International Journal of Malay-Nusantara Studies,
Vol. 1, No. 2, Nov. 2018.
e-ISSN 2621-2951
p-ISSN 2620-9578

Page

55-77

CLIMATE CHANGE SCENARIOS IN MALAYSIA: ENGAGING THE PUBLIC

Haliza Abdul Rahman
dr.haliza@upm.edu.my

Department of Environmental & Occupational Health,
Faculty of Medicine and Health Sciences,
University Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.

ABSTRACT: *Introduction: Climate change are any change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable periods. Climate change has become a global environmental issue which dominates the international agenda and one of the most challenging issues for mankind.Research methodology: This paper involved with secondary data which are collected from journal, proceedings, books and internet sources regarding the topic. Result and discussion: Malaysia could be considered as a free zone from climate related disaster. However, mild climate related disasters are quite frequent to happen lately. The potential impacts of climate change in the Malaysian context would include sea level rise, reduced crop yields, greater diseases among forest species and biodiversity loss, erosion of shorelines, increased flood intensities, coral reef bleaching, increased incidences of disease, tidal inundation of coastal areas, decreased water availability, loss of biodiversity, and more droughts. To tackle the scenarios, Malaysia adopts 'precautionary principles' to mitigate and adapt to climate change. However, the important and immediate action needed in mitigating the climate change effects is the actively participating and involving the public in this issue.Conclusion: Malaysia has made significant progress in setting up legal framework for the implementation of climate change mitigation and voluntary environmental disclosure. Improving education, training and public awareness on climate change is an important measure for persuading the whole of society to jointly participate in activities for the mitigation of an adaptation to climate change.*

Keywords: Climate Change, Scenarios, Malaysia, Mitigate, Public Participating and Involving

Climate change results from increased of greenhouse gases (GHGs) in the atmosphere. Carbon dioxide concentrations in the atmosphere have risen one third since the industrial revolution and are set to double in the next 100 years (IPCC, 2007).

Climate Change can be defined as the changes in the state of a climate that can be identified (e.g. using statistical test) by changes in the mean and/or the variability of its properties, and that persist for an extended period, typically decades or longer (IPCC, 2007). According to UNFCC (1992), climate change are any change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable periods. Globally so many places have reported forecasting the gradual warming of the planet, with an increase in the global temperature of 1.8-4.0^{0}C (average 3.0^{0}C) during the next century (IPCC, 2007). For Malaysia, the effect of climate change and global warming is real, and cannot be viewed lightly. Hence, these issues should be taken seriously by all parties in ensuring that human environment is not affected by it. The government, non-governmental organisation (NGOs) and the public should take initiatives to enhance their awareness about the factors that lead to climate change.

The Intergovernmental Panel on Climate Change (IPCC) confirms that the global average surface temperature shows a warming of about 0.85^{0}C over the period of 1880 to 2012 (IPCC, 2013). Additionally, with the continued emission of greenhouse gases at the year 2000 levels, a further warming of about 1^{0}C per decade would be expected. The World Meteorological Organization (WMO), reported that 2011-2015 have been the warmest five-year period on record with many extreme weather events especially heat waves which are influenced by climate change (WMO, 2012). Furthermore, currently, each of the first six months of 2016 set a record as the warmest respective month globally in the modern temperature record, which dates to 1880 (NASA, 2016).

In 2007, the IPCC's Fourth Assessment Report (AR4) confirmed that "warming of the climate system is unequivocal" and changes in climate will have effects on the natural and human systems. Some of the major observed changes include increases in global average air and ocean temperatures, decreases in snow and ice extents, declining mountain glaciers and snow cover and increases in sea level. Observation data points to the fact that climate change has caused more frequency and intensity of extreme weather events, such as increased intensity of tropical cyclone activity, more hot days, hot nights and heat waves and more heavy precipitation. Numerous other changes are also suggested, including climate change effects on terrestrial, marine and freshwater biological systems, and impact on human health caused by excess heat, and changes in infectious disease vectors (Rayanakorn, 2011).

Thus, climate change has become a global environmental issue which dominates the international agenda and one of the most challenging issues for mankind. The challenges posed by this highly complex phenomenon will affect a large number of people in the present and future, especially who are a most vulnerable but have less capacity to adapt and respond to climate risks.Human activities are transforming the world, it is now accepted that climate change has been caused by concentration of greenhouse gases in the atmosphere due to human activities.

The effects of climate damage can be found in all parts of the world and no country is immune from the impacts of climate change. The expected changes shall be reflected in higher temperatures, widespread changes in precipitation patterns, increased risk of drought, rising ocean levels, and increased frequency of bad weather. Furthermore, the projected increase in atmospheric concentration of climate-related greenhouse gases would likely change the balance of seasonal variation of temperature in most parts of the world, which is expected to increase the danger faced by human civilization in years to come (McNutt, 2015; Schuur et al., 2013).

In climate change issue, Malaysia is the fourth largest emitter of greenhouse gases in ASEAN, behind Indonesia, Vietnam and Thailand, contributing to 0.52% of the world's carbon emissions. Malaysia is projected to cut another 32 million tonnes from its carbon emissions by 2020. Furthermore, Malaysia pledged to cut greenhouse emissions by 45% by 2030 and have already introduced measures to do so like the developing new cities to be carbon neutral, giving tax incentives to companies that report and limit their emissions, procuring more environmentally-friendly Government assets and planting 13 million new trees since 2011 (The Star, 19 September 2016). Generally over the years, Malaysia had adopted "precautionary principle" policies with actions to mitigate or adapt to climate change.

RESEARCH METHODOLOGY

This paper involved with secondary data which are collected from journal, proceedings, books and internet sources regarding the topic.

RESULT AND DISCUSSION

i) Scenarios and Some Effectsof Climate Changein Malaysia

The climate of Malaysia is tropical and humid. It is very much influenced by the mountainous topography and complex land-sea interactions. Malaysia could be considered as a free zone from climate related disaster. However, mild climate related disasters are quite frequent to happen lately. These refer to the occurrence of floods and droughts that caused significant socio-economic impacts to the nation while the occurrence of landslides due to excessive rainfall and strong winds happened at the hilly and the latter, at the coastal areas caused minimal damage. In Malaysia, forecast have been made on climate modeling using 14 GCM's (Global Climate Models) which shows that Malaysia could experience temperature changes from 0.7 to 2.6 degree Celsius and precipitation changes ranging from -30% to 30% (www.met.gov.my/.../metmalaysia/.../socioeconomic impactsofextremeweatherandclimate)

The direct impact of climate change can be seen in the degradation of natural resources, infrastructure and environment, and health facing humans. Also, there are certain indirect damages, which are projected to be serious as well (Al-Amin and Leal Filho, 2014). The potential impacts of climate change in the Malaysian context would include sea level rise, reduced crop yields, greater diseases among forest species and biodiversity loss, erosion of shorelines, increased flood intensities, coral reef bleaching, increased incidences of disease, tidal inundation of coastal areas, decreased water availability, loss of biodiversity, and more droughts, among other things (Haliza, 2009).

1) Temperature – Unlike the global mean temperature that exhibits significant increases in the early and late 20^{th} century and slight cooling in the middle of the century, the annual mean temperature in the most of the southern Asian region has been steadily rising in the past 100 years (Folland et al., 2001). One of the most significant climate change phenomena is the continuing decrease in the diurnal temperature range (DTR). Due to the larger rise in the daily minimum temperature over the daily maximum temperature.

Malaysia relatively has uniform temperatures throughout the year with mean temperature in the lowlands ranges between 26°C and 28°C. Although the annual variation of the daily mean temperature may be small which about 2°C to 3°C, the diurnal variation may be as large as 12°C. By 2050, projections show that Malaysia's going to be hotter with a temperature rise of up to 1.5°C. (http://www.adb.org/water/champions/zakaria.asp).

Higher temperature increases are recorded in Peninsular Malaysia compared to East Malaysia when comparing the long term means obtained for 1961- 1990 and 1998-2007. An average temperature increase of 0.5°C to 1.5°C is recorded in Peninsular Malaysia and 0.5°C to 1.0°C in East Malaysia. Western Peninsular Malaysia experiences more significant rise in temperature when compared to other regions in Malaysia (Malaysian Meteorological Department, 2009).

2) Heavy rainfall – Torrential rain often causes floods and landslides and results in natural disasters. One of the major focuses of climate change study is to understand whether there is a change in the occurrence frequency and strength of heavy rainfall events. Due to the limited of data, detailed analysis can only be done for the last few decades. Manton et al (2001) detected the overall decreasing trend in number of rainy days (with at least 2 mm of rain) in Southeast Asia from 1961-1998.Malaysia also expect more rainfall extremes— intense rainfall in the wet period and a lack of rainfall in the dry period. This would lead to higher high flows, meaning more severe floods, and lower low flows, meaning longer droughts.In fact, the rapidly changing weather patterns and climate variability in the region and in the country proper have already seen Malaysians suffer from recent major flood events in December 2006 and January 2007 which badly affected the southern state of Johore in Peninsular Malaysia (Haliza, 2009).

Comparing the seasonal rainfall trend in 1961-1990 with those in 1998-2007, East Malaysia shows an increasing trend as opposed to the decreasing trend in Peninsular Malaysia. Most regions in East Malaysia experienced an increase of up to 100 mm in rainfall during the two periods. Highest increase in rainfall between the periods was up to 200 mm recorded in south-east Sabah. Sabah experiences lesser rainfall than Sarawak In details, west coast of Peninsular Malaysia has an increase of 6 - 10 % in rainfall amount, whereas a decrease of 4 – 6 of rainfall amount over central Pahang and coastal Kelantan. As for East Malaysia, Sarawak has an increase of 6 – 10 % in rainfall amount and Sabah has an increase of more than 10% (Malaysian Meteorological Department, 2009).

More rainfall is simulated during the last decade (2090 – 2099) for the whole country compared to the first quarter (2020 – 2029) and middle (2050 – 2059) of the century. Rainfall amount seems to be increasing throughout Malaysia. Higher increase in rainfall is simulated for Peninsular Malaysia compared to East Malaysia during 2090 - 2099. During 2020 – 2029 it was the reverse with higher negative anomalies recorded in Peninsular Malaysia

compared to East Malaysia, with the exception of East Sabah. Highest rainfall is simulated towards the end of the century for Southern Peninsular Malaysia, followed by Western Sarawak and Central Peninsular Malaysia. Least rainfall increase is simulated in Sabah with East Sabah recording a negative anomaly during 2090 – 2099 compared to the rest of the regions in Malaysia Least increase in rainfall is simulated for North-east Peninsular Malaysia compared to the rest of Peninsular Malaysia and Sarawak (Malaysian Meteorological Department, 2009).

3) Human health – Climate change affects human health through a range of direct or indirect exposures. Directly through extreme events of fire, flooding and heat waves, while indirectly when climate affects some environmental parameters (Hanna and Spickett, 2011). Heat stress due to high temperature and humidity is an environmental and occupational hazard that can lead to chronic illnesses and even death, from the after effects of heat stroke (Adelakun et al., 1999). Working in hot environment increases the risk of health problems and the ability to perform work task, this increases accident risk and if prolonged lead to heat exhaustion or even heat stroke (IPCC 2007). Climate change poses serious implications for environmental, occupational health and safety. The effect of heat stroke is susceptible to both outdoor and indoor workers (Shanks and Papworth, 2001).

In Malaysia, very little work has been done on projecting potential impacts of climate change on health burdens. Hence, a direct impact could be deaths due to heat stress or respiratory diseases due to air pollution, while indirect effects could include increased food and water-borne diseases, resulting from changes in rainfall pattern. An Institute for Medical Research (IMR) model shows that high rainfall is required for high transmission of dengue. There could be an increase in vector-borne disease – such as malaria and dengue fever – as changes in temperature will increase the availability of suitable breeding habitats for the vectors. For example, between Jan 1 and Aug 20 2016, a total of 71,590 dengue cases were reported in Malaysia with 162 deaths. The bulk of the cases were in the states of Selangor, Kelantan, Johor and Kuala Lumpur. Climate change would

have a direct effect on vector distribution and consequently in diseases, such as, dengue, malaria, filariasis and Japanese encephalitis (JE) as well. Water-borne diseases are also concentrated in the tropical and subtropical regions of the world. Food and water-borne diseases are due to indirect health effects of a changing climate. These include: (i) diarrhoeal diseases caused by a variety of organisms (such as, Escherichia coli, Vibrio cholera, salmonellae and viruses), (ii) other viral diseases (such as, hepatitis A and poliomyelitis) and (iii) protozoan diseases (such as giardiasis and amoebic dysentery). Climate and seasonality are important determinants in the incidence of air-borne diseases, such as, asthma, and other respiratory infections.

4) Coastal areas – Coastal zones are particularly vulnerable to climate variability and change. Key concerns include sea level rise, land loss, changes in maritime storms and flooding, responses to sea level rise and implications for water resources. Sea level is rising around the world. In the last century, sea level rose 5 to 6 inches more than the global average along the Mid-Atlantic and Gulf Coasts, because coastal lands there are subsiding. Higher temperatures are expected to further raise sea level expanding ocean water, melting mountain glaciers and small ice caps, and causing portions of Greenland and the Antarctic ice sheets to melt. The IPCC estimates that the global average sea level will rise between 0.6 and 2 feet (0.18 to 0.59 meters) in the next century (IPCC, 2007).

The coastal areas are continuously put at risk because of the projected increase in siltation due to soil erosion. Serious soil erosion in degraded forest lands and watershed areas is expected to occur with projected increase in precipitation, especially during the wet season. Silted coastal areas will reduce seagrass beds and coral reefs, which are important components in maintaining diversity in coastal waters. Moreover, coral reefs will be adversely affected by sea level rise due to increase in water depth. Higher sea level will reduce the amount of light reaching the bottom of the sea where the corals are located Mangrove forests, habitats for numerous coastal organisms, would be severely affected by

future changes in rainfall pattern, runoff, salinity and sediment deposition. Reduction of mangrove forests will likely affect the biodiversity of coastal species (Florencia and Rodel, 2010).

Moreover, climate change can lead to frequent occurrence of El Nino events and affect ocean currents, sea level, sea water temperature, salinity, wind speed and direction, strength of upwelling, the mixing layer thickness and predator response. These impacts would significantly affect breeding habitats and food supply for fish production (IPCC 2001). The distribution of estuarine flora and existing habitat will likewise be altered because of the projected increased occurrence of extreme climatic events (Cruz et al., 2007).

The impact on coastal resources in Malaysia can be classified into four broad categories. The first is tidal inundation, where about 1200 km^2 in Peninsular Malaysia alone will be submerged subsequent to bund failure, and mangroves will be lost if sea level rises at a rate of 0.9 cm/year. The second is shoreline retreat. The third is increased wave action which can affect the structural integrity of coastal facilities and installations such as power plants. The last is saline intrusion, which can pose a potential threat of water contamination at water abstraction points. Examples of other impacts include submerged of corals, coral bleaching due to increasing levels of CO^2 in the water, and depletion of fisheries resources due to loss of mangrove habitats.

5) Sea level rise - Changes in sea level have traditionally been measured. Sea level change is of great interest for two fundamental reasons. First, changes in the rate of sea level rise are intimately related to changes in the Earth's climate. Second, sea level change has important socioeconomic consequences for populations living near the current mean sea level (A. Cazenave andR. S. Nerem 2004). According to Nerem and Mitchum (2001), it is confirmed that globally the sea level has risen during the 20th century and it is still going on. The main driver is global temperature change (global warming phenomenon). According to Dasgupta et al. (2007), three main factors contributing to the rising seas are:

ocean thermal expansion; melting of the Greenland and Antarctica glacier and ice sheets; and changes in terrestrial storage, with ocean thermal expansion as the dominant factor. There are several possible negative impacts of sea level rise to coastal environment in the future such as beach erosion, inundation of land, increased flood and storm damage, increased salinity of coastal aquifers and coastal ecosystem loss. Therefore, an understanding of past and future changes in sea level and related ocean are important in coastal management.

Naeije et al. (2008) was studied almost 17 years sea level change, the study came out with the analysis of the global mean sea level rise at the rate of 2.53 mm/year. Although the global prediction for sea level rise is about 1.7 – 3.1 mm/year, the regional sea level rise in Malaysia is expected to be higher, owing to local climate and topographical conditions. Total land area of Malaysia are 329 733 km2, however most coastal regions are low-lying areas that are less than 0.5 m above the highest tide or are within 100 m inland of the high-water mark. These areas are especially vulnerable to rises in sea level. Sea level rise was estimated ranging from 1.5 to 8.9 mm/year using two decades of tide gauges observations along the coast of Malaysia.Studied by Ami Hassan et al (2012) in order to investigate sea level rise for the Malaysian seas found, the trends for tide gauge stations in Malaysia all show positive values, indicating an overall rise in the sea level around the coast of Malaysia. They established that sea level has been rising at a rate of 0.1 to 3.5 mm/yr at tide gauge stations.

In details, The Study of the Impact of Climate Change on Sea Level Rise in Malaysia (NAHRIM 2010) was carried out in 2010, to project SLR in the Malaysian coast for the year 2100. Using linear trend analysis, satellite altimetry data (1993 – 2010) from 30 stations around Malaysiawere analysed to obtain the rate of SLR for Malaysia.The results showed that (NAHRIM 2010): (i) There is a significant increase in SLR trend over the recent 5 years, compared to the SLR trend over 20 years ago; (ii) The observed Mean SLR rate along the Malaysian coast (based on satellite altimetry data from 1993 – 2010) is between 2.7 – 7.0

mm/yr.; (iii) In Peninsular Malaysia, the projected SLR for the year 2100 is 0.25 – 0.5 m with the maximum value occurring in low-lying areas along the Northeast and West coast of the peninsular (Kelantan and Kedah); (iv) In Sabah, the projected SLR for the year 2100 is 0.69 – 1.06 m with the maximum value occurring in low-lying areas, river mouths and estuaries in the East coast (Tawau, Semporna, LahadDatu, Sandakan and Kudat); and (v) In Sarawak, the projected SLR for the year 2100 is 0.43 – 0.64 m with maximum value occur in low lying areas, river mouths and estuaries in the Southwest coast (Meradong, located between BatangIgan and Batang Rajang).

Low lying areas with high population and socio-economic activities are at risk of being inundated. Malaysia has a long shoreline with most of the cities located near the coast, and National Hydraulic Research Institute of Malaysia (NAHRIM) has carried out a number of studies as our preparation to face global warming issues in terms of projections for sea level rise in Malaysia, and production of Potential Sea Level Rise (SLR) Inundation Maps and Coastal Vulnerability Assessments for high risk areas as a guide for planning and implementation agencies in their development and adaptation planning to avoidmassive development in critical areas (Nor Aslinda and Mohd Radzi,2013).

6) Biodiversity – Climate change also affects many sectors, such as rivers, ponds, swamps and forests through changes in temperature, water levels and flows. Occurrence of flood will also increase with decreasing forests (Nguyen et al., 2010). Thus, climate change certainly has several impacts on biodiversity-from ecosystem to species levels. The increase of temperature and rise in sea levels would affect ecosystem boundaries, thereby allowing some ecosystems to expand into new areas, while others are diminishing in size. Climate change, however, increases extinction rates, and threats to the survival of many species than the destruction of their natural habitats (Nguyen et al., 2010).

The impacts of climate change, relative to other threats to biodiversity, would vary from one region to another (Gitay et al., 2002). The impacts that

floods, sea level rise, and changes in climate are likely to have on natural habitats means that some protected areas may no longer be appropriate for the species that they were designed to conserve (Thomas et al., 2004). The IPCC Fourth Assessment Report (Cruz et al., 2007) projects that up to 50 per cent of Asia's total biodiversity is at risk due to climate change. Moreover, IPCC reviewed relevant published studies of biological systems and concluded that 20 percent to 30 percent of species assessed may be at risk of extinction from climate change impacts within this century if global mean temperatures exceed 2-3 °C relative to pre-industrial levels (IPCC, 2007). Though evidence of climate change-related biodiversity loss in Asia remains limited, a large number of plant and animal species are reportedly moving to higher latitudes and altitudes as a consequence of observed climate change impacts in many parts of Asia in recent years (Yoshio and Ishii, 2001, IUCN, 2003).

While Malaysia has only 0.2% of the worlds land mass, its diversity of flora and fauna species makes it one of the richest countries in the world in terms of biodiversity per unit area, second only to Indonesia in South East Asia. The 2001 Global Diversity Outlook recognised Malaysia as one of the 12 mega-diversity countries in the world. Thus, the impact of climate change on Malaysia's rich biodiversity is also of great concern, where, with the intricate interrelationships between plant and animal species, the impact on any one species can have consequences for other species as well. Climate change and biodiversity degradation would bring additional stresses to Malaysia which classified as mega diversity region. The reason is, climate change would result in higher temperature which consequently affects many ecosystem structures, i.e. decrease in the number of species in coastal ecosystems, changes in the species' living environment – from low zones and latitudes to higher one, changes in the structure of food chain and net.

7) Land cover change –In general, forests are sensitive to climatic variability and change. Climatic factors that influence forest health-temperature, rainfall,

atmospheric levels of carbon dioxide (CO2) and other greenhouse gases and extreme weather and fire events—are changing and are expected to continue changing due to human activities. The following climate factors are likely to play an important role in determining future forest conditions (IPCC, 2007):

- Air temperature
- Precipitation amount and seasonal distribution
- Atmospheric CO2 concentrations
- Frequency and severity of wildfire events
- Climatic variability and the frequency and severity of extreme events
- Indirect effects on pollution levels such as tropospheric ozone.

The forest's response to climate change is biologically complex. The effects are not quickly observed. Forests, however, are more vulnerable to land use than to climate change. Upland forest can be expected to expand by 5% to 8% but this could be nullified by a loss of between 15% and 20% of mangrove forests located along the coast as a result of sea level rise. Disease infestation on forest plantation species may be aggravated by climate change (Haliza, 2009).

8) Water Resources and Water Availability -All regions of the world show an overall net negative impact of climate change on water resources and freshwater ecosystems. Areas in which runoff is projected to decline are likely to face a reduction in the value of the services provided by water resources. The beneficial impacts of increased annual runoff in other areas are likely to be tempered in some areas by negative effects of increased precipitation variability and seasonal runoff shifts on water supply, water quality and flood risks (IPCC, 2007).

Climate change will have an impact on water availability (surface runoff). For a 1^0C increase in temperature, in general, there is an increase in the potential evapotranspiration (PET) of between 3% and 9%, that is about 90 mm additional loss of moisture on the average per annum. For a 1^0C temperature increase, the PET is expected to rise to a range of 9% to 13%, which represents potentially about 170 mm of extra moisture loss. With temperature increases of 10C and 30C,

the reductions in long term average monthly runoff during wet months are found to be relatively low, ranging between 1% and 5% and between 2% and 17%, respectively. During the dry periods, the ranges for 1^0C and 3^0C scenarios are between 1% and 16% and between 1% and 24%, respectively. In the case of a reduction in rainfall (10%) in combination with temperature rise (1^0C and 3^0C), the impact of rainfall reduction on runoff rates is found to be much more pronounced than that due to temperature rise. When rainfall totals are reduced by 10% across the whole time series, the corresponding, decrease in runoff production reduces by an amount of between 12% and 31% during wet months. During dry months the reduction ranges from 13% to 38%. For the case of combined effects with 30C rise in temperature, the reductions in runoff ranges from 13% to 48% and from 17% to 53% during wet and dry months, respectively. Given the likely significant reductions in surface runoff as a result of climate change, the nation's water resources have to be carefully managed (Haliza, 2009).

Climate change is likely to increase both the number and magnitude of hydrological extremes, namely floods and droughts. In Malaysia, Nahrim study on Extension Study of the Impact of Climate Change on the Hydrologic Regime and Water Resources of Peninsular Malaysia on streamflow of 11 watersheds in Peninsular Malaysia showed, there would be water supply issues in the future, especially in areas with higher risk or vulnerability, such as in the Muda watershed in Kedah and small basins like Linggi. Furthermore, drought or reservoir storage analysis based on 15 climate change scenarios, or projections, in Bekok Dam shows that there will be several critical drawdown periods from 2010 to 2100.

9) Crops – Weather plays a major role in determining crops yield. Environmental stressors such as drought, high temperature and air pollution are major limiting factors to crop productivity in the tropics (Ariffin et al., 2003). Agriculture in Malaysia contributes about 3.6% of GNP and at least a third of the country's population depends to the agriculture sector for their livelihood. Thus,

significant climate change definitely affects the agriculture sector in term of production as well as the impacting socio economics problem to the people involved in the sector and the nation as a whole.

In Malaysia, at least one third of the country's population depends on the agriculture sector for their livelihood, with some 14% working in farms and plantations. From the land use perspective, about 39.2% of total land use or about 5.18 million hectares are planted with tree crops like rubber, oil palm, cocoa, coconut, fruits and vegetables.

(www.met.gov.my/.../metmalaysia/.../socioeconomicimpactsofextremeweatherandclimate).

Physical damage, loss of crop harvest, drop in productivity, vigor and others related to crop potentials are examples of direct and indirect effect of the extreme climate change. The impact of climatic stresses on crop productivity does affect agriculture industry in Malaysia. Meanwhile, the rising in sea level due to climate change could force the abandoning of low-lying planted areas such as paddy, corn, coconut and others.

Based on agricultural cycle, increasing in rainfall is not good for rubber. Rubber plantations could suffer due to loss of tapping days and crop washouts. Some crops like oil palm could flourish with higher rainfall. However, excessive rainfall is detrimental as yield is significantly affected. It was reported that flood related problems in southern Malaysia had decreased the production of crude palm oil to 1.1 million metric ton or 26.3% in December 2006.

(www.met.gov.my/.../metmalaysia/.../socioeconomicimpactsofextremeweatherandclimate).

Study by Zabawi et al (2010), stated that if rainfall or temperature increased by 15%, rice yield will fall by 80%. According to Singh et al (1996), rice production in Malaysia ranged from 3-5 MT per hectare, whereas the average potential yield was 7.2 MT per hectare However due to climate change, rice yield declined on a range of 4.6-6.1% if the temperature increased by 1%. Hence it will

be the threat to national food security and the economic contribution from the agricultural sector.

Furthermore, occurrence of disaster due extreme climate change such as floods, could impact damaging effect on the economy, social and psychology of the people affected. Recent floods in Johor (2007) had displaced 110,000 people, damaging an estimate of RM 0.35 billion worth of infrastructures and RM 2.4 billion of economics losses. An estimate of RM 84 million worth of agriculture produce were damaged or losses affecting 7000 farmers .
(www.met.gov.my/.../metmalaysia/.../socioeconomicimpactsofextremeweatherand climate).

ii) Climate Change Mitigation

Climate change mitigation is a challenge faced by most nations of the world. Climate change control approach is divided into two, 'hard' measures and 'soft' measures. 'Hard' measures involve high capital engineering and building of climate-friendly structures, which require high budgetary input. 'Soft' measures involve ecosystem-based adaptation (EbA), which is cost effective by maintaining existing natural ecosystem structures and improve ecosystem services (Huq, Renaud, &Sebesvari, n.d.). Mitigation measures, adaptation practices and change in consumption patterns are three important tools to be adopted to do away with the sufferance of the people posed by climate change.

In Malaysia, the cumulative cost of climatic damage without climate control policies over the period of 2010–2110 amounts to MYR40.1 trillion (Rasiah et al., 2017). Thus, the most important things need to be focused to mitigate the climate change impacts are to bridging the gap between the climate change mitigation or adaptation and development activities. Proper policy relevant adaptive framework to climate change, networking and communication among stakeholders and policy makers is extremely needed as well.
On top of that, the Community Based Adaptation (CBA) is an important component of the larger picture of management and avoidance of Climate Change

impacts and pressures by local people. It provides information and concrete examples on potential impacts of climate change and mitigative measures which are location specific and community managed. CBA also provides information needs which can be shared and replicated in an appropriate format and manner acceptable by communities. The need for information on adaptation by incorporating and building upon existing coping strategies of communities can be articulated and demonstrated through CBA projects. Therefore, it is very crucial to develop capacity of local communities and improve their livelihoods, empowering them to become more resilient to severe climate events and variability.Furthermore, by mapping the effects of climate change, awareness of communities on the issue of climate change can be enhanced through workshops, seminars and training continuously.

iii) Engaging The Public

The IPCC recently stated that climate change poses many threats to humankind and it is essential for governments and the public to plan and commence action for protection from a significantly changed climate. However, as the risks posed by anthropogenic climate changehave become increasingly well documented,the urgency of engaging the public around theserisks has grown (Pidgeon and Fischhoff, 2011).At a general level, concern about climate change is highest in nations(e.g. Brazil, Bangladesh) that are likely to bemost vulnerable to its impacts (Brechin, 2010). Hence in Malaysia as well, it is requires a community engagement strategy as part of mitigating the climate change effects.

Climate change is not only affecting our environment but it is also expected to affect people's health. Impacts on human health will vary geographically, as a function both of environment and topography and also, of the vulnerability of the local population. Impacts on human health are predicted to be both positive and negative, although expert scientific reviews anticipate predominantly negative impacts (McMichael, 2003). In Asia, as in Africa, the main public health risk due to climate change and variability are malaria, dengue

and cholera. Thermal stress and air-pollution related illnesses also projected to occur in Asia.As the temperature of the climate increases, these diseases could become more frequent in many parts of Asia including Malaysia. A warmer climate will also cause direct effects on human health in this region due to heat waves (increasing incidence of heat stroke) (McMichael, 2003).Thus public must participate and involved actively in mitigating the climate change effects to human health and environment as well.

Participation is a fundamental human rights principle, documented in most human rights documents. With respect to environmental concerns, the Rio Document holds that "[e]environmental issues are best handled with the participation of all concerned citizens." This includes the responsibility of the state to ensure "appropriate access to information concerning the environment that is held by public authorities" (UN News Centre, 2014).The role of public as active agents in climate change mitigation especially to focus on local possibilities for action on climate change was brought to the foreground of climate change mitigation efforts following the failure of the international community to reach significant global agreements on the reduction of greenhouse gas emissions.

Thus, improving education, training and public awareness on climate change is an important measure for persuading the whole of society to jointly participate in activities for the mitigation of and adaptation to climate change. Chapter 36 of Agenda 21 States that "Both formal and non-formal education is indispensable to changing people's attitudes so that they have the capacity to assess and address their sustainable development concerns. It is also critical for achieving environmental and ethical awareness, values and attitudes, skills and behaviour consistent with sustainable development and for effective public participation in decision-making"(Rejoice, 2014).

The United Nations Framework Convention on Climate Change (UNFCCC) was signed by more than 150 countries at the Rio Earth Summit in

1992 and the convention took effect in 1994. The convention sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change.One of the commitments of the parties under the UNFCCC in Article 4 requires all parties to 'Promote and cooperate in education, training and publicawareness related to climate change and encourage the widest participation in this process, including that of non-governmental organisations;....'. To fulfil the commitments presented in Article 4, Article 6 of the same convention requires parties to develop and implement educational and public awareness programmes on climate change and its effects; promote and facilitate public access to information on climate change and its effects; as well as public participation in addressing climate change and its effects and developing adequate responses; and training of scientific, technical and managerial personnel. Improving education, training and public awareness on climate change is an important measure for influencing the whole of society to jointly participate in activities for the mitigation of and adaptation to climate change. Public education is necessary if negative and wrong perceptions about climate change are to be cleared to allow for the implementation of climate change mitigation and adaptation strategies (Rejoice, 2014).

Furthermore, the increasing of interactive media needed as well. Community advice identified that future engagement activities need to allow people to ask questions and share ideas on an ongoing basis. Therefore the use of interactive social media by government will be increased over time. The extensive networks, diverse communication tools and methods used will extend the 'reach' of current information on climate change into the community.

CONCLUSION

Malaysia adopts 'precautionary principles' to mitigate and adapt to climate change, even though there are still scientific uncertainties. Malaysia has made significant progress in setting up legal framework for the implementation of climate change mitigation and voluntary environmental disclosure. As example,

in 2010, Malaysia launched a National Policy on Climate Change to mainstream and to provide a framework for the country's various activities in this area. Moreover, the Government spent some RM51bil under the 10th Malaysia Plan (2011-2015) to "enhance resilience" against climate change.At the national level, Malaysia has formed a National Climate Committee to formulate and implement strategies on climate change. The strategies drawn include policies on energy usage, public awareness on climate change, food supply and effective forest and coastal management to mitigate deforestation and the rising of sea level. Apart from the national policies implemented, specific adaptation measures are necessary to manage sectoral impacts due to climate change.In global arena, Malaysia has sent its climate change action plan to the United Nations for the UN Climate Change Conference (COP21) in Paris. In a document Malaysia planned to reduce greenhouse gas emissions intensity by 45% by 2030.Among the key initiatives recently taken by the Malaysian government against global warming and climate change issue is the low carbon economy. All this action was taken in order to reduce the effects against climate change.

REFERENCES

A. Cazenave& R. S. Nerem. 2004.Present-day sea level Change: Observations and causes. *Reviews of Geophysic*.42(3), September 2004.RG3001, doi: 8755-1209/04/2003RG000139

Adelakun A, Schwartz E. &Blais L. 1999. Occupational Heat Exposure. *Appl. Occup. Environ Hyg*., 14(3):153–154.

Al-Amin, AQ, Leal Filho, W.2014. A return to prioritizing needs: adaptation or mitigation alternatives? *ProgDevel Stud*. 14:359–371.

Ami Hassan Md Din, KamaludinMohd Omar, Marc Naeije&SahrumSes.2 March 2012. Long-term sea level change in the Malaysian seas from multi-mission altimetry data.*International Journal of Physical Sciences,* 7(10): 1694 – 1712.

Ariffin T., Ariff T.M & Abdullah M.Y. 2002.*Stabilization of upland agriculture under El Nino induceclimatic risk: Impact, assessment and mitigation measures in Malaysia*. Working Paper No.61, Bogor, Indonesia: CGPRI Centre.

Brechin SR. 2010.Public opinion: a cross-national view. In: Lever-Tracy C, (ed.).*The Routledge Handbook of climate change and society*. London: Routledge.

Cruz, R, h. Harasawa, M.lal, S.Wu, Y. Anokhin, B. Punsalmaa, Y. Honda, M. Jafari, C. Li and N. HuuNinh. 2007. *Asia. Climate change 2007: Impacts, adaptation and vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.). United Kingdom: Cambridge University Press, Cambridge. 469-506.

Dasgupta, S., Laplante, B., Meisner, C., Wheeler, D. &Jianping, Y. 2007.*The impacts of sea level rise on developing countries: A comparative analysis.* World Bank Policy Research Working Paper 4136: 51 pp.

Florencia B. Pulhin&Rodel D. Lasco. 2010. Climate change and biodiversity in the Philippines: Potential Impacts and Adaptation Strategies.In Percy E.Sajise, MarlizaV.Ticsay and Gil C. Saguiguit, Jr. (Eds.), *Moving Forward: Southeast Asian Perspective on Climate Change and Biodiversity*. SEARCA Philippines and ISEAS Singapore.141-164.

Folland, C.K., T.R. Karl, J.R. Christy, R.A. Clarke, G.V. Gruza, J. Jouzel, M.E. Mann, J. Oerlemans, M.J. Salinger, and S.-W. Wang. 2001. Observed climate variability and change. In: *Climate Change 2001: The Scientific Basis.* Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change (Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J., Dai, X., Maskell, K. and Johnson, C.A. Eds.). Cambridge: Cambridge University Press. 99-181.

Haliza Abdul Rahman. 2009. Global climate change and its effects on human habitat and environment in Malaysia. *Malaysian Journal of Environmental Management*.UniversitiKebangsaan Malaysia Publisher.Vol.10(2): 19-42.

Hanna E &Spickett J. 2011. Climate change and health: Building Australia's adaptation capacity. *Asia Pacific Journal of Public Health,* 23(2): 7S-13S

http://www.adb.org/water/champions/zakaria.asp. (October 2007). *Adapting to climate change*.Retrieved 4 March 2017.Retrieved on 5 October 2017.

Huq, N., Renaud, F., &Sebesvari, Z. (n.d.). Ecosystem based adaptation (EbA) to climate Change - integrating actions to sustainable adaptation.

IPCC. 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. & Hanson, C.E. (eds.). Cambridge: Cambridge University Press.

IPCC. 2013. Fifth Assessment Report - Climate Change 2013. www.ipcc.ch/report/ar5/wg1/. Retrieved 28 February 2017.

IUCN.2003. Indus Delta, Pakistan: Economic Costs of Reduction in Freshwater Flows. Case Studies in Wetland Valuation No.5, Pakistan Country Office, Karachi, 6 pp.

McMichael, A.J. 2003."Climate change and human health."World Health Organization.1- 306. Retrieved from www.who/climatechange.com.Retrieved on March 15th, 2011.

Malaysian Meteorological Department.(2009). www.met.gov.my/documents/10661/194684/climate-scenarios.pdf/.Climate change scenarios for Malaysia (2001 – 2099).

McNutt M. 2015.The beyond-two-degree inferno.*Science*. 349:7–7

M.J. Manton, P.M. Della-Marta, M.R. Haylock, K.J. Hennessy, N. Nicholls, L.E. Chambers, D.A. Collins, G. Daw, A. Finet, D. Gunawan, K. Inape, H. Isobe, T.S. Kestin, P. Lefale, C.H. Leyu, T. Lwin, L. Maitrepierre, N. Ouprasitwong, C.M. Page, J. Pahalad, N. Plummer, M.J. Salinger, R. Suppiah, V.L. Tran, B. Trewin, I. Tibig, D. Yee. 2001. Trends in extreme daily rainfall and temperature in Southeast Asia and the South Pacific: 1961–1998**.** *Int. J. Climatol*., 21(3): 269–284.

Mustafa Kamal Baharuddin, Climate change – its effects on the agricultural sector in Malaysia.www.met.gov.my/.../metmalaysia/.../socioeconomicimpactsofe xtremeweatherandclimate. *National Seminar on Socio-Economic Impacts of Extreme Weather and Climate Change*, 21 -22 June 2007, Putrajaya.

NASA.2016. https://climate.nasa.gov/news/2465/2016-climate-trends-continue-to-break-records.2016 climate trends continue to break records - NASA Climate Change. Retrieved 15 February 2017.

Naeije, M., Scharroo, R., Doornbos, E. &Schrama, E. 2008. Global altimetry sea-level service: glass, NUSP-2 Report GO 52320 DEO, NIVR/DEOS, Netherlands. Nerem, R.S.

NAHRIM. 2010.*The Study of the impact of climate change on sea level rise in Malaysia* (Final Report), National Hydraulic Research Institute Malaysia: 172pp.

Nerem, RS &Mitchum, T. 2001.Sea level change. In: L.L. Fu, A. Cazenave (eds.) *Satellite altimetry and earth sciences: A handbook of techniques and applications*, Academic Press, San Diego, California.329-349.

Nerem, R.S. &Mitchum, G.T. 2002. Estimates of vertical crustal motion derived from differences of Topex/Toseidon and sea level measurement. *Geophys. Res. Lett*. 29: 1934.

Nguyen HuuNinh, Le ThiThuyet and Chao Thi Phuong Ly. 2010. The role of biodiversity in climate change mitigation in Vietnam: The Red River Estuary-Ba Latcase study. In Percy E.Sajise, MarlizaV.Ticsay and Gil C. Saguiguit, Jr (Eds.), *Moving Forward: Southeast Asian Perspective on*

Climate Change and Biodiversity. SEARCA Philippines and ISEAS Singapore. 181-208.

Nor AslindaAwang&MohdRadziAbd.Hamid. 2013. Sea level rise in Malaysia. *Hydrolink* number 2/2013: 47-49.

Pidgeon NF and Fischhoff B. 2011.The role of social and decision sciences in communicating uncertain climate risks.*Nat Climate Change*. 1:35–41.

Rasiah, R., Ahmed, A., Al-Amin, A.Q and Shanta Chenayah. 2017. Climate change mitigation: comparative assessment of Malaysian and ASEAN scenarios. Environmental Science and Pollution Research, January 2017, 24(3): 2632–2642.

Rayanakorn. K. 2011. Introduction.In Rayanakorn. K (ed.) *Climate Change Challenges in the Mekong Region*.Chiang Mai: Chiang Mai University Press: 1-7.

Rejoice Mandobi. 2014.The role of public awareness in climate change mitigation and adaptation in Zimbabwe. *International Journal of Science and Research*. 3(11): 1270-1275.

Schuur E et al. 2013 Expert assessment of vulnerability of permafrost carbon to climate change.*Climate Change*. 119:359–374.

Shanks, N. J., & Papworth, G. 2001.Environmental Factors and Heatstroke.*Occupational Medicine*, 51(1): 45-49.5

Singh S. Amartalingam R., Wan Harun W.S & Islam T. 1996. *Simulated impact of climate change on rice production in Peninsular Malaysia*. Proceedings at National Conference on Climate Change, University of Putra Malaysia, 41-49.

The STAR. 19 September 2016. Malaysia to ratify climate change accord soon.

UN News Centre. 2014. UN expert urges states to treat participation as 'fundamental human right.' Available at http://www.un.org/apps/news/story.asp?NewsID=45021&Cr=human+rights&Cr1=#.U4yuHy_BLxl.Sheffield PE, Durante KTE, Rahona C. Zarcadoolas/Health and Human Rights. 16(1):113–121.

WMO. 2012. WMO Statement on the Status of the Global Climate in 2012. www.wmo.int/pages/prog/wcp/wcdmp/documents/WMO_1108.pdf. Retrieved 25 February 2017.

Yoshio, Masanobu&Minoru Ishii.2001. Relationship between Cold Hardiness and Northward Invasion in the Great Mormon Butterfly, *Papilio Memnon, L*. (Lepidoptera: Papilionidae) in Japan. *Applied Entomology and Zoology*, 36: 329-335.

Zabawi M.A.G. 2012.*Impact of Climate Change on Rice and Adaptation Strategies*. Report submitted to the Economic and Planning Unit (EPU), Prime Minister Department, Putrajaya, Malaysia.