Freshwater Resources and Climate Change

By

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Water – A Global Issue

- Water a pre-requisite for life
- Historically, secure access to water essential for social & economic development, and stability of cultures & civilizations
- While world's oceans seem unbounded, freshwater actually available to people is finite – and a mere fraction of total
- Only 2.5% of global water is freshwater

Water – a Diminishing Resource

- As populations have grown, freshwater has become increasingly less available where and when it is needed
- Agriculture single largest consumer of water (about 69% of all water use)
- Easily accessible renewable freshwater resources – rivers, streams, lakes and aquifers already developed

Scenario for 2025

- *Water Stress < 1700 m^3 per capita*
- *Water Scarcity < 1000 m^3 per capita*
- **Some water sufficient states (India, Pakistan) will face stress, some scarcity (Algeria, Kenya)**
- **Water *stress* states to become water *scarce***
- **Water scarce states will nearly collapse**
- **"Water Wars" within and between countries**

IS GLOBAL WARMING REAL?

- Earth temp. increased by 0.6°C past century
- 15 warmest years last century all after 1980
- 1990s warmest decade of entire millennium
- 7 out of 10 warmest years occurred in 1990s
- 1998 warmest year on record
- Changes outside range of natural variability

IPCC 3rd ASSESSMENT REPORT (2001)

Impacts of Climate Change on Fresh water Resources in Asia

- Freshwater availability to be highly vulnerable to anticipated climate change.
- Permafrost degradation, increased vulnerability of climate-dependent sectors
- Surface runoff increases during spring and summer periods to be pronounced
- Large deltas and coastal low-lying areas inundated by sea-level rise.
- Climate change & variability to exacerbate vulnerability of DCs to extreme events

IPCC Report--- *contd…*

- Increased precipitation during summer Monsoon to increase flood-prone areas in temperate/ tropical Asia.
- Drier conditions to cause severe droughts.
- Tropical cyclones to become more intense
- Combined with sea-level rise, more risk of loss of life and property in coastal low-lying cyclone-prone areas
- Crop production & aquaculture threatened by thermal and water stresses, sea-level rise & increased flooding
- Warmer-wetter conditions to increase heat-related & infectious diseases in tropical and temperate Asia.

Joint Water Project

IGBP – IHDP – WCRP - Diversitas

Rationale:

Humans have begun to affect the Global Water System significantly without adequate understanding of how the system works

Mission:

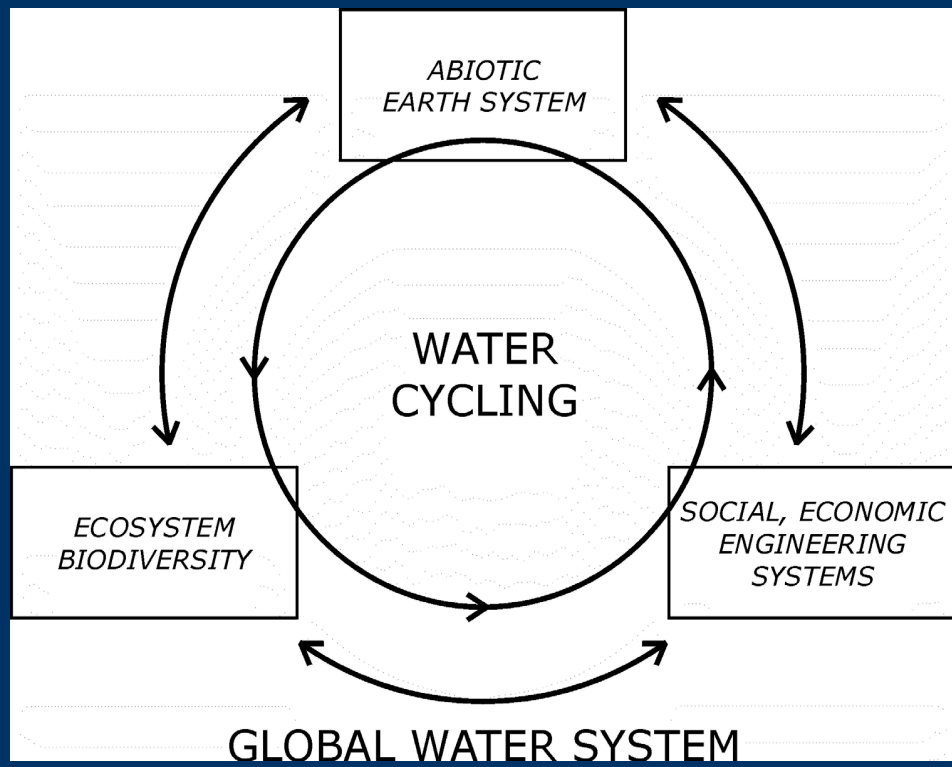
Improve knowledge of, and responsible interaction with, the Global Water System

e.g. global observation
consolidation of global data sets
predictive and coupled modelling

Joint Water Project

Overarching Question:

How are humans changing the global water cycle, the associated biogeochemical cycles, and the biological components of the Global Water System, and what are the social feedbacks arising from these changes?



Joint Water Project

Short term Task:

Identify data needs, and early efforts to construct first generation global data sets via synthesis and coordination with other programs (+ conceptual framework)

Medium term Task:

Facilitate the development of first-generation models that would allow prediction of physical, chemical, biological, and socioeconomic aspects of human manipulation of the Global Water System

Long term Task:

Promote development of interactive models capable of predicting possible responses and feedbacks of the Global Water System (and especially its terrestrial components) to human use and abuse with reliable uncertainty estimates

US Study on IMPACT OF CLIMATE CHANGE ON WATER RESOURCE

Water: the Potential Consequences of Climate Variability and Change for Water Resources of the United States: September 2000

By

Multi-disciplinary Water Sector Assessment Team of the National Assessment of the Potential Consequences of Climate Variability and Change

a. Nature of Expected Climate Changes:

- Surface temp. increase unless life patterns change
- Rainfall to increase with increasing GHG concn.
- Temp. increases in snowy mountains will increase rain to snow ratio and decrease length of snow storage season.
- Flood frequencies to increase In northern latitudes
- CC to increase heavy precipitation events
- Higher sea levels reduce freshwater supplies
- Water-quality problems worsen with rising temperatures
- Perturbed ecosystems
- Frequency and severity of droughts to increase
- Northward shift in species due to warming.

b. Impacts on Water Resources

- Model results suggest that some significant changes in the timing and amount of runoff will result from plausible changes in climatic variables.
- Watersheds with a substantial snowpack in winter will experience major changes in the timing and intensity of runoff as average temperatures rise
- Risk of increased flooding in parts of the U.S. that experience large increases in precipitation.
- Relative sea-level rise adversely affects groundwater aquifers and freshwater coastal ecosystems.
- Higher thermal stress for cold-water fish, improved habitat for warm-water fish due to higher temp. in lakes

c. Impacts on Managed Water Systems

- Large changes in reliability of water yields from reservoirs could result from small changes in inflows.
- Climate changes that reduce overall water availability will reduce the productivity of hydroelectric facilities.
- Climate change to affect conventional fossil fuel and nuclear power plants by raising cooling water temp. and reducing plant efficiencies.
- Water-borne shipping and navigation are sensitive to changes in flows, water depth, ice formation, and other climatic factors.
- Possible economic impacts of reductions in flow could be very large
- Additional costs due to CC more than costs imposed by population growth, industry and agriculture

d. Is CC Already Affecting Water Resources?

Evidence that humans are changing the water cycle is increasingly compelling.

- U.S. has, on average, warmed by 0.7°C since 1900.
- Permafrost in the Alaskan arctic is beginning to thaw.
- Mean sea level has risen 10-20 cm since 1890s.
- Mountain glaciers are melting at unprecedented rates
- Vegetation is blooming earlier in spring and summer
- Snow and ice cover are decreasing and melting earlier.
- Average precipitation has increased by 10% since 1910.
- Arctic ice thickness declined since mid-20th century.

e. Recommendations for Coping/Adaptation

- Develop better methods of planning under climate uncertainty
- Re-evaluate legal, technical, and economic approaches to manage water resources in light of potential CC
- Water managers reexamine engg designs, operating rules, contingency plans, and water allocation policies under different climate conditions
- Water agencies and scientific organizations cooperate to exchange information about climate change and impacts on water resources.
- Consider traditional and alternative forms of new supply: waste water reclamation & reuse, water marketing and transfers, desalination
- Rationalize water prices & markets- incentives to use less and produce more tiered rates, water banking, and conjunctive use of groundwater.
- Improve legal tools for managing &allocating water resources

PAKISTAN:

Recent Trends in Climate Change

- Prolonged droughts in Pakistan and India
- Drought in Pakistan for last three years
- Forecast for continued dry weather in arid areas of the sub-continent
- Extremes are getting severe-intense rains of short duration and prolonged dry spells

Climate Change Impact on Rainfall & Warming

Historical data comparison (1930-60 and 1960-90):

- Rise in mean temp. of 0.5-1.0^{0}C in arid coastal areas, arid mountains and hyper arid plains
- 10-15% decrease in both winter and summer rainfall in above regions
- 15-35% increase in rainfall in monsoon zone especially the sub-humid and humid areas
- 4% decrease in relative humidity in Balochistan
- 0.5 to 0.75% Increase in solar radiation in Balochistan and Southern Pakistan
- 1-2% decrease in cloud cover in central Pakistan with increase in sunshine hours

CC Impact on Rainfall & Warming—contd.

Historical data comparison (1930-60 and 1960-90):

- 3 – 55% increase in evapo-transpiration due to 0.9°C temp. increase
- 5% Increase in net irrigation water requirement with no change in rainfall.
- Expanding aridity in Northern parts outside monsoon range and arid regions
- Out of 90 years 7 strong, 9 moderate and 6 weak *EL Nino* events
- Departure from normal of 17-64% under strong events

Impact on Water Resources and Economy

- Less snowfall, slow deposits& glacierization
- Reduced river flows
- Reduction in storage of water in dams
- Less rainfall in arid areas, prolonged droughts

APN Project #2002-12

WATER RESOURCES IN SOUTH ASIA:
An Assessment of Climate Change- associated Vulnerabilities & Coping Mechanisms

Project Objectives

- Assess impacts of projected CC & variability and extreme hydrological events on water resources of Pakistan, India, Nepal and Bangladesh
- Analyze recent experiences in climate variability and extreme events, and impacts on regional water resources
- Determine vulnerability of regional water resources to CC, identify key risks to sub-regions, prioritize adaptation responses
- Evaluate efficacy of adaptation strategies and coping mechanisms to reduce vulnerability of regional water resources
- Provide inputs to national/ regional development strategies

Research Structure

(based on Burton 2001)

YEAR - I: 2002/3:

VULNERABILITY ASSESSMENT

- Analysis of Recent Climate Variability & Extreme Events
- Impacts of Above on Water and Related Sectors
- Climate Change and Socio-economic Scenarios
- Projected Impacts and Vulnerabilities

Research Structure *...contd.*

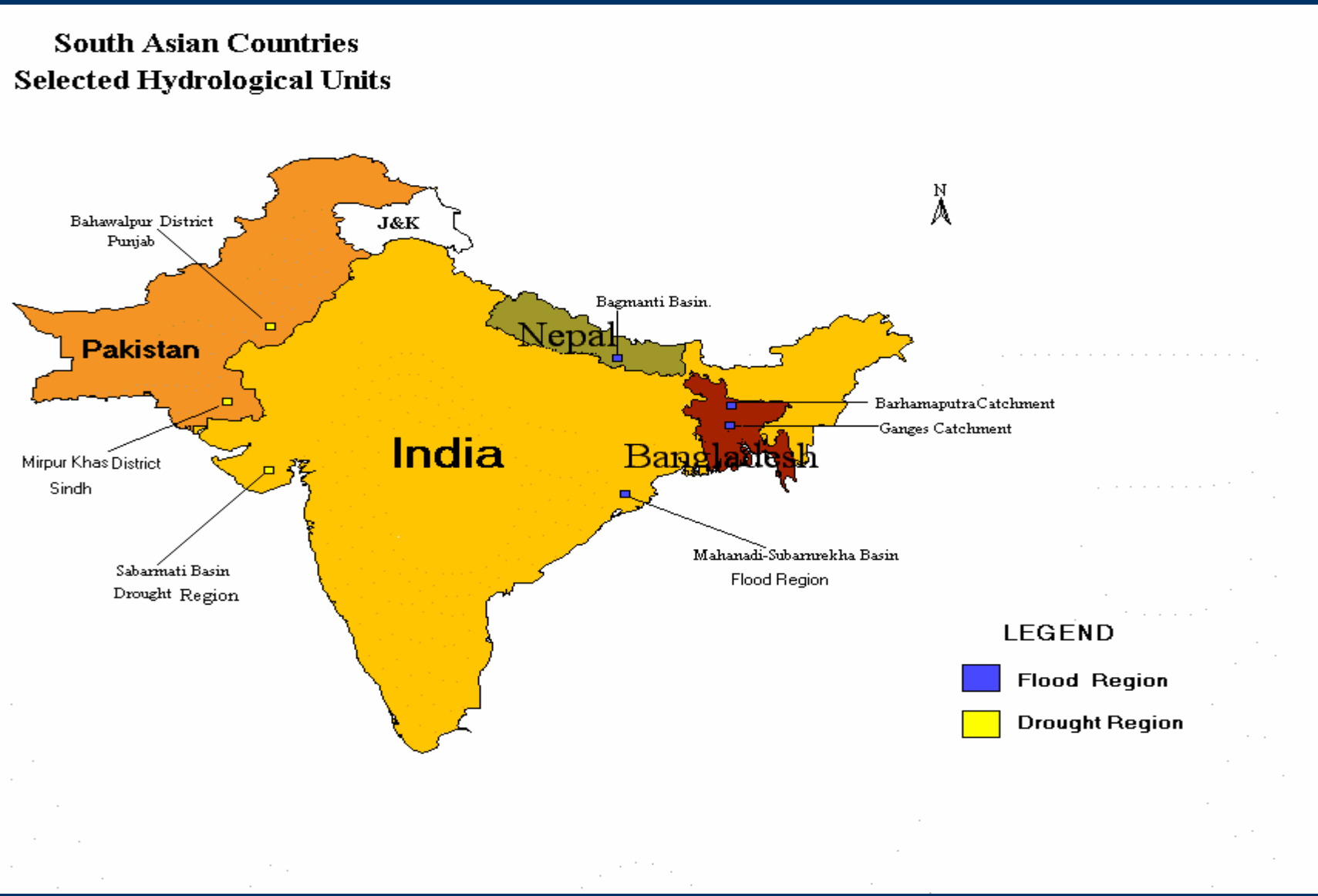
YEAR 2: 2003/4: **ADAPTATION ASSESSMENT**

- Case Studies: Field Surveys, Key Actor Interviews
- Evaluation of Adaptive Measures, Economic Efficiency, Acceptability and Technical Feasibility
- Lessons Learned and Experience Sharing

YEAR 3: 2004/5: **INFORMATION FOR POLICY MAKERS**

- Draft Final Report
- Stakeholder Meetings
- Inputs to National Development Strategies
- Final Report Dissemination
- Capacity Building Meetings

Project Locations



Year One-Specific Efforts

- National studies on climate variability and impact assessment based on historical record and climate change projections
- Identify extreme hydrologic events and assess recent experience with adaptive responses (spontaneous and planned), including their costs and effectiveness.
- Katmandu Workshop in December 2002 to discuss results of national studies

Thank you