Asia-Pacific Network for Global Change Research

Workshop on "Global Water System Hotspot in the Asian Region: Mega cities and Dams"-2nd GWSP-Asia Network Meeting

Final report for APN project: ARCP2006-14NSY-Chen

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Final Report submitted to APN

Overview of project work and outcomes

Non-technical summary

Workshop on "Mega Cities and Dams" was organized by the School of Geography and Planning, Sun Yat-sen University (SYSU) and the International Project Office (IPO) of the Global Water System Project (GWSP) and took place during 8-11 June, 2006 in Guangzhou, China jointly with the international conference "Hydrological Sciences for Managing Water Resources in the Asian Developing World". The workshop was the follow-up of the 1st GWSP-Asia meeting held in Kyoto, Japan in the year 2005. The objective of the meeting was to compile and summarize existing knowledge about impacts of Asian dams and of mega cities on the global water system. About 40 participants from 12 countries attended the workshop. The workshop was made up of sessions for presentation and discussion, a discussion of follow-up activities, and an excursion. In addition to APN funding, the workshop was co-sponsored by the Chinese National Committee for GWSP (CNC-GWSP), the Monsoon Asia Integrated Regional Study (MAIRS), the Research Institute for Humanity and Nature (RIHN), and the Land-Ocean Integration in the Coastal Zone (LOICZ).

Objectives

The main goals of the workshop was to summarize existing state of knowledge on current cumulative impacts of mega cities and that of dams in Asia and to set and launch a research agenda for mega cities and dams in Asia in the context of the global water system. The other objective of the project is the creation of databases on dams and mega city under the umbrella of GWSP-Asia Network.

Amount received and number years supported

2006/07: APN Grant US$ 24000; Number years supported: 1 year

Activity undertaken

Three days of presentation and discussion and one day of excursion were arranged. The first day of the meeting was convened jointly with the International Conference on "Hydrological Sciences for Managing Water Resources in the Asian Developing World" that was co-sponsored by the International Association of Hydrological Sciences (IAHS), the World Meteorological Organisation (WMO), the United Nations Educational, Scientific and Cultural Organisation / International Hydrological programme (UNESCO-IHP), the Chinese Ministry of Water Resources, and other international and domestic sponsors. Prof. Changming Liu (member of the GWSP Scientific Steering Committee and chairman of the CNC), Jun Xia (Executive VP of the GWSP CNC) and Charles Vörösmarty (Co-chair of the GWSP Scientific Steering Committee) delivered keynote speeches at the joint plenary conference sessions.

The first workshop day concentrated on issues related to dams, irrigation and water transfer with 15 papers presented. The wide range of topics covered included water management, water quality, sedimentation, biodiversity conservation, the impacts of dams on the hydrological cycle, on ecosystems and on land use, and the development of dam databases. It was recognised that despite the large number of dams in Asia and the importance of their (positive and negative) impacts on society and environment the availability of data and information about dams in the region is inadequate and that there is a need for further research, particularly on upstream/downstream relationships and vulnerability issues.

The second day of the workshop focused on mega cities and covered topics such as water security in urban areas, the use of sub-marine groundwater resources for water supply, virtual water trade, and problems related to intensive groundwater extraction. Groundwater issues, including the decline of groundwater levels and groundwater pollution, were considered to be of utmost importance in the region. The assurance of good (ground and surface) water quality is also a challenging issue that needs further

investigation and monitoring activities. For in-depth studies, a database with information about total population, population growth, source of water, quality of water, and water price for different cities or urban regions would be very helpful. Sixteen papers were presented in this session.

All participants were invited to the excursion on June 11 to Zhuhai Campus of Sun Yat-sen University, where the Comprehensive Experimental Station for Water Cycle in the Coastal Area is located

Results

Three outcomes were indicated in the proposal: 1) a research agenda or proposal, 2) publications of proceedings and a first version of a database, and 3) enhanced academic cooperation. The objectives were well achieved: a proposal on "Training course and research on cumulative impacts on water resources of dams and megacities in Asia" was proposed to the APN by Dr. Jun Magome, Dr. Makoto Taniguchi, Dr. Jianyao Chen, and Dr. Sharad Kumar Jain.

Relevance to APN's Science Agenda and objectives

Organized a workshop in Guangzhou in June 2006 to compile and summarize the existing knowledge related with cumulative impacts of dams and that of mega cities on global water system. Regional cooperation in global change research is the highest priority goal of APN's Second Strategic Plan 2005-2010.

Self evaluation

The full papers, extended abstracts and submitted presentations (including the case studies in Indonesia, Sri Lanka) suggest that the cumulative impacts of dams were well reviewed in terms of storage of water, stream flow, downstream flooding, irrigation withdrawal and diversion, reservoir sedimentation, estuaries, eco-systems, and trade-offs in dams and diversion. Topics related to megacities were introduced primarily by means of case studies for the cities of Beijing, Guangzhou, Hong Kong, Chennai, Karachi, Jakarta, Bangkok, Taipei, and Tokyo. It can be readily appreciated that the case studies covered seven countries of Asia.
The main goal is considered to be well achieved by the presentations, papers, and databases introduced during the workshop.

Potential for further work

To refine the proposal "Training course and research on cumulative impacts on water resources of dams and megacities in Asia" and organize the training course; To create the version 2 of dam database; To cooperate closely with MAIRS and LOICZ on the topics of dams and megacities.

Publications

Agenda and a book of abstracts were distributed at the workshop, and all presentation files are available online at the website of the GWSP (www.gwsp.org). Selected papers were compiled and published as proceedings of 2nd GWSP-Asia Workshop along with a soft copy on CD-ROM.

References

1. GWSP Newsletter: Global Water News no. 4, http://www.gwsp.org/products.html
2. Chen J (ed.), 2006. Proceeding of 2nd GWSP-Asia Network Workshop "Global Water System Hotspots in the Asian Region: Mega Cities and Dams".

Acknowledgments

Funding from Asia-Pacific Network for Global Change Research (APN) was gratefully appreciated. The project leader would also like to thank the supports from: Sun Yat-sen University, Chinese National Committee for GWSP, GWSP-IPO, Monsoon Asia

Integrated Regional Study (MAIRS), Research Institute for Humanity and Nature (RIHN), and Land-Ocean Integration in the Coastal Zone (LOICZ).

Technical Report

Preface

The workshop is the follow-up of the 1st GWSP-Asia meeting held in Kyoto in the year 2005, and the objective of the meeting was to compile and summarize the existing knowledge related with cumulative impacts of dams and that of mega cities in Asia on global water system. Nearly 40 participants from 12 countries attended the workshop. As an integral part of GWSP network, GWSP-Asia has already started its activities and could include and amplify the work of the GWSP and contribute to GWSP Water Atlas, indicator work and global dam effort.

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1.0 Introduction

The Global Water System Project (GWSP, a joint project supported by IGBP, WCRP, DIVERSITAS, IHDP)--Asia meeting was held on August 29-31, 2005 in Kyoto, focusing on three themes from the GWSP Scientific Framework: 1 Magnitude and Mechanism of Changes, 2 Linkage and Feedbacks, and 3 Resilience and Adaptation. During this meeting three key issues were identified: 1 Mega Cities (WG1) 2 Dams, irrigation and diversions (WG2), and 3 Land use/cover change regarding their tremendous impacts on regional and global water balance and nutrient transfers (WG3). Accordingly, three working groups (WG) were constituted and work was initiated under the umbrella of GWSP-Asia Network to develop on new proposals and capacity building, i.e., website construction, and database creation. It was also proposed to organize a workshop or 2nd GWSP-Asia Network Meeting on the issues of mega cities (WG1) and dams (WG2). The objectives of this project are the creation of databases on dams and mega cities and organization of a workshop on "Global water system hotspots in the Asian region: mega cities and dams" under the umbrella of GWSP-Asia Network.

Since the GWSP is primarily concerned with regional-scale issues, these would have priority at the workshop. The workshop participants were mainly national representatives plus some experts to lead discussions on crosscutting issues. Hotspot area were identified as:

- Mega city in the coastal zone: the Pearl River basin where several mega cities are located has a total population more than 20 million (including Hong Kong, Guangzhou, Shenzhen etc.); Beijing, Shanghai, Bangkok 10 million population; Jakarta 8 million; Manila; Calcutta; Dhaka; Karachi; Tokyo; Osaka
- Dams in the semi-arid and arid zones in Asia: China and India.

Research works related to both mega cities (WG1) and dams (WG2) are given in details as follows:

WG1: Mega City

Mega cities (with a population ≥ 10 million) differ from smaller urban areas not only in population size but also in the scale of economy, infrastructure water utilization and waste generation etc., Mega cities which have regional and/or global impacts on water and environment. These impacts are especially significant in Asia due to its huge population, rapid economic development and intensive urbanization. The following aspects related to the impacts of mega cities needs to be addressed:

Water supply and water security Local authorities and engineers might focus on supply solutions to water crisis or security, ignoring environmental, economic and social policies associated with water management. This aspect is especially true in the case of the developing countries. The change of approach from water supply to water demand leads to a new concept of adaptive management, which could improve water security, water use efficiency, equality, and ecological environment as in the cases of

Mexico City (Tortajada et al., 2003), Calcutta (Basu, 2001), and Jakarta Metropolitan Area (Nur et al., 2001).

Groundwater problems Mega cities are mostly located in the coastal zone where the interactions of groundwater and seawater, and nutrients transfers to the sea are rather active. Quite a lot of nutrients might pass through the mega cities to the sea by submarine groundwater discharge (SGD). Urbanization changes not only groundwater flow systems but also mass transfers. Sewage, abandoned landfill, and waste dumps were found to be main factors related to groundwater pollution in Karachi (Rahman, 1999) and the metropolitan Seoul area (Lee et al., 2005; Kini et al., 2001). Over pumping of groundwater in the coastal zone could result in seawater intrusion.

Environmental issues Environmental characteristics in terms of major ion or trace metals are found to be associated with development stage or levels of urbanization within a mega city. The nutrient levels in the reservoirs, on which Istanbul depends for water supply, was found to correlate to the levels of development, e.g., population density, industry, urban land use within the watershed (Baykal et al., 2000). Actually, the relationship between development stage and water problems of mega city is an interesting topic for comparative study in Asia or between Asia and Europe. Urbanization was an important cause of eutrophication in metropolitan Melbourne, Australia (Taylor SL, 2004, by assessing benthic algal biomass). Changes of flux of vapor and CO_2, and temperature field (heat island) are another concern with high priority.

In 1999, the workshop "Urbanization, Industrial Transformation and Environmental Change" (Project leader Richard C. ROCKWELL) was approved by APN, and it mainly fell in the scope of IHDP in the Asia Pacific Region. The workshop in Guangzhou will focus on mega cities and water, and database creation in Asia, especially in China and India.

The purpose of this working group is to bring together scientists, policy makers and municipal administrators to address water problems of mega cities in Asia with a global perspective based on a hotspot study area approach. The study themes of this working group fall in the science framework and implementation activities of both LOICZ (Land-Ocean Interactions in the Coastal Zone) and GWSP.

WG2: Dam, irrigation and diversions

Dam practices and the factors driving their construction vary within and between countries， and dam impacts on a regional or catchment scale were well reviewed by the World Commission on Dams, or were raised in general terms in some papers (Yevjevich, 2001; Vorosmarty, 2002). However, very few papers have quantitatively addressed the problem related to the impact of dams and diversions using long-term observed data, and analysis with a global perspective is scant. One reason behind the lack of studies is the non-availability of data sets. No such published work was encountered in literature for India and China.

Very few (if any) large dams are being planned in the North America and Europe, though they do affect freshwater ecosystem and their management (Naiman et al., 1995). In Asia, the large and growing population combined with highly seasonal rainfall and need for economic development is driving the construction of dams. The Chang Jiang (Yangtze) River is the largest river strongly affected by the dams, and the Ganges-Brahmaputra system encompasses the widest diversity (10 biomes) (Nilsson et al., 2005). The needs and perceived benefits of dams in Asia are such that construction would certainly continue and thus there would be consequent influence on the global water system. Although opposition to dams due to perceived adverse impacts is also growing, inability to beneficially regulate rivers has led to excessive extraction of groundwater and associated problems. Before the planners and decision makers can ensure steps to mitigate adverse consequences of these impacts, it is necessary to understand the magnitude and coverage of these.

In many regions, the local impacts of dams on ecosystem of both upstream and downstream are well understood but the long-term, long-distance and cumulative impacts of dams are less appreciated (Pringle, 2001), partly because these have received limited attention, and they are complicated by inter links between different

forms of anthropogenic effects as well as climate change (Malmqvist and Rundle, 2002). The term *cumulative impacts* includes two distinct outcomes:

- Life-cycle impacts describe the direct and indirect impacts of dams within the drainage basin and on receiving coastal waters, and
- Continental-scale impacts refer to the impacts of a group of dams on the regional/ global hydrologic cycle.

The effect of dams and their nature or construction and/or operation features are different in Asia than elsewhere in the world. Further, the cumulative impacts of dams in Asia are apparently higher than those in other regions. In this connection, four overarching relevant issues are:

- Dams within a single country (or region) may be built for different reasons, can have different operation, local climate, socioeconomic conditions, and so on. Hence their impacts are likely to be different.
- The cumulative effect of large dams across Asia in terms of resettlement of people, submergence, sedimentation, nutrient storage/transport, evapotranspiration, local and regional biodiversity, fisheries, etc. may be far in excess of impacts in other regions.
- The cumulative impacts of dams in Asia, superimposed on ongoing changes in land use /land cover and other landscape processes, have important implications on subsurface water, evapotranspiration, fluvial processes, flood plain, coastal ecosystems, and other facets of the water cycle.
- There is a need to develop or transfer methods for assessing environmental consequences of dams (relates to capacity building) and to develop/transfer practices relating to dam operation procedures that will minimize adverse impacts.
- Benefits of dams to governments are widely known. Dam builders are also aware that dams could have negative effects but the overall view in Asia is that the benefits outweigh adverse impacts provided attention was paid to mitigate undesirable effects of construction and operation.
- Environmental impact assessments carried in past have covered periods that were rather short relative to the life of typical dams. It is likely that long-term consequences of dams might not have been properly accounted for. In any case, these are not always well documented.

Studies of the impact of dams integrate hydrology, ecology, social science, economics, and governance. Thus, they provide a unifying theme to study the global water system and an opportunity to bring together disparate research groups. Holistic case studies are needed to understand the cumulative impact of dams on hydrology, ecology, evapotranspiration, food production, industrial and socio-economic development, nutrient transport, biodiversity, coastal zones, and so on.

The purpose of this working group is to identify and help in initiating studies on effects of dams, irrigation and long-distance transfers of (real) water in Asia on the local and global water system. The proposed workshop will be a unique opportunity for the experts to meet, discuss, and firm up the ideas, and prepare proposals to take up the studies.

2.0 Methodology

WG1 (Coordinator, Makoto Taniguchi) and WG2 (Coordinator, Sharad Kumar Jain) worked on the database of mega cities and dams respectively with members from Asian countries. Actually, there are three working group under the umbrella of GWSP-Asia Network as follows. Members of WG3 joined WG1 and WG2 in the workshop according to their interests and possible contribution to the database. The organizing committee consisted of coordinators of two working groups and a local organizer, i.e., Makoto Taniguchi, Sharad Kumar Jain and Jianyao Chen who were responsible for calling for papers, selecting and reviewing the papers, and publishing the proceedings. The 1st version of database was presented in the workshop. Dr. Eric T. Craswell of GWSP-IPO, and Prof. Changming Liu of Chinese Academy of Sciences served as advisors for the organizing committee. An Excursion was arranged, e.g., to visit the experimental station at Zhuhai campus of Sun Yat-sen University.

The following topics were set during the workshop:

- Water supply security in Asian mega cities
- Virtual water trade related to mega cities in Asia
- Potential benefits and cumulative impacts of dams and water transfer projects in Asia
- Database and network on mega cities, dams and relevant land use/cover change in Asia
- Strategy and national policies of water governance in Asia
- Comparison of mega cities and dams: development stage and water problems, future scenarios for mega city and dam development in Asia
- Change of physical, chemical and biological processes related to Asian mega cities and dams, and their implications for the global water system.

The 1st version of geo-referenced database related to dams under GWSP-Asia network umbrella focused on two countries: China and India.

3.0 Results & Discussion

GWSP Asia is an integral part of the GWSP network. Since GWSP Asia has already started its activities, it could be the step further than other new activities in the region. Prof. Vorosmarty, GWSP Co-Chair gave the open address in the workshop. In addition to three recognized themes: dams, megacities, land use-water links, he mentioned additional theme, such as upstream/downstream conflict-governance, water quality and MDGs water goals, biodiversity issues. These actions/activities could include and amplify the work of the GWSP:

- Contributions to GWSP Water Atlas
- Joint work in GWSP Indicators
- Participate in Global Dams Effort with strong Asian contributions (data, impact studies)
- Consider some other themes (water quality, MDGs, biodiversity)
- Make specific plans for future workshops, student exchanges, etc.

In the introduction to 2nd GWSP-Asia network workshop, Prof. Chen of Sun Yat-sen University welcomed new members of GWSP-Asia network from Laos PR, Sri Lanka, Pakistan, and representatives from MAIRS and LOICZ as well. Beijing, Shanghai and the Pearl River Delta were identified as hotspot areas in China.

Dr. de Vries, Executive officer of MAIRS, introduced MAIRS as an integration of processes, components, disciplines, methods, data, concerns, scientists, clients in the Monsoon Asia region. He mentioned 5 key environmental issues in the region as water, energy, air quality, food security and disasters. MAIRS focuses more on zones than on processes, especially on coastal zones, high mountain ecosystem, semi-arid region, urbanization. He suggested the cooperation between MAIRS and GWSP: promoting exchange of science, data; joint approaches to donors and clients (government, private sector).

Two sessions were arranged on June 9 and 10, and they were summarized respectively as follows:

Dams, Irrigation and Diversions

Prof. Xia of Institute for Geographical Sciences and Natural Resources talked about river eco-problem and restoring approach by water projects management and pollution control with a case study in Huai River Basin. Three researches were suggested: 1) environmental monitoring for water cycle and related ecosystem change due to building water project and reservoir operation in river system 2) distributed modelling system to integrated major interaction and impacts due to building of dam on physics, biology, chemistry and others 3) integrated assessment system to evaluate the positive and negative effects on economic, social and ecological aspects under the different scenarios, and provide the best operation scheme for ecosystem restoration. He concluded that river pollution and related eco-system degradation due to regional economic development and water project construction is a big issue in China.

Presentation by K.P. Sudheer on behalf of Sharad Jain reviewed the cumulative impacts of dams and diversions on hydrological cycle, which can be beneficial as well as harmful. These impacts were classified as following: impacts due to storage of water; stream flow; changes in downstream flooding; impacts of irrigation withdrawal; reservoir sedimentation; estuary area; eco-system. Presently there are more than 4200 large dams in India, and total storage capacity of all dams/reservoir is about 3.23×10^{11} m^3, about 20% of the estimated average annual flow of Indian rivers (1.869×10^{12} m^3). Analysis and decision making for the problem is complex due to the non-linearity, poorly monitoring network, and multiple stake holders involved. Holistic research is necessary with collaborative efforts on the creation of database of dams (dam operation data needed), knowledge based new models, and closer interactions among various groups.

Dr. Endejan of GWSP-IPO introduced the dam-related activities of GWSP in terms of three themes of GWSP and cross-cutting activities. He presented a framework for the actual development of dam database with dam and reservoir separated. The other dam-related aspects are users, governance, hydrograph, water quality, infrastructure and the river system. Several points for discussions were suggested, such as: what are the main challenges/research questions related to dams in Asia? He outlined some questions as follows: How much dams contribute to supporting global/regional agriculture? What is the role of reservoirs in global/regional water supply? How much of the water flow from one country to another is regulated by dams? How do reservoirs influence the risk of water borne and water related diseases?

Prof. Liu of Institute for Geographical Sciences and Natural Resources talked about the impacts of dam construction on ecosystem. There are 4694 large completed or under-construction dams with the dam height over 30m in China. Total storage capacity of all dam/reservoir is 5.843×10^{11} m^3, i.e., 20% of average annual flow of Chinese rivers. Several regulation modes of dams were mentioned for base flow, man-made flood, water temperature, residence time, water and sediment.

Joesron Loebis gave a list of 117 dams in Indonesia with information: name of dam, province, river system, catchment area, height, storage capacity, irrigation area, year completed. All these dams were categorized as single, double, triple and multiple purposes. The problems that require attention include water pollution, drought & fish death, and land cover change due to building of dams.

Ranjith P.D.S. presented hydrological impacts assessment of large dams and associated land use changes with a case study in the upper Mahaweli catchment, the largest river system in Sri Lanka. The construction of dams have changed the environments due to displacing households, inundating agricultural land, initiating new settlements in upper catchments, and cultivating hill slopes. The important impacts that have been witnessed are: landslides, erosion, eutrophication, social problems, diminishing river flow, and dramatic changes of hydrological regime. Land use change was identified in the case study area and used an input for the hydrological modeling.

Qu JS from information center of CNCs-IGBP/IHDP/WCRP presented a scheme for the development of international dam information system which could include three modules: dam knowledge platform, global dam database, and information and management system. Feasibility regarding the technical issues was also presented.

Petrus S talked about the sedimentation problem of Saguling Reservoir in Indonesia related to the life of the reservoir estimated by using sounding measurement. The reservoir was being operated in 1986 with a designed volume of 881 MCM, but it reduced to 730.5 MCM in 2004. Land cover change was significant in the basin with forest area of 27% and 14% in 1993 and 2003 respectively, and the reduction in forest area was regarded as one of the most important factors attributing to the sedimentation.

Oloth Sengtaheuanghoung presented some issues in the degraded highland region in the Northern Laos PDR, where poor farms of minority groups are blamed for negative impacts on downstream communities (e.g. sedimentation) – nutrients, suspended solids, faecal coliform, bacteria, and pesticides. Comparative study was carried out in the catchment for various agricultural practices, e.g. fallow, cropping. It was found that large negative correlation of fallow period with sedimentation load and annual cropping system is the main factor for high sedimentation.

Hansa V. from Thailand introduced the functions of reservoir/dam as "FRIENDS" = flood control, reclamation/recreation, irritation, electivity/environmental, navigation, drought/drainage, storage. MODIS/TERRA could be used for the assessment of water quality, inundation of reservoir and the drought area.

David Dudgeon raised an issue of riverine biodiversity in Asia. Hydrologic alteration (e.g. by dams), pollution, direct habitat destruction & drainage-basin degradation, overexploitation (fish, turtles, etc.), invasive exotic species, and global climate change are regarded as the main threats to the biodiversity, and e-flow was proposed to maintain the biodiversity in terms of connectivity. Several questions were raised and discussed: How much water is enough? Who should assess the success of e-flow allocations? What do we want? Ecosystem goods and services or biodiversity/structure (strategy might be different)? – Further questions specific for Asia are: Concentration to low flow, high flow, seasonal allocation, and etc. – E-flow competes with other water users; how to deal with it? Dams are often built on local areas and impacts are often not appropriately taken into account.

Dzung presented on dam development in Vietnam and their social and environmental impacts. During the period of 1959 – 2005, more than 500 dams of middle scale were constructed in Vietnam. Benefits and negative impacts of dam development was elaborated. Benefits: Water supply for food production; Electricity production; Flood control; Improvement of microclimate; Improvement of navigation; Opportunity for recreation and tourism. Negative impacts: Inundated areas and the resettlement of the local people; Hydrologic Impacts; Environmental and ecological Impacts; Other Impacts (decomposition of organic matter on the flooded lands). Social and environmental impacts were identified as: upstream and downstream relationship; significant impacts on people's livelihoods (material & cultural), especially the ethnic minorities.

A global dam/reservoir database was developed by University of Yamanashi. Dr. J. Magome introduced the progress and the problems in the development of database. Among total registered 32391 dams in the world, 47% have been geo-referenced. The percentage of geo-referenced dams in Asia is only 27% (3656 in total registered 13279 dams) for the reservoirs of more than 0.1 km^3 (Fig.1). Change of georeferenced dams/reservoirs in Asia shown in Fig.2.

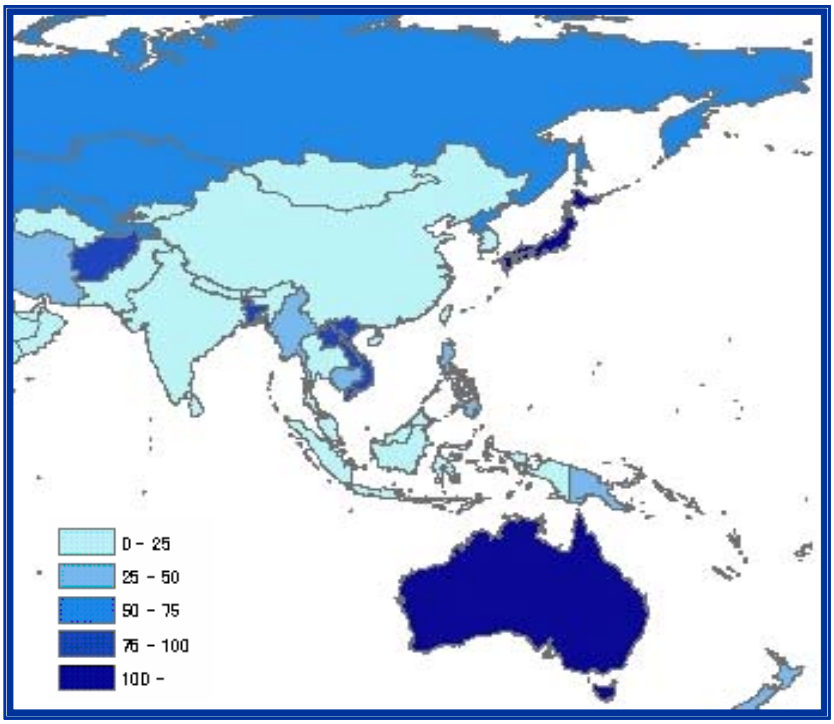

Fig.1 Percentage of geo-referenced dams to total registered dams in Asian country in %.

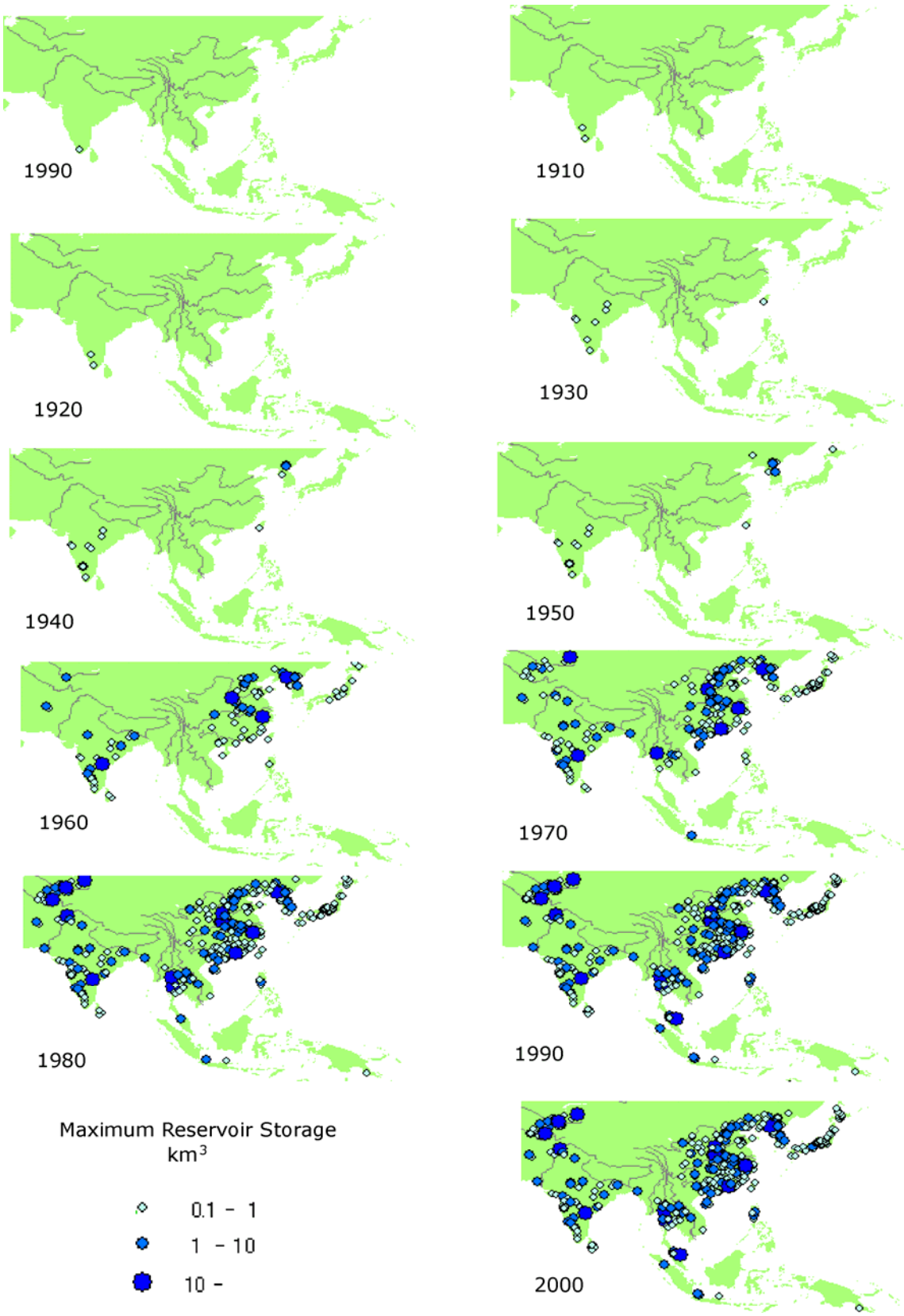

Fig.2 Change of geo-referenced dams/reservoirs in Asia during the period of 1900-2000 (modified from the presentation file of Magome et al. (Chen, 2006))

Dr. Endejan of GWSP-IPO chaired the discussion of the dam session, and comments and/or discussions are enumerated as follows (each comment was separated by hyphen -):
Is the total storage capacity in global reservoirs declining?

Assessment of the actual total reservoir capacity would be needed and the database needs to be more comprehensive. – Joint work with ICOLD would be beneficial – Important aspect: reservoir and sedimentation; food security and sedimentation – Impacts of and linkages to land-use and land-use change might be too complicated to be included in dam analysis – E-Flows and associated tools of relevance for analysing Asian dam-related questions – Asian Development Bank may have interest in bringing together a group of experts on sedimentation (should be done through a government or governmental organisation) – Project of World bank on 'Environmental flow window'[1] – There is a (US) national heritage programme with studies about operation of dams –Change of sediment regimes is considered to be important –Water transfer to other basins needed – Uses of the databases – Reflection of the future, 100 years, functionality changes with time; water flow may increase for some time and finally it may decrease – Database development should not be the end; enhancing use of the database: relation to global issues (including global change issues such as food security and water scarcity), indicators for monitoring, UNEP Watershed Indicators (progress markers for Watershed development) – the software products SWAT, GRASS mentioned as examples of open source projects; following the same approach might lead to some problems, including those related to issues of 'copyrights' and open access to data in some countries/cases – The use of a WIKI-like environment that enables all users to include available data was suggested; possible problems include: quality control, consistency check, e.g. related to underlying definitions of terms – Some datasets about dams in Indonesia are publicly accessible through the internet – In Laos, the dam DB belongs to the ministry of industry – In Sri Lanka data is in public domain: easier to get permissions as in former times – In India, mechanisms for quickly providing the data to the users are being developed.
Important related topics include: ecological impacts, sustainability, electricity and water as major topics, intercepted storage, influence on global water system – In the Philippines data can be provided by the country – Users should be asked before finalizing the DB design – In Indonesia it might be difficult to get funds for this kind of effort (e.g. sedimentation information); benefits needed to be clarified for governments; land-use change is an important related issue – The reports of the first phase of LOICZ may provide relevant information.
Suggested next step: write APN proposal. A Training course might be a good first step. Plan: 2 pages will be written on a short term and circulated through the consortium; a task team for writing a proposal has been defined (at the end of the second workshop day; see below). The GWSP IPO will be able to help as well as the global GWSP network – Chen Jianyao, K.P. Sudheer, and Jun Magome agreed to be the co-leader of this effort.

Mega City

Zheng HX and Liu CM presented water issues related to urbanization in China: shortage of water, floods and drought, and water pollution. Total water use for all the cities in China is relatively stable since 1995 with an amount of approximately 43 billion m^3, in which, domestic use shows an increasing trend while industrial use is continually decreasing in the last 10 years (Fig.3). Three principles were suggested dealing with water problems in China: water saving as first priority; pollution prevention as national basic principle; and excavating water sources through multi-channels.

Zhang RH presented a two-layered model to estimate transpiration of the virescence land in Beijing City by using TM data. As an example, soil evaporation in the area of 651.6 km^2 in Beijing City on July 5, 2004 was estimated at 90.35 tons, while transpiration pumped by the vegetation was 330.2 tons.

[1] See http://www-esd.worldbank.org/bnwpp/index.cfm?display=main&Item=3 for further information about this activity of the Bank-Netherlands Water Partnership Programme

Nalin W, as the representative of LOICZ, introduced the ideas, scientific thems and framework of LOICZ: basins approach for regional synthesis of catchment-coast interactions; DPSIR (drivers, pressure, state, impact, and response) to link impacts to causal factors. Ideas for impacts and application in the coastal zone were suggested: To what degree does dam change flows – develop metrics for changes in average flow, peak flow, and low flow? What in the coastal region is impacted by the dam and associated water transfer? Concept of "coastal footprint" might be useful. Further, can coastal footprint be classified for vulnerability in terms of natural and human systems? Quantify socio-economic impact of dams – both positive and negative; Link to vulnerability and food security may be useful.

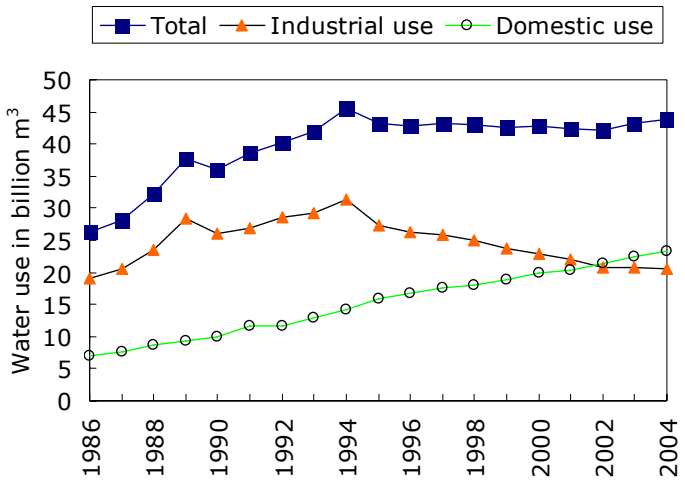

Fig.3 Change of water use in the urban area in China.

As a city with population of 7 million, Hong Kong consumed approximately 760 million m^3 water in 2005, 70% of which is supplied by Guangdong Province from the East River. J. Jiao of HKU introduced an alternative source of water for Hong Kong from submarine groundwater discharge (SGD), which could have a low salinity of about 10 g/l and could be desalinized at a much less than the current price of water.

Y. Wang presented on virtual water trade exported from Guangdong Province to Hong Kong in terms of three groups: crops, poultries and livestock, and aquatic products. Annual average virtual water trade was estimated to be 1.24×10^9 m^3 during the period of 1981-2000, much higher than that of real water consumed in Hong Kong.

F. Lansigan presented on water security and the environment: challenging issues for growing cities of Asia (Tab.1). Global changes in Asia were categorized as: climate change and climate variability, land use and cover change, increasing urbanization, accelerated population growth, and they are closely related to water availability in Asian countries. Challenging issues to growing cities in Asia are increasing water scarcity and competition for water resources.

Karen Ann Jago-on of RIHN presented on urban development and its impact on subsurface environment in selected Asian cities. City development is well related to the factors: natural resource scarcity, resource degradation, reduction of biodiversity, deforestation, and air/water/solid pollution, and it could be divided into several stages, e.g. preliminary, industrial, IT and service. DPSIR framework was adapted for analyzing urban environmental issues, and indicators in terms of natural condition, demography, economy/infrastructure, environment, transportation, and nutrient flux for city evolutionary processes.

Nazim Ali from Global Change Impact Studies Centre of Pakistan talked about climate change and water supply security in Karachi, Pakistan. Developed world developed gradually; in developing world urbanization increases exponentially. Parts of the Karachi are ill planned or not planned at all (informal settlement); infrastructure is

missing and hard to build in already existing informal settlements. Main source of drinking water is groundwater in most rural and urban areas except in Karachi and Islamabad which rely primarily on surface water sources. Leakage (non-revenue water) and poor water quality are main issues in Karachi. Institutional response to climate change was suggested as Triple-P: People, Place, and Policy.

Tab. 1 Population of mega city in Asia*

Mega City	Population
Bangkok, Thailand	6604
Beijing, China	10849
Kolkata, India	14299
Dhaka, Bangladesh	12560
Jakarta, Indonesia	13194
Karachi, Pakistan	11819
Manila, Philippines	10677
Osaka, Japan	11286
Shanghai, China	12665
Tokyo, Japan	35327

**Source*: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2002 Revision* and *World Urbanization Prospects: The 2003 Revision*, http://esa.un.org/unup.

Jianyao Chen from Sun Yat-sen University presented on impacts of urbanization on water quality in the Pearl River delta, where more than 25 million people are living. Population in Guangzhou was about 740 million in 2004, and density in the city centre was as high a 50000 people/km^2. Total water use increases as the population grows in the last 25 years (Fig.4). Population increase, GDP, land use and water use change are the main factors affecting water use in terms of quality and quantity. Temporal hydrochemical features change in responding to the shift of water supply from groundwater to surface water, and groundwater is polluted by N-pollutants and heavy metals as well in the Pearl Delta.

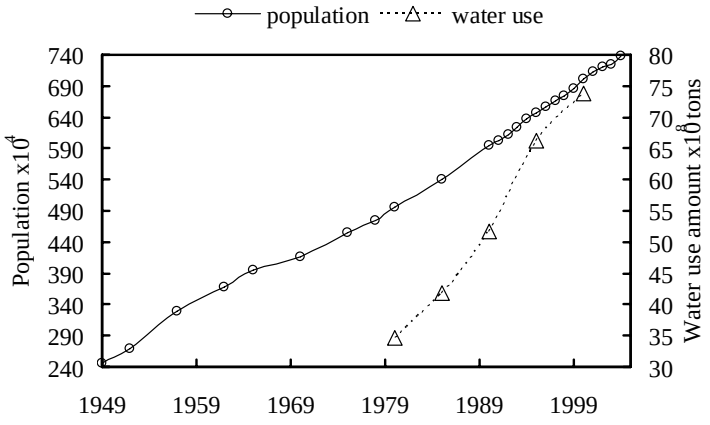

Fig. 4 Change of population and total water use amount in Guangzhou

Kasdi Subagyano presented on soil and water conservation for urban area protection in Indonesia: the role of dams and land management. River flow can be reduced by 63% after construction of 2 channel reservoirs, and the time response of the river flow is extended up to 1 hour in a case study area located at upstream Ciliwung watershed, West Java, Indonesia. Channel reservoirs and land management in upstream areas are significance for controlling flood hazard and environmental problems in the downstream where urban area, e.g. Jakarta, is located.

Jingjie Yu introduced urbanization, water supply crisis in Beijing, which has population of currently 15 million people. Main water source for Beijing is groundwater (74%), and surface water comes from two reservoirs: Miyun and Guanting reservoir (north east and north west of the city). Discharge (inflow) to Miyun is changing dramatically, and it is half in 1984-2001 to that in 1961-1973; inflow of Guanting reservoir also reduced. Reasons for inflow reduction: drought, water use in upstream area, land-cover use/change. Two catchments were monitored for the mechanism of water yield and its change.

Makoto Taniguchi gave an overview on three hot-spot areas, suggested in the 1st GWSP-Asia meeting: dams, coastal zone, land use/cover changes. Atmosphere-land interaction and its application in evapotranspiration were discussed with respect to irrigation, urbanization, deforestation, and forest plantation. Use of satellite GRACE was introduced for evaluation of change in water storage.

K.P. Sudheer introduced groundwater perspective for Chennai City. Monsoon affects Chennai City with annual rainfall of 1320 mm mostly in two months: July and August. About 50% of water demand is provided by groundwater. As a result of this unplanned large scale extraction of groundwater, the water table in the city is depleting at an alarming rate and also causing serious quality problems and seawater intrusion.

Yan Zeng presented on the change of potential (pan) evaporation, PE, daily precipitation in recent years in China, which could be affected by the urbanization processes. In recent decades, annual PE has significantly decreased, it has reduced by 99.8 mm (5.8%) from the 1961-1980 to 1981-2000. The reduction in solar radiance and wind speed contributed to the decrease of PE.

Charles Vörösmarty chaired the discussion of database/research agenda for mega city in Asia. Key themes reported/ need to consider are given as:

- Urban regions are a major focal point for change
- Broadly, Asian cities are a major focal point for system stress
  - "Tension" between surface water / groundwater use and supply
  - "Tension" between formal and informal settlements
  - "Tension" between upstream / downstream stakeholders
  - Pollution
  - Subsidence
- Responses to stress vary
  - Reduced use, reuse, efficiency changes, transfer to surface supplies incl. submarine aquifers, desalination, inter-basin transfers, harvesting

Research strategy, information needs, and next steps were suggested as:

1. Project definition: One or more of the issues presented by the GWSP-Asia network workshop participants
2. Execute, stepwise the project over the GWSP-Asia domain
   Define: demographic distributions, level of industrialization, water use, role of private/public supplies, governance structures
   Link: to upstream basins, dams, land use, characterize hydrologic fluxes
   Identify or Create and then Apply: appropriate modeling and analysis tools
   Exercise: models to develop a picture of the conjunction of use and supply…, mean state and trends (past and into future)
3. Produce Outputs
   Identify: current and emerging hotspots
   Identify: gaps in monitoring and knowledge
   Identify: response strategies
   Produce:strategic documents to identify scope of problem, stimulate investments in research and action
4. Immediate steps
   Identify: responsible individuals
   Write: Scientific project plan
   Consider: converting project plan into proposal (e.g. APN -- September 2006)

The other comments were summarized as:

Need to identify gaps in database and monitoring activities/products related to groundwater – growing mega-cities in Asian (coastal) region;
vulnerability to different sources of stresses (risk assessment due to climate change, land-use change, … needed); any analysis should relate to the GWSP Framework document.
Suggestions: document the changes and reasons for changes, upstream/downstream questions, vulnerability question (following the framework). LOICZ has already looked at groundwater in coastal zones; but would like to study also more rural areas; health impacts should be included; institutional aspects need to be considered – it was surprising, that private/public sector (privatisation) debate was not mentioned at this workshop (privatisation is part of the puzzle).

4.0 Conclusions

The main goals of the workshop were: (1) summarize existing state of knowledge on current cumulative impacts of mega cities and that of dams in Asia and to set and launch a research agenda for mega cities and dams in Asia in the context of the global water system; (2) create databases on dams and mega city (version 1.0) under the umbrella of GWSP-Asia Network.

As the rate of geo-referenced database for dam is low for China and India, where major large dams were constructed, database of version 1.0 was focused on the data collection in these two countries.

Cumulative impacts of mega city and that of dams in Asia were presented by the participants with their case study and summarized in the previous section. Though impacts of mega city and dam were discussed separately, they are interacted in the context of stress and response (Fig 5): water scarcity/vulnerability in the mega city requires sustainable water supply with good water quality from dam/reservoirs and/or groundwater, while the construction of dam affected environmentally the downstream/coastal area, where mega city is generally located. The interaction and impacts of dam and mega city are significant in Asia from the perspective of global water cycle and nutrient flux.

Human activities and global change are factors related to the development of mega city and the construction of dams. The impacts of mega city and dams could be evaluated from the aspects of natural hydrological processes and human kind, and the framework of DPSIR could be adapted for the impact evaluation of dam and mega city.

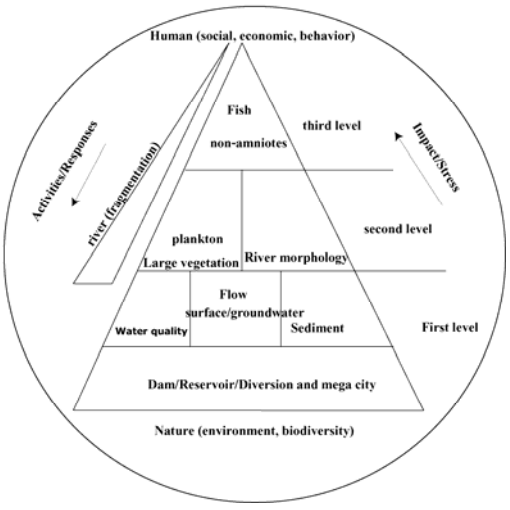

Fig. 5 Impacts and interaction of dam/mega city in terms of nature/human activities (modified from Geoffrey (1984))

5.0 Future Directions

After a discussion, the participants agreed to prepare APN proposals (one on dams and one on mega-cities) utilising the structure of the GWSP framework (for further information see below) – further remarks: APN may provide short term funds; what about the long-term perspective? Other organisations, including AUSAID, EU, need to be approached.

1. Preparation of APN Proposals

APN Pre-proposal (2 pages) will be prepared before end of July; proposal (4 pages) due September 30. The main contributors to the APN proposal are given below.

- *Proposal 1 – Dams*
  - *Magnitudes and mechanisms of change (Theme1)*
    Contributors: Jun MAGOME, Xixi LU, Ranjith Premalal DE SILVA
  - *Linkages to the broader system (e.g. the climate system, pan evaporation, virtual water)*
    Contributors: K.P. SUDHEER, Jianyao CHEN, Nalin WIKRAMANAYAKE
  - *Adaptability, Mitigation*
    NN
- *Proposal 2 – Megacities*
  - *Magnitudes and mechanisms of change (Theme1)*
    Contributors: Makoto Taniguchi, Karen Ann JAGO-ON, Nazim ALI, Joesron LOEBIS
  - *Linkages to the broader system (e.g. the climate system, pan evaporation, virtual water)*
    Contributors: Frits Penning de Vries, Jianyao CHEN, Yan ZENG
  - *Adaptability, Mitigation*
    Felino LANSIGAN, Nalin WIKRAMANAYAKE

2. Database of Version 2.0 for dams

In the first stage of GWSP-Asia network, only limited data for dams was collected and compiled. The database needs to be improved and expanded with geo-referenced rate increased, i.e., from version 1.0 to version 2.0. The training course on the database of dams/mega city and the related hydrological analysis were proposed during the workshop.

3 Close cooperation with MAIRS/LOICZ and the other organizations

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Appendix

Agenda for 2nd GWSP-Asia Network Workshop

June 8-11, 2006, Guangzhou, China

Guidelines for Workshop Participants

Correspondence:

Dr. Jianyao CHEN
E-mail: chenjyao@mail.sysu.edu.cn
Tel: 13527639524
Fax: 86-20-8411-4575

Workshop venues

Opening Ceremony: Room: International Hall on 3th floor of Guangdong international Hotel
Keynote Lectures: Room: International Hall on 3th floor of Guangdong international Hotel
Session one: Room: Kunming Hall on 4th floor of Guangdong international Hotel
Session two: Room: Kunming Hall on 4th floor of Guangdong international Hotel

Address: Guangdong International Hotel (339 Huanshi Dong Lu, Guangzhou, People's Republic of China, 510098. Tel: (86-20) 83311888, Fax: (86-20) 83311666.)
(Please consult the following map of Guangdong International Hotel)

Workshop materials

Please submit your workshop materials or PowerPoint file(s) to the secretariat upon registration

Meals arrangement

Time	Meals	Venues
07:00-08:00	breakfast	The hotel where you live
12:10-13:00	Lunch (buffet dinner)	Lv Yin Ge (The Greenery Cafe)
18:30-19:30	dinner	

Points for attention

1. Every presenter is strictly allowed 15 minutes of presentation and about 5 minutes of question and answer during Sessions.
2. All mobile phones should be switched off or set to vibration mode during sessions.

Opening Ceremony and Keynote Presentations

Time: June 8, 2006

Venue: International banquet Hall, Guangdong International Hotel

Time	Itinerary	Chairman
8:30	Opening	Prof. Xiaohong Chen
8:30 - 8:35	Introduction of officiating guests	
8:35 - 8:45	Speech by Mr. Siyi Hu, Vice Minister of Water Resources, P.R. China	
8:45 - 8:55	Speech by Mr. Ronggen Li, Vice Governor of Guangdong Province	
8:55 - 9:00	Speech by Dr. Arthur Askew, IAHS President	
9:00 - 9:05	Speech by a chief officer of Sun Yat-sen University	
9:05 - 9:10	Speech by Mr. Zhongming Yue, Director of Pearl River Water Resources Commission	
9:10 - 9:15	Speech by Mr. Rifang Zhou, Director of Guangdong Provincial Bureau of Water Resources	
9:15 - 9:20	Speech by a chief officer of Natural Science Foundation of China	
9:20 - 9:40	Photo-taking	
9:40 - 10:00	Coffee/Tea break	
10:00 - 10:25	Keynote presentation by Dr. Arthur Askew, IAHS President	Prof. Jun Xia
10:25 - 10:50	Keynote presentation by Prof. Changming Liu, CAS Academician and IGU Vice President	
11:50 - 11:15	Keynote presentation by Prof. Ben Dziegielewski, IWRA Executive Director	
11:15 - 11:40	Keynote presentation by Prof. Jiyang Wang, CAS Academician	
11:40 - 12:05	Keynote presentation by Dr. Z.W. Kundzewicz, IAHS Editor and Editor-in-chief of *Hydrological Sciences Journal*	
12:15 - 13:30	Lunch	
14:00 – 14:25	Keynote presentation by Prof. V.P. Singh, Editor-in-chief of ASCE *Journal of Hydrologic Engineering*	Prof. Yongqin Chen
14:25 – 14:50	Keynote presentation by Prof. Hao Wang, Academician of Chinese Academy of Engineering	
14:50 – 15:15	Keynote presentation by Prof. Charles Vorosmarty, GWSP Chairman	
15:15 – 15:40	Keynote presentation by Prof. Jun Xia, Vice Presidents of IAHS and IWRA	
15:40– 16:00	Coffee/Tea break	
16:00 – 16:25	Keynote presentation by Prof. Shenglian Guo, Vice Governor of Hubei Province	
16:25 – 16:50	Keynote presentation by Prof. Andreas Schumann, IAHS-ICWRS Secretary	
16:50 – 17:15	Keynote presentation by Prof. Renduo Zhang, Sun Yat-sen University	
17:15 – 17:40	Keynote presentation by Prof. Gordon Huang, University of Regina, Canada	
18:30 - 20:00	Conference banquet (speech by representatives of conference co-organizers)	

Session One

Theme: **Dam/irrigation/water transfer**

Venue: Kunming Hall , Guangdong international Hotel

Time: 08:00－18:00, June 9, 2006

Time	Speakers	Title	Author's Institution
8:00-8:10	Opening address **Changming LIU** (CAS)		
8:10-8:20	Opening address **Charles VOROSMARTY** (GWSP-Chair)		
8:20-8:30	**Jianyao CHEN**, Introduction of the 2nd GWSP-Asia Network Workshop		
8:30-8:40	**Frits Penning de Vries**, Opportunity for cooperation between MAIRS and GWSP		
Morning session Chairman: Prof. Dr. **Chenghu ZHOU** (IGSNRR), Dr. **Sharad JAIN** (NIH)			
8:40-9:00	Jun XIA	River eco-problem and rehabilitation approach by water projects management and pollution control: problems & challenges in Huai River Basin	IGSNRR
9:00-9:20	Sharad JAIN	Cumulative impacts of dams and diversions on hydrologic cycle	National Institute of Hydrology, India
9:20-9:40	Chenghu ZHOU	Construction of dam/reservoir database in China (to be confirmed)	IGSNRR,CAS
9:40-10:00	Marcel ENDEJAN	Identification of important dam-related aspects of the global water system	GWSP-IPO
10:00-10:10	Coffee/Tea break		
10:10-10:30	Changming LIU	Large dams implications for water systems in China /Impacts of Dam Construction on Ecosystem and Dispatches of Ecological Water	IGSNRR,CAS
10:30-10:50	Joesron LOEBIS	The Effect of Dams Development towards Water Conservation and River Basin Management in Indonesia	Research Institute for Water Resources, Indonesia
10:50-11:10	Suxia LIU	The Countermeasure of Minimum Ecological Instream Flow Requirements for the areas in Western Route South-to-North Water Transfer Project in China	IGSNRR,CAS
11:10-11:30	Ranjith Premalal De Silva	Hydrological Impact Assessment of Large Dams and Associated Land Use Changes – A Case Study in Upper Mahaweli Catchment, Sri Lanka	University of Peradeniya
11:30-11:50	Qu Jiansheng	Development of International Dam Information System（IDIS）: Scheme and Feasibility	Lanzhou University

Time	Speakers	Title	Author's Institution
11:50-12:10	Petrus SYARIMAN	Effect of Sediment Rate at Saguling Reservoir to its Life Time	Research Institute for Water Resources, Indonesia
12:10-13:30	LUNCH		
Afternoon session Chairman: Prof. Dr. **David Dudgeon** (The University of Hong Kong) and Prof. Dr. **Jun XIA** (IGSNRR)			
14:00-14:20	David Dudgeon	Conservation of Riverine Biodiversity in Asia:The Challenges of Assessing Ecosystem Requirements for Water and Determining Environmental Flow Allocations (e-flows)	University of Hong Kong
14:20-14:40	Jun Magome	Develoment of geo-referenced global dam and reservoir database for hydrological analysis	Yamanashi University
14:40-15:00	habil Nguyen Trung DZUNG	Dam Development in Vietnam and their Social and Environmental Impacts	Water Resources University
15:00-15:20	Oloth SENGTAHEUANGHOUNG	Enhancing Water Quality through the Better Land Management of Degraded Highland Regions in Northern Lao PDR	National Agricultural and Forestry Research Institute, Vientiane, Laos
15:20-15:40	Hansa Vathananukij	MODIS/TERRA demonstrably encompassed upon reservoir	Kasetsart University
15:40-16:00	Coffee/Tea Break		
16:00-18:00	Discussion for database/research agenda for dams. Chairman: **Marcel ENDEJAN**		
Evening Event: boat tour in the Pearl River(dinner on the boat)			

Session Two

Theme: **Mega city**

Venue: Kunming Hall, Guangdong international Hotel

Time: 08:00－18:00, June 10, 2006

Time	Speakers	Title	Author's Institution
Morning session Chairman: Prof. Dr. **Felino P. LANSIGAN** and Prof. Dr. **Jingjie YU**			
8:00-8:20	Changming LIU	Water Resources Problems in the First Half of 21st Century in China: A Water Security in Urbanization	IGSNRR
8:20-8:40	Makoto TANIGUCHI	GWSP-Asia Database – Dam, Coastal zone, and Land Cover/Use Changes	RIHN

Time	Speakers	Title	Author's Institution
8:40-9:00	Renhua ZHANG	The quantitative retrieval of transpiration for virescence land in Beijing city using two-layer remote sensing model and TM data	IGSNRR
9:00-9:20	Nalin WIKRAMANAYAKE	Impacts of Dams and Water Transfer Projects on Coastal Systems : Examples from South Asia	South Asian Regional Node for LOICZ
9:20-9:40	Jiu Jimmy JIAO	Submarine groundwater, an alternative source of water supply for Hong Kong	The University of Hong Kong
9:40-10:00	Ya WANG	Virtual water trade from Guangdong Province to Hong Kong	Sun Yat-sen University
10:00-10:10	Coffee/Tea break		
10:10-10:30	Felino P. LANSIGAN	Water Security and the Environment: Challenges to Growing Mega-Cities in Asia	Univ. of the Philippines Los Banos College
10:30-10:50	Karen Ann Jago-on	Urban Development and Its Impact on Subsurface Environment: Focus on Groundwater Situation in Selected Asian Cities	RIHN
10:50-11:10	Nazim ALI	Climate Change and Water Supply Security in Karachi, Pakistan	Global Change Impact Studies Centre, Pakistan
11:10-11:30	Jianyao CHEN	Urbanization impacts on groundwater quality in the Pearl River Delta	Sun Yat-sen University
11:30-11:50	Kasdi Subagyono	Indonesia. Soil and water conservation for urban area protection in Indonesia: the role of dams and land management	IAHRI
11:50-12:10	Jingjie YU	Urbanization impacts on hydrological processes in Beijing (To be confirmed)	IGSNRR, CAS
12:10-13:30	LUNCH		
Afternoon session Chairman: **Makoto Taniguchi** (RIHN), **Jianyao CHEN** (Sun Yat-sen U)			
14:00-14:20	Zhongqin LI	Environmental Problems in South China Sea (to be confirmed)	South China Sea Branch of SOA
14:20-14:40	K.P. SUDHEER	Ground Water Perspective of Chennai: a Coastal City in India	Indian Institute of Technology Madras
14:40-15:00	Yan ZENG	Changes of Pan Evaporation in the recent Years in China	Jiangsu Institute of Meteorlogical Sciences
15:00-15:20	Yameen MEMON	Effect of Water Scarcity on the Indus Delta Ecoregion	Management & Development Center
15:20-15:40	Coffee/Tea Break		

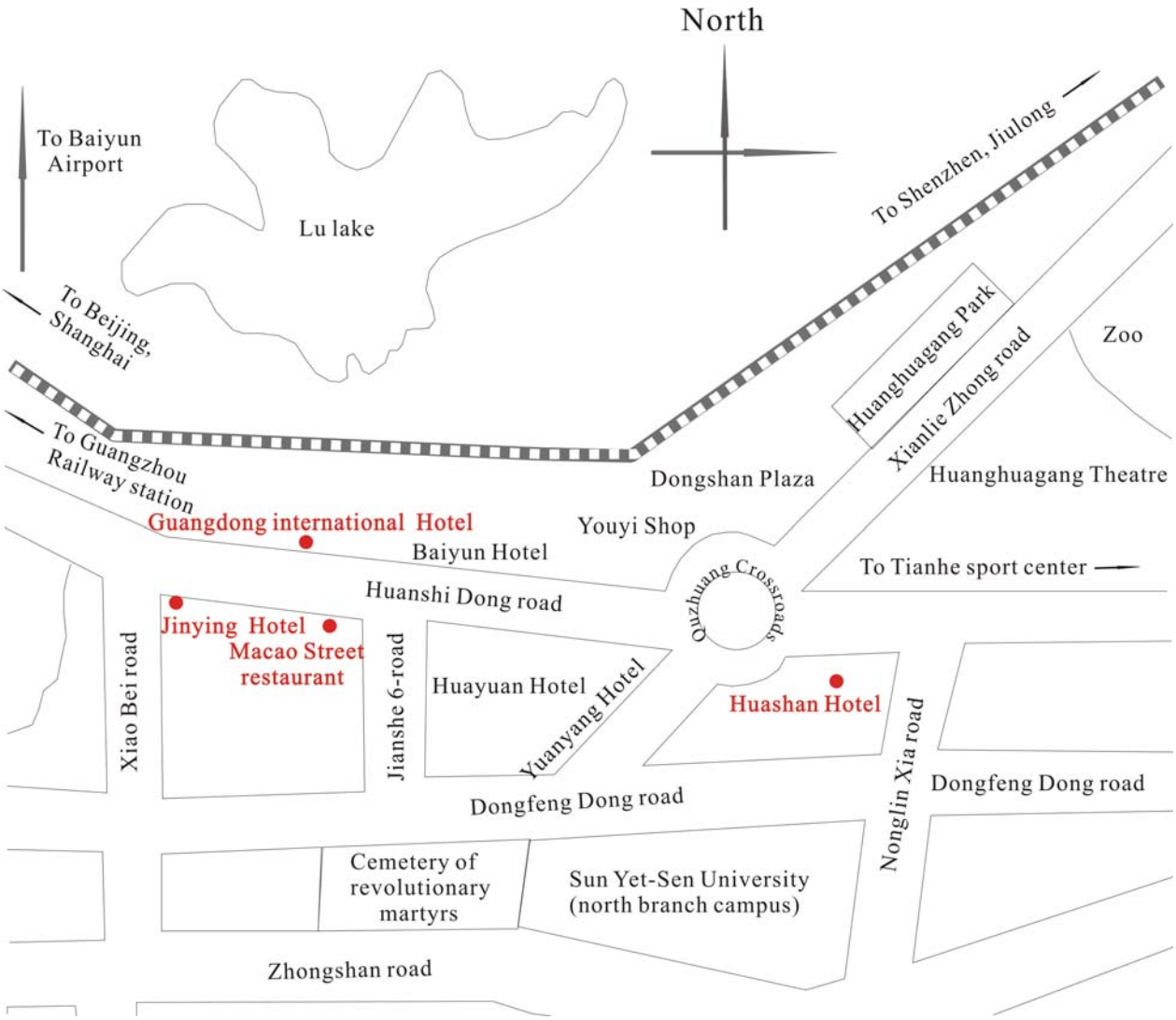
15:40-17:40	Discussion on database/research agenda for mega city. Chairman: **Charles VŐRŐSMARTY**
17:40-18:00	Reports from the discussions of dam/mega city
18:00	Close

Excursion to Zhuhai

Time: June 11,2006

Bus leaves from Guangdong International Hotel at 8:30 am., June 11,2006

Map of Guangdong International Hotel



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River eco-problem and rehabilitation approach by water projects management and pollution control: problems & challenges in Huai River Basin

Jun Xia

Key Lab. of Water Cycle & Related Land Surface Processes,
Institute of Geographic Sciences & Natural Resources Research,
Chinese Academy of Sciences (CAS)

Abstract

The River pollution and related eco-system degradation due to regional economic development and water project construction is a big issue in China, such as in Yellow River, Hai River and Huai River of North China. For instance, Huai River Basin, with total area of 270,000 km^2 and 165 million populations, is such a representative case where waste water load is very significant in river system. For planning objective of regional water pollution control in the river system, water quality should be clear with water functional standard in 2000. However, this objective could not realize until now. On the other hand, human activity is very significant in Huai River that was controlled by many dams and floodgates. It may enhance water pollution events during flooding period when floodgate opened to discharge. To rehabilitate polluted river and keep river heath, an emergency issue is to evaluate reasonably causes to result in water pollution and eco-system degradation if due to water projects building and load control. Moreover, it is big issue if eco-system could be improved by reasonable water project operation and load control?

This paper addresses such problems by recommendation of case study on Huai River Basin. Basic background will be introduced on both natural condition and environmental change impact. Major causes will be also preliminarily analyzed by author investigations and visions. Several research themes and related project are suggested to carry out international cooperation on environmental impact assessments and protection technologies for watershed & ecosystems sustainability. It will shown that Huai River Basin will be a good case to do NSFC-JST bilateral cooperation. Major issue will focus on how to establish effective environmental impact assessments approach and conservation technologies for sustaining watershed ecosystems, focus on water-material circulations or ecosystem mechanisms on watershed in the river system and river basins by fully utilizing state-of-the-art environmental monitoring, assessment, simulation, or conservation technologies that was developed by Japan and China.

Cumulative impacts of dams and diversions on hydrologic cycle

Sharad K Jain

National Institute of Hydrology
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Abstract

A large number of dams and diversion have been constructed in the last century and many more will be constructed in different parts of the world so as to meet ever increasing requirements of water by the society. Thus the anthropogenic impacts on water cycle are likely to further intensify. Before the planners and decision makers can ensure steps to mitigate adverse consequences of these impacts, it is necessary to understand the magnitude and coverage of these.

World over, there are more than 45000 dams of heights exceeding 15 m together these have the storage to hold nearly 6500 billion cubic m (BCM)of water which is about 15% of the total annual global runoff. World wide, the water withdrawal and consumption in the year 1995 were 3788 and 2074 km^3 and this is expected to grow by 10-15% each year. Water withdrawals, as a percentage of renewable surface water resources greatly vary across the world. IN Europe and Asia, the withdrawals for the year 1995 were about 16% of the resources and these are likely to grow to 22% by the year 2025.

In India, about 4300 major dams have been constructed and the storage capacity created (Including the proposed projects) is about 380 BCM. This will be 20% of the estimated average annual flow of Indian rivers (1869 BCM) and about 55% of the utilizable surface water potential of 690 BCM. Besides, more than 100 barrages have also been constructed to divert water mainly for irrigation. In view of growing water scarcity, it is necessary to attain a higher degree of regulation of streamflows. The dams and barrages are going to have significant influence on the river flow regime of the basins. As water is being thinly spread over agricultural area, this will increase ET flux as well as infiltration. It is important that these impacts of dams and diversions are examined at various scales – local, regional, and global.

A global database of dams and diversions is necessary to study their impacts. A few such databases have been created but these are not complete and lack accuracy. Ideally, such a database should be created in the framework of a GIS so that the information can be complied on spatial basis. A framework for such a database is being prepared.

The present paper discusses the above aspects in details and elaborates them.

Identification of important dam-related aspects of the global water system

Marcel Endejan

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Abstract

Dams play an important role in the global water system. The impacts of dams and associated reservoirs are not limited to altered local runoff but include changes in the regional hydrological cycle, the transportation of sediments and nutrients, and changes of biological and socio-economic aspects of the global water system. The range of planned activities of the Global Water System Project (GWSP) related to dams, such as the analysis of water governance schemes and impact assessments of water diversions, and the fact, that one focal point of the newly established GWSP Asia Network is to analyse the impacts of dams in Asia demonstrate the importance of dams on the global and regional scale.

To analyse the impacts of dams, it is necessary to identify the *main elements and linkages* of the global water system that are *related to dams*. To make quantitative analysis of the effects of dams on the global water system *datasets* describing the main elements and linkages are needed. These datasets should be provided via a consistent *database on dams*. Since the global water system has to be examined from the *viewpoint of different scientific disciplines*, the wish list of information provided by such a database does not only include physical aspects, such as the location of a dam and the volume of its reservoir, but also socio-economical and other aspects, such as the operating purpose of a dam. Although the ultimate goal would be to provide data for all dam-related aspects relevant to the global water system, limited availability of (financial) resources make it necessary to select those elements which are considered to be the most important ones in the current phase of the GWSP and the GWSP-Asia Network.

Based on an analysis of the GWSP Framework Document, the proceedings of the first GWSP-Asia Workshop held in August 2005, descriptions of various dam databases, and following a discussion at a first GWSP workshop on global dam databases held in April 2006, a *first conceptual model* was developed. The presentation will provide an overview of this model by describing the main elements of the model and their main characteristics and interlinkages. The presented model might serve as a starting point for further discussion on dam-related aspects of the water system in Asia and the development of a comprehensive database on dams.

Large Dams Implications on Water Systems in China

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Abstract

China has built almost half of the world's large dams being estimated 45,000. Virtually all these dams have built since the founding of the People's Republic of China in 1949, when were only 22 large dams apparently existed before. In China, debates on large dams are clearly. Opponents to large dams in China argue that over reliance on structural responses to China's water and energy problems have led to unsustainable practices in the long term and largely ignore the delicate balance of nature. They suggest the physical manifestations and direct effects of practices that degrade ecosystems and habitats were of clear significance. These effects include an increase in the drying up of dam downstream courses, and decrease in flowing function of major river systems. For instance the Yellow river no longer has had sufficient water flows reaching the sea for many years since a dam cascade has formed. Opponents also argue that the direct and indirect social impacts of dams on rural population have resulted in terms of the habitat resettlement, and consequently their environmental impacts can outweigh the benefits of large dams.; For the large riverine communities affected by dams, the loss of livelihoods, cultural property, loss of social cohesion, disruption of social networks, increasing marginalisation of minorities, and so forth are all concerns.

Yet on the whole, China's natural situation as regard to water and energy resource development is somewhat unique in world terms. For many reasons including the sheer scale and magnitude of the challenges it faces in providing water and energy services for 1.3 billion population and the extent to which it is constrained or locked in by past development choices.

As well known, "The mission of the GWSP is to understand the ways in which humans influence the dynamics of the global water system and to inform decision makers on how environmental and socioeconomic consequences of these impacts can be mitigated.?" has projected by the GWSP. Based on this scientific focus of Global Water System Project (ESSP/GWSP), the authors of the present paper mainly dealt with impact of dams on the water systems, especially , influence of the dams on detention period of river water system. To take a example from China's river system with a case study on the Yellow River, the authors found that the dams with intercepting large amount of water would prolong the duration of the detention of river water system in terms of lengthening water exchange or decreasing renewability of river water.

The Effect of Dams Development towards Water Conservation and River Basin Management in Indonesia

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Abstract

Since 1900, there have been more than 100 dams built in Indonesia. The aim of these constructions was to increase the welfare of Indonesian communities, mainly to fulfill the need for paddy fields irrigation. Most of these dams' constructions built using government budget while there are others funded by the local people around the location. Due to the increasing demand of water supply, industrial raw water, irrigated water, powers generation, and navigation; the dams construction has rapidly increased from the small up to the large scale storage capacities. This paper will discuss about dams that conform with the standard International Commission on Large Dams (ICOLD).

There are 82 dams already declared as conform with the ICOLD criteria, varied from single purpose to multipurpose dams functions. It is interesting to observe that beside many advantages that may harvested from the dams constructions, they were also some impact for socio aspects and also its land acquisition. The other related impact is land used and cover change (LUCC), which affected the surface flow changed. On its functions, applying proper dams management may enhance the function of the existing dams to serve as the water conservation as well river basin management.

At the moment, attention of dams management were more focused on water supply sector and its sector distribution techniques. The decision makers gave less consideration to the environment criteria and social effect caused by the existing dams. This paper hence will elaborate comprehensively the governess of dams management and how they should managed properly in order to optimize its potential benefit and avoiding cumulative negative impacts that could affect the life of the communities.

The Countermeasure of Minimum Ecological Instream Flow Requirements for the areas in Western Route South-to-North Water Transfer Project in China

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Abstract

How much of water to be able to go to meet both the minimum local environmental needs and maximum water services contribution for the Western Route South-to-North Water Transfer Project in China poses a big challenge. Several specific aspects in the donating catchments, such as limited data available, hardness to access and not a method ready to use make the estimation more difficult. Several common methods such as Tennant, TEXAS, NGPRP, 7Q10, minimum monthly discharge and wetted perimeter methods were used to estimate minimum ecological instream flow requirements (MEIFR). Additionally an analytical wetted perimeter method is established in this paper to treat with data shortage specifically. Different results from these different methods show that a more holistic method should be applied in order to get a better understanding on the eco-hydrology involved in the transfer project.

Key Words: Minimum ecological instream flow requirements; Analytical solution; Western Route South-to-North Water Transfer Project in China; Ungauged basins; Temporal and spatial variation

Hydrological Impact Assessment of Large Dams and Associated Land Use Changes – A Case Study in Upper Mahaweli Catchment, Sri Lanka

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Abstract

Sustainability of water resources is imperative for the continued prosperity of Sri Lanka where the economy is dependent upon agriculture. The Mahaweli s the longest river in Sri Lanka, with the upper catchment (above 300 m) covering an area of 3124 sq. km. The Mahaweli Development Programme, a major undertaking in the upper catchment has been implemented during 1975 – 1980 with the aims of providing water to the dry zone of the country through a massive diversion scheme and also for generating hydropower. In this programme, seven large dams have been constructed across the river and large scale land use changes in the catchment have been occurred during the construction phase and implementation stages of the project.

Critics now say that the micro climate and the hydrological regime of the area have been adversely affected due to the construction of large dams and indiscriminate changes in the catchment ecosystems. Accordingly, it is argued that the river flows have been diminishing during the last two and half decades, thus jeopardising the expectations of this massive national development programme. It is also questioned whether there have been significant impact of the rainfall regime of the area due to the changes of the micro climate. This study was undertaken to develop a comprehensive hydrological modelling framework to represent the hydrological dynamics of the Upper Mahaweli catchment and assess the hydrological impacts of large dam construction and associated land use changes.

The spatial distribution of land use was identified through the supervised classification products of IRS-1A LISS II satellite imagery. In addition, historical maps were also acquired to obtain snapshots of land use prior to the commencement of the development programme. Rainfall and flow data were collected for a period of 30 years and statistically analysed. GPS data were collected to verify the location information. A comprehensive hydrological model was developed in Geographical Information Systems environment to simulate the catchment dynamics during the periods before and after the development programme. Sensitivity of the model was assessed for the defined hydrological parameters, spatial resolutions and interpolation techniques. It was found that the model can simulate the catchment dynamics and provide information to assess the hydrological impacts of the large dams and associated land use changes.

Development of International Dam Information System（IDIS）: Scheme and Feasibility

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Abstract

The proposed paper is aiming at the development of International Dam Information System (IDIS), which include extensive knowledge involving dam construction and geographical natures, to allow the further intercommunication among dam designers and engineers worldwide and to promote the public understanding on the contributions and threatening of the global dam. The prominent characteristics of IDIS are that it includes the global dam-involved information where possible and can be easily managed and visited via WebGIS-based software platform. The designed IDIS include three main modules, i.e. Dam Knowledge Platform, Global Dam Database, and Information and Management System (IMS). Primarily, the development of computer science and the application of large-scale information systems facilitate the establishment of IDIS, while the major difficulty we are facing is data collection, a global problem in the geographical field. However, we argue that the collaboration with some international/regional projects and organizations will be helpful in this respect.

Key words: IDIS; dam; information system

Effect of Sediment Rate at Saguling Reservoir to its Life Time

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Abstract

Citarum River and its tributaries, flowing on a catchment area of about 2,283 km^2, have been the primary sources of water for Saguling Reservoir. The Saguling Reservoir started to operate in 1986 with the originally designed total volume of 881 million m^3. In 2004, a sounding of the reservoir was carried out and found the recent volume of the reservoir to be only 730.5 million m^3. Forests in the upper Citarum, which is assumed as land cover and can protect the soil surface from destruction caused by kinetic energy of rainfall, now remains only 14% of the total catchment area. This fact means that soil erosion process at the upper Citarum catchment area increases in every rainy season. The erosion yields to sedimentation along the Citarum river basin and its tributaries, and ends at Saguling Reservoir.

Sedimentation at a reservoir can be measured by sounding method. It is known that the average sedimentation rate at Saguling Reservoir is about 5.5 million m^3 per year. The erosion rate occurring recently at the upper Citarum area is 2.8 mm per year, which has exceeded the permitted limit. The erosion process keeps occurring so that the lifetime of Saguling Reservoir has become less than 20 years at +616 m of elevation (dead storage elevation).

This paper discusses elaborately about the sounding method and analyzes the actual reservoir's sedimentation rate. It can be known then that there is a significant difference on the calculation result based on suspended sediment data and sounding data. The sedimentation rate at the reservoir can indicate the remaining lifetime of it.

Keywords: land cover destruction, erosion, sedimentation rate, reservoir, sounding, lifetime

Conservation of Riverine Biodiversity in Asia: The Challenges of Assessing Ecosystem Requirements for Water and Determining Environmental Flow Allocations (e-flows)

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Abstract

Riverine habitats in Asia are experiencing a variety of human impacts to the detriment of biodiversity and ecosystem goods and services. These include hydrologic alteration, pollution, direct habitat destruction, overexploitation, invasive exotic species, and the ongoing effects of global climate change. Their combined effect is such that Asian rivers may now be among the most endangered ecosystems on Earth. In some instances, amelioration or mitigation of impacts (such as gross pollution or overexploitation) is a matter of implementation or enforcement of legislation. In others, such as hydrologic alteration caused by dams, research is needed to determine the environmental water allocations (e-flows) that are needed to maintain intact groundwater and hydrologic regimes and thereby preserve biodiversity and maintain ecosystem functioning. A particular challenge that must be addressed is balancing projected increases in water use by humans and agriculture against the need to provide e-flows for ecosystem maintenance. Assessment of whether or not particular e-flow allocations are sustainable requires a comprehensive knowledge of the water requirements of human society and aquatic ecosystems, as well as the type and magnitude of ecosystem services provided by fresh waters. It must also involve determination of the adaptive capacity of freshwater ecosystems (i.e. how much water can be removed without influencing ecosystem integrity), combined with investigation of approaches to enhance adaptive capacity of these systems. Both structural and functional indicators of ecosystem integrity will need to be considered. This is necessary because there is uncertainty about the relative sensitivity of ecosystem responses to flow alterations: are they more accurately reflected in modified structure (e.g. biodiversity and species loss) or function (e.g. changes in rates of processes) or both? Formulation and assessment of appropriate e-flow allocations will require research collaborations that should be a priority for ecologists, hydrologists, water engineers and water-resource managers.

Development of Geo-Referenced Global Dam and Reservoir Database for Hydrological Analysis

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Abstract

Under the University of Yamanashi 21st Century COE Program "Research & Education on Integrated River Basin Management in Asian Monsoon Region", the Geo-referenced global dam and reservoir database, which has higher location accuracy to be applied for both regional and global scale hydrological analysis is developed by assembling several existing dam inventories and latitude/longitude coordinates that are obtained digitally or taken from printed maps. This database is has following characteristics; 1) Detailed geospatial information: coordinates values of dam are from about 1:1 million resolution to higher and shape of reservoir also prepared as polygon data. 2) Detailed and many attributes: reservoir capacity, area, dam height, purpose of reservoir etc. are registered. 3) High accuracy information: detection and revision of invalid data and avoiding duplicates comparing many data sources. 4) Dam and reservoir data are separated: for better database management. In, current database, 15 067 dams and 14 599 reservoirs are geo-referenced in total 32 391 and 31 642 records respectively and reservoir polygons also provided for 4 404 reservoirs. Especially for large dams and reservoirs which reservoir storage is over 0.1 km^3, all records were checked and finally about 68 % of dam (2 623) and 71 % of reservoir records (2 432) in this category (3 848 and 3 415) are geo-referenced. The total storage capacity of the geo-referenced dams is 5 672km^3, which is equivalent to the 89% of total storage capacity of all reservoirs and lakes over the world (6 400 km^3). Furthermore, this database will be planning to release to the research community.

In the workshop, development and quality control procedure of database will be presented. In addition, analyses used this database also will be shown eg, distribution dams and reservoir, percentage of evaporation loss from reservoir surface and increase of river water residence time caused by dam reservoir. Since a geo-referenced reservoir database which covers whole global area is rarely available, this new database will greatly contribute to making water resources managements and impact assessments of dams and reservoirs on the freshwater systems. However some problems were found by a quality assessment of database, for example the number of geo-referenced records in Asia and completeness of data attributes are relatively few, only 27 % of reservoir records (3 656) are geo-referenced in total 13 297 reservoirs in Asian region, in comparison with other region/continent, because some countries like china and India have huge number of dam and reservoir. Therefore, further geo-referencing of dams and reservoir in Asian regions are necessary and International Corporation of data collection and shearing are very important.

Dam Development in Vietnam and their Social and Environmental Impacts

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Abstract

Vietnam has an estimated hydropower potential of about 17000 MW, of which 4000 MW have so far been developed and about 1000 MW are under construction. About 5000 MW is planned to be commissioned in the period up to 2010 and most of the remaining potential will be harnessed by the year 2020. Vietnam is characterised by rapid development, and the need for electricity is increasing. Therefore, many hydropower projects have been planned without sufficient consideration of their social and environmental impact. The Yali Falls dam is but one sad testimony to this fact. The project has greatly impacted upon the ecosystem and the communities along the river, not only in Vietnam but also downstream in Cambodia. It may prove difficult to integrate poverty reduction aims with hydropower, as the profit created by dams will have to be considerably reduced in order to protect the interests of the poor. National Hydropower Plan (NHP) is an attempt at mapping the total hydropower potential of Vietnam and it strategically ranks potential projects according to a combination of economic, technical, social and environmental aspects. The recommendations are intended to create the foundation for a development process that should be followed up at a national level. The main objective is to 'contribute to a sustainable, environmentally as well as socially sound management of the water resources of Vietnam'. However, NHP is currently being criticised for favouring hydropower at the expense of alternative energy sources. In this contribution the dam development (daming landscape) in Vietnam will be reported and the the social and environmental impacts (in Vietnam and other contries related) will be shown.

Enhancing Water Quality through the Better Land Management of Degraded Highland Regions in Northern Lao PDR

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Abstract

Rural water supply and human health are primary development focal areas for many countries of Southeast Asia. In many of the water supply systems based on open water bodies, increased turbidity during periods of high rainfall are common place reducing the quality of water for human consumption. The cause of this increased turbidity is invariably rapid land conversion that induces a change in the pathway in which water moves within the landscape. In this respect the ratio of surface (turbid) / sub-surface flow (clean) increases resulting in a significant increase in sediment loads. Limited attention has been given to the downstream impacts of elevated sediment and nutrient loads associated with waters emanating from these upper basins and their potential impact on water quality and the livelihoods of these rural communities. Off-site impacts of inappropriate land management in upland agricultural production systems can have a negative impact on the life span of reservoirs and other structures through sedimentation, water quality deterioration, degradation of downstream aquatic ecosystems and a decline in fisheries production all contributing to deterioration in the livelihoods of downstream communities. Sedimentation and eutrophication of aquatic ecosystems leads to declining fish catches that in turn threaten the nutrition and health of downstream communities.

To provide data that are lacking and the catchment scale, outflow and sediment yield have been monitored from 8 small (0.5-64 ha) rural catchments since 2000 in northern Lao PDR. Soil conservation strategies have been developed and tested on three of these catchments.
Results clearly show that sediment yields can be reduced from 5-11 Ton ha-1 yr-1 under the current slash and burn system to nearly nil when appropriate practices are selected. These include improved fallow systems based on legumes. These innovative practices that rehabilitate degraded land and enhance water quality are currently disseminated by several organizations in the region.

MODIS/TERRA Demonstrably Encompassed upon Reservoir

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Abstract

Inundation and drought has been impacted to cultivation-economic country like Thailand which reservoir system has been demonstrated as a rather best security scenarios solution.

North Eastern area of Thailand contains the most dense population in Thailand, is situated on plateau where encountered drought, flash flood and inundated problem almost every year. One of the complex river systems in this area is Chi river basin which has Tributary drainage area about 8,084 square kilometers. Lampao Reservoir was introduced to relieve those problems, has drainage area about 5,960 square kilometers and could irrigate to about 314,000 rais agriculture area including with supplying all domestic area of Kalasin Province.

TERRA satellite imageries with MODIS instrument of 250 and 500 square meters resolution together with geoinformatics data system were assessable on this prototype area in order to illustrate feasible disaster tendency.

Key Words; MODIS/TERRA, Reservoir, Resolution250/500

Water Resources Problems in the First Half of 21st Century in China:

A Water Security in Urbanization

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Abstract

This paper mainly dealt with water resources in China with special reference to urbanization. Based firstly on the projection of the gross national economy and social development in the first half of the 21st century, the author indicated that the gross demand for water resources would be continuously increasing. Both industrial and urban domestic water requirements would have a higher increasing ratio in comparison with the demand in agriculture sector. It is estimated that the growth of water demand in China would be stable around year 2050 following zero growth of nation's population. Especially secondly the author discussed the water development concerned with water problem in urbanization and finally, suggested major countermeasures for sustainable development of water resources.

GWSP-Asia Database – Dam, Coastal zone, and Land Cover/Use Changes

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Abstract

The first GWSP-Asia meeting was held on August 29-31, 2005, in Kyoto, Japan. In this first meeting, we tried to make a network of water related studies and institutes in Asian countries, and to link the GWSP (Global Water System Project) to develop the understanding and knowledge on future potential human impacts and climate changes effect on water issues in Asia. We discussed new facts, new information, new methodologies, and new trends, related to water issues in Asian countries as well as water conflicts, policy making process, and capacity building in Asia. Hot spots studies were also discussed to demonstrate both impacts of climate change and human activities on water cycle in Asia. Throughout the discussion at the fist GWSP-Asia meeting, we recognized the following hot spots study areas in Asia; (1) Effects of dam on water cycle, material cycle, and ecosystem in the basin, (2) Water and biogeochemical flows in the coastal zone with high population, and (3) Effects of land cover/use changes on physical and biogeochemical flows in the monsoon climate.

In order to make progress of water studies in Asian region, we need common data bases for the hotspot study areas mentioned above and water related issues in Asia, and networks of interdisciplinary water studies of WCRP, IGBP, DIVERSITAS and IHDP, should be made among the Asian research groups to link with GWSP groups.
RIHN (Research Institute for Humanity and Nature) plan to provide a platform for exchanging information and establishing database.

The quantitative retrieval of transpiration for virescence land in Beijing city using two-layer remote sensing model and TM data

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Abstract

As well known, City virescence is the best way for the improvement of ecological and micrometeorological environment in mega city. However, virescence land is a big water pump for soil due to strong transpiration of trees and grasses. A part of the vapor into atmosphere through transpiration can increase air humidity, but the most of part become could which is blown to the Pacific Ocean by the west atmosphere circumfluence. Therefore we must consider water supply security of mega city in the region of west and northern China, which is lack of water Obviously, virescence wise should be optimized. In other words we should choose the best virescence wise, which can be both for saving water and for improving ecological environment. In order to reach the purpose, first we must obtain transpiration distribution information for various virescence lands in mega city.

In this paper, we calculated transpiration distribution for various virescence lands quantitatively in Beijing city using an operational two-layer remote sensing model and TM data. The model was developed by author in 2005 [Zhang Renhua et al., 2005, Sience in China]. The result can answer following questions:

1. How much water is pumped from soil for various virescence lands in a day of representative spring season in Beijing city?
2. Which kind of virescence land is both for saving water and for improving ecological environment?
3. What is effect of the results for water supply security in Asian mega city?

Finally, we will inform to decision makers of the virescence agency in Beijing city on how the best way of virescence can be selected.

Key words: virescence, transpiration, two-layer remote sensing model, saving water

Impacts of Dam Construction on Ecosystem and Dispatches of Ecological Water

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Abstract

According to the statistic of China Commission on Large Dams made at the end of 2003, there are 4694 large completed or under-construction dams with the dam height over 30m in the country, intercepting over 584,3 billion m3 of annual river runoff, namely, total capacity of reservoirs has reached to 20% of nation’s annual runoff as a whole. Besides the acceleration of the water resource gradual development on Yangtze River, Yellow River and some other large rivers, more dams have been also built for water resource development and utilization towards medium and small watershed develop at very fast speed. The river possesses important ecology functions.The large dam construction across river produces many man-made changes over different kinds of circulation patterns and impacts on the ecosystem function of the river systems. Based on large dam's influence on the river ecosystem, this essay made a research on river ecological function changes on hydrologic features, chemical features and its channel function, etc. Combined with some projects practice, towards some constructed projects which has already created ecological impact, the authors proposed to make some adjustments on the reservoir's operation schedule mode, ease its ecological impact to reach a harmony between water resource development and protection of the river basin's healthy ecosystems.

The authors of this essay started from the large dam construction's impact approaches, through the analysis of impact phenomena the essence issue of water resource development's impact on river ecosystem was analyzed to include: impacts of dams on hydrologic features, chemical feature and ecological function as well as the ecological response to the dams, etc. Based on the research, the authors proposes the large dams ecological dispatch measures to ease the ecological impact of water resource development.

Submarine groundwater, an alternative source of water supply for Hong Kong?

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Abstract

Hong Kong imports about 70% of the drinking water from East River via an 83 kilometer closed aqueduct. The spectacular industrial and population growth of cities along and near the river catchment has made them into both major polluters and competing consumers over the river water. To find another source of drinking water for Hong Kong, the Hong Kong Government has again began to looking into desalination as a serious supply alternative. It is hypothesized that submarine groundwater below the seabed may be another possible source of water supply for Hong Kong. It is well known that fresh or relatively fresh groundwater may exist below the sea in some coastal areas due to complex geological environment and history. The sea level around Hong Kong has fluctuated significantly in recent geological time and the shallow seabed was then elevated and exposed to the ground many times. In about 10,000 years BP, the sea level was about 100 m below the current sea level and the coastal line was about 100 km away from the current coastal line. It is believe that the aquifers which are now below the current seabed but once exposed above the palaeo sea level may still preserve fresh groundwater or blackish water with salinity much lower than current sea water. The typical geological profile from top to bottom in coastal HK sea consists of soft marine mud, hard clay and sand and gravel aquifers and decomposed igneous rock. The aquifer thickness can be up to 50 m. The low-permeability mud and clay with thickness of up 20 m overlying the aquifers may effectively impede the hydraulic connection between the seawater and underlying groundwater and preserve the fresh water in the aquifers. Such a water resource may be used at least in times of emergency. Even the water is not fresh enough to be directly drinkable, desalination of the blackish water may be much cheaper than that of the seawater.

On Virtual Water Trade Exported from Guangdong Province to Hong Kong

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Abstract

The concept of 'virtual water' was first given by Tony Allan of London University in 1993, and it was defined as the water used in the production process of commodities and service. The concept of 'Virtual Water Trade' was used to explain how water deficit was balanced in a region and country by importing water-consumed commodities, especially agricultural products. Virtual water trade provides a new way to deal with water resource management, allocation, and the impacts of water resource on social and economical aspects on the regional and global scale. Hong Kong is located in the southern part of China, one-third of its area, about 300km^2, is used for water catchment, which provides 2.95×10^8 m^3 fresh water per year, less than 30% of total water demand. Guangdong province is adjacent to Hong Kong, and both of them are closely connected economically. Export of agricultural products from Guangdong to Hong Kong is equivalent to water export, i.e., virtual water trade between them. The main objective of the study is to calculate virtual water in the agriculture products exported from Guangdong to Hong Kong during the period of 1981 to 2000. Analysis of water balance associate with real water and virtual water in the year 2000 would be made.

Key words: Virtual water, Virtual water trade, Guangdong, Hong Kong

Urban Development and Its Impact on Subsurface Environment:

Focus on Groundwater Situation in Selected Asian Cities

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Abstract

There has been an unprecedented increase in population in recent decades. United Nations estimates show a total global population of over six billion people of which is increasingly concentrated in high density areas. Urban development, which is often attributed to population growth, expansion of human activities, settlements and social infrastructures, has created impacts on the environment. These environmental problems often occur along with the stages of development in cities.

In the past most studies on environmental effects of population growth and urban development have been focused on the problems above the ground. The subsurface environment, which plays an important role in urban infrastructure development, notably in the provision of water supply, sanitation and drainage, and in the disposal of industrial effluents and solid waste, has not been given much attention. In Asia wherein most of the mega-cities are located in coastal areas, it is very important however, to understand the intensive interactions of subsurface environmental systems and the unwanted changes and impacts that urbanization has created, especially on groundwater level and quantity.

The objective of this study is to identify the socio-economic factors that have caused environmental stresses on the groundwater situation during the different stages of urban development. The causal relationship of environmental issues affecting groundwater will be analyzed in a DPSER (Driving force – Pressure – State – Effect – Response) framework. Urban population growth and change will be described in a city-specific demographic model that will cover a period of fifty years. Along with this is the analysis of selected economic growth indicators. Spatial analysis as well as a review of planning policies will also be conducted to understand land use patterns and land cover changes during the selected years. Assessment of technology and infrastructure changes will focus on water supply and wastewater treatment facilities.

Based on the results of the aforementioned analyses, a system dynamics model of economy-population-environment will be constructed and will be applied to assess the impact of urbanization on groundwater level and quality. Individual characteristics and conditions of cities will be highlighted in the case studies for Tokyo, Osaka, Seoul, Jakarta, Bangkok, Manila and Taipei.

Climate Change and Water Supply Security in Karachi, Pakistan

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Abstract

The rapid growth of the mega cities of the developing world has posed major water planning and management challenges. Besides exponential population growth trends, climate change also poses threat to sustainability of urban environment. This paper focuses on the issues of sustainable water supply to the only mega city of Pakistan, Karachi; a city of estimated population of over 12 million. Currently the city is being provided about 550 million gallons per day (mgd) against a demand of 650 mgd. This shortfall is not only due to rapid increase in population but also due to unavailability of fresh groundwater. Sea water intrusion has salinized groundwater in Karachi; therefore, supply of municipal water is totally dependent on surface water supplies of which three quarters come from Indus River. In addition to quantitative shortage, quality is a growing problem. Reports show the presence of bacteria in about 68% of tape water samples collected from Karachi.

Climate change would have a multidimensional impact on already stressed environment of mega cities. In Karachi, population growth and climate change may aggravate the problem of water qualitatively and quantitatively. Quantitatively, population and economic growth would cause 3 to 4 fold increase in demand by the year 2025. But climate change may inflate this figure as increase in average atmospheric temperature accelerates the rate of evaporation and demand for water for various activities in human settlements, thereby increasing overall water demand. On supply side, as reported by IPCC, runoff in Indus Basin may decline by 27% till 2050 which would pose a major threat not only to irrigation activities but also to urban water supplies. Qualitatively, it would be even more difficult to manage additional burden on infrastructure to convey drinkable quality water with current tariff.

Institutional response to incorporate issues in urban policies attributed to climate change is not visible because institutional actions are often directed at immediate and obvious problems; issues that might emerge fully only after several decades are perceived as less pressing. But to address issue of water supply in holistic way, a multidimensional approach would require studying interaction among environmental factors and their interactions based on concrete social realities for future planning of urban water supplies.

Impacts of urbanization on water quality in the Pearl River delta, China

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Abstract

The Pearl River has three main tributaries from west, north and east with a total basin area of about $4.4x10^5$ km^2. Urbanization has developed expansively in the delta area of about $3.1x10^4$ km^2 since the end of the 1970s, and total population in this area in 2004 was more than 25 million. Affluent water resources are one of primary conditions for urbanization process in the last 25 years. Annual surface runoff was estimated to be $3.13x10^{10}$ m^3, while groundwater recharged be about $8.9x10^9$ m^3/a in the delta. Though groundwater used in the delta is less than one percent of total water used, it could play an important role in municipal water supply in emergency situation, such as pollution accident, which occurs often nowadays in China. On the other hand, annual groundwater resource that is suitable for exploitation decreases from $6.65x10^9$ m^3 in the 1970s to $6.19x10^9$ m^3 in the 1990s, due mainly to groundwater pollution, which is closely associated with urbanization.

Impacts of urbanization on surface water and groundwater quality in the Pearl River was assessed based on documents of water quality available since the 1960s, and field surveys and water sampling carrier out in Mar and July of 2005, and April 2006. It was found that water quality deteriorates in the urban reach of the Pearl River in terms of COD, BOD, TP, DO, nitrite and NH_4. Though there are no big changes in the contents of major ions, groundwater in most of the delta area can not be used directly as drinking water due to high content in nitrate and ammonium, and possibly, Fe and Hg, which are high in natural background.

Soil and water conservation for urban area protection in Indonesia:

The role of dams and land management

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Abstract

The integrated soil and water conservation in a watershed system is crucial to protect urban areas from flood, drought, sedimentation and water quality deterioration. We evaluate the impact of dams and land management system on reducing runoff and erosion with insight of flood control in the urban areas, where in many cases these areas are situated in the downstream side. Channel reservoir (small dams) is one of many rainfall and runoff harvesting techniques, which has been proven to be an effective method to reduce peak runoff, extend the time response to runoff generation and to some extend to increase available water for irrigation during the dry season. Other study on catchment hydrology and nutrient balance in Central Java has come up with the results that runoff was higher under food crops based-cropping system compared with that under tree crops (Figure 1). Soil was more susceptible to erosion than that when the land has been used for tree crops. Under food crop cover, erosion process involving detachment, entrainment and deposition occurred intensively, while tree covers large interception leading to decrease runoff and soil loss. Grass planting was applied as soil conservation measure in the food crops catchment. The results showed that soil lost can be decreased as much as 90% after two years grass planting (Figure 2). As far as nutrient lost are concerned, lost of nitrogen (N) was much higher in the food crops based cropping system compared with that under tree crops (Figure 3), which may effect to water quality in the downstream areas. Both dams and land management have been proven to be the effective methods to reduce runoff, erosion, and nutrient lost, which may give insight to flood control, sedimentation and water quality deterioration in the urban areas.

Keywords: Soil and water conservation, Dams, Land management, Water quality deterioration, urban areas

Ground Water Perspective of Chennai: a Coastal City in India

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Abstract

Growing population and their dependence on natural resources causes a concern/threat on environmental resources round the world. Water is one among many becoming an increasingly scarce resource for most of the world's occupants. The alarming deteriorating trend of both quality and quantity of water is changing the scenario for their present and future perspectives. Among the available water resources, the most important, natural resource available to mankind is groundwater. More than one and a half billion people in the urban parts of the world today depend on groundwater. Among all other sources, groundwater is the most reliable source and provides the main line of defense against drought. Moreover, groundwater has superior quality compared to other sources available. Also on large it is cheaper to develop.

India has a long coast line, extending to about 7500 km. It is dotted by numerous cities; the major coastal cities are Kolkota, Chennai, and Mumbai. The present study gives the scenario of ground water quality and quantity (water levels), and seawater intrusion status for Chennai, one of the coastal cities of Southern India, during the last decade. Chennai is prone to natural disasters such as earthquakes and tsunamis. There has been some alarming changes in ground water levels, ground water quality and seawater intrusion. Groundwater levels are analyzed and compared across the years (1994-2004) for both post-monsoon and pre-monsoon conditions. Results indicate that in post-monsoon the water table has gone down by 1.0 m to 7.0 m below the normal depth. This indicates that the pumping of groundwater during the last decade was very high. Similarly, during the pre-monsoon season the water level was 1.0 m to 5.0 m below the normal. The results of the analysis also reveal that seawater has entered much ahead due to negative gradients caused by excessive pumping with in this coastal region.

This paper presents the details of the ground water level, quality and the status of sea water intrusion around the Chennai coast. The study has been done with help of observation wells, water quality analysis and a geographic information system data base. The paper also presents a prospective of the ground water status (both quality and quantity) for the Chennai city.

Changes of Pan Evaporation in the recent Years in China

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Abstract

Based on observational data of 664 meteorological stations in China from 1960 to 2000 and combined with the Geographic Information System (GIS) of ArcGIS, the spatial and temporal distributions and their trends for pan evaporation (PE) in China are investigated in this study. The results indicate that, from 1960 to 2000, the rate of pan evaporation has steadily decreased in China. Compared with the period of 1960s to 1970s, the rate of annual pan evaporation during 1980s to 1990s has decreased 99.8mm or 5.8%. Seasonal analyses show that the decrease of PE is mainly in spring, summer and winter. Spatial distribution of the rate of change shows that the decrease of PE is mainly occurred in East China and Central South China. Further analysis show that the decrease of PE is mainly related to reductions in solar irradiance resulting from sun-shine percentage decrease.

Keywords: Climate change, GIS, Pan evaporation

Effect of Water Scarcity on the Indus Delta Ecoregion

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Abstract

The surface irrigation system of Pakistan is recognized one of the world largest contiguous systems for irrigated area. The average annual river diversions for irrigation in the Indus Basin are 103.84 MAF for irrigating over 14.6 million hectares and that has been gone down up to 40-60 percent in last seven years period. Further, the continued rapid population growth, which is one of the most important driving force affecting the water sector, has affected the water delivery and consequently, distribution of water was disturbed. This has resulted in devastating the Indus Delta Ecoregion as whole.

There are severe problems emanating in Pakistan in the aftermath of the water shortage – destruction of mangroves forest, seawater intrusion, devastation of Katcho (Riverine) area, deforestation and desertification, mangrove forest destruction, pollution of the Indus water and wetlands and inadequate water for drinking and health.

Seawater intrusion has resulted in loss of 0.49 million ha land that has caused the displacement of the large population of the delta and destroyed the sources of livelihood of the people living in the area. The most important fish which were main source of people living in downstream of Kotri Barrage is no more available. Water shortage subsequently, has badly damaged the bio-diversity and degraded the coastal environment.

This paper presents the overall situation of water shortage, the major causes and threats to the Indus Delta Ecoregion and also suggests short and long term measures to protect the region that will bring the improvement in socio economic of the delta people for sustainable development.

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