Water Conservation for Maintaining Ecosystem Services

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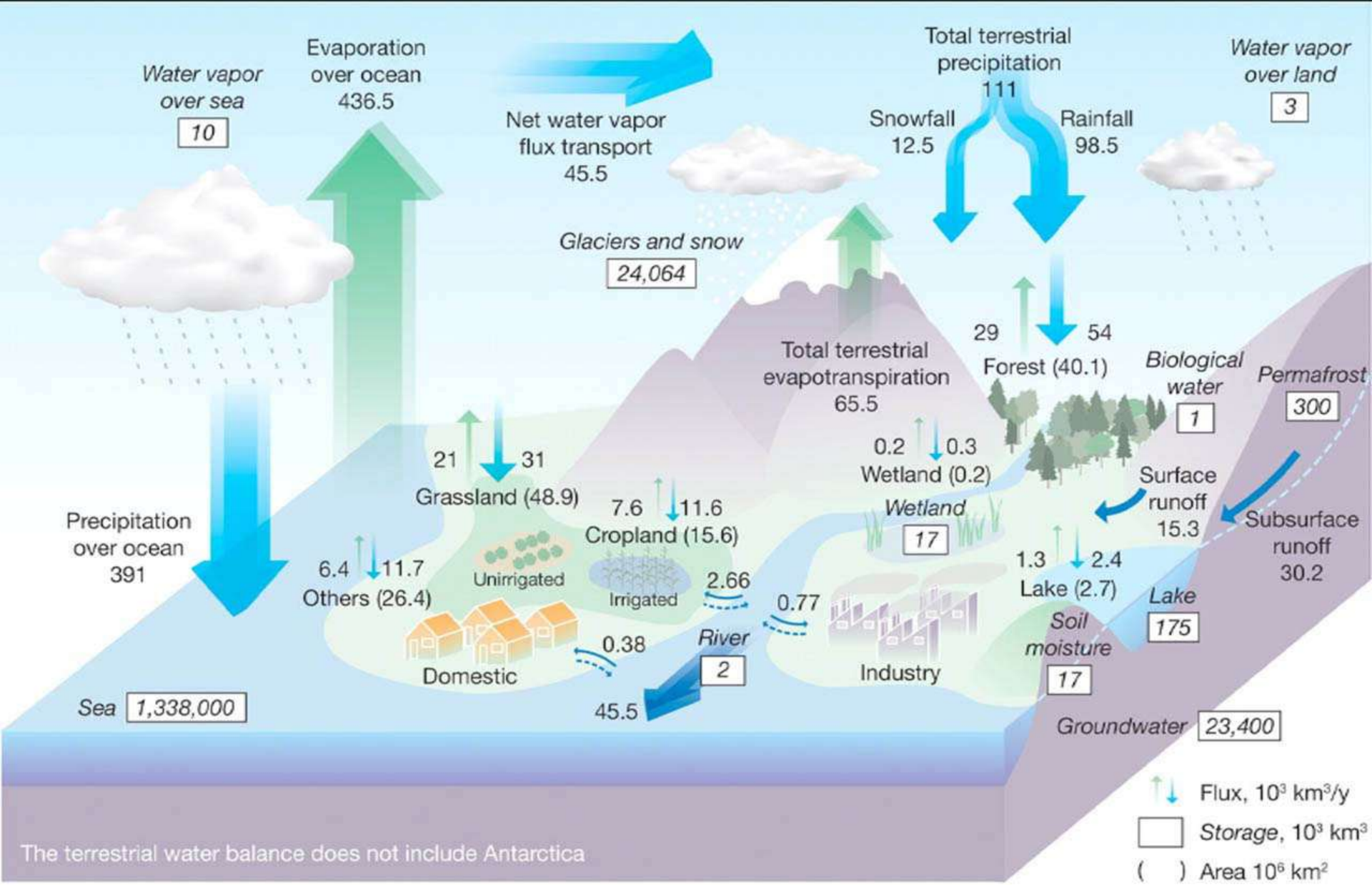
Global water reserves

total water reserves	1.385.968.000	km^3	100	%
total *fresh*water reserves	35.029.000	km^3	2.53	%
total *fresh*water reserves	35.029.000	km^3	100	%
In glaciers and snow	24.064.000	km^3	68.7	%
in ground water	10.530.000	km^3	30.0	%
In permafrost	300.000	km^3	0.86	%
In lakes	91.000	km^3	0.26	%
In soil moisture	16.500	km^3	0.047	%
In atmosphere	12.900	km^3	0.037	%
In swamps	11.470	km^3	0.033	%
in rivers	**2.120**	**km^3**	**0.0061**	**%**
In bio mass	1.120	km^3	0.0032	%
average annual freshwater surface water flux to the oceans	**44.500**	**km^3/a**	**~20**	**1/a**

based on Igor A. Shiklomanov's table 2.1 of chapter 2 in Gleick, P.H. (ed.) (1993), Water in Crisis: A Guide to the World's Fresh Water Resources. Oxford University Press. New York, 1993



Global Water Cycle

Hydrological Cycle binds together the components of atmosphere, lithosphere, biosphere and atmosphere. It ensures the availability of water to humans and nature resources.

Humans disrupt water cycle at every step – changing the pathways and the rates of flow.

This is reflected in the view.
“Let not a drop of water go waste into the sea”

Humans have appropriated increasingly more water for themselves and their numerous activities.

We consider water as a commodity to be allocated among users which become stakeholders. Now there are many human stakeholders and NATURE – the provider and sustainer of water – is just another stakeholder.

Human Use of Flows in India

Annual water requirement for different uses (in km3)

		2010			2050	
	1997–98	Low	High	%	Low	High	%
Surface water							
Irrigation	318	330	339	48	375	463	39
Domestic	17	23	24	3	48	65	6
Industries	21	26	26	4	57	57	5
Power	7	14	15	2	50	56	5
Inland navigation	7	7	7	1	15	15	1
Environment–Ecology	5	5	7	1	20	20	2
Evaporation losses	36	42	42	6	76	76	6
Total	399	447	458	65	641	752	64
Groundwater							
Irrigation	206	213	218	31	253	344	29
Domestic	13	19	19	2	42	46	4
Industries	9	11	11	1	24	24	2
Power	2	4	4	1	13	14	1
Total	230	247	252	35	332	428	36
Grand total	629	694	710	100	973	1180	100

Annual Precipitation 4000 km3 Total river flow 1953 km3
Total utilizable surface water (river flow) 690 km3
Total replenishable groundwater resource 432 km3
Total utilizable groundwater resource 396 km3

from National Commission for Integrated Water Resources Development, 1999

Conservation

Demand for Water Disproportionate to natural availability

Disposal of all kinds of wastes into water

Humans are the only organism which creates chemicals which are unknown to nature but end up after a short life cycle into water.

Focus on Quantity and Quality from Human Perspective

Conservation Strategies

Recycle, Reuse, and

Rainwater Harvesting

emphasise

quantitative dimension

Problems in Conservation

We do not recognise or ignore

Land-Water Linkages
Importance of Natural Variability in Availability
Needs of Non-human Stakeholders
Needs for Ecosystem Services

The Upland-Lowland Linkages

All natural or Anthropogenic Changes in
Terrestrial Systems impact upon the Aquatic Ecosystems
These Impacts are Always Ignored

Many Ecosystem Services provided Downstream
Biodiversity
Fisheries
Water Quality
Sediments and Fertility
Habitat Diversity
Influence on Climate
Altered by Impacts from Terrestrial Ecosystems

SERVICES PROVIDED BY AQUATIC ECOSYSTEMS

SERVICES	Examples
Provisioning	
Food	production of fish, wild game, fruits, and grains (rice)
Fresh water[a]	Storage and retention of water for domestic, industrial, and agricultural use
Fiber and fuel	production of timber, fuelwood, peat, fodder
Biochemical	extraction of medicines and other materials from biota
Genetic materials	genes for resistance to plant pathogens, ornamental species, etc.
Regulating	
Climate regulation	source of and sink for greenhouse gases; influence local and regional temperature, precipitation, and other climatic processes
Water regulation (hydrological flows)	Groundwater recharge/discharge
Water purification and waste treatment	retention, recovery, and removal of excess nutrients and other pollutants
Erosion regulation	Retention of soils and sediments
Natural hazard regulation	flood control, storm protection
Pollination	Habitat for pollinators

SERVICES PROVIDED BY AQUATIC ECOSYSTEMS

Cultural	
Spiritual and inspirational aspects	**source of inspiration; many religions attach spiritual and religious values (sacred lakes, rivers)**
Recreational	**Opportunities for recreational activities**
Aesthetic	**Scenic beauty or enhancement of aesthetics of landscape**
Educational	**Opportunities for formal and informal education and training**
Supporting	
Soil formation	**Sediment retention and accumulation of organic matter**
Nutrient cycling	**Storage, recycling, processing, and acquisition of nutrients**

Are Rivers mere conduits for Water?

Function of Rivers
(Ecosystem Goods and Services)

Water Quality : Processing of Wastes
Water: Transport downstream; Groundwater Recharge
Biodiversity and Fisheries
Soil Building (sediment, nutrients & organic matter)
Navigation and transport of goods
Recreation & Aesthetics
Cultural Tourism
Microclimate
Coastal Systems & Fisheries
Associated Livelihoods

Why do we need FLOW in our rivers?

Upstream vs Downstream Communities

Specific Reaches vs Entire River vs Coastal Areas
OR
River Basin

Bathing, swimming, rafting?
Fishing? Sediments (Gravel, Sand)?
Waste assimilation?
Groundwater recharge?
Birds? Wildlife? Floodplain Grazing?

What does the community value more?
Off-stream benefits OR In-Stream benefits

Impacts of Large, Deep Reservoirs

Submergence
Killing vegetation
Release of nutrients
Anoxia
Spread of weeds
(Kakki reservoir in Kerala)

Rapid Siltation → Shallowing → Marsh formation

Changes in Water Quality

Natural fisheries reduced

Aquatic vegetation may develop or get reduced or modified

Culture fisheries can be promoted
(depends upon the depth of the reservoir)

Downstream Impacts

No flow/ reduced flow/reduced flooding

Reduced sediment availability
Change in Habitats – Pools, Prolonged drying
Floodplain vegetation lost
Other aquatic life lost
Breeding and feeding habitats lost
Upstream Fish Migration restricted

Rapid Degradation in Water Quality

Rapid decline in fish catch
Loss of livelihoods; Economic loss

Upstream gains do not compensate downstream losses

Ecosystem Services Dependent upon Flow

- Transport and deposition of sediments along river course
- Watering Floodplain wetlands
- Recharging groundwater
- Moderation of salinity

Role of Floodplains

Supply of good quality water
Resources: fish, reeds and forage
Purification of wastes
Flood protection
Agriculture and fisheries
Recreation, aesthetics, social-cultural activity
Eco-tourism
Support estuarine and marine species
Support terrestrial species

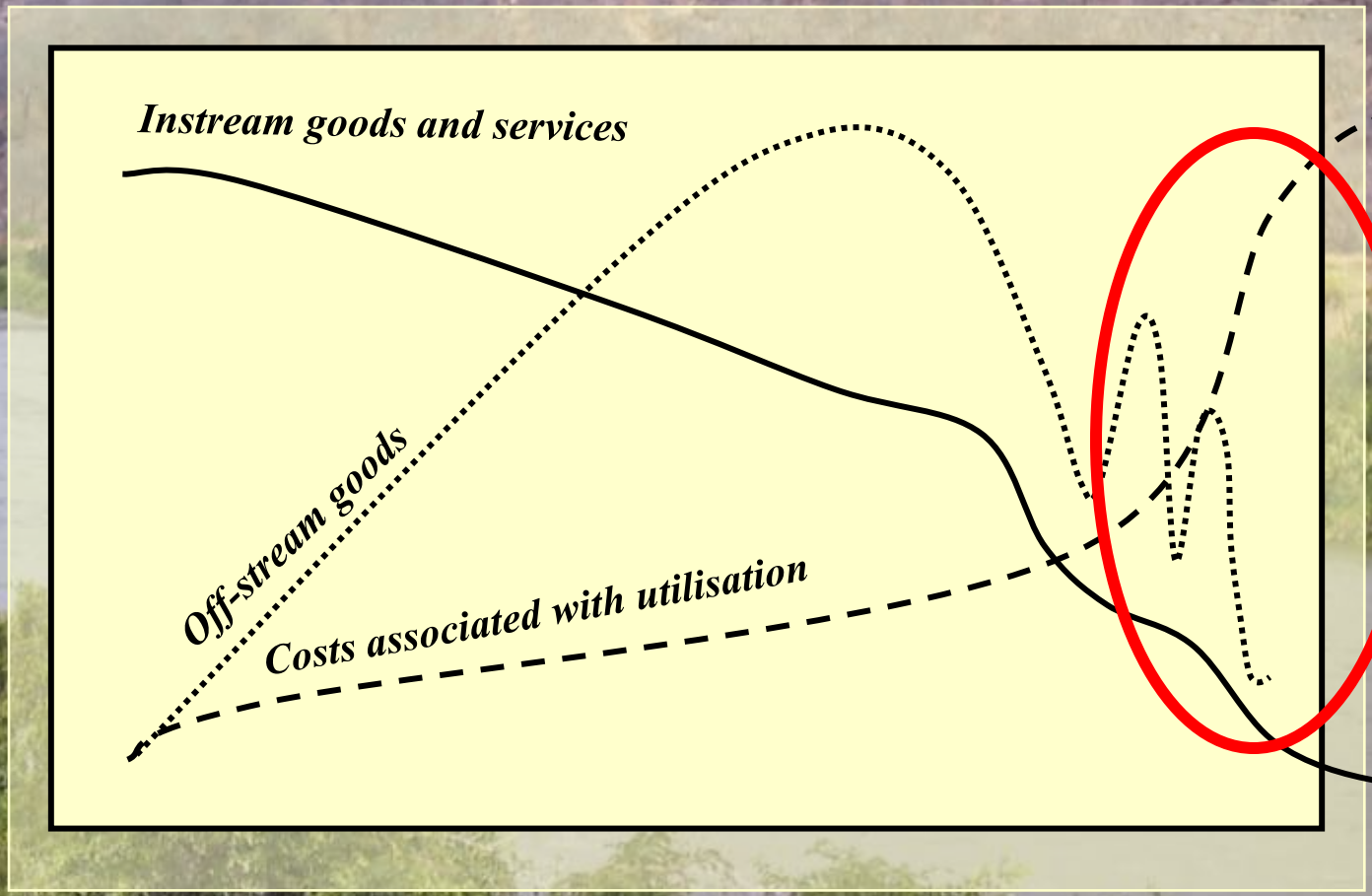
livelihoods, food, income, quality of life for communities

Valuation of Ecosystem Services

Disruption of natural flows and alteration of pathways of the hydrological cycle directly cause a loss of ecosystem goods and services that often are not offset or compensated by the benefits derived from human uses of water.

Cost-benefit analysis of water resource use must take into account the ecosystem services.

Instream and offstream goods and services



From Cate Brown)

Goods and Services of River Ecosystems Need Proper Evaluation


River Yamuna near Asan Barrage
Thank You