Vulnerabilities Related to Glacier Melt and Changing Water Availability/Demand

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12/22/2011
Questions to be Addressed

- What are water-related vulnerabilities?
- What are the vulnerabilities related to changing glaciers and hydrology in Central and South Asia?
- What is driving increased water demand?
- What are likely approaches to addressing water and glacier-related vulnerability?
Definitions

- **Vulnerability to Changing Water Availability and Demand:**
  The degree to which human communities, water infrastructure, agricultural systems, industries, and natural ecosystems are susceptible to or unable to cope with adverse effects of water availability or water-related natural disasters.

- **Water Security:**
  Access to safe drinking water and sanitation (MDG and UN human rights) plus availability of, and access to, water for all human and ecosystem uses.
Definitions (continued)

- **Water Stress:**
  Less than 1,700 m$^3$ person/year water availability.

- **Water Scarcity:**
  Less than 1,000 m$^3$ person/year.
  - **Physical**: insufficient water to meet all demands.
  - **Economic**: insufficient water access due to underinvestment in infrastructure.
Key Considerations

- **Context Specific** (biophysical, socioeconomic, governance)
- **Multiple Scales** (community, sub-basin, basin, sub-national, national)
- **Climate Change Effects** on glaciers, precipitation, temperature
- Upstream/Downstream Relationships
- **Water Volume and Timing**
- **Access and Allocation** (governance/management: fragmented authority)
- **Consumptive vs. Non-Consumptive Use**
Glacier Melt

- **Complex Hydrologic Systems**: relative contribution of GM uncertain.
- **Timing Crucial**: max GM in growing season.
- **Water Availability Already Critical**: even small change in GM flow exacerbates vulnerability.
- **Increasing Aridity/Population Growth from East to West**: Indus system highly GM-dependent – Ganges/Brahmaputra less so
- **Mountain Communities Particularly Vulnerable**: Natural hazards, water availability.
Water-Related Vulnerabilities

- Human Health
- Food Security
- Energy Security
- Governance/Conflict
- Biodiversity
- Natural Disasters (GLOFs, floods, droughts)
Water-Related Vulnerabilities

Human Health

- Domestic Water Supply (access, waterborne disease, hygiene)
- Nutrition (water supply is a key determinate of food production)
- Energy for Cooking and Heating (black carbon)
- Population Dynamics
- Gender Considerations
Water-Related Vulnerabilities

Human Health

2008 Total Population

Data Source: US DOE ORNL Landscen 2008 (downloaded December 2009)
Water-Related Vulnerabilities

Human Health

Distribution of Hunger

- Percent of children age 0-5 underweight, 2000
- Legend:
  - <10
  - 10.1 - 20
  - 20.1 - 30
  - 30.1 - 40
  - 40.1 - 50
  - >50
  - No Data
  - River Basins

Source: CIESN, Columbia University, 2004
Water-Related Vulnerabilities

Human Health

Total Fertility Rate

- TFR: 17-18
- 19-24
- 25-29
- 30-34
- 35-42
- 43-50
- 51-57
- 58-63
- 64-8.0

Excluded

River Basins
Water-Related Vulnerabilities

Food Security

- Surface Water Irrigation (flow volume/timing; dam impact; use efficiency)
- Groundwater Irrigation (energy for pumping, water availability)
- Floods/Droughts
- Warmer Temperatures (shift crops/practices/disease)
Water-Related Vulnerabilities

Food Security
Water-Related Vulnerabilities

Food Security

2005 Total Cropland

Total Crop Land (Km2) within 5x.5 degree grid cell
50
0
River Basins

Data Source: WRI Netherlands Environmental Assessment Working Group (2009)
Water-Related Vulnerabilities

Hot Spots of Climate Change and Food Insecurity

CGIAR Research Program on Climate Change, Agriculture, and Food Security (CCAFS)
Energy Security

- Hydro-power (flow volume/timing; downstream impacts)
- Thermal Cooling (coal, nuclear)
- Biofuels
- Trade-offs (food production, GHG emissions, biofuels)
Water-Related Vulnerabilities

Governance/Conflict

- Diminished/Unequal Water Access undermines governance credibility/stability
- Weak water governance creates competition/conflict among user groups and sub-national governments
- Transboundary water conflict if basin-wide international agreements/institutions and reliable hydrologic data absent
Water-Related Vulnerabilities

Biodiversity

- Aquatic Ecosystems (rivers, wetlands, lakes)
- Marine Ecosystems (estuaries, fisheries)
- Terrestrial Ecosystems (forests, grasslands)
- Human dependence on ecosystem services and products
Water-Related Vulnerabilities

Biodiversity

Biodiversity Hotspots, 2004

Mountains of Central Asia

Mountains of Southwest China

Himalaya

Indo-Burma

Data Source: Conservation International Hotspots February 2005 (downloaded 7/7/2010)
Water-Related Vulnerabilities

Natural Disasters

- Glacial Lake Outburst Floods
- Landslides
- Floods/droughts

Glacier melt in the Kunlun Mountains (Dan Miller)
The Water, Energy and Food Security Nexus

Water Demand Drivers

- Population Growth
- Income Growth
- Industrialization/Globalization
- Energy Demand
- Food Demand (more volume and greater demand for water intensive crops; international trade)
Constraints on Water Availability

- Inefficient infrastructure (evaporation/leakage, poor irrigation practices)
- Water allocation economically/socially/ecologically inefficient (e.g. cotton in Aral Basin)
- Increased variability in rain/snow/temperature patterns
- Glacier melt patterns changing
- Groundwater levels falling
- Water pollution
Approaches to Reducing Water Vulnerability

- **Governance:**
  Clear management authority, integrated management approach, transparent/equitable water use rights, basin-wide management institutions, conflict management/mitigation.

- **Equity:**
  Ensure that basic human needs are met.

- **Economics:**
  Adjust incentive structures to encourage conservation and highest return to water.

- **Technology:**
  Water reuse and conservation in agriculture, industry and municipal supply. Small-scale harvesting/storage systems
Approaches to Reducing Water Vulnerability

• **Balance:**
  Actively manage the water/energy/food nexus.

• **Drivers:**
  Reduce population growth and demand for water-intensive food/products/energy.

• **Knowledge:**
  Learn more about river hydrology, glaciology, and how water is used.

• **Awareness:**
  Inform decision makers and the public about challenges and solutions.