

TD 603

Water Resources

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Lecture 1: A Perspective

Outline

Two parts:

- **The technical side to water.** -M. Sohoni
 - ▶ The basic hydrological cycle.
 - ▶ Surface and Groundwater-the watershed approach
 - ▶ Basics of groundwater.-simulations
 - ▶ Interventions.
- **The societal side to water.** -N. C. Narayanan

Texts

- *Applied Hydrogeology*, by C. W. Fetter, in the study room.
- *Groundwater Hydrology*, by K. R. Rushton, in the study room.
- *Basic ground-water hydrology* U.S. Geological Survey, Water Supply Paper 2220 by Ralph C. Heath, available on moodle and on the web.
- *Minor Irrigation Handbook*, Govt. of Maharashtra.
- Sundry papers.

Water

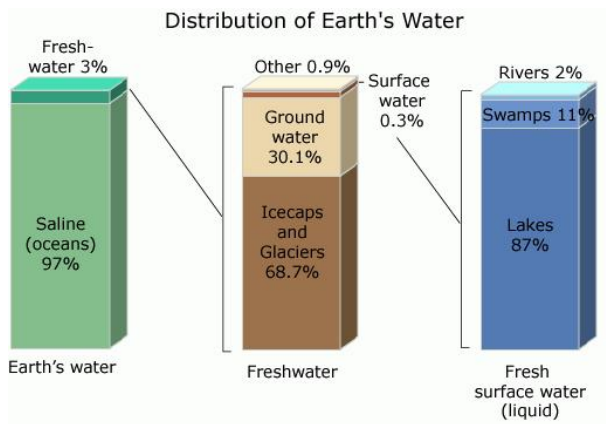
- Chemical formula H_2O . The existence of strong *hydrogen bond*
- Exists in nature as Ice, water and vapour. Melting point 0 C, boiling point 100 C.
- Specific heat (water): 1 calorie/gm/degree C. **Second highest!**
 - ▶ very important for temperature regulation
- Density (water) 1gm/ml, maximum at 4 C. Ice floats on water.
 - ▶ very important for the existence of marine life.
- High surface tension and therefore strong capillary action.
 - ▶ very important for the sustenance of plants.
- Coefficient of thermal expansion (linear): $70 \times 10^{-6} /C$.
 - ▶ Roughly 5mm of sea-level rise due to thermal expansion alone. **Can we explain this?**

Life and water

- Roughly 60% of body weight is water.
- Water-key ingredient in most life processes-photosynthesis, energy transfer in animals, and so on.
- Life as we know it is water-centric (and organic carbon-centric).
- Water in the solar system:
 - ▶ Mercury atmosphere- roughly 4%
 - ▶ Enceladus (a moon of Saturn)- 91 %
 - ▶ recently-traces on the Moon.
- In general, earth is the only body which is (i) at the right distance from the sun, (ii) has a strong enough gravity to retain an atmosphere, and (iii) has water.
- Besides, early civilizations also revolved around water.

Water on Earth

- Roughly 71 % of earth's area are the oceans, i.e., about 36 b.Ha.
 - ▶ Average depth of oceans: 3790m.
 - ▶ Salt content: 3%



source:Wikipedia.

Water availability

Total **renewable** (defined using the water cycle) per-capita, per year.

Country	cu. m.
Congo	275,000
Canada	94,000
Brazil	48,000
Mongolia, Indonesia	13,000
Japan, Italy, Iraq	3300
Pakistan	2700
China	2200
India	1880
Germany , Ethiopia	1800
Israel	275

Roughly 3000 cu.km fall on India, of which roughly 300 cu.km. are used as surface water and about 200 cu. km. as ground water.

The main sectors

Use	India	Developed Countries
Agricultural	85%	25 %
Industrial	8 %	60 %
Domestic	7 %	15 %

Indian Hall-marks:

- Very low charges for agricultural water (Rs. 0.10 /cu.m.). Roughly Rs. 10 per cu.m. for domestic use, and Rs. 50 for industrial use.
- Investment of Rs. 150-200 required to develop a cubic meter of renewable resource.
- Very poor domestic use network.
- Limited use of water saving practices in agriculture.

Agriculture

- 330 m.Ha, total, 180 m. Ha cultivable area. 110 m.Ha. irrigation potential, 54 m. Ha actually under irrigation.
- Only 25-30 % irrigation through canals.
- More than 50 % through tube-wells and open-wells.
- indication of poor canal infrastructure.
- Two typical water allocation systems, *shejpali* (pre-bid allocation), and *wadabandi*, fixed rotation.
- Typical billing, if at all, is per crop-acre and not volumetric.

Water needs

Substance	Needs (in liters)
1kg Rice	1900
1kg Chicken	3300
1kg Wheat	1000
1kg Wool	150
1kg Sugar	3000
1kg Gur	1000

- The numbers depend on the technology used. Drip Irrigation will typically reduce consumption by about 50 %.
- So why is there so much ruckus about sugarcane?

Fishing

Besides being a food, Fish is also an important source of protein.
Here is the fishing data for 2004 (F.A.O). Amounts are in million tonnes.

Country	Wild	Farms	Per-Capita/year (kg)
World	94	45	23
India	3.4	2.8	6.2
Iceland	1.8	0	??

Here is the consumption data (in kg. per capita/year):

France	28	Japan	60
China	28	Brazil	6
USA	21	UAE	27
Yemen	7	India	5

India is thus a fish-exporter!

- Wild production: 3kg/Ha.

Farm: 2000 kg/Ha.

Industrial Use

- 40,000 million cubic meters were consumed by indian industry in 2001.
- Thermal Power plants consumed 87% of this water.
- Engineering, Paper and Textiles consumed 5% , 2 % and 2% respectively.
- Very poor industrial productivity per cubic meter: \$ 7 /cu.m.
- 10-80 cu.m. per tonne of steel, no water recycling. In US 10 cu.m./tonne, full recycling.
- In power generation, again 80 cu.m. per Mwh, while global norm is 10-20.

<http://www.cseindia.org/dte-supplement/industry20040215/non-issue.htm>

Domestic Use

- Rough International Urban norm: 200 lpcd.
- Mumbai, roughly that, or a bit higher. Bangkok, London similar.
- Delhi, Chennai lower. Most cities in India plan for 150 lpcd or higher.

Surprisingly, rural design norm is 40 lpcd!

- Habitation is in stress if 40 lpcd is not met at any point of time within 2 km of the habitation.

What is domestic use

- Ablutions, Washing clothes, vessels, cleaning house.
- Drinking, cooking.
- Cattle?
- Livelihoods?

Maharashtra-Demographics-from govt. reports

Districts	33
Panchayat Samities	378
Gram Pachayats	27626
Habitations	86000
Rural Families	1.1 crores
Growth rate (decadal)	22 %
Area	307 lakh ha.
Population density	314 /sq.km. 3.1 /ha.
Grain requirement ¹	1130 kg./ha.
Percentage BPL	23.7

¹at 1kg/person-day

Land and Irrigation

Area	307 lakh ha.
Cultivable	225 lakh ha. (73 %)
Irrigated	39 lakh ha. (18 %)
Ground-water based irrigated	> 50 %
Country-wide average	43 %
Max. Irrigable	85 lakh ha.
Drought-prone	32 %

Watershed sub-units	2415
Average size	120 sq. km.
Critical and worse	460
Safe	1874

“Even in the safe category ... a large number ... become dry in the summer...”

Rural Drinking Water

Total habitats	86,000
> 40 LPD	62,000 (68 %)
Dependence on ground-water	> 80%
summer tankers	5,500
dug-wells	90,000
bore-well hand-pumps	2,20,000
non-functional	12,000
piped water supply schemes	18,500

“Even those which are treated as fully covered, the service levels are reduced during summer months”

Discussion

- 1 What is a mechanical fly-wheel and what is its role in machines?
- 2 Discuss the role of river-valleys in early civilizations.
- 3 Why do you think is the rural drinking water infrastructure so poor?
- 4 How would rural communities use a 200 lpcd norm?