



Vulnerabilities Related to Glacier Melt and Changing Water Availability/Demand

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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 of 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 m³ person/year water availability.

- **Water Scarcity:**

Less than 1,000 m³ 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



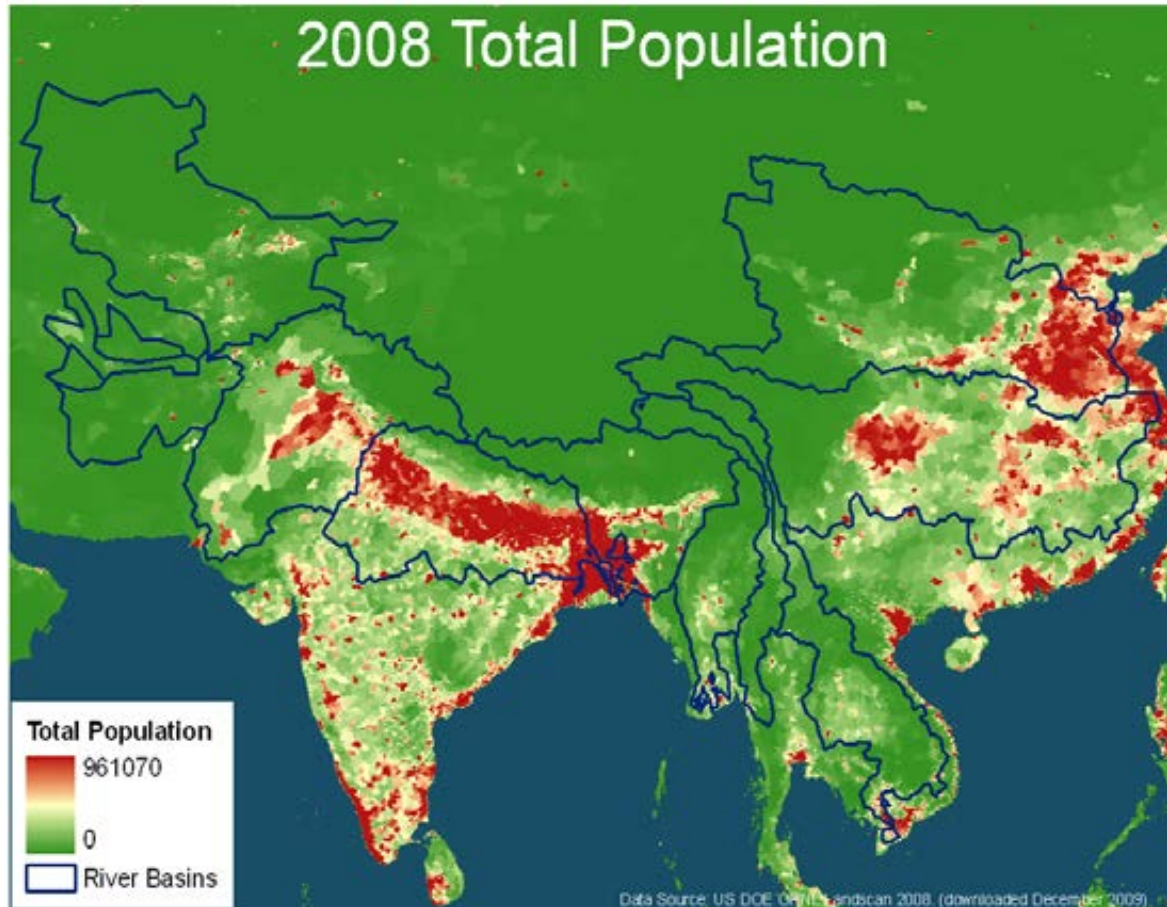
Varanasi bathing ghat (commons.wikimedia.org)



Clean cookstoves for developing countries: Improving health, reducing climate change. (E. Haiger, Partnership for Clean Indoor Air)

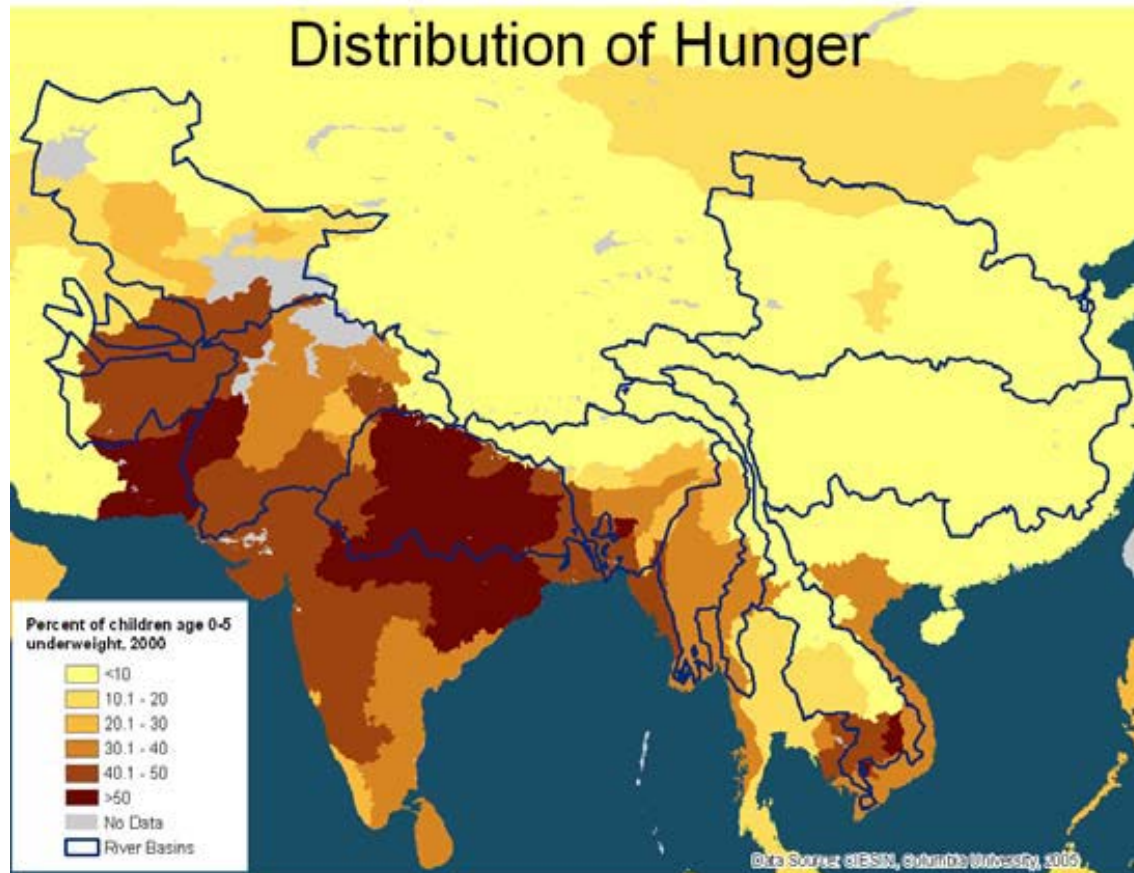
Water-Related Vulnerabilities

Human Health



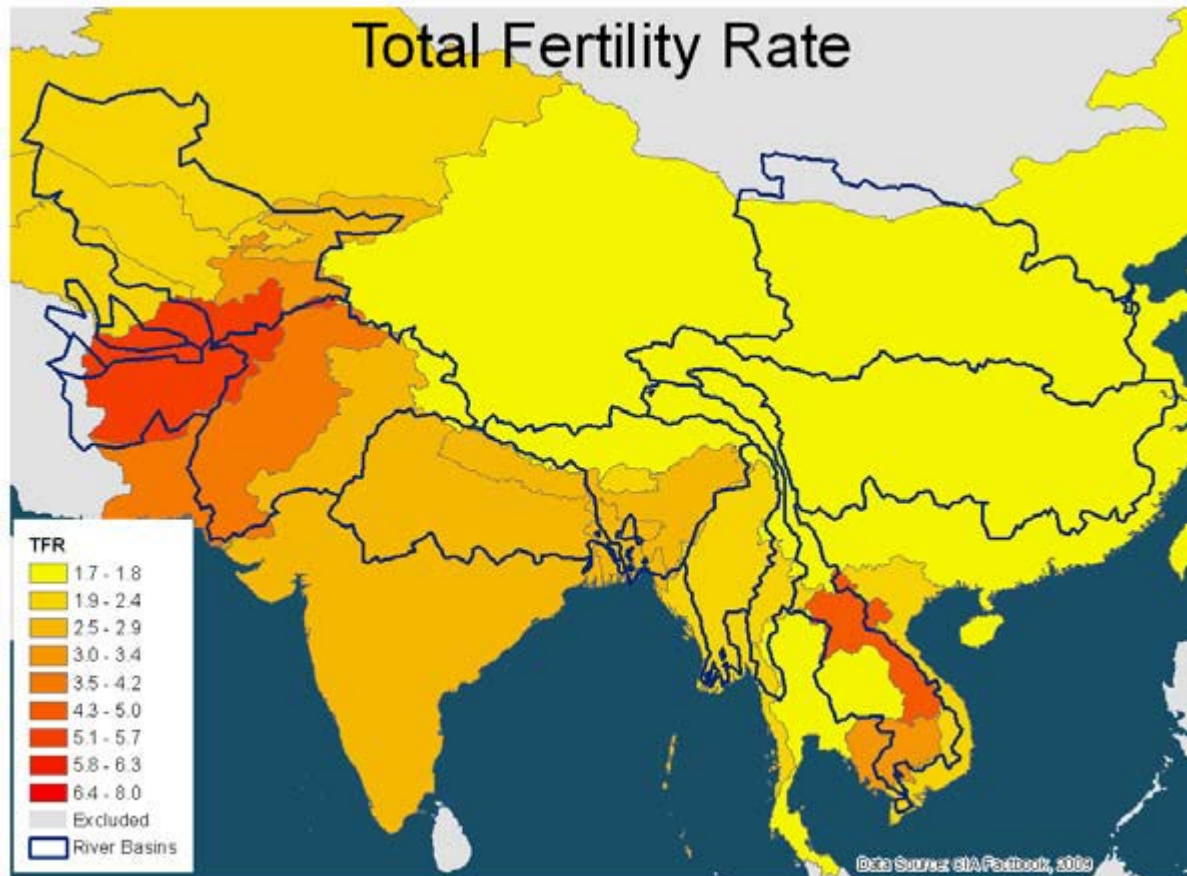
Water-Related Vulnerabilities

Human Health



Water-Related Vulnerabilities

Human Health



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)



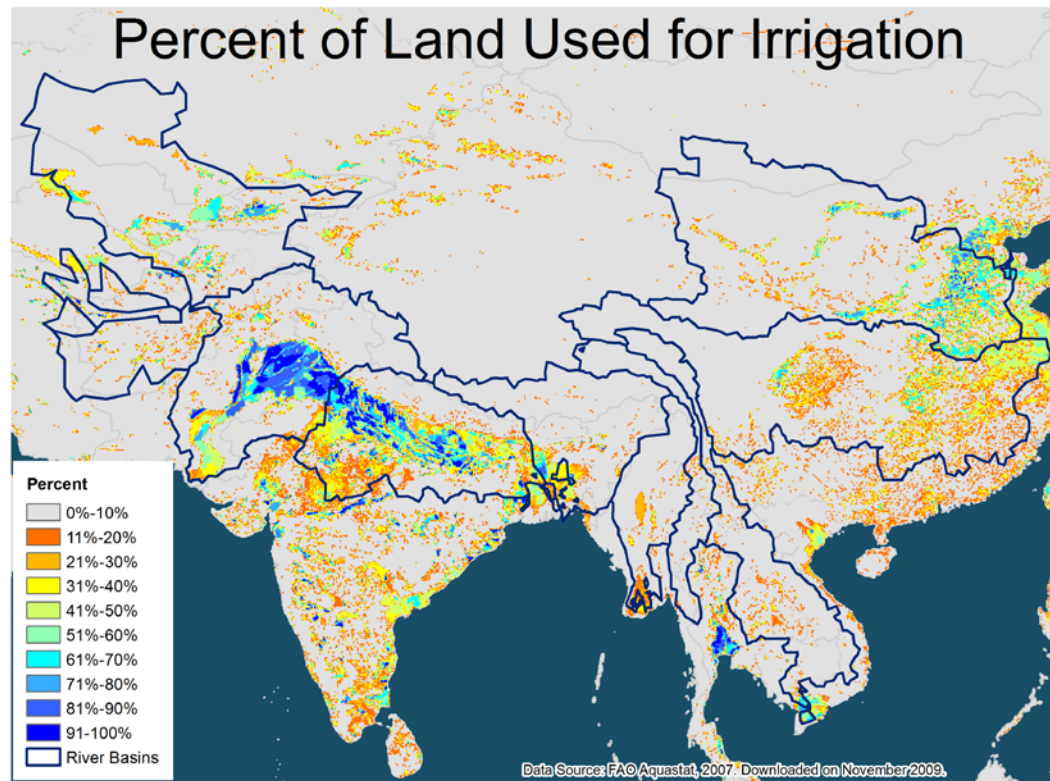
Pakistan flooding, (commons.wikimedia.org)



Central Asia photo (Bjom Guterstam, Global Water Partnership)

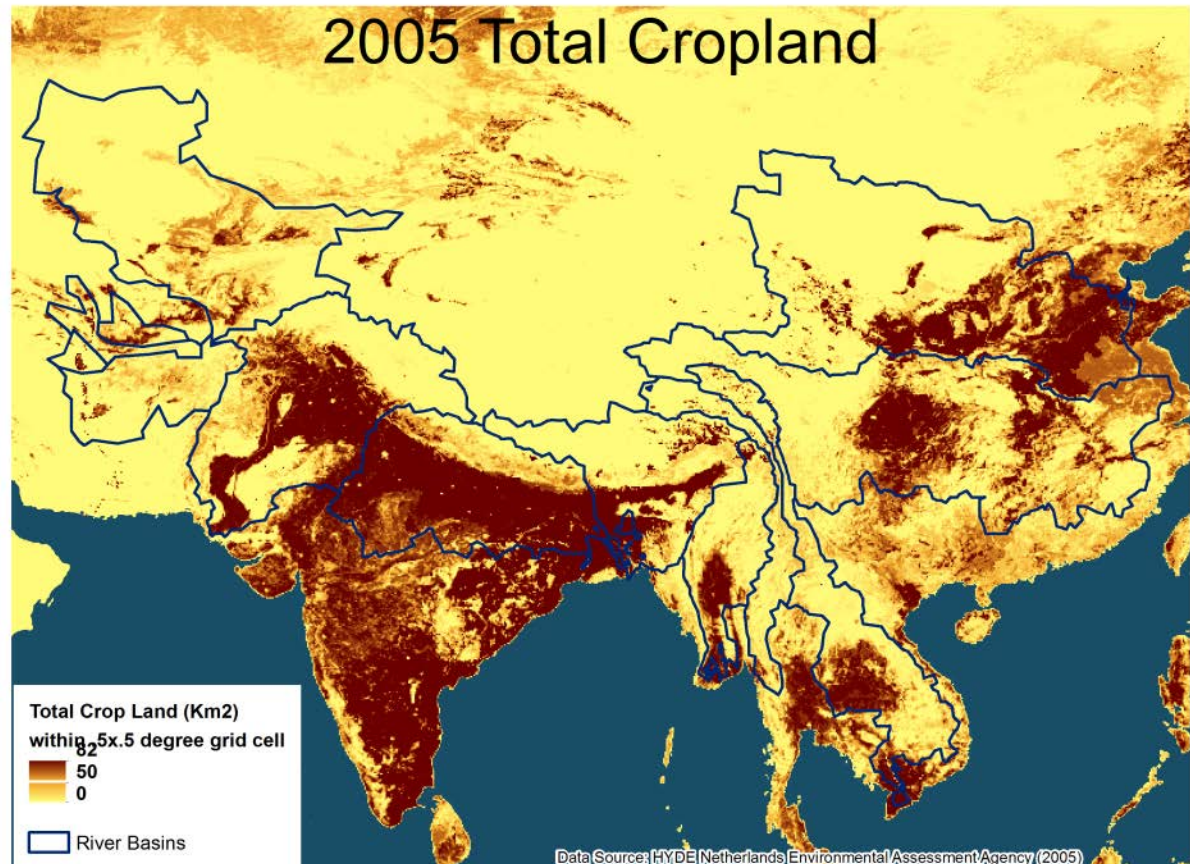
Water-Related Vulnerabilities

Food Security



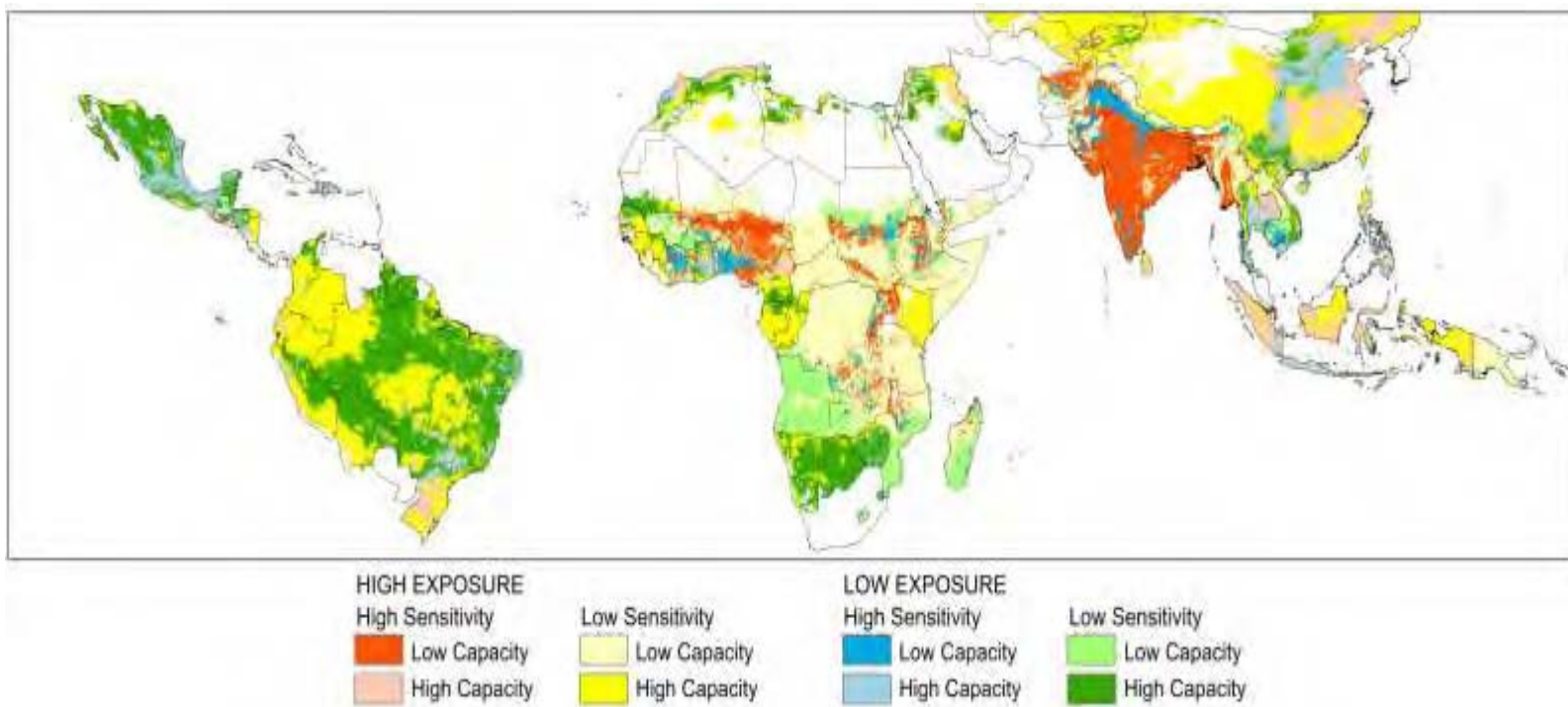
Water-Related Vulnerabilities

Food Security



Water-Related Vulnerabilities

Hot Spots of Climate Change and Food Insecurity



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

Water-Related Vulnerabilities

Energy Security

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



Central Asia photo (Björn Guterstam, Global Water Partnership)

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



July - September, 1989

October 5, 2008

Aral Sea (en.wikipedia.org)



Water-Related Vulnerabilities

Biodiversity

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



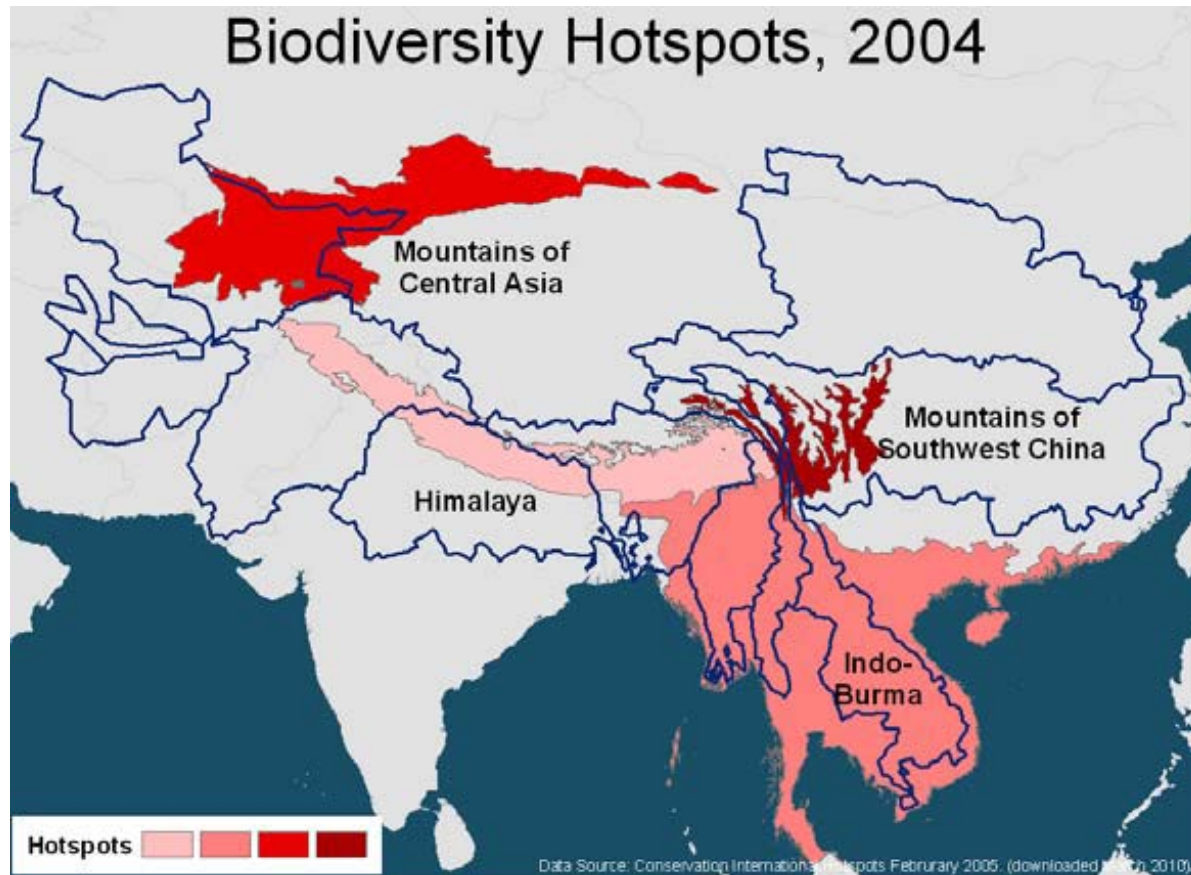
Central Asian Lake (travelgrove.com)



Kyrgyz mountain stream (M. Melnyk)

Water-Related Vulnerabilities

Biodiversity



Water-Related Vulnerabilities

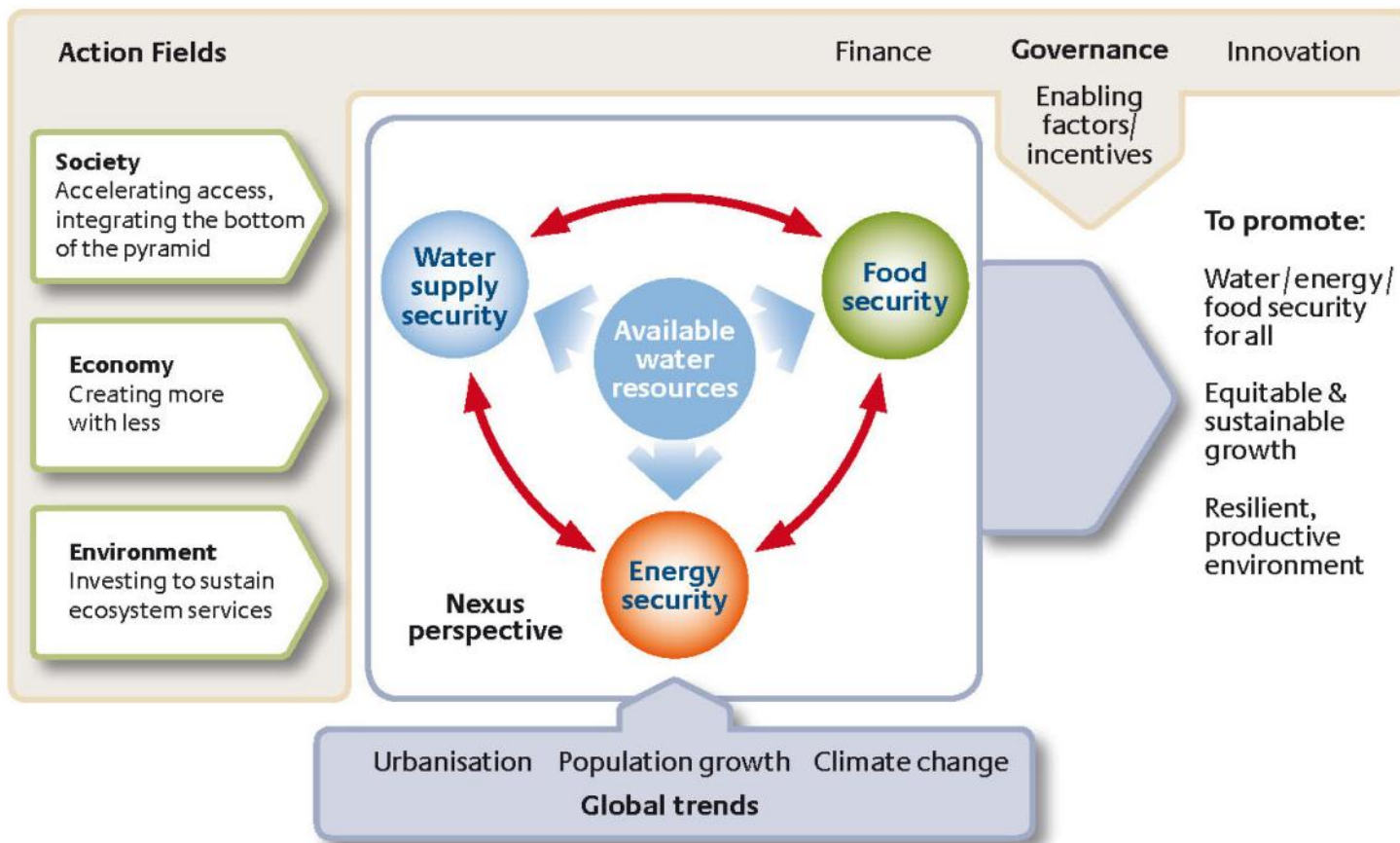
Natural Disasters

- Glacial Lake Outburst Floods
- Landslides
- Floods/droughts



Glacier melt in the Kunlun Mountains (Dan Miller)

The Water, Energy and Food Security Nexus



Source: Stockholm Environment Institute. Understanding the Nexus Background paper for the Bonn2011 Nexus Conference.



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.