Prototype Training Workshop on Water Affairs

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Water Resources University
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Michael H. Glantz, National Center for Atmospheric Research

"You play with Nature, and Nature will play with you"
(comment by workshop participant)

The WMO/NCAR/WRU prototype workshop on "Water Affairs" was developed and co-organized by Michael Glantz, director of the Center for Capacity Building at the National Center for Atmospheric Research (NCAR) and supported and co-organized by the World Meteorological Organization (WMO) Hydrology and Water Resources Program Officer, Claudio Caponi. It was held at Water Resources University (WRU) in Hanoi, Vietnam. The WRU staff provided logistical support for the workshop in Hanoi as well as provided some of the participants to the four-day workshop.

The main purpose of this prototype workshop was to introduce the multifaceted concept of Water Affairs to hydrologists, hydro-meteorologists and meteorologists and to explore the interactions in the Greater Southeast Asian region of climate, water and weather and the impacts of those interactions on societies. Please note that all presentations available to the workshop's participants and observers are located on the workshop's updated agenda at our website on the Internet. They can also be found on the "Reports" link.

The participants represented 11 countries in the region that we refer to as "Greater Southeast Asia" (India, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, and Vietnam). Representatives from Bangladesh and Indonesia had been invited and accepted but at the last minute were unable to attend. The brief country presentations of the 11 participants as well as of the invitees from Bangladesh and Indonesia have been included in this report. Also included is a written presentation by the Rector of the WRU. A presentation from the director of the Center for Climate Affairs at the University of Malaya-KL is also included.

Claudio Caponi officially opened the workshop by greeting the Vietnam host and the participants from the region, encompassing both South and Southeast Asia. He presented the WMO's perspective on the objectives of the prototype workshop on Water Affairs, which is basically to provide mid-managerial staff of National Hydrological Services (NHSs) with the understanding of the importance of their activities, especially those deriving from the widening of scope of their responsibilities in recent years, in the socioeconomical framework of their countries. Prof. Dr. Dao Xuan Hoc, the Rector of WRU's Hanoi campus, also greeted the participants to the workshop and presented information about the university, the programs of which are focused on theoretical as well as engineering and operational aspects of water issues. He noted that WRU currently has more than 10,000 students enrolled in programs of scientific research, technology transfer, and field applications on its two campuses, one in Hanoi and the other in Ho Chi Minh City.

Michael Glantz then presented a brief statement about the overarching objectives of the prototype workshop on water affairs. He underscored the fact that “water affairs,” as a multidisciplinary educational and training activity, must include at least the following aspects: water science, water impacts on ecosystems and societies, water policy & law, water politics (national and international), water economics, and water ethics & equity. He noted that other water-related aspects could be added to the list in order to address a hydrological service’s national concerns, such as water-related geo-engineering projects or water technology. Glantz then described the agenda topics and the materials to be used in support of the workshop presentations and discussions. The main course materials included the water affairs “Viewbook” and a water affairs Reader (a 250-page collection of short readings for the topics encompassed by the aspects of water affairs, noted earlier). These are available on the workshop website (see above).

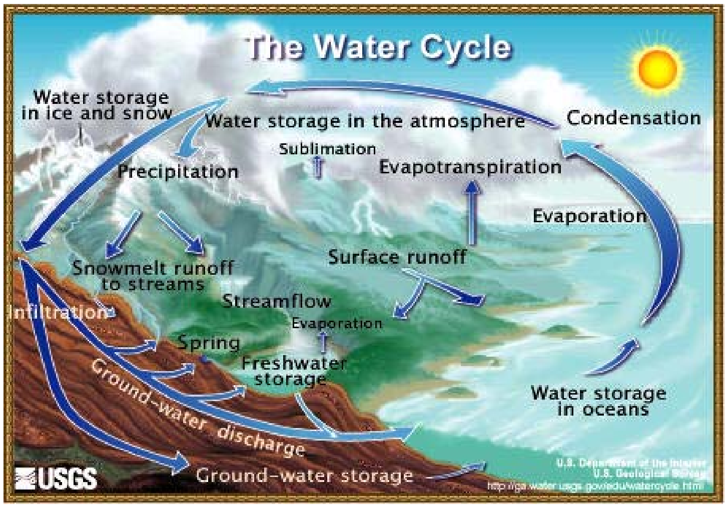
Glantz introduced the notion of Water Affairs. He suggested that support of societies divide nature into components that enable them to be able to “manage” each of those components. They do so by creating specialized sub-units within a much larger bureaucracy. In reality, though, nature is holistic and its components are integrated in ways that societies have forever sought to understand with a greater precision than presently exists, in part for reasons of curiosity, and in large measure for reasons of necessity and survival. Thus, it is not easy to discuss, for example, the climate system without talking about the hydrological cycle and water. It is difficult to meaningfully discuss water without reference to climate and weather. And much of the concern about weather relates directly or indirectly to water and climate.

Dr. Rita Colwell, former Director of the US National Science Foundation, noted that “in the 21st century we have to develop an integrated approach across the disciplines to understand the complexity of water issues worldwide” (Colwell, 2002). In other words, society must come up with ways to accurately reintegrate the way it deals with climate, water and weather systems.

A Water Affairs program enables and hopefully empowers students, trainers, and educators alike to concentrate at least a part of their educational experience on research, impact assessment, climate applications, and policy centering on water and water-related issues. The issues raised in the various sessions throughout the workshop were supplemented by the participants’ experiences and presentations. Each participant had been asked to present, in a special evening session, the major water issues facing their particular country.

Water Science

The obvious place to start a discussion about water science is with the hydrological cycle. It was the intention not to lecture on hydrology but to present an overview of the water cycle as the basis for future discussions. The components of the cycle – water storage in ice and snow, water storage in the atmosphere, condensation, transpiration, evaporation, precipitation, snowmelt runoff to streams, surface runoff, streamflow, water storage in oceans, infiltration, groundwater storage, groundwater discharge, evapotranspiration, and spring freshwater storage – are shown in the following diagram.



After brief discussion about the hydrological cycle as represented in the USGS graphic, attention was directed toward a specific, often underplayed, aspect of water (and for that matter, climate) science: seasonality. Understanding and coping with seasonality is central to meeting the needs of societies and the maintenance of societal well being today as well as under a warmer global climate regime.

Water-related hazards, like climate-related ones, are often seasonal; that is, they are tied to specific times of the year. Droughts, floods, forest fires, vector-borne disease outbreaks, streamflow from mountain glaciers, snow cover, and tropical storms are for the most part bounded by the natural flow (rhythm) of the seasons. Glantz suggested that the activities of most individuals, organizations, governments, as well as societies, are attuned to their ***expectations*** and perceptions about the natural rhythm of the seasons, whether or not their expectation and perceptions are correct. Any disruption of the ***expected*** flow can result in foreseeable adverse or undesired changes in those activities. Glantz emphasized his belief that most people, whether living in an industrialized society or in a developing one, are more dependent on their expectations about the natural flow of the seasons than most people (and governments) realize. Human activities are also adversely affected by anomalies in the flow of the seasons.

There are different definitions of seasonality. For example, one definition refers to “the changing availability of resources according to the different seasons of the year.” Another definition of seasonality states that it is the “periodic fluctuations in the climate related to seasons of the year.” Another is “changes that occur predictably at given times of the year.” A fourth definition notes that “seasons are defined differently in different environments and by different societies.” In some parts of the globe, four distinct seasons are apparent, determined by the combinations of temperature and precipitation. In other regions, such as parts of Southeast Asia, the seasons are defined as either wet or dry. And, to be sure, there are “seasonal biases” in the prevalence of climate-sensitive vector-borne diseases.

All locations on earth are disrupted at one time or another by anomalies in either temperature or precipitation. It is the out-of-season anomalies that often catch people and their governments off guard. For example, heavy rains in a dry season are usually unexpected and therefore unprepared for. The two major floods in Venezuela in the 1990s that caused major deadly mudslides (the one in 1999 caused at least 30,000 deaths) occurred out of season. Hurricane Andrew in the United States was a blockbuster and a very damaging storm in an El Niño year, which is a year when fewer hurricanes are to be expected, according to probabilities and statistics.

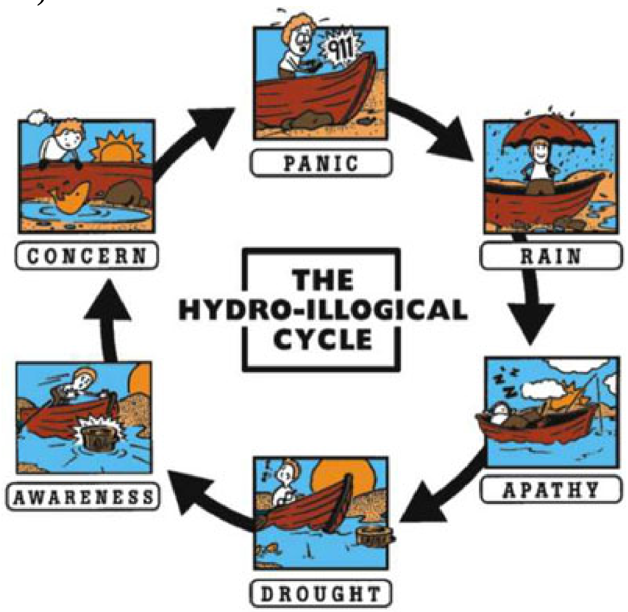
El Niño events, which are the occasional (quasi-periodic) warming of sea surface temperatures in the central and eastern tropical Pacific, tend to change the characteristics of the seasons, i.e., shift the seasonality of a country or regions within it, bringing wet conditions and flooding to normally dry seasons and dry spells, and drought to normally wet seasons. Seasons are quite pronounced for food production activities. There is a time to plant and a time to harvest. There is a "hunger season" among many farmers who have to harvest crops when their family food stocks are at their lowest levels. There is a seasonal pattern to water availability in many parts of the globe as well: reservoirs fill at certain times of the year only to be emptied in later seasons for agricultural, energy and recreation purposes.

Participants raised concern that there has been a decreasing focus in the region on funding for basic research. They suggested that for some countries, basic information or access to it is not easily available for the pursuit of research on the hydrological cycle. Participants also recognized that, in fact, there are several water communities with specialized and sometimes overlapping (and sometimes competing) water-related interests. Understanding the characteristics of the seasons and the flow of the seasons from one to the next as they have been in past decades provides a major step toward understanding and coping with changes in seasonality that might result from the consequences of global warming of the earth's atmosphere during the 21st century.

The degree and timing of societal dependence on seasonality are also affected by human activities. For example, many societies choose to store water during wet periods in order to irrigate cultivated lands using the stored water whenever they choose to release it. Deep wells are put into desert environments to bring water to livestock well beyond the end of a rainy season. This alters dependence by herders and their livestock on natural rainfall processes and on the natural flow of the seasons. Heating, refrigeration, irrigation, dams, and air conditioning are but a few of the many ways that societies resort to in order to overcome some of the constraints on human activities.

In fact, there are many examples of how societies have sought to overcome the constraints imposed on their activities by climate, water and weather variability and change on a variety of time scales. In a later session, the participants discussed different ways that societies interfere with the naturally occurring hydrological cycle in the same way that human activities are now known to interfere in an otherwise naturally occurring climate system.

In addition to the hydrological cycles, other water-related cycles have been proposed, such as the "hydro-illogical cycle." This cycle relates to the way that societies tend to overlook their proneness to drought and neglect developing effective mechanisms to cope with future drought. Once the rains return, societal apathy tends to set in, regardless of country, and the water information cycle reverts to neglect. (This cycle relates to the flow of information about water needs and water hazards, from monitoring to early warning dissemination.)



In sum, water science involves developing an understanding of the physical aspects of the hydrological cycle, as well as understanding the climate system and accepting society as a component of both the hydrological cycle and the climate system.

It is important to remember that one could effectively argue that a thousand years ago humans were not part of the global climate system or global hydrological cycle. Today, human activities are an integral part of each of these systems. Finally, the hydrological cycle as we have witnessed in the past century is changing as a result of a human-induced global warming of the earth's atmosphere, which results from the burning of fossil fuels, the emission of other greenhouse gases and tropical deforestation. The cycle is expected to intensify with about a 15% increase in global precipitation. Where, how and when in the seasons this increase may occur remains a high-priority issue of concern of scientists and policy makers alike.

Water Impacts on Ecosystems

"Water is life." This adage takes on a variety of forms in different cultures and different countries. It is as valid for plants and animals as it is for humans. The literature, scientific as well as popular, on the water needs of ecosystems is bountiful. Vegetation types in various regions reflect, for the most part, the influence of the mixture of soil fertility and water availability. There are periods of too much water and periods of too little water.

Vegetation in a given location is most likely to be stressed under both extremes. Societies manage their water resources for the production of food, energy, manufactured goods and for domestic purposes. They are managed in ways to avoid moisture stress for such activities.

The value of water resources relates to the ecological and societal functions that the resources perform. The Millennium Ecosystem Assessment is based on identifying the value of a range of different ecosystems in terms of the goods and services they provide to society (MA, 2005). Given the growing scarcity of water at the regional and local levels, the ratio between the costs and benefits of acquiring and consuming water continues to change, which explains why a major concern of most governments has become how water is being used by their people.

A lot of attention focuses on the amount (and share) of water diverted for use in agriculture. However, "figures for water withdrawal in agriculture do not include the direct use that is made of rainwater in rainfed agriculture. In fact, more food is produced from the direct use of rainwater than from the use of irrigation water --- even irrigated agriculture uses considerable rainwater" (FAO, 2002).

Two lengthy paragraphs from an article in the Water Affairs Reader prepared for workshop participants help to explain the importance of water to ecosystems (Baron et al., 2002).

> Human society has used freshwater from rivers, lakes, groundwater, and wetlands for many different urban, agricultural, and industrial activities, but in doing so has overlooked its value in supporting ecosystems. Freshwater is vital to human life and societal well-being, and thus its utilization for consumption, irrigation, and transport has long taken precedence over other commodities and services provided by freshwater ecosystems. However, there is growing recognition that functionally intact and biologically complex aquatic ecosystems provide many economically valuable services and long-term benefits to society. The short-term benefits include ecosystem goods and services, such as food supply, flood control, purification of human and industrial wastes, and habitat for plant and animal life—and these are costly, if not impossible, to replace. Long-term benefits include the sustained provision of those goods and services, as well as the adaptive capacity of aquatic ecosystems to respond to future environmental alterations, such as climate change. Thus, maintenance of the processes and properties that support freshwater ecosystem integrity should be included in debates over sustainable water resource allocation (p. 1247).
>
> Freshwater ecosystem structure and function are tightly linked to the watershed or catchment of which they are a part. Because riverine networks, lakes, wetlands, and their connecting groundwaters, are literally the "sinks" into which landscapes drain, they are greatly influenced by terrestrial processes, including many human uses or modifications of land and water. Freshwater ecosystems, whether lakes,

> wetlands, or rivers, have specific requirements in terms of quantity, quality, and seasonality of their water supplies (p. 1247).

A key message from the environmental community is that water is an integral part of an ecosystem and not apart from it. This reinforces the need to view water in its broader context, as an integral part of all kinds of ecosystems.

Creeping Environmental Problems

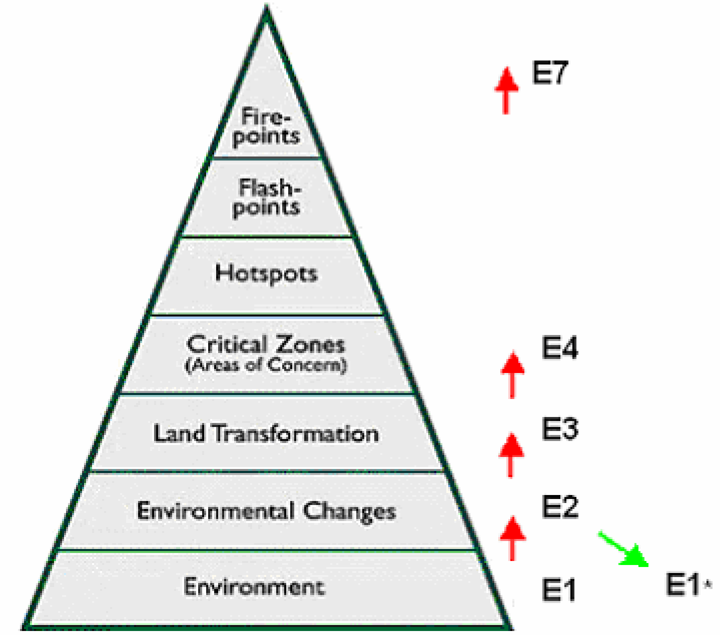
The notion of creeping environmental problems (or CEPs) is centered on environmental changes that are slow-onset, low-grade, long-term but cumulative over time – such as air and water pollution, global warming, desertification, mangrove destruction, tropical deforestation and even droughts and famines. Each one of these CEPs appears to be not much worse today than yesterday, and the degree of change tomorrow is not likely to be much different than today. Yet, those incremental changes in environmental conditions accumulate over time, with the result that, after some threshold has been crossed, those imperceptible increments of change have added up to a major degradation, for example, in water quality or in the health of ecosystems. If no action is taken, as is usually the case, incremental changes will continue to mount until a crisis eventually emerges. Once a CEP reaches a crisis stage, it will likely require immediate attention and will likely be more difficult, as well as costly, to correct.

Few societies deal effectively (that is, in a timely, efficient and cost-effective manner) with constantly accumulating incremental environmental changes. Often, such changes receive policy-maker attention only when a crisis stage has arisen. When that occurs, countries are forced to use their resources to address the problem, no matter how costly. However, a developing country, where funds are often in short supply, ends up having to learn to live with those adverse changes to the environment.

The developing countries want to protect their environments, as well as meet their most basic needs (safety needs) and their development goals. Once they have developed economically (so the argument goes), they can begin to meet esteem needs, as the developed countries had done in a successful pursuit of their economic development goals. It is often mentioned, citing the United States as an example they seek to follow, that the US deforested large parts of the country in order to develop its economy. Once it had begun to industrialize, it paid attention to the environment it had destroyed such as its forests.

In Malaysia, the government feels it is necessary to educate its citizens, especially the children, about safeguarding the environment. They are doing this well and now focus on how to educate the general public. Malaysians see increases in news coverage of climate, water and weather, and one can see improvements that have been made in public awareness. This can be viewed as a positive creeping environment-related phenomenon that is reinforced by extreme events, such as the severe flooding situation that occurred in Malaysia at the end of 2006.

Glantz presented the hotspots pyramid as a graphic portrayal of creeping environmental changes. The pyramid, as shown in the following figure, has stages in it as one moves from the base of the pyramid to the apex: the base is represented by the pristine environment, then moving up the pyramid, environmental changes, environmental transformations, areas of concern (critical zones), hotspots, flashpoints and firepoints.



Environmental changes brought about by human activities (E1→E2), in particular those associated with agriculture can gradually lead to land transformation, for instance from forest (E1) to various farming systems (E2), from swamp (E1) to drained areas (E2) or from dry areas (E1) to irrigated rice production systems (E2). Such changes are usually *neutral* and, to some extent, reversible. This means if the land E2 is abandoned again, it will spontaneously revert to a system (E1*) similar to the original *natural* system.

At level E3 the land (land and water resources) is transformed by human activities for a purpose: for reasons of shelter, food, energy, safety, etc. Too much land transformation can lead to environmental changes that are moving toward irreversibility degradation of the environment. Severe transformation and extreme degradation continues (E4) and is becoming visible to more than local people. If the creeping changes continue unabated, AOCs become "hotspots" demanding attention and intervention from political leaders (E5). Flashpoints (E6) represent the level of irreversible change but resources can still be protected and restored but only with the input of considerable amounts of human effort and financial resources. It represents the proverbial 11th hour or last chance to take action. Firepoint (E7) is the level of degradation from which there is no practical way to return to earlier conditions.

Another example of creeping environmental changes that are occurring worldwide is the increase in the number and severity of water crises that will occur, because of population needs and demands. As population numbers increase and as some segments of the population become more affluent, the limited amount of water resources that have been available are becoming even more scarce in terms of per capita supply.

WMO Hydrology and Water Resources Program

Caponi, in his Powerpoint presentation, illustrated the objectives of the WMO's Hydrology and Water Resources Program, 2000–2009:

> (1) To apply hydrology to meet the needs for sustainable development and use of water and related resources;
> (2) To mitigate water-related disasters; and
> (3) To ensure effective environmental management at national and international levels.

The program is implemented through five mutually supporting components:

- Basic Systems in Hydrology
- Forecasting and Applications in Hydrology
- Sustainable Development of Water Resources
- Capacity Building in Hydrology and Water Resources
- Water Related Issues

In this context, the Water Affairs prototype workshop is designed to assist hydrologists to become better managers and to be successful at convincing high level managers that what you are doing is useful. If we were able to cut back or do more with less, why would we need a hydrological service? This is the essential question that needs to be addressed. The WMO can give you the elements, but its managers need to know if this is the right way to go.

Problem Climates or Problem Societies?

Glantz raised the issue of "Problem Climates or Problem Societies?" with a Powerpoint presentation. This question is about determining which adverse impacts on societies and on ecosystems can be attributed to the natural climate system (variability, change, extremes) and which can be blamed on human activities (land use planning).

While there has been considerable focus, some say over-focus, by governments and funding agencies on climate change, participants considered water as the most important resource to be impacted by climate change everywhere on the globe. In addition to some examples of actual as well as proposed impacts proposed for South and Southeast Asia, examples of impacts of climate variability and change on water resources were mentioned for Latin America.

Glantz's talk generated a limited discussion about the Kyoto Protocol and other efforts worldwide to reduce greenhouse gas emissions. The Intergovernmental Panel on Climate Change (IPCC) process was also briefly discussed. Participants focused on a belief that it is difficult to convince resource managers that climate and weather models are reliable enough to be useful for climate change projections about changes that might occur with regard to quantity, quality and access to water resources. It was, however, recognized that models are better at projecting temperature change scenarios than they are at projecting shifts in precipitation patterns (amount, timing, and location).

There was little doubt that uncertainty about the impacts of climate change and about associated changes in climate variability and in climate, water and weather extremes is still perplexing to those who have to make water-related decisions on all time scales. Clearly, uncertainty has a cost, but so too do erroneous decisions.

Glantz then mentioned the concept of "Forecasting by Analogy" as a qualitative way to gain a glimpse of at least the near future. Forecasting by Analogy is a way to identify how societies have responded to similar hazards in the past in order to identify societal strengths and weaknesses in those past responses. Identifying actions that worked well in a recent past disaster and distinguishing them from those that fared poorly provide an opportunity to reduce the weaknesses encountered and to fortify the strengths in the face of future occurrences of similar climate, water and weather related hazards in today's geographical areas of concern.

Participants noted that climatologists as well as hydrologists could benefit in their work by seeing just how dependent sectors of society are on their output products. To that end, activities such as Climate Affairs and Water Affairs can help them to gain a better understanding of the larger setting of which their activities are an integral part.

Q&A Session

The organizers planned a Question & Answer session at the end of the first day in order to determine how the prototype course was going, whether the agenda was useful, whether topics not on the agenda might be added and what the participants thought about the notion of water affairs.

Concern about water goes well beyond consideration of climate variability and change. It also relates to societal aspects of water, including economics, politics and equity: if one constructs a dam, for example, what might be the impacts on those downstream? Transboundary water problems, whether occurring within a country or across an international border, are extremely sensitive politically. Water availability strongly affects social as well as economic development.

Participants agreed that Water Affairs education and training must encompass more than just hydrology. Caponi asked whether adding discussions about pollution might be beneficial and have a direct application in the operational programs of the workshop participants. At WMO, there had been discussions about whether a module on the recent controversy about dam construction should have been included. For this prototype workshop, we decided not to include discussion of these issues. What might be other issues of interest to governments in Greater Southeast Asia that are not being addressed in the workshop?

A Malaysian participant stated that, following a 2002 UNU/NCAR workshop on Climate Affairs held in Malaysia, he proceeded to develop a center focused on the subject at the University of Malaya. A basic discussion among faculty centered on the importance of climate variability, change, and extremes and their impacts for Malaysia. The occurrence of climate, water and weather related extreme events serves to strengthen the argument to support the development of such a center. Based on his experience in setting up the climate affairs center on his campus, he asked the group: who would serve to champion climate, water and weather issues in their organization or on their campus? He said that such a champion (i.e., a driving force) for setting up a water affairs activity would be necessary to achieve success.

Glantz asked participants to revisit how human activities influence the hydrological cycle and to identify the various ways that humans have been altering the cycle at local, regional, and global levels. Societies, for example, have altered the land surface through land clearing of natural grasslands and forests which changed the reflectivity (albedo) of the earth's surface which in turn influenced the behavior of the atmosphere. As another example, humans have irrigated large expanses of land that can change the relative humidity of a region in the same way that local bodies do. Societies have used irrigation canals to bring water to arid lands. The human influence on climate is perhaps most obvious in urban centers as a result of what is known as the urban heat island effect: the urban atmosphere is a few degrees warmer than the surrounding areas due to the heat trapping characteristics of concrete and asphalt, for example, and rainfall has increased not only in many urban areas, but downwind as well. Humans have sought to alter precipitation processes through attempts at cloud seeding to increase rainfall, snowpack, or to suppress hail.

Participants believed there is strong evidence that global warming is resulting from greenhouse gas emissions (from industrial processes and land use activities) and that it is going to intensify the hydrological cycle as well as alter the location, timing, and amounts of precipitation on land and over the oceans. They also noted that deforestation of rainforests alters local and regional rainfall patterns, in large measure because – in the case of the Amazon – an estimated half of the rain that does fall in the rainforest comes from evapotranspiration from the rainforest itself. Deforestation sparks a downward spiral of reduced evapotranspiration-reduced vegetative growth- reduced evapotranspiration, and so on.

Country Presentations

An evening session was convened so that participants could present their country-specific water issue overviews (on line at www.ccb.ucar.edu/waf/presentations.html).
Most of the eleven country presentations showed that drought, floods, flash floods, and water pollution are major concerns. Most presentations focused on national problems as their priority issues. Hydrologists do want to know what might happen in their country and in Greater Southeast Asia in general because of global problems.

Water Politics, Policy and Law

Water policy and law is what you end up with, once the process of politics has played itself out. In other words policy is what you get and politics is how you get there. Water politics and policies and law can be divided in to domestic and international. They relate to water quality and quantity and water variability across national jurisdiction and across international borders. Other issues subjected to politics, policy and law include water consumption, access to water, water-use practices, water rights and responsibilities, transboundary water issues, river diversions, resolution of upstream-downstream conflicts, conservation of water resources as opposed to all-out exploitation, water markets vs. free water, and competition among various users, and so on. Once again, global warming has affected the politics of the atmosphere. The corporate world is increasingly accepting the findings of the IPCC reports, especially when matched with the observations of change occurring in different parts of the globe including the melting arctic ice and mountain glaciers.

Participants briefly discussed the differences between concerns about water and concerns about climate. Climate politics is quite different from water politics. Water is a tangible resource, whereas climate is a more difficult resource to evaluate. People feel they can do something about water problems much more easily than they can do anything about climate problems. Water issues span time scales from hours (flash floods) to decades (dam construction parameters) and there are communities and sub-communities that deal with each and every concern about water. It seems that climate science is left pretty much to the physical scientists.

Role and Management of National Hydrological Services

Caponi gave a presentation about WMO's Guidelines on the role, operation, and management of National Hydrological Services. The following summary is taken from the booklet, *Guidelines on the Role, Operation, and Management of National Hydrological Services* (WMO, 2006).

In general terms, for the purpose of the WMO, a "Hydrological Service" is defined as an institution whose business is information about the water cycle (the hydrological cycle) and which may provide services relating to such information. The business may or may not be a profit-making business, but it implies that managers of Hydrological Services should (1) recognize that their primary reason for existence is to serve their many clients; (2) adopt or develop administrative, management and leadership practices to produce the best possible results in terms of efficiency, effectiveness and responsiveness; and (3) ensure that the assets of the Hydrological Service are not depreciating and that its prospects for future business are expanding rather than contracting.

The *Guidelines* focus on issues that were raised and discussed by participants in an expert meeting on the management of NHSs, organized by the WMO and the Government of South Africa in 2002. Several recent trends in hydrology and water resources management were identified. Key areas of change experienced during the past decade include (*Guidelines*, pp. 1–2):

- A growing global commitment to sustainable management of natural resources to improve the living conditions of the poor, who are most closely dependent on natural resources.
- A strong emphasis on poverty alleviation in developing countries and among international funding agencies.
- A growing emphasis on a need for Integrated Water Resources Management.
- A seeming increase in the impact of natural disasters, particularly floods and droughts.
- Rapid developments in technology that enable Hydrology Services to offer improved or new products.
- A growing expectation that public services should be responsive to the general public.
- Increasing competition for resources in the public sector.
- The growing impacts of globalization and internationalism, which are felt directly and indirectly by individual Hydrological Services.
- The effects of general social trends on operations of Hydrological Services, such as the growing use of the Internet and web-based delivery of hydrological data and products.

Water Economics

There are many books and articles about a wide range of economic issues related to water, too many in fact to present and discuss in a time-limited prototype workshop. Entire multi-day conferences have been devoted to various water economics topics. The notion that “water flows uphill to money” was presented and discussed. This suggests that in many parts of the globe those with the funds to obtain or access water in the quantity and the quality that they desire can do so by using their financial resources to secure access to water. The notion of winners and losers with regard to water resources was also discussed. This centered primarily on two aspects: upstream-downstream relationships and transboundary water issues. It was noted that 11 major rivers in Asia begin in the Tibetan-Qinghai Plateau with their water flowing to more than 2.5 billion people in Greater Southeast Asia. This geographic reality underscores the need for upstream-downstream countries to work together with regard to the management of those rivers so that conflicts can be avoided. It is not just an international problem but a domestic one as well. In the absence of binding agreements downstream groups are vulnerable to negative changes in the amount and the quality of the waters that they receive (e.g., Uzbekistan and its autonomous Republic of Karakalpakstan as an example of internal water distribution issues; the Mekong River serves an example of an international river system that requires international cooperation among upstream and downstream countries).

In addition to traditional issues about water economics, we chose to focus on a relatively new aspect, “virtual water.” A recent report defines water footprint: “Water footprint of a nation is equal to the use of domestic water resources, minus the virtual water export flow, plus the virtual water import flows. The total "water footprint" of a nation is a useful indicator of a nation's call on the global water resources" (Chapagain and Hoekstra, 2004).

Virtual water refers to the amount of water required to produce products, agricultural and otherwise. In many instances virtual water is exported either to other regions within a country or to other countries. A close accounting of virtual water shows that developing countries are engaged in agricultural trade that exports the water that was used to produce those exports. In essence this could be interpreted as water poor countries exporting a portion of their scarce water supplies to those countries (usually the industrialized ones) that can afford to buy their products. Virtual water also enters a country through its imports as well.

1 cup of coffee needs 140 litres of water.
1 litre of milk needs 800 litres of water.
1 kg of wheat needs 1100 litres of water.
1 kg of rice needs 2300 litres of water.
1 kg maize needs 900 litres of water.

- The production of one kilogram of beef requires 22 thousand litres of water.
- To produce one cup of coffee we need 140 litres of water.
- The water footprint of China is about 775 cubic meter per year per capita. Only about 3% of the Chinese water footprint falls outside China.
- Japan with a footprint of 1100 cubic meter per year per capita, has about 60% of its total water footprint outside the borders of the country.
- The USA water footprint is 2600 cubic meter per year per capita.

Source: UNESCO-IHE - Water Footprint

In another article in the Water Affairs Reader (SIWI, 2005), it was noted that

> Investments in water can be an engine for accelerated economic growth, sustainable development, improved health and reduced poverty. Those are the main messages of a report released April 18, 2005, by the Stockholm International Water Institute (SIWI) at the United Nations in New York in conjunction with the 13th Meeting of the Commission on Sustainable Development (CSD). The title of the report is "Making Water a Part of Economic Development."

For example, the report finds that poor countries with access to improved water and sanitation services have enjoyed annual average growth of 3.7% of GDP, while those without adequate investment saw their GDP grow at just 0.1% annually. The report advances five major arguments in support of increased investment in water and sanitation:

- Improved water supply and sanitation and water resources management boost countries' economic growth and contribute greatly to poverty reduction;
- The economic benefits of improved water supply and - in particular - sanitation far outweigh the investment costs;
- In countries where water storage capacity is improved national economies are more resilient to variability in rainfall and economic growth is boosted ;
- Investing in water is good business - improved water resources management and water supply and sanitation contribute significantly to increased productivity within economic sectors; and
- Meeting investment needs in the water and sanitation sector is within reach of most nations.

The report reinforced the importance to a society of its water resources. It also noted that "The productivity and production capacity of people and economic sectors, such as agriculture and industry, depend on people's health and secure water availability. Investing in the health of people, ecosystems and more efficient water use are investments that not only provide immediate economic benefits but also safeguards future economic gains" (SIWI, 2005).

Water and Climate Change

Glantz provided an overview of the impacts on water resources of climate change (foreseeable changes in storms [intensity, location, frequency], rainfall patterns [droughts, floods, timing of precipitation, seasonality shift], melting glaciers [an estimated 97% of the globe's glaciers are receding], seasonality changes [longer summers, warmer nights and winters]).

Changes in water resources worldwide are a growing concern of governments, especially those already facing shortages. Although there is an expected intensification of the hydrological cycle, it is not at all certain where, how and when precipitation patterns will change from past trends. The Kyoto Protocol was briefly discussed, and it was recognized by all countries that the Protocol was but a first step and that once taken, it would require major rethinking on how countries use energy to develop their economies. Tropical deforestation was noted as well as a major contributor to an increase in carbon dioxide emissions. As deforestation occurs, the sink for CO_2 (trees pull carbon out of the air and store it) is diminished.

There are three approaches to dealing with the potential impacts of a global warming: prevention, mitigation, and adaptation. For years it was politically incorrect to talk about adaptation and mitigation, but acceptable to talk about prevention. Once governments realized that preventing CEPs from occurring is not possible, they stopped talking about prevention and began talking only about adaptation and mitigation. In the absence of any corrective action, Southeast Asia as a whole, coastal cities in general, and low-lying areas as well are all facing major climate-change-related sea level rise impacts (shifting typhoon and cyclone tracks, heightened storm surges, and saltwater intrusions).

It was noted that the developing countries would have surpassed the industrialized ones in the 21st century in terms of the absolute amount of CO_2 increases to the atmosphere, in the absence of new alternative energy technologies. In any event the residence time in the atmosphere of CO_2 is on average a century which means that there are enough CO_2 and other greenhouse gases in the atmosphere to continue to increase global temperatures throughout the rest of the 21st century.

Participants were shown the movie, "An Inconvenient Truth", about global warming in which former US Vice President Al Gore presented a fact-based argument about why global warming must be taken more seriously than it has been to date by various governments.

Participants divided into four sub-groups to examine the prototype water affairs cells, using a Climate Affairs template that was prepared for the Greater Southeast Asian region. The following cell components were addressed by each of the four groups (the result of this exercise is attached as Appendix 1):

- For what reasons might climate, water and weather affairs be applied to South and Southeast Asia?
- Climate Science for the region (regional climate, water, weather influences of the global climate system)
- Climate, water and weather
    - Science
    - Impacts on ecosystems
    - Impacts on societies
    - Policy & Law
    - Politics (national and international)
    - Economics
    - Ethics & Equity in Greater Southeast Asia
- Possible research topics for climate, water and weather in the region
- Identification of hazards in Greater Southeast Asia

Variability & Extremes

In this session, participants discussed the situation of too much water and too little water. Too much water centered on floods and flood management. The hazards for Greater Southeast Asia were identified as being primarily tropical storms, ENSO-related extremes and their teleconnections (drought, floods), fires, haze, mudslides, vector-borne disease outbreaks, and tsunamis.

These hazards disrupt what people expect to be the natural flow of the seasons. Discussion ensued about the flow of the seasons and year-to-year variability in the region. Forecasts are attempts to foresee that variability and to, in essence, "ride the variability curve" (ups and downs in climate parameters) and form the basis to better manage climate, water and weather related variability on a range of time scales from hours to years.

The topics of El Niño, La Niña and their teleconnections were presented, with emphasis on their impacts in Greater Southeast Asia. The ENSO cycle (El Niño –Southern Oscillation) is a quasi-periodic oscillation that is of great interest to many countries and especially to those countries in Greater Southeast Asia. Although ENSO was "uncovered" as a Pacific basin-wide phenomenon only recently (in the late 1960s), it provides considerable hope to improve forecasts of climate, water and weather related hazards in the region.

Forecasts of the onset of El Niño and La Niña provide guidance to decision makers in some regions in the tropics and extra-tropics as to likely anomalies that could take place. Forecasting the onset of El Niño is still rent with uncertainties and remains a major research effort in the scientific community. Once an El Niño is known to have begun, however, projections about its characteristics generally improve (the magnitude of the event and expected impacts) but are still deprived of accuracy because of scientific uncertainties.

When an El Niño does occur, there are foreseeable (but not certain) impacts. Droughts plague Indonesia and the Philippines; El Niño events have been associated with typhoon landfalls in Indochina; sharp increases in fires in Borneo, and haze throughout the region. Dengue fever incidence spikes in Vietnam, and cholera outbreaks are increasingly likely in Bangladesh. La Niña events in general produce the opposite impacts.

In the session on "too much and too little," the notion of Superstorm was described to the workshop participants. Since the early 1990s, the use of the label "super" has increased for description of cyclones, typhoons, dust storms and hurricanes. Extreme events have been called super for a variety of reasons: physical aspects of an extreme hydrological or meteorological episode superseded previously set records, the damage that resulted was much higher than anticipated, or the media used the term to attract attention to their stories.

The typhoon and hurricane seasons of 2004 were noted as unusual, because 10 typhoons made landfall in Japan and four hurricanes made landfall in the US State of Florida. Both of these were record-setting. In 2005, the hurricane season in the tropical Atlantic contained 28 named storms for the first time in many decades. The year 2005 raised the specter of the possibility not only of an occasional superstorm, but even more worrisome, it raised the specter of a season filled with superstorms, i.e., a "season of superstorms."

Water Ethics and Equity

Several ethical and equity issues were raised such as the "precautionary principle" (when is it better to act in a precautionary way even though scientific uncertainties on the environmental concern in question remain?), "polluter pays" principle (those responsible for the adverse changes to the environment should be held financially responsible to address them), the aforementioned upstream-downstream issues, "water as a human right" (do people have an inherent right to free access to water) and the "Nature's bank analogy" (treating the environment as a bank, the rich countries have borrowed from the quality of the natural environment [by polluting the air, by degrading forests, soils and bodies of water, by reducing biodiversity, etc] and as with loans from a bank, the industrialized countries have to pay back to Nature the quality that they had used to develop their economies). It is their responsibility to take the first steps toward, for example, reducing the amount of carbon dioxide in the atmosphere. Discounting the needs of future generations by decision makers representing current generations was also discussed. What responsibilities do those alive today have toward yet unborn generations in terms of environmental conservation and preservation of resources.

Ending the session on ethics and equity, Glantz briefly highlighted a PowerPoint presentation that had been prepared a few years ago by Tuft University Professor Sheldon Krimsky called "Water Ethics: Beyond Riparian Rights." He raised five core ethical issues relating to the environment: (1) anthropocentrism vs. non-anthropocentrism; (2) responsibility to natural systems; (3) cross cultural environmental equity; (4) intergenerational equity; (5) social risk management. As he noted in his PowerPoint Krimsky applied "these concepts to the issues of water supplies, quality and eco-systems". In his section entitled "Water as an Ethical Issue, he quoted renowned Kenyan scientist Thomas Odhiambo:

> "The art and practice of equitable distribution of and access to fresh water for all people in the 21st century, as a fundamental human right and international obligation, is the mother of all ethical questions of all transboundary natural resources of a finite nature."

Krimsky's presentation is in the workshop's Water Affairs reader (pp. 219–222) and can also be found on the Internet at www.tufts.edu/water/ppt/ShellykWater%20Ethics.ppt.

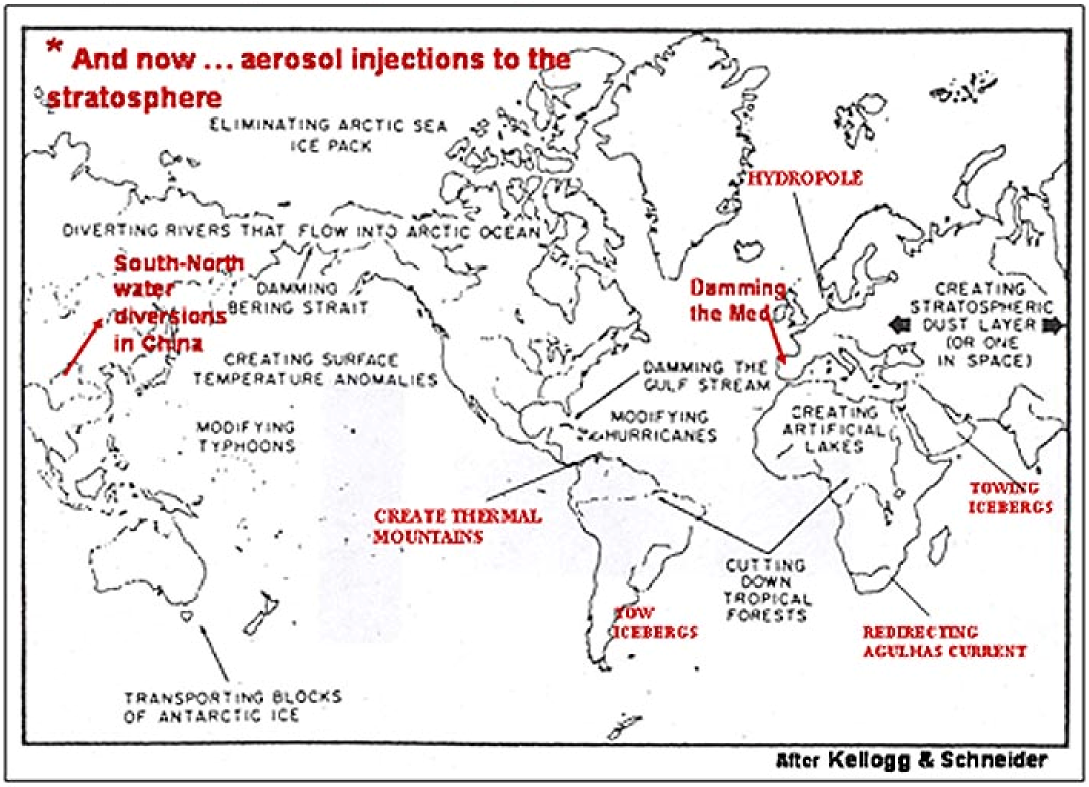
Geo-Engineering for Water Resources

Discussion in this workshop session was entitled "Our War Against Climate: Geo-engineering Climate and Weather Modification" and was centered on many geo-engineering schemes that have either been proposed or have been undertaken in order to overcome in a given region the limitations that had been imposed by the climate system. Climate has been changed at the local level (e.g., the urban heat island effect), at the regional level (tropical deforestation, desertification) and now humans are foreseeably influencing climate on the global scale.

Some types of climate modification have been inadvertent; that is, they have resulted as unintended consequences of actions unrelated to deliberate attempts to influence or change atmospheric processes. Other schemes are advertent, meaning that they are planned to achieve a specific goal, such as cloud seeding or snowpack augmentation in mountainous regions.

Throughout history and up to the present, there have been three views about societal interactions with Nature: (1) society in harmony with nature; (2) society subordinate to nature; and (3) society dominating nature. The latter perspective on how society should compete with nature is ever-present, as can be seen from the growing list of suggested ways to alter climate, water and weather influencing processes. Such grandiose schemes have included the following: diverting river flow, eliminating Arctic sea ice, damming semi-enclosed seas (Bering Sea and the Gulf of Mexico), hurricane modification, "blacktopping" coastal deserts, and so forth.

The following chart depicts some of the proposed climate, water and weather modification schemes that have been developed since at least the late 1800s.



An active discussion about dams followed the geo-engineering presentation. It was generally felt and expressed that dams are a necessary part of the solutions for most countries that are threatened by floods, which consists of most of Southeast Asia.

Global warming was discussed in terms of the various proposals to mitigate the consequences for the environment of increasing amounts of greenhouse gases (especially carbon dioxide) released into the atmosphere: distributing large amounts of iron particles in the ocean, sequestering CO_2 in abandoned mines, reforesting denuded landscapes and even putting tiny mirrors into space. Each idea likely works at the theoretical level. Some have been tested at local scales but they have not yet been put into practice; that is, operationalized.

While many technological fixes are being offered to correct the environmental insults to the atmosphere, e.g., to the climate, water and weather systems, the only way to "fix" the human contribution to the global warming problem is to address the central cause(s) and that requires reducing sharply, and soon, GHG (greenhouse gas) emissions. Other proposals to arrest global warming are uncertain in their outcomes, and extremely costly (e.g., recurring injections of sulfates into the stratosphere every few years or so). Several of the proposed technological fixes are only temporary solutions to a much deeper and longer-lasting environmental change.

Ever since humans first appeared on earth, they have sought to exploit nature to their advantage. It seems that perhaps nature is now striking back at humans, because they have wantonly crossed many environmental thresholds in a wide range of ecosystems, and those changes are proving negative, as well as irreversible, on time scales that are of interest to society.

Socioeconomic Benefits of NHSs in Theory and Practice

Caponi discussed the socioeconomic benefits due to the activities of national hydrological services. Hydrological products have no intrinsic value in an economic sense. Value is acquired through influencing behavior of users whose activities are influenced by water quantity, quality, timing and access. The societal and individual benefits of increased information are the increase in the economic efficiency of the decisions taken with that information as opposed to the ones taken without that information. The benefit part is always more difficult to evaluate than the cost part.

Value of data can be defined as the difference of benefits from a project resulting from decisions made and actions taken with and without the data. This concept is generally applicable but difficult to apply. A prescriptive approach assumes that users behave in a manner consistent with prescribed principles, and generally involves the use of formal models for decision-making. Descriptive approach attempts to describe the actual behavior of users, and may or may not involve the use of formal models. Forecast decision systems can be classified according to deterministic vs. probabilistic forecast, single objective vs. multi-objective decisions, monetary vs. non-monetary objectives, static decision vs. dynamic decision problems, and optimal vs. non-optimal decision procedures.

Caponi also noted that the WMO had convened several conferences which addressed the uses and value of meteorological and hydrological information by governments, societies, corporations, groups and individuals. For instance, in September 2005, WMO organized in Geneva an Experts Meeting on the economic value of the hydrologic information and services provided by NHSs and work is progressing on the preparation of a set of Guidelines on the Economic Valuation of Hydrological Services. It is planned to finalize the draft and publish the Guidelines in 2007.

An expert meeting on “The needs of Water Managers for Climate Information in Water Resources Planning” was held in December 2006 in Geneva. The results of the expert meeting could form the basis for the integration of climate information in water resources planning and management.

He also informed participants about the WMO’s International Conference on “Secure and Sustainable Living: **Social and Economic Benefits of Weather, Climate and Water Services”** to be held in Madrid, Spain 19–23 March 2007. Its objectives are as follows:

> “The Conference will provide an important occasion for representatives of various sectors of society to describe how the environment impacts them; how weather, climate and water information helps them make decisions and reduce risks; and to outline what changes would be needed to improve decision-making.

It is an opportunity for dialogue -- for the services providers to have a better knowledge about how their products and services are used, and where improvements are needed to increase their value to civil society and the economy; and for users and decision makers to appreciate better the current capabilities, responsibilities and limitations of the various service providers. By bringing together decision-makers, users and service providers, WMO aims to increase further, in view of their growing value and impact, the utility of weather, climate and water knowledge for social and economic benefit" (WMO, 2007).

Final Session

The WMO distributed a form to participants for evaluation of the first –ever prototype training course on Water Affairs. The participants were also asked to provide their ideas about the value of Water Affairs training activities (e.g., multidisciplinary approach to education and training related to water resources for professionals of water agencies).

Workshop conveners wanted feedback on how to improve the prototype workshop's format and content in the event that future activities of this nature are developed in other parts of the globe. In addition, it was noted by the conveners that the Greater Southeast Asian region would again be eligible for such a training course.

A field trip on the final day was attended by many of the workshop participants, which had been arranged by the staff at Water Resources University. The participants visited the dikes of the Red River to see a Flood Mitigation Project to protect Hanoi from excessive flow of water from the Red River during the wet season. The dikes prevent the city center and nearby agricultural area from flooding. The control mechanisms also allow the water to be used for irrigation when needed.

Water Affairs workshop conveners and participants alike gave a heartfelt round of applause to the Water Resources University local organizers, Pham Hong Nga and Lam Thi Lan Huong for their exceptional attention paid to the organization of the workshop and the needs of the participants.

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Prototype Water Affairs Cell for Southeast and South Asia

South and Southeast Asia Cell Prototype

Water Affairs should be applied to Asia for the following reasons

- ***Growing interest in various water issues throughout all parts of Asia and in other countries and donor, development and humanitarian organizations – concerns about water and changes in distribution (rainfall shifts, ENSO, sea level rise)***
- ***But insufficient, inconsistent attention by government – some departments are more engaged (industry, trade, etc.)***
- ***Awareness about water issues is low***
- ***Fear that water-related hazards are becoming more frequent, more deadly and more costly throughout the region (droughts, floods, diseases)***
- ***Lack of technology, resources, and institutions for dealing with impact studies and hydrological data***
- ***Greater involvement of all stakeholders is needed – education and awareness for communities***
- ***The region needs to focus on water affairs – with greater emphasis on economy, extreme climatic events and regional hydrology***
- ***Environmental justice issues are increasingly being raised, following extreme events, and with regard to the dissemination of forecasts***
- ***Sustainable development and water variability and change concerns***
- ***Public health (vector-borne infectious diseases and water concerns)***
- ***Improvements in the science and monitoring of water resource systems***
- ***Growing awareness of the need to consider hydrological information in risk-related decision making***
- ***The realization that costly water-related impacts on a national economy can in many instances be mitigated by human activities***
- ***Similarity of institutional arrangements and issues***
- ***Basic technologies are doing well; how do advanced technologies make a difference***
- ***Realization that water related resources have significant/major impacts on human activities (droughts, flood, pollution).***

Water Science – Asia

- ***Regional water influences of the global water system***
  - Monsoon, ENSO, Eurasian snow cover, storm surge, typhoons, glaciers, salt-water intrusions, sea-level rise, mudslides

- ***Regional watersheds***
  - Can any be called “problem” watersheds? Drought-prone, flood-prone, fire-prone, frost-prone, soil erosion prone, landslide prone
  - Inter-regional relationships are not well understood
- Water-social science linkages are weak
- Better information sharing for monsoons
- Limited data availability and sharing
- Multi-decadal and long-term trends and periodicities are not well understood
- Tropical storms - Cyclones, typhoons, heavy rainfall
- Extreme events (floods, droughts, mudslides, tsunamis)
- Water-environment-society interactions

- ***Forecasting***
  - “Translation mechanism” for general public
  - Variability (seasonal, inter-annual, multi-year); Fluctuations (decade scale); Change (new water resource averages); Extremes (weather, water, water-related)

Hydrological Impacts (on ecosystems) – Asia
humans are part of ecosystems

- ***Biodiversity***
- ***Land use and suitability***
- ***Desertification - Arid and semi-arid areas***
- ***Rainforests***
- ***Mangrove ecosystems***
- ***Agriculture***
- ***Fisheries***
- ***Aquaculture – low harvest***
- ***Coral reef***
- ***Species movement patterns***
- ***Rivers drying up – linked also to low hydropower generation***
- ***Indirect human impacts, including through population displacement***
- ***Highlands***
- ***Coastal erosion***
- ***Wetlands***
- ***Frost, fire, drought, flood***
- ***Rivers and estuaries***
- ***Inland seas***
- ***Pollution***
- ***Water management, quality***
- ***Domestic/industrial uses***
- ***Lake ecosystems***
- ***Inter-basin water diversion***
- ***Watershed erosion***
- ***Sedimentation***
- ***Tourism***

Hydrological Impacts (on societies) – Asia

- ***Poverty – chronic poverty, socioeconomic impacts***
- ***Politics, government stability and economy***
- ***Ecosystem management needs to be done better – using raised awareness (e.g., water demand management and recycling)***
- ***Livelihood security***
- ***Property and infrastructure destruction***
- ***Change in livelihood strategy and lifestyles***
- ***Population movement – planned/forced – rural-urban or marginal-degraded***
- ***Human trafficking***
- ***Peace and border security***
- ***Food production***
  - Domestic food security
  - Export crops
  - Crop pattern practices

- ***Water resources management (national, transboundary)***
- ***Energy production and consumption***
- ***Health impacts (e.g., AIDS/HIV)***
- ***Public safety***
- ***Disaster-related Migration***

Water Policy and Law – Asia

- ***Domestic or National***
  - Overall policy for dealing with water resources is not available (both national and regional)
  - Application of existing policies has limitations, bottlenecks
  - Gap in enforcement of existing laws – linked to lack of awareness, resources and governance
  - Domestic empowerment is needed for better representation internationally
  - Water allocation – demand management – policies
  - Countering deforestation: Re-forestation and governmental ambiguities towards it
  - Fisheries (inland and coastal) – dense fish farming policies
  - Water pollution, discharge control, water quality

- ***International***
  - Regional cooperation (e.g., Wetland laws (e.g., Ramsar Convention)
  - ASEAN, Mekong River Com., SAARC, Indus, Ganges)
  - Foreign debt
  - Kyoto Protocol-based policies and COP negotiations (also IPCC)
  - Polar issues and marine affairs (e.g., UNCLOS)
  - Trans-boundary Laws
  - How international conventions have helped address nation concerns

Water Politics – Asia

- ***International***
  - Water-induced migration (national and international) – environmental refugees
  - Transboundary smuggling – humans, goods, drugs
  - Transboundary issues
  - Shared resources
  - National vs. regional politics
  - Industrial vs. agricultural societies
- ***Domestic or National***
  - Water-induced migration (voluntary and forced) – urban-rural movement linked to harvesting seasons
  - Stability of governments due to water resource related events
  - Include civil society
  - Gender and water issues
  - Core-periphery
  - Rich vs. poor
  - Industrial vs. agricultural
  - Upstream vs. downstream
  - Urban vs. rural

Water Economics – Asia

- ***Should include indirect factors impacting water (e.g., energy consumption) – "Pro-water" technologies and economics***
- ***Optimization of economic policies through decision analysis (green economy) – improvements in understanding the valuation of ecosystem services***
- ***Capturing short-term seasonal impacts on local economics***
- ***Role of markets and corporate sector in water developments***
- ***Public/Private partnerships in water development/management***
- ***Upstream/Downstream relationships***
- ***Implementation and enforcement of "water quality quotas" and water standards***
- ***Water and development***
- ***'Pay now or pay later'***
- ***Discount rates***
- ***Trade-offs***
- ***Risk analyses (risk takers, risk avoiders, risk makers, risk manager)***
- ***Who benefits from hydrologic variability, extremes, seasonality, forecasts?***
  - Who loses?
- ***Greenhouse Gas reduction***

Water Ethics & Equity – Asia

- ***Who is affected by water variability, change, extremes, seasonality?***
  - Poorest of the poor?
- ***Water rights – justice and equity***
- ***Impacts of free-trade zones on environment – difficulties in enforcing national environmental laws***
- ***Impacts of free-trade zones on food supply***
- ***Sharing of information is restricted and less equitable***
- ***Notions of "eco-justice" for those affected – upstream-downstream***
- ***Inclusion of and attention to indigenous knowledge***
- ***Who gets protection?***
- ***Responses within the region: indigenous, local, national, regional***
- ***Disaster relief and Development aid: conflicting or complementary bureaucratic objectives?***
- ***Core vs. periphery***
  - Domestic: transparency, corruption, equity
  - International: transparency, donor-recipient 'partnership', etc.

Water Impact Methods – Asia

- ***Context-based analysis needs to be emphasized***
- ***Minimize undue bias towards quantitative analysis – linked to inaction***
- ***Qualitative***
  - Participatory methodologies
  - Historical
  - Analogies
  - Case studies
  - Foreseeability assessments
- ***Quantitative***
  - Scenario analysis
  - Simulation models (prototype kits for modeling)
  - Statistical
  - Risk assessment
  - Surveys
  - GIS

Possible Research Topics for Water Affairs in Asia

- ***Social science research – focusing on social equity***
- ***New opportunities through hydrologic change lens***
- ***Vulnerability assessment for society***
- ***Coastal urban development and water affairs***
- ***Institutional alliance – on early-warning systems***
- ***Regional approaches towards hydrological planning and influence on existing environmental problems***
- ***Impact and adaptation options and coping strategies***

- ***Health and water issues***
- ***Collection of endemic/indigenous knowledge about water use***
- ***Data sharing on regional basis – particularly hydrological information***
- ***History of water resource development on regional basis in various parts of Asia – Specific country, region or socioeconomic sector***
- ***Assessments of water and water-related forecasts (e.g., flood, flash flood) in Asia – Comparative value to countries or sectors in Asia of water and water-related forecasts***
- ***Eco-justice issues***
- ***Natural disasters and local and national coping mechanisms***
- ***Ethics and politics of treaties, agreements and conventions at national, regional and international level***
- ***Change in watersheds and national sovereignty for transboundary issues – military/civil***
- ***Corporate-driven globalization and water – market forces***
- ***Water-related law and policy***
- ***Water resource planning and management***
- ***Risk and Uncertainty analysis***
- ***Modeling methods***