NATURAL DISASTERS AND CLIMATE CHANGE IN ASIA

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Editors:
Julian Hunt
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Workshop on Natural Disasters and Climate Change in Asia

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Foreword

Assalamualaikum WBT & Salam Sejahtera

The Southeast Asia Disaster Prevention Research Institute (SEADPRI-UKM) was established in June 2008 at Universiti Kebangsaan Malaysia. The Institute addresses crucial challenges on disaster risk reduction in the Southeast Asian region. The importance of having a research focal point in this region was felt when Malaysia and neighbouring countries grappled with various issues related to science and governance in facing the 26.12.04 tsunami disaster. SEADPRI-UKM was created to provide basic solutions for disaster prevention through multidisciplinary, interdisciplinary and transdisciplinary research on risk management to bridge the science-governance interface. The focus of research is on climatic hazards, geological hazards and technological hazards. The emphasis is on capacity building, mainly through post-graduate programmes and specialised training.

SEADPRI-UKM is proud to jointly host the Workshop on Natural Disasters and Climate Change in Asia with the Cambridge Malaysian Education and Development Trust (CMEDT) in Association with the Malaysian Commonwealth Studies Centre (MCSC) at University of Cambridge, National Security Council of the Prime Minister's Department and the Ministry of Natural Resources and Environment. The Workshop serves to strengthen existing ties between Universiti Kebangsaan Malaysia and University of Cambridge whilst exploring the possibility of establishing an affiliation of networks and institutions working on issues related to natural disasters and climate change in Asia, to facilitate better information sharing and collaboration between operational and research centres. The participation of the National Security Council of the Prime Minister's Department and the Ministry of Natural Resources and Environment, which are National Focal Points for disaster risk reduction and climate change adaptation, respectively, serves to remind us on the need for policy relevance in all our initiatives.

SEADPRI-UKM has played an active role in building capacity to implement the Hyogo Framework for Action (HFA) 2005-2015 in the region. Our researchers have always supported the National Security Council in preparing for the bi-annual Asian Ministerial Conferences on Disaster Risk Reduction and Global Platforms for Disaster Risk Reduction of the United Nations International Strategy for Disaster Reduction (UNISDR). At the national level, SEADPRI-UKM bridges the disaster risk reduction and climate change adaptation fraternities by working closely with both Focal Points. SEADPRI-UKM is also keeping abreast of the on-going UNISDR consultation for the post-2015 HFA agreement. I hope that the Workshop will provide insights to strengthen our inputs to this discourse.

The Workshop will most certainly provide inputs for SEADPRI-UKM in refining our work programme in the coming years. I thank all the participants, co-organisers and collaborators for their contributions in this regard.

Prof. Dr. Mazlin bin Mokhtar
Acting Director SEADPRI-UKM

Preface

Natural disasters are having a large and growing impact on societies and economies in Asia. The impact of natural disasters may increase as a result of climate change and increased variability. Also the nature and extent of these hazards is changing as a result of climate change, as well as rapidly changing patterns in agriculture, loss of forest cover, rapid urbanisation and extractive industries. Many relevant aspects of this problem are characteristic to Asia, e.g. hazards of monsoon rains and tropical cyclones, and vulnerability from extensive coastal and island infrastructure.

Recently the Intergovernmental Panel on Climate Change (IPCC) has issued a summary report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX). The report focuses on the relationship between climate change and extreme weather and climate events, and also the impacts of these events on vulnerable societies. The long term implications for sustainable development are also emphasized. The report integrates perspectives from several historically distinct research groups studying climate science, climate impacts, adaptation to climate change, and disaster risk management. This Workshop is being held for researchers, practitioners and policy makers in Asia to review findings of the IPCC-SREX, consider action plans for their implementation and create stronger regional collaborations.

The Workshop on Natural Disasters and Climate Change in Asia aims to review and publicise progress in the region regarding research on natural disasters and climate change, and policy implications. The specific objectives are to provide a platform to bring together researchers, practitioners and policy makers from the natural disasters and climate change communities; review the role of science and technology in collaboration with policy makers for managing the risks of natural disasters and climate change especially for vulnerable communities; and explore the establishment of an affiliation of networks and institutions working on issues related to natural disasters and climate change in Asia, especially better exchange of information and collaboration between operational and research centres.

Papers and Panel Sessions have been designed to highlights developments in climate change science, prediction and risk reduction in Asia, and key issues related to the policy and practice of disaster preparedness for vulnerable communities in the advent of climate change. The final Panel Session is devoted to discuss future collaboration through the proposed Asian Climate Change Network, focusing on regional priorities, proposed actions and cooperative mechanisms.

We thank the Cambridge Malaysian Education and Development Trust (CMEDT) in association with the Malaysian Commonwealth Studies Centre and Universiti Kebangsaan Malaysia for making this initiative a reality. We also thank all our co-organisers and collaborators as well as the presenters and participants of the workshop for their support.

Emeritus Professor Lord Julian Hunt and Prof. Dr. Joy Jacqueline Pereira
Convenors, Workshop on Natural Disasters and Climate Change in Asia

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THEME 1

SCIENCE, PREDICTION AND RISK REDUCTION

GLOBAL WARMING AND TYPHOON ACTIVITY IN ASIA

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Guy Carpenter Asia-Pacific Climate Impact Centre, School of Energy and Environment
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In the last few years, some researchers have suggested that as a result of global warming, sea-surface temperatures (SSTs) are likely to increase. Because an increase in SST will likely provide more available energy in the atmosphere and because tropical cyclones derive their energy from the ocean, such an increase is likely to lead to concomitant increases in tropical cyclone activity and/or intensity. These researchers demonstrated this argument through both data analyses and some model simulations. However, in the last few years, global tropical cyclone activity has been on the decrease while SST continues to rise. In the western North Pacific region, the year 2010 saw the lowest number of tropical cyclones during the last 60 years. So why does such a large discrepancy exist and what is the relationship between global warming and tropical cyclone activity, and in particular, typhoon activity in Asia? This paper will attempt to address these questions.

A careful examination of typhoon activity data during the last 100 years suggests that the increasing trend in typhoon activity identified by some researchers is simply the rising segment of a multi-decadal variation that has a period of around 30 years. Such a multi-decadal signal exists in almost all the characteristics of the typhoons – annual number, annual number of intense ones, formation locations, tracks, landfall locations and even possibly size. All such variations can be explained by changes in the atmospheric circulation as well as the SST distribution. The only exception is the total amount of rainfall associated with typhoons, which appears to be on an increasing trend, a result similar to those found in other studies on the variations in the frequency of occurrence of heavy rain events. All these results will be presented at the conference.

Such results can be interpreted as follows. Global warming does provide more energy to the atmosphere through higher evaporation. More moisture in the atmosphere means that if such moisture condenses to become rain, the rain can be heavier. However, the requirements for the formation and maintenance of a tropical cyclone are not only thermodynamic, i.e. high moisture content and an unstable atmosphere. Just outside of the main convective cloud cluster that will eventually become a tropical cyclone, the atmosphere must also have a strong cyclonic rotation in the lower atmosphere and a strong anticyclonic rotation in the upper atmosphere. In addition, the vertical wind shear near the centre of the cluster must also be weak. These dynamic conditions have not shown to become more favourable under global warming. Hence, while the thermodynamic conditions may have become more conducive for tropical cyclone formation, they are simply necessary but not sufficient conditions, the latter being the dynamic ones. On the other hand, the thermodynamic conditions alone are enough to produce more rain, and hence the increasing trend of tropical cyclone rainfall.

The main implication of these results is that although the main variations in typhoon activity have multi-decadal cycles and are unlikely related to global warming, heavier rain associated with typhoons should be expected. At landfall, such heavy rain will lead to more disasters associated with flooding, which will also be contributed by storm surge that will likely be higher due to sea-level rise caused by global warming.

MULTI-SCALE MULTI-PHYSICS SIMULATIONS FOR NATURAL DISASTERS UNDER CLIMATE CHANGE

Keiko Takahashi
Japan Agency for Marine and Earth Science and Technology (JAMSTEC)

The earth environment is one of typical complex systems that are composed of phenomena with different scales of space and time. The first prior question to be answered by scientists is how natural disasters are influenced from climate variability or climate change. As recognizing easily, multiple scales interaction and multi-physics approach should be introduced to answer the above question.

Fully coupled atmosphere-ocean-land-sea ice models are recognized widely as a most powerful tool available for forecasting future weather/climate variability. Under the condition of global warming, there have been changes in climate variability such as El Nino Southern oscillation or Indian dipole mode phenomena [1]. Furthermore, weather/climate in regional/urban areas will be influenced by climate variability or climate change. This fact requires us not only to improve model physical performance with interactions among atmosphere, ocean, land and sea-ice but also to perform a huge scale of simulations capitalizing on high performance computing capabilities.

To be focused on such emerging, diversified requirements to simulations in research on weather or climate events, the Earth Simulator Center has been developing an ultra-high resolution coupled model that incorporates non-hydrostatic atmosphere, ocean, land and sea-ice model components, which is made tailored to high performance computing architectures. We call the above coupled model Multi-scale Simulator for the Geoenvironment (MSSG) [2]. MSSG is a coupled model with a nesting scheme between the globe and a region. It means that MSSG is capable of conducting seamless, comprehensive simulations with a single model for different scales ranging from the entire globe to urban areas (Figure).

Validation simulations with MSSG will be introduced in this presentation. MSSG-A model allows us to put huge-scaled simulations into practice. The global simulation result with a world-highest horizontal resolution of 1.9 km and 32 vertical layers by using the optimized MSSG-A program on the Earth Simulator. One-week integration was performed. Results show the precipitation distribution which was obtained by incorporating cloud microphysics and is comparable to observational data. In these simulation results, the precipitation in the Indonesian region and the fine structure of fronts are captured. In addition, MSSG-A is conducted regarding 3.0km Run that is discussed in earlier sections with respect to computational performance. The structural characteristics of a typhoon such as its eye, spiral structure and associated rain band are clearly indicated. The precipitation distribution is comparable to the observational data statistically processed from the original data measured by Automated Meteorological Data Acquisition System (AMeDAS) of Japan Meteorological Agency, thus demonstrating the reproducibility of meteorological events with MSSG-A in high resolution simulations. Furthermore, now we are promoting research on various aspects of heat island phenomenon and local downpour which are unique in urban areas [3]. Tokyo metropolitan city is one of the hottest cities over the world and is well known that temperature in the area is getting increasing with three degree during this one hundred year. The increasing temperature would be caused by variety of reasons. Those reasons are complex and still not clear. In addition, during these 15 years, the frequency of heavy rain is increasing in Tokyo. In our recent research, we try to understand the consequence between heat island phenomena and increasing heavy rain using simulations with ultra high resolution MSSG. These challenges offer the basic knowledge on adaptation scenarios whether urban environment is improved by “water and green” city planning and measures.

In order understand mechanism with multi-scale interaction in climate variability, several typical events which have impacts to local area were simulated and analyzed. Those latest results will be presented and discussed from point of view multi-scale interactions.

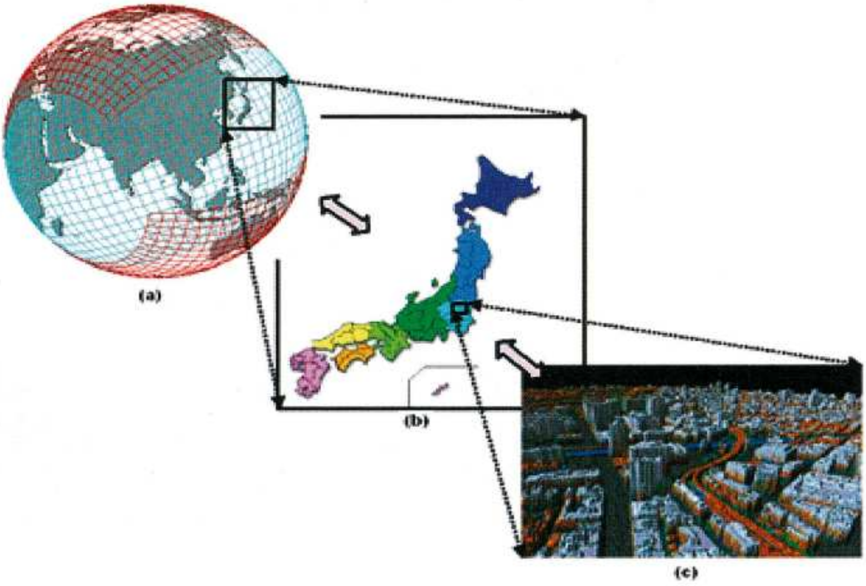

Figure. Multi-scale model representation. (a) The Yin-Yang gird system is used for global modeling. The regional model such as (b) is nested with the global model by incorporating one/two-way interactions. (c) Urban-scale weather/climate simulations are allowed with two-way interactions through the coupling with global/regional scale simulations. The urban topographical data were provided by Geographical Survey Institute.

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INTRODUCTION OF CORDEX-EAST ASIA DATABANK

Kyungsuk Cho, Juyon Im & Won-Tae Yun
Korea Meteorological Administration (KMA)

East Asia area has complex and unique geographical characteristics so that it's associated regional and/or local atmospheric phenomena are highly complicated due to non-linear interactions among climate systems as well as multi-scale interactions from mesoscale to planetary motions. Furthermore, climate change impacts in the East Asia such as extreme events or natural disasters (floods, droughts and so on) are likely expected very various and serious according to the 4th IPCC (Intergovernmental Panel on Climate Change) assessment report (AR4). Thus, high resolution climate information or dataset easily collectible and distributed is preferentially required for climate adaptation and risk management.

The CORDEX (Coordinated Regional climate Downscaling Experiment) is one of programs supporting by WCRP (World Climate Research Program) to organize an international coordinated framework to produce regional climate change projections based on research communities over the world for climate change impact and adaptation studies within the 5th IPCC Assessment Report (AR5) timeline. In addition, the major aims of the CORDEX initiative is to provide a coordinated model evaluation and a climate projection framework, and an interface to the applicants of the climate simulations in climate change impact, adaptation, and mitigation studies.

The CORDEX-East Asia databank (http://cordex-ea.climate.go.kr) which is designed as a web portal for user friendly system will be operated by KMA since the end of December 2012. All climate projections in this databank are currently produced by National Institute of Meteorological Research (NIMR)/KMA and three universities (Seoul National Univ., Yonsei Univ., and Kongju National Univ.) in Korea. Other countries such as the UK, Japan and China etc. will join in near future. The model domain set based on the CORDEX-East Asia domain (50km horizontal resolution) which is the biggest domain among eleven CORDEX domains over the world, covers most of Asia, the western Pacific, the Bay of Bengal, and the South China Sea (Fig. 1). However, all experimental regimes are different among climate projections, which will be discussed in the presentation.

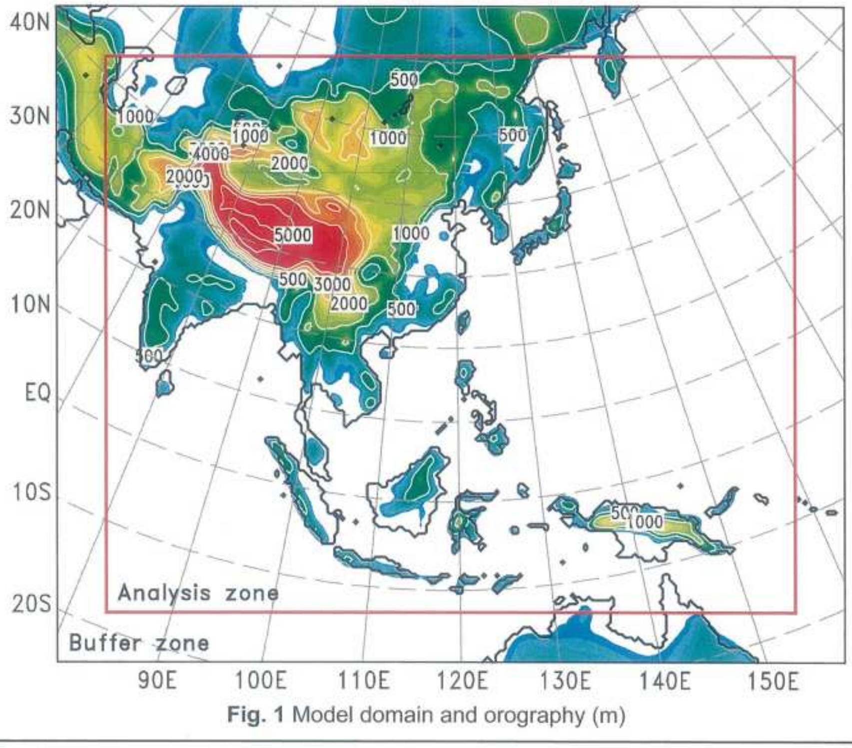

Fig. 1 Model domain and orography (m)

All output format and variables are followed as CORDEX Archive Design proposed by DMI (Danish Meteorological Institute), however, especially CORDEX-East Asia databank produces graphical products based on core variables and additionally anomalies can be calculated by users using simple statistics. Three classes of variables are provided and defined as followed; (1) Core, relevant to all communities (or users): monthly and seasonal mean (43 variables) (2) Tier 1, relevant to most communities (or users): daily surface/selected upper air data (59 variables), and (3) Tier 2, higher frequency and more complete atmospheric/surface variables (37 variables of 6-hourly and 13 variables of 3-hourly). All outputs are easily accessible and downloadable as data-files on stand lat-long grids and netCDF file conforming to agreed standards.

NIMR/KMA produced its climate projection data using HadGEM3-RA which is a Regional Climate Model (RCM) that is based on the atmospheric component of the latest Earth System Model developed by Met Office Hadley Centre (HadGEM3, 135 km resolution) under IPCC Representative Concentration Pathway (RCP) 8.5/ 4.5. The period of historical and future runs covers for 1950-2005 (56 years) and 2006-2100 (95 years) respectively. Result of historical simulation shows that the HadGEM3-RA has small large-scale drift from lateral boundary forcing and at the same time has ability to produce small-scale features due to its high resolution. This feature may lead that the RCM simulates current climate more improved than the Global Climate Model (GCM) around complicated topography and coast lines. Other climate projections based on three universities will be explained in the presentation.

DEVELOPMENTS IN THE OPERATIONAL FORECASTING OF SEVERE WEATHER EVENTS IN THE CONTEXT OF A CHANGING CLIMATE

Chris Gordon
Science Partnerships, Met Office, UK

The IPCC SREX report (IPCC, 2012) highlights that many weather extremes are likely to either occur more frequently and/or change in intensity as a consequence of anthropogenic climate change. In a number of regions this includes the increase in frequency of heavy rainfall events and the intensity of maximum cyclone winds. These extreme weather events can lead to increases in local flooding and wind damage and subsequent impacts on vulnerable populations. The SREX report also highlights the role of 'no-regrets measures' to deal with changing weather related risks. They are 'no regrets' in that these measures bring benefits under current climate and under a range of future climate change scenarios. One such measure is improved early warning systems. Put simply, if high impact severe weather events become more frequent and intense, the importance to provide early warnings of these events increases.

An important step in improving the availability of severe weather forecasts to some regions of the world has been taken by the World Meteorological Organisation (WMO) by the establishment of the Severe Weather Forecast Demonstration Projects (SWFDPs) in Southern and Eastern Africa, South Pacific Islands and SE Asia (with Bay of Bengal also planned). The main goals of SWFDP are to improve severe weather forecasting, to improve the lead-time of warnings and to improve the interaction of National Meteorological and Hydrological Services with media, disaster management and civil protection authorities. Where the provision of forecasts is concerned, the global producing centres, which run the state-of-the-art global forecast systems, make their forecasts available to the region. The models used in the global forecasting systems typically have a resolution of 20-50km. These model forecasts are provided within the SWFDPs via web portals along with guidance and interpretation provided by a specialist centre within the region.

Regional models at higher resolution are often used to provide a better representation of local weather systems. Over a number of years the Met Office has developed a UK regional forecast system based around a model that can explicitly represent atmospheric convection and that also provides a much improved representation of topographical influences on the weather. The first part of this talk will focus on this recent development in forecasting systems. The resolution of the models described will be either 4 km or 1.5 km. The forecasts produced show much greater detail in quantities that are important in severe weather, such as the forecast heavy rainfall amounts or maximum wind speeds. A further characteristic of the fully operational forecast system is that it has been designed to be relocatable to any geographical region with a minimum of effort. The forecast system was first implemented operationally in the UK and is now also being used in a number of other regions around the world. Examples will be given from the simulation of severe weather events in the UK, Australia, Lake Victoria and South Asia.

One issue that is widely recognised by the climate research community is that the climate models used in IPCC are of a too coarse resolution to properly resolve many of the weather features that are responsible for extreme weather events. For this reason, the quantitative results given in the SREX report, of for example changes in heavy rainfall events, should be regarded as preliminary estimates. In the second part of this talk, research from the Met Office Hadley Centre will be described where the high resolution models developed for severe weather forecasting (described earlier) are used in the climate context. A 1.5 km model covering the southern part of the UK has been used to simulate the statistical properties of rainfall events and these have been compared with the equivalent statistics derived from rain radar observations. These have also been compared to simulation of a regional model at a resolution typically used in the generation of regional climate scenarios. It is found that the new generation of high resolution models provide a substantially improved representation of the statistics of heavy rainfall events. This will clearly be important to estimate changes in local flood risk due to the changing frequency of these heavy rainfall events. Finally, a joint UK-US project to carry out a similar study over much of the US will be described.

The main message of this talk is that recent significant developments in science and operational forecasting systems can now be applied in the world's most vulnerable regions to substantially enhance severe weather early warnings. Working through partnerships, implementation of these systems in any region of the world is technically relatively straightforward. The increase in forecast capability needs to be combined with strengthened capacity of National Meteorological Services, emergency responders and end-user communities to enable the best use of these forecasting products in the provision of effective early warning systems.

UNDERSTANDING GLACIAL DYNAMICS IN THE HIMALAYA

Anil V. Kulkarni
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The Himalaya has one of the largest concentrations of glaciers and large area is also covered by snow during winter. Many Himalayan rivers including Indus, Ganga and Bramhputra and their numerous tributaries originate from the snow and glacier bound regions. Melt water from snow and glaciers make these Himalayan rivers perennial, and has helped to sustain and flourish several Indian civilizations along the banks of these rivers for ages. However, this source of water ought not be considered permanent, as Himalayan cryosphere is constantly changing.

However, controversial statement by IPCC report as, "Glaciers in the Himalaya are receding faster than in any other parts of the world. If present rate continues, the likelihood of them disappearing by year 2035 and perhaps sooner is very high if the Earth keeps warming at the current rate" and another statement in MoEF discussion paper, " A large mountain glacier would take 1000 to 10,000 years to respond to warming today, while small mountain glaciers take 100 to 1000 years to respond. Thus, one explanation for the glacier retreat could be: they are responding to natural warming that occurred either during the Medieval warm period in the 11 th century or to an even warmer period that occurred 6000 years ago". Both the statements are not supported by scientific evidences and speculative in nature. This error was occurred due to incomplete understanding of glacial dynamics in the Himalaya.

Conventionally health of glaciers is assessed using changes in glacial length. This could be misleading, as change in length can be influenced by numerous climatically insensitiveterrain parameters as slope, area altitude distribution, size, debris cover and orientation. In addition, retreat can also be influence by climatically sensitive parameters like mass budget and supra glacial lakes. Theseinfluences can produce complex pattern of glacial retreat and it may lead to erroneous conclusions. Therefore, it would be useful to understand changes in glacial mass to assess future changes in glacial extent.

Measurements of mass budget for glaciers in H-K region are relatively few and for short duration. The available data suggest that mass budget over large part of Himalaya has been negative over past decades and rate of loss is increased after roughly 1995. Rough estimates suggest that glaciers in Indian Himalaya losing mass at the rate of 16 Gt per year.The loss in mass for many small glaciers located in low altitude range could be larger than mean and it could be as high as 1m per year. This is substantial loss considering mean depth of small glaciers could be between 30 and 50 m. These small glaciers and ice fields are important source of water for many mountain communities. By considering small volume and large mass loss, this source of water could be significantly influenced in near future and could affect sustainability of many mountain communities. Therefore, major program needs to be undertaken to study changes in small glaciers and its impact on local communities.

The investigations in Indian Himalaya suggest that most of the glaciers are retreating and also loosing mass. This consistent shrinkage in mass and areal extent can affect stream runoff over a long term. In addition this process can be further influenced if more glacier lakes are formed due to increase in debris cover and if Black Carbon is transported in accumulation areas of the glaciers. Therefore, continuous monitoring is needed to understand changing dynamics of Himalayan glaciers.In my talk, I will discuss these issues. In addition, I will also discuss present state of Himalayan glaciers and its long term effect on people living on the banks of rivers originating from glaciated terrain.

Key words: glacier, mass balance, Himalaya, retreat, climate change

CURRENT UNDERSTANDING OF CLIMATE CHANGE AND KNOWLEDGE GAPS IN MALAYSIA

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Scientific knowledge of climate change at local and country levels is the basis for decisions on adaptation measures. At a global scale, the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) is the most comprehensive assessment of climate change scientific knowledge (IPCC 2007). However, the report provided limited assessment for regional scales. For example, the assessment for the Southeast Asia region was limited. Moreover, there was no assessment for Malaysia as IPCC report was not intended for any particular country. Hence, this paper provides an assessment of scientific knowledge of climate change over Malaysia and surrounding region based on available published literatures. For any region or country, assessment of climate change should encompass the evaluation of changes on mean climate, climate variability and extremes. Malaysia lies in the heart of the Southeast Asia region where its climate on the annual timescale is basically modulated by the Southeast Asia monsoon system. There was no available literature on the long-term changes on the onset, intensity and duration of the monsoon over Malaysia or the Southeast Asia region. In fact, there was no convincing evidence of long-term changes of mean precipitation over Malaysia associated with monsoon shifts. However, a recent study by Zhou et al. (2011) based on the satellite data indicated precipitation intensification for the last 20-30 years period over the rising regions of Walker and Hadley circulations which suggest shifts in the monsoon system. Juneng and Tangang (2010) indicated the strengthening of easterly wind over the South China Sea during winter monsoon, which may be an indication of changing monsoon circulation. However, surface mean temperature over Malaysia has been rising steadily since the last 40 years (Tangang et al. 2007). Future projection indicates some significant changes on rainfall. Similarly, the mean surface temperature is projected to increase by 3-5oC by the end of the 21st century. Several studies also indicated changes in the extreme precipitation (e.g. Suhaila et al 2010). Juneng and Tangang (2010) showed increased frequency of Borneo vortices that may result in increase of precipitation extreme events. On intra to inter-annual time scales, the climate over Malaysia and the surrounding region is also influenced by the El Nino – Southern Oscillation (ENSO) (e.g. Tangang and Juneng, 2004 and Juneng and Tangang 2005), Indian Ocean Dipole (IOD) and Madden-Julian Oscillation (MJO). Future changes on the characteristics of these phenomena due to warming climate are very likely changing the characteristics of their impacts such as drought and floods (i.e. in terms of severity, duration and affected area). For example the tendency for the ocean-atmosphere coupled system in the tropical Pacific Ocean to favor El Niño Modoki instead of the conventional El Niño in a warmer environment (e.g. Ashok et al., 2007) would mean expansion of drought affected region over Malaysia to include the Peninsular Malaysia (e.g. Feng et al., 2010). However, understanding of how major modes of climate variability such as ENSO, IOD, and MJO would be affected by anthropogenic warming is incomplete partly due to the inability of most climate models to simulate these phenomena. Overall, the amount of available literatures for assessment of scientific knowledge of climate change in Malaysia is low and much lower compared to developed countries and other countries in Asia such as Japan, Korea, China and Taiwan.

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CLIMATE CHANGE AND WEATHER EXTREMES IN MALAYSIA

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Introduction

According to the IPCC Fourth Assessment Report (IPCC, 2007), the updated 100-year linear trend from 1906-2005 shows that the global temperature has risen by 0.74±0.18oC, which is larger than the corresponding trend of 0.6oC for 1901-2000 given in the Third IPCC Assessment Report (IPCC, 2001). In the context of global warming, extreme weather and climate events have assumed significant changes in intensity, areas and frequency of occurrence (IPCC, 2007). However, extreme events are rare and difficult to identify their long-term changes (IPCC, 2012). Despite of the difficulty, understanding the trend in frequencies and occurrences of extreme weather events are of utmost importance for disaster preparedness and the enhancement of the adaptive capacity for disaster risk management. It is therefore crucial to understand the extremes trend in Malaysia, particularly on rainfall events.

Data and Methodology

The hourly precipitation data from Principal Meteorological Stations in Malaysia and projection data for the period 2000 – 2099 from the PRECIS Regional Climate Model (UNDP-GEF, 2003) driven by the HadCM3 AOGCM were used in this study. Bias correction was performed on this data using the cumulative distribution function-based downscaling method (Iizumi et. al, 2011) to scale the data for the selected station locations. Rainfall intensity was computed based on the actual highest accumulated rainfall for 1-hour, 3-hour and 24-hour period for each year, and their time series were plotted for the selected stations. The non-parametric Mann-Kendall test (Yue et al. 2002) was performed on the observed data at 95% confidence interval to detect the presence of a significant trend. Wavelet power spectrum analysis based on Torrence & Compo (1998) was performed on the observed and projected annual daily rainfall maximum data, by decomposing the time series data into time-frequency space, to determine both the dominant modes of variability and how those modes vary in time. The rainfall return period analysis was also performed according to Makkonen (2007). A 100-year return period was computed to describe the change in return periods between two 30-year periods: 1951-1980 and 1981-2010 of the observed data. A comparison of up to 100-year return periods between 2000-2099 of the PRECIS projection data and 1951-2010 observed data for the highest daily rainfall were also performed for the same meteorological stations.

Results and Discussion

Most parts of Malaysia show inconsistent and mixed trends for the 1-hour, 3-hour and 24-hour rainfall intensity. However, the central part of Peninsular Malaysia and whole of East Malaysia have their 1-hour and 3-hour rainfall intensity trends consistently increased although their respective 24-hour intensity have a decreasing trend or no apparent change, which suggests that highest intensity of rainfall from small scale convective rainfall that last only for a few hours has increased over the said region.

The wavelet power spectrum of annual daily rainfall maximum shows that most of the significant signals are found within 2 to 7-year periods and lack of regularity, which is consistent with the ENSO's irregular cycles. The projected wavelet power spectrum of the annual daily rainfall maximum from 2000 to 2099 for several referred stations shows most of the significant signals are also found within 2 to 7-year periods, indicating the ENSO remain as the main feature in modulating the temporal distribution of rainfall in this maritime continent country, but the 2 to 7-year periods are more well distributed, indicating possible increase in the frequency of ENSO events in the future climate change with more regular patterns compared to the current climate. The return period analysis shows Northern Peninsular Malaysia and West Coast of Sabah have their decrease in rainfall return period indicating an increase in the extreme rainfall events, while most parts of Malaysia have an increase in the return period indicating a decrease in extreme rainfall events. For the projection of future climate, comparison of up to 100-year return periods of the highest daily rainfall between 2000-2099 and 1951-2010 shows both significant decrease and increase in projected return periods at different locations in Malaysia.

Concluding Remarks

Changes in the large-scale atmospheric circulation as the results of global warming and natural climate change have apparently influenced the regional and local atmospheric circulation, and possibly increased climate variability and weather extremes in Malaysia. By virtue of its location in the maritime continent, Malaysia is vulnerable to the impacts of climate change.

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DROUGHT AND ITS IMPACTS IN CHINA

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The surface wetness index, Palmer drought severity index and the retrieval of soil moisture over China were calculated using monthly precipitation and monthly mean surface air temperature. Based on the contrast analysis of the variation of the above three indices and precipitation, the dry/wet spatio-temporal pattern of northern China in the last 54 years was revealed, and the evidence of drying trend over northern China was analyzed, especially. The results show the following four facts: (1) The drying trend is the main characteristic of the eastern part of Northwest China and the central part of North China since the 1980s and it was enhanced in the last 15 years mainly due to the precipitation decrease and the temperature increase; (2) During the last 54 years, there was only one dry/wet shift at the interdecadal scale occurring in the eastern part of Northwest China and the central part of North China in the late 1970s, which was related to 1977/1978 global abrupt change, whereas there were three shifts in Northeast China, one was in the mid of 1990s and the other two were in 1965 and 1983, respectively; (3) Unlike the variation trend of other sub-regions of northern China, the western part of Northwest China is currently located in a relatively wetting period, which is weakened due to the temperature increase; (4) The extreme drought frequency is obviously increasing in the eastern part of Northwest China, the central part of North China and Northeast China since the 1980s, which is closely related to the precipitation decrease and temperature increase in these sub-regions.

Based on monthly precipitation and monthly mean surface air temperature (SAT), the dry/wet trendsand shift of the central part of North China and their relationship to the Pacific Decadal Oscillation (PDO)from 1951 to 2005 have been analyzed through calculating surface wetness index (SWI). The resultsindicate that there was a prominent drying trend and an abrupt change in the analysis period. A persistentwarming period with less precipitation from the mid and late 1970s to present was found, and ashift process exists from the wet to the dry in the central part of North China during 1951-2005. Thetransition is located in the mid to late 1970s, which should be related to the shift variation of large-scaleclimate background. The correlation analysis has brought about a finding of significant correlativitybetween PDO index (PDOI) and SAT, precipitation and SWI in this region. The correlation exhibits thatthe positive phase of PDOI (warm PDO phase) matches warming, less precipitation and the droughtperiod, and the negative PDOI phase corresponds to low SAT, more precipitation and the wet period.The duration of various phases is more than 25 years. The decadal variation of sea surface temperature(SST) in the North Pacific Ocean is one of the possible causes in forming the decadal dry/wet trend andshift of the central part of North China. Finally, we give the impacts of droughts on agricultural production and water resource across China.

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EXPLORING AEROSOL-CLOUD LINKS IN DROUGHTS AND FLOODS OVER SOUTHERN INDIA

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The past decade witnessed severe drought waves in many districts of southern India and farmer suicides were reported from the state of Andhra Pradesh. In order to augment precipitation over the rain shadow region of this state, a suite of seeding experiments were conducted during 2008. Calcium Chloride was released from aircraft-based hygroscopic flares into cloud bases. Clouds were then seeded at altitudes between 1200 to 2500 metres above the mean sea level. Precipitation enhancement was indeed observed for many cases (Samaddar et al 2012). For example, during August 2008 the percentage of Rainfall attributed to cloud seeding operations in 12 disctricts of Andhra Pradesh was of the order of 18% with a cost of approximately 500,000 USD. For a developing nation the seeding costs are substantial. It was observed that these seeding experiments were not preceded by any aerosol-cloud microphysical modelling studies to consolidate optimal aerosol size distributions- in this paper we present detailed aerosol-cloud process modelling analyses to prescribe the most suitable size distributions vis-à-vis the prevailing dynamics. From an examination of the post seeding flight log, it was ascertained that the cloud base temperatures were around 20oC-ensuring the preponderance of warm rain microphysics. A detailed parcel model, with resolved microphysics was used to study the condensational growth of droplets from an observed aerosol spectrum released from the flares. The model used is one of the most sophisticated models of its kind with the capacity of handling multi-component aerosols (Ghosh et al 2007; Rap et al 2010). Repeated modeled runs consolidated the most favourable conditions during cloud seeding for the conversion of dry aerosol particles into cloud condensation nuclei (CCN). Modified Kohler Theory was invoked to ascertain activation diameters. The growth rate depended sensitively on dry aerosol particle size, updraft speed, pressure, temperature and relative humidity. Both modelling and the seeding operations showed that since the size of seeded particle were smaller than natural air-borne salt particles; the efficiency of precipitation augmentation was much curtailed. Times of onset of precipitation were calculated from analytical solutions using an optimized Kessler scheme (the preferred scheme in most Large Eddy Simulations and Climate models) scheme. Observed precipitation rates, and onset times compare favourably with modelled results.

Indian media is currently awash with claims that climate change induces extreme weather patterns. This being a sensitive issue, the subsequent focus of the paper concerns large scale flooding associated with tropical storms over the Bay of Bengal. A large number of cyclones form over this region severely affecting the coastal regions of India, Bangladesh and Myanmar. These cyclones are responsible for property damage, agricultural crop destruction, and severe loss of human life (Paul 2010). A tropical disturbance was first reported on December 23rd, 2011, by the Joint Typhoon Warning Center (JTWC) to the east of Indonesia. Over the course of the next five days the depression developed into a severe cyclonic storm as the wind speed picked up to a maximum of 150 km h-1. The cyclone, on 30th December, made landfall on the eastern coast of India resulting in a death toll of 46 and heavy damage to public property. An ENVISAT image analysis is coupled with Large Eddy Simulation (LES) runs to study the growth, progression, and dissipation of Thane. The ENVISAT analysis shows a cloud cover increase exceeding 197.5% as compared to the usual northeast monsoon cloud covers. The large cloud cover resulted in high precipitation rates over a large spatial extent. The LEM analysis shows high mean winds of the order of 20 m s-1 over Chennai city and a succession of strong up draughts and downdraughts indicating very vigorous convective activity. Interestingly, the LESs show large velocities but low to moderate wind shear ensuring that the severe cyclonic activity was not blown apart even at land fall close to Chennai. Since cyclonic storms are sensitive to precipitation forming processes, the paper analyses how cloud condensation nuclei (CCN) weaken storms by slowing down the conversion of cloud drops into precipitation.

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THAILAND FLOODS 2011: CAUSES AND SHORT & LONG TERM MEASURES

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During July-November 2011, Central Plain of Thailand suffered from the serious flooding started from July in the northern area and the flood went downward to middle area and near Bangkok area in September and October. It was the first time that flood water reached the inner city of Bangkok and caused flash flood to many main industrial estates in the suburb of Bangkok. The damages of this flooding was estimated to be more than ten times of the previous major past flooding especially to the industrial sector and in the ranking number four of disaster damage in the world. The floods also induced huge impacts to the world's insurance and hard disk industries.

Hydrological data were collected and analysed to investigate the flow peak and volume compared with the past flood events and regulating rules. The investigation on flooding causes were also conducted via interviews, field visit and data collection. Thai Government had set up a strategic committee and working teams to review and draft the long and short term flood prevention measures which included operational rule of main dams for flood fighting. Some measures had been implemented to counter this year possible flood event.

The study summarized the hydrological analysis and the causes of flooding. The Government's short & long term measures and operational rules of flood fighting were reviewed and commented.

KEYWORDS: floods, causes, short, long term, measures, operational rule, flood fighting

DEALING WITH GEOHAZARDS IN A CHANGING CLIMATE

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Introduction
The Hyogo Framework for Action (HFA) encompasses disasters triggered by geological hazards, hydrometeorological hazards, biological hazards, technological hazards and environmental degradation (UNISDR 2005). Hazardous events are different from hazardous processes (Schimidt-Thome 2006). Hazardous events are intense events that cause abrupt situational change over a specific period of time, which then reverts back to normal. The event is generally measurable with specific start and ending times. Examples include earthquakes, tsunamis, volcanic eruptions, landslides, floods, storms and forest fires. In contrast, hazardous processes are insidious and relatively slow, permanent or long lasting with unclear start and ending times. Examples of such processes are erosion, soil degradation, desertification and climate change. Events and processes are distinguished by their location, intensity, frequency and probability and they may be interrelated depending on the circumstances. The risk of a disaster may increase if a hazardous process influences a hazardous event or vice versa. Climate change is a process that influences all hydrometeorological hazards. Generally, geological hazards are not influenced by climate change. However, landslides and subsidence are to a certain extent influenced by the water table level that is sensitive to rainfall which is in turn susceptible to climate change. Depending on the circumstances, biological hazards, technological hazards and environmental degradation may also be influenced by climate change.

The Intergovernmental Panel on Climate Change released its Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) in early 2012. The SREX documents findings from the assessment of scientific literature on issues that range from the relationship between climate change and extreme weather and climate events ("climate extremes") to the implications of these events for society and sustainable development. The SREX presents evidence that parameters such as warming of extreme daily minimum and maximum temperatures; intensification of extreme precipitation; and increasing extreme coastal high water levels due to increase in mean sea level have changed as a result of anthropogenic influences, including increases in atmospheric concentrations of greenhouse gases. However, the link between single extreme events to anthropogenic climate change has not been established.

Susceptibility, Exposure and Vulnerability
The definition of vulnerability in the SREX has been modified to harmonise its usage between the disaster management and climate change adaptation communities. In the Fourth Assessment Report of the IPCC, vulnerability refers to "The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes". This definition of vulnerability includes both the physical aspects i.e. causes and its impacts; as well as the social context as expressed by concepts such as exposure, sensitivity and adaptive capacity. Vulnerability has been defined as in the SREX as "The propensity or predisposition to be adversely affected". This definition of vulnerability separates the physical aspects and emphasizes explicitly its social context.

The concept of vulnerability now has more clarity when juxtaposed with susceptibility, exposure, adaptive capacity. Susceptibility is described as the "physical predisposition of human beings, infrastructure and environment to be affected by a dangerous phenomenon due to lack of resistance and predisposition of society and ecosystems to suffer harm as a consequence of intrinsic and context conditions making it plausible that such systems once impacted will collapse or experience major harm and damage due to the influence of a hazard event". Exposure refers to "The presence of people, livelihoods, environmental services and resources, infrastructure, or economic, social, or cultural assets, in places that could be adversely affected"; and adaptive capacity is "The combination of the strengths, attributes, and resources available to an individual, community, society, or organisation that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities".

The simplicity of explanations in the SREX paves the path for developing a conceptual framework that addresses disaster risk management and climate change adaptation. The conceptual framework has to take into account the spatial context as well as existing and future susceptibility, exposure and vulnerability, in addition to projected climate and impacts. It should also draw on the best available science in the country, ranging from the atmospheric, geological, biological, chemical, and engineering to the social sciences and humanities.

Given the limitations in Malaysia, the focus should be on starting point adaptation to identify no-regret options that strengthen disaster risk reduction, in conjunction with stakeholder engagement (Pereira et al. 2012a). Research is required to produce tools that support decision-making at appropriate scales. One potential tool is the geological terrain assessment conducted by the Minerals and Geoscience Department of Malaysia (Pereira et al. 2012b). In order for terrain assessment to be more relevant to climate change adaptation, the current information on susceptibility, which represents the intrinsic weakness of a system, has to be expanded (Pereira & Ng 2010). The assessment has to include potential interaction with climate related stressors. The priority should be to delineate areas that highly susceptible to hazardous events particularly in the wake of climate change, including climate variability and extremes.

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BEYOND GREENHOUSE GASES: DIRECT HYDROCLIMATIC CONSEQUENCES OF MEGAPOLITAN EXPANSION

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The world's urbanized regions are expected to add more than 2.5 billion new inhabitants by 2050. Meeting the rising demand of urban infrastructure will require substantial conversion of natural to built environments, resulting in newly developing and rapidly expanding megapolitan areas. The emerging vulnerability of urban inhabitants to the twin forcing agents of global climate change and impacts arising from built environment growth requires assessment to begin prioritizing effective adaptation and mitigation strategies aimed at offsetting harmful consequences.

We use the rapidly ex panding Sun Corridor as a case study to investigate direct hydroclimatic consequences of rapidly urbanizing megapolitan complexes and their relation to global climate change. The Sun Corridor is the most rapidly growing megapolitan area in the United States, and is composed of four metropolitan areas in Arizona (USA): Phoenix, Tucson, Prescott and Nogales. We use scenario-based projections of Sun Corridor growth through 2050 in conjunction with the WRF modeling system, coupled to an urban canopy model, to explore direct climate consequences of rapidly urbanizing megapolitan complexes.

Multi-year, ensemble-based simulations are conducted over the continental US with a low Sun Corridor expansion scenario (SUNCORR_Lo), and a high Sun Corridor expansion scenario (SUNCORR_Hi), and are compared to a modern day representation of the urban complex. In addition, one adaptation approach (SUNCORR_Ad) is conducted, identical to SUNCORR_Hi in every respect except for the incorporation of highly reflective "cool roofs".

Results show that locally greatest summertime warming due to expansion to SUNCORR_Hi approaches 4°C, with urbanizing regions primarily experiencing a 3-4°C increase in near-surface temperature. The incorporation of cool roofs reduces this warming by about half, while a reduced expansion scenario illustrates similar magnitude warming as SUNCORR_Ad. Relative to warming owing to increased levels of greenhouse gases (LLGHGs), expansion to SUNCORR_Hi induces temperature increases at least two or three times greater through mid-century, highlighting the importance of incorporating land-based adaptation and mitigation strategies that extend beyond greenhouse gases. The particular contribution of urban-induced warming relative to LLGHGs, however, is critically dependent on urbanization paths and emissions scenarios.

Finally, we demonstrate the importance of assessing such impacts beyond a mere focus on mean temperature and argue in favor of policies targeting sustainable expansion that includes consequences for the entire climate system (e.g., to include consequences for the regional hydrologic cycle).

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THE EFFECT OF CLIMATE CHANGE ON LONG WAVES PROPAGATING ONSHORE

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Climate change and anthropogenic factors are having a major impact on the near shore topography. The two effects which will be considered in this talk will be an increase in sea levels and an increase in sea temperatures. Sea levels are increasing due to 1) thermal expansion and 2) melting of trapped water in glaciers and icebergs. Sea levels are due to increase by as much as 0.6m by 2100 (IPCC 2007), which can increase the distance up a beach that a wave has to travel by about 30m for a typical beach of slope α=0.02. The second climatic change which will be considered is that sea temperatures are increasing by as much as 1.1 C at the sea surface (Roemmich et al. 2012), which can result in coral reefs being severely degraded (Selig et al. 2012). This, in combination human influences such as coral reef mining can completey destroy coral reefs, which can result in increased tsunami inundation due to decreased drag and jetting effects, Fernando et al. (2008). The effects of this were seen during the 2004 Boxing Day tsunami in Sri Lanka, where inundation levels, where blast mining was prevalent, were far greater than in regions where this practice did not occur.

In this work, high resolution 2D numerical simulations of the Navier-Stokes equation are carried out to look at a solitary wave's momentum and energy as it propagates in typical near shore topography. The geometries which will be considered are a wave propagating over uniform depth and then interacting with a submerged semi-circular cylinder and secondly a shoaling solitary wave interacting with a submerged semi-circular cylinder. Baseline simulations with no obstacles present are carried out to highlight the effect of the obstacles. Integral measures such as momentum and energy are extracted by accurately calculating sensitive boundary and domain integrals. Morison's semi-empirical equation, which splits the force on an obstacle into drag, inertial and hydrostatic pressure differences (due to an asymmetry of the wave height across the obstacle) gives a leading order estimate for the force on an obstacle. The force on the obstacle is split into its viscous and pressure components and it is found that the pressure contribution is far greater than the viscous contribution. For a shoaling wave, the significant effect of the horizontal component of the hydrostatic pressure force on the horizontal momentum can be well predicted by the mass of the wave over the shoaling region. This shows that even for inviscid shoaling solitary waves, horizontal momentum is not conserved. As the shoaling solitary wave steepens and increases in height, it would be expected that the potential and kinetic energy would increase and decrease respectively. However, the fluid elements local to the crest of the wave are accelerated to approximately four times the fluid particle velocity over uniform depth resulting in the kinetic and potential energy increasing and decreasing respectively Qualitative diagnostics such as the normalized second invariant of the velocity gradient tensor (which distinguishes between irrotational, shearing and vortical flow regions) and vorticity are used to help interpret the flow field.

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QUADTREE FLOOD SIMULATIONS WITH SUB-GRID DIGITAL ELEVATION MODELS

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Flooding is an increasing hazard to society. Good governance nowadays implies careful water management in terms of design, planning and control of urban and rural areas. This requires that rainstorms, extreme water levels, etc. are taken into account with relevant precision. A great aid is the existence of Graphical Information Systems with raster based Digital Elevation Models. Due to modern technology, like LIDARWIKI, DEM are of ever increasing resolution. In this contribution we describe how, without adaptations, DEM can be used efficiently for detailed 2D flooding simulations. The method is based on four components: (1) sub-grid method (Casulli, 2009 or Casulli and Stelling, 2011), (2) bottom friction derived from the divided channel method. (e.g. Sturm, 2010) (3). finite volume staggered grid method for Shallow Water Equations with rapidly varied flows (Stelling and Duinmeijer, 2003) and (4) quadtrees (e.g. Wang, Borthwick and Eatock Taylor, 2003)

Cartesian grids have many advantages like simple numerical equations while generating suitable meshes is relatively quick and can be fully automated. But the accurate representation of arbitrary land water boundary outlines is often a problem. Land water interfaces vary in type. Steep walls, like quays and dikes, do not move in space as the water level changes. Here finite elements and unstructured grids might be a better solution. However for land/water boundaries that move horizontally as well, like tidal flats, river banks with mildly sloping bottoms or overland flow, every method faces similar problems. The last decades have shown a resurgence of Cartesian grids for CFD. The classical disadvantage has been largely removed by proposing flow solvers, such as cut cell , immersed boundary method, quadtrees, etc. that deal with moving and arbitrary boundaries (e.g. Aftosmis, Berger and Melton, 1998, Causon, Ingram, Mingham, 2001, Mittal and Iaccarino, 2005, Rosatti, Cesari and Bonaventura, 2005). Another development of the last decades is by raster based Digital Elevation Models of ever-growing resolution. These DEMs are often applied in flooding simulations (e.g. P.D. Bates and A.P.J. de Roo, 2000, Horritt and P.D. Bates, 2001, Marks and Bates 2000). In some papers detailed bathymetric data is used as sub-grid (Bates, 2000, Yu and Lane, 2006) that is taken into account by some kind of porosity (Cea and Vazquez-Cendon, 2010, Sanders, J.E. Schubert and H.A. Gallegos, 2008). The effect on bottom friction of sub-grid depth variation inside a coarse grid cell, might be accounted for by the definition of the so-called "effective depth (Defina 2006, Yu and Lane, 2006). Casulli (2009) and Casulli and Stelling (2011) apply detailed sub-grid data in combination with unstructured grids, both for 2D and 3D flow equations. This approach combines the advantages of accurate representation of both sharp and mild land/water interfaces. Casulli (2009) explains the non-linearity of the continuity equation due to the sub-grid combined with flooding and drying. Brugnano and Casulli (2009) give a rigorous proof of convergence of the Newton method for a sparse system of non-linear equations if the wet surface is a non-decreasing function of the water level. Flooding problems may contain different flow types within one domain such as: overland flow and rapidly varied flow due to dam break and/or dam overflow. Rapidly varied flow is often simulated with Godunov type of methods (Begnudelli, Sanders and Bradford, 2008, Cea and Vazquez-Cendon, 2010, Liang, Borthwick and Stelling, 2004) These methods however are often not very efficient for overland flow and flow in deeper water due to explicit time integration and time consuming computational procedures on non-staggered grids. Stelling and Duinmeyer (2003), Kramer and Stelling (2008) and Kernkamp, Van Dam and Stelling (2011) describe a semi-implicit method that is reasonably accurate and efficient for a variety of situations such as rapidly varied flow, overland flow and flow in normal conditions such as rivers, estuaries and coastal seas.

In our contribution we combine the best of the afore mentioned literature. Our method is based on four components: (1) sub-grid method including flooding and drying of Casulli(2009), (2) bottom friction based on the concept of roughness depth, described in this paper (3). finite volume staggered grid method for Shallow Water Equations with rapidly varied flows (Stelling and Duinmeyer, 2003) including semi-implicit time integration (Casulli and Walters 2000) and (iv) quadtrees (e.g. Wang, Borthwick and Eatock Taylor, 2003).

First we define our grids. Then we describe the integration of a fine raster grid, the DEM, with a Cartesian coarse grid. For this goal we use indicator functions to get approximating step functions with a continuous domain. The result is suitable for the application of a finite volume method. The local variation of the bottom within a coarse grid cell requires special attention for friction. For overland flow this is a dominant aspect of the momentum balance. The notion of roughness depth will be defined here to account both for depth- and roughness variation. Advection of momentum is applicable to rapidly varied flows, like dam overflow. The implicit time integration includes non-linear implicit equations suitable for flooding and drying is. We will show that a sufficiently refined sub-grid can represent both sharp and soft land/water interfaces with satisfactory accuracy, similar to cut-cells. We also show some practical examples of very efficient flood assessment in The Netherlands with the approach outlined in this contribution.

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THE IMPACTS OF CLIMATE CHANGE IN LAO PDR

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Lao PDR

Lao PDR has a high exposure, high sensitivity and low adaptive capacity to climate change (ADB, 2009). This is largely due to the fact that 80% of the Lao population rely on agriculture for their livelihood; with poor and disadvantaged groups unable to adapt to a shifting climate events. Extreme weather events and flooding have presented a serious issue for the livelihoods and welfare of the Lao people. Floods in the South of Lao PDR during the monsoon season last year caused a reported 34 people to lose their lives, 64,400 rice paddy fields to be destroyed and 140,000 homes to be under water.In the years 2000 to 2009, the total cost of flood damage in Lao PDR was USD 322.8 million (APFM, 2011). Hoanh et al. (2004) conducted an analysis of the impact ofclimate change scenarios on the flow of the Mekong River, and estimated a 16-19 percent increase in the delta maximum monthly flows, which indicates there will be more regular floods than those experienced in the south of Lao PDR last year. Minimum monthly flows in the Mekong delta were estimated to decrease by 26 – 29 percent (Hoanh et al. 2004), which will likely result in water shortages for crop irrigation and freshwater supplies during winter months. Chinvannoet. Al (2006) have identified midseason dry spells as the main risk for damaging young plants, and late-season floods before harvest as severely damaging to crop yields. Fisheries will also be affected by climate events in Lao PDR, due to the changing patterns of precipitation and snow melt, which will affect hydrology and water quality (Easterling et. al, 2007). Indirect negative effects will also arise from a change in vegetation patterns, which could alter the food chain and increase soil erosion. This will have an impact on the 1,000 species of fish commonly found in the river and the fisheries that it supports (MRC, 2003). In addition, air quality is a growing concern in the major cities of Lao PDR, especially the capital Vientiane. It is a generally held belief, by those in the Lao PDR Government and in International Agencies, that the air quality in Vientiane will deteriorate much like the cities in neighbouring countries, such as Bangkok (Thailand) and Hanoi (Vietnam). In fact, the United Nations Environment Programme and World Health Organisation have identified air quality in Vientiane as a potential issue for the future, which will be further intensified by the effects of climate change.

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IMPACTS OF NATURAL HAZARDS IN THE PHILIPPINES AND THE LATEST GOVERNMENT INITIATIVE TO ADDRESS RECURRING DISASTERS

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The Philippines being a locus of typhoons, tsunamis, earthquakes and volcanic eruptions, is a hotbed of disasters. Natural hazards inflict loss of lives and costly damage to property. Last year, the devastating impacts of Pedring, Quiel and Sendong resulted in a high number of fatalities with economic losses amounting to billions of pesos. Early this year a shallow focus 6.2 magnitude earthquake generated landslides that left 51 dead and 62 missing with total damage amounting toPhP363.5 million Situated in a region where climate and geophysical tempest is common, the Philippines will inevitably suffer from calamities similar to those experienced recently. With continued development and population growth in hazard prone areas, it is expected that damage to infrastructure and human losses would persist and even rise unless appropriate measures are immediately implemented by government.In response to President Aquino's instructions to put in place a responsive program for disaster prevention and mitigation, specifically, for the Philippines' warning agencies to be able to provide a 6 hour lead-time warning to vulnerable communities against impending floods and to use advanced technology to enhance current geo-hazard vulnerability maps, the Nationwide Operational Assessment of Hazards (NOAH) was launched by the Department of Science and Technology (DOST).NOAH's mission is to undertake disaster science research and development,advance the use of cutting edge technologies, and recommend innovative information services in government's disaster prevention and mitigation efforts. NOAH's immediate task is to integrate current disaster science research and development projects and initiate new efforts within the DOST to achieve this objective. Presently there are eight (8) component projects under the NOAH program, namely: 1) Hydromet Sensors Development, 2) LIDAR 3-D Mapping Project, 3) Flood NET-Flood Modeling Project, 4) Hazards Information Media, 5) Enhancing Geo-hazards Mapping through LIDAR, 6) Doppler System Development, 7) Landslide Sensors Development Project, and 8) Storm Surge Inundation Mapping Project. Initial efforts of Project NOAH include: deployment of weather-related sensors; use of state-of-the-art methods to construct high-resolution flood and landslide hazard maps that are relevant to the community; delivery of readily accessible, timely and accurate hazards information through various media and communication platforms; multidisciplinary disaster research and development; integration of disaster efforts by the national government, academe, civil society organizations and private sector; empowerment of Local Government Units (LGUs) and communities by providing access to near real-time data and information; and application of a bottom-up disaster prevention approach for more resilient communities.Through the use of science and technology and in partnership with the academe and other stakeholders, the government is taking a multi-disciplinary approach in developing systems, tools, and other technologies that could be operationalized by civil authorities to help prevent and mitigate disasters.

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CLIMATE-RELATED DISASTERS IN SOUTH-EAST ASIA: NATURAL OR HUMAN INDUCED?

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South-East Asia (SEA) is particularly vulnerable to climate-related hazards, such as droughts, floods, and typhoons, which can be triggered by natural climate variability (e.g., El-Niño Southern Oscillation) or human-induced climate change or a combination of both. As a result of the warming trend, theSouth-East Asian countrieswith coastal and low-lying areas are also facing the threat of sea-level rise, and storm surges, which cause coastal erosion.

A hazard, whether natural or human induced, can become a disaster if there is a loss of human lives and/or a destruction of properties and ecosystems. Climate-related hazards are no exception. However, climate-related disasters have often been termed "natural" disasters.

This paper reviews three well-known climate-related disasters in South-East Asia: the 1997 forest fires and haze associated with a prolonged drought in Indonesia, the 2008 Cyclone Nargis in Myanmar and the 2011 6-month flood in Thailand. It examines the underlying factors that contribute to the scale and severityof these disasters, and concludes that these disasters were not entirely "natural" but caused by a combination of natural and human-induced factors.

STUDY OF IMPACTS, ADAPTATION AND MITIGATION OF GLOBAL WARMING ON PADDY FIELD, OF SIKEP SAMIN COMMUNITY PATI DISTRICT, CENTRAL JAVA, INDONESIA

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Global Warming
Global average of temperature on earth increased 0.74 ± 0:18° C over the past 100 years. Global warming affects patterns of precipitation, evaporation, runoff, soil moisture and climate variations are very volatile. Climatic aberrations such as heavy rainfall, triggering floods and landslides. Climatic aberrations such as low rainfall accompanied by an increase in air temperature, causing drought. Threaten the success of the overall food production.

Community of Sikep Samin, Sukolilo - Pati Central Java.
Community of Sikep Samin are groups of people who try to run their daily lives according to the teachings of Samin. This Community of Sikep Samin most are in the Bojonegoro, Lamongan, Blitar, Madiun East Java province and region Blora, Pati, Kudus, Central Java. In carrying out this teaching (since Samin Suryo Sentiko passing away in 1914 in exile in the city of Padang West Sumatra) Community of Sikep Samin have started to adapt to the changing times and not too rigid in running pure concept teaching. Community of Sikep Samin only working on agricultural activities and exerting to make ends meet.

Climate and Rainfall
Oldeman's climate classification devide by the number of rainfall in each month. Based on the sequence of wet and dry months with specific terms are sorted as follows: (1) wet when rainfal l > 200 mm, (2) humid when precipitation 100-200 mm, (3) dry when rainfall is < 100 mm. Climate A: If > 9 consecutive wet months. Climate B: If 7-9 consecutive wet months. Climate C: If 5-6 months of wet berurutan.Iklim D: If 3-4 consecutive wet months. Climate E: If < 3 consecutive wet months.

Cropping Patterns & Field Production
Cropping pattern arranged according to the needs of farmers. The choice of plants cultivated tailored to market needs. The determination of cropping patterns and crop heavily influenced the availability of water. Cropping pattern at different water deficit when the addition of water to do. Prevalent cropping pattern: (1) rice - rice - rice, (2) rice - rice - soybean, (3) rice - rice - bero, (4) rice - soybean – without plant, (5) rice - rice, (6) rice – soybean, (7) rice.

The basic method used in this research is descriptive method (deskriftive analysis) quantitative and qualitative quantitative analysis using correlation and multiple regression analysis with the following production function: Y = f (X1, X2, X3, X4, X5). Where Y = Production, Productivity = X1, X2 = Area planted, X3 = Area harvested, X4 = Month damp / humid and X5 = Adaptation to climate change.

Tables 1 and 2 show the comparison Sikep Samin community that can reduce the risks of climate change on rice plants. Rice crop productivity of Sikep Samin higher than the average productivity in Pati regency, Central Java.

Table 1: Impact of Climate Change on Rice Plant, Pati District, Central Java

		2006	2007	2008	2009
Planting Broad (ha)	104480	280622	104018	109937	96277
Harvested (ha)	91277	92911	75131	94349	
Failed Harvest (ha)	13205	12289	28887	15587	
Flood (ha)	217	7234	2751	11398	8587
Flood (%)	0,21	8,89	2,64	10,37	
Drought (ha)	1.137	207	18.987	341	
Drought (%)	1,9	0,26	22,25	0,31	
Production (tons)	40654	459823	368025	541944	527903
Rate of Production		53283	-91789	175919	-152961
Rate of Production (%)		13.11	-19.96	47	-2.93

Table 2: Impact of Climate Change on Rice Plant, Sikep Samin Community, Pati District, Central Java

	2005	2006	2007	2008	2009
Planting Broad (ha)	101.4	101.4	101.4	101.4	101.4
Harvested (ha)	93.288	94.302	87.204	90.246	90.25
Failed Harvest (ha)					
Flood (ha)	8.11	7.10	14.20	11.15	8587
Flood (%)	12.5	14.29	7.14	9.09	
Drought (ha)	0,3	0	0	0	
Drought (%)	0,3	0	0	0	
Production (tons)	764.96	773.3	715.07	740.02	740.02
Rate of Production		8.31	-58.20	24.94	0.00
Rate of Production (%)		1.08	-8.14	3.37	0.00

Pattern Adaptation and Mitigation of Climate Change

In dealing with climate change, Sikep Samin Commnities said that crop failure occurs manage to land his own fault. Land should be valued, respected and venerated as the mother who gave birth. Land that gave birth to life everything is well off from the beginning until now. For Sikep Samin Community , respect, nurture, and preserve the balance of nature is done by understanding the nature of which should only be used to taste (not greedy) to survive in life. If not, do not be surprised if that would set the balance of nature itself, such as the presence of flooding and landslides.

Sikep Samin Community now trying to return to organic farming methods without chemical fertilizers and pesticides. They make a liquid fertilizer ingredients derived from nature, the coconut water, water used to wash rice (Leri), Moringa leaves and banana stems, fermented with molasses for about a month. When dry climate people use river water from hundreds of springs that tipped in Kars Region G. Kendeng to meet irrigation needs. That is also why community of Sikep Samin with the very fight to againts environmental destruction that is and will be happening in Kars Region G. Kendeng, where spring comes.

Conclusion

Pati climate classification Oldeman including drier climates (E). Changes in climate (wet / humid) greatly affect rice production in Pati and Community Sikep Samin. Sikep Samin community better able to adapt to climate change compared to the farming community at large. Sikep Samin community to mitigate climate change are consistent with the farming community in general.

Keywords: Climatological hazard, Climate change mitigation and adaptation, Samin Sikep Community.

CLIMATE CHANGE AND CARBON DIOXIDE SEQUESTRATION

Herbert Huppert
United Kingdom

Global consumption of energy has quadrupled over the last fifty years and shows no sign of abating. Nearly 90% comes from the combustion of fossil fuels. As a consequence, anthropogenic emissions of 34 gigatonnes per year of carbon dioxide have led to an increase in the carbon dioxide content of the atmosphere from 315 to 385 parts per million from 1960 to 2012, and a concomitant increase of average global temperature by approximately 1°C. A possible solution to this potentially disastrous imbalance is to store carbon dioxide by pumping liquid, or supercritical, carbon dioxide into porous reservoir rocks, such as depleted oil and gas fields and regional saline aquifers. The presentation will discuss the rate and form of propagation to be expected. It builds on theoretical and experimental investigations of input of liquid of one viscosity and density from a point source above an impermeable boundary, either horizontal or slanted, into a porous medium saturated with liquid of different viscosity and density. In the Sleipner natural gas field, in Norway carbon dioxide has been injected at the rate of ~ 1 Mt/yr since 1996. We will apply our results to interpret these field observations and suggest possible means of exploitation of these ideas in Asia.

NO REGRET MEASURES: RISK MANAGEMENT AND EARLY WARNING SYSTEMS FOR WEEKS TO YEARS AHEAD

Alberto Arribas
Seasonal Forecasting Group, Met Office, United Kingdom

One of the strongest recommendations to reduce the negative impacts of climate change in the IPCC SREX report (IPCC, 2012) is the implementation of early warning systems to increase the lead time of warnings and deployment of protective measures, and the use of end-to-end risk management systems to reduce the exposure of vulnerable populations and environments to natural disasters.

These are defined as 'no-regrets measures' because, independently of the benefits they would bring in the future to mitigate the adverse effects of climate change, these systems are necessary now to reduce the negative impacts of severe weather (e.g. flooding and wind damage). In other words: they are an optimal strategy to adapt to climate change in the future because they improve our adaptation to climate variability today. Crucially, if high-impact weather events were to become even more frequent and intense than they currently are, the importance to manage the risks and provide early warnings of these events would increase even further.

A clear implication of this is that we need to extend the usefulness of our operational forecasts beyond a few days and into the period covering from one week to a few years ahead. However, until recently most of the efforts and resources in the weather and climate community have been focused in either short timescales (a few days ahead as typically done for Numerical Weather Prediction) or very long timescales (50-100 years ahead for Climate Change studies). This is changing rapidly though as people start recognising the importance of improving our forecasting capabilities for intra-seasonal to inter-annual predictions (also known as near-term climate predictions).

At the Met Office – a WMO designated Global Producing Centre for long-range forecasting – a new generation of operational forecasting systems for lead times between 1-week and a few years ahead have been developed including an important design feature: these forecasting systems are now fully integrated within our scientific and technical model development process. This allows us to implement improvements faster than any other centre world-wide. For example, we have increased the horizontal resolution of our seasonal forecasting system from 300 km in 2009 to 50 km in 2012.

Forecasting for long-range remains a notoriously difficult endeavour and the skill is limited but, as will be shown in this talk, when connected to early warning and risk management systems, these forecasting systems can provide useful guidance to disaster management and civil protection authorities.

THE IMPACT OF CLIMATE CHANGE IN MYANMAR

Tun Lwin
Myanmar Climate Change Watch

By using the climatological records and the Myanmar Daily Weather Reports (MDWRs) for the period from 1950 to 2010, the changes in Myanmar Monsoon Climatology and the behavior of extreme weather events have been investigated. Three phases of changes in weather are found. These are regarded as long term, medium term and short term changes.

Long term changes are observed in monsoon climatology as early as since 1978. Delayed onset, earlier withdrawal and shorter duration in rainy season comparing to the long-term average are the main features of changes in monsoon. In addition, other changes like substantial decrease in frequency of monsoon depressions, annual increase in annual temperatures and annual decrease in annual rainfalls are also the chief findings in the investigation.

As for the mid-term change, occurrence of adverse weather and the extreme events such as thunderstorms, tornados, flash floods, land slides, heavy falls, heat waves, are more frequent annually both in terms of intensity and frequency. Moreover, Myanmar has been struck by storms each and every last six years since 2006. Increase in fatalities caused by thunderstrikes has been reported every year. In some year more than 100 fatalities caused by thunderstrike are also reported. Ten to Fifteen tornados are reported every year since 2006.

The short-term changes are primarily the frequent occurrence of El Nino and La Nina events, which normally lasted for 12-18 months. In the past the El Nino and La Nina episodes occur with a periodicity of 5 to 7 years. However, starting from 1990s, they occur more frequently in almost every one to two years.

Thus, the country is experiencing impacts from the changes in Myanmar climate in increasing the adverse weather and the weather related disasters.

COASTAL LIVING IN ASIA: WILL THE RISKS BE GREATER IN A FUTURE WARMER CLIMATE?

Adam D. Switzer
Nanyang Technological University of Singapore

Geological (e.g. Woodruff et al., 2009; Lane et al., 2011; Nott, 2011), archaeological (e.g. Roland and Ulm, 2012) and historical evidence(e.g. Lee et al., 2012) have been used to investigate the periodicity of large tropical cyclone events in many parts of the world. In Asia this type of work is in its infancy however several recent studies clearly show the vulnerability of many Asian coastlines and their inhabitants (Yu et al. 2009; Switzer and Yu, in press). Unfortunately many Asian coasts are experiencing unprecedented rates of rapid coastal development much of which is on what are clearly vulnerable coasts e.g. low lying deltas (Syvitskiet al., 2009). In many cases this development is poorly regulated with little due diligence or consideration for future scenarios of sea level rise (e.g. Kemp et al., 2011),the response of coastlines to rising global temperatures (e.g. Mann et al., 2009) and the potential for changes in cyclone periodicity or intensity (e.g. Donnelly and Woodruff, 2007). Only through integrated programs that incorporategeological analysis of long-term recurrence intervalswith shorter records from historical archives, archaeology and indigenous knowledge the task of developing affective planning policies, risk analysis and insurance pricing will likely remain ineffective. The development of such programs is timely and essentialif we are to help our rapidly developing Asian societies avoid some of the mistakes of the past.

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THEME 2

POLICY AND PRACTICE OF DISASTER PREPAREDNESS

ASEAN REGIONAL POLICY FRAMEWORK AND INITIATIVES ON CLIMATE CHANGE

Raman Letchumanan
Environment Division, ASEAN Secretariat

The ASEAN Heads of State/Government have proactively led ASEAN's efforts to address climate change issues in the region and beyond. They have consistently issued their ASEAN Leaders' Declaration/Statement on Climate Change to UNFCCC COP17/CMP7, UNFCCC COP16/CMP6, and UNFCCC COP15/CMP5 in 2012, 2011, and 2010 respectively, articulating ASEAN's common position for and expectations of the global climate change negotiations. The Roadmap for an ASEAN Community 2009-2015 adopted by the Leaders situates the ASEAN climate change agenda in the context of sustainable development outlining strategies and actions in the ASEAN Socio-cultural Community Blueprint, ASEAN Economic Community Blueprint, ASEAN Political-Security Community Blueprint, and 2nd Work Plan for the Initiative for ASEAN Integration. ASEAN is therefore addressing climate change, not just through a policy on climate change, but through the framework of ASEAN Community building, with strategies and actions rooted in the various development and sectoral areas. The presentation highlights the ASEAN climate change agenda and actions planned to address climate change.

THE GRANDEST CHALLENGE: ENABLING POLICY AND PRACTICE THROUGH NETWORKS AND PLATFORMS

Jemilah Mahmood
Humanitarian Futures Programme , King's College London

Since 2009 the Humanitarian Futures Programme, King's College London, has been supporting an exchange between a group of climate scientists, meteorologists and humanitarian organisations. The exchange includes two demonstration studies – one in Senegal and one in Kenya – as well as dialogue activities within a Natural Environment Research Council Knowledge Exchange Fellowship.

Learning from the exchange has made clear that, to effectively support those most at risk, climate information needs to be contextualised within the multi-hazard environments in which these communities live. The process of making climate science useful requires the development of dialogue approaches which challenge existing assumptions on the part of both the providers and users of science about how information can best support different levels of decision making and demonstrate value in the shorter-term. This process encompasses (1) strengthening levels of scientific literacy within communities at risk, as well as amongst the wide range of humanitarian and development agencies which seek to support them; (2) enabling scientists to develop understanding of the contexts in which scientific information is to be applied; and (3) creating approaches which support direct, two-way dialogue and identifying resources to enable more systematic, sustained provider-user frameworks for engagement.

How can the lessons be applied to the Asian context and what are the networks available for this? One mechanism would be to take advantage of the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) ratified by its 10 member states and using the available academic and civil society networks in the region.

CLIMATE DISASTERS AND CLIMATE CHANGE IN VIETNAM: TASKS, STRATEGIES AND ACTION PLANS

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Vietnam Institute of Meteorology, Hydrology and Environment

Vietnam is situated in South East Asia, stretching from 8o27 to 23o23N and from 102o08 to 109o30E. The coastal line of about 3,260 km covers the East and the South. Three-fourth Vietnam territory is covered by mountains and hills with the elevation typically from 100 to 1000 m. The plains concentrate in the down streams of two big rivers: the Red and Mekong Rivers. As a peninsula in the monsoon tropical area of Southeast Asia, Vietnam is particulared as one among nations with a high potential of being influenced by negative influences of climate change. In fact, Vietnam has already been experiencing manifestations of climate change in terms of basic climatic elements as well as extreme weather and climate events such as tropical storms, floods, heavy rains, and droughts. In recent years, under the influences of climate change, the frequency and intensity of climate disasters is increasing, causing enormous losses of human lives, property, infrastructure, economic, cultural and social impact on the environment. Only in the last 10 years (2001-2010), the types of climate and weather related disasters such as tropical storms, floods, flash floods, droughts, salinity and other natural disasters have done significant damage of life and property. More than 9,500 people had been killed and missed during this time, and the value of property damage estimated at around 1.5% GDP / year (Nguyen, T. H., 2008). This review has three main points, including (i) Climate disaster tendency in Vietnam, (ii) Strategic tasks for climate change and climate disaster reduction, and (iii) Action plans for climate change and climate disaster risk reduction.

In the first place, climate disasters in Vietnam such as floods, flash floods, droughts, heavy rainfall will increase in quantity and intensity where as drizzling rain, cold front; cold days significant decrease; frequency of tropical cyclones is not clear trend but strong typhoons increase in both frequency and intensity. Although cold days and damaging cold days decrease, extremes cold fronts are appeared more frequency (MONRE, 2012).

Secondly, this review shows teen strategic tasks for climate change as follows (Socialist Republic of Vietnam, 2011):

1. Proactively responed to natural disasters and climate monitoring
2. Food and water security
3. Positive response to sea level rise consistent vulnerable areas
4. Protection and sustainable development of forest, increasing carbon absorbabilities and biodiversity conservation
5. GHG emission reduction to protect global climate system
6. Strengthen the leading role of the Government in response to climate change
7. Community capacity development to effective respond to climate change
8. Scientific and technological development for climate change response
9. Strenthening international cooperation and integration to enhance the country's status in climate change issues.
10. Diversification of financial resources and investment focus effectively.

In terms of climate disaster risk reduction, general strategic tasks and specific strategic tasks for two biggest river deltas (Red and Mekong river deltas) in Vietnam are presented. The general tasks are (Socialist Republic of Vietnam, 2007):

1. Consolidate the system of laws, policies and mechanisms
2. Consolidate organizational structure
3. Socialization of disaster prevention, response and mitigation and human resource development
4. Ensure financial resources for natural disaster prevention, response and mitigation
5. Community awareness raising
6. Develop science and technologies on the natural disaster prevention, response and mitigation.
7. Ensure safety for dyke, reservoir and dam systems
8. Capacity building for salvage and rescue:
9. Promote international cooperation and integration

Finally, this review shows priority programmes for 2011-2015 for climate change response (Socialist Republic of Vietnam, 2008) as well as focus to implement the National Target Programs up to 2020 for climate disaster risk reduction.

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DOES ADAPTIVE POLICIES MEAN EFFECTIVE POLICIES? IMPLICATIONS FOR CLIMATE CHANGE ADAPTATION AND DISASTER RISK REDUCTION

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It has been widely regarded that policies that are adaptive in nature are better able to deal with dynamic and uncertain issues such as environmental degradation and climate change adaptation. However, verifying the veracity of this hypothesis is difficult in the field of climate change often due to absence of long experience of policy making for climate change adaptation in most countries in general. Hence, this study, which is based on a country study of natural resource management policies in Japan, looks into how various natural resource management and disaster risk reduction related policies have evolved over the years along with the evolving issues that they are designed to address and tries to answer questions such as how adaptive policies are in Japan, does adaptive policies relate to the effectiveness of policies and problem solving, and what are the political, institutional, economic and social factors that will lead to adaptive but effective policies. This paper is derived from a set of consultations and questionnaire surveys conducted in Japan. While addressing the above research questions, this study aims to draw lessons for developing countries which often lookup towards developed countries for solutions including those in policy successes. One of the interesting outcome of this study has been that indicators such as 'timeliness' of introduction of policies and 'regular updating' of policies may not necessarily translate into effective policies since other factors such as how different stakeholders understand the issue that policy intends to address, understanding on the part of the governments and institutions on how a policy works on the ground after it is designed and implemented, and most importantly the driving forces that are behind policy formulation and implementation determines the effectiveness of any policy.

IMPLEMENTATION OF GLOBAL RISK MANAGEMENT STRATEGIES FROM A MACRO - GOVERNMENTAL PERSPECTIVE

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In essence, the scientific discipline of Risk Management as a structured response to risk centres upon the body of knowledge and desired skills in managing systematically all potential risk exposures including the risk of natural disasters continually faced by individuals, companies, organizations and countries worldwide. Despite various attempts and efforts (including programs and related activities) carried out from time to time, total integration and coordination continue to be an issue of concern. Total integration of systems and processes (including databases), and also the effective coordination of various programs and activities from the Holistic Risk Management perspective urgently needs serious attention for successful implementation of global strategies. On a brighter note however, there are positive signs of better preparedness and resilience by all parties concerned. That includes active participation and continued engagement of various parties and stakeholders in recent years. In addition, the holistic approach of risk mitigation in relation to the immediate implementation of Global Risk Management Strategies would certainly contribute to effective management of risks and natural disasters from time to time. For overall efficiency therefore, the eventual implementation of Global Risk Management Strategies for effective Disaster Risk Reduction (DRR) (including Contingency Planning) and Climate Change Adaptation (CCA) requires the full support, total commitment and ultimate endorsement of all Governmental Leaders who are expected to be driving all initiatives and task-related activites for their respective countries.

Keywords: Risk Management, Holistic Risk Management, Disaster Management and/or Contingency Planning

VULNERABILITY ANALYSIS OF LOW INCOME SYSTEMS TO THE CLIMATE CHANGE THREAT

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Introduction

Global warming affects the behavioral patterns of regional atmospheric, oceanic and hydrological process-response systems and in the long term the regional and local climate of Southeast Asia. Recent studies have shown that there are marked changes in the behavioral patterns of Southeast Asia's Monsoons and its adjoining Oceanic Circulation Systems (such as the effects on the behavioral patterns Indian Dipole and El Nino Southern Oscillation Cycle (IDO and ENSO). These changes would affect regional and local weather patterns, river basin hydro-meteorological and geomorphological processes and with an impending threat of sea level rise, and associated effects of coastal degradation, saltwater intrusion and ground water contamination, flooding, and the destruction of habitats and ecosystems would pose serious threats on local population welfare and their livelihood activities. Southeast Asia's coastal regions are especially vulnerable as most of the coastal population livelihoods are dependent on coastal resources exploitation. The rural coastal populations of countries such as the Philippines, Vietnam, Thailand, Indonesia, Myanmar, Brunei and Malaysia are still very much involved with inshore and offshore fishing and rural – cottage industries that utilizes the fish products. Other than fishing, small – scale agricultural cultivation which is usually a family enterprise also dominates most of Southeast Asia coastal zones today. Apart from fishing and agriculture, tourism related activities also dominates the economy of the rural coastal populations such as in fabric and handicraft manufacturing and those associated with small scale enterprises in the provision of accommodation and food for the tourists. Any change to the onset, duration, frequency and intensity of weather events and the local and regional climate would severely affects the operation of these activities as they are not only climate governed but also climate dependent. Most Southeast Asian countries coastal populations could be categorized belonging to the low income group and many are near or below the poverty threshold line as identified based on an individual country's poverty threshold formulae. Regional climate change would severely affect the rural coastal population livelihood activities thus pushing them towards poverty or below the poverty threshold values. When this happens, it would compromise on the respective countries efforts to achieve the Millennium Development Goals (MDGs) targets of poverty eradication. The rural coastal populations' vulnerability to climate change is a function of their physical exposure and the ability to adapt to changing weather and climate conditions. Thus, vulnerability recognizes the role of societal systems in adjusting to and moderating the impacts of climate change and emphasizes the degree to which the risks of disaster can be cushioned or ameliorated by adaptive actions that can be brought within the reach of populations at risk. The significance of climate variation or change depends on the change itself and the characteristics of society exposed to it .These characteristics determine its adaptive capacity and its adaptability. Adaptive capacity refers to the ability to prepare for hazards and opportunities in advance (as in anticipatory action) and to respond or cope with the effects (as in reactive adaptation). This paper discusses the findings of a study that was conducted on the rural coastal populations of the coastal regions of Northeastern Peninsular Malaysia. The study region was chosen as it is categorized as one of the most vulnerable regions in Malaysia because of the existence of predominantly low income populations and potential threats from changing regimes of the Northeast Monsoon and Low Oceanic Pressure Cells of the South China Seas. Vulnerability analysis shows that the coastal populations are exposed to potential threats of climate change induced stresses. The populations too are dependent on livelihood activities which are mainly environment driven where income generated hovers about the national poverty threshold/line. These makes the coastal populations to be at low resilience and high vulnerability with very limited inherent coping mechanisms to manage the impending threats of climate change induced stresses.

Theoretical Framework – Vulnerability Model

Vulnerability can be defined in many ways. Vulnerability of a system to a threat (sometimes refer to stresses) describes its susceptibility to be harmed by that threat. Social scientists and climate scientists have different interpretations of the term "vulnerability". Social scientists views vulnerability as representing the set of internal and external factors that determine a system's resilience to impending threats and its ability to cope with the threats (Allen, 2003), whereas, climate scientists views vulnerability as the likelihood of impacts from threats attributed changing-behavior of weather and climate events or climate induced hazards on a particular system (Nicholls et al., 1999; IPCC FAR 2007). Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity". Adaptive capacity is "The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences". This combined vulnerability, a function of hazard, exposure and sensitivity, is sometimes referred to as physical or biophysical vulnerability (O'Brien et al., 2003). In this formulation, vulnerability is something that exists within systems independently of external threats or hazards. For many systems, vulnerability is viewed as an inherent property of that system arising from its internal characteristics. Inherent vulnerability is determined by the type of system under threat. In this formulation, it is the interaction of threat with inherent vulnerability that produces an outcome, generally measured in terms of the impacts on the system's activities and sustenance (Brooks and Adger, 2003). The nature of a system's inherent vulnerability will depend on the nature of the hazard to which the system is exposed; certain properties of a system will make it more vulnerable to certain types of hazard than to others. The integration of the risk-based and vulnerability-based approaches is desirable if we are to address the numerous threats that human systems will face in the future as a result of climate variability and change, and also from non-climate hazards. As stated by Kasperson et al. (2001), "What is essential is to assess vulnerability as an integral part of the causal chain of risk and to appreciate that altering vulnerability is one effective risk management strategy." The discussion above paved the way towards developing a conceptual framework of vulnerability and risk analysis of systems under imposing threats or stresses as a result of climate change. In this study the vulnerability model adopted consists of 3 main components – (1) threat, (2) system's at risks, and (3) adaption. The threat component examines the type of threats that are affecting a system and their changing behavior from baseline conditions. The systems at risks are the low income systems exposed to the threats. Risks are define by external and internal indicators of vulnerabilities that are associated with the systems and also include inherent adaptive capacities that the systems posses. Whereas the adaptation component describes the need for the systems' at risks to adapt to the immediate, short term and long term future towards sustainable habitation and continuing livelihood activities.

The Study Region – Coastal Zone of the Northeast Region of Peninsular Malaysia

The Northeast Region of Peninsular Malaysia was chosen as the study region because of the following reasons, (1) a coastal zone which is becoming more exposed to changing environmental conditions, (2) low income economic systems which are highly dependent on the development of environmental resources available, and (3) rural communities whose income are below the poverty threshold value of RM760.00 and many whose income hovers just above this poverty threshold value.

Methods & Materials

The study involves a number of phases. In phase 1 the study examines the low income economies of the coastal zone of the state of Kelantan and Terengganu. Data acquisition involves identification and mapping of the coastal morphogenetic zone. This was followed with identification and mapping of the low income populations that dominates the coastal zone. Information on the total number of poverty driven population was derived from secondary sources. A representative sample of 600 poverty driven low income population was selected to examine the relationships between threats, systems at risks and adaptation. Data on the vulnerability model was primarily derived in the field through observations and interviews.

Results & Interpretations

Poverty driven populations of the coastal zones of the Northeast Peninsular Malaysia can be classified as those belonging to the following low income economic systems, (1) fishing and associated activities, (2) fabric printing enterprises, (3) agriculture and associated activities, (4) tourism and associated activities, and (5) household retail enterprises. These low income economic systems are directly or indirectly affected by the state of environmental conditions which affects the availability and quality of resources and the ability to sustain an activity associated with the practices of the low income economic systems. For

example, availability and quality of fish products to be processed in the rural cottage food industries and also the influence of the state of environmental conditions on the practices of dyeing, printing and drying associated with the fabric printing enterprises. There are generic as well as specific characteristics of the low income economic systems of the coastal regions that describe their vulnerability. The main generic vulnerability indicator is their income. Income here is defined by the total remuneration a family received in a day, which could then be translated to monthly or yearly earnings (this is because in general the source of income is not fixed and consistent). However, for low income economic systems, daily income is much more important as the daily activities of the household unit are defined and governed by its daily income, with limited savings available.

Whatever limited savings that are available would be used for other social obligations inherent in the culture systems of the society which includes providing for their children education, religious obligations and needs associated with increasing the performance of their economic activities such as investing in better machineries and technologies and others. The more specific indicators of vulnerability are associated with the nature / behavior of the prevalent / impendent local environmental stress, the socio-demographic profile of the communities at risk, their external and living environment and availability of inherent cultural practices. To add to these indicators are the communities level of awareness, whether they perceived environmental stress as part of the normal cycle of man-environment relationships or whether the effect of environmental stress is actually changing and would influence their future relationships with the environment.

Discussions

Generally, in the study region, the vulnerability of the people associated with low income economic systems could be the function of many factors. 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 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 system's awareness on the nature of the threat that they are exposed to. 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. 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. Adaptation is very important amongst the poor because they are more vulnerable to the impacts of environmental change.

Conclusions

Broadly speaking, there are two reasons why the low income economic systems are vulnerable to environmental change. One is the very low inherent 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 coastal zones of the Northeast of Peninsular Malaysia which are exposed to multidimensional impacts of threats. In terms of livelihood and employment vulnerability, there is not much effort in adaptation. There are very little evidences of alternative livelihood and employment strategies taken by the population themselves as well as by the authorities. As far as infrastructure and physical adaptation, in terms of their houses and properties, the population seems to be taking small, ad hoc strategies, very much inhibited by their low income. However, the state government through the department of Irrigation and Drainage has taken various Curative and Preventive Actions, which includes:

1. Construction of erosion control structures, including: Groin, Offshore Breakwater Revetment - rock revetment and Labuan Block revetment, beach nourishment and beach management system.
2. Coastal Zone Land use Planning and Development Management with priority to natural coastal processes. Various instruments towards such planning efforts includes: a general Guidelines for development of coastal areas by the department of Irrigation and drainage, preparation of the Integrated Beach Management Plan- involving various adjoining states.

However these efforts are more focus on the mitigation of vulnerability of the environmental/ecological, not the social vulnerability which covers the community. This is especially true in terms of education and awareness towards the hazards and threats of environmental degradation especially the impending threats as a result of climate change. 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). Whatever the response, it should be an integral part of development planning. 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 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.

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METRICS FOR MAINSTREAMING ADAPTATION IN AGRICULTURE AND WATER SECTORS: INSIGHTS FROM A FARM-HOUSEHOLD LEVEL SURVEY IN TAMIL NADU, INDIA

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Both agriculture and water sectors are highly vulnerable to climate change, and hence basic livelihoods of majority of people are at risk. Increasingly, adaptation is becoming critical to rural livelihoods. In fact, vulnerable farmers are implementing different adaptation measures to counteract negative climatic impacts, though it varies temporally and spatially. Thus, it is imperative to understand current adaptive practices for successful implementation of adaptation options in the future. A few studies have emerged in this light investigating issues associated with micro-level adaptation separately (e.g. output and cost effective, and constraints related to farm, household and institutional level). The present study has attempted to develop an adaptation metrics in the context of agriculture and water sectors covering all the above issues. For empirical assessment, about 146 farmers are being interviewed from different agro-ecological zones of Tamil Nadu state of India in the perspective of seven commonly practiced adaptation measures, e.g. micro-irrigation, rain water harvesting, resistant crop, use of bio-fertilizers, crop insurance, income diversification, and community based efforts. These adaptation measures were evaluated through Analytical Hierarchy Process (AHP) using four criteria: (i) effective awareness, (ii) economic viability, (iii) individual and institutional compatibility and (iv) flexibility and independent benefits. More importantly, this study provides a methodology to evaluate different adaptation measures in order to find out the constraints, to enable target oriented policy measures to promote adaptation measures at local scale.

Key Words: adaptation metrics, agriculture, water, multi-criteria analysis, Tamil Nadu

HIGHER EDUCATION IN ENVIRONMENT AND DISASTER MANAGEMENT THROUGH UNIVERSITY NETWORK

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The Asian University Network of Environment and Disaster Management (AUEDM) is a unique initiative of prominent Asian universities that come together to share knowledge resources related to environment and disaster risk management among themselves and with the larger group of stakeholders working on these issues, in addition to conventional national and thematic boundaries. AUEDM members work in close collaboration to conduct education and research, share findings, and find ways forward in a region that is increasingly threatened by climate change impacts. AUEDM also works closely with governments, international agencies, and corporate and civil society organizations to establish collaborations that eventually lead to resilient communities. It reflects each member's commitment to implementation-oriented education and research in the field of environment and disaster risk reduction. Among AUEDM's specific objectives are:

1. To share and work together (bilaterally or multilaterally) in promoting environment and disaster risk reduction in higher education (focusing on, but not restricted to, post-graduate education);
2. To collaborate on field-based and policy-oriented research focusing on different aspects of disaster risk reduction and environmental management;
3. To broaden the scope of education and learning in the environment and disaster risk reduction field through collaboration with diverse stakeholders including NGOs and local governments;
4. To document, develop, and disseminate knowledge products in the field of environment and disaster risk reduction;
5. To provide a forum for consultation, information sharing, and cooperation among universities on matters and themes of common interest; and
6. To enhance recognition of the vital role of universities in implementation-oriented education and research in environment and disaster risk reduction

One of the specific features of the AUEDM is close cooperation with the civil society organizations. Non-government organizations (NGOs) have direct field access, and experiences in grass-root project implementation. However, these experiences are not properly reflected in the educational curriculum. Thus, the network aims at bridging academic research, education and field practice.

AUEDM has come about from needs that appear to be crucial for the survival of millions of poor and vulnerable men, women, and children living on the margins of society in Asia. Its member institutions come together for reasons of educational, research, and networking imperatives.

1. Educational imperative: To discuss the status and scope of environment and/or disaster risk reduction curriculum in the higher studies in each university.Each country has its own perspective. Some countries have a full 2-year DRR master's program. Some universities have some modules of DRR in the postgraduate programs. Therefore, the attempt is not to standardize the program, but to learn and understand the process in DRR. The challenge is how effective the process can be customized into each context.
2. Research imperative: To discuss the possibility of climate change adaptation as the key entry point of collaborative research. Each country has a high prevalence of impacts of climate change beingborne by the most vulnerable communities. Impacts are most visible oncoastal, mountain, urban poor, and migrant communities. Becauseadaptation is a relatively new subject, heavy investments need to be madein research on effective local adaptation as a means for coping withimminent climate change impacts and linked disasters.
3. Network imperative: To discuss the establishment of the Asian Universities Network. While there are integral commonalities in the vulnerability context and thenature of impacts, the local setting and contextual nuances are highly variedacross Asian countries. Networking is the only way to share knowledge

andexperiences, and to draw lessons based on principles derived from practices.The network is thus expected to go a long way in the development of aregional knowledge base, making it accessible for practitioners, and using itto influence the policy environment.

Initiated through a workshop held on July 28-29 at the Kyoto University, AUDM now composed of 25 Universities representing 17 countries in Asia. Its key activities include the following: 1) developing higher education essentials for DRR; 2) developing implementation research guidelines; 3) bilateral and/or trilateral projects under AUEDM framework; 4) exchange of students and faculty members; 5) student internships; organize workshops and focused meetings; and publish research papers, journals, books. Among its research priority activities are: 1) linking higher education to research and its implementation; 2) field based action research; identifying gaps and opportunities for regional research; 3) regional policy directions on DRR and CCA; 4) bilateral collaboration with multilateral application; 5) Sharing of experience and capacity building for research; and 6) publication and information dissemination. AUEDM publishes the Asian Journal of Environment and Disaster Management (AJEDM), an interdisciplinary journal that has started to gain wide readership among academics, practitioners and students working in the field of environment and DRR.

ASIA PACIFIC ADAPTATION NETWORK

Puja Sawhney
Asia Pacific Adaptation Network

Adaptation is a knowledge-intensive undertaking, and access to relevant and usable knowledge is an important prerequisite for successful adaptation efforts. The need for information and knowledge spans the interlinked stages of adaptation actions, from climate change impact assessment and vulnerability analysis, through policy making and planning, to piloting, demonstrating, and full-scale implementation. Huge knowledge gaps are observed in many critical areas for adaptation such as autonomous adaptation processes, management of critical ecosystems, migration, human health, water management and financing mechanisms for risk management. In particular, due to the fragmentation of knowledge under different disciplines, knowledge in a packaged and ready-to-use form, integrating the different stages of adaptation, is rarely available. In addition, knowledge about adapting to climate change lies at an international level and is failing to reach those in the developing world who need it the most.

The Subsidiary Body for Scientific and Technological Advice (SBSTA) of the United Nations Framework Convention on Climate Change (UNFCCC) recognized at its 28th Session that "regional centres and networks undertaking work relevant to climate change play an important role in enhancing adaptation" and "agreed to promote existing networks for studying the impacts, vulnerability and adaptation and encourage the establishment of new networks". The discussion of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA) at the 15th Conference of the Parties (COP) proposed regional centres and networks such as those for adaptation, technology and capacity.

Since 2008, United Nations Environment Programme (UNEP) in partnership with key UN agencies and international organisations has been facilitating the development of a Global Adaptation Network (GAN). The Asia Pacific Adaptation Network (APAN) is the first network under GAN and was launced in Bangkok in October 2009.

Aims and objectives

The Network aims to help build climate resilience of vulnerable human systems, ecosystems and economies through mobilisation of knowledge and technologies to support adaptation capacity building, policy-setting, planning and best practices.

Specific objectives of APAN include the (i) generation and share knowledge and information on adaptation to enhance adaptation actions; (ii) facilitatation application of appropriate knowledge to adaptation programmes/projects;(iii) facilitation access to adaptation finance mechanisms; and (iv) development of capacity of national and local planners, communities, development partners and the private sector in adaptation.

Network Activities

APAN aims to fulfil its objective through the mobilization and sharing of knowledge and technologies to support adaptation capacity building, policy-setting, planning and practices primarily to the policy makers and national institutions in order to contribute to climate policies at the national level.

The activities of APAN are organized around a framework of knowledge management, capacity development, and adaptation integration. Adaptation knowledge management fills gaps when adaptation domains need improved understanding, such as in identifying ways to better manage risk and uncertainty or build resilience, overcome limits etc to adapt, or where there is a need for improved dissemination of existing knowledge. Capacity development recognizes the need for both strengthening the knowledge and skills of different actors at different levels to plan, design, implement, and evaluate appropriate adaptation measures, and to acquire financing and technologies for implementation as well as for integrating adaptation into development planning at different levels and in different adaptation domains. Adaptation integration covers different adaptation domains or areas of particular concern such as agriculture and food security, water resources, health and sanitation, disaster management, coastal and islands, and mountains etc, and the need for integrating adaptation into policies, strategies, plans and actions.

APAN has established a database on good adaptation practices to climate change which also includes practices on loss and damage. The database comprises of good practices from across the region outlining different approaches to climate adaptation and loss and damage to climate change. A total of a 135 are currently included in the database. The purpose of the database is to enhance exchange of good practices, help in possible replication of the good practices and ideally, be useful to policy makers.

Structure of APAN

To be able to effectively coordinate across such a large region, APAN works through a regional hub in collaboration with implementing sub-regional nodes (SRNs) and partner institutions in the Asia Pacific region building upon existing networks and initiatives. Sub-regional nodes designated under APAN coordinate activities with national partner institutes in each sub-region. APAN has five Sub-Regional Nodes covering five sub-regions in Asia-Pacific. SRNs are organisations whose key functions are to lead the implementation of the sub-regional activities of the Network in collaboration with the regional hub and national implementing partners. APAN also has three Thematic Nodes (TNs) on water, agriculture and mountains reflect the current priorities of the region and are composed of organizations with specific expertise on their respective thematic areas.

Notes

About SEADPRI-UKM

The Southeast Asia Disaster Prevention Research Institute, (SEADPRI-UKM) was established in June 2008 at Universiti Kebangsaan Malaysia. The Institute addresses crucial challenges on disaster risk reduction in the Southeast Asian region. The importance of having a research focal point in this region was felt when Malaysia and neighbouring countries grappled with various issues related to science and governance in facing the 26.12.04 tsunami disaster. SEADPRI-UKM was created to provide basic solutions for disaster prevention through multi– and inter–disciplinary research on risk management to bridge the science-governance interface. The focus of research is on climatic hazards, geological hazards and technological hazards. The emphasis is on capacity building, mainly through postgraduate programmes and specialised training.

Mengenai SEADPRI-UKM

Institut Kajian Bencana Asia Tenggara, (SEADPRI-UKM) telah ditubuhkan pada bulan Jun 2008 di Universiti Kebangsaan Malaysia. Institut ini merupakan jawapan di dalam menangani cabaran penting kepada pengurangan risiko bencana di rantau Asia Tenggara. Kepentingan mempunyai takat penyelidikan tumpuan di rantau ini telah dirasai apabila Malaysia dan negara-negara jiran bergelut dengan pelbagai isu yang berkaitan dengan sains dan tadbir urus dalam menghadapi bencana tsunami 26.12.04. SEADPRI-UKM telah diwujudkan untuk menyediakan penyelesaian asas untuk pencegahan bencana melalui penyelidikan pelbagai dan antara disiplin mengenai pengurusan risiko untuk merapatkan ahli sains-pentadbir. Tumpuan penyelidikan adalah mengenai bencana iklim, bencana geologi dan bencana teknologi. Penekanan adalah pada pembinaan keupayaan, terutamanya melalui program-program pascasiswazah dan latihan khusus.

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