Water Energy Nexus and Need of Research

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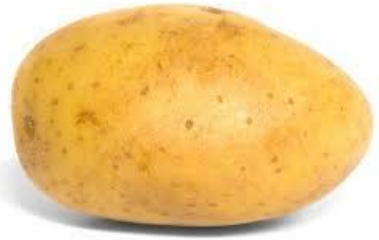
Q. How much water is needed to make a cup of tea?

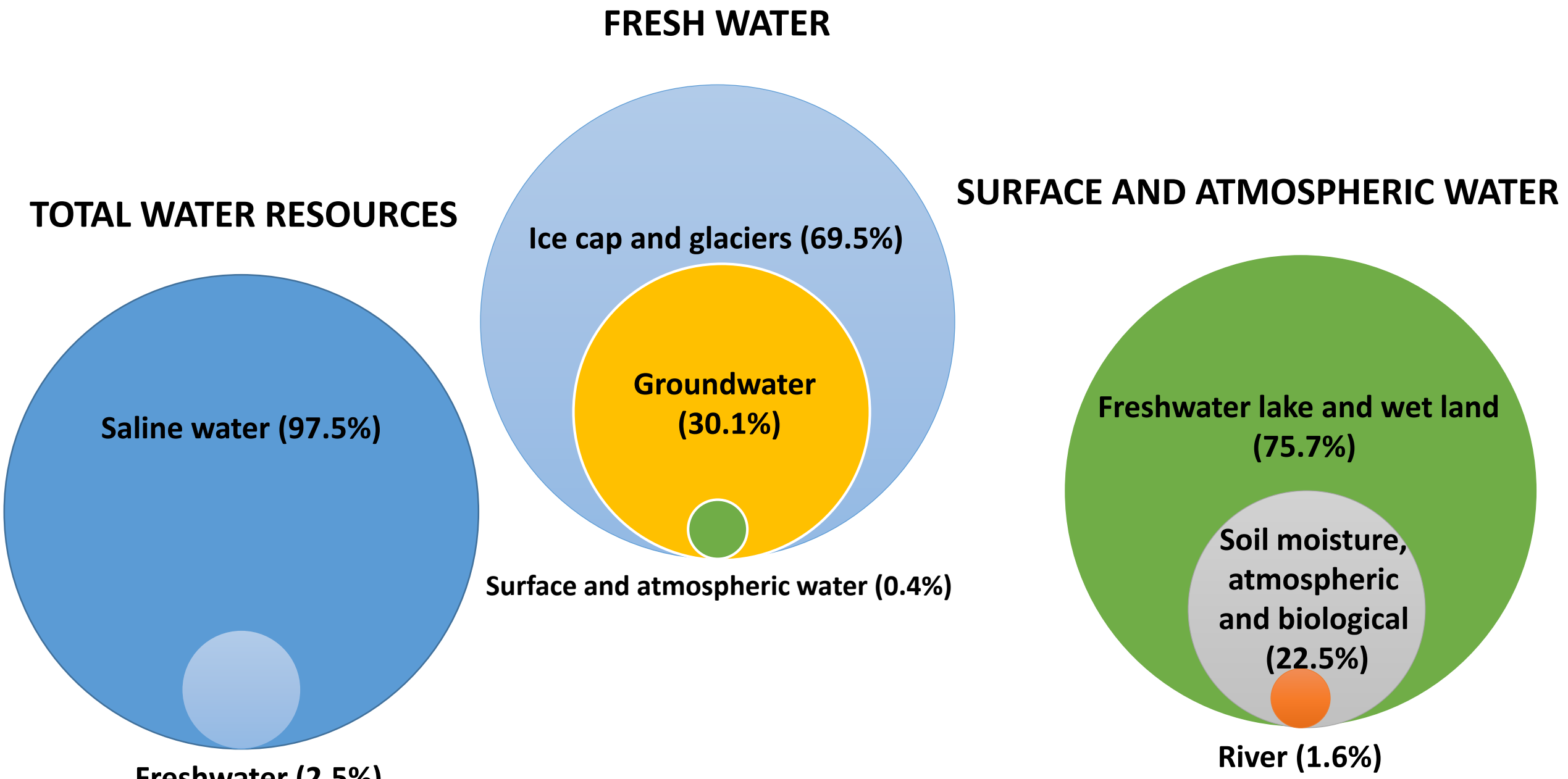
Ans. 27 litre per cup (250ml)

Q. How much water is needed to make a cup of coffee?

Ans. 132 litre per cup (125 ml)

1 glass of Milk	1 Apple	1 Orange	1 Potato
			
200 L	70 L	50 L	25 L

1 Pizza	1 Kg Chocolate	1 Kg of Rice	1 L of Bio-diesel (soybean)
			
1259 L	1260 L	2497 L	11397 L


FRESH WATER
TOTAL WATER RESOURCES
SURFACE AND ATMOSPHERIC WATER
Saline water (97.5%)
Freshwater (2.5%)
Ice cap and glaciers (69.5%)
Groundwater (30.1%)
Surface and atmospheric water (0.4%)
Freshwater lake and wet land (75.7%)
Soil moisture, atmospheric and biological (22.5%)
River (1.6%)

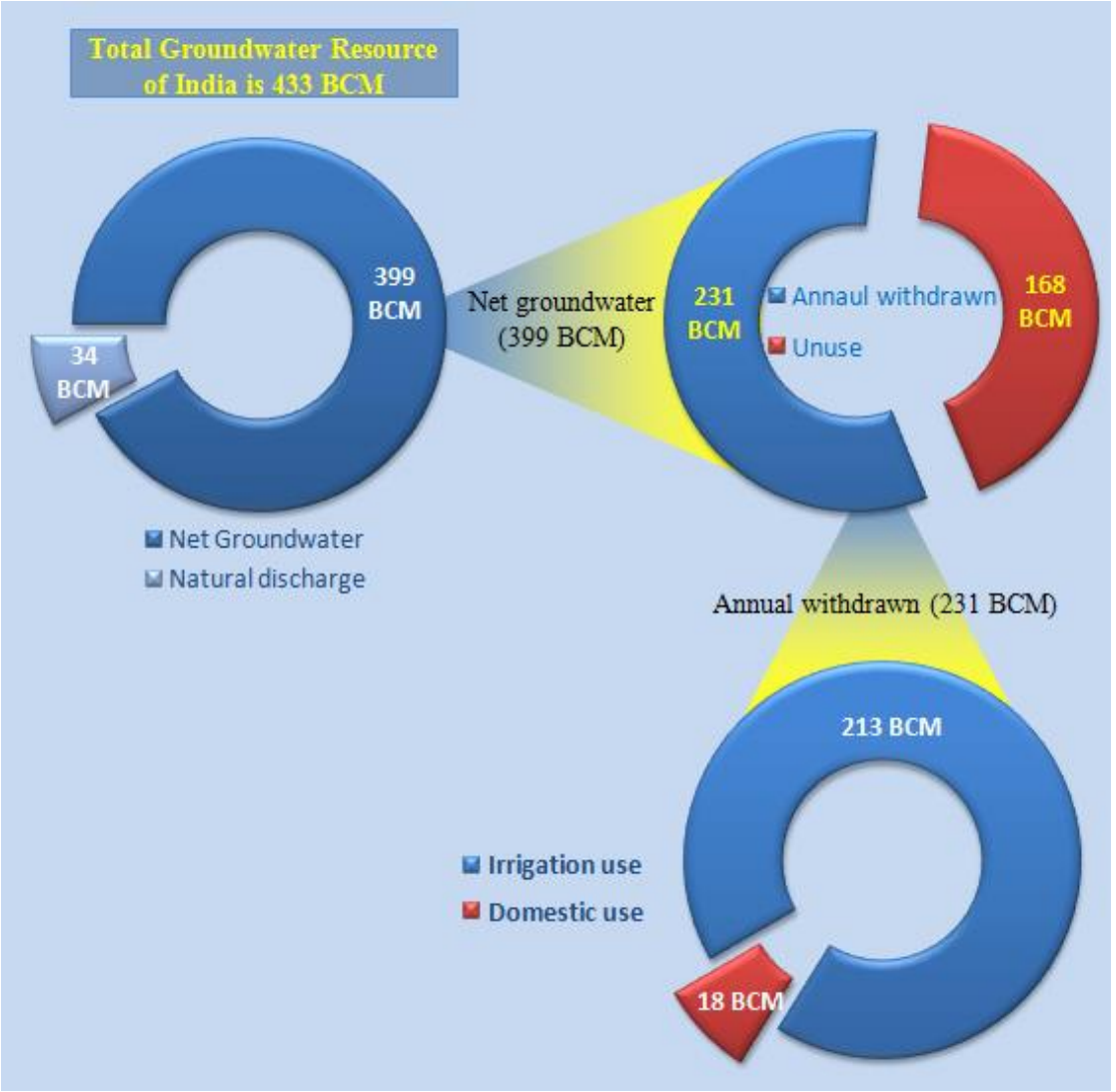
Amount of renewable water resources of INDIA

Surface Water: 1869 BCM

Groundwater: 433 BCM

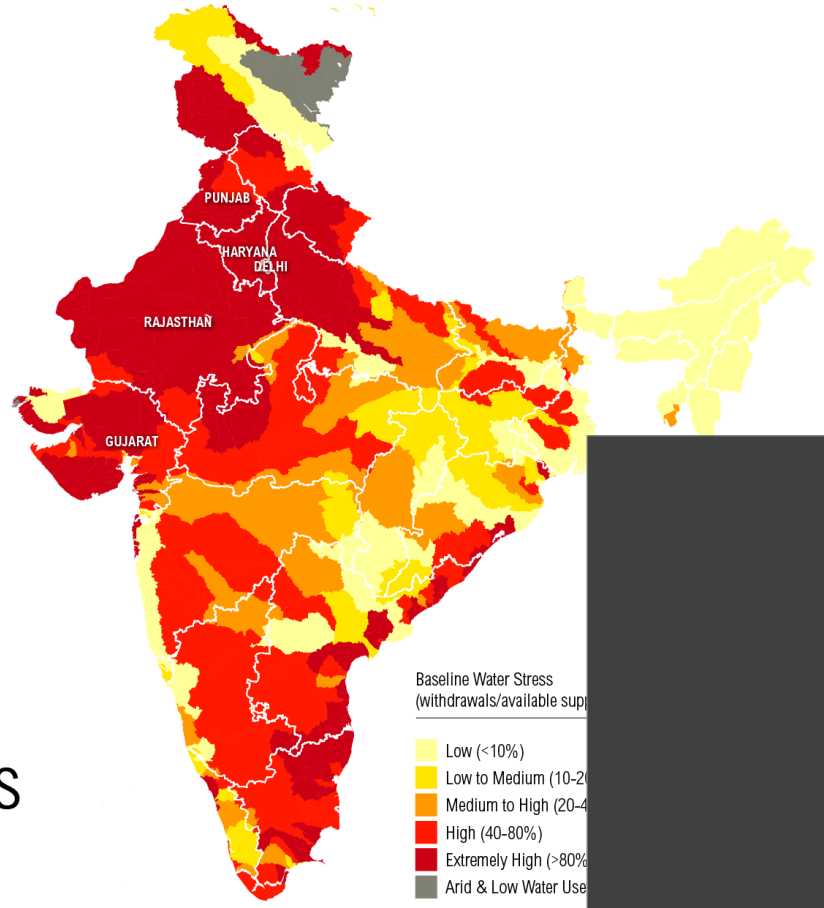
Pressure on water

1582 m^3/yr/capita



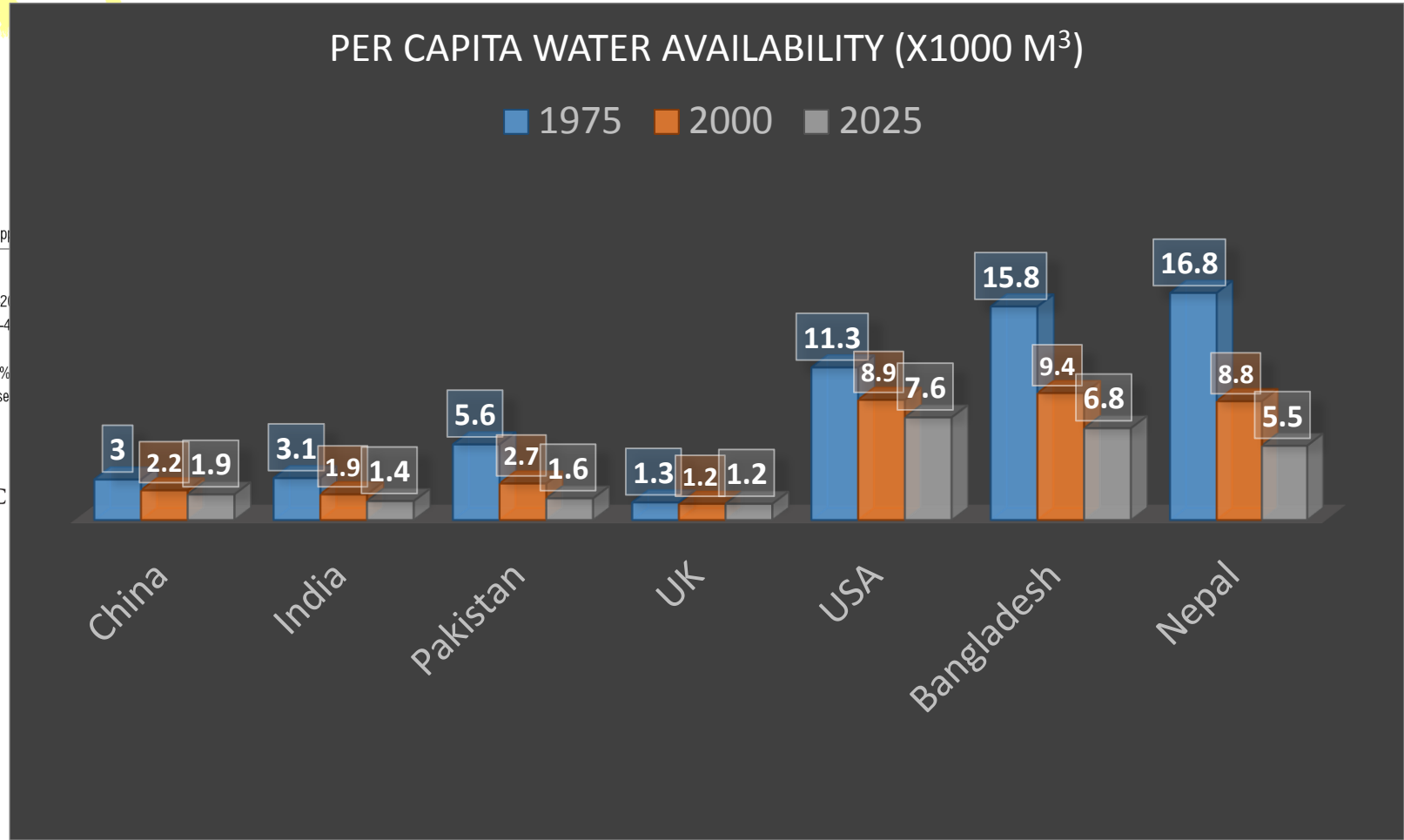
54%

of India Faces **High** to **Extremely High** Water Stress

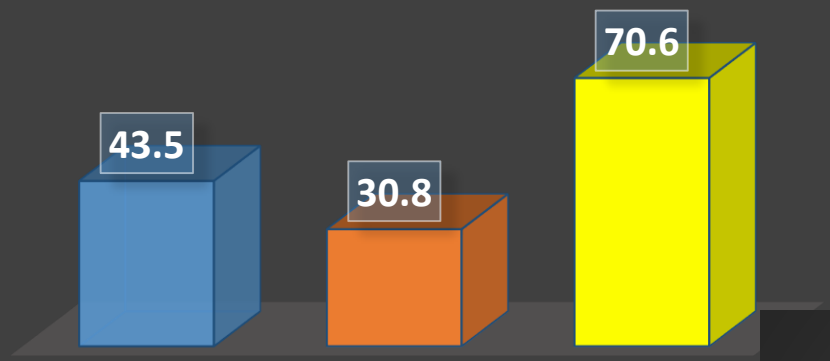


www.indiawatertool.in

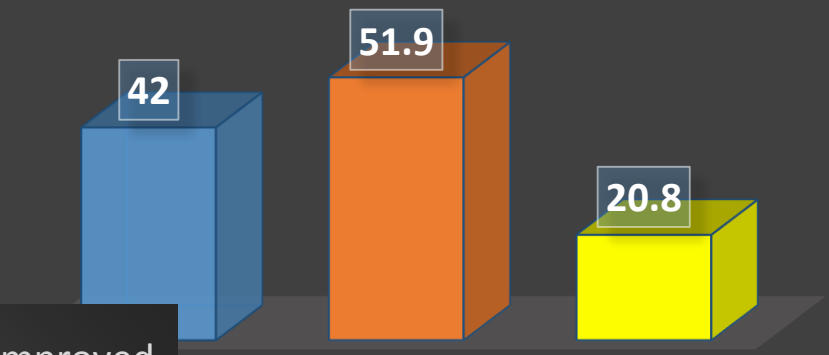
WORLD RESOURC



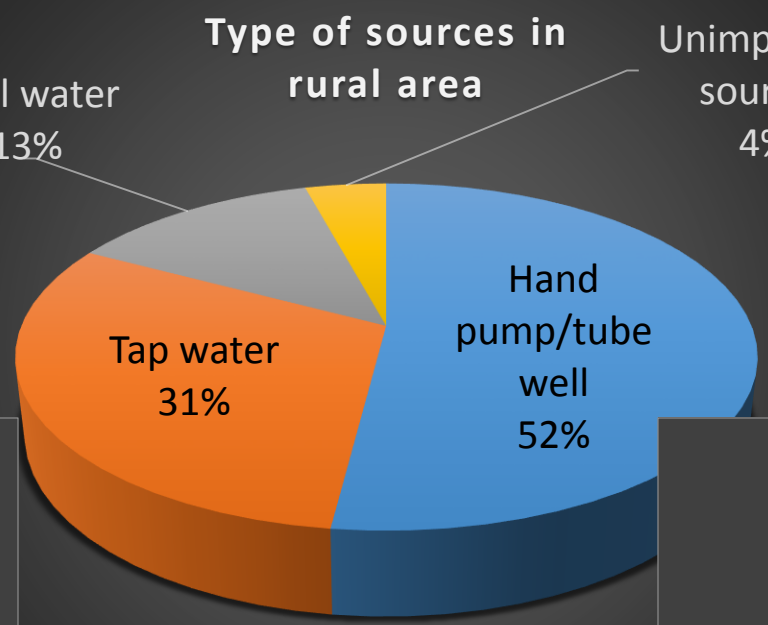
ACCESS TO TAP WATER



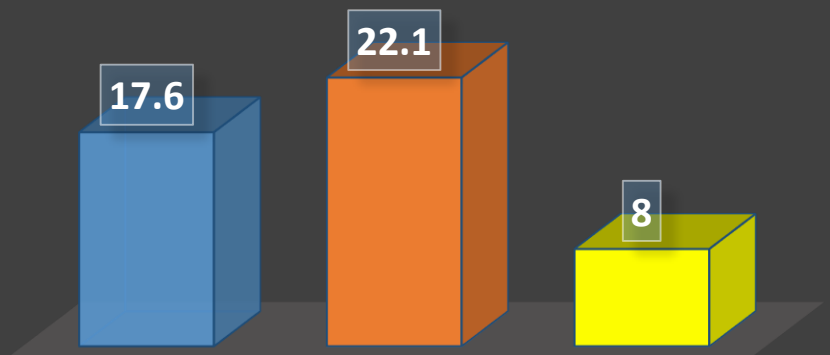
HAND PUMP/WELL



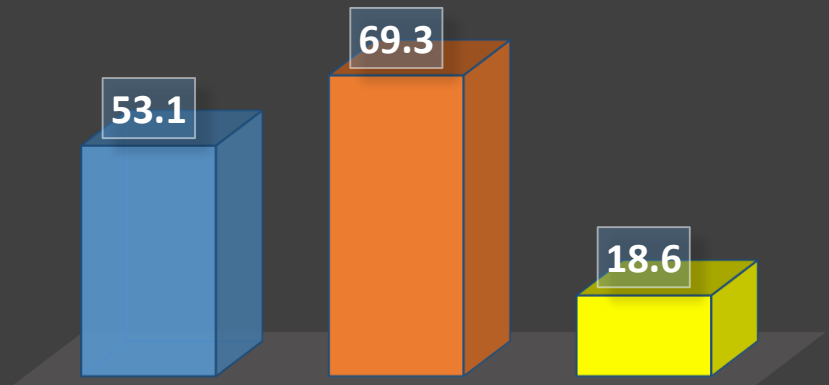
Type of sources in rural area

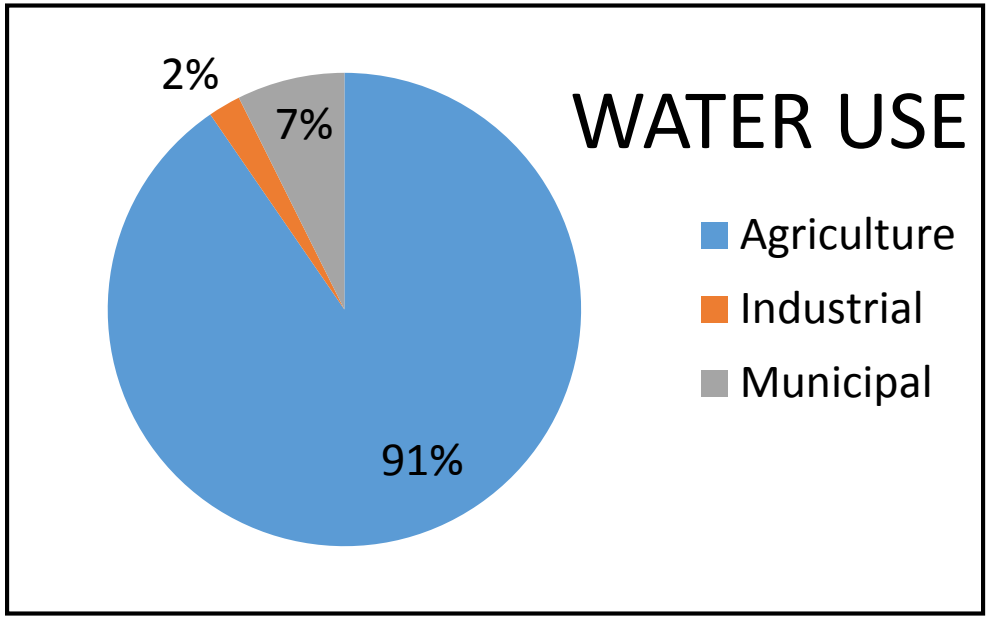


WATER SOURCE AWAY FROM HOME

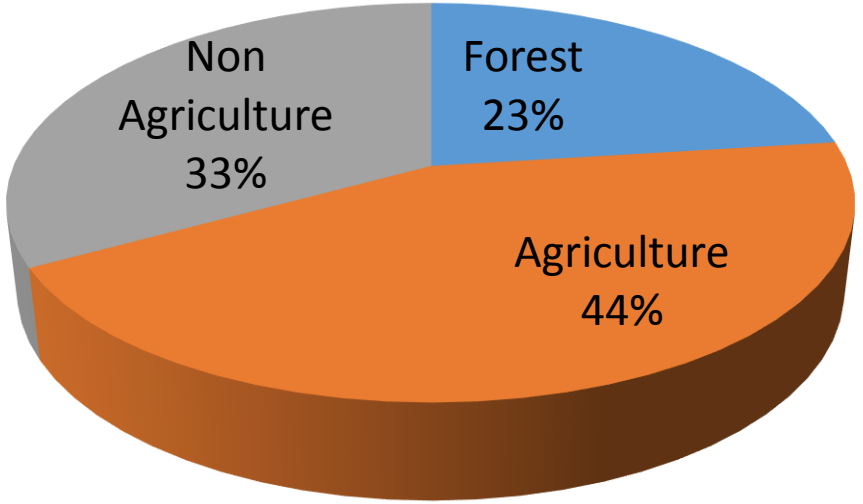


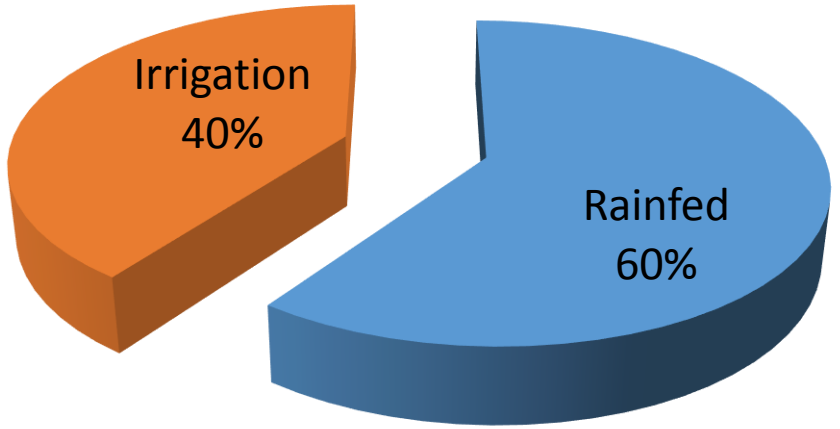
NO ACCESS SANITATION

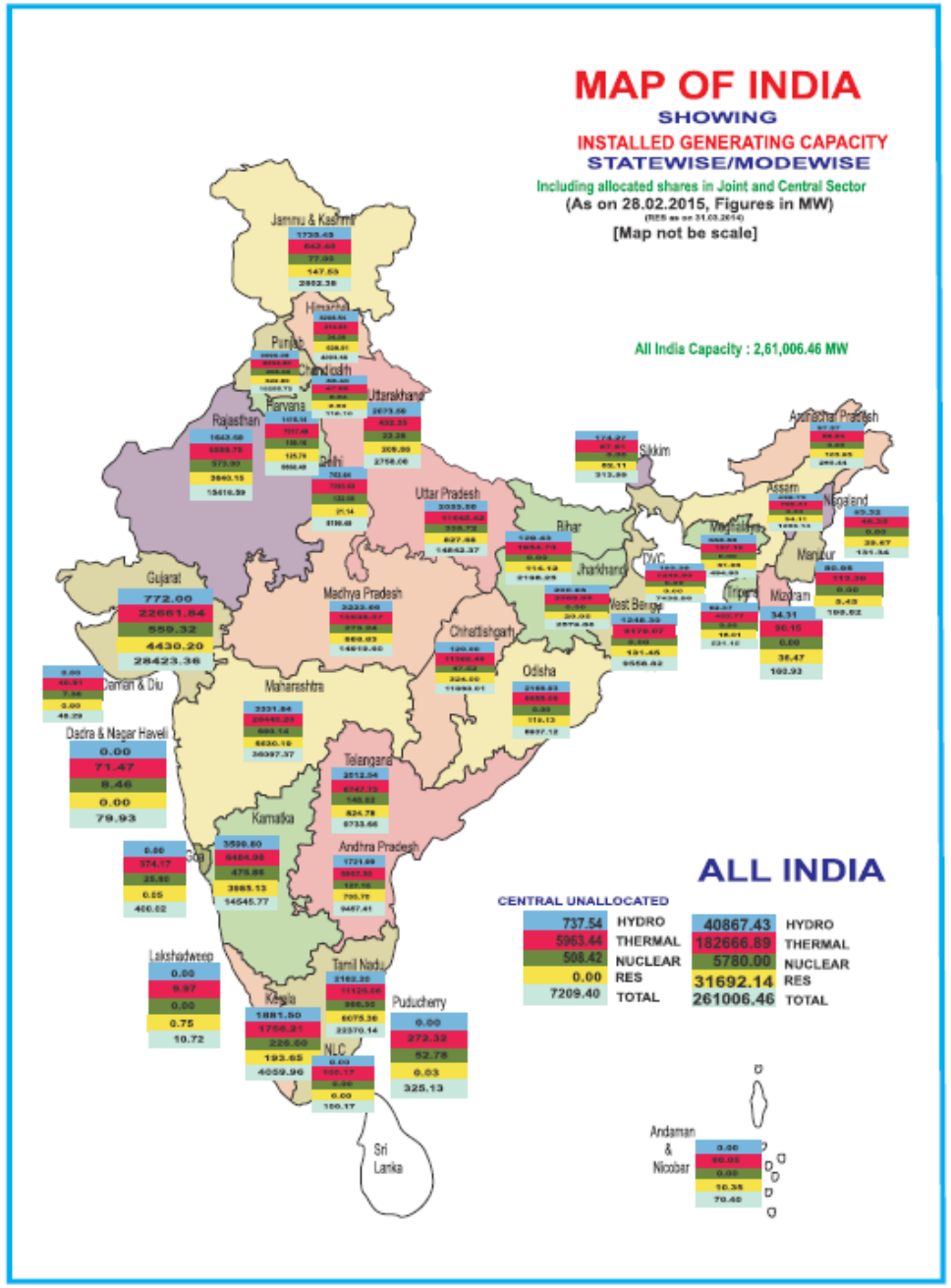




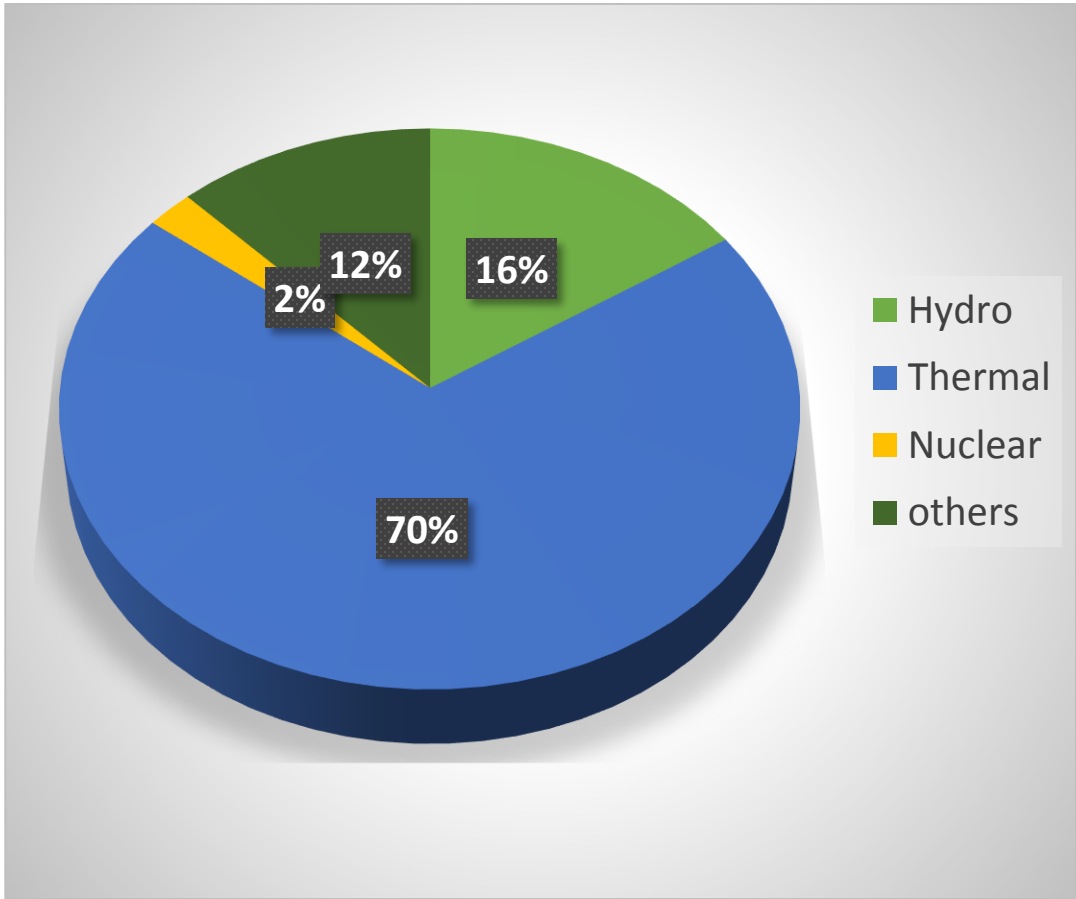
AREA DISTRIBUTION



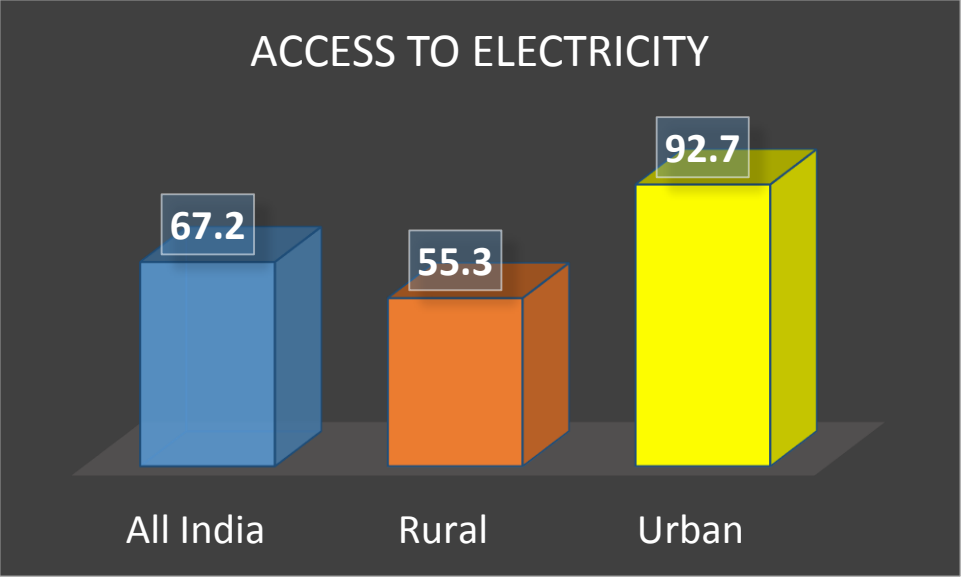


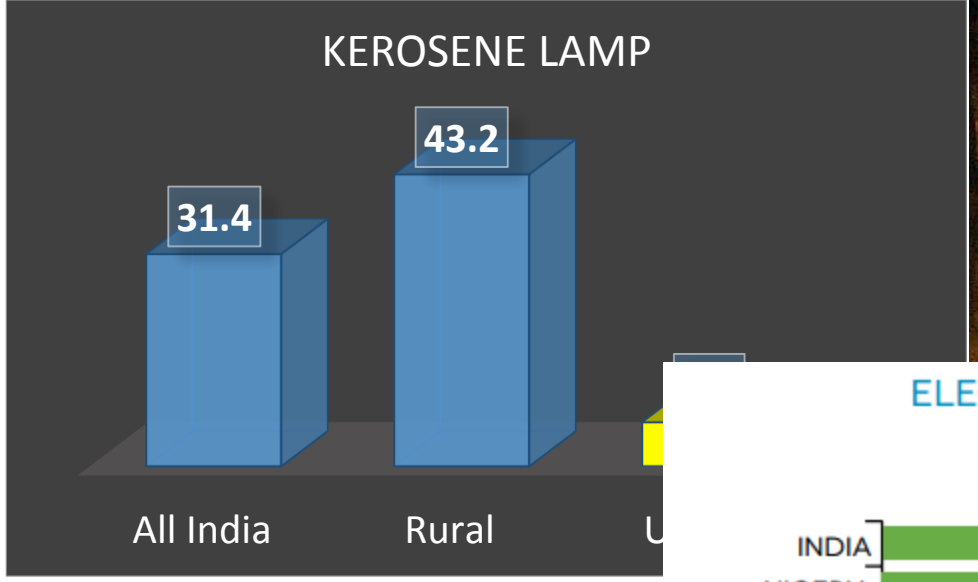


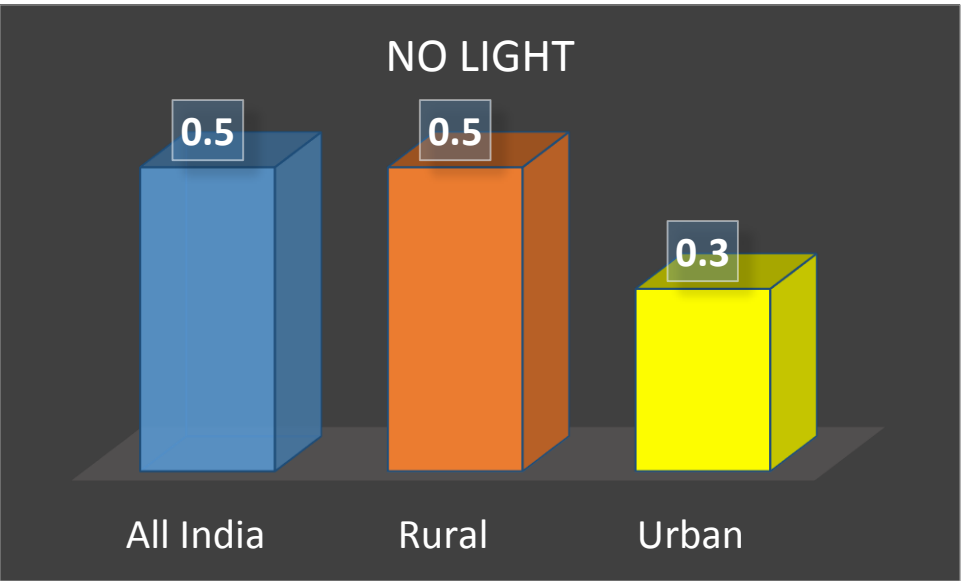
Installed capacity	**2,61,006 MW**
Thermal	1,82,666 MW
Hydro	40,867 MW
Nuclear	5,780 MW
Others	31,692 MW

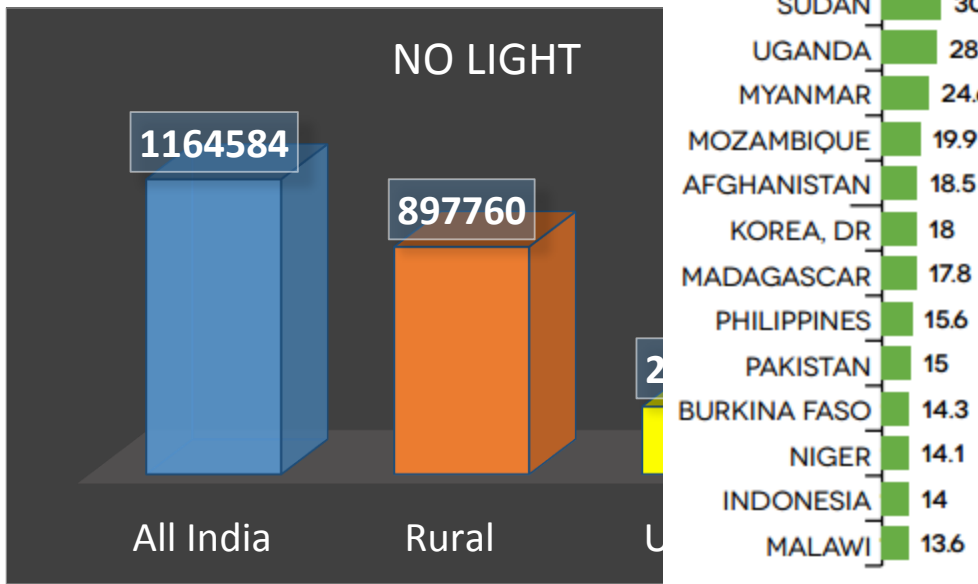


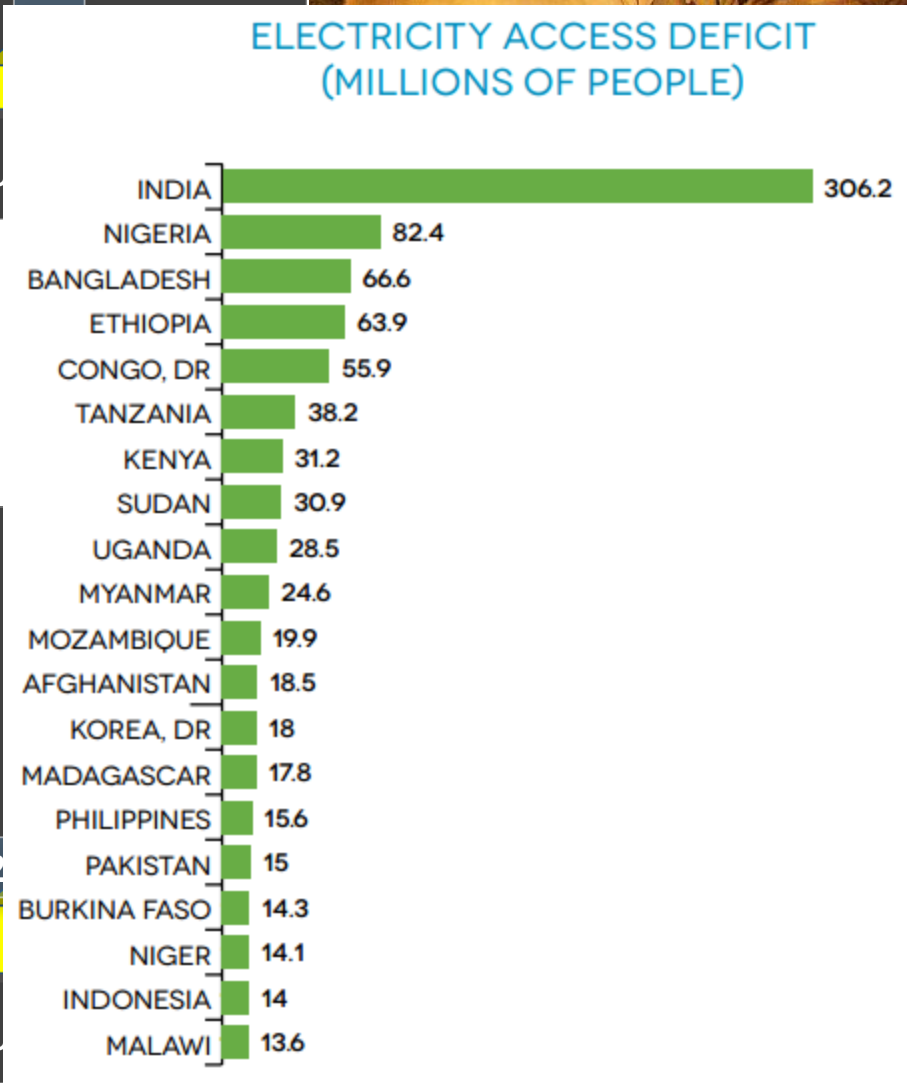
Source: Annual report 2014-15, Ministry of power, Govt. of India


ACCESS TO ELECTRICITY
67.2
55.3
92.7
All India
Rural
Urban


KEROSENE LAMP
31.4
43.2
All India
Rural


NO LIGHT
0.5
0.5
0.3
All India
Rural
Urban


NO LIGHT
1164584
897760
All India
Rural


ELECTRICITY ACCESS DEFICIT
(MILLIONS OF PEOPLE)
INDIA 306.2
NIGERIA 82.4
BANGLADESH 66.6
ETHIOPIA 63.9
CONGO, DR 55.9
TANZANIA 38.2
KENYA 31.2
SUDAN 30.9
UGANDA 28.5
MYANMAR 24.6
MOZAMBIQUE 19.9
AFGHANISTAN 18.5
KOREA, DR 18
MADAGASCAR 17.8
PHILIPPINES 15.6
PAKISTAN 15
BURKINA FASO 14.3
NIGER 14.1
INDONESIA 14
MALAWI 13.6

We use energy for water

Source	Approx. Energy (kWh/Mgal)
Surface water	1400
Groundwater	1800
Seawater	9780-16500

We use energy for wastewater treatment

Treatment Type	Approx. Energy (kWh/Mgal)
Trickling filter	955
Activated sludge	1300
Advanced treatment without Nitrification	1500
Advanced treatment with Nitrification	1900

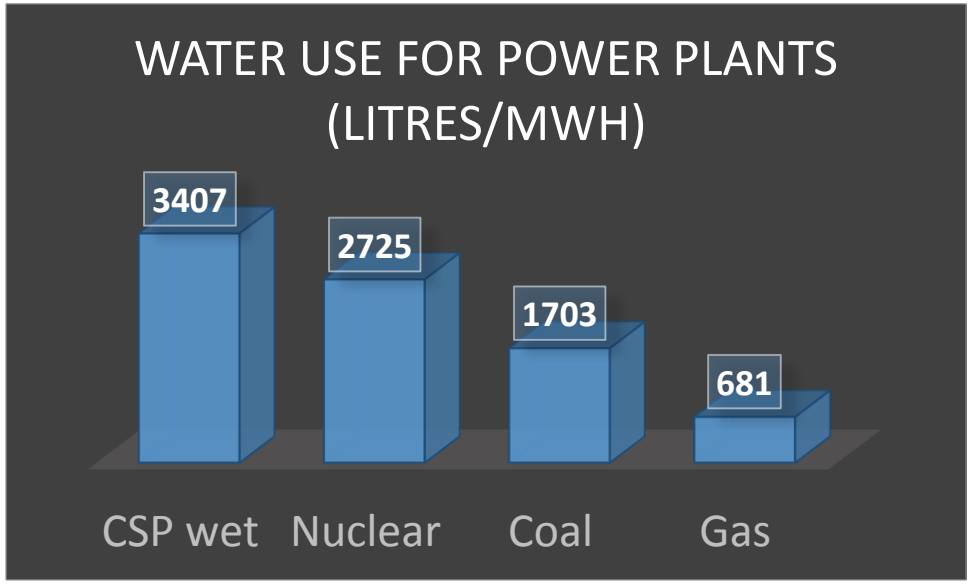
We use energy to reclaimed water

Source	Energy (kWh/Mgal)
Reclaimed water	1514-3785

We need water for producing energy

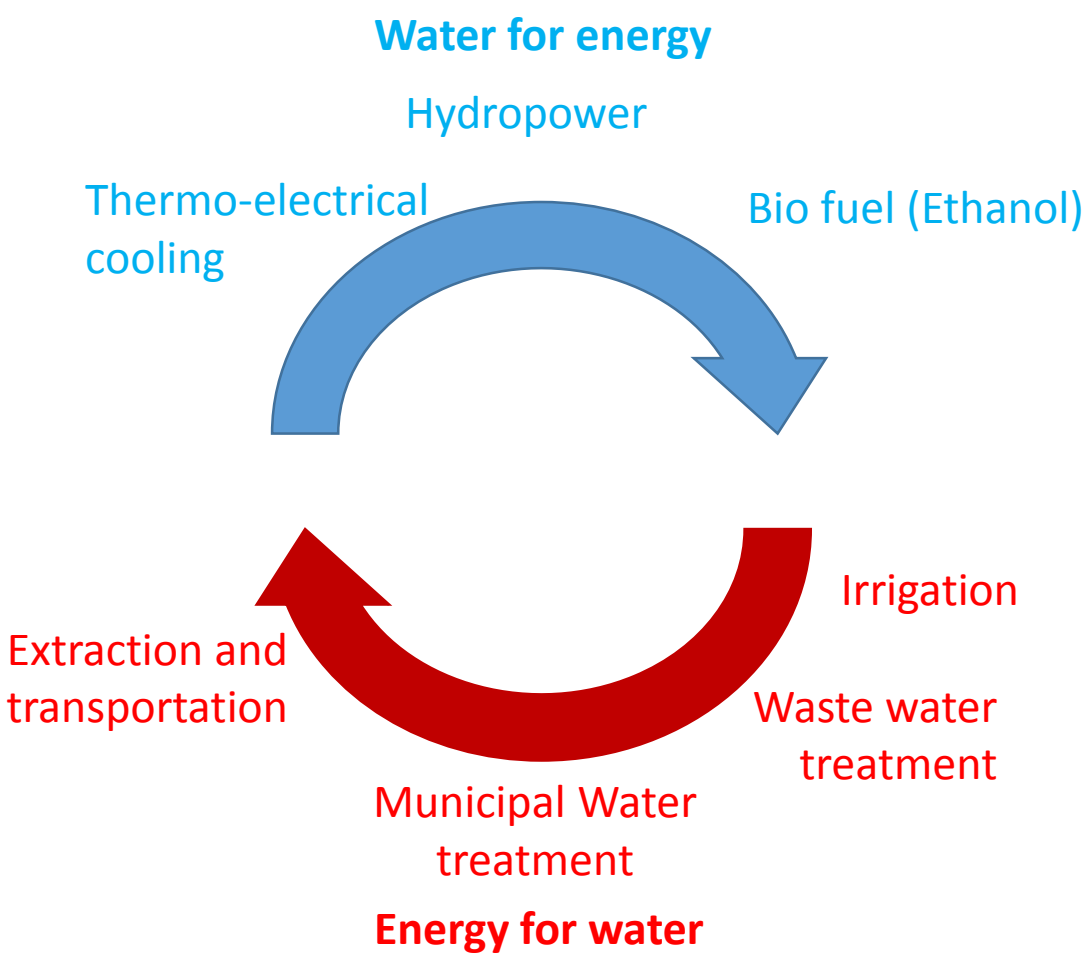
Water plays a number of roles in energy production

- Pumping crude oil out of the ground
- Remove pollutants from power plant exhaust
- Generating steam that turns turbines
- Flushing away residue after fossil fuels are burned
- Keeping power plants cool

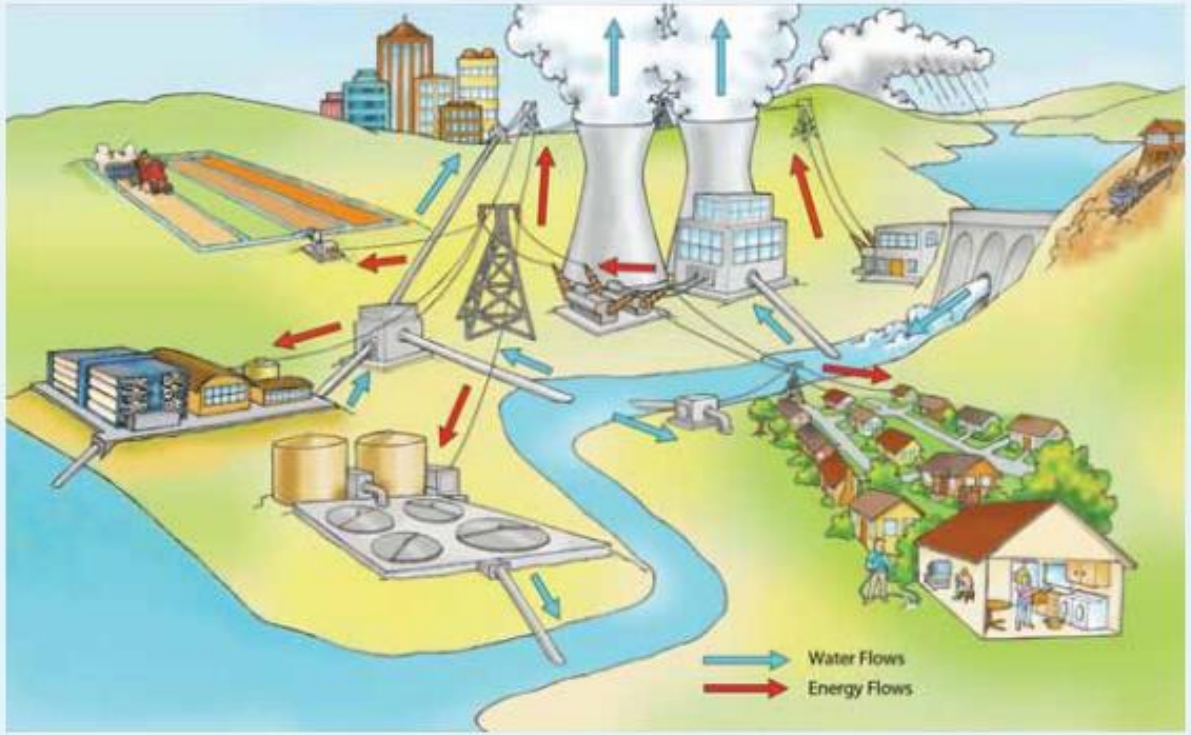


If operate my Air conditioner (2000 watt) for 8 hours a day

Plant type	ML/year
CSP wet	2.10
Nuclear	1.73
coal	1.05
Gas	0.43



The energy–water nexus



Note: Energy flows are shown in red and water flows are shown in blue. As shown in the residential community, electricity and water are both used for different purposes.
Source: Courtesy of EPRI (prepared by EPRI for a US DOE Report to Congress in 2006).

Strained Energy-Water relationship

Scarcity of one resource will put pressure on the other

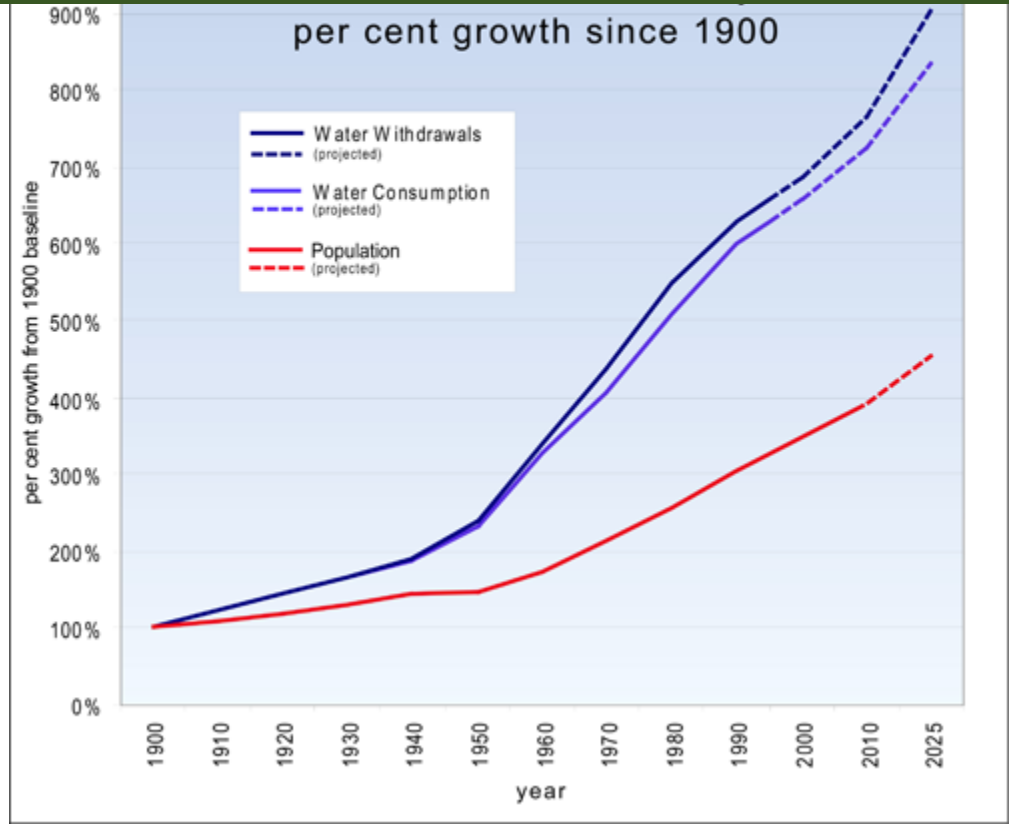
- ✓ Drought can prohibit power plan production
- ✓ Blackout disrupts water treatment and distribution

Increase in population: put pressure on demand of water and energy

Economic growth: Increase in per capita demand of energy and water

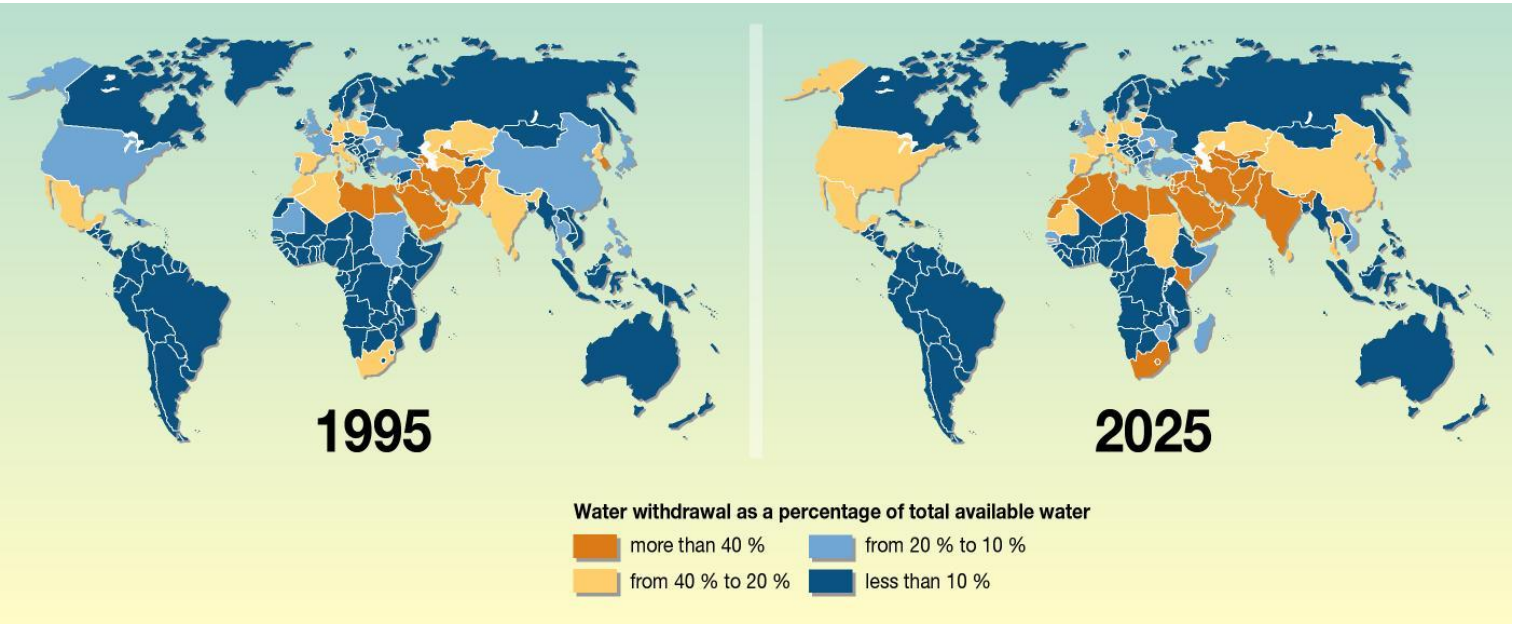
Change in policy: Water intensive energy and energy intensive water

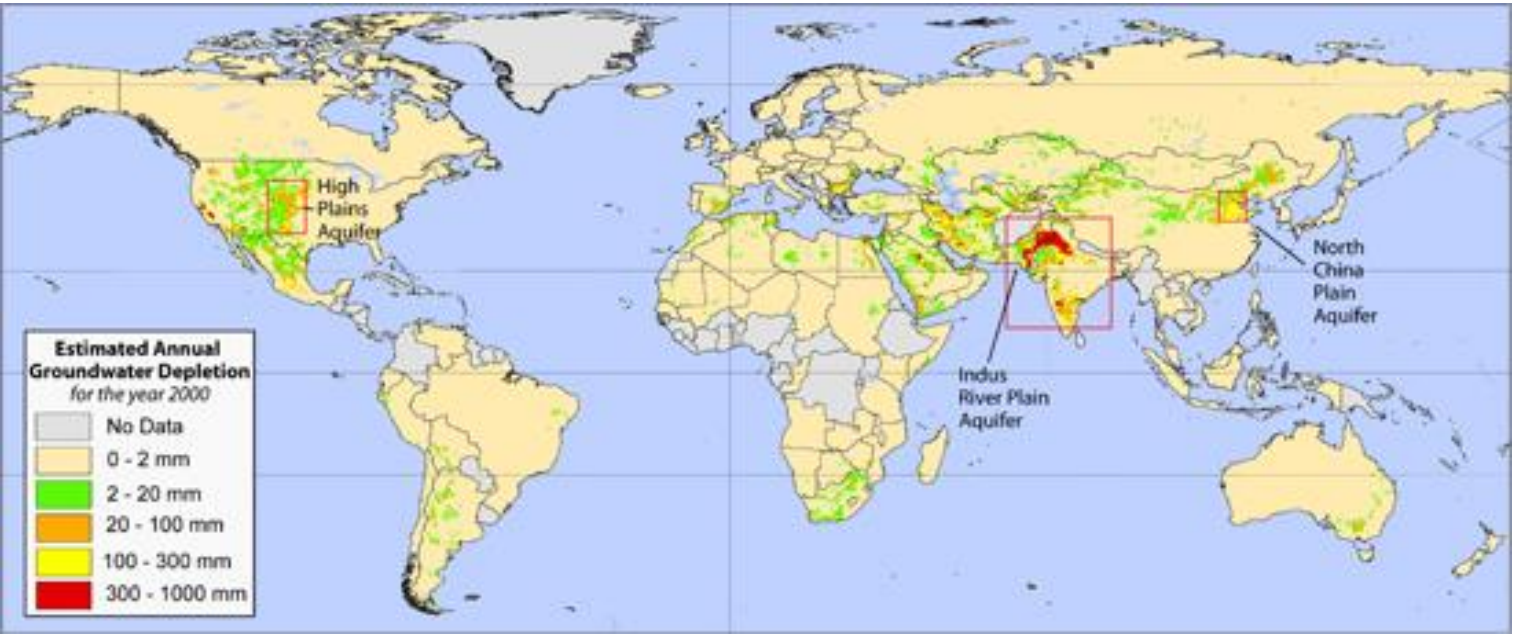
Global climate change: Spatial and temporal redistribution of global water

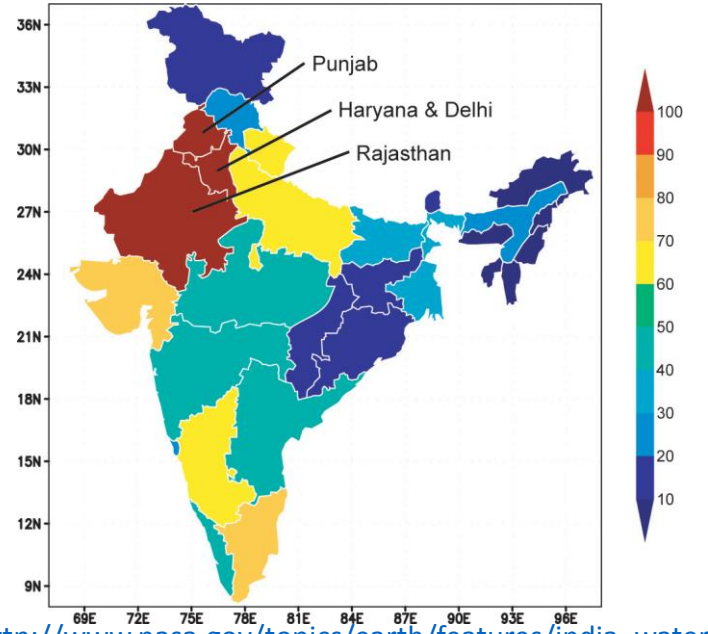


- ✓ 99.6% of all the water on earth is not available for human and animal consumption
- ✓ 54% of India faces high to extreme high water stress
- ✓ 56.5% of our people do not have piped water in their house
- ✓ 32.8% of our people do not have access to electricity

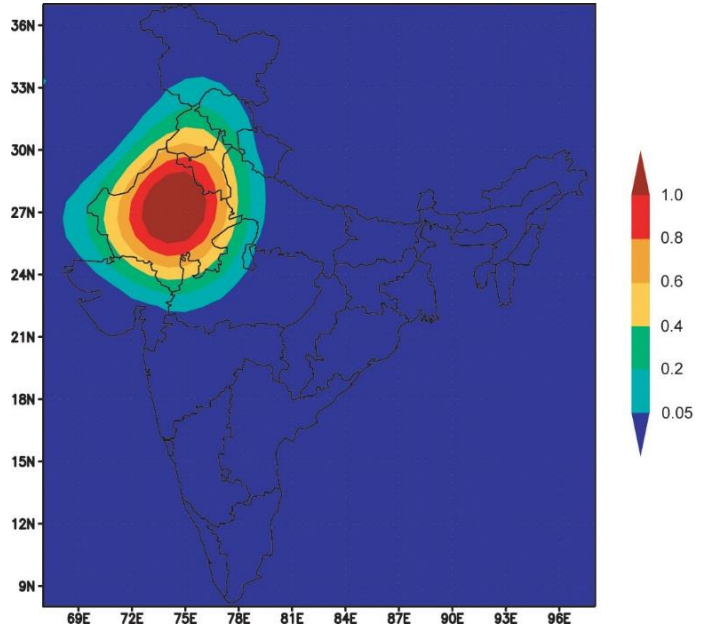
Depletion of water table



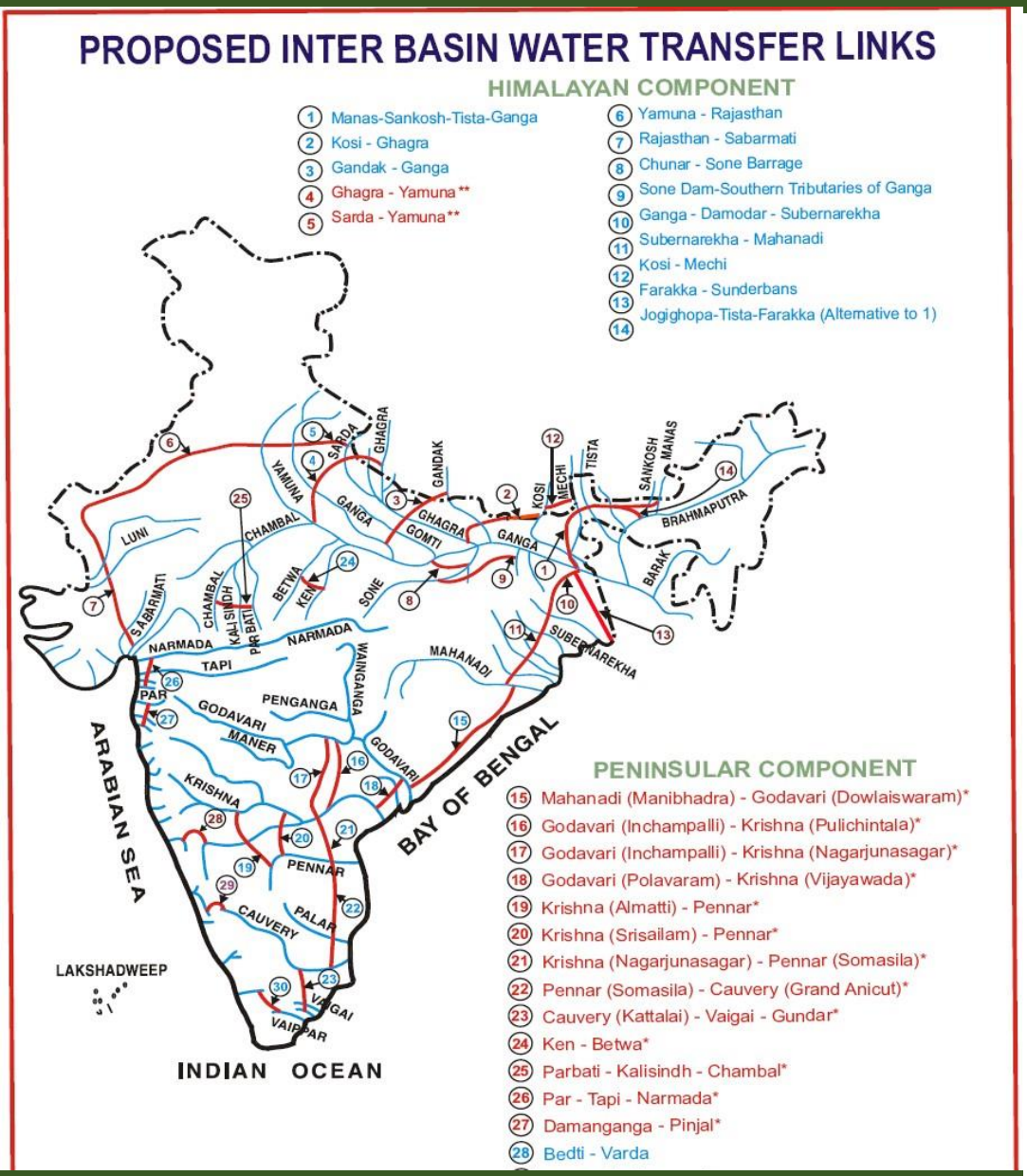




Source: http://www.nasa.gov/topics/earth/features/india_water.html

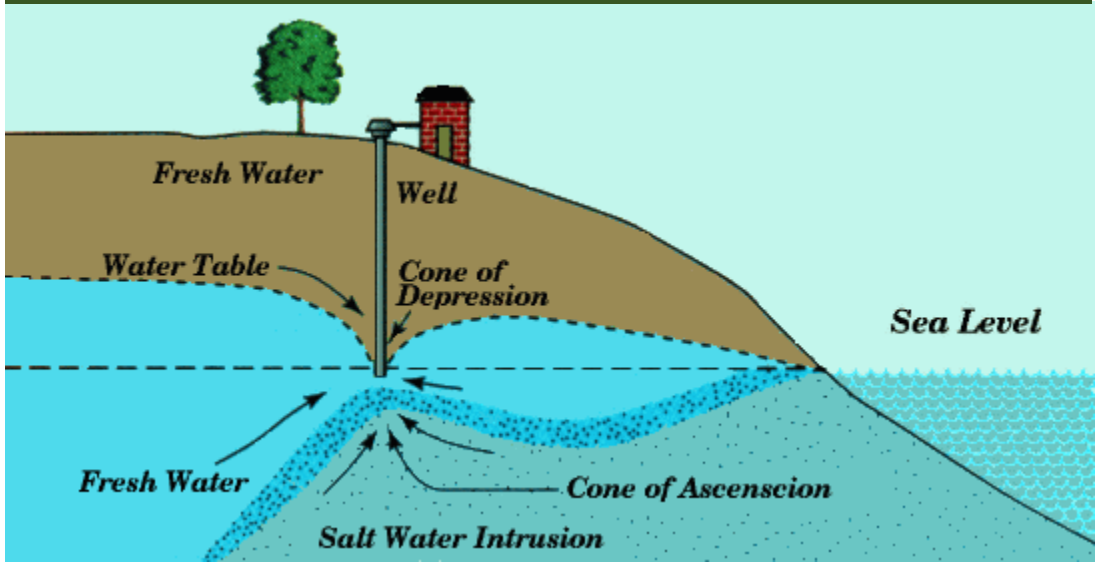


Moving towards energy intensive water



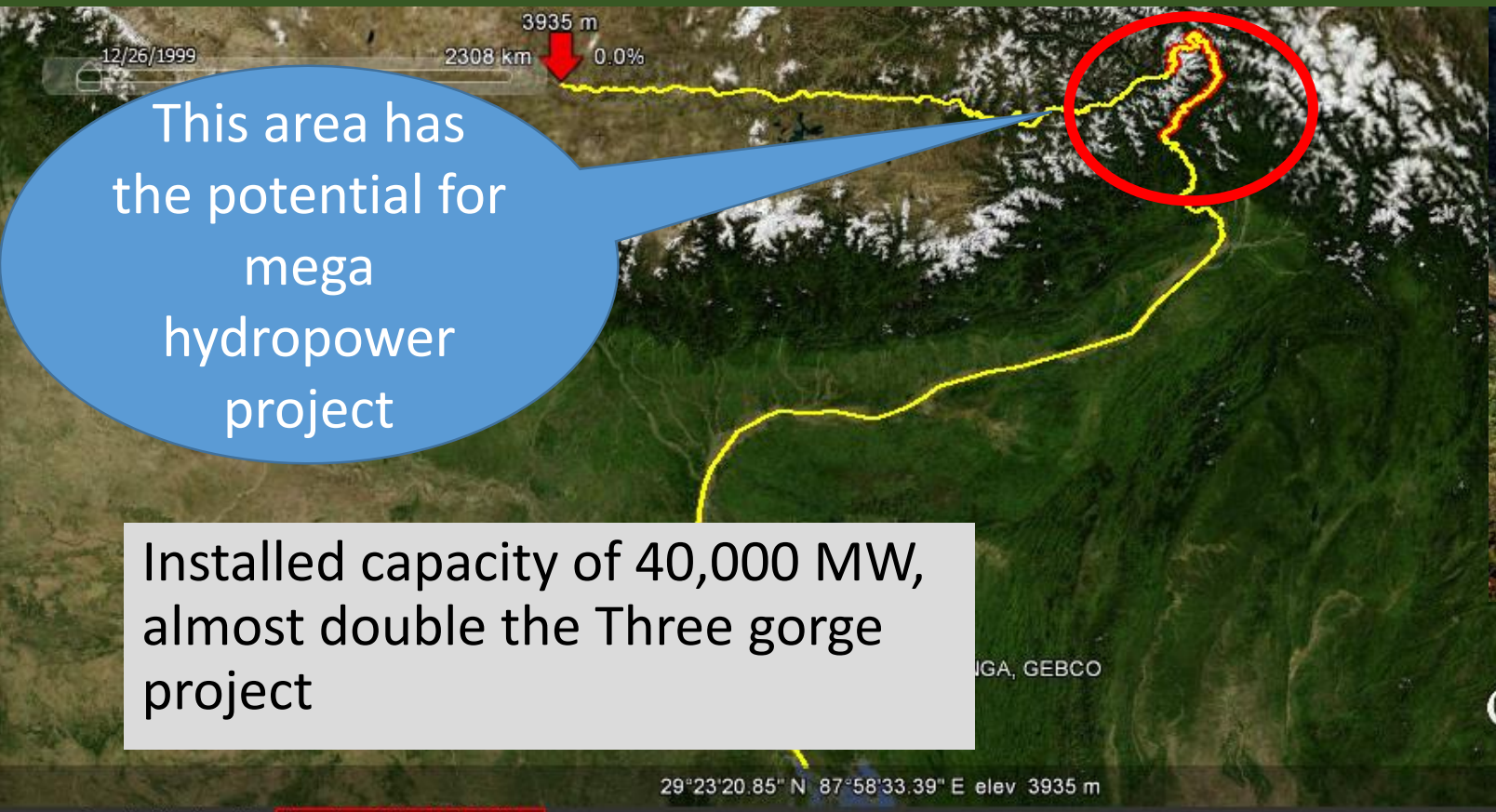
Inter-basin transfer

Seawater intrusion

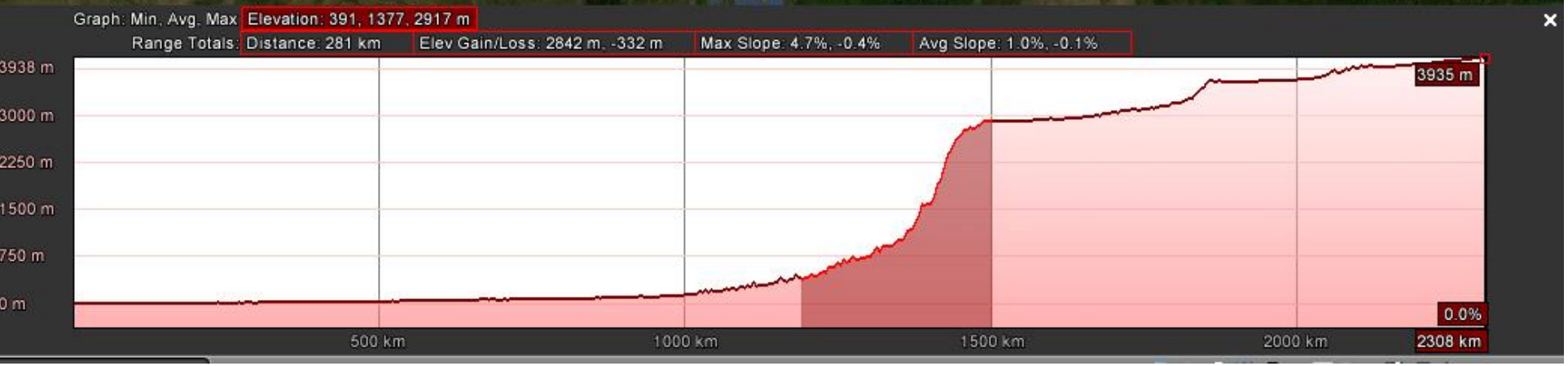


Source: http://sabrinadoyle.com

Transboundary issue



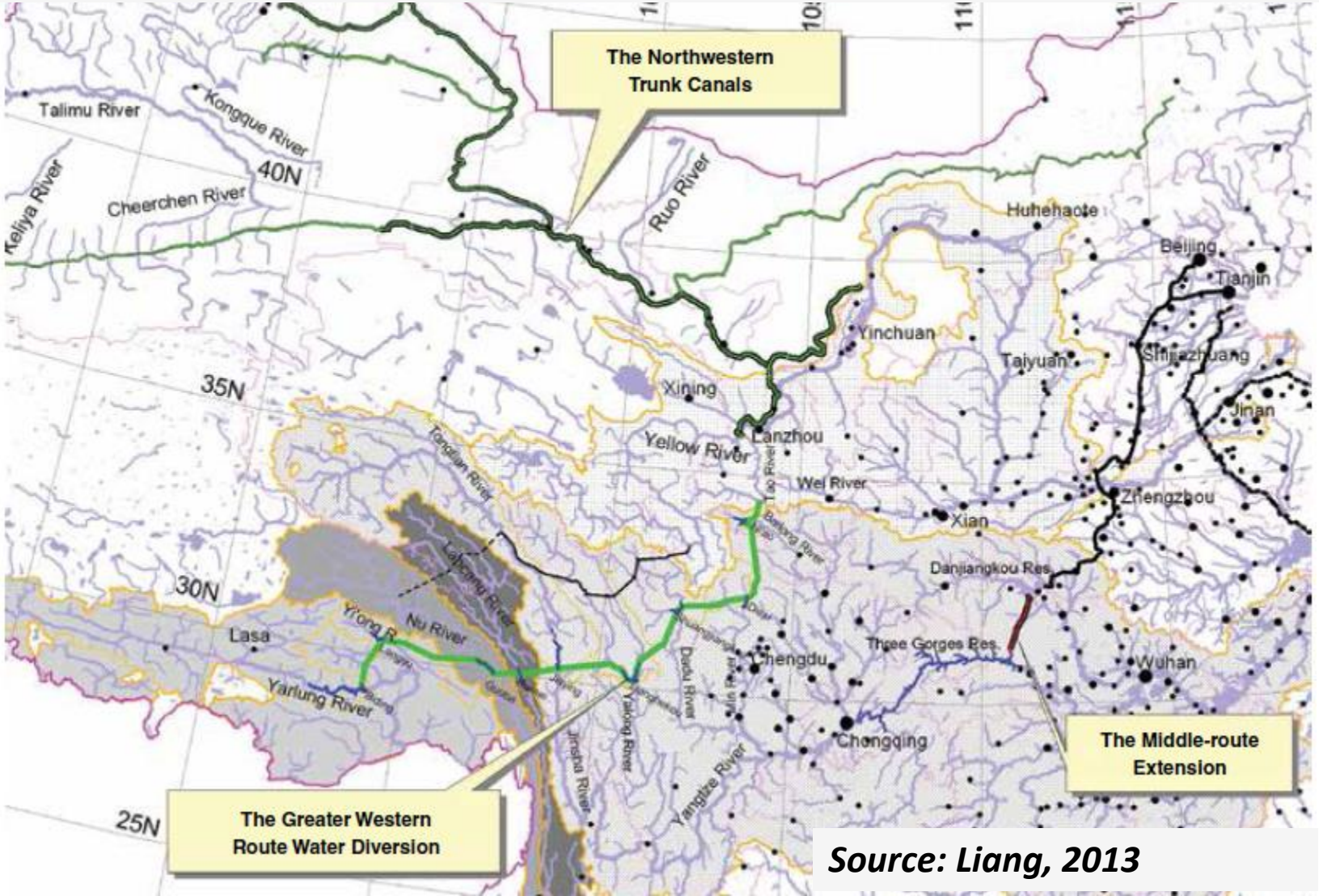
GREAT BEND



Elevation difference between two ends of the red line is around 2299 m

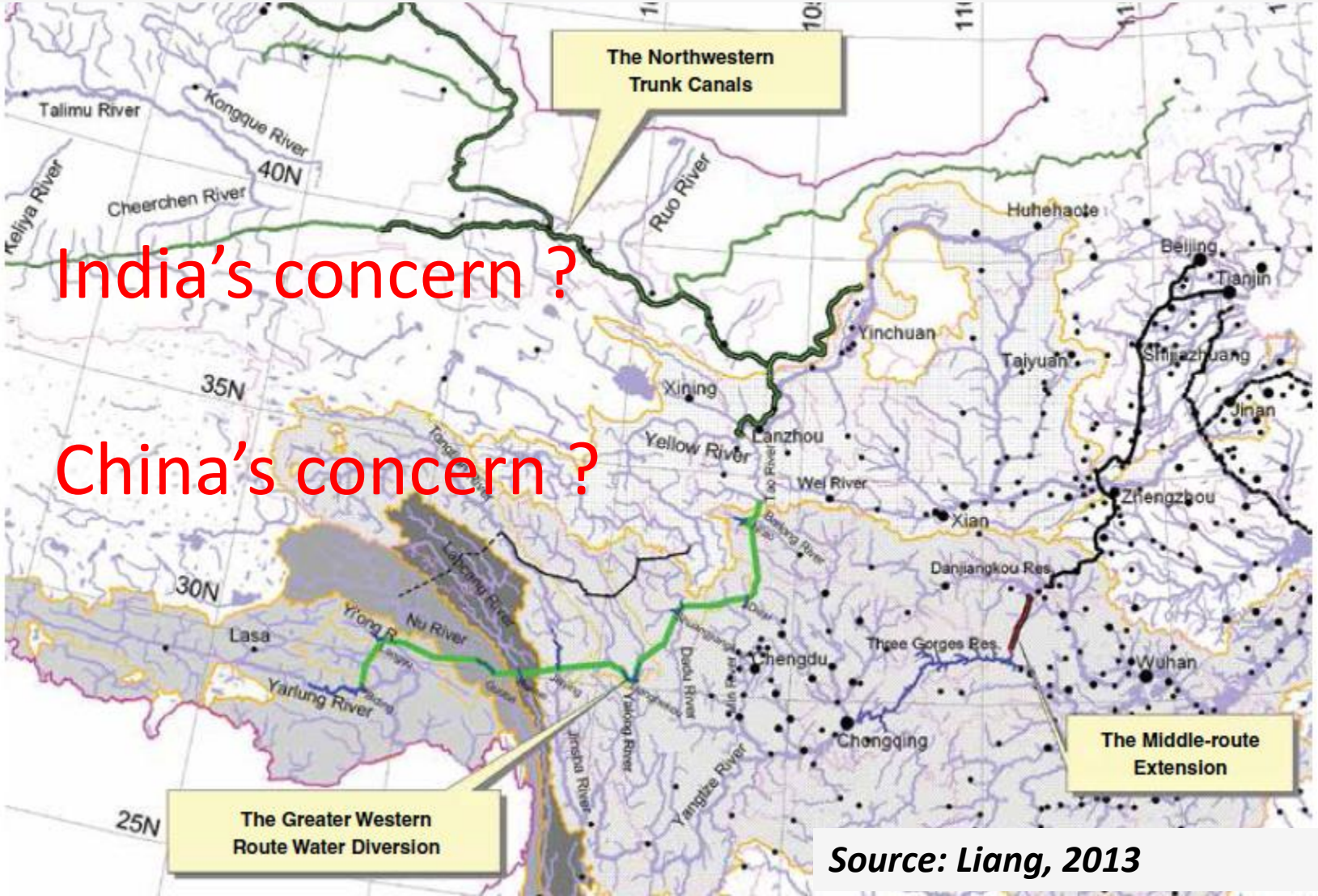
Water Diversion Project of China

- Can divert 57 BCM water



Source: Liang, 2013

Water Diversion Project of China

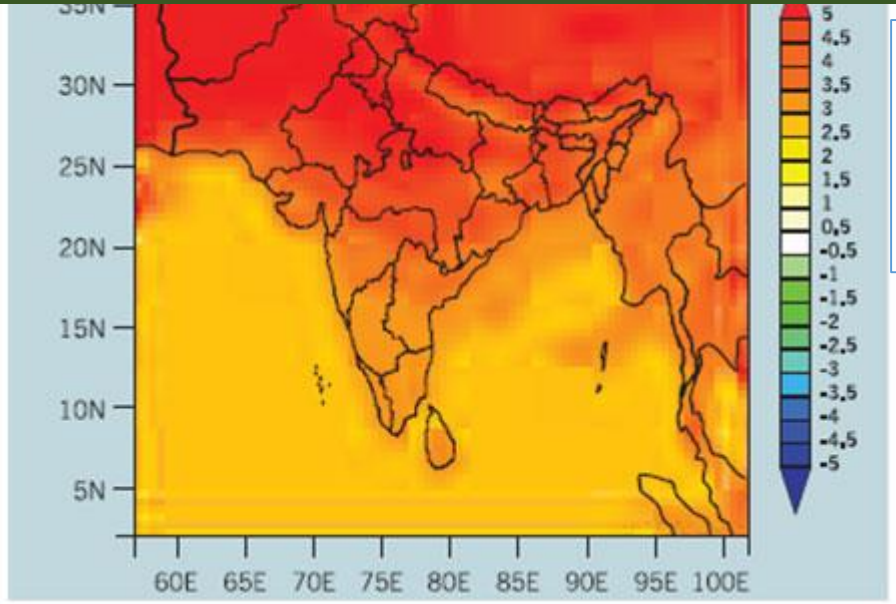


Source: Liang, 2013

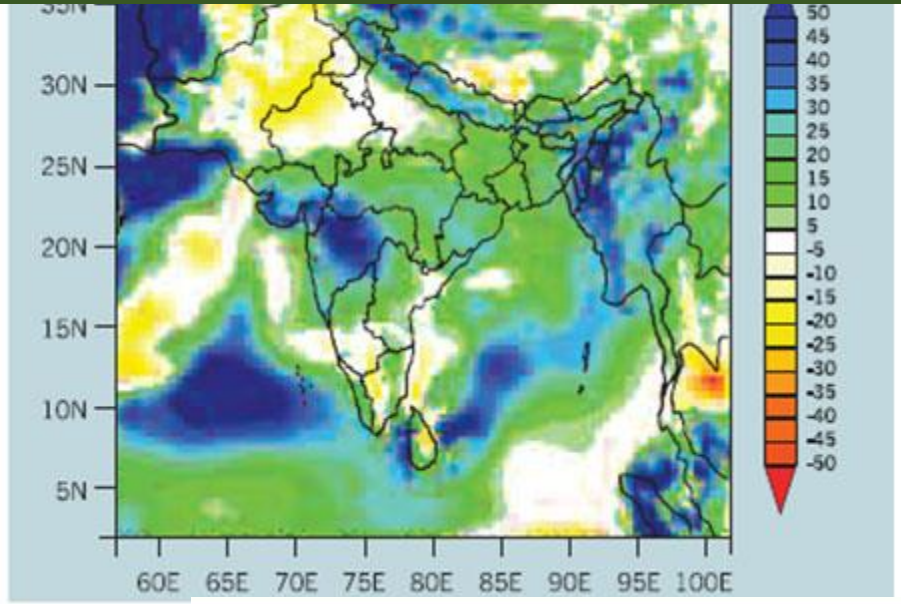
- Three ways to implement the project
  - Only hydropower generation
  - Divert water during monsoon
  - Divert water throughout the year

PER CAPITA WATER AVAILABILITY WILL REDUCE FARTHER

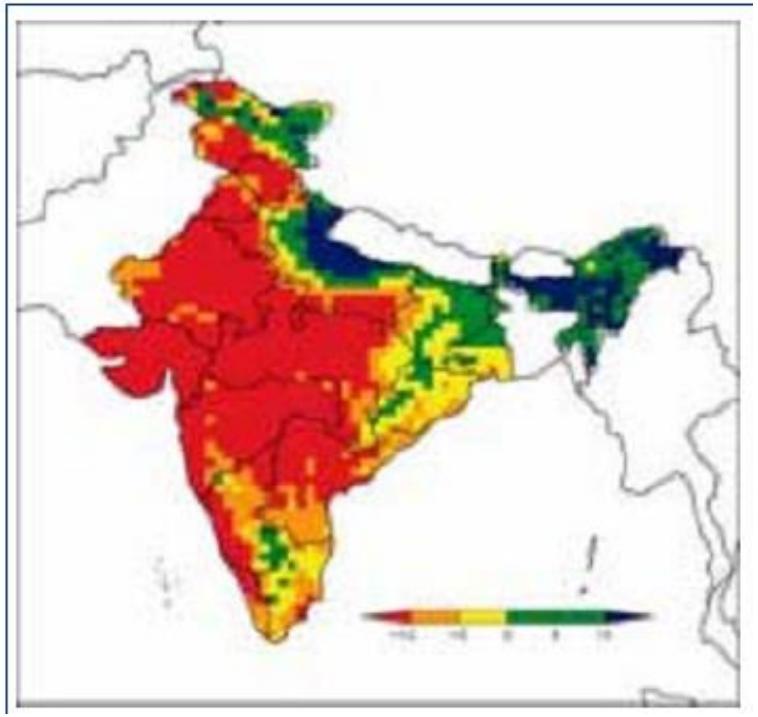
Impact of climate change



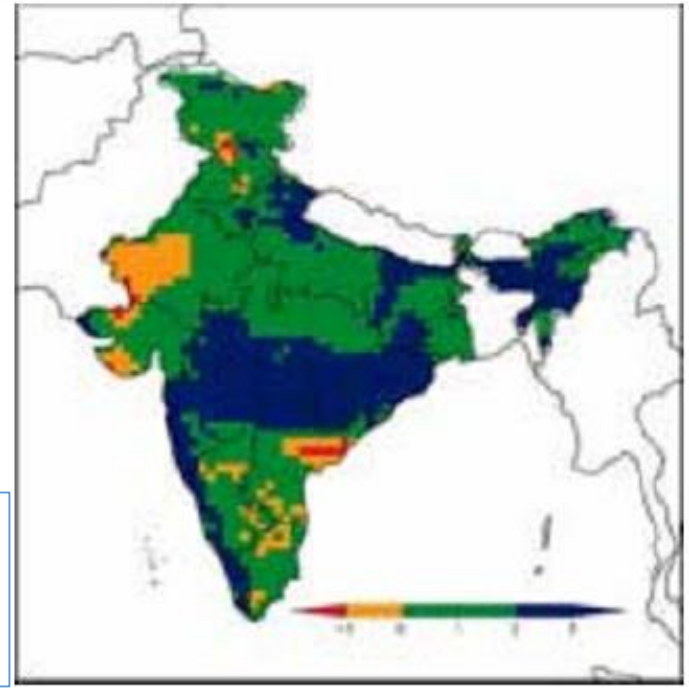
Change in annual mean surface air temperature (ºC) for the period **2071-2100** with reference to the baseline of **1961-1990** (A2 scenario)



Changes in summer monsoon rainfall (%) for the period **2071-2100** with reference to the baseline of **1961-1990** (A2 scenario)



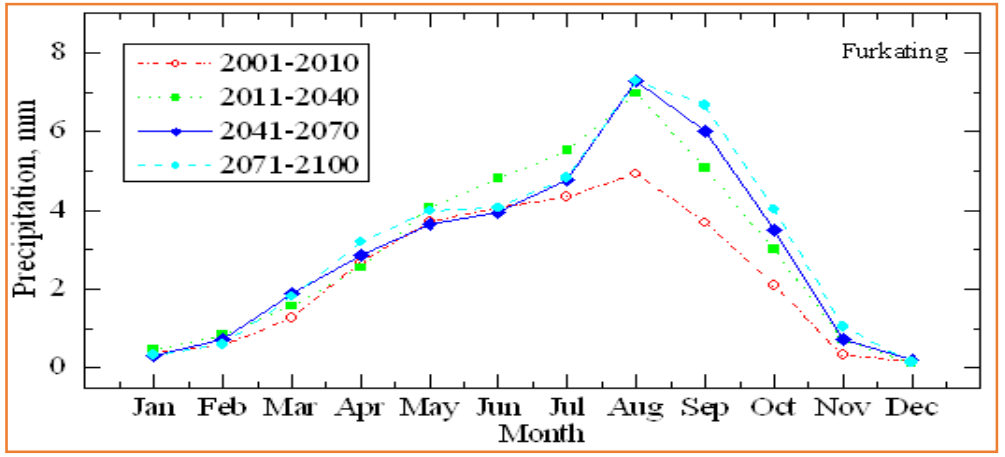
Projections of mean incremental annual number of rainy days for the period **2041 -2060**

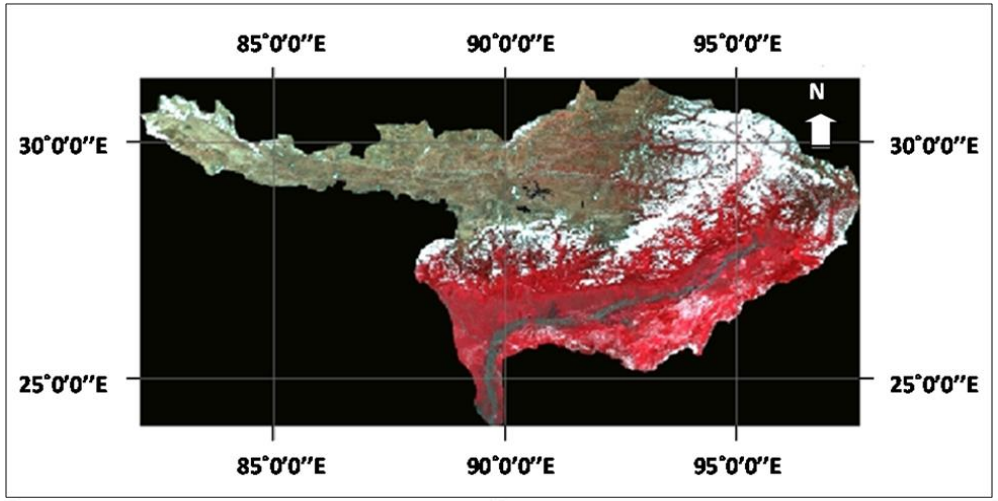


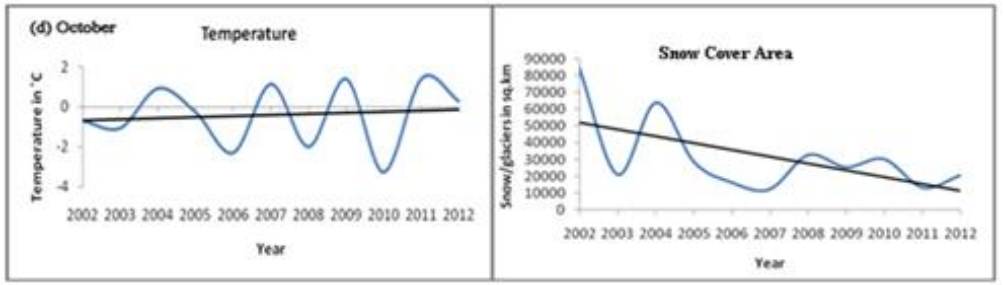
Projections of mean incremental rainy day intensity (mm/day) for the period **2041 -2060**

Impact of climate change

- ✓ Climate change may have significant impact on flow of river Brahmaputra
- ✓ Monsoon flow of the river may increase by twenty percent in future
- ✓ Lean period flow may decrease by fifteen to twenty percent
- ✓ Number of dry day may increase in future
- ✓ Temperature increase by 0.5 to 1.0 degree
- ✓ Shifting of Monsoon
- ✓ Reduction in Himalayan glacier/snow cover



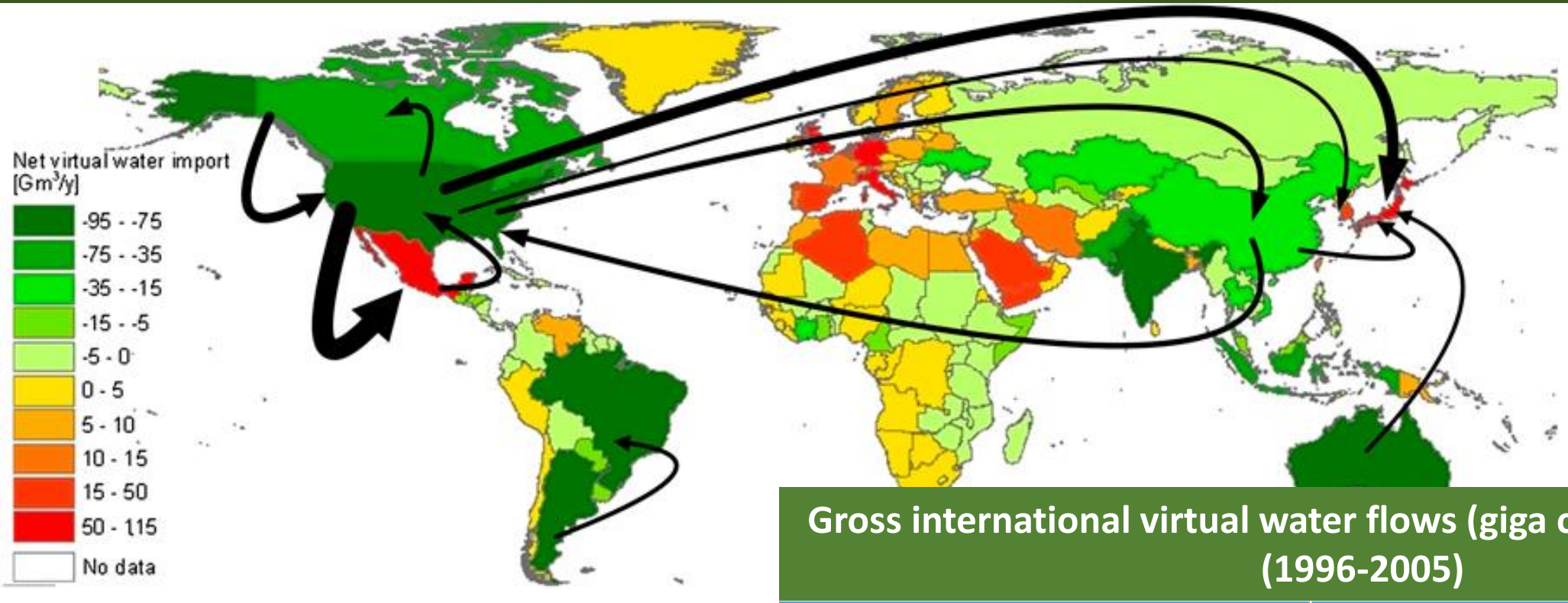




Impact of climate change

- **Warmer seasons**
  - increases in both maximum as well as minimum temperatures
- **Annual precipitation**
  - Increased monsoon rainfall along the west coast, north Andhra Pradesh and north-west India
  - decreasing trends over east Madhya Pradesh and adjoining areas, north-east India and parts of Gujarat and Kerala
  - there is an overall decrease in the number of rainfall days
  - Himalayan foothills and in northeast India, the number of rainfall days may increase by 5-10 days
  - increase in rainfall intensity
- **Water availability**
  - reduction in the quantity of available runoff
  - severity of droughts and intensity of floods in various parts of India is likely to increase.
- **Sea-level rise**
  - 0.4-2.0 mm/year on average
  - 1 m of sea level rise will displace 7.1 million of people
  - increased saline intrusion

Trade of virtual water



Source: Hoekstra and Mekonnen, 2012

Gross international virtual water flows (giga cubic meter per year) (1996-2005)

	Agricultural products	Industrial products	Total
Export of domestically produced goods	1597	165	1762
Re-export of imported goods	441	117	558
Total	2038	282	2320

Trade of virtual water

Country	Tea (MKG)		Water (ML)		Water (MCM)	
	14-15	13-14	14-15	13-14	14-15	13-14
Russian Fed	39.14	38.62	346780	342173	347	342
Ukraine	2.56	2.21	22682	19581	23	20
Kazakhstan	11.46	10.26	101536	90904	102	91
Other CIS	0.68	1.7	6025	15062	6	15
Total CIS	**53.84**	**52.79**	**477022**	**467719**	**477**	**468**
United Kingdom	**18.58**	**17.64**	**164619**	**156290**	**165**	**156**
Iran	**17.53**	**22.9**	**155316**	**202894**	**155**	**203**
Pakistan	**15.01**	**19.92**	**132989**	**176491**	**133**	**176**
U.A.E	**13.95**	**23.33**	**123597**	**206704**	**124**	**207**
U.S.A	**13.54**	**14.09**	**119964**	**124837**	**120**	**125**
Egypt (ARE)	**7.54**	**7.45**	**66804**	**66007**	**67**	**66**
Germany	**7.05**	**7.77**	**62463**	**68842**	**62**	**69**
Bangladesh	**5.01**	**13.94**	**44389**	**123508**	**44**	**124**
Poland	3.94	4.72	34908	41819	35	42
Japan	3.15	3.61	27909	31985	28	32
Australia	3.1	3.16	27466	27998	27	28
Saudi Arabia	3.03	2.63	26846	23302	27	23
China	3.01	4.14	26669	36680	27	37
Sri Lanka	2.88	1.55	25517	13733	26	14
Netherlands	2.78	3.26	24631	28884	25	29
Ireland	2.06	2.21	18252	19581	18	20
Afghanistan	1.95	2.46	17277	21796	17	22
Kenya	1.62	2.69	14353	23833	14	24
Canada	1.48	1.24	13113	10986	13	11
Singapore	0.4	0.34	3544	3012	4	3
Other countries	16.36	13.92	144950	123331	145	123
Total	**197.81**	**225.76**	**17,52,597**	**20,00,234**	**1,753**	**2,000**

Virtual water flow from India through tea industry is around 20 lakh million liters per year

Trade of virtual water

Mitigation of water-energy nexus and need of research

The negative impacts of the water-energy nexus can be mitigated

- ✓ Optimize the freshwater efficiency of energy production, electricity generation, and end use systems
- ✓ Optimize the energy efficiency of water management, treatment, distribution, and end use systems

Reducing surface runoff

Producing less waste

Reuse of energy

Conservation of water

Conservation of power

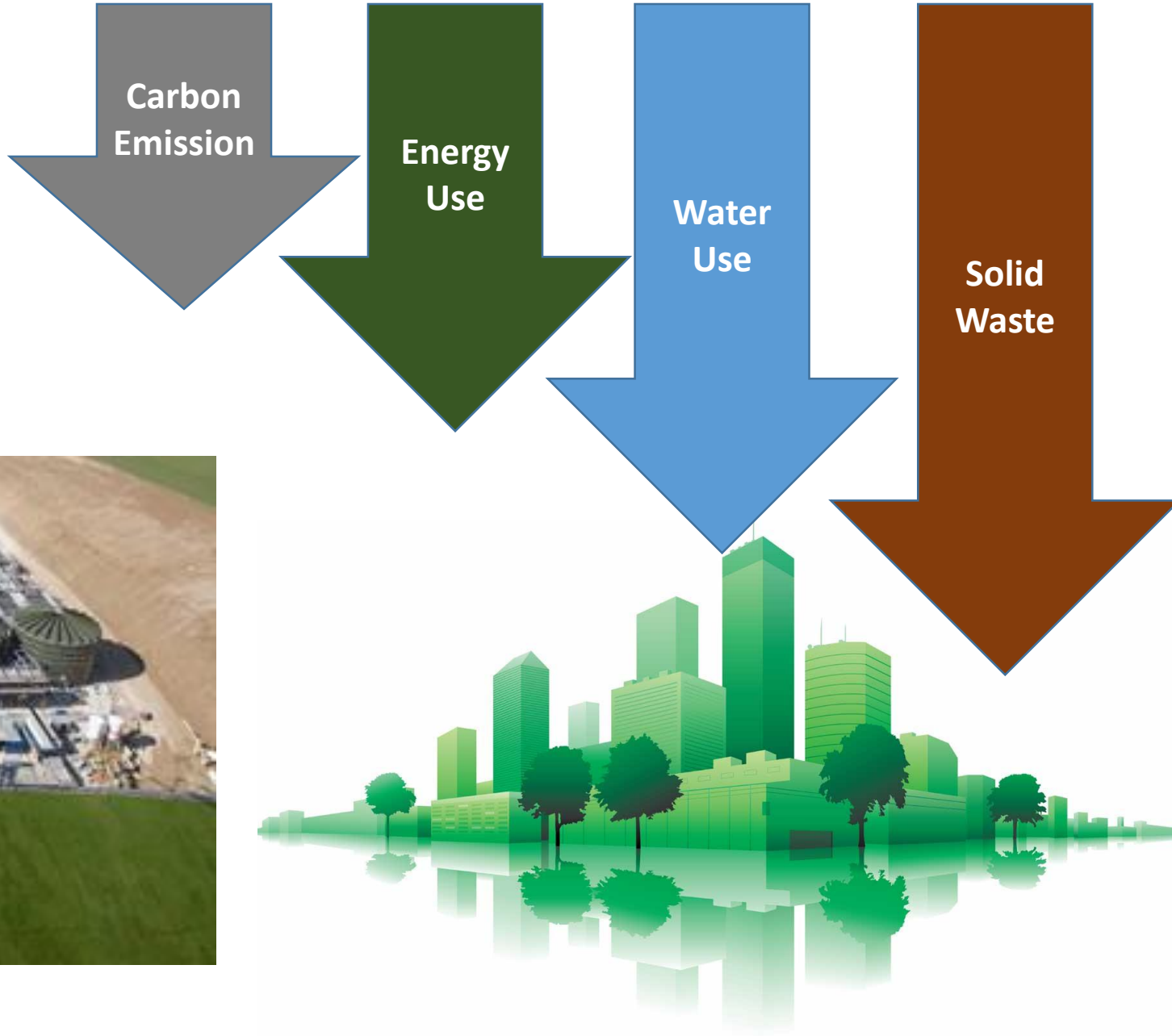
Energy efficient appliances

Waste to energy

Mitigation of water-energy nexus and need of research

Adopting green building concept

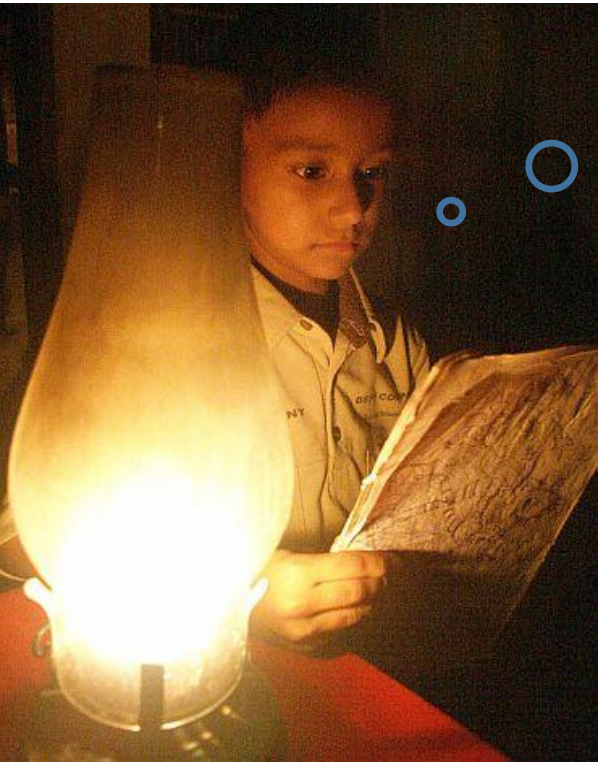
Energy efficiency, Water efficiency, Material efficiency, Waste and toxics reduction



Green roof

SAVE ENERGY TO SAVE WATER

SAVE WATER TO SAVE ENERGY



Let’s work together
and fulfill their dreams

Thanks