Climate Change & World Water Problems: A Geographic Perspective

Climate Change: Science and Society
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“Water is Life” Decade

Millennium Development Goals:

End Poverty by 2015

Goal 1 End hunger and extreme poverty
Goal 2 Universal education
Goal 3 Gender equity
Goal 4 Improve child health
Goal 5 Improve maternal health
Goal 6 Combat HIV/AIDS, Malaria, TB
Goal 7: Ensure environmental sustainability
Goal 8: Develop global partnerships

Water and the MDGs

Water is fundamental to all 8 MDGs

Goal 7: Ensure environmental sustainability

Target 10:

To halve by 2015 the proportion of people without access to safe drinking water and basic sanitation

Global Water Picture

- More than 70% of the Earth's surface is covered with water
  - 97% of it is salty and in the oceans
  - 3% of the Earth's water is fresh
    - two-thirds stored in glaciers, polar caps, and snow
    - one-third stored in groundwater
    - 0.5% is surface water (lakes, streams, ponds, human created reservoirs)
- Mountains as watertowers: 50% of drinking water originates in mountainous areas

Global Water Consumption

- Global daily consumption = 1 trillion gallons (That's 1,000,000,000,000 gallons!)
- The world's demand for water is doubling every 20 years
- Predictions are that by 2015 nearly 3 billion people will live in countries that are water stressed

Critical Water Vulnerability Concerns:

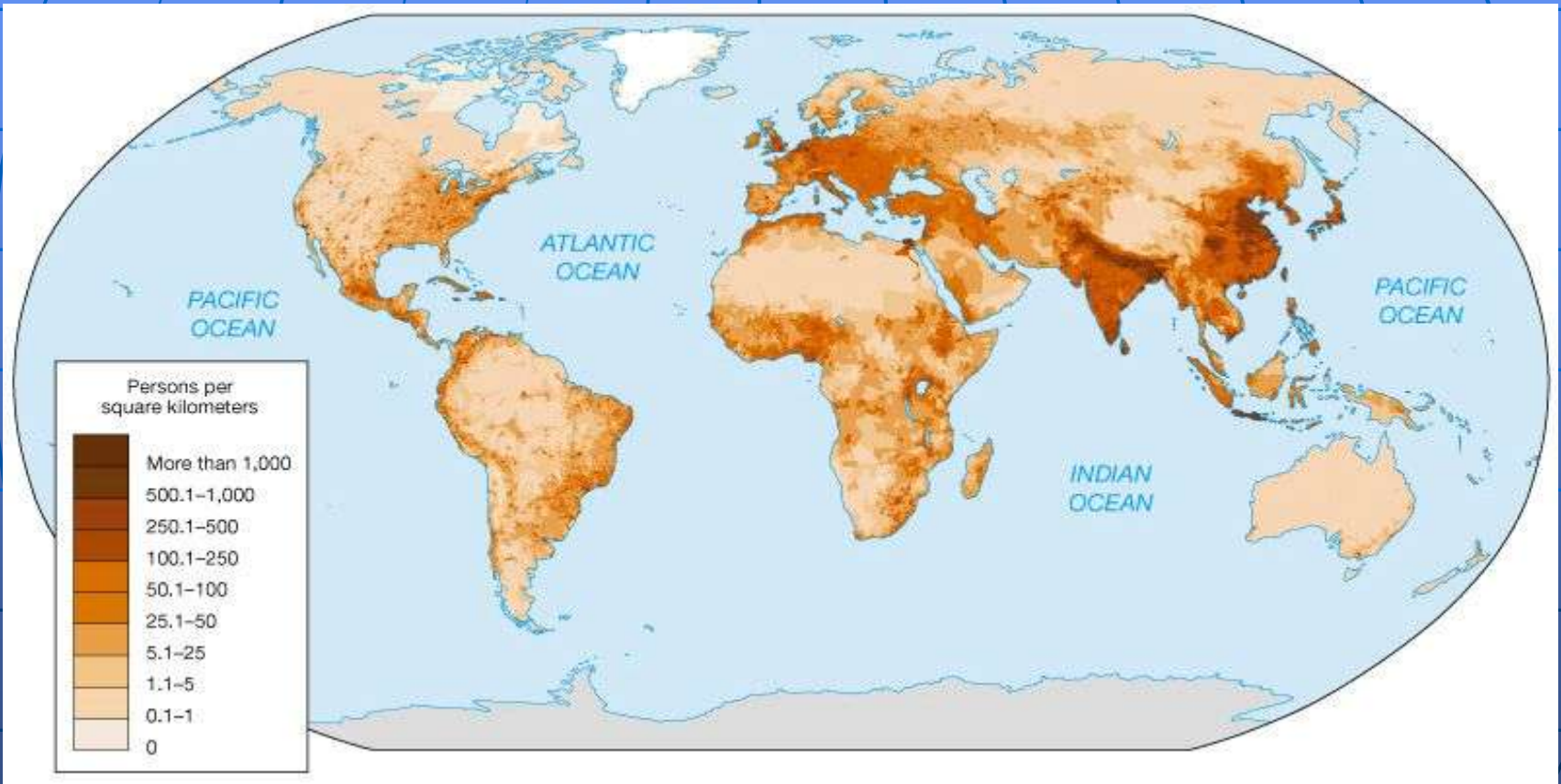
- Uncertainties: Growing demands
  - 1 billion + lack potable water and sanitation
- Inequities: Uneven Distribution, Control, Uses, Needs, Impacts
  - Example: 80% of diseases in developing world are water-related and preventable
- Unsustainabilities: Deteriorating water quantity and quality, degraded environmental health
- Unpredictabilities: climatic risks and long-term climate change

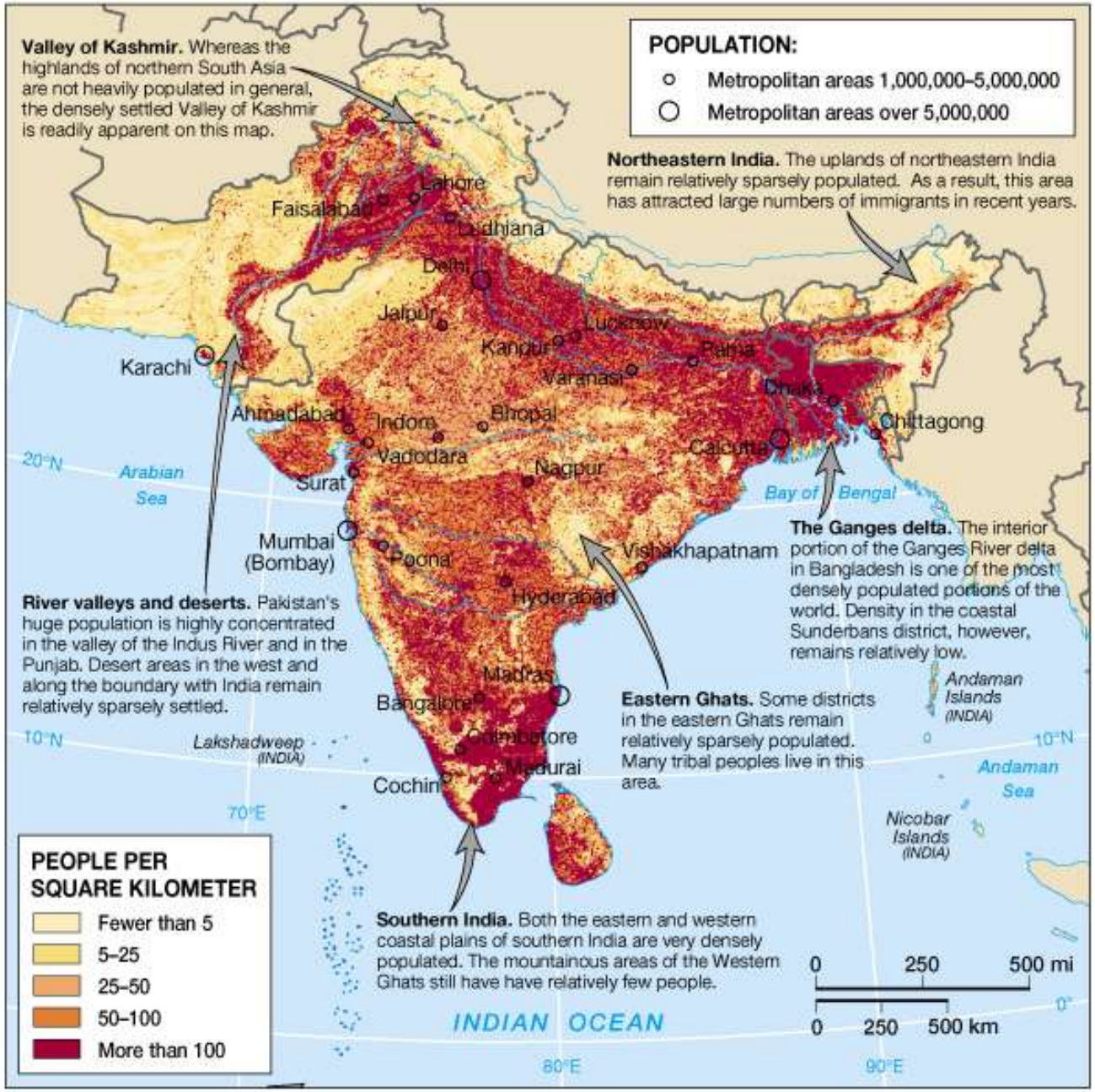
Our Urbanizing World

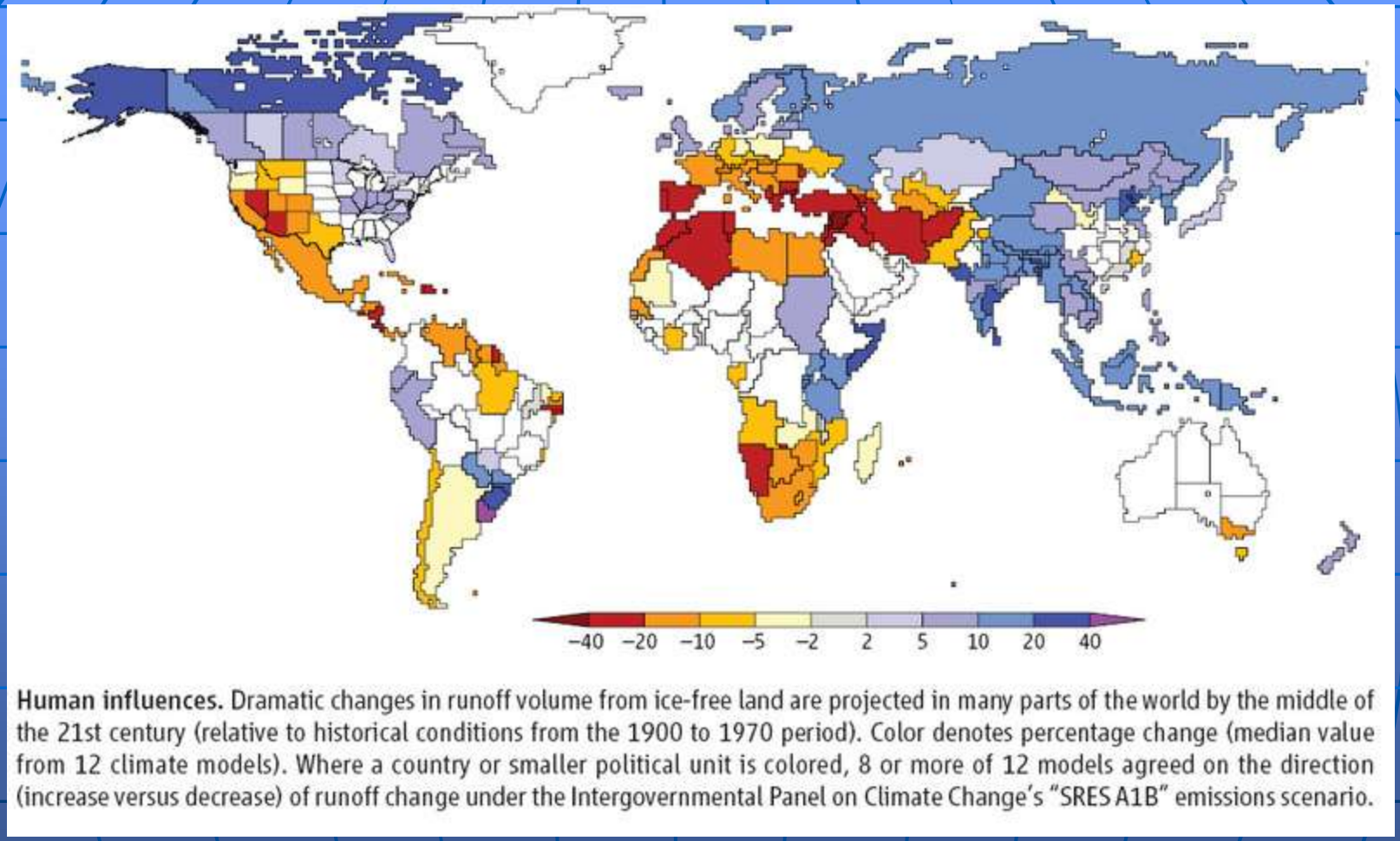
Approximately 51% of world's population is located in an urban setting

- Rapid migration (complex processes ~ economic and/or environmental conditions)
- High population densities
- Development of **megacities**
- Scenarios of **overurbanization**
  - Examples: Peri-urban areas/squatter settlements lacking water and sewer services

Water and the World's Population



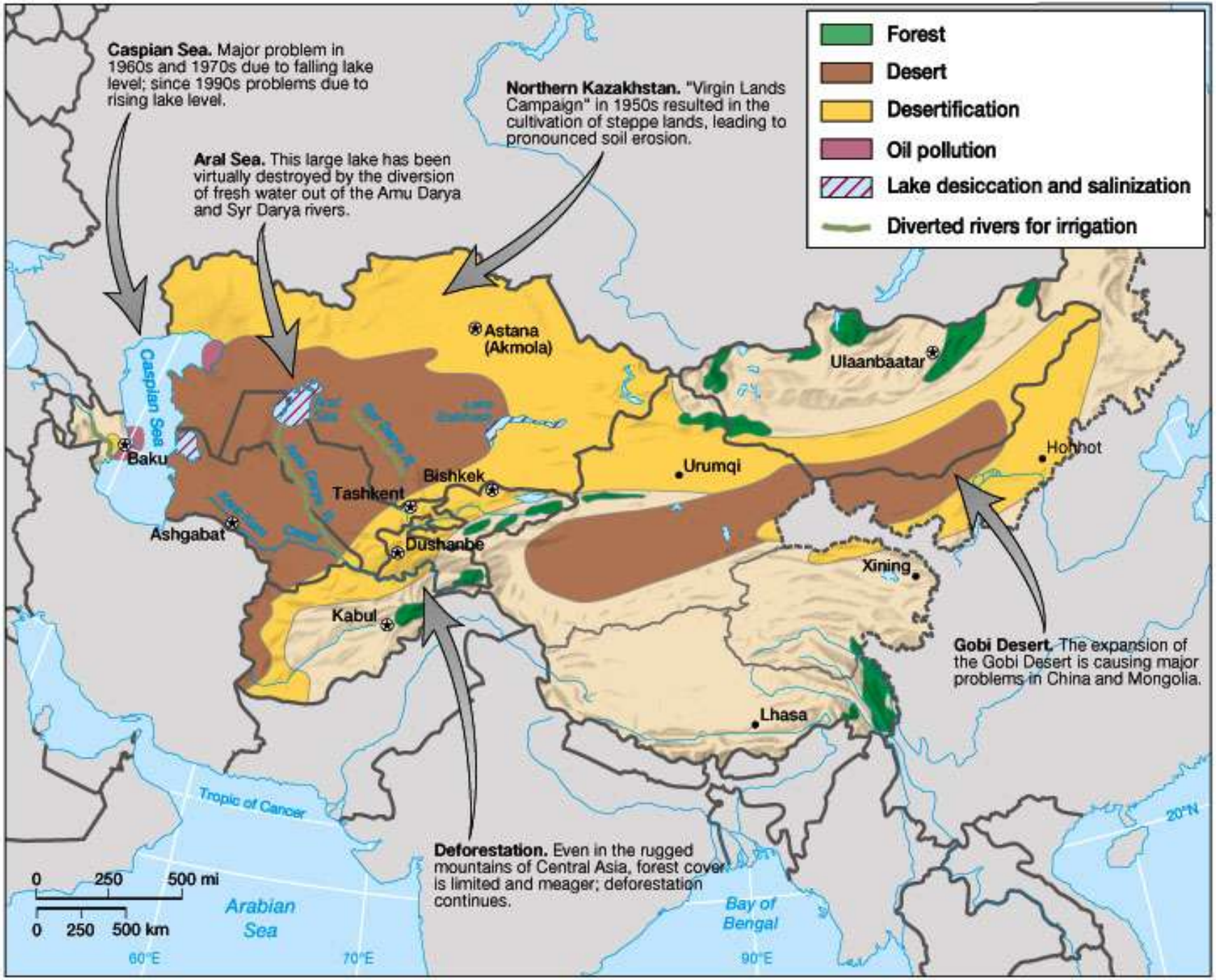

Valley of Kashmir. Whereas the highlands of northern South Asia are not heavily populated in general, the densely settled Valley of Kashmir is readily apparent on this map.
POPULATION:
Metropolitan areas 1,000,000–5,000,000
Metropolitan areas over 5,000,000
Northeastern India. The uplands of northeastern India remain relatively sparsely populated. As a result, this area has attracted large numbers of immigrants in recent years.
Lahore
Faisalabad
Ludhiana
Delhi
Jaipur
Lucknow
Kanpur
Patna
Karachi
Varanasi
Dhaka
Ahmadabad
Indore
Bhopal
Chittagong
Vadodara
Calcutta
20°N
Arabian Sea
Surat
Nagpur
Bay of Bengal
Mumbai (Bombay)
Poona
Vishakhapatnam
The Ganges delta. The interior portion of the Ganges River delta in Bangladesh is one of the most densely populated portions of the world. Density in the coastal Sunderbans district, however, remains relatively low.
River valleys and deserts. Pakistan's huge population is highly concentrated in the valley of the Indus River and in the Punjab. Desert areas in the west and along the boundary with India remain relatively sparsely settled.
Hyderabad
Madras
Andaman Islands (INDIA)
Bangalore
Eastern Ghats. Some districts in the eastern Ghats remain relatively sparsely populated. Many tribal peoples live in this area.
10°N
Lakshadweep (INDIA)
Coimbatore
Madurai
Andaman Sea
Cochin
70°E
Nicobar Islands (INDIA)
PEOPLE PER SQUARE KILOMETER
Fewer than 5
5–25
25–50
50–100
More than 100
Southern India. Both the eastern and western coastal plains of southern India are very densely populated. The mountainous areas of the Western Ghats still have have relatively few people.
0 250 500 mi
0 250 500 km
INDIAN OCEAN
80°E
90°E



Human influences. Dramatic changes in runoff volume from ice-free land are projected in many parts of the world by the middle of the 21st century (relative to historical conditions from the 1900 to 1970 period). Color denotes percentage change (median value from 12 climate models). Where a country or smaller political unit is colored, 8 or more of 12 models agreed on the direction (increase versus decrease) of runoff change under the Intergovernmental Panel on Climate Change's "SRES A1B" emissions scenario.

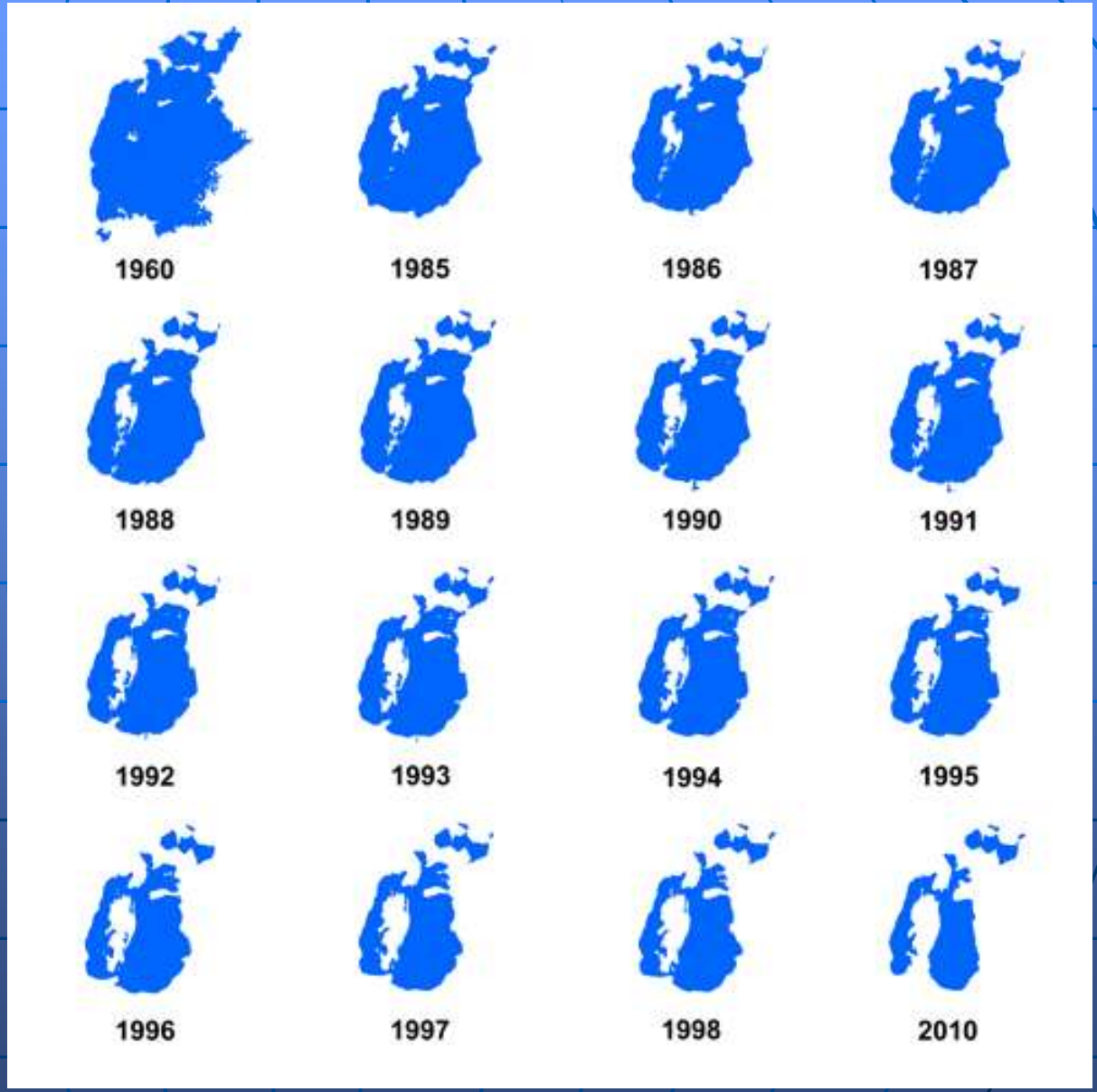
Source: Milly et al., 2008. Stationarity is Dead: Whither Water Management, *Science*, 319: 573-574


Trinitron


Forest
Desert
Desertification
Oil pollution
Lake desiccation and salinization
Diverted rivers for irrigation
Caspian Sea. Major problem in 1960s and 1970s due to falling lake level; since 1990s problems due to rising lake level.
Aral Sea. This large lake has been virtually destroyed by the diversion of fresh water out of the Amu Darya and Syr Darya rivers.
Northern Kazakhstan. "Virgin Lands Campaign" in 1950s resulted in the cultivation of steppe lands, leading to pronounced soil erosion.
Astana (Akmola)
Ulaanbaatar
Hohhot
Urumqi
Baku
Caspian Sea
Tashkent
Bishkek
Ashgabat
Dushanbe
Xining
Kabul
Lhasa
Gobi Desert. The expansion of the Gobi Desert is causing major problems in China and Mongolia.
Deforestation. Even in the rugged mountains of Central Asia, forest cover is limited and meager; deforestation continues.
Tropic of Cancer
20°N
0 250 500 mi
0 250 500 km
Arabian Sea
Bay of Bengal
60°E
70°E
90°E

(Source: http://www.cawaterinfo.net/photolibrary/index_e.htm)

Chronology of the Dessication of the Aral Sea



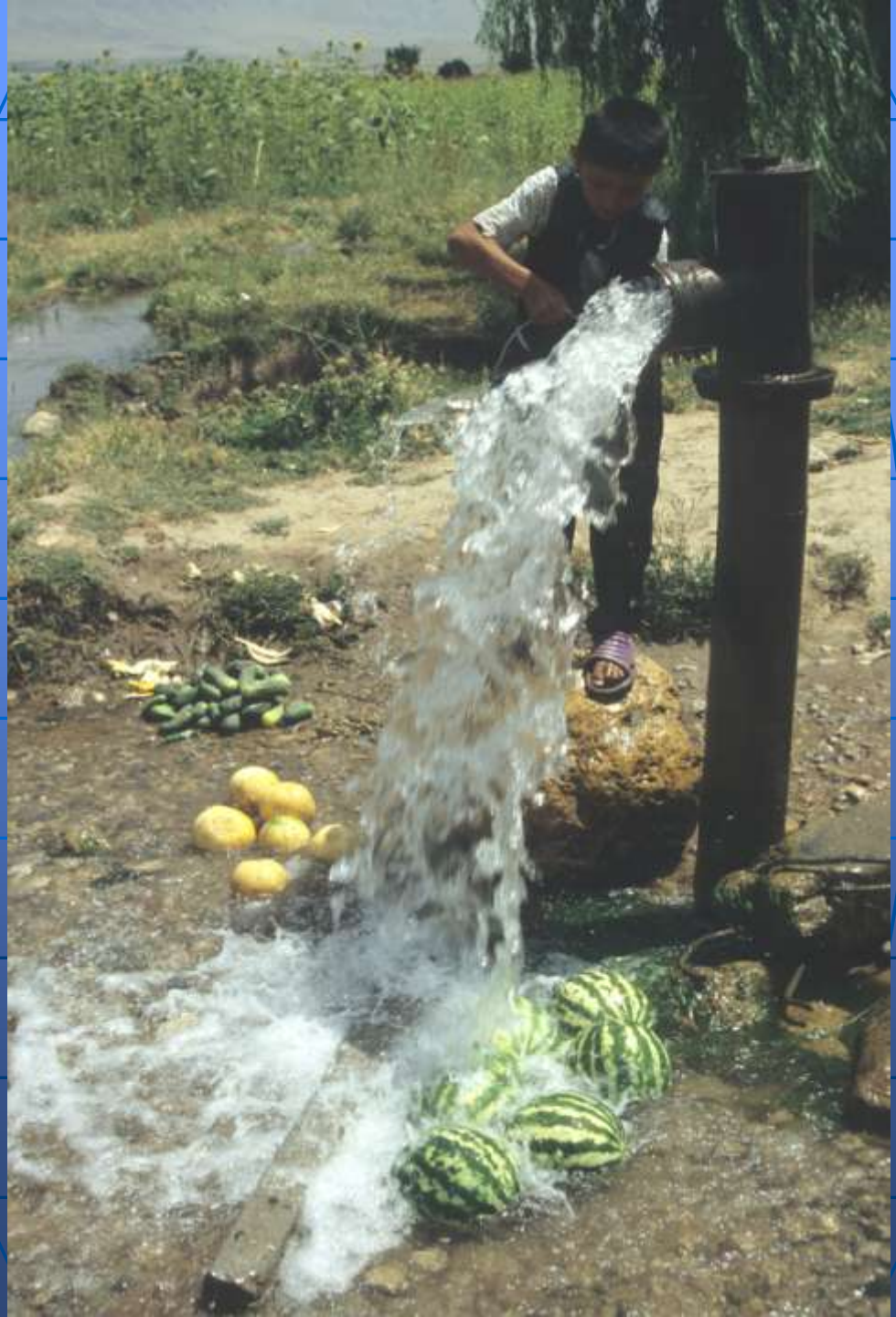
(Source: http://www.cawater-info.net/aral/)

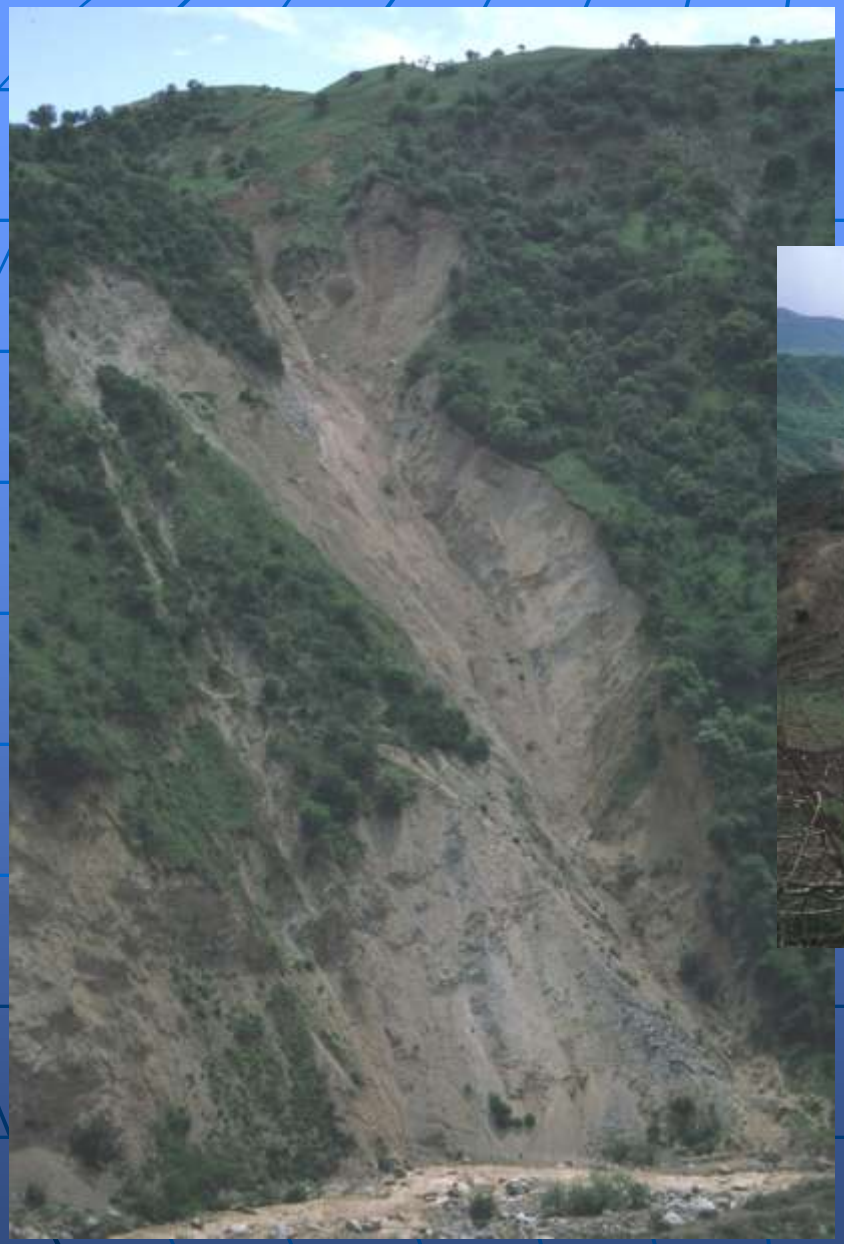
(Source: *National Geographic Society*)


0 500 1,000 mi
0 500 1,000 km
RUSSIA
Ob R.
Volga R.
Ural R.
Steppes
Astana (Akmola)
KAZAKHSTAN
Caspian Sea
Aral Sea
Syr Darya R.
Lake Balkhash
Ili R.
Kara-Bogaz Gol
Kyzyl Kum Desert
Fergana Valley
Bishkek
KYRGYZSTAN
UZBEKISTAN
Amu Darya R.
Kara Kum Desert
Kara Kum Canal
Tashkent
Dushanbe
TURKMENISTAN
Ashkhabad
Caucasus
GEORGIA
ARMENIA
Baku
AZERBAIJAN
TAJIKISTAN
Pamir Knot
Hindu Kush
AFGHANISTAN
Kabul
Khyber Pass
Indus R.
IRAN
IRAQ
KUWAIT
QATAR
U.A.E.
SAUDI ARABIA
OMAN
YEMEN
PAKISTAN
Tropic of Cancer
Arabian Sea
60° E
Altai Mountains
Steppes
Ulaanbaatar
MONGOLIA
Gobi Desert
XINJIANG
Tian Shan
Turfan Depression
Junggar Basin
Tarim R.
Taklamakan Desert
Altun Shan
Kunlun Shan
Tsaidam Basin
QINGHAI
Karakoram Range
Tibetan Plateau
TIBET (XIZANG)
HIMALAYAS
Yangtze R.
Mekong R.
Brahmaputra R.
NEPAL
BHUTAN
Ganges R.
INDIA
BANGLADESH
Bay of Bengal
BURMA (MYANMAR)
VIET-NAM
LAOS
THAILAND
CHINA
90° E
Tibetan Plateau
Highlands
Steppe Zone
Desert
Important rivers of desert zone

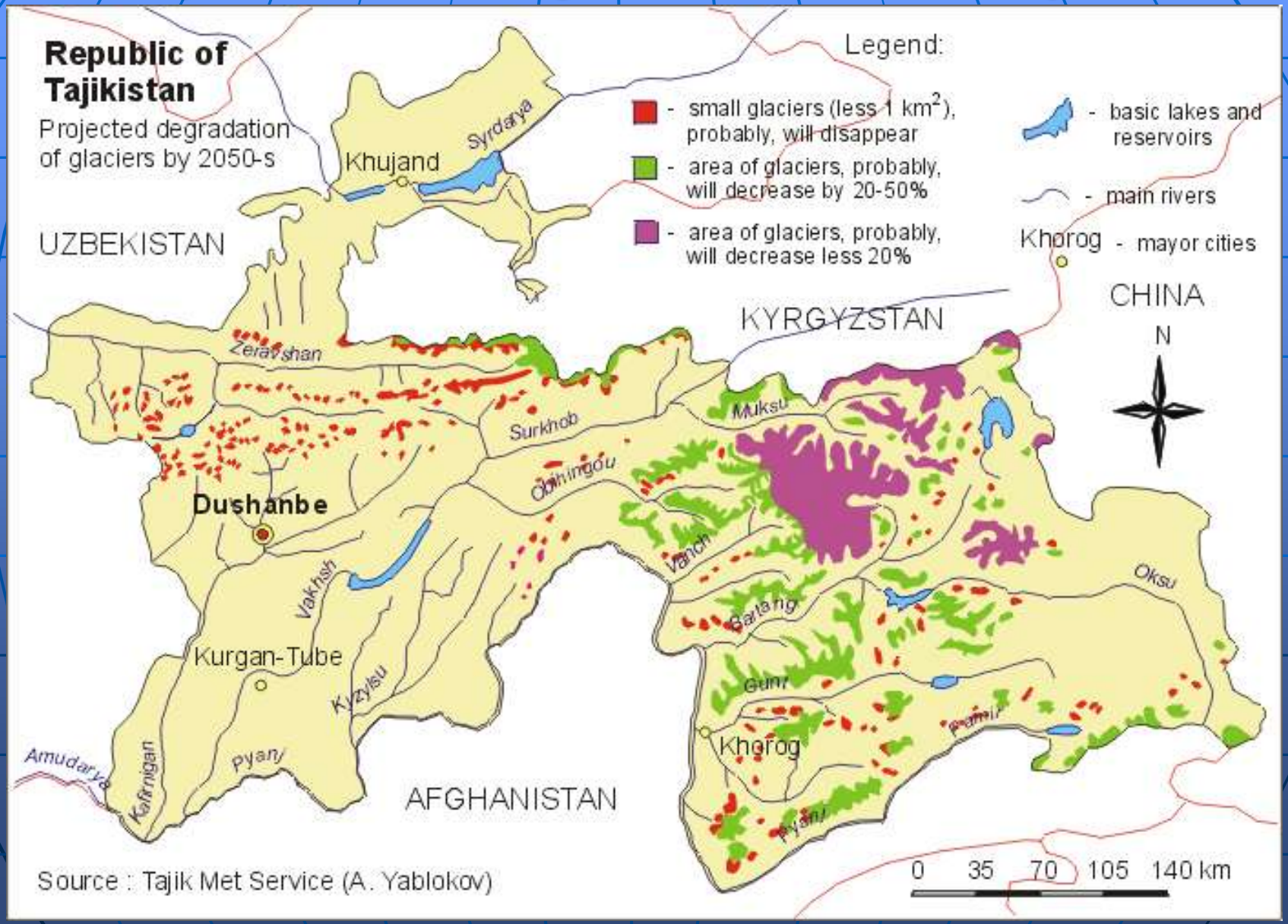
Water Resource Issues in High Asia

- High elevation snow, ice, glaciers
- Irrigation accounts for over 80% of all diverted freshwater
- Most domestic water sector relies on surface water (springs, streams, rivers, canals, etc)
- Human dimensions of glacial recession



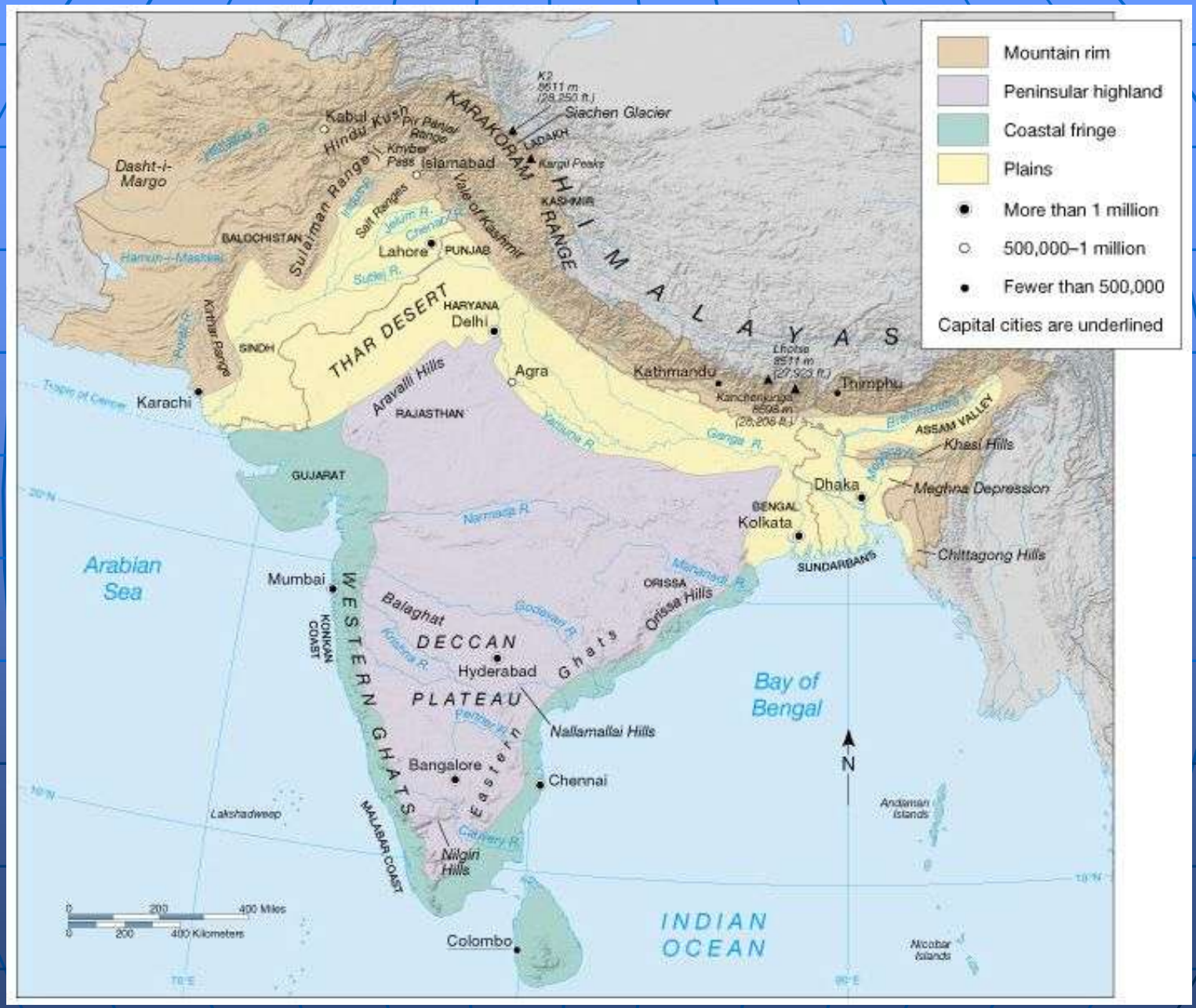


Projected Melting of Glaciers ~ Tajikistan



Ongoing Water-Health-Related Problems

- Unsafe/contaminated drinking water
- Inadequate sanitation
- Severe water shortages
- Waterborne and water-washed diseases
  - Diarrhea, dysentery, hepatitis A, typhoid, malaria
- Industrial and agricultural pollution
  - Heavy metals, nitro-organic compounds
- Groundwater contamination
- Hydropower Development


Mountain rim
Peninsular highland
Coastal fringe
Plains
More than 1 million
500,000–1 million
Fewer than 500,000
Capital cities are underlined
Kabul
Hindu Kush
Dasht-i-Margo
Khyber Pass
Islamabad
KARAKORAM
K2 8611 m (28,250 ft.)
Siachen Glacier
LADAKH
Kargil Peaks
KASHMIR
HIMALAYAS
Vale of Kashmir
Sulaiman Range
Indus R.
Salt Ranges
Jhelum R.
Chenab R.
BALOCHISTAN
Lahore
PUNJAB
Hamun-i-Mashkel
Sutlej R.
Kirthar Range
Pab R.
SINDH
THAR DESERT
HARYANA
Delhi
Agra
Aravalli Hills
RAJASTHAN
Karachi
Tropic of Cancer
Kathmandu
Lhotse 8511 m (27,923 ft.)
Kanchenjunga 8598 m (28,208 ft.)
Thimphu
Brahmaputra R.
ASSAM VALLEY
Khasi Hills
Yamuna R.
Ganga R.
Meghna Depression
Dhaka
BENGAL
Kolkata
GUJARAT
Narmada R.
Chittagong Hills
SUNDARBANS
Arabian Sea
Mumbai
Mahanadi R.
ORISSA
Orissa Hills
Balaghat
Godavari R.
KONKAN COAST
WESTERN GHATS
DECCAN PLATEAU
Krishna R.
Ghats
Hyderabad
Bay of Bengal
Eastern Ghats
Nallamallai Hills
Bangalore
Chennai
N
Andaman Islands
Lakshadweep
MALABAR COAST
Cauvery R.
Nilgiri Hills
0 200 400 Miles
0 200 400 Kilometers
Colombo
INDIAN OCEAN
Nicobar Islands

Implications for Research & Collaboration

- Undertake water vulnerability assessments;
- Examine local participation in water planning and reforms;
- Comparative studies on indigenous water ethics and approaches to conservation;
- Low-cost, practical alternative technologies
- Monitoring of trends in socio-hydrological conditions throughout major basins

Ongoing Issues & Challenges

- Economic crisis
- Deteriorating infrastructure
- Commodification of water
- Gendered livelihood transformations
- Deforestation, soil erosion, long-term denudation of watersheds
- Drought and flooding
- Climate variability and change
- Human dimensions of glacial retreat
- Water shortages driving migrations

What actions can we take?

- Inventory of adaptation strategies & resiliencies
- Grassroots/civil society participation

What actions can we take?

- Improve monitoring and forecasting capabilities for glacial regions in Central Asia
- Regional water vulnerability mapping and dialogue