Climate Risk Adaptation and Mitigation in India: Role of Reservoirs and Hydropower

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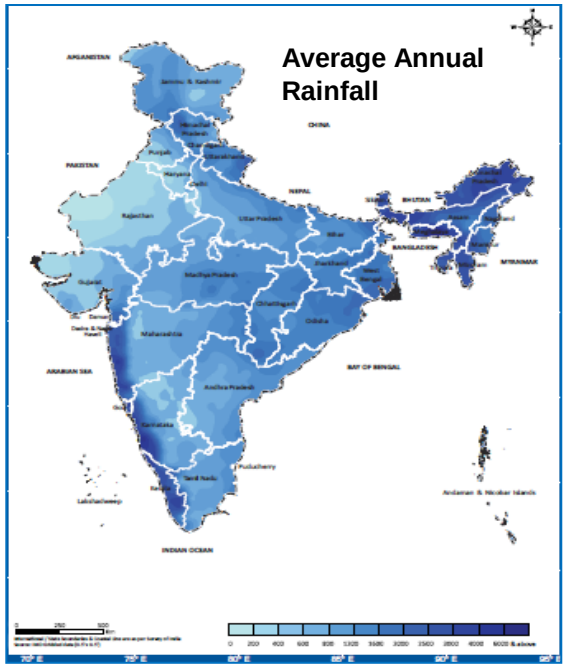
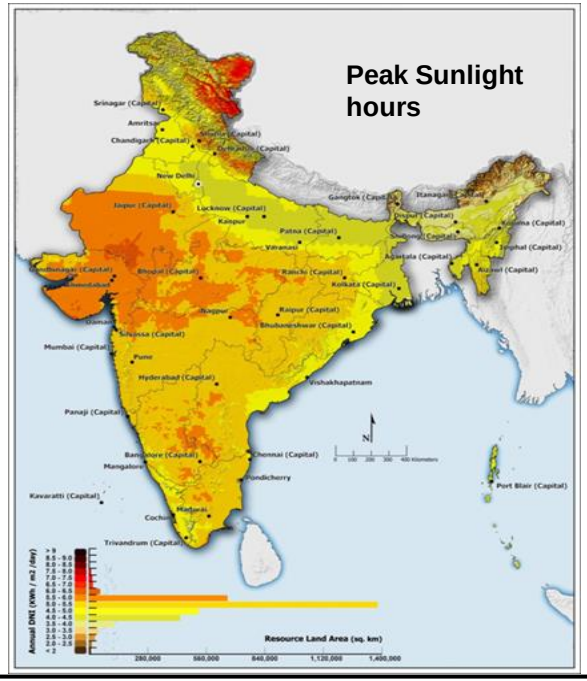
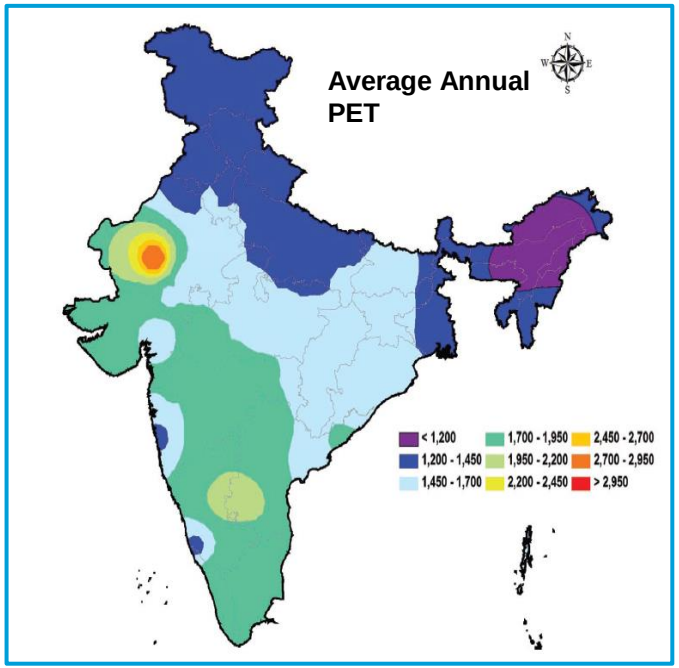
Climate Variability and Water Demand







Regions with low rainfall, have high solar irradiance and potential evapo-transpiration (PET), and high water demand

Maps Source: GoI

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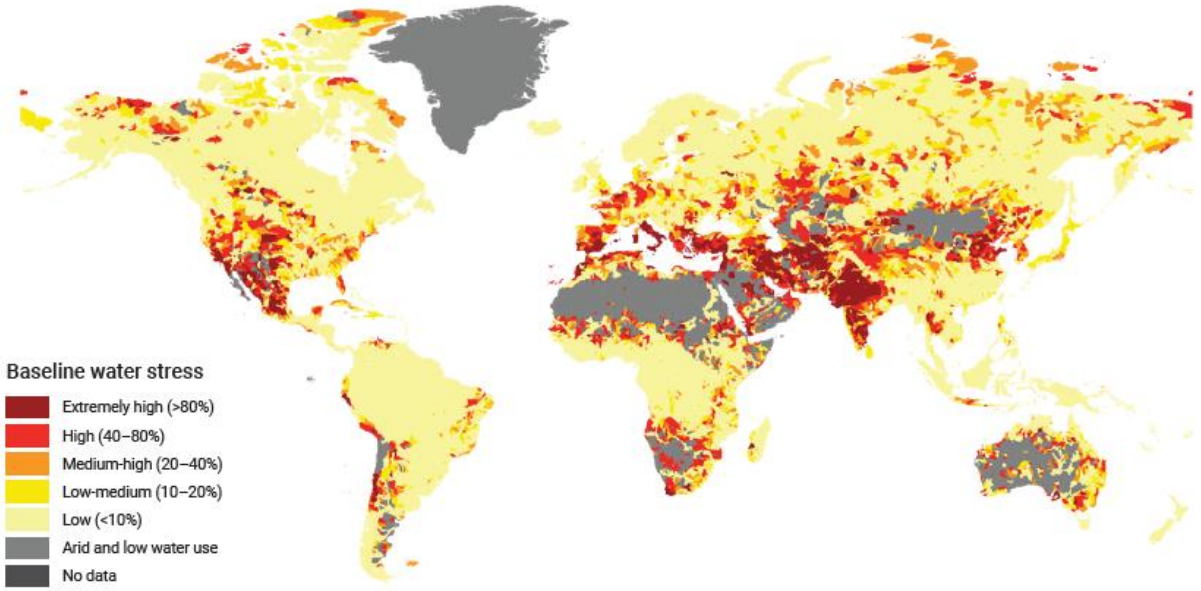
Water Stress- Annual Water Withdrawals/Renewable Water Supply

In India, the water demand will increase to 1,180 billion cubic metres (BCM) by 2050.

Average annual utilizable is about 1,123 BCM.

Large parts in western and peninsular India are already experiencing water stress



Source: WRI, 2019 and GoI, 1999

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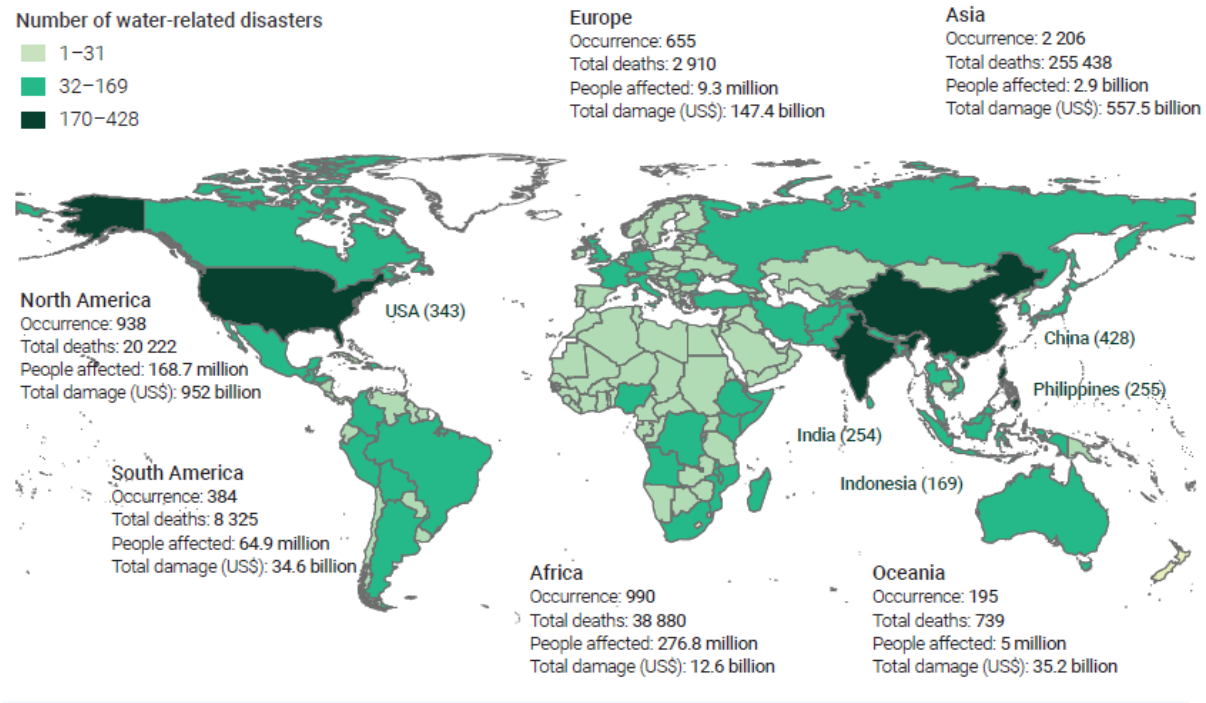
Climate-induced Hydrological Changes in India: As Per IPCC AR6

- Global surface temperature was 1.09°C higher for 2011–2020 than 1850–1900, mainly due to greenhouse gases emissions from the human activities.
- Both the intensity of heavy precipitation (especially in coastal areas) and the length of the dry spell have increased in the Indian sub-continent.
- Global terrestrial annual ET has increased since the early 1980s, driven by the climate-induced increasing atmospheric water demand, and vegetation greening.
- In parts of southern India, the ET has been increasing by up to 100 mm/year.
- As a result of rainfall and ET changes along with land-use changes in the catchment, the river flow has been altered--decreased in most of the river basins.

Water-related Disasters, 2001-2018



In India, frequency of occurrence of weather related events have increased post 2005

Post 2005, the yearly average of number of districts affected by floods are 55 and by droughts are 79

Source: UN, 2020 and Mohanty, 2020

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Impact of Hydrological Changes in India: As Per IPCC AR6 Projections

- The Ganges and Brahmaputra basins are likely to see increased flooding. By 2050, 3.5 crore people could face annual coastal flooding.
- By 2050, 40% of the people will live with water scarcity.
- Paddy production will decrease by 10-30% and maize production by 25-70% by 2080 due to water stress under a temperature increase of 1° to 4°C.
- Coal power plants' annual usable capacity factor is likely to decrease due to water constraints under a 2°C global warming scenario.
- Urbanization and climate change driven urban heat island (UHI) effect will increase the domestic water demand substantially.
- Urban extent in drylands is expected to increase by 2030, exposing the cities population to drought risk.

India needs to secure its 'Water Future'

Multipurpose Dams

Climate Adaptation:

- Flood protection
- Provide water during the period of stress (lean season)

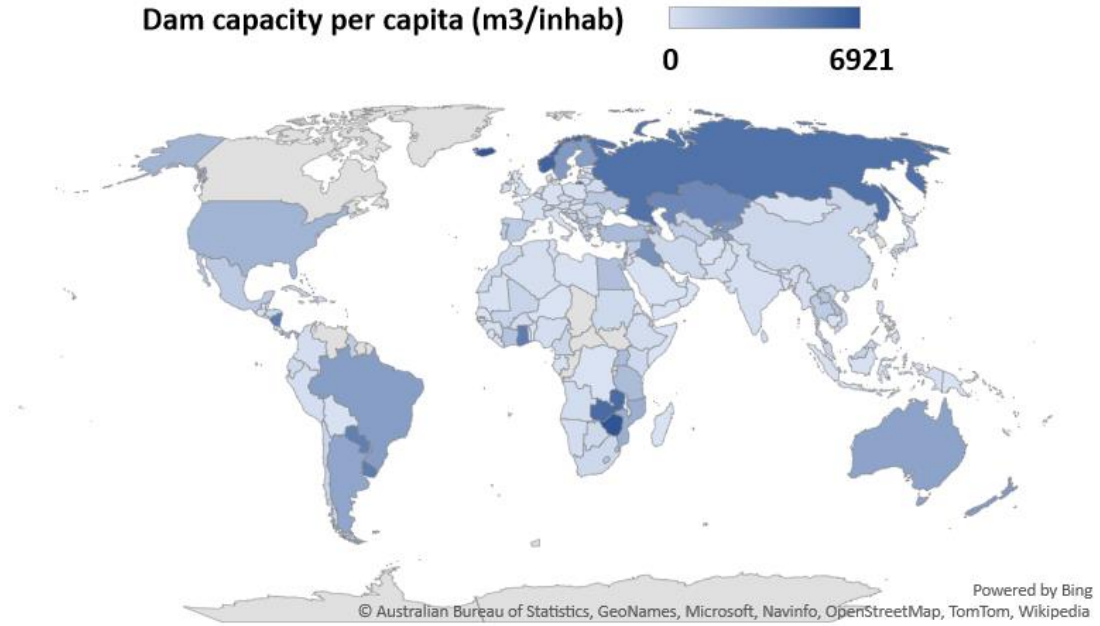
Climate Mitigation:

- Clean energy production- Hydropower
- Organic carbon burial in reservoirs sediments

Importance of Reservoirs in Climate Adaptation

- As of 2018, there are 5,334 completed large dams in India having a gross reservoir storage capacity of about 325 billion cubic metres (BCM).
- By the end of the 12th five-year plan, the irrigation potential utilised by developing reservoir-based irrigation projects was 46.5 million hectares.
- About 90% of the 33.6 BCM (2015) freshwater withdrawal for electricity generation in India is from the reservoirs.
- Many metropolitan cities such as Delhi, Bengaluru, Hyderabad, depend on reservoirs to meet their growing water demand.
- New rural water supply schemes are being increasingly planned on surface water sources on account of their reliability.
- Thus, reservoirs are important for the water, energy, food, and livelihood security in India.

Per Capita Dam Storage in India is Inadequately Low



Selected Countries	Per capita dam storage
India	183 cu m
South Africa	537 cu m
China	569 cu m
Spain	1,153 cu m
United States	2,250 cu m
Australia	3,124 cu m
Brazil	3,344 cu m
Russia	5,500 cu m

India needs more storage to better adapt to the climate-induced challenges in the future

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Dams in Climate Mitigation

- Hydroelectric plants are the cleanest low-carbon technology in terms of their carbon footprint over the full life cycle.
- The hydroelectric potential in India is 148.7 gigawatt (GW), as of January 2022, only 45 GW capacity has been installed.
- Considering its commitment to carbon-neutral growth, India needs to further exploit the hydropower potential.

2–13 g CO_2-eq/kWh of electricity production

15–53 g CO_2-eq/kWh of electricity production

20–38 g CO_2-eq/kWh of electricity production

26 g CO_2-eq/kWh of electricity production

35–88 g CO_2-eq/kWh of electricity production

Data Source: POST, 2011
Images: Zohuri & McDaniel, 2021

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Way Forward

- Climate variability and change are altering the hydrological systems and likely to have an adverse impact on water security in future.
- Dams offer climate adaptation and mitigation options to tide over risk that the communities may be exposed to.
- India needs to invest in creating more storages and further exploit the hydropower potential.
- Large dams do present a challenge of managing the economic, social, and environmental trade-offs.
- This is where alternate ways of water resources development are needed, it may include:
  - Developing run-of-the-river hydro-power projects that require very limited storage; and
  - Constructing off-stream reservoirs to not interfere with the river's natural flow.

Thank you

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For any suggestion or queries, please write to:

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