appropriate graphs in presenting data;
- make predictions based on existing data; and,
- estimate the ratio of the people living below poverty line to that of the rest.

Climate Change Objectives

- define poverty;
- describe why climate change will have more impact on poor communities in the poverty cycle;
- identify the different ways in which men, women and children are affected by extreme weather events and climate change; and,
- identify ways to minimise the impact of climate change on the poor.

MAIN CONCEPTS AND SKILLS

- *Absolute Poverty* means not having enough income to meet the most basic human needs for adequate food, water, shelter, clothing, sanitation, health care, and education.
- The three dimensions of poverty can be summed up as lack of **income,** lack of **access,** and lack of **power**. A person whose income level falls below the poverty line is considered poor.
- Climate change and poverty are interconnected. Climate change will increase the spread of diseases, the prevalence of droughts and floods leaving populations without enough food, making it more difficult for poor countries to alleviate poverty in order to respond to immediate disasters.
- The poverty cycle is a continuing situation whereby poor families become trapped in poverty for generations. Family's limited access to education means that school-age children will remain poor because they are unable to improve their skills and thus lose the opportunity to make a better life.
- People living in poverty are the most vulnerable group that will suffer the most from the impacts of climate change which can lead to a sense of powerlessness or helplessness as they are trapped in the vicious cycle of poverty.
- There are many interventions to break the poverty cycle which includes education of girls and boys, availability of micro credit loans, literacy and numeracy education of adults and women linked to business, access to medicine and medical care.

MATERIALS NEEDED

- Strips of paper, pens, envelope

PRESENTATION OF THE LESSON

Scenario

The teacher will show some current data about the population of the country, the annual gross income of the country, number of people living below poverty line, and the average annual income of the middle income group. The data can be shown in graphs and tables.

Then ask the following:

- Describe the data by comparing the quantities.
- What do you think are its implication to us? What does it show?

- How do you know that this is our current condition in terms of population, annual income, and number of people living below poverty line?
- What do you think can you do to help the government in poverty alleviation?

Student Activities

In this lesson, students may participate in any two or more activities below:

1. Playing the Poverty Statistics Bingo (Motivational)
2. Defining Poverty and Organising Data (Motivational)
3. Relating Poverty Cycle and Climate Change
4. Collecting, Organising, Presenting and Interpreting Data

Process Guide for Teachers

The teacher may choose one or two motivational activities before proceeding to the Data Organisation and Interpretation activity

Activity 1: Poverty Statistics Bingo

1. To stimulate the students' attention, the teacher will ask students to do the following:
    - Draw a square about 6 x 6 cm.
    - Divide the square into 3 equal size columns.
    - Again, divide the square to have 3 equal size rows.
    - Color in any 3 of the small squares.
2. Copy all the numbers from the number checklist on to the board as found in ***Attachment 7.1.1.***

3. Tell the students to select any six of these numbers and to write one number in each of the blank squares in the grid.

4. Explain that they will hear all these **numbers as part of a sentence** *(Use data from **Attachment 7.1.2** for sample Poverty Statistics Sentences)*. If they hear the number that they have included in their grid, instruct them to draw a cross through that number. Remind the students that a sentence may contain more than one number, so they must pay attention.

5. Statistics Sentences from ***Attachment 7.1.2*** should be printed/written on a piece of paper. Cut into strips and fold it. All folded strips must be placed in a

box or a hat and mix together. Randomly pick one paper containing one sentence at a time and read it out to the class.

6. Explain that as soon as a student succeeds in crossing out all the numbers on their card, the student should shout “BINGO!” If this happens, cross check against the teacher’s number checklist and ask the student to read the numbers on his/her card, one by one. If all the numbers have been called then that student is the winner.

    - Before closing this motivational activity, tell students, “**Poverty statistics sentences** were used in our Bingo Game, what are the significance and implications of these statistics to poverty? What is poverty, anyway?

    - Tell the students, that the next activity will give them deeper understanding of the concept of poverty and the indicators typically used to measure poverty.

Activity 2: Defining Poverty and Organising Data

1. Divide the class into small groups of between 5 and 6 members.
2. Give each group an envelope containing the **Poverty Statistics Sentences** from ***Attachment 7.1.2*** cut up into separate strips.
3. Ask them to sort the **Poverty Statistics Sentences** into sub-groups according to the kind of information provided.
4. Ask them to give a heading to each of their sentence sub-groups (e.g. work/ employment, health, education, nutrition, sanitation).
5. Invite students to add other ways of measuring poverty that they think should be included.
6. Elicit feedback from other groups on the headings chosen.
7. Rank according to what they consider to be the most serious problems in their own country, city, or community.

8. Ask students to think about the poorest person they have ever seen and ask students to write their own definitions of poverty beginning with the words "**Poverty is….**"

9. Allow each group to read their definition. Provide comments on their definitions with reference to the levels of poverty as described in this Chapter and briefly highlight the difference between "basic needs" and "wants".

Activity 3: Poverty Cycle and Climate Change

1. Draw a chicken and next to it an egg on the board.
2. Pose the question "Which came first the chicken or the egg?"
3. Elicit some responses – try to get students to think laterally.
4. Assuming it is an actual chicken egg, draw a circle on the board or in a poster/flipchart. Point out that the discussion will go round and round. Explain that it is one example of circular cause and consequence and that for people living in poverty, this cycle can also be seen.
5. Below are samples of poverty cycle data sets, which can be cut into individual cards. Distribute the poverty cycle cards to each of the groups. You may wish to change the group membership from the previous activity. Ask them to place the individual cards in the cycle.

low income	**no funds for school**	**low education**
lack of qualifications	**low paid work**	**no money for education**
low income	**poor diet**	**sickness**
perform badly in school	**low qualifications**	**low paid work**

6. Make a table as shown below and ask students to respond to each of the following questions:

WHERE	WHO	WHAT
• In which region(s) of the country is there a high incidence of poverty?	• Who are some of the poorest people in this/these regions? (occupations could serve as a prompt)	• Identify examples of climate change phenomena.

7. Ask the groups to imagine how specific climate change phenomena might affect the poor farmers and fishermen and to illustrate this in a poverty cycle diagram.

8. Display the poverty cycles identified by each group on the walls of the classroom for gallery viewing and elicit comments from the group.

9. Summarise the main message and collective insights generated from the activity by saying that: "The impact of climate change will be an added burden for the poor - the most vulnerable group which can lead to a sense of powerlessness or helplessness as they are trapped in the vicious cycle of poverty.

Activity 4: Collecting, Organising, Presenting and Interpreting Data

1. Ask the students to work in small groups. Then, introduce the next activity to the students by saying that:

   "Now that you have fully grasped the definition of poverty and its relationship to climate change, we will use these concepts as a context for data collection, organisation and interpretation.

   Prior to this lesson, I requested you to **conduct a survey in your community to gather basic information on the socio-economic situation** which may include:

   - *total population, number of males, number of females, number of households, average annual income of households, number of population who are of school age, number of out-of-school youth, working population (labour force), number of unemployed and underemployed, number of older people who need care and support, number of people living below poverty line, etc*." (This assignment is to be given in advance).

2. Ask the students to present the results of their community survey which include an organised data using graphs and tables.
3. Students will interpret the data collected and predict what would happen in the socio-economic life of the people in the community if the trend will continue in the absence of any intervention.
4. Discuss how to organise a systematic data and how to use available data to make predictions and identify the appropriate interventions.

Closure

Plan of action for the students: Based on the information you have collected (*i.e., from community survey*) and shared, each group will think of three (3) things that each of the following key stakeholders must do to alleviate poverty:

- Government
- International or Regional Organisations, like SEAMEO
- Non-Government Organisations
- Individuals (e.g., students)

Achieving the Objectives

Objective	This is achieved by
Gather, organise, and present data systematically	Class discussion on **Poverty Statistics Sentences** sorted into sub-groups according to the kind of information provided and ranking the most serious problems in a community.
Use appropriate graphs in presenting data	Class discussion on the results of community survey which include an organised data using graphs and tables.
Make predictions based on existing data	Class interaction on the interpretation of data collected and predictions on what would happen in the socio-economic life over time.
Estimate the ratio of the people living below poverty line to that of the rest	Class discussion on where, who and what to identify the regions with a high incidence of poverty and the poorest people in the region.
Define poverty	Students writing the definition and levels of poverty and highlighting the difference between "basic needs" and "wants".
Describe why climate change will have more impact on poor	Illustrating the diagram on poverty cycle and making a conclusion that "Climate change

Objective	This is achieved by
communities in terms of the poverty cycle	effects will be an added burden for the poor."
Identify the different ways in which men, women and children are affected by extreme weather events and climate change	Group brainstorming and discussion on climate change phenomena
Identify ways to minimise the impact of climate change on the poor	Writing an essay on how students can help break the vicious cycle of poverty which is linked to climate change.

Assessment

Using their own words, students will write their answers on the following questions.

- How do I define poverty?
- What problems do poor people encounter in their daily lives?
- What is meant by poverty cycle?
- How does climate change add to these problems?
- How does your knowledge on data collection, organisation, and interpretation help you understand the vicious cycle of poverty?
- What kind of interventions are needed and by whom?
- How can we break the vicious poverty cycle?

To assess team performance, the teacher may adopt the sample *rubric* ***(See Attachment 7.2.1)*** or design a new performance rubric in terms of the following criteria: planning, data gathering, brainstorming, data organisation and analysis, output presentation, level of knowledge, creativity and integration of subject matter concepts to real life.

RESOURCES

Save the Children UK Teachers' Resources: *Saving Lives Bingo*.

SEAMEO SPAFA (2010). Climate Change and its Impact to Poverty. Integrating Climate Change Issues in Southeast Asian Schools, A Teachers' Guidebook. SEAMEO.

Attachment 7.1.1
NUMBER CHECKLIST

1/3	**1/2**	**1**	**2**	**3**
5	**15**	**17**	**18**	**20**
33	**37**	**51**	**63**	**136**
1000	**1990**	**2005**	**2.2 million**	**4.8 million**
6.1 million	**72 million**	**350 million**	**500 million**	**3 billion**

Note: To be used for Student Activity (1) The Poverty Statistics Bingo

Attachment 7.1.2
SAMPLE POVERTY STATISTICS SENTENCES

- In **2005**, about **72 million** children of primary school age in the developing world did not attend school.
- About **33%** of children in the developing world are without adequate shelter.
- About **20%** of children in the developing world do not have access to safe water.
- About **15%** of children in the developing world have no access to health services.
- An estimated **2.2 million** children die each year because they are not immunised.
- Every year, there are between **350 million** and **500 million** new cases of malaria.
- **Half** the world or nearly **3 billion** people live on less than USD **2** a day.
- In 2005, over **30%** of people living in cities were living in slum conditions.
- There are still an estimated **6%** of children living in Thailand who do not receive an education.
- It has been estimated that **6.1 million** Thais live below the national poverty line.
- An estimated **18%** of Indonesians are officially poor.
- According to statistics, **17%** of Vietnamese children are malnourished.
- The Philippines has the **third** highest rate of inequality between rich and poor in the Asia Pacific.
- Around **4.8** million Cambodians live on less than USD **1** per day.
- In Laos, only **37%** of children are educated beyond grade **5** in school.
- In Timor Leste, **136** out of **1000** children die before the age of **5**.
- Between **1990** and **2005**, the percentage of people living in urban areas in Malaysia rose from **51%** to **63%**.

Note: To be use for Student Activity (2) Defining Poverty and Organising Data

Lesson 2

LIFE STORIES

GRADE LEVEL: Fourth Year High School (Grades 10 to 11)

SUBJECT: English

TOPIC: Narratives

DURATION: 1 session

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this lesson, students should be able to:

- describe what information they can see about a character in a picture;
- formulate questions about things they cannot see from a picture;
- write a short story about a picture being shown; and,
- create different media to heighten awareness on climate change and poverty.

Climate Change Objectives

- describe the effects of climate change on poor people;
- describe the feelings behind a story (*i.e.,* show empathy with poor people who are often at the mercy of external events)
- identify particular problems faced by men, women and children; and,
- identify the issues linking climate change and poverty.

MAIN CONCEPTS AND SKILLS

- Extreme weather events such as typhoons (cyclones), floods, drought, etc. will have significant short and/or long term effects on people, the environment, livelihoods, as well as national development. It affects everyone on the planet in some way but will be an added burden for the poor.
- Women are the most vulnerable to climate change because they make up a larger share of the agricultural workforce and they have lesser power and access to income-earning opportunities than men.
- Women's knowledge, priorities and strategies have to be integrated in climate change *adaptation, mitigation* and *disaster management*. This will enable them to fully contribute as well as *build resilience* to climate change.

- To mitigate the impact of climate change requires action-intervention at all levels in the areas of food, housing, education, basic health, agricultural inputs, safe water, transport and communications, and credit. Other issues such as gender inequality need to be addressed to improve the quality of life of poor people in terms of *income, access, and power.*

PRESENTATION OF THE LESSON

Scenario: Who is it?

1. As a motivational and opening activity, the teacher will find or draw a suitable picture for the main character of the story. Show to the class the picture of a famous character in a story, a stage play, or a movie. In here, students will describe what information they can see about a character in a picture and also discover things that they cannot see from a picture.

2. Lead the discussion by asking students to answer the following questions:
    - Who is it? (*Note*: Obviously they don't know)
    - What do you know about him/her?
    - What is it that you don't know, but would like to know?
3. Make a list of five questions that the students would ask on the board.
4. Summarise the lesson from this activity by saying,

    "Based on this picture, you were able to visualise and describe the personality of a famous character and raised questions to disclose the mystery behind the subject or character in the picture. In this lesson, you will again visualise and use critical thinking in analysing life stories that depict climate change impact on poverty."

Student Activities

The students will participate in the main activity which involves *Story Telling and Role Play*. Students in groups will describe the effects of climate change on poor people. They will share their feelings behind a story about poor people who are often at the mercy of external events (e.g., natural calamities due to global warming). They will also identify particular common problems faced by men, women and children as narrated in the given story.

Process Guide for Teachers

Together with the students, review the poverty cycle and read *Episode 1* of the sample story on *Climate Change and Poverty* for adaptation. Show **Figure A** to provide an illustration of the story.

EPISODE 1

This is Lek. She's 15 years old and comes from a village in the North East of Thailand. For many generations her family has been farmers. Before Lek was born, her parents had some land where they grew tapioca and rubber. But their land was taken away for a regional development project. Plantations of imported eucalypts (drought resistant trees) were planted and paper pulp factories established instead. Lek's parents moved to a new site, on the Mekong Delta, where Lek was born.

Despite being near the river, every year they faced water shortages. Some said it's because of new dams further upstream which blocked the flow of water. Others said that couldn't be true because the water in the dams was used to generate electricity so it had to be released from the dams to do that. They blamed the lack of water on global warming and the effects of El Niño which brings a much longer and hotter dry season and also sudden storms and flash floods.

Last year there was a terrible storm. Most of the rice Lek's family had planted was destroyed so there was nothing to sell at the market. Lek's father needed to borrow money for seed so that they could try for a second harvest in the off season when the price of rice would be higher.

Figure A

Activity 1

1. Ask students: *Where can the family of Lek borrow money?* Draw out the options and list them on the board.
2. Briefly discuss some of the advantages and disadvantages of each option.
3. Get students to vote for which option they think the family will choose.

EPISODE 2

Lek's father went to the local money lender. He bought the seedlings, but there wasn't enough water to keep the young plants alive and the crop died. The local authorities were afraid the drought would be very long and had decided to save what they had in the reservoirs so people would have enough for their personal needs later. With no crop to sell, there was no money to repay the money lender. Lek's father had to sell their small piece of land.

Activity 2

1. Ask students to read Episode 2 of the Story. Show **Figure B** to illustrate the scenario.
2. Ask students what happened next. List the possibilities on the board.
3. Tell the students to listen to *Episode 2* and confirm which possibilities on the list are mentioned.

Figure B

Activity 3

1. Ask the students to identify the links with poverty cycle as discussed in Lesson 1 of this Chapter.
2. Elicit any other factors they think should be added (e.g., power of authorities to take away land without adequate compensation; and to withhold water flow)
3. Divide the class into groups of between 5 and 6 members.
4. Ask students to read *Episode 3* of the Story. You may show **Figure C** to the class to symbolise the scenario of migration from the village to the city.
5. Tell students to identify all the characters from *Episodes 1 to 3* which may include the following:
    - Lek
    - Lek's brother
    - Lek's mother and father
    - Lek's grandmother and grandfather
    - Other farmers, families in the community
    - The money lender
    - The construction site employer
    - The authorities in charge of dams and water supply
    - Other labourers
    - Teachers

EPISODE 3

With no land to farm, Lek's father had to leave the village to look for work. Since other farmers had been affected too, there wasn't much work for them in the area. Eventually, he decided to try his luck in the city. There he sometimes found work on the big construction sites. At first, Lek's mother stayed in the village and tried to make money by doing laundry, but later she joined her husband so they could earn more money to take care of the family. Lek and her little brother went to live with their grandparents in the village, but when the grandparents died they had to join their parents in the city. Lek got a job as a maid for a rich family. Her brother moved with her parents from site to site and rarely stayed anywhere long enough to go to school.

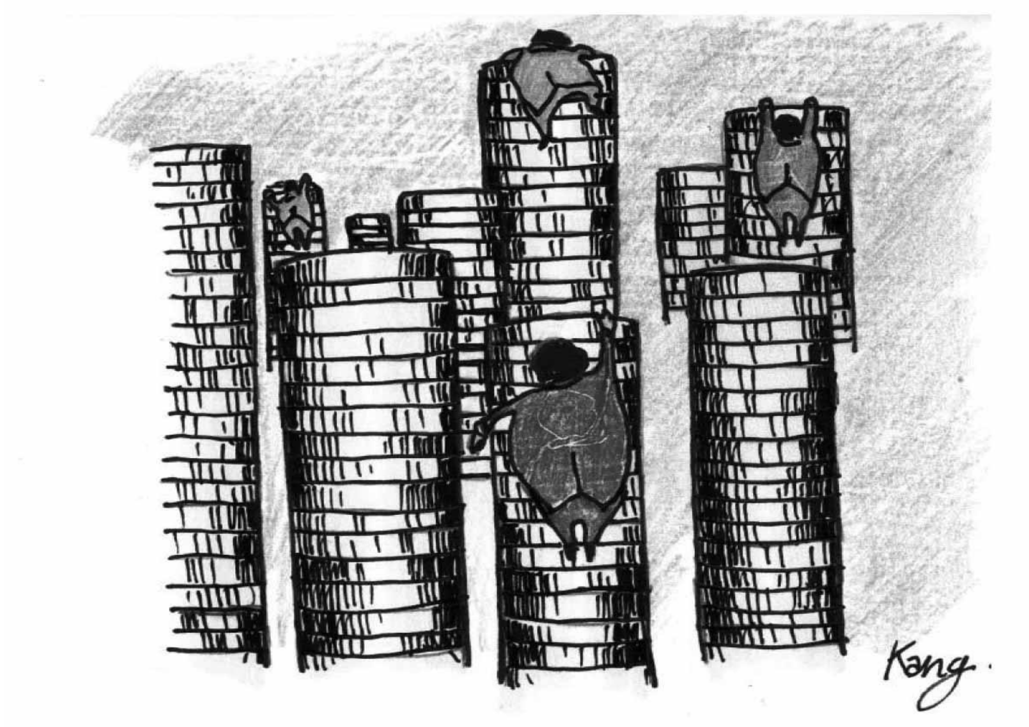

Figure C

6. Tell students that Lek's story is to be used as basis for the next activity which involves a mini TV series and that they will perform as scriptwriters. Half of the class will focus on a particular female character in the story and half will focus on a male character. Divide the class by drawing an imaginary line. Divide each half again into smaller sub-groups. Try to limit the number to 4 groups only.
7. Explain that each group is to produce and act out a 2 to 3 minute scene in which the particular problems faced by the main character are highlighted. Assign each group their main character to portray.
8. Allow time for students to think about the problems the main character has and to decide on the scenario to take on.
9. Set the time limit for writing and rehearsing in fifteen (15) minutes.
10. Allow each group to present their mini TV series.

Closure: A Public Exhibit: The A-Z of Poverty

1. Write the letters A to Z on the board.
2. Based on the scenes they have acted out and what they know already, ask students to identify key problems and issues linked to climate change and poverty, beginning with each of the letters. This doesn't have to be done in any particular order. Elicit an example.
3. If they work in sub-groups this could be set up as a race to see how many ideas they can generate in a given time. The group with the most ideas wins and starts the feedback.
4. When they have given their ideas, invite the other groups to add anything they have for letters where there is no example.

Achieving the Objectives

Objective	This is achieved by
Describe what information they can see about a character in a picture	Picture observation and interpretation
Formulate questions about things they cannot see from a picture.	Critical thinking and analysis of a character in a picture.
Write a short story about a picture being shown.	Acting as scriptwriters of a mini TV series to portray the problems faced by each character in the story of Lek.
Create different media to heighten awareness on climate change and poverty.	Working on the assignment to highlight the different stories of people affected by climate change in Southeast Asia through: a. Poster Making b. Collection of Pictures depicting Diorama c. Mime show d. School Exhibit inviting the community and other people who should be informed about Climate Change
Describe the effects of climate change on poor people.	Story telling on the impact on climate change to poor farmers.
Describe the feelings behind a story (i.e., show empathy with poor people who are often at the mercy of external events).	Students analysing the story of the family of Lek and sharing of feelings and reactions about the plight of poor farming communities.

Objective	This is achieved by
Identify the issues linking climate change and poverty.	Group Contest on listing key problems and issues linked to climate change and poverty, beginning with letters A to Z.
Identify particular problems faced by men, women and children.	Essay writing on how the most vulnerable men, women and children are affected by climate change.

Assessment

1) After the closure activity, ask the students to write a narrative (an essay or article) using not more than 150 key words. The essay will focus on the following questions:

   - Who is most vulnerable to climate change?
   - How are men and women, the old and the young affected by climate change?

2) To assess team performance, the teacher may adopt the sample *rubric* in this Chapter ***(**See **Attachment 7.2.1)*** or design a new performance rubric in terms of the following criteria: planning, data gathering, brainstorming, data organisation and analysis, output presentation, level of knowledge, creativity and integration of subject matter concepts to real life.

Assignment

Divide the class into working groups and assign each group to do one of the creative tasks below that *depict different stories of people affected by climate change in Southeast Asia*:

- Poster
- Collection of Pictures depicting Diorama
- Mime show
- Organise a Public Exhibit in your school inviting the community and other people who should be informed about climate change

RESOURCE

SEAMEO SPAFA, (2010). Climate Change and Poverty, Integrating Climate Change Issues in Southeast Asian Schools, A Teachers' Guidebook. SEAMEO

Attachment 7.2.1
Sample Rubric on Group Performance

Subject/Topic____
Project/Activity Title____
Date____
Group Name____
Team Members____

Group Process	Below Average	Satisfactory	Excellent
1. Has clear objective of final output	1, 2, 3	4, 5, 6	7, 8, 9
2. Properly organised to complete the task (presence of team work)	1, 2, 3	4, 5, 6	7, 8, 9
3. Managed time wisely	1, 2, 3	4, 5, 6	7, 8, 9
4. Acquired needed information and knowledge base	1, 2, 3	4, 5, 6	7, 8, 9
5. Communicated efforts with teacher	1, 2, 3	4, 5, 6	7, 8, 9
Group Output	**Below Average**	**Satisfactory**	**Excellent**
1. Format of output presentation	1, 2, 3	4, 5, 6	7, 8, 9
2. Manner of communicating the output (i.e., speaking and writing)	1, 2, 3	4, 5, 6	7, 8, 9
3. Data organisation and structure	1, 2, 3	4, 5, 6	7, 8, 9
4. Creativity	1, 2, 3	4, 5, 6	7, 8, 9
5. Knowledge on basic concepts (e.g., lifestyles and consumerism)	1, 2, 3	4, 5, 6	7, 8, 9, 10
6. Awareness on current issues affecting climate change and poverty	1, 2, 3	4, 5, 6	7, 8, 9, 10
7. Ideas and suggestions to combat climate change and poverty	1, 2, 3	4, 5, 6	7, 8, 9, 10
8. Integration of subject matter concepts and values (e.g., consumerism and social responsibility/commitment) to climate change and poverty.	1, 2, 3	4, 5, 6	7, 8, 9

Lesson 3

TIME FOR ACTION

GRADE LEVEL: Fourth Year High School (Grades 10 to 11)

SUBJECT: Social Studies

TOPIC: Consumerism

DURATION: 2 to 3 sessions

PREREQUISITE: Students should have basic knowledge of the law of supply and demand; and basic understanding of needs and wants.

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this session, students should be able to:

- define consumerism;
- explain the factors influencing consumerism;
- identify symbols of prosperity;
- choose what they hope for in their own future; and
- write an essay about what they want to be in the future.

Climate Change Objectives

- identify links between lifestyles, consumption and climate change;
- describe their responsibilities as consumers in lessening the negative impacts of climate change; and
- develop a plan and commit to support the desired behaviour change.

MAIN CONCEPTS AND SKILLS

- Consumerism is a social and economic order that is based on the systematic creation and fostering of a desire to purchase goods or services in ever greater amounts.

- The factors influencing consumerism includes poverty and backwardness, population, unemployment, illiteracy, unable to understand technical complexity, imbalanced distribution of the income and wealth

- Climate change induced disasters force people further into poverty and poverty forces people to the exploit of the environment even further. This inseparable and inextricable link between climate change and poverty means that the measures needed to combat both are thus the same.

- The youth of Southeast Asia, educated on these issues, can make a valuable contribution now and in the future. By raising their environmental awareness, they will be more open to change, more informed and able to make a significant difference in saving mother earth.

MATERIALS NEEDED

- Sample pictures/images of contrasting economic conditions in different communities.

PRESENTATION OF THE LESSON

Scenario

The teacher will show two contrasting pictures – one shows an extremely poor/disadvantaged economic conditions and the other shows a progressive community. Then ask the following questions:

- What do you see in the pictures?
- How do the sets of picture differ from each other?
- Which pictures show a desirable place to live? Why?
- If you were to make a choice which pictures would you like? Why?

Student Activities

Students will perform three main activities. First they will talk about the opposite of living in poverty and imagine a life in “prosperity”. Then they will interpret a cartoon on consumerism and reflect on their own lifestyles as consumers that contribute to climate change. Thirdly, they will commit to change their behaviours that are not supportive of protecting the environment from the negative effects of climate change.

Process Guide for Teachers

Activity 1: “Defining Prosperity”

1. Begin by saying, “What is the opposite of poverty? We focused on poverty in the previous lessons, but this time we will talk about a more positive image of life which is “*prosperity*.”
2. Ask students, “What are the symbols or objects that describe “prosperity?” List them on the board.
3. Using the symbols written on the board, ask students to write sentences to describe prosperity e.g., *Prosperity is driving your own BMW car.*
4. Clarify with students if this is what they hope for their own future.
5. Using the different sentences on prosperity, instruct students to write a 50-word paragraph on what they want to be in the future and to give their own title.

Activity 2: “Faces of Consumerism”

1. Ask students to carefully observe the cartoon below:

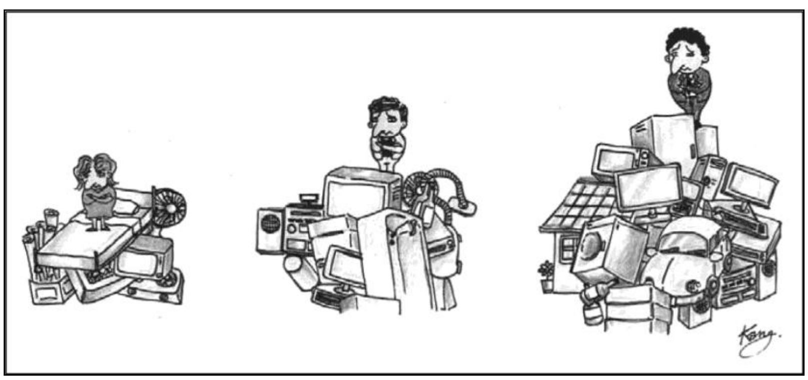

Figure 1*:* Don't Blame Me, I Don't Have Enough!
Source: SEAMEO SPAFA (2010)

2. Lead the discussion with students to analyse the three people in the cartoon by asking the following questions:
   - Describe what you see in the picture.
   - Examine the piles of rubbish and list what’s there.
   - Explain why the piles differ in size.
   - Identify what happens to rubbish in your country/ community
   - State the problems caused by the different items to our environment/to us.

- Which cartoon do you associate yourself with? Why?

Activity 3: *Commitment to Change*

1. Write the following quote on the board:

   > "*Each one of us is a cause of global warming, but each one of us can make choices to change that. The solutions are in our hands we just have to be determined to make it happen."*

2. Write 3 letter Rs on the board, one below the other, and ask the class what the 3 Rs stand for – **Reduce, Reuse, Recyle.**
3. Ask the class members to think about: "**How does your current lifestyle and behaviour as a consumer contribute to climate change?"** Divide the class into sub groups and ask each group to focus on one of three topics: food, drinks, and entertainment or travel. Set a time limit of 10 minutes.
4. Elicit feedback from the groups.
5. From these "confessions", ask students *"If you were to make a commitment to change the environment by changing one of your "bad" behaviors, which do you think you should change?"*
6. Draw a line on the board. Write "easy" at one end and "hard" at the other. Ask the groups how easy they think it will be for them to make this change by indicating a point on the line.
7. Warn them not to underestimate the behaviour change they are committing to.
8. Explain that in the next 20 minutes they need to develop a plan. In that plan, each group should:
   - Identify the desired change (e.g., *create a zero-waste self-sustaining school*)
   - Consider what factors, people or events can help and those who could prevent them from being successful.
   - Develop a group strategy to overcome the identified obstacles – this might involve actual ways to prepare you for change or to offer encouragement or support to each other.
   - Decide how are you going to measure your achievement and over what period of time.

9. Monitor the progress of the groups.

Closure

- Explain that it is their job now to put the plan into action. Advise them that they will be expected to report back to the class on how their project is going in **two weeks** and to observe the changes in their lifestyles that support a cleaner and greener environment in the future.

Achieving the Objectives

Objective	This is achieved by
Identify symbols of prosperity.	Listing on the board the symbols and objects of prosperity
Choose what they hope for in their own future.	Writing sentences to describe prosperity and clarifying if this is what the students hope for their own future.
Write an essay about what they want to be in the future.	Writing a 50-word paragraph on what the students want to be in the future and to give their own title.
Identify links between lifestyles, consumption and climate change.	Students' observation and interpretation of the cartoon on consumerism and lifestyles and relating its contribution to climate change negative impact on people and environment
Describe their responsibilities as consumers in lessening the negative impacts of climate change.	Working in groups, students focus on one of three areas which they need to change their lifestyles: food, drinks, entertainment or travel.
Develop a plan and commit to support the desired behaviour change.	Group discussion and individual reflection on how they will change their lifestyles by identifying the desired change, helping factors, strategy, timeframe and how they will monitor their progress. Also, signing of commitments.

Assessment

1) Answer the following questions:
   - What is consumerism?
   - What are the factors influencing consumerism?

- Cite one factor that influence consumerism and explain its effect on the economic situation of the family.

2) Ask students to write a commitment statement individually by reflecting on the following:
   - How does my behaviour affect climate change?
   - Do I want to change?
   - How can I change?
   - Do I have a plan?

*Assignment**:** Environmental Awareness Begins at Home*

➢ Advise the students to encourage and involve their respective families in the advocacy work to reduce climate change.

1. Share your learning experience in this session with your own families.
2. Write a **Family Commitment Statement** indicating the desirable behaviours that your family wants to change. (e.g., to breathe fresher air and live in a cleaner environment we commit to be actively involved in eco-friendly: clean and green activities starting within our own homes and beyond.)
3. Ask every member of the family to sign this commitment form.

RESOURCES

SEAMEO SPAFA (2010). Climate Change and Poverty, Integrating Climate Change Issues in Southeast Asian Schools: A Teachers' Guidebook. Lesson Plan on *Time for Action*

CHAPTER VIII:
Impact of Climate Change on CONFLICT

[SEAMEO SPAFA]

Introduction

Conflict means disagreement between individuals or groups of people over ideas or interests. Conflict is a normal part of life. In itself it is neither good nor bad; it is how it is managed that is important. If it is managed well it may lead to new and/or different ways of doing things. We need to know the potential causes of conflict so that it may be either prevented and/or managed effectively.

There are many different sources of conflict. It may be caused by one or more of the following:

- **relationships** e.g., between family members, cultural groups which may include distrust, prejudice, personality clashes, abuse, and violence
- **territory or space**, which involves
  - physical space e.g., land, fishing and/or hunting rights and territories; cutting down protected forests
  - psychological space e.g., areas of responsibility, personal space, privacy, status, personal identity
- **resources** e.g., land, water, money, goods, objects, buildings
- **principles, values and beliefs** e.g., cultural and religious values, beliefs and rituals; political beliefs, personal and/or family reputation and pride.

There are different scales of conflict. We may have arguments at home, at school or at the workplace. This is a form of conflict. Larger forms of conflict between groups of people within a country or between countries may lead to breakdown of negotiations or could lead to violent conflict such as war.

What is the relationship between climate change and conflict?

The changes in climate that lead to rising sea levels, flooding or droughts might force people to move (temporarily or permanently) to another safer place where there is access to shelter (housing), water, and food. These population shifts mean that there are more people seeking access to or use of the land, water and food to be found in other places. This can be seen as competition over resources such as land, food, and water.

The relationship between climate change and conflict is complicated and difficult to clearly determine and explain. This is because when conflict happens there are many underlying reasons for it. The environmental impacts or results associated with climate change are never likely to be the only cause of conflict. However, climate change certainly can contribute to the conditions that make conflict more likely to happen.

Climate change and Southeast Asia

Changes in climate will have different impacts all over the world, some positive, some negative. But some regions are more vulnerable than others. Southeast Asia, as a geographical area, faces major or severe consequences due to climate change mainly because a majority of the people lives very near the coastlines and because of its dependence on agriculture for food production.

Figure 8.1 below illustrates the links between climate change and conflict and why climate change impacts greatly on Southeast Asia.

Physical Impacts

- More severe floods
- Rising sea levels
- More frequent severe weather storms, cyclones/typhoons
- Higher winds
- More severe droughts
- Higher rises in temperatures towards the poles

Outcomes

- Less land to use
- Loss of coastlines, salination of ground water in coastal areas, water logging
- Flooding and/or loss of delta areas which are major sources of food production
- Loss of trees
- Increase in and/or more intense bush/forest fires
- Less food, less safe water, less land for living and agriculture
- Increase and spread of disease

Impact on People

- Increase in poverty
- Decline in health
- Loss of livelihoods
- Increase in migration (population shifts)
- Increase in social tension because there will be more people trying to use fewer resources
- Competition over resources could lead to conflict

Figure 8.1 Links between Climate Change and Conflict

Southeast Asia is home to about 563 million people. About 80% of this population live within 100 kilometers of the coast, leading to an over-concentration of economic activity and livelihoods in coastal mega cities. Altogether Southeast Asia has more than 173,251 kilometers of coastline and tens of millions live in rapidly growing coastal cities and delta areas which are vulnerable to rising seas (ADB, 2009).

It is this combination of rising sea levels, with the majority of the population living near the coasts, and a dependence on agriculture that makes Southeast Asia one of the regions in the world to be worst affected by climate change.

Rising sea levels can flood farmlands and disrupt and harm fish populations. Severe or extreme weather events can disrupt and harm agriculture, for instance:

- Increased heavy rains lead to soil erosion (loss of soil) and can make land infertile hence, not good for planting crops;
- Increased temperatures can advance grain sterility and disrupt and harm agricultural processes;
- Access to clean water is affected by the shifts in rainfall and salination (to make salty) of ground water in coastal areas. Together, a shortage of clean water and increased temperatures may also spread disease.

There is a notion that the effects of climate change will be unevenly felt throughout the world and that the social and economic impacts on developing countries will be greater even though a majority of these countries contribute the least to climate change. A report by the economist, Stern (2007) concludes that developing countries are most vulnerable to climate change because of the following factors:

- Topical geography
- High population growth
- Dependence on agriculture
- Rapid urbanisation
- Weak infrastructures
- Lack of resources

Therefore, there is a need for:

- early warning systems;
- disaster management plans and education especially for vulnerable communities;
- strong and organised governance in times of disaster.

This report, along with many other studies, conclude that the effects of climate change that lead to food and water shortages and poor health will increase poverty and migration and in doing so could possibly increase the chances of conflict happening.

History of Climate Change and Conflict

> "The interaction between climate change and conflict started as early as 35,000 years ago!" (ADB, 2009)

Today some people still argue that there is no link between climate change and conflict. It is true that climate change alone is not the cause of conflicts, but it is a contributing factor. History shows us that the effects of climate change in the past contributed to conflicts and social collapse. Think of the Neanderthals, Vikings, and Mayans as examples. There are others too. What really happened to the civilisations on Easter Island and at Angkor in Cambodia? The changing climate has certainly influenced how, when, and where people live and migrate to. Climate change is continuous, and over time events such as a rise in temperature by a few degrees can gradually contribute to the risk of conflict.

It is easier to understand the link between climate change and conflict when we look at it as a cause and effect situation. However, the reality is much more complicated. Although we know that we cannot blame conflicts only on climate change, we must not underestimate the impact of climate change. By analysing climate change, we can try to avoid conflict by adapting to and mitigating the effects of climate change.

Climate adaptation as an action that helps cope with the effects of climate change could be the construction of barriers (e.g., levees) to protect against rising sea levels, or conversion to crops capable of surviving high temperatures and drought or planting mangroves in coastal areas to protect the coastline.

> **Climate Adaptation** refers to the ability to adjust to climate change to limit its potential damage, to take advantage of opportunities, and to cope with the consequences.

Climate mitigation as an action that will reduce man-made climate change includes steps to reduce GHG emissions or absorb GHG in the atmosphere for e.g., reducing the use of coal oil and gas; reducing deforestation and illegal logging.

> **Climate mitigation** is any action taken to permanently eliminate or reduce the long-term risk and hazards of climate change to human life and property (ADB, 2009)

This is important as GHGs are the natural and industrial gases that trap heat from the Earth and warm the surface. We need to use more sustainable energy sources like solar, hydro, wind, and geothermal power.

What Should We Do Globally?

A peace building organisation reported that poorer countries are at risk of falling victim to climate related conflict (Smith & Janani, 2009). Unless there is a change in approach, 3.9 billion people in 102 countries around the world i.e., more than half the world's population is at a high risk of political instability as a consequence of

climate change where 2.7 billion people face a high risk of violent conflict as a result (Smith & Janani, 2009). So what should we do?

1. Think About the Whole Picture

   Some measures already taken to mitigate climate change could actually have increased the risk of conflict such as the push to produce bio-fuels (Smith & Janani, 2009).

   Biofuels are derived from renewable, biological sources, including crops such as maize and sugar cane, and some forms of waste e.g., manure. Land that had been used for food production was switched to the production of low carbon energy sources, and the change has been blamed for contributing to a 30% rise in food prices in 2008. This had caused violence and unrest in some 30 countries around the world and estimated that bio-fuel production pushed about 30 million people into poverty.

   Therefore, climate change adaptation and mitigation strategies need to take into account the whole picture i.e., the impact locally and globally in a "conflict sensitive" manner. Smith & Janani (2009) concluded that there must never be a repeat of the rapid move to bio-fuels and that:

   > *"Shifts towards a low-carbon economy must be supportive of development and peace."*

   The report calls for climate change and development to be integrated, rather than seen as separate issues. This makes sense and is also the suggestion of the ADB.

2. Build Awareness and Adaptation and Mitigation Strategies into Development Work.

   Raising awareness alone does not change behaviour. Southeast Asia is situated among the regions with the greatest potential for mitigating CO_2 by reducing deforestation and improving land management practices e.g., discouraging shifting cultivation and illegal logging (ADB, 2009).

So with Southeast Asia having such potential to mitigate climate change, the future outlook need not be all ‘doom and gloom’.

In fact, Southeast Asia has untapped opportunities for energy efficiency improvements and resources for increasing the use of renewable energy including biomass, solar, wind, hydro, and geothermal.

Southeast Asian countries need to treat climate change adaptation as a key part of development polices, such as adapting agricultural practices to changes in temperature and precipitation and adapting water management to greater risk of floods and droughts (ADB, 2009).

Carbon dioxide (CO_2) is a gas in the Earth's atmosphere. It occurs naturally and is also a by-product of human activities such as burning fossil fuels. It is the principal greenhouse gas produced by human activity.

Deforestation is the permanent removal of standing forests that can lead to significant levels of carbon dioxide emissions.

3. Engage Women Actively on Climate Change Plans and Action

It is vital to involve women actively in development and climate change planning and implementation.

Gender norms, roles and relations are important factors in determining both vulnerability and adaptive capacity to the impacts of climate change.

Gender refers to the socially constructed norms, roles and relations that a given society considers appropriate for men and women (ADB, 2009).

The role of women as generally assigned by society as a whole shapes what is expected of them and how they should behave. As an example, in many societies it is not considered appropriate for young girls to be taught how to swim, but this is an essential and potentially life-saving skill (WSM, 1986).

Changing unequal gender relations through the greater participation of women is necessary in any efforts made to combat climate change if they are to be effective and sustainable. This is especially when we consider that the poor are the most affected by climate change where as many as 70% are women. This means that the worst impact of climate change will affect poor women the most. Therefore, it is only logical that women’s knowledge, priorities, and strategies have to be integrated in climate change adaptation, mitigation and disaster management.

How Should We Help Locally?

As teachers your role in the classroom is vital to:

- educate youth about the effects of climate change;
- engage youth actively in adaptation, mitigation and disaster management schemes where possible;
- ensure that youth realise there are “choices” to be made for e.g., in affluent areas “shopping” as a major pastime is not the ultimate source of happiness;
- ensure youth channel their immense creative and resourceful energies productively so that they have realistic “hope” in their future and that of their children.

The concept of **Gross National Happiness** (GNH) was coined in 1972 by Bhutan's former King. It measures quality of life or social progress as compared to Gross National Product or Gross Domestic Product (GDP). GDP depends on continued economic “growth”. As a result, many countries encourage spending and consumerism for its own sake, but this is unsustainable. The four pillars of GNH are the promotion of:

- sustainable development
- preservation and promotion of cultural values
- conservation of the natural environment
- establishment of good governance

These and the earlier messages are built into the lesson plans that follow this introduction and are designed especially for young people to engage their interest and commitment.

i. Make Learning Relevant to Youth

“Think globally, act locally”

One way to ensure the interest of students on climate change relies on is to make it relevant to their lives. As a developing region, Southeast Asia still faces many socio-economic challenges. Thus, concern over climate change is not a high priority on the government’s action agenda. This is understandable when we consider that in the year 2000, the whole region was responsible for just 12% of mankind’s GHG emissions.

However, as explained earlier, Southeast Asia is one of the regions in the world that will be worst affected by climate change. To emphasise the relevance of climate change for Southeast Asia, consider the following facts and statistics (ADB, 2009):

- Climate change is already affecting Southeast Asia, with higher temperatures, decreasing rainfall, rising sea levels, greater frequency and intensity of extreme weather events leading to massive flooding, landslides and drought.

- Climate change is also making worse the problem of water stress, affecting agricultural production, triggering forest fires, damaging coastal marine resources, and increasing outbreaks of infectious diseases.

- Rice yield could decline by up to 50% on average by 2100 compared to 1990 in four countries namely, Philippines, Vietnam, Thailand and Indonesia; and a large part of the dominant forest/woodland could be replaced by tropical savanna and shrub with low or no carbon sequestration (storage) potential.

- Food insecurity and loss of livelihood are likely to get more worse by the loss of arable land and fisheries to inundation and coastal erosion in low-lying areas. More people will be at risk of hunger and malnutrition. Hence, the possibility of local conflicts may increase.

ii. Engage Students in Small, Active School and Local Community Projects

- These are described in the lesson plan exemplars of this Chapter and in the *Chapter on Poverty*.

iii. Engage All Education Stakeholders in Climate Change Education

When students undertake projects it is always useful to engage other education stakeholders (e.g., teachers, parents, local government, business and industry, health practitioners, farmers and other members of the community) as climate change is such a multi-disciplinary concept.

In an emergency, schools are often used to shelter people temporarily and/or for community meetings and the distribution of food and supplies. It may be useful to discuss this with the school-community and develop a school “Disaster Management Plan”.

iv. Large Scale Changes

There are many things that individuals can do to help combat climate change. It is always preferable to talk about possible solutions (e.g., prevention, adaptation and mitigation measures successfully done in the past) and not just the problems, otherwise we feel helpless and unable to cope. ***Figure 8.2*** illustrates a possible action plan that could lessen the chance of conflict occurring from climate change.

Action Planning

- Education and awareness raising about climate change, adaptation, and mitigation built into development work plans
- Behaviour change campaigns help/support people to adapt by providing subsidies and information
- Mitigation schemes
- Disaster prevention and disaster management planning
- Development of early warning systems
- Involvement and training of women as disasters impact women the most
- Preparation by schools as they often function as meeting, sleeping and distribution centres in times of crisis

Outcomes

- Cooperation and effective use of existing resources
- Building up of levee banks
- New buildings sited on higher and/or more protected land especially schools, hospitals, police and fire stations, radio transmitter towers
- More educated and skilled people able to cope with climate change

Positive Impacts

- Poor people are less vulnerable, better educated and better prepared
- Planned migration linked to education would result in "climate change migrants" instead of "climate change refugees"
- Such migration bestows dignity and respect for the people which is important for their self-esteem and enables them to become productive members of society
- Enhanced cooperation and more effective and efficient use of resources

Figure 8.2 Action Planning Leading to Positive Impacts

Addressing the issue of climate change is urgent and concerns us all. The lesson plans that follow are designed for you, the teacher, to raise students' awareness in your

classroom about climate change and how its impact can be a contributing factor to conflict. By understanding this, students and the school-communities can be better prepared to manage the conflict or lessen its likelihood of occurring. The youth of

Southeast Asia are one of its greatest resources. By educating them on these issues, you will be helping mobilise a whole generation that will be better informed and thus able to apply their knowledge and skills constructively for the benefit of society.

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Lesson 1

HOW MUCH DO I GET?

GRADE LEVEL: 12 to 14 years of age (Grades 6 to 7)

SUBJECTS: Mathematics

TOPIC: Ratio and Proportion

PREREQUISITE

- Students should have good background knowledge on collecting, tabulating and comparing data.

DURATION: 1 session

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this lesson, students should be able to:

- compare two quantities using ratios;
- use ratio and proportion to represent and describe quantitative relationships; and
- solve problems on ratio and proportion.

Climate Change Objectives

- use ratio to determine the relationship of a certain population and the amount of available resources in a local community;
- realise the importance of sharing available resources to minimise conflict;
- suggest ways to improve access to resources in order to avoid conflict; and
- discuss the causes of conflict.

MAIN CONCEPTS AND SKILLS

- Rising sea levels can flood farmlands and disrupt or harm fish populations. Severe or extreme weather events can disrupt and harm agriculture in the following ways:
  - ➢ increased heavy rains leads to soil erosion (loss of soil) and can make land infertile hence, not good for planting crops;
  - ➢ increased temperatures can advance grain sterility, disrupt and harm agricultural processes; and

- access to clean water is affected by the shifts in rainfall and salination of ground water in coastal areas. Together, a shortage of clean water and increased temperatures may also spread disease.

- Food insecurity and loss of livelihood are likely to be made worse by the loss of arable land and fisheries to inundation and coastal erosion in low-lying areas. More people will be at risk of hunger and malnutrition. As such, the possibility of local conflicts may increase.

- There are many sources of conflict. It may be conflict on *relationships*, *territory or space*, *resources*, and *principles, values and beliefs.*

- Some possible ways to minimise conflicts include thinking about the whole picture, building awareness, integrating adaptation and mitigation strategies into development work and engaging women actively on climate change plans and action. Schools have a vital role in educating the youth about the effects of climate change; engaging them to be actively involved in adaptation, mitigation and disaster management programmes where possible; ensuring that youth realise there are “choices” to be made e.g., in affluent areas, “shopping” as a major pastime is not the ultimate source of happiness, and ensuring that youth channel their immense creative and resourceful energies productively so that they have realistic “hope” in their future and that of their children.

MATERIALS NEEDED

- Movie clip or pictures showing
  - overcrowded people in a particular evacuation area; or
  - war between two groups over a dispute of land or resources (e.g., as portrayed in the “AVATAR” movie).
- Picture of people ***(Attachment 8.1.1)***
  - Living in conflict situation; and
  - In an evacuation area
- Data as inputs to determine the following:
  - how much rice could a community produce in a year and how much a community could consume;
  - how much water a particular dam could supply in cubic meters and the number of persons in the community; and
  - in case of a calamity, data on number of evacuees and total land area of evacuation.

PRESENTATION OF THE LESSON

Scenario

1) The class views a portion of the movie "AVATAR" where the people from earth wanted to exploit the natural resources of the other planet. (*Note:* If the movie clip is not available, as an alternate activity, the teacher can show a picture depicting war between two groups over a dispute of land or resources.)
2) The teacher poses the following questions:
    - What do you think is the message of the movie (or picture)?
    - Why do humans try to go outside of earth to exploit other resources?
    - What was the source of conflict in the movie (or picture)?
    - What can you suggest to avoid such conflict?

Student Activities

Activity 1: Identifying the Possible Causes of Conflict

1) The teacher will present to the class two pictures – the first one shows people living in a conflict situation in a community and another picture showing people in an evacuation area ***(Attachment 8.1.1)***.
2) To facilitate the class-discussion, students will answer the following questions:
    - Which of the two pictures can possibly lead to conflict? Why?
    - What do you think can be the source of conflict?
    - What causes people to evacuate from their homes?
    - Suppose that in a big community, there are about 300 people and the total land of the community is 400,000 square meters. How many square meters can be allotted to each person assuming that there will be equal distribution of land?
    - Suppose that in an evacuation area, there are 100 persons that are placed in each room with an area of 56 square meters, how many people should occupy each square meter of area? If 20 more people are added in the same room, how many people can occupy a square meter of the floor area?
    - What are some of the implications if the ratio of the number of people to that of the area they are occupying becomes less?

Activity 2: Group Project on Community Survey

- The students will be organised into two working groups. They will conduct a community survey to investigate the issues on rice production and water supply:
  - How much rice could a community produce in different seasons of the year and how much could be consumed by the community?
  - How much water (in cubic meters) a particular dam could supply in different seasons of the year and how many persons could be served in the community or city?
- Using the concept of ratio, the students are asked to compare two quantities in each of the following cases:
  - At what time of the year is the ratio highest or lowest in terms of *rice production* (i.e., in kilograms) and the *amount a community can consume*?
  - What can you suggest to increase the ratio during this particular time?
  - At what time of the year is the ratio highest or lowest in terms of the *amount of water supply* (in cubic meters) and the *number of population* in the community?
  - What can you suggest to increase the ratio during this particular time of the year?
  - What are the possible causes of a decreasing amount of water supply or rice production? Can these phenomena be avoided? How?

Process Guide for Teachers

1. Lead the discussion with students to identify the possible causes of conflict over certain resources (e.g., land, water) for survival.
2. Help the students understand that people are forced to evacuate due to unforeseen calamities like typhoon and flood. An evacuation incident can cause people to compete for limited resources such as food, space, water, and other basic needs.
3. The students will be given time to present their project report in groups.
4. Ask each group to identify the possible causes of conflict and how to minimise them.

Closure

- **OPTION 1**

  Students will make posters about climate change awareness and how it can cause environmental stress and thus could become a potential cause of future *conflicts*.

- **OPTION 2**

  As a group, they will write a letter to the community youth leaders and civic organisations and cause-oriented groups to help in addressing climate change issues that directly affect any existing conflict situation in the community involving the use of basic resources for human survival (e.g., agricultural land, fishing ground, watershed, forest, mining industry).

Achieving the Objectives

Objective	This is achieved by
Solve problems on ratio and proportion	Working in groups to solve problems on ratio and proportion. Student-teacher interaction on how to solve problems related to *Activity 1.*
Use ratio to determine the relationship of number of persons and the amount of available resources in the community.	Using data obtained in the survey on food consumption and amount of water supply while performing *Activity 2*.
Realise the importance of sharing available resources to those in need to minimise conflict.	Watching a portion of the movie AVATAR. Students will answer the guide questions and exchange ideas with one another.
Suggest ways to improve access to resources in order to avoid conflict.	Designing a poster to increase people's awareness on conflicts with regard to resource inequities.

Assessment

- To assess the level of performance of each group, the teacher will utilise a poster rubric and a group presentation rubric ***(Attachments 8.1.2 and 8.1.3).***
- Formative assessment: On a clean sheet of paper, the students will answer the following questions:

1. The head of the Disaster Coordinating Council in a city is planning to use the schools as their evacuation centre during the incoming typhoon. He estimates that there are 25,000 people including children who need to be evacuated. If each classroom can accommodate 27 people, approximately, how many classrooms are needed for the evacuation?

2. The city government has a total of 2,500 cavans of rice in the warehouse. The City Mayor plans to distribute the rice equally to the families living in the slum areas which were affected by the typhoon.
   a. If there are 300 families, and each family has an average of 5 members, what is the ratio of the *number of persons* to that of the *number of kilograms of rice* assuming that each cavan contains 45 kilograms?
   b. How many days would the rice supply last if each family consumes 2 kilograms of rice a day?
   c. How should the government ensure that every family will receive their share of rice equally without conflict during the distribution to the overall population in the slum area?

RESOURCES

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Attachment 8.1.1

Sample Picture 1

EVACUATION CENTER

Half a million people in evacuation centres after Typhoon Ondoy–DSWD, Philippines

Source: The Associated Press

Photo by AP/Aaron Favila

Sample Picture 2

IMAGES OF CONFLICT

Source: SEAMEO SPAFA

Attachment 8.1.2
Sample Poster Rubric

Group Name ____

CATEGORY	4	3	2	1
Required Elements	The poster includes all required elements as well as additional information.	All required elements are included on the poster.	All but 1 of the required elements are included on the poster.	Several required elements were missing.
Labels	All items of importance on the poster are clearly labelled that can be read from at least 1 m away.	Almost all items of importance on the poster are clearly labelled that can be read from at least 1 m away.	Many items of importance on the poster are clearly labelled that can be read from at least 1 m away.	Labels are too small to view OR no important items were labelled.
Relevance of Graphics	All graphics are related to the topic and easy to understand. All borrowed graphics have a source citation.	All graphics are related to the topic and most are easy to understand. Some borrowed graphics have a source citation.	All graphics relate to the topic. One or two borrowed graphics have a source citation.	Graphics do not relate to the topic OR several borrowed graphics do not have a source citation.
Attractiveness	The poster is exceptionally attractive in terms of design, layout, and neatness.	The poster is attractive in terms of design, layout and neatness.	The poster is acceptably attractive though it may be a bit messy.	The poster is distractingly messy or very poorly designed. It is not attractive.
Grammar	There are no grammatical/ mechanical mistakes on the poster.	There are 1-2 grammatical/ mechanical mistakes on the poster.	There are 3-4 grammatical/ mechanical mistakes on the poster.	There are more than 4 grammatical/ mechanical mistakes on the poster.

Source: http://www.teacherweb.com/ME/JALeonardMiddleSchoolOldTown/Ecologywebquest/page3.htm,2003-07-28

Attachment 8.1.3
Sample Group Presentation Rubric

Traits Presented		4 Exceeds Standard	3 Meets Standard	2 Progressing to Standard	1 Below Standard
Content	*Opening*	Opening captivates the audience with interest and/or intrigue.	Interesting opening; engages audience.	Opening is minimally engaging.	Opening is not engaging.
	Focus	Purpose of presentation is clear. Supporting ideas maintain exceptional focus on the topic	Topic of the presentation is clear. Content consistently supports the purpose.	Presentation lacks clear direction.	No clear focus.
	Organisation	Information/ideas are presented in a consistently logical sequence. Transition/ connections are eloquent. A strong sense of wholeness is conveyed. Conclusion leaves the audience with a strong sense of closure.	Important ideas and information are identified for the audience. Information/ ideas are presented in a logical sequence with few lapses. Transitions and connections are made. Closing effectively summarises the presentation.	Irrelevant, unnecessary information detracts. Big ideas are not specifically identified. There are significant lapses in the order of ideas. Transitions are inconsistent and weak or missing. Closing demonstrates an attempt to summarise.	No clear organisa-tion. Ideas do not connect with one another. There are no clear transitions. No closing is evident.

Traits Presented		4 Exceeds Standard	3 Meets Standard	2 Progressing to Standard	1 Below Standard
Presen-tation	*Speech*	Commands audience politely using eye contact, making sure audience is ready. Can be heard by all members of audience without assistance. Uses visual aid as guide or outline for speaking. Consistently maintains eye contact.	Makes sure audience is ready before starting. May need reminders from audience to speak up; generally consistent, maintains eye contact, and minimises reliance on notes.	Makes occasional eye contact, makes few attempts to command audience; may start speaking before audience is ready. Needs reminders from audience to speak up. Mostly reads from notes.	Audience hears with great difficulty. Reads notes and seldom establi-shes eye contact.
	Visual Aid	Visual aid can be seen and attractive from all parts of the room. Graphic is clear and professional looking, enhancing the message.	Visual aid can be seen from all parts of the room. Graphic is neat. Appropriate subject chosen to depict message.	Visual aid is not completely accessible to all audience members. Graphic may be messy. Visual may not be most appropriate to support presentation.	Visual aid undeci-pherable. Graphic detracts from message. Messy or inappropri-ate visual.
	Question & Answer	Speaker expands upon previous statements. Cites additional examples to answer question.	Thoughtful, concise response. Conveys knowledge of subject.	Response not clear or did not add to comprehen-sion of the listener.	Could not answer questions or answers are irrelevant.

Lesson 2

THE TWO GOATS

GRADE LEVEL: 12 to 14 years of age (Grades 6 to 7)

SUBJECT: English

TOPIC: Cause and Effect Relationships

DURATION: 1 session

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of this lesson, students should be able to:

- identify cause and effect relationships;
- discuss the causes of a conflict; and
- write a short essay about resolving a conflict at home or in the community.

Climate Change Objectives

- compare the differences between "lose-lose", "win-win", "win-lose" conflict resolution strategies;
- suggest creative solutions to a conflict in a story;
- identify different conflicts they have observed at home, school or in their community;
- give examples of the main types of conflict; and
- describe how the results of climate change might exacerbate some conflicts.

MAIN CONCEPTS AND SKILLS

- Climate change is continuous, and over time events such as a rise in temperature by a few degrees can gradually contribute to the risk of conflict.
- It is easier to understand the link between climate change and conflict when we look at it as a cause and effect situation. By analysing climate change, we can try to avoid conflict by adapting to and mitigating the effects of climate change.
- Conflict is a normal part of life and unavoidable. There are different levels of conflict from disagreement, to verbal and physical abuse to full scale physical violence and war.
- There are many causes of conflict. It may involve one or more of the following:
    1) *relationships* e.g., between family members, cultural groups which may include distrust, prejudice, personality clashes, abuse, and violence
    2) *territory or space*, which involves

- physical space e.g., land, fishing and or hunting rights and territories; cutting down protected forests
- psychological space e.g., areas of responsibility, personal space, privacy, status, personal identity

3) *resources* e.g., land, water, money, goods, objects, buildings
4) *principles, values and beliefs* e.g., cultural and religious values, beliefs and rituals; political beliefs, personal and/or family reputation and pride.

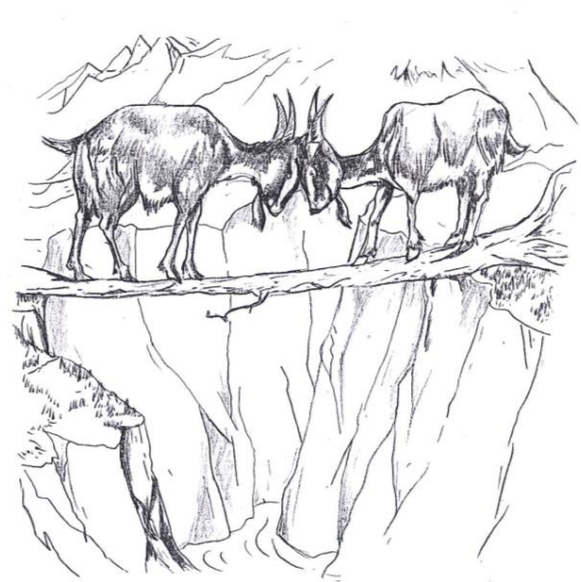
- Thinking before acting, empathy, compassion, cooperation to find creative solutions and forgiveness are all important factors in conflict resolution.
- There is power for peace and good in everyone, which can transform our relationships and enable us to manage and/or resolve conflict.

PRESENTATION OF THE LESSON

Scenario

Option 1) Invite students to join in on a story telling entitled, “The Two Goats”.

- Explain that you will say a phrase and they must repeat it exactly altogether (this improves their listening and concentration skills).
- Use first and second fingers of each hand in the air to represent the horns of each goat and move them up and down the imaginary mountain and over the bridge like puppets. Ask students to imitate your hand movements.
- Tell the first story which ends in a *confrontation.* Then immediately tell the second story, and then lead the discussion. Remind them to join in after you altogether.



Source: SEAMEO SPAFA

Option 2) Role Play: Students will be divided into two groups. Each group will act out a short story entitled, "The Two Goats", (*Source:* Unknown but similar concept with Aesop Fable).

Story 1	Story 2
Once upon a time there were two goats... Northern goat, Southern goat Lived in the mountains Every day, Northern goat, came down the mountain Crossed the bridge Ate the grass "Nim nim nim nim" (eating sounds) Went home Every day, Southern goat, came down the mountain Crossed the bridge Ate the grass "Nim nim nim nim" (eating sounds) Went home... One day ... Both goats came down the mountain Crossed the bridge "Oh!!!" (Southern goat) (rudely) "Oh!!!" (Northern goat) (rudely) "You!...Get out of my way" (aggressively) "I want to go eat the grass over there" "You!!! ...Get out of my way" (aggressively) "I want to go eat the grass over there" "No!" (louder) "No!" (louder) "Bah!" (louder, really angry) "Bah!" (louder, really angry) ***End of Story***	Once upon a time there were two goats Northern goat, Southern goat Lived in the mountains Every day, Northern goat, came down the mountain Crossed the bridge Ate the grass "Nim nim nim nim" (eating sounds) Went home Every day, Southern goat, came down the mountain Crossed the bridge Ate the grass "Nim nim nim nim" (eating sounds) Went home... One day ... Both goats came down the mountain Crossed the bridge "Oh, hello, what are you doing here?" (Southern goat) "I'm going to eat grass over there" (Northern goat) "And you, what are you doing here?" "I'm going to eat grass over there" "Uuumm we have a problem" "Maybe... we can squeeze past?" "Let's try that" "Eek, eek eek eek eek" Ah!!!!! "We did it" (smiling)..... They both ate the grass They both went home, ***End of Story***

Discussion Ideas

- What were the causes of conflict in the first story? (e.g., lack of space, a narrow bridge i.e., territory; stubbornness i.e., relationships; lack of communication and listening; bullying and lack of problem solving skills)

- What were the results of Story 1? (e.g., aggression, stalemate i.e., “lose-lose”). Write “lose-lose” on the board.
- What were the results of Story 2? (e.g., questioning, listening, creative & cooperative problem solving i.e., “win-win”). Write “win-win” on the board.
- In how many different creative ways can you solve the problem to get to the other side of the river? (e.g., fly, swim across, go across one at a time in turn, cross on alternative days)

Student Activities

- Based on the central theme, “Climate Change Contribution to Conflict,” students will share their opinions, ideas, and experiences about conflict, and cite examples of conflict situations.

Process Guide for Teachers

1. Discuss the main concepts of conflict, including the levels of conflict, factors affecting conflict, managing and resolving conflicts.
2. Ask students to sit down in small groups of 4 to 5 members. Each group will write examples of conflict they have seen at home, school or in their community (one example per piece of paper).
3. Students will present their outputs to the class.
4. The teacher will guide the students in clustering the examples and ask them to give headings for each cluster (or type of conflict) e.g., “an argument with my sister” and “my parents arguing” would go under the heading “relationships.”
5. Each group representative will write the headings on the board. The teacher will explain the four types of conflict namely: (1) relationships (2)territory or space (3)resources and 4) principles, values and beliefs. Allow students to identify other types of conflict, if they have any. Note that some conflict may fall under two or more categories.

Closure

To provide a summary of lessons learned, ask students to review the types of conflict identified by the class based on the guide questions below:

- What are the causes of conflict?
- What are the different conflict resolution strategies?
- How might climate change make a conflict worse?

For example:

- *Relationships:* disasters, migration and/or living in refugee camps may increase the pressure on family members and in some cases lead to arguments or even violence
- *Territory:* erosion by the sea or flooding may lead to land disputes or make them worse
- *Resources:* less safe water and less food, as “salt” from the rising sea levels kills crops and make water undrinkable
- *Principles, values and beliefs:* migration may lead to conflict as people learn to resettle in new and different communities.

Achieving the Objectives

Objective	This is Achieved by
Identify cause and effect relationships.	Story telling about the *Two Goats*, where students discussed the causes of conflict in Story 1.
Discuss the causes of a conflict.	Student-teacher interaction and analysis of the story on *Two Goats.*
Write a short essay about resolving a conflict at home or in the community.	Students sharing their own story by writing a short essay about resolving a **real-life** conflict situation at home or in the community.
Compare the differences between “lose-lose”, “win-win”, “win-lose” conflict resolution strategies.	Class discussion on the results of Story 1 and Story 2 and students writing on the board the conflict resolution strategies.
Suggest creative solutions to a conflict in a story.	Using students’ critical thinking, they will suggest creative ways to solve the problem in the story i.e., *how to get to the other side of the river.*
Identify different conflicts they have observed at home, school or in their community. Give examples of the main types of conflict.	Students working in groups to share their experiences and examples of conflict situations Students clustering the examples that they gave for each type of conflict.
Describe how the results of climate change might exacerbate some conflicts.	Summarising the lessons, students will recall the types of conflicts, its causes and different conflict resolution strategies. They will give their opinions and share ideas on how might climate change make conflict worse.

Assessment

1) Use a group participation rubric to assess students' performance.
2) For formative assessment, ask students to:
   - Write a short essay about resolving a **real-life** conflict situation at home or in the community which you may or may not be directly involved.

RESOURCES

SEAMEO SPAFA, (2010). Climate Change Impact on Conflict, Integrating Climate Change Issues in Southeast Asian Schools, A Teachers' Guidebook. SEAMEO

Aesopica, (2008). The Two Goats. Retrieved October 31, 2010 from mythfolklore.net

Lesson 3

WHERE DO I BELONG?

GRADE LEVEL: 12 to 14 years of age (Grades 6 to 7)

SUBJECT: Social Studies

TOPIC: Climate Change Migration

DURATION: 2 sessions

LEARNING OBJECTIVES

Subject Matter Objectives: By the end of the lesson, students should be able to:

- describe some of the feelings generated when families are forced to leave their homes, communities, cultures due to rising seas and/or disasters;
- describe the feelings of newcomers to their school and/or community;
- explain why it is important to show understanding to people who may have to move their homes as a result of natural disasters due to climate change;
- state phrases from different cultures which encourage us to put things off until tomorrow;
- state phrases from different cultures which encourage us to act; and
- give clear reasons why we all have to act NOW to make changes in our life styles to adapt to climate change.

Climate Change Objectives

- explain that natural disasters like typhoons are already being made worse by climate change (i.e., warmer seas lead to more heating of the ocean, more evaporation which intensifies the typhoon);
- describe the impacts of natural disasters on affected people;
- identify the many different ideas, power sources and contributions different groups can make to tackle climate change; and
- explain the need for people from different disciplines (areas of knowledge) to work cooperatively to combat climate change.

MAIN CONCEPTS AND SKILLS

- Climate change will affect everyone on the planet in some way; we are all in this together.

- Climate change is a very complex problem which requires people from physical and social sciences, politics, industry and communities from different countries to cooperate.
- "Saving the planet" is a "mega goal" that is complex and needs many different groups to cooperate in order to achieve it. We can achieve this if we all cooperate.
- The changing climate has influenced how, when, and where people live and migrate to. Climate change is continuous, and over time events such as a rise in temperature by a few degrees can gradually contribute to the risk of conflict. By analysing climate change, we can avoid conflict by adapting to and mitigating the effects of climate change.

    - **Adaptation** helps cope with the effects of climate change e.g., construction of barriers to protect against rising sea levels, or conversion to crops capable of surviving high temperatures and drought or planting mangroves in coastal areas to protect the coastline.

    - **Mitigation** helps reduce man-made climate change which involves reducing GHG emissions through lesser use of coal oil and gas; reducing deforestation and illegal logging and using more sustainable energy sources like solar, hydro, wind, and geothermal power.
- To avoid the risk of conflict as a result of climate change, we should:

    1) *Think about the whole picture*. Think about the impact of climate change locally and globally in a "conflict sensitive" manner. Any shift towards a low-carbon economy must be supportive of development and peace.
    2) *Build awareness and adaptation and mitigation strategies into development work.* Tap opportunities for energy efficiency improvements and increase the use of renewable energy such as biomass, solar, wind, hydro and geothermal. Treat climate change adaptation as a key part of development policies, such as adapting agricultural practices to changes in temperature and precipitation and adapting water management to greater risk of floods and droughts.
    3) *Engage women actively on climate change plans and action*. Gender norms, roles and relations are important factors in determining people's vulnerability and adaptive capacity to the impact of climate change. The worst impact of climate change will affect women, because 70% of the poor are women. Hence, women's knowledge, priorities, and strategies have to be integrated in climate change adaptation, mitigation and disaster management.

PRESENTATION OF THE LESSON

Scenario

1. Announce to the students that they are going to take part in a group simulation activity, but first they have to stay still with their eyes closed. (*Note:* Closing eyes requires trust and feeling safe. If any students have been involved in any traumatic recent events they may not wish to close their eyes. If so, ask students to face the wall so they cannot see what you are doing.)

2. Tell them using these exact words: “I am going to come around to each of you and I am going to put a dot on your forehead” (or on the back of their right hand if this is culturally more appropriate). Do not say anything else.

3. If there are 40 students in the class you need to distribute dots as follows:

   - x 25 brown
   - x 7 blue
   - x 5 red
   - x 2 yellow
   - x 1 green

   Ensure that you give the one green dot to a strong, *popular student* who is not normally left out and who has many friends.

4. When you have finished tell them “Open your eyes, and form a group without speaking”. Do **NOT** tell them to form a group by colour. *(Note:* It is important they do this in silence.)

5. Students tend to assume that they need to group according to colour. The student with the green dot may try to join in with other groups but is **often rejected**.

6. Let the exercise go on for a little while. Sometimes students in a group would realize the need to let the “green” student join them.

7. In some classes, the students would link together to form one group (though this does not happen often).

8. Some de-briefing questions you may use include:

   - What did it feel like to be in the big *brown* group?
   - What did it feel like to be in the *group of two* (2)?
   - What did it feel like to be the *green* person all alone? What was it like to be *rejected* by a group?

- Why did that group reject the green student?

9. Remind students that this was a simulation only. Now ask the students to think about this in real life. Ask:
   - Are there times when some students are left out by the others?
   - Why does this happen?
   - What does it feel like to be left out?
   - What should you do?

Student Activities

Students will work on two activities, namely:

1) Case study about the “Impact of Typhoon Ketsana”
2) Story telling on “Monkeys in the Rain”

Process Guide for Teachers

Activity 1) “Moved out by Ketsana Disaster”

1. Tell students to read out a short case study about Typhoon Ketsana, then ask:
   - What is a typhoon?
   - What are other names for a typhoon in other countries?” (cyclone, hurricane, “bagyo” in Philippines).
   - Do any of you remember anything about Typhoon Ketsana?

2. Read out the following case study.

Case Study: TYPHOON KETSANA

Hundreds of people were killed and millions affected when Typhoon Ketsana tore through the Philippines, Thailand, Vietnam, Cambodia and Laos, causing massive flooding in September 2009. Whilst typhoons occur naturally in nature, the intensity of these storms will be increased as the seas become warmer due to climate change.

Typhoon Ketsana brought the worst rainfall to Metro Manila among recorded typhoons since the start of rainfall record keeping producing only moderate winds, but hours of extremely heavy rain. President Gloria Arroyo declared a "state of calamity" encompassing most of Luzon after at least 86 people were initially reported dead in landslides and other incidents. Flood water levels reached a record 20 feet high in rural areas. As of October 24, 2009, at least 464 deaths were officially reported from the typhoon in the Philippines.

Typhoon Ketsana also hit southern Laos, causing flooding, strong winds and heavy rainfall.

Aid agencies focused on providing access to safe water, emergency food supplies and livelihood support. Now, months later the onset of the colder weather presents a threat to the most vulnerable survivors. Aid agencies are providing blankets and jackets to help ward off the cold.

3. Divide the class into two groups. Ask them to sit in parallel lines facing each other. Label one row “Group A” and the other “Group B”.

4. Ask *Group A* students to “Imagine you are a member of a family whose home, fields and animals have been swept away by floods. You have come to this school in your community and it is your first day. Think about what you want to say about what has happened to you in the past weeks”.

5. Ask *Group B* students to “Imagine you have been at this school all your life and you are meeting the newcomers for the first time. Think about different ways of introducing yourselves and talking to these strangers”.

6. Let everyone think for a couple of minutes. Then ask students to talk for 5 minutes.

7. Ask the Groups to exchange roles so members of *Group A* will now talk to newcomers and *Group B* will share about their flooding experience.

8. Next lead a discussion with the class around feelings and thoughts of newcomers and locals.

   Discussion Questions

   - What will be the impact of extreme weather events e.g., droughts, floods, typhoons on the physical landscape?
   - What impact will these events have on families?
   - Explain why it is important to show understanding to people who may have to move their homes as a result of natural disasters and/or sea level rise.
   - Describe the variety of feelings of communities who take in people who have been displaced by natural disasters and/or climate change.
   - Explain the meaning of empathy i.e., (listening with the head to information and with the heart to feelings), compassion, etc.

Activity 2) "Monkeys in the Rain"

1. Tell students the story of the "Monkeys in the Rain" or preferably a story from your culture that has the same message (i.e., if something is wrong you need to take action to try to improve things).

MONKEYS IN THE RAIN: A BRAZILIAN FOLK TALE

Once there were five little monkeys
In the morning the sun was shining
The monkeys woke up and said
"Let's play"
do actions: hand over hand over hand over hand, it's fun"
everyone "hand over hand over hand over, it's fun"
"ooohhh, let's play chase"
"are you ready? if you are caught, you must come out"
"oooh caught yer"
"oooh rain..." ***everybody (shivering)***
"rain..., ra...in..., ra...in..." ***(sound sad, cold, shivering and miserable)***

Little monkeys were wet; little monkeys were cold
"What shall we do?"
"Let's build a house"
everybody "let's build a house"
one more time

"Let's build a house"
"to-morrow... tomorrow".
"ahhh..." ***(sigh and yawn)*** little monkeys went to sleep

In the morning, the sun was shining
Everyone woke up
Little monkeys were happy
They said "Let's play"
"Hand over hand it's fun"
"Oooo let's play another game let's play chase" ...yes
"Ok oooooooooo" "caught you"
"Caught you", ooooo caught you"
"Rain..., ra...in..., ra...in..." ***(sound sad, cold and miserable)***
Little monkeys were wet, little monkeys were cold
"What shall we do?"
"Let's build a house"
everybody "Let's build a house"
"To-morrow... tomorrow".
"Ahhh..." ***(sigh and yawn)*** little monkeys went to sleep

In the morning, the sun was shining
Everyone woke up
Little monkeys were happy
They said "Let's play"
"Hand over hand it's fun"
"Oooo let's play another game let's play chase" ...yes
"Ok oooooooooo" "caught you"
"Caught you", ooooo caught you"
"Rain..., ra...in..., ra...in..." ***(sound sad, cold and miserable)***
Little monkeys were wet, little monkeys were cold
"What shall we do?"
"Let's build a house"

Stop! (hold palm of hand up, and speak seriously)
Don't be like the monkeys!
Everyone
Don't be like the monkeys
Do it today, do it now

That's the story

Discussion Questions

- What happened to the monkeys?

  (*Answers:* They repeatedly got wet; they didn't learn from their mistakes; they were stupid and only thought in the short term; all talk and no action.)

- Why didn't they take action to build a shelter from the rain?

  (*Answers:* Lazy, mañana: leave it until tomorrow, lack of forward planning, live for today, they failed to link cause and effect *i.e.,* rain led to being cold and miserable and if they build a house this was avoidable.)

- What phrases have you heard that may stop people taking action about climate change?

  [*Answers*: "Bo pen yang" (It will be ok, don't do anything in Lao PDR). "Ke garne" (What to do in Nepal). "It's the will of God/Allah", "She'll be right" in Australia].

- What phases have you heard that advise action?

  (*Answers:* "Never put off until tomorrow what you need to do today", "Do it now. God helps those who help themselves.")

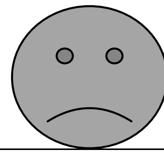
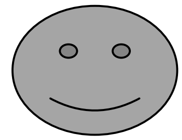
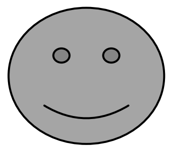
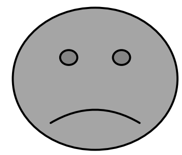
- Why do we need to act now regarding climate change?

  (*Answers:* The trends are already happening, we must all take action otherwise the changes will be irreversible)

Closure Activity: "International Conference on Climate Change and Disaster Management."(Source: UNICEF: Heat Up Over Climate Change, Resources for Peer Teaching)

1. Explain that traditional folk tales often have survived because they teach us valuable lessons. First introduce students to the model below as shown in the figure below.
2. Ask students to consider the outcomes of the four basic choices using the visual below. Draw the four basic choices on the board.
3. Ask if they can see where the monkeys in the story would fit (*i.e.,* if we ignore Climate Change Box 2, "Take no Action")

Four Basic Choices Regarding Global Climate Change

	A	**B**
Global Climate Change	**YES: Take Significant Action**	**NO: Take No Action**
FALSE Climate Change does not happen	1. Take action, but Climate Change does not happen 	2. No action and Climate Change does not happen 
TRUE Climate Change happens	3. Take action and Climate Change happens 	4. No action taken and Climate Change happens 

4. Explain the consequences of the four basic choices (see explanation in the box below).

Box 1. Take Action, but Climate Change does not Happen

The "Climate Change deniers" *(i.e., those who think climate change is not caused by human activity and those that think it is happening naturally and that we are powerless)* warn that spending money on adaptation and mitigation will lead to:

- rises in taxes
- burdens on industry
- new government regulations
- cut backs
- lay offs

In the worst case scenario they claim that this money spent would lead to a world recession. However, others argue that if the money is well spent and the environment will be improved, new jobs involving sustainable energy (solar wind and wave power) will be created. Oil and gas are running out anyway so developing sustainable energy sources like solar, wind, geothermal, etc make sense.

Box 2. No Action Taken and Climate Change does not Happen

We continue as usual. We use up the fossil fuels (coal, oil, gas, wood) until they run out. Continue the pollution caused by fossil fuels, etc.

Box 3. Take action and Climate Change Happens

Money was well spent on:

- awareness raising and education about climate change
- behaviour change strategies
- adaptation
- mitigation
- disaster management plans

The impacts of climate change will be less intense. It will be a different world, but it will be liveable. There will be less loss of life.

Box 4. No Action Taken and Climate Change Happens

If we sit back and take no action, the results globally could be horrendous. In the worst case scenario it could lead to catastrophes in the areas of:

- economic downturn
- political upheaval
- social upheaval
- environmental degradation
- health

Lack of preparedness could lead to:

- conflict over scarce resources
- epidemics
- forced movements of refugees
- armed conflict, etc.

Some point out that humans may be eventually wiped out; the earth will still exist but in a very different form. Extinctions have happened before. It would be the height of arrogance to think that we humans are here forever.

Choice

Each choice we make in life has a range of consequences ranging from positive to negative. Column A is the only logical choice. We cannot afford the risk. **The most illogical thing to do is nothing.**

(Source http://www.youtube.com/watch)

5. Emphasise that each choice we make in life has a range of consequences ranging from positive to negative. **Column A** in the Four Basic Choices figure earlier is the only logical choice. We cannot afford the risk. The most illogical thing to do is nothing.

6. Set the scene for the *Climate Superhero Auditions* by explaining that they are going to explore what different groups can do regarding climate change adaptation, mitigation and disaster management.

7. Ask the class to imagine they are interviewing potential candidates to join the climate change superhero dream team and explain that there are only four places (slots) given on the team to attend the "*International Conference on Climate Change & Disaster Management".*

8. The entire class is the interviewing panel, but divide the class into seven smaller groups. Each group should be given a character card. See ***Attachment 8.3.1***. The group will represent that character and will try to convince the interview panel (the rest of the class) why they should join the *Climate Change (CC) Dream Team*

9. If the group decided to represent the young people, they will represent Ms. Severn Suzuki. See ***Attachment 8.3.2*** entitled "The Twelve–Year Old Girl Who Silenced The World For 5 Minutes". The group will watch her video on *U*-tube or read her speech to understand her character and appreciate her own views about climate change and explain why should Ms. Suzuki (as voice of the youth) be part of the "CC Dream Team

10. Once everyone in the sub-group is familiar with the character described on the character card, they should decide together why that character is essential to combat climate change.

11. Tell them they have 2 minutes to convince the interview panel and they can do this in whatever way they choose – it may be through a drama, speech, drawings, song or presentation. Each group is then invited to state and defend its case.

12. After the presentations, the whole class could vote to say who joins the team. Having established the CC Dream Team, ask:

    - "Can just one team of people deal with climate change?"
    - "Is there a chance of a better outcome if everyone in the world is part of the CC Dream Team?" Explain.

13. As they are part of the team to save the earth ask them:

- "What are you doing already?"
- "What can you do in the future?"

Achieving the Objectives

Objective	This is Achieved by
Describe the impacts of natural disasters on affected people.	Analysing the case study of Typhoon Ketsana.
Describe some of the feelings generated when families are forced to leave their homes, communities, cultures due to rising seas and/or disasters.	Students sharing their experience and personal insights while acting out on roles where members of *Group A* will talk to newcomers in school which were affected by disaster and *Group B* will share about their flooding experience.
Describe the feelings of newcomers to their school and/or community.	Class discussion around feelings and thoughts of newcomers and locals after the role play.
Explain why it is important to show understanding to people who may have to move their homes as a result of natural disasters due to climate change.	Students' interaction and sharing of ideas and opinions based on the Guide Questions for discussion.
State phrases from different cultures which encourage us to put things off until tomorrow. State phrases from different cultures which encourage us to act. Give clear reasons why we all have to act now to make changes in our life styles to adapt to climate change.	Review and analysis of the story of the "Monkeys in the Rain" which talk about the phrases encouraging others to put things off until tomorrow and taking action if something is wrong to improve things. Class discussion and interaction based on the discussion questions used on the story of "Monkeys in the Rain"
Identify the many different ideas, power sources and contributions different groups can make to tackle climate change.	Students performing the activities on Four Basic "Choices regarding Global Climate Change" and "International Conference on Climate Change and Disaster Management."
Explain the need for people from different disciplines (areas of knowledge) to work cooperatively to combat climate change.	Students doing the *Climate Superhero Auditions* and exploring what different groups can do regarding climate change adaptation, mitigation and disaster

Objective	This is Achieved by
	management. Class discussion on challenges and opportunities to combat climate change after analysing the speech or video of Ms. Severn Suzuki at the Earth Summit.

Assessment

- Use a group participation rubric to assess students' performance. For the formative assessment, ask students to get a clean sheet of paper and write their answers on the following questions:

  1. Why is doing nothing about climate change considered be dangerous?
  2. Why will climate change adaptation and mitigation require cooperation from people from different countries and different groups (e.g., physical & social sciences, politics, industry and communities)?
  3. What do you recommend needs to be done by community leaders, journalists, scientists, young people, politicians, business leaders, women's groups, development workers, etc.?

*Assignment: "*Interview of Community Elders on Conflict Experience" (Suggested follow-up project activity)

Procedure

1. Ask students in two's or three's (or if necessary with an adult) to interview a relative or respected elder that they know about their personal experience where a disagreement or conflict was well managed and resolved.
2. Explain that first they must:
   - introduce the "purpose of the interview" (i.e., "we are conducting interviews to learn from the experience of our elders about successful conflict resolution methods")
   - ask if the respondent or interviewee (elder) would like to change his/her name and the names of the people in the story to maintain anonymity.
   - Distribute ***Attachment 8.3.3*** to each group to guide them.
3. Explain the different types of questions and ask students to give their own examples:
   - Open Question: "Could you tell me about your childhood please?
   - Closed Question: "What is your name; where did you live as a child?
   - Clarifying Question: "Could you explain to me what you meant by the term "xxxx"
   - Probing Question: "Can you tell me more about"
4. Ask students to form groups of three students and to name themselves: A, B & C, where: A = interviewer, B = interviewee, C = observer
5. Allow students to practice in conducting interviews with each other. Ask them to recall a story in their lives where a conflict has been resolved successfully. At the end of the story they must try to summarise "The Positive Strategies Used" in 10 minutes.
6. Remind the student-interviewer to use each of the four types of questioning: *open, closed, clarifying, and probing.*
7. Ask the student-observer to check whether all four types of questions have been used.
8. Explain the concept of "confidentiality" (i.e., elders may say some things to the student-interviewer that they would NOT want to be written in the story).
9. Explain that a story has:

- a *beginning* in which the era (date) place, people are introduced
- a *middle* in which the story takes place
- an *end* where the key learning may be pointed out.

10. You may wish to give an example from your personal experience to the students.
11. Stories could be put together to make small booklets of local history to go into the school library as a positive community development project.

Variations

➢ This exercise could also be applied to an environmental project to research behaviour adaptation to find out from elders how they used to survive hardship through self sufficiency, thrift, mending, reduce, reuse, recycle.

RESOURCES

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Attachment 8.3.1

CHARACTER CARDS FOR SUPERHERO AUDITIONS

Instructions for Students

- Each group will be given a **Character Card**.
- The group will represent that character and will try to convince the interview panel why they should join the *Climate Change Dream Team.*
- Decide together why the character assigned to your group is essential to combat climate change.
- If your group decided to represent the young people, you will represent Ms. Severn Suzuki. Your teacher will provide Ms Suzuki's speech entitled "The Twelve-Year Old Girl Who Silenced the World for 5 Minutes". Watch her video on *U*-tube or read her speech to understand her character and appreciate her own views about climate change and explain why Ms. Suzuki (as voice of the youth) should be part of the "CC Dream Team".
- Each group is given 2 minutes to convince the interview panel. Do this in a creative way. It may be through a drama, speech, drawings, song or presentation.

Journalists	**Young People (Ms. Severn Suzuki)**
Community Leaders	**Politicians**
Scientists	**Business Leaders**
Activists / Campaigners	**Development Workers**

Attachment 8.3.2
Students' Worksheet

"THE TWELVE YEAR-OLD GIRL WHO SILENCED THE WORLD FOR 5 MINUTES"

Ms. Severn Suzuki (daughter of David Suzuki) at the age of 12 spoke at the **Earth Summit** in Brazil in 1992. She received a standing ovation. Her video on U tube is very inspirational. The speech of Ms. Suzuki is shown below for those without access to Internet.

Hello, I'm Severn Suzuki speaking for E.C.O. - The Environmental Children's organisation.

We are a group of twelve and thirteen-year-olds from Canada trying to make a difference: Vanessa Suttie, Morgan Geisler, Michelle Quigg and me.

We raised all the money ourselves to come six thousand miles to tell you adults you must change your ways. Coming here today, I have no hidden agenda. I am fighting for my future.

Losing my future is not like losing an election or a few points on the stock market. I am here to speak for all generations to come.

I am here to speak on behalf of the starving children around the world whose cries go unheard.

I am here to speak for the countless animals dying across this planet because they have nowhere left to go. We cannot afford to be not heard.

I am afraid to go out in the sun now because of the holes in the ozone. I am afraid to breathe the air because I don't know what chemicals are in it.

I used to go fishing in Vancouver with my dad until just a few years ago we found the fish full of cancers. And now we hear about animals and plants going extinct every day - vanishing forever.

In my life, I have dreamt of seeing the great herds of wild animals, jungles and rainforests full of birds and butterflies, but now I wonder if they will even exist for my children to see.

Did you have to worry about these little things when you were my age?

All this is happening before our eyes and yet we act as if we have all the time we want and all the solutions.

I'm only a child and I don't have all the solutions, but I want you to realise, neither do you!

- You don't know how to fix the holes in our ozone layer.
- You don't know how to bring salmon back up a dead stream.
- You don't know how to bring back an animal now extinct.
- And you can't bring back forests that once grew where there is now desert.

If you don't know how to fix it, please stop breaking it!

Here, you may be delegates of your governments, business people, organisers, reporters or politicians - but really you are mothers and fathers, brothers and sister, aunts and uncles - and all of you are somebody's child.

I'm only a child yet I know we are all part of a family, five billion strong, in fact, 30 million species strong and we all share the same air, water and soil - borders and governments will never change that.

I'm only a child yet I know we are all in this together and should act as one single world towards one single goal.

In my anger, I am not blind, and in my fear, I am not afraid to tell the world how I feel.

In my country, we make so much waste, we buy and throw away, buy and throw away, and yet northern countries will not share with the needy. Even when we have more than enough, we are afraid to lose some of our wealth, afraid to share.

In Canada, we live the privileged life, with plenty of food, water and shelter - we have watches, bicycles, computers and television sets.

Two days ago here in Brazil, we were shocked when we spent some time with some children living on the streets.

And this is what one child told us: "I wish I was rich and if I were, I would give all the street children food, clothes, medicine, shelter and love and affection."

If a child on the street who has nothing, is willing to share, why are we who have everything still so greedy?

I can't stop thinking that these children are my age, that it makes a tremendous difference where you are born, that I could be one of those children living in the Favellas of Rio; I could be a child starving in Somalia; a victim of war in the Middle East or a beggar in India.

I'm only a child yet I know if all the money spent on war was spent on ending poverty and finding environmental answers, what a wonderful place this earth would be!

At school, even in kindergarten, you teach us to behave in the world. You teach us:

- not to fight with others
- to work things out

- to respect others
- to clean up our mess
- not to hurt other creatures
- to share - not be greedy

Then why do you go out and do the things you tell us not to do?

Do not forget why you're attending these conferences, who you're doing this for - we are your own children.

You are deciding what kind of world we will grow up in. Parents should be able to comfort their children by saying "everything's going to be alright', "we're doing the best we can" and "it's not the end of the world".

But I don't think you can say that to us anymore. Are we even on your list of priorities? My father always says "You are what you do, not what you say."

Well, what you do makes me cry at night. You grown-ups say you love us. I challenge you; please make your actions reflect your words. Thank you for listening.

(*Source: U tube http://www.youtube.com/watch?v=TQmz6Rbpnu0)*

Attachment 8.3.3

SUCCESS STORIES OF CONFLICT
(Assignment/Alternative Project)

Objectives

In this project, the students will be able to:

- gather stories of elders on conflict prevention, management, resolution from the stories of elders;
- identify key lessons so as not to repeat the same mistakes;
- celebrate innovation to maintain harmony in the family or community;
- develop the attitude of maintaining confidentiality when required.

Materials

- paper and coloured pencils
- thread or staplers to bind stories together
- cardboard for book covers

Procedure

1. Each member of the group will be given separate tasks. Members A, B and C will perform the following roles: A = interviewer, B = interviewee, C = observer
2. Prepare an interview guide using the different types of questions: For example:
    - ➢ Open Question: *“Could you tell me about your experience in handling conflicts?*
    - ➢ Closed Question: *“What is your position or designation in this community?*
    - ➢ Clarifying Question: *“Could you explain to me what you meant by the term conflict mediation?”*
    - ➢ Probing Question: *“Can you tell me more about your strategy in resolving conflicts?”*
3. Your group can invite an adult to assist during the interview of a relative or respected elder in your community.
4. Before the interview, introduce yourselves and the purpose of the interview (e.g., “we are conducting interviews to learn from your experience about successful conflict resolution methods”). Be ready to answer clarifying questions by interviewees about the project.

5. Ask if the interviewee (elder) would like to change his/her name and use different names of the people in the story to maintain anonymity.
6. Begin by asking the interview to recount an experience where a dispute or conflict was well managed and resolved.
7. Take notes and collect stories.
8. Write up stories including the moral or learning from the story.
9. Develop small books for the school library about the local community.

CONCLUSION

Azhar is a fisherman from Balikukup island, Berau, East Kalimantan, Indonesia. This is his story (WWF, 2010);

> "The weather is increasingly uncertain and unpredictable. I do not understand the causes, but clearly, the condition is bringing changes to my life as a sea cucumber fisherman.
>
> In the old days, we fishermen could predict the weather. But not anymore. The elders on our island also mentioned the same thing. Since 2002, Atang, one of the elders whom we regard as an expert in predicting the weather in Balikukup, said that the weather was getting unpredictable. Before, Atang could produce a very good prediction, even for the course of a full year.
>
> One example of unpredictable weather is the lost phenomena of 'bulan janda', or 'widow month'. It is the called widow-month because when the fishermen go to sea during that month, they rarely come home safely. Thus, their wives become widows. Widow month is an annual event when the wind blows very strongly for 44 days from the south. This wind stops for a short period of time (half an hour), and then goes back to blowing very hard. During that time it is impossible for fishermen to go at sea.
>
> Fishermen who have saved enough money and food supply do not need to go to sea during the 'widow month' because the conditions are too dangerous. However, other fishermen have no option but to go to sea during that time.
>
> The phenomenon of 'widow month' does not exist anymore. The last time it happened was in 1991. After 1991, during the supposedly 'widow-month', there could be calm periods for up to 2 weeks. None of the fishermen understands why the 'widow month' phenomenon has slowly disappeared.
>
> The unpredictable weather is a disadvantage for us fishermen because we no longer know when we can go fishing. It is difficult for us to predict when we will make money. Before, we could estimate when was the right time to make income and put some money aside, as we could predict when we can go fishing. Now, whenever we have good weather, we just go fishing. We can no longer make financial plans".

Disasters coming from changing climate are very real. They make the lives of Southeast Asian countries more unbearable. These countries are usually lacking in funds to educate their people, build strong roads, bridges, school building, and many others. They are also most likely to suffer in terms of diseases, malnutrition, conflict, and poverty when cyclones, floods, and droughts unpredictably strike.

Although the rich countries emit more CO_2 and other GHGs, the fast-growing populations of Southeast Asian countries equally contribute a significant share to the destruction of natural resources through continued deforestation, unregulated chemical use in farming and overfishing and coral mining to meet their daily food and income requirements.

Now is the time to adapt and mitigate, and to educate ourselves with what can be done to reduce CO_2 and GHGs. Although we have a long way to go to educate the peoples of Southeast Asia, we hope this Guidebook will be a good start for teachers to introduce to our young people what climate change is all about.

We urge you to act now!!

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Appendix (Concept Map)

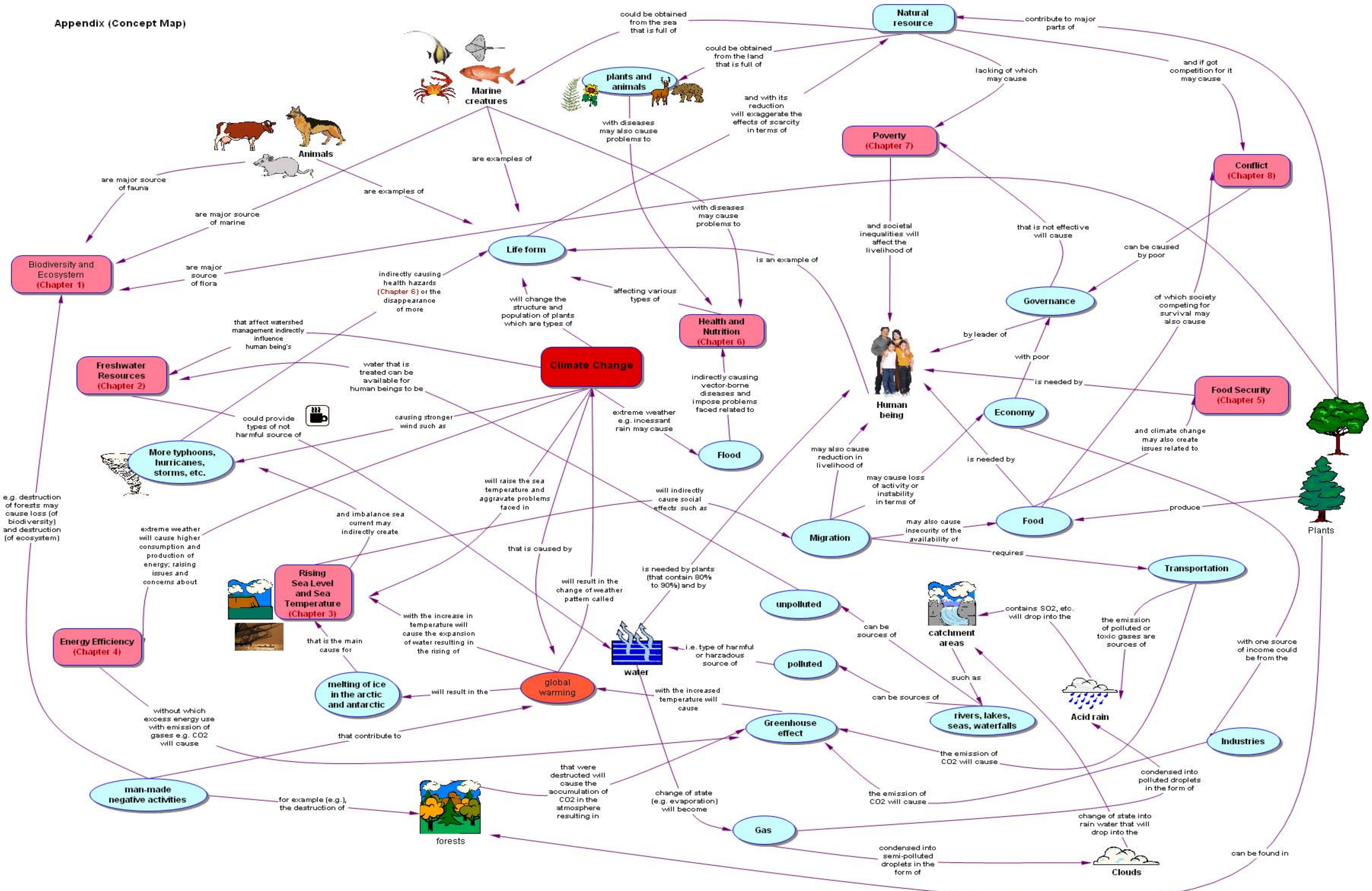

Figure 6: An illustration of climate change and its related issues