WORKSHOP REPORT

APN Scoping Workshop on Global Earth Observations and the Capacity Building Needs of the Region: Focus – Climate

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17-18 November 2005, Mita Kaigisho, Tokyo, Japan

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The Scoping Workshop on Global Earth Observations and the Capacity Building Needs of the Region: Focus – Climate was held in Mita Kaigisho, Tokyo, Japan, during 17-18 November 2005. The Workshop was organized by the Asia Pacific Network for Global Change Research jointly with the Ministry of the Environment, Japan and National Institute for Environmental Studies, Japan.

1. Attendance

The workshop was attended by as many as 32 participants from 12 countries, which included Bangladesh, China, Fiji, Indonesia, Japan, Malaysia, Mongolia, New Zealand, Samoa, Thailand, United States of America, and Vietnam. The attendees also included participants of several key organizations, namely Institute for Global Environmental Strategies (IGES), International START Secretariat, Intergovernmental Oceanographic Commission (UNESCO), Secretariat of the Pacific Regional Environment Programme (SPREP), US Climate Change Science Program (US National Science Foundation). A number of resource persons from research institutes, universities, and private companies also attended the Workshop. One important aspect was that the participants included as many as three Coordinating Lead Authors

(responsible for chapters on Asia and Small Island States), three Lead Authors and one Review Editor of the WG II Fourth Assessment Report of Intergovernmental Panel on Climate Change.

2. Objectives of the Workshop

The major objective of this workshop was to consider the capacity building necessary for research and monitoring related to climate change and its impacts, to discuss the role of the APN in such research and underpinning systematic observations and to create road maps for designing ideas appropriate for capacity building activities in the Asia Pacific. The discussions also focused on exchange of information on observational data needs, experience and views on climate change and adaptation strategies among the countries in Asia and the Pacific and to facilitate further activities to address the capacity building needs for climate change related issues in relation to implementation of 10 year plan for GEOSS in the region and the call in May 2005 by UNFCCC's Subsidiary Body for Science and Technological Advice conclusions on research needs relating to the convention, Agenda 8.4, inviting Parties to the Climate Change Convention to identify "research needs and priorities relating to the Convention, including information relating to the enhancement of the capacity of developing counties to contribute to and participate in climate change research."

3. Workshop Proceedings

The entire proceedings of the workshop over the two days were conducted under four sessions. The Session I focused presentations on the GEOSS Outline and the Workshop Objectives. Session II was devoted to recent developments in climate change research and the need for capacity building. Both the Sessions I and II were chaired by Dr. H. Harasawa of NIES, Japan. Session III was a break-out discussion session for identifying the priority issues focusing on capacity building needs of the Asia Pacific region in observational data requirements and on vulnerability and adaptation to climate change for sustainable development. A Chair and a Co-Chair for each of the two Working Groups (*see Workshop Agenda for further details*) were nominated to conduct the proceedings of the working groups and two Rapporteurs each were assigned to take note of the discussions. Session IV was devoted to collating the priority issues on observational data needs and vulnerability assessment for adaptation purposes and reaching a broad agreement among participants on thematic issues as regards capacity building needs of the region. Session IV was chaired by Dr. Andrew Matthews, Chair of the Workshop *(see file APN_WS_Agenda_17-18Nov2005.pdf in the CD for more details).*

At the outset, Mr. Toshiro Kojima, Vice-Minister for Global Environmental Affairs of the Ministry of the Environment, Government of Japan thanked all the participants for being an important part of the APN scoping workshop with a welcome note in Session I of the Scoping Workshop. He emphasized that current scientific understanding suggests that Asia-Pacific region is exceedingly vulnerable to global change and there is no doubt that the climate change will continue to cause serious damage to human health, society and ecosystems in this region. Vice-Minister Kojima pointed out that scientific knowledge on the global change is scarce in this region for the lack of information and data availability as also due to poor capacity, particularly in developing countries. Vice-Minister Kojima stated that the 10-Year Implementation Plan for establishing a Global Earth Observation System of Systems (GEOSS) has been adopted by Governments from approximately 60 countries and the information collected under this platform is expected to help us obtain a much better understanding of the complex global change mechanism. Also, an early warning with more denser and sophisticated observational data also should help us identify potential weather and climate related extreme events well in advance and respond appropriately when disasters occur. He also informed the participants that G8 Summit in Gleneagles in July 2005, while discussing Climate Change issue as one of the main themes, also welcomed the GEOSS 10-year implementation plan and made a commitment to support efforts to help developing countries and regions gain full benefits from GEOSS as the international framework for earth observation due to its immense importance in filling data gaps, developing regional capacity for interpreting observational data, and establishing decision-support systems and tools relevant to local needs. Vice-Minister Kojima stated that the ongoing policy processes, e.g., the UNFCCC, WSSD (related to climate change and sustainable development) are also placing greater emphasis on the need for capacity building and now we are in the stage to advance concrete discussions to develop a common awareness of global change. Vice-Minister Kojima hoped that this workshop will be the first responding action in the field of capacity building in Asia-Pacific to these policy agendas [*Full text of Vice-Minister Kojima's address is available on the CD as APN_WS_ViceMinister_WelcomeNote*].

3 (a) GEOSS Outline and Workshop Objectives

The first presentation in Session I was by Dr. Andrew Matthews, the workshop chairperson which provided an outline of the 10-year implementation plan of GEOSS with a focus on the capacity building initiatives planned for the year 2006 in relation to the Workshop objectives. He highlighted that the capacity-building activities for 2006 will be coordinated with the GEO Committee on Capacity Building and

Outreach and will focus on (i) assessing existing and planned capacity building activities in Earth observations globally, to provide frame for future GEOSS capacity building initiatives, (ii) initiating and supporting relevant training initiatives, and (iii) initiating specific activities for a number of societal benefit areas, including disasters, health, water, weather, ecosystems and agriculture. In the climate domain, he stated that, the important goals for GEOSS include ensuring the sustained provision of both key climate data and climate products derived from these data in all domains, promoting the completion of partially implemented observing systems, and facilitating access to quality-assured climate data. GEO supports the GCOS Implementation Plan, as referred to in the Gleneagles G-8 Summit statement, through emphasizing the need to develop successful mechanisms for sharing critical climate observations and strengthening existing climate institutions. Activities for 2006 will focus on (i) Providing coherent, consistent, continuous long-term records for key climate datasets and products derived from these datasets, (ii) Expanding earth observations of critical climate variables such as those identified in the GCOS Implementation Plan, and (iii) Enhancing and improving coordination of terrestrial climate observations and improving coherence in global ocean observation coordination. In particular, improving water resource management through a better understanding of the water cycle is a priority objective for GEOSS. Dr. Matthews also briefed the participants on the SBSTA's call for action in its 22nd session held in Bonn in May 2005 on the need to continue to work towards enhancing the research capacity of developing countries and hence their contribution to national, regional and international climate change research efforts (*Full text and power point files of Dr. Matthews's presentation are available on the CD as APN_WS_Presentation1_AMatthews*).

Next presentation in Session I was made by Mr. Hiroki Hashizume, Director of the APN Secretariat who spoke about the past capacity building activities undertaken by the APN and it achievements. Mr. Hashizume informed the participants that the APN was established as an Inter-governmental network in the Asia-Pacific Region in 1996 (it has 21 member countries) whose mission is to (i) Identify, explain and predict changes in the context of both natural and anthropogenic forcing, (ii) Assess potential regional and global vulnerability of natural and human systems, and (iii) Contribute, from the science perspective, to the development of policy options for appropriate responses to global change that will also contribute to sustainable development. He summarized the various milestones leading to the establishment of the APN since 1990 and the major activities launched by the APN since its establishment in 1996 till to-date which led to its international recognisation. A special mention was made of the APN's CAPaBLE Programme, an effective and integral part of the APN's activities in education and scientific capacity

building for global change and sustainable development. He stated that CAPaBLE is developing and enhancing scentific and educational capacity in developing countries to improve their decision-making in the target areas related to climate change and water and food security that are directly linked to their sustainable development in addition to Capacity Building for GHG Inventory Development for national communications to UNFCCC. The key focus of Mr. Hashizume's presentation was the 2 year (2005-2006) target plan of GEOSS and the active role that the APN envisages to play, as one of the participating Organizations in GEOSS and in accordance with the APN's current mission statement and science agenda as outlined in its Second Strategic plan which clearly puts the APN objectives in line with those of GEOSS, in strengthening the existing capacity building components with new initiatives in each societal benefit area in the Asia-Pacific region (*A power point file of Mr. Hashizume's presentation is available on the CD as APN_WS_Presentation2_ Hashizume*).

Following this, a background summary paper was presented by Dr. Murari Lal, workshop coordinator as the last presentation under Session I of the worskhop. This presentation was, in general, based on the responses and feedbacks received from the APN National Focal Points, Scientific Planning Group Members and the workshop participants on a Questionnaire sent to them prior to the workshop and covered the issues pertaining to Observational data needs for climate research, on understanding of vulnerability to Climate Change in relation to adaptation and development in the Asia Pacific, and on the Capacity Building Needs in Asia – Pacific region. The presentation also highlighted the specific outcomes for GEOSS, both short and long-term, as elaborated in the 10-Year Implementation Plan. A list of the essential climate variables that are both currently feasible for global implementation under GEOSS and will have a high impact on UNFCCC requirements was presented and the major shortcomings of current efforts in observing, processing and dissemination capabilities in the developing countries of Asia and the Pacific were identified. A few important observational data related issues relevant to Asia and the Pacific region were highlighted and some key capacity building needs of the Asia Pacific region as regards utilization of the data emerging from all available sources and networks, information exchange and additional data needs in the region were suggested. Adaptation to the impacts of climate change is emerging as a critical concern for both the developed and the developing countries in the Asia Pacific Region [*Full text of Background Summary paper and power point files of Dr. Lal's presentation are available on the CD as APN_WS_Presentation3_Lal*). The responses and feedbacks from the APN Focal Points and SPG members and Workshop participants to the Questionnaire summarized in this presentation highlighted the following as limiting factors for scientific

and technical capacity in the region: (1) Lack of access to observed data (meteorological, socio-economics etc.) and analytical tools, (2) Limited research experience of scientists, (3) Scarcity of scientists, science infrastructure and science funding, (4) Lack of familiarity with relevant methods and models, (5) Lack of capacity to construct credible scenarios, and (6) Difficulty of establishing and continuing collaborations from scientists from multiple disciplines needed for climate change research. An urgent need for education, training, research and related capacity building initiatives in the developing countries of the Asia Pacific Region was desired so that these are able to meaningfully participate in international initiatives and plan and implement national sustainable development activities (*Responses to the Questionnaire and a consolidated summary of these are available on CD under Questionnaires_Responses&Summary folder*).

3 (b) Recent Developments in the Climate Change Research and the Need for Capacity Building in the Asia Pacific Region

Session II was devoted to some high priority issues of the Asia Pacific Region including recent developments in Climate change research and capacity building needs. Five invited experts made their presentations in this session on topics covering some aspects of Global Earth Observations, Advances in Climate Modeling Research, Impacts of Climate Change and Adaptation, and Capacity Building Needs.

Mr. Howard Diamond's presentation (delivered by Dr. A. Matthews) focused on details of U.S. NOAA's (involves all U.S. federal agencies with a role in climate observing and monitoring) role in facilitating improvements in the management and operation of observational networks for monitoring important climate factors, atmospheric profiles, and pollutant emissions, aerosols, and ozone as part of a GCOS Cooperation Mechanism (GCM) which begun in 2004. The presentation suggested that the program reflects a broad-based approach which looks at supporting observing and data management activities at the international, regional, and bi-lateral levels. In addition, NOAA's Pacific Region Integrated Data Enterprise (PRIDE - to meet critical regional needs for ocean, climate, and ecosystem information to protect lives and property, support economic development and enhance the resilience of Pacific Island communities in the face of changing environmental conditions), the overall support for Pacific Islands Ocean and Climate observing regional coordinators in Fiji and Samoa to aid in coordinating these observing activities among developing countries in the region, and the U.S. – New Zealand Bi-Lateral Climate Change Partnership signed July 2003, updated in July 2004 and July 2005 has been a great boost towards capacity building in the Pacific Island Countries. The presentation highlighted that the U.S. has been very supportive of the

overall international GCOS program effort and has provided considerable support on both a global, regional, as well as bi-lateral basis for several years now. The support for GCOS should be global in nature and the U.S. is working to be a leader in helping to make GCOS a sustainable and robust system both regionally and globally, and that can serve the needs of an improved global climate monitoring system that will be part of the Global Earth Observing System of Systems (GEOSS) [*Full text of the paper and power point files of Mr. Diamond's presentation are available on the CD as APN_WS_Presentation4_HDiamond*).

The next presentation in this session was delivered by Dr. Seita Emori and covered the recent climate modeling advances aimed at generating confident projections of future regional climate change scenarios. Dr. Emori stressed that future climate change scenarios projected by climate models have been and will be the only credible input as premises for the vulnerability and impact assessments of climate change. He suggested that the recent high-resolution climate modeling efforts enable us to discuss the future changes in regional climate and extreme events with more confidence as it can feed detailed future climate change scenarios for advanced impact assessments. He informed that, since the IPCC Third Assessment Report (TAR) released in 2001, considerable efforts have been made to improve the climate models in various climate centers in the world. The improvement of physics includes more realistic parameterizations for radiation, cloud, convection, boundary-layer, ocean mixing and so on, and more realistic interactions among them. Some climate models also incorporate an on-line aerosols module and its interaction with cloud and radiation, which is completely a new feature since the TAR. Today, the 'Earth Simulator', one of the world largest computing facilities developed in Japan, has enabled a Japanese Atmosphere-Ocean Global Climate Model ('MIROC' model developed by CCSR[1]/NIES[2]/FRCGC[3]) to run at the resolution of approximately 100 km for the atmosphere and approximately 20 km for the ocean. A global 20 km-mesh atmosphere-only model developed by MRI/JMA[4] has also been running on the Earth Simulator. These high-resolution climate models on the Earth Simulator have significantly enhanced our ability to represent regional characteristics and relatively small-scale atmospheric phenomena (such as tropical cyclones etc.). Dr. Emori demonstrated that new modeling results have enabled us to identify areas mainly in subtropics where the rate of increase in extreme precipitation is likely to be significantly larger than that in the mean in the future. He however cautioned that, one should be conscious of general uncertainty issues in climate change projections as any climate model is inherently incomplete

[1] Center for Climate System Research, the University of Tokyo
[2] National Institute for Environmental Studies
[3] Frontier Research Center for Global Change, Japan Agency for Marine-Earth Science and Technology
[4] Meteorological Research Institute/Japan Meteorological Agency

mainly because of the approximations introduced in the parameterizations of various physical processes. Hence, future climate change scenarios projected by any climate model, no matter how high its resolution is, bear inherent uncertainty. Dr. Emori stressed the importance of 'understanding' aspect of climate change research, rather than the future projection work itself, as it contributes to the enhanced confidence of the projected results. He suggested that the understanding on projected climate change as well as its uncertainty should be conveyed to the impact researchers more clearly to avoid the misinterpretation of the information on projected climate change and improve the overall quality of vulnerability and impact research. In other words, the intercommunication between climate researchers and impact researchers is desirable not only for transferring data, but also for transferring knowledge [*Full text of the paper and power point files of Dr. Emori's presentation are available on the CD as APN_WS_Presentation5_Emori; a movie clip on projections of climate change scenarios presented by Dr. Emori is also available on CD as CC_Scenario_Presentation5*).

Next, Dr. Lin Erda presented the likely impacts of regional climate change on agriculture productivity in China. Key findings of his results suggested that the climate change without carbon dioxide (CO_2) fertilization would reduce the rice, maize and wheat yields by up to 37% in the next 20–80 years. He also suggested that the complex interactions of CO_2 with limiting factors, especially water and nitrogen, are now increasingly well understood and are capable of strongly modulating observed growth responses in crops. More complete reporting of free-air carbon enrichment experiments confirms that CO_2 enrichment under field conditions consistently increases biomass and yields in the range of 5–15%, with CO_2 concentration elevated to 550 ppm (parts per million by volume). He, however, cautioned that it seems likely that the extent of the CO_2 fertilization effect will depend upon other factors such as optimum breeding, irrigation and nutrient applications. He suggested that, to build adaptive capacity for agriculture, risk management approaches such as establishing early warning systems, developing technologies of avoidance and tolerance must be introduced in addition to dryland farming, and use of water conservation practices [*Text of the paper and power point / pdf files of Dr. Erda's presentation are available on the CD as APN_WS_Presentation6_LinErda*).

Mr. Taito Nakalevu presented an overview of the experiences of current threats and risks faced by Pacific Island Countries and Territories from the effects of extreme weather and climate variability. He reported that the recent findings from climate models are suggestive of enhanced warming of the tropical Pacific region and this warming has the potential to alter and indeed increase such risks, through changing the frequency

and/or intensity of extreme weather or climate variability phenomena or through accelerated sea-level rise. The impacts of these climate events will exacerbate already stressed marine, freshwater and terrestrial environments. Mr. Nakalevu suggested that reducing the risks associated with the impacts of extreme weather and climate variability in Pacific Island Countries needs various expertise, skills and financial support. Drawing heavily on the recent Pacific Islands Climate Change Framework 2006-2015 as it contains one of the very recent capacity needs identified by Pacific Island Countries and Territories, Mr. Nakalevu discussed some of the capacity challenges in the Pacific region and how best this could be alleviated [*Text of the paper and power point files of Mr. Nakalevu's presentation are available on the CD as APN_WS_Presentation7_Taito*).

In the last presentation of this session, Dr. Nguyen H. Ninh of Vietnam primarily focused on the key characteristics of Cambodia, Lao PDR and Vietnam both in terms of social vulnerability to reforms and the vulnerability to the potential impacts of climate change. He reported that, despite increasing levels of industrialization and urban growth, much of the population in these countries remains dependent on agriculture and, as such, is particularly susceptible to the impacts of climate variability and climate change. He suggested that, while flooding and heat stress pose a serious threat to both irrigated and rainfed agriculture in the region, more frequent droughts, heat stress, likely changes in the frequency and/or intensity of tropical cyclones and sea level rise will also exacerbate the miseries of the people in this region. Capacity building for developing countries in Indo-China region such as methodologies and measures to assess impacts and possibility of damages to socio-economic conditions, suitable responses as regards enhancing the monitoring and data analyzing/interpretation capacity in the region including technology transfer to cope with planned adaptation to climate change is critical. Dr. Ninh concluded that the constraints of the region lie into two most important domains, namely, (i) the lack of awareness on climate change and variability at different levels and sectors, and (ii) the lack of communication between the national to regional and local levels in implementing the adaptation strategies [*Full text of the paper and power point files of Mr. Ninh's presentation are available on the CD as APN_WS_Presentation8_Ninh*)

Following these presentations and prior to the lunch break, a brief discussion took place on the objectives of the break out parallel sessions for the afternoon of day 1. Two working groups were set up under Session III to discuss (a) the capacity building issues related to observational data requirements for advancing the understanding of climate change, and (b) the capacity building needs on vulnerability and adaptation to climate change for sustainable development in the Asia

Pacific region. A Chair, a Co-Chair and two Rapporteurs were assigned to each Working Group to lead the discussion and to record the summary of the discussions.

4. Observational Data Requirements for Advancing the Understanding of Climate Change – Capacity Building Needs in Asia & Pacific (Working Group - A Report)

Working Group A (on observational data requirements for advancing the understanding of climate change) had a series of deliberations and lengthy discussions on all aspects of the current status of observational data and that required for an improved understanding of climate variability and climate change at national, regional and global scales. The group noted that there have been improvements in implementing global observing systems for climate, especially in the use of satellite information and provision of some ocean observations. However, it was also conscious of the serious deficiencies that remain in the ability of global observing systems for climate to meet the identified needs of the UNFCCC in that:

- Atmospheric networks are not operating with the required global coverage and quality;
- Ocean networks lack coverage and commitment to sustained operation; and
- Global terrestrial networks remain to be fully implemented.

The group noted that the surface air temperature is the most important variable for determining the state of the climate system. It is a key variable for detection of climate change and assessing the relative importance of anthropogenic and natural influences. It is a prime driver of many impacts on natural and human created systems. The GCOS Surface Network (GSN) is a subset of approximately 1,000 stations that support the global network of meteorological or climatic surface stations that provide local and regional-scale observations. On its own, the GSN is capable of determining change in the global surface temperature average, but must be augmented to provide detailed patterns of spatial change, particularly in the data gaps regions of the Asia - Pacific. Analysis of indices of extremes derived from daily land-based data is generally temporally limited to the last half-century or less and spatially limited to roughly 50% of the planetary land surface due to limited data digitization and exchange. Oceanic air temperature data are sparse in many areas e.g., tropical oceans in the 19th and early 20th century. Moreover, it was felt that permafrost temperature data are also essential for detecting the terrestrial climate signal in permafrost terrains of Russia, Mongolia and Northern China. Precise measurements of permafrost temperatures can be used to detect integrated changes in the ground surface heat balance an order of magnitude smaller than can be

determined by direct instrumental heat balance measurements. Changes in permafrost temperature and thawing of permafrost can result in changes to the surface heat and moisture balances. The strength and stability of frozen ground is temperature-dependent; warming of permafrost may result in ground instability and slope instability which has important implications for infrastructure. Unfortunately, many permafrost temperature records are of short duration or discontinuous. An expanded network of sites in the mountainous regions of the Asia & Pacific is required.

The key issues and priorities as regards surface air temperature data monitoring, archiving and availability were identified as:

- The overall usefulness of information from the GSN is reduced because there are major regions in the Asia-Pacific for which few observations are available (either in the GSN or the full WWW network), these deficiencies require urgent attention.
- Data archaeology, digitization of longest available data records.
- Access to daily data.
- Homogenization of daily data as much as possible.
- Integration of satellite and *in situ* data.
- Testing climate model data sets against observational data products.

The group stated that currently there are no research quality global or regional near-surface wind products feasible for climate change studies. Thus, development of international archives that cover at least the past 50 years of synoptic observations is warranted. It was also noted that satellite scatterometers are key instruments to measure ocean wind fields and are giving important new information for operational forecasting and climate model evaluation and need to be continued as part of the operational global observing system for climate.

The group noted that precipitation (frequency, intensity and quantity) is a key variable for specifying the state of the climate system. It varies considerably in space and time and requires a high-density network to observe its variability and extremes on regional scales. Analysis of precipitation and its change is crucial for the assessment of climate change and of the impact on nature, environment and human society. Changes in its timing (e.g. seasonality) have implications for water supplies and agriculture. In particular, the knowledge of surface precipitation resulting from rainfall and snowfall is important for assessment of water resources and for understanding of the interaction between the energy and water cycle as well as for the assessment of climate impact on ecosystems. Aspects are climate change impact on vegetation, desertification (duration of droughts, shift of climate zones),

water resources, river runoff and floods (intensity and duration of extreme events).

Estimates of precipitation from satellite observations of visible, infrared and microwave radiance are available for parts or all of the period since January 1979. Such estimates are valuable for their ability to provide consistent coverage over large parts of the globe, including in particular those regions with poor or no rain gauge coverage. Currently available estimates based on satellite observations are all subject to significant errors, including biases that are poorly understood. Estimates of global and regional precipitation and its variability need to be significantly improved by nations routinely exchanging their current and historical observations with the regional and international data centres including the GPCC. Moreover, improvement in the data availability for climate analysis and research is critical as is the enhancement and facilitation of the regional and international exchange of required data from denser networks. Development of distributed data archives for precipitation data with easy access is warranted. Analysis of extension or shift of climate zones, energy and water cycle studies and assessment of climate change impacts require time-series of precipitation data from a larger number of stations than are existing in GSN. Analyses derived from denser collections of rain gauge observations are needed, as are improved analysis techniques. In particular, more observations are needed in regions of complex terrain and in high latitudes of the Asia-Pacific. The errors in gauge-based analyses and in estimates derived from satellite observations must also be better characterized and understood. Compilation of time-series of daily data for the 20th century as a basis for statistical analysis on the human impact and the change of frequency, intensity and duration of extremes is necessary.

The current capabilities on river discharge / runoff data availability at a global scale are limited to estimations of mean monthly grided runoff values as there is no operational system that provides near real time data from many large rivers discharge stations. Authority over hydrological data and information and specifically on river discharge is scattered regionally and sectorally, resulting in highly fragmented approaches to their management. Researchers and managers either spend too much time retrieving data or omitting relevant information, both leading to stagnation in research and management. Thus, the primary issue and priority is to raise public and political awareness on the need to better integrate existing information in both, an organizational and technological sense. Looking at the current stratus of overexploitation of groundwater resources, creation of a information system on groundwater resources assessments with key supporting data, including depth to water table, net water volume change (annual, monthly) of major aquifers, and processing and assessment of monitoring data, in support of and in

collaboration with national agencies in the Asia Pacific region should also be helpful for research and policy actions. Promotion of public awareness on the strategic importance of groundwater is also critical.

Upper air temperatures are a key dataset for detection and attribution of tropospheric and stratospheric climate change. Temperatures measured by radiosondes are a vital reference against which satellite-based measurements can be calibrated. Upper air temperatures are crucial for separating the various possible causes of global change, and vital for the validation of climate models. Instrument discontinuities make radiosonde-based climate trends questionable. Upper tropospheric humidity measurements have historically been considered so unreliable that many radiosonde observations omitted dew points in cold temperatures, usually under -40 or -50°C. Continuous global satellite data exist back to late 1978 from which atmospheric water vapour data can be constructed, but operational satellite moisture retrievals are not routinely published in a form suitable for climate trend monitoring. With improved use of reanalysis and the anticipated attention by the space agencies to GCOS monitoring principles, there is best prospect of future improvement if the GUAN network is fully maintained as a baseline component. Global Positioning System (GPS) radio occultations can provide, per satellite, around 500 accurate, all weather, round-the-clock, well distributed, temperature profiles with good vertical resolution through the mid-upper troposphere and lower stratosphere. These can be accurate to 1-2°C random error and have a vertical resolution comparable to that of radiosondes but with global coverage and low bias. GPS receivers could be incorporated on operational meteorological satellites to provide useful temperature estimates in the upper-troposphere and stratosphere.

The monitoring of the *forcing of climate* involves variables from natural sources including solar irradiance and volcanic aerosols. It also includes those anthropogenically-influenced atmospheric components of aerosols and the greenhouse gases including carbon dioxide, methane, ozone and other long-lived greenhouse gases. The Global Atmosphere watch (GAW) currently has a network for determining the long-term trends in the meridional distribution of non-reactive greenhouse gases, currently the network is being enhanced to determine the global distribution of these non-reactive greenhouse gases and to include the monitoring of certain short-lived greenhouse gases and aerosols.

Carbon dioxide is the most important of the greenhouse gases emitted by anthropogenic activities. The atmospheric build-up is caused mostly by the combustion of coal, oil, and natural gas, and reflects to a significant extent the cumulative anthropogenic emissions rather than the current rate of emissions due to its very long lifetime (up to thousands of years)

in the atmosphere-ocean-terrestrial biosphere system. High precision and accuracy of the measurements is necessary to derive significant information on the carbon budget expressed as sources and sinks of carbon dioxide. Major limitations are the sparseness of data and the fact that almost all data are ground-based. The latter has severely hampered the improvement of model representations of vertical mixing and boundary layer processes. Development of remote sensing methods to measure carbon dioxide, closely and continuously compared to accurate *in situ* measurements is essential.

Methane (CH_4) is the second most significant greenhouse gas, and its level has been increasing since the beginning of the 19th century. In addition to methane other long-lived greenhouse gases (GHGs) include nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydrochloro-fluorocarbons (HCFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6), and perfluorocarbons (PFCs). The current direct radiative forcing from CH_4 is 20% of the total from all of the long-lived and globally mixed greenhouse gases and the other trace gases contribute another 20% of the changes in climate forcing since the start of the industrial revolution.

The Kyoto Protocol of the Climate Convention includes future restrictions on the emissions of the GHGs including CO_2, CH_4, N_2O, HFCs, SF_6, and PFCs. The Montreal Protocol on Substances that Deplete the Ozone Layer includes mandatory restrictions on the production and consumption of the CFCs and HCFCs for individual countries that are also GHGs. The above trace gas measurements are vital to international and national regulatory agencies, climate models, and scientists interested in atmospheric chemistry and transport. There is no one central clearinghouse or organized network to make a consistent data set with traceable stable gas standards available in real-time. There is a real need to increase the number of vertical profiles of these measurements from airborne platforms. Such measurements would help to resolve the differences of more than a factor of two in the latitudinal distributions that climate models predict for CO_2 and SF_6.

Atmospheric aerosols are minor constituents of the atmosphere by mass, but a critical component in terms of impacts on the climate and especially climate changes. Anthropogenic aerosol influences are considered to have a negative radiative forcing, which on a regional basis may be equal to or greater than the warming associated with greenhouse gases. The IPCC identified anthropogenic aerosols as the most uncertain climate forcing constituent. The loss of ozone in the lower stratosphere due to heterogeneous chemistry on aerosols or polar stratospheric clouds (PSCs) will cool the Earth's surface and, therefore, is a negative forcer. The changes in cirrus cloud amounts, particle size, and/or lifetime, also have important radiative effects on climate.

Limited networks of sun photometers (e.g. AERONET) have collected relevant observations from which aerosol amounts and properties can be derived. Only limited aerosol chemical composition data are available from regional monitoring networks established to deal with acidification issues and from sites operated as part of research programmes. Observations of chemical composition require additional sophistication in measuring techniques including awareness of data quality. There is essentially no global network of aerosol composition measurement sites. Climatologies of aerosol properties, and in particular time histories of these characteristics, are useful to document changes in climate, as well as to evaluate possible causal links with specific effects. Aerosol properties and distributions are also useful for atmospheric chemistry studies and impact assessments. Aerosols are notoriously difficult to repetitively characterize over large areas. Reasons include the wide diversity in chemical composition, size and shape of the particles, great variability in spatial and temporal distributions, as well as difficulties of distinguishing their radiative effects from those of underlying surface elements over bright surfaces. The full characterization of the properties and distribution, in space and time, of atmospheric aerosols has been identified as one of the top priorities in all climate and global change reviews. Space Agencies should be strongly encouraged to further develop new techniques and operationally exploit advances that have been made in recent years. An infrastructure to facilitate data transfer processes and data access is required so that standard format datasets, which have been subject to Quality Assurance / Quality Control (QA/QC) procedures, would be readily accessible.

Fluctuations of glaciers and ice caps in mountain areas have been systematically observed for more than a century in various parts of the world. The corresponding changes are considered to be indications of highest reliability concerning world-wide warming trends. Mountain glaciers and ice caps are, therefore, key variables for early-detection strategies in global climate-related observations. Advanced monitoring strategies integrate detailed observations of mass and energy balance at selected reference glaciers with more widely distributed determinations of changes in area, volume and length; compilation of glacier inventories enables global representativity to be reached. The World Glacier Monitoring Service (WGMS) co-ordinates world-wide glacier monitoring and publishes corresponding data for about 60 glaciers (annual mass balance) and roughly 500 glaciers (length, area and volume change) every 5 years. More numerous observations of glacier area, thickness and length changes by application of remote sensing technologies (laser altimetry; aerial photography; high-resolution satellite, visible and infrared imagery from systems such as ASTER and Landsat) need to be co-ordinated with the *in situ* measurements.

The Group stated that there is an urgent need to develop a comprehensive time series of recent land cover changes with a high spatial resolution (national / regional scale) and a decadal temporal resolution. Existing land cover data should be analyzed and/or reprocessed, wherever possible, to ensure the compatibility of maps produced for the last decade. Another relevant parameter, the Fraction of Absorbed Photosynthetically Active Radiation (FAPAR, non-dimensional) which refers to the fraction of the incoming Photosynthetically Active Radiation (PAR) that is effectively used in photosynthesis, is a primary variable controlling the photosynthetic activity of plants, and therefore an indicator of the presence and productivity of vegetation and the intensity of the terrestrial carbon sink. FAPAR varies in space and time due to differences in species and ecosystems, weather and climate processes, and human activities. It is a key variable in the carbon cycle and thus in the assessment of greenhouse gas forcing. Spatially-detailed descriptions of FAPAR provide information about carbon sinks and can help to verify the effectiveness of the Kyoto Protocol's flexible-implementation mechanisms. Changes in FAPAR are also an indicator of desertification and the productivity of agricultural, forest and natural ecosystems. There are no known global networks that systematically collect FAPAR measurements or historically archive of FAPAR data. However, new products are being generated on the basis of currently or recently acquired data, and these are usually archived by space agencies. Major efforts are needed to generate global data sets of FAPAR for relatively long periods.

Sea level rise, including the changing frequency and intensity of extreme events, is one of the main impacts of anthropogenic climate change and is particularly important to all low-lying land regions including many small-island states. Changes in sea level are a significant parameter in the detection and attribution of climate change and an indicator of our ability to model the climate system adequately. Sea level is also an indicator of ocean circulation and is an important component in initializing ocean models for seasonal-to-interannual and possibly decadal climate prediction. Present knowledge of global sea level variability and change is not adequate. Estimates of global averaged sea level (over a 10 day period) from satellite altimeter data have a precision of about 5 mm. Available information on satellite biases and vertical movement of tide gauges limits the accuracy of estimates of global averaged sea level rise since 1992 to order of 0.5 mm/yr. The 20th century estimates of global averaged sea level change range between 1 and 2 mm/yr because of few long tide gauge records, the poor spatial distribution of the historical tide gauge sites and lack of sufficient information on vertical land motion at tide gauge sites. Understanding and projecting the risk from regional extreme sea level events requires

that sea-level observations be freely exchanged.

The upper ocean is the primary planetary reservoir of heat. The large heat capacity of the ocean (the largest in the climate system) slows the rate of anthropogenic climate change, affects the regional distribution of change and is a major determinant of interannual and decadal climate variability. The redistribution of heat over time is a primary variable for climate change detection and attribution, and for evaluation of coupled climate models. The ocean density distribution (the distribution of temperature and salinity) determines ocean currents and thus is one control on the health of ocean fisheries and ecosystems. Increased interest in global and regional ocean data assimilation will lead to improved knowledge of the distribution and redistribution of upper ocean heat and to refinements of the Ocean observing system strategy. International participation in the Global Ocean Data Assimilation Experiment, to facilitate intercomparison of ocean thermal analysis products and for exchange of technique improvement, needs to be encouraged.

Knowledge of ocean ecosystem change is not adequate at present. Adequate data pertaining to ocean biological processes is extremely difficult to obtain due to the vast area of the ocean (over 70% of the earth's area) and to the logistical difficulties of shipboard sampling. Satellite views of ocean colour are our only chance for gaining an overall view of the state of ocean biology at any given time, but knowledge of the linkage between ocean colour and ecosystem variables remains limited. Research is underway to improve knowledge of the relationships between ocean colour and ecosystem variables, including chlorophyll. Data from moorings, satellites, ships, and drifters need to be merged to produce synthesized data sets useful for climate studies.

The group desired that time and space resolution as well as calibration routines of existing and future satellite-based measurements should be enhanced, particularly for water resources management [including water quality for sea, rivers and inland water bodies], land management for food production and biodiversity, integrated coastal zone management and local and trans-boundary issues in air quality to better understand the impacts of climate change.

The key messages that emerged out of the deliberations in this Working Group was that:-

(1) Many existing data are not accessible to researchers in the Asia Pacific, either within country or internationally. Resolution of this barrier requires: promoting political commitment to data sharing; removing practical barriers by enhancing electronic

interconnectivity and metadata; and data rescue and digitization.

(2) Substantial ongoing research and surface observation is needed to calibrate and verify algorithms and satellite products.

(3) The provision of necessary resources to improve and make available existing archives of observed data on the variables noted above will require largely national efforts to be complimented with international support on technology transfer and human resource training / capacity building for analytical interpretations and appropriate use for societal benefits. These can build on strong international endorsement of the importance of information for scientific reasons as well as for practical socio-economic reasons.

The Group stated that, as the fundamental driver that sustains observational networks is the utility of the data and information generated, it is important to build capacities in the region to utilize the data emerging from all available sources and networks. Some key capacity building needs of the Asia Pacific region as regards information exchange and data needs are:-

1. there is a need to improve networks for the exchange of information — workshops to provide training on developing national Web sites would be desirable;
2. there is a role for regional capacity building to promote technology-related information networks — in particular there is a need to raise awareness of the existence of energy efficiency “win-win” solutions; and
3. assistance is required to improve data acquisition and storage, to obtain access to the Internet, and to build capacity to develop databases.

[*A brief tabular summary of issues that constituted the WG – A discussions held during the break out session is available on CD as APN_WS_WG-A_Report_Table*).

5. Capacity Building Needs of A & P Countries on Vulnerability and Adaptation to Climate Change for Sustainable Development (Working Group - B Report)

The changing climate is altering exposures to climate hazards and posing threats to the environment and human well-being. The community of nations is responding to these dangers with efforts and plans to mitigate the human causes of climate change. But avoiding severe and dangerous impacts also requires adaptations to reduce vulnerabilities. Growing recognition of the immediate and long term implications of climate change for sustainable development has, in recent years, spurred greater discussion and action regarding adaptation at the national and

international level. The Working Group was aware that the key issues before the international community as it moves forward on adaptation to climate change are:

- How to support integration of adaptation considerations into mainstream projects, plans, policies and sustainable development strategies at the local, sectoral, national and international level, including:
  - How to develop, test and share the knowledge, tools and technologies required to increase capacity to adapt to climate change; and
  - How to obtain and expand the financial resources required to support adaptation efforts;
- How to address the special needs and concerns of developing countries; and
- How to develop capacities to overcome the present gaps in the earth observation in relation to vulnerability and adaptation to climate change for sustainable development.

Adaptation to climate change could be addressed by enhancing consistency between climate change and development policies within and outside of the UNFCCC regime. This policy coherence would enhance the ability of countries to reduce their exposure to the risks associated with the impacts of climate change; improve their capacity to adapt to changes, and particularly those changes felt by the poor; and increase the efficiency and effectiveness of adaptation efforts. There is also an urgent need in the developing countries of the Asia Pacific Region for education, Training, research and related capacity building so that they are able to meaningfully participate in international initiatives and plan and implement national sustainable development activities.

For effective adaptation, understanding is needed of the vulnerabilities and adaptation options that are specific to place and time. The Group stated that the level and quality of adaptation in most developing countries of Asia and the Pacific is currently insufficient and falls short of that which is required to cope effectively with present-day risks of extreme weather events and to prevent further growth of vulnerability to the now inevitable and unavoidable changes in climate. The Group identified a number of factors which are responsible for this: One is the lack of priority given to adaptation, which itself may be due to lack of awareness and knowledge of climate change impacts or perceptions that the impacts are less threatening or less immediate than other risks. Lack of financial resources, technical capacity, and institutional capacity are also factors that constrain adaptation responses. The constraints are most binding in some of the poorest countries (including Island Nations),

where climate change threatens to impede and undermine development and poverty reduction. In many of these countries, little adaptation is likely to take place without external assistance and human resource capacity building. The outcomes within the affected countries could be severe and could have spillover effects beyond their borders (such as large scale migration etc.). External assistance should help to overcome the constraints, stimulate greater adaptation, and moderate the severity of impacts.

The Group also noted that effective adaptation requires a variety of institutional capacities. Institutions with scientific capacity are needed to advance knowledge of the changing climate, vulnerabilities, and adaptation options. Institutional capabilities to translate scientific knowledge and communicate it in usable forms to different user communities are also needed. Government agencies in the Asia-Pacific Countries need capacities to interpret and apply knowledge about climate risks within their spheres of action (e.g. agricultural productivity, fresh water availability, risk and disaster management such as flood control, public health, finance), as well as to implement effective programs and projects that are climate proof. Capacities are also needed in private sector, civil society and local government organizations to facilitate, promote and take actions that integrate climate change adaptation into local scale actions. A capacity that cuts across institutions, sectors and scales is crucial for strategic planning, coordination and oversight to manage climate risks, much as the environment ministries promote and coordinate the management of environmental risks.

The Working Group recognized that adaptation measures are very different from sector to sector. Adaptation measures in agriculture are quite different from those that can be used in coastal zone management or biodiversity conservation. For this reason, adaptation has to involve a heavy dose of sector-specific expertise. The locus of much of this expertise, including knowledge of practices and problems in managing present day climate risks, is in the line agencies that have responsibility for the different sectors. Expertise can also be found in private sector firms, trade groups and associations such as farmer associations. While sector-based approaches are not sufficient by themselves, mainstreaming adaptation will require that the government and stakeholder organizations with the relevant expertise, interests and authorities be engaged for each sector.

The Group also felt that the creation and spreading and sharing of information about climate change are major and ongoing tasks. The current shortcomings in observational networks in developing countries are masking severe impacts of climate change for many regions, systems

and communities. At the national or local levels very little could be done in the absence of a good appreciation and awareness of the risks of climate change and the ways in which they are adding to the more familiar risks of climate variability. The need also extends to the field of technical knowledge, not only about the climate change itself, but also about available and possible adaptation options.

The Working Group B first examined the drivers and exposure systems in terms of impacts of climate change, and tried to identify gaps and needs for capacity of earth observation in the regional, sub-regional and national levels.

The **key drivers of impacts** identified by the Working Group are:-

- Concentrations of CO_2 and other GHGs,
- Urban air quality in key Asian countries,
- Surface air temperature and rate of temperature change,
- Rainfall frequency, intensity and intra-seasonal and inter-annual variability in monsoon regions of Asia and the Pacific,
- Salinity in inland water bodies (aquifers and rivers) and in coastal areas
- Frequency and intensity of extreme weather events (e.g., floods, droughts, cyclones, typhoons etc.), and
- Trends in sea level rise, storm surges and coastal erosion.

The **identified exposure systems** which, the group agreed, need to be considered on priority in the Asia Pacific region are:

- water resources,
- glaciers,
- groundwater in terms of its quantity and quality,
- ecosystems and biodiversity (terrestrial, coastal and marine),
- land management for agriculture and food security,
- energy in particular hydropower generation capacity,
- infrastructure for communities, promotion of tourism and expansion of industries, and
- human health etc.

The Working Group felt that the capacity of earth observation in the individual countries of the Asia Pacific region vary in their effectiveness because of the existing challenges to the maintenance and sustainability of the operations of national meteorological services and other relevant agencies. Human resource issues also compound of these issues, in particular the lack of technically and scientifically trained personals at the national level. The Group also felt that many developing countries in the Asia Pacific lack systems for real time or near real time data processing, analysis and transferring the processed product as daily,

weekly, monthly and seasonal weather forecasts to farmers and other user communities. The capacity to acquire, process and utilize remotely sensed satellite data for meteorological / climatological applications and for land use management through GIS tools is also quite different among countries of the region.

The Working Group identified the **current gaps and needs of observation for drivers** which included:

- emission inventories of green-house gases (GHGs),
- concentrations of CO_2 especially in tropical regions,
- application of CO_2 flux inverse modeling,
- availability of long-term station – wise meteorological / climatological data in particular the historical records in digitized form, and
- a concise data set on national socio-economic developments and projections of future scenarios in the Asia Pacific region.

While the Working Group identified a number of hot spots (discussed in the next section), it was felt that the precise targets for capacity building activities on both observational systems and related host of issues of data availability, analysis and interpretation for enhancing the coping strength of the impacts of climate change and development of adaptation strategies in the Asia Pacific region need more focused discussion within a larger group engaging all of the APN National Focal Points and other stakeholders. This should form part of the activity for the second APN Scoping Workshop scheduled early next year.

A critical issue that drew attention of all in the Working Group was that of the availability of credible regional and local climate change scenarios at various time scales for assessing the sector specific vulnerability analysis and it was widely agreed that there is a lack of understanding between the researchers engaged in impact assessment and the climate modelers in terms of the appreciation of the uncertainty in currently available climate change projections and the limitations of various downscaling approaches.

The Working Group identified the factors which limit the scientific and technical capacity in the Asia and Pacific on coping with and developing adaptive strategies to climate change as under:-

- Scarcity of scientists, science infrastructure and science funding,
- Limited research experience of scientists,
- Lack of observational data (meteorological, socio-economic etc.) and analytical tools,

- Lack of familiarity with relevant methods and models,
- Capacity to construct credible scenarios, and
- Difficulty of establishing and continuing collaborations from scientists from multiple disciplines needed for climate change research.

The Working Group strongly felt that the APN National Focal Points and other stakeholders in the Asia Pacific countries should be encouraged to find ways and means to reduce the existing lack of understanding impact assessment researchers and the climate modelers in order to gain useful scientific outputs from vulnerability assessments at national and local levels. Attention was also drawn to the pioneering work done by the Task Group on Scenarios for Climate Impact Assessment (TGCIA) - a body of international researchers set up by the Intergovernmental Panel on Climate Change (IPCC) in 1997 and the Data Distribution Centres operating under TGICA. A wider circulation of the two technical documents to researchers engaged in climate change vulnerability assessment in developing countries of the Asia-Pacific [GUIDELINES ON THE USE OF SCENARIO DATA FOR CLIMATE IMPACT AND ADAPTATION ASSESSMENT (Version 1), Prepared for Task Group on Scenarios for Climate Impact Assessment of Intergovernmental Panel on Climate Change (by T. R. Carter, M. Hulme and M. Lal, December 1999, 69 pages) and GUIDELINES FOR USE OF CLIMATE SCENARIOS DEVELOPED FROM REGIONAL CLIMATE MODEL EXPERIMENTS available at Data Distribution Centre of the IPCC TGICA (by L. O. Mearns, F. Giorgi, P. Whetton, D. Pabon, M. Hulme, M. Lal, 2003, 38 pages)] was recommended. These two documents as also the relevant chapters from WG I and WG II Third Assessment Report of IPCC (currently available most authoritative scientific assessment report) are being provided in the Workshop CD-Rom for their wider dissemination.

[*A brief tabular summary of issues that constituted the WG – B discussions held during the break out session is available on CD as APN_WS_WG-B_Report_Table*).

6. Priority Issues and APN's role to Strengthen Regional Cooperation in Addressing these Issues

The two Working Groups, within the limited available time, deliberated at length on the priority issues relevant to capacity building needs and on ways and means to strengthen regional cooperation in the Asia Pacific region. They collectively felt that a systematic observation of sensitive and fragile systems (hot spots) in the region is very important as detection of early warning indicators and for demonstrating the evidence of global warming to national leaders and the society. Some of the

identified hot spots for more intensive observations and systematic analysis of the available ground truths are listed as below:

- Himalayan Glaciers – Spatial and temporal distribution of snow cover
- High Elevation Areas of Tibetan Plateau
- Degradation and depletion of Ground Water Aquifers in China, India and Pakistan
- Desertification trends in Arid/Semi-arid areas of west Asia
- Mongolian Tundra
- Hydrological Cycle and its changes in Asian Monsoon System and its linkage to El Niño – Southern Oscillation episodes
- Potential Changes in Extreme weather events including Tropical Cyclones and Typhoons.
- Trends in deterioration of Coral reefs, mangroves, and sea grass in Coastal Waters of East, South, Southeast Asia, Australia and Island Countries
- Loss of Biodiversity in Fragile Ecosystems of Highlands, Wetlands and Islands.

The two Working Groups identified *three levels of capacity to be developed in the region*, namely, individual, organizational / institutional and system of institutes/society. Coordination of capacity building activities within and between these levels was also considered important.

The *identified capacity building needs* are:-

- Global and Regional Climate Models,
- Credible high resolution climate scenarios,
- Integrated Impact Assessment Models,
- Remote Sensing and Geographic Information System (GIS),
- Linkage between climate change observations and human dimensions,
- Emergency Preparedness,
- Rescue, re-analysis, and dissemination of historical data and knowledge focusing to the use of end-users,
- Institutional framework (regional, national and local),
- Funding Resources to meet the capacity building needs.

The two Working Groups appreciated that the APN has been supporting projects proposed by teams consisting of individual researchers and, sometimes, policy-makers and NGOs. The APN has also encouraged dialogues between research community and policy-makers and society in the Asia Pacific region over the past decade.

While both the Working Groups identified a number of hot spots (listed

above), it was felt that the precise targets for capacity building activities on both observational systems and related host of issues of data availability, analysis and interpretation for enhancing the coping strength of the impacts of climate change and development of adaptation strategies in the Asia Pacific region need more focused discussion within a larger group engaging all of the APN National Focal Points and other stakeholders. This should form part of the activity for the second APN Scoping Workshop scheduled early next year. They felt that, once the targets of capacity building for earth observations are identified, the APN may need to develop new ways to support new CB levels.

The time available for further detailed discussion on critical issues and also identifying the APN's precise role in capacity building activities relevant to observational data needs in the region with climate as focus theme was limited and hence it was desired that this issue needs to be re-visited at the next Workshop planned for Bangkok early next year wherein efforts should be directed to engage the APN National Focal Points, representatives of the National Meteorological services and WMO-WCP Personnel in addition to climate change researchers.

The Working Group decided that the participants would take stock of the capacity building needs of their individual nations and return back to the APN with more specific issues and requirements (in the next Scoping Workshop) that the APN could facilitate through implementation of projects on those critical issues by way of developing the human resources and by strengthening the institutional structures and the technical capacity necessary to cope with climate change.

The very constructive discussions over the short two day Workshop allowed all to focus and develop a list of key issues for the Asia-Pacific Region. The intense discussions and the resultant consensus provided an excellent platform for the development of detailed plans for action and potential pathways for this action that will be concluded in the follow-up workshop in March 2006.

At the end, the Workshop Chair commended the participants for their commitment to enhance the capacity of their country and the region in coping with the adverse impacts of climate change and facilitate the decision makers through development of appropriate adaptive strategies to protect their communities. The workshop concluded with thanks from the Workshop Chair to all the Workshop participants for their open and frank contributions and to those who worked behind the scenes to make the Workshop such a success.

7. Future Directions and Concluding Remarks

While the details provided in sections 1 to 6 above are an elaborated version of the Workshop Chairperson's Summary, the workshop coordinator, as part of his assigned task by the APN, has undertaken a critical analysis of the response and feedback received from the APN Focal Points and SPG members and Workshop participants to the Questionnaire, the presentations made by various invited experts in this Workshop and a review of recent published work by the international scientific community and relevant to the theme of the workshop.

Based on the said analysis and review, some of the salient issues are highlighted here – these statements and issues provide a background for potential directions in the APN Workshop scheduled for March next year but do not express the views of or may have endorsement of the APN or other Organizing Agencies of the workshop.

(a) The Current Understanding of Climate Change Science in Asia Pacific Context:

- Most countries in the Asia Pacific region have experienced more variable weather (including intra-seasonal and inter-annual variability in climate) and associated disasters such as intense heat waves, heavy rainfall extremes, severe floods and droughts, more frequent cyclones/typhoons with higher intensity, more persistent and stronger ENSO event and a positive trend in sea level rise in the 21st century.
- Surface temperature records indicate that the 1990s were the warmest decade of the millennium over the globe. Seven of the 10 warmest years on record have all occurred since 1990, and all 10 of them have come since 1980.
- Reported thawing of permafrost in north Asia in recent years has been unprecedented. Several glaciers in highlands of Asia have also retreated significantly in past few decades and are facing immediate threat from surging atmospheric heat observed in recent decades and have contributed to recurrent flash floods and land slides.
- Unprecedented changes have also been reported in terrestrial, coastal and marine ecosystems in most countries of the Asia Pacific region in recent decades (e.g., shifts in flora and fauna, extinction of several species, beaching of coral reefs etc.).
- The current scientific understanding makes it difficult to attribute the enhanced variability in climate at local / national / regional levels exclusively to anthropogenic factors (it could be due to a combination of natural variability and human activities).

- It is widely accepted that the threat of global warming is real and that all nations need to take collective actions to arrest the increasing trends in emissions of greenhouse gases.
- More stringent steps than those envisaged in Kyoto Protocol would be needed to prevent the rise in surface air temperature beyond the critical threshold of ~2^{o}C and prevent, *in relation to Article 2 of the UNFCCC*, dangerous anthropogenic (human-induced) interference with the climate system.
- It has been established scientifically that the planet earth has already warmed significantly during the 20th century and is already committed to continued rise in surface air temperature and sea level rise in 21st century and beyond.
- The recent studies suggest that the agricultural production losses due to rise in surface air temperature above 3.5^{o}C above the pre-industrial level would be most significant and may drastically increase the number of undernourished, severely hindering progress against poverty and food insecurity in the developing countries of the Asia Pacific region.
- Studies also suggest that available fresh water resources will be a scarce commodity (due to enhanced demand with increases in population, likely changes in hydrological cycle as a consequence of climate change and salinity intrusion in coastal areas) in many developing countries of the Asia Pacific, in particular in arid and semi-arid regions.
- Most cyclone prone coastal areas in the Asia Pacific region would be under serious threat of large scale devastation (extensive damage to infrastructure, property and loss of human lives) due to more intense cyclones/typhoons and associated surges in coming decades.
- Most Island nations in the Asia Pacific region would be under threat of submergence due to sea level rise – this threat has become more critical with new findings of significant melting of polar ice in recent years and the possibility of accelerated sea level rise in future.
- Inspite of considerable improvements in scientific knowledge on the climate change issue during the past three decades, uncertainties still exist.
- Part of this uncertainty has been attributed to lack of adequate ground truths (stagnant or diminishing array of observational data networks, inadequate application of newer technology for collection of in-situ and remotely sensed observational data), limitations in climate modeling techniques, adequate computing resources and future trends in socio-economics of nations.
- The development and implementation of appropriate adaptation strategies to climate change is the way forward for sustainable future and must be mainstreamed into development activities of all nations to minimize the impacts of climate change on society.

(b) Current Status of Vulnerability Assessment and Development of Adaptation Strategies in Asia Pacific Countries and Constraints:

The scientific community has been engaged in research to better understand the impact of global warming on continental, regional and local scales for over four to five decades now. This extra information could help planners concerned with monsoon regions, mountain areas or coastal zones to develop more targeted adaptation strategies against the adverse effects of climate change. A better understanding of the vulnerability of nations in the Asia Pacific is crucial to develop sector specific adaptation strategies at local, national and regional levels. The impact of future climatic change would be felt more severely in developing countries in the Asia Pacific as the economy of many countries is largely dependent on agriculture. However, while many of these are already under stress due to current population increase and associated demands for energy, fresh water and food, they lack the coping capacity to adapt to climate change.

A host of studies on national vulnerability assessment in many countries of the Asia Pacific region have been undertaken during the past decade. A series of international initiatives such as US Country Study Program, UNDP/UNEP/GEF supported activities, APN Funded projects, AIACC projects and many bi-lateral projects have assisted the developing countries of Asia and the Pacific to enhance their capacity and undertake these vulnerability assessments. Most of these studies have relied heavily on the climate change scenarios which are based on numerical experiments conducted with rather coarse resolution coupled ocean – atmosphere global climate models (GCMs). As a consequence of this:-

- The climate change scenarios downscaled from coarse resolution GCMs provide only plausible estimates of large scale changes (not suited for local scale adaptation purposes) – the hydrological projections used in most vulnerability assessments have low confidence due to substantial inter-model differences.
- Many of the studies have used only monthly mean future changes (model generated daily data are, in general, not accessible to most scientific community engaged in impact assessment), the nature of likely changes in climate variability have not been appropriately accounted for.
- Many of the climate change scenarios have been adopted from an individual model without properly validating the model for a particular region in its skill to simulate realistically the present day climate and its intra-seasonal and inter-annual variability.

In view of above, the available country vulnerability analyses provide only a generalized and rather crude guess on the likely impacts (at best they could be referred to sensitivity analysis).

Thus, a credible quantitative assessment of the magnitude of high resolution regional climate change over a country with a degree of confidence and accuracy is, as yet, not available to impact analysts so that the they may properly assess the social and economic consequences expected due to the change and appropriate, though flexible, policy options be formulated on national and regional levels to arrest the impacts of climate change for sustainable development activities.

In addition, the capacity of the developing countries of Asia and the Pacific in sector specific vulnerability assessment and in development of appropriate adaptation strategies is currently limited by:-

(1) Lack of access to observed data (meteorological, socio-economics etc.) and analytical tools,
(2) Limited research experience of scientists,
(3) Scarcity of scientists, science infrastructure and science funding,
(4) Lack of familiarity with relevant methods and models,
(5) Lack of capacity to construct credible future scenarios, and
(6) Difficulty of establishing and continuing collaborations from scientists from multiple disciplines needed for climate change research.

(c) Future Pathways for Strengthening Capacity in Vulnerability Assessment and Development of Adaptation Strategies in Asia Pacific Countries:

More powerful computers and better modeling techniques have improved the skill of global and regional climate models in recent years. Researchers are now becoming more confident that they will generate information that will assist *long-term* planning in agriculture, protection from hydro-meteorological disasters and air-quality management.

Some very high resolution global and regional climate model simulations have been performed over selected regions of the Asia Pacific by a few climate modeling centres of excellence. Vast volumes of model-generated data have been produced with these new experiments.

The said model generated data at selected spatial and temporal scales should provide very valuable information to impact researchers, if made available in a consolidated archived format on national / regional scales. Simultaneously, the scientific community engaged in vulnerability assessment would need to be trained in handling of these large volumes

of data, the limitations and uncertainties and in appropriate downscaling techniques for its proper use and application.

As the availability of credible high resolution climate scenarios is the backbone for developing future strategies for sector specific adaptation, possible pathways need to be found as to how APN could facilitate production of scenarios of future changes in climate mean and its variance at country specific basis in the Asia Pacific region. This subject matter has been highlighted in the response to the questionnaire and also briefly touched upon by the participants during their deliberations at the November workshop.

Creation of a data bank on quality controlled observed climatology including statistics on socio-economics, vulnerable populations, and sectors at local and national scales in the Asia Pacific and free exchange of data and information among the countries of the region is also crucial and needs to be discussed with the national representatives for meaningful outcome of future research projects to be funded by APN.

The creation of a consolidated data base and availability of credible scenarios of future changes in climate mean and its variance at country specific basis will be a major break through in facilitating the capacity of the developing countries of the Asia Pacific region for whom adaptation to climate change is a necessity. This has added advantage in that vulnerability and adaptation are central to international policy on climate change in both UNFCCC and Kyoto Protocol and will significantly assist the developing countries in meeting their obligations to these conventions/protocols and actively participate in international science and in policy negotiations.

Assistance would be required in developing countries of the Asia Pacific to improve data acquisition and storage, to obtain access to the Internet, and to build capacity to develop databases. The precise targets for capacity building activities on both observational systems and related host of issues of data availability, analysis and interpretation for enhancing the coping strength to undertake studies on the impacts of climate change and development of adaptation strategies in the Asia Pacific region would need more focused discussion within a larger group engaging, if feasible, the APN National Focal Points and other stakeholders. This should form part of the activity for the second APN Scoping Workshop scheduled early next year.

APN's precise role in capacity building activities relevant to supporting or enhancing observational data monitoring / recording needs in the region with climate as focus theme seems rather limited and perhaps, at the follow-up workshop in Bangkok, efforts could be directed to engage the

APN National Focal Points, representatives of the National Meteorological services, relevant space agencies (those monitoring, interpreting and archiving remotely sensed data) and WMO-WCP Personnel in addition to climate change researchers for facilitating improved access to required data for research and analysis. Several key hot spots have been identified in the scoping workshop and a systematic monitoring and analysis of the identified sensitive and fragile systems in the Asia Pacific region is urgently required as this should facilitate detection of warming signals and its impacts. The follow-up APN workshop in Bangkok should focus on the ways and means to undertake this analysis and the availability of required data for the purpose.

New and targeted ways and means need to be explored at the follow-up workshop to engage the scientific community in developing countries of the Asia Pacific towards development and application of appropriate analytical tools to advance scientific understanding of climate change impacts, vulnerabilities and adaptation opportunities in their countries / regions. Efforts should be directed in identifying approaches to ensure that the research projects aspire to develop and/or use new tools for integrated impact assessment. Priority focus needs to be given to enhancing capacity for coping with hydro-meteorological hazards in these discussions.

In Developing Countries of Asia and the Pacific, the existing mechanisms for establishing linkage between science and policy communities for adaptation/mitigation planning and implementation are entirely inadequate and need to be substantially augmented. The policy makers at all levels need to be briefed / sensitized on the advancement of scientific knowledge and suggested possible remedial measures in terms of integrated approach to risk management and technical approaches to sector-specific adaptation for minimizing the adverse impacts. Organization of workshops / seminars on annual basis with involvement of all stake holders should facilitate a two-way communication between the scientific community and the policy/decision makers. At local scale, implementation of adaptation measures requires direct involvement of communities (local empowerment, and linkages to scientific and traditional knowledge) and there is a need to enhance their knowledge base and coping capacity. This assumes a special significance in coastal communities (disaster preparedness, and emergency responses and measures) and in farming communities (management of farming practices to circumvent the impacts of climate change). In major urban centres of the Asia Pacific, the focus for capacity building in terms of adaptation to climate change needs to be on health issues, environmental management, life styles and sustainable consumption pathways through involvement of health services personnel, civil societies, industry and NGOs. The participants in the follow-up APN

workshop will need to come up with more focused approaches and concrete actions needed to address these issues for implementation of targeted activities.

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Appendix 1: Agenda

Asia-Pacific Network for Global Change Research
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APN Scoping Workshop on Global Earth Observations and the Capacity Building Needs of the Region: Focus – Climate

17 - 18 November 2005, Mita Kaigisho, Tokyo, Japan

Co-organized by
Ministry of the Environment, Japan and
National Institute for Environmental Studies, Japan

Workshop Chair: Dr. Andrew Matthews

AGENDA

Day 1: Thursday, 17 November 2005

Session: I (Chair: Dr. H. Harasawa)

0930 – 0940: Welcome Notes: Mr. Toshiro KOJIMA, Vice-Minister for Global Environmental Affairs, Ministry of the Environment, JAPAN (5 minutes)

0940 – 1000: GEOSS Outline and WS Objectives: Dr. Andrew Matthews (20 minutes)

1000 – 1015: APN's Past Capacity Building Activities and Achievements: Mr. Hiroki Hashizume (15 min)

1015 – 1045: Outcomes of the Questionnaire, Presentation of Background Paper (Capacity Building Needs in the Region): Prof. Murari Lal (30 min)

1045 – 1115: Coffee Break

Session: II (Chair: Dr. H. Harasawa)

High Priority Issues of the Asia Pacific Region
(*Recent Developments in the Climate Change Research and the Need for Capacity Building*)

1115 – 1140: Global Earth Observations: Mr. Howard Diamond[1](15+5 min)

[1] Mr. Howard Diamond had to cancel his travel to Tokyo at the last minute due to official exigencies and his presentation was delivered by Dr. A. Matthews.

1140 – 1200: Climate Modeling Advances: Dr. Seita Emori (15+5 min)

1200 – 1220: Impacts of Climate Change: Prof. Lin Erda (15+5 min)

1220 – 1240: Adaptation to Climate Change: Mr. Taito Nakalevu (15+5 min)

1240 – 1320: Global Change & Capacity Building Needs: Dr. Ninh Huu Nguyen (25+15 min)

1320 – 1330: Concluding Discussions

1330 – 1430: Lunch Break

Session: III

1430 – 1730: Working Group Parallel Sessions

Working Group – A: Observational Data Requirements for advancing the understanding of climate change – Capacity Building Needs in A & P

Chair: Prof. Taikan Oki; Co-Chair: Dr. E. Desa
Rapporteur: Prof. Sharifah / Dr. Emori

Working Group – B: Capacity Building needs of A & P Countries on vulnerability and adaptation to climate change for sustainable development

Chair: Prof. M. Mimura; Co-Chair: Dr. Roland Fuchs
Rapporteur: Dr. M. Mirza / Dr. Ancha Srinivasan

Coffee Break: During the Working Group Session

1800 – 2000: Reception / Dinner

Day 2: Friday, 18 November 2005

Session: IV (Chair: Dr. A. Matthews)

0900 – 0945: Working Group Parallel Sessions Continue

0950 – 1130: Reports from WG Chairs
Collation of Key Themes and Possible CB Activities

1130 – 1200: Coffee Break with Small Snack

1200 – 1330: General Discussion and Wrap Up
Agreement on Thematic Issues for Priority Capacity Building Activities

1330 – 1430: Lunch

1430 – 1500: Workshop Chair's Summary and Closing

Appendix 2: Participants List

APN Scoping Workshop on Global Earth Observations and the Capacity Building Needs of the Region: Focus - Climate
17 and 18 November 2005, Tokyo, Japan

LIST OF PARTICIPANTS

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