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NPTEL ONLINE CERTIFICATION COURSES

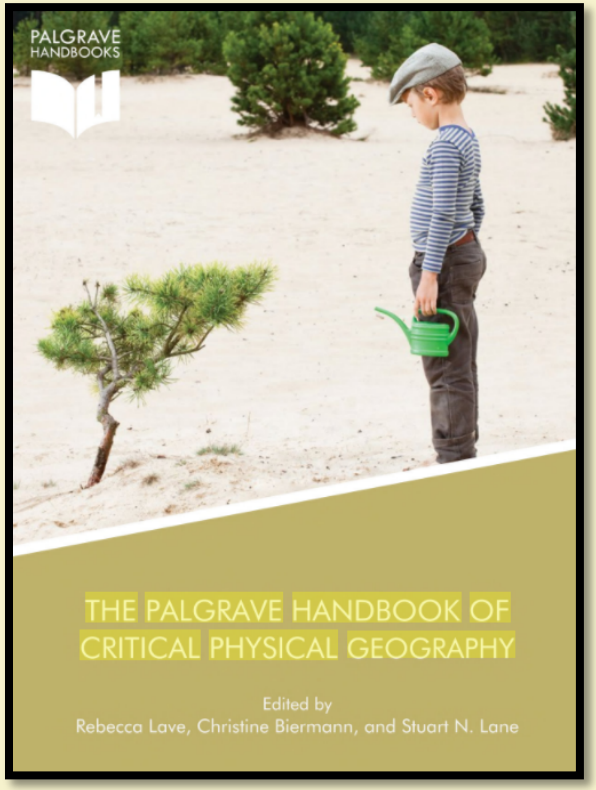
Water, Society and Sustainability

Lecture No 6: Critical Physical Geography (CPG)

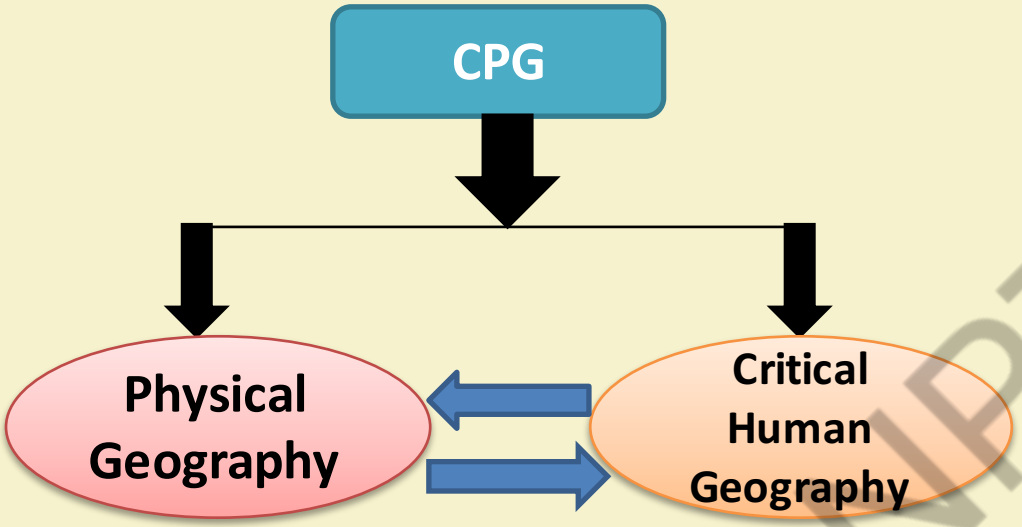
Jenia Mukherjee
Department of Humanities and Social Sciences
IIT KHARAGPUR

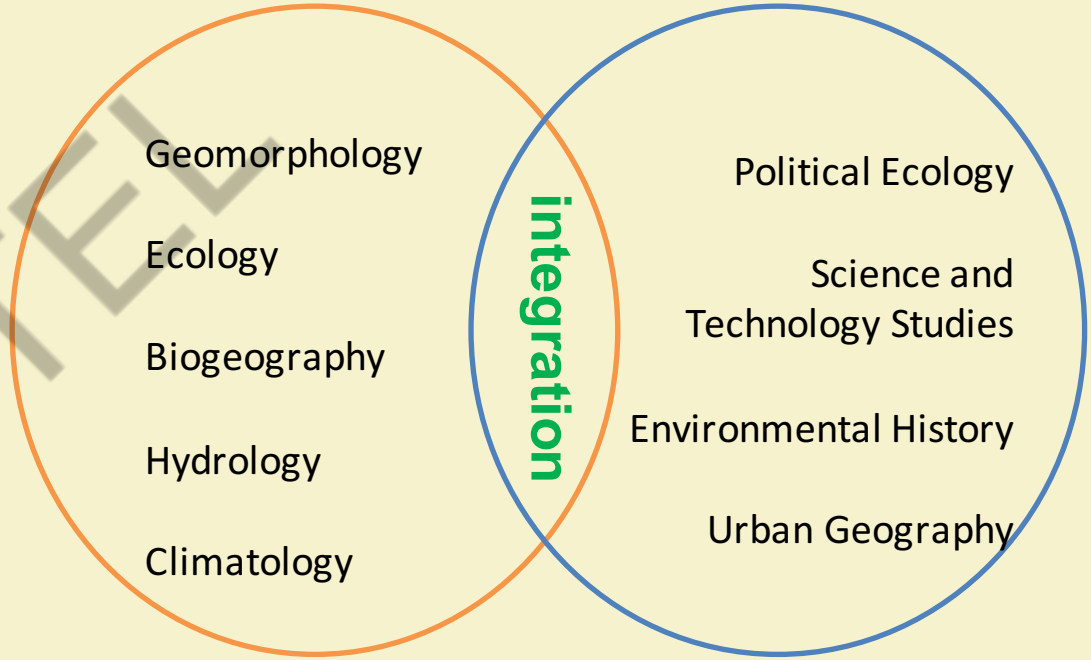
Route map

- What is CPG?
- Why CPG?
- How CPG?
  [within riverine contexts]
- Mobilizing CPG
  [radicalizing river research]



What is CPG?





[from 'bipolarity' to 'integration']

…we cannot rely on explanations grounded in physical or critical human geography alone because socio-biophysical landscapes are as much the product of unequal power relations, histories of colonialism, and racial and gender disparities as they are of hydrology, ecology, and climate change. Critical physical geography is thus based in the careful integrative work necessary to render this co-production legible.

(Lave et al., 2014: 2–3)

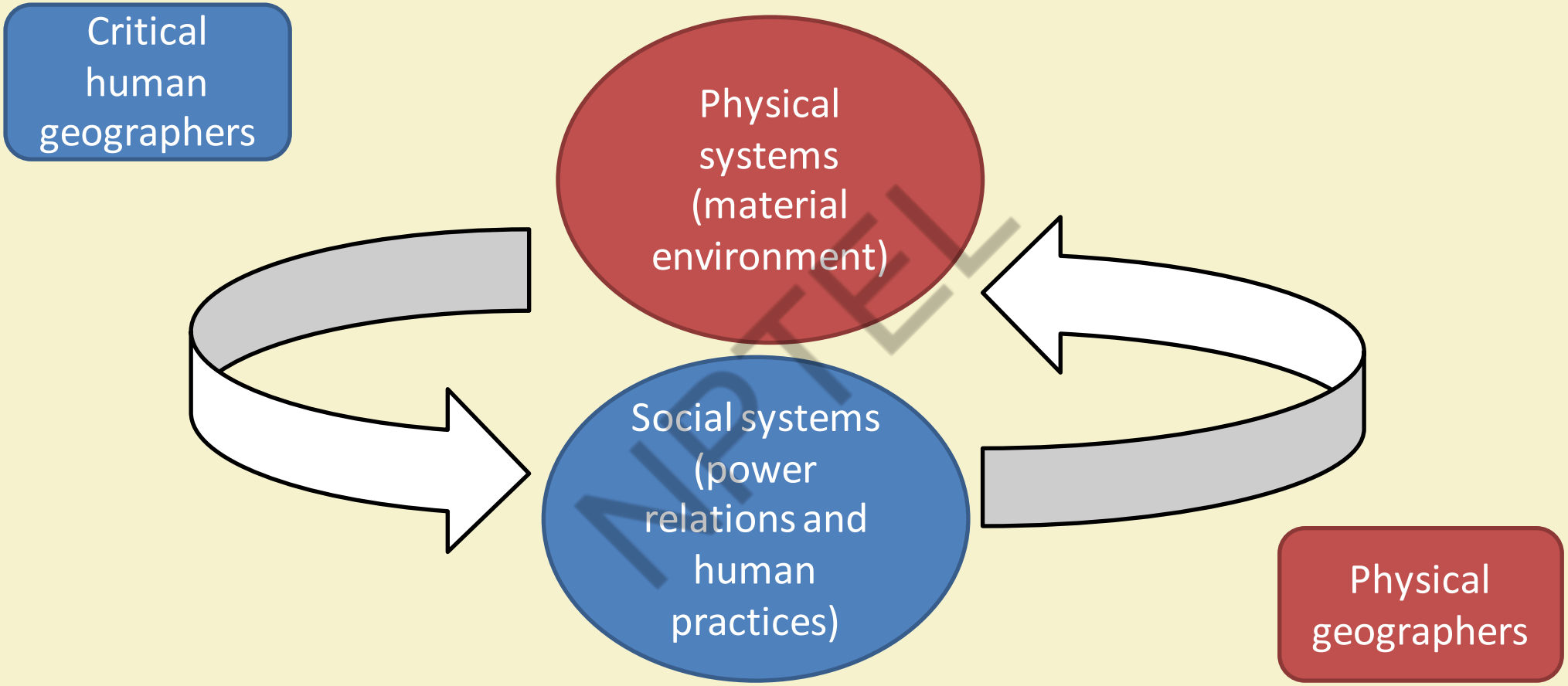
CPG evolves…

- Precedence in biogeography (Vale 1982; Denevan 1992)

- Three decades of work in:
  - Political ecology (Blaikie 1985; Blaikie and Brookfield 1987; Robbins 2012)
  - Environmental history (Watts 1985; Cronon 1995)

"…while political ecology has done a great deal to foreground our always-politicized interactions with the biophysical environment, it frequently privileges social processes/theories in the explanation of biophysical situations" (Lave et al. 2014: 3).

The "ecology" is rarely an equal partner to the "political" (Walker 2005).


Critical human geographers
Physical systems (material environment)
Social systems (power relations and human practices)
Physical geographers

- Flood science within a wider participatory framework (Lane et al. 2018)
- Pain and team; Rivers Trust Group (Pain et al. 2011)

Participatory Action Research

- agency to affected and interested people
- trust members:
  - ✓ collected data
  - ✓ conducted analysis with support from scientists
  - ✓ discussed the implications of their findings
  - ✓ planned and implemented follow-up action

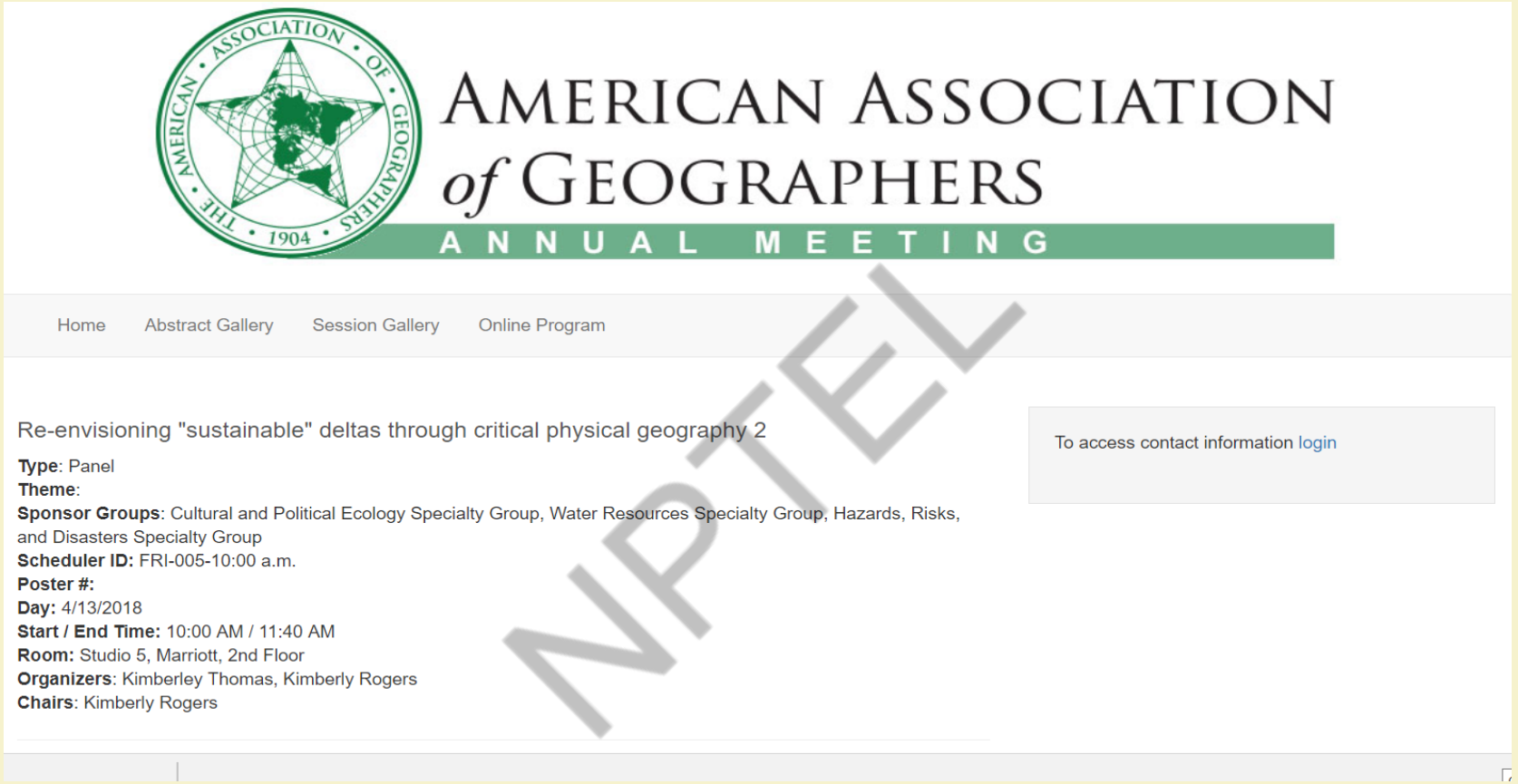
- series of maps of:
  - ✓ land cover
  - ✓ risk across the catchment
- a model to identify farm vulnerability, allowing locally tailored and politically sensitive solutions to slurry pollution

- CPG's contribution to geomorphology (Blue and Brierley 2016)
  - Politics and social relations shaping geomorphology and also physical geographers
    Not everything that can be counted counts. Not everything that counts can be counted
    (Cameron 1963: 13)
  - Need for development of rigorous, place-based and democratic understandings of landscape
  - Lacks detailed methodological and practical analyses

The Upper Yellow River, Dari, China

- the interplay between human agency and biophysical processes in the agricultural landscape of the Midwestern United States (Urban & Rhoads 2003)

- ‘overflow irrigation’ in Bengal (Klingensmith 2001)



https://aag.secure-abstracts.com/AAG%20Annual%20Meeting%202018/sessions-gallery/11181

Mobilizing CPG as an important frame of analysis

socio-biophysical landscapes are as much the product of unequal power relations, histories of colonialism, and racial and gender disparities as they are of hydrology, ecology, and climate change

South Asian context

- huge, complex diverse in terms of both physical and socio-political dimensions
- from theorization to policy recommendations to radicalizing river research

…that passes from the dark ages to the golden ages of ***a truer, purer, and, above all, better*** kind of analyses (Lane 2018)

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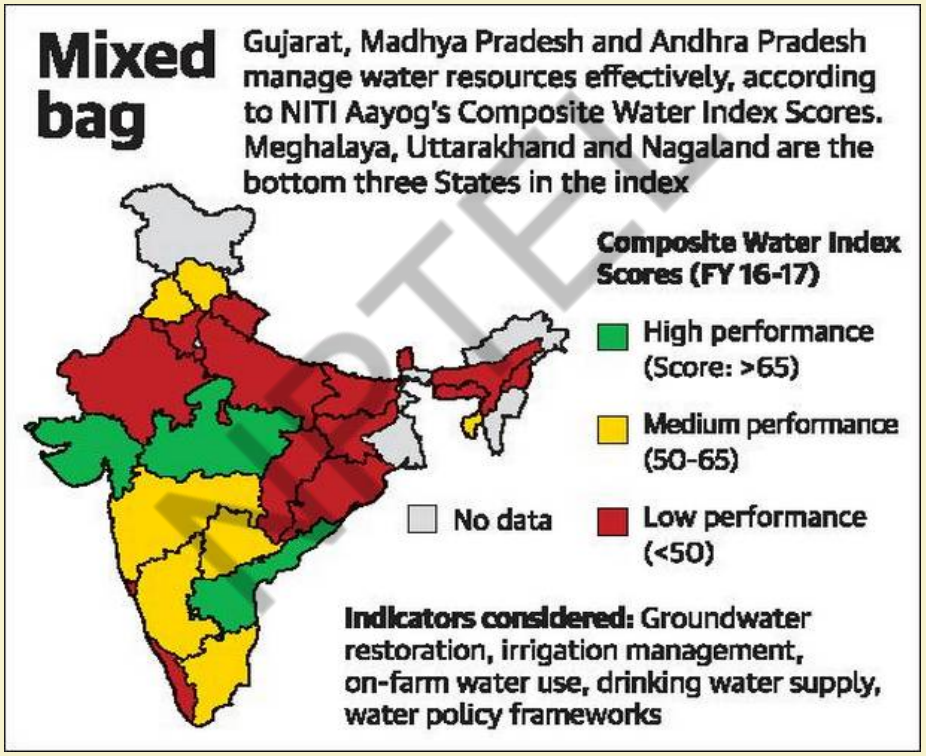
Water, Society and Sustainability

Lecture No 7: The South Asian Context

Jenia Mukherjee
Department of Humanities and Social Sciences
IIT KHARAGPUR

The NITI Aayog Report 2018

https://www.youtube.com/watch?v=3BdsXiEPv44



Why South Asia?

BI-MONTHLY NEWSLETTER OF THE EU-INDIA PROJECT E-QUAL
VOLUME 3, ISSUE 3, MAY 2016

Towards Environmental Humanities: Relevance, Approaches and Agenda within the Indian Context

Jenia Mukherjee and Purbita Chowdhury

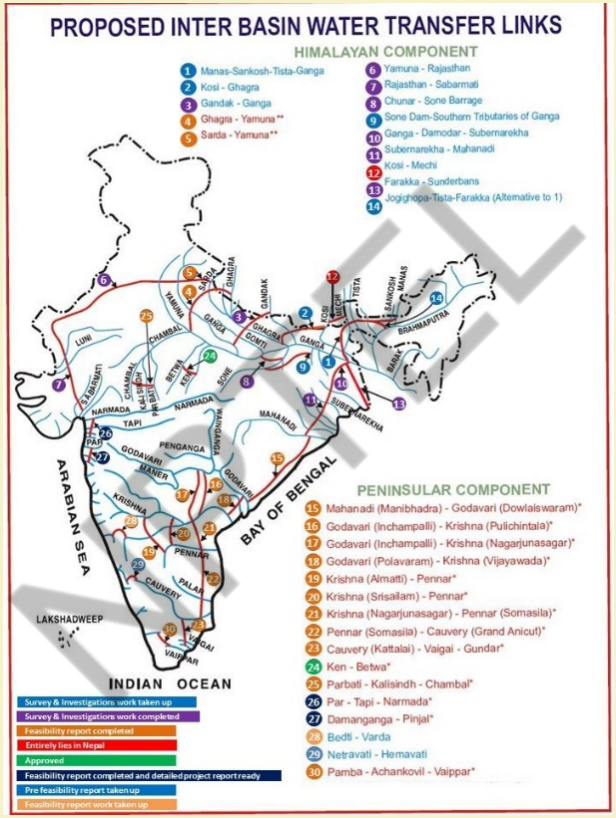
- The context is divergent from the west; apart from global environmental problems, it encounters 'additional' vulnerability connected to the long historical past of colonial intervention and subjugation, and its continued legacy in the post-independence years, especially against profound and prominent functioning of trans-national aid agencies.
- It offers rich historical traditions of ecological and humanistic knowledge and wisdom that were deliberately not provided agency or accorded importance strictly due to political reasons like enforcing a cultural hegemony and economic manoeuvrings.

Contd.

- the scene is huge, diverse and complex thickly loaded with:
  - colonial encounters
  - decolonized ideologies of development
  - trans-boundary complexities - shared rivers

- offers knowledge, expertise and wisdom beyond mainstream, 'modern', Eurocentric paradigm
  - have the transformative potentials
  - can be operated at scales

Interlinking of Rivers



Source: http://www.indiawaterportal.org/articles/national-river-linking-project-dream-or-disaster

The 'Grand' Initiative

- National Water Development Agency (http://nwda.gov.in/content/):
  - 14 inter-link projects for Himalayan component
  - 16 inter-link projects for Peninsular component
  - 37 intrastate river linking projects
- To link or not to link!
- Social Concerns (Iyer 2002; Vombatkere 2003; Vaidyanathan 2003; Bandyopadhyay & Perveen 2004; Patkar, 2004)
- Environmental Concerns (Bandyopadhyay and Perveen 2004; Lakra et al. 2011)
- A matter of South Asian proportions (shared rivers); lack of international legal framework (Misra et al. 2007); unilateral decision for a multilateral project (Patkar 2004)

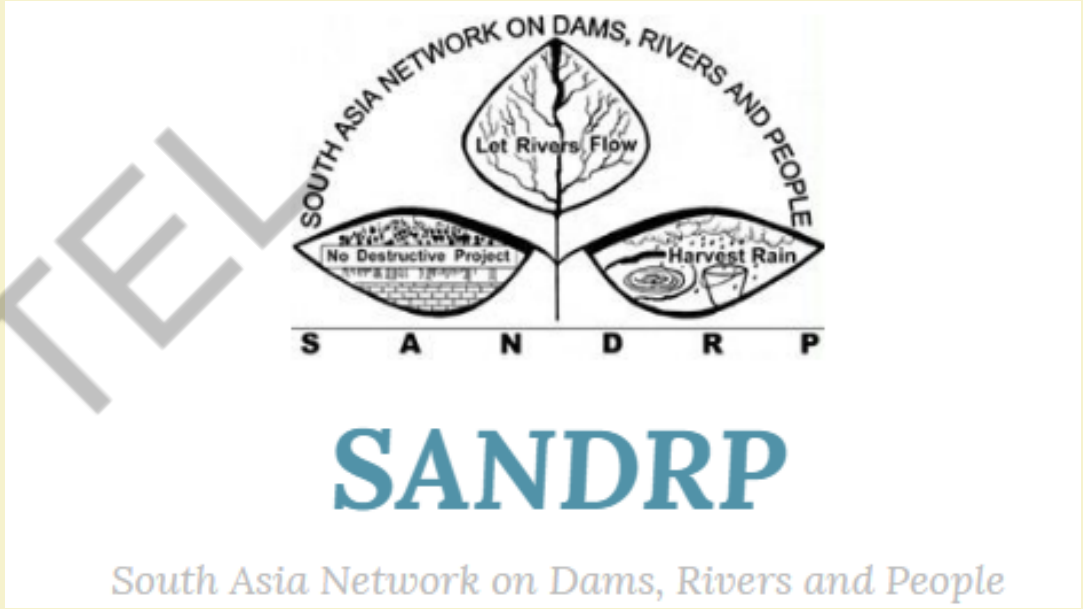
Why ILR?

- Is arithmetic expansion in irrigated land the only possible solution towards maintaining India's food security? (Bandyopadhyay & Perveen 2003)
- To be contextualized within South Asian hydrualic (interventionist) trajectory
    - Colonial encounters with South Asian waters
    - Continued legacy of 'modernist', 'western', 'big', 'scientific' hydraulic management discourses, policies and practices
- 'Colonial hydrology' (D'Souza 2006)
    - Embankment era
    - Perennial Irrigation
    - Multipurpose River Valley Development Projects (MPRVDPs)

Consequences and Implications

- Detailed surveys and findings by environmental (water) historians of South Asia (Mukherjee 2018)
- South Asia Network on Dams, Rivers and People (SANDRP)

  (https://sandrp.in/)
- MPRVDPs: South Asian basin-scale complexities and challenges



What Next?

- Where lies solutions for the South Asian water challenges?
- Do small-scale, cost-effective, local mechanisms, knowledge, technology, expertise offer river mouths?
- What can we learn from our past?
- Is it a fruitful exercise to explore and learn from pre-colonial water harvesting practices and techniques (that are believed) to had retained the water-society metabolism for centuries?
- Is the 'pre-colonial equilibrium' vs. 'colonial hydrology' binary valid?
- Do these pre-colonial techniques and practices have the potential to get implemented at scales during contemporary times?

Course Coverage: South Asian Waters

- Pre-colonial water scenario
- Colonial water management
- Post-independent MPRVDPs
  - Anti-dam resistance and protests
- Urban waters
  - Urban environmental history
  - Urban political ecology
- Peri-urban water justice in the Global South
  - Trans-local learning and explorations

Mobilizing the emerging theoretical frames of analysis: PE, HS (HSS), CPG

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Water, Society and Sustainability

Lecture No 8: Water Harvesting and Water Use Techniques in Ancient India

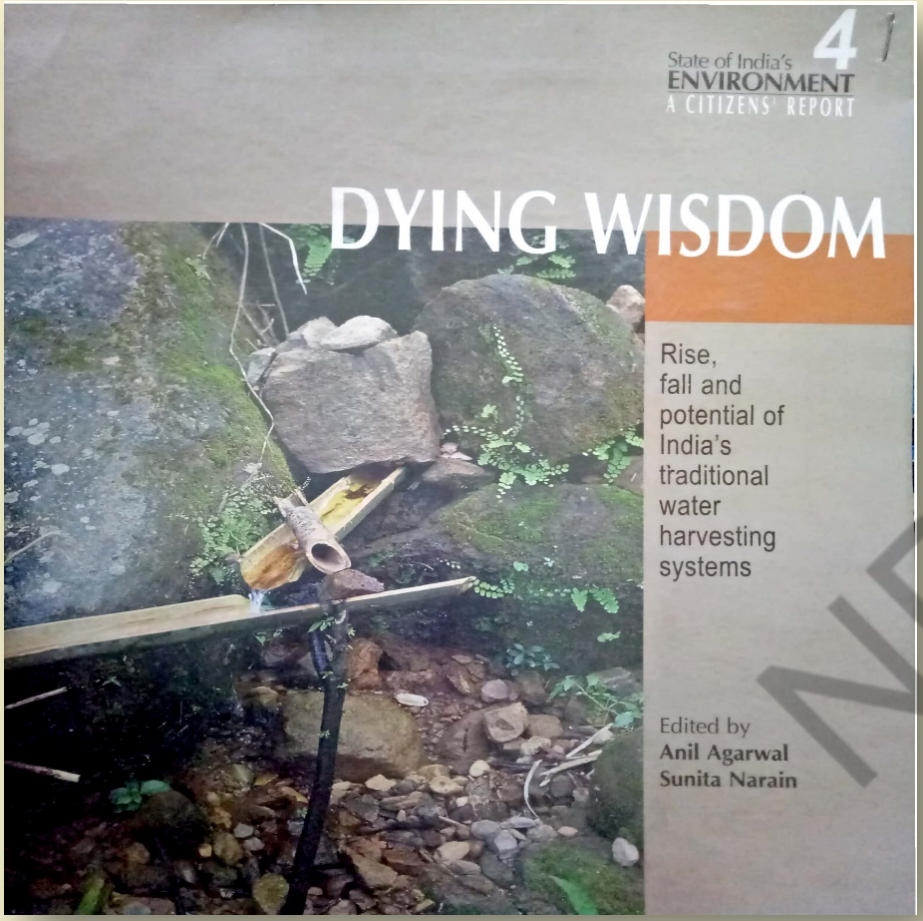
Jenia Mukherjee
Department of Humanities and Social Sciences
IIT KHARAGPUR

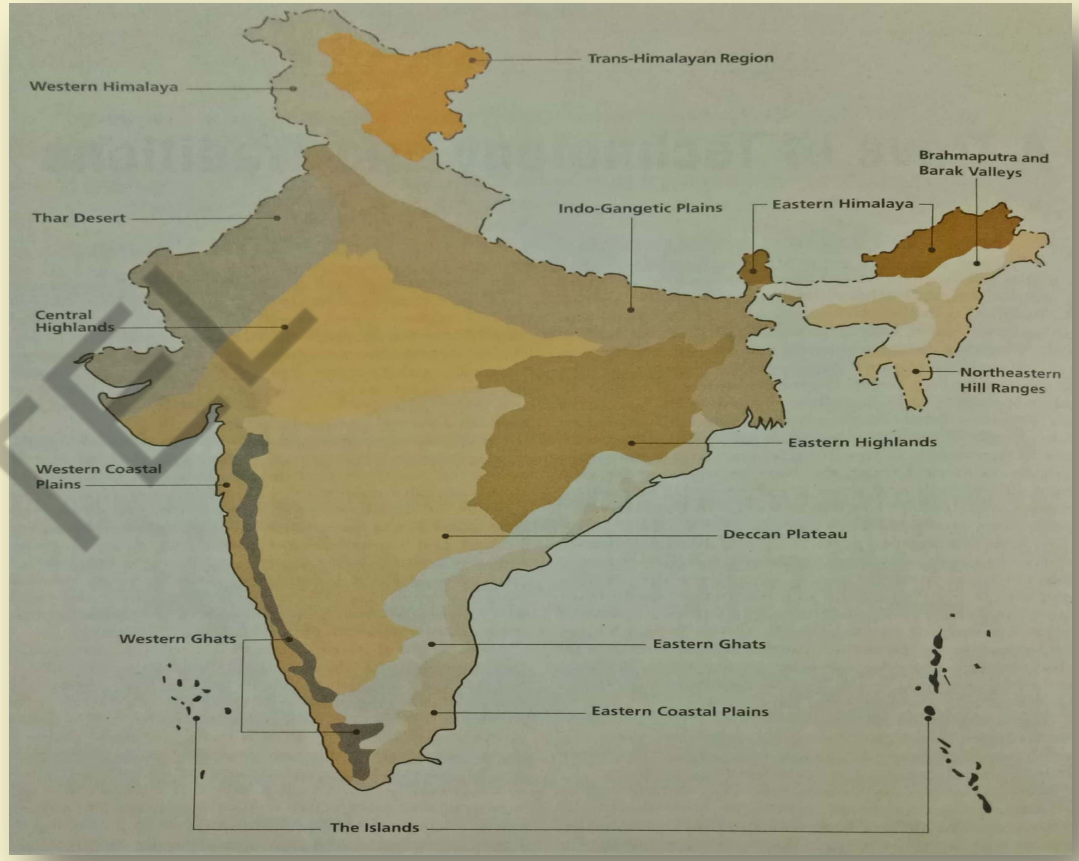
Why is back casting important?

"…a society which tries to move ahead without keeping itself firmly rooted in its own traditions, tends to fall" (Agarwal & Narain 1997: iv)

"The Indians have historically been the world's greatest water harvestors" (Agarwal & Narain 1997: 25)

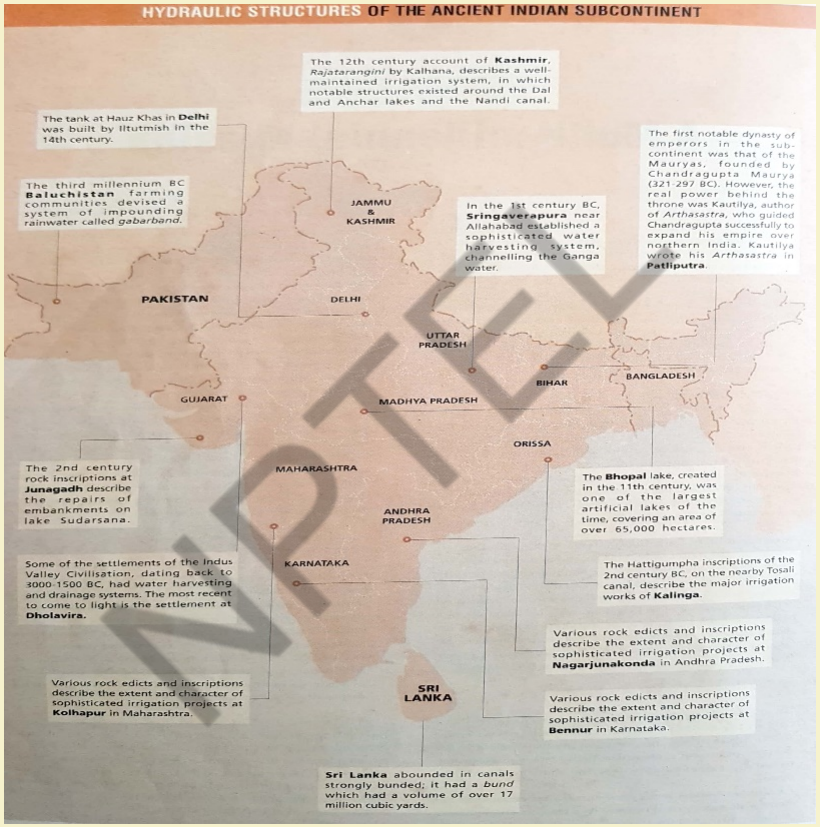
Development of a range of techniques to harvest every possible form of water – from rainwater to GW, stream to river water, and floodwater





Source: Agarwal & Narain 1997: 26

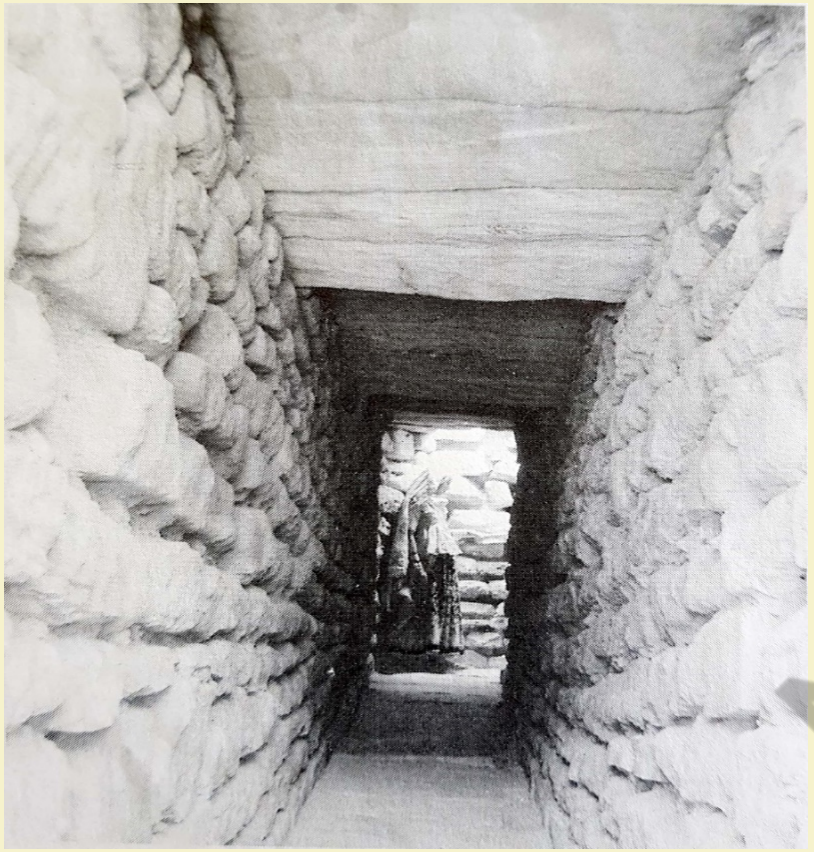
Historical sources and evidences



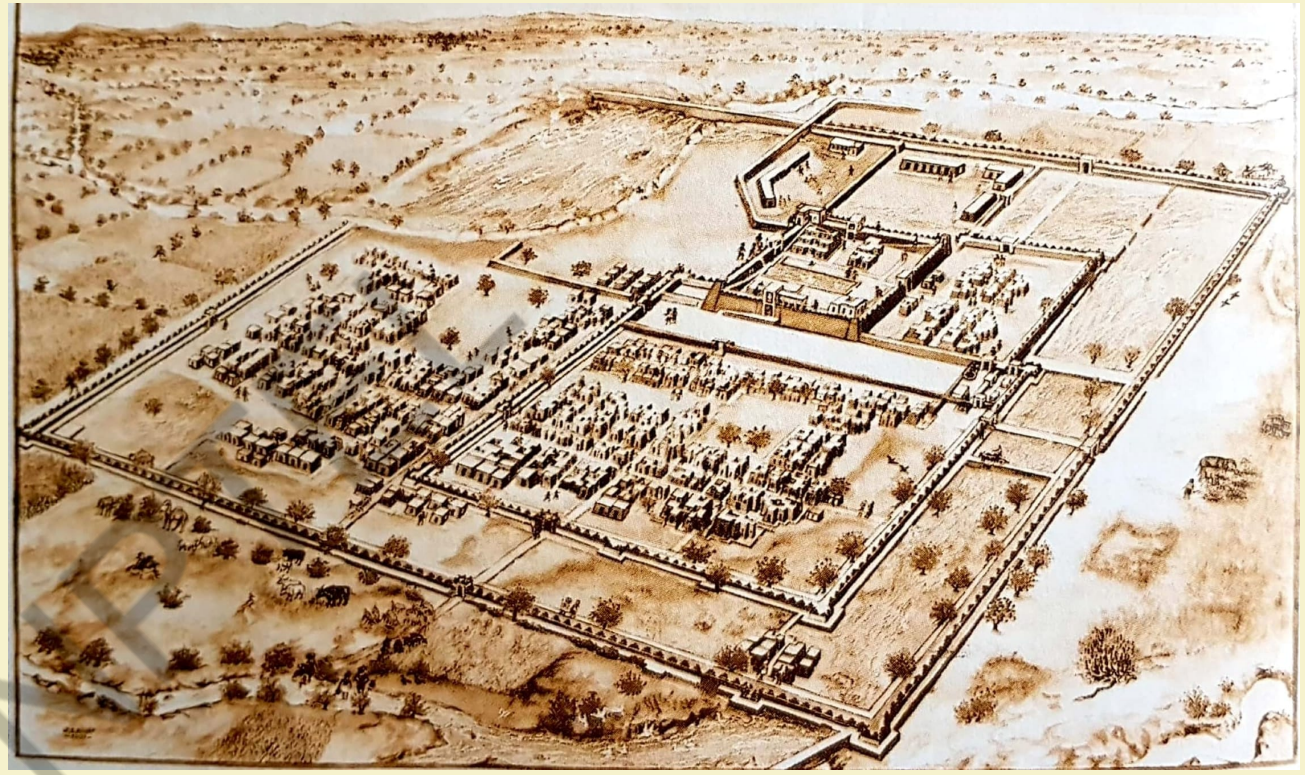
Source: Agarwal & Narain 1997: 12

The Indus Valley Civilization

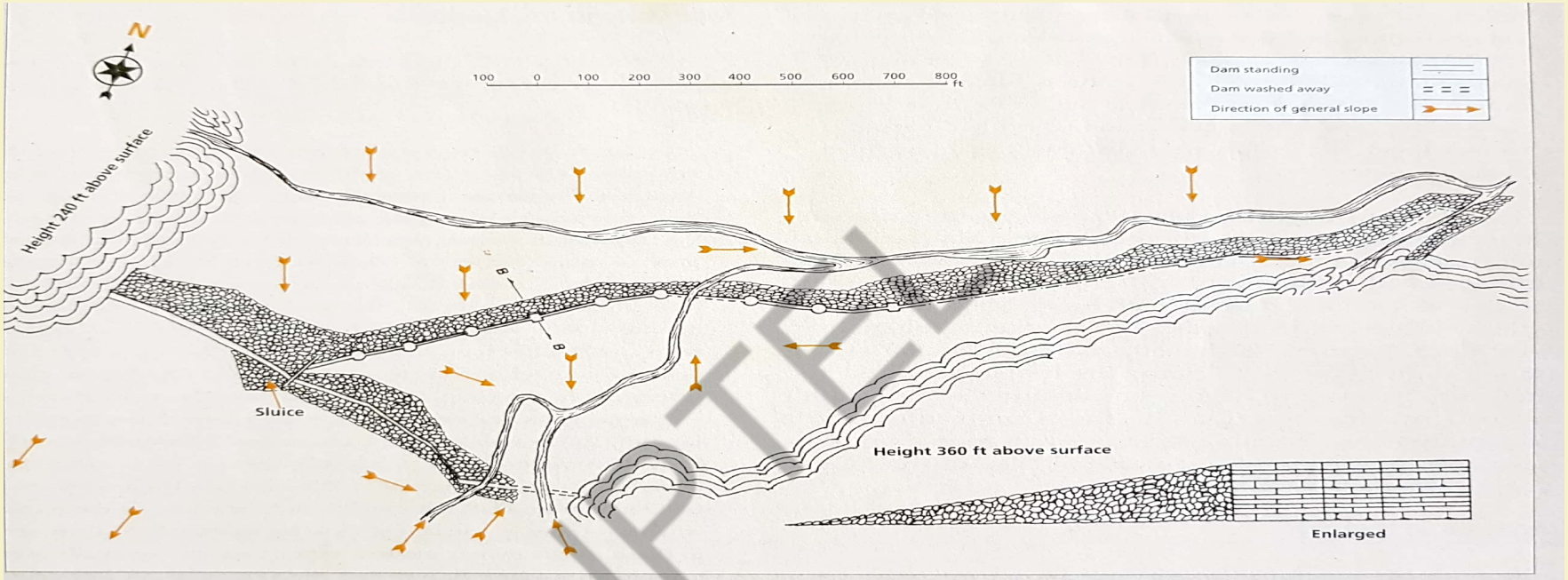
- efficient irrigation system in the outer areas
- wells in every HH site; 700 wells have been counted; digging wells for water might be a Harappan invention
- prevalence of artificial irrigation (Nuka, Kirthar-Kohistan region) similar to *gabarbands* of Baluchistan
- Dholavira – a sloping terrain between two stormwater channels and surrounded by series of water reservoirs



Storm Water Drain



Source: ASI, cited in Agarwal & Narain 1997: 20



Dams built of stone rubble are called *gabarbands* in Baluchistan, which have been assigned to the pre-Harappan period. These are a series of platforms which are about 60-120 cm high and rise in receding steps, gradually narrowing towards the top. These were used for controlling floodwater and retaining alluvium coming down the hills. The sketch shows the Pir Munaghara gabarband of Baluchistan.

Pir Munaghara *Gabarband*, Baluchistan
Source: Buller 1903-04

Typology of Indian Traditional Water Harvesting Systems

Ecological regions	Systems for agriculture	Systems for drinking water
1. Hill and mountain regions	a) Diversion channels leading directly to agricultural fields (eg. *guhls* and *kuhls* of western Himalaya). b) Occasionally, the channels first lead into a storage structure so that water can be used in the subsequent dry period, too (eg. *zings* of Ladakh).	a) Natural springs were often harvested. b) Rainwater harvesting from rooftops. c) In the Northeast, springwater is often carried over long distances with the help of bamboo pipes.
2. Arid and semi-arid regions	a) Rainfed storage structures which provided water for a command area downstream (eg. tanks). b) Stream or riverfed storage structures, sometimes built in a series, with overflow from one becoming runoff for the subsequent one (eg. system tanks of Tamil Nadu, *bandharas* of Maharashtra, *keres* of Karnataka). c) Rainfed storage structures, which allow runoff to stand over and moisten the fertile soil-bed of the storage structure itself, which is later used for growing crops (eg. *khadins* of the Jaisalmer district and *johads* of the Alwar district in Rajasthan).	a) Groundwater harvesting structures like wells and stepwells were built to tap groundwater aquifers (eg. *bavdis* of Rajasthan). b) Groundwater harvesting structures like wells and stepwells were invariably built wherever they were possible, especially below storage structures like tanks to collect clean seepage for use as drinking water (eg. several such structures can be found in the forts of Chittor and Ranthambhore). c) Rainwater harvesting from rooftops (eg. *tankas* of Pali). d) Rainwater harvesting using artificially created catchments which drain water into an artificial well — just about any land can be used to create such a water harvesting structure (eg. *kunds* of Rajasthan). e) Special rainwater harvesting structures which help to keep sweet rainwater from mixing with saline groundwater and, thus, providing a layer of potable water (eg. *virdas* of Kutch). f) Horizontal wells similar to the *qanats* of the Middle East to harvest seepage down hill slopes (eg. *surangams* of Kerala).

Source: Agarwal & Narain 1997: 27

Typology of Indian Traditional Water Harvesting Systems

3. Plains and flood plains	a) In the flood plains of major rivers, people built inundation channels which allowed floodwaters to be diverted to agricultural lands (eg. flood irrigation system of West Bengal). b) In specific types of soil and cropping regions, people also store rainwater in the agricultural fields by bunding them (eg. *haveli* system of Madhya Pradesh).	a) Dugwells.
4. Coastal areas	a) Regulatory systems to control ingress of saline riverwaters, especially during coastal tides, and thus maintain crop productivity in the coastal plains (eg. *khazana* lands of Goa).	a) Dugwells.

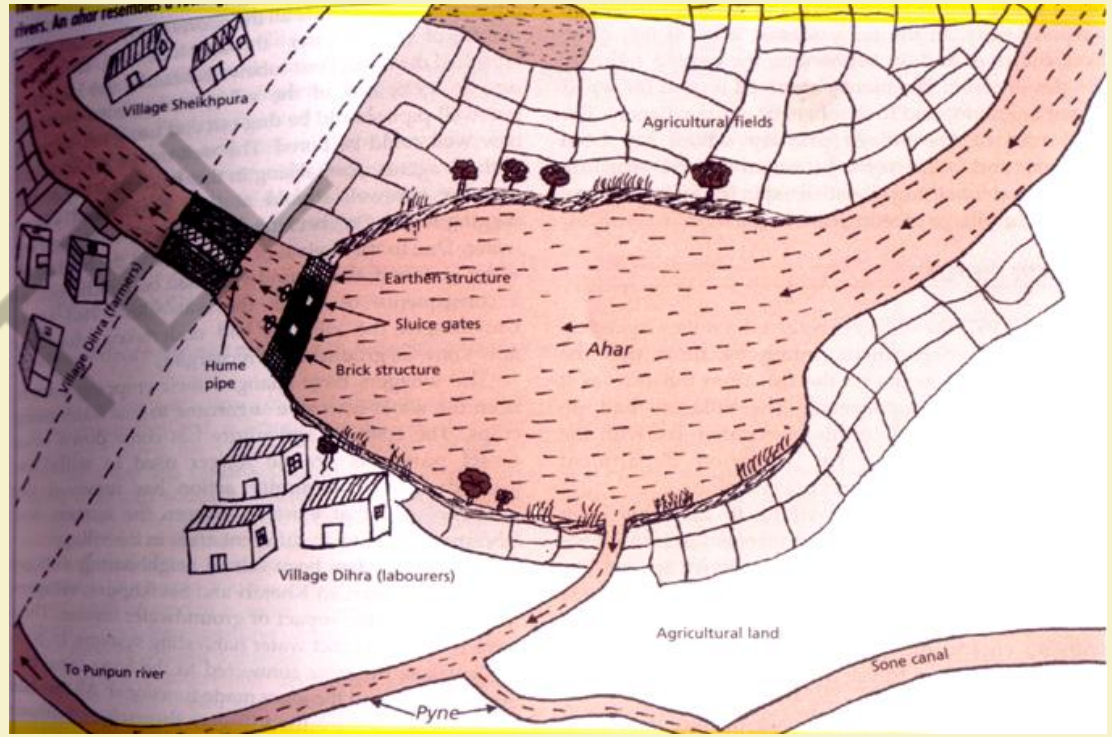
Source: Agarwal & Narain 1997: 27

East

Bihar

- *Ahar* and *Pyne* systems
- Prevalent during the time of the *Jatakas*
- *Arthashastra*; Megasthenes's *Indica*

"…both canals and reservoirs contain so considerable a supply that they enable the farmer not only to bring the crop of rice to maturity but to rear a winter crop of wheat and barley" – Buchanan 1810-11, cited in Agarwal & Narain 1997: 91



Bengal

- Inundation canals
- debate – ancient irrigation vs. modern dams (Klingensmith 2007)
- 'overflow irrigation' – William Willcocks (1930)
  - coverage of 7,000,000 acres
  - aligned canals
  - the role of local boards
- Malaria and morality in Bengal (Klein 1972)

Orissa

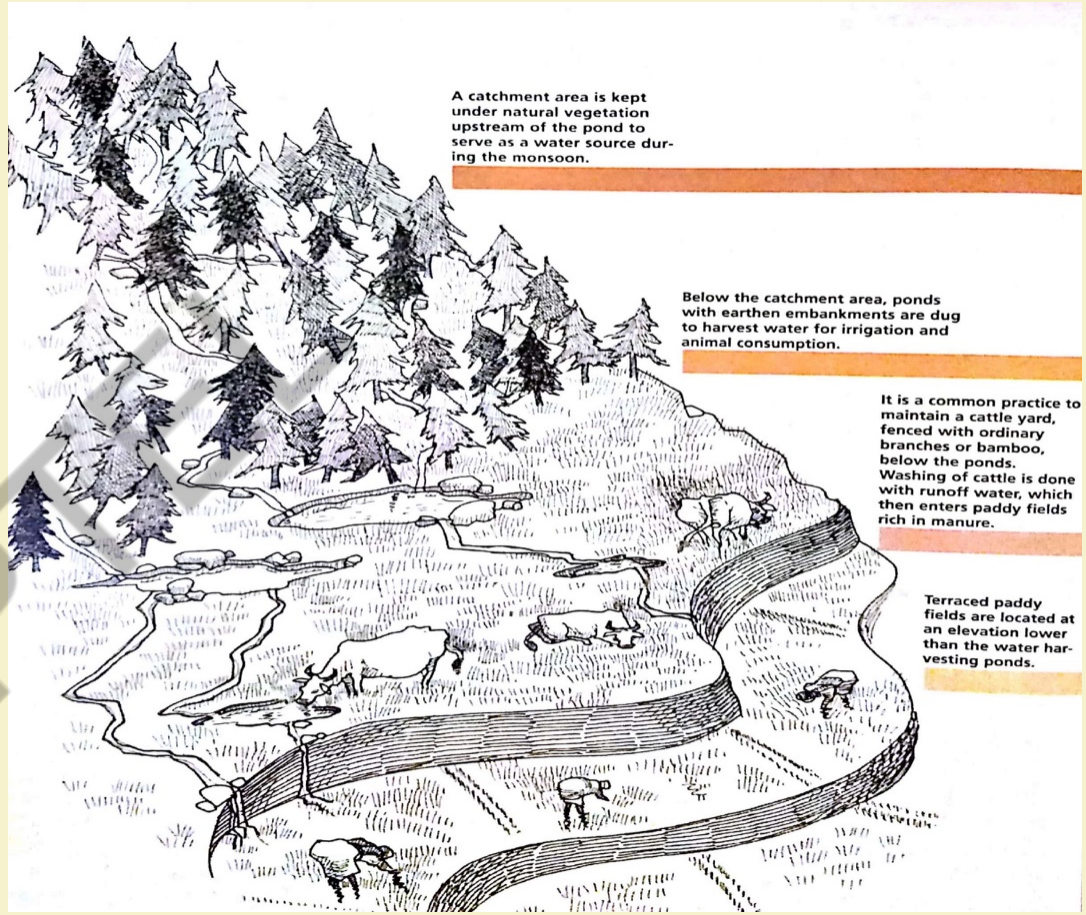
- Flood dependent agrarian regime (D'Souza 2002, 2006)

North East

Nagaland

- *Zabo* (impounding water) or the *ruza* system

"…a combination of forest, agriculture and animal husbandry with a well-founded conservation base, soil erosion control, water resources development and management and protection of environment" – Sonowal et al. 1989

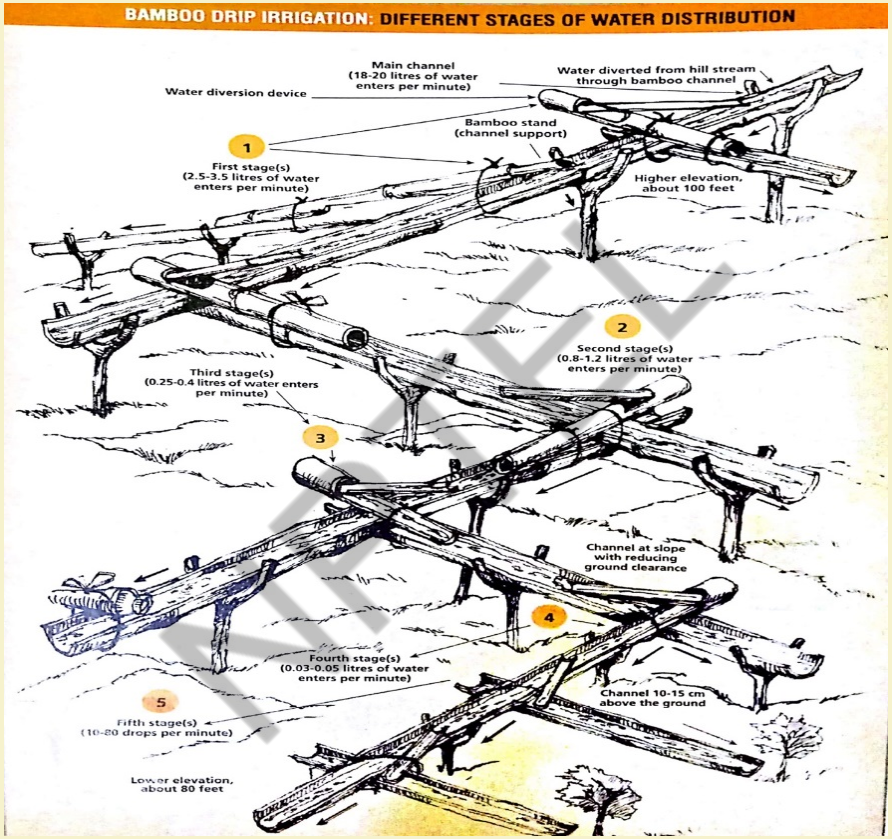


Source: Agarwal & Narain 1997: 60

Meghalaya

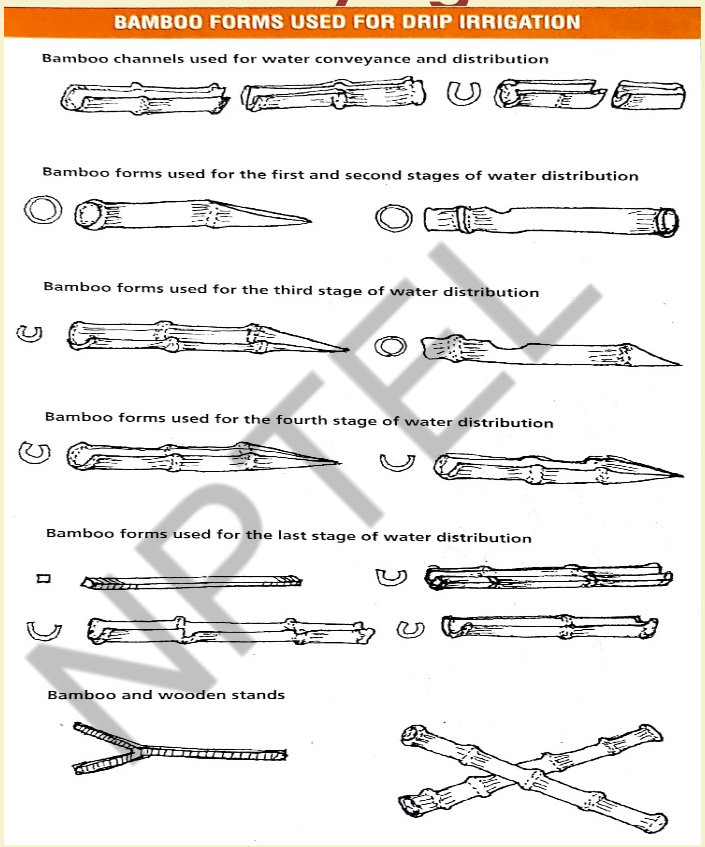
- Bamboo drip irrigation
- Used by the tribal farmers of Khasi and Jaintia Hills
- Ingenious system of tapping of stream and spring water by using bamboo pipes
- 18-20 litres of water entering pipes/min. gets transported over several hundred metres; gets reduced to 20-80 drops per minute at the site of the plant
- Normally used to irrigate betel leaf, black pepper, etc.
- Maintenance of pipes done by farmers

Different stages of water distribution



Source: Agarwal & Narain 1997: 66

Bamboos of varying diameters



Source: Agarwal & Narain 1997: 67

Assam

- *Dongs* by the Bodo tribes
- Water lifted from these ponds and taken into the fields by *lahoni*
- Accumulation of flood waters in the natural depressions appreciated

Manipur

- Water harvesting tradition among the Nagas
- Hills cut into terraces, water brought to them from hill streams through irrigation channels
- Little documentation

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Water, Society and Sustainability

Lecture No 9: Water Harvesting and Water Use Techniques in Ancient India II

Jenia Mukherjee
Department of Humanities and Social Sciences
IIT KHARAGPUR

West

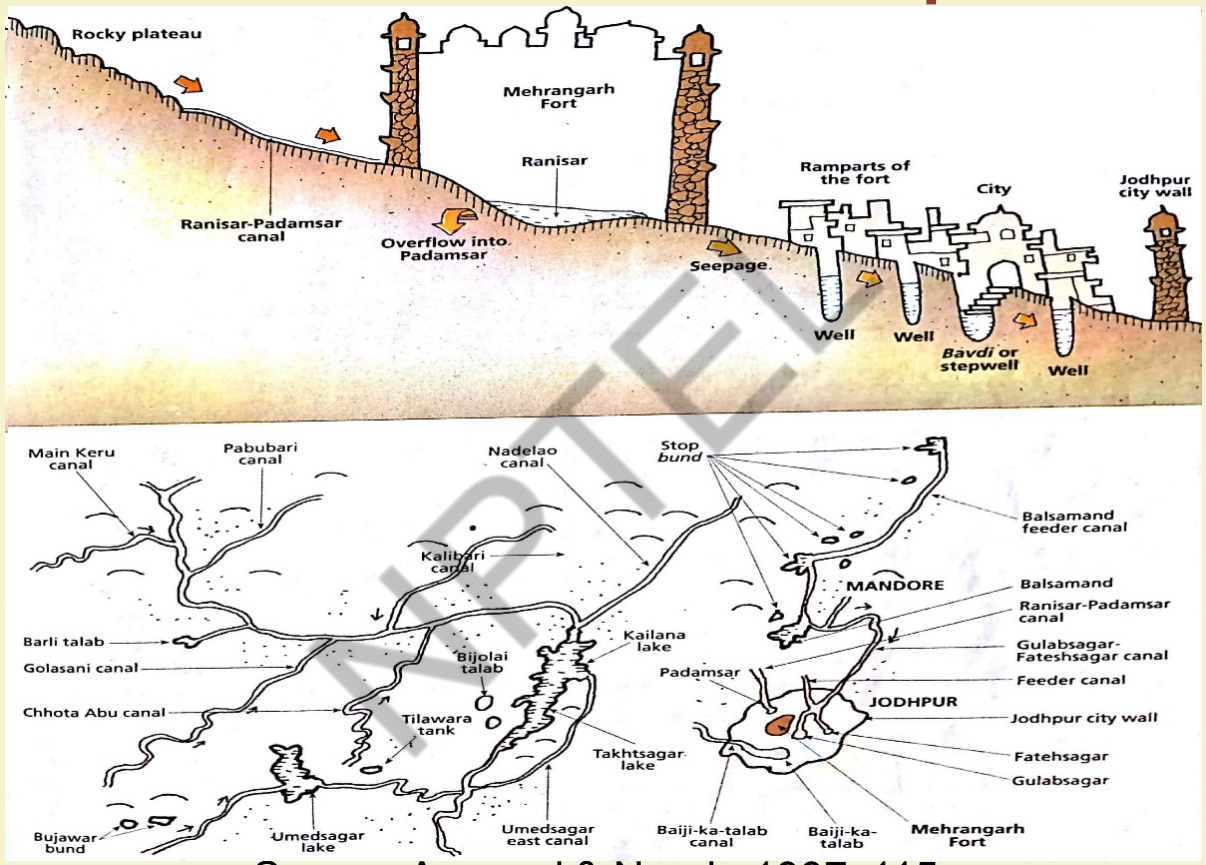
Rajasthan

- Arid parts – a near rainless desert
- *Chahi* – land irrigated by wells; well irrigation (Brake-Brockman 1908)
- Use of various water lifts
- *Jhalaras* or step wells

- Tank irrigation – 35 tanks in Jodhpur
- Jaisalmer – Gadisar, Gulabsagar, Govindsagar, Sudharar, etc.
- Bikaner – Jassolai, Baghinada and Rangolai
- *Tankas* – use of *chunams*
- Dams on the Luni and the Cuhiya rivers
- Formation of artificial lakes: Jaswantsagar and Sardar samnad
- Rainwater harvesting – *kunds* and *toba*
- Elaborate system inside forts

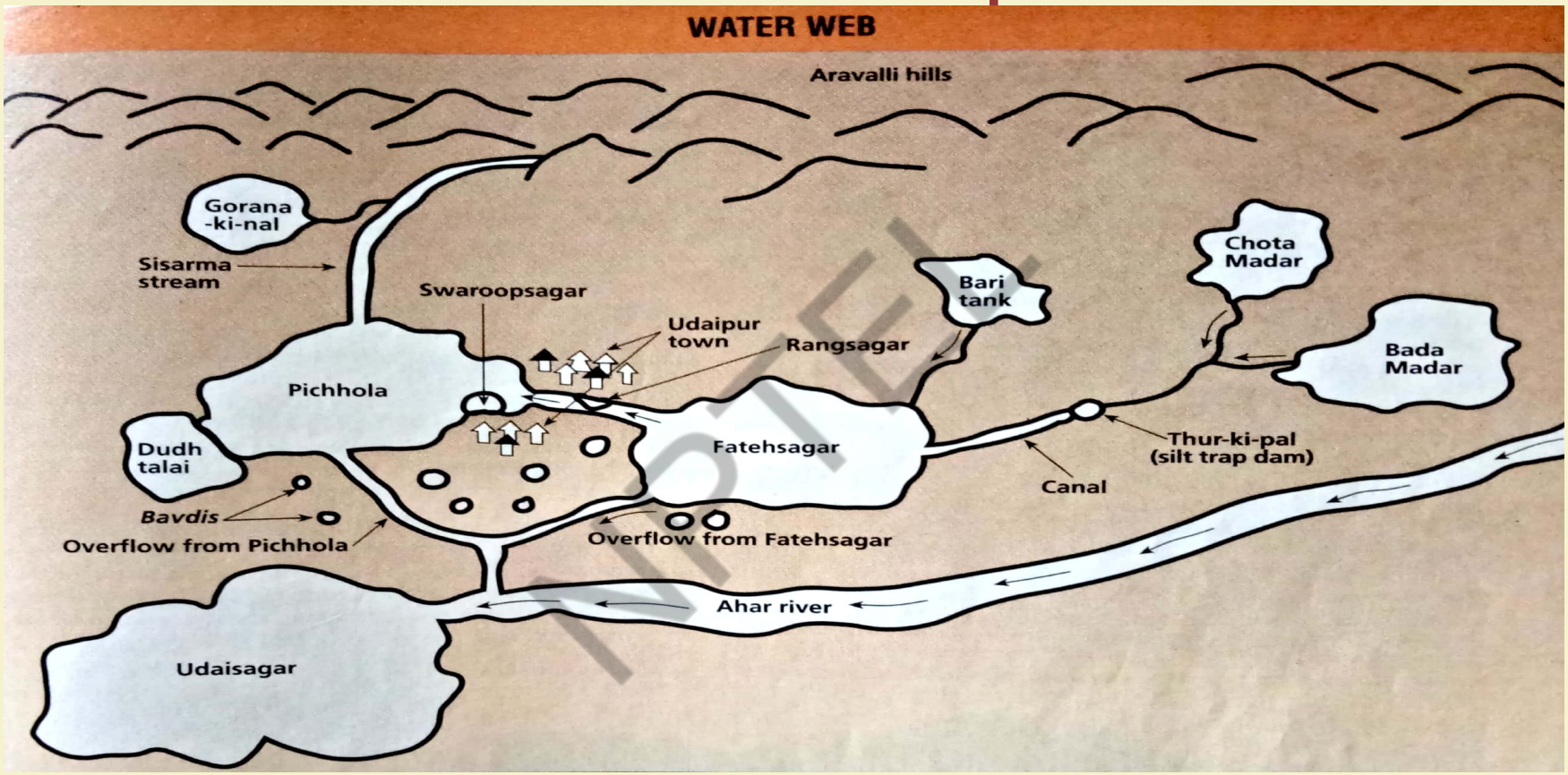
Kunds
Source: Agarwal & Narain 1997: 130

‘Water wisdom of Jodhpur’



Source: Agarwal & Narain 1997: 115

Water web of Udaipur



Source: Agarwal & Narain 1997: 161

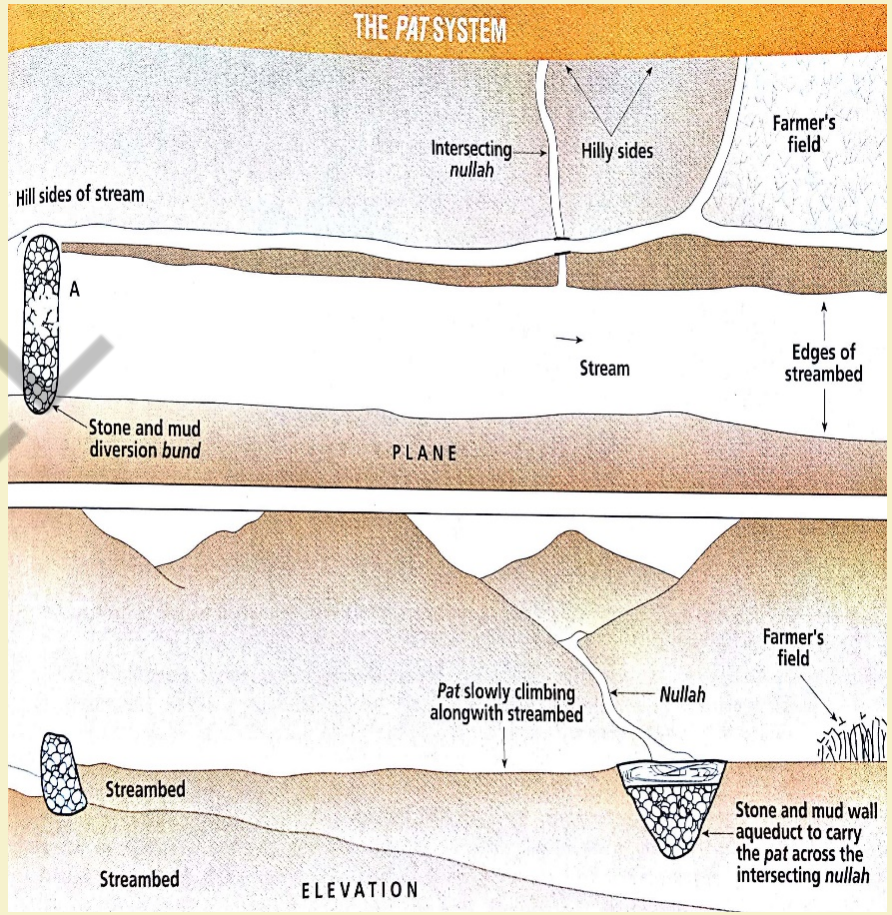
Gujarat

- Step wells – *vav* or *vavadi*
- Traditional wells and tanks
- *kunds*
- *Virdas* – Maldharis of the Banni pastureland

Virdas
Source: Agarwal & Narain 1997: 148

Madhya Pradesh

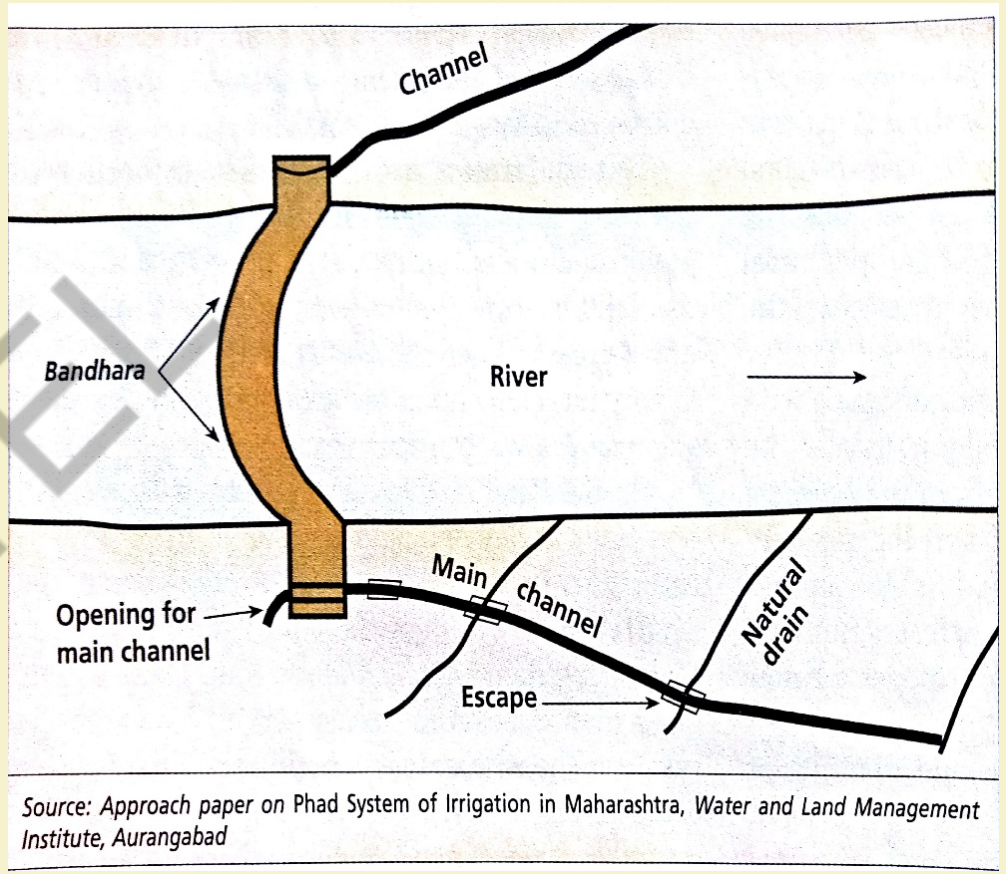
- *Haveli* – based on water harvesting and runoff farming
- Sanchi hill – three ancient tanks (3rd c. BC) – *Jatakas*; connected to the Betwa river
- Water climbing up hill slopes to irrigate fields! the *pat* system



Source: Agarwal & Narain 1997: 173

Maharashtra

- Artificial reservoirs
- *Phad* irrigation system; series of *bandharas* on the rivers to divert water for agricultural use
- *Khazana* in Goa – a unique coastal, estuarine agroecosystem
- Sluice gates – to protect fields from salt water; regulation of fishing
- *Bunds* – eco-friendly materials like mud, straw, bamboo, twigs, etc.



Source: Approach paper on Phad System of Irrigation in Maharashtra, *Water and Land Management Institute, Aurangabad*

Source: Cited in Agarwal & Narain 1997: 190

North

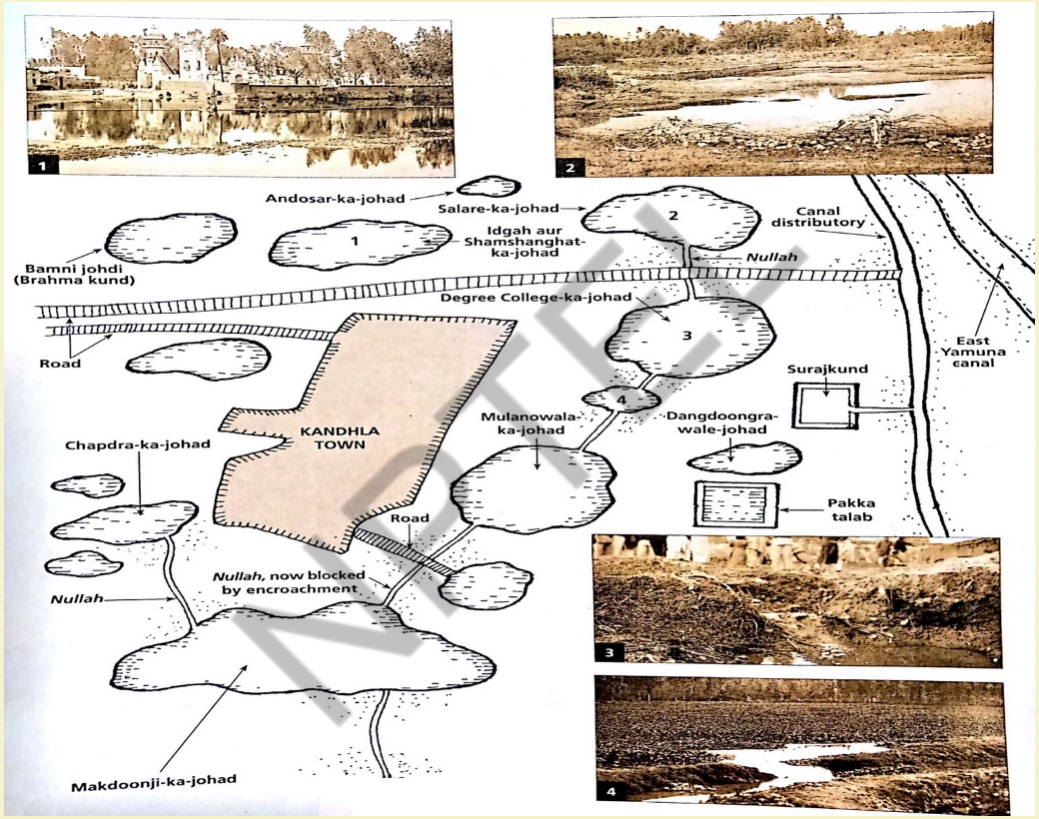
Delhi

- Tanks, *baolis* (step wells)
- Deeg (*Brajbhumi*), *Skanda Purana*
  - Large reservoirs – Gopalsagar (*kuchcha talab*), Roopsagar (*pucca talab*)

Uttar Pradesh

- Tanks, wells, minor streams or *nullahs*, embankments across *nullahs*
- *Lat* – long, straight, covered embankment
- *Johads* of Kandhla

Johads of Kandhla



Source: Agarwal & Narain 1997: 85

Punjab

- *Punj* = five, *ab* = water; the land of the five rivers
- Well irrigation in the Beas-Sutlej area
- Irrigation by floodwaters
- No perennial canal irrigation system

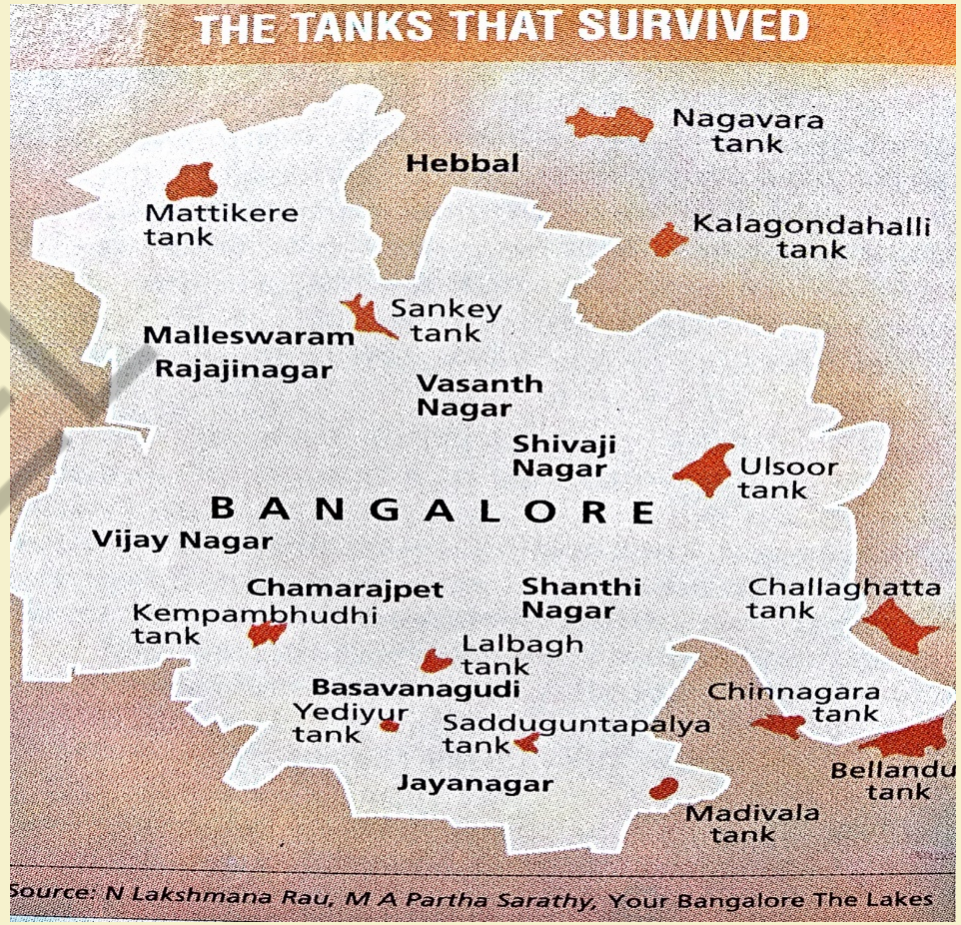
Haryana

- *Khadar* – active flood plains of Ghaggar, Markanda, Saraswati and Yamuna
- *Abi* – tank irrigation
- Prevalence of *kunds* and *bunds*

South

Karnataka

- Series of tanks (*kere*) – Bijapur, Shimoga, kadur, Bellary (280), Hassan, Tumkur, Kolar, Bangalore
- Minor tanks (*arakere*) – Nitimarga inscription (ninth c. AD)
- *Devikere/devagere/devarakere*
- Cultural meanings and manifestations
- Dykes, anicuts
- *Bunds* (*katte*) – daily needs



Source: Agarwal & Narain 1997: 206

Andhra Pradesh

- Tank irrigation
- Artificial tanks
- Embankments
- Series of dykes (*kolwas*) across the Tungabhadra river

Kerala

- Wet irrigation fed by channels branching out from anicuts
- Dam during the Pandyan rule – the Pandyan Kal connected to 11 anicuts; Puthen dam
- Numerous tanks in south Travancore – *oornis*

Tamil Nadu

- Large areas fed by rivers like Cauvery, Godavari, Tungabhadra, Noyil, Bhavani, Amaravati, etc.
- Padugai lands – long mud embankments (125 kms) built by the Chola kings o the Cauvery river
- Temporary dams (*korambus*) constructed
- Very old anicuts
- The size of the water harvesting structures reflected the importance of its sponsor
- Artificial irrigation in the drought-prone areas including Tanjore

"for the most part, the soil is naturally poor, and it is irrigation alone which makes the province such a scene of fertility" – Registrar General and Census Commissioner 1985

The Grand Anicut

"Waiting for wisdom to make its way"

Is big the best?

[big dams are politician-friendly, administration-friendly and contractor-friendly (Joshi 1990)]

Or

Is small beautiful?

(revival of the community tradition)

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NPTEL ONLINE
CERTIFICATION COURSES

Water, Society and Sustainability

Lecture No 10: Water Harvesting and Water Use Techniques in Ancient India III: Debates and Discussions

Jenia Mukherjee
Department of Humanities and Social Sciences
IIT KHARAGPUR

River/water society metabolism

Pre-colonial equilibrium

- Environmentally benign
- Socially accommodative

versus

Colonial hydrology

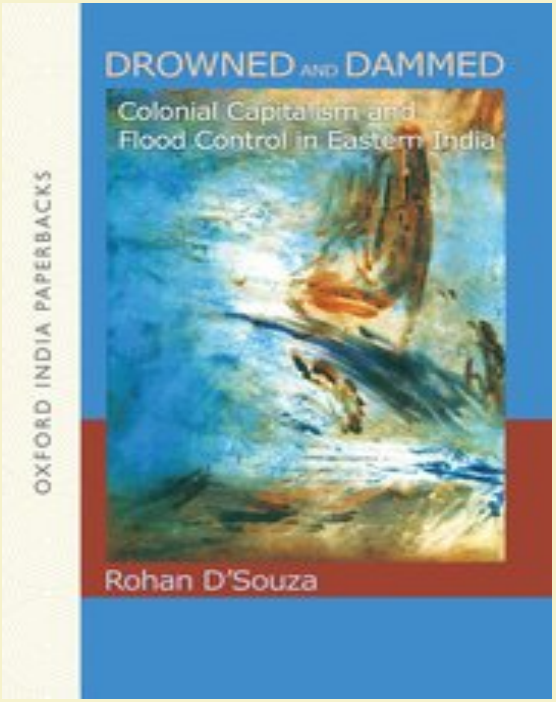
- Environmentally malign
- Socially disruptive

Pre-colonial equilibrium

'flood dependent agrarian regime'

- Diverse production choices
- Flexible taxation arrangements

" He (the Oriya cultivator's) whole system of cultivation has been adapted to an uncertain and precarious rainfall and periodic inundation. He is a gambler, he has one field on the high ground, another in the hollow and another half-way between, so that if he loses one crop by either flood or drought he is pretty sure to save the other" –



- Judicious use of scarce resource and cultural/ritualistic practices

  - The Thar desert example – series of folk beliefs that emphasize the value of water; cultural practices
  - Celebration of rain and water in Rajasthan's folk tradition; numerous folk songs on clouds
  - *Anga* system – water for all
  - Deity worship in step wells (*vav*), Gujarat; *Vastupujan*; offerings to the deity

- Ecological vitality and participatory community framework

  - The Sanchi hill is a celebration of water cosmology.
  - *Virdas* – integrated ecosystem functioning; collective community management; common meeting point
  - *dasabandham* irrigation sources
  - *Nirgranti* – distribution of water

Beyond reductionist dualisms

- canals in the northwest became a source of economic dynamism and constant innovation (Stone 1945)
- hydraulic engineering projects in the deltas of Cauvery and Godavari Rivers were “less environmentally disruptive or destructive than colonial riparian works of the north and blended more into the environmental and cultural landscape of the respective delta regions” (Schmitthenner 2011: 181)
- commercialization and peasant indebtedness were processes that predated colonial regime in the region, and which were integral to the expansion of well irrigation in the west (Hardiman 1998)

Contd.

- co-existence of ‘modern’ with pre-colonial techniques in western India (Rosin 1993)
- village communities were unstable entities driven and shaped by hierarchies (Mosse 1997, 1999, 2003)
- folksongs and stories inscribed in popular memory bear testimony to hydrological irregularity, technological vulnerability, and social anxiety (Shah)

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Thank You!!