

# CLIMATE CHANGE AND ITS IMPLICATIONS ON POVERTY IN MALAYSIA

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## Abstract

Climate change would have a profound impact on the poor and on those who are categorized as low income earners by virtue of their unfixed economies which are barely enough to sustain their day to day expenses. Many of these poor people and those belonging to the low income group are involved with economic activities that are highly dependent on environmental conditions where climate is a major determinant. Climate change would affect environmental conditions and the sustainability of resource development associated with agriculture, fishing and informal sectors such as low income urban commerce. Regional climate change which is governed by the behavioural patterns of the Monsoons. El Nino-la Nina, Indian Ocean Dipole (IOD) and those associated with the Low Pressure Oceanic Cells (LPOC's) of the South China Seas and the Bay of Bengal would have significant effect on the behavioural pattern of Malaysia's climate and would thus influence environmental conditions in Malaysia and the economic activities practiced by the poor and the low income groups. Climate change would make the poor poorer and that low income group which are hovering just above the poverty threshold value to fall below the poverty line. An understanding of the changing behavioural patterns of the atmospheric-oceanic systems and land meteorological – hydrological processes and vulnerability indicators of the populations at risks is needed so as to devise adaptation strategies in the short and long terms under impending threat of climate change.

**Keywords** : climate change, poverty, drivers of climate change; vulnerability, adaptation

## Introduction

The turn of this new Millennium has witnessed a number of very significant and challenging threats to the global population (more so in the developing regions of the world) that have had severe impacts on human security issues (food, health and livelihood activities). The ongoing global financial meltdown and the impending threat of influenza A H1N1 viral pandemic shows how vulnerable human societies are. There are a number of overarching concerns to these threats and among these are the relationships between these threats and climate change and poverty. What is even more tantamount to these threats are the presence of multi-cause and effect linkages between climate change, threats and poverty as seen through the effects of climate change on environmental resources development and the sustenance of human economic activities (subsistence, traditional as well as modern economic systems) within an ever integrated global web of trade and movement of people and ideas (UNFCCC 2007, Khairulmaini 2003). Evidence has shown that climate change could have a profound effect on the onset, timing, duration, frequency and magnitude

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of hydro-meteorological events (such as that associated with the behavioral patterns of rainfall events within a particular locality/region) (World Meteorological Organisation 2007; Khairulmaini 2009; Khairulmaini et al.2009).

Changing hydro-meteorological behavioral patterns could influence, for example, the traditional rural economic practices of the highland and coastal – island regions of developing countries. Rural economies such as agriculture, fishing and the harvesting of forest products could be severely affected by changes in the local / regional climate and weather. In urban regions, certain informal economic sectors commonly associated with the urban poor and lower income groups could also be affected when the supply of raw resources used in such simple economic systems are affected by floods and other forms of changing urban climate and emerging weather anomalies. It can be argued that climate change is a security issue for some nation-states, communities and individuals. In the case of atoll-countries such as Tuvalu or Kiribati, for example, there is widespread agreement that climate change and associated sea-level rise threatens the long-term ability of people to remain living on their islands. In addition to this, for the Inuit communities living in the Arctic circle where snow cover is less predictable, thinner ice sheets restrict hunting; for families living on low-lying deltas in Bangladesh they are increasingly prone to flooding; for people living in the highlands of Papua New Guinea who are increasingly prone to diseases spread by mosquitoes due to changed temperature and rainfall regimes, climate change poses cultural, health, and life threatening risks (IPCC FAR, 2007a, 2007b, 2007c).

In Malaysia, the coastal regions of Northeast West Malaysia have been shown to be the most vulnerable to impact of climate change making livelihood activities of coastal communities there vulnerable (Khairulmaini et al. 2009; Fauza and Khairulmaini, 2008). The failure of the Kyoto Protocol to reduce green house gases emissions may spell the end of the habitability of atoll-countries and the displacement of their peoples. In addition to this there is the problem of internal and international refugees that would affect the stability of social systems and structures of the receiving region and countries. Large migrations could be the consequence of climate change. In the first instance it will be climatic extremes and increasing climate variability that will enhance migration as soils are degraded, economic systems fail, food production fail, water supplies are contaminated and depleted, housing, livestock and infrastructure are damaged, insurance costs rise, and human comfort, health and livelihood activities are compromised (Parry et al. 1998; Homer-Dixon 1999). Communities generally adapt and are resilient to extreme events. However, as climate becomes increasingly variable extreme events may become more frequent and severe, and this may stretch the limits of adaptability and resilience, especially among the poor and lower income population whose livelihood activities centres around traditional economic systems, making migration an attractive, if not the only option. Sea-level rise, for example, is very likely to induce large scale migration in the longer-term.

According to Nicholls *et al.* (1999) by 2080 the flood risk for people living on islands will be 200 times greater than in a situation where there was no global warming. The recent exodus and influx of global migration from Asia and Eastern Europe to Australia attests to the internal situations of these regions to the potential climate change threat there amidst internal economic and political conditions. Therefore, to avoid climate-induced migration and the subsequently enhanced risk of tension and violent conflict, slowing the rate and ultimately reducing the amount of greenhouse gas emissions, as well as

enhancing adaptive capacity to extreme weather events is essential (Homer-Dixon et al. 1998). It is likely that for social-ecological systems that are highly sensitive to climate change existing avenues of migration be explored first. In developing countries planning for enhanced internal migration and international immigration is required given that they are more vulnerable to the impacts of climate change and most existing migration is within and between developing countries (Findley 1994). For example, many of the 5.5 million people living on the Ganges Delta in Bangladesh who will be forced to relocate with a 45cm rise in sea-level may seek to move inland within Bangladesh, but a significant number may seek to move to neighboring India and Pakistan – and previous migration of this kind has been a factor in violence and conflict in the region (Khairulmaini 2008a and 2008b).

Existing patterns of ‘environmental refugees’ may also be indicative of the places from where climate migrants might emerge as these represent movements from areas already under environmental stress, and possibly under increasing stress due to climate change. The IPCC suggests that the most sensitive natural systems to climate change are: coral reefs, mangroves, boreal and tropical forests, polar and alpine ecosystems, prairie wetlands, and remnant native grasslands (IPCC 2007a). Climate change may affect scarcities of renewable environmental resources in these regions, which in most cases are the homes of traditional economic systems associated with the poor and the lower income groups. Human systems that are most sensitive to climate change include: water supply systems, forestry activities, agricultural systems, and coastal zones and fisheries (Sanchez et al. 2000; IPCC 2007b). In terms of broad geographical regions and on the basis of the central scenarios from the range of all emissions scenarios (see IPCC FAR 2007), the IPCC sees Africa as being highly vulnerable to climate change, particularly due to decreased water availability, enhanced food insecurity, impacts on human health, and increased desertification (IPCC 2007a).

Asia is likely to have problems with food security and flooding, but overall is probably less vulnerable than Africa (although at the upper end of the range of emissions scenarios food security would be very substantially impacted by changes in the South Asian monsoon). Latin America is also less vulnerable than Africa, but is nevertheless likely to experience increasingly severe and possibly increasingly frequent climatic variations largely due to changes in the El Niño Southern Oscillation (ENSO), as well as decreasing biodiversity and reduced crop yields. Of all developing regions, however, it is the small island states that are most vulnerable to climate change through sea surface warming and coral bleaching, droughts and flooding, and changes in ENSO. Climate change may thus force drastic changes to livelihood strategies. Where economic diversification is low, income opportunities and hence options for developing alternative livelihoods in response to climatic changes may be limited. In some cases migration, which is an important coping strategy for poor people, might be their only solution, but will potentially cause social disruption.

Climate change not only affects the poor and those living under poverty driven conditions. Climate change is expected to have effects on the overall economy of poor countries, thus hampering potential for economic growth (UNFCCC 2007). In addition, poor adaptation will increase the impacts of extreme events, increasing the costs of rehabilitation and diverting funds from longer term development purposes. Current extreme weather events are already taking their toll on developing countries’ economies, leading to loss

of human and economic capital. Regions where climate change exacerbates climatic extremes and which have limited adaptive capacity will be further constrained in their development prospects due to additional loss of life, private assets, reduced productivity of important economic sectors, and destruction of infrastructure. This is particularly true for small countries and countries with low economic diversity, where the impact of climatic extremes cannot be well absorbed by economic activity in other regions or sectors. The Pacific Islands, for example, are becoming increasingly vulnerable to extreme weather events as growing urbanisation and squatter settlements, degradation of coastal ecosystems, and rapidly developing infrastructure on coastal areas intensify the islands' natural exposure to climate events. In the 1990s alone, the cost of cyclones and typhoons exceeded US\$800 million, while the 1997 drought cost upwards of US\$175 million even before nutrition-related deficiencies were taken into account. During the 1997–98 droughts (ENSO) in Fiji US\$18 million in food and water rations had to be distributed (Glantz).

Climate change provides an additional threat that adds to, interacts with, and can reinforce existing risks, placing additional strains on the livelihoods and coping strategies of the poor. In 2000, leaders of 189 nations agreed on the Millennium Declaration that outlined eight fundamental goals. Climate change challenges the achievement of the Millennium Development Goals (MDGs) and related national poverty eradication and sustainable development objectives. Unless concrete and urgent steps are undertaken to reduce vulnerability and enhance adaptive capacity of poor people, and unless these actions are integrated in national strategies for poverty eradication and sustainable development, it may be difficult to meet some of MDGs by 2015. Strategies to strengthen capacity to cope with current climate variability and extremes and to adapt to expected future climatic conditions are mutually supportive and will have immediate benefits. They will also help identify and take advantage of the positive impacts of climate change. Even though both poverty driven systems and rural traditional economic systems appear to be generally more vulnerable to sudden disruptive changes than gradual ones, long-term climate change can be just as harmful, and would have severe impact on the resilience of even the most developed countries economies.

Changes in average climatic conditions, as well as extremes, and loss of productive areas due to sea level rise, have both been highlighted in their projected impacts on the agricultural sector. Changing El Nino ENSO behavioral patterns in the Southern Pacific Oceans are postulated to drastically affect the economies of Australia and many South American countries. Countries where tourism represents a major source of income may be affected by a decrease in revenues due to the effects of both gradual climatic changes and extreme weather events. Such events are likely to alter the attractiveness of certain holiday destinations, for example coral reef mortality is expected to reduce income opportunities for local populations in some regions. All of these factors can affect the GDP of the particular country, balance of payments, level of indebtedness, state of public finances, and may divert investments from important development objectives.

### **Potential Poverty Implications of Climate Change in Malaysia**

Malaysia has an enviable record in terms of achieving success in poverty reduction. The incidence of poverty for 1976 to 2004 shows a phenomenal reduction in the incidence of poverty from a very high 49.3% in 1970 to a commendable low of 5.7% in 2004 (Economic Planning Unit 2007). This is an achievement that is largely attributable to the growth

in household income over the same period coupled with a reduction in inequality in the distribution of income. Despite the spectacular reduction of poverty in Malaysia, an estimated 2.7% of the population is still below the poverty line in the year 2007. Notwithstanding the strides made in poverty reduction there are still significant disparities between urban and rural households and between urban and rural economies. Economic growth and widespread government interventions are the key ingredients to Malaysia's success on poverty reduction. It is also critical that the targets of poverty abatement programmes were sharply defined as in the case of the hardcore poor.

Malaysia has been on a high and rapid growth scenario, averaging 9% between 1990 and 1997 prior to the Asian financial crisis. During the same period, poverty incidence has been continuously declining from 16.5% in 1990 to 6.1% in 1997 before the crisis. While the crisis reversed previous trends, such that poverty incidence rose by 1.5 percentage points to 7.5% in 1999 from 6.1% in 1997, the rate is still low as compared to that of other countries. It is widely acknowledged that poverty is multi-dimensional and as such study of poverty in any country must be based on a range of measures and indicators. These may include the level of expenditure on food and the availability and distribution of nourishment; access to basic amenities such as housing, clean water and sanitation; ability of households to access health and education. In general recognition of the complexity of studying the nature and extent of poverty the Millennium Development Goals set targets to achieve a level of poverty alleviation based on a range of measures. Notwithstanding the complexity and multidimensional nature of poverty, total and per capita household expenditure remains a very important determinant of poverty. Household expenditure and income dictate a household's purchasing power and its ability to meet its basic needs and beyond. Furthermore, it is common place to observe a strong correlation between the level of household expenditure and other poverty-determining characteristics.

Considering measurement issues, it is also acknowledged that household expenditure is a more reliable yardstick to determine the poverty status of the household than the household income. Household expenditure coupled with government expenditure on behalf of households on important services like housing, education, health and basic social and economic infrastructure are the key factors affecting the incidence and severity of poverty in any given country. The first and the most important step in the study of poverty is the determination of the poverty line. Poverty lines are used in estimating the incidence of poverty as well as in examining the nature and severity of poverty in any given country. Poverty lines may be determined in different countries using the absolute or relative concepts. In most developing countries the absolute concept of poverty line or some variant of it is used. Even within a country, several poverty lines are usually in existence. These poverty lines refer to different geographical regions, for example rural and urban, or for different time periods or for households of different sizes and composition. In Malaysia the poverty line is set at ~RM500.00 (as compared to ~ US10,488 in the United States of America for a single person under 65 years ), whereas a value of about ~RM1750.00 (?) has been considered to be more representative for urban areas. Though there are major debates on what value should constitute the poverty line the expectation is that this threshold value should be able to provide for a comfortable and decent living of the household members without any breakdown on the whole rubric of social structures of that household unit. This threshold value also describes the level of vulnerability (to use the metaphor "money got money buys") inherent in the household unit and its ability to adapt to imposing conditions detrimental to its survival that could

undermine its stability and continued sustenance. Poverty reduction programmes could thus be summarized as consisting of two main objectives - to reduce vulnerability and increase the adaptive capacities of the individual household unit to achieve and sustain some level of quality of life standards.

Computation of the poverty line value must take into account of the climate change threat as the costs of adapting to sustain household comfort, health and livelihood economic activities would be costly and increasing as global warming increases. Though the incidence of poverty in Malaysia is very low (~2.7%) in 2007 the poverty line value of RM500.00 would not be sufficient to offset the climate change threat. Even for developed countries such as the European Union and the United States whose poverty line index is much higher than Malaysia, the adaptive capacities of the population to adapt to the climate change threat is very much limited as evident by the number of deaths attributed to heat waves and cold snaps. Hurricane Katrina which hits the Gulf Coast of the United States for the period 23-29 August 2005 brought about death and destruction costing billions of dollars, population displacements, and poverty and changing social structures. What this means is that there is a substantial percentage of the country's population whose household income might be higher than the poverty line value but would be still be exposed to the climate change threat – they are vulnerable and their adaptive capacities limited.

Another factor that needs to be considered is the *cause – effect linkages* between climate change, environmental resources development and poverty. The metaphor “the poorer gets poorer and the richer gets poorer” could be used to explain when economic systems that are very dependent on climate as a resource fails as a result of climate change. Traditional economic systems which are environment driven such as that found in Malaysia's highland regions, coastal – island regions and urban regions where economic activities are often been directly or indirectly dictated by the behavioral patterns of climate and weather are the most susceptible to changes in the cause – effect linkages between climate change, environmental resources development and the incidence of poverty (Plates). According to the IPCC FAR (2007a) the total temperature increase from 1850-1899 to 2001-2005 is 0.76° C (0.57°C to 0.95°C), this amount of increase spanning ~ 150 years have set in motions changing behavioral patterns within the atmospheric, oceanic and land based (drainage basins) circulation systems. Eleven of the last twelve years (1995-2006) rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850) and are thought to influence the increasing intensity, frequency, magnitude of impacts, duration, time of onset and timing of occurrence of low pressure system cells across the Pacific and Atlantic Oceans (WMO, 2007).

What is important here is that the postulated gradient of temperature trend increases from 2007 to 2100 would be much more steeper (although based on different scenarios projection models of fossil fuel utilization) and the implications on the Earth's atmospheric, oceanic and land based systems (river basins) circulation behavioral patterns should change drastically and certain threshold boundaries within the systems breached and the impact on poverty and human security issues would be cataclysmic. Malaysia's being an archipelago; her coastline would experience severe erosion, saltwater intrusion, groundwater contamination, destruction of extensive mangrove forests and habitat displacements and migrations. Malaysia's coastal populations and their activities

(traditional and modern) would be seriously affected and what Bangladesh faced in flood threats and disasters in the last half decade could be seen in Malaysia's coastal regions.

### Potential Drivers of Climate Change and Poverty Generation in Malaysia

The cause – effect linkages between green house gases emission and global warming would be the prime driver of climate change. However, global warming and its effects on climate change vary within a space – time continuum. What this means is that from now and the immediate future certain regions would be much hotter and certain regions much colder than other parts of the world. Temperature gradient changes between hot and cold regions over the earth's surface would greatly influence the behavioral patterns of the Earth's atmosphere, oceanic and land based circulation systems, which in most cases are detrimental in influencing regional and local climates. The climate of Malaysia and the Southeast Asia region are greatly dictated by the behavioral patterns of the Monsoons (Northeast and Southwest), the Oceanic Low Pressure Systems of tropical storms, cyclones and typhoons, the el Nino ENSO event of the South Pacific Ocean and to a certain extent the Indian Dipole Oscillation of the Indian Ocean, which would then affect the local river basin circulation systems (Ashok et al. 2001). Changes to the behavioral patterns of these major circulation systems would bring about an increase in the time of onset, timing of occurrence, intensity, frequency, magnitude, and duration of impact of floods, droughts, ecological manifestations, emergence of diseases in new regions (such as highlands), accelerated erosion, rapid slope failures and associated debris flow and other forms of climate induced hazards.

The Intergovernmental Panel on Climate Change, Fourth Assessment Report (IPCC FAR (2007a) states that –“climate change will lead to an intensification of the global hydrological cycle and can have major impacts on regional water resources, affecting both ground and surface water supply for domestic and industrial uses, irrigation, hydropower generation, navigation, in-stream ecosystems and water-based recreation. Changes in the total amount of precipitation and in its frequency and intensity directly affect the magnitude and timing of runoff and the intensity of floods and droughts; however, at present, specific regional effects are uncertain. The impacts of climate change will depend on the baseline condition of the water supply system and the ability of water resource managers to respond not only to climate change but also to population growth and changes in demands, technology, and economic, social and legislative conditions. In some cases - particularly in wealthier countries with integrated water-management systems - improved management may protect water users from climate change at minimal cost; in many others, however, there could be substantial economic, social and environmental costs, particularly in regions that already are water-limited and where there is considerable competition among users.”

The tragedy of 'the poor and low income groups' is linked strongly to the access to water. The poor generally live in a critical balance with the water resources available. For that reason, the people who are most vulnerable to current climate change - variability effects are the poor, more so for developing regions like Southeast Asia. In the context of long-term climate change and possibly enhanced climate variability, it is once again the poor who will suffer most. Whereas in the rich regions of the world, people have a relatively large coping capability, in developing countries a small change in climate variability (i.e. slightly higher frequency of extreme events or a slightly shorter growing period) can have very large effects in terms of food and water security, health, mortality and economic well-

being. By affecting climate, and hence climate variability, the rich may affect themselves, but more and in particular the poor.

The political issue that thus emerges is which mechanism one can put in place to 'institutionalize' the responsibility of the rich (North) towards the poor (South). On the one hand, this responsibility can be translated into international agreements on the reduction of greenhouse gas emissions. That has to take place particularly in the North. On the other hand, the North should take the responsibility to contribute to demand-driven institutional capacity building in the South, albeit in a non-political threat way, in order to help increase the capacity in the South to cope with impacts of climate variability and climate change.

### **Potential Impact of Climate Change on the Poor (Poverty Driven)**

Climate change creates shocks and stresses and is already known to have a devastating impact on the vulnerability of the poor as evident in the food crisis, water crisis, and impact of diseases outbreaks in the African continent, the Indian subcontinent and certain parts of Southeast Asia in the last half decade or so. Increasing frequency and intensity of weather-related extremes and anomalies, and the gradual changes in the average regional temperatures and changing patterns of regional rainfall will exacerbate these impacts (to a certain threshold by which after this there could be a cataclysmic collapse of the whole rubric of human social and economic systems). This would have serious implications on the existing vulnerability of the poor to offer any form of resilience and adaptation to the threat. Even within a livelihood adapted to a particular climatic stress, an increase in intensity of the stress, climate extremes, or unseasonal changes can cause severe shocks that set back households. Coping with such events can result in a loss of assets, negative impacts on health and can require high expenditure in order to recover.

In a set of participatory poverty assessments from over 24 countries, the rural and urban poor identified natural hazards, changing climate conditions and unpredictable seasons as contributing to an increasingly fragile environment and increasing the vulnerability of their livelihoods (UNFCCC 2007). During the 1998 floods in Bangladesh, some households were able to use emergency food and change their employment away from agriculture in order to cope. However, poorer households coped through reducing food consumption and through the sale of assets, reducing their resilience to future shocks. The poor are often the most exposed to climate variability because of where they live or their livelihood activities. The urban landless are particularly vulnerable to climate extremes, as illustrated in Honduras, where hillside shantytowns were amongst the worst affected by intense rainfall and landslides during Hurricane Mitch. Pastoralists are often particularly vulnerable to drought due to their dependence on marginal lands. Within poor communities, women and children may be particularly exposed, as seen in Bangladesh where they made up 90% of the victims during the 1991 cyclone. This incidence rate was related to a range of factors including their capabilities in survival (e.g. swimming), and socio-cultural beliefs that prevented women with their children from congregating in public cyclone shelters. As a result of social or political restrictions, the poor may also be forced to remain in exposed areas after a shock or stress. Following the torrential rains of 1999 in Venezuela, a large number of the marginalised poor were forced to rebuild their homes in the same risk-prone ravines due to a lack of alternatives.

The Millennium Development Goals (MDGs) recognise the role of poor health in increasing the vulnerability of individuals of certain age groups, gender and social status, and of perpetuating vulnerability by hindering education and livelihoods. Climate change will modify the dispersal, reproduction, maturation and survival rate of vector species. Climate change will worsen health principally through: increased vulnerability to poor health due to reduced food security and water security; water-borne diseases associated with reduced water quality due to floods and drought; more favourable conditions for the spread of vector-borne and air-borne diseases; and the direct link between temperatures and heat stress. Food insecurity and water insecurity are likely to increase because of the greater frequencies of droughts and floods, which have a direct impact on areas vulnerable to malnutrition. Climate change will also have an impact on food supply in the wider economy (due to impacts on large scale agriculture, loss of land through rising sea level and salinisation, and the impacts of rising sea level and changes in water temperatures, currents, freshwater flows and nutrient circulation on fisheries production). Malnutrition is a global health problem and it is estimated that approximately 790 million people do not have adequate nutrition.

Regions where malnutrition is widespread are usually areas characterised by erratic rainfall, resulting in highly variable agricultural yields seasonally and from year to year. This yield variability can lead to malnutrition or even famine where it is combined with the absence of effective coping strategies or safety nets. Groups that are most at risk from malnutrition include the rural producers, pastoralists, rural labourers, the urban poor people, refugees and displaced people. Pastoralists in particular will be affected by lowered livestock productivity and death due to drought, floods or disease. Currently approximately one billion people do not have access to safe water, and suffer from water-borne diseases. Climate change will increase the occurrence of conditions that favour the spread of water-borne disease. Increase in temperature and humidity will result directly in increased rates of reproduction and survival of bacterial, protozoan and viral pathogens. Many diarrhoeal diseases, which can be transmitted via multiple routes, peak in the hottest months of the year, e.g. Salmonella and Shigella. In situations of drought, the reduced water supply results in an increased rate of waterborne disease due to both physical and human factors: there is an increased concentration of pathogens in water sources as pathogens multiply at an increased rate, and the volume of water decreases; people are forced to use more contaminated sources as their preferred source runs out; and there will be increased concentrations of people around the remaining water points. Floods can result in acute health impacts for vulnerable regions, through increases in infectious diseases increases in respiratory and diarrhoeal diseases because of crowding of survivors, often with limited shelter and access to potable water. Floods can also disrupt water supply or sewerage systems, and lead to exposure to dangerous chemicals or pathogens released from storage sites and waste disposal sites. Sudden onset of floods can also cause injury, and the impact on livelihoods causes increased anxiety and depression.

Vector-borne infectious diseases, such as malaria and dengue fever, have a significant impact on health and poverty. Currently, approximately 40% of the world's population is at risk from malaria, and this is projected to increase to 80% by 2080. More than half the world's population live in areas at risk of dengue fever. Climate change will modify the dispersal, reproduction, maturation and survival rate of vector species and consequently alter disease transmission. Temperature, humidity, rainfall, soil moisture and the rising

sea level are changes in climate that have implications for disease transmission. The following vector borne diseases are considered sensitive to climate change, (1) Malaria – transmitted by mosquitoes in tropical areas, (2) Dengue – transmitted by mosquitoes, (3) Schistosomiasis – transmitted by flat worm; and (4) Tick-borne diseases. Climate change will increase the occurrence of conditions that favour the spread of waterborne disease. Climate already plays a significant role in health. Our current climate has a number of implications for health of the poor and their livestock. Current climate affects health outcomes through, 'Climate envelopes' i.e. areas of a particular climate and ecosystem; Seasonality; Inter-annual variability; Climate extremes (shocks); and Climate shifts (decadal). Climate envelopes - Certain diseases are confined to areas of a particular climate and ecosystem i.e. 'a climate envelope'.

Malaria is a case in point where, depending of the type of mosquito-vector, the distribution is limited by certain climatic and environmental conditions, in particular temperature and humidity. Seasonality: a number of infectious diseases (e.g. vector borne and bacterial diseases) is closely associated with seasonal patterns. For example in the Gambia, diarrhoea in young children has been linked with the summer rains. In West Africa, meningitis is associated with dust in semi-arid conditions, and among people with poor, overcrowded living conditions. Inter-annual variability: variability in water supplies or food security can be a consequence of inter-annual climate variability where poor planning systems are combined with reduced rainfall or reduced river flows. In 2000, 18,000 villages in Gujarat were faced with serious water shortages following the worst drought in 100 years. Climate extremes - Extreme climatic events can trigger infectious diseases or death, disrupting access to health services, and causing the displacement of people.

- a) Infectious diseases and death - Infectious diseases and death are often associated with climate extremes. The poor are most often the victims of such impacts owing to their inability to protect themselves. Following the flooding associated with Hurricane Mitch (1999), the incidence of cholera increased four-fold in Guatemala and six-fold in Nicaragua. In May 2002 an intense heat wave hit southern India killing more than 1,000 people, mainly those living in over-crowded conditions or out-doors labourers. Bangladesh has experienced an increase in cholera occurrence with the increase in the severity of El Niño-related floods over the past 70 years. Rift Valley Fever among livestock is associated with heavy rainfall: for example, flooding associated with the 1997-8 El Niño led to the loss of huge numbers of livestock to Rift Valley Disease and resulted in a billion dollar ban by the Gulf States on trade from East Africa.
- b) Disrupting access to health services - Climate extremes such as flooding or windstorms can disrupt access to health services through damage to facilities and transport networks. The 1997-1998 El Niño flooding and hurricane events across Ecuador and Peru resulted in damage to 34 hospitals and 485 health centres, many of which were the only facilities for miles around. The 1999 floods in Mozambique caused damage to road networks estimated at US\$6 million. Despite the essential role of health services following such a disaster there is often no means in place to protect medical supplies or quickly reinstate access to health services.
- c) Displacement - Extreme events are also associated with the displacement of people, makeshift accommodation, inadequate facilities, and inadequate nutrition. Incidences

of TB and malaria have been found to increase in refugee camps as a result of the overcrowded conditions and lack of protective elements of the home. Climate shifts - Climate shifts over decades can result in landuse change and migration. Land-use influences the environmental conditions that limit certain diseases, and migration can have implications for the spread of diseases (e.g. HIV/AIDS).

In Malaysia, though the level of poverty incidence had dramatically lowered to a very low of ~2.7 % in 2007, two important issues needs to be ascertained. Firstly, at that level of the poverty line value of ~RM500, can the poor cope to the impending threat, and secondly, which is considered more important is that if this value is insufficient than the existing poor (and hardcore poor) becomes more vulnerable but the percentage of the population becoming vulnerable to the climate change threat would also increase till a new poverty line value that incorporates the climate change threat be included in calculating the new poverty line value. To these two issues a third can be added where existing poverty abatement programmes which had never incorporate the climate change threat would have failed and the incidence of poverty would increase in the following years.

The United Nations Millennium Development Goals would be severely handicapped and the possibility of not achieving its target in 2015 as a result of climate change threat could in fact be a reality. Climate change adds urgency to understanding and addressing the poor's vulnerability to current and future climate variability and to reevaluating the role of policies and programmes in reducing this vulnerability. Vulnerability is an indication of people's exposure to external risks, shocks and stresses and their ability to cope with, and recover from, the resulting impacts. Vulnerability may differ seasonally or at different times within people's lives. It also differs across groups within communities or individuals within a household, owing to their livelihood activities or social standing. People draw on a range of coping strategies in times of stress; however, those available to the very poor are likely to be more restricted and less resilient. Changing vulnerabilities can often explain how people move in and out of poverty, suddenly, seasonally or gradually overtime. People may use a number of strategies to move out of poverty, but without also reducing their vulnerability they can easily slip back into poverty at a later date.

### **Vulnerability and Poverty**

The literature on environmental hazards/disasters on population vulnerability has grown enormously over the past few years. Key articles include Bohle et al. (1994) and Chambers (1989), Blaikie et al. (1994), Cutter (1996), Kelly and Adger (2000), Stephen and Downing (2001), Adger et al. (2004), Bohle et al.(1994), Downing et al. (2004), Handmer et al. (1999), Kaspersen et al. (2001), and Leichenko and O'Brien (2002), and the IPCC's Third and Fourth Assessment reports on Impacts, Adaptation and Vulnerability (IPCC 2001; 2007). Vulnerability has no universally accepted definition (Downing and Patwardhan 2007). The literature on risk, hazards, poverty and development is concerned with underdevelopment and exposure to climatic variability – among other perturbations and threats. In this view, vulnerability is systemic, and a consequence of the state of development. It is often manifested in some aspect of the human condition, such as under-nourishment, poverty or lack of shelter. Final outcomes are determined by a combination of climate hazards and system vulnerability. Thus based on Hazards literature: Risk = Hazard (climate) x Vulnerability (exposure). The Intergovernmental Panel on Climate Change (IPCC) tuned its definition of vulnerability specifically to climate change. Using

this lens, vulnerability is seen as the residual impacts of climate change after adaptation measures have been implemented. The uncertainty surrounding climate change, impacts scenarios and adaptive processes is such that very little can be said with confidence about vulnerability to long-term climate change. Climate change (IPCC): Vulnerability = Risk (predicted adverse climate impacts) – Adaptation. Regardless of which framing is adopted, it is important to ensure that the choice is made explicit, and that the analysts and stakeholders are clear about the interpretation of the different terms. Despite the IPCC's conclusion that anthropogenic climate change is a real phenomenon, there is a large amount of uncertainty relating to the nature of these changes.

Projections of change are dependent on global climate models that simulate elements of the climate system and can be forced according to particular plausible scenarios of emissions (SRES) (e.g. Arnell et al, 2004). In addition to changing distributions of temperature and rainfall, other potential impacts include changes in the patterns, nature and intensity of climate-related natural hazards, such as hurricanes and droughts. Whilst uncertainty is an important consideration, the incremental nature of climate change also differentiates it from natural hazards, most of which are discrete events after which populations have a chance to recover and reduce their vulnerability levels. However, even if the exposure to climate change is similar there will be variation in the impacts due to the differential vulnerability of ecosystems to such changes. Investigating the potential effects of changing climate has been studied for different ecosystems on a case study basis, for example studies on coasts, rivers/water resources, forests, wetlands, agricultural productivity (Adger et al. 2003; Dolan and Walker, 2004).

Essentially such studies are predicated upon a simple linear relationship between hazard and impact, and vulnerability is referring to the sensitivity of natural environments to projected changes in climate, or their biophysical vulnerability. Through influencing resource availability, such impacts might in turn filter through to impact human populations, particularly those that are geographically proximate to the exposure. Other studies have explicitly investigated the impacts of climate change on human lives through such parameters as malaria incidence, food security, water availability and coastal flooding (Nicholls and Klein 2004). This trend of assessing impacts based on biophysical vulnerability is also enshrined in the IPCC process. However, the approach has attracted criticism through assuming humans are passive recipients of global environmental change, and thus failing to capture their dynamic ability to mediate such hazards, either through resisting an event or coping once it occurs. Essentially, as once predominated with regard to natural hazards, climate change is seen as a problem *for* society, not *of* society. Many impacts assessments have thus been impeded by only considering one side of the equation.

Researchers in the field of vulnerability to climate change have also started to embrace more interactions approaches to society-nature relations. Political ecology is a synthetic approach that brings together critical insights from political-economy perspectives with the awareness of physical human systems interaction and place specificity that are the focus of the human ecology school. Instead of focusing solely on the risk of exposure to physical phenomena, this approach recognises that such physical phenomena are embedded in and mediated by the particular human context (social, political, economic, and institutional) in which they occur. Whilst physical phenomena are necessary for the production of a natural hazard, their translation into risk and potential for disaster

is therefore contingent upon human exposure and a lack of capacity to cope with the negative impacts that exposure might bring to individuals or human systems.

This broader approach has thus highlighted the importance of assessing the complex reality of vulnerability when predicting future impacts of environmental change as the most vulnerable people may not be in the most vulnerable places: poor people can live in resilient biophysical environments and be vulnerable, and wealthy people can be in fragile physical environments and live relatively well. Understanding the impacts of climate change is thus inextricably linked with the human conditions that create a resilience or vulnerability to that event. This recognition has consequences for vulnerability and impacts assessments, and there has been a growth in theoretical and conceptual studies aimed at highlighting the nature of vulnerability to climate change. Social vulnerability, in contrast to being seen as an outcome, is viewed more as a potential state of human societies that can affect the way they experience natural hazards.

This potential state is in constant flux, reflecting its dependence on the dynamic interaction of a range of economic and social processes which influence the capacity of individuals, social groups, sectors, regions and ecosystems to respond to various socio-economic and biophysical shocks. The most vulnerable are considered those who are most exposed to perturbations, who possess a limited coping capacity and who are least resilient to recovery. Other definitions of vulnerability focus on concepts of marginality, susceptibility, adaptability, fragility and risk. Given evidence of differential social vulnerability in the face of hazards or broader environmental risk exposure, a number of studies have tried to characterise the determinants that may give rise to vulnerability, or its reciprocal state of resilience. Vulnerability is therefore a function of economic, social, political, environmental and technological assets. Who, where, and when vulnerability and disaster strike is determined by the human and physical forces that shape the allocation of these assets in society. This is dependent on the scale of enquiry.

On the large-scale macro processes will be most important in determining the distribution and production of entitlements. In the well-developed food security literature famines have been explained on the basis of entitlement theory, where the distribution and reproduction of entitlements is dependent on the structural factors of political economy that precipitate entitlement failure. In the face of exposure to climate change, some populations will be able to draw on their entitlements to adapt to the risk, for example through awareness and preparation, insurance for losses, and diversifying livelihoods. Adger (1999) shows how collective vulnerability (at community level or higher) to extremes in coastal Vietnam is determined by institutional and market structures. In contrast, on the local scale the role of human agency has a greater influence in access to resources and household-level social status. In such cases entitlements are socially and spatially differentiated according to such factors as gender, ethnicity, religion, class and age. The fact that vulnerability is embedded in wider processes also creates the opportunity for reduction or increase through the social amplification of risk.

Developing countries are particularly vulnerable to climate change impacts because of exposure and sensitivity to climate change and because some elements of the capacity to adapt may be limited: hence biophysical and social vulnerability. Africa is thought to be particularly at risk due to having a higher share of economies in climate-sensitive environments than other continents and a heavy reliance on the natural resource base.

Recurrent droughts and over dependence on rain fed agriculture mean that livelihoods are closely related to resource availability, itself sensitive to climate change. A key threat of climate change to Africa is thus the projected changes in water availability. However, such generalisations disguise heterogeneity that exists at the sub-continental scale due to variation in vulnerability. Some populations have shown resilience in the face of the climate variability that characterises the vast swathes of semi-arid drylands. Country-level analyses of vulnerability are therefore required.

In Malaysia, the vulnerability of the poor and those categorized under the low income group could be the function of many factors (Khairulmaini and Fauza 2000; Fauza and Khairulmaini 2000, Khairulmaini and Fauza 2003a, 2003b; Khairulmaini 2007; Fauza and Khairulmaini, 2008; Khairulmaini 2008). In general these factors describes, (1) the population and demographic structure of the household members, (2) their economic livelihood activities, (3) the physical characteristic of the household unit (4) the immediate living environment, (5) the exposure to climate induced hazards, (6) inherent coping mechanisms and (7) the existence of infrastructure and support systems. In addition to this it could be added that (8) the nature of awareness (apathy, sympathy or empathy) to the climate change threat. Limited knowledge and awareness of climate change threat could hinder their immediate response) actions) to any form of climate change induced hazards which could be costly or fatal in the future. The failure and success of implementing early warning systems for climate change induced hazards (floods, droughts, outbreak of vector borne diseases, heat waves etc.) would be dependent on the level of the poor's awareness on threat they are exposed to (Khairulmaini et al. 2006 ; Khairulmaini et al. 2007).

### **Adapting to Climate Change**

People develop coping strategies to deal with climate variability as with other shocks or stresses. These include building social networks as forms of insurance, traditional forecasting in order to be prepared for climatic changes and ingenious means of protecting assets such as the use, in Asia, of floating seed beds in times of floods. However, the poor's range of coping strategies is naturally more restricted by their lack of assets and by the other stresses on their livelihoods. These stresses are increasing following a number of trends such as increasing prevalence of HIV/AIDS, conflict, globalisation and environmental degradation. The poor are already struggling to cope with current climate variability. The climate is becoming more variable and creating additional risks so that the poor are becoming more vulnerable. As climate extremes are 'covariant risks' (i.e. simultaneously affecting a wide range of people), current safety nets are likely to be overwhelmed. This includes both formal systems (e.g. social assistance), and informal systems (e.g. social networks). Many developing countries are already taking action to adapt to climate change, beginning with an analysis of their vulnerability.

Vulnerability to climate variability has significant implications for the achievement of the Millennium Development Goals. Development must be based on understanding existing and future vulnerabilities to climate risk if it is to be resilient to the risks of climate change. In some cases climate change adds urgency to current activities to improve policies and institutional mechanisms that impact on the poor. In other instances there may be a case for changes in planning or institutional reform to take account of climate risks, or for building additional capacity into infrastructure investment. Whatever the response,

it should be an integral part of the development process of a country. There are three major requirements to address this response; Firstly, the need to understand the present state of vulnerability and inherent capacities to adapt of the poor. Understanding the impacts of climate variability on the poor requires an understanding of their vulnerability to all external shocks and trends and their coping strategies. Vulnerability analysis can be strengthened by understanding climate hazards better. Work is already underway in Southern and East Africa and the Sahel on seasonal forecasting to enable communities to cope with current climate variability. Similar approaches would be valuable in other parts of Africa and other regions. In addition, further work is required to assess longer term climate risks (up to 20 years).

Until recently the predictions provided by the available Global Climate Models (GCMs) have been on too coarse a scale and too long term to have much relevance to developing country policy makers. For precisely these reasons the UK Hadley Centre is developing a finer resolution, medium timeframe (20 years) model for use in developing countries. Secondly, reducing the vulnerability of the poor and increasing their resilience to future threats. Based on an understanding of vulnerability, support can be given to supporting poor people's coping capacity for future shocks. Governments should take specific actions to reduce the vulnerability of the poor. These could include improving the socio-economic status of the poor, strengthening their physical environment to threats of changing climate and weather, and providing immediate reliefs aids when climate change hazards becomes a high risk threat.

Finally, the need to integrate climate risks into development planning as a long term solution to the problem. Responding to climate variability requires development agencies and governments to work on the development of strategic planning systems, which take account of current and projected climate patterns. There are opportunities to achieve this through Poverty Reduction Strategy Processes (PRSP) in the least developed and highly indebted countries, and similar sectoral planning processes elsewhere. Compared with industrialised countries, most developing nations have small greenhouse gas emissions, making mitigation a less urgent priority. Adaptation is very important in poor countries because they are more vulnerable to the impacts of climate change. Broadly speaking, there are two reasons for this vulnerability. One is low adaptive capacity – high levels of poverty and a relative lack of the financial capability, institutional strength, skills, infrastructure, technology and other elements needed to cope with the effects of climatic shifts. The other is geographic location: large numbers of poor people live in areas such as drought-prone sub-Saharan Africa or flood-prone Bangladesh. In Southeast Asia the most populous regions are also the areas most at risks to the impact of climate change (Khairulmaini, 2009a, 2009b).

Reliance on climate-sensitive sectors such as agriculture and fishing is also high in developing countries. The IPCC recognises Africa as a whole to be “one of the most vulnerable continents to climate variability and change because of multiple stresses and low adaptive capacity”. In Asia, “coastal areas, especially heavily-populated mega-delta regions in South, East and Southeast Asia, will be at greatest risk due to increased flooding from the sea and, in some mega-deltas, flooding from the rivers”. The IPCC also states that “small islands, whether located in the tropics or higher latitudes, have characteristics which make them especially vulnerable to the effects of climate change, sea level rise and extreme events. There are two types of responses to the threat of

climate change. The first, mitigation, involves reducing emissions of greenhouse gases as a way of slowing or stopping climate change. The second, adaptation, is learning to cope with temperature increases, floods and the higher sea level associated with climate change. Adaptive responses can be technological (such as sea defence construction), behavioural (such as altered food and recreational choices), managerial (such as altered farm Adaptation to climate change needs to be mainstreamed into development policy and practice at national, international and regional levels. Particular attention needs to be paid to supporting community-based approaches to adaptation. Building on the considerable body of knowledge already possessed by poor people is essential. In the Yamuna River area of Rajasthan, India, for instance, a number of poor communities have revived traditional rainwater harvesting methods in the form of johads — small semicircular dams— and helped recharge groundwater and virtually drought-proof their villages.

The country - level response to climatic change is just one aspect of the external events and changes to which economies and societies must adapt. Governments can, however, attempt to increase the resilience of their growth strategies to the impacts of increasing climate variability and climate change. Unfortunately there is, as yet, little experience of best practice of adaptation to climate change on which to draw, but experience of more general adaptive economic policies offers some pointers. Vulnerability to climate change can be reduced or increased by the choice of development path. For example, national investment in large-scale agricultural programmes may be misplaced if more droughts and flash floods are expected. Small-scale drought resistant agriculture might be more sustainable in the long term. Each country needs its own plans and institutions to ensure adaptation is both mainstreamed into development activities (such as integrated water resources management) and considered at a strategic planning level (for example, planning for increased malaria incidence in the health sector).

## **Conclusion**

The potential threat of climate change induced hazards exacerbating poverty in Malaysia should not be taken lightly. Although the IPCC 2007 report on the “Science of Climate Change” shows a small increase in temperature for the Southeast Asia region in the last 50 years or so, there is general agreement amongst scientists that the changing behavioral patterns of the el-Nino ENSO, monsoons and to a certain extent the Indian Dipole Oscillation circulation systems are triggering weather extremes and variability to influence changing behavior patterns of hydro-meteorological and geomorphological events (floods, haze pollution and slope failures) in the region. To date the impact of these changes can still be absorbed by the strong foundations of Malaysia’s environmental management programmes backed by stringent economic policies, including effective poverty eradication programmes. However, this scenario could change if the gradual increase in global warming is left unchecked and unabated because increasing global temperatures could lead to thresholds being breached where habitats and ecosystems may not recover to existing equilibrium and stable conditions. Malaysia must strengthen her environmental management programmes and their implementation taking into account the climate change threat. In relation to this, Malaysia needs to address the issues of vulnerability and adaptive capacities of her economics systems, more so that practiced by the poor or those within boundaries of the poverty line. The poor are especially vulnerable and their inherent adaptive capacities and coping mechanisms low. Malaysia

needs to reassess the significance of the existing poverty line value to take into account the challenge of climate change threat to enable the poor and those living within the fringes of the poverty line to be able to reduce their vulnerability to the threat. This, however, needs to be done within the context of streamlining existing environmental management strategies within the existing National Economic Development programmes.

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