Climate change urban adaptation strategy

Briefing paper

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A. Global Climate change

The world climate has started to change. The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as “a change of climate that is attributed directly and indirectly to human activity that alters the composition of the global atmosphere and that is in additional to natural climate variability observed over comparable time periods” (IPCC, 2007, p. 30).

Global surface temperature has increased up to 0.7°C during this century (Red Cross / Red Crescent Climate Guide, 2007; IPCC, 2007). Over this century, the averages of Arctic temperatures have increased at almost one hundred percent. Islands have become warmer faster than the ocean.

Changing in climate patterns will impact either direct or indirectly almost all sectors in human life (Tubiello & Fischer, 2007). With the concentration of population, economic activities and material and energy consumption, urban will be the sector with the most comprehensive climate change implications (Roy, 2009).

B. Urban community, climate change, and adaptation strategy

The total population in world is now more than 7 billions which more than half are living in urban areas (Roy, 2009; UNFPA, 2007). The number of people who live in towns or cities will continue to rise every year; and in 2030 total urban population will reach 4.9 billion. Moreover, by 2925 the urban population will represent two third of world population (UNFPA, 2007). In relation to this, Roy (2009, p. 1) notes that “…indeed, cities cover only 2% of the earth’s surface, yet consume 75% of all resources and produce 75% of all waste”.

The global warming and climate uncertainty will enhance the vulnerability of urban population (Douglas & Alam, 2006; Habitat, 2008). Moreover, in most developing countries many people, particularly poor people, are forced to live in hazardous areas such as steep and unstable hillsides or along the foreshore on former mangrove swamps or tidal flats (Douglas & Alam, 2006). All of these conditions will be worsened by several climate change risks such as high rainfall intensity, high tide, drought, cyclone, or other extreme weather events (Action Aid, 2006).

Hunt and Watkiss (2007) argue that the changes in climate will continue for many decades. This therefore, essential for human system, including cities, develop urban adaptation strategies to prevent the climate change risk and to take advantage of the opportunities from this inevitable global climate change event. In addition, sustainable adaptation is an investment to mitigate potential disasters in the future (Laukkonen, et al., 2009).

C. The implication of climate change for urban settings in Indonesia

Indonesia is a tropical country which has more than 17.000 islands. The total number of Indonesian population is 236 million people (MOH, 2007). According to data from World Bank (2007) as cited in MOH (2007), 45.2% of Indonesian people are categorized as poor and vulnerable poor. These numbers of people are at risk to be impacted by climate change. Other vulnerable groups that has potential to be impacted by climate change are coastal area population (65% of Java Island's population live in the coastal area), elderly and children, traditional societies, farmers or peasants, small islands population (MOH, 2007).

In Indonesia, many sectors have been and are being adversely impacted by the global warming and climate uncertainty. Indonesia is also prone to natural hazards especially climate related hazards including floods, droughts, landslides and wild land fires (Bakornas & Bappenas, 2006; Hadi, 2007).

El Nino-Southern Oscillation is one of the main factors of climatic problems in Indonesia. Every few years, the Pacific Ocean's temperature is changing. Sometimes the temperature is becoming unusual warm which is called the El Nino event, and in other time is also turning to unusual cold which is the La Nina event. These natural phenomena like or dislike, will influence the climate situation in Indonesia (UNDP, 2007).

In many urban areas in Indonesia, cities development and urbanization enhances the impact of climate related hazards, for example the flooding issue. Due to the large parts of the grounds have been covered by roads, pavements, and roofs the flood waters will have no way to go or at least limited; and as more people crowd into the urban areas, the effects of flood will intensify more in urban than in rural (UNDP, 2007).

Because of the rainfall intensity and rain duration has increased, floods are unavoidable in many urban areas in Indonesia (Sutardi, 2006). Several low lying areas and river basin areas suffer from floods regularly. Even in the capitol city of Indonesia, Jakarta, in 2007, almost all of the communities who live in river basin areas were suffered from this climate change-related disaster (Red Cross / Red Crescent, 2007). Therefore, to avoid further loss and damage due to the climate change and global warming, the adaptation strategies for urban settings need to be developed.

The impact of climate change on Indonesia is classified based on the type of the exposures, which include direct and indirect exposures.

1. Direct exposure

From the global context, the exposures of climate change can either directly or indirectly (Confalonieri, 2007). Direct exposures of climate change are extreme temperature and extreme climate event. Sari et al (2007) argue that extreme temperatures can directly impacts human health. People with some particular health problem, like heart dysfunction, are vulnerable to hot climate. This is because these people would need extra energy to keep their body cool during the hot weather. Another direct exposure is extreme weather (Sari et al, 2007). Furthermore, Sari et al (2007) argue that there is some evidence that shows that extreme weather has

already happened in Indonesia. In June 2006, there were several heavy rain events in southern Sulawesi Island which killed at least 216 people. In January 2006, rainfall and accompanying landslide killing at least 207 people in north shore of Java Island. Moreover, in the beginning of 2007, there was a mega flood in Jakarta, which was caused by extreme rainfall of 250 mm, and powerful storm that destroyed some parts of Jogjakarta city and even some parts of Jakarta. This tropical storm was a result of dramatic weather change, from dry season to sudden heavy rain.

Figure 1 summarizes the climate change-related disaster, such as draught, epidemics, extreme temperature, famine, floods and wind storm, which have happened in Indonesia in the period of 1991-2001. There were no extreme temperature and wind storm reported yet within this period. From this figure, it is clear that climate change related disaster has directly impacted population health in Indonesia. People were not only injured but also died. Moreover, people whom have to be displaced will tend to suffer from psychosocial problem.

Figure 1 Data of emergency disasters in Indonesia from 1991-2001

	Affected	% of Population	Killed	% of Population	Number of Events
All Events	6,335,635	3.243	4,807	0.00	**65**
Drought	1,155,000	0.591	672	0.00	**2**
Epidemics	58,932	0.03	2,122	0.00	**13**
Extreme Temperature	0	0	0	0	**0**
Famine	162,000	0.083	260	0.00	**3**
Floods	1,808,030	0.925	1,123	0.00	**28**
Wind Storm	0	0	0	0	**0**

Source: World Resources Institute cited in Sari et al (2007) p. 77

2. Indirect exposures

Meanwhile, the indirect exposures of climate change are livelihoods, health, food security, and environmental degradation (UNDP, 2007).

Livelihoods

Agriculture and fishery are the dominant type of livelihoods in Indonesia, especially in rural areas (UNDP, 2007). These two types of livelihoods are acutely climate sensitive. Due to the climate uncertainties, many works in agriculture or fisheries are disrupted. In fishery sector, small changes in ecosystem can have large effects. For example, changing water temperatures will damage coral reefs which in turn will reduce the fish stocks. Another example, their fishing boats will also have to deal with more uncomfortable weather and high waves. In Maluku, for example, the fishermen found difficulties to predict the right time or places to catch the fish because of the climate uncertainties. In Java, Aceh and Sulawesi the phenomenon of sea level arise has inundated many of the shrimp and fish pond (UNDP, 2007)

There are so many people in Indonesia that earn their incomes from marine fishing, brackish water aquaculture, reef gleaning or mangrove harvesting. These kinds of livelihoods will be impacted by the rise of the mean of the sea level (Sari et al, 2007).

In Kamal Muara village (*kelurahan*), North Jakarta, almost more than half of the communities are working in fishery sector, either as fisherman, fisherman labor, and shell opener. Because of climate factors, such as high tide and climate uncertainties, fishing activities has been disrupted, which caused economic loss almost 50% of their income.

Climate change has impacted the crop yields and agriculture production. Global warming will alter precipitation, evaporation, run-off water and soil moisture. These will have effects on agriculture in Indonesia, which will then affect most of population in rural areas, especially for the peasant families (Sari, et al., 2007).

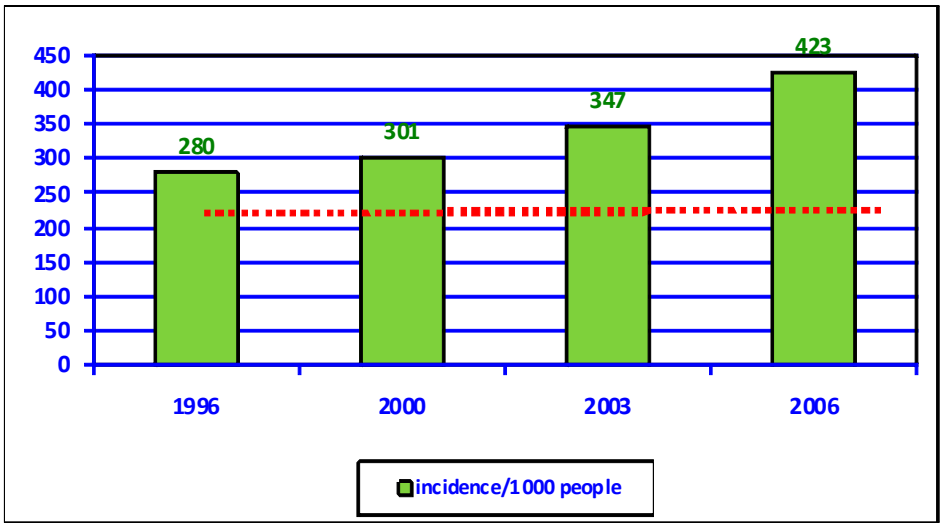
Health

McMichael and Hanes (1997) believe that the changes in climate and season variability may cause disturbance to environment in which has potential to impact human health. They argue that the disturbance of ecological system would generally have adverse effects on health.

WHO (2007a) notes the relationship between climate variables (temperature, humidity and rainfall) and diarrhoeal diseases is mediated by some factors such as the quality of the available water and hygiene sanitation.

Some diseases that are climate sensitive are water borne diseases, food borne diseases and vector borne diseases (Agtini, 2005; Indonesian CDC, 2007; UNDP, 2007). IPCC working group II report (2007) notes that one of the projected health impacts of climate change is that climate change may lead to increase the burden diarrhoeal diseases. Blaser et al. in WHO (2007a, p. 39) believe that “temperature and relative humidity have a direct influence on the rate of survival and replication of bacterial and protozoan pathogens”, in which may increase the prevalence of diarrhoeal diseases. The occurrence of water borne disease is also due to the changes in precipitation, contamination of fresh water supplies, and sea level intrusion into the source of clean water. Moreover, flood also has the potential to contaminate the shallow ground water and stream waters, which in Indonesia are the main source of drinking water. Because of this, IPCC (2007) also projected that morbidity and mortality due to diarrheal disease will increase in Indonesia. In relation to this, as can be seen from Figure 2, the annual incidence of diarrhea in Indonesia is increasing every year.

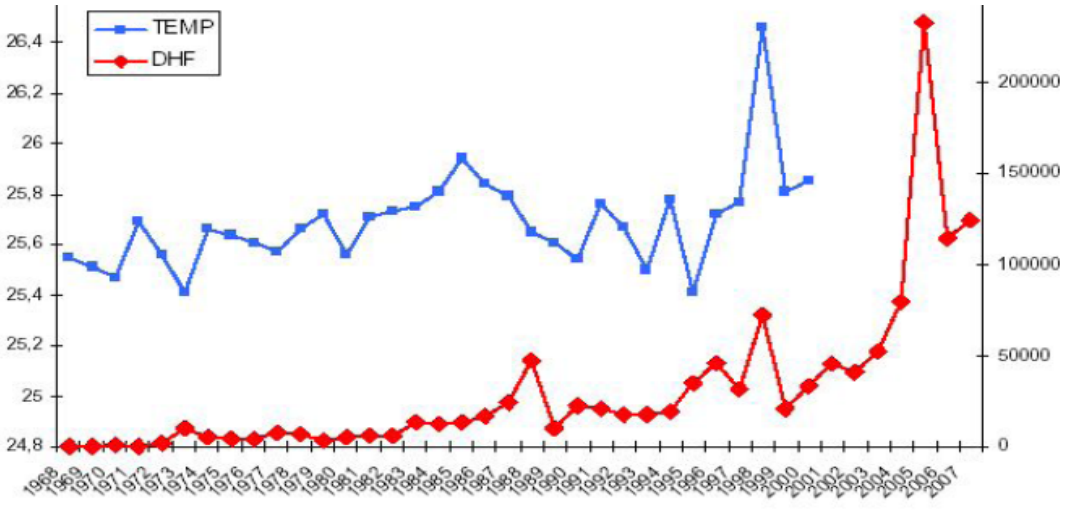
Figure 2 Annual incidence of Diarrhea in Indonesia from 1996-2006



Source: Indonesian CDC (2007), p. 20

Other climate change health related problem is the mosquito spread to the new areas due to the increase of temperatures. It is therefore, malaria or dengue disease is now an issue in many areas in Indonesia (Indonesian CDC, 2007; UNDP, 2007). Figure 3 shows the correlation between temperature and dengue cases in Indonesia.

Figure 3 The correlation between temperature and dengue cases in Indonesia from 1968-2007



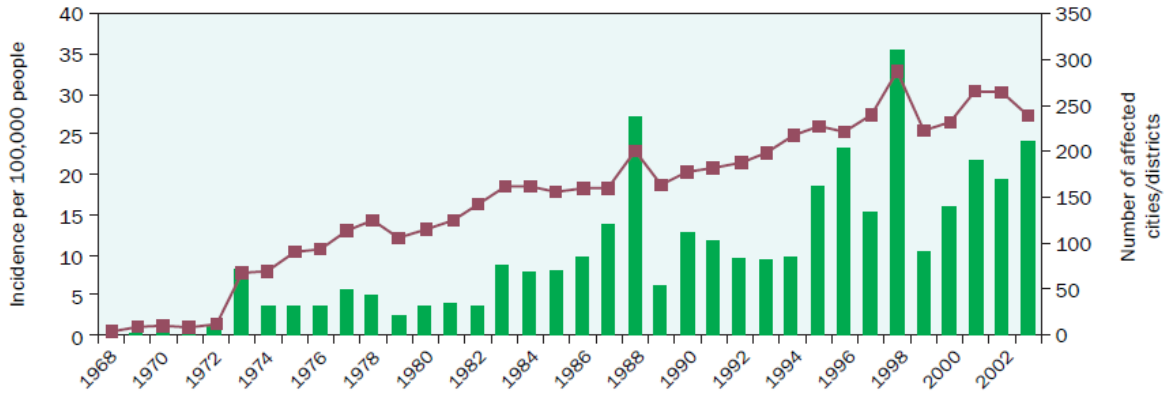
Source: Bakhtiar, 2008, p.11

It can be seen from the figure 3 that the trend of dengue fever cases increased along with the increase of temperature in Indonesia. In relation to this, ADB (2009) also argues that climate variables have the potential to enhance the distribution of dengue fever cases in Indonesia. To

support this argument, ADB observe the number of cities/districts affected by dengue fever disease and the La Nina occurrence which was in 1973, 1988, and 1998 (see figure 4). It is clear from Figure below that dengue cases in Indonesia increased significantly in La Nina years. The number of cities/districts affected by dengue cases also increased significantly during the past three decades (ADB, 2009).

In urban settings where many areas have been cemented, the rain will exacerbate the breeding place of mosquitoes. Hence the mosquito density will increase significantly (UNDP, 2007). In urban slum areas where the hygiene and sanitation facilities are not in place, climate uncertainty will make the population within the areas vulnerable to many diseases namely upper respiratory diseases, skin diseases, and diarrhoea (Douglas & Alam, 2005; UNDP, 2007). The combination between prolonged intense heat waves and high humidity increases the vulnerability of urban population, particularly the poor and elderly, to heat exhaustion (UNDP, 2007).

Figure 4 Number of affected cities/districts by Dengue Fever Disease in Indonesia



Source (ADB, 2009, p. 52)

Food security

Climate change also will adversely impact the national food security. As cited in UNDP (2007, p. 8) “the Climate Laboratory at the Bogor Institute of Agriculture says that during the period 1981-1990, every district in Indonesia was losing on average around 100,000 tons of rice production per year; by the period 1992-2000, this amount had increased to 300,000 tons”. Not only rice, but also other products like corn and soybean. ADB (2009) notes by the end of this century, due to the water shortage issue, corn and soybean production will decline in about 50%. These agriculture problems may result a serious threat to long term food security in Indonesia, particularly for the poor people.

Environmental degradation

Due to the global warming, the temperature rate in ocean has become warmer. One of the consequences of this ocean warming is coral bleaching. This will lead to shift the habitats and,

the worst one, force some species to be vanished (Sari, et al., 2007). UNEP (2008) suggests that the advancing sea water has reduced the size of mangrove forest, which in turn will disrupt the capacity of mangrove forest to protect storm surges and coastal erosion.

The extreme weather event will directly impact the built environment and the surroundings (Hunt & Watkiss, 2007). These extreme weather events include wind storms, floods, flash floods caused by high rainfall rate, heat wave and long drought. Storm risks intensify the hydrological cycle and enhance the magnitude and frequency of intense humidity events (Kundzewicz, et al., 2006).

In relation to this, the heavy rainfall has the potential to create landslides, by which in turn will create built environment damage and loss (UNDP, 2007). UNDP (2007) argues that the destruction of property and infrastructure will set back the development and economic growth, especially in the area with a limited budget for reconstruction and rehabilitation process in the after math of the disaster events.

Climate change is also a threat for forestry in Indonesia. Much modeling research found that the area of tropical evergreen forest will be decreased due to the high-temperature and high-rainfall events. Indonesian would also experience limited change in biome distribution (tropical forest) (ADB, 2009). Moreover, one of the most important wood products which commonly found in Java Island, the teak (Tectona grandis), is currently being threatened by climate change risks (ADB, 2009).

Environmental degradation also may occur due the fire forest which can be triggered by droughts combined with changing patterns of land use. What had happened in Central Kalimantan is one of the examples. In 1990s, the Peat Project aimed to convert one million hectares of peat land for palm oil plantations. As the main livelihood for the people was rubber plantation, this project has “stolen” the livelihoods of the communities in that area. Moreover, many trees have caught fire as a result of the burning of the peat land. During the El Nino years in 1997, the fires were difficult to control, which caused major damage on the environment. Fire in El Nino years caused major disruption across the country; even UNDP (2007) notes that in 1997 alone, the cost that incurred due to this fire was estimated between US$ 662 million and US$ 1.056 million.

Another issue of environmental degradation is clean water issue, which in turn has the potential to affect water demand in urban settings. IPCC argues that the increases in the average atmospheric temperature will speed up the evaporation rate and demand for cooling water in human settlements in many cities (Hunt & Watkiss, 2007). While in one hand the water demand increased, the changes in rainfall pattern will influence the water availability in many places. In most cities in developing countries, improving the clean water accessibility is still one of the key issues in their development plan (UNDP, 2007; Hunt & Watkiss, 2007). It is estimated that, due to the long term impact of climate change, 20% of one billion people in the world will experience water scarcity by the year 2025 (Cowden, 2008).

D. Suggested method for urban adaptation strategy

From the perspective of decision makers, climate change creates uncertainties in many things, particularly in urban development planning (Cowden, 2008; .Hallagete, 2009). Lack of financial sources and technological barriers forced the decision makers to develop the adaptation strategy that fits with this uncertainty (Hallegete, 2009).

In relation to this, this some suggested methods that can be taken into consideration by the decision makers. These are: no-regret and reversible strategy; local settings and community based strategy.

1. No-regret and reversible strategy

When dealing with the impacts of climate change, in fact, there are lots of adaptation options that can be taken. However, when choosing the adaptation strategy, we also need to deal with the risks of whether the adaptation is effective, or even whether the climate change does happen as projected before. With no-regret strategy, kind of risks like these can be limited. No regret adaptation strategies mean the measures that are able to limit the impact of climate change and still benefits even in absence of climate change, therefore in other word; no-regret strategy is a zero risk and very good investment method (Hallagete, 2009).

Examples of no-regret strategy are such as land-use policies that aim at limiting urbanisation and improve the building codes for the new construction buildings (Hallagete, 2009). Another example is government should ban activities that are not sustainable and relatively not reasonable from the perspective of climate variables projection. For instance, prevent development on coastal area, low lying areas and rehabilitate natural vegetation. These activities would reduce the factors that may enhance the vulnerability of a community or a region.

To deal with climate uncertainty, reversible and flexible options are much better that irreversible option. The nature of reversible strategy is easy to be adjusted or modified and relatively cheap. The aim is to limit the economic losses due to the inadequate adaptation strategy. For instance defences that initially designed to allow for cheap adjustment if the defences are no more able to deal with sea water due to sea level arise (Hallagete, 2009).

2. Local settings and participatory approach strategy

Climate change is local and location specific. Indigenous knowledge and local coping strategies should be the fundamental and starting point of adaptation planning (FAO, 2008). Adaptation measure should be based on understanding of climate risks. To understand the risks of climate change, comprehensive identification of local vulnerability and the implications of climate change on specific local/area are required (Cowden, 2008).

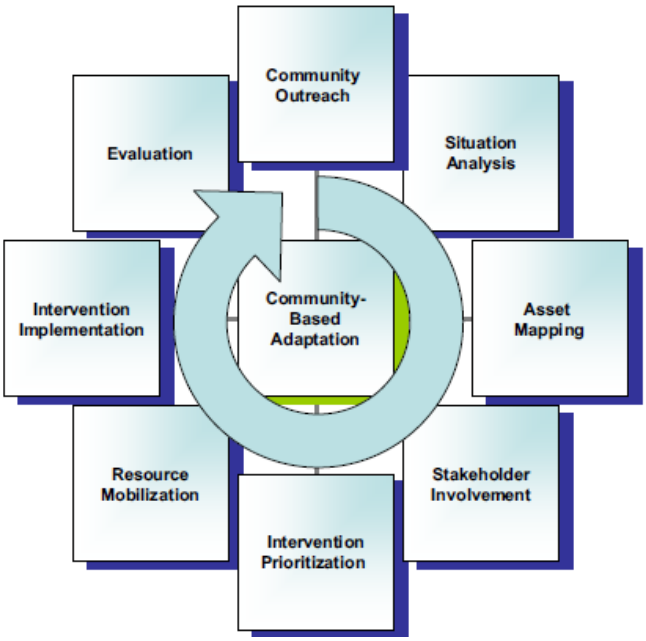
Adaptation measure should be a process, not a one time activity of risk management. This therefore, to make it success, the intervention should involve societal, cultural, political, and economic context that related to climate change vulnerability within a community. To include all these sectors, it will be more effective if we approach the strategy from local setting perspective and participative (Ebi & Emenza, 2008 Cowden, 2008).

Local setting means the strategy should be based on the local situation such as local climate related hazard, local vulnerability, and local capacity (Ebi & Semenza, 2008; Cowden, 2008). In relation to this, community engagement will be the back bone in this adaptation process. With community involvement, adaptation process will not only enhance their resiliency to climate risks, but also will improve their ability to cope with other social-environmental issues that relate to climate issues (Hallagete, 2008; Ebi & Emenza, 2008).

Freire (1994) has listed some reason why community participation process is important: (1) People will act on issues about which they feel strongly. Education programs begin by identifying those issues about which communities speak with excitement, fear, hope, anxiety or anger; (2) all people have the capacity to solve the problems; (3) everyone has different perspectives based on their own experiences; (4) action is more effective when people stop to reflect upon a problem, analyze it, and seek it to identify what needs to be done to bring about change.

In relation to this, Labonte (1997) defines participation as a concept that describes the attempts to bring different stakeholders together around problem-posing, problem-solving and decision making. Ebi and Emenza (2008) suggest the framework of community based adaptation strategy that includes: (1) Community outreach, (2) situation analysis, (3) asset mapping, (4) stakeholders involvement, (5) Intervention prioritization, (6) resource mobilization, (7) intervention implementation, and (8) monitoring and evaluation. Figure 5 below shows this framework.

Figure 5 The framework of community based adaptation strategy



Source: (Ebi & Emenza, 2008)

From the figure 5, it is clear that the first step of the community based adaptation response is community outreach. In community outreach, along with the community, we will define the major issues of climate change and the most frequent climate change risks within their area. Then, we need to conduct participatory situation analysis, where the needs of community and the constraints for adaptation will be listed and explored. In this step, the factors that enhance the vulnerability of the region and community to climate risk will be analysed. Afterwards, the adaptive capacity of the community will be analysed and mapped. Network to all related stakeholders should be established so that all institutions can be involved, particularly during the intervention prioritization process. Things that need to be concerned during prioritization process are local capacity, technological barriers, local wisdom, financial barriers, and sustainability (Dessai & Hulme, 2007). Therefore, all available resources should be mobilized during the implementation of the adaptation responses. Indeed, the community will be the key element of the implementation (Ebi & Emenza, 2008; Hallagete, 2008). The final step is to conduct participatory monitoring and evaluation. Early detection for mistakes is important, so that the adjustment of the adaptation intervention can be done in early phase (Ebi & Emenza, 2008).

E. Key challenges for adaptation strategy in urban settings

Urban development VS adaptation response

Urban development planning and climate change adaptation response in the potential of conflict each other (Hamin & Gurann, 2009). Adaptive capacity of a region will depend on its capacity on economic, social and human development which is closely related to income levels, inequity, urban poor development capacity, illiteracy rate, and area disparity. The adaptive capacity will also influenced by the finance capability of the government (ADB, 2009). In the context of fast growing cities in most developing countries, development in many other sectors (for instance transportation, housings, and regional development) have “sucked” the attention of the policy makers which in turn all regional finance capability will focus on these developments. This will then make a condition of where no available budget for the implementation of the adaptation strategy (Adger, 2007; UNDP, 2007).

Urban activity contributes enhance climate change risks

In most countries, jobs opportunities are still concentrated in urban areas, thus millions of people have to commute within a long distance. Indeed, this will create environmental consequences due to traffics, transportation, wasting fuel and air pollutions (Roy, 2009). From the long term perspective, this situation has the potential to contribute to global warming and climate change (Habitat, 2008; IPCC, 2007).

To address this air pollution issue, conflicts with the national interest are often occurred. This is because an abatement process will require a combination of technology such as clean technology, energy efficient and low emission transportation modes; and reduction of travel distance (Roy, 2009).

Climate change impacts are closely correlated to the communities' demand on energy. Due to the global warming, the demand for winter heating is much less than an increase for summer cooling (Hunt & Watkiss, 2007).

Energy demand is one of the most important categories within a house hold. The changes in climate variables may be induced by the type of energy sources. The winter heating dominantly needs primary fossil fuel use; meanwhile most of the summer cooling devices are associated with electricity demand. Hence may "imply higher marginal costs and be more important in economic terms than the energy balance alone suggests, especially in locations where peak electricity demand is in the summer" (Hunt & Watkiss, 2007,. P. 23). In Athens, for example, Giannakopoulus ,as cited in Hunt and Watkiss (2007), conducted research and found that by 2080, energy demand will increase in about 30% because of air conditioning. Another example comes from California where 30% of peak electricity demand was because of residential and commercial air conditioning use alone.

In certain climatic regions, climate change impacts may also increase the energy use for water supply (pumping, desalination, recycling, and water distributions); meanwhile in some regions the issue is water availability for hydro-electricity (Hunt & Watkiss, 2007).

Rapid urbanization and population growth

Urbanization is still one of the key issues in many developing countries. Urbanization will direct or indirectly increase the energy demand and consumption within a region. In addition, natural ecosystem will also be influenced by the urbanization (UNFPA, 2007). Roy (2009) notes that urbanization activity tends to create a condition of where the metropolisation process faster than the development of basic infrastructure. This will end up with the growth of slum areas due to the widespread of poverty. Indeed, the urban vulnerability will be accumulated (Habitat, 2008). Cowden (2008) notes the rapid population growth issue will be one of the main obstacles for urban water supplies and infrastructure. In some cases in most major cities, due to the incapability of the local government to provide new infrastructure and proper housings for all population, illegal settlements is growing very fast (Cowden, 2008). This will increase the vulnerability factors within a region, in which will adversely impact the adaptive capacity of the respective region (Adger, 2007).

F. Best practices from other countries

1. Dhaka Metropolitan City, Bangladesh

Bangladesh is one of countries that most vulnerable to the implications of global warming and climate change. This is because of some background reasons such as unique geographic location, dominance of floodplains, low elevation from the sea, high population density, high levels of poverty, and overwhelming dependence on nature (Ahmed, 2004; Bangladesh Government, UNDP, & USAID, 2007; Roy, 2009).

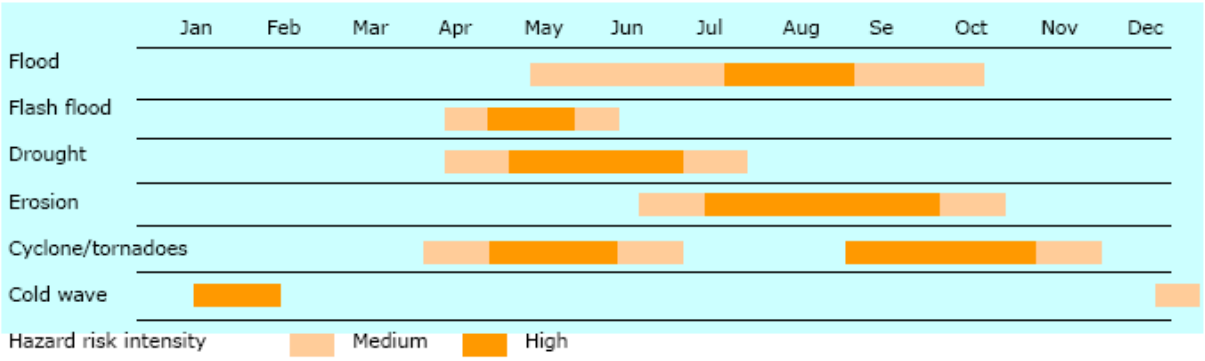
Almost all the areas of Bangladesh are situated in very low and flat topography, except the northeast and southeast regions. Only about 10% of the country is above the mean sea level (MSL) and one third is under tidal excursions (Bangladesh Government et al., 2007). It is therefore, Sea Level Rise (SLR) is one of the main threats for Bangla people (Bangladesh Government et al., 2007).

Background to the problem in Dhaka

The capitol city of Bangladesh – Dhaka – is the 11th biggest mega cities in the world. The population growth in Dhaka is one of the fastest in the world (Roy, 2009). It is estimated that by 2015

Bangladesh is also prone to climate related hazards such as flood, flash flood, drought, erosion, cyclone, and cold wave. The climate variables (temperature, precipitation, rainfall) of Bangladesh are much influenced monsoon and partly by pre-monsoon and post monsoon circulations. The figure 5 below indicates the six most frequent climate related hazard events in Bangladesh. From this figure it is clear that each type of hazards has their own typical season which much influenced by climatic season (Bangladesh Government et al., 2007; Huq, n.d).

Figure 6 Climate related hazard seasons in Bangladesh



Source: (Bangladesh Government et al., 2007, p. 5)

Intergovernmental Panel for Climate Change (IPCC) in their publication of Fourth Assessment has listed the climate-related problems in Bangladesh that include:

- In Bangladesh, average temperature has registered an increasing trend of about 1°C in May and 0.5°C in November during the 14 year period from 1985 to 1998.
- The annual mean rainfall exhibits increasing trends in Bangladesh. Decadal rain anomalies are above long term averages since 1960s.
- Serious and recurring floods have taken place during 2002, 2003, and 2004. Cyclones originating from the Bay of Bengal have been noted to decrease since 1970 but the intensity has increased.

- Frequency of monsoon depressions and cyclones formation in Bay of Bengal has increased.
- Water shortages has been attributed to rapid urbanization and industrialization, population growth and inefficient water use, which are aggravated by changing climate and its adverse impacts on demand, supply and water quality.
- Salt water from the Bay of Bengal is reported to have penetrated 100 km or more inland along tributary channels during the dry season.
- The precipitation decline and droughts has resulted in the drying up of wetlands and severe degradation of ecosystems.

(As cited in Bangladesh Government et al., 2007, p. 9)

Figure 7 summarizes the environmental impact of climate change and socio economic resources and sectors affected in Bangladesh.

Figure 7 Environmental impacts and socio-economic resources & sectors affected in Bangladesh

Environmental Impacts	Socio-economic Resources & Sectors affected
• Changes in rainfall patterns • Increased frequency and severity of: Floods Droughts Storms Heat waves • Changes in growing seasons and regions • Changes in water quality and quantity • Sea level rise • Glacial melt	• Water resources • Agriculture and forestry • Food security • Human health • Infrastructure (e.g. transport) • Settlements: displacement of inhabitants and loss of livelihood • Coastal management • Industry and energy • Disaster response & recovery plans

Source: (Bangladesh Government et al., 2007, p. 10)

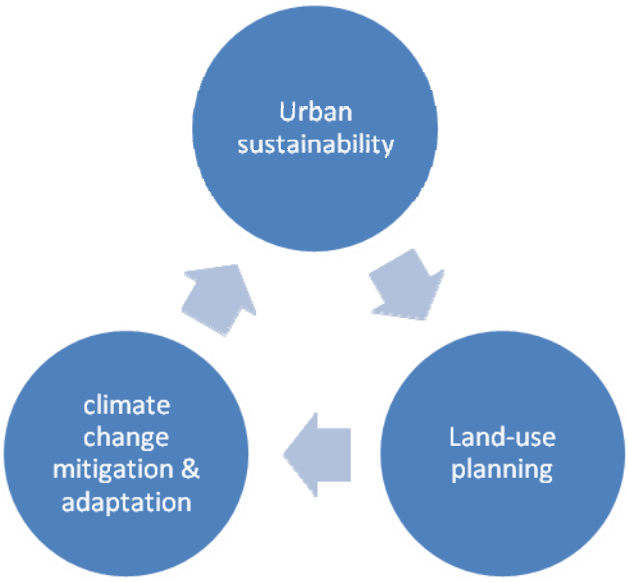
As can bee seen in the above figure, the impacts are felt most in the following sectors: water resources, coastal resources, agriculture, health, livelihoods, food security, and habitat/settlement security.

In respond to this issue, the National Government is really committed to take concrete and sustainable actions to limit the impact of climate change by reducing the risks and vulnerabilities of its people.

Climate Change Urban Adaptation Strategies in Dhaka: Dealing with floods

Climate change urban adaptation in Dhaka implements an integrative planning between urban sustainability, land use planning, and climate change mitigation & adaptation (Roy, 2009) (see figure 8).

Figure 8 Linking urban adaptation, land-use planning, and climate change issues



Modified from Roy (2009)

Table 1 summarizes the Dhaka Metropolitan Development Planning Support System (DMPSS) which integrates between land-use planning, urban sustainability, and climate change issues in Dhaka, Bangladesh

Table 1 Integration program of Land-use planning, urban sustainability, and climate change in Dhaka

Activities for progressing towards overall urban sustainability[1]	**Specific relevance to climate change**
<u>Economic</u> **Land-use planning activities**: 1. Decentralisation, generation and a more balanced distribution of employment 2. Establishment of Export Processing Zones for promoting exported-led production 3. Establishment linkage between the formal and informal sector, rural and urban economy	1. Enhancement of financial capital; reduction of travel time and distance, congestion, overcrowding and heat island effect 2. Enhancement of financial capital; reduction of exposure to industrial pollution; promotion clean energy 3. Enhancement of financial and social capital; synergy between rural and urban climate change responses

Urban sustainability 4. Provision of micro credit by NGOs 5. Strengthening of small and micro enterprises, particularly those developed by women 6. Expansion of initiatives such as the UNDP assisted Local Partnership for Urban Poverty Alleviation Project, which aims to build the capacity of the urban poor	4. Enhancement of financial and social capital; reduction of vulnerability of the poor 5. Enhancement of financial and social capital; reduction of vulnerability of women 6. Enhancement of financial and social capital; reduction of vulnerability of the poor
<u>Social/institutional</u> **Land-use planning activities:** 7. Adoption of a strategic approach to planning 8. Increased public transportation in the planning process 9. Preparation of land use plans addressing the effects of land use alterations 10. Strengthening the participation in and responsiveness of municipal authorities 11. Research and development in the field of building materials and construction **Urban sustainability** 12. Mechanism for private developers to promote low cost housing schemes 13. Development of secondary town 14. Enhanced community participation in the Slum Improvement Project Components of the Urban Infrastructure Projects of	7. Enhancement of responsive capacity; synergy between national and urban climate change strategies 8. Increase of public awareness; enhancement of responsive capacity 9. Reduction exposure and vulnerability; enhancement of responsive capacity, protection of carbon sink 10. Enhancement of responsive capacity of local government 11. Enhancement of energy efficiency and resilience of the built environment 12. Enhancement of resilience; reduction of vulnerability of the poor 13. Enhancement of responsive capacity; synergy between national and urban climate change strategies 14. Enhancement of resilience and reduction exposures and vulnerability of the poor

Local Government Engineering Department 15. Health Services Program, which involves stakeholders in the preparation and delivery of services.	15. Enhancement of resilience and reduction exposures and vulnerability of the poor
Environmental **Land-use planning** 16. A proper implementation of environment by laws	16. Reduction of exposures and vulnerability; and enhancement of responsive capacity
17. A reduction in the average travel time through a balanced distribution of works places	17. Reduction of travel time and distance, congestion, overcrowding, and heat island effect
18. Preservation of land with good agricultural productivity and ecological importance within peri-urban and urban areas	18. Enhancement of productive capacity; enhancement of resilience; protection and enhancement of carbon sinks
19. Flood mitigation and adaptation measures	19. Reduction of vulnerability; enhancement of responsive capacity
Urban sustainability 20. Increased recycling, improved solid waste management, waste water treatment, sanitation arrangement, and measures to tackle pollution from industry and vehicles	20. Reduction of exposure and vulnerability; reduction of GHG emissions

Source: Roy (2009, p. 279)

2. Case study of Kenya: Dealing with climate related communicable diseases

Kenya is located in the East Africa region which relatively cool and breezy highland area. Due to this cool and breezy environment, for many years, Malaria prevalence had been very low in Kenya compare to other lower African country. This is because, malaria could not tolerate to the area with temperature lower than 18^0C (CCAA, 2007).

However, recently, due to the global warming, it was recorded that from 1997-1998, the global temperature in Kenya has increased in about four degrees. One of the implications of this climate changes, the incidence of Malaria was increased 300% over the baseline average (CCAA, 2007) Until now, Malaria is an emerging climate related epidemic in Kenya. Almost 40,000 of infants die every year because of Malaria in this country (Opondo, 2007). Besides

climate factor, some human factors have worsened the situation. The highland dwellers have low malarial resistance and the health system in highland areas is lack of preparation for epidemic events.

Researchers at the Kenya Medical Research Institute (KEMRI) found that the outbreaks of malaria in Kenya's highland districts have correlation with the warmer and wetter conditions, especially during the El Nino episode in 1997-1998. This finding was supported by medical records in Ethiopia which showed the high degree of relationship between rainfall and temperature increases and malarial incidences (CCAA, 2007).

To deal with this issue, KEMRI conducted Malaria projection study which aimed to create a malaria prediction model that identifies risk conditions in highland temperature using a simple formula. KEMRI used the climatic factors to detect the future epidemic which expected to be happened in about 2-4 months. This projection will provide sufficient time for Kenyan Government to do the climate related epidemic preparation strategy. As the time is sufficient, the health workers can respond immediately by taking preventive measures like distributing mosquito nets, spraying mosquito breeding places, prepare the adequate staff and medical supplies (CCAA, 2007; Opondo, 2007). Figure 9 shows a health officer is surveying the breeding places of mosquitoes.

Figure 9 Mosquito Breeding places and Population at risk in Kenya

The project will promote active collaboration among six key stakeholder groups: the subsistence farming community at risk, health service providers, NGOs, environmental health scientists, government health policy makers and donors.

To ensure the effectiveness of the strategy, several important partners need to be involved including the community at risk, health service providers, NGOs, environmental health scientist, government health policy makers, and donors(Opondo, 2007).

The institutions those were involved are: Kenya Medical Research Institute (KEMRI) (Project leader), Ministry of Health (Uganda), National Institute for Medical Research (Tanzania), Intergovernmental Authority on Development's Climate Prediction and Application Centre, International Centre for Insect Physiology and Ecology, Community Health Support (Kenyan NGO), Walter Reed Army Institute for Research (U.S.). Some institutions from neighbor countries are useful in this Malaria case because the nature of this communicable disease is borderless (CCAA, 2007).

The key stakeholders within this adaptation strategy are: National health ministries, Local health planning authorities, and of course, Highland communities.

Beside this projection method, some activities which are being conducted to deal with Malaria issue for the period of 2007-2010 are (CCAA, 2007):

- Mapping the local terrain and the immune profile of the affected population. Comparing the traditionally malaria endemic areas where people have some level of immunity (or resistance), and newly infected areas where there is less immunity of the people.
- Improving the capacity of decision makers (either local or national) and health officers to provide early warning strategy for malaria outbreaks and an effective outbreak prevention action.
- Assessing the role of nonbiophysical factors in determining the incidence and control of the disease.
- Training district health care providers to use the prediction model to prevent and get ready for the outbreak events.

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