

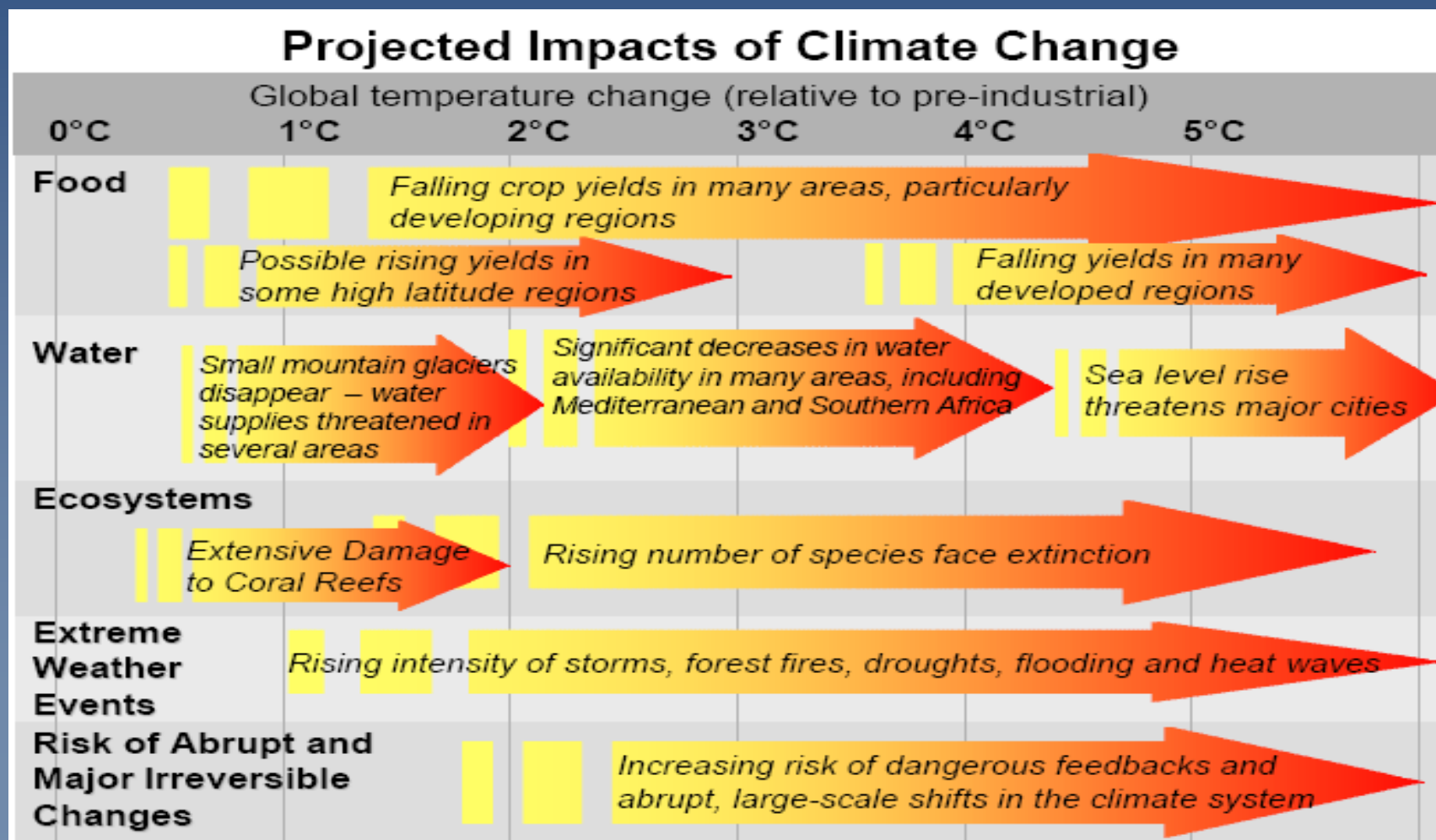


Assessment of Climate Change Impacts on Water Resources and How to Adapt

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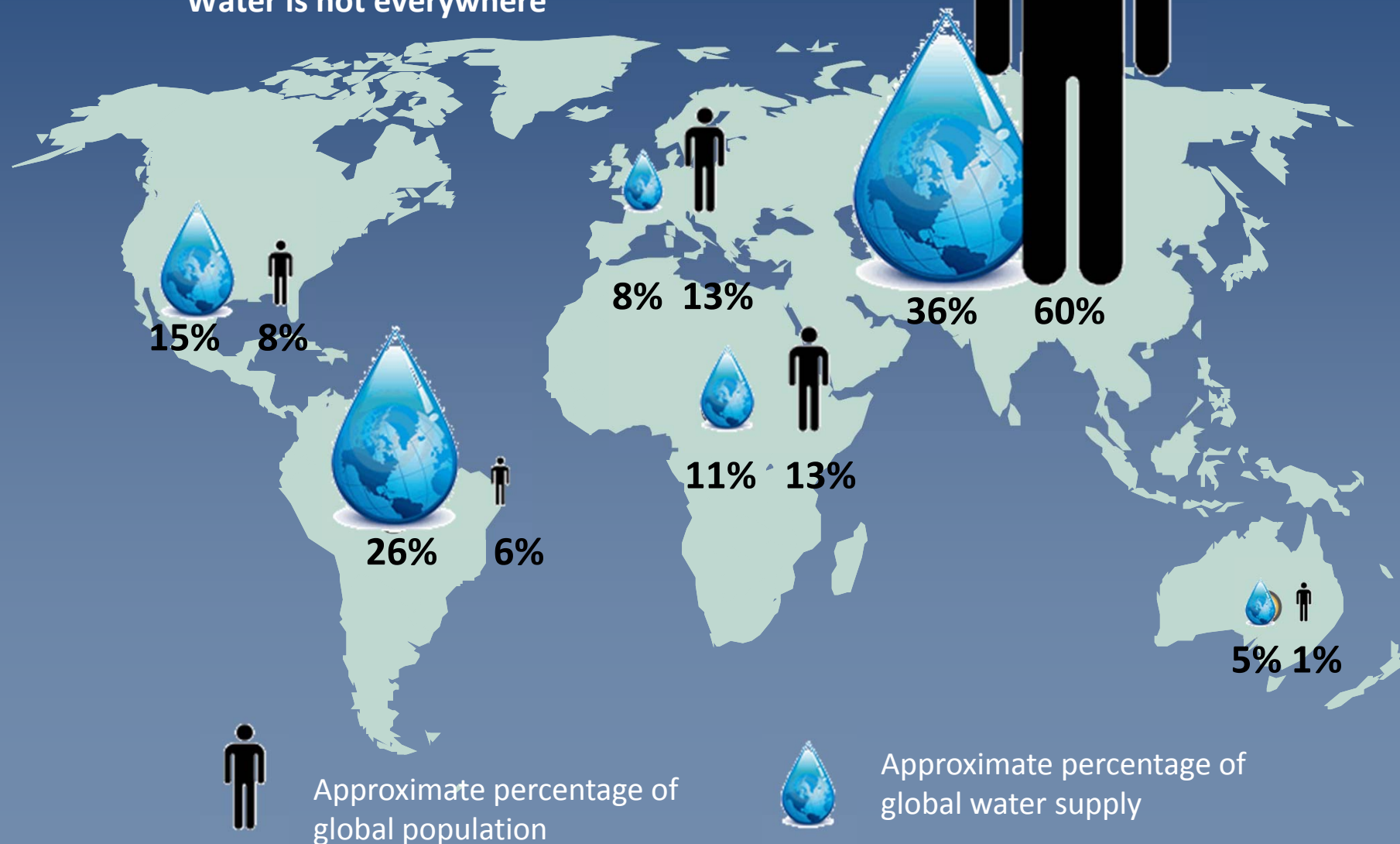
Climate change is effecting our environment, our societies and our cultures



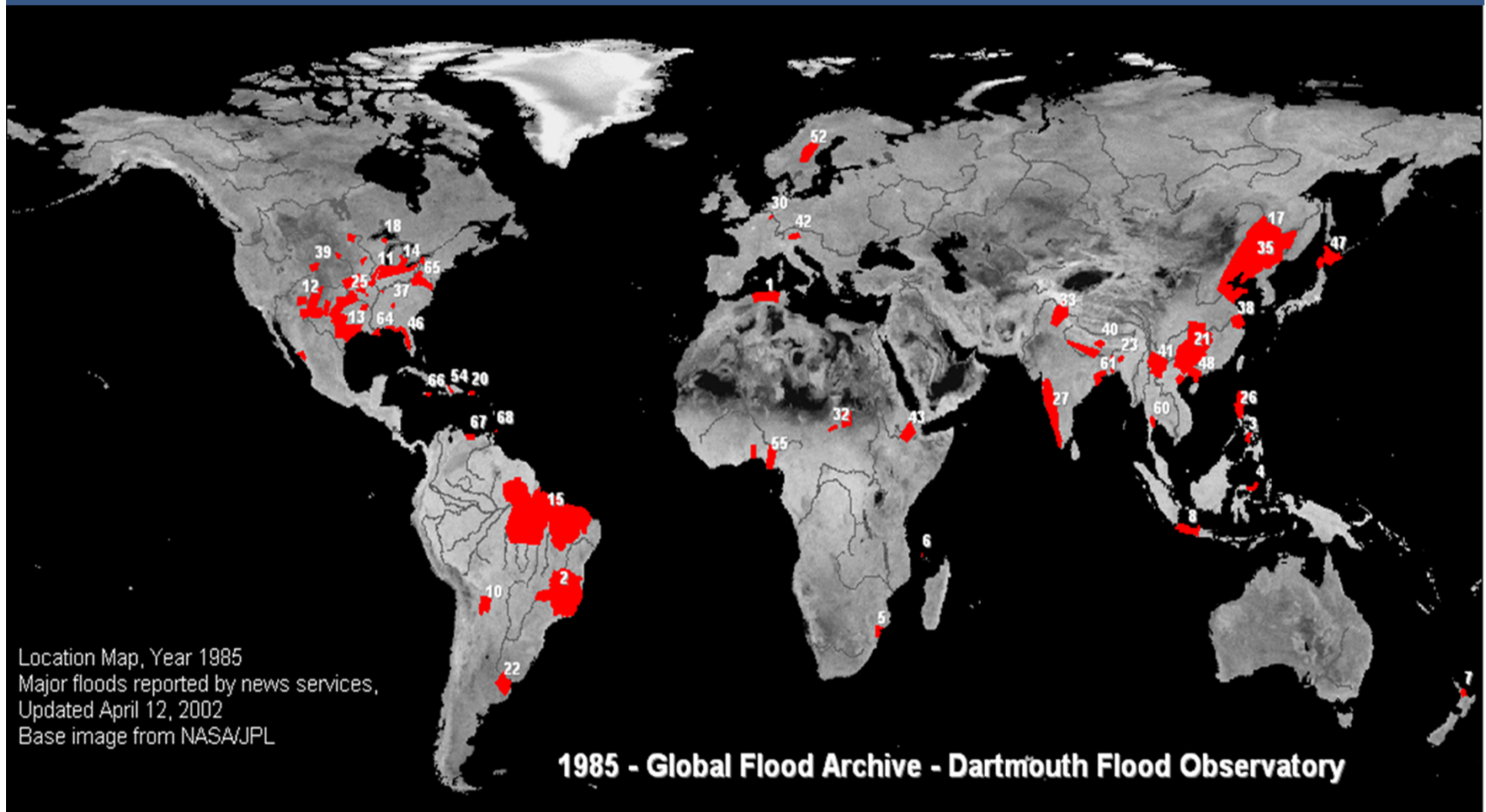


Water and Population

Water is not everywhere



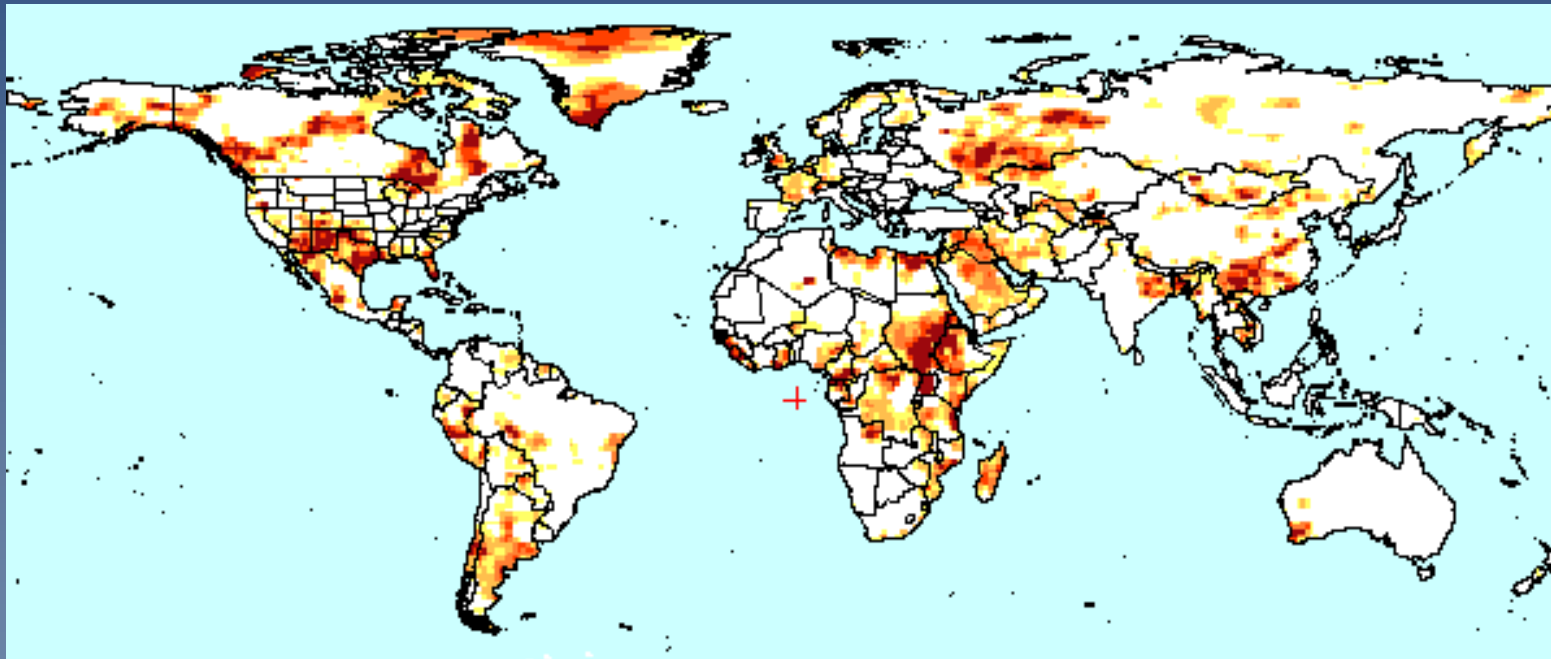
Major Floods 1985-2007





Droughts

36 months of drought conditions starting Sept 2011



Drought
Severity



Minor
Drought



Moderate
Drought



Severe
Drought



Extreme
Drought



Exceptional
Drought

302,800,000 People are under severe drought condition

Data from UCL global drought monitor. Based on 36 months standardized precipitation index



Sedimentation problems are a matter of global concern



- The annual erosion of surface soil from global river basins amounts to 60 billion tons
- 5 to 7 million ha of farmland are annually ruined



- About 1% of the precious storage capacity of the world's reservoirs is annually lost to deposition
- Economic Loss over USD 6 billion/year



United Nations Educational,
Scientific and Cultural Organization



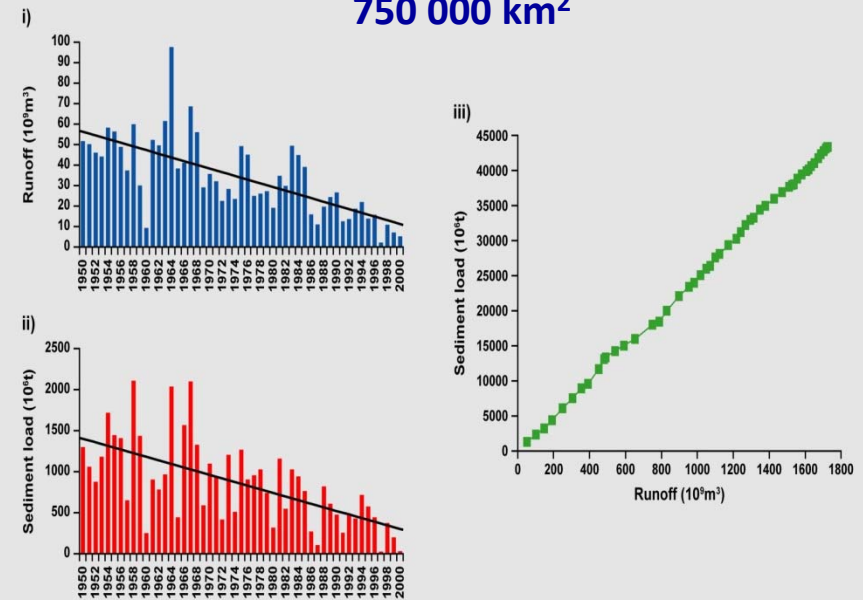
International
Hydrological
Programme



The Evidence

Yellow River

Yellow River at Lijin, China, 1950 - 2000
750 000 km²



CAUSES OF REDUCED SEDIMENT LOAD

Wang et al. (2006)

Soil Erosion	40%
Climate Change	30%
Reservoir Trapping	30%

Des Walling, 2008



Water pollution: Degradation of water quality





World Cities exceeding 5 million residents

1950

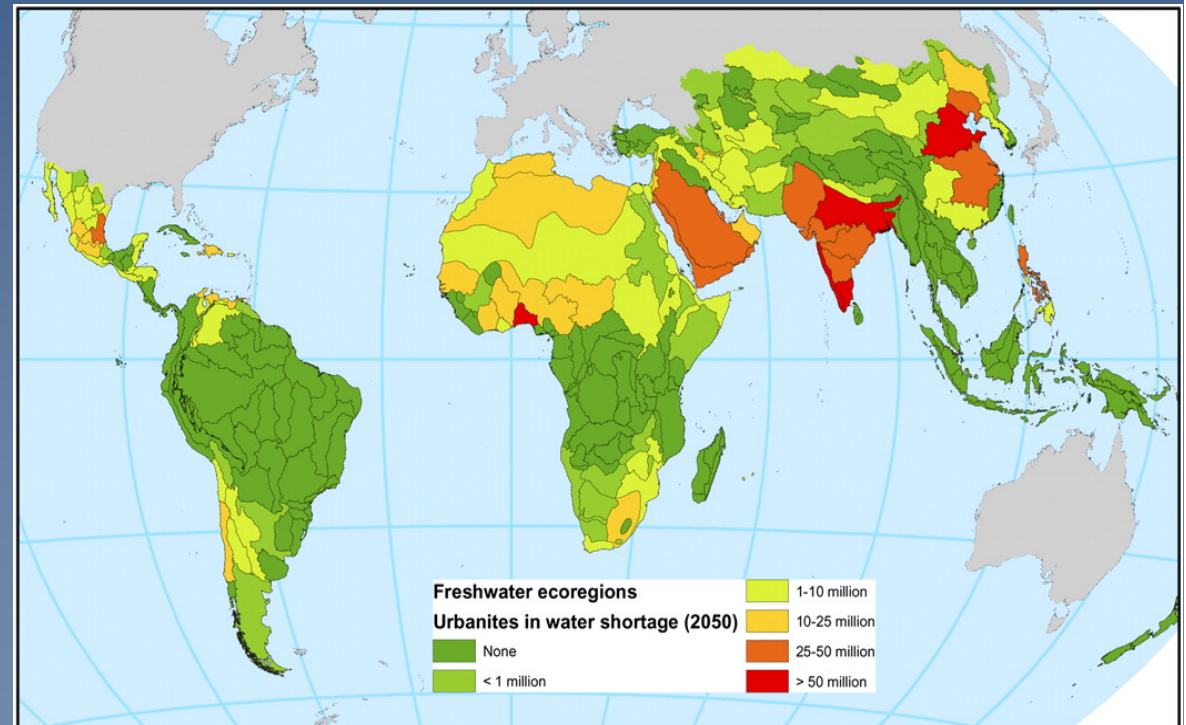


Source: U.N.
Population
Division



Impact on Urban Water Supplies & Systems

- Shortage in urban water supplies
- Damage to infrastructure caused by flooding
- Less reliable water resource base
- Increase in water temperature and pH
- Higher water purification costs





Mountain Glaciers

IMPACTS

- Vulnerable and sensitive ecosystems
- Diverse ecosystems and habitats at all latitudes
- Important for livelihoods & ecosystem services
- Excellent sites to study and monitor global change and its impacts

ADAPTATION STRATEGIES

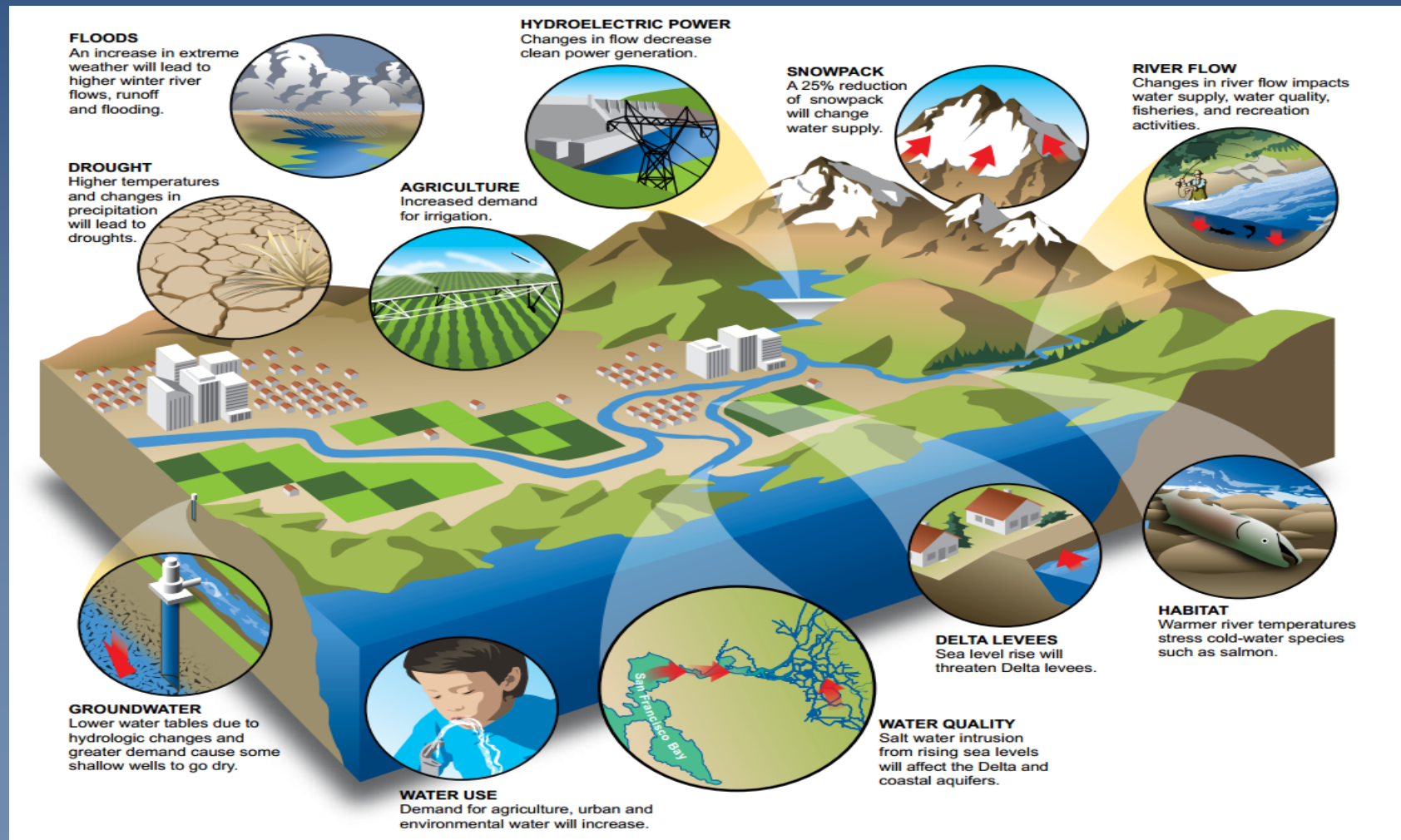
- Shifting away from hydroelectric power
- Hazard mapping to alert for landslides, avalanches, and floods



South Cascade Glacier

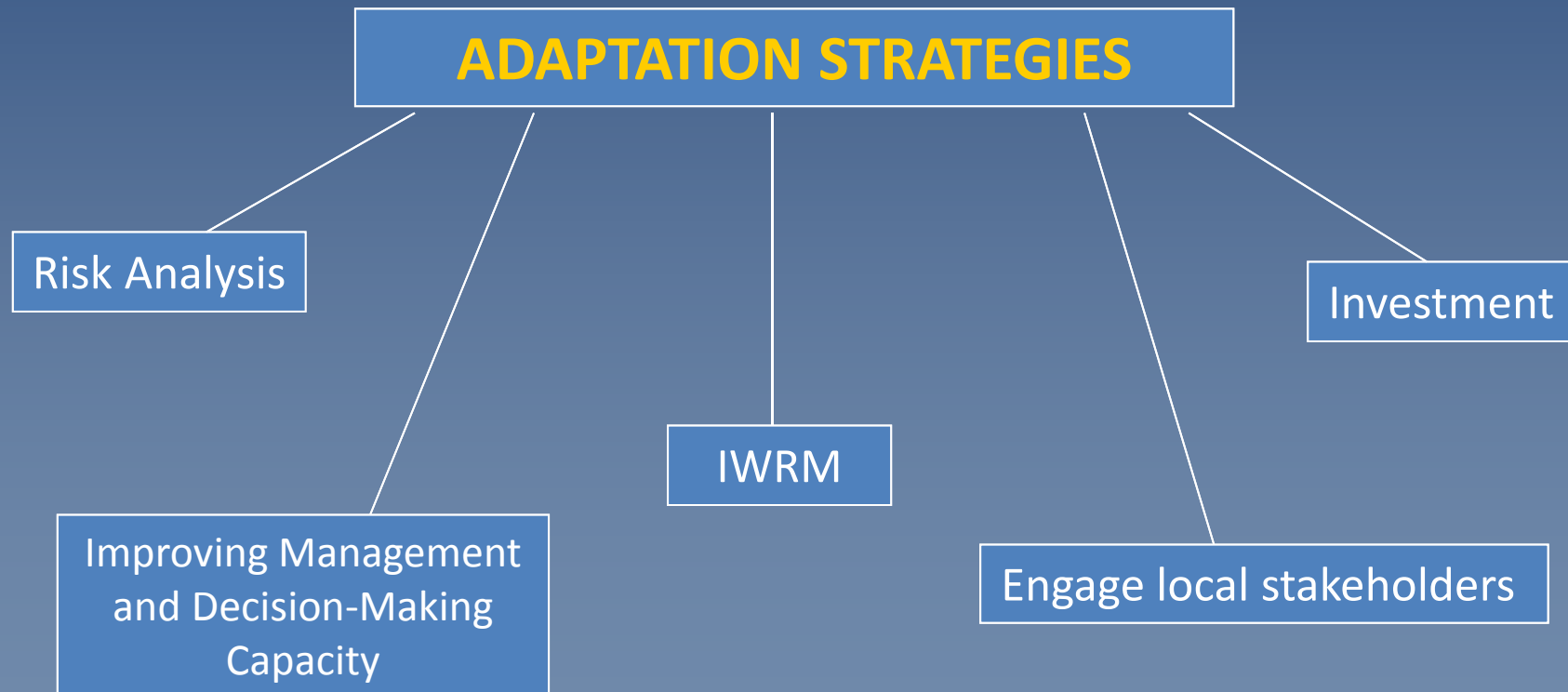


Climate change impact in a basin





Adaptation Strategies - general plan of action for addressing the impacts of climate change, including climate variability and extremes. It will include a mix of policies and measures with the overarching objective of reducing the country's vulnerability





IWRM Components



Principles

Economic Efficiency

Equity

Environmental Sustainability

Structure

Management Instruments

- Assessment
- Information
- Allocation Instruments

Enabling Environment

- Policies
- Legislation

Institutional Framework

- Central - Local
- River Basin
- Public - Private

Balance “**water for livelihood**” and “**water as a resource**”

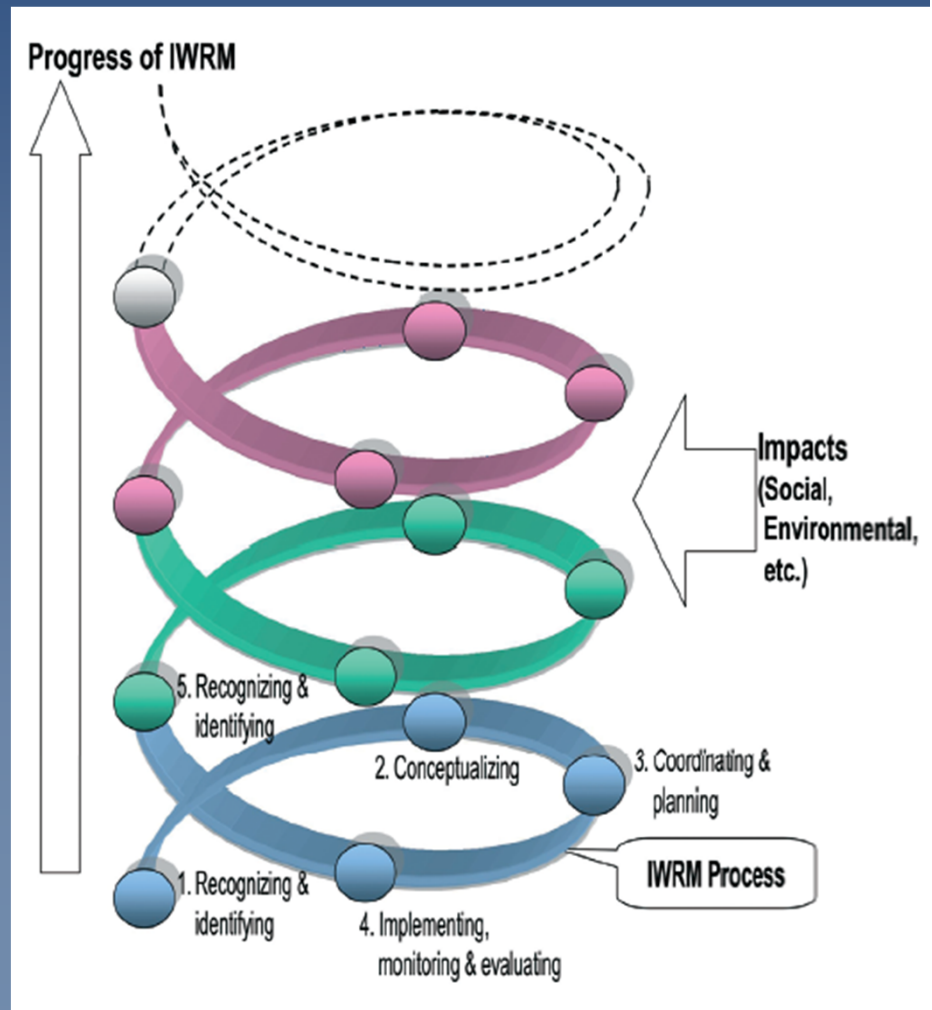


Integrated Water Resources Management (IWRM)

- IWRM - a process which promotes the coordinated development and the management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems

Processes

- Phase 1: Recognizing & Identifying (determine pressing issues or needs)
- Phase 2: Conceptualizing (delineate the problem and find possible solutions)
- Phase 3: Coordinating & detail planning (work with stakeholders to reach an agreement)
- Phase 4: Implementing, monitoring & evaluation (carry out the plan and study its outcome)



Urban Water Adaptation Strategies

- Need for long-term planning to deal with weather variability and uncertainty of water resources
- Need to adopt adaptation measures and adaptive management
- Improve operational performance of existing infrastructure
- Reduce water demand

Examples of potential effects of climate change at the urban level

Climate hazard: Decreased precipitation
 Impact: Water scarcity
 Vulnerable system: Urban green space
 How this could affect a city: Reduced biodiversity and ecosystem services

Climate hazard: Decreased precipitation
 Impact: Water scarcity
 Vulnerable system: Human health
 How this could affect a city: Malnutrition and increase in waterborne diseases

Climate hazard: Higher temperatures
 Impact: Increase in bacterial and fungal content of water
 Vulnerable system: Water supply infrastructure
 How this could affect a city: Increase in treatment requirements to remove odour and taste

Climate hazard: Increased heavy precipitation
 Impact: Flooding
 Vulnerable system: Transportation
 How this could affect a city: Damage to transport infrastructure

Climate hazard: Decreased precipitation
 Impact: Water scarcity
 Vulnerable system: Food production
 How this could affect a city: Reduced availability of irrigation water and yield decreases

Climate hazard: Higher temperatures
 Impact: Reduced water oxygen concentrations and altered mixing
 Vulnerable system: Water supply (lakes/reservoirs)
 How this could affect a city: Reduced water quality for example through algal blooms, increase in treatment requirements

Climate hazard: Increased heavy precipitation
 Impact: Increased erosion and sediment transport
 Vulnerable system: Water supply (reservoirs)
 How this could affect a city: Sedimentation and decrease in water storage capacity and turbidity increase



Climate hazard: Decreased precipitation
 Impact: Reduced streamflow
 Vulnerable system: Energy supply
 How this could affect a city: Disruption of thermal power plant cooling processes

Climate hazard: Sea level rise
 Impact: Storm surges, flooding
 Vulnerable system: All
 How this could affect a city: Damage to all coastal infrastructure

Climate hazard: Higher temperatures
 Impact: Snow and ice cover change
 Vulnerable system: Water supply (rivers)
 How this could affect a city: Change in peak flow timing and magnitude

Climate hazard: Sea level rise
 Impact: Saltwater intrusion into coastal aquifers
 Vulnerable system: Water supply (groundwater)
 How this could affect a city: Salinisation of groundwater, abandonment of source

Climate hazard: Increased heavy precipitation
 Impact: Flooding
 Vulnerable system: Wastewater
 How this could affect a city: Flooding of facilities causing damage and contamination of water bodies

Climate hazard: Decreased precipitation
 Impact: Reduced streamflow
 Vulnerable system: Food production
 How this could affect a city: Negative impact on coastal fisheries due to decreases in the outflow of sediment and nutrients

Image by: Loet van Moll - Illustraties
 Aalten, Netherlands | www.loetvanmoll.nl



Conclusion

- Lack of data both quality and quantity for many rivers and aquifers is a major constrain in assessing changes
- Changes we face are due to various drivers e.g. population growth, land use change, migration, urbanisation and climate change
- It is important to address current problems with current variability
- Use regional approach – not global. Develop adaptation strategies at the local level
- Little understanding of the storage and renewable groundwater resources, which will play a key role in future food production