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Water, Society and Sustainability

Lecture No 11: Water Technologies in Medieval India I

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The changing context

- North-west frontier province
- 'agricultural revolution'

This set him apart from the peasants of a large portion of the globe, whose knowledge remained confined to a very few crops (Chowdhury & Habib year)

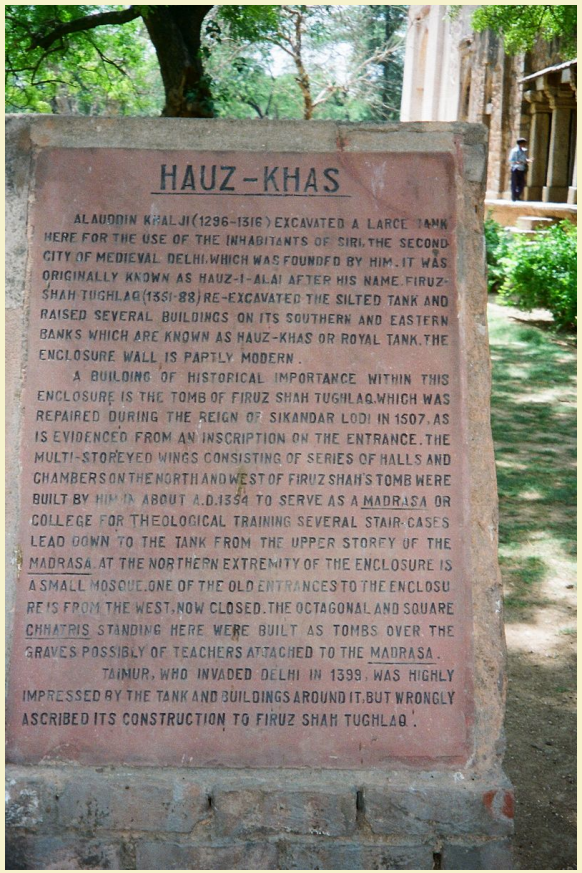
- new crops – more water (sugar, rice, cotton, wheat)
- pre-Islamic methods – inadequate to meet the new agrarian productivity
- development and diffusion of water technologies to raise/lift, store and distribute water

The Sultanate

- Iltutmish – construction of reservoir; large lake – *Hauz-i-Samshi*
  - Drinking water for Delhi (Khusrau, Isami); irrigation (Batutta); RW storage
  - Re-excavation by Aluddin Khalji

- *Hauz-i-Alai* or *Hauz-i-Khas* by Alauddin Khalji
  - Large square tank with 600 m length and 70 acres breadth

daryacha or 'small sea' that was filled up with water during the rainy season and served the need of water supply to the people of Delhi for the whole year – Ali Yazdi, *Zafarnama* (p. 108-09)


HAUZ-KHAS
ALAUDDIN KHALJI (1296-1316) EXCAVATED A LARGE TANK HERE FOR THE USE OF THE INHABITANTS OF SIRI, THE SECOND CITY OF MEDIEVAL DELHI, WHICH WAS FOUNDED BY HIM. IT WAS ORIGINALLY KNOWN AS HAUZ-I-ALAI AFTER HIS NAME. FIRUZ-SHAH TUGHLAQ (1351-88) RE-EXCAVATED THE SILTED TANK AND RAISED SEVERAL BUILDINGS ON ITS SOUTHERN AND EASTERN BANKS WHICH ARE KNOWN AS HAUZ-KHAS OR ROYAL TANK. THE ENCLOSURE WALL IS PARTLY MODERN.
A BUILDING OF HISTORICAL IMPORTANCE WITHIN THIS ENCLOSURE IS THE TOMB OF FIRUZ SHAH TUGHLAQ, WHICH WAS REPAIRED DURING THE REIGN OF SIKANDAR LODI IN 1507, AS IS EVIDENCED FROM AN INSCRIPTION ON THE ENTRANCE. THE MULTI-STOREYED WINGS CONSISTING OF SERIES OF HALLS AND CHAMBERS ON THE NORTH AND WEST OF FIRUZ SHAH'S TOMB WERE BUILT BY HIM IN ABOUT A.D.1354 TO SERVE AS A MADRASA OR COLLEGE FOR THEOLOGICAL TRAINING. SEVERAL STAIR-CASES LEAD DOWN TO THE TANK FROM THE UPPER STOREY OF THE MADRASA. AT THE NORTHERN EXTREMITY OF THE ENCLOSURE IS A SMALL MOSQUE. ONE OF THE OLD ENTRANCES TO THE ENCLOSURE IS FROM THE WEST, NOW CLOSED. THE OCTAGONAL AND SQUARE CHHATRIS STANDING HERE WERE BUILT AS TOMBS OVER THE GRAVES POSSIBLY OF TEACHERS ATTACHED TO THE MADRASA.
TAIMUR, WHO INVADED DELHI IN 1398, WAS HIGHLY IMPRESSED BY THE TANK AND BUILDINGS AROUND IT, BUT WRONGLY ASCRIBED ITS CONSTRUCTION TO FIRUZ SHAH TUGHLAQ.

- Tughluqabad – Ghiyasuddin Tughluq
  - A tank for storing RW; wells (six unearthed)

  The sagacious king ordered the digging of a tank under the elevated fort. Every moment the tank was beset by waves like the seven oceans beneath the Caucasus Mountains – *Futuh-us-Salatin*

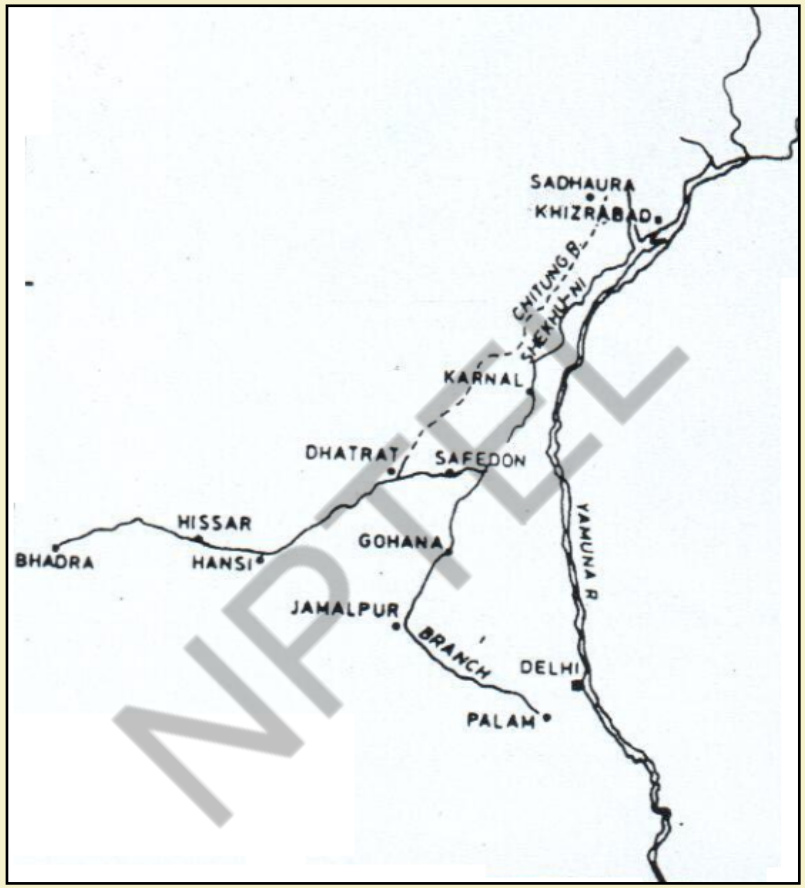
- Loans advanced to peasants for digging wells and *bunds* by Mohammad Bin Tughluq

- Firuz Shah Tughluq's reign

  – water reservoirs, lakes, aqueducts, irrigation channels
  – biggest network of canals created (*Tarikh-i-Firuz Shahi)*; two canals: *Rajabwah* and *Ulughkhani* to ensure water supply in Hissar Firuza; the Firuzabad canal (1335)

  the canal was extremely important in the area where well 130 feet deep, and the springs often are salt (Colvin 1833)

  – large tanks: *Haudi Tughluq Shah, Haud-i Qutlugh Khan, Haud-i Shahzada Fath Khan*
  – use of sluice gates for control of water in dam



Source: cited in Mukherjee 2008: 283

The Mughals

- Well irrigation

  most of the province of Lahore is cultivated with the help of well-irrigation (*Ain-i-Akbari*)
- Irrigation tanks in peninsular India
- *Bunds*
- Thousands of canals cut from river served towns and villages
- History of large canal excavation (maintenance and remaintenance) in the North
  - *Rajabwah* – Akbar, by Shihabuddin Khan – *Shihabnahr*; *Shaikhu-ni*
  - *Mir-i-Ab* (the Canal Superintendent)

- ‘Nahir-i-Birhist’ or ‘Nahir-i-Faiz’ – Shahjanabad
  - Map by Susan Gole (1989)

enters the city and passing through it by an open channel it traverses another extensive aqueduct into the palace (Colvin 1833)

ramifies in opened or covered water courses having outlets to the Jamuna, thus permitting the passage of constant streams of fresh water (Colvin 1833)

Undoubtedly Shahjahan’s Western Yamuna Canal was a considerable feat of engineering, for which its builders have yet to receive due credit (Khan 1999)

- Small system of canals in the Upper Bari Doab, Punjab; *Shahnahr*
- Small canal cut from Tavi to irrigate Ali Mardan's garden at Sodhra near Wazirabad
- Multan crisscrossed by canals
- Inundation and well irrigation – Auranzeb
- Water works by **provincial ministers**
  - 1628-29: Mir Abra's canal, North Sind
  - Darya Khan, Delta
- *Bandharas* – western ghats (Hardiman 2006)

The Outcome

- agricultural productivity
- multiplicity of crops
- *Ain-i-Akbari* – revenue rates for sixteen crops of *rabi* and twenty five crops of *kharif* in Agra; forty-one crops/annum
- seventeenth century – introduction of two major crops – tobacco and maize
- sugarcane, grapes, pomegranates, citrus fruits
- good quality of crops and fruits – Jean Baptiste Travernier, Jean de Thevenot

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Water, Society and Sustainability

Lecture No 12: Water Technology in Medieval India II

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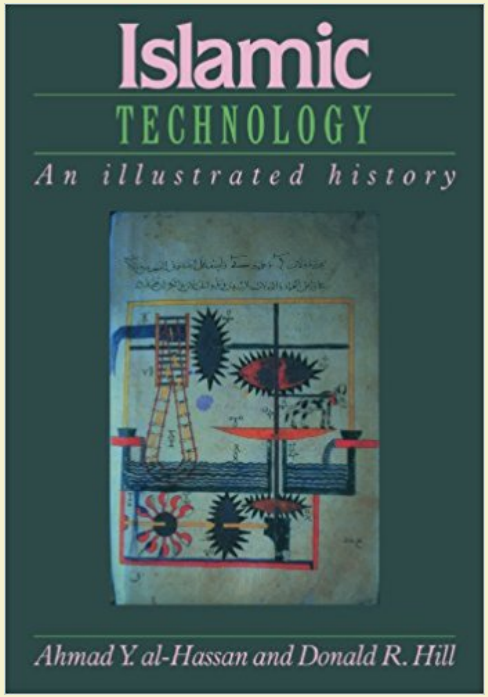
Exploring the Roots

The supply of water irrigation, drinking, domestic and industrial and agricultural purposes has always been a vital consideration in Muslim lands (al-Hassan & Hill 1992)

Central and West Central Asia – Bagdad, Istanbul, Persia, etc.

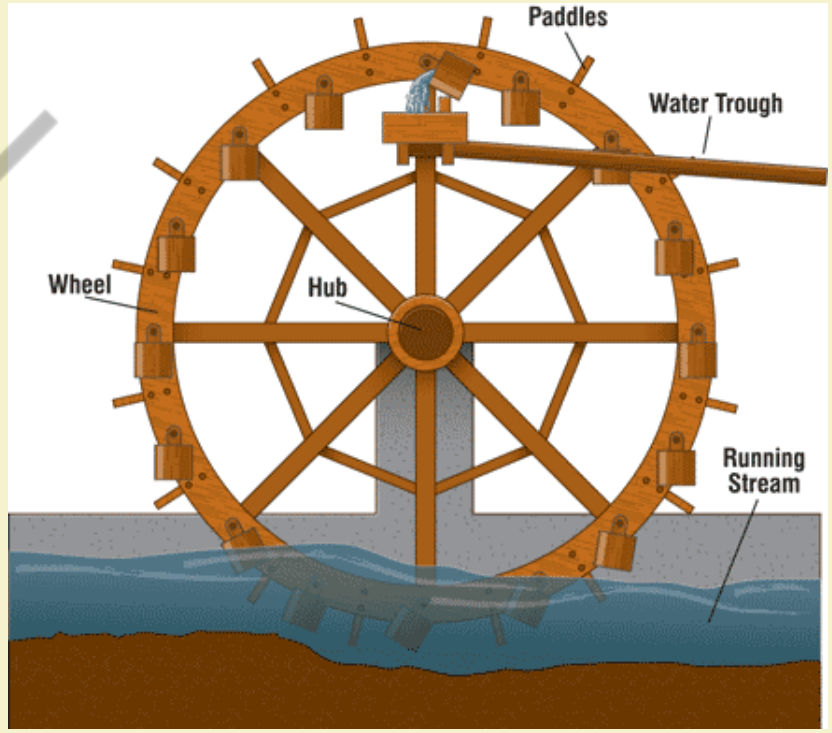
Hydraulic technologies in the (Mediterranean) region have reaped wonderful rewards: productive fields, beautiful gardens, sparkling fountains and populous cities.



Water lifting devices

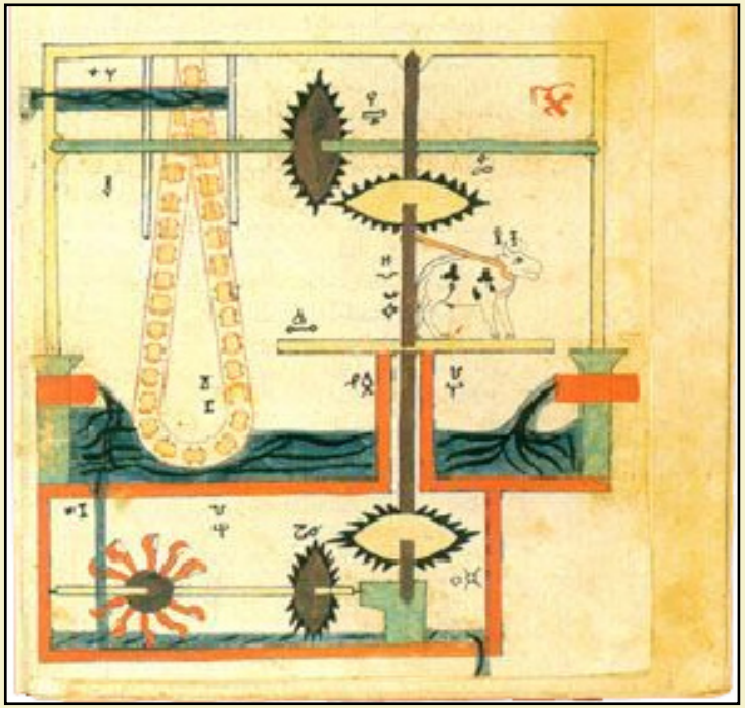
Noria

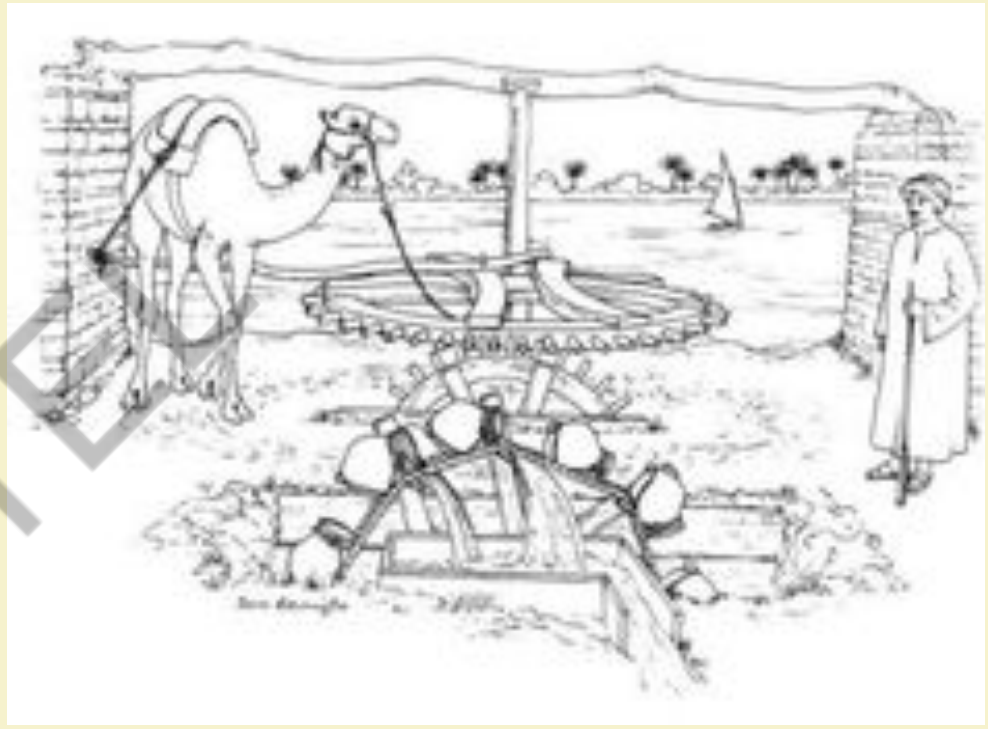
- a machine activated by **water power**
- uses the energy derived from the flow of a **river**
- consists of a large, very narrow undershot water wheel
- used for lifting water into a small aqueduct
- derived from the classical (Hellenistic) world with further improvisation (?); examples from Egypt (Oleson 2000)
- *Kitab al-Hawi* – noria in Iraq 153,000 litres/hour



The Persian Wheel (*saqiya*)

- *Panchatantras* – *araghatta*
- *ara* – spoked wheel, *ghatta* – pot
- Islamic improvisation – references of intricate device
- use of complex *saqiyas* (200 separate components) by Muslim inventors and engineers (Hill 2002)
- Al-Jazari also constructed a water-raising device – both animal and water-driven

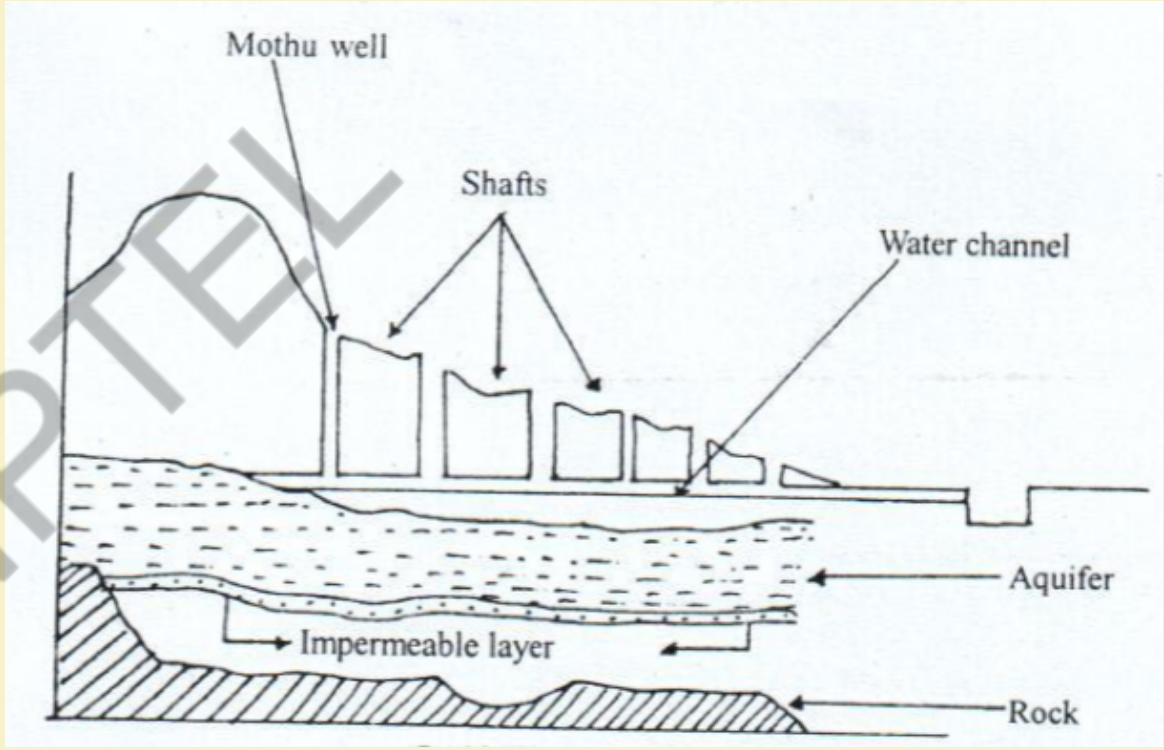


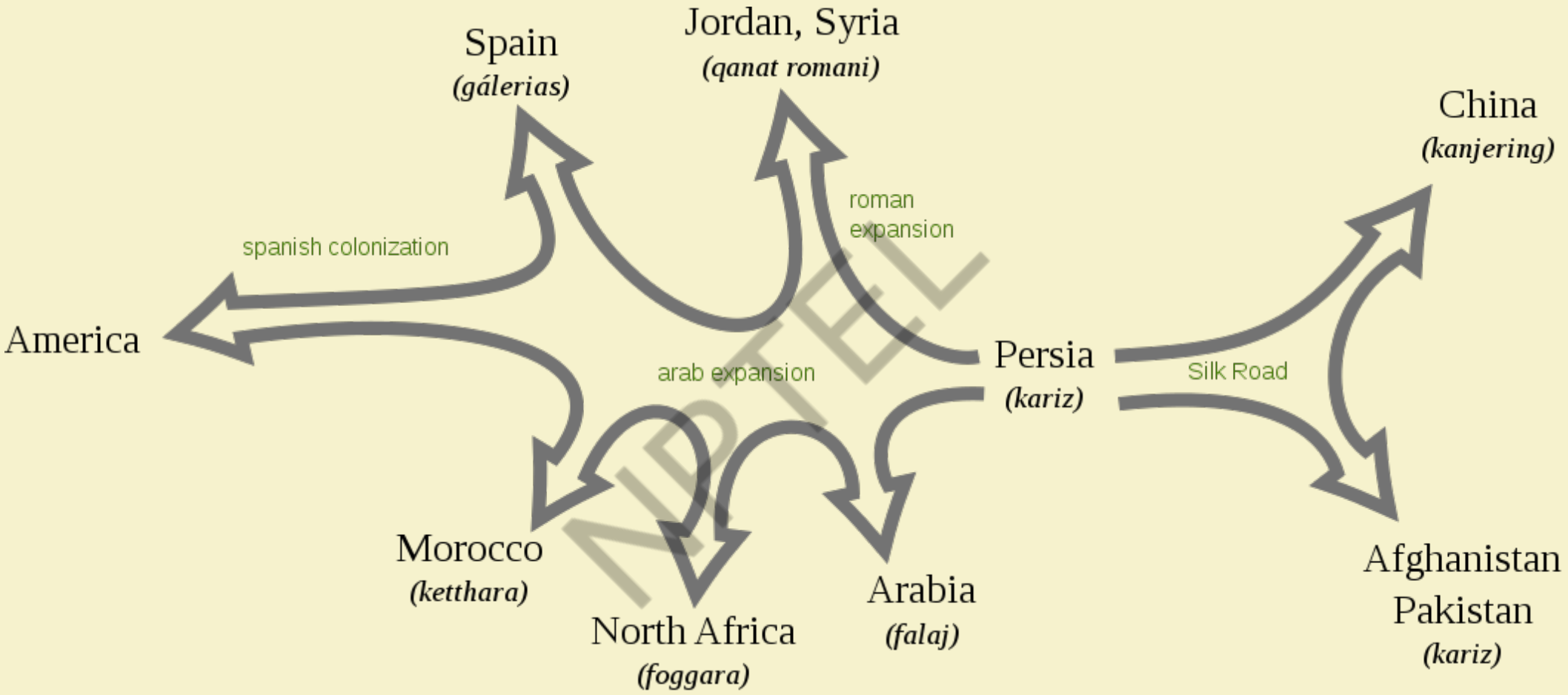


https://www.youtube.com/watch?v=tUIOfwprz6k

Qanat

- *Qanat* – channel
- First millennium BC invention in Persia
- a series of well-like vertical shafts
- connected by gently sloping tunnels
- Delivery of subterranean water to the surface without the need for pumping
- water drains through gravity
- Iran, Asia, North Africa




Spain
(gálerias)
Jordan, Syria
(qanat romani)
China
(kanjering)
roman
expansion
spanish colonization
America
arab expansion
Persia
(kariz)
Silk Road
Morocco
(ketthara)
North Africa
(foggara)
Arabia
(falaj)
Afghanistan
Pakistan
(kariz)

Interrogating imperial categorization

'Dark Age'? Asiatic mode of production

[proselytizers, autocrats, destroyers of Indian civilization]

Or

Technologically advanced and dynamic society?

(elaborate and sophisticated technologies, tuned to ecological/geographical settings)

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Water, Society and Sustainability

Lecture No 13: Colonial Hydrology

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What is 'colonial hydrology'?

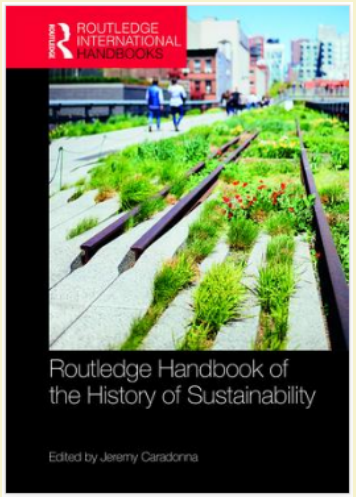
- Did the British experience comprise of an altogether distinct paradigm for hydraulic interventions in South Asia?

Water in British India: The Making of a 'Colonial Hydrology'

Rohan D'Souza *History Compass* 4/4 (2006): 621–628

- Relationship between colonialism and water

- Three snapshots: North, South and East

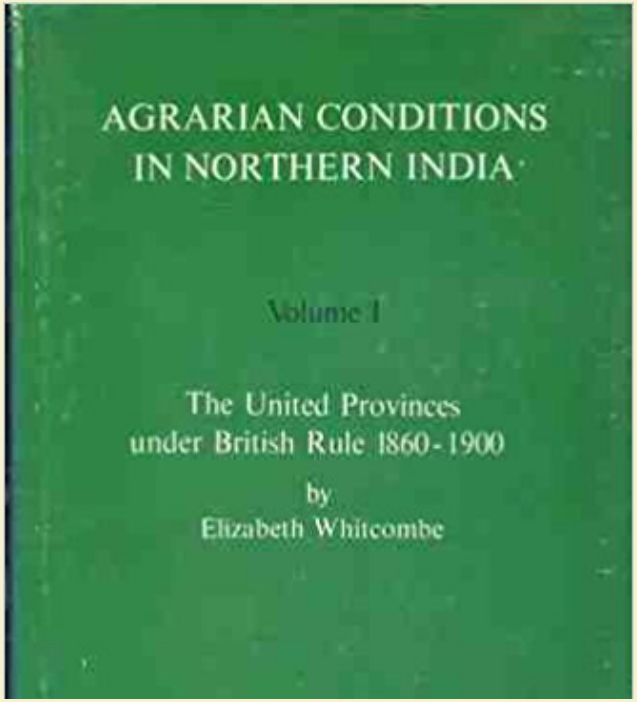


16. From Hydrology to Hydrosociality: Historiography of Waters in India *Jenia Mukherjee*

North India

- NWFP
- replacement of traditional well irrigation system
- impact of perennial irrigation had an adverse effect on the environment and the peasantry
  - saline deserts, waterlogged swamps, and decreased soil fertility
  - rich landlords - distribution channels; collection of water tax

depressed peasantry laboured in a distorted environment (xi)



The Rivers Come: Colonial Flood Control and Knowledge Systems in the Indus Basin, 1840s-1930s
Author(s): BENJAMIN WEIL
Reviewed work(s):
Source: *Environment and History*, Vol. 12, No. 1 (February 2006), pp. 3-29

- colonial flood control in the Indus valley (Dera Ghazi)
- conflict between the local knowledge-based approach and technological mentality of engineers

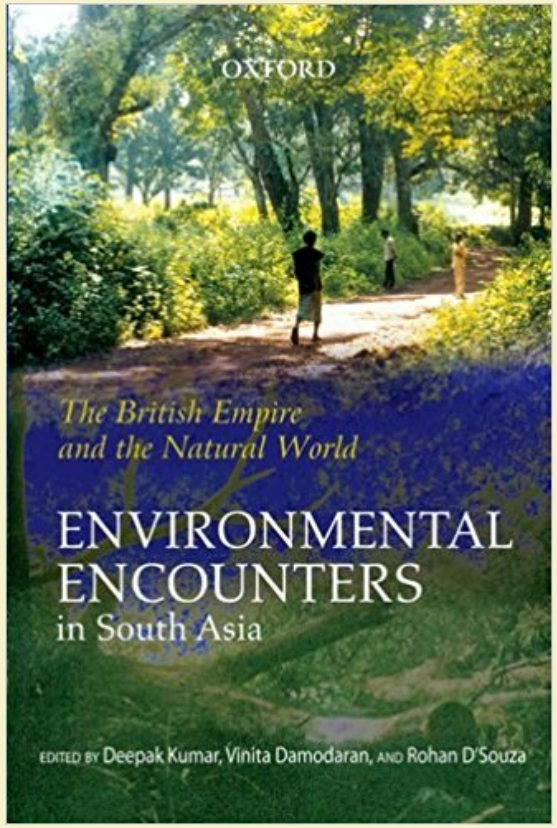
*Complex engineering works replaced **traditional warning systems and mobility,** undermining alluvial farming systems as well as a precautionary approach to environmental management.*

- Agnihotri 1996
  - colonial canal systems in Punjab overran the existing inundation canal system, affecting pastoralists and eroding the vibrant pastoral economy of the region

- Gilmartin 1994
  - the perennial canal system – technochauvinism of imperial science
  - environmentally benign community-managed small-scale structures replaced with socially and environmentally disruptive interventions
  - centralized control - the Irrigation Department

South India

- B. Eswara Rao, *Taming 'Liquid Gold' and Dam Technology: A Study of the Godavari Anicut* (2011)
  - Godavari Anicut – 1847 – 1852
  - 1843-44 Montgomery report
  - Involvement of Arthur Cotton
  - Commercial crops like sugarcane, tobacco, coconut
  - Capitalist farmers - *Kammas, Reddys, Rajulus, Kapus, Telegas, Gavaras*
  - Rise in the number of poor tenants and agricultural labourers
  - rise in salinity, waterlogging; 'red rot' (crop disease), *Jalaga Rogam* (cattle disease); exhaustion of soil; decrease in fish



Eastern India

- The Embankment Era:
  - Permanent Settlement in the Bengal Province
  - Flood = curse
  - Embankments on the Mahanadi (D'Souza 2002, 2006), Kosi and Gandak Rivers (Mishra 2008)
  - colonial zamindars crafted an embankment driven flood control regime (Singh 2011)
  - replacement of 'overflow irrigation' (Wilcocks 1930; Klingensmith 2007)
  - from 'flood dependent agrarian regime' to a 'flood vulnerable landscape' (D'Souza 2006)

'Colonial Hydrology'?

Beyond reductionist generalizations

- canals in the northwest became a source of economic dynamism and constant innovation (Stone 1985)
- 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)

- 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 2008; 2012)

A group of Dalit women singing a sacrifice song.

A shrine on an embankment to a woman sacrificed in the tank.

Watershed: from metabolism to 'metabolic rift'

- the greatest moment of hydraulic transition in India (D'Souza 2006)
- the 'rule of profit'
- the era of the 'scientific management'
  - absolute control over flow pattern, distribution, allocation
  - cultural dominance of the engineering paradigm
  - community replaced by metaphor of machines (stop dams, weirs, etc.)
- colonial legacy during the post-independent period: **MPRVDPs**

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Water, Society and Sustainability

Lecture No 14: Dams and Development in Modern India

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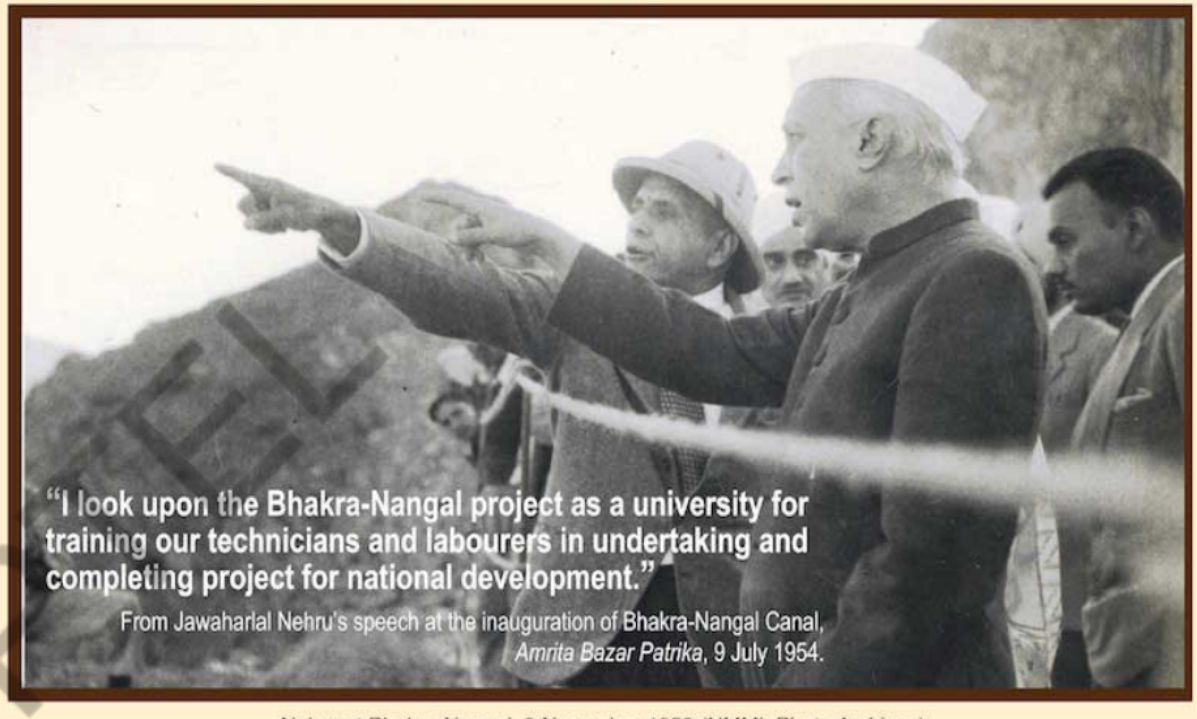
The Larger Context

- Multi-Purpose River Valley Development Projects (MPRVDP)
- western hydraulic legacy
- the global context (45,000 dams post-1945 period):
  - decolonization and 'development' discourse (Escobar 1995; Caufield 1996) and nationalism
  - 1930s - the Tennessee Valley Authority (TVA), USA – *a module of high modernism* (Scott 1998)

The National Context

- Damodar flood of 1943
- 10-member Damodar Flood Enquiry Committee
- Meghnad Saha: replication of TVA in India urgent
- 1945: Central Waterways Irrigation and Navigation Commission (CWINC)
- 1950s, 60s, 70s: optimism and passion in the building of India's mega dams – "dam building spree" (Swain 1997)

Nehru at the model of the Hirakud Dam, 13 January 1957 (NMML Photo Archives)
हीराकुड बांध का प्रतिरूप देखते हुए नेहरू, 13 जनवरी 1957 (ने.स्मा.सं.पु. चित्र अभिलेखागार)



Nehru at Bhakra-Nangal, 8 November 1953 (NMML Photo Archives)
भाखड़ा-नंगल में नेहरू, 8 नवंबर 1953 (ने.स्मा.सं.पु. चित्र अभिलेखागार)

When I lay the foundation stone here of this Nagarjuna Sagar, to me it is a sacred ceremony. This is the foundation of the temple of humanity of India, a symbol of new temples that we are building all over India.

From Jawaharlal Nehru's speech while laying the foundation of Nagarjuna Sagar Dam, 10 December 1955

Some Big Dams

State / UT	River	Dam	Reservoir Area	Complete
Telangana	Godavari	Sriram Sagar	450.82 km² (111,400 acres)	1977
Andhra Pradesh / Telangana	Krishna	Nagarjuna Sagar	284.9 km² (70,400 acres)	1960
Andhra Pradesh	Krishna	Srisailam	616.42 km² (152,321 acres)	1984
Andhra Pradesh	Pennar	Somasila	212.28 km² (52,456 acres)	1989
Himachal Pradesh	Sutlej	Bhakra Dam	168.35 km² (41,600 acres)	1963
Odisha	Mahanadi River	Hirakud Dam	83,400 km²(20,608,589 acres)	1957
Uttar Pradesh	Rihand River	Rihand Dam	5,148 km²	1962

Development or Displacement?

- local interest sacrificed at national cause (no significant protest)
- continued ecological and social costs
  - Vast areas of forests and agricultural land submerged
  - Massive population displacement
    - 1951 – 1985: 21 million (Paranjpye 1990)
    - Rehabilitation limited and unsuccessful (Singh 1985; Maloney 1990, 1991; Thukral 1992)

the very people whose wealth and welfare the projects were supposed to enhance are now worse off economically and demoralized socially (Chandoke & Ghosh 1995)

Environmental or New Social Movements

- late 1970s: steadily increasing anti-dam resistance
- protests against severe socio-ecological implications of dam construction including:
  - deforestation, water logging, downstream water shortages, siltation, and salinization
  - displacement and inadequate rehabilitation schemes

The Tehri Dam Movement

The Silent Valley Movement

- *Only an Axe Away*
- Kerala Sastra Sahitya Parishad (KSSP)
- the project was canceled in 1984

The Narmada Bachao Andolan

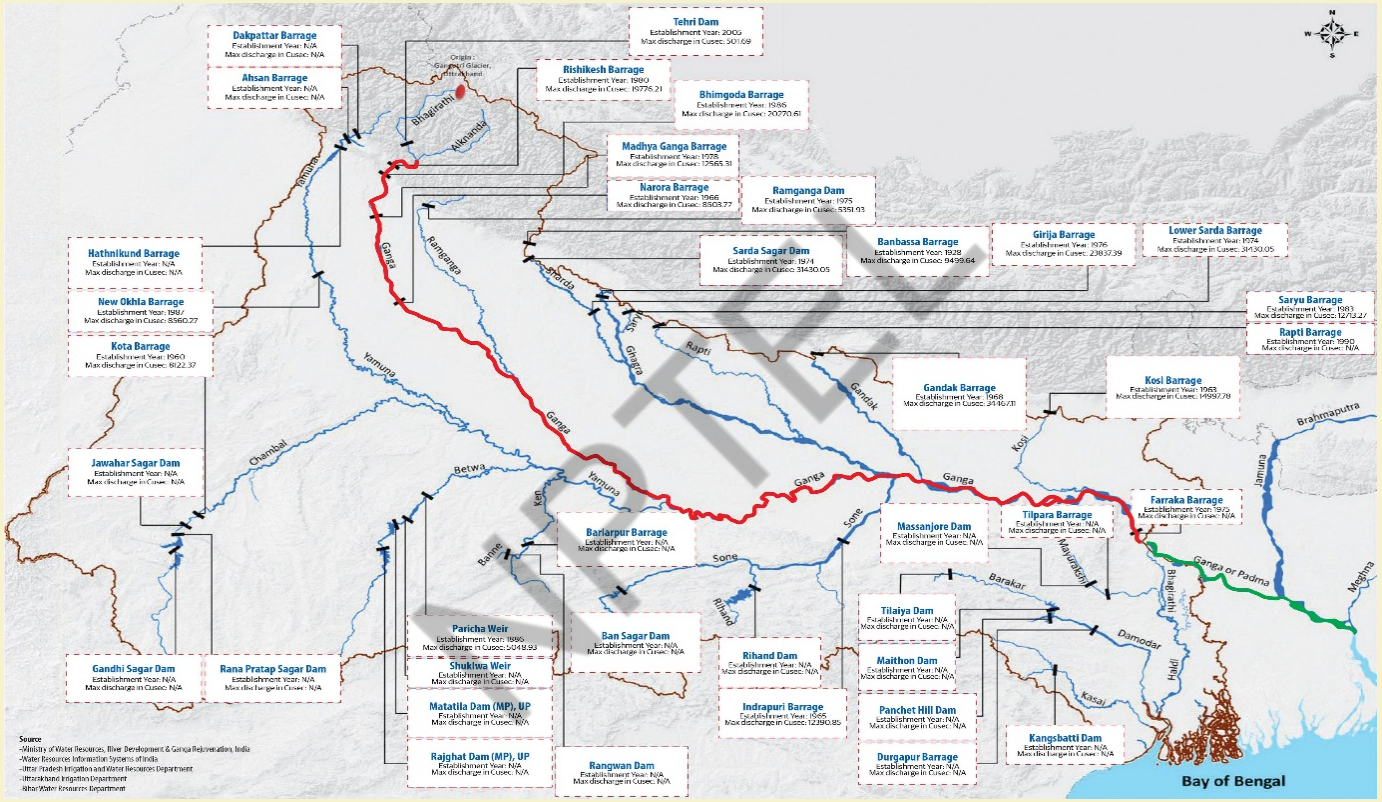
Chronology of events: 1961 – 2017

Other Movements

- Vishnuprayag dam on the Alakananda River – Chandi P. Bhatt
- Koel-Karo dams – Jharkhand Visthapith Mukti Sangh
- Poondi dam – farmers and agricultural labourers of Ramanjeri and Thirukkandalm, Tamil Nadu
- Bedthi dam – farmers of Karnataka

The fight is on…

Upstream, downstream complexities



Source: https://ganges.dhakatribune.com/

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Water, Society and Sustainability

Lecture No 15: The Farakka Barrage Project: Historical and Technical Details

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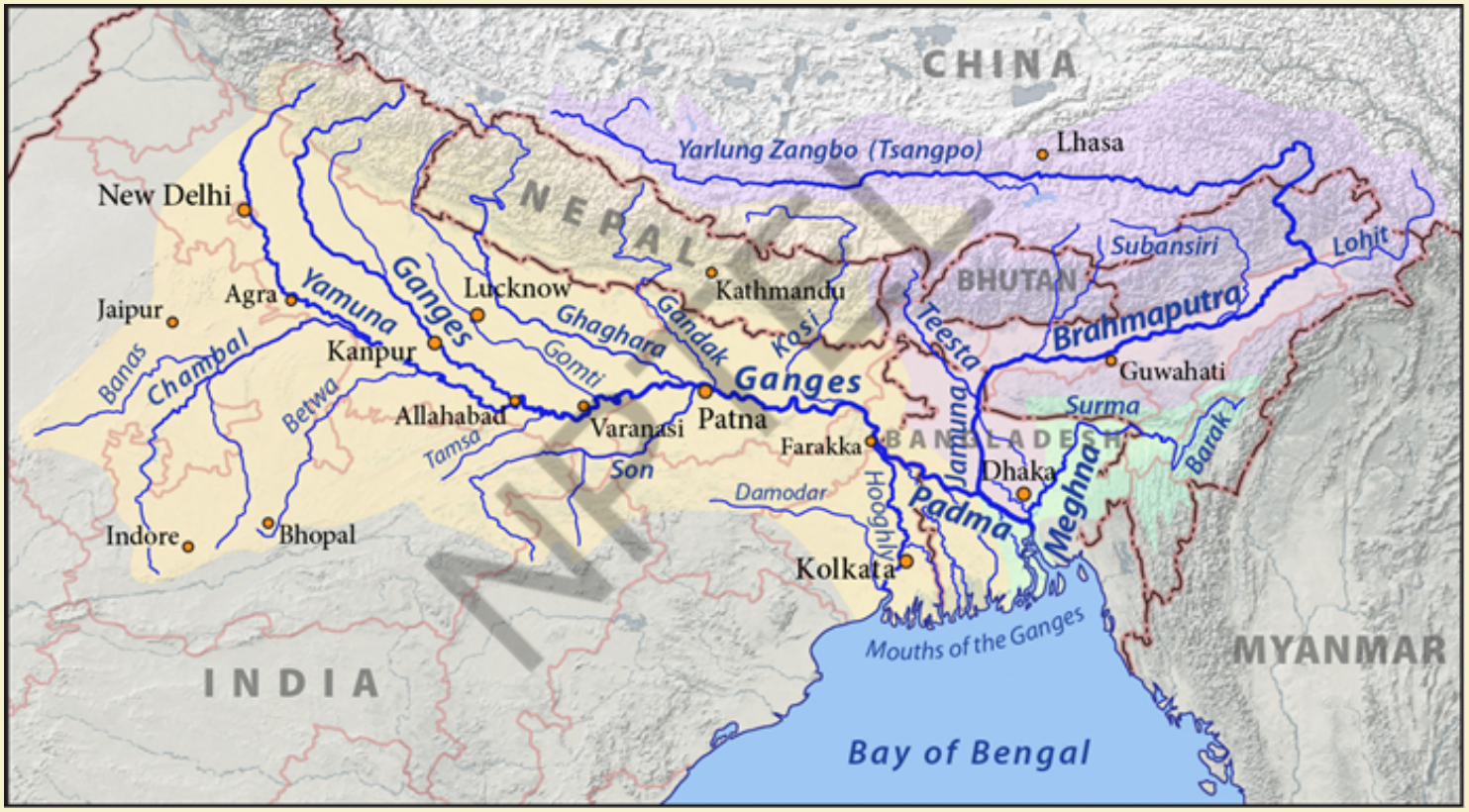
Farakka


CHINA
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Lohit
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Lucknow
Kathmandu
Ghaghara
Gandak
Kosi
Teesta
Brahmaputra
Guwahati
Banas
Chambal
Kanpur
Gomti
Ganges
Surma
Betwa
Allahabad
Varanasi
Patna
Farakka
Jamuna
Barak
Tamsa
Son
Dhaka
Damodar
Hooghly
Padma
Meghna
Indore
Bhopal
Kolkata
Mouths of the Ganges
MYANMAR
INDIA
Bay of Bengal

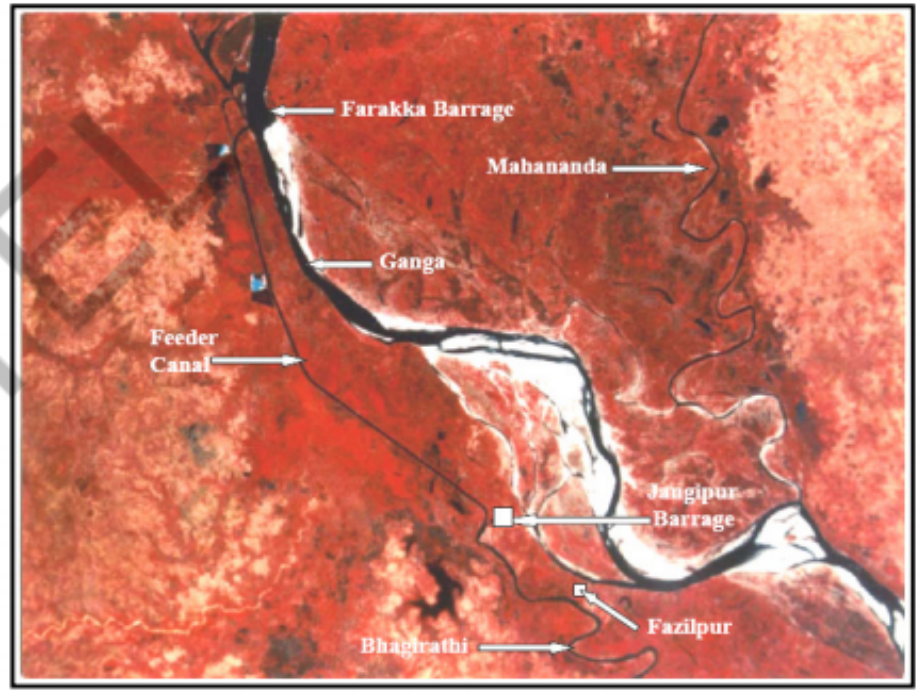
The Farakka Barrage

Why the Farakka Barrage Project?

- Transboundary dismension
- Explorations from the Bangladesh perspective
- Indian (West Bengal) scenario under explored
- The Lower Gangetic Basin – nebulous, fluid, hybrid space
- Personal exposure – field observations and findings

Components and Implementation

- 1961 – commencement
- The project complex:
  - Farakka Barrage
  - Feeder Canal
  - Jangipur Barrage
  - Navigation Lock and associated structures



Source: Rudra 2003

A. Farakka Barrage	
Length :	2.62 Km
Number of Bays :	109
Span of Each Bay :	18.30 m
Lowest Bed Level :	10.30 m above m.s.l.
Pond Level :	21.90 m above m.s.l.
Crest Level of Spillway :	15.80 m above m.s.l.
Crest Level of Under Sluices and River Sluices :	14.30 m above m.s.l.
B. Head Regulator	
Pond Level :	21.90 m above m.s.l.
Full Supply Level at Land :	1133 cumec
Clear Water Way :	11 bays of 12.20 m each
Crest Level :	18.10 m above m.s.l.
C. Feeder Canal :	
Length :	38.30 km
Design Discharge :	1133 cumec
Bed Width :	150.80 m
Full Supply Depth :	6.10 m
D. Jangipur Barrage :	
Length :	212.70 m
Number of Bays :	15
Span of Each Bay :	12.2 m
Crest Level :	14.30 m above m.s.l.

The Historical Context

- 1853 – Sir Atherton
- 1896 – Vernon Harcourt
- 1913 – Reak
- 1916-19 – Stevenson-Moore Committee
- 1930 – William Willcocks
- 1939 = T.M. Oag
- 1946 – A. Webster
- 1957 – Walter Henson

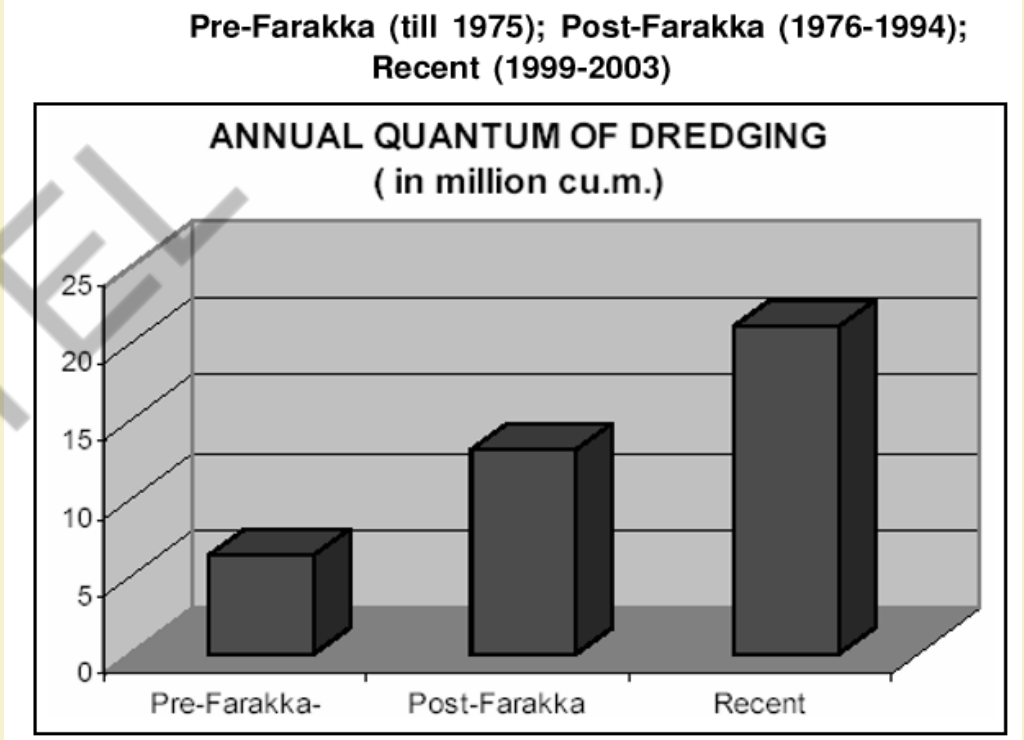
Boundary Commission – deviation from the religious principle (MEA 1978)

Changing flows in rivers

Van den Brouche	James Rennell
The Bhagirathi, through which the waters of the Ganges used to pass from the 12th – 16th centuries, is no longer the main stream of the river. The Padma channel, which is shown as a broad, braiding stream, entwining numerous large islands, now carries the bulk of the Ganges waters.	The Bhagirathi has been further reduced, its connection with the Ganges functioning only during the rains. Among the active distributaries of the Ganges are the Chandna and Jalangi.

Is it a story of technical success?

- sedimentation in the estuary continues unabated
- annual quantum of dredging has increased from 6.40m.m3 during pre-Farakka days to 13.24m.m3 during post-Farakka days; 21.18m.m3 per annum during 1999-2003



Source: Rudra 2003

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Thank You!!