Proceedings of

International Workshop

on

EDUCATION

for

MANAGING HYDROLOGICAL EXTREMES & RELATED GEO-HAZARDS

Islamabad - Pakistan, 24-26 January 2011

Organized by:

NUST Institute of Civil Engineering
School of Civil & Environmental Engineering
National University of Sciences & Technology
Sector H-12 Islamabad, Pakistan

In Collaboration with:

United Nations Educational, Scientific & Cultural Organization (UNESCO)
Higher Education Commission
Islamabad - Pakistan

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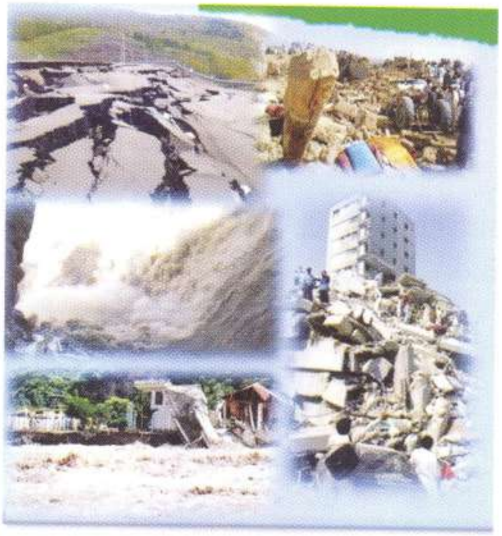
ISLAMABAD – PAKISTAN, 24 – 26 January 2011



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Education for Managing Hydrological Extremes and Related Geohazards

Report of an international workshop
Islamabad, Pakistan, 24–26 January 2011

The international workshop was organized by the NUST Institute of Civil Engineering (NICE), School of Civil and Environmental Engineering (SCEE), National University of Sciences and Technology (NUST)

and sponsored by:

United Nations Educational, Scientific and Cultural Organization (UNESCO) and Pakistan Higher Education Commission (HEC)

IHP

Executive Summary

Hydrological extremes (floods and droughts) and related geohazards induced by global change are of growing concern for communities around the world. It is therefore important to build capacity at all levels to understand, predict and manage potential impacts of land use change, population increase and climate change impacts on the increasing frequency of floods droughts and geohazards such as landslides. Recent floods in Pakistan have also highlighted the need to strengthen national, provincial and local capacities in Pakistan to manage hydrological extremes and geohazards through dedicated tertiary education and training courses.

While there are a range of teaching materials and workshops focusing on hydrohazards related education, these are not well connected to offer customised solutions to individual country needs. Some of the limitations identified in the existing education systems include use of outdated, discipline biased or irrelevant information; poor medium of instruction; lack of continuity between different levels of water education; lack of integration with the wider curriculum and with local knowledge; lack of practical relevance to local and community needs; lack of resources; and poor linkages between trainers and locally available professional bodies to achieve desired level of accreditation for career development.

This workshop was based on the results of a mission by a multidisciplinary team of six senior science experts from UNESCO and associated centres of excellence who visited Pakistan from 23 to 26 August 2010 on the request of the Government of Pakistan. As a result of this mission the following areas of water education were agreed to be explored through a targeted education workshop with stakeholders in Pakistan.

Training Higher Level Policy Stakeholders in Floods Management

- Specialized training for politicians, policy makers and higher level managers in hydrological and related geohazard risk management to deal with uncertainty

Advanced Tertiary Level Education and Research

- Capacity of existing institutes in water education
- Specialized education and training of flood forecasting specialists at the tertiary level

Training Middle Level Managers and Technicians

- Training of middle level technician and managers of water departments – update curricula of existing institutes in Pakistan

Community Education and Capacity Building

- Community and school education in managing geohazards

Workshop Structure

The workshop was structured into the following four technical sessions:

Technical Session 1: Training Higher Level Policy Stakeholders in Floods Management
Technical Session 2: Advanced Tertiary Level Education and Research
Technical Session 3: Training Middle Level Managers and Technicians
Technical Session 4: Community Education and Capacity Building

Objectives of the Workshop

The workshop had the following objectives:

- To identify examples of best practice in water education for managing hydrological extremes (floods and droughts) at all educational levels and how these can be used to strengthen education system in Pakistan;
- To analyse best practice examples to identify barriers and opportunities;
- To develop a work plan to enable effective water education in Pakistan at all educational levels.

This workshop included contributions from key stakeholders from Pakistan as well as experts from the extended UNESCO family. The workshop participants applauded the academic institutions in Pakistan for doing an excellent job in dealing with engineering issues in Pakistan however, it was realized that the water issues are becoming more complex due to acceleration of the water cycle caused by global change impacts. It was concluded that hydrological extremes induced by global change are of growing concern for the global, regional and national stakeholders. It is therefore important to build capacity at all levels to understand, predict and manage potential impacts of land use, population and climate change risks on freshwater resources and find innovative ways for utilizing extra flood waters during droughts in order to turn liabilities into new opportunities. There is an urgent need to promote participatory approaches for planning and decision making which can be coupled with traditional water resources planning methods and cutting-edge science and technology tools for managing both floods and droughts.

SWOT Analysis

The workshop participants carried out a Strengths, Weaknesses, Opportunities and Threat (SWOT) analysis to prioritize water education actions in Pakistan and South Asia region. This analysis along with the focused studies and participants background knowledge helped explore the following areas in water education for managing hydrological extremes and related geohazards:

- Advanced Tertiary Level Education and Research
- Training Middle Level Managers and Technicians
- Community Education and Capacity Building
    - Through formal school education
    - Informal community awareness programs

Based on the SWOT analysis, key messages and actions were recommended for the Government of Pakistan and the international community, in particular for informing future strategic water sector plans. In addition this analysis provided useful directions for the relevant organizations in the region, in particular for ministries in charge of education and water resources, for local authorities, the private sector and NGOs and for practitioners, including academics, researchers, trainers, teachers and mass media professionals. A summary of the SWOT analysis for each of the areas of concerns is given in the following paragraphs.

Advanced Tertiary Level Education and Research

S:

Pakistan has infrastructure already in place (academic institutions, teachers, professors, etc.) which has worked well in training excellent engineers who have successfully solved many complex water problems however the water problems are becoming trans-disciplinary due to global change; most of individuals are professionally water literate; water knowledge hubs also exist in the region (e.g. Asia Pacific Water Forum, APWF Knowledge hubs and UNESCO Centres of Excellence in China, Iran and Japan);

W:

There is a general lack of communication and information exchange between stakeholders and disaster management institutions; lack of necessary skills to communicate and work with related stakeholders communities; because of limited supply of professional staff, international competition is leading to brain drain from Pakistan and the greater South Asian region; lack of incentives to stay in water industry can lead to loss of professionals from water sectors; the water sector is not attractive in the job market as compared with other professions; gender is not generally not well balanced therefore need further attention; water is not persistently of high importance on national agendas including that of Pakistan; water is not valued in a proper way (including all social and economic aspects); decision makers do not appreciate the need for water knowledge; non technical background of decision makers leading to paradigm locks; lack of trained hydrologists to visualize climate change impacts on water resources

O:

Provide greater access and affordability; professional development for future careers (build on existing facilities); competition between institutions; big demand/need for water professionals in Pakistan and the greater region; demand is greater then supply; appropriate institutional structure can lead to incentives for water professional; water professional are not valued appropriately (not considered important and paid well); enact laws and policies leading to devolution of authority and responsibility to the lowest levels; there is a need for defining IRR (Implementing Rules and Regulations) – create proper funds and structure to enables these laws; huge losses in the water system can be tapped by trained water professionals to help improve water productivity

T:

Individual water management discipline based education (such as hydropower engineering, engineering hydrology etc) is under risk to become irrelevant because of narrow focus; cross-disciplinary education alone may also lead to lack of hard core professionals; sustained funding mechanisms are extremely important;

Training Middle Level Managers and Technicians

S:

Some good examples of accredited professional training programs

W:

Lack of appropriate sub-professional accreditation; qualifications are not transferable between different water utilities; lack of national institutions, manual guidelines and standards of performance assessment; lack of coordination between individual training programs and institutions; outdated standard procedures and skills to operate hydraulic structures; lack of water analysis skills in the forecasting bureaus

O:

Big demand for skilled technicians; professional bodies and professional training centers can create a major role in developing appropriate programs for water technicians; UNESCO Category II Centers, wherever present, to introduce new refreshing courses (in local settings) in association with local organizations/partners;

T:

Deterioration of water infrastructures and services due to lack of professionals; may not follow new technological development; lack of accreditation and career path leading to reduced interest by mid level managers;

Formal Community Education through Schools

S:

There are good examples such as Kawish school model for teachers' education through public-private investment

W:

Many countries do not have national programmes, lack of sustained efforts, water stories, books on water culture; existing efforts do not lead to interest in the key skills for water management; students are mainly exams oriented

O:

Possibilities to broaden water knowledge/awareness from early age; create projects and competitions in right water educations at all levels; create extra curricula activities for water reduce, reuse and recycle; organize youth conference on water at national level; UNESCO should take initiatives on youth water education; universities and communities can own parts of a river; internet based games learning; critical appraisal of existing curricula to understand H_2O learning needs; need for follow up on existing intergovernmental resolutions

T:

Teachers and students are already overloaded; lack of water programmes for schools may lead to reduced interest at all level.

Informal Community Education

S:

Communities are willing to participate if their local needs are well reflected in water education programs; right perception can make the difference; many pilot projects examples are available from different countries; corporate bodies wish to be seen as social and environmentally responsible entities therefore there are opportunities for local education project investments; religious and cultural institutions can also act as vehicles for delivery but good examples are missing; Multimedia outreach and availability; immediate impact in managing risks at the local level

W:

Multi level/multi sectoral stakeholders; lack of trust on regulatory bodies; traditional education systems not geared to link with local community needs; regulatory barriers for stakeholder's education and empowerments; lack of education of media professionals leads to inappropriate and biased coverage of water issues: politicians are followers of public opinion shaped by the media; time constraints lead to misrepresentations of water issues;

O:

Opportunities for greatest impacts because stakeholders are the real water managers; non threatening approach; dialog, consultation, socialization to be put in place; use audio-visual media to convey flood and drought risks; learning water partnerships at basin level; NGO and local leaders as vehicle for community involvement; public/private partnership; combine traditional and modern knowledge to address water issues; simplify water knowledge for education; mobilize local leader's funding (whenever available and appropriate); create incentives and penalties (no profit no interest); setting up water museums; need to convey messages about good and bad floods

T:

Sustainable water management is not possible without community involvement; failure to secure political commitment and formal sustained funds; social unrest/conflict/poverty if communities are not empowered through education; tremendous potential for creating public opinion and awareness; water education of mass media professionals can lead to better links with water scientists; engage media professionals in field campaigns; need to have supported short courses for media professionals; linkages between professional bodies and media associations; Without proper water knowledge the media may create wrong perception/opinions leading to disastrous decisions and defensive behaviors; non reliability of information sources; lack of water concepts/knowledge leads to misunderstandings;

Key Messages

Tertiary education and professional development of water scientists, engineers, managers and decision makers

- Using the existing infrastructure, it is possible to build trans-disciplinary water professional programmes
- Demand for competent water professionals far exceeds current and projected supply therefore urgent further investment in education is a must
- To retain professionals in water management, there is a need to provide financial and career incentives
- Governments need to create opportunities for trans-disciplinary water professionals along with appropriate funding mechanism for tertiary education

Education and training of mid level water managers

- There is a need to improve training of water technicians and to organize the training courses in water education
- Sustainable water management needs to find ways to include water education in schools curricula through practical projects
- There is a need for urgent follow up of IHP resolution on water education in schools through the Ministry of Education

Community education

- Combine religious historical and cultural approaches in water management (emphasize need to streamline Water and Civilisation in community awareness programs)
- The water education for mass-media professionals needs to be urgently addressed
- There is a need of an active engagement with media professionals at all levels
- There is a need to have a two way education of media and water professionals to promote scientifically credible media reporting
- Scientists needs to be trained to be media friendly and to interact with media

Recommendations

Tertiary education and professional development of water scientists, engineers, managers and decision makers

- UNESCO and other UN agencies to take the lead in promoting good examples of regional trans-disciplinary water programmes to create multilateral and bilateral cooperation networks and funding opportunities for Pakistan and South Asia region
- Government of Pakistan is encouraged to promote trans-disciplinary water programmes in the university curricula building on existing knowledge locally and through the UN system
- Professional bodies such as the Pakistan Engineering Council to create equivalence for accreditation of trans-disciplinary water professionals
- Government of Pakistan and its National Disaster Management Authority to take steps to mainstream hydrological risk management in education system by creating formal linkages across UNESCO centres of excellence, universities, at regional and international level
- Government of Pakistan is encouraged to take necessary steps to formalise establishment of a UNESCO Category II Centre on Managing Hydrological Extremes and Related Geohazards in collaboration with other countries

Education and training of middle water managers

- Leading universities in Pakistan such as NUST should act as catalyst for creating professional educational and vocational programmes
- The Government of Pakistan is recommended to establish a UNESCO Chair on training mid level managers for managing hydrological extremes under global change impacts
- The Higher Education Commission of Pakistan is recommended to hold targeted intuitional building workshops for effective use of models as education tools for decision makers
- The professional bodies such as the Pakistan Engineering Council may consider carrying out critical analysis of water education curricula through

comparative international analysis in collaboration with the UNESCO water education program

- The education institutes are recommended to participate in twinning exercises between river basins and nations for communities based learning programmes

Water Education in Schools:

- The government of Pakistan is recommended to train teachers on innovative methods for Water Education
- UNESCO to create teaching materials for water education at schools
- International organisations are recommended to set up pilot projects through seed funds
- Establish a repository of teaching material for water education, including movies. Potentially internet based
- The Government of Pakistan is recommended to assess current state of Water Education in Schools
- Train teachers to develop there own water education tool.

Community Education:

- The water management organisations are recommended to hold targeted symposia on water culture and civilisation (including religion)
- The government departments are recommended to train water professionals in communication issues, as a specialization. Teach how to write press releases.

Apart from the specific recommendations and the main areas of action for the concerned education groups in Pakistan, the meeting also emphasised need for regional action for improving water education in South Asia. In that respect, the key recommendations are given below:

- UNESCO to continue holding regional institutional capacity building workshops to demonstrate multi level stakeholders education, communication and engagement needs for integrated flood and drought risk management at the river basin level

- UNESCO's International Hydrological Program to share water education information with the member states through national, cluster and regional offices
- UN bodies to promote transboundary water and environment education by supporting activities of regional water education networks

Detailed Program of Workshop

International Workshop on Education for Managing Hydrological Extremes and Related Geo-Hazards

January 24-26, 2011, Islamabad, Pakistan

Day 1 (Monday, 24 January 2011)			
0830	0930	Registration	
Inaugural Session			
0930	0935	Recitation from Holy Qura'an	
0935	0945	Welcome Address by Rector NUST	Engineer Muhammad Asghar
0945	1000	Opening Address by ADG/SC UNESCO	Dr. Gretchen Kalonji, Assistant Director General, Science, UNESCO, France
1015	1045	Introduction to UNESCO Water Education Programs and Pakistan's Scoping Needs	Prof. Dr. Shahbaz Khan, UNESCO, France
1045	1100	Keynote Address	Mr. Kamal Majidullah, PM Advisor on Water and Agriculture
1100	1130	Address by the Chief Guest	Chief Guest (Federal Minister for Environment)
1130	1200	Refreshments	
Technical Session-I Training of Higher Level Policy Stakeholders in Flood and Drought Management Session Chair: Mr. Shamsul Mulk, Session Co-Chair: Prof. Dr. Liu Cheng, IRTES, China Repertoire: Dr. Muhammad Salik Javaid, NUST			
1200	1230	Speaker-1	Prof. Soontak Lee, Korea
1230	1250	Speaker-2	Sardar Muhammad Tariq, GWP-SAS
1250	1400	Lunch and Prayer Break	
1400	1420	Speaker-3	Mr. Riaz Ahmed Khan, MoW&P
1420	1440	Speaker-4	Dr. Izhar ul Haq, WAPDA
1440	1500	Speaker-5	Dr. Qunli Han, UNESCO Tehran
1500	1520	Tea/Coffee	
1520	1550	Panel Discussion on Work Plan	
1550	1600	Remarks & Certificates by Session Chair	
Day 2 (Tuesday, 25 January 2011)			
Technical Session-II, Advanced Tertiary Level Education and Research Session Chair: Prof. Kuniyoshi Takeuchi, Japan, Session Co-Chair: Mr. Naseer A. Gillani, PCP, Repertoire: Dr. Sajjad Haider, NUST			
0930	1000	Speaker-1	Dr. Bart Schultz, UNESCO-IHE, Netherlands
1000	1030	Speaker-2	Dr. Nimal Gunawardane, SaciWATERs, Sri Lanka

1030	1050	Speaker -3	Mr. Arif Mehmood, DG PMD
1050	1110	Speaker -4	Prof. Dr. Muhammad Latif, CEWRE
1110	1130	Tea/Coffee	
1130	1215	Panel Discussion on Work Plan	
1215	1230	Remarks & Certificates by Session Chair	
1230	1330	Lunch and Prayers Break	
Technical Session-III, Training Middle Level Managers and Technicians Session Chair: Dr. Bart Schultz, UNESCO-IHE, Netherlands, Session Co-Chair: Dr. Muhammad Nasrullah Khan, Principal SCEE, Repertoire: Dr. Hamza F. Gabriel, NUST			
1330	1400	Speaker-1	Prof. Kuniyoshi Takeuchi, Japan
1400	1430	Speaker-2	Dr. Sanjo Bamgboye, Nigeria
1430	1450	Speaker -3	Engr Naseer A. Gilani, PCP
1450	1510	Speaker -4	Dr. Bakhshall Khan Lashari, MUET/ Dr. Zahid Hussain, Minfal
1510	1540	Panel Discussion on Work Plan	
1540	1600	Remarks & Certificates by Session Chair	
1600	1630	Tea/Coffee	
Day 3 (Wednesday, 26 January 2011)			
Technical Session-IV, Community Education and Capacity Building Session Chair: Dr. Muhammad Nasrullah Khan, Principal SCEE, Session Co-Chair: Dr. Saleh Khaled, UNESCO, Repertoire: Engr. Muhammad Ukasha, NUST			
0930	1000	Speaker-1	Dr. Homayoun Motiee, RC-UWM, Iran
1000	1030	Speaker-2	Prof. Dr. Liu Cheng, IRTES, China
1030	1050	Speaker -3	Prof. Dr. Uzma Qureshi, LCWU
1050	1110	Speaker -4	Mr. Hamid Sarfraz, IUCNP
1110	1130	Tea/Coffee	
1130	1200	Panel Discussion	
1200	1215	Remarks & Certificates by Session Chair	
1215	1315	Lunch and Prayers Break	
SWOT Session. SWOT Analysis and Work Plan			
1315	1415	SWOT Analysis for Each Water Education Area	Moderated by: Prof. Dr. Shahbaz Khan, UNESCO Dr. Muhammad Salik Javaid, NUST

			Dr. Hamza Farooq Gabriel, NUST
1415	1515	Response by UNESCO Water Family, UNESCO-IHE, ICHARM, RC-IRBM, RCUWM, IHP-HELP, etc	Facilitated by Prof. Soontak Lee, President UNESCO IHP
Closing Session			
1530	1545	Recap of Previous Sessions	Prof. Dr. Shahbaz Khan, UNESCO
1545	1600	Closing Address by Chief Guest	Federal Minister for Science and Technology
1600	1615	Distribution of Workshop Certificates	Federal Minister for Science and Technology
1615	1645	Refreshments	

List of Speakers & Titles of Presentations

Speaker	Title
Prof. Dr. Soontak Lee, IHP, Korea	Water Education and Training for Managing Flood Disasters
Sardar Muhammad Tariq, GWP-SAS	Training High Level Policy Stakeholders on Drought Management in Pakistan
Engr. Riaz Ahmad Khan, MoW&P	Floods and Droughts Management in Pakistan
Dr. Izhar-ul-Haq, WAPDA	Educating Policy Makers and Stakeholders on Flood and Drought Management
Dr. Qunli Han, UNESCO Iran	IHP in Action in UNESCO Tehran Cluster: Building Capacities Towards Sustainable Water Management
Prof. Dr. Bart Schultz, UNESCO-IHE, Netherlands	Advanced Tertiary Level Education and Research on Impacts of Hydrologic Extremes on Flood Prone Areas
Prof. Dr. Nimal Gunawardane, SaciWATERs, Sri Lanka	Water Resources Education in South Asia: Experiences of the Crossing Boundaries Project
Mr. Arif Mehmood, DG PMD	Flood Forecasting and Drought Early Warning Capabilities of PMD
Prof. Dr. Muhammad Latif, CEWRE, UET, Lahore	Advance Tertiary Level Education and Research in Hydrology and Water Resources
Prof. Dr. Kuniyoshi Takeuchi, ICHARM, Japan	Flood Risk Management Courses at ICHARM
Dr. Olusanjo A. Bamgboye, NWRI, Nigeria	Training Middle Level Managers and Technicians
Engr. Naseer A. Gillani, PCP	Institutional Mechanism for Managing Hydrological Extremes
Prof. Dr. Bakhshal Lashari, MUET, Jamshoro	Irrigation Water Management Issues and Options: A Case Study from Sindh, Pakistan
Dr. Zahid Hussain, Minfal	Water Management at Farm Level in Pakistan
Prof. Dr. Liu Cheng, IRTCES, China	IRTCES & its Training Courses
Dr. Homayoun Motiee, RCUWM, Iran	Drought as a Water Related Disaster Case Study : Uroomiyeh Lake
Prof. Dr. Uzma Qureshi, LCWU, Lahore	Water Education: Implications for Teacher Education Policy and Practice - Water Education as a focus
Mr. Hamid Sarfraz, IUCNP	Community Resilience in Hydrological Extremes: Lessons Learnt and the Way Forward

Brief of Technical Sessions

Technical Session – I
Training of Higher Level Policy Stakeholders in Flood and Drought Management

Professor Soontak Lee discussed challenges faced by water education for flood management. He presented the new directions of water education under the IHP including adoption of integration of flood management. He gave examples of WET programs in Korea in which this new technique have been put in practice.

Sardar Muhammad Tariq discussed approaches adopted for drought management in Pakistan. He presented the components of drought management plans. He concluded that drought preparedness and management are effective strategies to reduce risks and drought impacts.

Engr. Riaz Ahmed Khan presented the lessons learnt from 2010 floods in Pakistan. He discussed the issues and options in flood management. He also discussed the strategies for drought mitigation. Also he emphasized the need for review of design of hydraulic structures & flood protection infrastructure.

Dr. Qunli Han presented an overview on hydrological conditions and challenges of the countries in the cluster – Pakistan, Iran, Afghanistan and Turkmenistan. He gave a brief on UNESCO Tehran actions for IHP in the Cluster and commented on recent floods and droughts in each of these countries. He also highlighted the needs of education and sharing of knowledge/information for cooperation.

Technical Session – II
Advanced Tertiary Level Education and Research

Professor Bart Shultz explained interactions of land use, water management and flood protection and the role of tertiary education and research in managing hydrological extremes. He outlined the challenges for tertiary education and research and how UNESCO-IHE is responding by imparting postgraduate education, training and capacity building in Water, Environment and Infrastructure.

Professor E.R. Nimal Gunawardena gave a brief on water resources education in South Asia. He shared the experiences of Crossing Boundaries Project of South Asia Consortium for Interdisciplinary Water Resources Studies (SaciWATERs).

Mr. Arif Mehmood described in detail the flood forecasting and drought early warning capabilities of Pakistan Meteorological Department (PMD). He explained the meteorological phenomenon which resulted in heavy flooding in Pakistan in 2010.

Professor Muhammad Latif gave an overview of advance tertiary level education and research in hydrology and water resources being conducted by the Centre of Excellence in Water Resources Engineering (CEWRE), Pakistan.

Technical Session – III
Training Middle Level Managers and Technicians

Professor Kuniyoshi Takeuchi gave an overview of flood risk management courses being offered by the International Centre for Water Hazard and Risk Management under the auspices of UNESCO (ICHARM). He also described the programme IFAS - Integrated Flow Analysis System for early warning & hazard mapping.

Dr. Olusanjo A. Bamgboye presented the systematic approach to training of middle level managers and technicians. He shared the experiences from National Water Research Institute (NWRI), Nigeria. He highlighted the various training activities being undertaken in the Nigerian water sector.

Dr. Izhar-ul-Haq discussed the emerging challenges for Pakistan in managing hydrological extremes. He explained the prospects of adoption of integrated flood management in Pakistan. He suggested approaches for educating policy makers and stakeholders for managing hydrological extremes.

Professor Bakhshal Lashari discussed irrigation water management issues and options by presenting a case study from Sindh, Pakistan. He highlighted the concept of Integrated Water Resources Management (IWRM) for sustainable water management.

Dr. Zahid Hussain presented a review of agricultural water management program in Pakistan. He described the various current and future programs/projects being undertaken in Pakistan for on-farm water management.

Technical Session-IV
Community Education and Capacity Building

Dr. Homayoun Motiee's presentation was devoted to droughts as one of the water disasters specifically occurring in arid and semi arid regions, particularly in Iran by demonstrating the results on a case study - Uroomiyeh Lake.

Professor Liu Cheng gave a brief on International Research and Training Center on Erosion and Sedimentation (IRTCES) and the training courses being offered by it. He also discussed the co-operation with Pakistan in providing technical assistance.

Professor Uzma Qureshi presented community case studies to improve education policy and practice with regards to Water education in Pakistan. She presented the lessons learnt from the Kawish model.

Mr. Hamid Sarfraz presented the lessons learnt from community resilience and how it can be enhanced in hydrological extremes. He also shed light on Ecosystem-Community based adaptation.

Technical Session-I

Training of Higher Level Policy Stakeholders in Flood and Drought Management

Professor Soontak Lee

Professor Soontak Lee is Chairperson / President, UNESCO IHP Intergovernmental Council. He is also Governor, World Water Council (WWC). Dr. Lee is currently Distinguished Professor at Yeungnam University, Korea. He is also a guest professor of Civil and Water Engineering, Shandong University, Deputy Chairperson of the IHP National Committee for Republic of Korea, President of the Korea Federation of Water Science and Engineering Societies and Korean government delegates of United Nations water conference. He also has experience as chairman of the UNESCO/IHP regional steering committee for Southeast Asia and Pacific.

Water Education and Training for Managing Flood Disasters

Prof. Soontak Lee
Distinguished Professor, Yeungnam University, Republic of Korea
President, International Hydrologic Environmental Society (IHES)
Chairperson/President, UNESCO IHP Intergovernmental Council, France

Abstract

In an age of rapid technology and social changes, the advanced and intensive education & training system is necessary for human resources who are and will be engaged in water resources field that needs various and complex knowledge and information. We all use water daily but the importance of water tends to pass unnoticed. Awareness of water issues is high only in times of floods and extreme shortage along with dramatic degradation in quality with little attention to long term preventive measures. The WET becomes an essential part of curriculum and personal development for proper water use in times of water crisis in terms of both quantity and quality. In Korea, various types of WET have been being executed on the service, and some researches have been conducted for development of internet-based teaching materials and internet programs of WET. Some organizations including the K-Water provide WET programs, which are not sufficient for regular WET programs organized by national government offices. For a public awareness as well as professional reeducation, we need to establish and develop systematical contents and systems of WET programs by age, degree, occupation, and step for the efficient teaching and learning.

1. Introduction

Water is one of major natural resources that covers about 70% of earth's surface and makes up 70-80% of the human bodies. It is evidently clear that water is a critical factor for life on earth and in economic development. It should be protected to ensure sustainable development. Korea has an average precipitation of about 1,274 mm annually, which is 30 % more than the world average but the average annual precipitation per capita is only about 10% of the world average. Moreover, 70 % of the annual total precipitation is concentrated in summer season through June and September, leading to floods in summer and water shortage in other seasons. The combination of rapid industrial expansion, urbanization, and population growth has affected the water quality in the major rivers in Korea. A wide variation of water quantity and quality in time and region makes water resources management hard to handle, and the health and economic effects of a shortage of clean water are matters of great concern in Korea. Water education and training (WET) can play a significant role for conservation of water and control of flood disasters and also avoiding misuse through public awareness at the present state of a significant increase in demand and pollution of water, a limited resource. In this paper, various types of WET for flood disaster management such as water education in schools, tertiary education & professional development of water scientists, managers, and decision makers, and training for water technicians which are available in Korea are introduced.

2. Water Education and Training (WET): Types

The world societies are now knowledge-based more than ever, and are becoming learning soceites where everybody needs lifelong learning. Therefore, it is necessary that informal, formal and non-formal education in water should be remained necessary as shown in Fig.1 from UNESCO's World Education Report which describes very well the different types of education necessary for creating a healthy "learning environment" in water, allowing for continuing education and training, and for effective transfer of technology adapted to the absorption capacity of a given society.

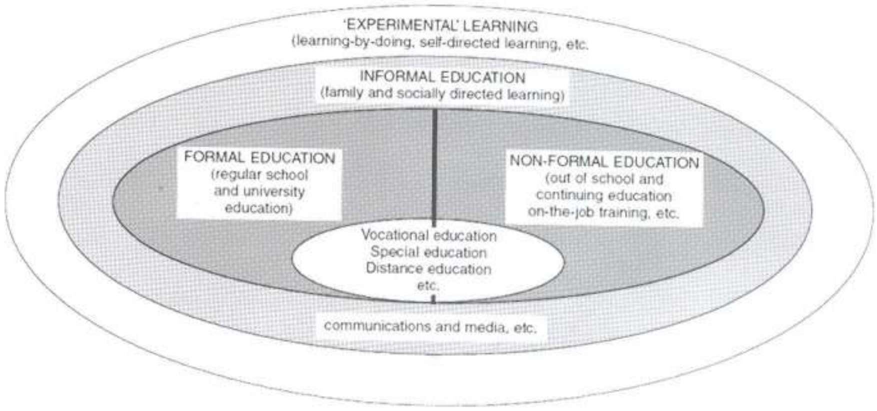

Figure 1: Education and the Learning Environment (UNESCO, 1991)

Formal education is characterized by a clear sequence of events. Although there are great divergences in level and extent, the following groups and steps can be found in education systems in almost all countries:

- pre-school training
- primary education(in school)
- secondary education(in higher institutions)
- tertiary education(postgraduate education and doctorates)

In addition, there are many forms of non-formal education and training for technicians; continuing education and training; continuing professional development and individual learning programs; and adult education. Among these non-formal educations and trainings, continuing education and training (CET) is needed because the overall knowledge and skills capacity of a person will lessen with time, due to the erosion of knowledge and the time-dependency of an individual's skills (Fig.2). CET is therefore considered a lifelong learning process even in water field.

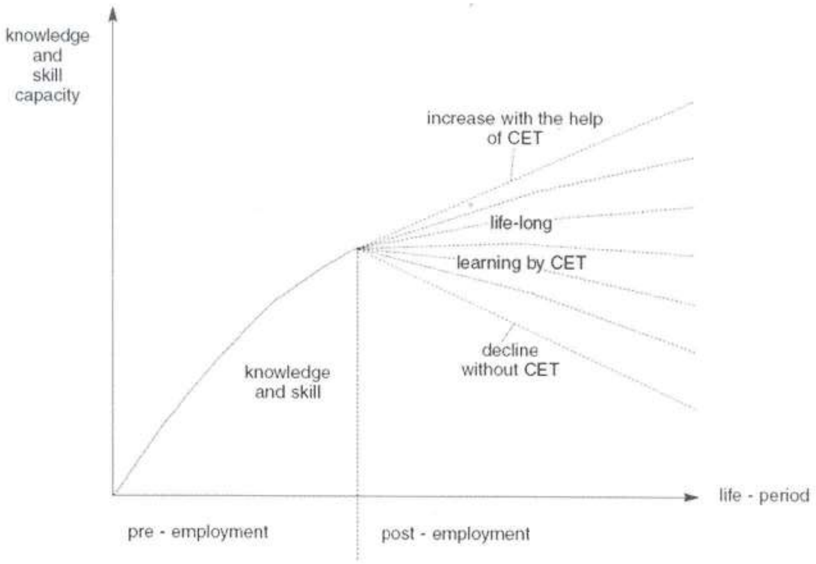

Figure 2: The Role of Continuing Education and Training (CET) in Developing the Knowledge and Skills Capacity of an Individual

3. Vision and Strategy of WET

The specific challenge for water education is to raise public awareness of, and participation in, water issues at all levels, and to seek better technology and transfer it worldwide in appropriate ways to solve water problems. This will need a vision as follows:

- environmental awareness
- solidarity
- IWRM
- subsidiarity

and key elements of the WET vision are;

- research and education
- collaborative clusters
- quality first
- public awareness

The follow-up of the WET vision is a WET strategy on human capacity building for

IWRM. In order to translate the strategy into action, a five pronged approach is required. This is designed to meet the needs for water-related education and training in the formative years; vocational training; university education; continuous learning; and research capacity strengthening.

4. Challenges of WET for Flood Management

The flood management practices have been traditionally focused on reducing flooding and reducing susceptibility to flood damage through a variety of interventions such as structural and non-structural; physical and institutional; implemented before, during and after the flood. These interventions include source control to reduce runoff, storing of runoff through detention basins or reservoirs, increasing of the river channel capacity, separating of river and population, emergency management by flood warnings or emergency works, and flood recovery measures.

However, the WET for flood management has to be turned into the new direction with the consideration of the following challenges;

- securing livelihoods
- need for a basin approach
- absolute safety from flooding is a myth
- ecosystem approach
- climate variability and change
- changes in the decision making processes
- risk management

The risk management particularly is a most necessary component of the development process, essential for achieving sustainable development because flood risks are related to hydrological uncertainties and the extent of their future changes cannot be predicted with certainty, as these changes may be random(e.g. climate variability), systemic(e.g. climate change) or cyclical(e.g. El Nino). There is a need to find a ways of making life sustainable in the floodplains – even if there is considerable risk to life and property. This can be approached through the integrated management of floods.

5. New Paradigm of WET for Flood Management

Adoption of the Integrated Flood Management (IFM) is becoming a new paradigm shift of WET for flood management. Integrated Flood Management is a process promoting an integrated – rather than fragmented – approach to flood management (Fig. 3). It integrates land and water resources development in a river basin, within the context of IWRM, and aims at maximizing the net benefits from flood plains and minimizing loss to life from flooding. IFM calls for a paradigm shift from the traditional fragmented approach of flood management and recognizes the river basin as a dynamic system in which there are many interactions and fluxes between land and water bodies. The attempt is to try to improve the functioning of the river basin as a whole while recognizing that gains and losses arise from changes in interactions between the water and land environment and that there is a need to balance development requirements and flood losses.

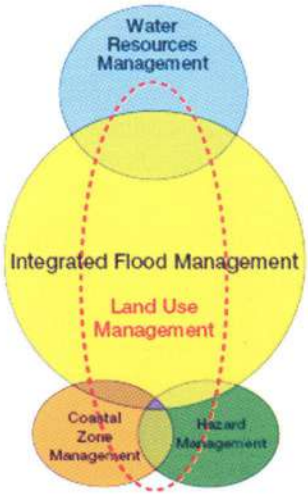

Figure 3: Defining Integrated Flood Management (IFM)

The defining characteristic of IFM is integration, expressed simultaneously in different forms: an appropriate mix of strategies, points of interventions, types of interventions (i.e. structural or non-structural), short or long-term, and a participatory and transparent approach to decision making. Integrated flood management plan should address the following five key elements that would seem to follow logically for managing floods in the context of an IWRM approach:

- manage the water cycle as a whole;
- integrate land and water management;
- adopt a best mix of strategies;
- ensure a participatory approach;
- adopt integrated hazard management approaches.

6. Present Status of WET Programs in Korea

■ K-Water Academy WET Programs

The K-water Academy conducts both domestic training programs for K-water staff and governmental officials as well as international trainings, technical cooperation, and exchange programs for water sector professionals and governmental officials from Afghanistan, Nepal, Sri Lanka, Viet Nam, and other developing countries. Since 1997, the K-water Academy has implemented training on water resources managed by Korea International Cooperation Agency(KOICA), Asia Development Bank(ADB), and World Bank(WB). The regular courses in 2008 consist of water resources management, dam planning and construction, integrated water resources management(IWRM) & hydro-informatics, dam & reservoir operation, groundwater management, flood forecasting systems, hydro-electric power engineering, drinking water management, waterworks system design, drinking water analysis, drinking water treatment, water treatment plant operation, pumps-flow meters-electricity, drinking water administration, and sewage & wastewater treatment management.

1) Regular Course Program

As the basic, job and leadership training, fundamental courses, advanced courses, and expert workshop courses open regularly for the following programs;

Water Resources

Water Resources Management
Dam Planning and Construction
IWRM & Hydroinformatics
Dam & Reservoir Operation
Groundwater Management
Flood Forecasting Systems
Hydro-Electric Power Engineering

Water Treatment & Supply

Drinking Water Management
Waterworks System Design
Drinking Water Analysis
Drinking Water Treatment
Water Treatment Plant Operation :
Pumps, flow meters, electricity
Drinking water administration
Sewage and Wastewater Treatment Management

2) Water Training Programs

Target/Field		Water Resources	Water Supply
Domestic	In-house	- Planning & Investigation - Design & Construction - O & M - Water quality management in the reservoir - Hydropower operation - River restoration - Environment-friendly D&M - Action Learning - K-water Expert (Business Management/Fare/River/Hydrologic prediction / Clean Energy, etc)	- Planning, Design & Construction - O & M : water treatment/ facilities / pipe management/water quality analysis - Action Learning - K-water Expert (Water Quality management in Pipeline, Efficiency improvement in facilities operation, membrane filtration process, Integrated water management technology, etc)
	Public officials	- Hydrologic investigation -Groundwater Investigation, development	- Planning, Design & Construction - O & M : water treatment

		and management	/facilities/pipe management/water quality analysis -Advanced / Conventional WTP management - Small WTP management - NRW improvement - NRW detection -Water Meter management
	Private sector		-WTP facilities management (pipe/valve/electricity) - Water Treatment System -Advanced water/ Sewerage water treatment
Overseas	Foreign Officials	- Water Resource Development & Management - IWRM - Water Resources Management responding to Climate Change - River Policy & Management	- WTP development & management -Waterworks improvement : treatment process/monitoring & controlling process/pipe network/facilities/business management

3) Expert Training Programs

• mixed type training

- lectures, action learning based discussion, quiz & test and visit & benchmark at overseas selected colleges, companies or institutes

• preparation of human resources to respond properly and lead the next change
• balance between knowledge and experience
• important sources of instructors for training program

4) International Training Program

• practical training
• demand-based training
• implementation facilitating training
  - Dissemination of Water Knowledge & Experience
  - Problem Solving Focused on Efficient Operation of Utilities

Figure 4: International Training Program

■ IHP-KNC WET Programs

The Korean National Committee for the IHP is contributing to the Korean Universities hydrology and water resources courses in the framework of the IHP in which graduate students and engineers are mostly involved with IHP projects and also educated or trained through the formal courses. Special workshops and seminars in the field of hydrology and water resources are annually organized by the KNC-IHP in collaboration with other organizations such as K-Water, Korea Water Resources Association (KWRA), Korean Society of Civil Engineers (KSCE), Society of Agricultural Engineers (SAE), Korean Meteorological Society (KMS), Korean National Committee on Large Dams (KNCOLD), Korean Geographic Committee (KGC)-International Water Resources Association (IWRA), International Hydrologic Environmental Society (IHES), Korea Federation of Water Science and Engineering Societies (KFWSES), Korea Institute of Construction Technology (KICT), Korean Universities Hydrology and Water Resources Programs, etc. In these specific courses, special topics are dealt with practical application in river basins. The KNC-IHP has actively been participating in IHP courses which were held in Asia-Pacific regions such as Japan, China and Malaysia by sending highly qualified hydrologists or proper candidates.

- Cyber WET System Studies entitled as “Establishment Strategy of Cyber Education System for Strengthening of Water-Resources Education and Training” and “Development of Publicity Program for Internet based Water Education”: These researches have investigated the domestic and foreign trends of education systems for water resources to establish a cyber WET system. The following researches to survey existing WET systems and users’ demands, design H/W, S/W, & application systems, and develop education contents & materials have been carried out.

■ **Korea Water Resources Association (KWRA) WET Programs**

A series of researches have been pursued for education and human resources development in the field of water resources technology. Systematical education technology based education & training programs and operating systems are proposed for water resources engineers who need abilities to provide new products and new services in the current society combining education, information technology, and knowledge. Researches establish education direction and contents required for performance of duties, such as training programs for basic & general information management, and professional

& supportive skills. They also present the web and ubiquitous based education & training programs that encourage the growth and innovation of human resources engaged in water resources field to keep up with rapid social changes and technology improvement.

7. Conclusions

In an age of rapid technology and social changes, the advanced and intensive education & training system is necessary for human resources who are and will be engaged in water resources field, particularly in hydrological extremes that needs various and complex knowledge and information. We all use water daily but the importance of water tends to pass unnoticed. Awareness of water issues is high only in times of floods and extreme shortage along with dramatic degradation in quality with little attention to long term preventive measures.

The WET becomes an essential part of curriculum and personal development for proper water use in times of water crisis in terms of both floods and droughts. In Korea, various types of WET have been being executed on the service, and some researches have been conducted for development of internet-based teaching materials and internet programs of WET.

Some organizations including the K-Water provide WET programs, which are not sufficient for regular WET programs organized by national government offices. For a public awareness as well as professional reeducation, we need to establish and develop systematical contents and systems of WET programs for the hydrological extreme's management by age, degree, occupation, and step for the efficient teaching and learning.

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Sardar Muhammad Tariq

Sardar Muhammad Tariq is the Regional Chair of the Global Water Partnership South Asia (GWP SAS) which is a fully independent constituent of the Global Water Partnership (GWP) family and network umbrella. GWP SAS currently represents Bangladesh, Bhutan, India, Pakistan, Nepal and Sri Lanka linked to the network through the respective **Country Water Partnerships (CWPs)** which are themselves independent and autonomous organizations brought together with common objective of promoting **Intergrated Water Resources Management (IWRM)** in the region. Induction of Afghanistan and Maldives in to the GWP SAS family is envisaged in the near future.

Training High Level Policy Stakeholders on Drought Management in Pakistan

Sardar Muhammad Tariq
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1. Background

Natural disasters such as earthquakes, tsunamis, floods, droughts and landslides can often come at the least expected time. Others, such as hurricanes and cyclones are increasing in severity and destruction. Typically, the poor are the worst hit for they have the least resources to cope and rebuild.

A disaster is either a natural or man-made hazard which has come to fruition, resulting in an event of substantial extent causing significant physical damage or destruction, loss of life, or drastic change to the natural environment. It is classified as either a natural disaster or a man-made disaster. A disaster can be defined as any tragic event with great loss stemming from events such as earthquakes, floods, droughts, catastrophic accidents, fires or explosions.

In contemporary academia, disasters are seen as the consequence of inappropriately managed risks. These risks are the product of hazards and vulnerability. Hazards that strike in areas with low vulnerability are not considered a disaster, as is the case in uninhabited regions.

Developing countries suffer the greatest costs when a disaster hits – more than 95 percent of all deaths caused by disasters occur in developing countries, and losses due to natural disasters are 20 times greater (as a percentage of GDP) in developing countries than in industrialized developed countries.

Researchers have been studying disasters for more than a century. The studies reflect a common opinion when they argue that all disasters can be seen as being human-made, their reasoning being that human actions before the strike of the hazard can prevent it developing into a disaster. This is primarily based on reactive approaches rather than proactive approaches. All disasters are hence the result of human failure to introduce appropriate disaster management measures. Hazards are routinely divided into natural or human-made, although complex disasters, where there is no single root cause, are more common in developing countries. A specific disaster may spawn a secondary disaster that increases the impact. A classic example is an earthquake that causes a tsunami, resulting in coastal flooding.

2. Global Disasters

The world has seen many disasters over the years. Following table gives an account of worst natural disasters happened during 1900 to date:

Sr.#	Year	Nature of Disaster	Area	Deaths
1.	1908	Earthquake of 7.2 magnitude and the tidal wave	Italy	123,000
2.	1911	flood in Yangtze River	China	100,000
3.	1918-19	Influenza pandemic	World-wide (16 million in India)	75,000,000
4.	1920	Drought	China	500,000
5.	1920	Earthquake of 8.6 magnitude	China, Gansu	200,000
6.	1923	Earthquake of 8.3 magnitude	Japan (Tokyo & Yokohama)	200,000
7.	1927	Earthquake of 7.9 magnitude	China (Nanshan City)	200,000
8.	1931	Flood in the Changjiang River	China	145,000
9.	1932	Earthquake	China (northwest Gansu Province)	70,000
10.	1933	Flood in Changjiang River	China	140,000
11.	1935	Flood in Yellow River	China (27 counties inundated)	3,400,000
12.	1935	Earthquake of 7.5	Pakistan (Quetta)	30,000

		magnitude		
13.	1939	Earthquake of 8.3 magnitude	Chile	28,000
14.	1939	Flood	China	200,000
15.	1939	Earthquake of 7.9 magnitude	Turkey (Erzican Province)	32,000
16.	1942-43	Drought in the Henan province	China	1,000,000
17.	1948	Earthquake of 7.3 magnitude	Turkmenistan (USSR)	110,000
18.	1950	Earthquake of 8.6 magnitude	India (Assam)	30,000
19.	1957	Asian Flu	World-wide	100,000
20.	1958-61	Famine out-burst	China	20,000,000
21.	1970	Earthquake of 7.9 magnitude and resultant landslides	Peru	66,000
22.	1970	Cyclone and related floods	Bangladesh (Bay of Bengal)	500,000
23.	1971	Flood in Red River	Vietnam	100,000
24.	1976	Earthquake of 8.3 magnitude	China (Tangshan)	255,000
25.	1981–84	Drought (Rivers and lakes dried up)	Africa (monthly deaths)	20,000
26.	1985	Volcano *Nevado Del Ruiz* mudflow	Colombia	25,000
27.	1988	Earthquake of 6.9 magnitude	Armenia	100,000
28.	1990	Earthquake of 7.7 magnitude	Iran	50,000
29.	1991	Flood	Bangladesh	139,000
30.	1995-98	Famine and floods	North Korea	3,000,000
31.	1996	Meningitis outbreak	West Africa	25,000
32.	2003	Earthquake in Bam	Iran	26,271
33.	2004-05	Earthquake of 9.0 magnitude & resulted tsunami	South Asia	285,000
34.	2005	Earthquake of 7.8 magnitude	Pakistan, Afghanistan & India	84,000

35.	2010	Earthquake of 8.6 magnitude	Haiti	220,000
36.	2010	Floods	Pakistan (displaced over 2 million)	2,000

A serious drought has been developing across eastern Africa since early last year, placing millions of people in danger of starvation. The failure of rains has put tremendous strain on the nutrition, health and general welfare of as many as 16 million people in a dozen countries, including millions of children. UNICEF estimates that some 16 million people face immediate risk due to the current drought.

In the country of Ethiopia alone, about 8 million people are in danger. Of those, about 1.4 million are children under age five. But Ethiopia is not alone. In Eritrea, Djibouti, Kenya, Sudan, Uganda, Somalia, Tanzania and other countries of the eastern Africa region, millions of people are threatened with starvation, illness and stunted development because of drought conditions. Some countries have large numbers of internally displaced people. Eritrea is an example. There, some 300,000 people have been forced away from their homes by a border dispute with neighbouring Ethiopia. The challenges of being displaced from their homes - away from employment, food sources, health care and education - are multiplied by the drought conditions. Pakistan has also faced similar situation when 7 million people from war-torn Afghanistan migrated to Pakistan, resulting Pakistan economy under further strains.

3. Disasters in South Asia

In the global context, the South Asia region has begun to lag behind all other regions of the world, both in its income and in human development levels. One assessment termed South Asia as fast emerging as the poorest, the most illiterate, the most malnourished, the least gender-sensitive and indeed the most deprived region in the world. The per capita GNP of South Asia is lower than that of any other region in the world. South Asia with 25% of the world population has only 9% of world water and uses over 90% of its water for irrigation. According to World Bank estimates, over 500 million people survive below the poverty line, where even the basic needs are not met. Its share in global income is only 1.3 percent and it has the largest share (40 percent) of the poorest people in the world. South Asia has also been left behind in the field of education. Its adult literacy rate of 48 percent lags behind the 55 percent rate achieved in Sub-Saharan Africa and 98 percent in East Asia. Nearly one-half of the world's illiterate population lives in South Asia. Despite its much higher GNP growth rate and its more robust increase in food production, it is South Asia rather than Sub-Saharan Africa which is the region with the greatest number of malnourished children. Almost two-thirds of the children in South Asia are under-weight compared to one-sixth in Sub-Saharan Africa.

Natural disasters mostly water related, in South Asia, kill some 500,000 people annually and affect some 7.2 million people. Being an agrarian society, agriculture suffers most in natural disasters. We therefore, need to revisit our hydraulic economy in its totality.

South Asian countries are adversely impacted by flash floods, disastrous earthquakes, tsunamis and prolonged droughts since time immemorial. These natural disasters have intensified with the fatal impacts of climate change. In recent years intensity and frequency of floods and droughts has increased because of - climate change. Fourth Assessment Report (2007) of the Intergovernmental Panel on Climate Change (IPCC) clearly predicted such manifestations in the weather systems due to rising Green House Gases with consequential increase in atmospheric and sea temperatures. This report further states that new evidence shows that climate change has affected many sectors in Asia. Crop yields in many Asian countries have declined, partly due to rising temperatures and extreme weather events. IFPRI, 2009 predicts wheat and rice yields in India and Pakistan to be reduced by 50% in next 30-40 years. Glacier retreat and accelerated permafrost reduction in Asia is unprecedented as a consequence of warming. The frequency of occurrence of climate-induced diseases and heat stress in Central, East, South and South-East Asia has risen due to higher temperatures and rainfall variability.

IPCC report pointed out that 50% of droughts are associated with El Niño. Consecutive droughts in 1999 and 2000 in Pakistan and N-W India led to sharp decline in water tables;

consecutive droughts between 2000 and 2002 caused crop failures, mass starvation and affected ~11 million people in Orissa alone.

Similarly floods in South Asia, particularly in India, Pakistan and Bangladesh result in millions of deaths including human and livestock both every 4 to 5 years and resulting in millions of dollars worth of damages to crops and infrastructures displacing millions of families including old, young, women and infants.

The floods of 2010 in Pakistan have alone killed about 2,000 people and millions of livestock and displaced around 20 million, destroyed 1.16 million houses, damaged standing crops over 2 million hectares, 25,000 km of roads were damaged, 10,404 educational institutions including schools, colleges, VTI's were destroyed, over 2,000 water supply and sanitation facilities were damaged. The physical damages alone were to the tune of Rs. 855 billion.

Along with profound grief and misery caused by the large scale death and destruction in the wake of the earthquake of 8th October, 2005 in Northern Areas and Azad Jammu & Kashmir, a number of tough challenges were also thrown on the nation for organizing rescue, relief, rehabilitation and reconstruction for the unfortunate affectees. The disastrous earthquake left about 80,000 dead and millions injured, shelter-less under the open sky in the killing winters with the rapidly increasing intensity of coldness. After a brief and intense rescue phase, the relief phase started with provision of shelter and food to the hundreds of thousands of people rendered homeless and shocked by the tragedy.

The major landslide at Attabad blocked river Skardu inaction resulted in creation of a lake of large volume cutting off internal communication and transboundary trade with hundreds of people getting displaced. Valuable infrastructure including village houses remain submerged even to date.

To analyze all these calamities in Pakistan, one would realize that disaster management policies have been based entirely on post-event reactive approaches resulting in severe damages of complex web.

4. Formation Mechanism

Drought in winter occurs when rainfall generally fails, when the tracks of Western Disturbance which move on to lands of Pakistan from the west, remain at a latitude of 35° N or higher. Under such a situation, no secondary western disturbances form below 30°N and consequently Sindh province and parts of Baluchistan can completely go dry. This situation has been found to occur quite often. The situation get aggravated if the subsequent months of April and May also go completely dry and temperatures become very high which is a normal feature of these months. Evapo-transpiration tremendously increases and results in perpetual drought. During the summer months June to September, if a monsoon low or monsoon depression which forms over Arabian Sea or over Bay of Bengal fails to reach the country, the monsoon rains are very scanty and that too in the northern parts of the country which include northern divisions of Punjab, parts of Khyber Pukhtunkhwa (KPK) & Northern Areas.

5. Recent Droughts in Pakistan

Pakistan is one of the most arid countries in the world. 70% of the area having rainfall less than 250 mm and 20% having rainfall even less than 125 mm. Pakistan has many hyper-arid areas as well. The water availability per capita is close to 1,000 cubic meters per person per year which puts Pakistan in the category of water scarce country. Per capita storage in Pakistan is 132 cubic meters as against Americas 6,500 cubic meters. Pakistan's carry over storage capacity is only for 30 days as against Egypt's 1,000 days. These figures indicate that Pakistan is in the category of countries who have managed their water resources in the most dismal way. Droughts in Pakistan have been frequent and going to intensify under climate change scenario. Pakistan's irrigated agriculture depends on a single basin and there are no options available where appreciable amount of additional water can be injected into the system. With these water statistics, Pakistan is placed in the category of most vulnerable to droughts.

Following are some of the worst droughts in Pakistan in recent history:

- The major drought in whole of Pakistan was from 1996 till 2002, peaking from 1998 till 2001. While in 2002 drought conditions started to dissipate. The drought period from 1998 to 2001 was considered worst in 50 years. This drought adversely affected agriculture, livestock, forestry and fisheries resulting in cumulative impact of decline in GDP of 25%, loss in export earnings to the tune of 75% and increase in unemployment by 45%.
- In 2004, no rain occurred in Sindh province but during the month of October heavy downpour lashed different parts of Sindh due to Cyclone Onil.
- In 2005, the drought conditions continued in the Sindh Province, but a post-monsoon low pressure dumped heavy rains on 12 and 13 September.
- In 2009, drought conditions emerged during the summer season in suburban areas of Karachi, Provincial Capital of Sindh due to El Nino phenomenon caused drought during the winter season but the monsoon rains of 2009 were above-normal.
- In early 2010, drought condition griped Punjab and Khyber Pakhtunkhwa Provinces due to El Nino phenomenon. The winter rains all over the country were 30% below normal according to the PMD. But drought-conditions dissipated during the Monsoon season.

6. Risk Management versus Crisis Management

The traditional approach to drought management has been reactive, relying largely on crisis management. This approach has been ineffective because response is untimely, poorly coordinated, and poorly targeted to drought stricken groups or areas. In addition, drought response is post-impact and relief tends to reinforce existing resource management methods. It is precisely these existing resource management practices that have often increased societal vulnerability to drought. The provision of drought relief only serves to reinforce the status quo in terms of resource management. Many governments and others now understand the fallacy of crisis management and are striving to learn how to employ proper risk management techniques to reduce societal vulnerability to drought and, therefore, lessen the impacts associated with future drought events.

As vulnerability to drought has increased globally, greater attention has been directed to reducing risks associated with its occurrence through the introduction of planning to improve operational capabilities (*i.e.*, climate and water supply monitoring, building institutional capacity) and mitigation measures that are aimed at reducing drought impacts. In the past, when a natural hazard event and resultant disaster has occurred, governments have followed with impact assessment, response, recovery, and reconstruction activities to return the region or locality to a pre-disaster state. Little attention has been given to preparedness, mitigation, and prediction/early warning actions (*i.e.*, risk management) that could reduce future impacts and lessen the need for government intervention in the future.

Presently reactive administrative backed disaster management and response mechanism exists in Pakistan to deal with extreme conditions where relief is paramount, integrated approaches to reduce or preempt adverse impact of drought are restricted to mostly sector based institutions and some institutional extension activities. As drought onset is gradual and generally considered to be transient, focus has been on policy response and institutional systems geared towards relief operations. Mechanism for drought monitoring, prediction, preparation and mitigation would require strengthening. While vertical organizational integration somewhat exists, horizontal enlargement of collective measures involving communities for adaptation and coping are minimal with drought management.

Most of the well-known approaches to drought management, both structural and non structural have been tried in the country but with limited success. All such approaches have, however, been characterized by total dependence on government machinery including drought preparedness, drought integration and post-drought measures. No doubt government intervention is unavoidable but it has its own limitations because of usual inaccessibility, delay in response etc. Moreover government does not have an adequate machinery to reach every affected household during drought, especially in interior villages and habitations. NGOs too may not have a presence in many areas. Hence a need to introduce community involvement in drought management is the prudent way forward.

7. History of Drought Management and Policies

South Asia has witnessed some of the greatest famines, like the Bengal famine of the pre-Independence era. Since then, the continuing economic and social impacts of droughts have led all the affected governments to put in place effective policies. The present policies on drought management in the region have evolved over a period of time. The relief policy, broadly speaking, consisted of ad hoc measures during the initial period of drought management. A famine code was provided for taking measures when a danger of large-scale human mortality was apprehended and aimed at preventing deaths on account of calamities. Later, famine-relief codes were replaced with scarcity relief measures with emphasis on reducing human distress and misery. The public distribution system was evolved in response to the droughts of the mid-1960s for building up a reliable food supply system.

Drought management policy seeks to provide social and economic goals and the egalitarian objective of the State. The objective was not only to prevent starvation death but also to halt physical deterioration and destitution of people and livestock. The existing drought management package consists of several programmes, which aim at mitigating the severity of drought. However, notwithstanding their welfare goals, these programmes in general suffer from poor

infrastructure, technical content and low credit flow in the chronically drought prone areas In South Asia, the practices of drought management in terms of policies, laws, use of technological inputs, etc. follow certain patterns but no universal model. In countries with a historical tradition of a highly centralized government, the drought management institutions and systems that have evolved typically are also highly centralized and dependent upon national government institutions and capabilities. In countries where there is a stronger tradition of local power, authority, and autonomy, drought management systems tend to be more locally driven, relying on support from higher levels of government.

8. Components of Drought Management Plans

Drought plans commonly have three major components:

- Monitoring and early warning
- Risk and impact assessment
- Mitigation and response

8.1 Monitoring and early warning

The overall goal of drought monitoring is to provide information that enables and persuades people and organizations to take action to maximize the probability of successful crop production and/or minimize the potential damage to established crops and other assets. In this regard, a reliable assessment of water availability and its outlook for near and long term is valuable information.

In drought monitoring, data and information on each of the relevant indicators (e.g. precipitation, temperature, evapo-transpiration, seasonal weather forecasts, soil moisture, stream-flow, ground water, reservoir and lake levels, and snowpack) should be considered in the evaluation of water situation and outlook for the country. There should be a monitoring committee comprising of representatives from agencies with responsibility for monitoring climate and water supply, traditionally meteorological, hydrological and agricultural services.

8.2 Risk and Impact Assessment

Drought produces a complex web of impacts that not only ripple through many sectors of the economy but may be experienced well outside the affected region. To more clearly understand the impacts of drought, the phenomenon should not be viewed as merely a natural event. It is the result of interplay between a natural event and the demand placed on water and other natural resources by human-use systems. For example, societies can exacerbate the impacts of drought by placing demands on water and other natural resources that exceed the supply of those resources.

Information on drought's impacts and their causes is crucial for reducing risk before drought occurs and for appropriate responses during drought. As part of the drought planning process, it is recommended that a Risk Assessment Committee be established that represents those most at risk from drought. The task of this committee is to determine who and what is most at risk and why. This task is best accomplished through a series of working groups under the aegis of the Risk Assessment Committee. The responsibility of the committee and working groups is to assess sectors, population groups, and ecosystems most at risk and identify appropriate and reasonable mitigation measures to address these risks. Working groups would be composed of technical specialists representing those areas referred to above. Involvement of affected communities would be essential at all stages of planning and assessment.

8.3 Mitigation and Response

Mitigation is defined as short and long-term actions, programs, or policies implemented during and in advance of drought that reduce the degree of risk to human life, property, and productive capacity. The types and forms of mitigation activities vary from one natural hazard to another. Drought-related mitigation actions are, for the most part, different from those used for other natural hazards because of the insidious nature of the hazard and the non-structural characteristics of many of the impacts. In contrast to mitigation, response actions are those taken once an area is experiencing severe drought and are intended to address impacts and expedite recovery of the affected area. One of the tasks of the Risk Assessment Committee is to identify mitigation actions that could be taken to lessen the risk associated with future drought events for each of the principal impact sectors. The goal is to emphasize mitigation over emergency response actions because the latter does little to reduce risk and may actually increase vulnerability to drought through increased dependence on government or donor intervention.

The recommended actions are: (1) monitoring and assessment; (2) legislation and public policy; (3) water supply augmentation; (4) public education programs; (5) technical assistance; (6) demand reduction; (7) emergency response; (8) water use conflict resolution; and (9) drought planning.

9. A Way Forward

A key point of dealing with droughts is drought preparedness. However the hydrological cycle leads to shortsighted decision making. People tend to assume that plentiful water supplies are the norm, when occasional droughts are inevitable. The methodology for drought preparedness planning has been developed in the United States. This methodology, a 10-step drought planning process, has been used by many states in the United States and also by several foreign governments. The purpose of the planning process is to derive a plan that is dynamic, reflecting the changing government policies, technologies, and natural resource management practices. The 10-steps in this process are:

- *Appoint* a drought task force
- *State* the purpose and objectives of the preparedness plan
- *Seek* stakeholder participation and resolve conflicts

- *Inventory* resources and *identify* groups at risk
- *Develop* organizational structure and *prepare* the drought plan
- *Identify* research needs and fill institutional gaps
- *Integrate* science and policy
- *Publicize* the drought plan, *build* public awareness
- *Teach* people about drought
- *Evaluate and revise* drought preparedness plan

The above process is intended to serve as a checklist to identify issues that should be addressed in plan development, with appropriate modifications.

10. Conclusions

Drought preparedness and management are effective strategies to reduce risks and therefore the impacts associated with droughts. Preparedness for drought necessitates greater institutional capacity at all levels of government and more efficient coordination between different levels of government. Preparedness also implies increasing the coping capacity of individuals and communities to deal with drought events.

Most commonly, there are three components in a drought plan: monitoring and early warning; risk assessment; and mitigation and response. Given the improved tools and technologies available today, it is possible to provide drought information that enables action to maximize the probability of successful crop production and/or minimize the potential damage to established crops and other assets. To this end, information should be provided on the timing, intensity and duration and the spatial extent of droughts. An equally important element of drought early warning systems is the timely and effective delivery of this information to decision makers. To provide effective drought information, there should be improved collaboration among scientists and managers to enhance the effectiveness of observation networks, drought monitoring, prediction, information delivery, and applied research. Such collaboration could help foster public understanding and preparedness for drought.

Dr. Izhar-ul-Haq

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Educating Policy Makers and Stakeholders on Flood and Drought Management

Dr. Izhar ul Haq
GM/CEO, Diamer Basha Dam, WAPDA

1. Introduction

Hydrological extremes i.e floods and droughts are of great concern for the global and specific regions. It is important to build capacities at all levels to predict and manage potential impact of these floods and droughts.

Pakistan has been experiencing floods mainly because of its topography, Rivers Indus, Kabul and Swat are three hazard prone rivers. In the past Pakistan experienced severe floods in 1973, 1992, 2006 and 2010. But 2010 floods broke all past records.

The major drought in Pakistan was from 1996 till 2002 which was considered worst in last 50 years. The drought conditions also prevailed during the years 2004, 2005 and 2009 due to scarcity of rainfall in the country especially in Baluchistan and Sindh Provinces.

It is an irony that the nation, which was complaining about years-long shortage of water, till the month of June 2010, fell prey to unprecedented floods that damaged towns, villages and vast agricultural lands. This rotation of two extremes has plagued the nation with heavy economic losses and human sufferings.

2. General

The **2010 Pakistan Floods** began in late July 2010 following heavy monsoon rains in the Khyber Pakhtunkhwa, Sindh, Punjab and Balochistan regions of Pakistan and affected the Indus River Basin. Approximately on-fifth of Pakistan's total land area was underwater. According to Pakistani Government data the floods directly affected about 20 million people, mostly by destruction of property, livelihood and infrastructure, with a death tol of close to 2,000.

The Pakistani economy has suffered by extensive damage to infrastructure and crops Structural damages have been estimated to exceed 4 billion USD, and wheat crop damages are estimated to be over 500 million USD. Officials have estimated the tota economic impact to be as much as 43 billion USD.

The agricultural damages are more than 2.9 billion dollars, according to an estimate, ove 700,000 acres of cotton crops, 200,000 acres of sugar cane and 200,000 acres of ric crops lost.

The power infrastructure of Pakistan also took a severe blow from the floods, whic damaged 10,000 KM transmission lines and transformers, feeders and power houses i different flood-hit areas. Flood water inundated Jinnah Hydro Power Project and 15 small power plants in Gilgit. The damage caused a power shortfall of 3.135 gigawatt.

India received comparatively less rains, managed much of the water with the help of it newly constructed dams and reservoirs and caused minor flood in Satluj River, along wit borders of Kasur district of Pakistan. The disastrous natural calamity could have bee further destructive; had India released the surplus water in case of heavy rains there.

In early August, the heaviest flooding moved southward along the Indus River fro severely affected northern regions toward western Punjab, where at least 1,400,000 acre of cropland were destroyed, and then towards Sind and Baluchistan. By mid-Septembe the floods had begun to recede.

3. Present Water Availability

Pakistan is a water scare country. According to Falkenmark, Global Water Scarci Indicators, if a country has less than 1700 m^3 / capacita water availability, it face seasonal or regular water-stressed conditions. Pakistan per capita water availability i

1038 m^3 which would reduced to 800 m^3 / capita in the year 2025. (Fig-1). In Pakistan available storage per capita is about 150 m^3 which is very low as compared to other semi-arid countries (Fig-2). Also the water storage capacity of Pakistan is very small and can store only 30 days of average flows (Fig-3).

I. GLOBAL WATER SCARCITY INDICATORS

(BY FALKENMARK)

> 1700 m^3 / Capita	Water Scarcity Rare
< 1700 m^3 / Capita	Country Faces Seasonal or Regular Water-Stressed Conditions
<1000 m^3 / Capita	Water Shortages Hamper the Health and Well Being of the Human Beings
<500 m^3 / Capita	Shortages are Severe Constraints to Human Life

II. PAKISTAN'S PROJECTED SCENARIO

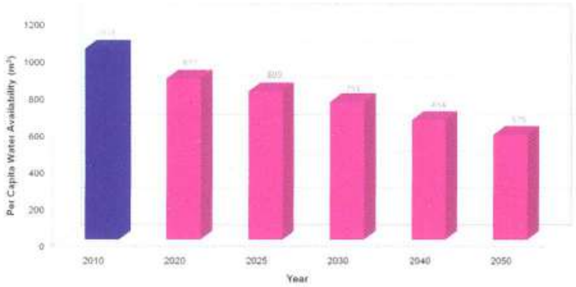


Figure 1: Global Water Scarcity Indicators and Pakistan's Projected Scenario

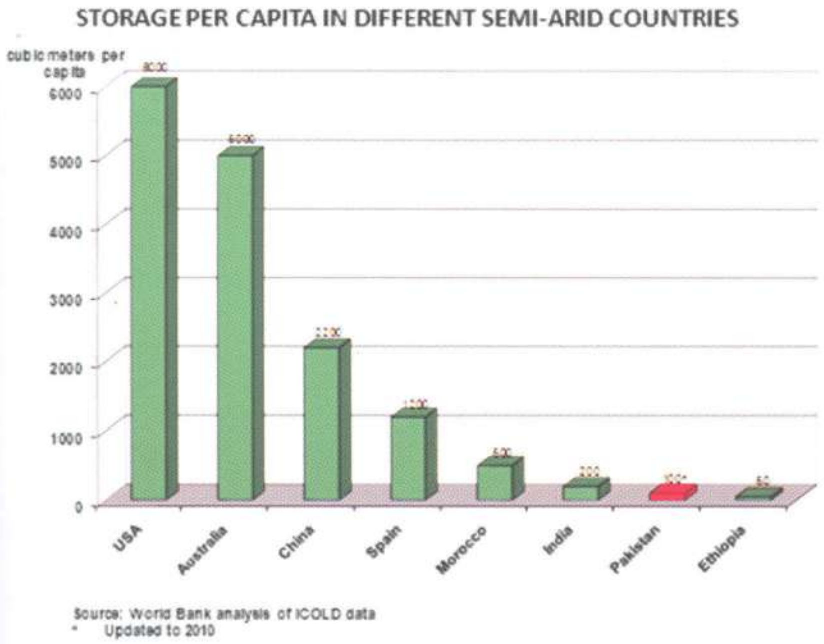


Figure 2: Storage Per Capita in Different Semi-Arid Countries

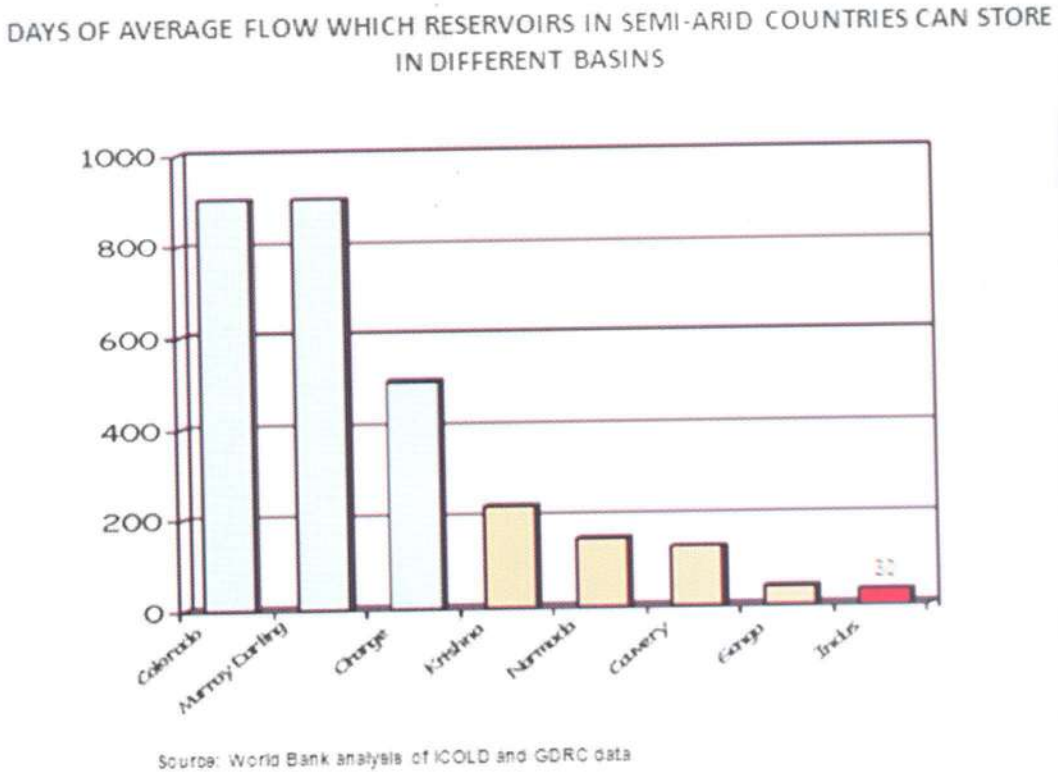


Figure 3: Days of Average Flow which Reservoirs in Semi-Arid Countries can store in Different Basins

3.1 Depletion of Existing Storages Capacity

Reservoir Sedimentation is one of the major problem, as the available capacity of existing reservoirs continues to diminish with accumulation of sediment in the storage space. Tarbela stores about 1/6 of the flows of river Indus while most the sediment is retained due to 90% trap efficiency. The storage lost is about 0.11 MAF per year. Tarbela has lost 30% of its gross storage. Similarly the per year storage loss in Mangla Dam is 0.019% MAF.

4. Need for New Storage Dams

The existing storage capacity is reducing while more water is required to meet with the growing demands due to increase in population.

During flood 2010 about 72.87 MAF of water passed through Guddu Barrage, 55 MAF of water passed through Kotri Barrage and went to sea. About 17.87 MAF flood water did not reach the sea, submerging areas in Sindh and Balochistan for next several months.

In an agricultural country like Pakistan, storage dams are life line to the nation. These reservoirs store water and regulate releases for irrigation supplies after saving precious river water from going into Sea and play an important role in mitigating floods. Low cost hydro electric power is secondary benefit of such multi purpose projects. While Pakistan has hydroelectric potential more than 50,000 MW, but we are not equally fortunate to have many storage sites.

No Mega storage dam was constructed after Tarbela and Mangla. The need for new water storage reservoirs must be realized to fulfill the water requirement and mitigate the floods.

The consequences we are facing for not building large Dams:

- Progressive loss of existing storage capacity with resultant shortfall in committed irrigation supplies.
- Sustaining colossal losses due to uncontrolled super flood.
- Recurring inter-provincial disputes on water sharing, particularly during early Kharif.
- Serious undermining of national food security.
- Stinted growth of domestic industrial and agricultural sectors.
- Enhanced dependence on thermal power generation through imported fuel causing prohibitive rise in the power tariff.

5. Proposed Flood Mitigation Plan

Following plans are suggested / being implemented for mitigation of future floods:

1. By constructing Mega Reservoirs:

   (i) Mangla Dam Raising Project

Additional flood storage capacity of 2.9 MAF.

(ii) Constructing Munda Dam on the Swat River will be helpful in mitigating the flood in Swat River by absorbiong 1.29 MAF.

(iii) Constructing Kurram Tangi Dam to mitigate the flood to the volume of 1.20 MAF.

(iv) Diamer Basha Dam, which can absorb a huge volume of 6.4 MAF will save downstream area upto Tarbela from any type of flood in Indus.

(v) 32 Medium Dams will be constructed in four provinces of Pakistan in two phases. In Phase-I, 12 dams & in Phase-II, 20 dams will be constructed from 2010 to 2013 & 2011 to 2016 respectively. These 32 dams will control and absorb the flows coming from the rivers/streams in their respective areas.

(vi) Construction of Off-channel Akhori Storage Project.

2. Feasibility of re-routing floods in desert areas.
3. By constructing breaches and by pass channels upstream of barrages allowing the flow to return back to the rivers.
4. Feasibility for strengthening and maintaining Flood Protection Bunds with at least 100 years return period.
5. Feasibility of development of weir / gates and channel at left bank of Sukkur Bartrage to divert floods under railway and roads, bridges to desert through channels.
6. Conversion of MNVD (Main Nara Valley Drain) into flood carrying drain.
7. Feasibility for rehabilitation of Hamal and Manchar Lakes to absorb moire flood volume.
8. Creation and development of lakes and wet lands where ever possible to control the flood.
9. Management of Hill Torrents by constructing check and delay action dams.

10. Updating the existing flood plain maps and preparation of flood maps in other affected areas like Kabul and Swat Rivers. No construction below maximum flood level in Malakand, D.G. Khan, Hazara.

6. Drought Management

Drought preparedness and management includes the strategies to reduce risks and impact associated with droughts. It needs greater institutional capacity and coordination at all levels. Main three components in a drought plan are monitoring, early warning, risk assessment and mitigation.

Drought mitigation includes short and long term actions, programs and policies implemented during and in advance of drought to reduce the degree of risk to human life and property.

7. Drought Impact and Mitigation

The drought impact causes long rooted crop failure and ground water depletion. In order to mitigate these causes there is great need to increase water storages through small and large dams and also manage the available water resources through conservation and optimal utilization.

The droughts can be managed by taking following actions:

- Proper form layout.
- Laser land leveling.
- Irrigation scheduling
- Sprinkler and Drip Irrigation.
- Adoption of Low delta Crops.
- Ground water monitoring and regulation.
- Conjunctive use of ground water.
- Treatment of Saline ground water.

- Rain water Harvesting.
- Construction of Small, medium, large and carry over dams.

8. Conclusions

The 2010 flood had attributed to heavy rainfall, climate changes, monsoon pattern and damming. There is great need for better management of Indus River System, emergency warning and evacuation systems and flood management.

To mitigate the drought, there is need of improvement in Ground Water Management, Rainwater harvesting and construction of new small, medium and large dams.

Following are the suggestions for educating policy makers and stakeholders:-

- Development by Federal Flood Commission (FFC) of an integrated flood management policy through special study by World Bank / ADB.
- Creation of effective liaison between FFC and the concerned Provincial and Federal Institutions / Departments.
- Establishment of an exclusive cell within FFC to develop and implement National Flood Management Education Program.

Engineer Riaz Ahmad Khan

Engineer Riaz Ahmad Khan, Advisor Ministry of Water & Power (Government of Pakistan), is a professional Engineer with over 44 years of practical experience in the Planning, Design, Construction, Management and Operation of various national projects in the fields of Hydro Power, Irrigation, Drainage and Flood Control on Indus Basin System. He has contributed at domestic and international fora in the field of engineering covering wide-ranging issues in Water & Power Sectors and the profession in general. He has participated and represented Pakistan in various Conferences and Seminars both in the country and abroad. Engineer Riaz has actively engaged on policy issues in the Water and Power Sectors, and contributed in the development of Power Policy 2002, National Water Policy and Water Resources Sector Strategy. He has over sight on large Water Sector infrastructure development, sustainability and environmental issues. Capacity building of water related Institutions. He has held key positions in various Government Departments at Policy and Senior management Level as head of Department both at Provincial and Federal level as Provincial Secretary, Member Planning & Development Board, Punjab and Special Secretary Water & Power.

Education for Managing Hydrological Extremes and Related Geo-Hazards – Floods and Drought Management in Pakistan

Riaz Ahmad Khan
Advisor, Ministry of Water and Power

1. Introduction

Hydrological extremes e.g. floods and droughts and related geo-hazards are of growing concern for global, regional and national stakeholders. The climate change has altered the temporal and spatial patterns of precipitation and triggered extreme events of droughts and floods in Pakistan. The country faced the worst ever droughts during the years 1999 to 2002, while catastrophic floods were experienced in 2010, which crossed all previous historic floods records in the Khyber Pakhtunkhawa province. Freshwater resources are vulnerable and have the potential to be strongly impacted by climate change, with wide-ranging consequences for human societies and ecosystems. Thus, Pakistan is faced with complex water resource issues owing to climate change which need to be addressed in a holistic manner following an integrated approach.

The Indus river basin is one of the six major key basins in Asia and Pacific which include Brahmaputra, Ganges, Yellow river, Yangtze and Mekong. The Indus, like all the great Asiatic rivers, has its farthest source, behind the Himalayan escarpment of the Tibetan tabeland itself. The Indus mostly flows through the greater Himalayas ranging within the heights 2400 m to 4500 m and some peaks are above this limit whereas the catchments of Jhelum river downward from Muzaffarabad which contribute significantly to Mangla dam lie within the lesser Himalayas having a range from 1200-2400 meter. The Indus has its catchments mostly within Pakistan whereas the catchments of its tributaries viz. Jhelum & Chenab (Ravi, Sutlej & Beas) lie across the border in India or Indian held Kashmir (Figure 1).

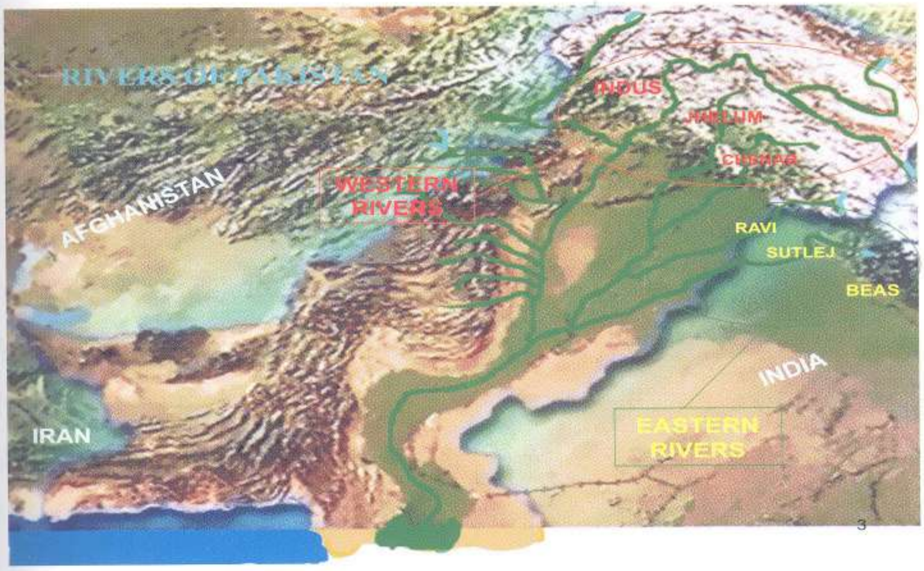


Figure 1: Rivers of Pakistan

Rains in Pakistan mostly fall during summer (July to September) and during winter (December to March). The Indus river flow is predominantly dependant on snow melt of Hamalayan glaciers whereas its tributaries have a mix of rain fall run off and snow melt. It is thus likely to experience signification changes in the follow pattern as a result of global warming and climate change. Weastren Rivers have been allocated to Pakistan while the eastern rivers have been allocated to India except some specified uses. Indus basin replacement works were constructed during sixties and early seventies to provide for storage and transfer capability through a system of link canals (Figure 2).

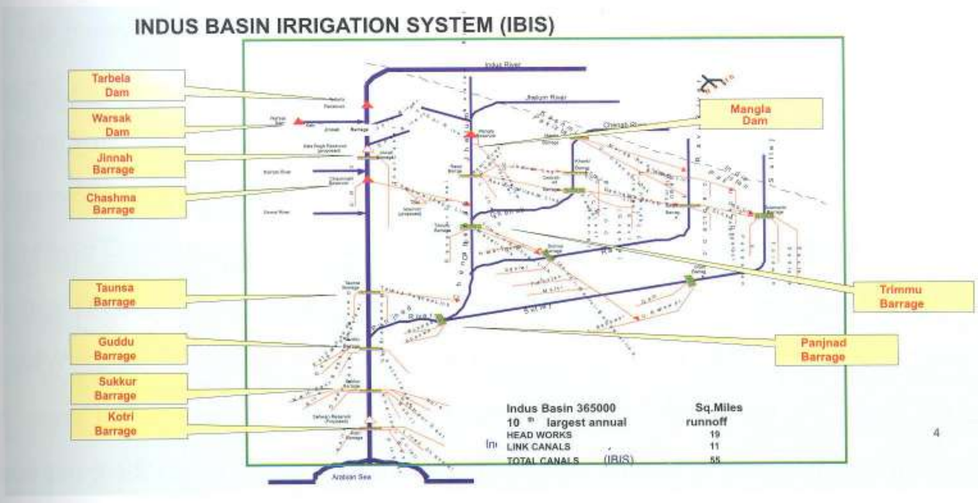


Figure 2: Indus Basin Irrigation System (IBIS)

Pakistan being an arid and developing country, heavily dependant on agriculture, is particularly vulnerable to the looming impacts of the climate change, but does not have adequate monitoring systems for predicting the likelihood of occurrence of extreme events. The climate change would affect agriculture in the form of extreme and more frequent droughts in arid parts of the country, extreme and more frequent floods, and occurrence of cyclones and storm surges in the coastal zones. Pakistan is already witnessing the early signals in terms of higher glacial melt, prolonged droughts (recent example of 1999-2000 drought affecting 3.3 million people and 30 million livestock, droughts of 2002-2004 in Balochistan, South-eastern Punjab, Sindh and Coastal Areas, and Winter 2005-2006 in parts of Balochistan and Sindh), hotter winters and earlier summers which are negatively affecting Pakistan's water resources and overall agricultural productivity. The carbon sinks are degrading fast as the country has low forest cover (4.5%) with a high rate of deforestation of about 0.2 – 0.4% per annum. In the long-term, climate change is feared to threaten the biodiversity (loss of species and their habitats), water availability, food security, human health and overall well being. Overall, the impacts of climate change for water resources are expected to be significant. Business as usual seems no more an option, and if the challenges are not realistically identified and addressed, major water catastrophes are looming.

1.1 Detecting and Coping with Effects of Climate Change

While Pakistan's Space and Upper Atmospheric Commission (SUPARCO) and GCISC are working on climate change, its climate change program only addressed the issues concerned to the parameters and processes responsible for inflicting climate change, and needs elaboration and further simulations to help predict weather and climate changes and their implications for water resources of the Indus basin. The Pakistan Meteorological Department (PAKMET) collects daily data, and makes weather forecasts. There is a need for additional investment in basic meteorological and related data systems and in the science and technology which will ensure that best use is made of the data. What these information imply for the hydrology of river basins, canals, and command areas, in the short, medium and long-term, is not done on a continuous basis. Thus, there is a need for improved coupled climate models for generating seasonal to inter annual climate predictions at as much as disaggregated scale as possible. This should ideally be available for each distributary canal command.

1.2 Comprehensive Expert System for Monitoring and Analysis of Droughts

The rainfall variability as result of climate change and the resultant droughts in some parts of the country, have highlighted the impact of reduced rainfall on the sustainability and security of Pakistan's water resources. The situation is particularly difficult in the southern Punjab, Sindh and Balochistan and coastal zones where the water use is high. Whether the drought is considered to be part of the recognized cycle of climate variation or the direct result of climate change, the implications for the Indus Basin are significant and the long-term predictions of climate experts paint a pessimistic picture. Studies indicate that the rise in temperatures would lead to increased water demand, as well as higher rainfall leading to increased flooding. Drought scenarios indicate a significant shortage of water and resultant hydropower. The climate change might make the crops more vulnerable to heat stress, possible shift in spatial boundaries of crops, changes in productivity potential, changes in water availability and use, and resultant changes in land use systems. Even a fractional increase in temperatures might lead to considerable increase in crop growing degree-days, which might require additional water for irrigation.

1.3 A Real-time Basin wide Water Resources Information System

Establishing and operationalizing an Indus Basin Water Resource Information System (IWRIS) comprising a database and related systems that will provide real time access to water resources data and, ultimately, aggregated water accounts across the entire basin (dis-aggregated by canal commands and distributary canals). A key feature of the IWRIS should be that it may develop a process whereby in the future data can be collected and collated from provinces and canal agencies and other sources using web based and mobile phone technologies. It will go some way to filling the huge gap in water resources data and tools that can deliver reports to policy makers and irrigators as well as to the farming community.

1.4 Flood 2010 Events

Widespread heavy rains in July and August 2010 resulted in high runoff in the Kab[ul] Swat, Jhelum, Chenab and Indus Rivers. In KP, based on 18 stations data, the 24-ho[ur] rainfall on 29 July varied from 21 to 280 mm with an average of all the stations equal [to] 128 mm. On 29 July, a 24-hr rainfall of 143 mm was recorded in Mirpurkhas, Sindh a[nd] 73 mm in Zhob, Balochistan and 274 mm in Peshawar. The following day a 24-[hr] rainfall of 240 mm was recorded in Kamra, Punjab and 189 mm in Ghari Dopatta, Az[ad] Jammu and Kashmir (AJK). Flash floods from the Kurram River and hill torrents fro[m] the Sulaiman Range aggravated the flood peak in the Indus River in the lower reaches.

High intensity and short duration rainfall due to interaction of westerly and easter[ly] weather system (Figure 3) generated unprecedented flood peaks at the Amandara a[nd] Munda Heakworks on the Swat River.

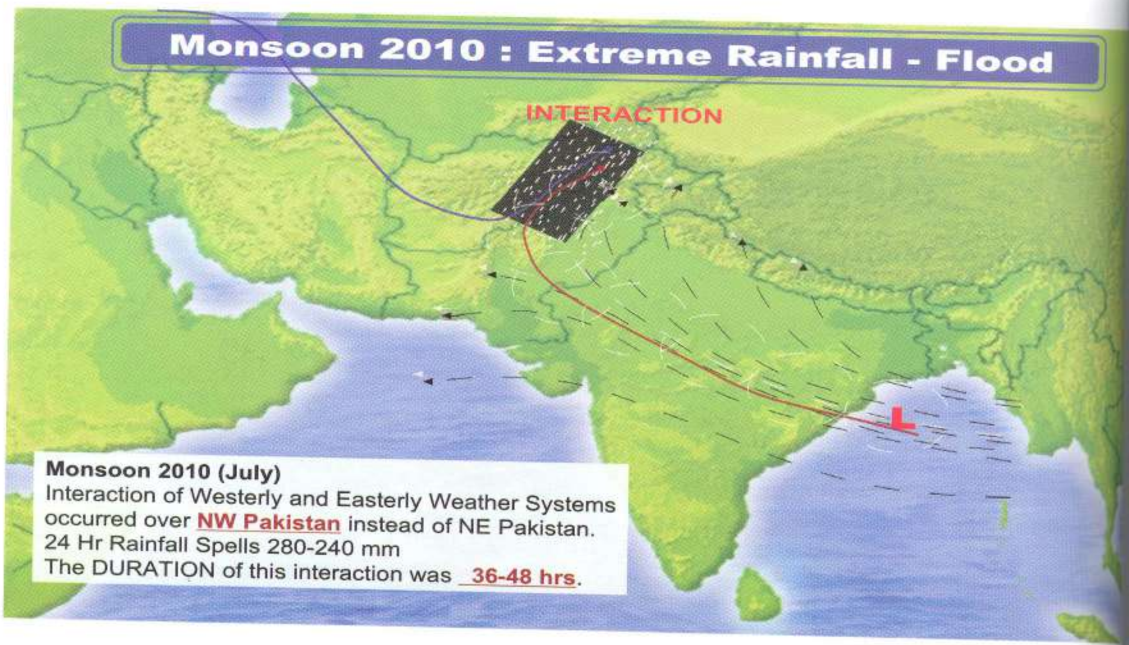


Figure 3: Interaction of Westerly and Easterly Weather System

This has severely damaged the Amandara Headworks and washed away the Mund[a] Headworks. The combined flow of the Swat and Kabul Rivers generated a historic hig[h] flood peak of about 480,000 cusecs at Nowshera town causing severe damages. On th[e]

Indus River, extreme flood flows were recorded. The inflow into the Tarbela reservoir was equivalent to a flood event with a return period of more than 3,000 years. Extreme flood flows with return period of more than 100 years were also recorded at the Chashma. Taunsa and Kotri Barrages. The 2010 flood peak at the Chashma\Barrage was the highest since its construction in 1971. The flood peak at Kotri was 10 percent higher than its design capacity but slightly lower than the historical flood peak in 1956. The flood peaks at Kalabagh and the Guddu and Sukkur Barrages were somewhat lower than historically recorded peaks as well as below the original design capacities.

On the Indus River, the Tarbela reservoir reduced the peak discharge from 835,000 cusecs at inflow to 604,000 cusecs at outflow. Similarly Mangla reservoir on the Jehlum River also reduced peak flow of 344,400 cusecs at inflow to 225,496 cusecs. These two reservoirs reduced the flood peaks (27 percent in the case of Tarbela and 26 percent in the case of Mangla) that played a critical role in lowering the flood peaks at Jinnah and Punjnad Barrages downstream which otherwise would have caused havoc on these barrages and lower reaches of the rivers. There was also a considerable contribution by hill torrents (Figure 4).

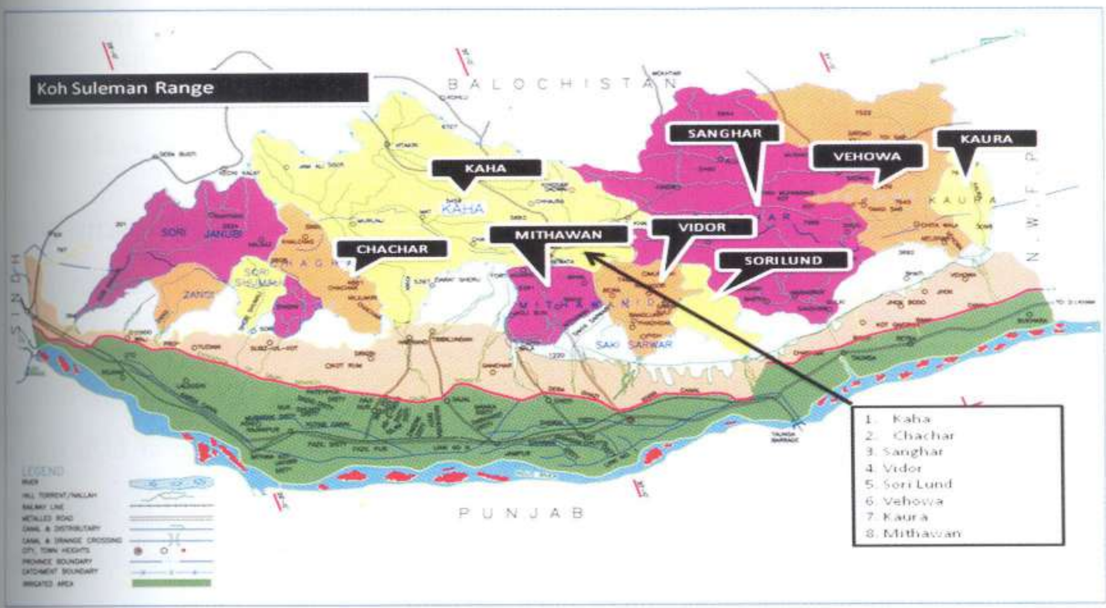


Figure 4: Contribution by Hill Torrents

The Indus River experienced two distinct back-to-back flood peaks in the reach between Kalabagh and Taunsa with a time lag of about 5 to 6 days. The two peaks merged Kotri Barrage. Exceptionally High flood flows over more than 6 consecutive days were recorded at the Guddu, Sukkur and Kotri Barrages.

1.5 Policy Considerations and Recommendations

The following key sector issues have emerged; (i) deferred maintenance of flood embankments and structural failure of embankment reaches, (ii) insufficient reservoir/storage capacity to absorb floods peaks, (iii) lack of an early flood warning system (FEWS) for the Swat and Kabul Rivers, and (iv) encroachment of the flood plains and riverine areas. The breaches in flood protection embankments along the Indus River caused the main damage. None of the breaches occurred due to overtopping of the embankments. Most of the barrages and river training works on the Indus River and its tributaries are 50 to 100 years old while most of the flood embankments are 30 to 5 years old. The aging of the infrastructure coupled with deferred maintenance call for immediate attention to this critical infrastructure. The impact of climate change, expected to cause more frequent extreme flood events in the future, needs to be taken into account while reviewing structural designs and maintenance requirements and procedures. In addition to the review process, a comprehensive inspection protocol for critically important major river training works and embankments could be introduced similar to the inspection protocol for dams.

The 2010 flood peaks were significantly higher than the discharge capacity of the Chashma and Kotri Barrages on the Indus River. In the case of the Sukkur Barrage, its capacity was significantly reduced at the time the flood reached the barrage due to the choking of several gates. Fortunately, the flood peak, which was higher than the reduced capacity passed through safely. Both Kotri and Sukkur Barrages were at high risk of washing away due to sustained water of more than their capacity for 7 and 15 consecutive days respectively. Although the 2010 flood event demonstrated that, in the case of some barrages, floods higher than their design capacity safely passed through, construction of spillways to improve the safety of these critical structures may need to be considered.

Such spillways together with downstream confined spillway channels would minimize the extent of flooding in case of extreme floods.

The 2010 flood has also demonstrated the effectiveness of the country's major reservoirs, in particular the Tarbela reservoir which absorbed an unprecedented flood peak of 835,000 cusecs. The already planned reservoir on the Swat River at Munda and additional reservoirs on the Indus River and its tributaries would enhance the country's capacity to manage exceptional floods as well as preserve flood water for productive purposes.

The above flood management related issues call for an urgent need to revisit the country's overall flood management strategy and implement a comprehensive long-term multifaceted flood management program. The following elements could be considered for this strategy review; (i) enhancing the absorptive capacity of catchments to reduce rainfall run-off; (ii) building additional reservoirs to absorb flood peaks; (iii0 improving flood regulation through flood diversions; (iv) enhancing the safe flood disposal capacities of the existing barrages and river training works; (v) adopting a 'living with the floods' approach for the riverine areas in Punjab and Sindh; (vi) improving and expanding flood forecasting and early warning systems; and (vii) enhancing evacuation and flood relief capacities.

1.6 Key Lessons Learnt from Flood Response 2010

(i) The exceptional intensity and prolonged period of the rains and consequent flooding clearly over-whelmed nationa, provincial and local disaster/flood management capacities, particularly at the district level.

(ii) Partial implementation of already prepared national response and contingency plans, limitations of existing early warning arrangements down to community level effects disaster preparedness, emergency response mechanisms and structural mitigation.

(iii) Affected communities lacked disaster preparedness awareness, sensitization and education regarding localized hazard and flood risk reduction, emergency preparedness and response functions – particularly required for populations located within flood plains.

1.7 Climate Change and Flood Linkages

Climate change is considered a critical factor behind changing rainfall patterns and the visible increase in precipitation during monsoon seasons in parts of the country. Research work based on long-term climate change data points towards a scenario of future occurrence of heavy rainfall events during monsoon seasons over north-west Pakistan instead of north-east. As a result, areas along the western rivers of the country (Indus and Kabul) will be more vulnerable to flood episodes similar to the one experienced during the current season.

2. Integrated Flood Management Concept

Integrated Flood Management (IFM) is a process promoting an integrated rather than fragmented approach to flood management; it integrates land and water resources development in a river basin, within the context of IWRM, and aims at maximizing the net benefits from the use of floodplains and minimizing loss of life from flooding. Globally, both land particularly arable land and water resources are scarce. Most productive arable land is located on floodplains. When implementing policies to maximize the efficient use of the resources of the river basin as a whole, efforts should be made to maintain or augment the productivity of floodplains. On the other hand economic losses and the loss of human life due to flooding cannot be ignored. Treating floods as problems in isolation almost necessarily results in a piecemeal, localized approach. Integrated Flood Management calls for a paradigm shift from the traditional fragmented approach of flood management. Integrated Flood Management recognizes the river basin as dynamic system in which there are many interactions and flux between land and water bodies. In IFM the starting point is a vision of what the river basin should be. Incorporating a sustainable livelihood perspective means looking for ways of working towards identifying opportunities to enhance the performance of the system as a whole.

The flows of water, sediment and pollutants from the upper catchments of the river into the coastal zone often taken to extend dozens of kilometers inland and to cover much of the river basin can have significant consequences. As estuaries embrace both the river basin and the coastal zone, it is important to integrate coastal zone management into IFM.

The attempt is, therefore, to improve the functioning of the river basin as a whole while recognizing that gains and losses arise from changes in interactions between the water and land environments and that there is a need to balance development requirements and flood losses. It has to be recognized that the objective in IFM is not only to reduce the losses from flood but also to maximize the efficient use of flood plains with the awareness of flood risk particularly where land resources are limited. In other words, while reducing loss of life should remain the top priority, the objective of flood loss reduction should be secondary to the overall goal of optimum use of flood plains. In turn, increases in flood losses can be consistent with an increase in the efficient use of flood plains in particular and the river basin in general.

2.1 Elements of integrated Flood Management

Integrated Flood Management takes a participatory, cross-sectoral and transparent approach to decision making. The defining characteristic of IFM is integration, expressed simultaneously in different forms; an appropriate mix of strategies, carefully selected points of interventions, and appropriate types of interventions (structural or non-structural, short or long-term.

An Integrated Flood Management plan should address the following six key elements that follow logically for managing floods in the context of an IWRM approach:

- Management the water cycle as a whole;
- Integrate land and water management;
- Manage risk and uncertainty;
- Adopt a best mix of strategies;
- Ensure a participatory approach; and

- Adopt integrated hazard management approaches.

(i) Manage the Water Cycle as a whole:

Most of the time runoff constitutes an essential pat of the available water resource and only poses a problem under extreme conditions. In arid and semi-arid climates in particular, floods represent a large part of the available water resource. Integrated Flood Management focuses on managing the land phase of the water cycle as a whole, taking into a count the whole range of floods-small, medium and extreme. It recognizes the influence of floods on the recharge of groundwater, which forms an important source of water during dry periods, and takes account of the other extreme of the hydrologic cycle-drought.

Flood management plans should include drought management, and should take measures to maximize the positive aspects of floods such as by retaining part of flood flows for use in crop production. Alluvial floodplains, in particular, provide opportunities for groundwater storage of floodwaters. Integrated Flood management should treat groundwater and surface water as linked resources, and should consider the role of floodplain retention capacities for groundwater recharge. Flood management plans should take a holistic approach to exploring the possibilities for accelerated artificial recharge under given geological conditions. Interventions that change the runoff regime, however, need to consider the potential adverse effects. Taking measures to reduce runoff during the rainy season, for example, could be counter-productive if those measures also reduce runoff at other times of the year.

Integrated Flood Management recognizes the need to manage all floods and not just those flood up to some design standard of protect Securing Livelihoods on. Flood plans must consider what will happen when a flood more extreme than the design standard flood occurs, and must foresee how such a flood will be managed. Plans must clearly identify areas to be sacrificed for flood storage in order to protect critical areas in an extreme flood event.

Urban flood management needs to deal explicitly with the three basic components of urban water management; drinking water supply; sewage and wastewater disposal; and surface run off disposal. Urban flood plans must manage both storm water quantity and the effects of storm water on water quality. Polluted flood waters cause one of the most severe post-flood problems in urban areas. Traditionally, the municipal divisions responsible for flood management have focused on the engineering aspects of drainage with the goal of channeling storm water as fast an unobtrusively as possible out of town, often without consideration of the downstream effects. In many urban areas, however, the complete separation of storm water management from the water supply systems is not feasible, and the draining of storm water as fast as possible is not desirable. A growing number of water sensitive cities recognize these emerging ideas and integrated Flood Management provides strong support for their efforts.

(ii) **Integrate Land and Water Management:**

Hydrological responses to rainfall strongly depend on the local characteristics of soil, such as water storage capacity, infiltration rates and preceding rainfall conditions. The type and density of vegetation cover and the land use characteristics are also important in understanding a catchment's response to rainfall. Human alterations to catchments can plan a significant role in increasing flood hazards if the run off generation process is changed, especially when the infiltration capacity of the soil decreases or a change in soil cover occurs. Environmental degradation and uncontrolled urban development in high risk zones, such as historical inundation plains and the bases of mountain ranges, lead to an increased vulnerability to catastrophic events for those communities on the flood plains. Changing pervious natural surfaces to less pervious or impervious artificial surfaces, leads to an increase on storm water runoff rates, and the total volume of runoff may also affect water quality. Changes in natural water storage as a consequence of urbanization also cause significant changes to the temporal characteristics of runoff from an urbanized area, such as shortening the runoff travel time, and can result in an increased incidence of flash flooding.

Land use planning and water management should be combined in one synthesized plan with a certain common field, such as the mapping of flood hazards and risks, to enable the sharing of information between land use planning and of information between land use planning and water management authorities. The rationale for this integration is that the use of land has impacts upon both water quantity, and quality. The three main elements of river basin management water quantity, water, quality, and the processes of erosion and deposition are inherently linked and are the primary reasons for adopting an approach to IFM based on river basins.

Upstream changes in land use can drastically change the characteristics of a flood and the associated water quality and sediment transport characteristics, especially conversion of forested areas and wetlands into other landforms. Upstream urbanization as well as river training can cause an accentuation of flood peaks and their early occurrence in downstream reaches. Low lying depressions can play an important role in flood attenuation, but the consequent deposition of solid wastes in depressions may worsen health conditions and increase flood peaks in downstream reaches. Ignoring these linkages in the past has often led to failure. Flood management needs to recognize, understand and account for these linkages in order to realize the synergies improving river basin performance. Taking advantage of these potential synergies will however, require the wider perspective of the development of the river basin in its entirety. Attempting to resolve local problems in an isolated manner is no longer a viable strategy, if it ever was.

(iii) Manage Risk and uncertainty

Climate change exacerbates the risks to modern society. Living on a floodplain involves the risk of damage to property and the loss of life, yet also provides opportunities. Policy design should consider flood risk in the context of other prevailing risks to individuals, households and communities, in particular, the risks associated with poverty. Otherwise, policies for reducing flood risk may have the unintended consequences of reducing opportunities for livelihood through such measures as restrictive floodplain regulation or resettlement programmes based on an imperfect understanding of the socio-economic implications.

Flood risks are also related to hydrological uncertainties. Our knowledge of hydrological uncertainties. Our knowledge of the present is incomplete and generally we have an imperfect understanding of the casual processes in operation. The extent of future changes cannot be predicted with certainty, as these changes may be random, systemic or cyclical. Hydrological uncertainty, however, is perhaps subordinate to social, economic and political uncertainties; the biggest and most unpredictable changes are expected to result from population growth and economic activity.

Uncertainty and risk management are defining characteristics of choice, and risk management is a necessary component of the development process, essential for achieving sustainable development. The application of a risk management approach provided measures for preventing a hazard from becoming a disaster. Flood risk management consists of systematic actions in a cycle of preparedness, response and recovery, and should form a part of IWRM. The actions taken depend on the conditions or risk within the social, economic and physical setting, with the major focus on reducing vulnerability.

Risk management calls for identification assessment, and minimization of risk, or the elimination of unacceptable risks through appropriate policies and practices. Flood risk management also includes the efforts to reduce the residual risks through such measures as flood sensitive land use and spatial planning, early warning systems, evacuation plans, the preparations for disaster relief and flood proofing and, as a last resort, insurance and other risk sharing mechanisms.

(iv) **Adoption of Best Mix Strategies:**

The following shows: The adoption of a strategy depends critically on the hydrological any hydraulic characteristics of the subject river system and region. Three linked factors determine which strategy or combination of strategies is likely to be appropriate in a particular river basin; the climate, the basin characteristics and the socio-economic conditions in the region. The nature of the region's flood, and the consequences of those floods are functions of these linked factors.

Optional solutions depend upon knowledge that is complete, precise and accurate. In light of the uncertainty about the future, flood management plans should adopt strategies that are flexible, resilient and adaptable to changing conditions. Such strategies would be multi-faceted with a mix of options.

Integrated Flood Management avoids isolated perspectives and the trap of assuming that some forms of intervention are always appropriate and that others are always bad. Successful IFM looks at the situation as a whole, compares the available options and selects a strategy or a combination of strategies that is most appropriate to a particular situation (Table 1). Flood management plans should evaluate, adopt and implement those structural and non-structural measures appropriate to the region, and should guard against measures that create new hazards or shift the problem in time and space.

Table 1: List of Strategies and Available Options

Strategy	Options
Reducing Flooding	Dams and reservoirs Dikes, levees and flood embankments High flow diversions Catchment management Channel improvements
Reducing Susceptibility to Damage	Floodplain regulation Development and redevelopment policies Design and location of facilities Housing and building codes Flood proofing Flood Forecasting and Warning
Mitigating the Impacts of Flooding	Information and education Disaster preparedness Post-flood recovery Flood insurance
Preserving the natural resources of floodplains	Floodplain zoning and regulation

(v) **Identification and Participation of Stakeholders:**

Integrated Flood Management, like Integrated Water Resources Management, should encourage the participation of uses, planners and policy makers at all levels. The approach should be open, transparent, inclusive and communicative; should require the decentralization of decision making; and should include public consultation and the involvement of stakeholders in planning and implementation. Representatives of all the upstream and downstream stakeholders need to be involved. The core of the debate in the stakeholder consultation process is frequently not what the objectives are but what they ought to be. The stakeholder consultation process should be clear about who has standing in the decision, and should ensure that the powerful do not dominate the debate.

It is essential that a good representative range of stakeholders is involved in the IFM dialogue and decision making process. The impacts of flooding and of interventions are often differentially distributed among households and sections of a community. Women are usually the primary providers of child and health care, and so commonly experience a disproportionate share of the burdens of recovering from floods. They also play a central part in the provisions, management and safeguarding of water, and their special requirements in dealing with flood situations need to be reflected in the institutional arrangements. Integrated Flood Management has to keep gender, religions and cultural differences in perspective.

A comprehensive and integrated flood management plan based on above mentioned principles has, therefore, to be put in place for the entire Indus system. Some interventions on this direction have already been implementation which needs to be further strengthened and augmented under a crash programme to ensure safety and minimize the losses by extreme events.

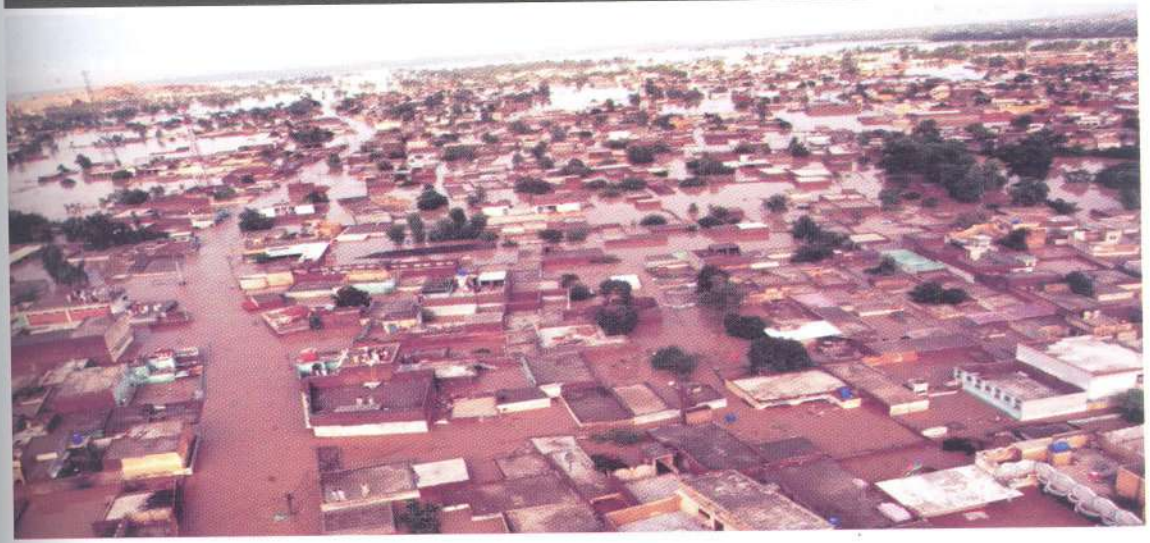
3. References

(i) Climate Change and its impact on the Water Resources of Mountain Regions of Pakistan by Mr. Muhammad Munir Sheikh and Dr. Qamaruzzaman Chaudhry.

(ii) Pakistan Floods 2010 – Preliminary Damage and Need Assessment by ADB.

(iii) Extracts from Miscellaneous related material.

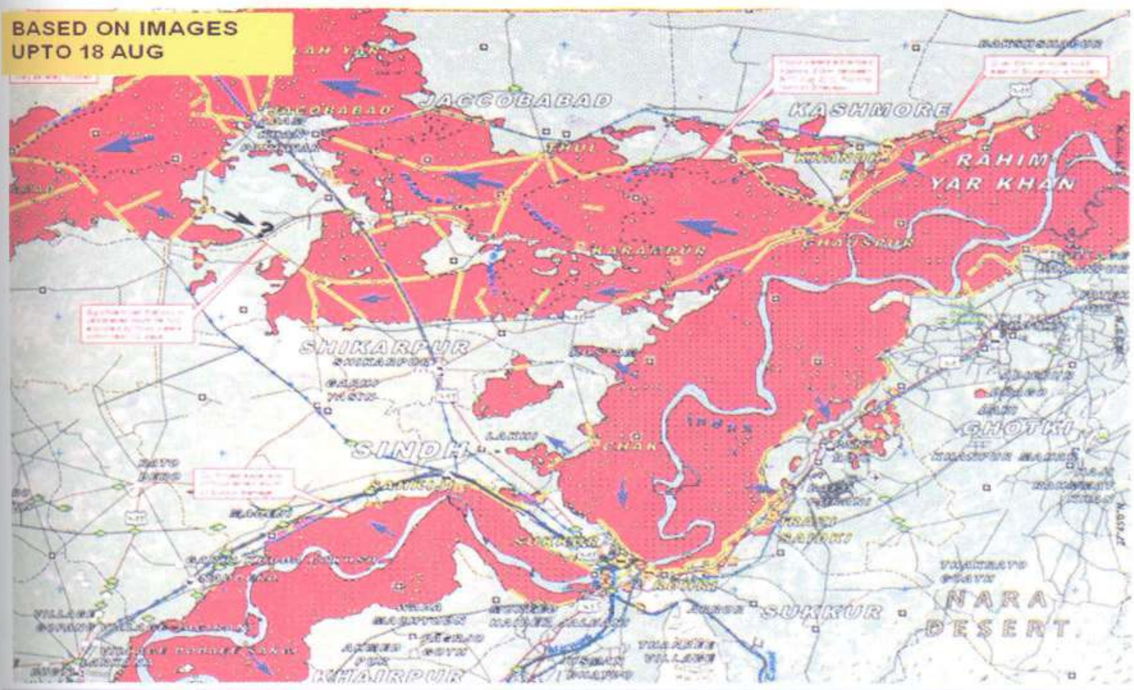
NOWSHERA FLOODED



GT ROAD NOWSHERA – PESHAWAR

NOWSHERA – RISALPUR BRIDGE

KANDKOT - SINDH



Rt Bank Outfall Drain Near Shahdadkot

Mr Qunli HAN

Mr. Han, Director UNESCO, joined the UNESCO Tehran Cluster Office, which covers four countries; Iran (resident) Afghanistan, Pakistan and Turkmenistan in 2007. From 1998 – 2007, he worked for the UNESCO Regional Science Bureau for Asia and the Pacific (Jakarta), mainly for Man and the Biosphere (MAAB) Programme and natural World heritage. His tasks include coordination of subregional MAB networks, site management support, monitoring, and assistance in Biosphere Reserves and World Heritage nomination. Between 1989 – 1997, Qunli worked in UNESCO Paris for MAB on ICT applications for ecosystem management and the establishment of MABnet. Han Qunli graduated from the Chinese University of Science and Technology in 1980n (UTSC) in computer sciences and received training in environmental information systems during 1985 – 1986 in Italy. He worked for the Chinese Academy of Sciences (CAS) in Beijing during 1980 – 1988 as research fellow and became deputy director of the Division of Terrestrial resources Information in the Commission for Integrated Survey of Natural resources of CAS in 1987.

IHP in Action in UNESCO Tehran Cluster:

Building capacities towards sustainable water management

Han Q., N.Sadeghi, UTCO

24 January 2011, Islambad

Contents

- Overview on hydrological conditions and challenges of the countries in the cluster
- Brief on UNESCO Tehran actions for IHP in the Cluster
- Comments on recent floods and droughts in each of these countries
- Needs of education and sharing of knowledge/information for cooperation
- Conclusive remarks

UNESCO Tehran Cluster

- Afghanistan
- Iran
- Pakistan
- Turkmenistan

Vision for IHP...

- **Integrating dependencies:** water science-policy, through research & education underpinned by cultural diversity
- **Understanding dependencies:** physical-social-biological environments
- **Promoting participatory decision making** in inter dependent systems: water-health-food-energy, in a changing world

...............*water management is not just a scientific and technological problem, it also has important social, political, environmental and cultural dimensions.*

Main requests from Member States: through global to local issues

- Climate Change and water resources
  - Extreme events, data uncertainties, hydro hazards & impact on society
- Sustainable water resources & environmental management
  - Groundwater management, ecohydrology, land use changes, water quality
- Risk assessment & management of water resources, water security
  - Institutions, capacity, economic & social externalities, ethics

Afghanistan

Climate

- Climate varies from arid in the South and Southwest to semi-arid in most other parts of the country.
- The high mountain ranges of Hindu Kush and Pamir are moderate humid and covered by permanent snow and glaciers at altitudes above 5,000 m.
- With a few exceptions of some locations receiving sufficient rainfall in spring (Northern slopes of Hindu Kush above 1,000m altitude), the climate is not favorable for rainfed agriculture.

Afghanistan

Water Resources

- Majority of surface water are originated in Afghanistan, but flow out to other countries;
- Four main hydrographic zones: Amu Darya in North, Hari Rud and Murgab in West, Helmand in South and Eastern Kabul
- Internal renewable water resources are estimated at 55 cubic km per year (km3/year).
- Recently, there has been a large development of groundwater use in some provinces causing over-exploitation in some areas
- There is considerable potential for the generation of hydropower, both by large dams and micro-hydropower stations
- Agriculture (irrigation) is the main water consumer

Afghanistan

Main challenges in Water Resources Management:

- **Lack of human resources and funds**, especially education of Afghan experts to manage their resources and their future;
- **Needs to improve water management and reducing water losses** to increase irrigated areas;
- Due to the increasing use of groundwater in recent years, there is a risk of **over-exploitation and depletion of groundwater resources** in the absence of regulating and licensing authorities, which in some places might lead to the **drying out of kareze or qanats**, springs, and wells, depending on the same water sources;

Afghanistan

Main challenges in Water Resources Management:

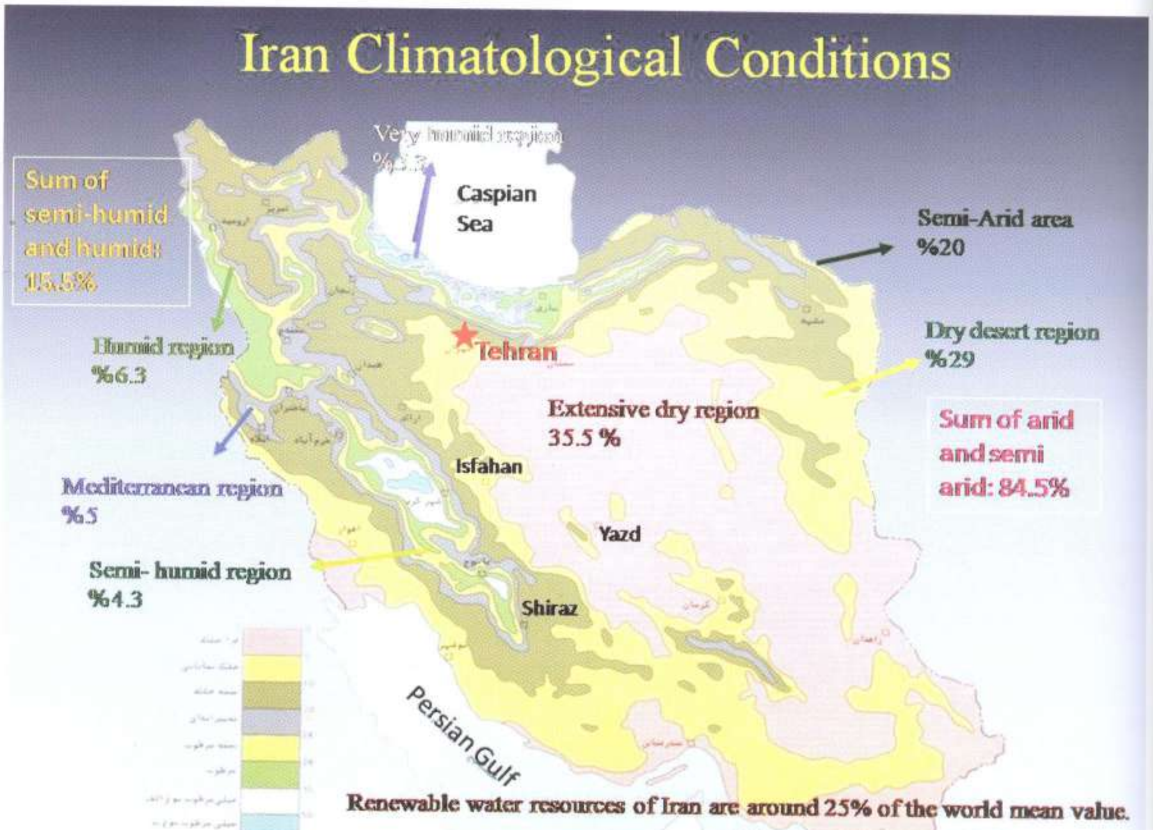
- In the next 50 years, it is estimated that **drinking water needs in the Kabul Basin of Afghanistan may increase sixfold** due to population increases resulting from returning refugees. It is also likely that future water resources in the Kabul Basin will be reduced as a result of increasing air temperatures associated with global climate change (USGS, 2005-2007).
- **Insufficient infrastructure** for proper water gauge, supply and efficient use; more than 20-year gap in the scientific record due to war and civil conflict;
- Although there is considerable uncertainty associated with **climate change** projections, warming trends forecast for southwest Asia would likely result in adverse changes to recharge patterns and further **stresses on limited water resources.** Such stresses were simulated to result in 50 percent of shallow groundwater wells in the basin becoming inoperable.

Afghanistan

UNESCO Tehran in Afghanistan:

- Establishment of National IHP Committee of Afghanistan (NHCA)
- Kabul River Basin
  - A million dollars Project on "Integrated Water Resources Management of Kabul River Basin" as well as capacity building for experts working in Kabul River Basin [extra-budgetary provided by Iran and UNESCO]
  - Special training for Afghan experts working in the River Basin on use of GIS and RS in modeling of Kabul River Basin
- Advocacy for rehabilitation and maintenance of Qanats system and inventory study on situation of Qanats in Afghanistan
- A wide range of capacity building programmes in various fields related to water resource management; some 20 events in different countries/regions


Iran
Area: 1.648 million km²
Population: 75 million
No of provinces: 30
Average Rainfall: 271 mm
Available water per capita (2009): approx. 2000 m3
TURKMENISTAN
AFGHANISTAN
PAKISTAN
IRAQ
QATAR
OMAN
Iran

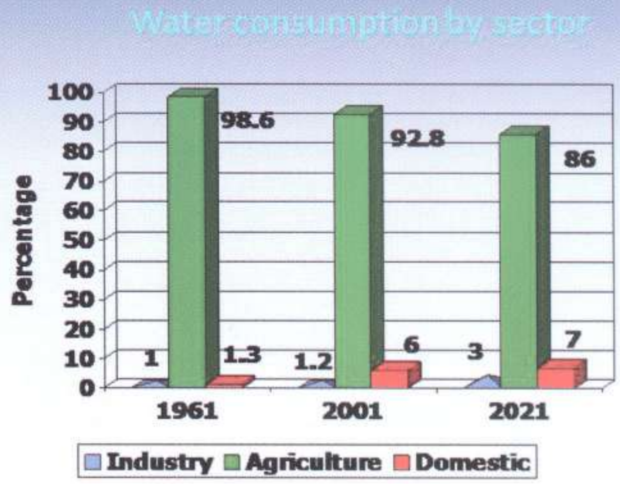

Iran Climatological Conditions
Sum of semi-humid and humid: 15.5%
Caspian Sea
Semi-Arid area %20
Humid region %6.3
Tehran
Dry desert region %29
Extensive dry region 35.5 %
Sum of arid and semi arid: 84.5%
Isfahan
Mediterranean region %5
Yazd
Semi- humid region %4.3
Shiraz
Persian Gulf
Renewable water resources of Iran are around 25% of the world mean value.

Iran

Water resources:

- Total available freshwater resources:
  Total: 130 Billion m3

- Consumption:
  Surface water: 42BCM
  Groundwater: 50 BM



Source: Ministry of Energy of Iran

Iran

Main challenges of the water sector in Iran:

- **Rapid population and urbanization growth** coupled with migration of Afghan refuges which have resulted in scarce water resources for future needs
- **Over exploitation of ground-water resources** and damage to Qanats systems
- Insufficient water supplies to meet **environmental water demands**
- **Rising competition over water** usage among different sectors as well as inland shared waters
- Agreements on **shared water with neighboring countries**
- **Climate change:** national studies predict 9% reduction in average rainfall, 0.5 ^{oC} increase in temperature and reduction of many river flows

Iran

UNESCO Tehran addressing Iran's needs:

- Close cooperation with very active IHP N.C.
- Two water related centers under the auspices of UNESCO
  - Int'l Centre on Qanats and Historic Hydraulic Structures (ICQHS)
  - Regional Centre on Urban Water Management (RCUWM)
- G-WADI programme well accepted by various Iranian authorities and civil society;
  - two G-WADI Pilot Basins (Kashafroud and Taleghan-Hashtgerd)
- Advocacy towards Qanats and traditional knowledge for meeting today's needs (major conference in Feb 2012)

Iran

UNESCO Tehran addressing Iran's needs:

- Devise of the ToT manual on Integrated Urban Water Management (already applied for training of Afghan, Pakistani and Tajik experts)
- Assisting the government to develop the National Action Plan for Climate Change Adaptation by means of the two G-WADI Pilot Basins
- Capacity building in trans-boundary water management
- A variety of trainings and joint activities including activities on groundwater, floods, modeling, water & culture, climate change, water harvesting, etc.

Pakistan

- **Area: 796,095 km^2**
- **Landscape: from plains to deserts, forests, hills, and plateaus**
- **Climate: varies from tropical to temperate with arid conditions existing in the coastal south**
- **Renewable water resources: decreased from 2,961 m^3 per capita in 2000 to 1,420 m^3 per capita in 2005**
- **Water use (year 2000): 96% by agricultural, 2% by domestic and another 2% by the industry sector**
- **Main challenges: access to clean drinking water for the growing population and groundwater mining**

Pakistan

UNESCO Tehran in Pakistan:

- The Regional Centre for Water Management Research in Arid Zones under the auspices of UNESCO (to be established)
- Close cooperation with PCRWR on groundwater management and water harvesting issues
- Safe Drinking Water for All under the UNDAF framework
- Advocacy for Qanats and inventory study on the situation of Qanats system in Pakistan
- A number of capacity building activities for experts as well as decision makers
- 2010 floods: act as a team member of UNESCO IHP

Turkmenistan

- Area: 488,100 km²
- Population (2009): 5,110,000
- Climate: cold desert
- Almost 80% of the country covered by Garagum desert
- Main rivers are located only in the southern and eastern peripheries; a few smaller rivers on the northern slopes of the Kopetdag which are diverted entirely to irrigation

Turkmenistan

Main challenges:

- **Contamination of soil and groundwater with agricultural chemicals and pesticides;**
- **Salination and water-logging of soil due to poor irrigation methods;**
- **Caspian Sea pollution;**
- **Replenish of the Aral Sea: diversion of a large share of the flow of the Amu Darya into irrigation;**
- **Desertification and loss of biodiversity due to leakage in main and secondary canals, excessive irrigation brings salts to the surface, forming salt marshes that dry into unusable clay flats**
- **Climate change: less water available, putting agriculture as main source of income and food in great vulnerability**

Turkmenistan

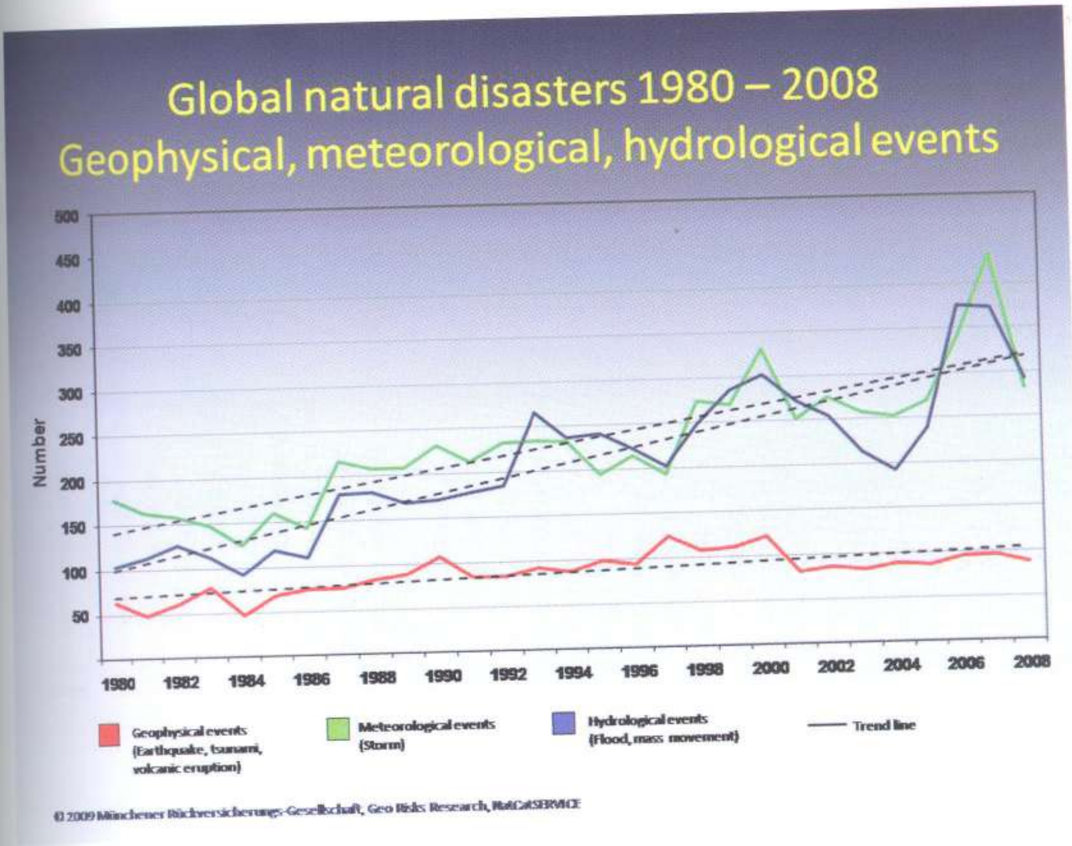
UNESCO Tehran in Turkmenistan:

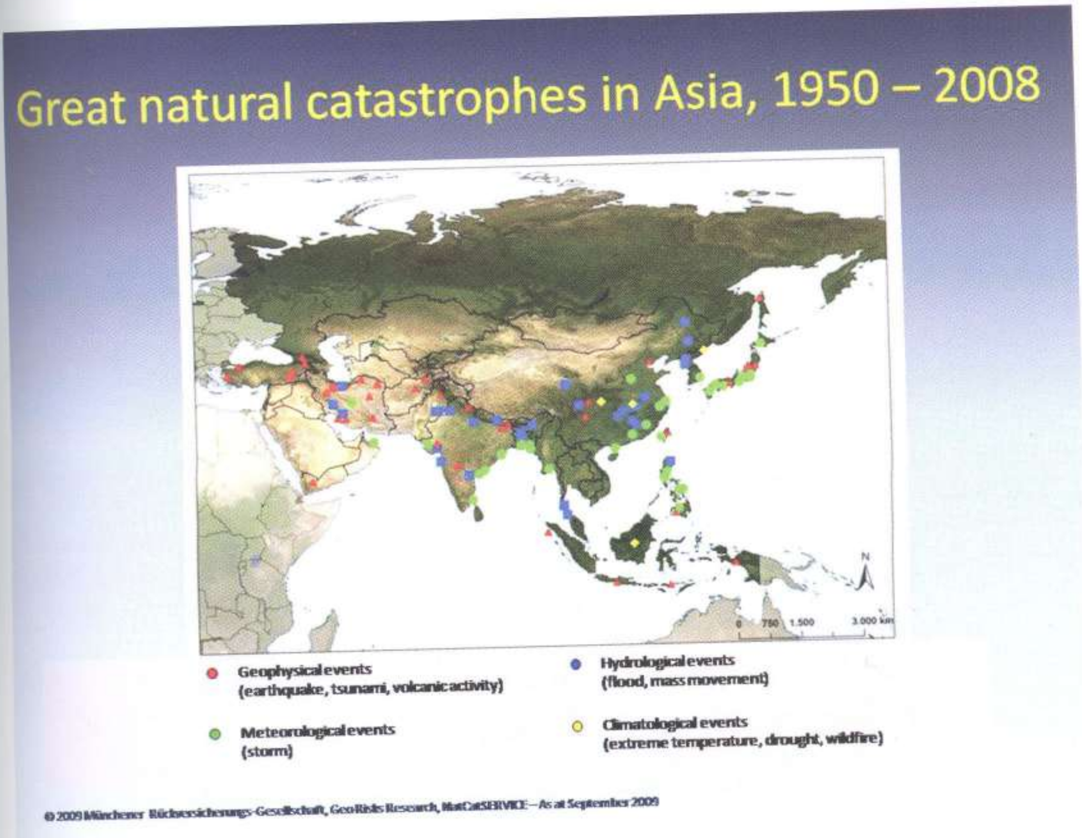
- MAB-IHP regional workshops including irrigation and trans-boundary issues
- UNESCO Chair on sustainable management of drylands (in the process of preparation)
- Various capacity building and training

Large hydro-engineering project

Summary of challenges of the four countries covered by UNESCO Tehran

- Commonalities:
  - Water scarcity as the most common challenge
  - Climate change likely to worsen water scarcity and cause climatic extremes
  - Sharing some joint water bodies (both surface and sub-surface)
- Differences:
  - Geography and demography
  - Different level of knowledge/expertise in managing/addressing water issues
  - Different national development policies/goals


Global natural disasters 1980 – 2008
Geophysical, meteorological, hydrological events
Number
500
450
400
350
300
250
200
150
100
50
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
Geophysical events (Earthquake, tsunami, volcanic eruption)
Meteorological events (Storm)
Hydrological events (Flood, mass movement)
Trend line
© 2009 Münchener Rückversicherungs-Gesellschaft, Geo Risks Research, NatCatSERVICE


Great natural catastrophes in Asia, 1950 – 2008
Geophysical events (earthquake, tsunami, volcanic activity)
Hydrological events (flood, mass movement)
Meteorological events (storm)
Climatological events (extreme temperature, drought, wildfire)
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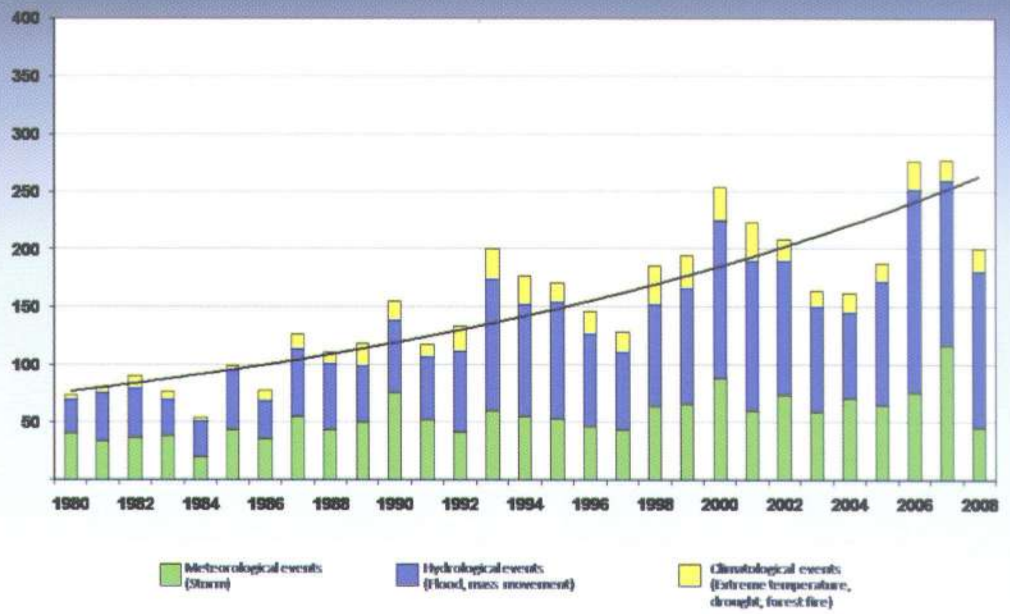
Weather catastrophes in Asia 1980 – 2008

Number of events



Top 10 recent natural disasters in Afghanistan

Disaster	Date	Damage (000 US$)
Flood	Jun-1988	260,000
Flood	6-Feb-1991	60,000
Flood	Jul-1978	52,000
Earthquake (seismic activity)	10-Jun-1956	25,000
Flood	25-Mar-2009	20,000
Earthquake (seismic activity)	4-Feb-1998	10,000
Earthquake (seismic activity)	30-May-1998	10,000
Earthquake (seismic activity)	2-Feb-1984	5,000
Storm	Jan-2005	5,000
Flood	31-Sep-1992	4,000

Source: "EM-DAT: The OFDA/CRED International Disaster Database

Top 10 recent natural disasters in Iran

Disaster	Date	Damage (000 US$)
Earthquake (seismic activity)	21-Jun-1990	8,000,000
Drought	Apr-1999	3,300,000
Flood	28-Apr-1992	2,969,100
Flood	30-Nov-1986	1,561,000
Earthquake (seismic activity)	28-Jul-1981	1,000,000
Flood	3-Feb-1993	1,000,000
Flood	9-Jul-1992	500,300
Earthquake (seismic activity)	26-Dec-2003	500,000
Flood	3-Oct-1991	404,000
Earthquake (seismic activity)	22-Jun-2002	300,000

Source: "EM-DAT: The OFDA/CRED International Disaster Database

Top 10 recent natural disasters in Pakistan

Disaster	Date	Damage (000 US$)
Flood	28-Jul-2010	9,500,000
Earthquake (seismic activity)	8-Oct-2005	5,200,000
Storm	26-Jun-2007	1,620,000
Flood	8-Sep-1992	1,000,000
Flood	Aug-1973	661,500
Flood	2-Aug-1976	505,000
Flood	10-Aug-2007	327,118
Drought	Nov-1999	247,000
Flood	22-Jul-2001	246,000
Flood	2-Aug-2008	103,000

Source: "EM-DAT: The OFDA/CRED International Disaster Database

Summary: natural disasters in the cluster

- Floods, droughts and earthquake are common among the four countries, posing permanent threats to human security and development.
- Although the countries are all prone to earthquakes, floods and droughts have caused more damages, esp. in economic terms;
- Attention insufficient to the needs for preparedness for water related hazards plus inadequate technical capacities.

Needs to mobilize S/T for early warning systems

- We know the technology exists to detect the natural disasters as they first occur.
- We know the technology exists to measure and record the magnitude, intensity, speed, and direction of these disasters in almost real time.

Quote from John Flanagan, August 29, 2010

Needs to mobilize S/T for early warning systems

- We know a multitude of actions that can be taken to lessen and mitigate the damaging effects of natural disasters if we can provide effective advanced warnings.

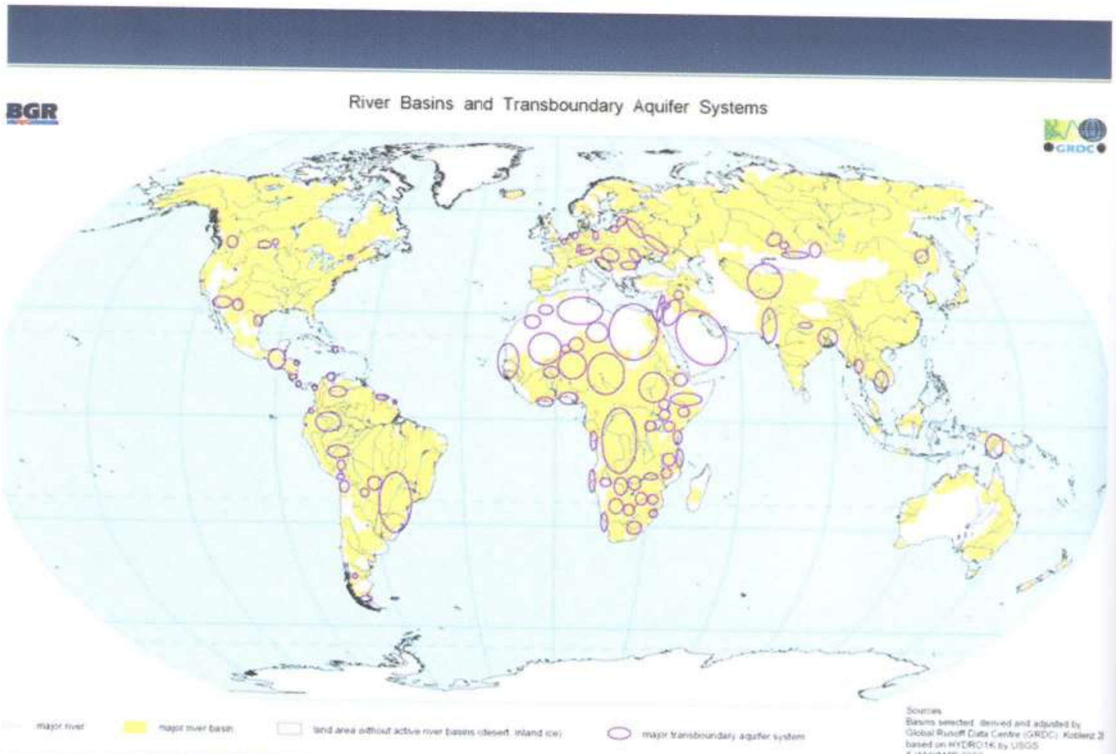
- We know that we can save many more lives and greatly reduce injuries and property damages with a more effective system of advanced warnings for natural disasters.

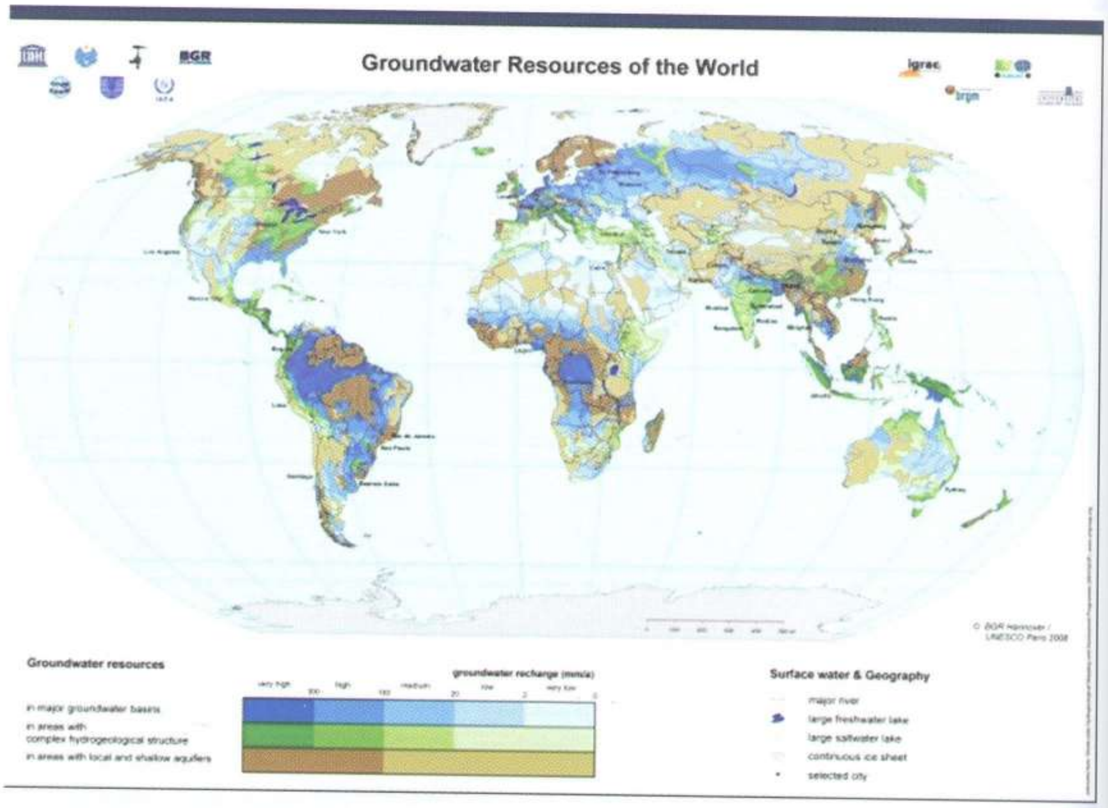
Quote from John Flanagan, August 29, 2010

Moving from response oriented to more proactive and preventive mechanism

Awareness, policy support, legislation, communication

But S/T is primary for EWS

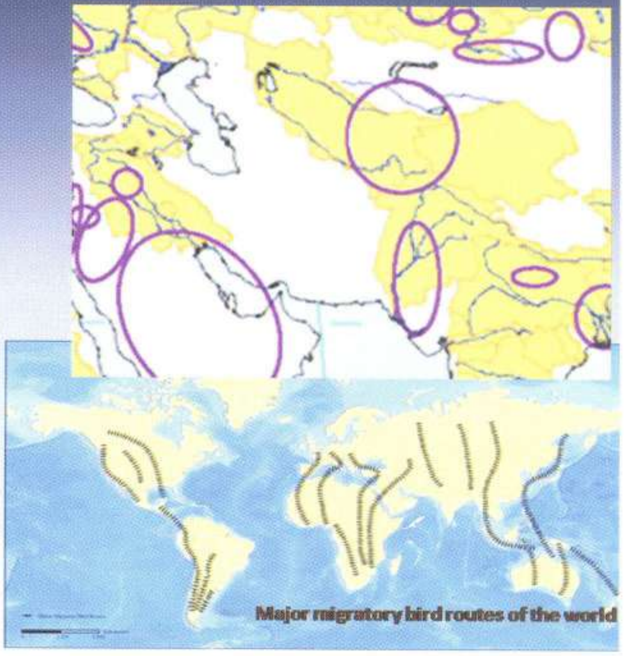

River Basins and Transboundary Aquifer Systems
major river
major river basin
land area without active river basins (desert, inland ice)
major transboundary aquifer system
Sources:
Basins selected, derived and adjusted by
Global Runoff Data Centre (GRDC), Koblenz
based on HYDRO1K by USGS
& WHYMAP 2006


Groundwater Resources of the World
© BGR Hannover / UNESCO Paris 2008
Groundwater resources
in major groundwater basins
in areas with complex hydrogeological structure
in areas with local and shallow aquifers
groundwater recharge (mm/a)
very high
300
high
100
medium
20
low
2
very low
0
Surface water & Geography
major river
large freshwater lake
large saltwater lake
continuous ice sheet
selected city

Regional ties by natural resources

Cooperation on shared resources will bring:

- Regional stability
- Economic prosperity
- Shared responsibilities and costs
- Holistic look to address common issues
- Contingency plan at the basin level to address floods and droughts



Where to get started towards 'Sustainable Regional Integrity'?

- Education, from early childhood to university
- Capacity development among policy/decision makers
- Regional forums for dialogue and exchange of views on common challenges
- Training of mid-level experts to acquire the same mindset
- Pilot projects among two or more countries
- Develop common databanks

Minds of people

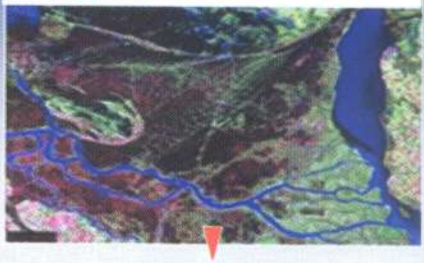
Making IHP-VII relevant globally and locally

Global issues

Adaptation to impacts of global changes

- Quantification of impacts, hydro hazards
- IWRM in the context of increasing climate variability
- Water and life support systems

Regional & Local issues



Co-operation of regional groupings of NC

- Strengthening governance for sustainability
- Sustainability at the landscape level
- Water, a shared responsibility

Conclusion remarks – IHP priorities in Tehran Cluster

- Climate Change:
  - Climate change is introducing so much uncertainty that global challenges can only be overcome by collective efforts of nations
  - anticipation and preparedness for adaptation: research, training and Pilot cases such as G-WADI
- Toward managing extremes: IDI (International Drought Initiative) to complement IHP flood initiative IFI

Conclusion remarks – IHP priorities in Tehran Cluster

- Learning from past: traditional knowledge, techniques and management as lessons from the past may help greatly reduce risk of failure of new methodologies and technologies.

- *Trans-boundary issues deserve far-sighted* strategic thinking and scientific cooperation. New forms of exchange, discussion, negotiation and planning are needed.

Conclusion remarks – IHP priorities in Tehran Cluster

- Education is key in any long-term development: for decision and policy makers - there should be regular special courses from IHP.
- The more frequent natural disasters require collective response to mitigate risks: more S/T work as long-term commitment on early warning and preparedness systems.
- Natural and cultural ties and social-economic connections between the countries are strong, therefore '***Cooperation***' is the way to go.


United Nations Educational Scientific and Cultural Organization
Thank You!
Rivers of the world
= rivers
UNESCO Tehran Cluster Office (UTCO)
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Tel: +98 (21) 22751315~17
Fax: +98 (21) 22751318
E-mail: tehran@unesco.org

Technical Session-II

Advanced Tertiary Level Education and Research

Professor Dr Bart Schultz

Professor Bart Schultz obtained his PhD degree from the Delft University of Technology, Netherlands. His career includes 35 years of research, advising and project implementation in the field of land and water development, drainage, irrigation, flood protection and environmental engineering. At UNESCO-IHE, Prof. Schultz is responsible for education and research in Land and Water Development. Under his guidance about 200 overseas participants obtained their Master of Engineering degree (MEng), more than 140 participants their Master of Science degree (MSc) and 12 participants their PhD degree. From September 1999 to July 2002 he was President of the International Commission on Irrigation and Drainage (ICID). He is a member of the International Water Academy, Oslo, Norway.

He is author of more than 240 papers in the field of land and water development, drainage, irrigation and flood protection and editor of several proceedings of National and International Conferences. He is chairman of the Editorial Board of the ISI Science Journals Citation Index listed journal Irrigation and Drainage.

Advanced Tertiary Level Education and Research on Impacts of Hydrologic Extremes on Flood Prone Areas

BART SCHULTZ
Prof. Land and Water Development, UNESCO-IHE, Delft, the Netherlands
Former Top Advisor, Rijkswaterstaat, the Netherlands
President Honoraire ICID

Abstract

Regarding advanced tertiary level education and research for managing hydrological extremes and related geo-hazard this paper focuses on two processes of major importance that are on-going in flood prone areas. They concern: the world population, population growth and increase in the standard of living, and urbanisation, especially in flood prone areas.

With respect to these processes at the global scale, three groups of countries can be distinguished, being: *developed countries, emerging countries and least developed countries*. Especially in the least developed and emerging countries, population growth and urbanisation are on-going processes. Most of the urbanisation is taking place in flood prone areas. These processes would have to guide education of future hydrologists, hydraulic engineers and water managers of the emerging and least developed countries.

The paper starts with a summarised overview of the relevant processes. Based on the needs of improved know-how on hydrology, water management and flood protection related to these developments, the paper presents the various options that may be of importance for updating educational programmes, as well as for the focus of and cooperation in research on hydrology, water management and food production.

We are concerned about the natural disasters that hit us.
However, a significant part of these disasters are only so disastrous while we started to live on volcanoes, on active faults, along subsiding coasts and in floodplains of rivers.

Salomon Kroonenberg, 2006

Keywords: Hydrologic extremes, Water education, Floods, UNESCO-IHE

1. Introduction

Regarding advanced tertiary level education and research for managing hydrological extremes and related geo-hazard in this paper the focus will be on the processes that are on-going in flood prone areas. In these areas two processes are of major importance. They concern: the world population, population growth and increase in the standard of living, and urbanisation, especially in flood prone areas.

With respect to these processes at the global scale, three groups of countries can be distinguished, being: *developed countries, emerging countries and least developed countries*[1] (Van Hofwegen and Svendsen, 2000 and Schultz, 2001). Especially in the least developed and emerging countries, population growth and urbanisation are on-going processes. Most of the urbanisation is taking place in flood prone areas. These processes would have to guide education of future hydrologists, hydraulic engineers and water managers of the emerging and least developed countries.

The paper starts with a summarised overview of the relevant processes. Based on the needs of improved know-how on hydrology, water management and flood protection related to these developments, the paper presents the various options that may be of importance for updating educational programmes, as well as for the focus of and cooperation in research on hydrology, water management and food production.

2. Worlds' Population and Population Growth

Figure 1 shows population and population growth in the three groups of countries. The developed countries house almost one billion people and there is almost no population growth at the current time. Some countries - like Germany and Japan - even show a

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[1] *Developed countries.* Most of the countries in Western and Central Europe, North America and some countries in Central and South America, the larger countries in Oceania and some countries in Asia;
Emerging countries. Most of the Eastern European countries (including Russia), most of the countries in Central and South America, most of the countries in Asia (including China, India and Indonesia), and several countries in Africa;
Least developed countries. Most of the countries in Africa, several countries in Asia, 1 country in Central America and most of the smaller countries in Oceania.

decline in population. The least developed countries are home to nearly 800 million people. In these countries, there is a rapid population growth resulting in an estimated duplication by 2050. The emerging countries house almost 5 billion people (74% of worlds' population). They still show a significant population growth, resulting in an estimated 30% increase by 2050. These countries also show a relatively rapid growth in the standard of living. Some characteristic data for population and population growth in Pakistan, Asia and at global level are shown in Table 1.

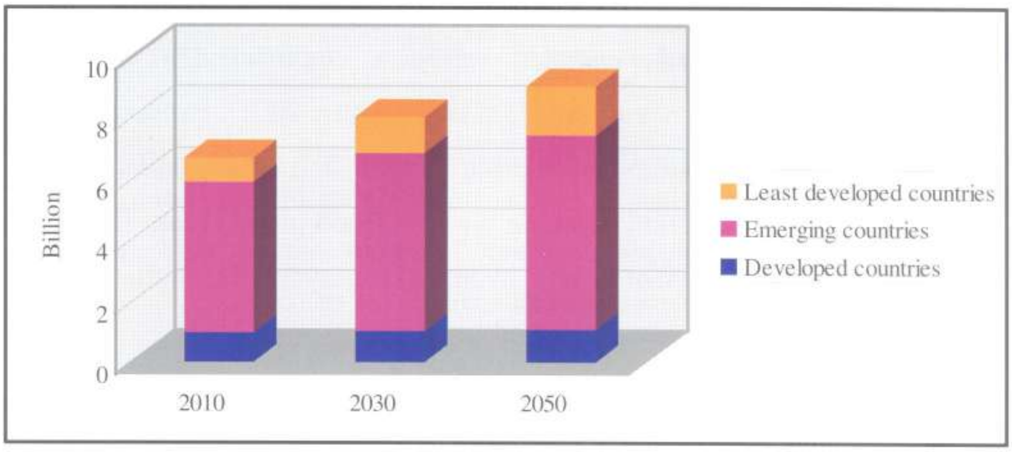
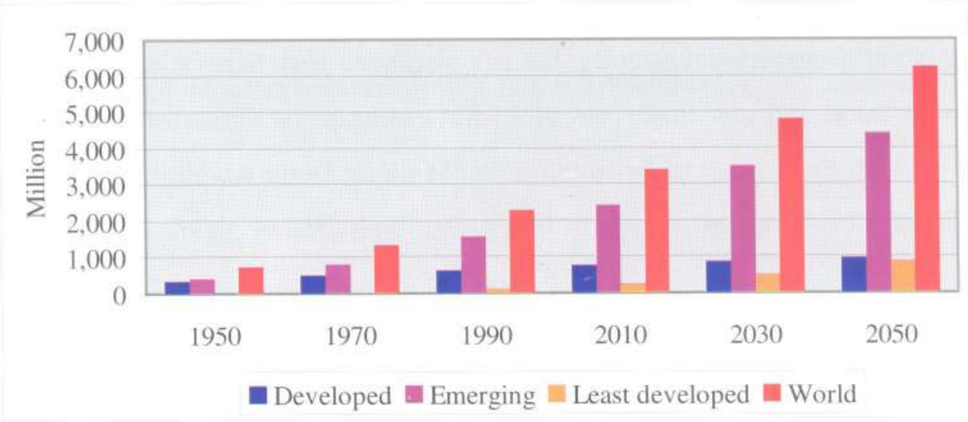


Figure 1. Population and population growth in the three types of countries (Schultz, 2010)

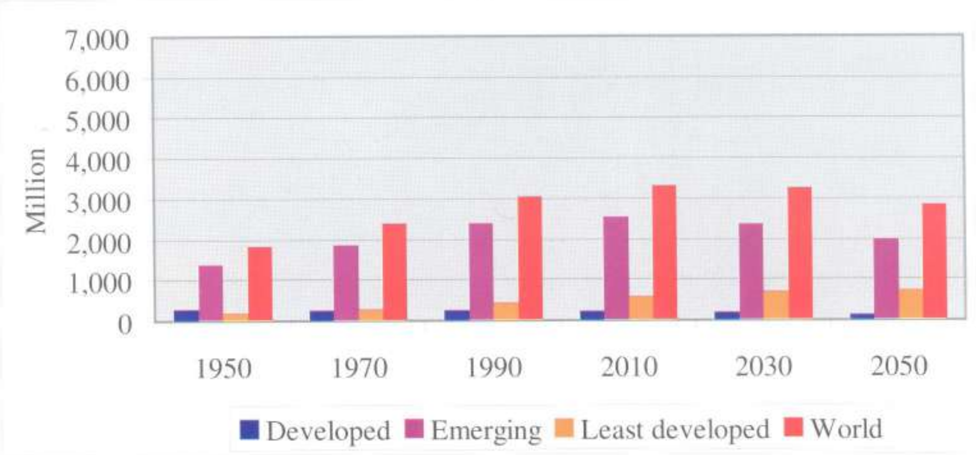
Table 1. Population in million and in persons per km² for Pakistan, Asia and the World in 2010, 2030 and 2050 (UN Department of Economic and Social Affairs. 2009 and Schultz, 2010)

	2010		2030		2050	
	million	persons/ km²	million	persons/ km²	million	persons/ km²
Pakistan	173	217	246	308	320	400
Asia	4,030	127	4,770	150	5,220	164
World	6,670	49	8,010	59	9,020	66

As shown in Figure 2, urbanisation is on-going throughout the world. In the developed countries, most of the urbanisation has already taken place, but still a certain increase in the urban population may be expected. In the emerging countries an increase in the urban population may be expected from 50% nowadays to 70% by 2050, which concerns respectively 2.4 and 4.4 billion people, more or less a duplication in 40 years and, when our development policies will not fundamentally change most of them in flood prone areas. In the least developed countries, duplication of the population may be expected over the next 40 years. The increase in the urban population in the same period is expected to be from 0.23 to 0.86 billion people.



(a)



(b)

Figure 2. Development of urban (a) and rural (b) population in the three different types of countries and at the global scale

3. Floods and Flooding

World wide the terms of flood and flooding may have a different meaning. Therefore the definitions as used in this paper are:

- *flood.* A temporary condition of surface water (river, lake, sea), in which the water level and/or discharge exceed a certain value, thereby escaping from their normal confines. However, this does not necessarily result in flooding (Munich-Re, 1997);
- *flooding.* Overflowing or failing of the normal confines of a river, stream, lake,

canal, sea or accumulation of water as a result of heavy precipitation by lacking or exceedance of the discharge capacity of drains, both affecting areas which are normally not submerged (Douben and Ratnayake, 2005)

Flooding is not necessary devastating, but can also been very beneficial if people are used to live with flood and can make use of it, for example for agriculture or fisheries. An interesting example of this can be found in the Mekong Delta where they have developed a classification of floods as shown in Figure 3 (Trinh Hoang Ngan and Bui Duc Long, 2009).

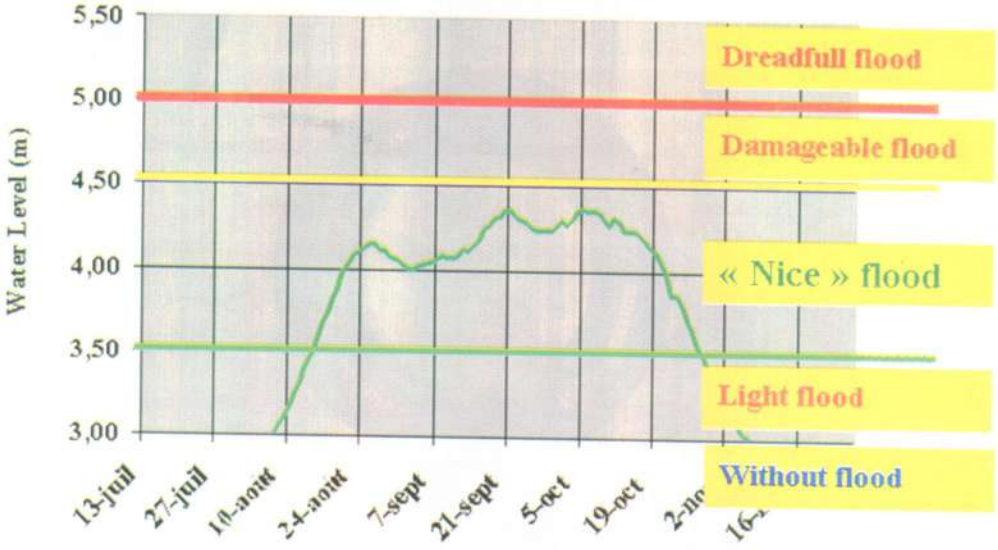


Figure 3. Classification of floods at Tan Chau Station in the Mekong Delta, Vietnam (Trinh Hoang Ngan and Bui Duc Long, 2009)

4. Characteristics of Flood Prone Areas

Flood prone areas are all over the world, like coastal areas, river floodplains and inland depressions. It are often sensitive areas with high ecological value. Due to this, to their physical conditions and possible impacts of climate change they are basically unsuitable for development. However, due to their often strategic location there is , especially in densely populated countries, a strong pressure to develop these areas for various types of land use (Schultz, 2006a). Due to this worlds' population is increasingly living in flood prone areas. There are no indications that this tendency will change. Because of the generally fertile conditions and possibility for a rational lay out of the farmers fields and farms, after reclamation we may observe an improvement in agriculture, increase in value of crops, buildings, water management facilities and infrastructure. In quite some cases in a second phase urbanisation is developing in reclaimed lowlands. Due to this the value of urban property, buildings and infrastructure has significantly increased and will further increase in future.

The urbanisation process in flood prone areas will have far-reaching consequences for impacts on the hydrological regimes, water management and flood protection.

Developments in flood prone areas of developed countries may be characterised by a stabilisation, or small growth of the population, but still a significant growth in the value of public and private property. In several of these countries significant flooding is still occurring from time to time, resulting in relatively high damage, but generally only a limited number of casualties (Douben and Radnayake, 2005).

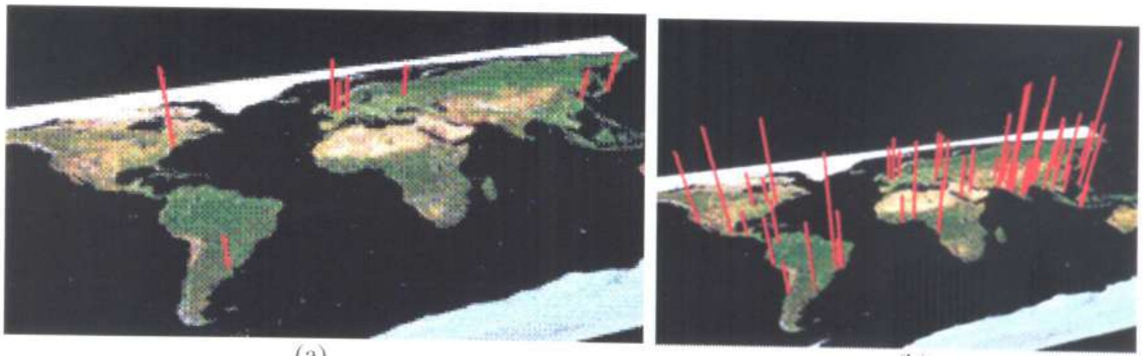
Developments in the emerging countries may be characterised by:

- rapid growth of urban areas resulting in removal of storage areas in the direct surrounding and increase in discharge;
- need for optimisation of flood protection measures related to the increase in value of protected properties and population growth;
- need for modernisation of urban drainage and flood protection systems;
- need to introduce a certain level of cost recovery for drainage and flood protection;

Developments in the least developed countries may be characterised by similar processes as in the emerging countries, although at a slower speed.

4.1 Cities in flood prone areas

Especially in flood prone areas in South and East Asia we may observe a very rapid growth of cities. Most of this growth taking place in the flood prone areas. During past decades cities like: Bangkok, Dhaka, Hanoi, Ho Chi Minh City, Jakarta, Manila, Osaka, Shanghai, Taipei and Wuhan have shown more or less an explosion in population growth and have transformed from less than one - two million inhabitants to in some cases more than 10 million inhabitants. Examples are shown in Figure 4, showing the cities with more than 5 million people in 1950 and in 2015, as well as by the growth of the city of Jakarta as shown in Figure 5. Increase in value of property has been in general even more rapid than the growth of population. As far as flood protection is concerned the level of protection is generally far below the economic optimum, especially in the emerging and least developed countries, but to a certain extent as well in the developed countries. In such cases there is a serious risk of loss of a large number of human lives and serious damage when an extreme event would occur. Costs of physical solutions are generally unaffordable for governments in these countries.



(a) (b)

Figure 4. Cities with more than 5 million inhabitants in 1950 and 2015

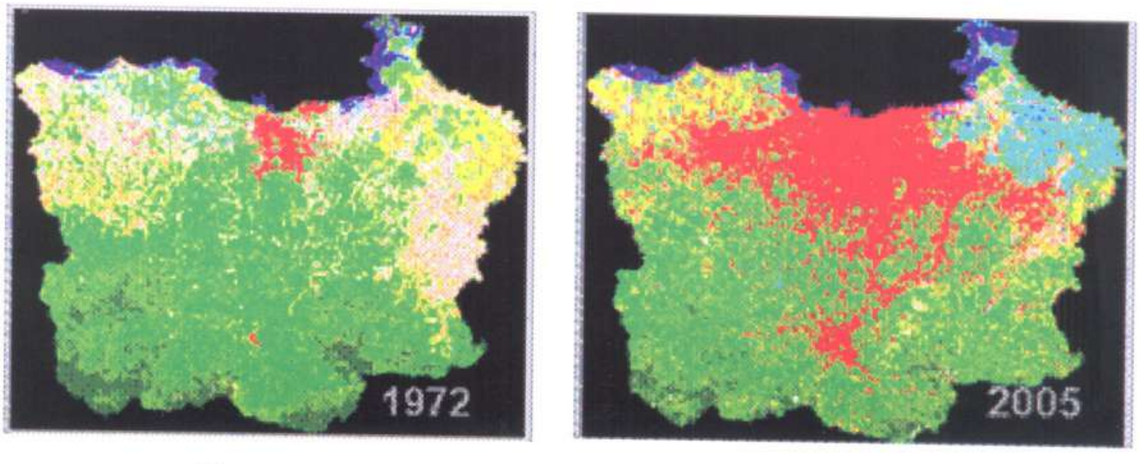


Figure 5. Urban area of Jakarta, Indonesia in 1972 and 2005

Figure 6 shows the statue of a wolf along the dike of Yangtze River upstream of Wuhan, as well as the dike at the same location. At this place the dike has breached several times in the past. The wolf is a symbol to prevent new breaches in future. About forty years ago

Wuhan had about 2 million people. Nowadays there are more than 15 million people. So if the same devastating flood would occur again the damage and casualties will be significantly higher.

Figure 7 shows two sections of the ring dike around the western part of Dhaka in Bangladesh. The dike is a strong dike. However, the level of safety has a chance of occurrence of 2% per year. There live more than 10 million people in that part of Dhaka. When the dike would breach there is water around everywhere and they can go nowhere.

Figure 6. Wolf on the river side of the dike along Yangtze River upstream of Wuhan, China as a symbolic protection

Figure 7. Views of the Ring Dike around the Western part of Dhaka, Bangladesh

5. Interactions of Land Use, Water Management and Flood Protection

If we look at the interactions of land use, water management and flood protection we may observe many problems in the emerging and least developed countries and to a certain extent in the developed countries as well, like: inadequate water management and flood protection, insufficient pollution control, increased damage and casualties due to flooding, operation, maintenance and management problems, negative environmental impacts, and long-term problems due to subsidence and impacts of climate change.

In order to recommend how these problems best can be solved under the different conditions it is first of all useful to analyse who are really the players in this field and what may be their different roles. With respect to this we may show which parties are responsible and which parties are contributing in water management. This is shown in Figure 8. A similar Figure can be made for flood protection.

In addition it is important what measures are in principle available for flood protection. Here a distinction can be made between structural and non-structural measures (Working Group on Non-structural Aspects of Flood Management, 1999 and Van Duivendijk, 2005):

- *structural measures:* dams, dikes, storm-surge barriers, etc. In fact it concerns physical provisions to reduce the risk of flooding;
- *non-structural measures:* flood forecasting, flood warning, flood mapping, evacuation plans, land use zoning, etc.

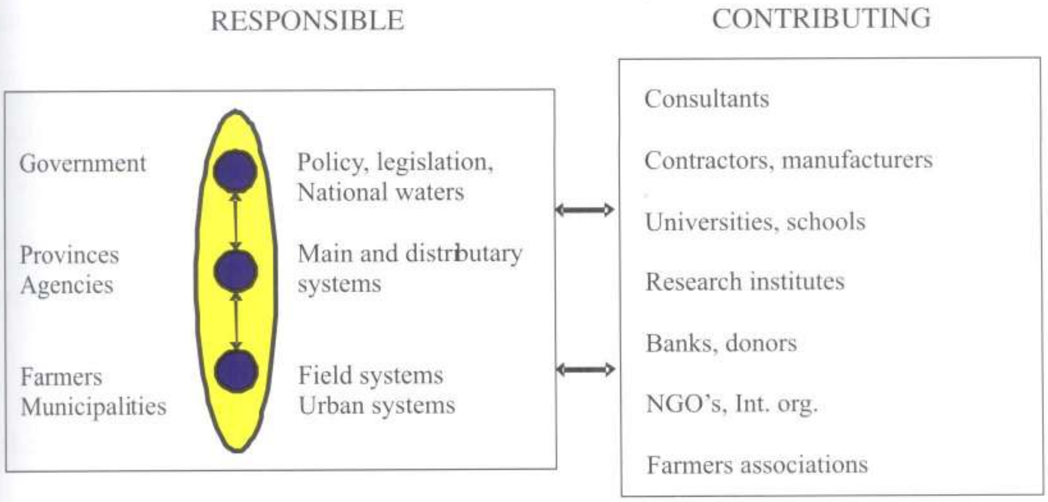


Figure 8. Actors in water management

In practice an integrated package of flood management and flood protection measures for both rural and urban areas would have to be developed at river basin level (Schultz, 2006b).

With respect to the strategies or approaches for flood protection three principle strategies can be distinguished, being:

- put relevant infrastructure and valuable buildings and structures relatively high and accept flooding of less valuable parts;
- protection with submersible dikes that protect the lands against regular floods, but are overtopped during more extreme floods;
- high level of protection with dikes that only fail in extreme events.

Within the strategies as shown above two other important issues may be listed, being:

- locate urban (valuable) areas higher, than surrounding rural areas;
- within rural areas, locate farm buildings higher than the cropped area;
- within urban areas, locate houses and buildings the highest, then the streets, and finally the parks and green areas.

A special aspect that may occur in coastal areas, or in peat areas is land subsidence. This is especially a problem in humid tropical peat soils where after reclamation a subsidence may occur of 10 – 15 cm per year (Figure 9). Due to this in time the lands will become lower, which may have very significant consequences for water management and flood protection. With respect to water management this may imply that drainage by gravity in time will have to be replaced by drainage by pumping. In case of agriculture this may make agricultural exploitation unfeasible and may lead to abandoning of the area leaving it in a devastating condition.

If we summarise the impacts of climate change and man induced changes in land use for flood prone areas, than the following can be stated:

- *climate change - impact 10 – 30% per century:* rise of the mean sea level, change in river regimes and increase in peak discharges of rivers, and increase in annual rainfall and in peak rainfall;
- *impact of human activities - Impact 100 – 1,000% per century:* increase in population, increase in value of public and private property and increase in value of crops.

The effect that the increase in value of property may have on design standards for flood protection works is indicated in Figure 10. In this theoretical figure the costs for flood protection measures are given for different design frequencies of the safety for a supposed situation in 1960. In addition the estimated damages as related to the design frequencies are given, based on the value of protected buildings, infrastructure and properties at the supposed value of 1960. An economically 'optimal' design is obtained when the total of costs and damages would be minimum. For the 1960 situation such an optimal design would in this theoretical example be in the range of a chance of occurrence of 1/1 per year to say 1/50 per year. In addition Figure 10 shows what the damage would be in 2010, when the same frequency for the design of the flood protection works would be maintained and the values in the protected area would have increased ten times during the 50 years. In many flood prone areas this is an increase, which easily has occurred in reality. So, finally in Figure 10 the total line is given for the 2010 situation, based on the assumptions as outlined before. From this line it can be observed that the design chance of occurrence of 1/1,000 per year. This would mean significant investments in flood protection, just to maintain the economic optimal level. Final conclusions can only be drawn when the cost figures for designs at this safety level would be determined. In this theoretical example the increase in number of people in the flood prone area has even not yet been taken into account.

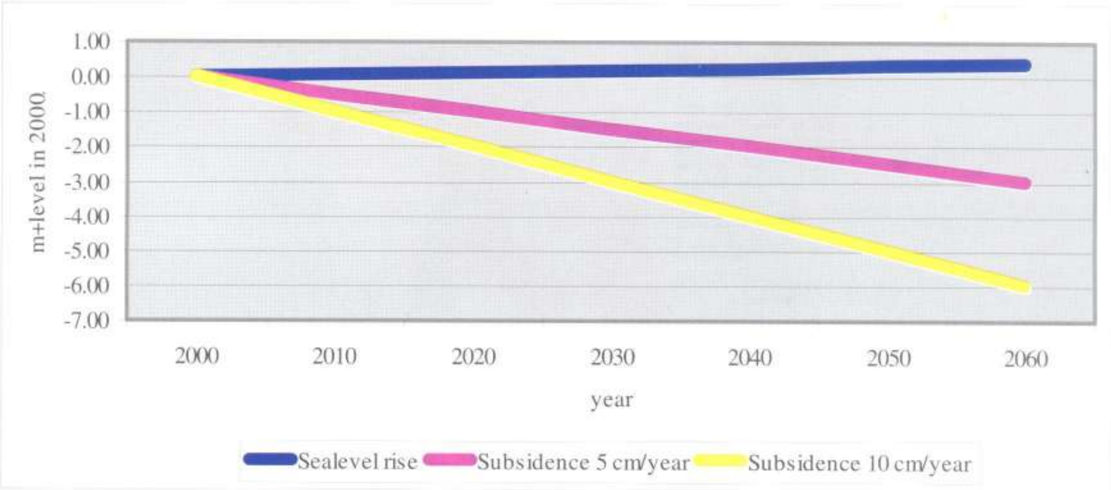


Figure 9. Possible impacts of sea level rise and land subsidence

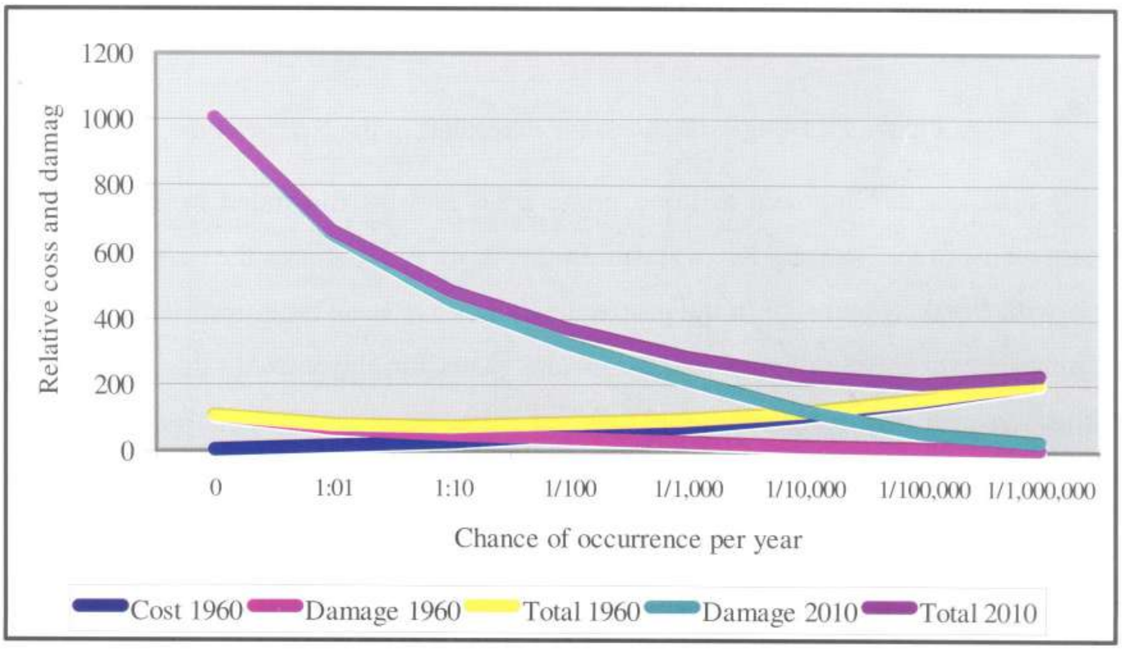


Figure 10. Interactions between design frequency, costs and damage

Finally Figure 11 shows the safety standards for flood protection in the Netherlands.

Finally Figure 11 shows the safety standards for flood protection in the Netherlands. Although this are the highest safety standards for flood prone areas in the world we know that especially for the densely populated western part of the Netherlands they are below the level that would belong to the economic optimum. Reconsideration of the standards is on-going and we have to see what the final decision with respect to them will be.

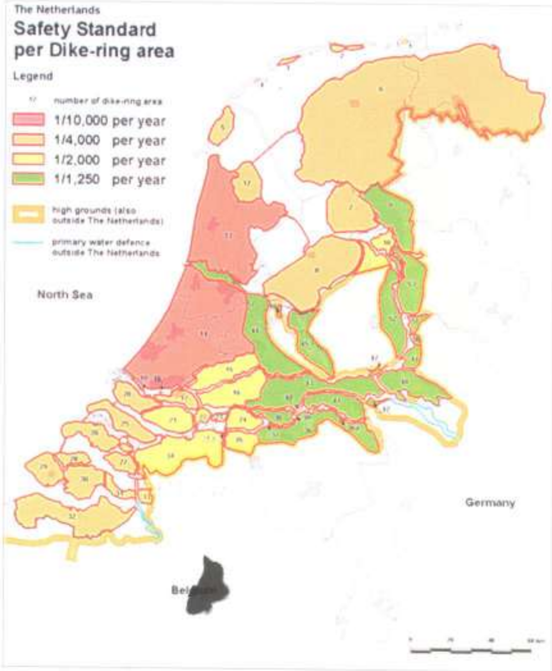


Figure 11. Design standards for dike rings in the Netherlands

A very different development in flood prone areas may be illustrated by the envisaged developments in the Mekong River Basin. In this basin for centuries the people have been living with floods (Figure 3). In the past some dams have been built upstream in the river in China. However, there are nowadays serious plans for eleven more dams, mainly for hydropower and irrigation (Figure 12). When these plans will indeed be implemented there will be a significant change in the hydrology of the river due to removal of peak floods and deposition of sediments in the reservoirs. The first aspect will have the advantage of reduction of damage due to floods, but will also have negative impacts for especially recession agriculture and fisheries in Ton Le Sap lake in Cambodia and for agriculture in the Mekong Delta. The deposition of sediments in the reservoirs will significantly reduce the deposition of fertile sediments in the same locations.

In light of the above critical issues with respect to flood protection will be:

- countries need a development strategy, taking into account, short, medium and long term perspectives;
- need for a strong Central Government for policy development, standards, laws and supervision;
- the need for development of integrated flood management packages, especially for densely populated flood prone areas need to be carefully developed and implemented;
- the need to put responsibility and funding for operation, maintenance and management of water management and flood protection as much as possible with stakeholders;
- the need to develop improvement works in close consultation with the stakeholders. At least partly funding by them.

Figure 12. Existing and projected dams in the Mekong River

The flood protection measures themselves can best be developed based on the so-called safety chain. Such a chain will consist of five components:

- *pro-action.* Removal of structural causes of disasters to prevent that they might occur;
- *prevention.* Measures to prevent accidents and disasters and reduction of consequences if they nevertheless occur;
- *preparedness.* Measures to take care that one is sufficiently prepared to combat accidents or disasters when they would occur;
- *response.* Actual combat of accidents and disasters;
- *aftercare.* Activities with result that effects of accidents and disasters will be repaired as fast as possible and enable affected persons to get back to normal situation and relations as soon as possible.

Pro-action concerns removal of structural causes of disasters in order to prevent that they occur. One can think of removal of abandoned structures and buildings, 'illegal' developments in the floodplain or river foreland, giving room to the river by lowering the river bed, removal of dike sections and replacement of dikes inland, making by passes, etc. (Figure 13).

Prevention concerns the measures to prevent accidents and disasters, and reduction of consequences if they nevertheless occur. One could think of: flood forecasting (Figure 14) and flood warning, as well as of the structural measures that in principle can be taken. With respect to the design criteria, it is of interest that nowadays increasingly these are being based on a risk analysis in which the various failure mechanisms are being taken into account (Figure 15).

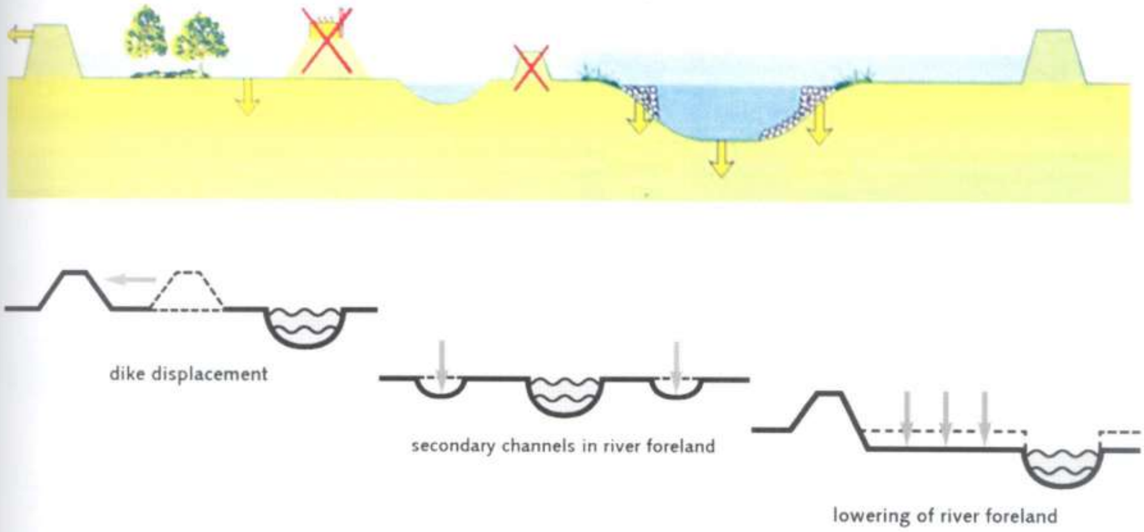


Figure 13. Measures to remove objections and to give room for the river

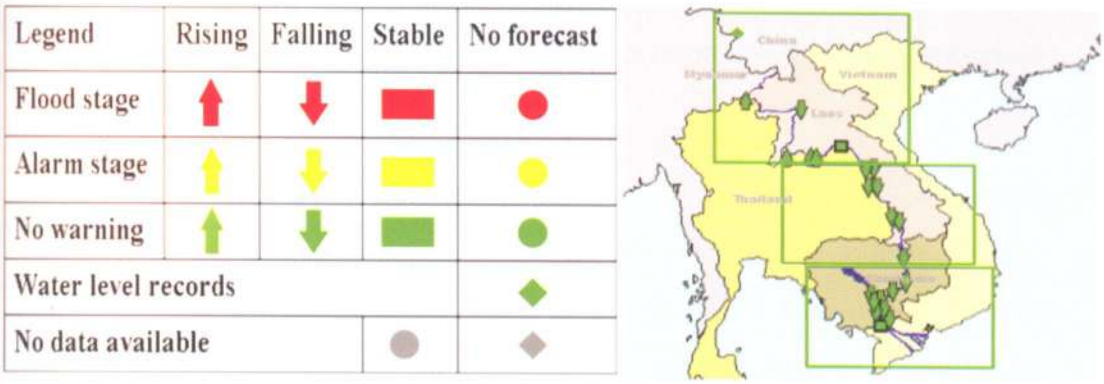


Figure 14. Basic elements of the flood forecasting site of the Mekong River Commission

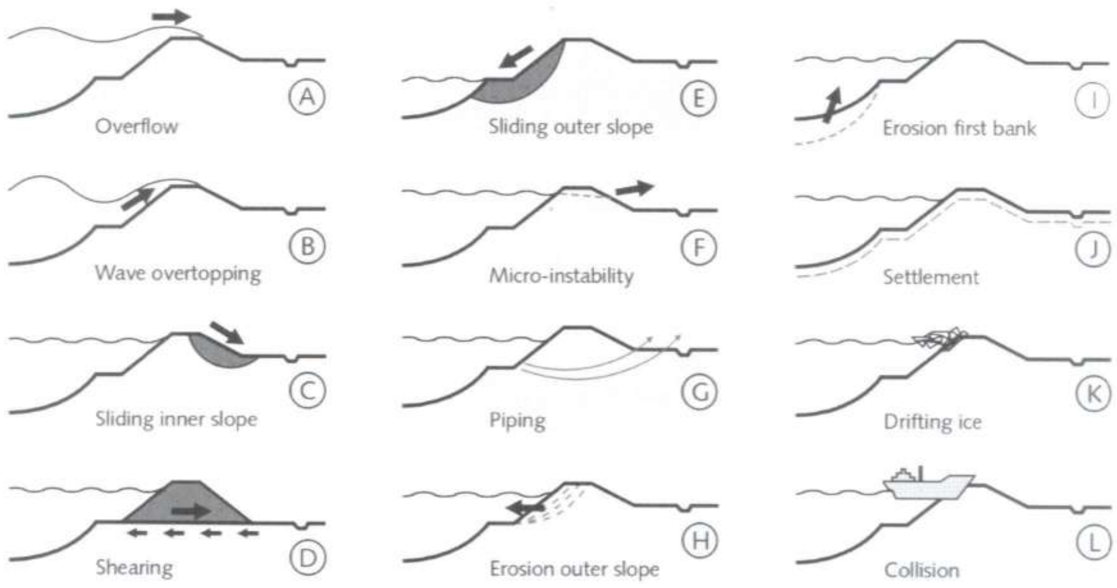


Figure 15. Failure mechanisms of dikes (Technical Advisory Committee on Water Defences, 2000)

With respect to the cost – benefit relations the following developments may be listed:

- from overtopping to risk of flooding with designs based on failure mechanisms and a risk based approach and analysis per dike ring;
- detailed investigation of damage;
- determination of optimum design standard, based on economic criteria and loss of human lives;
- robust designs taking into account future developments that may be expected.

Preparedness may involve the following items:

- measures to be sufficiently prepared to combat accidents or disasters when they would occur;
- temporal structural measures (sandbags);
- evacuation plans, refugee mounts, communication, medical aid, food and drinking water supply.

Response may concern the actual combat of accidents and disasters, in fact controlled implementation of the preparedness measures during a calamity.

Finally after care may concern activities with result that effects of accidents and disasters will be repaired as fast as possible and enable affected persons to get back to a 'normal' situation and relations as soon as possible, cleaning, repair, reconstruction, initial aid to those that are hit, and reactivation of public services and economic activities.

6. Role of Tertiary Education and Research

The role of tertiary education may concern to educate top level civil servants in such a way that they either can oversee the relevant processes and their interactions, or become high level specialists in such a way that they can enter in contracts with and supervise private sector in required measures, or to educate top level private sector staff. This would preferably have to be done by local universities, but for a certain share of the students by internationally operating universities and institutes. A new development concerns joint MSc and PhD programmes.

In light of the above the challenges for tertiary education are:

- educate the required number of future hydrologists, hydraulic engineers, water managers and related specialists and generalists;
- develop and implement needed research to enable direct answers to questions from policy and practice over say five years. This is important, while policy and practice often need direct answers and is not in a position to wait for several years;
- how can scientific findings more effectively be transferred to practical technologies, economic and institutional improvements, especially in emerging and least developed countries.

The processes and practices as outlined above hold several promises for international cooperation in tertiary education and research. In describing these practices, the distinction in the three groups of countries will be maintained, while each of these groups will have its own characteristics and requirements. In fact, there are various options for education and research with their interactions as summarised in Figure 16.

6.1 Curriculae

The curricula for tertiary education would have to be based on the requirement of integrated approaches and conceptual thinking with respect to water management and flood protection. This implies that during the programme students have to be made familiar with newest developments in techniques. However, they also need to understand which techniques would be most applicable under their local conditions.

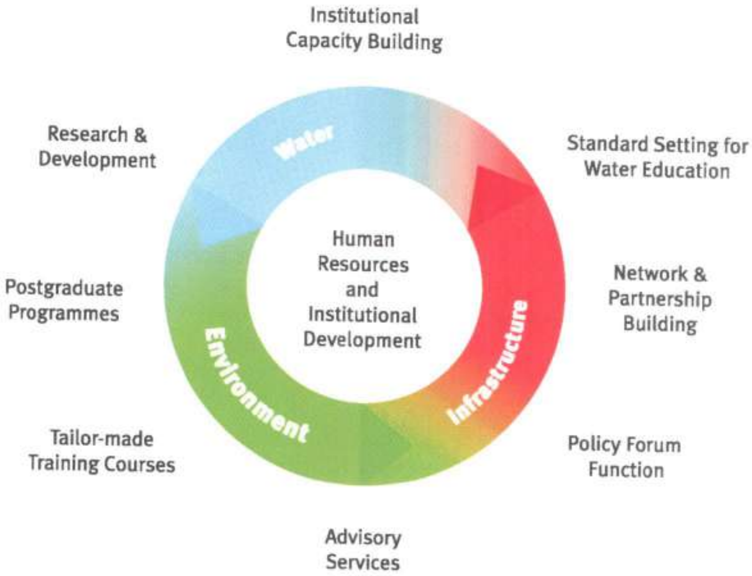


Figure 16. Various options for education and (joint) research with their interactions

7. Challenges for Education and Research

Before describing the needs for education and research for the future generation of hydrologists, hydraulic engineers and water managers some important points have to be addressed. In order for this to occur, it has to be realised that quite a wide gap has developed between research progress and results and the practice of water management and flood protection. In fact, many formulas, models, information, equipment, and other tools are available to design, operate and maintain water management and flood protection schemes under a wide range of applications. The real question in practice is often what would be the 'optimal' system under the local conditions, and what changes may be required in future, due to envisaged changes in societies and possible impacts of climate change (Schultz, 1993).

With this in mind, it can be stated that in developed countries there is sufficient education capability, and that research is focused on routine practices to identify possible water-induced problems, or is utilized to solve very specific research questions, generally related to the increasing complexity of the schemes, 'optimal' design standards, construction, operation and maintenance requirements, social, economical and institutional aspects. Universities and institutes in these countries may look for cooperation in education and research programmes to attract more students, to become more advanced in their specific research specialities, or to come in a better position to apply for research funds. In the framework of development cooperation they may also associate with universities in emerging or least developed countries in order to support development of education and research programmes in these universities.

With respect to emerging countries, conditions are different, but improving, especially when the governments of these countries take serious interest in dealing with water management and flood protection questions. The recent floods in several emerging countries have also resulted in more pressure on the concerned governments to take the urgently required measures. At lower, middle and polytechnic level the emerging countries may generally have sufficient schools and capability to educate their younger generation and to do the required research to gradually improve water management and flood protection approaches and provisions. At university level, one may also observe rapid improvements at undergraduate and graduate level. However, at post graduate (PhD) level joint education programmes, research and exchange of staff with universities in developed countries may be useful for staff and students of these universities, especially to become more familiar with modern developments, modern teaching methods and exposure to the outside world.

With respect to the least developed countries, the situation is more complicated. Among these countries a difference can be seen between least developed countries in Asia and in

Africa (Taniyama, 2009 and Musa, 2009). In general, least developed countries in Asia have relatively well-developed their water management and flood protection provision although at a level of safety that is significantly below the economic optimum. This is different in the least developed countries in Africa, where the potential has only been developed to a limited extent. For students from these countries, it may be useful to receive overseas education at, graduate and post graduate level. In this way, one may expect that sooner or later conditions will improve and that these countries at least can be relieved from significant damage and comparatively large number of casualties due to hydrologic extremes. Questions with respect to education and research are: how can we best educate the future hydrologists, hydraulic engineers and water managers of the emerging and least developed countries and how can scientific research findings more effectively be transferred to practical technologies, economic and institutional improvements (International Commission on Irrigation and Drainage (ICID), 2009).

8. International Education Programmes

As far as international education programmes and courses are concerned, several types may be distinguished, including regular MSc and PhD programmes, joint or double degree MSc and PhD programmes, short courses and online courses.

8.1 MSc programmes

A wide range of international MSc programmes in the water sector is offered by various universities and institutions in the developed countries, and increasingly by such organisations in some of the emerging countries. A new trend is to organise double or joint degree MSc programmes by a university or institute in a developed country in combination with a similar institution in an emerging country. A key issue with respect to such programmes is whether the credit points for the different components (modules) of the programmes can be accepted by the accreditation organisations in the concerned countries. In the framework of such programmes, exchange of professional staff may take place to obtain a broader experience with education practices in the various universities and institutions.

8.2 PhD programmes

There is an increasing interest and there are increasing possibilities for students from emerging and least developed countries to follow a PhD research programme in a university or institute in a developed country. Such studies are often implemented in so-called sandwich programmes, which implies that the student spends about 50% of her/his time in the home country, primarily to do fieldwork and to collect already available data, and the other 50% in the host university or institute, primarily to work with existing programmes and/or to develop new modules for such programmes or to do specialised laboratory research. In an initial stage, there exists the possibility to pursue double or joint degree PhD research. However, in this case academic procedures may be more complicated, dependent on the requirements in the different countries in which the involved universities are located.

8.3 Short courses

Various universities offer short courses on certain specific topics on a regular basis, such as annual courses. In addition, there may be a possibility of providing tailor-made training, which is generally designed for organisations whose staff requires training on specific topics or seeks to develop a common knowledge base to address future challenges. The focus of the tailor-made courses may be technical, managerial, strategic or operational, depending on the priorities. Generally tailor-made training caters directly to the needs of the organisation. This means that courses can be organized for groups of various sizes, from one or several organizations, sectors or regions. They can be designed to upgrade knowledge and skills, to introduce new technologies, or to strengthen sector performance, to name but a few options. Tailor-made courses can be given in the university, or institute, but also in the home country of the organisation, or organisations who want to follow such courses.

8.4 On-line courses

In the recent years, an increasing number of online courses have been developed by various universities and institutes in a wide range of topics of interest in the water sector. The innovative delivery format makes learning flexible, interactive and effective. It allows participants anywhere in the world to learn at their own convenience, and immediately apply their newly acquired knowledge in their working environment. Online courses are generally intended for professionals working in public and private institutions, non governmental organisations (NGO) and academic institutions.

9. Approach of UNESCO-IHE

UNESCO-IHE has more than 50 years experience with postgraduate education, training and capacity building in water, environment and infrastructure (Figure 17). Since 1957 the institute has educated about 15,000 alumni world wide. The activities focus on capacity building by education and research with a focus on conceptual thinking. Details can be found on the web site: www.unesco-ihe.org. The courses are demand-driven, based on a problem solving based approach and increasingly implemented in partnerships.

Figure 17. The UNESCO-IHE building in Delft, the Netherlands

Focus of the educational programmes has been and will be on:

- need for, required level of service, development and management aspects in the water sector in the emerging and least developed countries;
- impacts of global trends in population growth, urbanisation, increase in standard of living and possible impacts of land subsidence and/or climate changes on water

management and flood protection;

- planning, design, operation and maintenance aspects of water management and flood protection provisions;
- institutional aspects and stakeholder participation;
- environmental, social and financial aspects of water management and flood protection.

Pathways that have been and will be followed are:

- institutional reforms to increase impacts;
- accessing least developed and emerging countries through alumni and regional nodes;
- innovative educational activities by engaging partners (multiple degrees, distant education, short courses, sandwich programmes) to fill capacity gaps;
- multi-lateral research (North-South-South).

A recent development to improve cooperation with universities in emerging and least developed countries is the set-up of tailor made double degree MSc programmes in the field of water management and flood protection. For example as far as lowland development and agricultural water management are concerned, at present there are two of these MSc programmes:

- *Integrated Lowland Development and Management Planning* together with the University of Sriwijaya in Palembang, Indonesia;
- *Agricultural water management for enhanced land and water productivity* together with the Asian Institute of Technology in Bangkok, Thailand.

10. Concluding Remarks

In order to cope with the rapid developments in flood prone areas, especially in the emerging and least developed countries, in the coming decades, these countries will have to significantly improve their water management and flood protection provisions. To a certain extent this also applies to the developed countries. Over the years, a lot has improved in the field of education and research on water management and flood protection in the emerging countries. However, in the least developed countries, especially those in Africa, there is substantial scope for improvement at graduate and post-graduate level. The best students from these countries would have to be enabled to receive their education abroad, especially those who are expected to play crucial roles in the public and private sector with respect to water management and flood protection or those who may be expected to become university teacher after their return to the home country.

As long as population growth, increase in standards of living, urbanisation and industrialisation in flood prone areas goes on, increasingly water management and flood protection provisions will be required.

Climate change and land subsidence create complications, which make flood prone areas increasingly vulnerable. This may require to abandon such areas in medium, or long term future. If this would become actual in an area there is need for timely and complicated measures.

Flood management and flood protection measures are generally taken after a flooding disaster and not before. Many casualties and substantial damage would have been prevented when the same measures would have been taken before the disaster, but it looks like our societies are not able to take such decisions in time.

We may sincerely hope that the future hydrologists, hydraulic engineers, water managers and related specialists and generalists will have the required skills to cope in an adequate way with the future water management and flood protection questions and provisions resulting in improved conditions for those who will live in the flood prone areas. Advanced tertiary level education would have to play a major role in achieving this.

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Water Resources Education in South Asia: Experiences of the Crossing Boundaries Project

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1. Introduction

IWRM principles are accepted in all national water resources policies, but still have little force in practical terms. Operationalisation of the concept requires new human, organisational and technological capacity. The regional evolution and elaboration of the IWRM concept in South Asia requires a regional knowledge base and a regional human resources base. It was observed that as far as 'integration' and 'interdisciplinarity' are concerned, there are huge gaps in the South Asian knowledge and human resource base. A very major gap exists as far as gender & water issues are concerned: in terms of both female participation in the water resources sector, and knowledge and research on gender & water issues. In order to address these deficiencies, Crossing Boundaries (CB) project, a regional project on capacity building in integrated water resources management, gender and water is implemented in four countries in South Asia from 2006 to 2011 with the funds provided by the government of the Netherlands (SaciWATERs, 2004).

The CB project aims to contribute to the paradigm shift in water resources management in South Asia, summarised in the concept of IWRM (Integrated Water Resources Management), by means of a partnership-based programme for capacity building of water professionals on IWRM and gender & water through higher education, innovation and social learning focussed research ('research with an impact'), knowledge base development and networking.

SaciWATERs, the South Asian Consortium for Interdisciplinary Water Resources Studies, based in Hyderabad, India and the Irrigation and Water Engineering group at Wageningen University, implements the project with six Partner Institutions (PIs) of South Asia, namely;

- Bangladesh Centre for Advanced Studies (BCAS), Dhaka, Bangladesh
- Institute of Water and Flood Management (IWFM), Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh
- Centre for Water Resources (CWR), Anna University, Chennai, Tamil Nadu, India
- Tata Institutions of Social Sciences, Mumbai, India
- Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka and
- Nepal Engineering College of Pokhara University, Kathmandu, Nepal.

The activities of the project take place at two levels, the national and the South Asian. The university partner institutions implement the national level activities. The regional South Asia level activities are coordinated and implemented by SaciWATERs. For implementation of the project the CB Project Office was established in Hyderabad, India, in the SaciWATERs office. Wageningen University provides support and backstopping activities at both the South Asian and national levels, and selected substantive inputs. Wageningen University is the budget holder of the project and the DGIS of the Government of Netherlands is the contract partner.

2. Objectives and Activities of the Project

The project has three major objectives as listed below.

i) Educate a critical mass of South Asian water professionals trained in interdisciplinary analysis and design of intervention strategies for integrated and gender-sensitive water resources management and contribute to a more balanced gender composition of the community of

South Asian water professionals *(human resources capacity development & gender balance objective).*

ii) Conduct innovation and social learning focussed research in concrete development intervention settings, in partnership with water resource users and other stakeholders, as the core element of the capacity building *(research and innovation for development objective).*

iii) Develop a knowledge base for capacity building on IWRM and gender and water issues, and provide a platform for exchange, discussion and collaboration at the South Asia level through networking, publications and workshops/conferences *(knowledge base and outreach objective).*

An overview of the activities to be undertaken by the project organised by specific objective is presented below.

<u>Specific objective 1: Human resources capacity development on IWRM and gender & water in South Asia</u>

1.1 Provide 175 fellowships to active water professionals (154 female; 21 male) for obtaining a degree in an integrated water resources Masters programme, and provide short-term courses on IWRM for about 435 participants.

1.2 Introduce or strengthen three course modules in partners' institutions programme on a) IWRM, b) gender and water in South Asia, c) interdisciplinary field research methodology.

1.3 Conduct 10 two-week staff training programmes for staff of partner institutions.

1.4 Facilitate exchange of staff and students among partner institutions.

1.5 Hold 5 two weeks regional workshops for women Masters and Diploma candidates.

<u>Specific objective 2: Innovation and social learning oriented research</u>

2.1 Conduct innovation and social learning focussed research in concrete development projects.

2.2 Conduct one 6-7 week staff training on field research methodology.

2.3 Hold yearly research workshops for 20 South Asian researchers working on IWRM topics, and stimulate joint and comparative publication.

2.4 Hold two international conferences on water resources policy in South Asia for researchers/educationists, policy actors and practitioners.

Specific objective 3: Knowledge base development and outreach

3.1 Produce a series 10 readers on water resources management issues in South Asia.

3.2 Strengthen library and Internet resources of South Asian partner organisations.

3.3 Strengthen Women and Water Professionals networks in the South Asia region and establish linkages with other gender & water networks.

3.4 Collaborate and exchange with other IWRM research, education and networking programmes

These activities are implemented by the project partners either individually or jointly. The project office at SaciWATERs in Hyderabad, India coordinates the activities o the project.

3. Activities of education component

There are three important activities conducted under the education components, namely curriculum development and staff training, teaching case development and workshops for South Asian Water (SAWA) fellows (*Note: The students who were given fellowships at each PIs through the CB Project were have been identified as SAWA fellows*)

3.1 Curriculum Development and staff training

The education activities of the CB Project were initiated with the training in the Netherlands and Spain with academics of PIs attending the field research methodology course. A subsequent staff training programme was conducted in Dhaka, Bangladesh to tailor-made the course for the south Asian context. Two additional staff training in IWRM and Gender was also conducted in the first year thus facilitating the introduction of three new courses, such as (1) Field Research Methodology; (2) IWRM and (3) Gender and Water in all PIs.

During the following four years, demands for more training on different aspects of IWRM came from the academic staff of PIs. Accordingly, SaciWATERs organized 6 two weeks staff training programmes in the region. The topics included, a) Water and Equity, b) Water and Ecosystems, c) Water and Economics, d) Climate Change, e) Water and Health, and f) Water Rights. In order to make the Pis as national training hubs, two Training of Trainers (ToT) were conducted in IWRM and Field Research Methodology in year 2010. These series of staff training has helped to improve the curriculum along with teaching and research in IWRM at each PIs.

3.2. Teaching Cases Development

One of the main thrust areas of the CB project was to develop 'pedagogic material' for teaching IWRM in the engineering institutions, especially at the master's level. Experts have been of the view that teaching interdisciplinary courses should be interactive between the teachers and students and not follow the teaching method for engineering studies, which is a monologue of teachers. The project focused on developing 'case studies' with Tata Institute of Social Sciences leading this project component with faculty members from the three partner engineering institutions, viz., NEC, CWR and PGIA. Ten illustrative cases for teaching IWRM were prepared by a team of ten faculty members from these PIs. In addition, BCAS and BUET also developed 6 case studies. These cases cover different themes under the rubric of IWRM such as gender dimension of water sector, pollution of water, traditional institutional/governance arrangements, contestation/ claims on water etc.

3.3. Annual regional workshops for SAWA fellows

One of the most important activities of the project is to bring SAWA fellows of four PIs to one place for a two weeks programme for field training. The objective of bringing them together for this training is to provide them theoretical understanding on topics like social structure, social relations, institutional issues that determine water management and one week training on participatory field research methods. In addition this activity has helped them to share their own cultural setting and exposed them to issues related to IWRM in the region. The location was rotated in each year as five SAWA trainings were conducted in, Mumbai, India(2007), Katmandu, Nepal(2008), Kandy, Sri Lanka (2009 and 2011), and Dhaka, Bangladesh (2010).

4. Research

While new research and innovation in the different water resources disciplines is important, the notion of 'integration' remains elusive, particularly that between natural/technical science perspectives and social science perspectives. Innovative research is, therefore, needed to enhance the IWRM knowledge base. Such knowledge is best developed in the concrete context of real water resources management problems, and efforts at intervention, transformation or reform towards IWRM.

The CB Project provided support to each south Asian partner institution to carry out this innovative research programme by providing resources to enrol 4 research coordinators, 15 PhD and 175 masters fellowships during the project period. Inputs from the CB Staff, funds for research activities and stakeholder meetings have been provided by the CB Project.

4.1. Proposal formulation for research

The formulation process of the research programme for PIs started with the appointment of PIs' Research Programme Manager (PRM) from each PI. They are permanent staff members of the PIs and expected to coordinate the research programme. A training programme was conducted for RPMs to ensure that research programme address a "problem" and also produce "an impact" at the conclusion of the project. How it is to be done through "participatory" methods through an "interdisciplinary" approach were also discussed. Each PIs formulated their research themes with their colleagues and held stakeholder meetings before making their final presentation in front of group of invitees at the South Asian Regional meeting to generate intensive discussion and get their feed back.

These final research proposals gave broad thematic area under which the PhD and Master's research studies have been conducted.

The following sections describe the implementation of the research programme at one of the PIs, namely PGIA to explain the process followed.

4.2 Research programme at the PGIA

The goal of the research programme at the PGIA in Sri Lanka under the CB Project is to improve water quality of the river Mahaweli in order to provide good quality water for domestic, irrigation, hydropower and recreational purposes in a sustainable manner while maintaining the health of water resources and associated ecosystems.

The overall objectives of research programme are to;

- Introduce technically sound, economically feasible, environmental friendly and socially accepted approaches and techniques to reduce the pollutant loads to the reach of Mahaweli from Kotmale dam to Randenigala reservoir, and
- Strengthen the formal and informal institutional mechanisms related to water pollution issue in the study area to improve the effectiveness of their activities considering technical, social, financial and environmental dimensions.

The water pollution issue is interconnected and hence need to identify the network of issues to be researched. Therefore, mapping of the issues related to the problems reveals the contributing causes and their connectivity as described in Figure 1. Accordingly, the five sub themes were identified for the formulation of main research questions as follows:

- Solid waste disposal
- Health and sanitation in estate and rural communities
- Soil erosion and landslides
- Low cost wastewater treatment techniques
- Institutional and financial sustainability of urban and rural water supply and sewerage systems.

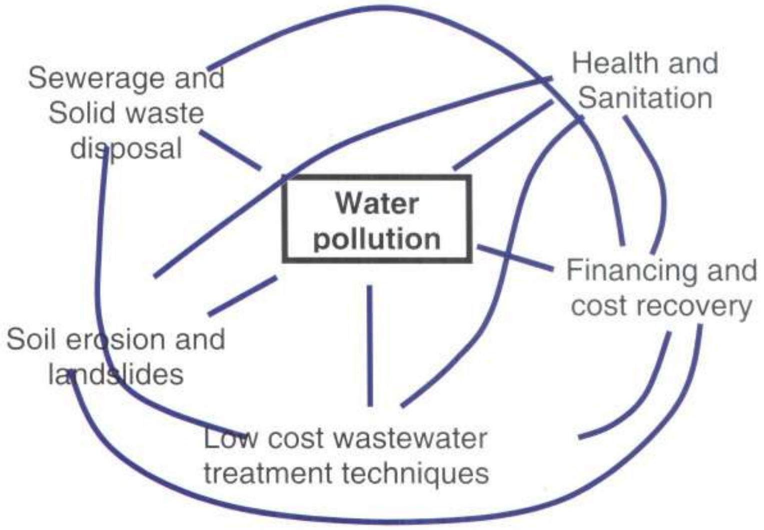

Figure 1: Mapping of issues related to water pollution

This research programme has been designed for the M.Sc., M.Phil and Ph.D. students (Total number of 45 (24 M.Sc., 16 M.Phil. and 5 Ph.D.) of the Integrated Water Resources Management (IWRM) postgraduate degree programme of the PGIA. The research programme is mostly concentrated on the research areas of five Ph.D. students. Sub components of the main research can be undertaken by the M.Phil and M.Sc. students.

Five PhD Students with different disciplinary background was awarded the fellowships under the CB Project at the PGIA to lead the five themes selected. The continuous dialogue between academic staff, CB Research Coordinator and PhD, MPhil and Msc students helped to formulate the research programme in such a way to address all the aspects in a holistic and interdisciplinary manner. The members of Research Advisory Committee (RAC) were invited at regular intervals for presentations of students so that their advices also could be incorporated to the research programme as it develops.

4.3 Appointment of Research Coordinator and Research Advisory Committee

Under the CB Project a Research Coordinator was appointed for each of the PIs with the main responsibility of providing guidance to students and arrange logistics for research programme. It was unanimously decided by the CB Team and the PIs that the ideal Research Coordinator should have a Ph.D in relevant engineering discipline with background in social science or a Ph.D in social science with working experience in water sector.

The TOR of the Research Coordinator are as follows:

- Provide day-to-day guidance to the PhD fellows, in collaboration with the academic supervisors of the PhD fellows
- Ensure integration between Ph.D and M.Sc theses
- Organise and facilitate the process of stakeholder involvement in the research programme.
- Organise and facilitate interaction of the research activities with the policy & practice domain: assure 'impact' of the research
- Liaise with government agencies with direct stake in the research programme
- Conduct own research in the programme and publish
- Do administrative and financial day-to-day coordination of the research component
- Liaise and interact with counterparts in other PIs and CB Office.

The Research Advisory Committee (RAC) was expected to play a major role in assuring its relevance and help to incorporate the findings to practice and policy. Under the Project, all the PIs established a RAC to advice and provide support to implement the research programme. This PAC comprised of researchers, policy makers, practitioners, professionals, academics, NGOs etc so that they would be able to provide:

a) Access to networks and organisations in the research area.
b) Expertise that is complementary to the expertise available in the PIs.
c) Links with policy and practice, which can help to assure 'impact'
d) Links with stakeholders groups/organisation

This committee does not have any legal binding with the institution and, therefore do not have any involvement in academic matters of the PIs. The RAC acts as a sounding board and platform for discussion in addition to provide advice. Formal decision-making is located within the PI which convenes the RAC at regular intervals. The members of RAC are invited for various activities organized by the CB Project in each PI, such as regional workshops, symposiums etc.

4.4. Participatory approach

Partcipatory apprecha has been used from the inception of the CB research programme at each partner institutions unlike conventional individual technical research that the selected PIs of CB project is used to. The feedback received from these stakeholder meetings have been incorporated in the research proposals.

The methodology of almost all proposals included the use of technological tools such as physical and numerical modeling approaches, GIS and remote sensing, design and development of novel technology, instrumentation etc. However, all sub-themes has also used various Participatory Rural Appraisal (PRA) tools along with social and gender analysis tools. Special attention was paid to variables such as key stakeholders, social and gender relations, institutional linkages, etc. In addition, the researchers worked closely with the existing projects and networks related to water pollution in the area such as field based NGOs, foreign funded projects, major water supply and sanitation service providers of the central and local government, private sector and civil society organizations.

4.5. Regional and International Conferences

To source 'frontline' research and enhance knowledge development in the field of IWRM the CB project organised yearly workshop of South Asia based IWRM/water resources researchers, around specific themes with competitive application for participation. This has allowed the project to benefit from the ongoing research in the region and influence the regional research agenda. The workshops also served as a benchmark for the research undertaken by the PIs. These regional research workshops have facilitated 20-30 South Asian researchers in each year working on IWRM topics to get together and discuss their findings. The themes, country and year of five regional research workshops held by the CB project is given below:

a) Water Access and Conflicts: Implications for Governance in South Asia, India, 2007
b) Water supply, sanitation and wastewater management in South Asia, Sri Lanka, 2007
c) Innovative modelling for IWRM, Bangladesh, 2008
d) Climate Change and Livelihood, Nepal, 2009
e) Water Governance in South Asia, Bhutan, 2010

The facilities were also provided to selected SAWA fellows to present their research findings in front of a learned audience during these research workshops since 2008.

For macro policy impact at the South Asian regional level, the CB project organised two international conferences in which the research-policy interface was the organising principle. The conferences also provided a forum for presentation of PIs research and innovation activities. The first conference was organized in December 2008 under the theme on "Water Resources Policy in South Asia". The second one on "Interdisciplinarity in Water Education: Challenges, Perspectives and Policy Implications for South Asia" was held in October 2010 in Kathmandu, Nepal.

5. Knowledge base development and outreach

This activity is expected to produce a series of readers with basic reading material on water resources issues in South Asia largely written by South Asians. On each topic a workshop was held, with commissioned papers. The papers are the base material for the book/reader to be brought out. Already two readers, one on "Integrated Water Resources Management: Global Theory, Emerging Practice and Local Needs" and the second on "Drought and IWRM in South Asia: Issues, alternatives and futures" were published by Sage, India and available for sale. The other volumes with the publisher includes, Gender and Water in South Asia, Water Conflict in South Asia, Civil Society and Governance, Ecosystems and IWRM in South Asia, Water and Health, Water Rights, Water Resources Policy in South Asia and Water Governance.

6. Women water professional (WWP) network

The CB project made a special effort to contribute to gender balance in the water (education) sector. In this activity support was provided to networks of women water professionals in the region. One of the activities undertaken included a situation analysis of WWP in India, Nepal, Bangladesh and Sri Lanka. The findings were widely disseminated through publications and also presented at the Stockholm Water week in 2009. Documenting life histories and professional experience of WWP in the water sector was completed in order to increase the visibility of WWP in the region. This output was disseminated as a CD version and the printed version is expected soon. A series of training programmes in IWRM for WWP was conduced in Bhutan, Nepal, Pakistan, Bangladesh and Sri Lanka to strengthen the WWP networks.

7. Concluding remarks with reflections

The most significant achievement of CB project is the initiation of interdisciplinarity in education and research in the engineering PIs in the four South Asian countries. The common staff trainings and curriculum development process has brought in a shared sense of understanding about the needed paradigm shift in the water sector. The major advantage is that there are now some "converts" in the faculty in all PIs who might work as future torch bearers of the CB sensibility. These are mostly middle level faculty who has enough experience to understand the need for a paradigm shift and who recognizes the professional incentives associated with it. Some of them are in great demand as trainers for various organizations (Narayanan and Kansakar, 2010).

This problem based, interdisciplinary research conducted through stakeholder participation to have an impact was new to all PIs. The traditional practice is to guide the student by the respective supervisor for a specific research project with clear objectives. In this case, academic staff along with the students addressed a common theme in different angles to address a major water management problem identified by the institution. Regular meeting of the academic staff, students and members of the PAC were held to make sure that all the individual research projects are interlinked while ensuring that repetitions are avoided. Closer interaction of all parties, especially the PhD candidates has ensured the cohesion and integration of the problems from different angles. The entire research programmes at each PIs were steered through a learning process with regular course correction by interaction, monitoring and intervention as this was a new experience for all those who participated in this project.

The interdisciplinary research programme conducted under the CB project was conducted with stakeholders. The cohesive thrust of research activities with the stakeholders has helped the water sector institutions to recognize the usefulness of findings to resolve some of the issues that they have been grappled with in the past. Some of the impacts of these research studies are very direct, quick and tangible whilst many other impacts are not so clear and the benefits could not be assessed in an objective manner (Gunawardena et al, 2010). The interventions in terms of changing policies and institutional reforms could have substantial impacts if pursued consistently through advocacy.

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Professor Dr. Latif, Director, Centre of Excellence in Water Resources Engineering (CEWRE), UET, Lahore has more than 30 years teaching and research experience in Irrigation, Drainage, Water Resources Management, and Conjunctive Use of Surface Groundwater Resources to his credit. He started pioneer work at the Centre of Excellence in Water Resources Engineering since its establishment in 1977. During his initial period of service at the Centre he helped in installation of the equipment in different laboratories of the newly established Institute. He worked with full zeal and established irrigation laboratory at the Centre.

Advance Tertiary Level Education and Research in Hydrology

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Introduction

Centre of Excellence in Water Resources Engineering, University of Engineering and Technology, Lahore is a pioneer institute in establishing postgraduate degree programs leading to M.Sc., M.Phil and Ph.D degrees in Hydrology since 1979. Over the years a number of changes were made in the course contents to reflect the state-of-art and update the curricula to include latest development in modelling, watershed development & management. Specifically the curricula were revised in 1988, 1992, 1998, 2002 and 2007as given in Table 1. Normally, an M.Sc student is required to complete twenty four credit hours course work followed by thesis research. Each student is required to take compulsory courses which are considered to be core courses. However students can choose from the elective or optional subjects in consultation to his/her advisor to fulfil the requirements of the course work. An M.Sc student is also required to present a seminar and submit thesis to qualify for the degree.

For admission in Ph.D degree, the applicant should have M.Sc degree in the relevant discipline. Initially there was no course work required for Ph.D degree but presently a Ph.D student has to pass a minimum of 24 credit hours courses and is also required to qualify for the comprehensive examination after passing the courses. Additionally both the M.Sc and Ph.D students are also required to pass subject GRE type test to fulfil the admission requirement.

To compare the curricula being taught at the Centre, a computer search was made to find the syllabi taught in different Universities/Institutes in different countries as given in Table 2. It is evident from this table that the courses offered at different Universities/Institute differ greatly. Each University/Institute has developed the curricula to fulfil specific goals/objectives.

Table 1: Centre's Curricula

1982	1988
A. Compulsory Subjects WRC-612 Hydrometeorology WRC-613 Statistical Hydrology WRC-614 Stochastic Hydrology WRC-615 Applied Hydrology WRC-616 Groundwater Hydrology **B: Elective subjects** WRC-605 Applied Mathematics-I WRC-606 Applied Mathematics-II WRC-607 Numerical Analysis & Computer Programming WRC-608 Advanced Computer Programming WRC-609 Advanced Numerical Analysis WRC-618 River Basin Development WRC-618 Groundwater Development	**Module 1. Basic Courses** **(Two subjects to be selected)** CEWRE-650 Applied Mathematics CEWRE-651 Numerical Methods WRM-600 Flow Through Porous Media HYD-700 Advanced Open Channel and Fluvial Hydraulics **Module 2. Compulsory Subjects** CEWRE-652 Computer Programming HYD-701 Statistical Hydrology-I HYD-702 Applied Hydrology-I HYD-703 Groundwater Hydrology-I HYD-704 Seminar HYD-705 Hydrometeorology **Module 3. Analytical Aspects** **(Two subjects to be selected)** HYD-706 Applied Hydrology-II HYD-707 Statistical Hydrology-II HYD-708 Groundwater Hydrology-II WRM-605 Water Resources Systems Analysis **Module 4: Design and Operational Aspects** **(Two subjects to be selected)** HYD-709 Groundwater Development HYD-607 Design of Hydraulic Structures WRM-610 Environmental Impact Assessment WRM-611 Remote Sensing Applications in Water Resources

Table 1 (Continued)

1992	1998
Module 1. Basic Courses (Two subjects to be selected) CEWRE-650 Applied Mathematics CEWRE-651 Numerical Methods WRM-600 Flow Through Porous Media HYD-700 Advanced Open Channel and Fluvial Hydraulics **Module 2. Compulsory Subjects** CEWRE-652 Computer Programming HYD-701 Statistical Hydrology-I HYD-702 Applied Hydrology-I HYD-703 Groundwater Hydrology-I HYD-704 Seminar HYD-705 Hydrometeorology **Module 3. Analytical Aspects (Two subjects to be selected)** HYD-706 Applied Hydrology-II HYD-707 Statistical Hydrology-II HYD-708 Groundwater Hydrology-II WRM-605 Water Resources Systems Analysis **Module 4: Design and Operational Aspects (Two subjects to be selected)** HYD-709 Groundwater Development HYD-607 Design of Hydraulic Structures WRM-610 Environmental Impact Assessment WRM-611 Remote Sensing Applications in Water Resources	**A. Compulsory Subjects** HYD-700 Groundwater Hydrology HYD-702 Hydrometeorology HYD-704 Experimental Methods HYD-705 Hydrologic Computations HYD-706 Statistical Hydrology HYD-710 Applied Hydrology **B: Optional (Six subjects to be selected on the advice of the Supervisor)** HYD-701 Catchment Hydrology HYD-703 Reservoir Operation HYD-707 Snow and Ice Hydrology HYD-708 Flood Estimation and Control HYD-709 Groundwater Modeling HYD-711 Groundwater Exploration CEWRE-650 Applied Mathematics CEWRE-651 Numerical Methods CEWRE-655 Remote Sensing Application in Water Resources CEWRE-656 Environmental Contamination CEWRE-657 Flow Through Porous Media CEWRE-658 Numerical Methods **C: To be taken by all students** CEWRE-652 Thesis Project (from the 2^{nd} term) CEWRE-653 Seminar (2^{nd} and subsequent terms)

Table 1 (Continued)

2002	2007
A. Compulsory Subjects	**A. Compulsory Subjects**
HYD-700 Groundwater Hydrology	CWR-601 Applied Hydrology
HYD-702 Hydrometeorology	CWR-602 Catchment Modeling
HYD-704 Experimental Methods	CWR-603 Statistical Hydrology
HYD-705 Hydrologic Computations	CWR-604 Reservoir Design and Operation
HYD-706 Statistical Hydrology	CWR-605 Flood Estimation and Control
HYD-710 Applied Hydrology	CWR-606 Groundwater Hydrology and Exploration
CEWRE-652 Thesis	
CEWRE-653 Seminar	
Options Subjects (Any six)	**Elective Subjects**
HYD-701 Catchment Hydrology	CWR-611 Advance Open Channel & Computational Hydraulics
HYD-703 Reservoir Operation	CWR-612 Dam and Reservoir Engineering
HYD-707 Snow and Ice Hydrology	CWR-613 Design of Hydraulic Structures
HYD-708 Flood Estimation and Control	CWR-614 Sediment Transport and River Engineering
HYD-709 Groundwater Modeling	CWR-615 Physical and Numerical Modeling
HYD-711 Groundwater Exploration	CWR-631 Drainage Engineering
CEWRE-650 Applied Mathematics	CWR-632 Irrigation Engineering and Management
CEWRE-651 Environmental Impact Assessment	CWR-633 Water Quality Modeling and Management
CEWRE-654 Computer Programming	CWR-651 Arid Zone Hydrology
CEWRE-655 Remote Sensing Application in Water Resources	CWR-652 Groundwater Modeling
CEWRE-656 Environmental Contamination	CWR-653 Hydrometeorology
CEWRE-657 Flow Through Porous Media	CWR-654 Snow and Ice Hydrology
CEWRE-658 Numerical Methods	CWR-655 Watershed Planning and Development
	CWR-681 Pressurized Irrigation System
	CWR-682 Land and Water Management
	CWR-691 Environmental Impact Assessment
	CWR-692 Project Construction and Management
	CWR-693 Remote Sensing and GIS Applications in Water Resources
	CWR-694 Water Resources Planning and Economics
	CWR-695 Water Resources System Analysis
	CWR-696 Computer Applications in Water Resources
	Seminar and Thesis

Table 2. **Syllabi taught in different Universities/Institutes**

Sr. No.	Name of University	Degree Title	Course Titles
1	**Boise State University, Boise, USA**	**Hydrology**	Surface Water Hydrology Water Quality and Aqueous Geochemistry Biogeochemistry Global Climate Change Geomicrobiology Fluvial Geomorphology Hydrogephysics Glacial Hydrology Numerical Methods Catchment Modeling
2	**Imperial College, London, UK**	**Hydrology**	• Hydrological Processes • Hydrometry • Irrigation • Mathematical Modeling • Meteorology and Climate Change • Rainfall-Runoff and Flood Hydrology • Stochastic Hydrology • Hydrogeology and Groundwater • Hydroinformatics • Hydrogeology and Groundwater • Urban Hydrology and Urban Drainage • Environmental Management in Developing Countries • Water Resources Management
3	**New Mexico Tech., USA**	**Hydrology**	ERTH-440 Hydrological Theory and Field Methods ERTH-441 Aquifer Mechanics ERTH-460 Subsurface and Petroleum Geology HYD-508 Flow and Transport in Hydrological Systems HYD-510 Quantitative Methods in Hydrology HYD-571 Advanced Topics: Geofluids Modeling GEOL-509 Soil Geomorphology HYD-507 Hydrogeochemistry HYD-538 Advanced Geographic Information Systems HYD-541 Water Resources Management HYD-544 Groundwater Remediation HYD-592 Graduate Seminar HYD-591 Thesis

4	**University of Idaho, USA**	**Hydrology**	HYDR-501 Hydrology Seminar HYDR-504 Water and Energy Interconnections HYDR-509 Quantitative Hydrogeology HYDR-512 Environmental Hydrogeology HYDR-513 Applied Hydrogeologic Concepts HYDR-514 Groundwater-Surface Water Interaction HYDR-518 Geomicrobiology HYDR-564 The Geochemistry of Natural Waters HYDR-566 Groundwater Chemistry HYDR-568 Aquifer Test Design and Analysis HYDR-576 Groundwater Modeling
5	**University Utrecht Graduate School of Bio-Sciences Netherlands**	**Hydrology**	GE04-4404 Land Surface Hydrology GE04-1434 Principles of Groundwater Flow GE04-4417 Unsaturated Zone Hydrology CE04-4420 Stochastic Hydrology GE04-4423 Hydrology, Climate change & Fluvial Systems GE04-1433 Hydrogeological Transport Phenomena GE04-1432 Environmental Hydrology GE04-1421 Reactive Transport in the Hydrosphere
6	**University Virije, Amsterdam, Netherlands**	**Hydrology**	• Hydrochemistry • Groundwater Hydraulics • Unsaturated Zone Hydrology and near-Surface Hydroloigcal Processes • Catchment Rainfall Runoff response Modeling • Regional Hydrology and Groundwater Management or Ecohydrology • Meteorology or Groundwater Flow Modeling
7	**University of Zimbabwe, Zimbabwe**	**Hydrology**	The Physical World I & II Hydrology Applied Hydrology Water Resources Management Environmental Impact Assessment Geographic Thought
8	**University of**	**Hydrology**	HWRS-250 Principles of Hydrology

	Arizona, USA	**and Water Resources**	HWRS-451 Environmental Hydrology HWRS-461 Environmental and Resource Geography HWRS-479 Economics of Water Management and Policy HWRS-513 Field Hydrology HWRS-519 Fundamentals of Surface Water Hydrology HWRS-520 Water Resources Management Planning and Rights HWRS-524 Hydroclimatology HWRS-528 Systems Approach to Hydrologic Modeling HWRS-549 Statistical Hydrology HWRS-560 Watershed Hydrology HWRS-573 Spatial Analysis and Modeling HWRS-595 Global Climate Change HWRS-630 Advanced Catchment Hydrology
9	**University of Newcastle Upon Tyne, U.K.**	**Hydrology and Climate Change**	Qualitative Methods for Engineering Integrated River Basin Management Sustainability and water Resources Climate Change: Vulnerability Impacts and Adaptations Climate Change: Earth System, Future Scenarios and Threats Hydrosystems Processes and Management Hydrosystems Modeling Groundwater Modeling Groundwater Assessment Hydroinformatics Systems Development Modeling Floods Climate Change and Mitigation Technologies
10	**University of *Southampton*, UK**	**Hydrology *and* Water Resources**	Section A: General Hydrology/Water Resources Assessment *Section B: Groundwater Hydrology &* Hydraulics Section C: Surface Water Hydrology Section D: Planning and Management Issues
11	**Jointly offered by the University of South Australia and University of Adelaide and Flinders**	**Hydrology and Water Resources**	Computing and Hydraulics Water Resources Management Surface Hydrology Water Quality Fundamentals and Processes Hydrogeology Advanced Water Quality Flood Hydrology

			Remote Sensing and Data Visualisation Statistical Analysis in Hydrology Water Distribution Systems Water Resources Planning Urban Hydrology Groundwater and Solute Transport Modeling Waste and Wastewater Treatment

Table 3M.Sc/M.Phil/Ph.D Degrees Awarded to CEWRE Students in Hydrology

Sr.#	Topics of Thesis
1.	Development of synthetic unit hydrographs in small ungauged catchments of Pakistan
2.	Mathematical model for dam-break studies
3.	Probabilistic Analysis of Mangla Reservoir Storage
4.	Statistical curve fitting methods applied to groundwater pumping test analysis
5.	Evaluation of aquifer parameters using sensitivity analysis method
6.	Three dimensional modeling of groundwater flow (Conduit Analogue)
7.	Probability analysis of upper Chenab Canal command releases to meet crop water requirements
8.	Pumping test analysis using numerical method
9.	Application of non-linear storage function model to selected watersheds of Pakistan
10.	A model for soil moisture prediction using best evapotranspiration method
11.	Numerical simulation of a partially penetrating well in confined aquifer
12.	Development of relationships between runoff parameters and catchment characteristics
13.	Regression models for Snyder's Synthetic Unit Hydrograph parameters
14.	Parameter optimization in flood routing
15.	Comparison of periodic auto-regressive stochastic models and flood frequency analysis
16.	Multiobjective dynamic programming and deviation of operating rules for reservoir simulation
17.	Geostatistical modelling to quantify the transmissivity field in an aquifer
18.	Determination of extent of salt water intrusion in bela Plain by using analytical techniques
19.	Stochastic simulation models for solar radiation and evapotranspiration
20.	Regression model for real time flood forecasting
21.	Comparison between Conceptual and Black-Box modelling approaches
22.	Modelling and mapping the evaporation with Sparse Data
23.	Probability analysis of peak runoff and rainfall for selected catchment of N.W.F.P.
24.	Groundwater flow modelling of the Lahore City and surroundings
25.	Application of electrical resistivity method for the assessment of groundwater

	quality
26.	Reliability of Surface runoff estimates using soil conservation service method
27.	Development of a simple procedure to synthesize direct runoff hydrographs for selected catchments in Pakistan
28.	Calibration of Standford Watershed Model for local catchment conditions
29.	A model of exploitation of fresh groundwater lens in Cholistan Desert
30.	Simulation of soil water flow in the unsaturated zone using SWATRE Model for optimal water table regime
31.	The study of probable maximum precipitation techniques for Lahore
32.	Simple Procedure for Developing Flow Duration Curves at Ungauged Sites Using Regionalization Approach
33.	Influence of Snow-Melt-Runoff on Stream Flows
34.	Comparison of Rainfall Excess Computation Techniques
45.	Study of Creep Theory by Using Two Dimensional Finite Difference Computer Model and Its Verification By Electrical Analogue Model
36.	Determination & implementation of flood risk zoning, employing physiographic & hydraulic parameters for flood prone areas of Chiniot Distt.
37.	Sustainable development of groundwater for Gaza Strip in Palestine
38.	Prediction/Forecast of seasonal inflows for Kunhar and Neelum Rivers on the basis of hydro meteorological parameters by statistical approach
39.	Hydrologic design of cross-drainage structures for road in mountainous areas (A case study of Ratti-Gali Bhattian Road)
40	Investigation of runoff regimes and the linkage between climatic variables and river flow in Swat River.
41.	Dominating factor affecting rainfall lag for hill torrent watershed: A case study of the Vidore Hill Torrents
42.	Runoff estimation for various sized catchments using SCS and modified SCS methods and their comparison
42.	Probable maximum precipitation and peak flood analysis for punch River at Kotli Gauging Station
44.	Probabilistic flood risk analysis of Chenab Riverain Area (Langarsaral-Shershah Reach in District Muzaffargarh).
45	Simulation of flow from Kanshi River catchments at Jhangi
46.	Rainfall Runoff Relationship Using Calibrated Strangers Runoff Factor in Select ed Watershed of NWFP.

Technical Session-III

Training Middle Level Managers and Technicians

Dr. Kuniyoshi Takeuchi

Dr. Kuniyoshi Takeuchi is the Director of the recently established International Center for Water Hazard and Risk Management (ICHARM) at Japan's Public Works Research Institute. Dr. Takeuchi served as professor of hydrology and water resources for 30 years at Japan's Yamanashi University. He was also heavily involved in UNESCO's International Hydrological Programme (IHP), a scientific program on water research, water resources management, education, and capacity-building. His involvement included stints in Southeast Asia and the UNESCO headquarters, plus the chairpersonship of the IHP Inter-Governmental Council from 1998 to 2000. From 2000 to the present, Prof. Takeuchi has been chairing the Japan IHP National Committee. From 2000-2004, he served as the President of International Association of Hydrological Sciences (IAHS), the oldest professional society on hydrology, and started a science program on Predictions in Ungaged Basins (PUB), an IAHS initiative for the decade of 2003-2012, aimed at uncertainty reduction in hydrological practice.

International Workshop on Education for Managing Hydrological Extremes and Related Geo-Hazards
January 24-26, 2011
Islamabad, Pakistan

United Nations Educational, Scientific and Cultural Organization

Technical Session-III, Training Middle Level Managers and Technicians

Flood Risk Management Courses at ICHARM

Kuniyoshi Takeuchi

International Centre for Water Hazard and Risk Management under the auspices of UNESCO (ICHARM)

Public Works Research Institute (PWRI)

Tsukuba, Japan

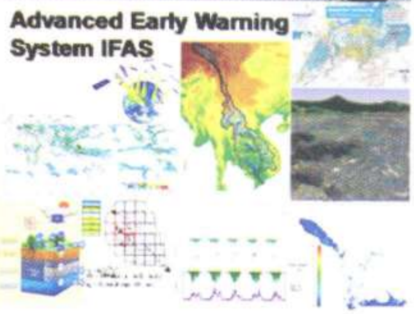
United Nations Educational, Scientific and Cultural Organization

ICHARM

International Center for Water Hazard and Risk Management

under the auspices of UNESCO
hosted by PWRI, Tsukuba

Objective: To serve as the Global Center of Excellence to provide and assist implementation of best practicable strategies to localities, nations, regions and the world to manage the risk of water related hazards including floods, droughts, land slides, debris flows and water contamination



ICHARM's Challenge: **Localism**

Delivering best available knowledge to local practices

ICHARM's Challenge: **Localism**

Delivering best available knowledge to local practices

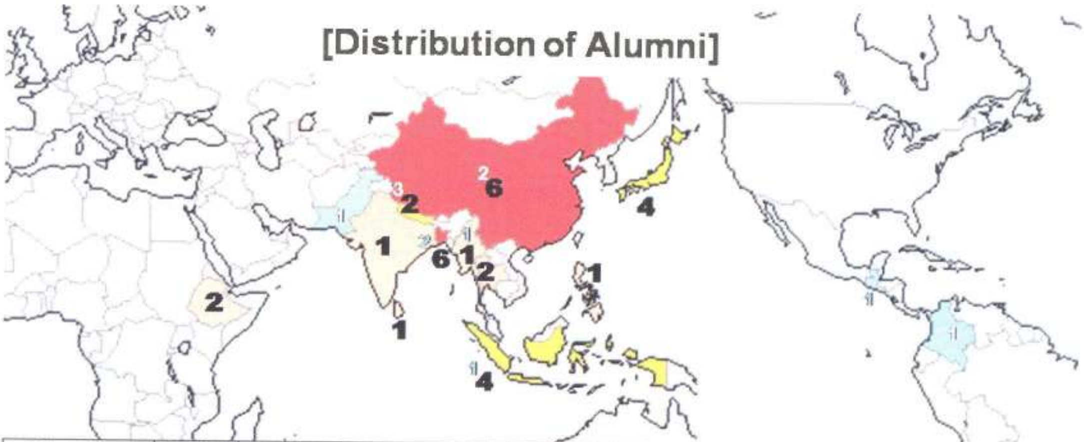
- *Localism* is a principle that takes into account local diversity of natural, social and cultural conditions, being sensitive to local needs, priorities, development stage, etc., within the context of global and regional experiences and trends.

Capacity Development Programs

- **Short training courses**
  - Flood hazard mapping course (2004-, JICA)
  - River and Dam engineering course (1973-, JICA)
  - Comprehensive Tsunami training (2008, ISDR)

Targeted to organizational capacity development

- **Aftercare program** for implementation at trainees local communities (2006-09, JICA)
  - KL, 2007; Guangzhou, 2008; Manila, 2009; Hanoi, 2010
- **Master Course on Water-related Disaster Management** with GRIPS (National Graduate Institute for Policy Studies) supported by JICA
  - 10 (2007), 8 (2008), 12 (2009) students from Bangladesh, China, India, Nepal, Indonesia, Philippines, Myanmar, Japan
- **Ph.D. Course on Disaster Management** with GRIPS
  - 2 (2010) Bangladesh, Nepal

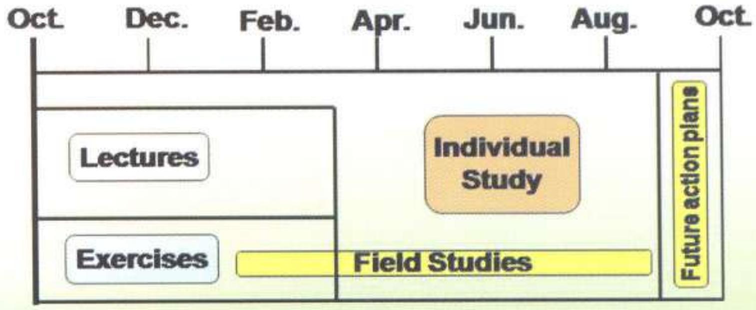


Country	Total	Organization	New Nations from 2010
Bangladesh	6	Bangladesh Water Development Board	Pakistan
China	6	Bureau of Hydrology, Ministry of Water Resources, etc.	Nicaragua
Ethiopia	2	Ministry of Water Resourse, Dire Dawa University	Columbia
India	1	Water Resource Dept., Govt. of Assam	
Indonesia	4	Ministry of Public Works	
Nepal	2	Department of Water Induced Disaster Prevention	
Myanmar	1	Ministry of Agriculture and Irrigation	
Philippines	1	Department of Public Works and Highways	
Sri Lanka	1	Department of Irrigation	
Thailand	2	Royal Irrigation Department, Ministry of Agriculture and Cooperatives	
Japan	4	Consulting companies, Japan Water Agency	

Master Course on Water-related Disaster Management

with National Graduate Institute for Policy Studies (GRIPS)
supported by JICA since October 2007

- To foster **solution oriented practitioners** with solid theoretical and engineering bases who can serve for planning and implementation of flood management practices within the framework of integrated water resources management at national to local levels.



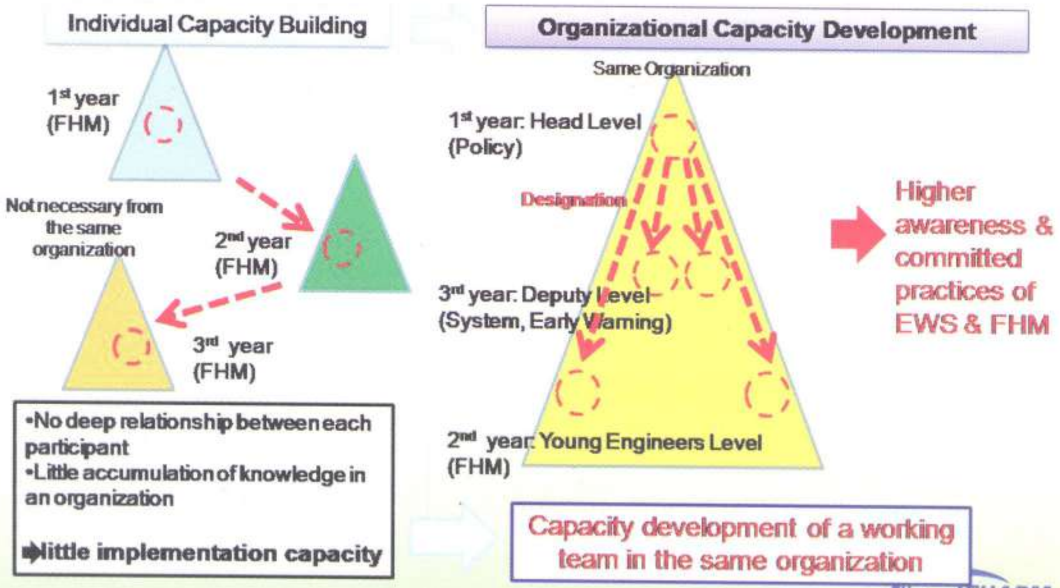
Ph.D. course starting Oct 2010

- Foster researchers who can guide and supervise researchers and research projects on water-related disaster risk management
- **Half work and half study**
- Publication of at least two papers in peer reviewed international journals from dissertation studies

ICHARM/JICA Training course on "Flood Hazard Mapping" 2004-2008

Course name	"Flood Hazard Mapping"		
Target countries	8 countries : China, Malaysia, Philippines, Cambodia, Lao PDR, Thailand, Vietnam		
Duration & No. of Participant	year	Duration	No. of Participants
	2004	2005/1/31-2/18 (3 weeks)	16
	2005	2005/11/7-12/2 (4 weeks)	16
	2006	2006/10/30-12/1 (5 weeks)	16
	2007	2007/10/29-11/30 (5 weeks)	20
	2008	2008/10/27-11/28(5 weeks)	10
Eligible/ Target Organizations	Organizations concerned about Flood or River Management at national or local level in the public sector such as national or provincial ministries or municipalities		

Concept of Organizational Capacity Development



Organizational capacity development

rather than individual CD

Working triangle for Local Emergency Operation Plan with Flood Hazard Map

(1) Division head (8-28 Nov, 2009) 3 weeks
See how it works in Japan.
Draw their own goal.
Identify what steps are necessary to reach.
Identify who should work together.

(3) Deputy-division heads (June-July, 2011) 5-6 weeks
Learn how to make early warning & HM work.
Identify necessary actions & institutional arrangements for its operation (data collection, process monitoring, communication networks, coordination etc.)

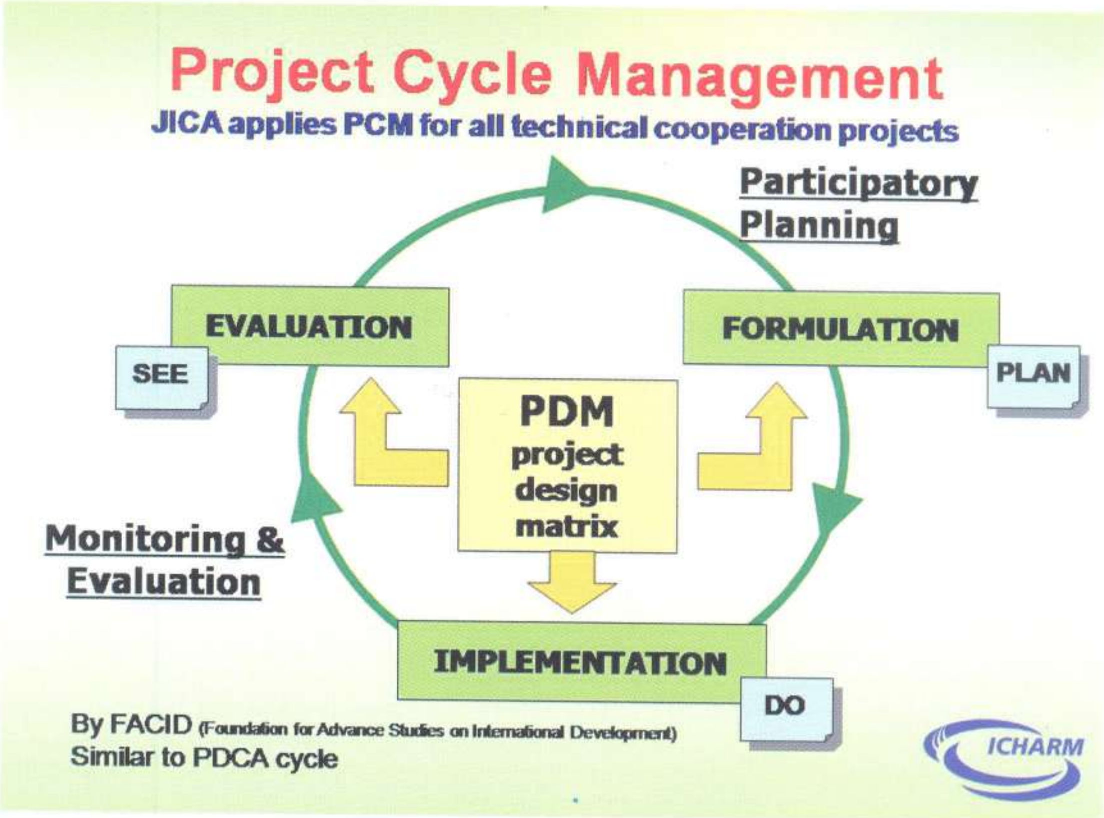
Bangladesh, Bhutan, Indonesia, Lao, Myanmar, Pakistan, Tajikistan, Sri Lanka, Nepal, Thailand

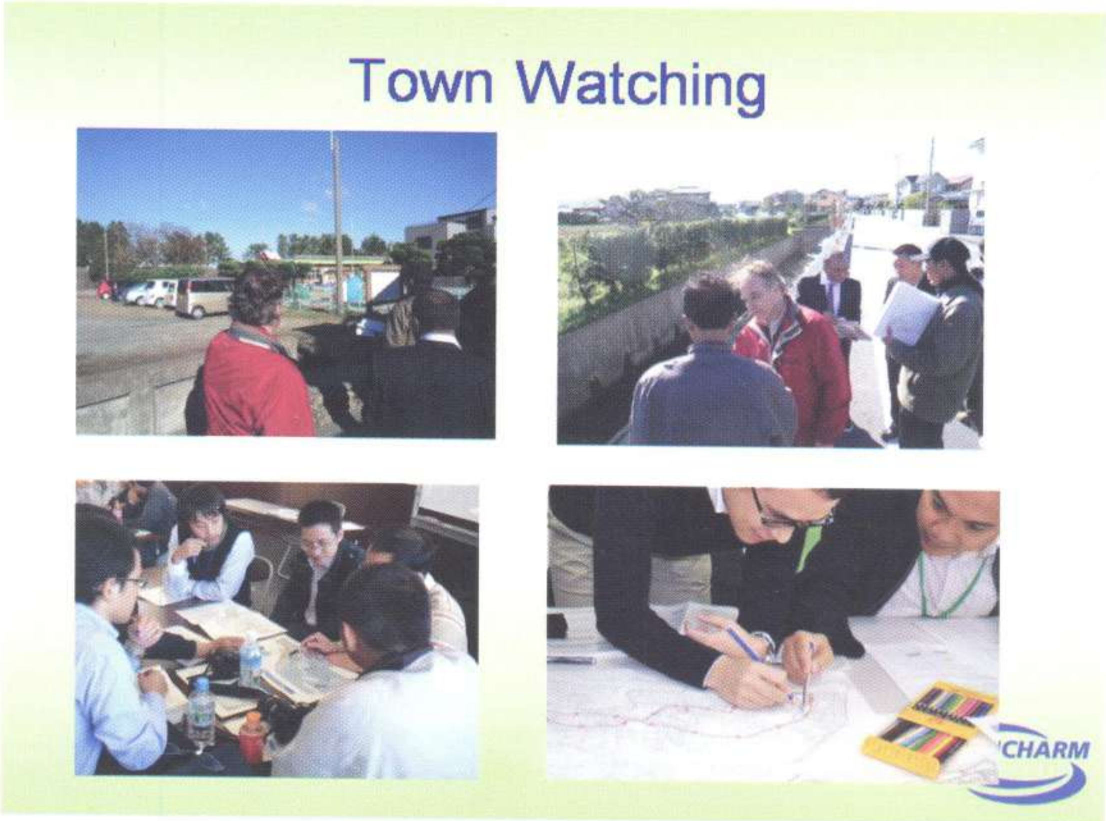
(2) Young engineers (12 Jan-16 Feb, 2011) 6 weeks
Learn how to make hazard maps & when to evacuate.

Curriculum

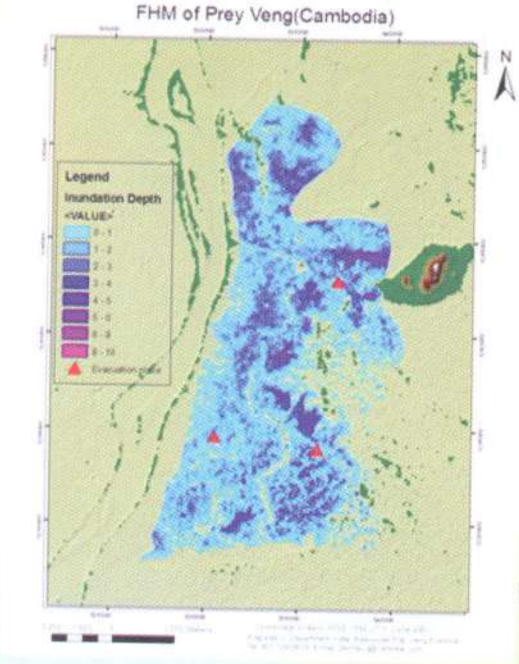
• Principles of disaster management	**Principle**
• **PCM** (project cycle management) by PP (participatory problem finding & planning,), PDM (project design matrix) and ME (monitoring & evaluation)	**Process**
• Early warning, preparedness & evacuation: flood fighting law, emergency community operation & communication during disaster	**Administrative know-how**
• **Town watching**: how it is working in Japan - Policy making, personnel formation for implementation - Administrative & institutional needs in addition to IFAS & HM	**Watching reality**
• **Hazard mapping**: topographical map processing, 2-D inundation simulation, plotting evacuation routes & shelters, necessary process to obtain detail topographic maps if not readily available • **IFAS** early warning system	**Hard technology**
• Discussions on local application	**Think breakthrough**

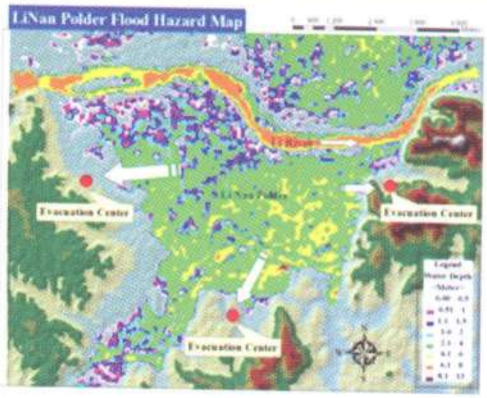
Difficulty of this approach: Participants may be decided not for the organizational CD purposes but for other internal reasons by indifferent organizations.


Project Cycle Management
JICA applies PCM for all technical cooperation projects
Participatory Planning
EVALUATION
SEE
FORMULATION
PLAN
PDM
project design matrix
Monitoring & Evaluation
IMPLEMENTATION
DO
By FACID (Foundation for Advance Studies on International Development)
Similar to PDCA cycle
ICHARM


Town Watching
ICHARM

FHM made by participants



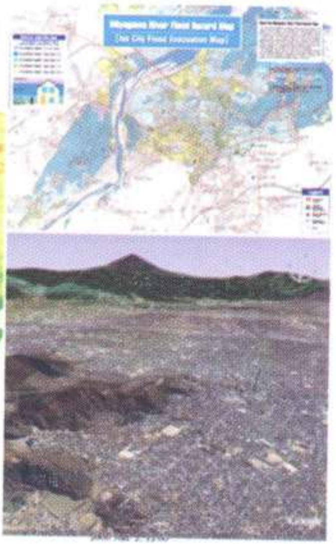


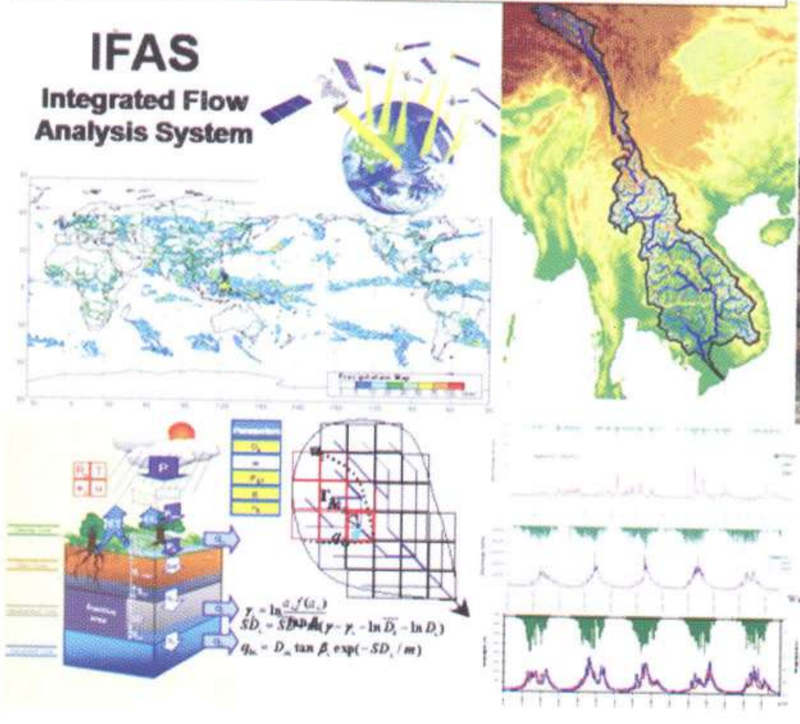
China

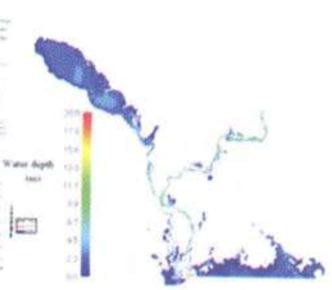
Cambodia

ICHARM

Advanced Technology for Early Warning & Hazard Mapping

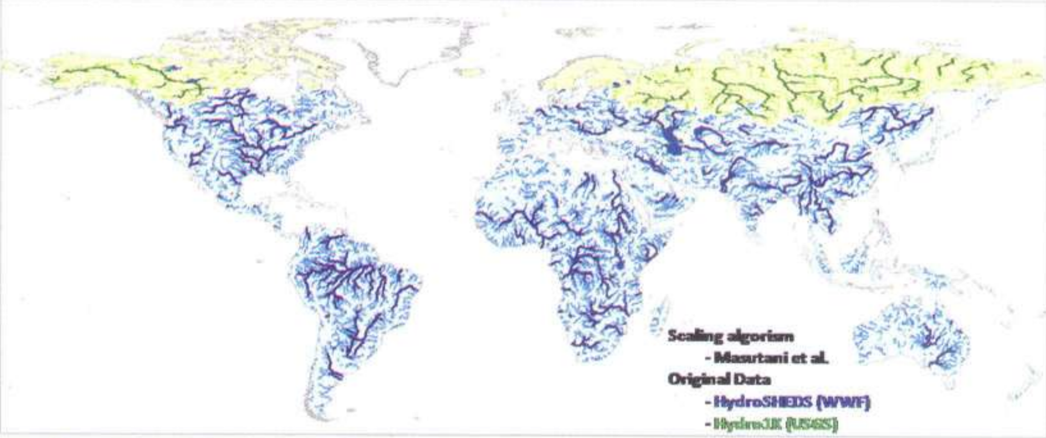






Globally covered stream network

(Resolution: 90m to 20km)



Green : 1km to 20km
Blue : 90m to 20km

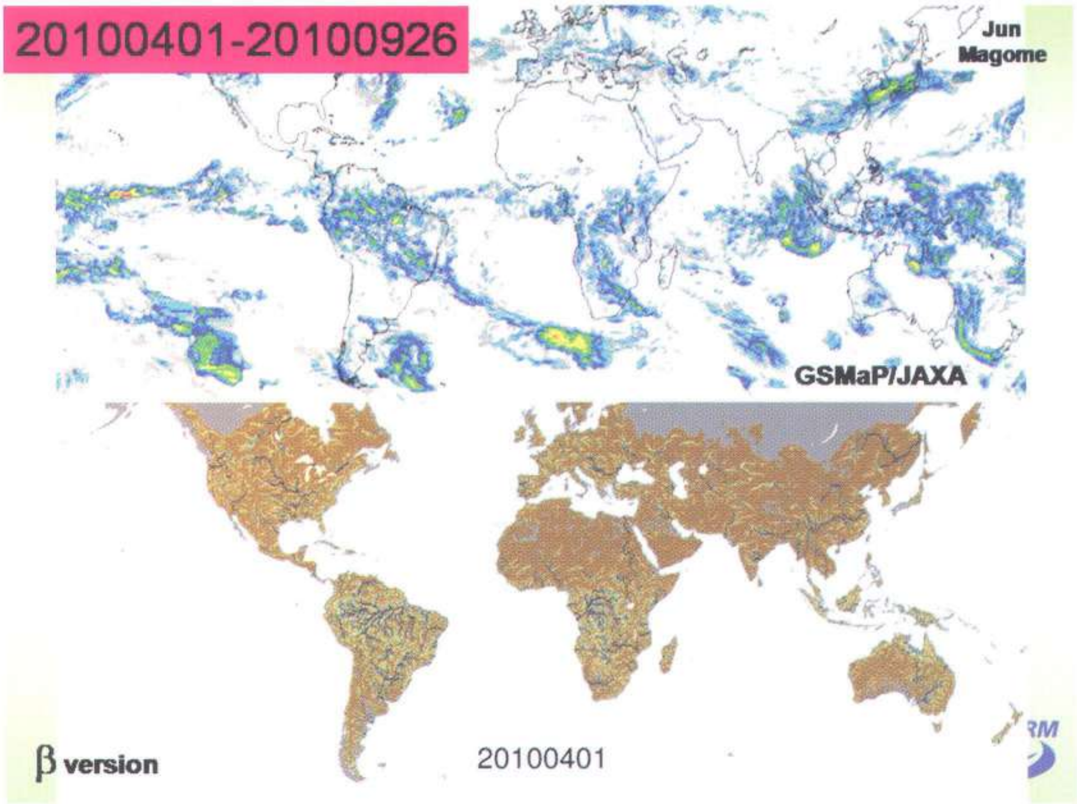
High level resolution 3"(≒90m original), 6", 9", 12", 15"
Middle level resolution 30" (≒ 1km), 45", 60", 90", 2.5'
Low level resolution 5' (≒10km), 10"

ICHARM

Examples of globally available data

Type	Elements	Source (standard data sets)
Topography, Land, Soil and Vegetation data	DEM	USGS-GTOPO30, Hydro1K, SRTM, HydroSHEDS, ICHARM (SFRN)
	Flow direction map	USGS-GTOPO30, Hydro1K, SRTM, HydroSHEDS, ICHARM (SFRN), IFAS-Tool
	(Sub) Basin Boundary	USGS-GTOPO30, Hydro1K, GDBD, SRTM, HydroSHEDS, ICHARM (SFRN), IFAS-Tool
	Root Depth	literature values (LiteraSellers et al., 1994,1996)
	River width	Assumed from contributing area (Lu et al., 1989)
	Soil Map	FAO-DSMW
	Soil Type	USGS soil clasification (Rawls et al., 1982, 1985)
	Soil Properties	FAO
	Land Cover Type	GLCC/IGBP V2
	NDVI	NOAA-AVHRR (GIMMS etc), Spot Vegetation
Hydro-Met data	Precipitation	Satellite Derived Dataset (TMPA, CMORPH, GSMaP etc) Reanalysis Dataset (NCEP, ERA-40(ECMWF), JRE-25 etc) Local ground observations Forecast (NOAA/NWS, ECMWF, JMA etc)
	Temperature Cloud cover Daylight duration Radiation Vapour pressure Wind speed	Reanalysis Forecast Climatic data set (CRU TS(CRU/EAU))
	Observed discharge	Local ground obs. GRDC, Mekong River Hydrological Yearbook, etc.

Jun Magome 2008



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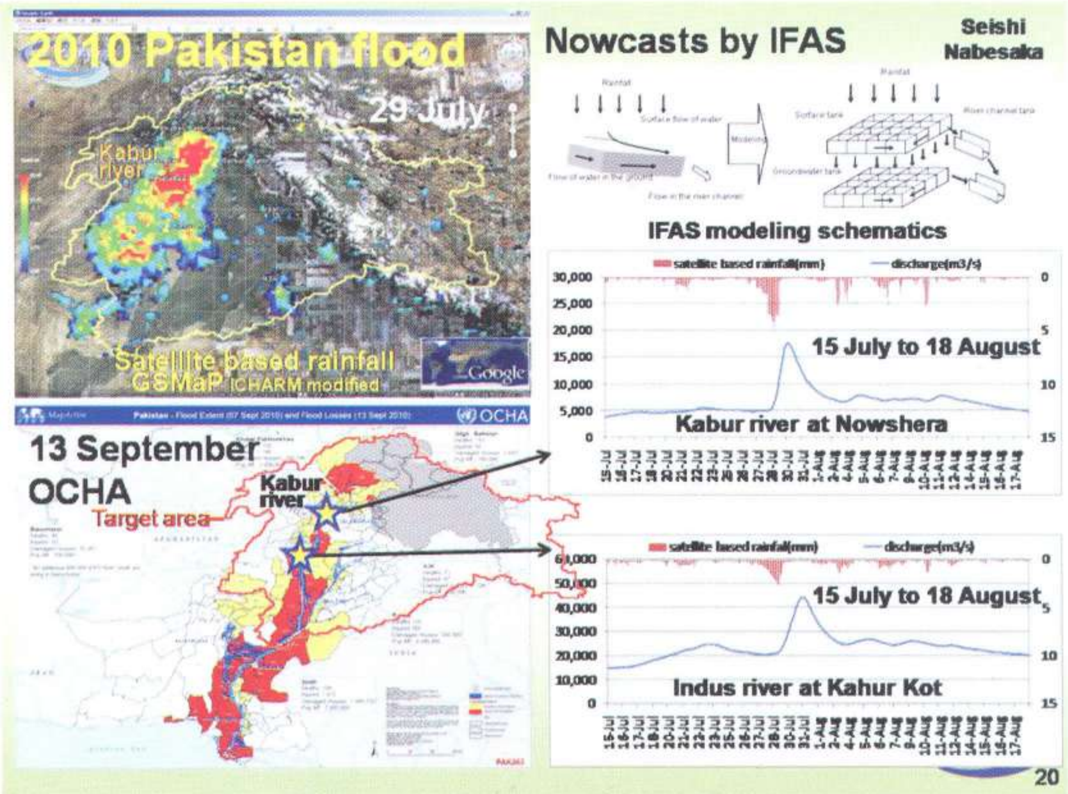
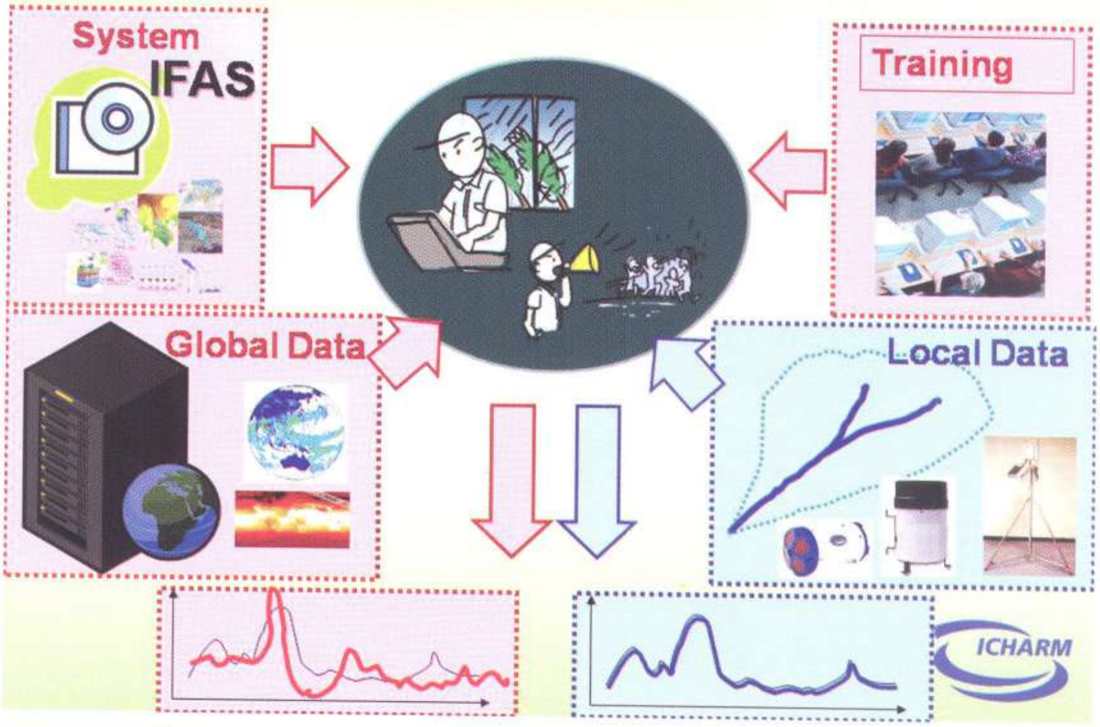


2010 Pakistan flood
29 July
Kabur river
Satellite based rainfall
GSMaP ICHARM modified
13 September
OCHA
Kabur river
Target area
Nowcasts by IFAS
Seishi
Nabesaka
IFAS modeling schematics
satellite based rainfall(mm)
discharge(m3/s)
15 July to 18 August
Kabur river at Nowshera
15 July to 18 August
Indus river at Kahur Kot
20

Promoting local ownership of flood forecasts



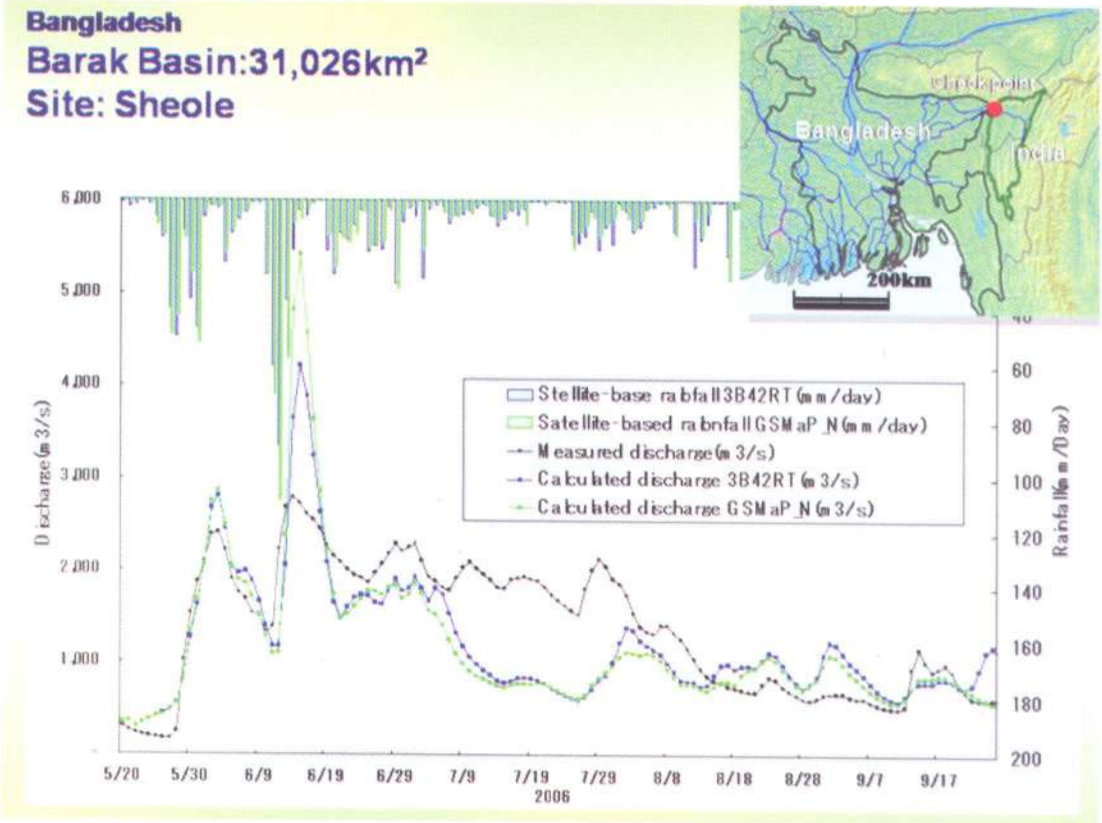
TRAINING WORKSHOP FOR THE GLOBAL FLOOD ALERT SYSTEM (GFAS) VALIDATION
3-8 Oct 2008, 3-7 Aug 2009 JAPAN

Objective

- Capacity development for local practitioners to validate GFAS-rainfall and translate it to GFAS-streamflow **(IFAS)** in ungaged or poorly gaged basins.

Participants from

- **2008: Ethiopia, Zambia, Cuba, Argentina, Bangladesh, Guatemala, Nepal**
- **2009: Bangladesh, India, Indonesia, Laos, Nepal, Vietnam**
- **2010: In Hanoi, Myanmar, Nepal,**


Bangladesh
Barak Basin:31,026km²
Site: Sheole
Bangladesh
India
200km
Discharge(m3/s)
Rainfall(mm/Day)
Stellite-base rainfall 3B42RT (mm/day)
Satellite-based rainfall GSMaP_N (mm/day)
Measured discharge (m3/s)
Calculated discharge 3B42RT (m3/s)
Calculated discharge GSMaP_N (m3/s)
6,000
5,000
4,000
3,000
2,000
1,000
60
80
100
120
140
160
180
200
5/20
5/30
6/9
6/19
6/29
7/9
7/19
7/29
8/8
8/18
8/28
9/7
9/17
2006


居安思危 Be aware of risk while we are safe
思則有備 Awareness leads us preparedness
有備無患 Preparedness leaves us no worry
「春秋」左氏伝
Source: Zuo Qiuming "Zuoshi Commentary" in Confucius ed. "Spring and Autumn", 480BC
ICHARM cares people's well-being and empowerment!
www.icharm.pwri.go.jp
ICHARM
preparedness for floods


27-29 September 2011
ICFM5
First Announcement
5th International Conference on Flood Management
5th International Conference on Flood Management (ICFM5)
• Only Intern Conf solely focused on floods
• Organized by field level practitioners of nations
• Plenary sessions discuss implementation of UNSGAB/HLEP actions
27-29 September 2011
Tsukuba, Japan
Floods: From Risk to Opportunity
- Integrated Flood Management Approaches
- The Impact of Climate Change on Floods
- Flood Forecasting and Early Warning
- Mega-delta Flood Risk Management
- Urban Floods/Flash Floods
- Extreme Flood Events
- Landslide and Torrential Rainfall
- Flood Preparedness/Emergency Response
- Flood Resilience Communities
Co-organised by:
The International Centre for Water Hazard and Risk Management (ICHARM) under the auspices of UNESCO and The Ministry of Land, Infrastructure, Transport and Tourism (MLIT-Japan)
MLIT
ICHARM
ASSOCIATED PROGRAMME ON FLOOD MANAGEMENT
International Strategy for Disaster Reduction
ISDR
UNITED NATIONS UNIVERSITY
INTERNATIONAL FLOOD INITIATIVE
IAHR
AIRH
IAHS
AISH
IWR
AWRA
ICIWaRM
IWHR
IRTCES
KDPA
JSCE
KICT
Rijkswaterstaat
NCDR
IF-Net
rimax

Dr. Olusanjo Akanji Bamgboye

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Training Middle Level Managers and Technicians

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Kaduna, Nigeria

Abstract

Human Resources Training has become one of the most important factors in Human Resources Development. The Middle-Level Managers and Technicians constitute the largest volume of personnel for Water Resources Infrastructures Operation and Maintenance. Training of these personnel must be task-oriented and affected regularly to meet the challenges of the Water Sector. This paper describes the experience at National Water Resources Institute, Kaduna, Nigeria to address the skill-improvement of Middle-Level Managers and Technicians using systematic approach to training.

1. Introduction

Human Resources Development is defined as increased acquisition, by individuals and groups, of the knowledge, skill and values required for better living, made available through all educational channels, including the mass media, other forms of modern and traditional communication, and social action, with effectiveness measured in terms of behavioural change. The education of water resources technicians and managers begins in Colleges and Polytechnics and continuous throughout the professional careers of concerned individuals.

The nature of problems associated with water resources sector, such as flooding and extremes of geo-hydrological events, are highly complex and challenging. It means that the sector requires skilled trained managers who have an aptitude to work with clear understanding of the problem and applicable solutions. Training has become one of the most important factors in human resources development, to cope with challenges in work and technology. The systematic approach to Training has been found to be effective for the sector.

2. The Systematic Approach to Training

The systematic approach to training is a seven (7) step sequence of activities to achieve skill or knowledge improvement is as follows:

STEP 1 Determine Training Needs	Study performance deficiencies within the organization. Determine which are due to a lack of skills and/or knowledge and will respond to a training solution.
STEP 2 Analyse Tasks	Study the task. Determine precisely what skills are necessary for its accomplishment
STEP 3 Develop Curriculum	Determine precisely what the successful trainee must be able to do at the end of the proposed training in order to accomplish the task. Write objectives in terms of observable behaviour. Determine the necessary pre-requisites, the proper sequences of instruction and the instructional system components.
STEP 4 Prepare Environmental Support	Ensure that adequate facilities and training aids will be available. Support staff (e.g. Secretarial help) should also be considered.
STEP 5 Conduct Training	Conduct training using activities that will enable the trainees to do the task described in the performance objectives
STEP 6 Follow-up Training	Observe trainees to determine if they have achieved the course objectives and are applying the new skills back on the job. Give reinforcement and feedback
STEP 7 Evaluate and Adjust Training	Assess the training course to determine if it is adequately designed to eliminate the intended performance problem

For the development and utilization of water resources of any country, systematic planning and development of manpower are necessary. This is particularly so such the water sector is highly inter-disciplinary in nature and the technology developments are rapid. Cadres of personnel to be trained include Top managers for Policy formulation, Professionals for Technical analysis of facts for policy formulation and implementation strategy. Higher Technicians and Technicians supervised by Middle Level Managers are needed for project implementation with craftsmen and operators trained for operation and maintenance of schemes. A typical training scheme for an officer in the sector is as in Table 1.

Table 1: Typical Scheme of Training for an Officer in W.R.O. Sector

Nature of Training	**Stage in Service**	**Duration of Training in Months.**	**Objective of Training**
A) Foundation training (Basic and technical).	On entry into service.	1-2 For probationary Asst. Exe. Engrs. 1-2 For probationary Asst. Engineers.	**Basic:** Procedures, rules and organisation of 1.0 **Technical:** Academic and practice- oriented.
B) (i) Refresher/ specialist course	After 3rd year of service.		Input of modern technology not covered under 'A' or during college education.
(ii) Specialised training	Between 8th to 12th years of service.		Develop special skills for planning, design, construction and management.
(iii) Advanced specialist training	3 to 5 years after (i).		Add on to specialised skills.
(iv) Refresher courses in field of specialisation.	3 to 6 years after (ii)		Refresh specialised skills.
C) (i) Appreciation Training	Between 15th to 20th year of service.	0-25 – 1	Give inter-disciplinary background and appreciation of modern technology.
(ii) Management training for Senior	After 20th year of service.	1 – 1 A minimum of 4 weeks at end of 5	For operation in a specialised field

Executives to develop individual competence.		years or 2 weeks at end of every 3 years service.	for considerable time, based on individual competence.

3. Middle Level Managers and Technicians Training in Nigeria

The overall objective of training Middle Level Managers and Technicians is to enable these cadres of officers acquire skills and techniques to provide efficient and sustainable services in the water sector to members of the public. The specific objectives are:

(i) Impact skill and knowledge on effective operation and maintenance of facilities.

(ii) Ensure availability of human resources needed for water resources development programmes.

(iii) Provide works and career development opportunities for the water sector.

(iv) Develop worker's motivation and attitude in the water sector through updating and application of new technology.

(v) Build capacity and ensure positive attitudinal changes of workforce through increased knowledge and education.

The training of these cadres at National Water Resources Institute, Kaduna is being achieved through five (5) broad group of Training Activities which are:

(i) **Certificate/Regular Career Training:** These are training of three (3) months to twenty four (24) months duration leading to award of Certificates and Diplomas recognised in the public service systems for career movements

Courses currently offered are:

I. Certificate in Water Resources Engineering for twelve months to train Operators.

II. Advance Diploma in Hydrogeology.

III. Certified Water Well Drillers.

IV. Household Water Managers.

V. Water Drilling Rig Fabrication.

VI. Water and Waste Water Scheme Operators.

VII. Irrigation Scheme Operators.

VIII. Young Engineers and Scientists Induction.

IX. Postgraduate Diploma and M.Sc. in collaboration with Universities in Integrated Water Resources Management

Annual Enrolment of the Regular and Self Empowerment Courses are shown on Tables 2 and 3.

Table 2: Regular Courses – Annual Enrolment

S/NO	COURSE	1986-1990	1991-1995	1996-2000	2001-2005	2006-2007	2007-2008	2008-2009	2009-2010	TOTAL
1	PRE-DIPLOMA	81	103	61	-	-	-	-		245
2.	CERTIFICATE	159	137	168	128	32	20	12	9	665
3	NATIONAL DIPLOMA I	101	164	115	166	31	14	-		591
4	NATIONAL DIPLOMA II	102	141	127	151	79	18	11		629
5	HIGHER NATIONAL DIPLOMA I	97	111	121	82	16	2	-		429
6.	HIGHER NATIONAL DIPLOMA II	105	106	134	120	37	3	1		506
7.	ADVANCED DIPLOMA	-	-	17	31	8	25	-	13	94
8	PROFESSIONAL POST-GRADUATE I	-	35	50	44	5	-	-		134
9	PROFESSIONAL POST-GRADUATE II	-	26	44	43	9	3	-		125
	TOTAL (REGULAR COURSES)	645	823	837	765	217	85	24		3,418

Table 3: Youth/Self Empowerment

S/N	Programme	Participants Trained		
		2008	2009	2010 (in progress)
1	Induction Course	18	30	18
2	Certificate Water Well Drillers	-	28	30
3	Water Drillers Rig Fabricators	-	16	-
4	Household Water Managers	-	-	24
5	Water and Waste Water Scheme Operators	15	9	-

5	Water and Waste Water Scheme Operators	15	9	-
6	Irrigation Scheme Operators	18	3	-
7	Handpump Maintenance for Motorcycle and Bicycle Mechanics	58	70	37

(ii) **Short Courses** are designed to address new disciplines and skills for which education and training are needed. A well-thought-out short course with detailed objectives is to improve professional developments through the use of recognised experts on the topic. Analysis of Case Studies and field practical are in use to enhance understanding and skills development. Duration of these courses ranges from 2 days to four (4) months. A short course lasting two weeks with about 6 to 8 hours of classroom contacts daily can cover materials that are normally offered in a three-hour class (3 unit) lasting for a semester.

National Water Resources Institute since 1986 has offered variety of short courses on topical issues dealing with applied problem in water resources, hydrology, hydraulics, water supply and sanitation, water quality, irrigation and groundwater studies. Up to 441 short courses were offered to date with overall 26,213 participants.

(iii) **On-the-Job Training (Outreach System).** These are trainings taking place in-house, within the trainee's workplace, using familiar tools and equipments for practical demonstration sessions. The on-the-job training is innovative, effective and economical for capacity-building practical skills of Operators, Technical Supervisory and commercial section staff of Water Agencies. Courses are tailor-made for each Agency and the cadre of staff to be trained.

National Water Resources Institute utilized the system for the manpower development component of the National Water Supply Rehabilitation Project whereby 11,213 participants were trained offering 711 courses as shown in Table 4.

Table 4: Outreach Courses Conducted

Period	Participating SWAs	Courses Conducted	Participants Trained
Jun. – Dec. 1996	11	13	195
Jan. – Dec. 1997	20	35	525
Jan. – Dec. 1998	26	98	1,470
Jan. – Dec. 1999	35	157	2,355
Jan. – Dec. 2000	36	108	1,620
Jan. – Dec. 2001	36	114	1,710
Jan. – Dec. 2002	36	77	1,152
Jan. – Dec. 2003	12	23	345
Jan. – Dec. 2004	9	15	389
Jan. – Dec. 2005	13	10	197
Jan. – Dec. 2006	12	56	1,172
Aug. – Sept.2007	7	5	83
TOTAL		711	11,213

(iv) **Project Specific Training** are demand driven and specific needs to ensure success of developmental projects in the Water Sector. Courses are developed for all cadres of staff to man the project from Design Stage through construction to operational stage. It may include community participation courses to ensure sustainability of project/programme.

Project specific Training conducted so far by National Water Resources Institute include:

- UNICEF supported Rural Water Supply & Sanitation Project (On-going)
- FMWR supported National Water Rehabilitation Program (Completed)
- FMWR supported National Fadama Development Program (Completed)
- PTF supported National Rural Water Supply Program (Completed)
- FMW&H supported Community Based Urban Development Project (On-going)
- FMA&WR supported Small Town Water Supply & San. Program (On-going)
- FMA&WR supported Urban Water Supply Scheme (On-going)
- FMA&WR supported Federal Rural Water Supply & San. Program (On-going)

204 courses were conducted for 15,652 participants as shown in Table 5.

Table 5: Project Specific Training

Project	Courses Conducted	Participants Trained
Rural Water Supply & Sanitation Project (UNICEF)	37	1060
National Water Rehabilitation Program	22	11,824
National Fadama Development Program	12	112
National Rural Water Supply Program	10	144
Community Based Urban Dev. Project	16	351
Small Town Water Supply & San. Program	54	1,058
Federal Rural Urban Water Supply and Sanitation Programme	62	851
Hygiene and Sanitation and Community Management	8	364
TOTAL	204	15,652

(v) **National Water Resources Capacity Building Network (NWRCBW) and Centres** are established to provide capacity building at regional levels and/or for sub-sector specialities for water resources stakeholders. National Water Resources Institute is to partner with six (6) Universities and six (6) Polytechnics at one each at six geo-political regions of Nigeria. Programmes to be offered jointly shall cover training, for technicians and engineers at post graduate professional levels up to Maters of Science degree levels.

Two Centres namely UNESCO Regional Centre for Integrated River Basin Management (RC-IRBM) and National Rural Water Supply and Sanitation Centre (NRWSSC) for Capacity Building are now established. They are to develop the sector workforce for improved services delivery.

4. Conclusions

Engineers, Scientists and Technicians in developing countries not only must execute their responsibilities in a professional manner but also have to keep pace with the advancements in science and technology. A major avenue available to these professionals is to attend intense short course on specific topics for a certain period of time. Task-oriented courses produced through systematic approach of Training have proved to be effective and economical for the water resources professionals' training in Nigeria.

A major challenge is the certification of these trainings and use as a requirement for yearly promotions to a higher grade or salary increase. An assured source of funding is needed to drive an effective long terms training programmes.

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Engineer Naseer A. Gillani

Engineer Naseer A. Gillani obtained his Masters Degree in Water Resources from AIT, Thailand. He started his career at Centre of Excellence in Water Resources Engineering (CEWRE), UET, Lahore. Presently he is Chief Water, Pakistan Planning Commission. Engr. Naseer Gillani has also served as Secretary, Pakistan Council of Research in Water Resources (PCRWR).

UNESCO – NUST International Workshop

Institutional Mechanism for Managing Hydrological Extremes

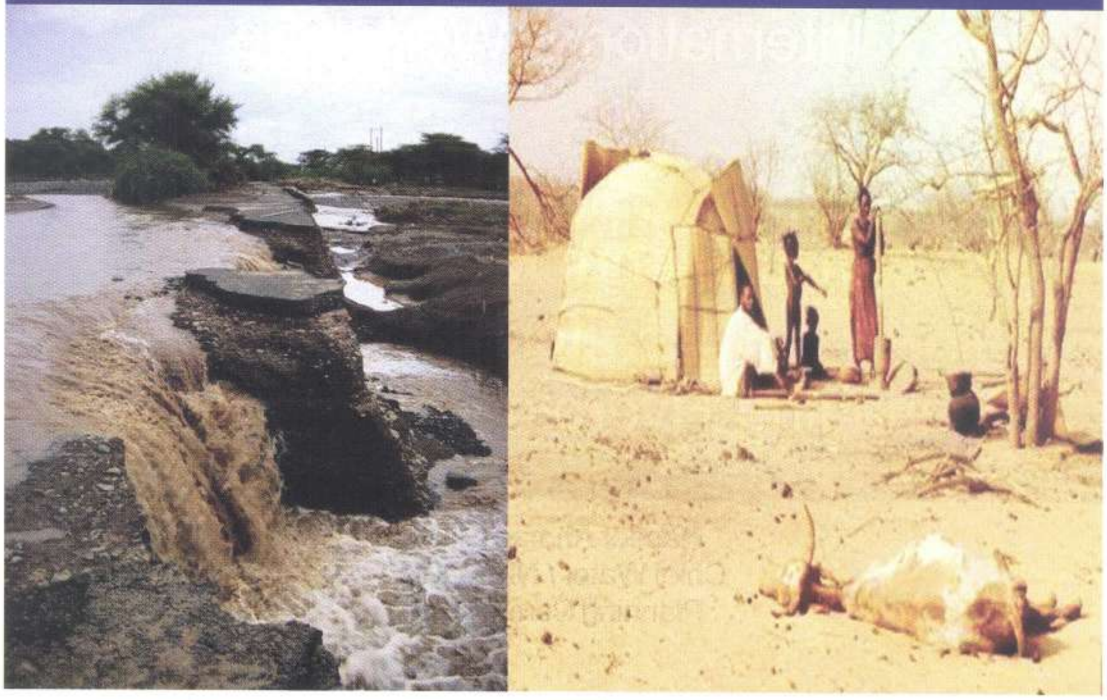
Naseer Ahmad Gillani
Chief Water / NPD DERA
Planning Commission

Objective of the Workshop

Influencing high-level policy stakeholders in flood and drought management.

Climate Change Reaches to Pakistan Through Water

Water Extreme Events: Flood & Drought



Integration

- Floods and drought
- Extreme value events
- Dry and wet cycles
- Seasonal variability
- Climate change

Synergy in integration

- Meteorology science
- Field measurement
- Satellite
- Remote sensing
- Models
- Predictions
- Impact Reduction
- Recovery

Message

- Inter-Governmental Panel on Climate Change (IPCC) : Pakistan/Indus Basin to face higher frequency, severity and aerial coverage of extreme events of water availability and non-availability (floods and droughts)

- Recent floods and droughts: our knowledge is not enough.

- Moving from structural measures to non-structural software initiatives.

Impacts on hydrology

•rainfall, runoff and streamflow – floods and droughts, more intense and more frequent	temperature – aridity, evaporation, glacier and snow melt, loss of storage	sea level changes -- impacts on estuaries, deltas, and groundwater intrusion

Who are policy makers

Planning Commission

- Cabinet
- Prime minister
- President
- Parliament

Focal issues with policy makers

- Public welfare
- Security
- National- geographic boundaries

- Food
- Energy
- Heath

- Scio economic growth
- Infrastructure
- Trade
- Natural resources

Communication strategy

- **Droughts cause reduction in growth: impacts on agricultural production and livelihood.**

- **Floods destroy infrastructure ,loss of life.**

- **There is not much to combat or de-accelerate the climate change by Pakistan, mandatory is : climate change adaptation.**

Need Assessment

- Knowledge gaps:
- ➢ Hydrology developed by Linsley
- ➢ Hydraulic Engineering designs developed by US System
- ➢ Hydraulic System Computation Models produced by Netherland
- ➢ European Model "SHE"
- ➢ Pakistan UNESCO Model of rainfall run off
- ➢ All have to be revisited
- ➢ Solution specific models to be developed.

Impact

Climate change reaches to Pakistan through water:

a. Threat to glaciers, water towers

b. Implications of GLOF

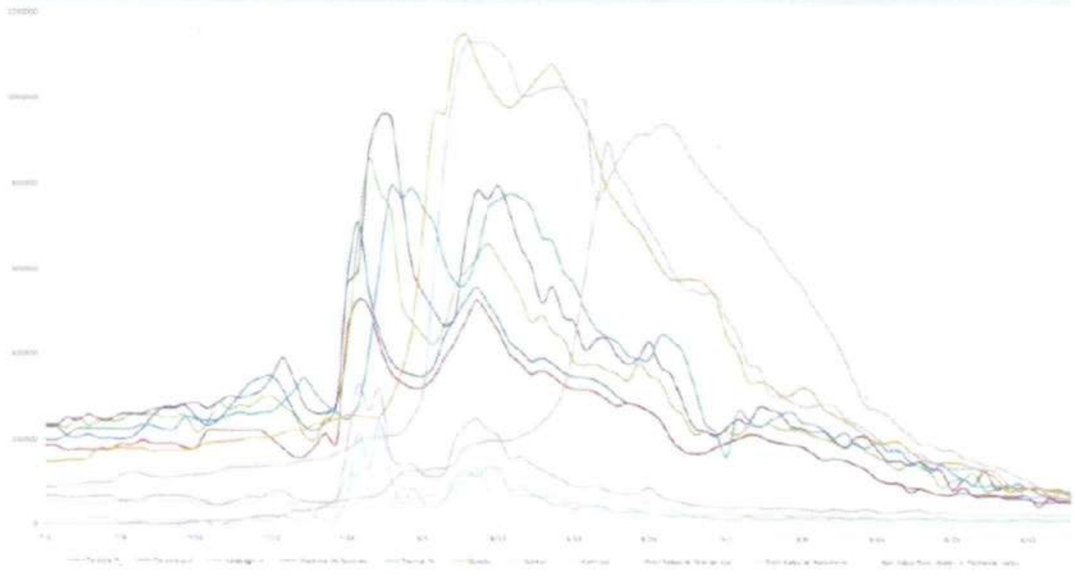
c. Changed pattern of monsoon, intensive rains, flash floods, prolonged droughts.

d. Increased temperature : enhanced crop water requirements.

e. Cyclones and sea-level changes.

Updating National Water Sector Data

Indus River Hydrograph during 2010 flood(cusecs)



Water, the primary medium

- Water is the primary medium through which climate change will impact people, ecosystems and economies
- Water resources management should therefore be an early focus for adaptation to climate change
- Water resources management does not hold all of the answers to adaptation; a broad range of responses will be needed
- But, water is both part of the problem and an important part of the solution. It is a good place to start

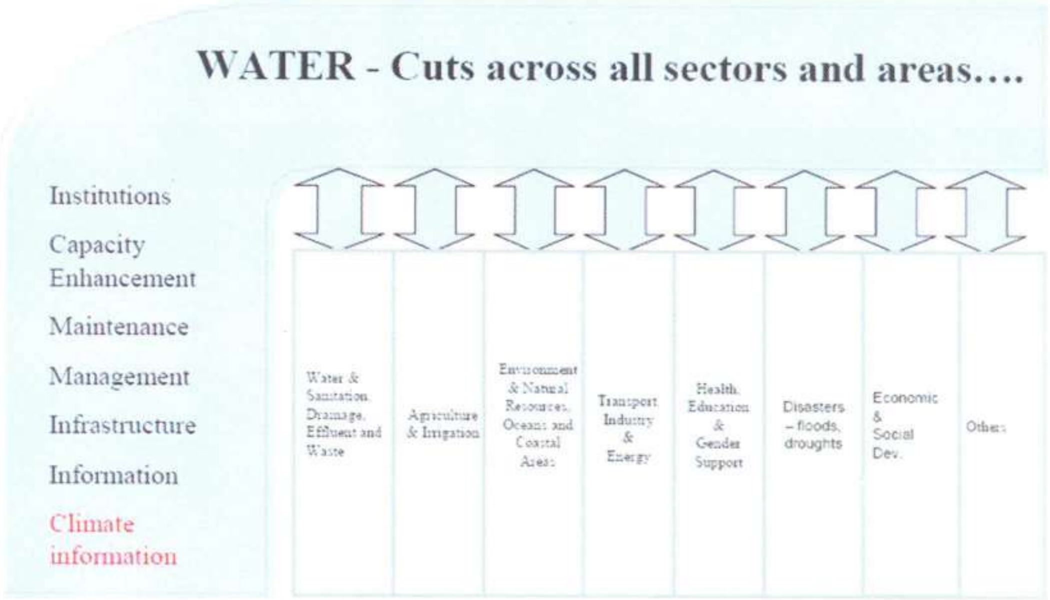
Actions Required

1. Evaluation of the existing system
2. Learning from the South Asia
3. Learning from the Global experience
4. Updating existing/create new models

Moving Towards Solutions

1. Partnership
2. Linkages with Research Institutions
3. Creation of network Institutions providing cost effective engineering solutions incorporating software components

Working together



The temporal dimension: timeframes, sequencing and uncertainty

Focus on:

- Strengthening management information, infrastructure
- New institutions and Co-operation with UNESCO.

Thanks : We don't deserve

Professor Dr. Bakhshal Khan Lashari

Professor Dr. Lashari, Director, Institute of Irrigation and Drainage Engineering, Mehran University of Engineering and Technology, Jamshoro has more than 30 years of working experience as an educationist and Principal Scientist in the field of water resources planning, designing and management both nationally and globally. In this role, he also worked to teach postgraduate and graduate levels of engineers at various institutes around the globe. His professional career has focused on promoting economic welfare through sustainable development and management of water resources for agriculture. During his professional career, he got an opportunity to teach and research on policy planning, system design and management, training and institutional capacity building at various prestigious institutes around the globe.

Dr. Lashari has extensive work experience as an advisor and consultant with national and international agencies on water resources planning, policies, gender education, social mobilization, rural sanitation, water policies and communities development. He has also led a comprehensive action research effort on institutional reforms and water management in Pakistan from 1995-2003 at International Water Management Institute (IWMI). He has conducted major research project in the field of natural resources management which have resulted in production of high quality scientific reports and research papers. He has also evaluated several community projects on education, small entrepreneur interventions, adoption of low cost interventions for energy saving and research projects related to environment and irrigation management.

IRRIGATION WATER MANAGEMENT ISSUES AND OPTIONS:
A case study from Sindh, Pakistan

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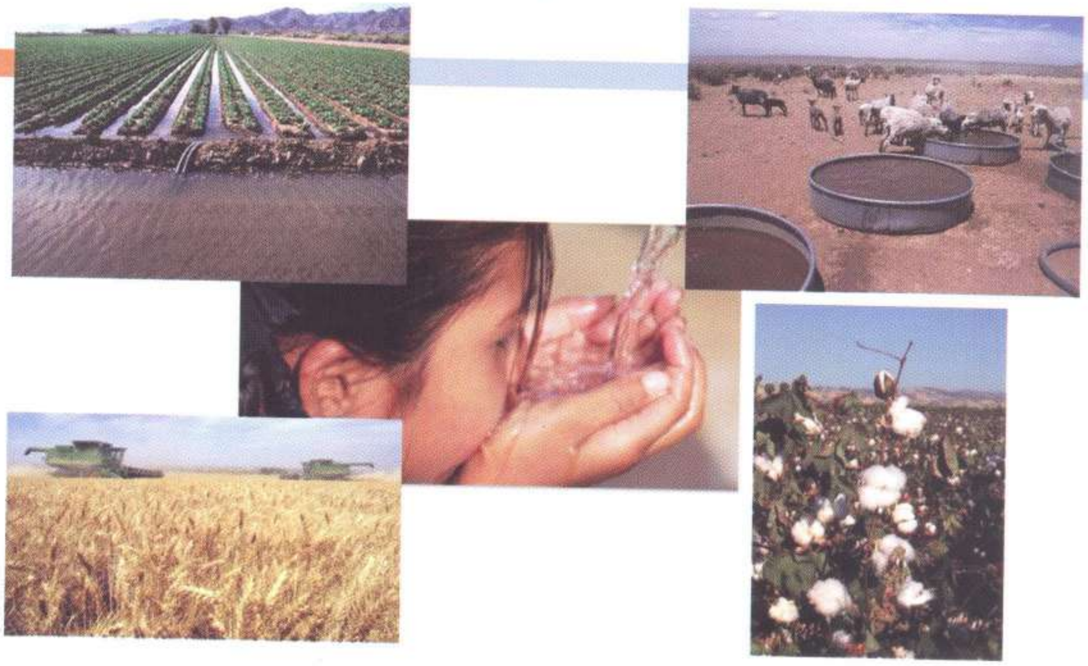
Professor/Director
Institute of Water Resources Engineering and Management
Mehran University of Engineering and Technology,
Sindh Pakistan

International Workshop on
Education for Managing Hydrological Extremes and
Related Geo-Hazards
January 24-26, 2011, Islamabad, Pakistan

Water: Source of Life, Food and Fiber



Water also brings miseries

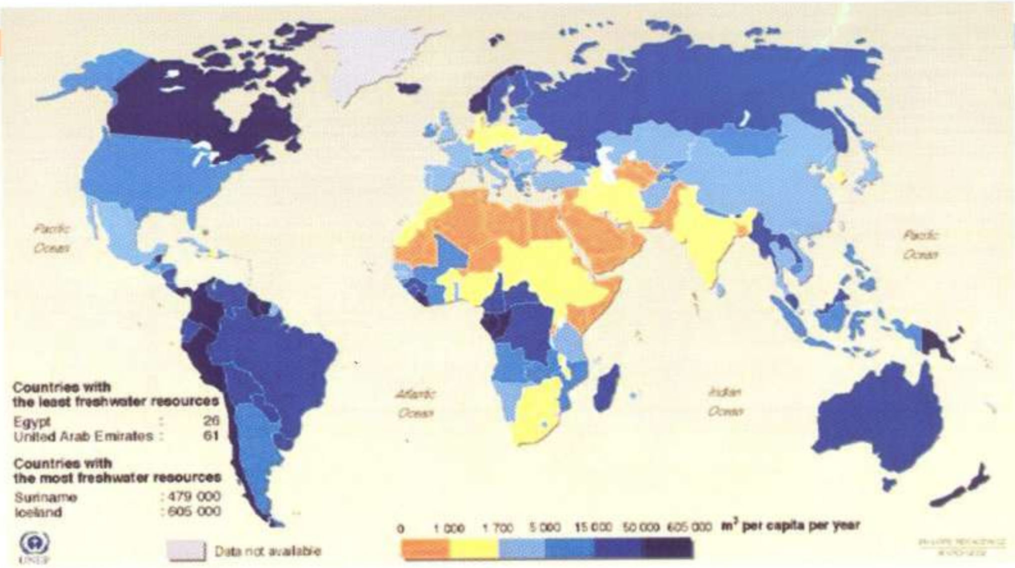
Hurricane Katrina (Sept. 2005)

Kenya Drought (Spring 2006)

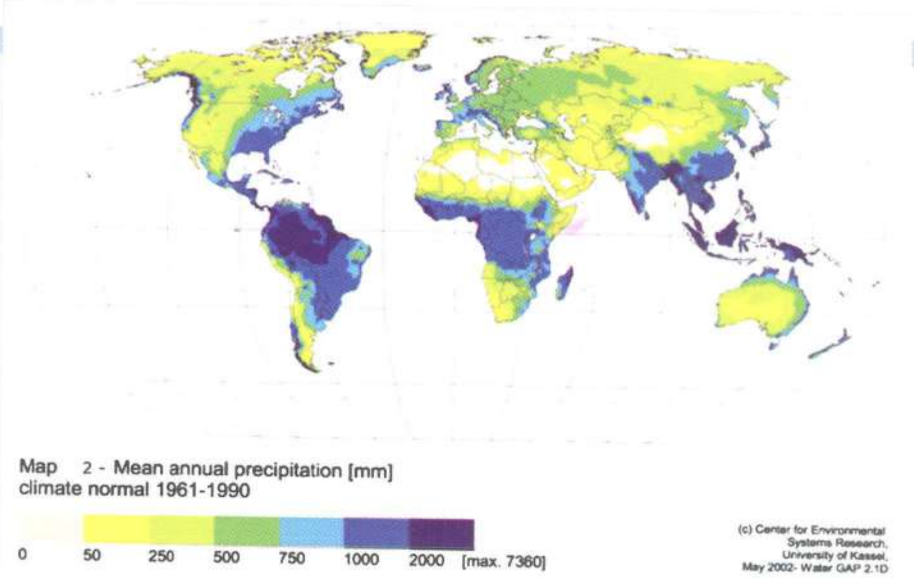
China Drought (Spring 2010)

Flood in Pakistan
(Aug. 2010)

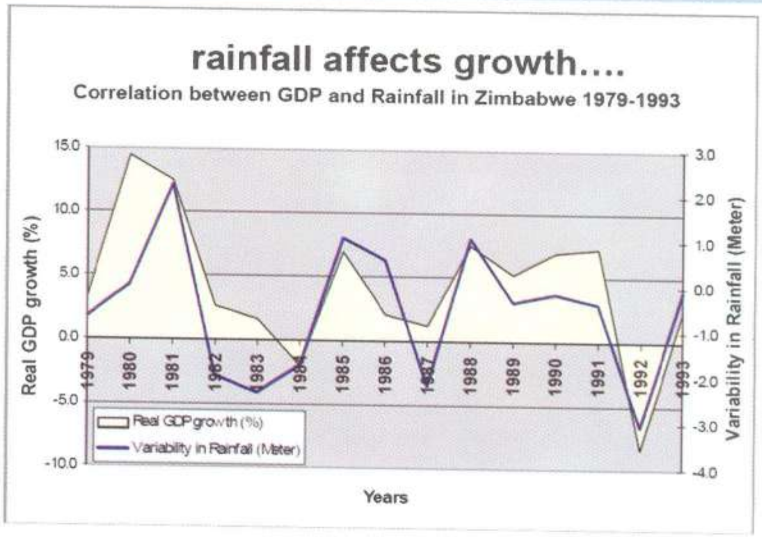
Per-Capita Freshwater Availability (2000)



Precipitation Variability



Water and Economy
Rain: A Symbol of Hope and Prosperity
(The Economy Connection)



6

Case study: Irrigation water management in Sindh

INTRODUTION

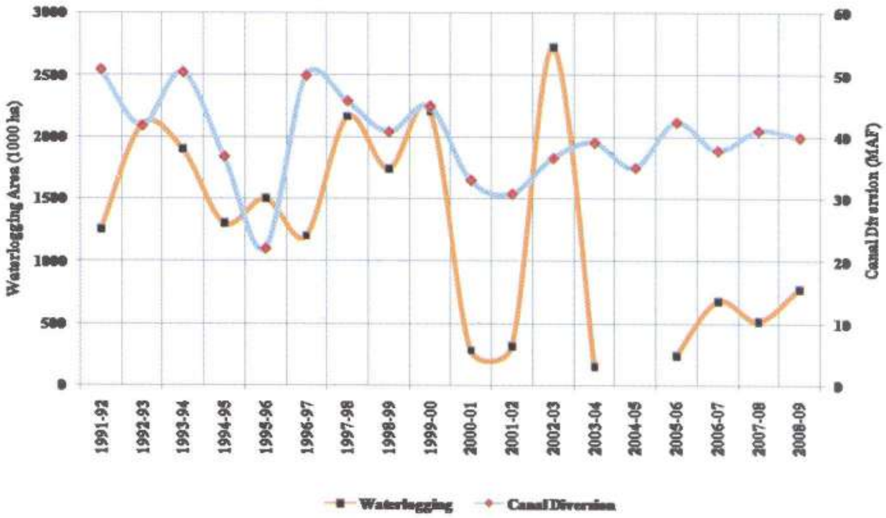
Irrigation System which supplies water to 16 million hectares through 3 major storage reservoirs, 19 barrages, 45 canal command, about 4000 distributaries/minors and 120,000 watercourses facing problems of:

- decline in reliability in water delivery
- decline in water equity
- low irrigation efficiencies
- low yields
- Poor maintenance

Irrigation Network in Sindh

- 3 barrages
- 14 main canals
- 1,446 distributaries
- 45,000 water courses

Canal Diversion and Water logging in Sindh



Crop production and drought effect

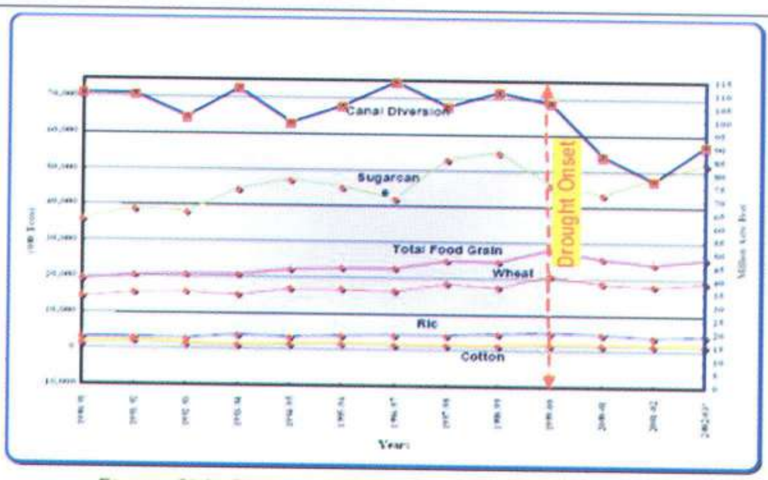


Figure S14: Crop production and drought

Source: World Bank 2003

Wheat yield

- Pakistan has good, abundant sunshine and excellent farmers
- Yet crop yield per ha and cubic meter is much lower than international benchmarks

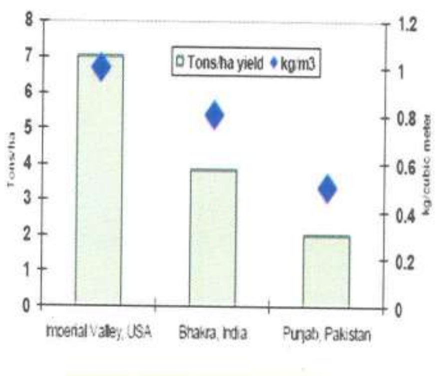
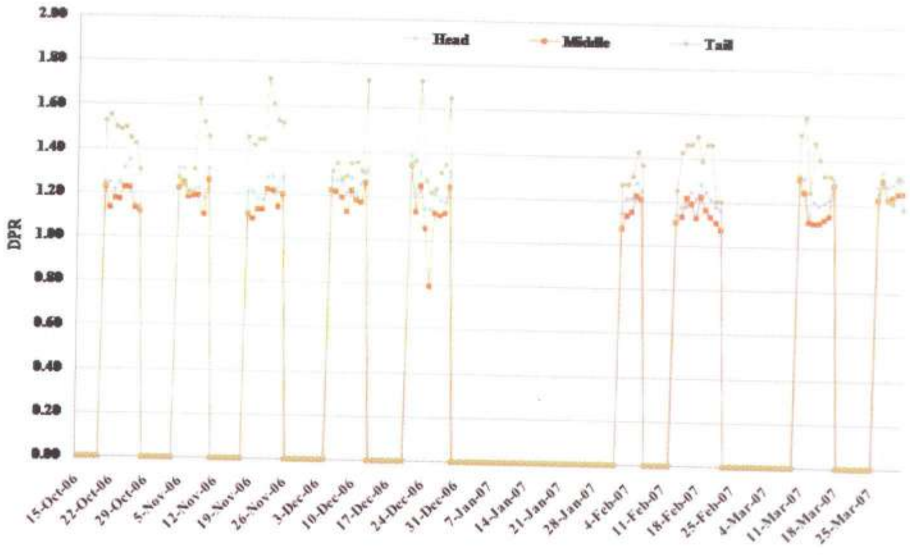
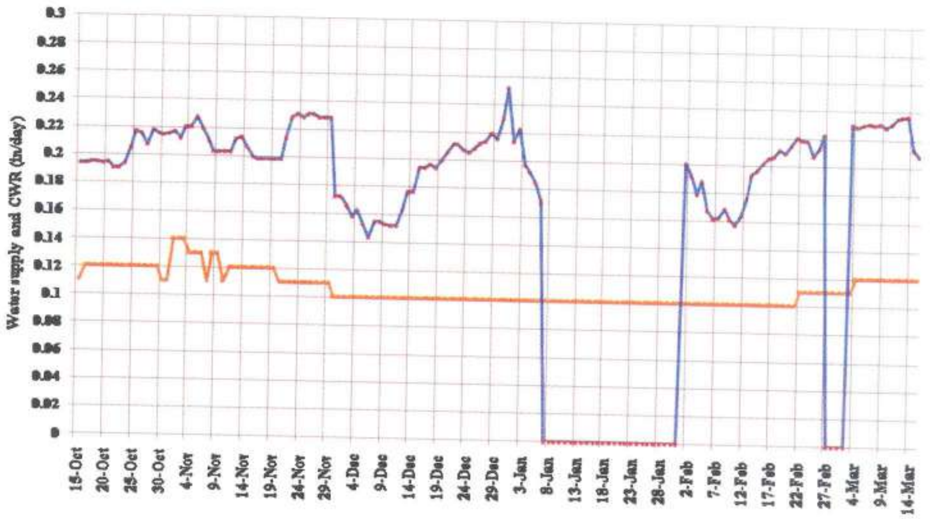


Figure S13: Wheat yields per unit of land and water

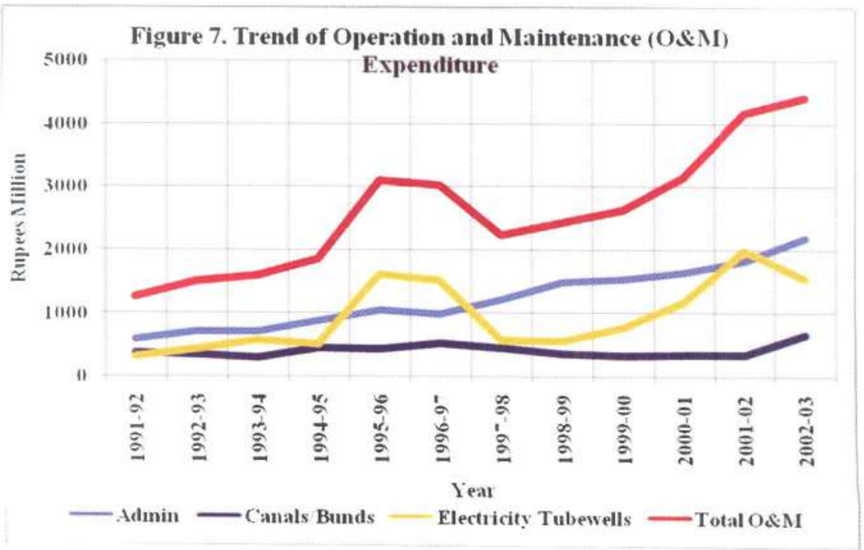
Supply of Irrigation Water

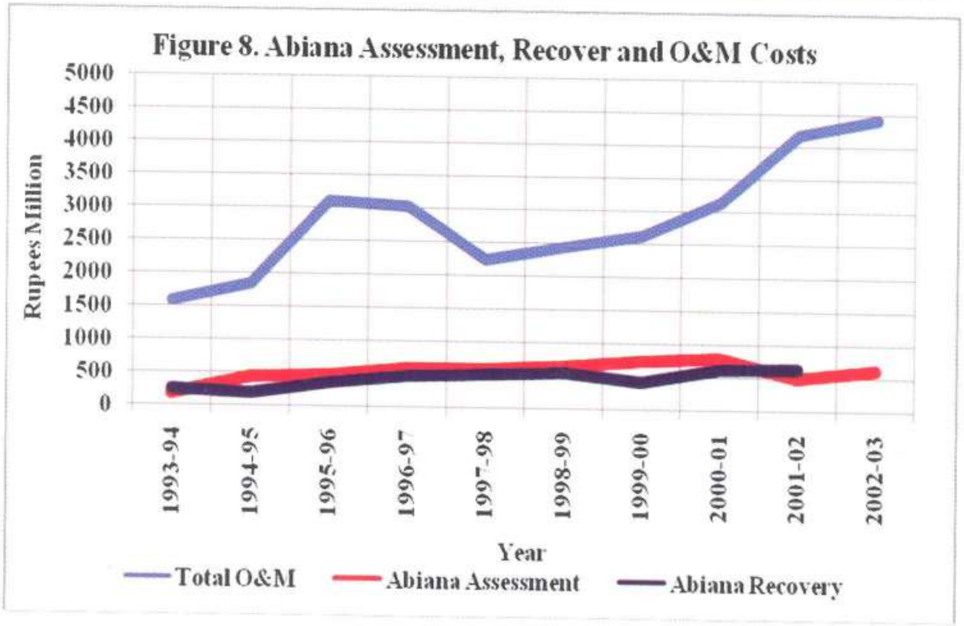


Water Application at Farm Level



Expenditure Trend on System Maintenance

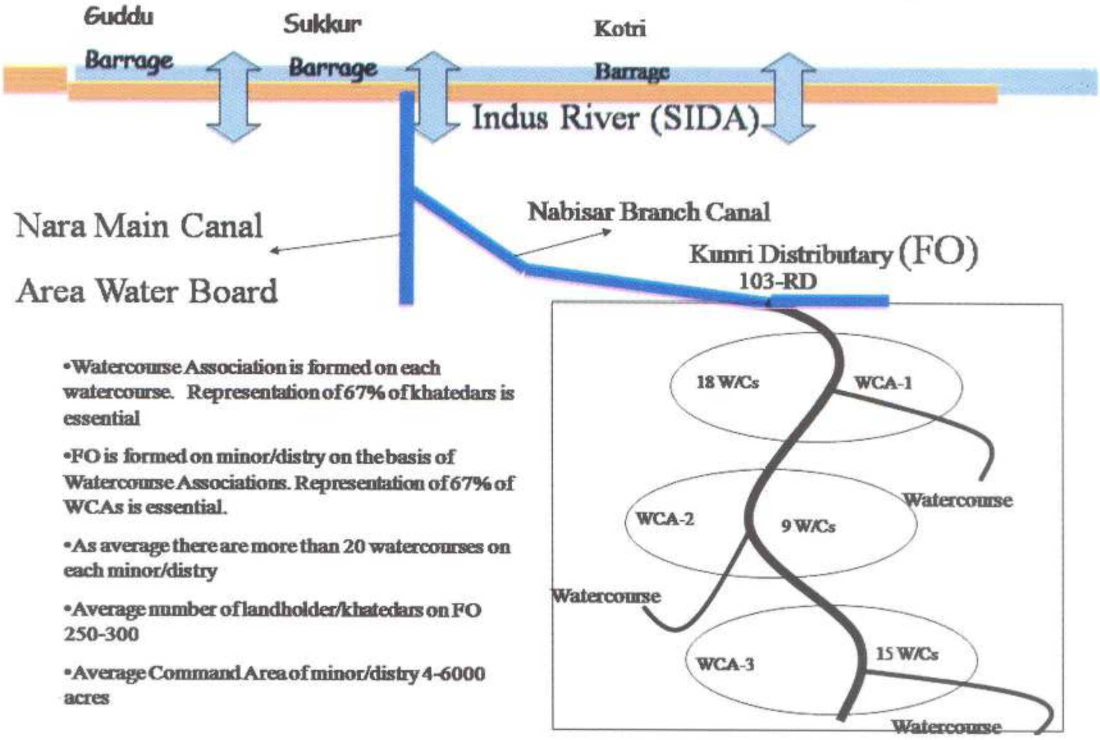




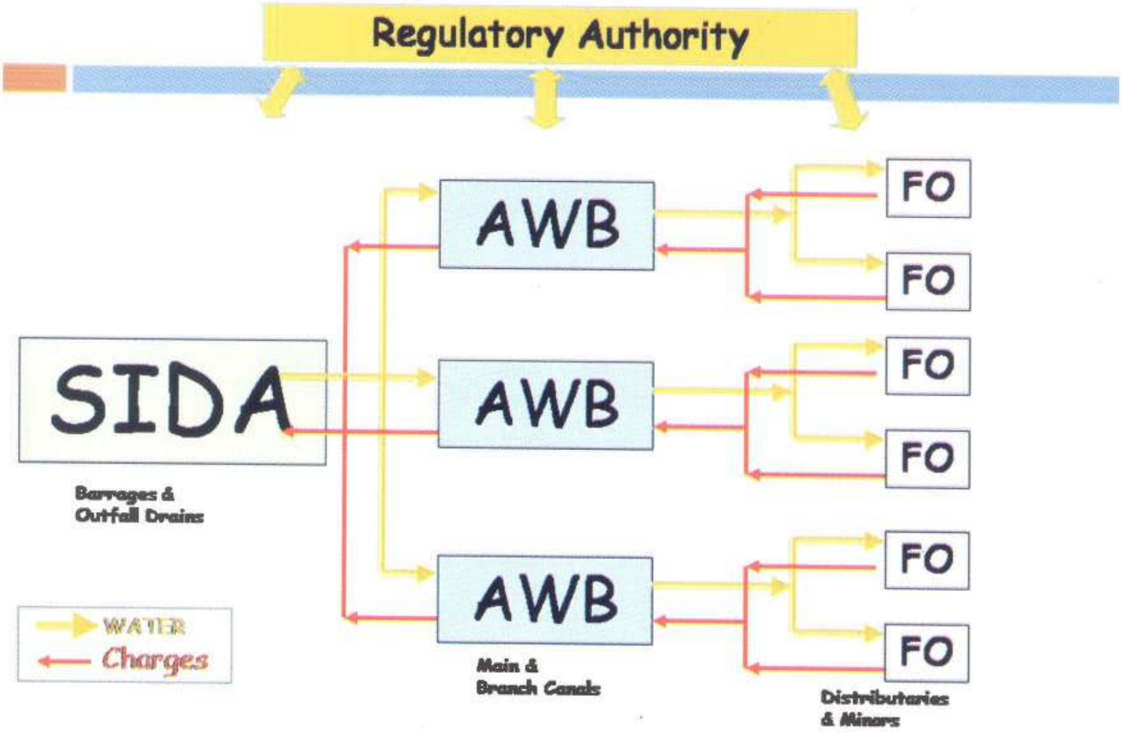
Institutional reforms in Sindh

- SIDA formed in 1997
- 3- Canal AWB established
- 369 FOs formed
- IDMT agreement made with 315 FOs
- Only 12% FOs are sustainable

Participation of Farmers in Water Management



Institutional Reforms - SWMO 2002



FOs role in maintenance of distributary

Distributary	Man-days	Tractor hours	Imputed Cost (Rs)	Earthwork (m^3)	Cost (Rs/ha)
Heran	1157	58	124100	7411	24.85
Khadwari	301	16	49275	n/a	39.59
Rawtiani	586	35	64025	1351	17.50
Bareji	1020	14	105700	5601	18.23
Mirpur	1311	120	172650	9993	26.29
Potko	*979*	*17*	*113611*	*8138*	*34.80*
MAW	427	30	44625	3806	28.76
DhoroNaro	2055	292	249375	7376	46.03

FOs Role in improving water distribution

Distributary	Before Desilting			After Desilting		
	Head	Tail	Ratio of Head:Tail	Head	Tail	Ratio of Head:Tail
Heran	1.36	0.38	3.53	1.31	0.51	2.55
Rawtiani	1.71	1.71	1.00	1.54	1.71	0.90
Tail	1.49	1.20	1.23	1.15	0.96	1.20
Mirpur	1.02	0.39	2.64	0.94	0.66	1.44
Bareji	2.13	1.63	1.30	2.13	2.36	0.90
Sanrho	1.29	1.11	1.16	1.34	1.58	0.85
Belharo	1.11	0.36	3.07	1.07	0.79	1.35
Digri	1.17	1.12	1.04	1.04	0.90	1.16
Potho	1.42	1.15	1.23	1.20	1.12	1.07
Khatian	1.31	0.65	2.00	1.25	1.35	0.92
Bagi	0.58	0.80	0.72	0.71	1.36	0.52

Water Management: Issues

- Water storage
- Flood and Drought due to climate change
- Lack of Institutional Coordination
- Knowledge gap/Capacity
- Low Irrigation Delivery and Application Efficiencies
- Drainage and Salinity Problems

Water Management: Issues

- Enforcement of Regulations
- Changing Cropping Pattern
- Deteriorating Irrigation Infrastructure
- Inequitable Distribution of Water
- Sea water intrusion-Coastal area
- Deterioration of groundwater
- Pollution of Wetlands-Lakes

Water Resources: Challenge

- Two Main challenges

  – Enough water of good quality:
  - to all people,
  - at all places,
  - at all times and
  - at an affordable cost

  – Sufficient resilience against floods and droughts

24

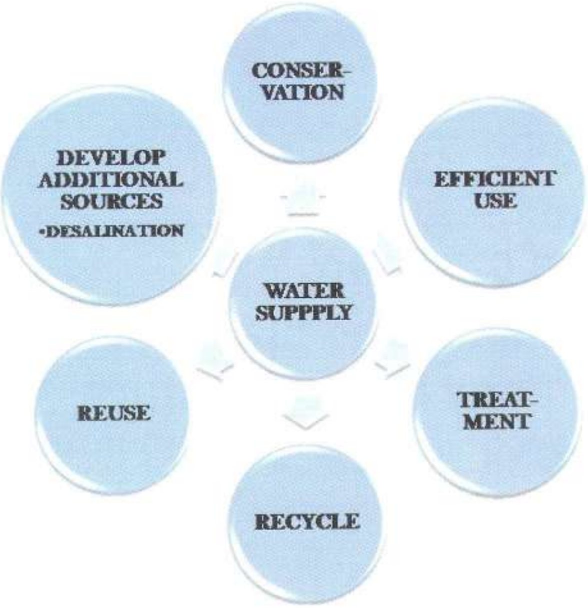
SUSTAINABLE WATER RESOURCES MANAGEMENT

25

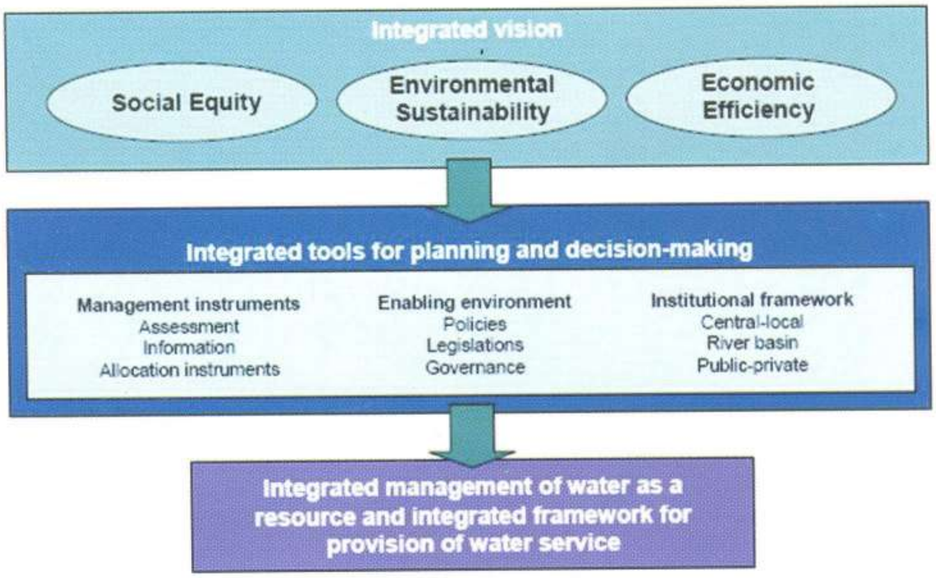
Integrated Water Resources Management (IWRM)

- Simultaneous consideration of:
  - Surface and groundwater
  - Quantity and quality
  - Watershed and water bodies
  - Hydrology, hydraulics, environment, policy and socio-economics
  - Multiple sectors, stakeholders, and decision makers

Strategies for Sustainable Water Use



IWRM



The Way Forward!

- Innovative, revolutionary, and self-sustaining programs
- Diverse and multi-institutional partnerships
- Pricing and valuing water for enhancing water-use efficiency
- Strongly integrated planning for water, energy and agriculture
- Robust regional-capacity building

29

Dr. Zahid Hussain

Dr. Zahid, Project Director Agricultural /Rural Development Project, Ministry of Food & Agriculture, Islamabad, graduated with Ph.D. from University of Leeds, U.K and has over 30 years of post-PhD international & local experience in formulation implementation and evaluation of public sector research and development projects particularly in agricultural fields of crop production, natural resources management , environmental issues, poverty reduction etc.). Evaluation of economic/financial viabilities of different research proposals and technological advancements aimed for improving farming systems and communities in different parts of the world is another area of specialty with market development strategy. Sustainable development with special reference to agricultural policymaking, food security, rural development of land and water resources in different areas of the world including Pakistan is another field of major achievement. Project management, training of the scientific staff and coordination with local and international donors and lined departments for preparation and implementation of different natural resources (research & development) plans for village level rehabilitation and upscaling rural development etc. is an essential part of his experience.

Water Management at Farm Level in Pakistan

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Abstract

Water is the key to produce the food and fiber to fulfill the human requirement. Pakistan's water resources have enough potential to feed the agricultural lands. But the only constraint is management of water from glaciers to farm gate and oceans. Available water in Pakistan is 142 MAF which have great prospective to perform the agriculture, industrial and electricity requirement. The main constraint is the conveyance losses of the water i.e. 88 MAF. Raised Bed Farming is the cheapest irrigation system which provides gravity flow and saves water up to 40 to 50 percent. Study shows that water saving in permanent raised beds was 45 in wheat crop and water productivity was 18.42kg/ha/mm which is more than fresh beds 11.82kg/ha/mm and basin irrigation 10.56 kg/ha/mm. Conveyance losses is decreased by lining of water courses 11.9 MAF and after rain water harvesting the water is also used for more agricultural production by spate irrigation. Generally raised bed farming system saved water in the field and reduce field losses, Conveyance losses is reduced by lining of water courses at the farm level from canal to field and laser leveling of the field also save the water and improve water use efficiency in hilly areas irrigation system will be improved by adopting spate irrigation system. By adopting these technologies we will manage the water and used to convert from kg/ha to kg/m^3.

1. Introduction

Water is an essential resource for survival of life in the world and management of water resources is the best way to live best life. Agriculture is the main component which is based on fresh water availability in the country and good water use efficiency to produces more crop per drop. Now the situation is changed because of higher population agriculture must convert its production from Kilogram per hectare (kg/ha) to kilogram per cubic meter of water (kg/m^3). Pakistan has good water resources and annually available water is about 142 MAF and after losses and sea escape it become 76 MAF for consumptive use of crop, net crop water requirement is 93 MAF. The shortfall of 17 MAF is available with 76 MAF of net available for crops but this shortfall decreases if rainfall contributes its 13 MAF precipitation [1]. Pakistan have one of the world's large irrigation system known as Indus Basin Irrigation System, (IBIS). IBIS comprises of 3 major reservoirs, 19 barrages, 12 link canals, 44 main canals (61000 km), 200 civil canals in Khyber Pakhtonkhwa, 400 distributaries and 144167 water courses. Total area of Pakistan is 79.61 million hectares the land use classification of the area is given in Table 1.

Table 1: Land use classification of Pakistan

Type of Land Use	Area	
	Million Hectares	Percent
Irrigated Area	18.04	22.7
Canal Only	6.81	8.6
Canal and Tubewell	7.40	9.3
Tubewells and Wells	3.65	4.6
Others	0.18	0.2
Rod Kohi (Spate)	2.00	2.5
Sailaba Riverine	1.25	1.6
Barani (Rainfed)	3.35	4.2
Total Cultivable Area	24.64	31.00
Culturable Waste Inside CCA	2.25	2.8
Culturable Waste Outside CCA	6.88	8.6
Total Culturable Waste	9.13	11.4
Total Cultivable Area	33.77	42.4
Forests	3.80	4.8
Total Area Suitable for Agriculture and Forestry	37.57	47.2
Total Geographical Area	79.61	100.00

18.04 million hectares are under irrigation which is 22.7 percent of the total area, and 2 million hectares are under spate irrigation (Rod Kohi). Pakistan has total cultivable area

33.77 million hectares, and shortfall of 4 MAF without rainfall. The water require for our major crops is given below in Table 2. [2]

Table 2: Water requirements of crops of Pakistan

Name of Crop	Water Required (MAF)	Percentage (%)
Wheat	23.09	24.8
Rice	17.55	18.9
Cotton	16.41	17.6
Sugarcane	9.56	10.3
Fodders	9.49	10.2
Others	16.84	18.2

Overall irrigation efficiency is 40% [3]. Now the situation is not allowing us to delay in water management for best interest of country's agriculture production. Modern technologies are available to improve irrigation efficiency up to 90%. i.e. Drip/Sprinkler irrigation system it pressurized irrigation system and upto some extent it is costly but its irrigation efficiency is 90%, after this technology Raised Beds (Furrow Irrigation) technology available which is very cheap because it is not pressurized irrigation system, it is working on gravity flow and its irrigation efficiency is 75%. Spate irrigation is also very important source of irrigation in the hilly areas of Punjab, Balochistan and Sindh, where now farmers are aware with management of rain water harvesting.

2. Water Courses Lining

Conveyance losses are reduced by the lining of the watercourses upto 30% after lining of watercourses 6 MAF water is saved which is now available for 17% more area for crop production, irrigation time saving is upto 28%, increase in cropping intensity 23% and labor saving is 50%. These results were achieved when 15% (15% of the total water course length) lining have been done in the fresh water zones and 30% in saline water zones. Lining of water courses also increase the share of the tail end users of the water courses. 100% earthen improvement of water courses have been done by the watercourses improvement department. This program also reduces the clashes between water user community.

3. Laser Land Leveling

Laser land leveling is the most important part of the land preparation, after leveling of land water conveyance in the field will be improved automatically because leveling provides an ideal slop for the movement of water from head of the field to tail of the field. Nowadays laser leveling is playing very important role by the farmers at their farms. At least 40% farmers are involves in this business by providing laser leveler on rental basis. It improves the water use efficiency by 45%, increase the uniformity of water distribution, increase fertilizer use efficiency 29%, and reduce weed problem 7%.

4. Permanent Raised Beds Farming System (Furrow irrigation)

Permanent raised beds (Furrow Irrigation) it is very old method of irrigation which was used for only vegetable but after shortage of water the concept of furrow irrigation is transferred to the crops to get better crop with minimum water use. In Pakistan permanent raised bed farming was started in 1998 with the collaboration of Australian Center for International Agriculture Research (ACIAR), after 1998 the major crops were tested on permanent raised beds the size of the beds were 180 cm but according to Pakistani conditions the size of beds were reduced during the research and finally 130 cm bed were find out for all types of crop according to soil type the bed size is adjustable from 75 cm to 130 cm. The crops which were tested on permanent raised beds are Wheat, Cotton, Maize, Sunflower etc. the results reviled that water was saved 30 to 50% and yield increase in Wheat crop from 8 to 15%, Maize 15 to 30%, Cotton 10 to 18% and fertilizer saving was upto 10 to 15%. Other benefits of the furrow irrigation are No crop lodging, labor saving, time saving, uniform application of seed, fertilizer, and water, easy to irrigate etc.

5. Wheat crop on Permanent Raised Beds in Mardan (A case study)

5.1 Methodology

The study area is located at Gohati (Mardan) in Khyber Pakhtonkhwa of Pakistan. It is semi arid zone with mean seasonal rainfall 250mm in summer and 300 mm in winter. The mean maximum temperature ranges from 22-30^{o}C during the month of June and mean minimum temperature ranges 5-8^{o}C during the month of January. Research site was established on the area of 5 acres and Wheat crop was sown on permanent raised beds and 5 acres were control to compare the results.

5.2 Data Collection

Data of irrigation, weed control, seed used, fertilizer used, rainfall and crop yield was recorded for the analysis and comparison of the basin irrigation and furrow irrigation.

5.3 Soil Salinity and Nutrient Behavior

Soil samples were collected from 0-10, 10-20 and 20-30 cm depth for salinity, pH and nutrient analysis. The soil moisture content was also determined by taking soil samples with the help of king tube at sowing and harvest, after rainfall, and before and after irrigations. The samples were taken from 0-15, 15-30 and 30-60 cm soil depths from edge and at centre of the beds also. The soil samples were dried at 105 ^{O}C for 24 hrs in oven and moisture content was calculated. The irrigations where scheduled based on soil depletion of available water in top 30 cm depth for determining depth of irrigation water to be applied. The irrigation water flow was measured by the help of cutthroat flume.

The soil samples were taken from centre and edges of beds and consolidated soil sample from basin plots for soil moisture content measurement. The soil moisture (water) content was measured during the whole crop growth period. The maximum soil water was observed as 20.73, 18.65 and 19.43 % at 0-15, 15-30 and 30-60 cm soil depths respectively at 49 days after sowing of crop. The minimum moisture content was 13.41 and 14.52 % for 15-30 and 30-60 cm soil depth at 114 days after sowing of crop. The soil water content varied due to rainfall and irrigation during the period. Preliminary data indicates that the soil water content at the edge of the bed was mostly higher than at the centre of the bed (Figure 1, 2 & 3) which indicates that irrigation management is required that no stress should be there for the crop at the centre of the bed during the period.

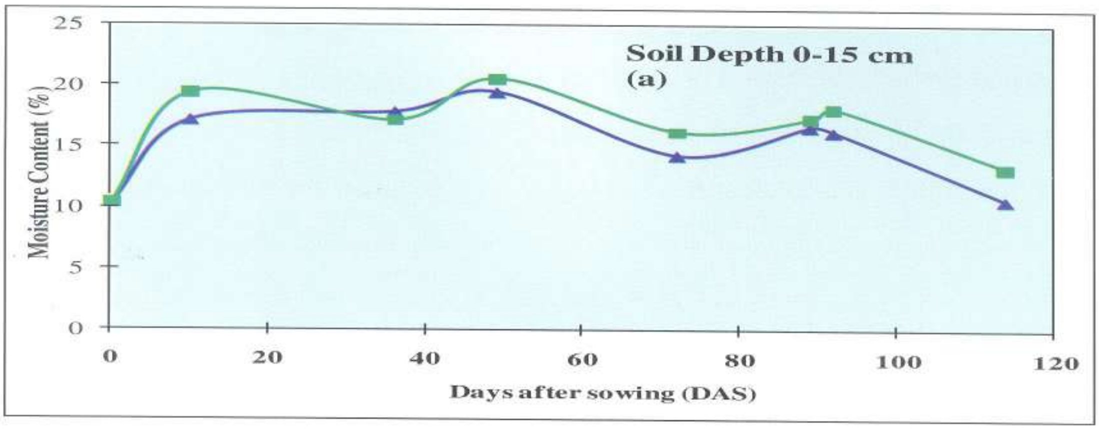

Figure 1: Soil Moisture behavior at the depth of 0-15cm

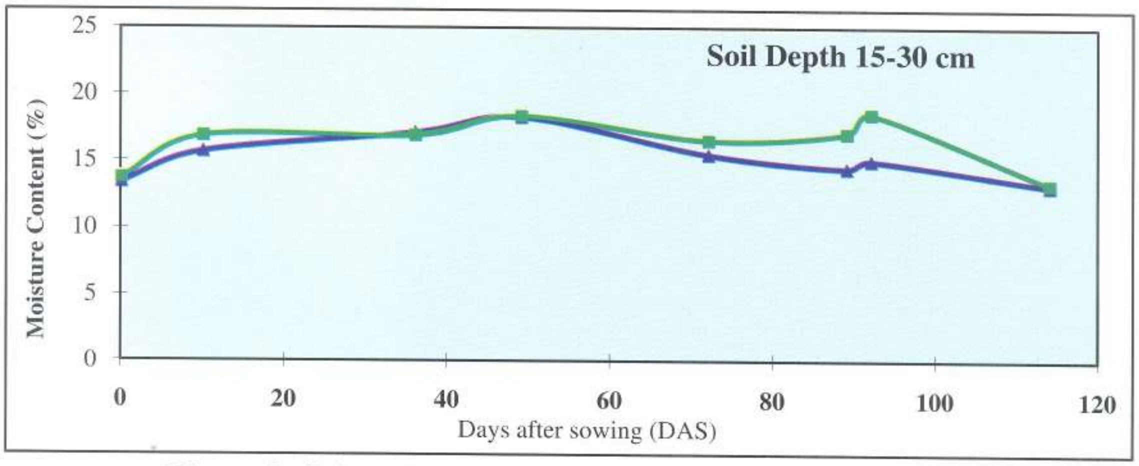

Figure 2: Soil Moisture behavior at the depth of 15-30cm

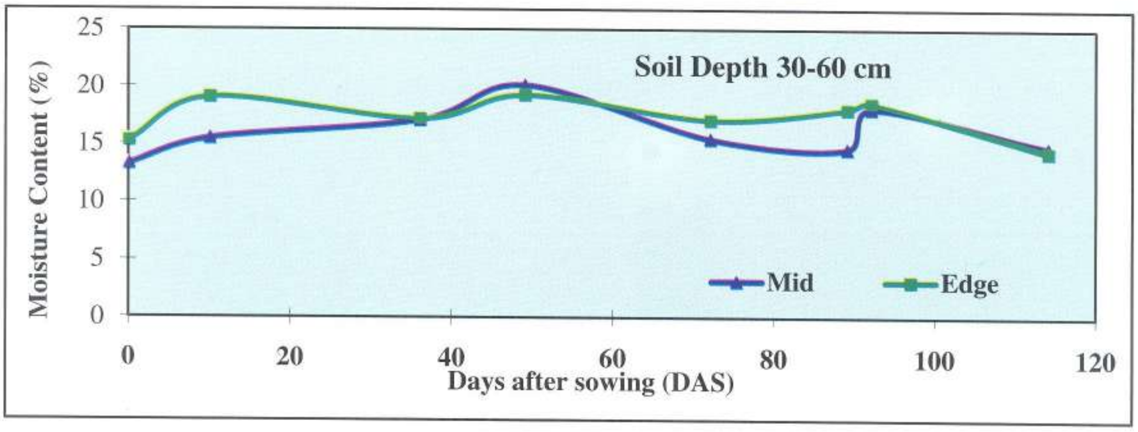

Figure 3: Soil Moisture behavior at the depth of 30-60 cm

Soil salinity and nutrient were also measured at sowing and harvest of the crop. pH was measured at sowing and harvest of crop. Soil pH was around 7.3 at sowing of the crop and it increased to 7.9 at harvest of wheat crop (Table 3). The EC which is an indicator of salinity was similar at harvest and at sowing. Results indicate that pH had increasing trend from sowing to harvest under all treatments and Salinity remained the same. The available phosphorous and potassium was also analyzed at sowing and harvest of the crop and detail of each depth is presented in Table 4. This is one season data, the more seasons data will guide the real behavior of water control and salinity behavior.

Table 3: Soil pH and Electrical Conductivity behavior under various treatments

Treatment	Soil Depth (cm)	EC (dS m^{-1})		pH	
		Sowing	Harvesting	Sowing	Harvesting
Basin	0-10	0.40	0.37	7.3	7.8
	10-20	0.39	0.34	7.3	7.9
	20-30	0.39	0.35	7.2	7.9
Bed	0-10	0.42	0.33	7.3	7.9
	10-20	0.38	0.33	7.2	7.1
	20-30	0.36	0.32	7.2	7.1

Table 4: Soil nutrients behavior under various treatments

Treatment	Soil Depth (cm)	Available Phosphorous		Available Potassium	
		Sowing	Harvesting	Sowing	Harvesting
Basin	0-10	4.08	7.55	272.5	41.65
	10-.20	4.24	4.67	257.5	58.73
	20-30	3.72	3.87	240.00	11.73
Bed	0-10	9.1	2.25	353.3	74.03
	10-.20	6.98	4.78	243.3	76.53
	20-30	6.3	2.6	233.3	75.9

6. Irrigation and Rainfall

The discharge of irrigation water was measured with cutthroat flume installed in the field channel during irrigation. The rainfall was measured with a rainguage and total rainfall during the crop period was 185 mm. Total irrigation water applied was 382 under basin and 135 under large beds. Total water used under basin was 567 mm and it decreased to

310 mm under beds (Table 5). There is saving of irrigation water about 50 % under furrow bed as compared to conventional basin.

7. Wheat Grain and Straw Yield under Various Treatments

The crop samples were collected in triplicate in all treatments for grain and straw yield. The average wheat grain yield under basin was 5.99 ton/ha, 5.71 ton / ha under furrow-bed (Table 5). The straw yield was about 10 ton/ha and results indicate that there is no significant difference in all treatments. The national average wheat grain yield is not more than 2.5 ton/ha.

Table 5: Wheat grain and straw yield

Treatment	Grain Yield (ton/ha)	Straw Yield (ton/ha)	Total Water (mm)	Water Saving
Basin	5.99	9.84	567	-
Furrow-Bed	5.71	10.1	310	45

8. Water Saving and Productivity

The crop was well established under furrow-bed system in the region (Figure 6-9). There was of 257 mm water saving under furrow-bed system. This shows that the irrigation water saving is about 45% under furrow-bed systems. The water productivity was 10.56 kg/ha/mm under basin. It was 18.42 kg/ha/mm under furrow-bed system (Figure 5). The water productivity of wheat crop was maximum under large furrow-bed along saving of water.

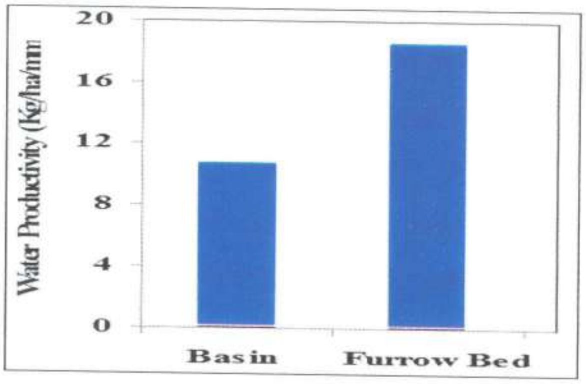

Figure 5: Water productivity of Wheat in Maize-Wheat farming system

9. Case study at Karachi site in addition with Drip Irrigation system

The same study given above was conducted at Karachi farm on the farmers farm (Mama Arif Farm) with the addition of Drip Irrigation on the beds. The results shows that the water productivity of the drip treatment was higher (0.878 kg/m^3) than bed furrow irrigation (0.77 kg/m^3) and basin irrigation was shows lower than both treatments (0.452 kg/m^3). The grain yield is slightly higher in basin Irrigation treatment (2.888 ton/ha) and drip irrigation treatment yield was (2.536ton/ha) and in bed furrow irrigation the yield was (2.363 ton/ha). Table 6 shows the results of the study at Karachi site.

Table 6: Grain yield and water use under various treatments, Karachi, Sindh

Name of site	Treatment	Total Water Used (m3/ha)	Total Yield (ton/ha)	Water Productivity (kg/m3)
Mama Arif Farm, Karachi	Drip	2887	2.536	0.878
	Bed Furrow	3054	2.363	0.774
	Basin	6387	2.888	0.452

10. Spate Irrigation

Spate irrigation is a type of water management that makes use of water from "Spates" short duration flood. Spate lasting from a few hours to few days are diverted from normally dry riverbeds and spread gently over agriculture land. After the land is inundated crops are sometime sown immediately. Often the moisture is stored in the soil profile and used later. The spate irrigation system support low economic value farming system, usually cereals (sorghum, wheat, barley), oilseeds (mustard, castor, rapeseed), pulses (chickpea, cluster bean), but also cotton, cucurbits and even vegetable. Besides providing irrigation, spate recharge shallow groundwater (especially in river bed), they fill (cattle) pounds and they are used to spread water for pasture or forest land in some place. (*Lisa Magazine 25.1 march 2009*).

Study shows that the results of yield with different pre sowing water application depths. The irrigation depths were ranging from 21cm to 73cm with the result of sedimentation of 1.8 to 3.6cm/irrigation. 2 to 3 hectares were the area of study sites. The soil texture of the study sites were loam, clay loam, silty clay, silty clay loam and silt loam and the water holding capacity of the soils were between 23 to 36.3% (on volume basis). Bulk density of the field was between 1.35 to 1.42 g/cm^3. Grain yield obtained from loam soil was (36%) more than (24%) from silt loam soils as compare with silt clay soils. Maximum yield of the wheat crop was 3448 kg/ha where irrigation depth was ranging 30-45 cm and lowest yield obtained with irrigation depth of 45cm. application efficiencies at the farm were ranging from 22% to 93% with average of 45%. Results reviled that optimum yield was obtained with pre sowing irrigation depth 30-45cm and avoid 45cm irrigation depth.

11. Conclusions

There was 45% water saving under the raised bed (furrow irrigation) farming system but it is greater with drip irrigation system on raised beds. The water productivity of the Gohati site at Mardan was 18.42 kg/ha/mm compare with basin irrigation system which was 10.56 kg/ha/mm. The results of the Sindh site shows the water productivity of the Drip irrigation system on raised beds higher than furrow irrigation system and then basin irrigation system. The result of the spate irrigation system shows the best water management of water using 30-45 cm depth of irrigation application for wheat crop. If we use water more than 45cm depth then the loss of the water will increase and production will decrease.

The furrow irrigation farming system can save water and address the scarcity of water with more crop per drop. We can fulfill the water requirement of the country's crops by adopting these technologies. Now we have no time to think how water will manage, this is the time to take serious action to use these technologies.

Figure 6: Furrow bed preparation for wheat sowing

Figure 7:Wheat sowing using PRB machinery

Figure 8: Wheat Germination on PRB

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Technical Session-IV

Community Education and Capacity Building

Dr. Cheng Liu

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IRTCES & Its Training Courses

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1. Introduction

The International Research and Training Center on Erosion and Sedimentation (IRTCES) is the first established Category II Center under the auspices of UNESCO. It was established in 1984 under the Resolution of the 22nd Session of UNESCO's General Conference (1983, Paris) and Agreement between the P.R. of China and UNESCO (1984). In the past 27 years, The Chinese government has supported IRTCES with resources and financial input. Especially under the guidance of UNESCO and Ministry of Water Resources, P. R. China, and with the support worldwide, IRTCES has conducted many bilateral and multilateral collaborative research and training. Since its establishment, IRTCES has conducted over 100 research projects and consulting programs, organized over 40 international and domestic training courses, and sponsored and co-sponsored over 100 conferences and workshops. It is the permanent secretariats of series International Symposia of River Sedimentation (ISRS) and International Conference on Estuaries and Coasts (ICEC), and 11 times of ISRS and 3 times of ICES have been organized in many countries. IRTCES serves as the Technical Secretariat of UNESCO International Sediment Initiative (ISI) and Secretariats of World Association for Sedimentation and Erosion Research (WASER) and World Association of Soil and Water Conservation (WASWAC). The quarterly published International Journal of Sediment Research and the annually published China Gazette of River Sediment are edited and compiled by the IRTCES, and it also manages Qian Ning Memorial Prize for Erosion and Sedimentation. Under the support of Chinese Government, UNESCO, as well as experts and scholars worldwide, IRTCES has made great achievements and become one of the important partners of UNESCO in China.

The renewed Agreement on IRTCES between the P.R. of China and UNESCO was signed in Beijing on Nov. 30, 2005. The functions of IRTCES list as follows:

a) to promote the scientific research on erosion and sedimentation (including sediment transport theory, fluvial/coastal and reservoir sedimentation, sedimentation engineering, soil erosion, soil and water conservation, environmental and ecological impacts of sedimentation);

b) to provide technical advisory services and to create a mechanism for the exchange of scientific and technical information on the results of research among experts in various countries;

c) to act as the Secretariat for the International Sediment Initiative, including hosting and coordinating the implementation of projects relevant to sediment, sustainable water management and water environment and ecology;

d) to coordinate international cooperative research activities and to establish laboratory and research centres in order to provide facilities for laboratory and field work for the experts from other countries;

e) to organize international training courses, symposia or workshops on special subjects and international study tour and lecturing activities.

2. IRTCES Training Courses

2.1 Recent Training Courses organized by IRTCES

Technical trainings on sediment related areas are one of main activities of the IRTCES. Since 2003, IRTCES has organized 8 international training courses and 3 domestic trainings. For more participants, some training courses were organized outside of China. They are:

- International Training Workshop on River Sedimentation and Flood Control on Sept. 21-29, 2003 in Beijing with 10 participants from 3 countries;

- Lectures on Sedimentation Engineering on Oct. 18-25, 2003 in Pyongyang, DPRK with 29 participants;
- International training on landslide and debris flow on Nov.25 – Dec. 2, 2004 in Pyongyang, DPRK with 34 participants;
- Research study under UNESCO fellowship programme: 2 engineers from DPRK were trained on water resources and remote sensing technology during Sept. 15 to Nov. 17 in Beijing;
- International Training Workshop on Watershed Eco-Environment and Water Resources Management on Sept. 11-19, 2005 in Beijing with 31 participants from 9 countries;
- Flood Forecasting and preparedness on June 13-27, 2006 in Pyongyang, DPRK with 25 participants;
- Advanced training workshop on reservoir sedimentation management on Oct. 10-16, 2007 in Beijing with 29 participants from 12 countries;
- Advanced Training Workshop on Integrated River Basin Management on July 27-Aug.3, 2009 in Beijing with 51 participants from 18 countries;
- Training workshop on sustainable reservoir sedimentation management on Sept. 20-28, 2008 in Beijing with 36 participants from China;
- National Training Workshop on Hydropower Project Construction on Oct. 21 – Nov. 2 in Hangzhou with 100 participants from China;
- National Training Workshop on River Training and Flood control on Sept. 21-29, 2008 in Yichang with 70 participants from China.

2.2 Main Parts of Training Courses

A good training course asks for good organization. IRTCES pays great attention to every training course and prepare it several months before in training topic selection, lecturer invitations, lecture note compilations and announcement distribution etc. A training course normally includes the following main parts:

1) Lectures: Lectures are most important part of the trainings and it normally spends 70% periods of training time. Several professors/experts in different specific fields according to the training topic are invited to give lectures. The lecturers are invited from:

i) Universities, such as Tsinghua, Hohai and Wuhan Universities;

ii) Research institutes, such as China Institute of Water Resources and Hydropower Research, Nanjing Hydraulic Research Institute, and research institutes from Chinese Academy of Sciences, Yellow River Conservancy Commission and Changjiang Water Resources Commission; and

iii) IRTCES Advisory Council, ISI Steering Committee and other UNESCO Category II centers

In the Advanced Training Workshop on Integrated River Basin Management held in 2009, famous professors/experts from China, Switzerland and Japan were invited to give lectures on topics of River Ecosystem and Integrated Management, Integrated Water Resources Management, Integrated River Basin Management, Ecology and Restoration in Integrated River Basin Management, Water Security Problem to Climate Change and Human Activity, and Case Study of the China South to North Water Diversion Project. These interesting lectures given by the world famous experts expose fundamental concepts to the participants and establish a good foundation for a successful training course.

2) Discussions: Participants are encouraged to interrupt the lectures anytime for free discussions whenever they have questions. They also like to have discussions with the lecturers and among participants after classes. Through discussions, the participants have better understandings on basic theories and fundamental concepts.

3) Laboratory Visit: A laboratory visit to the Laboratory Base of China Institute of Water Resources and Hydropower Research (IWHR) is arranged. There are laboratories of hydraulics, water resources, sedimentation, water supply and drainage, irrigation, estuary and coast, soil and water conservation, hydraulic concrete, large trixial earthquake

simulating shaking table, materials and structures, etc. in the base. The participants will get some understandings on modern experimental methods.

4) Field Study: According to the training topics, a one or half day's field study is arranged in the suburb of Beijing or other places. Several field studies of water and soil conservation, watershed management and eco-environmental protection were arranged in Suburban of Beijing in previous training workshops.

5) Seminar among participants: Participants are encouraged to bring their case study to make presentation for sharing and exchanging experiences in the seminar. The participants chair the session under the guidance of lecturer. The participants have different background with some as high as university professors or some only have one or two years working experiences. They also work in different fields from different countries. But all participants are actively participating in the presentations and discussions in the seminar.

6) Appraisal by the trainees: All participants are asked to fill and submit "Form for Training Evaluation by Participants" designed by UNESCO Office Beijing. It includes evaluation on lecture material, lectures, facilities, and recommendations for future trainings, etc.

2.3 Future Trainings

The IRTCES will organize training workshops in the future on the topics of:

- Water and soil conservation
- Fluvial process and river training
- Reservoir sedimentation
- Integrated river basin management
- Sediment management and wetland Conservation
- Sediment measurement techniques
- Flood control and management
- River environmental and ecological protection

- ……

To help the UNESCO member states in meeting their water education needs in sediment related areas, IRTCES is happy to:

- Organizing training courses in China and invite participants from the world.
- Sending lecturers to other countries or organizing training courses in other countries.
- Publicizing training materials in IRTCES and UNESCO-ISI Websites.
- E-training through internet in the future.

The International Training Workshop on Water and Soil Conservation and Eco-construction is going to be organized in September, 2011 in Beijing, China. The announcement will be distributed through UNESCO and in websites of IRTCES, UNESCO-ISI and WASER soon.

3. Community Education

3.1 Water-conscious community

One case of community education is my personal experience when I worked in Anhui University of Architecture. In a summer vacation, 10 university students majoring in Water and Wastewater are organized to go to the community for sharing knowledge on water saving.

- Volunteer – University students
- Participants – Housewives, Retired old people, Primary school students…
- Education type: Class training, Discussions, Bulletin boards, Newsletters, Go home helping…
- Measures: Replace for water efficient taps, Prevent taps from leaking, Reuse greywater, Efficient appliances, Put a plug in the sink

The Water-conscious community shows good effects not only the participants gained technical methods for water saving, but also some good water saving solutions thought by the themselves were exchanged among the participants.

3.2 Participatory Watershed Management Training in Asia – Wuhua, Guangdong Province

The Participatory Watershed Management Training in Asia – Wuhua, Guangdong Province is a FAO project organized by IRTCES during 1993-1996. Wuhua county is located at the mid-eastern part of Guangdong Province, China. The county has serious erosion and watershed degradation problems. Population density is 280/km^2, and the average arable land per capita is only 0.1 ha. Soil and water erosion in the county is responsible for weak geo-morphology, poor soils and vegetation, hydrological problems, irrational land-use and many socio-economic problems.

- Goals: improve agriculture production, Eradication of Poverty and land degradation for sustainable development.
- Principals: human-oriented and farmer depended; participatory and Partnership; sustainable; gender equity
- Evaluation: level of people's participation; gender equity; conservation of natural resources; distribution of benefits; farmer based research; rural organization etc.

To proceed the training, a working group was formed with participation of local technicians of agriculture, water resources, animal husbandry, forestry, fishery, and water and soil conservation; local governmental officials, farm representatives, and women representatives. 13 training courses were carried out with 1508 farmer participants trained in topics such as river basin management, fish farming, poultry raising, pig raising, water and soil conservation; and 2 technical consulting activities with 270 participants were organized. Support Rural Special Technique Associations and women collaboration were organized including 3 housewife financial management training courses with 120 women participants; and 3 training courses with 120 participants for the Women Association, Rice Association, and Citrus Association. Also 6 special technique demonstration with 1236 participants for training, and 235 participants for visiting technique demonstration sites were organized.

The benefits of this training and continuous erosion control measures:

- Reduction in soil and water losses: erosion rate decreases from 6262 ton/km^2.yr to 217 ton/km^2.yr;
- Improvement in ecology and environment: vegetation increased from 10-80 %;
- Soil fertility improvement: improved from 14 to 47 times; and
- Farm income: per capita income has increased 4-5 folds.

4. Concluding Remarks

Sediment problems are the most difficult issues in the world. With global climate change and intensified impact of human activities, many countries are now facing much severer challenges in sediment problems in river harnessing, flood control and disaster mitigation, water resources development and utilization and ecological and environmental protection. According to preliminary statistics, the world annual surface soil erosion amounts to 60 billion tons, resulted in the loss of farmland as much as 50-70 thousand square kilometers. The eroded sediment deposited in river channels has caused the continuous rising of the river beds, and about 1% of the precious storage capacity of the world's reservoirs is annually lost due to deposition. The constructions of hydraulic project on rivers have greatly changed the natural hydrologic and sediment processes, leading to a new evolution of the up and down stream river channels. It imposes direct impact on the river for flood control, power generation, water supply, navigation and watershed eco-environment. In view of the complexity and importance of these sediment problems and their process, it calls for countries all around the world to enhance awareness about the importance of erosion and sediment processes and their impacts, to promote related research and training on erosion and sedimentation, to strengthen education and capacity building for sustainable sediment management, and to promote exchange of information on relevant data, monitoring and management methods.

In recent years, in order to solve various sediment problems of different rivers in different regions, the relevant departments of the Chinese Government and research institutes carry out series of major research work, such as the studies on the sediment issues of the Three Gorges Projects on the Yangtze River, and water-sediment regulation by the Xiaolangdi Reservoir on the Yellow River. By these activities, we have achieved many research results, established sound theoretical basis and accumulated rich experience on sediment research and management. In May 12, 2008, the world shocked Wenchuan earthquake occurred in China, the quake triggered many problems, such as landslides and avalanches, quake lakes, slope soil looseness, river sediment load increasing. Last year has witnessed several disastrous storm induced landslides in Southwest and Northwest China, including Wenchuan quaked area. The Chinese government and water related institutes pay great attention to these issues, not only many governmental officials and experts rushed to the site solving problems and helping disaster relief, but also the related issues have been included in the medium and long-term research plans. These newly appeared sediment related problems call for international cooperation to make efforts together for solutions. China would like to further strengthen the scientific exchanges and cooperation worldwide in order to jointly promote the advancement of sediment related researches and practices, and solve the problems encountered from the projects and in the economic and social development.

As an UNESCO Category II Center, IRTCES will make effort to bring into full play the leading role in international sediment research, consultation, training, communication and cooperation for contribution to the UN Millennium Development Goals ! IRTCES welcomes future cooperation with related organizations and institutions in sediment related fields all over the World.

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Dr. Homayoun Motiee

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The Importance of Drought Investigation in a Global Dimension in the Frame work of an International Drought Initiative

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Abstract

Undoubtedly today's world experiences crisis appearing in different shapes, for various reasons such as climate change, population growth and imbalanced economic development of countries. Deep impacts of this crisis is considerable on natural sources especially on water resources which can be demonstrated as devastating floods and continues droughts in all 5 continents of world.

The year 2010 was introduced as the deadliest year during the recent years by the United Nations and the world witnessed deadly events in 2010 including the floods in Pakistan, August 2010 and droughts in Africa and the Middle East, autumn 2010.

This paper tries to introduce the "Regional Center on Urban Water Management", as one of the Category II Centers acting under the auspices of UNESCO in Tehran, Iran and later on addresses relevant information on droughts and subsequently the objectives of the International Drought Initiative (IDI) supported by UNESCO-IHP.

1. Introduction

The Regional Centre on Urban Water Management under the auspices of UNESCO, is based in Tehran, Iran. The agreement of the establishment of the Centre was signed in February 2002 between The Government of I.R. Iran and UNESCO.

RCUWM's mission is to transfer applicable scientific knowledge, and increase know-how and capacities in all of the cases and dimensions of urban water management in order to promote sustainable development, and undertake activities in this field in order to enhance human welfare in the region States.

The main objectives of this Category II Centre are:

1. To generate and provide scientific and technical information on urban water management issues in the region that will allow the formulation of sound policies leading to sustainable and integrated urban water management at the local, national and regional level.
2. To promote research on urban water management issues through regional cooperative arrangements using and strengthening local capabilities and involving international institutions and networks, in particular those under UNESCO/IHP auspices.
3. To undertake within the region effective capacity-building activities at institutional and professional levels, and awareness-raising activities targeted at various audiences, including the general public.
4. To advance cooperation with international institutions in order to advance knowledge in the field of urban water management.

2. Networking

RCUWM – Tehran has established a good network by other Regional / International entities around the world since its establishment. This networking includes the following organizations:

- Islamic Educational, Scientific and Cultural Organization (ISESCO)
- International Water Association (IWA)
- International Association of Hydrological Sciences (IAHS)
- Japanese National Committee for IHP
- UNESCO-IHE
- Islamic Development Bank (IDB)
- Water and Power Development Authority (WAPDA)

- Regional Centre for Training and Water Studies of Arid and Semi-arid Zones (RCTWS-Cairo)
- International Centre for Education, Capacity Building and Applied Research in Water (HYDROEX –Brazil)
- International Research and Training Center on Erosion and Sedimentation (IRTCES)
- International Center for Water Hazard and Risk Management (ICHARM)

3. Capacity Development Activities

Since its establishment the Centre has organized more than 52 program / project in the framework of IHP. These programs include 29 Workshops, 11 Training Courses, 2 Seminars and 3 Conferences and 10 Projects. It's worth mentioning that 5938 person / day have benefited from the events organized by RCUWM – Tehran and its partners.

In addition, as drought management has been amongst one of the most important activities of the Centre, the Islamic Republic of Iran has recently proposed an initiative entitled as the International Drought Initiative (IDI) to UNESCO General Conference later passed to the 19th International Hydrological Programme (IHP), Intergovernmental Council held in Paris, July 2010.

Due to the high capabilities of the Centre in carrying out various projects at regional and international levels related to water issues, the secretariat for this Initiative has been assigned to the Regional Centre on Urban Water management in Tehran by the Ministry of Energy, I.R. of Iran.

Brief information related to introducing IDI, its objectives and governance structure is provided in the next part.

4. Drought as a Water Related Disaster

The frequency of natural disasters between 1990 and 2006, particularly water-related disasters, has increased markedly – as has the estimated economic damage they cause. Extreme events have also become more frequent. Between 1900 and March 2007, 16301 disaster events were recorded throughout the world – 6.27 billion people were affected; fatalities were more than 37.58 million and the estimated economic damage was more than US$1,790 billion. In terms of fatalities and the number of people affected, Asia is the region most vulnerable to water-related disasters, accounting for more than 45% of fatalities and more than 90% of the people affected by disasters.

During the period 1900 to 2006, a total of 836 droughts were reported globally in the Emergency Disasters Database, killing more than 1 million people, affecting more than 752 million, and inflicting more than US$ 61 million of damage. The following map (Fig. 1) displays the drought prone areas in the world.

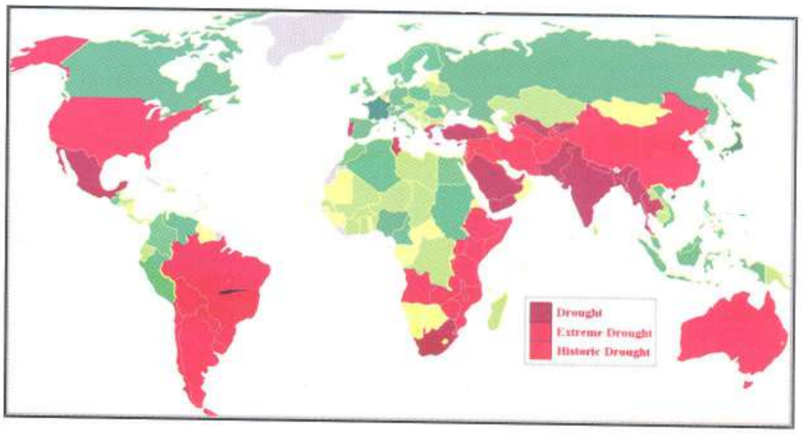

Figure 1: Drought Global Map according to unitedcats.wordpress.com

These facts simply mean that more must be done to mitigate natural disasters – particularly future water-related disasters, given the catalyzing effect of climate change.

5. International Drought Initiative (IDI)

More than 80 countries in the world are located in arid and semi-arid regions which have about 40 percent of the world population and is due to the rain fall scarcity. About 85 percent of Iran is located in the arid and semi-arid region and is one of the first civilizations which has constructed water reservoirs and conveyance structures since thousands of years ago and is called water civilization. The mean rain fall in Iran is about 250 mm a year (Fig. 2) which is equal to one third of world rain fall and about one percent of the world population is living in Iran and just about one third of its water resources are renewable which is equal to 130 billion cubic meters per year.

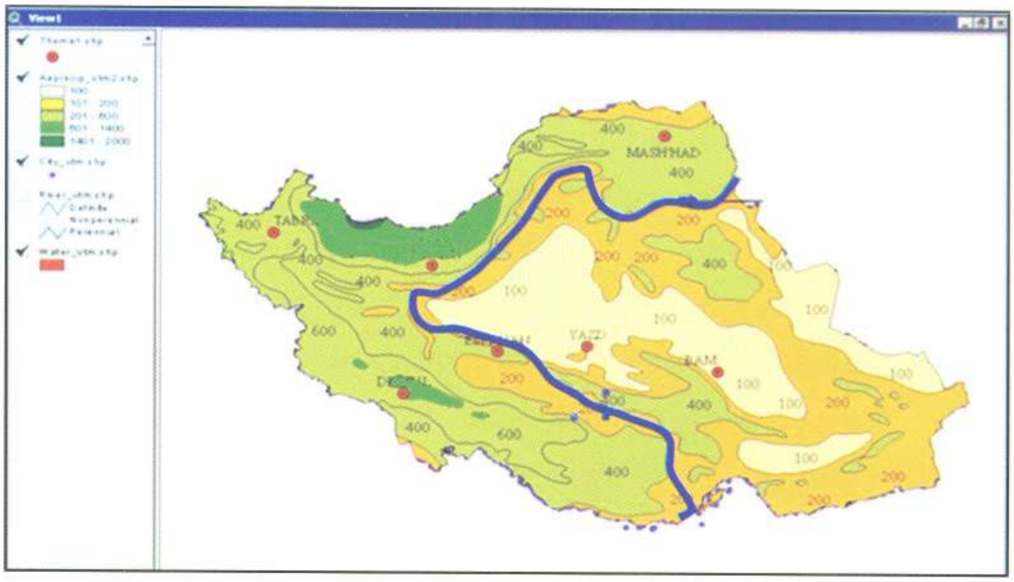

Figure 2: Rainfall zones in Iran divided by the average line of 250 mm per year

During recent decades high population increase rate, migration to cities and urbanization increase, country economic growth, particularly in agricultural and industrial sectors have led to water consumption increase in agriculture, industry and urban water. Three decades ago, the renewable water per capita was about 2000 cubic meters but currently it is about 1000 cubic meters which shows critical situation which we will face in future.

Other challenges such as global warming and climate change, regional long lasting droughts created the stresses which have been imposed to country's water resources in the recent decade.

Droughts have several economical, social and environmental impacts, depending on their intensity and duration. Occurrence of droughts is a natural event and it is not specific to a region or climatic regime, and it can occur in different climatic and geographic situations. Unlike floods that have limited coverage areas, droughts usually affect vast regions, and this causes a more widespread and extensive range of impacts which last for a long time. Therefore, droughts affect a large number of populations in comparison with other natural disasters. The experiences in developed and developing countries on drought management has proved that besides the level of development, the impacts and consequences of this phenomenon is deep and considerable, even with different characteristics and nature. With no doubt, the occurrence of this phenomenon is one of the important obstacles in the development process of the countries. As the impacts of this event lasts for a long period, the countries and people who have been affected by this phenomenon are forced to spend extensive financial resources to encounter it during and after the event.

Evidently, the frequency, intensity, duration, and spatial and geographical coverage of droughts will have wider dimensions in future due to climate change impacts. Hence, occurrence of droughts in any region, may pose global implications. The impact of water scarcity on global security cannot be ignored.

It seems that today's world, needs a global movement to face and encounter the challenges of natural disasters related to water, especially droughts, so that through systematic measures carried out by governments at national level and integrating them with the activities of international governmental and non-governmental organizations and entities, effective and coordinated action plans could be prepared.

6. An overview of the current situation

With respect to drought management, different measures are carried out in various countries according to their level of development and lessons learnt on the impacts of past droughts. These measures have different aspects and dimensions. In developed countries, integrated plans are defined and executed and responsibilities are well divided. In developing or less developed countries which are much more vulnerable to droughts, no systematic and harmonized measures have been taken. In the latter countries, most of the measures carried out are concentrated after drought events, e.g. granting different helps and incomplete aids. Usually, at critical periods, some financial and logistic contributions will be provided for the affected regions by United Nations or affiliated entities.

6.1 IDI Objectives

According to the above-mentioned points and the necessity of strengthening communities to effectively face and encounter the consequences of this phenomenon, especially in developing and less developed countries, taking benefit of developed countries' experiences in this process and according to the contents of UN Convention to Combat Desertification (UNCCD) which emphasizes on compiling a drought preparedness plan, the International Drought Initiative would create an appropriate opportunity for a global movement related to different aspects of this phenomenon.

The methodology to prepare and compile policies and strategies related to drought management, the way to act in emergency situations, compiling practical plans to confront this phenomenon, clarifying stakeholder's participation, establishing warning systems, using networks to gather meteorological data, methodology of assessing damages and procedure for addressing environmental conflicts are among the issues that can be addressed in the framework of this initiative.

This program should be implemented to reduce the existing gap between developed and developing countries by utilising valuable experiences and precise assessments of future needs. This program should also, guide the countries under coverage to follow acceptable standards in an appropriate time schedule by implementing necessary activities. The objectives of the International Drought Initiative can be considered as follows:

1- Surveying the current situation of drought management in selected countries (or all countries) in different aspects such as: policy making, structural and non-structural plans;
2- Surveying the plans and measures of international and regional governmental/non-governmental entities involved in drought management;
3- Executing necessary surveys to clarify needs and priorities of global measures in the framework of IDI;
4- Establishing Global Drought Preparedness Network (GDPM);
5- Helping different countries specially developing and less developed countries to prepare and compile strategic and practical drought management plans;
6- Develop and build capacities in: drought monitoring, mitigation, preparedness techniques and methodologies;
7- Holding international and regional conferences, seminars and workshops to exchange viewpoints, improve joint activities and exchange knowledge and experience related to different aspects of drought management;
8- Prepare and compile short-term, mid-term and long-term plans (perspective) for IDI and defining the indicators for assessing the progress made;
9- Supply financial, technical and logistic resources which are necessary for IDI activities.

7. Conclusions

Water management in arid and semi-arid regions is facing a crisis. Lack of water in regions with chronic shortages of water may lead to mass migration of people causing social and political problems. Drought is a weather-related natural disaster, a dangerous hazard of nature, related to a deficiency of precipitation over an extended period of time, usually for a season or more. It has an impact on food production and it reduces life expectancy and the economic performance of large regions or entire countries.

Considering the increasing trend of these events, particularly sudden floods, countries of the world, should increase the awareness, education and crisis management to decrease the losses, as much as possible, and find out solutions of how to adapt and learn to live in critical situations.

Professor Dr. Uzma Quraishi

Professor Dr Uzma Quraishi has a PhD in Educational Management & Planning from the University of Birmingham (UK). Presently she is Professor at Lahore College for Women University, Lahore. Dr Quraishi joined the Faculty of Education and technology as Associate Professor in 2006 at School of Social Sciences and Humanities at UMT. Prior to joining UMT Dr Quraishi was Head of the Foundation University College of liberal Arts and Sciences, Islamabad. Dr Quraishi also served as head of departments of Education, Computer Arts and Fine Arts at the Fatima Jinnah Women University, Rawalpindi. She has developed a series of professional development programs such as masters and advanced diploma in Art as a Social Practice, Management training for practicing and aspiring head teachers serving under federal Government and Fauji Foundation. Mentoring Programs for principals in Balochistan, Sind and Sarhad. She has also been a consultant to UNESCO, HEC and Ministry of Education, for training Managers Faculty, head teachers and principals in human rights education, educational leadership and management across Pakistan.

Water Education: Implications for Teacher Education Policy and Practice

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Abstract

Hydrological extremes such as floods and drought have generated a growing concern at both global and local level, compelling all stakeholders to develop strategies to raise awareness and build capacities at all levels. In addition to creating well trained human resource, there is also a need to develop a critical mass which can influence policy making and assist efforts for effective water resource management. This paper/presentation primarily deals with reporting best practices, at national and international levels, that can assist in developing comprehensive strategies to implement water education, especially, for managing hydrological extremes, effectively. Water education is a new concept as far as education policy and formal education practice at school level is concerned in Pakistan. Teacher Education is an important area that requires a clear focus for water education, to sustain good practice for capacity building and raising awareness about potential impacts of hydrological extremes.

1. Introduction

In recent years geological Education is one of the most important tools used, to meet the social, economic and political goals, to sustain nations that want to improve their socio-economic situation.

Pakistan is fortunate to have a national make up that has the capacity and potential to establish national goals, despite difficult economic and political situation. The country is blessed with the intellectual capital that can contribute effectively when utilised appropriately. National and international joint initiatives, from time to time on various issues, have been successful in all sectors. Education and environment are no exception - Education reforms in recent years are a good example. Furthermore, whenever there has been any kind of natural disaster, joint efforts have worked well for all those involved. Recent floods have once again called for a joint effort at all levels, not only to rebuild but to establish communities that are empowered to sustain themselves. Education, therefore, has to revisit its agenda to determine its proper role for a concerted effort, to fill the gaps that leave the country ill prepared to deal with many important issues, including environmental hazards such as Hydrological extremes (floods and droughts) and related geo-hazards.

2. Educating the Teachers to Create Responsible Schools

There is a growing consensus among educationists and practitioners that schools (especially public schools) are the main pillars for human capital, which, with appropriate knowledge and skills, is essential to sustain a progressive and developed society. School environment, curriculum , pedagogical practices and management structures knit together to give young individuals the learning experiences that then enable them to make informed choices in their future lives, contributing in all spheres of life. Schools in Pakistan need to undergo a drastic change – understanding the current socio-political, cultural as well as geological realities. Teachers are at the centre of this change.

There are over 275 pre-service teacher education programs in Pakistan. Recently, these have been focused upon by various governments to undergo important changes. Important innovations include.

3. Water Education in Pakistan: Teacher Education as a focus

There are troubling signs about the quality and distribution of teachers at school level- in view of this, reforms initiated in the past few years focused on Teacher Education programs. Teacher Education programs are now undergoing a change to, primarily, address quality concerns. However, this process of change has to be well informed, especially when it comes to sustainable development.

The initial analysis of 15 Teacher Education programs[2] in private as well as public sector universities has revealed that there is very little understanding of environmental concerns, and of the role of education to address these issues. Science Education programs are not any different, indicating that more attention and rethinking of educational agenda is required. These signs have far-reaching implications for the overall development and economic situation of the country. The Education sector needs to break away from conventional approaches and look toward national and international examples, where *out of the box thinking* has paid off well, to achieve education and development goals – teachers need to be well equipped.

4. Learning from Others

I have chosen to discuss two cases here to highlight good practices to inform the current educational practice about important issues, such as the one under consideration in this workshop.

5. The Environmental Adult Education (EAE) and Project Water Education for Teachers (WET) Model

5.1 Environmental Adult Education (EAE)

The Environmental Adult Education is a useful model, which has been developed by combining environmental movement/education components with adult educational approach, to teach environmental issues to the adult population in order to sustain ecosystems. It informs businesses and communities about eco-sensitive lifestyles, to live more sustainably. EAE is designed to take place in both formal and informal learning environments and programs. This paradigm refers to teaching/learning about the environment, through participatory methods, focusing on:

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[2] LCWU, Department of Education has initiated a research project to improve Teacher Education program content and practice to incorporate Water Education component to train more well informed teachers

- a knowledge of environmental problems and their causes
- the skills to engage in social activism to combat those problems
- the attitude of respect and connection to the natural world
- a desire to change current practices to protect the Earth '

(http://en.wikipedia.org/wiki/Environmental_adult_education, retrieved on 20.01.2011)

The program's gearing towards introducing awareness about Hydrological extremes, such as floods and droughts and related geo-hazards can benefit from this paradigm, to train adult population and raise awareness amongst the general population.

Teacher education programs can be informed and strengthened further by adopting the objectives of the EAE paradigm. There is a need to train teachers for both formal and non-formal sectors in Education.

5.2 Water Education for Teachers (WET)

Project WET promotes understanding, awareness, appreciation, knowledge and skills concerning water conservation and resources. The focus of the project is to train and support teachers and pedagogical practices through dissemination of information and teaching aids. The mission of the project is to implement global water education at community level.

Project WET paradigm is useful for both formal and non-formal, adult and school education in Pakistan, providing policymakers and practitioners with the teaching resources and knowledge base to learn and implement educational practice, which would contribute toward greater sustainability. One important consideration in this regards is how to sustain these programs, when the education sector in the country is already faced with lack of funds and structure that could support such an innovation. There are no neat answers to that, however, out of the box thinking could be crucial to facilitate much needed change in education.

6. Entrepreneurship for Community Empowerment: Kawish Model

Kawish [3]is a very simple model with central-operating centres called *hubs,* connected with a chain of Mosques, or one room schools opened in various adjacent villages. The hubs work at three levels. In the morning they work and coordinate with their schools in villages to run multilevel (middle & Primary) schools for young children (both genders). In the evening they function as a vocational centre, and once a week they work as a health centres. Kawish trust claims to involve the whole community as it is 'focussed on helping the unprivileged community to gain Empowerment; to transform masses into an honorable & self driven society by imparting education, values, health, skill / technology exchange & employment'. The hub also works as a business coordination unit for parents to do business with various industries. For example, the Hub facilitates farmers to provide milk to Haleeb Milk at mutually agreed premium rates. Earned profits are then used to cover the costs of schools & increase salary packages of Teachers.

6.1 Lessons from Kawish

There are important lessons to learn from Kawish – its model to develop HUB which coordinates with other smaller units, like village mosque schools, could be adapted by Teacher Education Institutions to improve overall school environments, Curriculums, pedagogy and management.

TEI or TE programs in public/private sector universities could work collaboratively with Environment Science, economics & engineering departments to develop and sustain HUBS in rural and urban areas.

Entrepreneurial practice, such as business centres, can help to develop and empower communities for sustainable development.

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[3] Kawish Welfare Trust, Lahore, is an NGO working to support and develop a literate, healthy & self sustained society, ready to take on challenges of life through social support. Primary & Middle level education, Basic Health facilities, Microfinance facilities, skill development programs and disaster management are areas of focus.

7. The Way forward

- Teacher Education has to be revised to include community development and environment focused content and skills.
- Management training: Education as a human capital enterprise (Kawish Model) – teachers and schools' administrators need to be trained as entrepreneurs – who are able to sustain good schools and create their own enterprise which is working towards the same goal, to sustain empowered democratic society. The teacher education programs need to be improved to move away from the conventional and traditional models- old and outdated mind sets have to be replaced with a new, young and progressive mind set.
- School curriculum - subjects must be designed to have all components providing students knowledge and skills required for appropriate selection of tertiary education and future professions.
- Text books need to be improved – science educators and scientists have to redesign jointly to have better quality books.
- Good Human Resource Management practices have to be evolved and sustained. Policy makers have to ensure that schools can attract, retain and train competent teachers – science subjects have to much more informed about Hydrological extremes (floods and droughts) and related geo-hazards.
- Empirical research has to be supported to design and implement curricula and pedagogical practices that can best sustain society and the environment.
- Replicate good international practice such as Project WET (Water Education for Teachers).

8. Conclusions

Water Education has important economic, environmental, social and cultural dimensions that need to be addressed for better sustainable development and effective water resource management. Formal as well as non –formal education sectors collaborative efforts including training and participatory research focusing on social, environmental and economic needs. Radical Educational change is not possible without political will and social support – politicians, educationists, scientists and community members have to take it upon themselves to engage in more collaborative efforts to sustain well equipped human capital in the country. .

9. Acknowledgements

I am grateful to UNESCO to invite me as an educationist to contribute in the important debate not just about the role of education but also how various segments can get together to be much more effective in sustaining an empowered society. I am also grateful to my students for their interest in the ongoing project on Water Education in Schools.

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Mr. Hamid Sarfraz

Mr. Hamid Sarfarz is Program Coordinator at IUCN, Pakistan Islamabad Office. With an overall objective to ensure a coherent and robust programme of the Union in Pakistan, his key responsibilities include a programme development system that results in high quality proposals operationalising the strategic framework; coherence and integration of IUCN programme in Pakistan, internally as well as with the Union's programme in the Asia Region and globally; systematic planning, monitoring and assessment of IUCN's programmes and projects in Pakistan, and reporting to donors as well as the Union; support to growth of the thematic programmes, especially the knowledge management; and active participation in senior staff meetings and the follow-up of its decisions. In this capacity, he is directly responsible to the Country Representative for providing advice on programmatic aspects of the Union's country programme in Pakistan.

Community Resilience in Hydrological Extremes

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1. Context and Historical Perspective

The recent floods in Pakistan (July–August 2010) were the worst floods to have hit the country in the last 80 years. They not only caused damage to human life, which totalled around 1,985 deaths[4], and displacement of about 7.5 million people, but also the loss of agriculture crops, livestock and key infrastructure. Altogether more than 20 million people, mostly women and children, were affected throughout the country from mountainous Gilgit-Baltistan to the coast of Sindh. The floods affected 79 of the 124 districts — 24 in Khyber Pakhtunkhwa, 19 in Sindh, 12 in Punjab, 10 in Balochistan and seven each in Azad Kashmir and Gilgit-Baltistan.

The national economy suffered badly as GDP growth plunged down to 2.0 per cent, causing massive job losses and affecting the incomes of thousands of families. The devastation also affected revenue collection and increased expenditures, widening the budget deficit. It hit the textile and sugar sectors and in turn affected the balance of payments and external resource stability. Inflation increased to 15.48 per cent[5], much more than the 9.5 per cent target. Inflation in the short term (one to three months) also increased significantly because of reduced supply due to crop destruction.[6]

Looking at the disasters' data[7], it can be inferred that floods happened to be the most frequent natural disasters in Pakistan as compared to the other hydrological extremes, like droughts, storms and cyclones (Figure 1). Such a frequency of one type of natural

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[4] NDMA update of 28 Nov 2010.
[5] http://www.tradingeconomics.com/Economics/Inflation-CPI.aspx?Symbol=PKR
[6] Speech of the Prime Minster of Pakistan at the National Assembly, 4 Sep 2010.
[7] EM-DAT: The OFDA/CRED International Disaster Database, www.emdat.be - Université catholique de Louvain - Brussels - Belgium

disasters warrants adequate coping strategies in place, which unfortunately is not the case. The data of 4 major earthquakes and 13 significant floods show that life losses in case of floods have been relatively much less as compared to those of earthquakes (Figure 2). However, the magnitude of population affected and economic losses in floods have been manifold. The disaster response in all such cases has been below the mark, leaving much room for the desirable. In this backdrop, community response to disasters becomes extremely important.

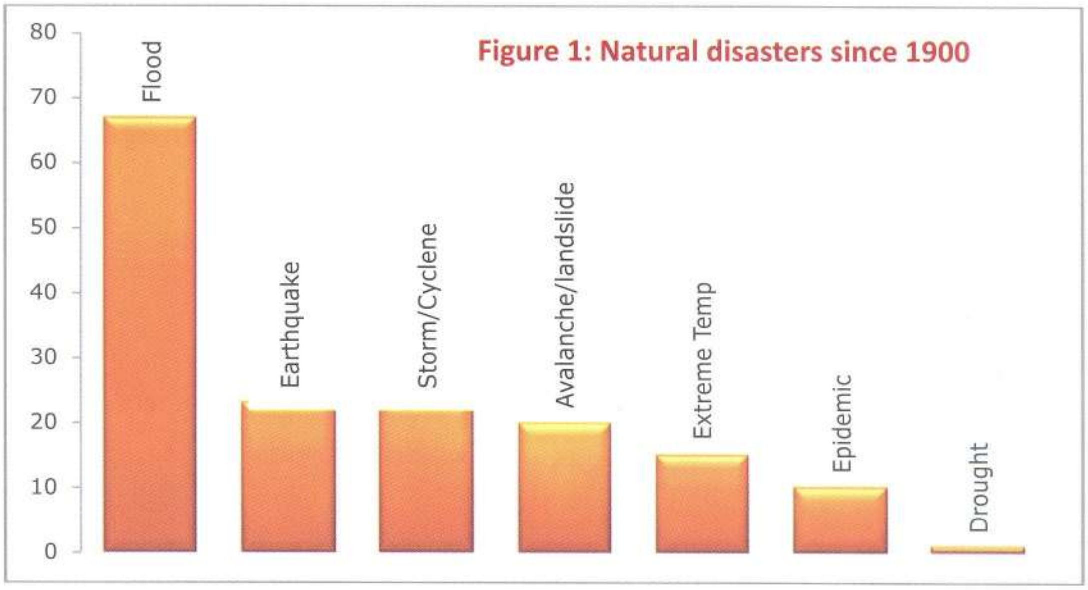

Figure 1: Natural Disasters since 1990

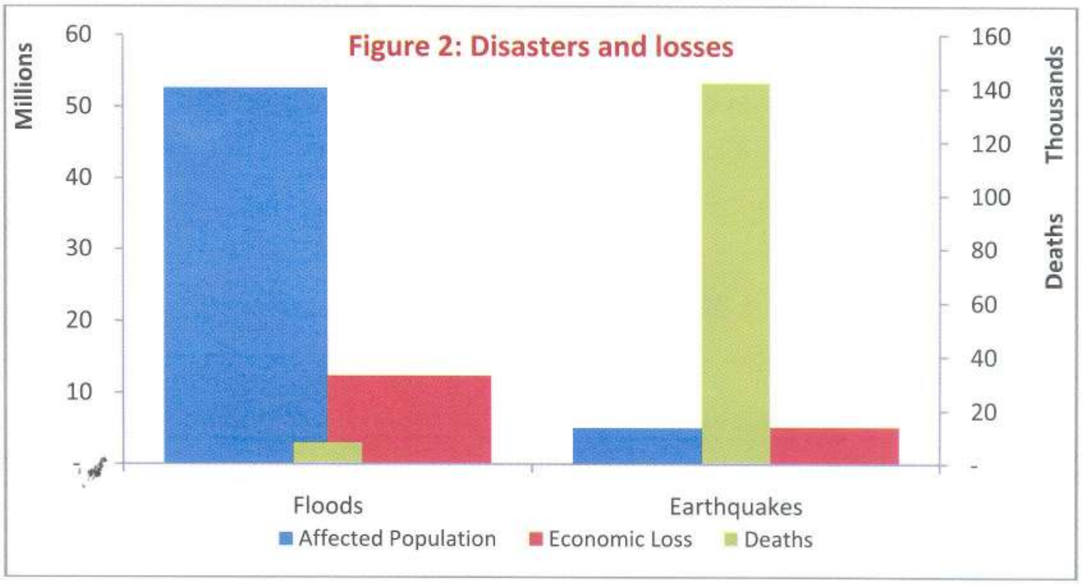

Figure 2: Disasters and Losses

2. Community's Behaviour and Disasters

Community behaviour is directly related to the incidencesand impacts of disasters. A few key determinants of community behaviour include:

2.1 Ecosystem Degradation vis-à-vis Harmony in Nature and Humans

Communities have a direct role in degradation of ecosystems or otherwise, hence, have a pivotal role in providing ecosystem based defence to cope with the natural disasters. Many studies, especially ISDR 2009 Global Assessment Report on Disaster Risk Reduction, have proposed a direct relationship between ecosystem degradation and incidence and severity of natural disasters. Deforestation which gives way to flash floods is just one example.

2.2 Over-dependence on Government vis-à-vis Self-reliance

During the 2005 earthquake and now more seriously during the recent floods, it has been realised that the government alone does not have the requisite capacity to cope with disaster of such magnitude. It has also been established that communities were neither prepared nor willing to respond effectively. People did not have right kind of institutional mechanisms and plans in place; they were not trained and most importantly they were not helping themselves; rather were waiting for the government to do whatever was required.The early warning and disaster preparedness, mostly a function of the government, has not been up to the mark. Community level advance warning and preparedness has been almost non-existent.

2.3 Vested Interest

In general, the decision-makers have failed to take right decisions for water storage and management. The recent floods have bitterly exposed manoeuvring vested interests of influential people and decision makers. Not only that technical advice was ignored on the basis of self-interest but decisions to breach or save dykes were made purely serving vested interests. Though individual acts cannot be taken as community action but in most cases the power to safeguard vested interests in ascribed to influential people through electoral mandate which is a clear manifestation of community action.

2.4 Motivation, Education, Information and Capacity

A number of examples from the recent floods prove that wherever the communities had prior information, were motivated to help themselves and had even a little capacity, the communities were able to face the disaster and winning against the odds. Tales of individual heroism aside, collective and affirmative actions of communities made it possible for many villages and towns to defeat the most disastrous floods of the century.

3. Community Resilience: Why Needed More in Hydrological Extremes?

Though community resilience is equally important to cope with all kinds of disaster, it becomes even more important in case of floods and droughts. Some of the reasons for this include:

- In case of hydrological extremes, vast geographical areas are involved as compared to non-hydrological events such as earthquakes. This entails a large population to be affected, though may not be killed, and requires much higher level of communities' engagement.
- In case of both floods and droughts, the disaster stays for a longer duration of time as compared to earthquakes which are momentary. Although in both cases, aftermath continues for a long time but mere presence of water, or otherwise, on huge geographical areas makes the recovery and rehabilitation process extremely difficult.
- Since hydrological events affect a vast geographical area, natural resource based livelihoods are affected more in terms of quantity as well as quality. Just as an example, agricultural lands are submerged in case of floods and or come under aridity attack due to drought. With lesser availability of fodder and forage, livestock – an extremely significant element of rural livelihoods – start starving and dying.
- In case of floods channels of communication are disrupted and remain non-functional for a relatively longer period. In this situation, community's self-reliance becomes even more important. Due to difficulties in transportation of relief goods, communal interdependence increases and communities become more

reliant on each other's help, rather than waiting for external agencies to come and help them.

4. How Ecological Resilience Can Help?

The recent floods have had both negative and positive bearings on forest and other ecosystems. While mountainous forests and wetlands ecosystems are disturbed by such extreme events, however, these are important in resetting the cycles of nature[8]. In forests, extreme erosion has been observed along with damage to the regeneration and forest floor which is negatively affecting the livelihoods of the population dwelling both upstream and downstream.

In addition to floods being a natural calamity, there are a number of other factors which contributed to this unprecedented devastation. These include:

- Climate change has increased Pakistan's susceptibility to, and frequency and unpredictability of extreme weather event, i.e., downpours, cyclones and droughts. Unpredictability also makes the disaster management more difficult – difficulties in relief and rescue due to continuous rains.
- Many of the areas inundated are either riverbeds or riverine forest lands which have been cleared for agricultural purposes.Waterways have been narrowed down due to encroachments by human population and business interests – Swat is a case in point.Human habitat alteration involving reengineering of rivers and floodplains has created obstacles in the normal river flow, causing spill-overs and breaches in the dykes.
- Deforestation in the mountainous areas has caused hill torrents and flash flooding. Ecosystem approach, which requires community participation, for water management has been ignored. It has left only with engineering options which have failed miserably in the recent floods.

In this context, it is important to promote healthy forests which serve as sustainable watersheds to avert droughts. They also serve as first line of defence against land erosion

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[8] Disturbance Dynamics in Wetlands

and siltation which has been a major cause of decreasing water storage and handling capacity of dams and barrages. Coastal forests, especially of mangroves, have evidently been proven as natural barriers against marine disasters such as cyclones and tsunamis. Better land use planning, especially of waterways and rangelands, is another key area in increasing ecological resilience. Free waterways can help accommodating large quantum of floodwater while healthy rangelands can help during dry years. At the same time, some water conservation measures such as payment for environmental services and using optimal water quantities for various crops would need to be introduced.

5. Ecosystem-Community Based DRR

Healthy ecosystems, such as intact forests, wetlands, mangroves, and coral reefs provide natural buffers to hazard events, and reduce the impacts of climate change. They contribute to flood abatement, slope stabilisation, coastal protection and avalanche protection, in addition to other structural and disaster preparedness measures. They also provide many livelihood benefits, such as firewood, clean water, fibres, medicine and food.

Ecosystem degradation has been identified by the ISDR 2009 Global Assessment Report on Disaster Risk Reduction as one of three key drivers of disaster risk. The people affected by reoccurring disasters are often the most dependent on natural resources for their livelihoods, and the management of ecosystems can play a critical role in their ability to prevent, cope with, and recover from disasters. Ecosystem-based DRR refers to activities that recognize the role of ecosystems in supporting communities to prepare for, cope with, and respond to disasters. This is of particular relevance to the field of disaster risk management as it is a meeting point for enhanced livelihood security for the poor and long-term sustainable management of ecosystems. Sustainable ecosystem management is based on equitable stakeholder involvement in resource management decisions, resource-use trade-offs, and long-term goal setting. These are central elements to reducing underlying risk factors for disasters and climate change impacts.

Adaptation for the poor must include locally-crafted actions tailored to local circumstances. Community-based adaptation (CBA) is increasingly seen as part of an efficient, sustainable and effective response to climate change, but there are limited tools and methodologies to move it forward. Poverty and marginalisation are key determinants of vulnerability to climate change, yet the voices of the poor and marginalised are rarely heard in decision-making on adaptation. Furthermore, the concept of Ecosystem-based Adaptation (EbA) identifies and implements a range of strategies for the management, conservation and restoration of ecosystems to ensure that they continue to provide the services that enable people to adapt to the impacts of climate change. As a component of broader adaptation and development strategies, ecosystem-based adaptation aims to increase the resilience and reduce the vulnerability of ecosystems and people in the face of climate change.

6. How to Enhance Community Resilience?

It has been established that the governments alone do not have the resources and capacity to respond, especially to a large magnitude of disasters. There is a lack of coordination within civil administration as well as among civil and military institutions. The disaster management authorities are yet at their infancy stage. The early warning and information dissemination systems are either non-existent or inefficient. In most cases, the access to information, especially for remote communities, has been restricted. Also, the transaction cost of relief and recovery operations is very high in case these are to be handled by federal and/or provincial governments. This situation warrants a community based system of disaster preparedness and management.

The following interventions would focus on gaps in the existing disaster management system through a thorough analysis of the current strategies and practices. These have been proposed on the premise that in addition to the government, communities' resilience needs to be enhanced to cope with different kinds of disasters, frequency of which is increasing due to climate change. This resilience will also help people to adapt to variations in`climate which Pakistan is experiencing more and more frequently in addition to these disaster situations.

6.1 Vulnerability Assessment and Mapping

The wide scale human and economic losses and ecological implications caused by floods in the immediate context and a norm in all natural disasters require an immediate response to ensure that ecosystems and livelihoods are both taken into account during the process of post disaster assessment and rehabilitation. While extreme weather floods cannot always be controlled, their impact can be minimised by vulnerability assessment and improving preparedness. The aftermath of such disasters can also be managed to avoid further environmental damage and hazardous or unsanitary conditions for recovering populations.

Based on the existing data, vulnerable and disaster prone geographical areas have generally been identified. Through a thorough review and assessment of data, the focus should be narrowed down to select hotspots throughout the country. Detailed assessments of select areas in different ecological settings should be undertaken to gauge the nature and extent of the losses and level of these areas' vulnerability to disasters. The assessments should also be cross referenced with climate data. These hotspots should be ranked in order of their vulnerability to earthquakes, floods, cyclones/tsunamis and drought. Rationalising the selection on the basis of available resources, a final list of hotspots to be focused for interventions shall be developed.

The assessment should also attempt to identify ways and means to incorporate natural disturbance regimes into restoration management mainly focusing on the riparian systems in order to diversify livelihood options by adopting a landscape approach.

6.2 Ecosystem Based Adaptation and Disaster Management Plans

The relevant community and government organizations at the selected hotspots should be assisted in developing their own disaster management plan based on indigenous coping strategies. The relevant government agencies at the local, provincial and national should be consulted and made part of these plans to facilitate the communities in coping with the disasters on self-help basis.

6.3 Community Managed Early Warning Systems

Considering the proneness of select disaster hotspots, community managed early warning systems should be designed and deployed through community participation taking into account indigenous knowledge and methods of forewarning. These systems, though modern and well-tested in other parts of the world like Indonesia and Bangladesh, should be easy to operate and manage, keeping in view communities literacy levels. Modern telecommunication networks and facilities should be used to run this system. The select representatives of the communities as well as government organizations should be trained on using these systems. These systems may be linked over all with a country wide early warning system and all the relevant departments in this regard, including national and provincial disaster management authorities (DMAs), Pakistan Meteorological Department, National Flood Commission, national and local NGOs and district authorities.

6.4 Community Based Disaster Response Mechanisms and Social Safety Nets

Following disaster management plans, the community and organizational strengths and gaps should be identified. Institutional structure, as and when needed, should be helped to establish with adequate participation of all stakeholders. Roles and responsibilities shall be defined and capacities to play these roles shall be strengthened.

Land use planning should be a key element in disaster preparedness, not only as response mechanism but also as a precautionary mechanism. The infrastructure needs should be identified and liaised with the relevant government departments to be fulfilled. Adequate linkages of the community mechanisms shall be fostered with the relevant government and non-government organizations for early response and recovery.

6.5 Education and Capacity Building for Community Based Response

Realising the need to motivate communities for self-help and reducing reliance on public sector response, relevant and effective communication channels should be used to raise awareness and motivation level, and to educate masses. The opinion leaders in the communities should be mobilised to lead such campaigns along with a special focus on women and children who have been affected the most in the recent floods.

The capacity of provincial governments and line agencies at the provincial level project shall be enhanced by providing tools and methodologies, processes, technical advice and training to conduct vulnerability assessments of target communities, develop provincial adaptation strategies, to climate-proof their sectoral investment – mainstreaming this as part of the normal local development planning processes.

This shall also include development and implementation of awareness-raising and training programmes for local governments and communities on climate change, vulnerability analysis, and adaptation options, as well as pilot case studies on integration of adaptation options into current and planned development strategies.

Policy Dialogue
Pakistan - From Food Bowl to Dust Bowl?

20 June 2011

Organized by:

NUST Institute of Civil Engineering (NICE)
School of Civil & Environmental Engineering (SCEE)
National University of Sciences & Technology (NUST)

In Collaboration with:

United Nations Educational, Scientific & Cultural Organization (UNESCO), Paris, France

Introduction

Pakistan is witnessing severe pressures on its natural resources and environment and the effects of climate change are being materializing as precipitation has decreased 10 to 15 percent in the coastal belt and hyper-arid plains over the last 40 years, while summer and winter rains have increased in northern Pakistan. Apart from that, droughts in 1999 and 2000 have caused sharp declines in water tables and dried up wetlands, severely degrading ecosystems. Water availability per capita has sharply declined from 5100 m^3/year in 1951 to 1100 m^3/year in 2006 just barely above the threshold of water scarcity indicator of 1000 m^3/year. If the current trends continue, it could go as low as 550 m^3 by 2025. Pakistan is currently experiencing water stress and will soon face outright water scarcity. Pakistan once a food bowl is slowly transforming to dust bowl due to population explosion, deforestation, rapid urbanization, industralization and climate change. There is an urgent need to raise awareness among media and policy stakeholders for coping with water scarcity and climate change adaptation.

NICE organized a dialogue on "Pakistan - From Food Bowl to Dust Bowl?" in collaboration with UNESCO for media and policy stakeholders on Monday, June 20, 2011. This policy briefing was a follow up of the three-day international workshop on "Education for Managing Hydrological Extremes and Related Geo-hazards held at NUST from 24 – 26 January, 2011, organized by NUST Institute of Civil Engineering (NICE). The dialogue was led by Professor Dr. Shahbaz Khan (Chief of Section on Sustainable Water Resources Development and Management, UNESCO, Paris, France).

Objectives

The main objective of this policy dialogue was to raise awareness among media and policy stakeholders regarding two silent tsunamis of water shortage and food shortage which can potentially transform Pakistan from the food bowl to dust bowl. A key output of the workshop was policy recommendations for proactive actions to manage the imminent water risks.

Program:

Day June 20, 2011			
Policy Dialogue			
0900	1000	Registration	
1000	1005	Recitation from Holy Qura'an	
1005	1015	Welcome Address by Rector NUST	Engineer Muhammad Asghar
1015	1025	UNESCO's Support for Pakistan	Dr. Kozue Kay Nagata, Director UNESCO, Pakistan
1025	1100	Pakistan's water and food futures – turning the tide of water disasters	Prof. Dr Shahbaz Khan, UNESCO, Paris, France
1100	1130	Tea/Coffee	
1130	1315	Dialogue on "Pakistan - From Food Bowl to Dust Bowl?"	Prof. Dr Shahbaz Khan, UNESCO Dr. Aftab Sadiq, NUST Dr. Hamza Farooq Gabriel, NUST
1315	1400	Lunch and Prayer	

Professor Dr. Shahbaz Khan

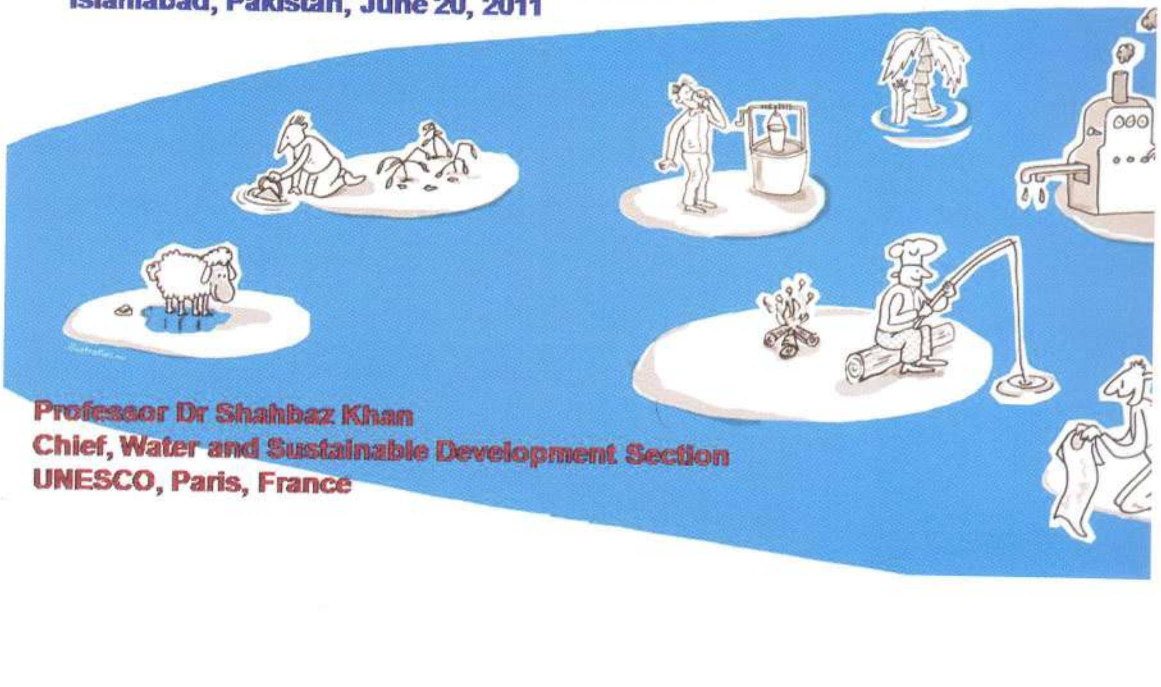
Professor Dr. Shahbaz Khan joined UNESCO in April 2008 as Senior Programme Specialist and Chief of Section on Sustainable Water Resources Development and Management. Dr. Shahbaz has an outstanding multidisciplinary background in water law and policy, management, civil engineering, IT, GIS & RS, economics and integrating societal water demands with environment. He received his Master and PhD degrees in water resources technology and management from the University of Birmingham, UK in 1992 and 1995 respectively. His other major qualifications include Master of International Environmental Law from the Macquarie University, Australia and Master of Applied Environmental Economics, Imperial College, University of London, UK.

Before joining UNESCO Shahbaz Khan was Professor and Director at the Charles Sturt University, Research Leader at CSIRO and Programme Leader, System Harmonisation at the Cooperative Research Centre for Irrigation Futures, Australia. His innovative science contributions and vision in water management has been widely recognized through the receipt of a number of awards including the 2008 CSIRO's Research Achievement Medal, 2007 Land and Water Australia Eureka Prize, 2006 Charles Sturt University's Vice Chancellor's Research Excellence Award, 2004 CSIRO Land and Water Partner or Perish Award, 2000 CSIRO Land and Water Exceptional Achievements Award. Mr. Khan has over 250 scientific publications including journal and conference papers, book chapters and scientific reports. He also holds Adjunct Professorial positions at the Charles Sturt University Australia, Chinese Ministry of Water Resources and the Chinese Academy of Sciences.

United Nations Educational, Scientific and Cultural Organization

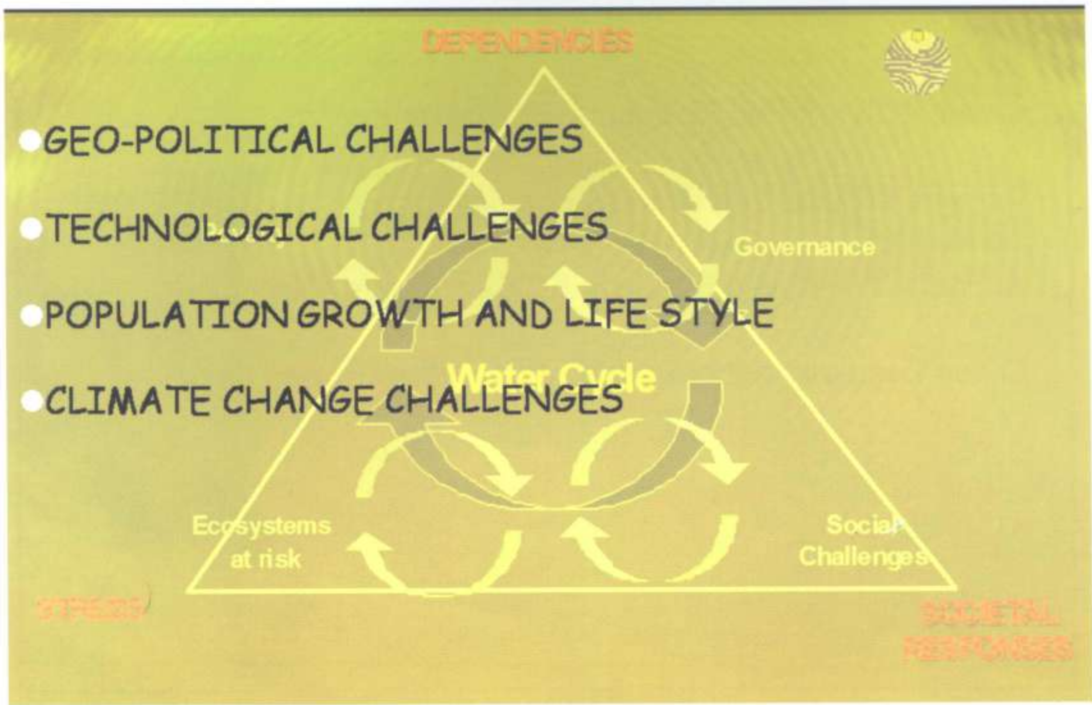
A Pakistan's Water and Food Futures – Turning the Tide of Water Disasters

National University of Sciences and Technology
Islamabad, Pakistan, June 20, 2011

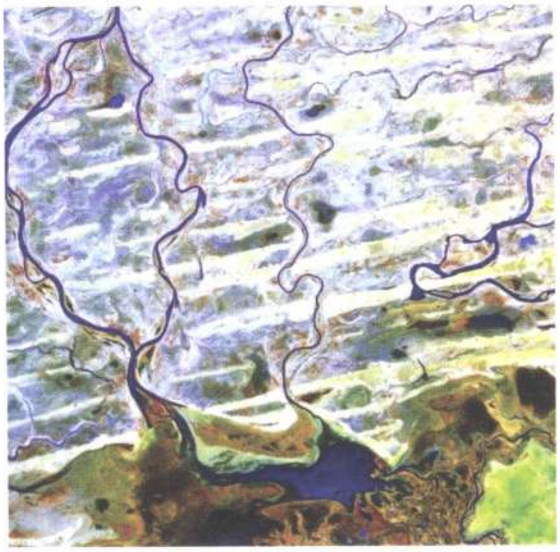


Professor Dr Shahbaz Khan
Chief, Water and Sustainable Development Section
UNESCO, Paris, France

Comparative Analysis of Pakistan's Water Problems



Geopolitical Challenges



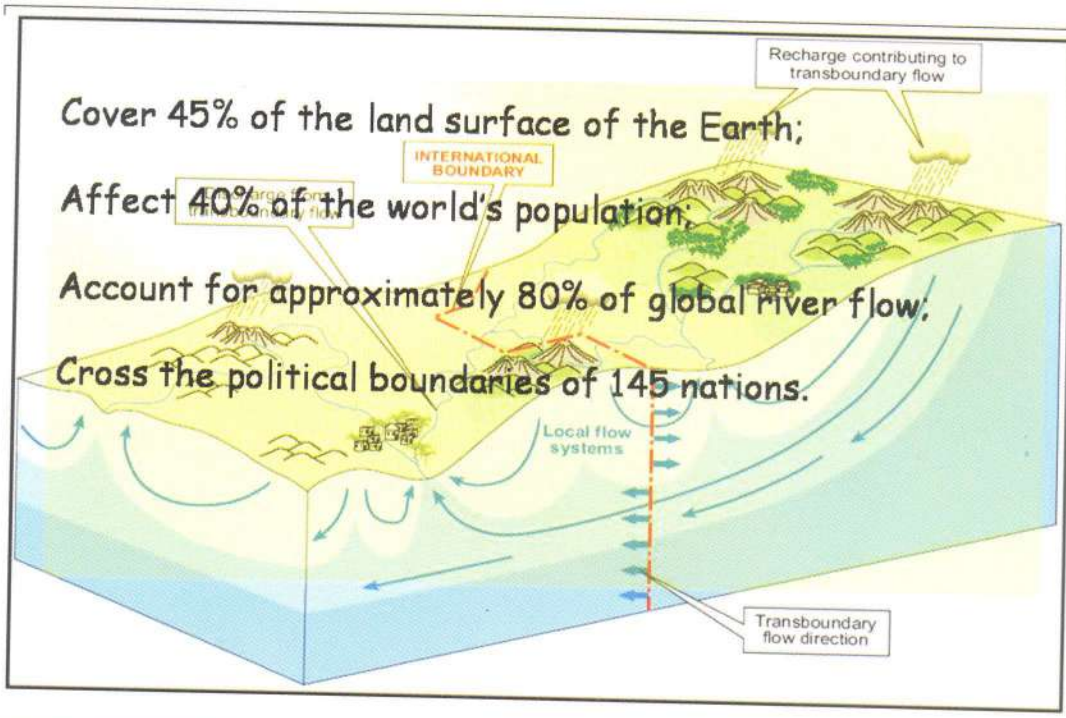
Transboundary Waters: The Facts

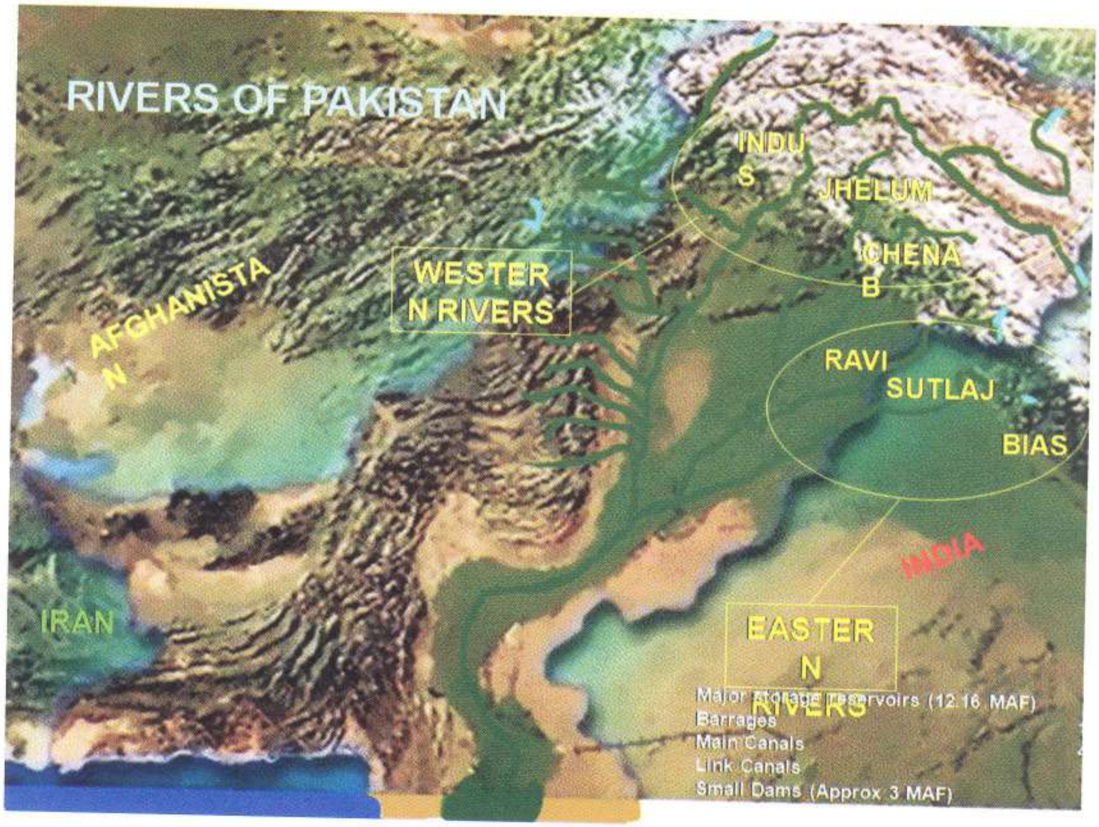
Cover 45% of the land surface of the Earth;

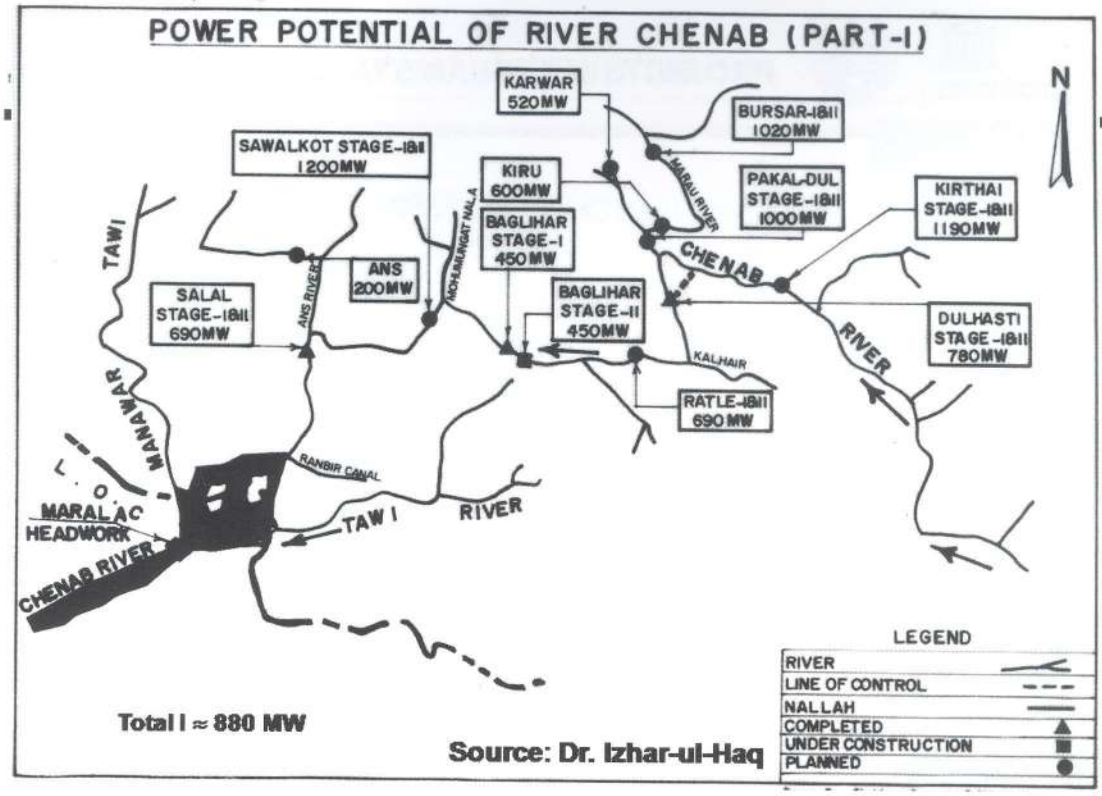
Affect 40% of the world's population;

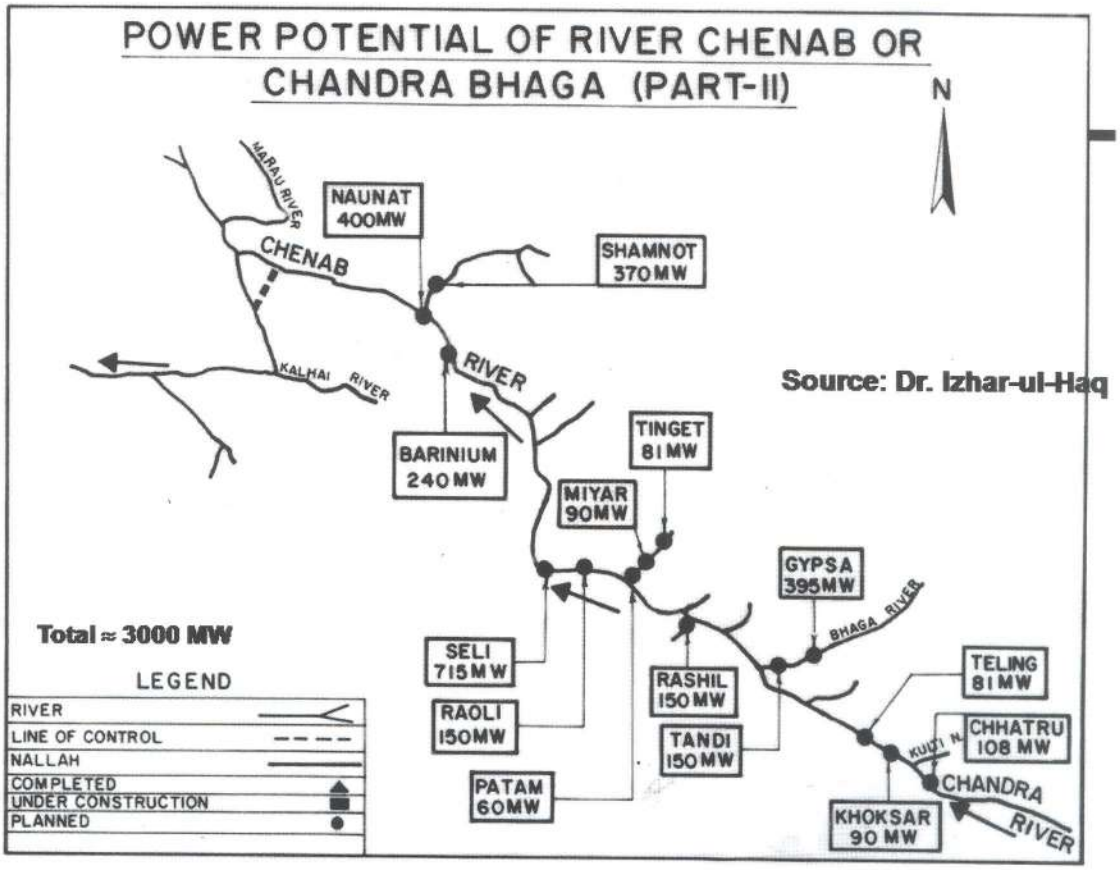
Account for approximately 80% of global river flow;

Cross the political boundaries of 145 nations.





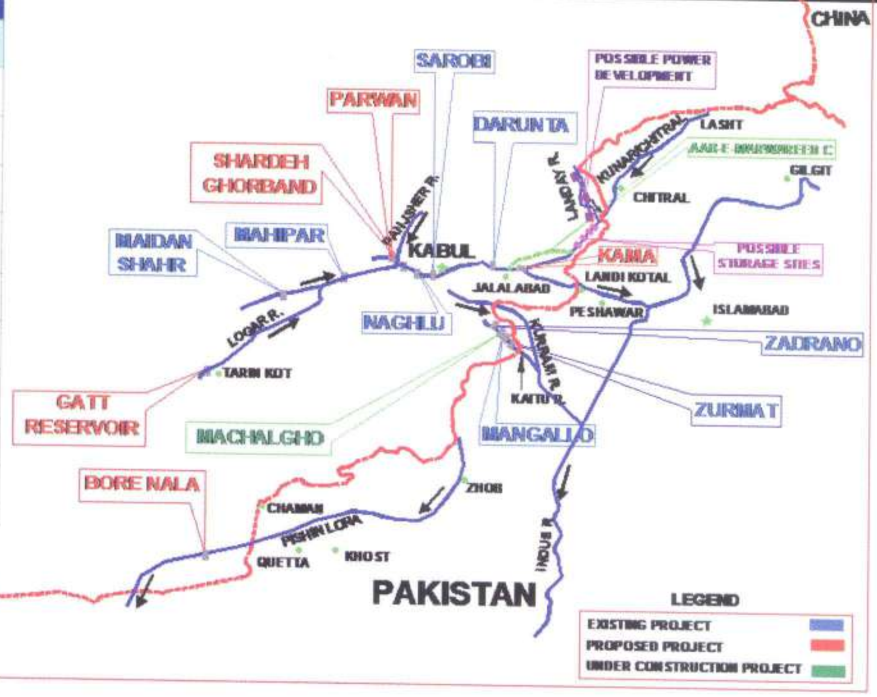

POWER POTENTIAL OF RIVER CHENAB (PART-I)
N
KARWAR 520MW
BURSAR-18II 1020MW
SAWALKOT STAGE-18II 1200MW
KIRU 600MW
PAKAL-DUL STAGE-18II 1000MW
KIRTHAI STAGE-18II 1190MW
BAGLIHAR STAGE-I 450MW
TAWI
ANS 200MW
SALAL STAGE-18II 690MW
BAGLIHAR STAGE-II 450MW
DULHASTI STAGE-18II 780MW
CHENAB
RIVER
KALHAIR
RATLE-18II 690MW
MANAWAR
RANBIR CANAL
MARAL AC HEADWORK
TAWI
RIVER
CHENAB RIVER
LEGEND
RIVER
LINE OF CONTROL
NALLAH
COMPLETED
UNDER CONSTRUCTION
PLANNED
Total I ≈ 880 MW
Source: Dr. Izhar-ul-Haq


POWER POTENTIAL OF RIVER CHENAB OR CHANDRA BHAGA (PART-II)
N
MARAU RIVER
NAUNAT 400MW
CHENAB
SHAMNOT 370MW
KALHAI RIVER
RIVER
Source: Dr. Izhar-ul-Haq
BARINIUM 240MW
TINGET 81MW
MIYAR 90MW
GYPSA 395MW
BHAGA RIVER
Total ≈ 3000 MW
SELI 715MW
RASHIL 150MW
TELING 81MW
LEGEND
RIVER
LINE OF CONTROL
NALLAH
COMPLETED
UNDER CONSTRUCTION
PLANNED
RAOLI 150MW
TANDI 150MW
CHHATRU 108 MW
PATAM 60MW
CHANDRA
KHOKSAR 90 MW
RIVER

UNESCO
United Nations Educational, Scientific and Cultural Organization

PROJECTS IN AFGHANISTAN

OTHER PROJECTS	
NAME	RIVER
Nangarhar	Kabul
Istalif	Kabul
Asadabad	Kunar
Amir Ghazi	Kabul
Gargha	Kabul
Shahtoot	Wardak
Haijan	Kabul
Gulbahar	Kabul
Pul-i-Khumri	Kabul



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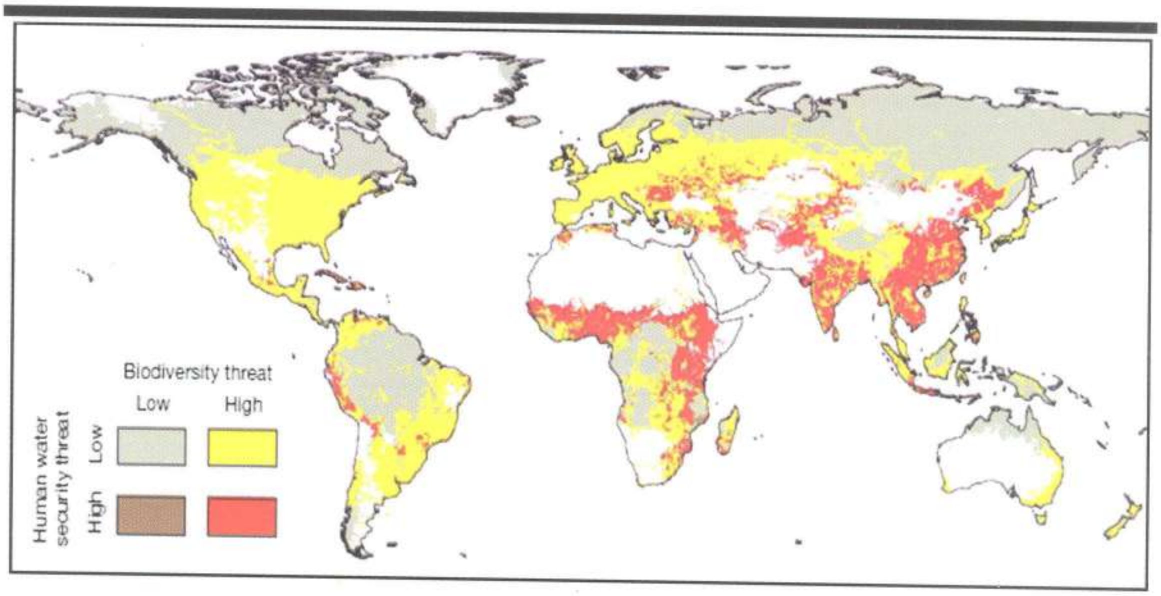
Global Environmental Water Stress (Human Water Security & Biodiversity)



Source: Vorosmarty, CJ., McIntyre,PB, Gessner, MO. et al. Global threats to human water security and river biodiversity. *Nature 467, 555-560 (30 Sept. 2010)*

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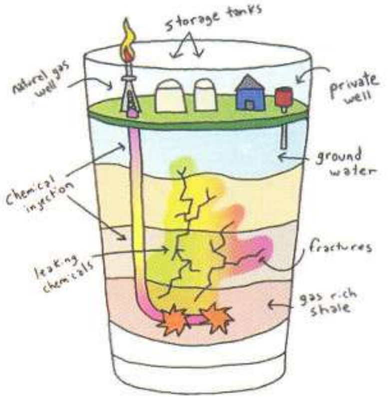
Technological Challenges



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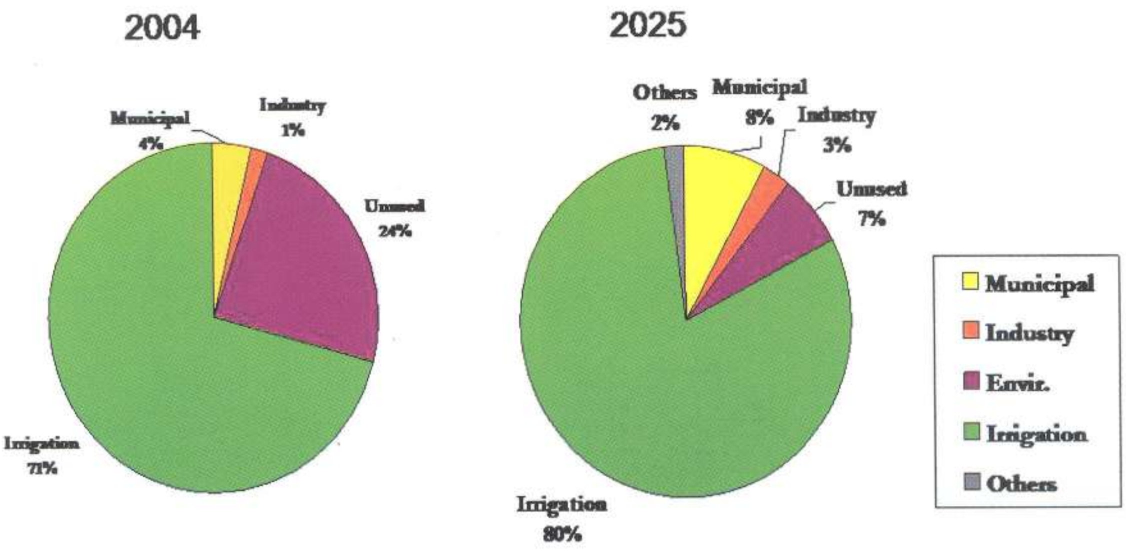
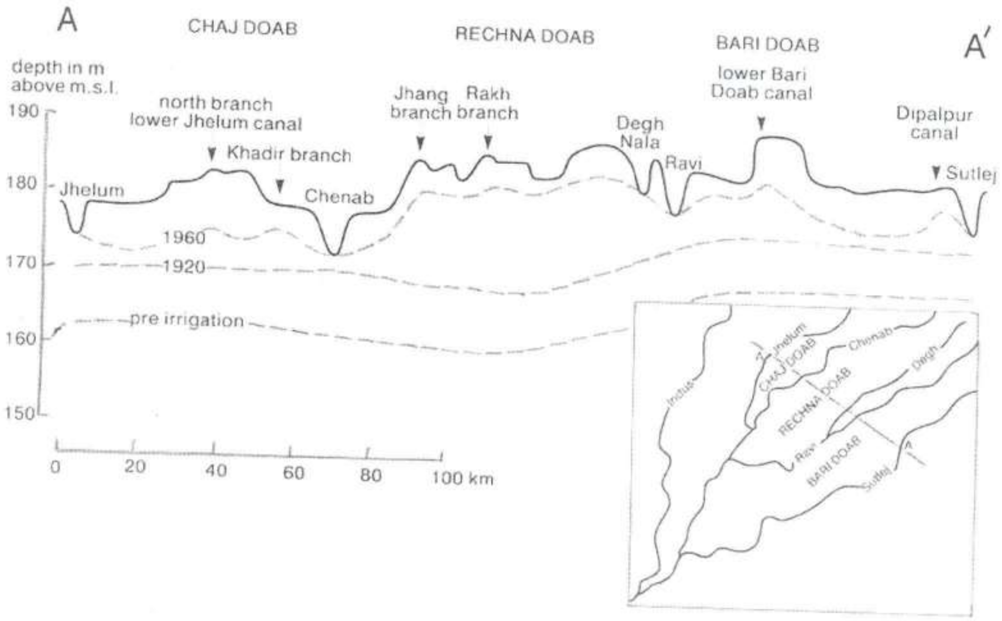
PAKISTAN WATER USE PATTERN



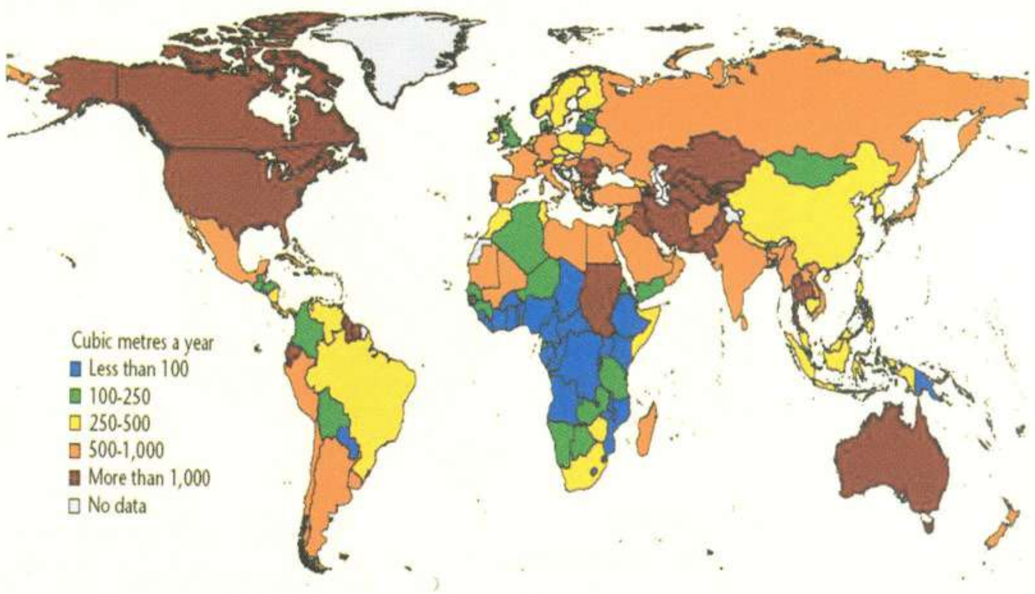
Total Requirements = 115 MAF
Availability = 104 MAF
Shortfall = 11 MAF (10%)

Total Requirements = 149 MAF
Anticipated Availability = 104 MAF
(No additional storage scenario)
Shortfall = 45 MAF (30%)

Irrigation and Groundwater Linkages

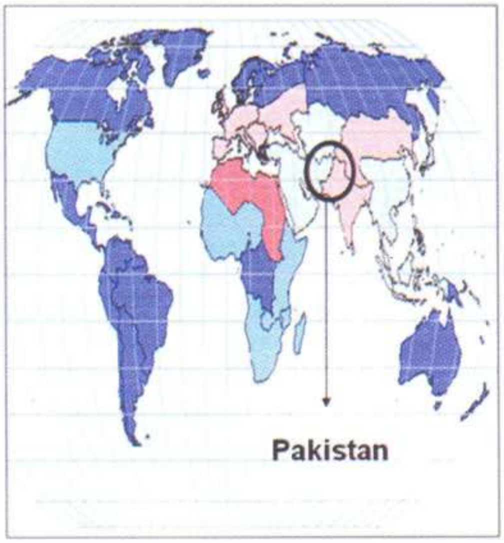


Annual water withdrawals per person by country, world view, 2000



Source: Based on FAO-AQUASTAT global maps (www.fao.org/nr/water/aquastat/globalmaps/index.stm).

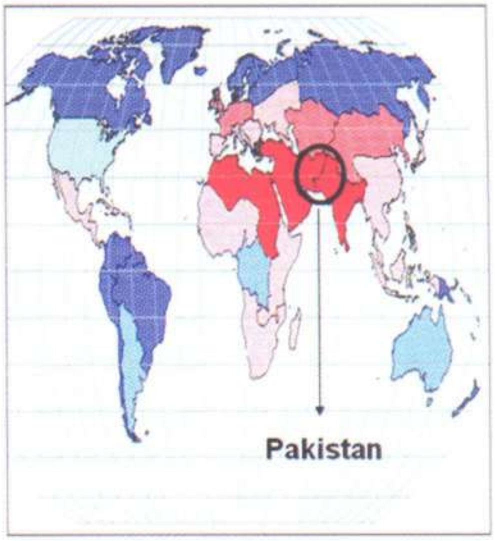
WATER AVAILABILITY 1950



More Water

Water availability in Pakistan : 5600m³

WATER AVAILABILITY 2010



Less Water

Water availability in Pakistan : 1000m³

(Water stress country)

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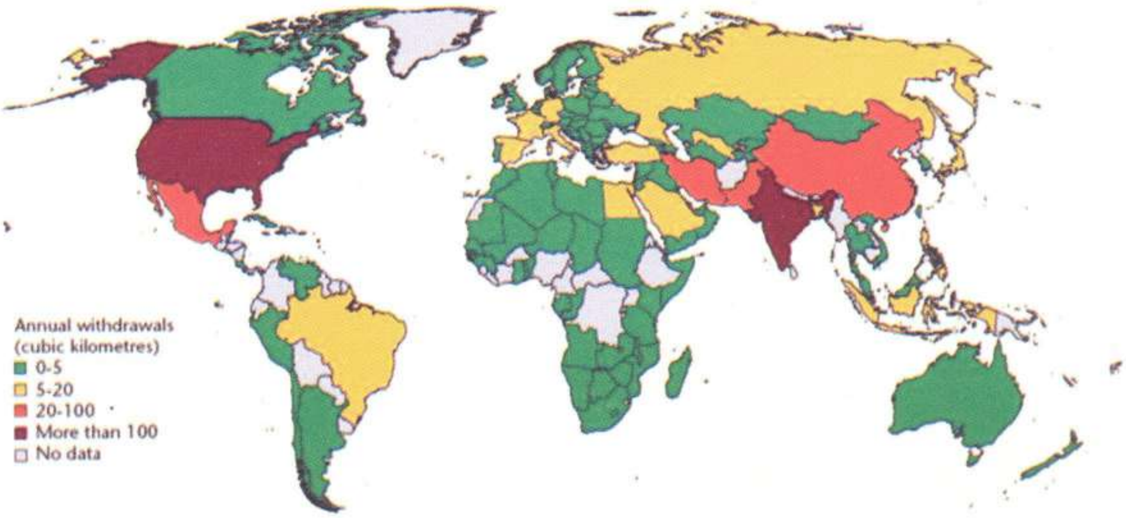
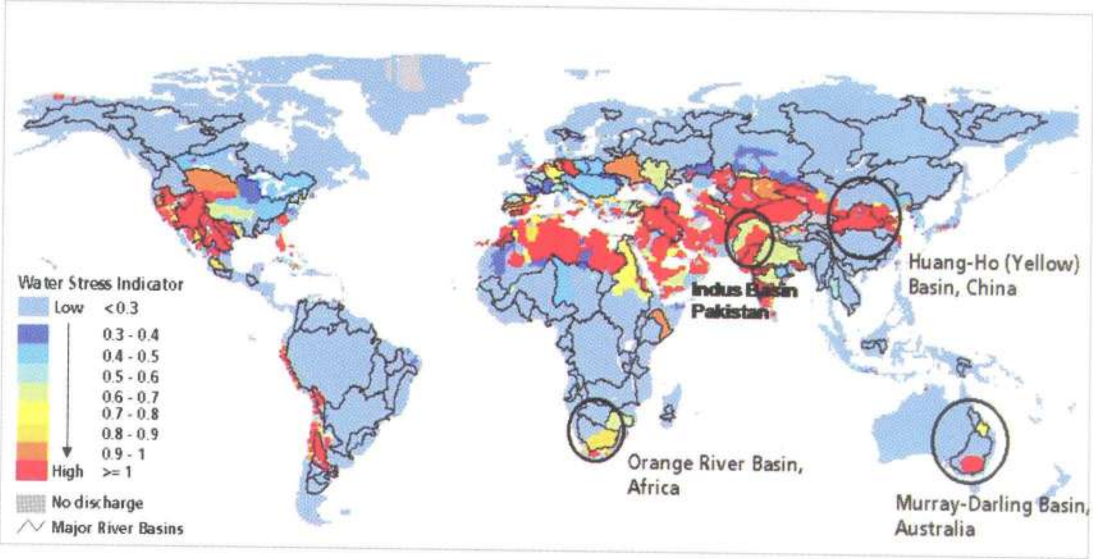
Annual withdrawals of renewable groundwater 1995-2004

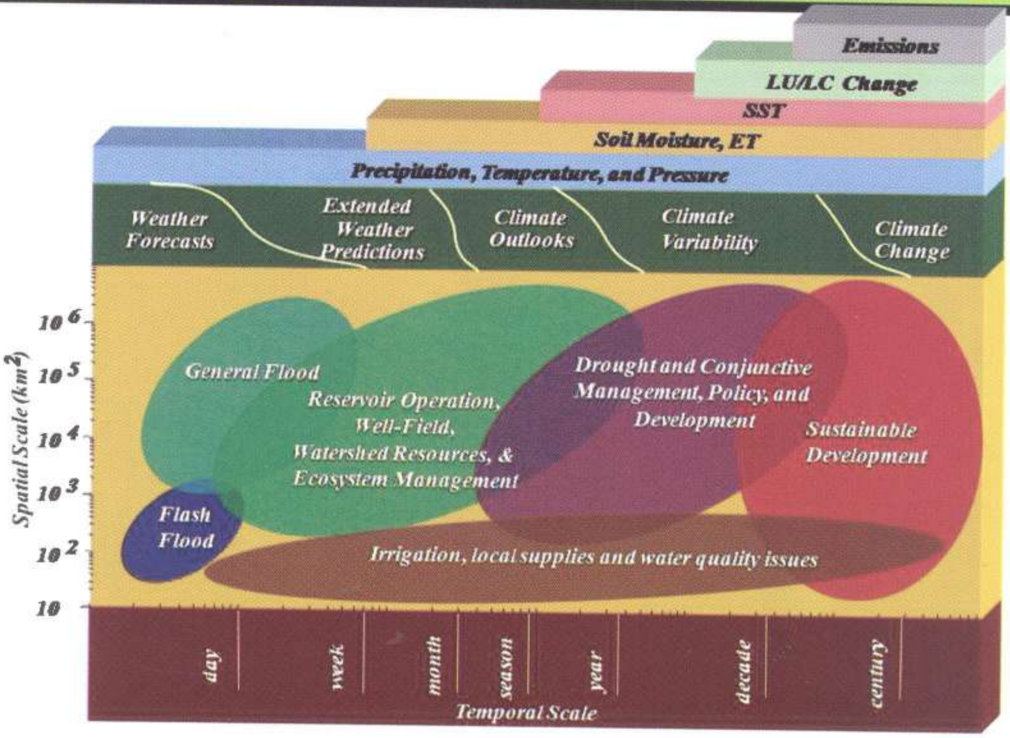
Renewable groundwater sources on a national basis



Global Environmental Water Stress



Water Resources Issues in Space and Time



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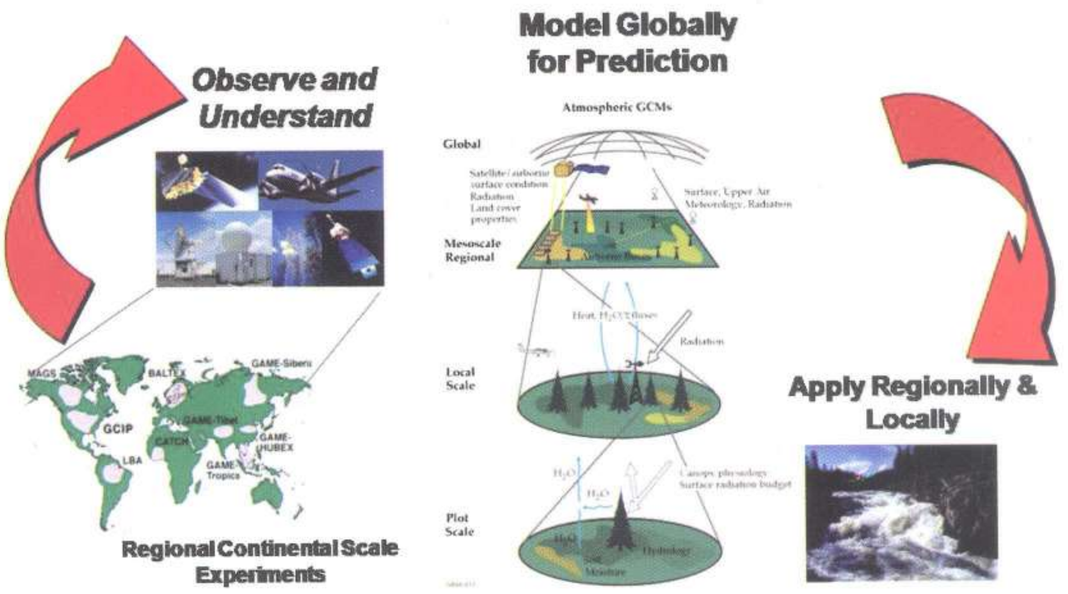
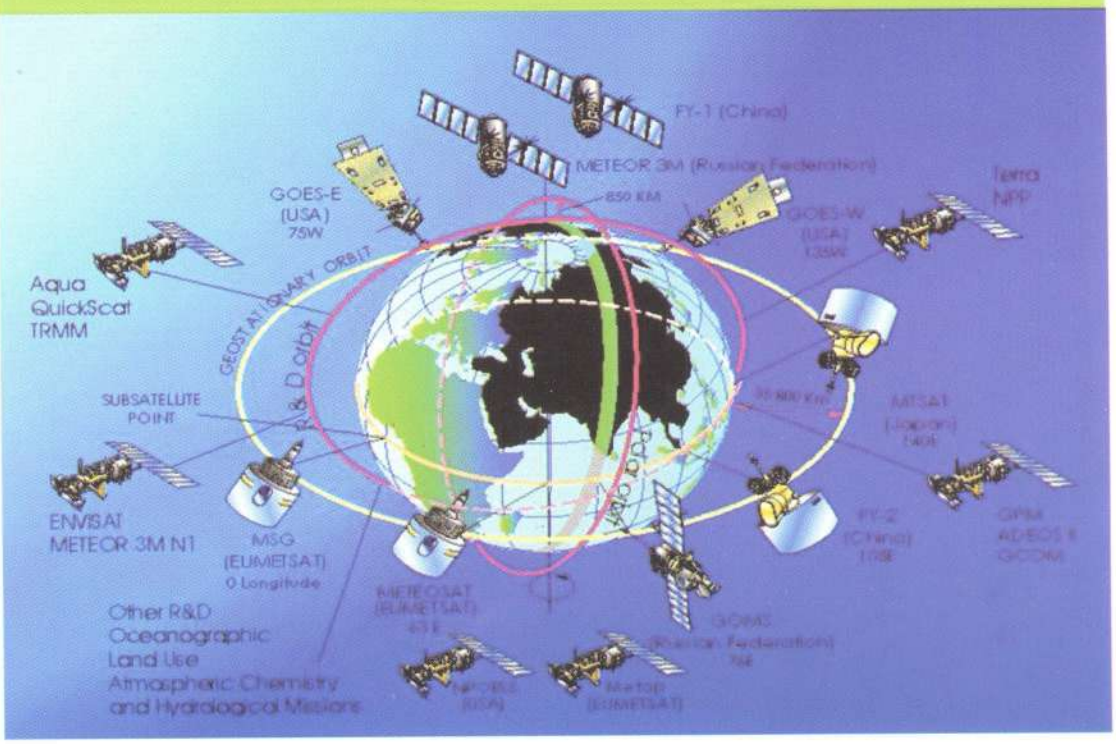
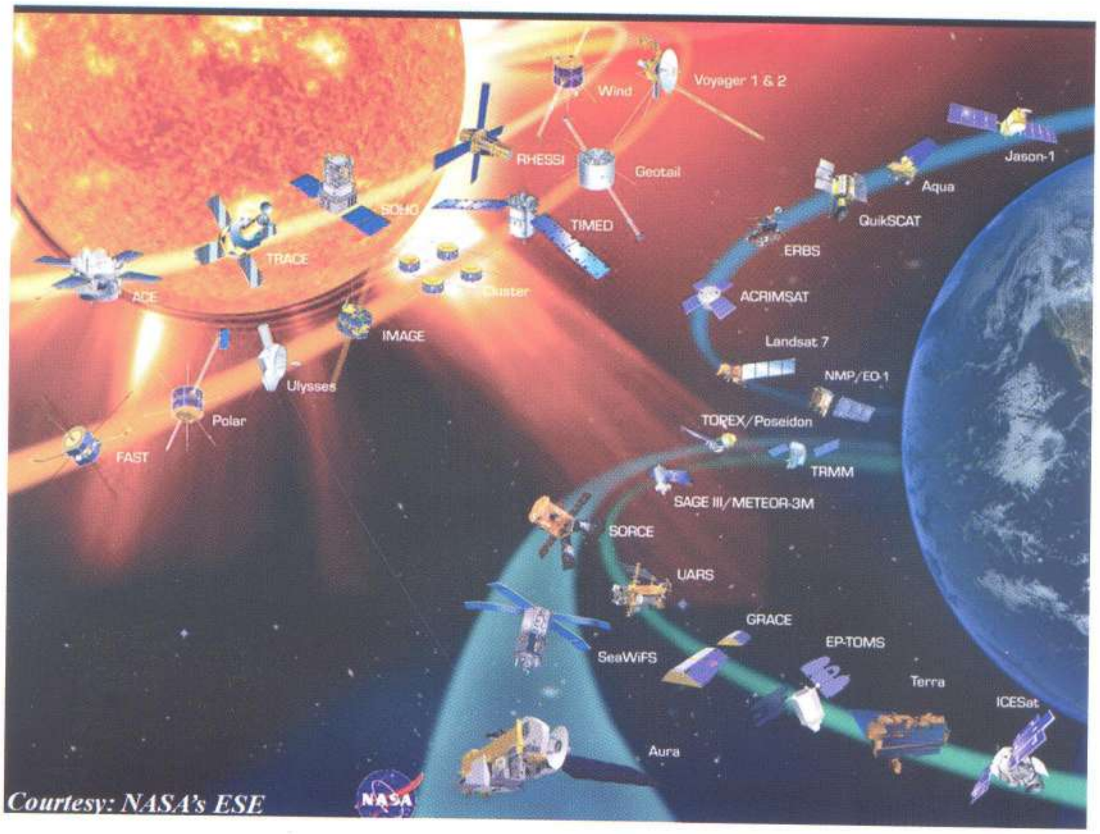
GEWEX WCRP

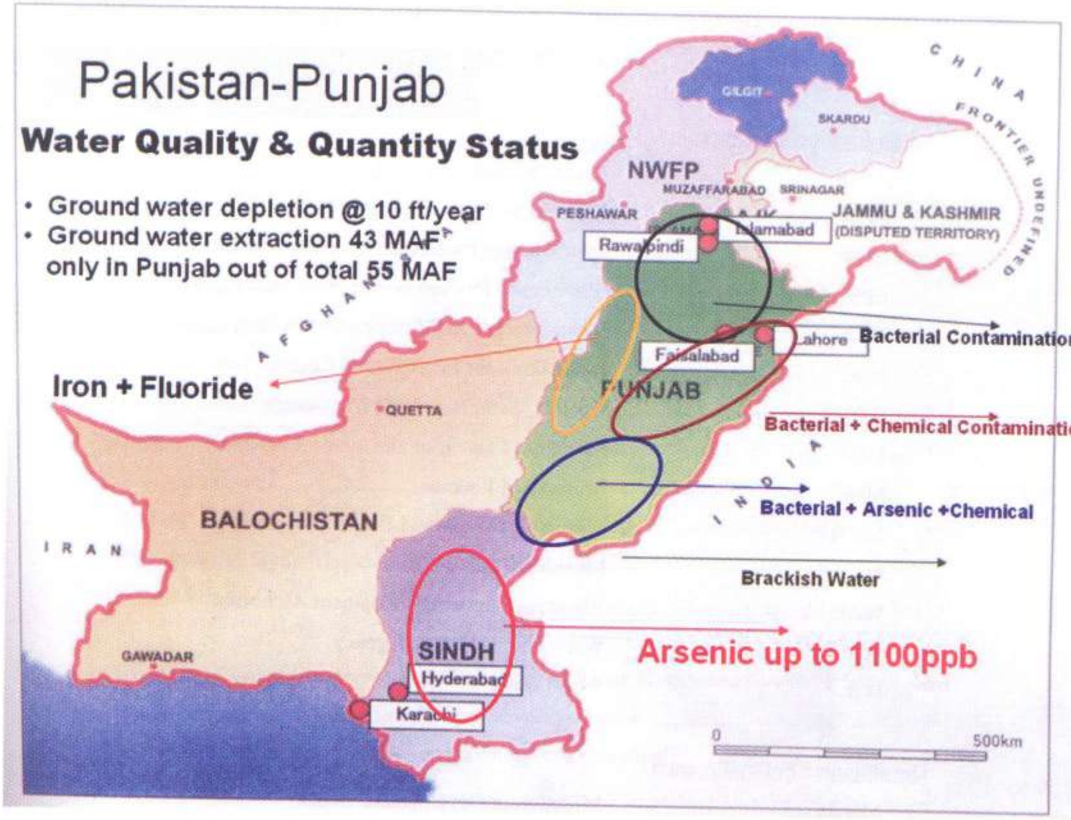
STRATEGY



Current Meteorological Satellites in Space




Wind
Voyager 1 & 2
RHESSI
Geotail
Jason-1
Aqua
SOHO
TIMED
QuikSCAT
ERBS
TRACE
ACE
Cluster
ACRIMSAT
IMAGE
Landsat 7
Ulysses
NMP/EO-1
Polar
TOPEX/Poseidon
FAST
TRMM
SAGE III/METEOR-3M
SORCE
UARS
GRACE
EP-TOMS
SeaWiFS
Terra
ICESat
Aura
Courtesy: NASA's ESE
NASA


Pakistan-Punjab
Water Quality & Quantity Status
• Ground water depletion @ 10 ft/year
• Ground water extraction 43 MAF only in Punjab out of total 55 MAF
CHINA
FRONTIER UNDEFINED
GILGIT
SKARDU
NWFP
MUZAFFARABAD
SRINAGAR
PESHAWAR
JAMMU & KASHMIR (DISPUTED TERRITORY)
Rawalpindi
Islamabad
AFGHANISTAN
Lahore
Bacterial Contamination
Faisalabad
Iron + Fluoride
PUNJAB
QUETTA
Bacterial + Chemical Contamination
INDIA
Bacterial + Arsenic +Chemical
BALOCHISTAN
IRAN
Brackish Water
Arsenic up to 1100ppb
SINDH
GAWADAR
Hyderabad
Karachi
0
500km

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Scientific and Cultur

HAND IN GLOVE LAYING OF SEWERAGE & WATER SUPPLY LINES
CONTAMINANTS INTRUTION ROUTE

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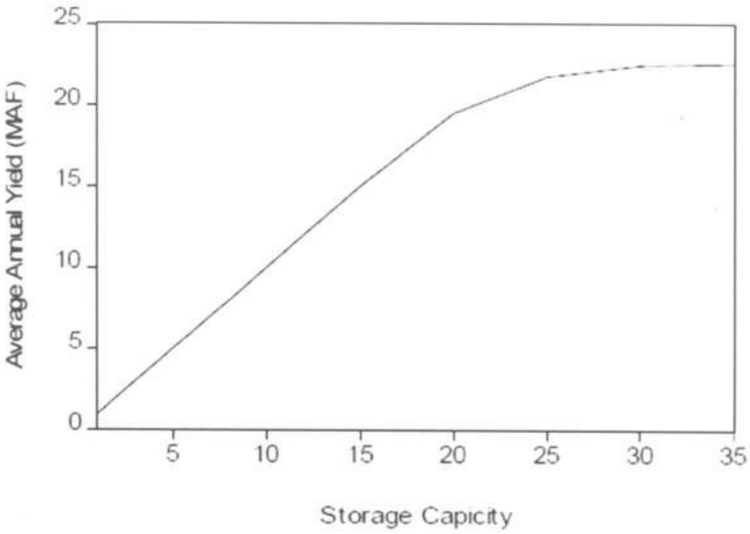
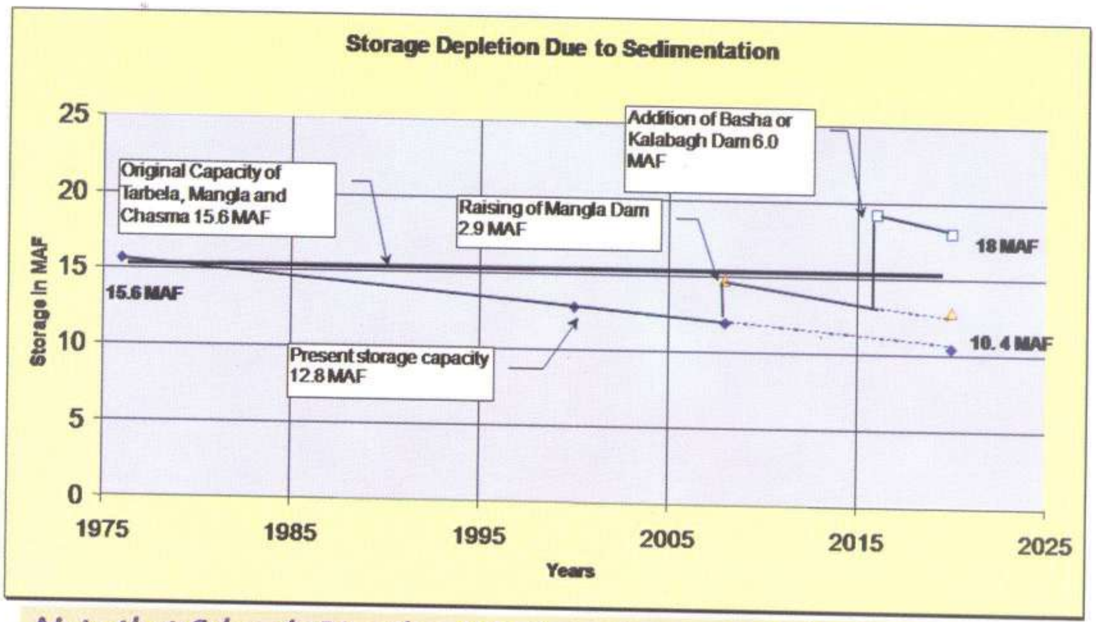
Storage Yield Curve of Pakistan

Average Annual Yield (MAF) and Efficiency of Storage Capicity on the Indus River



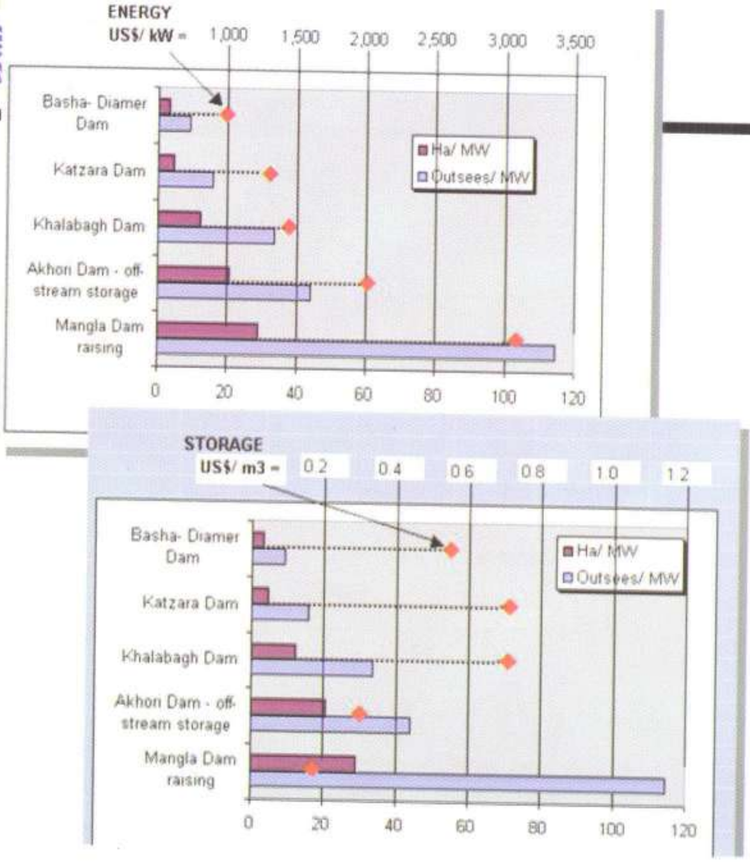
Source: World Bank, (Leiftnck Report), 1968

Business of increasing storage volumes...



Note that Colorado River has 900 days of storage; Indus has 30 days

The sorts of tradeoffs that have to be considered (with very preliminary data provided to us).



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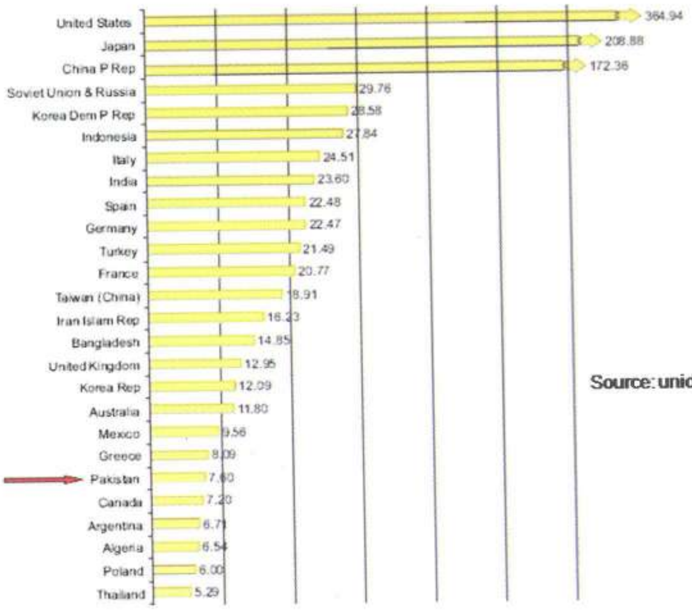
Economic Costs of Disasters

Total amount of reported economic damages : all natural disasters
1991 - 2005 (2005 US$ billion)



Source: unidsr.org

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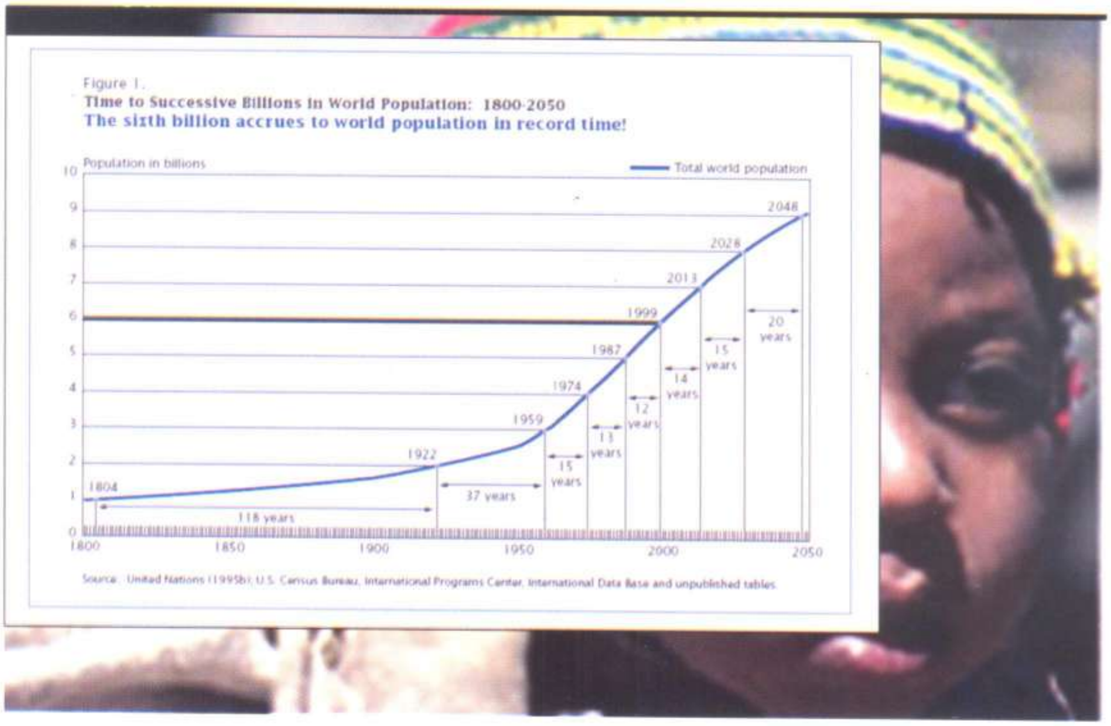
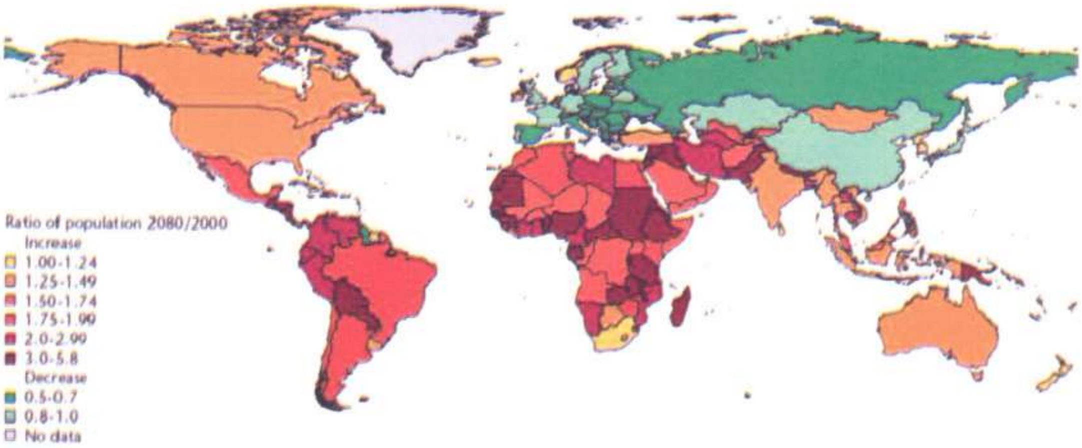
Population and Lifestyle Challenges

World Population Crisis



Expected areas of population growth and decline, 2000-2080



Source: Lutz, Sanderson, and Scherbov 2008.

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Drivers of Global Change

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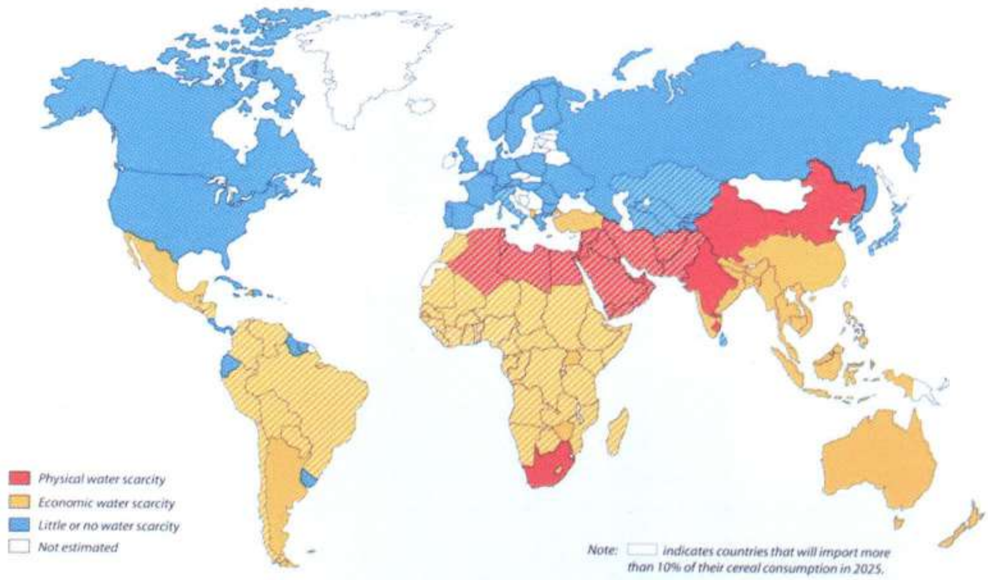
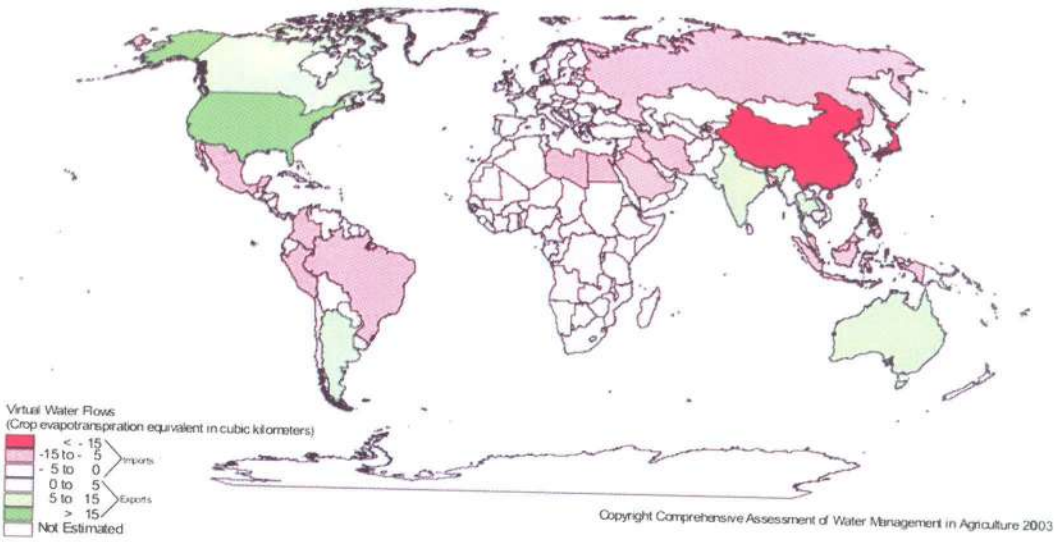
Water Management Challenge

Projected Water Scarcity in 2025



New Water Trade Regimes

Trading Food = Virtual Trading of Water

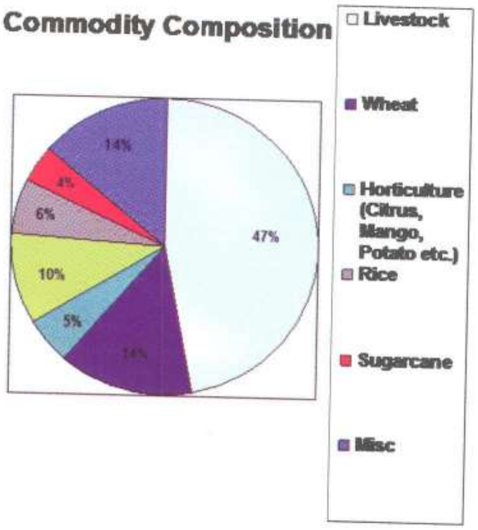


Overview Pakistan's Food Sector

Contribution of the agricultural sector to the GDP: 21.8%

Productivity per Unit of Land	
France	7.6 T/ha
Egypt	5.99 T/ha
Saudi Arabia	5.36 T/ha
Punjab (India)	4.80 T/ha
Punjab (Pak.)	2.30 T/ha
Pakistan (Ave.)	2.24 T/ha

Source: Water Sector10th Five Year Plan



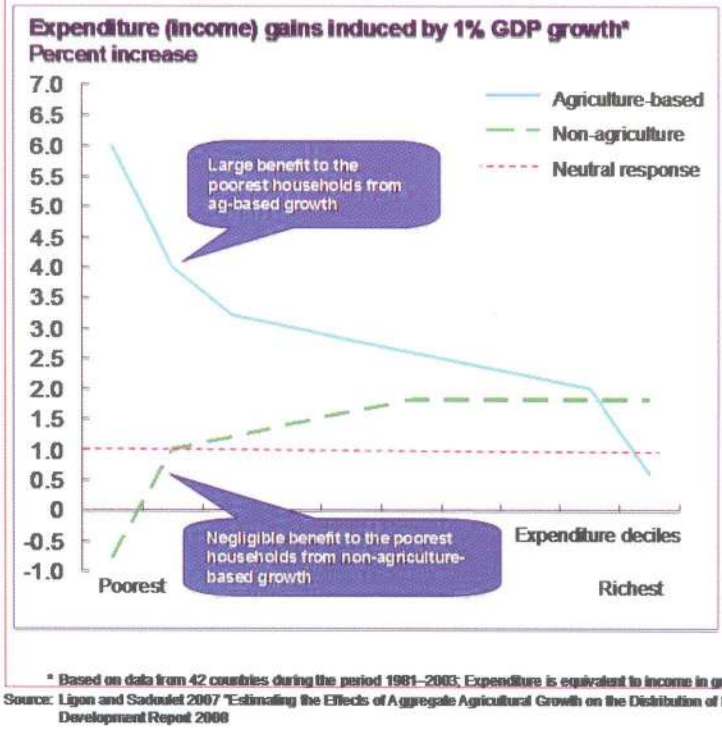
Source: USAID Weidemann Report 2009

Pakistan's Water Sector Contribution to the GDP

"The global average **contribution of water to GDP is US$ 8.6/cubic meter of water**. In the case developed economies such as the USA, Germany, France and Japan, the contribution of one cubic meter of water to GDP ranges from US$ 30-40. Even in some of the well-managed economies of Asia such as Malaysia, Hong Kong and South Korea, it is US$ 10-15 i.e. well above the global average. But in Pakistan each cubic meter of water contributes just **34 cents** to GDP."

(Source: Pakistan Water Sector 10th Five Year Plan)

Agricultural development is an economic growth strategy that specifically addresses the needs of the rural poor

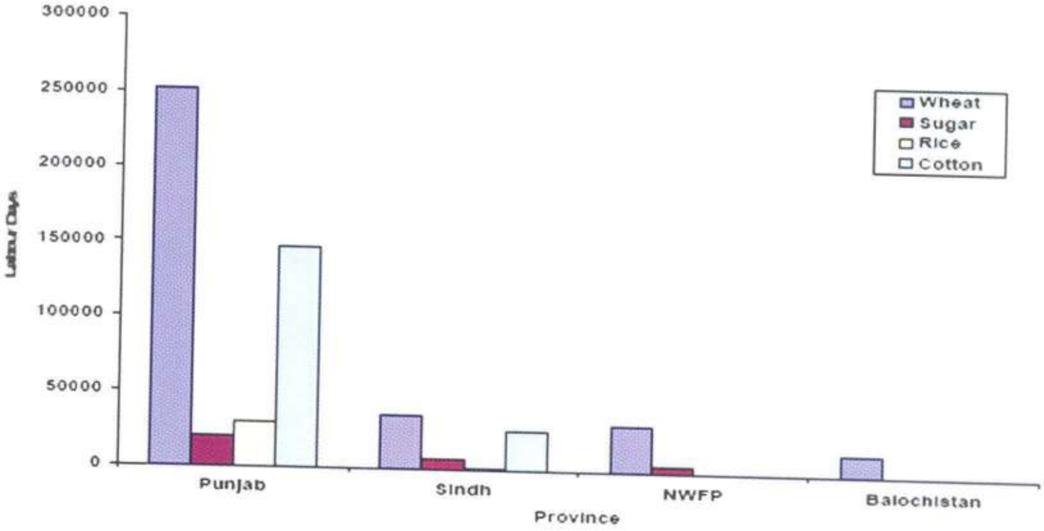


- On average in Sub-Saharan Africa and South Asia, a 1% increase in agricultural GDP induces a 6% expenditure gain for the poorest 10% of the population
- The large spillover benefits (a 2-4x multiplier) are due to the poorest being most reliant on agriculture for survival

* Based on data from 42 countries during the period 1981–2003; Expenditure is equivalent to income in growth accounting

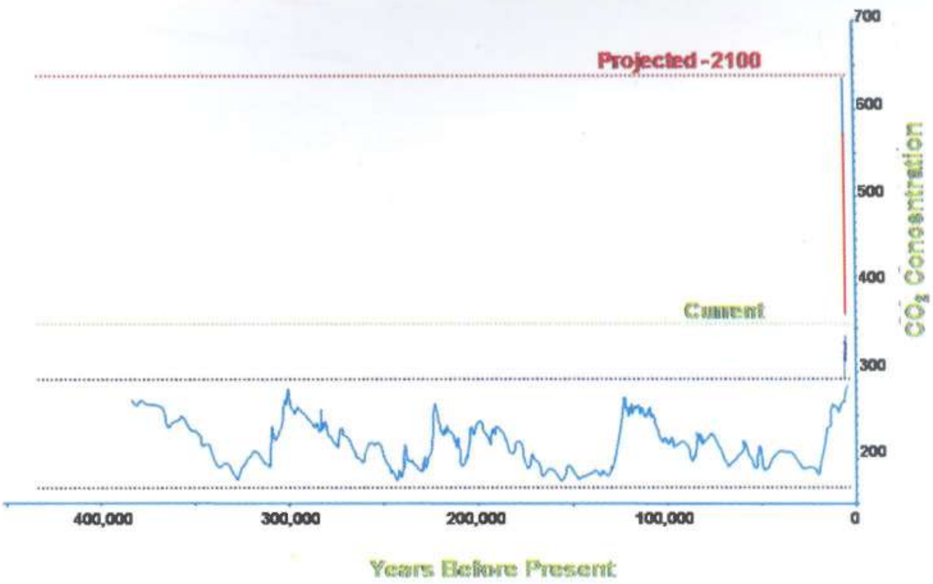
Source: Ligon and Sadoulet 2007 "Estimating the Effects of Aggregate Agricultural Growth on the Distribution of Expenditures." Background paper for World Development Report 2008 10

Employment by crops and province

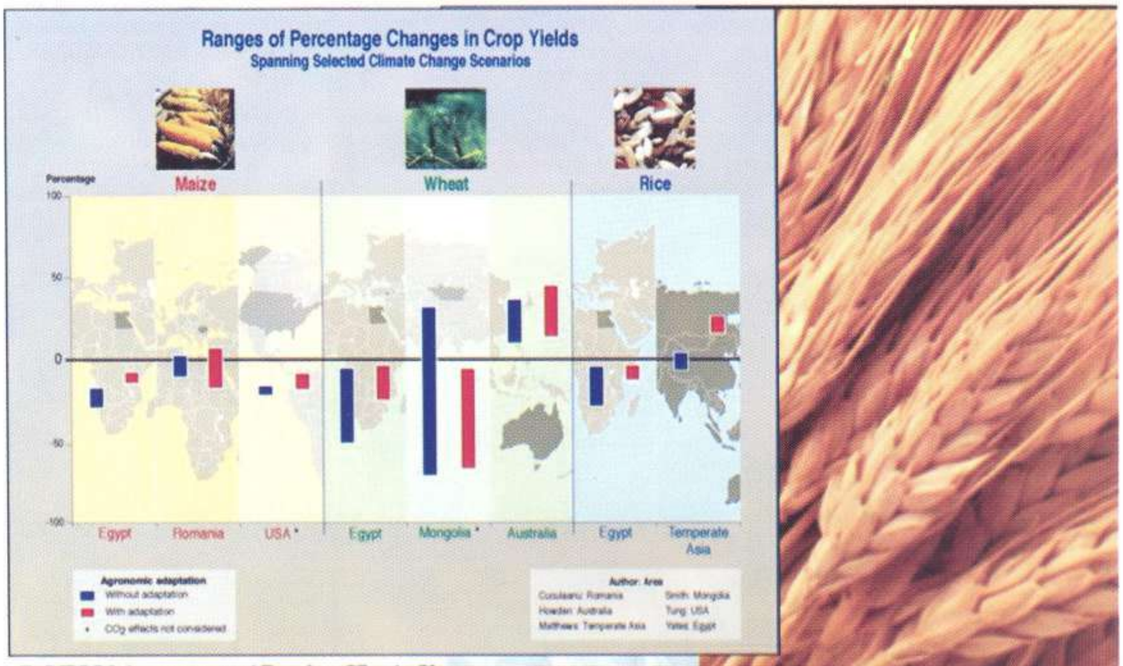


Climate Change Challenges

Increased Emissions a Reality !

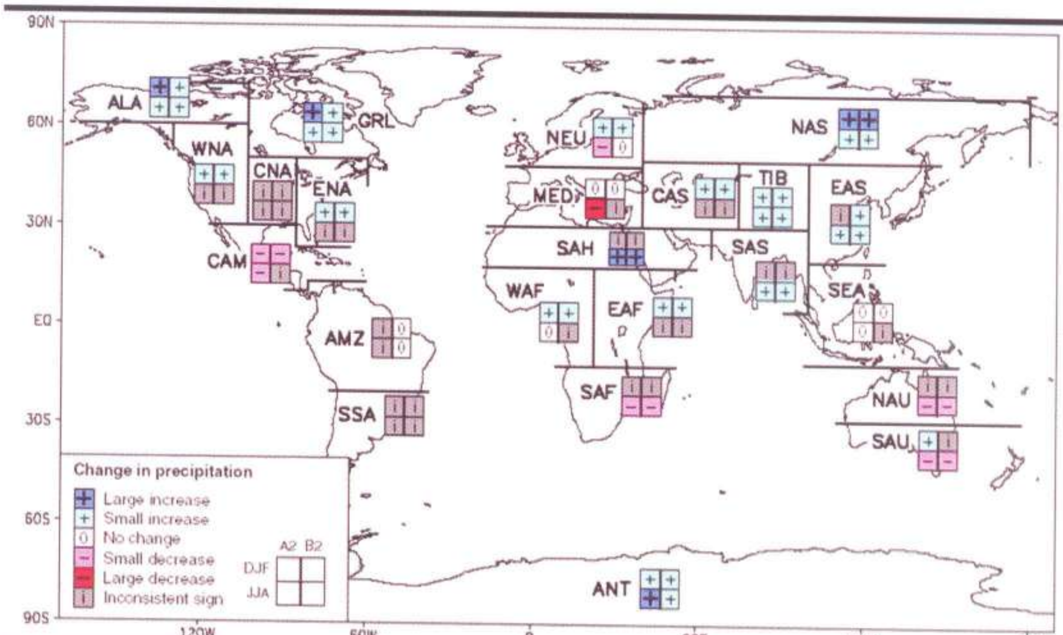


Crop Yield vs Climate Change



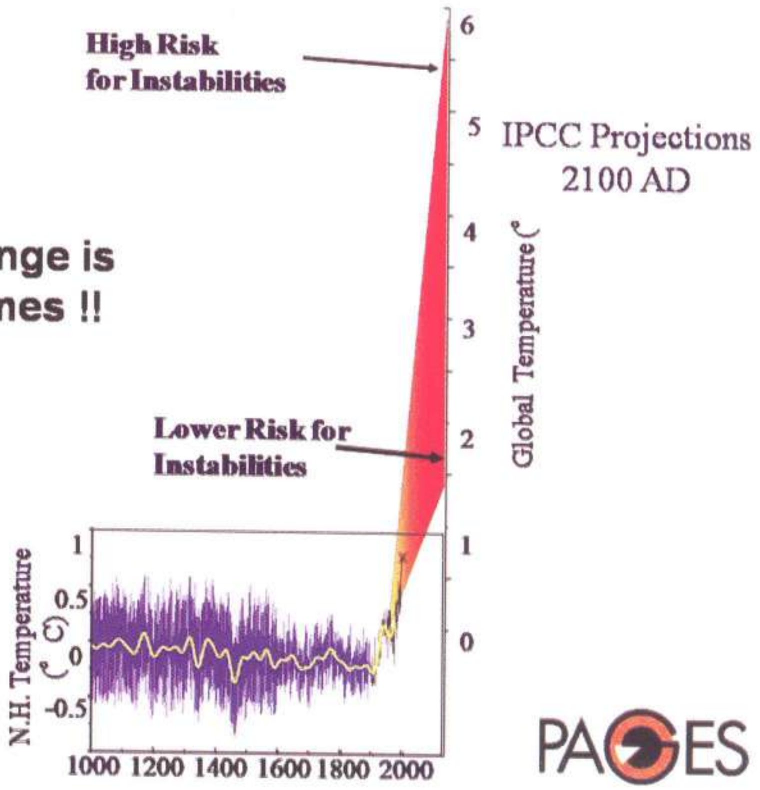
Ref: IPCC Intergovernment Panel on Climate Change WG2- Figure TS-4

Uncertain Climate Futures

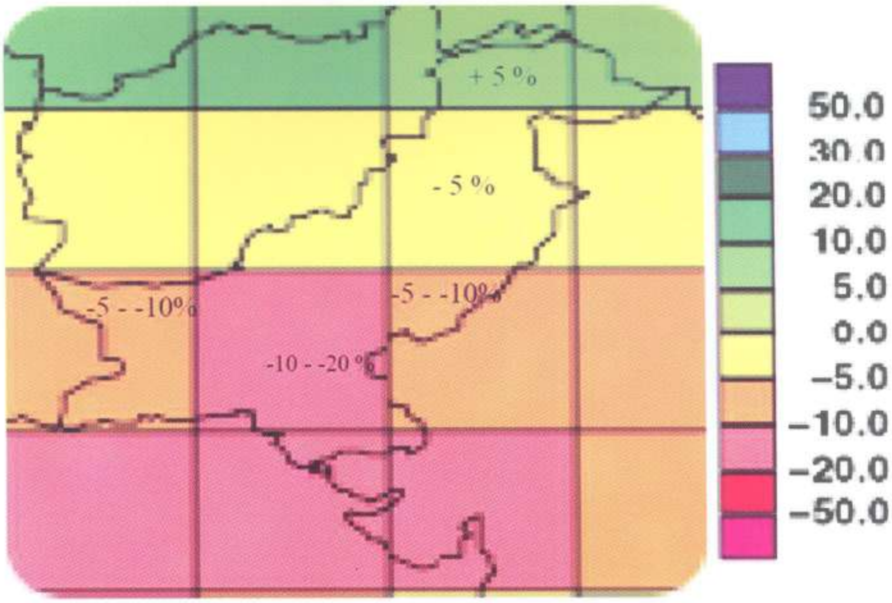


Projected future changes in precipitation patterns, according to 9 different models coupled Atmosphere Ocean General Circulation Models (AOGCMs). The gray boxes 'I', show inconsistent results across the different models

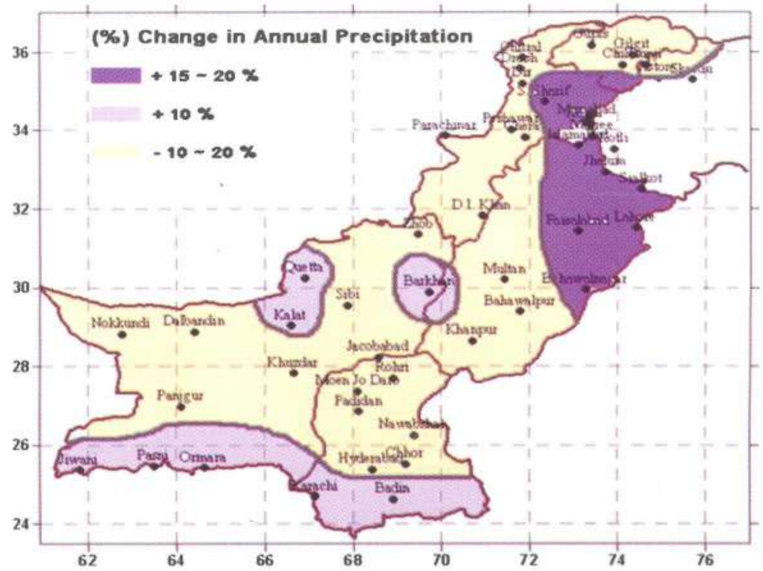
Climate Change is about Extremes !!



2050 Projected Precipation Changes in Pakistan Using GCM Models (Farooqi el at 2005)

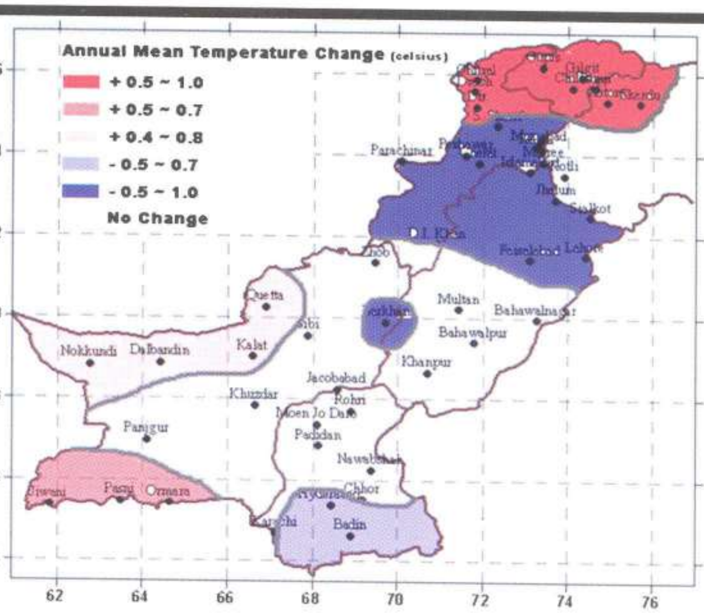


ANNUAL PRECIPITATION



- 10 to 20 % less annual precipitation in Multan Area.

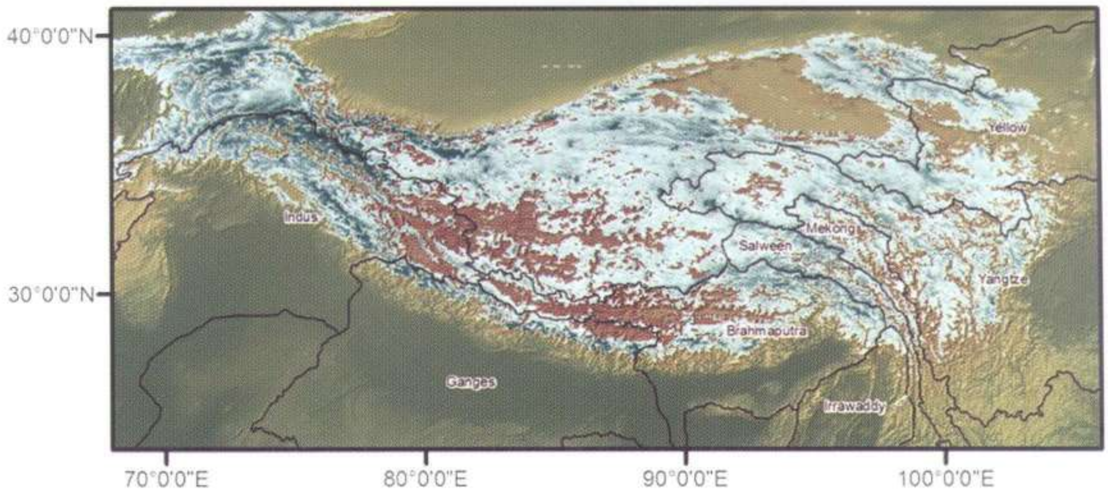
IMPACT OF GLOBAL WARMING ON WATER AVAILABILITY - PAKISTAN



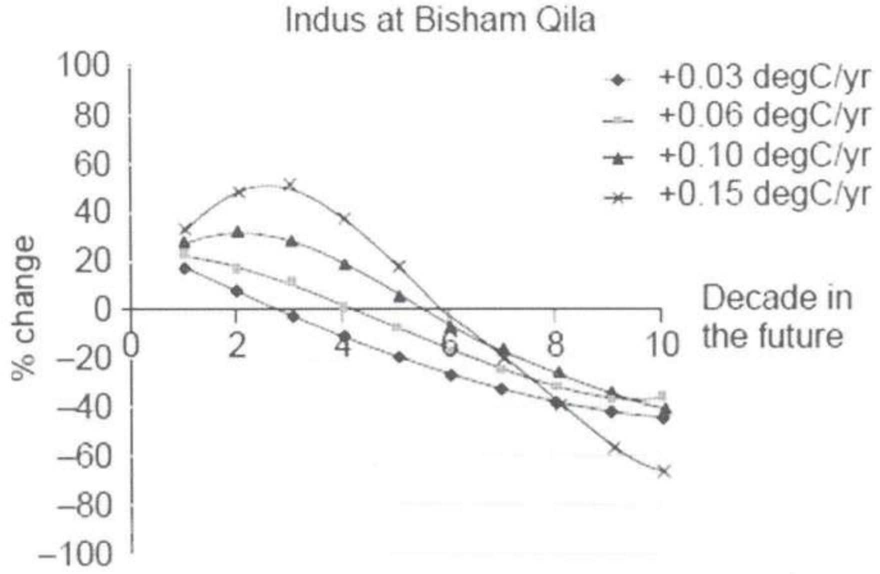
Intense rain – Quick runoff– less recharge – due to temperature variation global warming

Future Scenarios

Climate Change Impacts on Glaciers

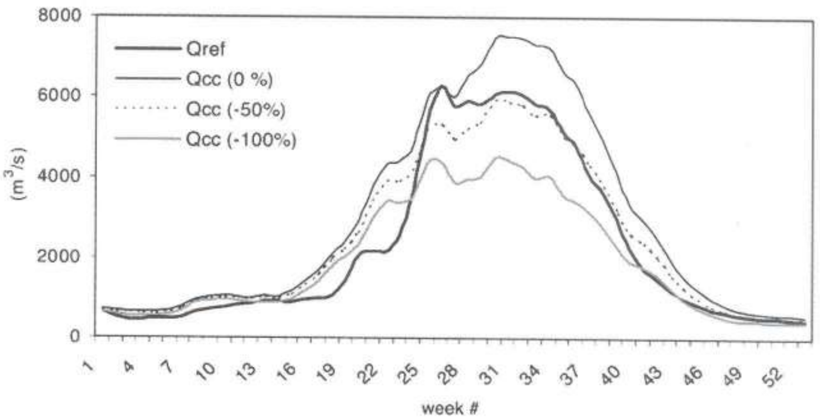


Predicted changes in Indus flows just above Tarbela



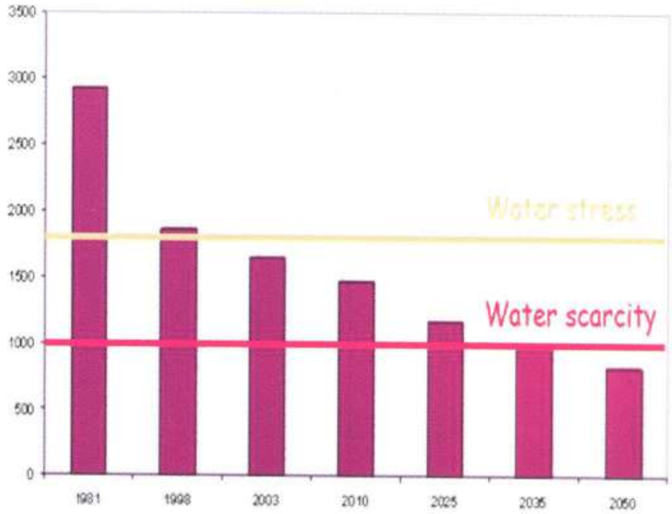
Source: Rees, 2005.

Impact of Glacier Disappearance on Discharge at Bisham Qila



Immerzeel et al 2009, Remote Sensing of Environment 113 (2009) 40–49

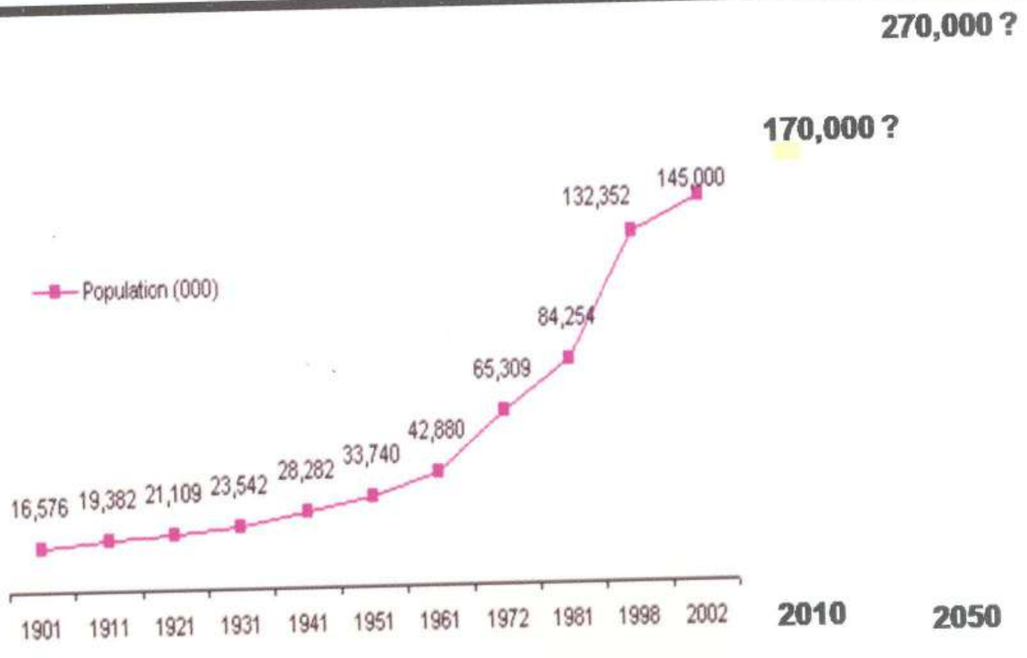
Future Water Scarcity



Source: World Bank Report "Pakistan Running Dry, 2005)

Improve water efficiency and availability	• Enhance water storage capacity • Improve the irrigation system to reduce the systemic water loss •I • Improve waste water management • Improve water distribution system
Increase farmer productivity	• Invest in on-farm management • Develop and subsidize water effective on-farm irrigat • Structural management •Subsidize seeds with more economic water consump
Result	• Higher food production • Increasing income for farmers • Economical water use/ increasing water availability • Better water quality

Water Future Linked with Population



Business as Usual Pakistan's Water Availability

Year 2000 – 1700 cubic meter per capita

Year 2005 – 1500 cubic meter per capita

Year 2035 < 1000 cubic meter per capita

< 100 Kg of beef per capita per year

+Transboundary Water Conflicts

+Climate Change

Leading to

3Ds Destructive, Dry or Dirty Water

Jobless, Poor and Hungry Population

2025 Business as Usual

Tons of Grains Required Food Supplies

1995 >>> 23.5 MMT

2025 >>> 52.56 MMT with a deficit of 17.37 MMT with water constraints

Pakistan Energy Demands

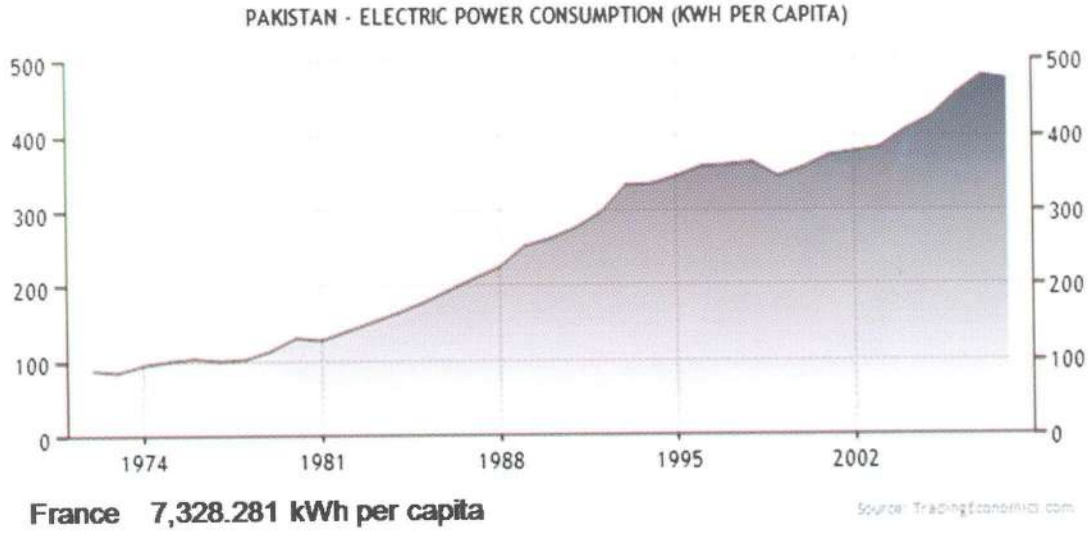
Electricity - total installed capacity: 19,505 MW (2007)

Electricity - Sources (2007)

- fossil fuel - 12,580 MW - 65% of total
- hydro - 6,463 MW - 33% of total
- nuclear - 462 MW - 2% of total

2020 Peak Summer Requirements = 41,132 MW

Comparative Analysis of Pakistan's Electric Power Consumption



France	**7,328.281 kWh per capita**
China	**2,584.876 kWh per capita**
Gabon	**993.905 kWh per capita**
India	**502.714 kWh per capita**

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Food for Debate After Lunch

-Geopolitical complexities demand new skills in hydrodiplomacy

-Water storage options are limited therefore technological fixes alone cannot solve water shortages.

-The is a wide water use efficiency technological gap between Pakistan and other countries. Knowledge investments can lead to better water futures.

- Population planning is essential to move towards better personal and national outcomes.

-Investments in water and agriculture can provide many fold returns to poor rural communities and hence social unrest.

-Climate change is a reality with serious threats to crop productivity as well as water availability.

-Better mix of hydro and other energy sources can reduce power shortages.

-New integrating academic disciplines to train water and energy leaders of tomorrow are needed as a matter of priority.

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Are You Ready for a Water Scarce Future ?

United Nations Educational, Scientific and Cultural Organization

Further info: s.khan@unesco.org

www.unesco.org

A Possible Way Forward?

The methodology of transition from problem identification for sustainable future