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ADAPTATION NETWORK

TECHNICAL REPORT ON
TECHNOLOGY GAPS AND NEEDS IN ASIA PACIFIC

Asia Pacific Adaptation Network (APAN)
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Institute for Global Environmental Strategies (IGES)
2108-11 Kamiyamaguchi, Hayama, Kanagawa 240-0115, Japan
Tel: +81 468 553 720
Fax: +81 468 553 709
e-mail: iges@iges.or.jp
Website: www.iges.or.jp

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EXECUTIVE SUMMARY

Climate change is a very real problem being faced globally. It is a challenge to address climate change effectively, but parallely this is an opportunity in disguise of a call of the hour. Adaptation capacity that have been embossed in the different tires of the society through ages, can be upgraded to modern technology call and modified into an inclusive, succinct and sustainable form of benefit to the people directly or indirectly. Technology is an important adjunct of sustainable development. Improving environmental technology makes growth and environmental sustainability compatible. Development and use of appropriate technologies can provide a partial solution to deal with climate change. What is required is a prudent combination of new technologies and ecological sustainability, thereby addressing existing and emerging adaptation needs. The report highlights available technologies which are appropriate for the region as well as the technology gaps that need to be addressed in the identified priority sectors for climate change adaptation in the region. This report is based on the inputs from the APAN nodes.

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I. INTRODUCTION

More than half the world's population and two-thirds of its poor inhabit the Asia and Pacific region. This region has seen remarkable economic expansion over the past decades, and as a parallel impact of this progress – the degraded environment. The region is reminded of its catastrophic and endangered tread of development through a plethora of reports, events and research results, at this juncture of climate change crisis. If future production and consumption patterns remain carbon intensive,Asia's developing countries will account for more than 40 percent of global greenhouse gas emissions in the next decade (ADB, 2008).

Climate change and the associated threats from anthropogenic emissions of greenhouse gases (GHG) are among the most daunting environmental problems confronting the world today. Former US President, Bill Clinton said that "Climate change is the only thing that I believe has the power to fundamentally end the march of civilization as we know it." As laid down in the document 'Momentum for change – Urban Poor' by UNFCCC, "addressing climate change effectively is not only a challenge, but also an opportunity in disguise. There are bountiful opportunities to benefit people directly, while at the same time enhancing adaptation capacity among the different tiers of the society. These opportunities have already been seized by many stakeholders, at global, regional, national or sub-national levels. Nevertheless, the idea of addressing climate change by looking for positive opportunities is often lost amongst the challenges of limited capacity, resources and political will". On the other hand, the adaptation activities have mostly been undertaken more on the natural disaster prevention rather than management of climate change, particularly in this Asia Pacific region.

The Stern Review Report (2006) recognised that adaptation to climate change, in contrast to mitigation, will in most cases provide local benefits (including economic benefits), brought about without long delays. Adaptation actions should be integrated into development policy and planning at every level. As the poorest countries will be hit earliest and hardest, adaptation efforts in developing countries must, according to Stern, be accelerated and supported by the international community.

II. CLIMATE CHANGE, ADAPTATION AND TECHNOLOGY

It is now an accepted hypothesis that the developing countries are the most vulnerable to climate change impact. This hypothesis is based on the fact that these countries have fewer resources to adapt: socially, technologically and financially. Climate change is anticipated to have far reaching effects on the sustainable development of developing countries including their ability to attain the United Nations Millennium Development Goals by 2015 (UN 2007). Many developing countries' governments have given adaptation action a high, even urgent, priority.

Adaptation is the process of adjusting to new conditions, stresses and natural hazards that result from climate change. Adaptation to climate change takes place in response to impacts experienced already, as well as in anticipation of expected impacts. In this sense, adaptation can be a spontaneous, autonomous process that takes place depending on existing capacity (so-called 'adaptive capacity') and it can also be planned. Planned adaptation can take many forms and be driven by decision makers from a distance and by policies on a macro scale as well as locally by those involved. Both autonomous and planned adaptation may require additional outside support in terms of financing, knowledge and technology, including, in particular, guidance on how to assess who and what needs to adapt and how to do it. For this reason, there are a raft of adaptation policies, plans and projects, which are supposed to facilitate the move towards adaptation at all levels — from local to national and from regional to national. Adaptation planning involves the full spectrum of activities from identifying and assessing to implementing adaptation measures, and is informed by the assessment of impacts and vulnerability (MRC, 2010).

2.1 How technologies have addressed environmental issue

Environmental degradation is prevalent and visible at all the levels – global, national and local. The effects are easily visible in every sectors/systems of the environment. These may be in the form of biodiversity loss and growing increase of the number of endangered species, greenhouse gas emissions, depletion of stratospheric ozone, deforestation spreading at an alarming rate all over the world, pollution in the air we breathe, water we drink, arable land and the consequent acid rain. Besides, there are an array of issues of international concerns - loss of topsoil, shortages of water, food, materials, and fuels in many parts of the world. The extent and degree of degradation maybe uncertain but the causes and the consequences of such global environmental changes on national economies, human health, and livelihoods are visible and not to be ignored.

It is believed that the world must move to a more sustainable, inclusive and efficient society, one that uses resources more responsibly and organizes industrial processes in ways that minimize and re-use wastes. Technology is an important adjunct of sustainable development. Improving technology makes growth and environmental sustainability compatible. Technologies affecting all societal activities must reflect the goals of sustainable economic development following the pathways to sustainability (NRC, 1995):

Technical efforts must be directed to increase the efficiency of energy supply and energy use and to using fossil fuels in a less-polluting manner. Natural gas, which produces fewer pollutants than either oil or coal, is in abundant supply and can play an important role in the transition to an economy much less dependent on fossil fuels.

Increased food production and the improved means of storage and distribution —necessary to support a burgeoning global population—will also depend on technological advances. Biotechnology has produced new strains of crops resistant to disease and drought. Further advances in producing crop varieties naturally resistant to pests will permit a further reduction in toxic chemicals used

as pesticides. The chemical industry is now producing pesticides that degrade more quickly, that have more focused effects, and that can be applied in lower concentrations. Best management practices include crop rotation systems, the use of computers to guide chemical use, and integrated pest management.
Manufacturing and mining manufacturers have begun to reduce, re-use, and recycle materials and products in a search for industrial ecosystems that can imitate natural ones. According to this concept, wastes from one part of the system are used as inputs to other parts of the system. Zero emission technology plays its role in here too.

Environmental Technologies have been the yardstick to sustainable development over the past few decades. At this stage what is needed is a prudent combination of new technologies and ecological sustainability, thereby gearing up to climate adaptation needs.

2.2 How technologies can address adaptation

The science of climate change has long been suggesting that mankind is heading towards 'dangerous anthropogenic interference with the climate system' and is on the verge of committing to catastrophic interference(IPCC 2007).The urgency for adaptation is highlighted by projections from the three reports produced by the IPCC in 2007.The global climate system has always confronted human societies with extreme events and thus, it should be possible to adapt to some extent by modifying or extending existing technologies (UNFCCC, 2006). The process of adapting to climate variability and related changes urges for changes or sometimes shift in activities as a result of changing conditions. Unlike mitigation, the forms of technology for adaptation are fairly familiar at all levels. Interestingly, many of them have been tried and tested over generations without the "adaptation technology" tag – rainwater harvesting, building houses on stilts to cope with floods, and cultivating floating vegetable plots. On the other hand, this hi-tech world has also appreciably contributed to recent and advanced forms of adaptation, mainly in the form of advanced material science and remote satellite sensing technologies. Under the framework of the Convention on Climate change, "technology cooperation is regarded as a key area of deliberation and collaboration between the developers of technology and recipients of such technologies". To ensure that the technology cooperation is fruitful, the demand for technology has to match the supply of technology (APAN and CANSA, 2012).

Adaptation technologies refer to a wide range of tools that help to achieve actual adjustments in resilience of social institutions to climate change. In this regard adaptation measures are usually differentiated into a set of hard and soft technologies. Hard adaptation measures refer to the use of specific technologies and actions involving capital goods, whereas soft adaptation measures comprise specific knowledge, skills and practices. Clements et al (2011) elaborates this classification further by separating also organizational technologies that respond to climate change threats through establishing a necessary institutional framework. Technology development has been the result of interplay of many factors(Vergragt, 2006):

- scientific discoveries,
- changing business self-image and interests,
- changing consumer demand,
- government regulation,
- the global citizens movement,
- emerging institutions and paradigms, and
- ultimately changing dominant values.

Developing the "right" technology depends both on far-sighted individuals and on a deep insight in technological opportunities and societal consequences. None of this is easy or self-evident (Vergragt, 2006). Appropriate technologies along with traditional and indigenous technologies have proved to be of enormous value for the development of a new technological paradigm. The combination of early twenty-first century high-tech developments with the principles embodied in the knowledge and wisdom of traditional technology, have inspired many developments which we now take for granted.

Energy conservation is practiced everywhere from production technologies to transportation, housing, agriculture, and consumption. Driving forces are government, policies, rising prices, experiments with alternative energies and energy conservation, research, experiments, and development. Many projects involve technology that processes and transforms organic waste such as cattle manure into energy, fertilizer, and reusable water for irrigation, while reducing greenhouse gas emissions and other environmental impacts(Vergragt, 2006).

Methods and tools for adaptation are the various guidelines, models and frameworks that have been developed to support the process of planning adaptation. These range from complex models to assess climate change impacts to guidelines on the steps to take for identifying, designing, implementing and evaluating adaptation measures. These approaches are being developed by government agencies, NGOs, community-based organisations, universities and think-tanks. More academic approaches are often accompanied by conceptual frameworks describing how adaptation relates to development, and analytical frameworks, which provide guidance on how to understand the application of adaptation measures (MRC, 2010).

- **"Hard technologies** refer to the tangible aspects such as the manufactured objects, the machinery, the equipment and tools required to produce goods or services. For example, a sprinkler irrigation system.

- **Soft technologies** refer to the processes associated with the production and use of the hardware, including know-how (such as manuals and skills), experiences and practices (such as agricultural, management, cooking and behavioral practices). Soft technologies also encompass elements of awareness-raising, including education and training. For example, capacity building in health.

- **Organizational technologies** refer to the institutional framework, or organization, involved in the adoption and diffusion process of a new technology. Organizational technologies relate to ownership and institutional arrangements of the community/organization where the technology will be used. An example is the establishment of Water User Boards."

Source: Clements et al 2011

Table1: Definitions of approach, method and tool

Approach	A complete framework that prescribes an entire process for the assessment of vulnerability and adaptation and offers a broad strategic approach. An approach may be built on the application of certain methods and tools. Example: The UNDP Adaptation Policy Framework (2004), which provides an overview of how adaptation should be approached, rather than a specific set of 'instructions'.
Method	A set or sequence of steps that should be followed in order to accomplish a specific task within a larger framework. Methods can be implemented through using a number of tools. Example: Vulnerability and capacity assessment is a method for which a number of tools can be used.
Tool	A means or instrument by which a specific task is accomplished. Examples include: impact models, decision tools (cost-benefit analysis), stakeholder tools (vulnerability indexes).

Source: Adapted from UNFCCC (2008a).

III. ADAPTATION TO CLIMATE CHANGE IN ASIA-PACIFIC

Adaptation to climate change in developing countries is vital and has been highlighted by them as having a high or urgent priority. Though uncertainty remains about the extent of climate change impacts, in many developing countries there is sufficient information and knowledge available on strategies and plans to implement adaptation activities now. On another encouraging note, there is the necessary political recognition of the impacts of climate change and the special vulnerabilities resulting from poverty, illiteracy and social inequities, which serve as a good foundation for adaptation. However, inadequate policy support is observed in several countries. There are improvements needed in this direction. Adaptation to climate change in developing countries is vital and has been highlighted by them as having a high or urgent priority. Though uncertainty remains about the extent of climate change impacts, in many developing countries there is sufficient information and knowledge available on strategies and plans to implement adaptation activities now. On another encouraging note, there is the necessary political recognition of the impacts of climate change and the special vulnerabilities resulting from poverty, illiteracy and social inequities, which serve as a good foundation for adaptation. However, inadequate policy support is observed in several countries. There are improvements needed in this direction.

3.1 South Asia (IGES, CANSA 2012)

Success in technology co-operation is judged by the ability of positive transformational changes that could be ushered in to meet the overarching goals for the region. In this regard, South Asia has a number of goals under the aegis of climate change and development. The adaptation technology priorities in the South Asian region are pertaining to few sectors such as agriculture, water resource management, health, coastal resource management and disaster management. South Asia as a region is already trying to respond jointly on building a foundation to access the technology mechanism effectively. The region has proposed for an enhanced collaboration between the countries in the SAARC declaration of 2008. This ranges from development of an information bank, sharing of expertise on climate science, establishing centres for excellence and developing coordinated adaptation strategies. This region is on the verge of stepping into higher levels of understanding, which has already begun with the trade co-operation. Well-defined action points and proposals have been made in the areas of climate technology and information sharing.

South Asia is a region through which the network of South–South technology co-operation could be developed to its fullest extent; primarily because the region as a whole has similar industrial patterns and its needs are overlapped. In this regard, the focus should be on the core sectors where the adaptation needs are overlapped in the countries within the region. Like on agriculture where all the countries of South Asia will face a massive impact. Further, one can cross-learn from the policies that are undertaken in the different sectors within the region.Another area where the South Asian region can use its unique character to access the technology mechanism better is through cluster development and collaborative learning. Education and trainings for the people at the bottom of the pyramid aim to help them access the benefits of such established technology network (improvement in their economic conditions) and connect with the technology mechanism.

Bangladesh – one of the few countries to develop NAPA in the very early stage, and has made an attempt to mainstream the adaptation policies in their planning programmes. Agriculture has been identified as the biggest challenge in adaptation. A whole range of techno fixes have been identified in the BCCSAP for the sector, which ranges from capacity building, systematic research on developing new climate seed varieties, developing smart inputs for agriculture, etc. Climate resilient cropping pattern which will include resilient crop varieties are currently under progress. At the community level innovative practices of drip irrigation are undertaken by the people to ensure input intensive cropping pattern practices as part of the solution to address the impacts of climate change. The government research agenda has been focused on developing flood, drought, and salinity resistant crop varieties, and in this regard, the government has tried to utilize the vast knowledge and traditional varieties that are available in the country. Responses to disaster preparedness have been mainly in the form of early warning systems and cyclone shelters. The strategies for coastal areas management and adaptation measures have two dimensions – strengthening of

existing infrastructure, development and identification of new infrastructure have been envisioned. The Government has proposed to establish a Centre for Research and Knowledge Management on Climate Change in near future to ensure that latest technologies and ideas for combating climate change are developed and disseminated without any impediments.

Bhutan – Hydropower and agriculture has been identified to be the most vulnerable sectors for the country. Keeping in mind that 70 per cent of the communities are dependent on subsistence farming and repercussions of impacts can easily affect them, the country has come out with pilot programmes for the hydropower sector and agriculture and has submitted NAPA for these sectors. Low level of awareness on climate related adversities among the stakeholders has been identified. For this the sectoral approach to address this involve policies that ensure creation of awareness, building on information bank on crop and weather related phenomenon and trends, up-scaling of effective extension services for the sector, designing more efficient after production marketing services. The hard technologies are required for bringing in farm-level adaptation inputs, efficient management of inputs. In this regard there has been extensive plans of provisioning High Yielding Variety of seeds, crop diversification practices are being introduced in the country. Future strategies involve development of programmes which would ensure investment in research for heat tolerant, low water using crops, hydrological studies, more research on ways to maintain water quality etc. The government has plans to invest hugely in the development of post-harvest marketing and provisioning of fair prices to the producers. Strengthening of biophysical and socioeconomic resource use related databases, and focused research to improve our understanding of climate-ecosystem-social system interaction at the macro-and micro- levels. Increasing genetic enhancement and base-broadening efforts: Broadening the genetic base of crops can contribute to increasing stability and performance in crops. Promote sustainable agriculture through diversification of crop-production and broader-diversity in crops. The future agriculture system will need to incorporate a broader range of crops including inter alias crops, which produce raw material or are sources of energy. Actions are warranted now to encourage and facilitate the use of more diversity in breeding programmes for the varieties and species used on-farms. Innovation approaches in plant breeding for the purposes of domesticating new crops, the development of new plant varieties and the promotion of higher levels of genetic diversity in crops. On farms, use of crop mixtures of adapted varieties, are recognized as means for adding stability in agricultural systems and promoting agricultural production and food security.

Nepal - In Nepal, the focus has been on six major areas which are in future going to be affected by climate change. The approach to design strategies for these sectors has been to integrate the local level perception on changes happening with the expert knowledge that exist on the issue. Food security has been the main focus for the strategy development. The problem the country is facing is the frequent changing of the streams flow, and erratic monsoon pattern. To address these two issues, the country have already put in place indigenous methods of storing water within the streams by building small height check dams, and also building

multiple number of ponds in the valleys, to store the rain water. Apart from these, the country is also seeking help from neighbouring country like India and China to help develop short maturing seed varieties that are suitable to the region. Further, there are several civil society organizations that are currently encouraging the farmers for diversification of cropping from one crop to vegetables. The problem deriving out of water sector in Nepal is both due to too much/too little of water availability. Due to climate induced water stress, the impacts are already felt on the agricultural productivity, malnutrition, human health and sanitation. On the other hand too much of water often impacts the agricultural land, human settlements, and infrastructure. Changes in stream flow affect the micro hydro projects. Increasing number of precipitation days would affect the solar power generation potential in the installed areas. Therefore the government is now collaborating with institutions like World Bank and ADB on the micro hydro projects to increase the efficiency of the hydelpower installations, and also to ensure sustainability of the streams. Further, soft engineering technologies like building reservoirs to catch rain waters, domestic shallow wells to capture rain water flow off on household basis are practiced widely in the valley region of the country. There are also information sharing measures being undertaken to understand the changes in the precipitation trends and timings.

India–Government of India approach towards climate change has ignored the enormity of adaptation needs in India and has focussed mostly on mitigation activities. This is evident even in the recent 12th five year plan draft document where the government is focussed on reducing India's carbon emissions rather than protecting people from the vagaries of climate change. Government of India is running multiple programmes across states to drought proof agriculture. There are also policies being put in place for flood control, wasteland development and development of watersheds which help in irrigation. All these practices are being brought under the ambit of National Mission on sustainable agriculture which is trying to make technological strides in agricultural innovation, soil conservation along with promoting balanced use of fertilisers.

National Mission on sustainable agriculture has identified the following:-

» Identification and development of new varieties of crops which are thermal resistant

» Evolve cropping patterns which are capable of withstanding extreme weather patterns

» Create a knowledge network integrating traditional knowledge and practices with modern technology

» Strengthen agriculture and weather insurance and credit support mechanism

The government has also created disaster management institutional support taking into account the vulnerability of Indian subcontinent from natural extreme weather events like cyclones and seasonal floods. In the water sector, government has put a lot of resources to curtail over use of water resources across

India and has come out with various policies to ensure ground water management and to prevent pollution of water bodies. In the National Water Mission under the NAPCC, integrated water resource management is the key theme. Some other features from the mission are equitable distribution of water resources, minimizing wastage of water from industrial and domestic use, strengthening regulatory mechanism around water, incentivizing water neutral technologies, optimising and expanding irrigation potential. Besides, the Green India Mission under the NAPCC envisions biodiversity regeneration, conservation of forests, wetlands and mangroves along with protection of livelihoods. NAPCC as part of its missions also has a National Mission on Strategic Knowledge for Climate Change.

Pakistan – Has been affected by disasters recently and the government has been forced to undertake step up action towards adaptation. Key areas have been agriculture, coastal zones, water sector, and managing the extreme weather events. In the agriculture sector the measures have been initiated to address the issues of heat stress and decreased yield. To address these issues, soft technology options regarding temperature and precipitation trends both current and historical are designed. There have been short term models developed by the meteorology department on temperature patterns and precipitation. In hard technology solutions research has been initiated through rice and wheat research institutes for new varieties of crops. Loss of fresh water resources and decreased agricultural productivity has been two important issues before the policymakers to address. In this regard, techno fixes have been sought through watershed management, and surface storage options.

Sri Lanka - Focus has been on the agriculture sector, and interestingly fisheries sector has been the top priority for the government. The government has been promoting the use of culture-based fisheries – use advances in fish breeding and management to develop fish culture under diverse environmental conditions. In the agriculture sector crop diversification and precision farming - Redesign cropping patterns based on forty six agro-climatic zones to cultivate the most appropriate crops/varieties in the most appropriate zone to most effectively utilize the natural resources, inputs, agrochemicals and stabilize the productivity. Forgotten types of traditional rice varieties can offer a home grown solution to the increasing soil salinity in Sri Lanka. But there is a challenge of successful scaling up of these trials in the country. There has been attempt to restore the sand-dunes, mangrove forests and coral reef transplantations in the country and also a continued collaboration in these methods with other countries which have similar rich resources so that the success stories can be replicated. In the water sector, steps have been taken to raise the water level, conserve the rainwaters and reviving the tank reservoirs/

3.2 Southeast Asia (IGES, ICLEI 2012)

Most Southeast Asian countries are vulnerable to climate change risks and impacts. In large part, this is due to a lack of adaptive capacity towards resilience or self-organization. These are specific governance challenges at various levels of human organization.A review of the vulnerability of Southeast Asian countries to climate change in terms of risks and impacts and their specific adaptation and mitigation response shows that the most vulnerable ones evolved advanced climate change adaptation and mitigation technologies to address these risks and impacts, as well as disaster risk reduction mechanisms to recover from calamities. The Philippines was recently cited as having the best Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) policies.

A range of possible sustainability parameters for CCA/CCM technologies are suggested given the existence of climate change risks, existing policies, practices on the ground, and specific outputs and outcomes that are being achieved. One parameter suggested is that of having a policy and a mandated government body that will be responsible for: (1) the management of the environment, agriculture and natural resources; (2) climate change; (3) disaster risk reduction and management; (4) social and economic development planning and; (5) local government units (LGU) mandated and enabled to effectively implement adaptation measures. Other suggestions include: policy alignment and a correct framing of climate change and adaptation measures; integrating CCA and DRR in local development planning; and mainstreaming CCA and DRR by first incorporating them in the MDG and focusing on the achievement of the MDG. The following paragraphs deals with specific countries.

- **Brunei** – As reportedby the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report, Brunei along with Malaysia and Singapore, experiences decreasing precipitation trend, rising temperatures and rainfall variability, and increase of 10-20% in tropical cyclone intensities. In a workshop on climate change adaptation technologies they identified flooding, risk in the coastal communities due to sea level rise and landslide erosion as particular risks. Another key threat for them is cutting down and conversion of forests into industrial area. Brunei has managed implementing a solid waste management program in different areas in the country.

- **Cambodia** – This country reports an increasing severity of floods and droughts, which have led to crop failures and contribute substantially to poverty levels, water management and agriculture, are priority areas from climate change impacts. NAPA has identified the priority activities as rainwater harvesting facilities at the villages, apt design of reservoirs and irrigation channels, multiple uses of canals, coastal protection infrastructure, community-based mangrove restoration, and agricultural soil conservation. Cambodia has implemented the following four schemes in response to the shortcomings of water resources:
  - Decentralization of irrigation management to communities
  - Adaptation of agricultural practices to changing climatic condition

- Planning for disaster reduction, and
- Promotion of information exchanges

Cambodia focuses its adaptation measures on the improvement of irrigation, disaster reduction in the local communities and infrastructure improvement particularly in the coastal areas.

Indonesia – An imbalance in the quality and quantity of water creates a water deficit in the various islands of the country. In addition, this country is not spared by the sea level rise, which has been partially addressed by the use of soft technologies and tools like a water balance model, a sea level rise model, and a digital elevation model. As a key strategy, Indonesia worked on Climate Proofing Development Processes and in Climate Literacy. A long-term framework and community level adaptation practices were introduced to the farmers in the country – cropping pattern and irrigation facility arrangement, establishment of early warning devices, and efficient use and conservation techniques of water resources.

Lao PDR –Erratic floods and drought historically has a significant effect on the agriculture industry of Lao PDR, which is one of the most important sectors for their economy. A compilation of the climate data and statistics for temperature and rainfall from 1995-2005 and regionally produced climatic data since 1980 and climate change predictions from MRC was made for the NAPA to climate change. In order to adapt to climate change and attain sustainable water resource management, institutional and legislative measures were implemented by the Lao Government. An IWRM was promoted and a Water Resource Coordinating Committee was established. This contains reinforcing links and synergies between water land use and environment. However, insufficient coordination from central agencies and provincial departments impedes successful implementation. Hence, this had been included in the priorities in the reduction of vulnerability of the water sector and a part of overcoming barriers in the formulation of adaptation strategies and building mechanisms for effective implementation.

Farmers in the country rely on adaptation methods readily available in the area, such as simple farm level measures and natural system to improve livelihood. Based on the result of research, an early warning system, accompanied by accurate risk communication techniques, may improve the on-farm adaptation measures of the affected population. Laos being one of the four LDC countries in SEA, the government sees Poverty Reduction as the main goal to combat climate change and this forms the basis of government policies.

Malaysia – As a country that is subject to monsoon seasons, it is particularly vulnerable to changes in weather patterns and rainfall variability and intensity. Climate change can impact this country through an increase in storm magnitude, which will result in more floods, and increase erosion and sedimentation rates. The government crafted national policies on adaptation measures for the agriculture

sector – agro-climatic classification in agricultural planning, use of soil suitability criteria for crop production and plant variety development. Most of all, sea level rise, damaging the coastal communities and facilities, has the highest impact among the identified effects of climate change. Infrastructure improvement, education and awareness programs, and food sustainability are among the local areas identified to lessen the socio-economic impacts of climate change in the country.

Myanmar - In a study by the Germanwatch, Myanmar ranked next to Bangladesh in terms of countries most affected by extreme weather events from 1990-2008. The country suffers from extreme weather events such as floods and prolonged droughts. In the coastal and delta areas, more severe storms and salt water intrusion are being experienced.

After signing the UNFCCC in 1992, Myanmar ratified the convention in 1994. The country regularly participated in the COPs of the UNFCCC and the meetings of its subsidiary bodies. It was one of the 12 participating countries in the ALGAS project, and it ratified the Kyoto Protocol in 2003. The 1997 Myanmar Agenda 21 has identified activities which are to be implemented to strengthen environmental education and awareness programs.

However, Myanmar will need to undertake numerous initiatives to mainstream environment, climate change and disaster risk management into national development planning as a whole. It has not yet prepared a national climate change policy, strategies and action plan for adaptation and mitigation, while relative cost-benefit and cost-effectiveness analyses of adaptation and disaster risk reduction options and technologies need to be identified and assessed. Climate- and disaster-resilient infrastructure for early warning, emergency response and social safety networks require strengthening, as does regional and international cooperation on environmental issues. Lastly, the international community should support Myanmar in accessing international funding and building regional and international cooperation, particularly for climate change adaptation (UNCT, 2011).

Philippines – The study of the impacts of climate change in the Philippines was conducted and it showed that the identified areas along the coast will be largely affected by sea level rise that leads to flooding. The already degraded state of the salt water body can even become worse due to severe storm surges, warmer temperature and reduced light penetration. These will eventually cause more coral bleaching. It will also affect the salinity and sediments of the water bodies connected to the bay that can limit the growth of mangroves. On the other-hand, the socio-economic implication of this is the decline of agricultural productivity and water quality that may also affect human health.

The Initial National Communication (of the Philippines), Jose and Cruz (1999) identified options for climate change adaptation. They proposed construction of new infrastructures, modification on the existing ones, comprehensive watershed management and reallocation system of water supply. They see

conservation and improved efficiency and technological change as also essential in the adaptation measures. This includes enhancement of irrigation efficiency, lining canals to reduce water losses, building drainage reuse system, usage of low water consuming crops, and improved farming practices. Adaptation and implementation is hindered in this country by the need for financial and technical support; and socio-cultural behaviours and traditions.

The Philippines can lose its arable lands due to sea level rise, decrease in soil fertility due to soil erosion, and decrease in crop productivity. Strategies, such as improved coordination of basic services offered by various government agencies, introduction of least cost technologies; introduction of new rice species and crop and yield intensification have been applied to date. In the socio-economic sector, local adaptation strategies have been applied to combat climate change.

Singapore – In this island country the potential impacts of climate change are: increased flooding, coastal land loss, water resource scarcity, heat stress, increased energy demand, and impacts on biodiversity. To address issues related to sea level rise and flooding, Singapore developed reclamation projects and there is constant widening and deepening of the drainage systems. One of their strategies in dealing with urban management is to build more parks and to use efficient technologies such as energy efficient air conditioning, and implementing green architecture.

Thailand – This country has been implementing mitigation and adaptation measures long ago. They have been doing interventions on water management such as large scale irrigation and flood protection and warning systems in the past. They see climate change measures as a new reason to continue what they have been doing. An integrated water resource planning includes promotion of participation by local administration agencies and communities in the country, as a priority in implementing their water projects, which have helped them to address immediate problems and adapt to climate change. Also, they have been exploring planting vetiver grasses for topsoil preservation, drought resistant plant and animal species, and construction of dams and irrigation systems. They have also been implementing traditional practices such as mixed cropping, agro forestry, and animal husbandry. Moreover, ADB has included Thailand in their projects on Climate Risk Management Assessment for Agriculture, which focuses on innovations in agricultural institutions, crop and resource management, the role of women, social capital and social networks. Bangkok Metropolitan Administration (BMA) reported that adaptation measures for Bangkok include land use planning, construction or improvement of levees and dykes, water reservoirs and waste discharge designs, coastal protection phased retreat, harbour/port operation and engineering for business and commercial and ecosystem protection.

Vietnam –Vietnam has been identified as one of the most vulnerable countries to sea level rise due to its long coastline. This may lead to sinking deltas, coastal degradation, loss of coral reef, drop in ground water level and a threat to the country's water security. There will also be an increase in coastal storms, inland hydrological changes, and changes in temperature and precipitation.

The Initial National Communication has recommended conducting long-term water studies and management/controls to mitigate the effects caused by climate change. It includes building reservoirs, upgrading and raising scales of drainage and dykes, reclaiming areas, controlling population and implementing sustainable use of water. Water scarcity in the country resulted to a proposal of inter basin transfer of water, wherein reservoirs with excess water supply will be connected to other water deficient reservoirs. It has also been suggested that a shift to improved water management with increased water efficiency and re-prioritizing current water use will help combat the country's woes from the changing climate and water shortage. The Ministry of Environment has also formulated short and long term adaptation plans for the country, wherein sub sectors such as water resource, domestic water, irrigation water, industrial water and coastal water will have various programs in order to reduce the effects of climate change to the activities under these.

The Initial National Communication has included 6 measures to combat climate change in Vietnam – development of crop patterns suitable to climate change, effective use of irrigation water, upgrading of irrigation system for agriculture, development of new varieties that could withstand severe environmental condition, reserve and storage of local crop varieties, establishing crop seed bank, and development of farming techniques appropriate to climate change. In an overall assessment of impact, infrastructure, income generation of the community and livelihood will most likely suffer if the country is unable to respond to climate change impacts.

3.3 North East Asia (IGES, KEIO 2012)

Climate change is a salient issue for the countries of NEA (the PRC, Japan, Republic of Korea, and Mongolia) in terms of impacts, adaptation, and mitigation. The PRC is the world's largest emitter of GHG and accounts for almost a quarter of global CO_2 emissions in 2010. Northeast Asia has been experiencing warming over the last 50 years. Preliminary analyses suggest (ADB-KOICA, 2011):

- Coastal areas in NEA are quite prone to the impacts of sea-level rise and increased storm surge. The costs of coastal protection are likely to be the largest adaptation costs across sectors in the region.
- In infrastructure, Mongolia will probably have the largest adaptation costs in percentage terms. Continued warming may exacerbate existing natural resource concerns, such as a diminution of water resources and desertification, the latter already affecting 78% of the country.
- In the People's Republic of China (PRC), there is a large "adaptation deficit" to extreme events (e.g., flooding and cyclones) in the infrastructure sector and "no regrets" adaptation measures should be addressed now.
- Regional cooperation is important as it can help reduce the total costs of implementing mitigation and enhancing adaptation in NEA.
- The costs of climate change may be significant in NEA under the business-as-usual scenario, and Mongolia is likely to be the worst affected.

Climate change is unambiguous in the northeast Asian nations of Mongolia, China, South Korea and Japan and in many cases the effects are local and can be responded to at thelevel of a community or local government. At the same time there are many instances where the effects of climatechange are regional and cross national borders, meaning that co-operation between countries is necessary. However in spite of this need, in north-east Asia the amount of co-operation to date has been limited.

A fundamental distinction between nations in north-east Asia is the amount of resources each country has at handto invest in climate change adaptation. Developing countries such as Mongolia face significantly different issuesthan a developed country like Japan; yet co-operation between all four countries could help to ameliorate the differences and better manage the difficultieseach faces in isolation. Similarly it is clear that support for adaptation activities in the face of climate changewill require an approach to research and to action that is entirely different from that required for mitigation. Newkinds of governmental and community support will be needed, as will new technology and new methods. As apreliminary effort technology and knowledge transfer could have significant impact with minimal financial burden.

Currently in Mongolia and in China, the range of problems related to climate change adaptation is dependenton which part of the country is being studied, although major shared concerns include damage from extremeweather events, including drought and flooding. In the case of Mongolia the effect of climate change is particularlyextreme when it coincides with the historical weather event called Zhud. Already damaging in itself, it hasbegun to exacerbate on-going cultural issues that arise from a nation undergoing a period of intense economicdevelopment. In this sense it shares many of the problems already faced by China but is required to cope withthem using fewer resources and a relatively weak government. At the same time, the pace of urbanization iscomplicating already difficult issues with problems related to environmental pollution and congestion.

In China, the situation is particularly complicated by the scale of the nation and the need to take on adaptationissues at regional and local levels. While that is not a unique challenge in itself, it is difficult to manage as a resultof the political context and the lack of support from the government as a whole.Korea is beginning to take on climate change in a serious way, with the expectation that increased rainfall andrising sea levels will impact the nation significantly between the present and 2050. However adaptation has notbeen a high priority on the ground, and basic research is needed in particular to create vulnerability assessments.Japan has invested politically in mitigation efforts against climate change with limited success within itsown borders, and until recently has focused most of its financial support for adaptation activities to projectsundertaken in developing nations. However, the 2011 Tohoku earthquake, tsunami, and nuclear disastershave triggered a sincere re-consideration of national policy with regards to energy and

climate change, andit seems likely that resiliency building and adaptation efforts have become more prevalent in Japan. Technical skills and financial resources are limited but as a so-called developed nation the chiefbarrier to adaptation is cultural rather than economic.Cooperation between the northeast Asian nations of Japan, South Korea, China, and Mongolia is relativelyweak with regards to climate change adaptation. There is a growing need felt for expanding cooperation,and hence some ways that might be accomplished are proposedbelow.

The effects of climate change are emerging at huge costs even in societies with high adaptive capacities such as China, Mongolia, Japan and South Korea. Considering that the "impacts of climate change are very likely to impose net annual costs, which will increase over time as global temperatures increase," the 4 countries have taken measures/policies to respond to it, when designing the overall climate policy. Given different situations in economy, society, and environment in the four major countries in Northeast Asia, climate change adaptation may need consideration of local conditions. There is no one-size-fits-all solution for every country.

There are many options and opportunities for countries to adapt, with adjustments and changes required at every level: community, national, regional and international. Appropriate adaptation strategies involve a synergy of the correct assessment of current vulnerabilities to climate change impacts; use of appropriate technologies; and information on traditional coping practices, diversified livelihoods and current government and local interventions. Followings are the main recommendations for the Adaptation in the Northeast Asia;

More research and development is needed for these adaptation technologies
Using the latest technology based on regional characteristics is essential,

- More data and information of currently insufficient knowledge on adaptation needs to be accumulated and studied,
- It is important that researchers and policymakers cooperate in the accumulation and sharing of data, information and research findings,
- Vulnerability assessment tools and early warning systems need to be developed and their use promoted,
- There is a need to distinguish between cases which can be addressed using latest science and technology, and cases which require technology that is better suited to regional characteristics,
- It is vital to promote research and development on how best to select the ideal technologies, and on specific technologies and techniques that are anticipated according to regional characteristics,
- Infrastructure for raising the awareness of decision-makers and the general public has to be fully developed,
- The dissemination of information is the most pressing need for the promotion of adaptation measures, and
- There is a need to deal with the insufficient human resources on adaptation arena (e.g. experts to conduct research on the impacts and adaptation measures

in each sectorand advisors and facilitators to communicate to a wide range of entities on the significance of adaptation measures are in shortage)

3.4 Central Asia (IGES, CAREC 2012)

Climate change imposes serious challenges for Central Asia, and the water and agriculture sectors will be the most affected sectors, given already existing water scarcity issues throughout the different parts of the region that are highly dependent on irrigated agriculture. The governments of Central Asia recognize these threats and have identified necessary measures for alleviating the expected climate change impacts in these sectors.

There is no doubt that adapting to climate change in the region requires adoption of certain hardware technologies that enable more efficient use of water in agriculture. Nevertheless, the findings of the report suggest that the so-called soft technologies are of equal importance and that, in some cases, they might even emerge as a prerequisite for the viability of technical measures. For example, installation of intra-farm flow measurement devices might become a questionable measure if there is a weak coordination mechanism used by the farmers that share a common hydrological sub-system. In fact, many proposed adaptation measures in Central Asian countries can be realized only through an integrated application of hard and soft technologies. This especially refers to adaptation in the water sector, where proposed measures require, as a rule, both technical modernization of hydrological facilities and the introduction of new techniques and practices for data processing. Whilst the technologies differ in the level of application (farm level, national and even trans-boundary), it is suggested that an adaptation action should envisage a comprehensive approach, inclusive of all inter-related technologies. As it was revealed, introducing technologies at the local level may be dependent on the promotion of organizational measures at the national or even trans-boundary levels.

Kazakhstan – It is estimated that agriculture consumes 78% of the country's total water intake. The SNC report suggests that climate change will likely have a significantly negative impact on precipitation patterns, especially in the arid regions of the country. The southern Kazakhstan where water-intensive crops (rice and cotton) are cultivated is likely to be the most vulnerable to climate change in the near future. This part of the country has already experienced water scarcity during the last decades.

According to the SNC assessment, owing to multiple reasons the water inflow has declined from 58.8 km^3 to 43.7 km^3 per year in the last decade. SNC proposes the following measures for alleviating climate change risks on water resources and arable agriculture:

» Adoption of micro-irrigation technologies;
» Construction of necessary infrastructure to access ground water;
» Reconstruction of the irrigation and water supply systems;
» Support to breeding programs for development of drought-tolerant crop varieties;

» Introduction of advanced farming technologies (soil protecting and moisture conservation technologies);
» Crop diversification and rotation.
» Adjustment of water releases from the region`s hydroelectric dams to the needs of the irrigation;

Kyrgyzstan– With its large glacier systems of 417.5 km^3, occupying about 4% of the country's territory, Kyrgyzstan is recognized as a water rich country in the region. About 45% of all Central Asian glaciers are concentrated in Kyrgyzstan. According to the Second National Communication, the rising of temperatures caused significant glacier degradation in Kyrgyzstan, which has reduced between the mid 1970's and the end of the last century by 15%. The climate change impact on glacier melting imposes serious challenges for the downstream countries as well, since they are dependent on the glaciers in the upstream countries.

As irrigation contributes to 92-96% of the country's total water intake, adaptation to climate change impacts on water resources could be significantly enhanced by a change of water use techniques. In this respect, SNC suggests to:
» implement more effective and careful management of irrigation systems;
» regulate surface water-flow by the creation of artificial water reservoirs;
» adopt modern, more efficient systems and modes of water distribution;
» stimulate water saving by the implementation of a paid water system.

For adaptation in the agricultural sector SNC proposes to:
» develop modern systems for early notification and prevention of natural and temperature anomalies, daily and seasonal weather forecasts;
» promote breeding programs on the diversification of crop and cattle varieties and the development of varieties and species, resistant to the expected alterations in the climatic conditions;
» introduce crop rotation systems;
» adopt efficient irrigation techniques;
» retime crop cultivation according to changes in temperature regime during the seasons in order to adjust crop cultivation to the new favorable temperatures during the period of sprouting and bushing out.

Tajikistan – Tajikistan is considered to be a water mogul in the region owing to the high concentration of glaciers on its territory. Along with Kyrgyzstan the country supplies around 70% of the rivers in the Aral Sea Basin (Bizikova et. al., 2011). The agricultural sector of the economy contributes 25% of total GDP and provides 70% of the country's employment. The glaciers of Tajikistan play an essential role in water availability in Central Asia. The warming trend in the last years has a significant impact on the fragile glacier ecosystems. According to the SNC, the glaciers have been melting at an alarming rate over the last century, and as a result 1/3 of the glacier area has been degraded since 1930. SNC also reports about decreased water flow in the rivers in the recent years.

The SNC proposes the following measures for alleviating climate change risks on water resources:

» To introduce water-saving irrigation systems (including micro-irrigation technologies);
» To increase efficiency of intra-farm network and inter-farm channels;
» To construct dams and diametric dikes in order to regulate river flows;
» To conduct channel dredging and flow straightening works;

Relevant adaptation measures for reducing climate change impacts on the country's agriculture include:

» strengthening material and technological base of the farms in order to reduce crop losses due to adverse weather events;
» planting tree shelterbelts;
» introduction of anti-hail systems;
» reconsider crop planting location based on the assessment of crop-resistance to conditions of different climatic zones (eg. cotton is more tolerant to high air temperature and soil salinity compared to cereals and potato, therefore, it is more cost-effective to cultivate cotton in hotter areas);
» breeding programs for development of drought-tolerant and pest-resistant crop varieties.

Turkmenistan–One of the few countries to develop NAPA in the very early stage, and has made an attempt to mainstream the adaptation policies in their planning programmes. Agriculture has been identified as the biggest challenge in adaptation. A whole range of techno fixes have been identified in the BCCSAP for the sector, which ranges from capacity building to suggested climate change adaptation measures. According to the SNC, water supplied to Turkmenistan through the Amudaryariver can diminish by 10-15% in the future due to climate change and increased water withdrawal in the upstream countries. Assessment of climate change impacts on other river systems in the country suggest that the annual run-offs of such rivers as Tejen, Mugrab and Etrek will also reduce by 5-8% in the future. On the other hand, more arid climate will foster water uptake from the rivers which will put additional stress on the water resources.

Regarding proposed adaptation actions, the SNC refer to measures encompassed by the Water Management Development Cooperation of Turkmenistan by 2030. Accordingly, respective adaptation measures are the following:

» Improvement of water management (transition to integrated water resource management – IWRM);
» Optimization of agricultural production arrangement for providing the country with necessary agricultural production, and minimization of water resource use;
» Conduction of measures enabling to increase efficiency ratio of irrigation systems;

» Innovation in advanced irrigation techniques (drip, micro-spray) and enhancement of existing ones (traditional);
» Conduction of measures for land reclamation improvement;
» Construction of additional water reservoirs;
» Reconstruction of the existing and construction of new hydro-technical facilities allowing reduce water losses and support rational water use.

SNC provides a roughly assessed water saving potential for the suggested measures of 7450 – 7500 million m^3 of water (Table 1). Nevertheless, it also admits at the same time that this saving can be realized upon development of a comprehensive plan of action which should be preceded by assessment of respective costs.

The SNC also proposes the following measures for alleviating climate change risks in agriculture:
» breeding program on development of drought-tolerant crop varieties.
» retiming field work (tillage, fertilizing, cultivation and harvesting) according to changed temperature regime during the seasons in order to adjust crop cultivation to the favorable temperature regime during the period of sprouting and bushing out;
» land reclamation activities;
» planting forage woody-bushed plants for the grassland protection;
» introduction of grassland rotation;
» optimization of agricultural crop structure in order to minimize water consumption;

Uzbekistan- The agricultural sector contributes to 24% of total GDP and employs around 28% of the country's population. Domestic agricultural production covers about 80% of the countries food demand. Uzbekistan's water resources are mainly presented by the Syrdaria, Amudaria and Zeravshan rivers and these rivers have been intensively exploited for agriculture. With 26.7 million people Uzbekistan is the most populated country in Central Asia. The country's demography has a positive trend, which is expected to lead to further intensification of agriculture and thus greater stress on water resources.

The SNC reports that water runoff in the basin have significantly changed over the last decades due to climate change and anthropogenic factors. As the glaciers of neighboring Kyrgyzstan and Tajikistan play an essential role for water availability in the downstream, melting of glaciers in those countries will have adverse impacts on water availability in Uzbekistan, where agriculture accounts for 90% of the country's total water intake. Aridification of climate adversely affects agricultural productivity of arable lands in Uzbekistan. As the Ministry of Agriculture and Water Resources of Uzbekistan reports, over 50% of the country's arable land is considered saline. Currently, about 56% of Uzbekistan's territory is exposed to deflation and about 20% to water erosion.

SNC proposes the following measures for mitigating climate change risks on water resources and agriculture:

» reformation and re-orientation of economic development strategy for more efficient utilization of available water resources;
» extensive introduction of water saving technologies in the water consuming industrial branches, agriculture and communal utilities sector;
» improvement of irrigation and drainage systems for reducing water loss;
» potential water resource recovery trough utilization of unconventional sources (ground water, water harvesting etc);
» transition to a flexible planning system in determining the optimal volume of agricultural output;
» optimization of the crop structure and expansion of drought-resistant and salinity-tolerant crop cultivation;
» expanding winter crop cultivation;
» introduction of crop rotation.

Table 2: Needed adaptation measures in the Central Asia (according to the National Communication reports under UNFCC) and their associated technologies

	Proposed measures	Hard technologies	Soft technologies	Organizational technologies
WATER SECTOR	**Development and introduction of the monitoring and early warning systems**	meteo stations, equipment for the snow and glaciers monitoring hydroposts, water volume measurement in irrigation network, water measuring devices on farm level	enhanced climate and weather forecast models, use of GIS and RS	research and extension services to enhance the capacity and delivery of information to the agricultural sector
	Improve regulation of annual river discharge	water reservoirs*		subregional and basin level water sharing coordination
AGRICULTURE	**Increasing water use efficiency in agriculture**	microirrigation technologies, laser leveling rehabilitation of water irrigation networks for reduction of water loss	new irrigation practices (e.g. alternative furrow irrigation) regulation of ground water use for agricultural purposes	Introduction of IWRM on a national level WUAs, introduction of payment system/scheme for irrigation water delivery
	Optimization of crop structure		research and promotion of drought resistant crop varieties	crop diversification, switch to less water intensive crops
	Adapting agricultural practices to anticipated climate fluctuations		introduction of climate specific insurance schemes	expansion of winter crops to take advantage of increased water availability,
	Promotion of sustainable agricultural practices	zero-tillage	Nutrient management, crop rotation	

Table 3: Adaptation technologies and main climate change imperatives the correspond to

Technologies/Measures	Drought	Need for soil moisture conservation	Need for water use efficiency	Land degradation, soil infertility, erosion	Heat stress	Pest and disease control	Excess rain, flooding, storms	Milder winters, longer growing seasons
Watershed management (IWRM and WUAs)	x	x	x	x			x	
Water reservoirs	x	x		x	x		x	
Micro-irrigation technologies	x		x					
Alternative irrigation techniques	x		x					
Laser levelling	x		x	x				
Crop diversification	x	x	x	x		x		x
Use water-efficient crops	x		x	x				x
Heat- and drought-resistant varieties	x	x	x		x			x
Crop rotation	x	x				x		
Zero tillage	x	x	x	x				
Nutrient management and use of organic matter	x	x		x				

3.5 Pacific (IGES,SPREP 2012)

All Small Island Developing States (SIDS) are highly vulnerable to climate change and sea level rise owing partly to their small land masses surrounded by ocean, and their location in regions prone to natural disasters. Adaptive capacity to climate change is generally low. The following impacts illustrate the urgent need to adapt to climate change, and include:

- Inundation of deltas, estuaries and coastal wetlands;
- Destruction of benthic systems, especially sea grass beds;
- Loss of productivity of coastal ecosystems;
- Flooding in coastal plains and increased coastal erosion;
- Increased saline intrusion causing freshwater contamination;
- Overall loss of freshwater supplies;
- Changes to traditional fishing sites;
- Loss of coral reef and mangroves;
- Damage and loss to coastal infrastructure and land;
- Increased vulnerability of human settlements;
- Biodiversity loss;
- Spread of vector-borne diseases;
- More frequent and intense weather events such as droughts and cyclones;
- Failure of subsistence crops and coastal fisheries; and
- Damage to industrial infrastructure.

The SPREP experience from PACC and other climate change projects shows that all climate change adaptation activities in the region need to utilise an open, transparent and highly-participatory process. This process needs to engage the community so that they can explore options and develop solutions to reduce vulnerability and effectively balance the needs and interests of a variety of stakeholders. There is also a strong need to increase people's skills and capacity in relation to climate change impacts and appropriate adaptation activities for long-term sustainability.

The above-mentioned report also identified the region-specific gaps between the needs and practices for CCA in the Pacific.Some of the major lessons learned from the stocktaking include:

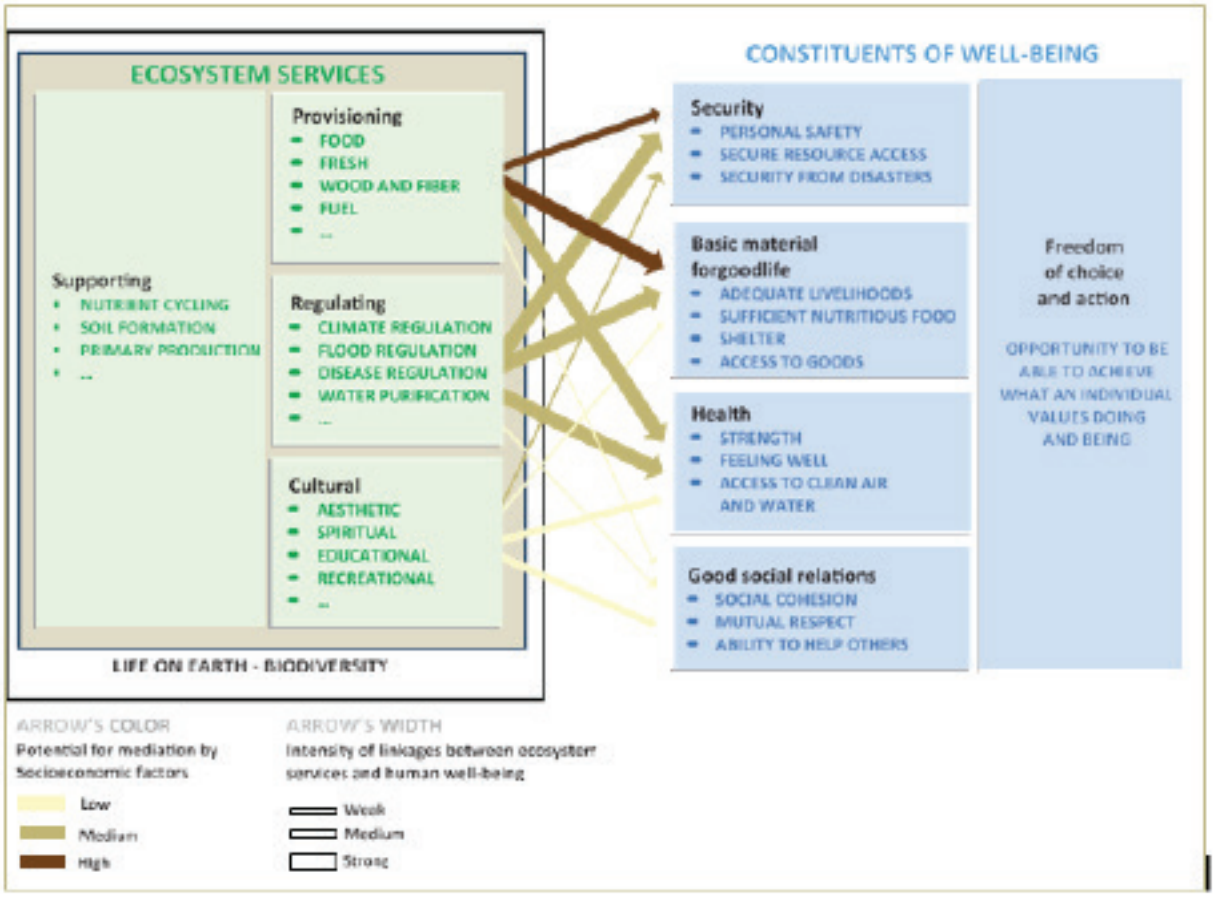
- The inability of the government to distinguish between climate change induced and human induced vulnerability of the sectors, which hinders them from identifying and prioritising national plans, vulnerable sectors and appropriate techniques for adaptation;
- The project durations were mostly short-term and the projects' impact on community resilience was not visible and fully realized during and beyond the implementation period;
- Lack of proper education and awareness on climate change issues, vulnerability and impacts;
- Large gaps between communication and coordination exists among stakeholders; and
- Knowledge on cost effective and culturally appropriate robust technologies is needed to enhance communities' resilience to climate-related risks.

The report found that CCA related activities in the region need to utilize an open, transparent and highly-participatory process that engages the community in the exploration of options to reduce vulnerability and effectively balances the needs and interests of a variety of stakeholders. There is also a strong need to increase the skill and capacity in analysis and interpretation of climatic data on future projections essential for effective and appropriate implementation of actions.

IV. ADAPTATION TO TECHNOLOGIES CAN ADDRESS SECTORS AND SYSTEMS

The potential impacts of climate change are becoming increasingly evident in the different sectors and systems – water resources, mountain systems, agricultural sectors, urban sector, coastal systems, etc. The Millennium Ecosystem Assessment (MA) is a ground-breaking study on how humans have altered ecosystems, and how changes in ecosystem services affect human well-being, both now and in the future. Integrating findings at the local, regional, global scales and from alternative intellectual traditions, the Millennium Ecosystem Assessment offers a comprehensive picture of the health of the planet.Ecosystems provide a range

of services to human beings such as the supply of food, energy and fuel, water purification, soil formation, and recreational and spiritual benefits (Figure 2.1). The following is a snap-shot:



Source: WRI Millennium Ecosystem Assessment (2005)

• Mountain regions are not only fragile ecosystems but are particularly vulnerable to anthropogenic emissions of greenhouse gases. There are indications that changes in temperature and other factors are taking place at a greater pace at higher altitudes than in the lowlands. Although mountain people have contributed very little to global greenhouse gas emissions, they are the first among the vulnerable communities bearing the brunt of the impacts (ICIMOD, 2010).

• Water resources and supplies will become increasingly pressing issues in theface of climate change as per the available statistics. The poor and vulnerable populations in developing countries are poisedto take the brunt of the impact, as a result of the deadly path of economic expansion that humans have followed for long. With burgeoning problems,nations need access to climate change adaptation options and also assistance in identifyingwhich options are appropriate for which situation, and how to incorporate these measures into theirclimate change adaptation strategies (Elliot et.al. 2011).

- Agricultural activity is highly sensitive to climate change, largely because it depends on biodiversity and environmental conditions. Sufficient freshwater supplies, fertile soil, the right balance of predators and pollinators, air temperature and average weather conditions all contribute to maintaining agricultural productivity. As agriculture depends directly on environmental conditions, climate change impacts on agriculture are becoming increasingly evident. Technologies that tend to homogenise the natural environment and agricultural production have low possibilities of success in environmental stress conditions that are likely to result from climate change. On the other hand, technologies that allow for, and promote diversity are more likely to provide a strategy which strengthens agricultural production in the face of uncertain future climate change scenarios (Clements et. al., 2011).
- Climate change adaptation discussions do not significantly engage with urbanisation despite a large proportion of the population most at risk from climate change being urban based. As per available statistics, there is more mitigation engagement but very less discussion on the potential of urbanisation to contribute to low-carbon development. However, there is a great deal which can be done to reduce vulnerability. Key issues for reducing vulnerability to poverty and climate change in urban settings are – (i) increasing political will and capacity to engage in informal settings, and (ii) increasing access to the kinds of services and infrastructures that can reduce vulnerability to climate change impacts and poverty alike.

4.1 Agriculture (IGES, SEARCA 2012)

Southeast Asia, being highly dependent on agriculture, is considered as highly vulnerable to the impacts of climate variability, climate extremes and future climate change (ADB 2009b). It is increasingly being recognized that collaborative thinking and responses to the issues generated by the interaction of food security, climate change, and sustainable development are needed. Food security must be regarded as one of the main criteria for the effectiveness of adaptation at the national and local levels. Food security and sustainable development considerations should be made explicit in adaptation technologies in the agriculture sector. In agriculture, the transformation towards ecological agriculture that started in the 1990s is now nearly complete.

Adaptation is considered to take place at three levels (local, national, and global) and in three kinds of ways --technical, policy, and negotiated (Locatelli and Evans 2009). Most literature for climate change and agriculture are focused on the technical adaptation at the local level. Several have been published showing the wide range of adaptation options theoretically available. Typically these include changing cropping patterns and dates of sowing, choice of crop varieties or species tolerant to droughts, floods and cyclones; development of new varieties; improved water supply and irrigation systems including efficiency in use; tillage practices; other inputs and management adjustments; and improved short term climate prediction. Historically, farmers have responded to environmental change

by gradually changing their agricultural practices and innovating technologies employing the aforementioned options, drawing from their indigenous knowledge and experience (Lasco et al. 2011).

Table 4

Proposedadaptations2007-2009	Proposedadaptations2009-2012
1. Increase the utilization of drought-prone map. 2. Conduct water-saving agriculture activities. 3. Implement good agriculture practices. 4. Implement the acceleration planting with appropriate technology. 5. Rehabilitate and increase irrigation network. 6. Optimize alternate system in water irrigation distribution. 7. Form working group on climate anomaly and climate change in Department of Agriculture. 8. Form commanding post to control flood and drought in Department of Agriculture. 9. Advocate and socialize the right understanding of climate change and its impact on the agriculture sector as well as government policy in mitigation and adaptation effort.	1. Develop drought early warning system. 2. Increase the utilization of alternative water resource potential. 3. Empower the P3A institution. 4. Strengthen the institution of water use farmer. 5. Empower the farmer group to arrange the planting schedule and decide the beginning of planting season. 6. Develop food diversification policy. 7. Develop agriculture climate information system and network invarious levels and regions including the development of Agriculture Field Schoolas a development of SLPHT and SLI (Climate Field School)
Proposedadaptations2009-2012	**Proposedadaptations2025-2050**
1. Conduct climate anomaly impact analysis toward seasonal shift todecide the beginning of the planting season 2. Conduct research on superior seeds with resistance to climate change. 3. Develop adaptive track husbandry. 4. Research program on government strategy and policy to address climate change in the agriculture sector. 5. Formulate detailed planning regarding agriculturedevelopment policy. 6. Develop program to increase farmer income.	1. 1. Improve various existing step and strategy based on evaluation of various concepts,strategy,efforts and technology that have been implemented in previous period. 2. 2. Develop various innovative technology, particularly for superior adaptive variation and technology for management of land and water that have been produced in previous period. 3. 3. Continue the food diversification policy that has been evaluated. 4. 4. Increase the minimum income of farmer equivalent to average income ofworker in Indonesia through various implementation of innovative technologyand institution and development of various commercial commodities.

Source: SME 2007 ascited by Boer and Rakiso 2008

Strategy and policy development on the national level works reasonably well. The new national climate change strategy in Philippines is a strong evidence of the government's commitment. However, the implementation of such strategies and policies are not adequate, particularly when it comes to the province, district and village levels.

Data and information on the possible impact of climate change on agriculture is insufficient for informed decision-making at both technical and policy levels (Snidvongs 2006). The weak resource and knowledge base on climate change related matters is acknowledged by both the policy and academic institutions. The present information is not adequate for addressing future agricultural, food security and development challenges. Baseline information is not available, and it is difficult to collect and to interpret. Access to remote areas is challenging and many communities cannot be reached during the rainy season (WFP 2007).

4.2 Water Resources(IGES, GWP-SAS 2012)

South Asia is a region with limited water resources to support its huge population. The limitations are compounded by the topography in countries such as Nepal and Bhutan, soil conditions and aridity in countries such as Pakistan, and disaster-prone areas in countries such as Bangladesh. The region is approaching the limits of sustainable use of those meagre resources as well. Investments by the national governments in water resources development and agriculture have helped alleviate poverty and improve the food security. However, the sustainability of such investments is doubtful due to the impacts of climate change. It is observed that the reservoir capacity is being limited due to highly intensive rains, landslides, and resulting soil erosion. In addition, a large proportion of the people have been elevated above the poverty lines only temporarily. This results in a huge population being vulnerable to the variations of water availability, thus threatening the sustainability of the poverty alleviation initiatives.

The sub-region of South Asia is a highly complex area with many contrasts affecting the climate variability as well as adaptation capacity. However, there are common features such as high rural population, dependency on agriculture and incidence of poverty. Water plays a key role in adaptation to climate change, agricultural productivity and poverty alleviation. The most threatened in the agriculture sector are the rain-fed farmers and the farmers who depend on small reservoirs and small diversion schemes. There is the necessary political recognition of the impacts of climate change, and the special vulnerability resulting from poverty, illiteracy and social inequities, which serve as good foundations for adaptation strategies. However, inadequate policy support is observed in several countries including Afghanistan and Sri Lanka. Whenever water policies are available, sometimes the phenomenon of climate change is not well integrated into the policy framework, especially in the development policies. This would increase the vulnerability and

contribute to the future water stress. There are improvements needed in the water regulations as well.

Increased storage would undoubtedly improve the adaptation capacity and resilience to climate change impacts. But considering the heavy population density and topographical factors, surface water storages are not always feasible. IWP (2012) recommended that underground water aquifers provide the best possible storages, and recharging such aquifers through water harvesting systems and flood waters etc are required. Other options include rainwater harvesting, of which the potential is not fully utilised. Other solutions being considered include inter-basin transfers from surplus to deficit (IWP, 2012). Considering social and economic costs of such solutions, they may have to be country- specific. But in the case of the trans-boundary rivers, the importance of river basin master plans has been highlighted. Water quality is already a concern in several countries such as India and Bangladesh. As this situation can worsen due to climate change, serious attention is required to address the issue. The suggested methodologies include avoiding over-exploitation and preventing pollution (IWP, 2012).

Research and development have the potential to make a significant contribution to climate change adaptation. Some of the areas where research and development could contribute include:

- Increasing the efficiency of rain-fed cultivation;
- development of drought-resistant crop varieties (IWP, 2012);
- Technologies to increase groundwater storage and recharging;
- Eliminating the ocial, economic and technological constraints to achieve the potential in rainwater harvesting; and
- Variations of the rainfall pattern including onset of monsoonal rains, and changes to the intensity and frequency of occurrence of such rains.

4.3 Urban Areas

Global cities are engines of economic growth and centres of innovation for the global economy and the hinterlands of their respective nations. The foundations of prosperity and prominence for most global cities lie in their long-standing commercial relationships with the rest of the world. The emphasis of climate change policy has largely been on mitigation. As necessary as these efforts are, it is clear that more attention needs to be given to adaptation to the climatic changes that are already underway and which will be exacerbated by future emissions of greenhouse gases. Among other elements, disaster preparedness and management plans are vital components of an adaptation strategy. But to design these, we need a better understanding of which people and systems are vulnerable to what kind of climate hazards; also what makes them vulnerable and where they are located. Adaptation measures are difficult to implement because they require long-term horizons, whereas politicians typically operate on short-term horizons. Incentives need to be intelligently designed so that politicians, officials and the private sector find it in their interests to build less risk-prone equitable cities (Sherbeninet.al., 2007).

In his report, Satterthwaite (2008) lays down that "urban governments have critical roles in adaptation to climate change in all nations as well as in mitigation (reducing greenhouse gas emissions). It can be argued that they have the central role in adaptation within their jurisdictions – although it is obvious that they need a supportive institutional, regulatory and financial framework from higher levels of government and, for most low- and middle-income nations, also from international agencies. City and municipal governments have the main responsibilities for planning, implementing and managing most of the measures that can diminish risks (and the high vulnerabilities of sections of the population) from the direct and indirect impacts of climate change – through provision of infrastructure and services, disaster preparedness and the planning and regulatory framework".

Table 5: The role of city-municipal governments in adaptation

Role of city/municipal government	Long term protection	Pre-disaster damage limitation	Immediate post-disaster response	Rebuilding
Built environment				
Building codes	High		High	High
Land use regulations and property registration	High	Some		High
Public building construction and Maintenance	High	Some		High
Urban planning (including zoning and development controls)	High		High	High
Infrastructure				
Piped water including treatment	High	Some	High	High
Sanitation	High	Some	High	High
Drainage	High	High	High	High
Roads, bridges, pavements	High		High	High
Electricity	High	Some	High	High
Solid waste disposal facilities	High	Some		High
Waste water treatment	High			
Services				
Fire-protection	High	Some	High	Some
Public order	Medium	High	High	Some
Solid waste collection	High	High	High	High
Schools	Medium	Medium		
Health care	Medium	Medium	High	High
Public Transport	Medium	High	High	High
Social welfare	Medium	High	High	High
Disaster response			High	High

Source: Satterthwaite, David (2007)

Table 6: The role of city-municipal governments in adaptation

Resources available to local government	The quality of local government/governance	
	From democratic and accountable local government structures…..	…to undemocratic, unaccountable and often client list local government
From relatively well-resourced, local government institutions with the need technical competence…	Local government can be well served by external funding, including funding to support adaptation by households and private enterprises, and funding for needed infrastructure and support services (whether provided by community organizations, NGOs, private enterprises or government agencies)	Long-term support needed for governance reforms at all levels of government; also support needed for local private and community provision both to improve conditions and to build local pressure on government for better governance.
….to poorly resourced local governments lacking funding, a strong local revenue base and technical capacity	Need for a string focus on capacity building for local government and support for its partnerships with civil society and local private-sector infrastructure and service providers (including informal providers)	As above but with strong support for local private providers and community provision within a long-term goal of supporting more competent, accountable and transparent local government

Source: Satterthwaite, David (2007)

4.4 Mountain ecosystems (IGES, ICIMOD 2012)

Mountains today have 12 per cent of the global population, but provide water and other services to about 50 per cent of the population. As a source of biodiversity, water, clean energy, provider of ecosystem services, culture and tourism and above all livelihood to the people, mountains are a fundamental part of our global ecosystem. Globally, mountains are undergoing major environmental changes with progressive warming at higher altitudes. They are also referred to as a barometer of climate change for their sensitive reflections of the impacts. This is particularly true in the case of the Hindu Kush-Himalaya (HKH) region where lies the world's tallest mountain ranges endowed with abundant natural resources on which depends nearly 1.5 billion inhabitants. The HKH region, which is also known for 'Water Tower' and 'Third Pole' of the Earth for the huge deposits of ice, has witnessed increased snow and glacial melt and frequency of extreme weather events that have exacerbated livelihood risks including poverty, food insecurity, hazards and social inequity.

There has been some progress on understanding significance of mountains and their specificities – fragility, marginality, inaccessibility and richness of niche ecosystem products and services. They are, however, far from adequate to have an impact on mainstreaming mountain agendas in the global policy fronts. Clearly, there is a need to take up the issue of mountains in a holistic manner - a deeper, comprehensive and effective approach to sustainable mountain development taking into account the developments in the last two decades. The regional initiatives such as the one by the countries associated with SAARC (South Asian Association for Regional Co-operation) and national initiatives such

as the international conference on mountain countries in April 2012 provide more opportunities to pave the way of greater co-operation on the mountain agendas. Materializing these actions requires investment with a focus on creating jobs, capacity building and policy reforms in the agriculture, natural resources and enterprise development sectors. It alsorequires facilitation for enabling knowledge sharing, regional co-operation, environmental governance and substantial and dependable support from the global community. Potential action points are outlined below to take these issues forward:

- Adapting and developing climate-resilient institutional systems for the HKH Mountains taking into account their unique characteristics as `water towers' and biodiversity hotspots for addressing poverty reduction and enhancing human well-being.
- Reducing increased vulnerabilities and risks of the HKH mountain ecosystems and linking adaptation and resilience-building plans to sustainable development to create green jobs and develop green infrastructures.
- Empowering and assisting the mountain communities to gain fair access to and benefits from the ecosystem goods and resources they have been safeguarding as the primary stakeholders.
- Providing enabling conditions and incentives for investment through public-private ventures with appropriate funding mechanisms and technological support for enhancing well-being and reducing disparities.
- Strengthening national and regional institutions to facilitate upstream-downstream exchanges, transboundary co-operation, capacity building, and generating and disseminating of knowledge, technical expertise and information for promoting sustainable mountain development (SMD), and consolidating all new and existing funding mechanisms related to climate change,
- Supporting biodiversity and the Millennium Development Goals (MDGs) for adequately funding the SMD actions in vulnerable and least-developed mountain countries and region.
- Enhancing local livelihoods through ecosystem services
- Capitalizing the potential of community actions for safeguarding local forest resources
- Applications of locally improved technologies for enhancing resilience to climate change
- Backstopping to traditional methods of water management
- Mainstreaming climate change adaptation in the national development
- Designing a holistic approach for addressing the mountain issues of knowledge gaps, scientific uncertainties, and challenge

At present the policies and actions aimed at resilience to climate change in the HKH region are focussed at the national level with specific time frames ranging from a few years to less than 10 years. At the national level, all HKH countries have identified climate-related vulnerabilities and prioritised adaptation measures (Rahman and Amin 2011) through the National Adaptation Programme of Action (NAPA).

4.5 Coastal Zones

Coastal zones in many parts of the world are densely populated centres of critical economic activity. Sea level rise and more intense storms, waves, and surges due to climate change pose a serious threat to largenumbers of people living in these areas. Consequently many developing countries have identified coastalzones as a priority area for climate change adaptation. These countries, however, often need assistanceto identify adaptation options, formulate adaptation strategies and plans, and implement adaptation measures that lower the risk and actual losses from climate change impacts.Based on impacts, needs, and the technologies applied to deal with them, information about adaptation technologies for coastal zones can be summarized as shown below.

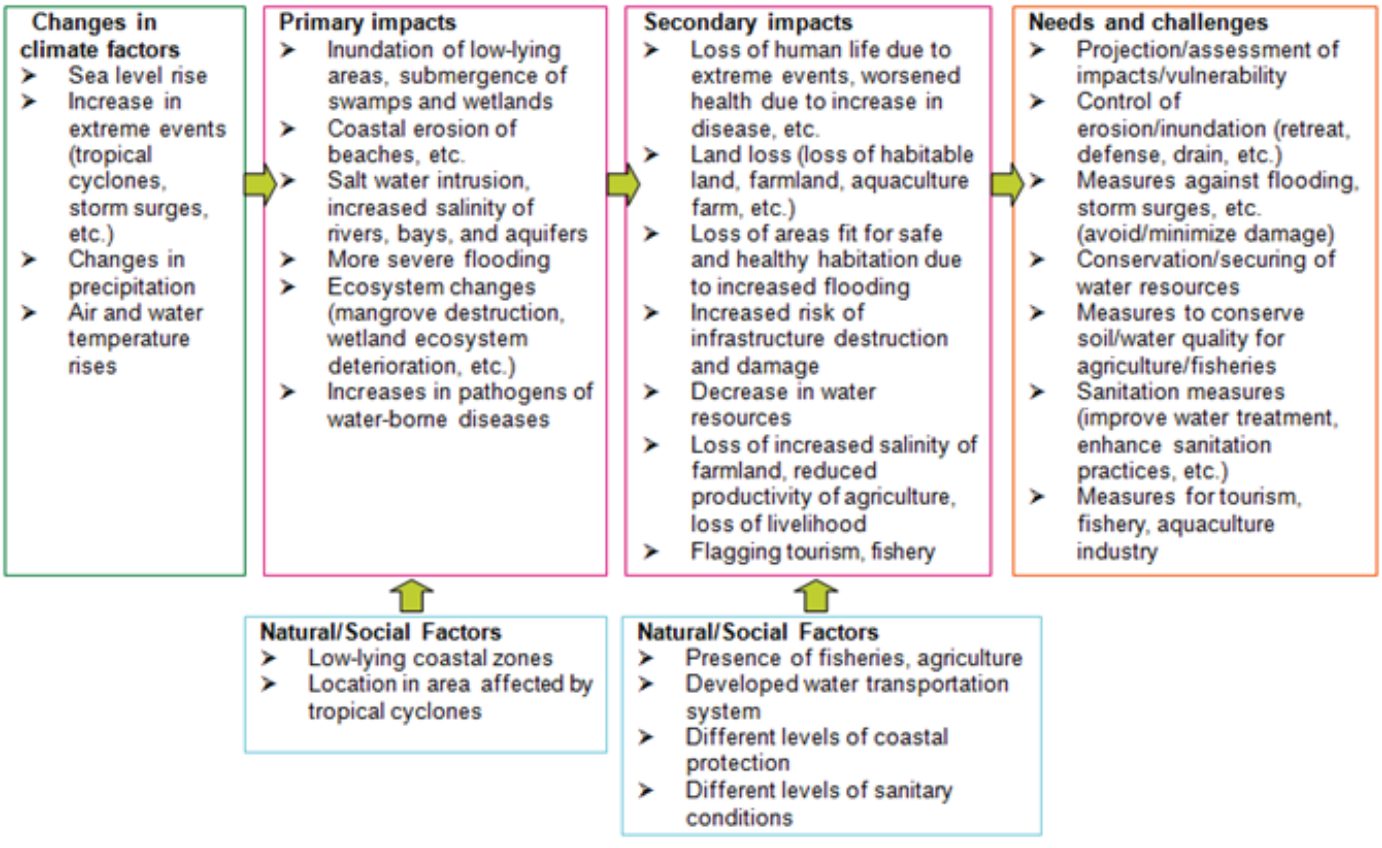
Table 7

Major category	Factors included
(1) Coastal protection, disaster management (soft measures)	Observation systems and information provision, land use changes, construction design changes, awareness raising about disaster management, etc.
(2) Coastal protection, disaster management (hard measures)	Improvement/reinforcement/repair/maintenance of shore protection, dikes, breakwaters, etc.
(3) Water environment and water resource conservation measures	Water quality improvement, measures to prevent saltwater intrusion of groundwater, water supply measures, water demand measures, etc.
(4) Conservation/restoration measures of coastal ecosystems	Conservation and restoration of wetlands/mangroves, coral reefs, sea grass beds, etc.
(5) Development planning and industrial policies	Mainstreaming into comprehensive development plans for coastal areas
(6) Adaptation measures in coastal cities	Adaptation measures (e.g., related to waste and sewage treatment) for impacts relating to social and economic activities particularly in coastal cities (including small and medium-sized cities)
Also to consider: Developing adaptation strategies	Useful information for major bodies (senior personnel of national and local government) responsible for overall planning, implementation and progress management/evaluation of adaptation steps.

Nessim Ahmad shares his experiences from the "Coastal Cities at Risk 2013" conference organised by the Manila Observatory and the Coastal Cities at Risk Initiative supported by the Canadian Government, in the APAN web-portal (http://www.asiapacificadapt.net/resource/why-asia%E2%80%99s-growing-coastal-cities-must-invest-climate-resilience). The climate risks facing the Asia Pacific region's great coastal cities have been a concern for some time. Back in 2007, in collaboration with the World Bank and the Japan International Cooperation Agency, ADB embarked on a suite of studies to examine climate change impacts in Bangkok, Ho Chi Minh City and Manila. The studies used downscaled global climate projections, hydraulic models, and geographic information systems to assess the likely impacts through 2050, including increasingly severe and frequent tropical cyclones. The studies concluded that the costs to each city's infrastructure and the economy - from major flooding events alone - could potentially reach

billions of dollars annually, and that the urban poor would be at greatest risk. Manila has the distinction of being one of seven cities globally judged to be at extreme risk from the combined impacts of climate change and climate-related disasters – and only Dhaka in Bangladesh is estimated to be at higher overall risk. He points out that:

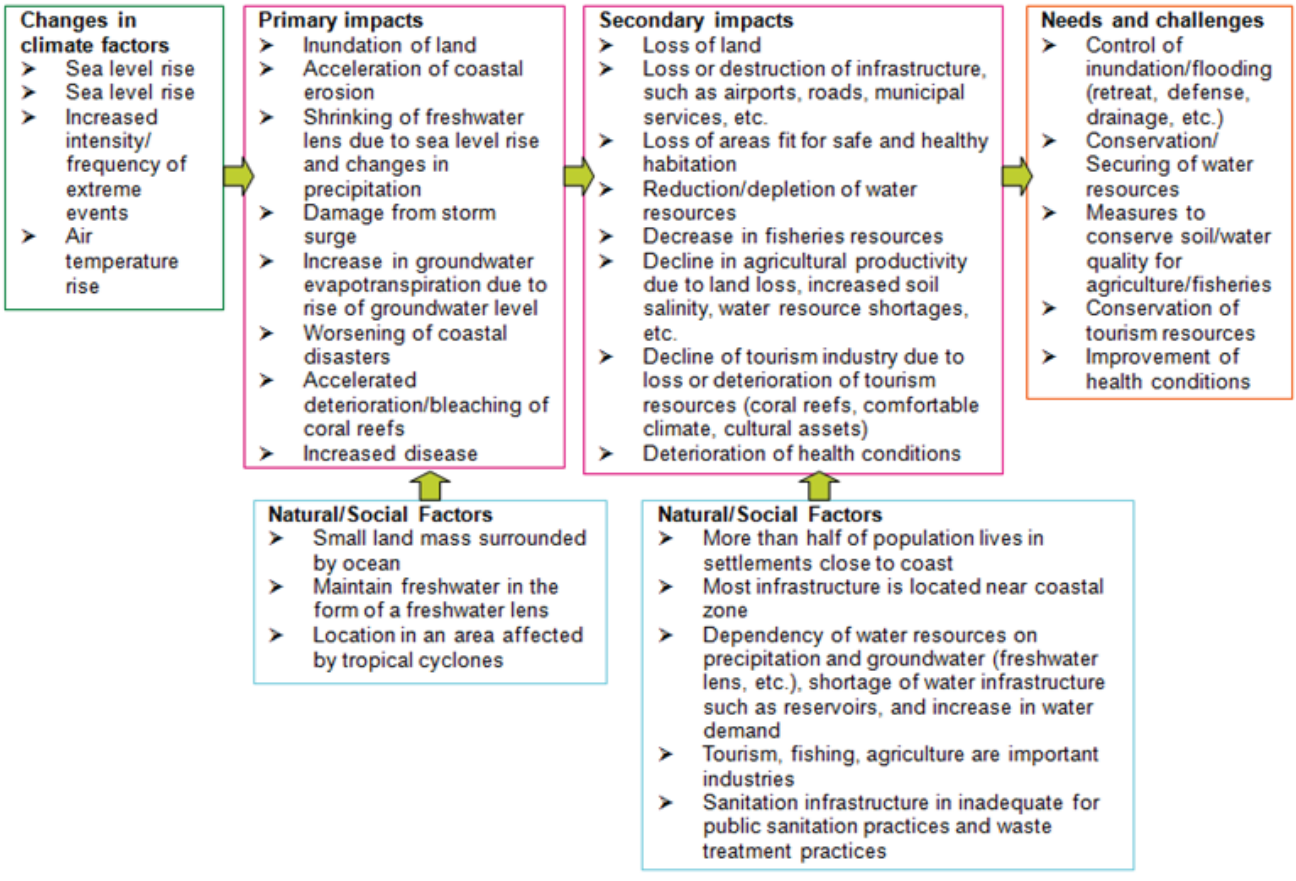
- The first point relates to the acute infrastructure deficit in urbanizing Asia.
- Second, for city governments to make the right choices, climate and disaster risks require much more and better analysis. There is a need to bridge the gap between climate science and adaptation practice on the ground. Decision makers urgently need projections and scenarios at a scale and resolution that make sense for immediate planning purposes.
- Third, cities need the capacity to transform this knowledge into improved development results. The required capacity ranges from establishment of sound design standards for urban infrastructure to enhanced capacity for disaster risk finance.



Adaptive capacity to climate change is generally low. The following impacts illustrate the urgent need to adapt to climate change, and include:

- Inundation of deltas, estuaries and coastal wetlands;
- Destruction of benthic systems, especially sea grass beds;
- Loss of productivity of coastal ecosystems;
- Flooding in coastal plains and increased coastal erosion;
- Increased saline intrusion causing freshwater contamination;
- Overall loss of freshwater supplies;
- Changes to traditional fishing sites;
- Loss of coral reef and mangroves;
- Damage and loss to coastal infrastructure and land;
- Increased vulnerability of human settlements;
- Biodiversity loss;
- Spread of vector-borne diseases;
- More frequent and intense weather events such as droughts and cyclones;
- Failure of subsistence crops and coastal fisheries; and
- Damage to industrial infrastructure.

Climate change impacts and needs in Asia-Pacific region (Small Islands)



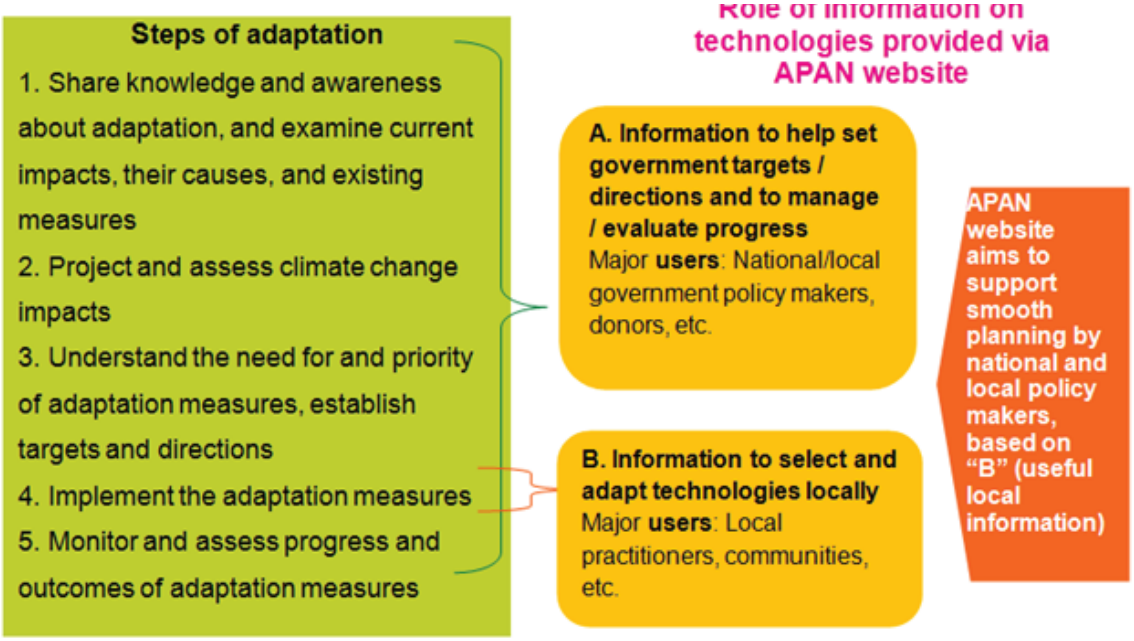
V. ADAPTATION TECHNOLOGY: KNOWLEDGE SHARING AND OUTREACH

(http://www.asiapacificadapt.net/adaptation-technologies)

5.1 Information on Adaptation Technologies

Objectives

Information on adaptation technologies was hosted by APAN website in order to promote the smooth formulation and implementation of policy when policymakers of national or local governments implement the series of adaptation steps, when adequately considering information that can be useful at the local level.



Users

The main users targeted for this website were the personnel of national and local governments and donor organisations in the Asia-Pacific region. The projection information and other countries' and regions' examples of planning, management and evaluation of adaptation strategies will serve as detailed and useful information on how this series of steps can be actually implemented (see text box "A" in figure). Meanwhile, for personnel involved in the actual local implementation and introduction of adaptation measures (e.g., practitioners and communities) descriptions, features, and costs of the technologies will be useful when selecting of the technologies and applying them locally (see text box "B" in figure).

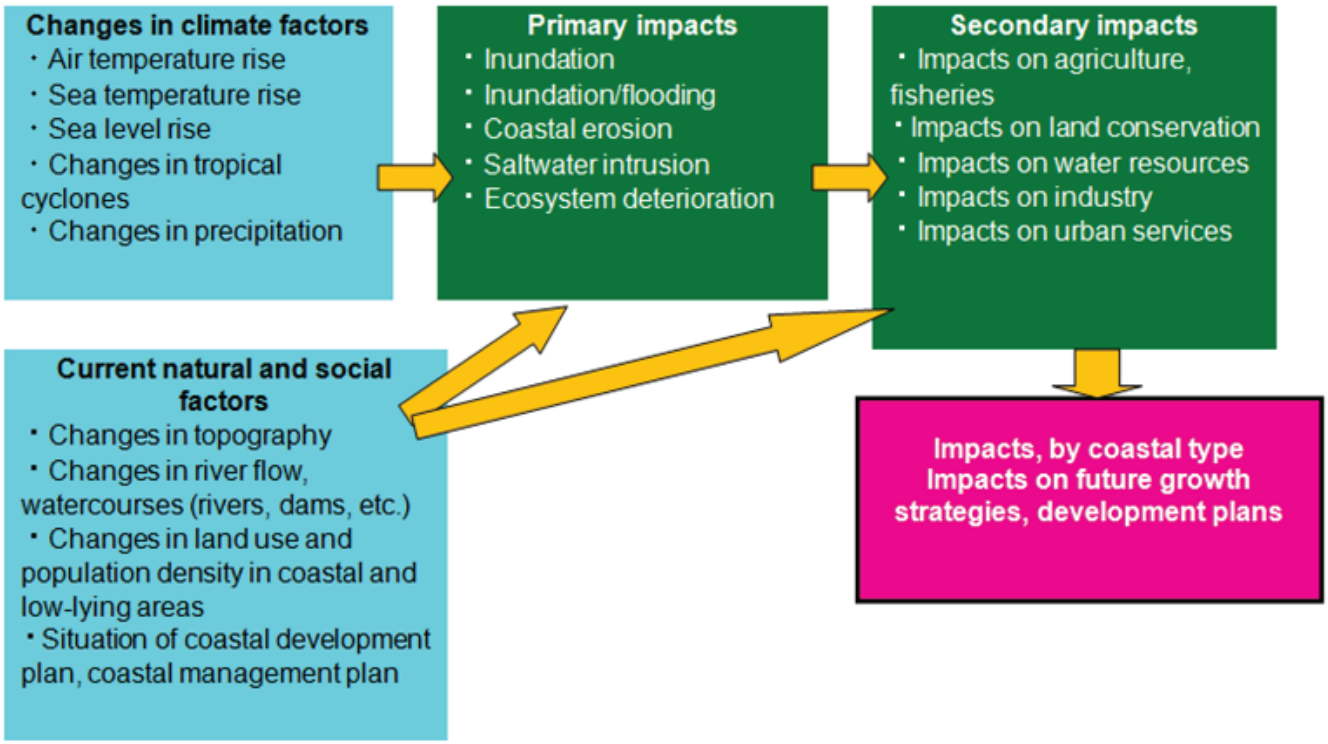
5.2 Mechanisms of Climate Change Impacts

When thinking about information on adaptation technologies as described earlier, if one is to accurately grasp the need for these technologies in the coastal

zones of the Asia-Pacific region, it is important to understand the mechanisms of climate change impacts in those zones. The flow described below is envisioned as an overarching framework for that understanding.

To begin with, "changes in climate factors" occur, such as air temperature rise, sea temperature rise, and sea level rise, followed by "primary impacts," such as flooding, inundation, coastal erosion, saltwater intrusion, and impacts on ecosystems. Next are the resulting "secondary impacts," such as impacts on agriculture and fisheries, and on land conservation. Finally, it is necessary to consider not only the primary and secondary impacts of climate change, but also the effects that arise from combinations of current environmental and societal factors. Based on the visible impacts and the assumed impacts, technology needs are then compiled for each coastal type. Finally, it is also important for national and local governments to consider the kinds of impacts climate change will have on future growth strategies and development plans.

Framework of the mechanisms of climate change impacts in coastal zones



5.3 Steps of Adaptation Measures

Adaptation to climate change is carried out in a series of steps, from awareness of necessity, to the planning, implementation and progress management/ evaluation of adaptation efforts. Basic steps for adaptation at the national and local government levels are typically as shown below.

Basic steps for adaptation

Step	Description
1. Share knowledge and awareness about adaptation, and examine current impacts, their causes, and existing measures	Share knowledge and awareness about the need for, the importance of, and concepts relating to adaptation. Compile information about current impacts and their causes (changes in climate factors, natural and social factors), and adaptation-related aspects of existing policies and measures, and identify areas where gaps exist.
2. Project and assess climate change impacts	Project and assess climate change impacts and assess vulnerability. If it is difficult to project future impacts based on local climate conditions and changes, it may be still possible to use available information to project and assess, or to implement qualitative and simplified projections and assessments.
3. Understand the need for and priority of adaptation measures, establish targets and directions	Based on the results of assessments, understand the need for and priority of adaptation measures and establish the required targets and directions.
4. Implement the adaptation measures	Consider practical procedures, persons in charge, schedules, and financing for the adaptation measures, and then implement.

VI. CONCLUSIONS/RECOMMENDATIONS

The challenge for adaptation technologies is to deal with the potential for future changes whilst being resilient to climate variability. Uncertainty is the other side of the coin on how climate change will manifest in a precise location. Hence, when selecting a technological solution, special caution and overview is urgently an offshoot to the choice, in an attempt to avoid locking a community into an unsuitable technology. Working with this uncertainty, technologies for adaptation need to boost resilience and increase capacity to adapt to the future. Appropriate technologies for adaptation enable people to make and act on choices about their livelihoods, to gain and share knowledge and also experiment and innovate with the technologies they are already using, thereby increase people's ability to make informed decisions. Access to local, up-to-date weather information helps farmers plan for the growing season and is particularly valuable in reducing vulnerability to extreme weather events such as floods and storms, or slower onset disasters such as drought.

Scaling-up of adaptation technologies has two important facets viz: replication and localisation. There are certain sectors such as agriculture, water resource management, etc. where the local specificities such as socio-economic, cultural and environmental diversities must be taken into consideration and locally appropriate modifications are required. On the other hand, there are technologies that can be replicated through blanket approaches such as resistant infrastructure development technologies, vaccinations, etc. Assessing these facets should be an integral part of scaling up adaptation technological approaches.

One of the main recommendations for the South Asian countries on adaptation technologies is that there should be an overarching roadmap to achieve the targets on adaptation. The roadmap should be inclusive of short-term, medium-term and long-term targets and strategies. Since the adverse impacts of climate Change are already being felt by the entire South Asian region, one of the most

vulnerable regions in the world and a "disaster hotspot", most of the existing plans and strategies of the South Asian governments have prioritised the most urgent adaptation requirements of the countries. However, the most appropriate adaptation technological approaches need medium-term and long-term strategies to establish a conductive environment with processes and institutional arrangements. In contrary, the most vulnerable sectors and communities where urgent adaptation measures are required should be given the required technological options through short-term targets. Such roadmap will allow the South Asian countries to strike the balance between short-term and long-term requirements while capturing the incremental impacts of climate change (IGES, CANSA 2012).

The challenge for Southeast Asian Countries (IGES, SEARCA 2012) is to set up the required Institutions (both policy and organizations, including structure and capacity). The interventions necessary are:

- range from formulating policy at various level, each aligned and strengthening the other, and linked to DRR
- setting up the institutions, capacitating the individuals, ensuring the availability of financing
- relevant policy, institutional framework and interpretation of policy;
- model for assessments
- model for capacity building and financing that exist to a large extent
- transferring learning within the region and across the organizational hierarchy and down the levels from the national to local, including communities.

It has been pointed out by Myanmar that during the period of 2008-2010, a number of activities for ETPA were implemented in line with those identified in the Myanmar Agenda 21, 1997. The ETPA activities that were implemented focused on: strengthening education and training; and raising public awareness.The major gaps identified by the National Commission for Environmental Affairs (NCEA) are as follow (Ne Winn, 2007):

- Lack of capacity building (e.g. training on relevant methodologies) and expertise in the area of vulnerability and adaptation assessment;
- Lack of vulnerability assessment such as the integrated and quantitative vulnerability assessment as well as assessment of impacts of climate variability and extreme weather events on key socio-economic sectors;
- Lack of cost-effective analysis of various adaptation options including adaptation technologies
- Lack of national strategies and action plan for climate change adaptation and its related disaster prevention and preparedness

Also there is mention of some usually overlooked and difficult areas - alignment of policy and organizational functioning; differentiating and integrating DRR and CCA; mainstreaming CCA; and engaging various stakeholders, especially the private sector, whose capacities have not yet been harnessed for adaptation and mitigation, especially in Southeast Asia.Capacity constraints for adaptation include:

(1) awareness of adaptation as an issue, (2) ability to analyse and apply climate information, (3) capacity to assess vulnerability to climate change, (4) effective system for dissemination of climate information, and (5) technical assistance to assess and implement adaptation options (Yussuf and Fransisco, 2009).

The analysis of the existing technology needs identified by the countries in the region shows that the existing gaps are not necessarily the "hardware" of the technologies. It is mainly related to the "soft" aspects of the technologies such as establishing the required capacity to use and benefit from the technologies, establishing appropriate processes to make conducive environment to use the technologies (policies and institutional frameworks) and up-scaling of the existing technologies. In terms of the UNFCCC negotiation pillars, the priorities are more related to capacity building and finance.

The recommendations of this report are also brought under this general picture and therefore, more relevant to capacity building; knowledge management sharing and outreach; and finance aspects rather than the hardware of the technologies. Improved analysis of adaptation technologies is required to show how they can contribute to building adaptive capacity and resilience in the agriculture sector. It is important to secure effective flows of information through appropriate dissemination channels.This information needs to be compiled and disseminated for a range of stakeholders from local to national levels. Relationships between policy makers, researchers and communities should be built so that technologies and planning processes are developed in partnership, responding to producers' needs and integrating the role to be played.

Key concepts around climate change adaptation are not universally agreed on. It is therefore important to understand local contexts – especially social and cultural norms – when working with national and subnational stakeholders to make informed decisions about appropriate technology options. Thus, decision-making processes should be participative, facilitated, and consensus-building oriented. This is vital for building adaptive capacity in the Asia Pacific region.

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Asia Pacific Adaptation Network (APAN)
IGES Bangkok Regional Centre
604 SG Tower, 6th floor
161/1 Soi Mahadlek Luang 3,
Ratchadamri Road, Pathumwan,
Bangkok 10330, Thailand
Tel: +66 (0)2 651 8794-99
Fax: +66 (0)2 651 8798
e-mail: info@asiapacificadapt.net
Website: www.asiapacificadapt.net