The Planter, Kuala Lumpur, ***96*** *(1130): 327-341 (2020)*

Understanding Climate Change: Causes, Impacts, Policies and Actions

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Climate change is already happening in the world today. Global warming leading to melting of polar icebergs and snow covers is seen today and causes the sea level to rise. Extreme weather conditions have also become the new norms. Consequently, life on earth is affected, mostly with negative outcomes.

Human activities that emit three primary greenhouse gases (GHG), namely carbon dioxide, methane and nitrous oxide are found to be the principal causes of climate change. As such, there is an urgent need for concerted efforts by mankind to limit and abate the emission of these gases in order to slow down climate change.

At the international level, Intergovernmental Panel on Climate Change (IPCC) which is a UN based institution, has been setting up policies and actions to abate climate change. It is presently coordinating actions to limit a global temperature rise to below 1.5°C. Malaysia is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) climate treaty in 1992 and is doing her part to contribute to this agenda. In this respect, Malaysia has pledged to maintain at least 50 per cent of the landmass perpetually under forest cover. Malaysia also pledged to reduce the GHG emissions intensity of Gross Domestic Product (GDP) by 45 per cent by 2030 relative to the emissions intensity of GDP in 2005 for the country at COP21 (Conference of Parties) in 2015.

Keywords: *Climate change, greenhouse gas, global warming, sea level rise, El Nino, Intergovernmental Panel on Climate Change*

Climate change is gaining greater attention in planters' lives and conversation in recent times. This attention has partly been sparked by severe and repeated weather pattern changes in recent years. Incidences of El Nino and haze that hit South-East Asia have become part of the vocabulary of planters today.

Severe El Nino related droughts struck South-East Asia in mid 2011 and 2012 while a milder one in mid 2014 disrupted regular water supply for household use and these severe droughts impacted oil palm yields negatively (Ling, 2014; Azlan *et al*., 2016). Moreover, the hot weather accompanied by lack of rain during these periods, is ideal for land clearing. Fires set to get rid of the biomass release large amounts of particulate matter into the atmosphere and cause haze that chokes human beings and causes respiratory problems. Although haze is not a climate change phenomenon, its presence has made people realise the impact of weather conditions on human and plant welfare. Thus, people have become more interested in the changing climate

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that has deleterious impacts on life on earth and is now plaguing the world.

When the existence of climate change was first announced, it was not well received. In 1930, Guy Steward Callendar noted that the United States and North Atlantic region had warmed significantly due to the Industrial Revolution (History.com, 2018). He argued that a greenhouse effect which was warming the planet was under way. Although his claims were met with much scepticism, he managed to draw attention to the possibility of global warming.

Then came the opposing view that the world was getting colder in 1945, in what is known as global cooling (Wikipedia[1]). These two contradictory views created confusion as to where the world's climate was heading. Obviously, this did not bode well for the belief that climate change involving warming was happening.

Climate change is assessed by analysing past observed climatic data and using this to forecast the future by using climate models. The high degree of uncertainty arising from the use of models in the early years to project climate change added to the disbelief. Moreover, weather can be very unpredictable and extreme weather conditions such as severe dry weather that causes drought or severe winter can be part of the normal meteorological cycle and, thus, not caused by climate change.

Today, evidence is clear that climate change is really taking place on earth, with 75 per cent of published scientific articles explicitly or implicitly accepting that climate change is happening (Oreskes, 2004). A more recent poll showed that 71 per cent of Americans agreed that climate change is a reality. Only 1 per cent disagreed while the balance of 28 per cent were either unsure or not concerned about climate change (Kennedy & Funk, 2019).

As the impacts of climate change become more serious with time if left unattended, future generations will face the brunt of climate change more than the present generation. As such, the younger generation has taken the stand to call nations of the world to take heed. This is clearly seen when a Swedish teenager and climate activist by the name of Greta Thunberg called for stronger action on climate change and gained international recognition in the process (Wikipedia[2]). She was given the rostrum to speak on this matter at the twenty-fifth United Nations Climate Change Conference or twenty-fifth Conference of Parties which was held in Kotavace, Poland in 2018.

The purpose of this article is to provide the planter with an easy to understand insight into the meaning of climate change, its causes and impacts. The important policies and actions taken internationally and locally, in Malaysia, to address climate change are also given.

WEATHER AND CLIMATE

The important atmospheric conditions around us are commonly expressed by different parameters e.g. temperature, humidity, air pressure, amount of rainfall, number of sunshine hours, carbon dioxide content, wind speed and wind direction. The weather is the state of the atmospheric conditions at a given time. These characteristics fluctuate with time. As an example, air temperature in a particular place fluctuates between day and night and this is called the diurnal variation in temperature. The temperature may also vary within a shorter time frame such as an hour and this is referred to as hourly variation in temperature. These variations can also be big or small depending on the place and the season of the year.

What causes weather? The energy that

drives the weather comes from the sun. After reflecting some of the solar radiation from the surface, the earth absorbs the balance. The absorbed energy is then distributed on the surface of the earth through atmospheric and oceanic circulations and results in varying weather in different places of the globe (IPCC,1995). On average, the incoming solar energy balances the outgoing radiation and results in a mean global temperature. Any factor that disturbs this balance changes the net global energy balance and changes the global temperature.

The long-term average of weather determines the climate. Data over a period of thirty years are commonly used (Jalota *et al*., 2018). In other words, climate is how the atmosphere or weather behaves over relatively long time periods (NASA.gov).

CLIMATE CHANGE

The climate of a region or country is statistically quantified by long-term averages or mean values of the atmospheric parameters. The parameters are also quantified by other statistical values e.g. variance; this reflects the variation of the parameter.

Climate change takes place when there is a long-term shift in global or regional climate pattern. This happens when the mean and variance of the climatic parameters change over time. Climate change is assessed by using past observed climatic data.

What causes the climate to change? According to the Intergovernmental Panel on Climate Change (IPCC) (1995) any factor that disturbs the global energy balance can alter the climate of the world. Climate change occurs due to the interaction between the atmosphere and the oceans, land and ice in the global system and the underlying surface (Jalota *et al*., 2018). The factors that alter the global energy balance can come from either natural or man made (anthropogenic) sources.

CAUSES OF CLIMATE CHANGE

The earth's climate has never been static. It has changed in the past and will continue to change in the future. In the past, the changes were caused by natural sources, such as the slow cyclical changes in the tilt of the earth's axis and the shape of its orbit.These small fluctuations in the earth's orbit can change the amount of sunlight reaching the earth by a small amount and affects the timing and intensity of the seasons. In fact, this natural mechanism is said to have been responsible for the timing of the ice age cycles (Wikipedia[1]).

Recent climate changes have been caused mainly by man made sources rather than natural sources (Chong & Mathews, 2000; Jalota *et al*., 2018). The main anthropogenic sources are particulate matter (also known as aerosols) and greenhouse gases (GHGs). While the presence of particulate matter in the atmosphere has a propensity to cause global cooling, because they reflect sunlight back into space, GHGs have the opposite effect and cause global warming.

The fact that anthropogenic emissions are real is supported by evidence obtained by using earth orbiting satellites during the COVID-19 shutdown. During the shutdown, economic activities and vehicular movement were tremendously reduced in the affected areas. It was observed that there was a drop in pollutants such as nitrogen dioxide in the atmosphere during this period. This is a gas which is emitted by motor vehicles and industrial facilities (Tenenbaum, 2020).

Particulate matter

Human activities emit particulate matter into

the atmosphere from the use of fossil fuels, such as coal and petroleum, and burning biomass or plant materials. These particles, are also produced naturally and originate from major volcanic eruptions. The particles absorb and scatter radiation from the sun and prevent it from reaching the earth. As a result, the earth's surface is not heated up and remains cool (Chong & Mathews, 2000).

Greenhouse gases

Unlike particulate matter, GHGs are gaseous constituents of the atmosphere. The main GHGs in the atmosphere are water vapour (H_2O), carbon dioxide (CO_2), methane (CH_4), ozone (O_3), nitrous oxide (N_2O), chloro-fluorocarbons (CFCs) and hydrofluorocarbons (HCFCs) according to IPCC (1990).

GHGs let sunlight pass through the atmosphere but they prevent the heat that the sunlight brings to the earth from leaving it fast enough. This phenomenon is called the greenhouse effect (environment.gov.au). It draws its name from a similar effect that is seen in a greenhouse or a glasshouse when sunlight penetrates its glass walls and warms it up. The greenhouse remains warm for a considerable period of time as the glass walls trap the heat inside the greenhouse and prevent it from escaping fast enough.

The GHGs trap the heat on earth and cause it to warm up. The phenomenon of a gradual increase in the earth's atmospheric temperature due to this greenhouse effect is called global warming.

The contribution of the different GHGs to global warming depends on their abundance in the atmosphere and their global warming potential (GWP). The latter refers to the ability of the particular GHG to trap heat over a specified time period (Wikipedia[3]).The larger the GWP value, the greater the ability of the GHG to trap heat and to warm up the earth.

Each GHG has its own GWP and, therefore, has a different ability to warm up the earth. Nitrous oxide has the greatest ability to warm up the earth as its GWP is 293. The GWPs of CH_4 and CO_2 are 21 and 1, respectively as seen in *Table 1*.

TABLE 1
GLOBAL WARMING POTENTIAL OF THREE DOMINANT GHGS IN ATMOSPHERE

GHG	*Global warming potential (100 years)*
Carbon dioxide	1
Methane	21
Nitrous oxide	293

Source: Wikipedia[3]

CO_2, CH_4 and N_2O are the three most abundant GHG in the atmosphere. Among them, CO_2 is the largest amount comprising 77 per cent of the total global emission followed by CH_4 and N_2O emissions with 16 per cent and 6 per cent share respectively (IPCC, 2014).This is seen in *Table 2*.

GHG sources and emission

The amounts of GHGs such as CO_2, CH_4 and N_2O in the atmosphere have been increasing over time. Their emissions come from both natural and anthropogenic sources. However, GHG emission from the latter source has become dominant and unprecedented for at least the last 800 years driven by population growth, increased economic activities, land use changes, and high energy use lifestyles (IPCC, 2014).

Carbon dioxide

Human activities account for the substantial increase in CO_2 present in the atmosphere

TABLE 2
RELATIVE SHARE OF DIFFERENT TYPES OF GLOBAL GHG EMISSION

GHG	*Relative share of total global GHG emission (%)*
Carbon dioxide (fossil fuel and industrial processes)	65
Carbon dioxide (forestry and other land use)	11
Methane	16
Nitrous oxide	6
Others	2
Total	100

Source: IPCC (2014)

today. The burning of fossil fuel such as coal, oil and gas to obtain energy for transportation and industrial usage is the biggest CO_2 emitter accounting for 65 per cent of the total GHG emission in the world (*Table 2*) .

In agriculture, carbon cycling starts with CO_2 from the atmosphere getting fixed in the plants *via* photosynthesis. The carbon is stored in both the above ground and below ground biomass. The above ground biomass is the plant vegetation and the below ground vegetation consists of the roots and decayed fallen biomass such as leaves.

Forests, especially tropical rain forests, have dense vegetation which are carbon rich. Similarly, the peat ecosystem also has a very rich carbon stock but this is stored mainly below ground since the peat soil, being an organic soil is made up of decomposed or decomposing plant matter. When the forests and the peat areas are cleared and the vegetation is burnt, large amounts of the carbon stock are released back into the atmosphere as CO_2. Similarly, root death and decay as well as microbial activities in the disturbed ecosystems after land clearing also emit CO_2 back into the atmosphere. The cutting down of forest for all kinds of land use including agriculture contributes to 11 per cent of total GHG emissions at the global level as seen in *Table 2* (IPCC, 2014).

Atmospheric CO_2 concentration has escalated to 400 ppm in 2014 from a concentration of 270 ppm in 1750; the period preceding the year 1750 is often referred to as the preindustrial period (Watson *et al*., 1990). The authors have projected that CO_2 concentration will reach between 600-1 000 ppm by 2100.

While the amount of CO_2 in the atmosphere has increased over the years, the annual rate of increase has also accelerated. It was 1.5 ppm per year in the 1980s and 1990s but this has gone up to 2 ppm per year for the period of 2006-2015. In 2015, the annual CO_2 increase was 3 ppm per year (Butler & Stephan, 2016).

Methane

Methane is emitted from natural sources such as wetlands or swampy areas, termite activity and from geological sources e.g. CH_4 trapped in coal seams. The main man made sources come from the rearing of ruminants such as cattle, waste disposal sites or landfills and agriculture. The livestock industry is the principal cause of CH_4 emission according to FAO (2006). Ruminants such as cattle, sheep and goats release large amounts of CH_4 through enteric fermentation of their food and the gas is released through belching with a smaller

amount through flatulence. A comparison of the livestock and palm oil industries has shown that the livestock industry used 300 times more land and released six times more GHG than the palm oil industry (Basiron & Yew, 2016).

The anaerobic conditions in wetlands emit CH_4. Thus, flooded paddy fields emit CH_4 when they remain waterlogged and flooded. Similarly, peatlands are also large CH_4 sources since the anaerobic conditions caused by the existence of a high water table favour methanogenic bacteria activity that releases CH_4. The same happens at dumping sites when wastes and rubbish are rotted by methanogenic bacteria and also release CH_4 in the process. There are other sources of CH_4 emission in the world, e.g. mining for coal also releases CH_4 but they are not the major CH_4 emitters globally.

Global CH_4 concentrations had gone up over the years, from 700 ppb in the preindustrial period to 1 720 ppb in 1994 according to IPCC (1995). In 2015, it reached a concentration of 1 850 ppb (Butler & Stephan, 2016).

Nitrous oxide

The main sources of N_2O emission come from the use of N fertilisers in agriculture, breakdown of nitrogen based organic materials in wastewaters and as a by-product of fuel combustion. Coal fired power plants also emit N_2O. Among them, the first source emits the most N_2O. A study carried out in 2017 in the United States found that agricultural soil management was the largest source of N_2O emissions and accounted for 74 per cent of total United States (US) N_2O emissions (EPA[1]).

When nitrogenous fertilisers are applied to the soil in agriculture, they undergo different fates depending on the type of nitrogen source; that is whether it is nitrate, ammonium or urea based. Depending on the N fertiliser type and soil conditions, microbial mediated mechanisms of nitrification and denitrification processes yield N_2O.

Atmospheric N_2O concentration has been increasing since the preindustrial period. From a concentration of 275 ppb during this period, the level increased to 312 ppb in 1994 (IPCC, 1995) and by 2015, it had reached a new high of 325 ppb (EPA[2]).

Contribution of economic sectors to GHG emissions

The results in *Table 3* show that the burning of fossil fuel to generate electricity and heat emits the most GHGs and contributes to 25 per cent of the total global GHG pool (IPCC, 2014). Agriculture, clearing of forests and other land use activities is the second largest GHG emitter with a 24 per cent share of the emissions. However, carbon sequestration in the plant biomass and soil amounting to 20 per cent of emissions in this sector is not taken into account here. The third highest GHG emitter is the industrial sector with 21 per cent share followed by transportation with 14 per cent and the building sector with 6 per cent of total GHG emission.

CLIMATE CHANGE PROJECTIONS

Climate change is projected by using mathematical climate models. These are also known as global climate models or general circulation models (GCMs). Past observed weather data are simulated by using these models in order to come up with projections on what the future climate patterns will be like.

GLOBAL WARMING OR GLOBAL COOLING?

Global climate change can go two ways; either

TABLE 3
CONTRIBUTION OF ECONOMIC SECTORS TO GHG EMISSIONS

Economic sector	*Share of GHG emission (%)*
Electricity and heat production	25
Agriculture, forestry and other land use	24
Industry	21
Transportation	14
Buildings	6
Others	10
Total	100

Source: IPCC (2014)

the earth is warming up as in global warming or the earth's temperature is going down as in global cooling. There were two schools of thought about this matter in the twentieth century.

One group opined that the world was warming up due to the presence of large amounts of GHGs in the atmosphere. In fact, Jalota *et al*. (2018) pointed out that as far back as 1827, J B J Fourier postulated that increase in GHG in the atmosphere could lead to an increase in surface temperature on earth. In 1930, a British engineer by the name of Guy Steward Callendar proposed that the US and North Atlantic region had warmed up as a result of an increase in CO_2 concentration due to the Industrial Revolution (History.com, 2018). He even stated that a doubling of CO_2 concentration in the earth's atmosphere could increase global temperature by 2°C.

Later in 1979, Jule Gregory Charney, who chaired an "*ad hoc* study group on carbon dioxide and climate" for the National Research Council, USA, published a milestone report entitled "Carbon dioxide and climate: A scientific assessment." The study group estimated that the most probable global warming for a doubling of CO_2 to be near 3°C with a probable error of ± 1.5°C. This estimate has been essentially unchanged for over three decades, e.g. the IPCC Fourth Assessment Report (2007) says that the equilibrium climate sensitivity is likely to be in the range of 2°C to 4.5°C, with a best estimate value of about 3°C. It is very unlikely to be less than 1.5°C.

On the opposite side, in the 1970s, another group of scientists were aware that global temperature had been cooling down since 1945 and claimed that the world was heading towards this direction (Wikipedia[1]). The cooling was attributed to the large amounts of particulate matter emitted as a consequence of the postwar boom in industrial activities. In fact, the earth did cool between the period of 1940 to 1970. The idea that the particulate matter could block the sunlight from reaching the earth and had a chilling effect on planet earth caught on in the media, which suggested that an Ice-Age was coming with a publication in TIME (1974) on this topic.

The 1980s were marked by warmer temperatures including the hottest summer in 1988. There were widespread droughts and wildfires in the United States. NASA scientist James Hansen presented climate models to the US Congress in June 1988 and testified that he was '99 per cent sure' that global warming was already happening (History.com, 2018).

The proposal that the earth was undergoing global cooling was dropped when clearer evidence emerged that global warming was the trend.

EFFECTS OF GLOBAL WARMING

The most direct effect of global warming is, of course, an increase in global air temperature. IPCC (1995) has projected that global air temperature will increase between 1°C to 4.5°C by 2030. When the effects of anthropogenic aerosols that are also emitted into the atmosphere are taken into account, a lower atmospheric temperature increase of 1°C to 3.5°C is anticipated.

The warming is not uniform everywhere. It is greater on the land surface than on the ocean surface. Warming is also higher in arid than humid regions (IPCC, 2007).

In reality, the average global temperatures across land and ocean surface areas have increased. It was 0.84°C higher than the twentieth century average temperature in 2017 according to NOAA/NCEI (National Oceanic and Atmospheric Administration/National Centers for Environmental Information) (2018). It was 0.94°C higher in 2016 and in the previous year it was 0.90°C higher. These results are shown in *Table 4*.

Over the last 50 years, some extreme events have changed according to Jalota *et al*. (2018). Cold days, cold nights and frosts have become less frequent while hot days, hot nights and heat waves have become more frequent. The average temperatures of Antarctica have increased at almost twice the global average rate in the past 100 years. The authors also mentioned that the warming has been more pronounced in the recent decades, with higher night temperatures.

TABLE 4
RELATIVE INCREASE IN WORLD TEMPERATURES IN 2015-2017

Year	*Increase in temperature relative to average temperature in twentieth century (°C)*
2017	0.84
2016	0.94
2015	0.90

Source :NOAA/NCEI (2018)

The main findings of IPCC (2014) on the observed changes in climate change are summarised as follows:

- Earth's atmosphere has warmed up,
- Earth's oceans have warmed up,
- Amounts of snow and ice have diminished,
- Sea level has risen, and
- Rainfall patterns have changed depending on the region.

Climate change has proceeded at an alarming pace during the past three decades. For example, earth's surface temperature has been successively warmer in the last three decades than in any preceding decade since 1850 (IPCC, 2014) and the period of 1983 to 2012 was likely the warmest 30-year period of the last 1 400 years in the Northern Hemisphere. On average, global air temperature has increased by 0.85°C over the period 1880 to 2012.

The increased air temperature has caused Greenland and Antarctica ice sheets to melt, with exceptionally high rates of melting seen since 2002. Glaciers in the world have continued to shrink worldwide.

The melting of ice sheets and glaciers leads to a rise in sea level. IPCC (1995) found that the mean sea level in the world has risen 10-25 cm between the period of 1895-1995. The average sea level rise was 19 cm for the period

between 1901 and 2010 (IPCC, 2014). The latter study also found that the rate of sea level rise has been larger since mid-nineteenth century when compared with the last two millennia.

Precipitation patterns are less clear. Global Circulation Models (GCMs) projected higher global precipitation under increased GHG concentrations (Chong & Mathews, 2000). Higher precipitation is expected in the mid to high latitudes during winter. However, the precipitation pattern in the tropics differs from model to model while in the dry subtropics there is very little change in precipitation.

Changes in precipitation in a warming world is not uniform (IPCC, 2014). The high latitudes and equatorial Pacific are likely to receive more precipitation by the end of the twenty-first century. Mean precipitation will decline in mid-latitude and subtropical dry regions. However, for mid-latitude wet regions, precipitation will increase. For wet tropical regions, extreme precipitation events will become more severe and more frequent.

Extreme weather conditions are also projected and it is likely that more areas in the world will come under the monsoonal systems (IPCC, 2014). Precipitation during the monsoon period is also likely to intensify. In addition, the El Nino-Southern Oscillation (ENSO) related precipitation variability is expected to intensify. In another study carried out by the Max-Planck Institute, it was found that the Pacific Ocean is tending towards an El-Nino like state, with the ENSO phenomenon becoming more energetic with climate change so that variations become more extreme (Timmermann *et al*., 1998). These changes in the ocean dynamics suggest that rainfall over Malaysia, especially Sabah, could become more variable, with more frequent occurrences of dry and wet weather.

Chong and Chan (1994) could not find a clear sign as to whether there was an increase or a decrease in typhoon activity with climate change in their study. However, Evans (1993) found that there was more formation of tropical typhoons in the Australian region with increased GHG conditions. Moreover, they were also more intense.

IMPACTS ON WORLD SYSTEMS

The impacts of the changing climate are broad in extent and deep in impact. The changing climate affects life on earth. At its worst, the changing climate alters ecosystems and makes them unfit for some plant and animal species; driving them to extinction. The concern is that biodiversity may be threatened. (Nik, 2000). Populations may be displaced due to intolerable changing climate conditions or flooding due to sea level rise. Migration of both human beings and animals to more suitable environments will take place.

The changing climate has a great impact on agriculture since crops perform best when planted in suitable agro-ecological zones. According to Ramadasan *et al*. (2000), climate change affects crop productivity through alterations in regional suitability for existing crops, photosynthesis, water availability, pest and disease incidences. Low lying areas may be flooded and inundated with saline sea water, rendering some areas unfit for cultivation of existing crops. Even methods of animal husbandry may have to be adjusted for the changing climate, such as the need for temperature controlled enclosed houses. As such, food security can be threatened.

Corley (2016) pointed out that the future climate in some regions may be drier and irrigation may be required. Thus, there will be a need for drought tolerant oil palms. In addition, flooding and high salinity may be important in

low lying areas and it will be necessary to breed for oil palms that tolerate a high water table and high salinity.

Climate change produces variations in the pattern and intensity of precipitation. In addition, sea level rise causes some low lying areas to be flooded, submerged and to be impregnated with saline sea water. The flooded areas will be unsuitable for upland agriculture. On a regional scale, the changing climate will increasingly affect water quality for human consumption and for agriculture. Its availability may be compromised.

Climate change has great potential effects, often unfavourable, on oil palm performance (Yew & Yew, 2020). One such unfavourable outcome is a rise in sea level. The Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) (2018) projected that sea level will rise by 0.11 m to 0.62 m in Malaysia by 2050. Sea level rise will cause some coastal areas to be flooded and to be inundated with sea water and render them unsuitable for oil palm cultivation if they are flooded for long periods of time. However, if they are flooded for short periods, oil palm cultivation may require the fields to be drained. The harvesting of fresh fruit bunches and their evacuation from the field pose serious problems. Under these conditions it is possible that some of the crop will not be harvested, resulting in an economic loss.

Oil palm is sensitive to saline conditions and intrusion of sea water will pose a serious problem to the crop (Ahmad, 1993). Corley (2016) pointed out that it will still be possible to grow oil palm close or even below the high sea level but costs of bunding and pumping out the water may make such areas uncompetitive.

With a rising sea water level, coastal resources and ecology may be changed. Mangrove zones with their rich biodiversity and coral reefs will be impacted. Indeed, coral bleaching due to the increase in the temperature of the sea water is already happening. (Nicholas *et al*., 2007).

Human society will be affected as homes get inundated with rising sea and river water. Tuvalu is a Polynesian island which is situated in the Pacific Ocean and is already affected by the sea level rise. The inhabitants of the island are fearful that the encroaching sea level will swallow up the island some day (Roy, 2019). As cities and towns get submerged, inhabitants will be forced to move elsewhere. Plans are already being made to move the capital city of Indonesia from Jakarta to East Kalimantan for fear that the sinking city will face serious problems due to rising sea level (Bendix, 2019).

Public health is also affected by climate change and the potential effects of climate change on it were first addressed by the World Health Organization and World Meteorological Organisation in 1990 (WHO,1990). Climate change has an impact on health directly or indirectly (Ambu *et al*., 2000). Some effects such as deaths due to heat waves are direct effects. Indirect effects, such as ecosystem disturbance can alter food production systems and affect nutritional status. Ambu *et al.* also found that there is a significant relationship between air temperature and relative humidity affecting the incidence of some vector-borne disease such as malaria, dengue and dysentery.

BIGGEST GHG EMITTERS IN THE WORLD

The five biggest GHG emitters in the world are China, United States, European Union 28, India and Russia in this order (WRI, 2017). The results in *Table 5* show that China alone

contributed more than a quarter or 27.51 per cent of the world's total GHG emission amounting to 45 261 Mt CO_2e in 2017. The share of global GHG emission for United States was nearly 15 per cent, European Union 9 per cent, India 6 per cent and Russia 5 per cent. Malaysia is the twenty-ninth largest GHG emitter from a list of 155 countries which have submitted their national GHG inventory balance to United Nations.

INTERNATIONAL ORGANISATIONS FOR ACTION AND POLICIES ON CLIMATE CHANGE

The IPCC is the United Nations body for assessing the science, environmental and socio-economic response to climate change. It was formed in 1988 by United Nations Economic Programme and World Meteorological Organisation. It is the most authoritative scientific and technical voice on climate change matters in the world (Grida).

The United Nations Framework Convention on Climate Change (UNFCCC) is an environment treaty that was adopted during the UN General Assembly in Rio de Janeiro, Brazil in 1992. This assembly is often called the Rio Summit. The treaty came into force in 1994. Today 195 countries have ratified the Convention and these countries are called Parties to the Convention. The ultimate objective of the Convention is to stabilise GHG concentrations at a level that would prevent dangerous anthropogenic interference with the climate system (UNFCCC[1]).

The Parties to the Convention meet annually at the Conference of the Parties (COP) as it is often known as (UNFCCC[2]). These annual meetings review the implementation of the Convention and take decisions necessary to promote its effective implementation. The first COP was held in Berlin, Germany in 1995 and COP for year 2020 will be the twenty-sixth Conference or COP26. It will be held in Glasgow, Scotland.

MALAYSIA'S COMMITMENT TO CLIMATE CHANGE

Malaysia is a signatory to the treaty to the UNFCCC at Rio Summit in 1992. The Prime Minister of Malaysia also made a pledge to maintain at least 50 per cent of the land area in the country perpetually under forest cover at the Summit. In 2019, Malaysia still maintains more than half of the country under forest cover.

Malaysia, as a Party to the Convention, is

TABLE 5
WORLD'S BIGGEST GHG EMITTERS IN 2017

Position	*Country*	*% share of world's total amount of GHG*
1	China	27.51
2	United States	14.75
3	EU-28	9.33
4	India	6.43
5	Russia	4.86
6	Others	37.12
	Total	100.00

Source: WRI (2017)

obliged to submit a report on the GHG balance of the country to UNFCCC every four years. This report is called the National Communication (NC). Malaysia's Initial NC was submitted to UNFCCC in 2000 (MOSTE, 2000). The Second NC to UNFCCC, also known as NC2, was submitted in 2011 (NRE, 2011) while the Third Communication or NC3 was submitted in 2018 (MESTECC, 2018).

Malaysia is committed to address climate change. The country launched the National Policy on Climate Change in 2009. This Policy serves as the framework for the government, industry and community to address climate change.

At COP21 held in Paris in 2015, Malaysia pledged to reduce its GHG emissions intensity of GDP by 45 per cent by 2030 using as a baseline the country's level of emission in 2005. This consists of 35 per cent on an unconditional basis: a further 10 per cent is conditional upon receipt of climate finance, technology transfer and capacity building from developed countries. At COP21, Malaysia also reiterated its commitment to maintain at least 50 per cent of the country under forest cover.

In 2014, the GHG emission intensity per unit of GDP, after taking into account Land Use, Land-Use Change and Forestry (LULUCF) emissions, has improved by approximately 27 per cent compared with 2005 levels. With the inclusion of removals by LULUCF, the GHG emission intensity per unit GDP had improved 33 per cent by 2014 compared with 2005 levels (MESTECC, 2018).

Malaysia's National GHG balance

According to Malaysia's Initial NC, Malaysian GHG emissions totalled 144 million tonnes (MT) CO_2e in 1994. Net emissions after accounting for the absorption of 68 MT CO_2e amounted to 76 MT CO_2e (MOSTE, 2000). Malaysia was one of the first countries in the world to submit the National Communication to UNFCCC in 2000. Malaysia's experience then revealed that some of IPCC's methodologies needed to be refined to suit local conditions. There was also a need for appropriate databases in the country so that a realistic estimate of the GHG balance inventory can be made.

In 2000, the GHG inventory for Malaysia showed that the country was a net CO_2 sink absorbing 26.8 MT CO_2e. The total emission was 223.0 MT CO_2e and the total sink was 249.8 MTCO_2e (NRE,2000).

The GHG emissions for the country have since gone up with time. According to NC3, Malaysia was a net carbon source with a net GHG emission of 50 479 Gg CO_2e in 2014 (MESTECC, 2018).

CAPPING GLOBAL WARMING AT 1.5°C

Projections by using GCMs showed that global temperature could go to as high as 4°C with business-as-usual activities. At COP21 held in Paris in 2015, the Paris Agreement adopted by 195 nations agreed to limit the temperature increase to 1.5°C above pre-industrial levels. The "Special Report on Global Warming of 1.5°C" or SR1 was published by IPCC in 2018 (IPCC, 2018) and showed that putting a cap to climate change not to exceed 1.5°C is possible. However, this will require global net human-caused emissions of CO_2 to fall by about 45 per cent from 2010 levels by 2030, reaching 'net zero' around 2050.

For this to happen, the world needs to engage in low carbon development activities (Lutken *et al.*, 2010) to reduce its carbon footprint. The replacement of use of fossil fuel

with renewable energy from solar, wind and biofuel sources is a step in this direction. Since the use of fossil fuel for transportation and industrial use is the biggest contributor to global warming, progressive countries such as United States and European Union have dedicated programmes to use renewable energy, with the use of biofuels being one of the forms of renewable energy. Malaysia has a similar Biodiesel Programme, whereby palm oil biodiesel substitutes fossil fuel in transportation. The B20 biodiesel programme whereby 20 per cent of the fuel is palm oil biodiesel and 80 per cent is petroleum diesel was launched in February 2020 (Malay Mail, 2020).

CONCLUSIONS

Climate change is happening in the world today. The changes are happening gradually and may not be felt immediately but over a period of time the effect may be seen. If atmospheric temperature is taken as an example, it has increased by 0.84°C when compared to the last century. Similarly, sea level has risen by an average of 19 cm between 1901 and 2010.

Human activities have contributed greatly to hasten the process by generating three primary GHGs, namely CO_2, CH_4 and N_2O. These gases have produced a greenhouse effect and caused the earth to warm up due to the trapped heat in the earth's atmosphere. Associated with this process of global warming, icebergs at the polar zones and snow covers are melting triggering a sea level rise which, in turn, causes lowlands to be flooded and leading to some parts near the sea shore to be inundated with sea water. Violent gyrations of weather patterns are also a feature of the changing climate.

All these changes threaten to wreck havoc on life on earth and affect all life forms. The future of different species may be compromised, causing them to migrate or face extinction if they cannot adapt to the changing climate or the changing geographical landscape.

The United Nations and World Meteorological Organisation have set up an organisation called IPCC to assess the science and impacts on climate change. UNFCCC's annual assemblies called COP set future directions and monitor progress on actions taken to address climate change. Malaysia is a signatory to UNFCCC global climate treaty and is playing her part to address climate change.

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