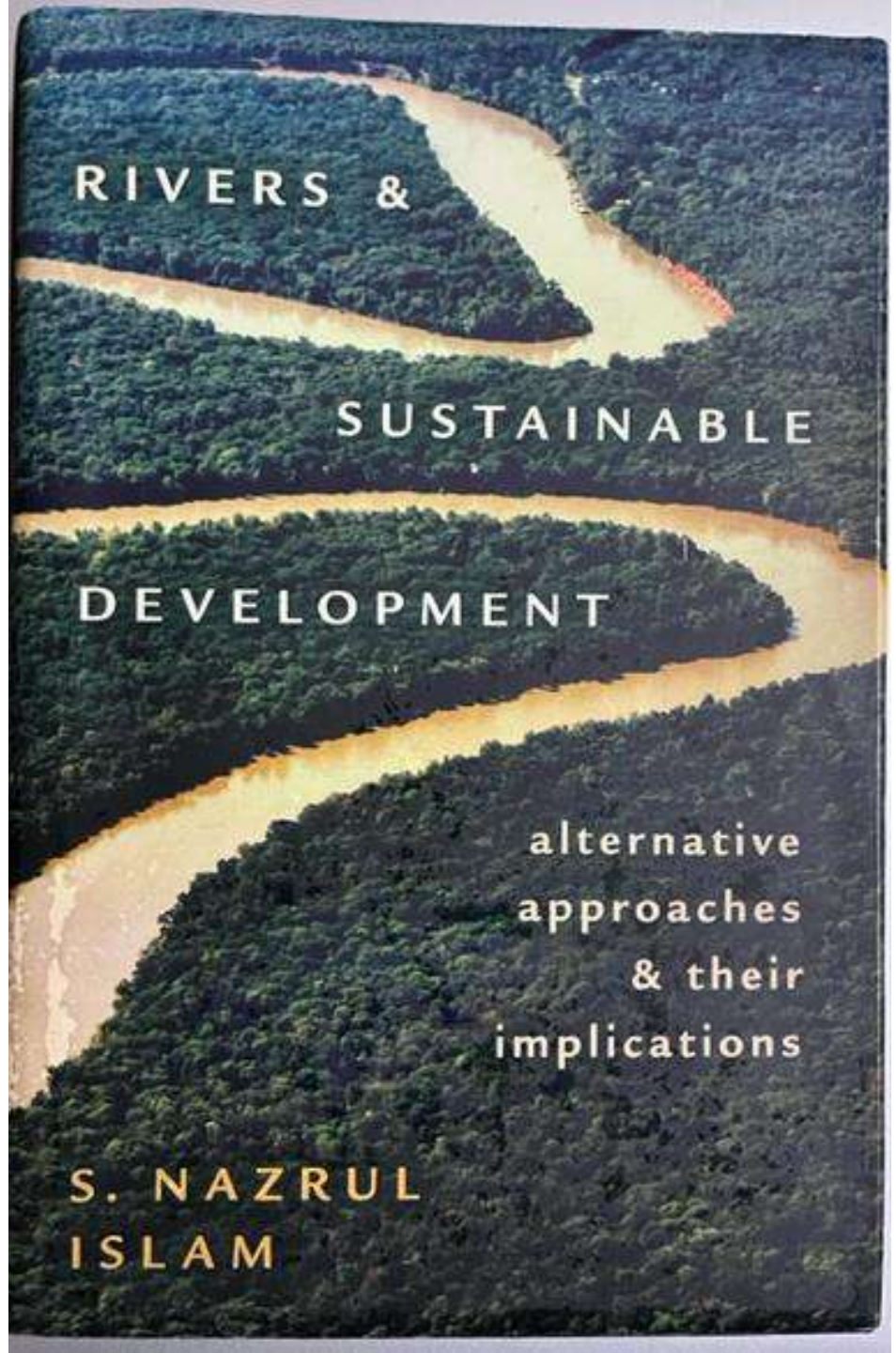
Water Development in Bangladesh

Past, Present, & Future

S. Nazrul Islam


RIVERS &
SUSTAINABLE
DEVELOPMENT
alternative
approaches
& their
implications
S. NAZRUL
ISLAM

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Land and water of Bangladesh

- Introduction
- Brief geological history
- Broad physiographic divisions
- Bangladesh rivers
- Water and sediment flows
- Rainfall – an internal source of water
- “Flood problem”
- Riverbank erosion problem
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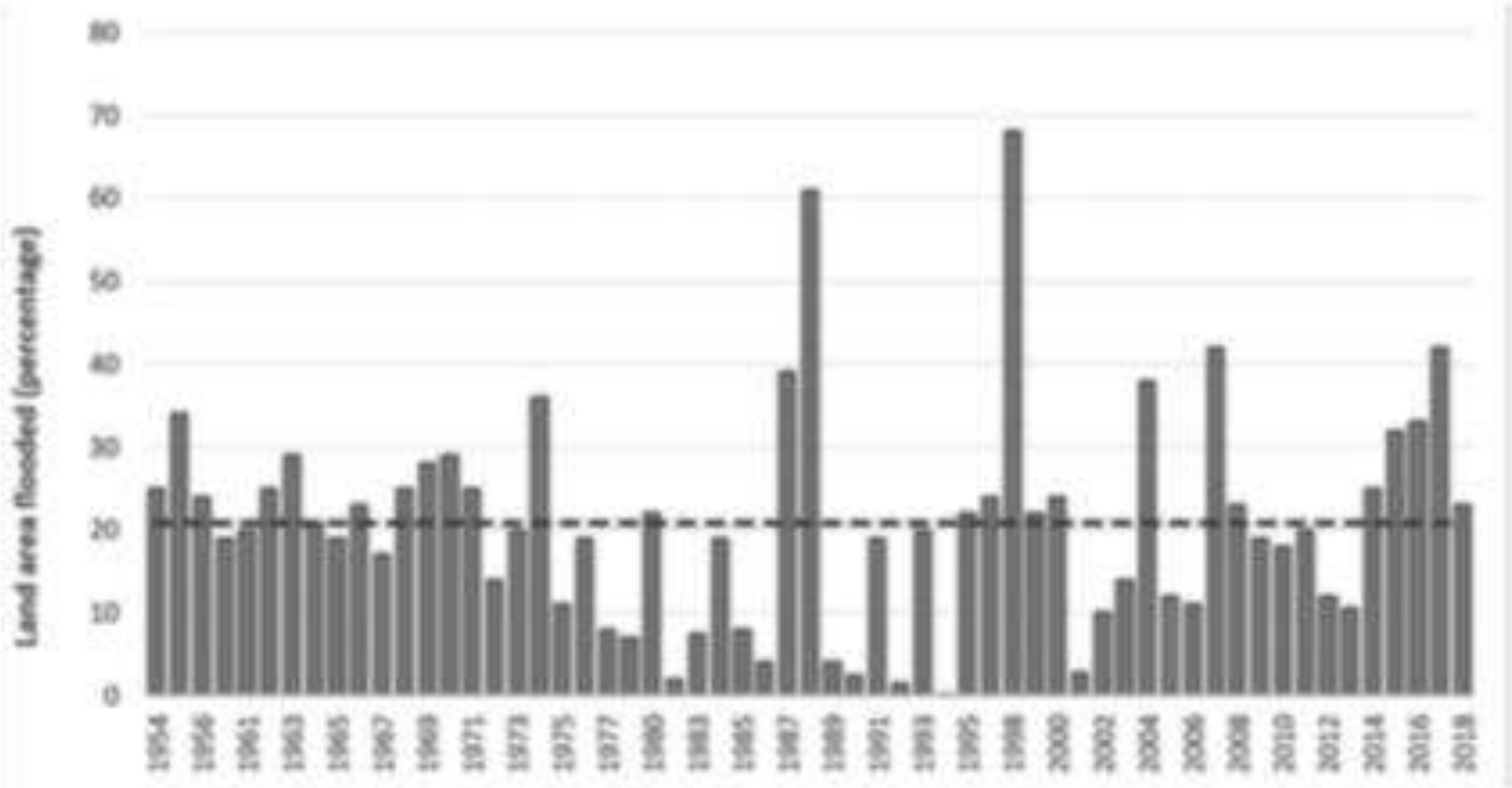
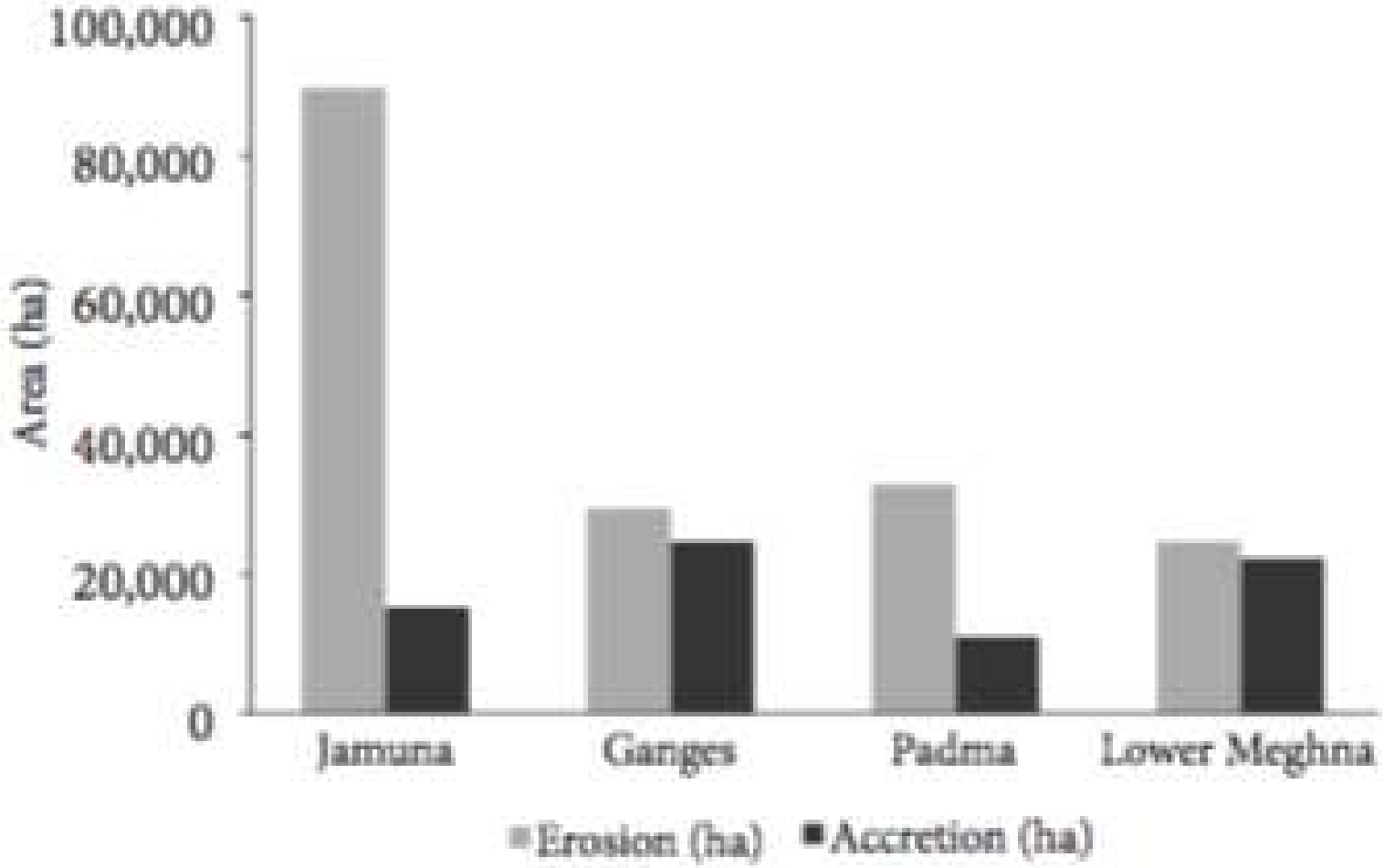
Figure 2.19 Percentage of land area of Bangladesh flooded in different years



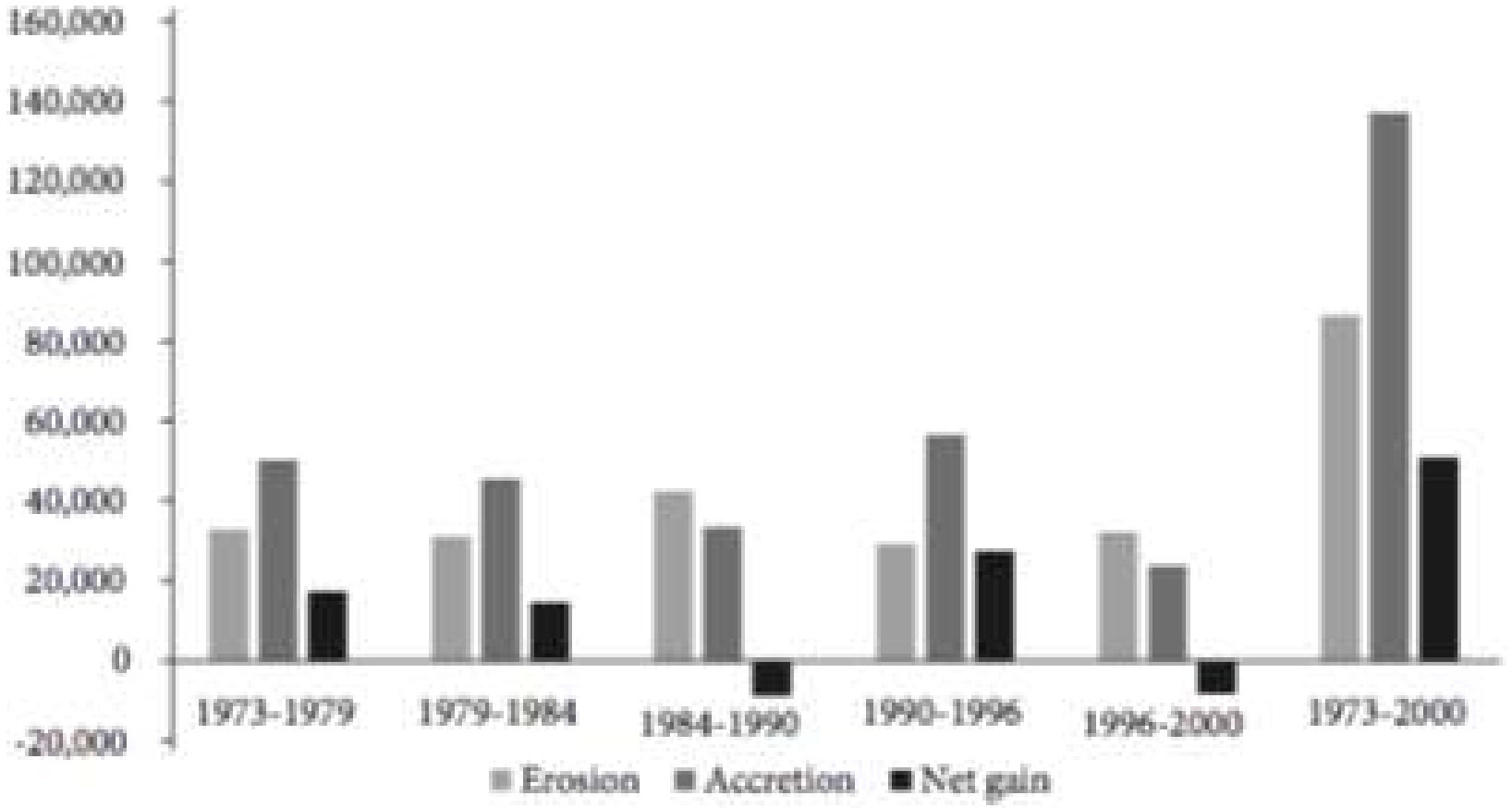
Source: A.S.M. Maksud Kamal. Mohammad Shamsuddoha, Bayes Ahmed, S. M. Kamrul Hassan, Md. Shahidul Islam, Ilan Kelman, Maureen Fordham (2018, p. 480), updated by the author.

Figure 2.26 Erosion and accretion by major rivers of Bangladesh (1973-2014)



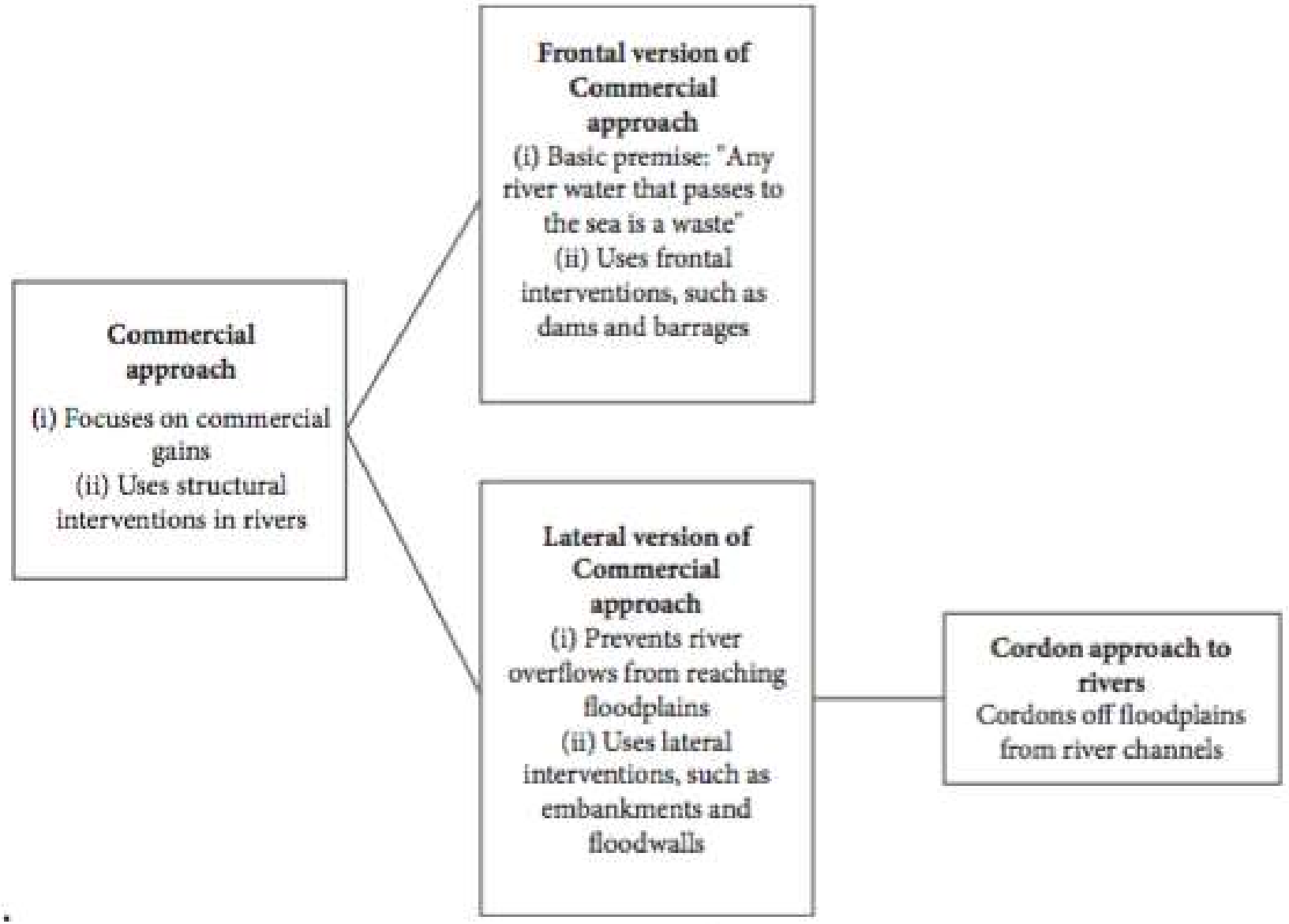
Source: Sarker (2018, p. 113)

Figure 2.36 Erosion and accretion hectares in the Meghna estuary during different time periods



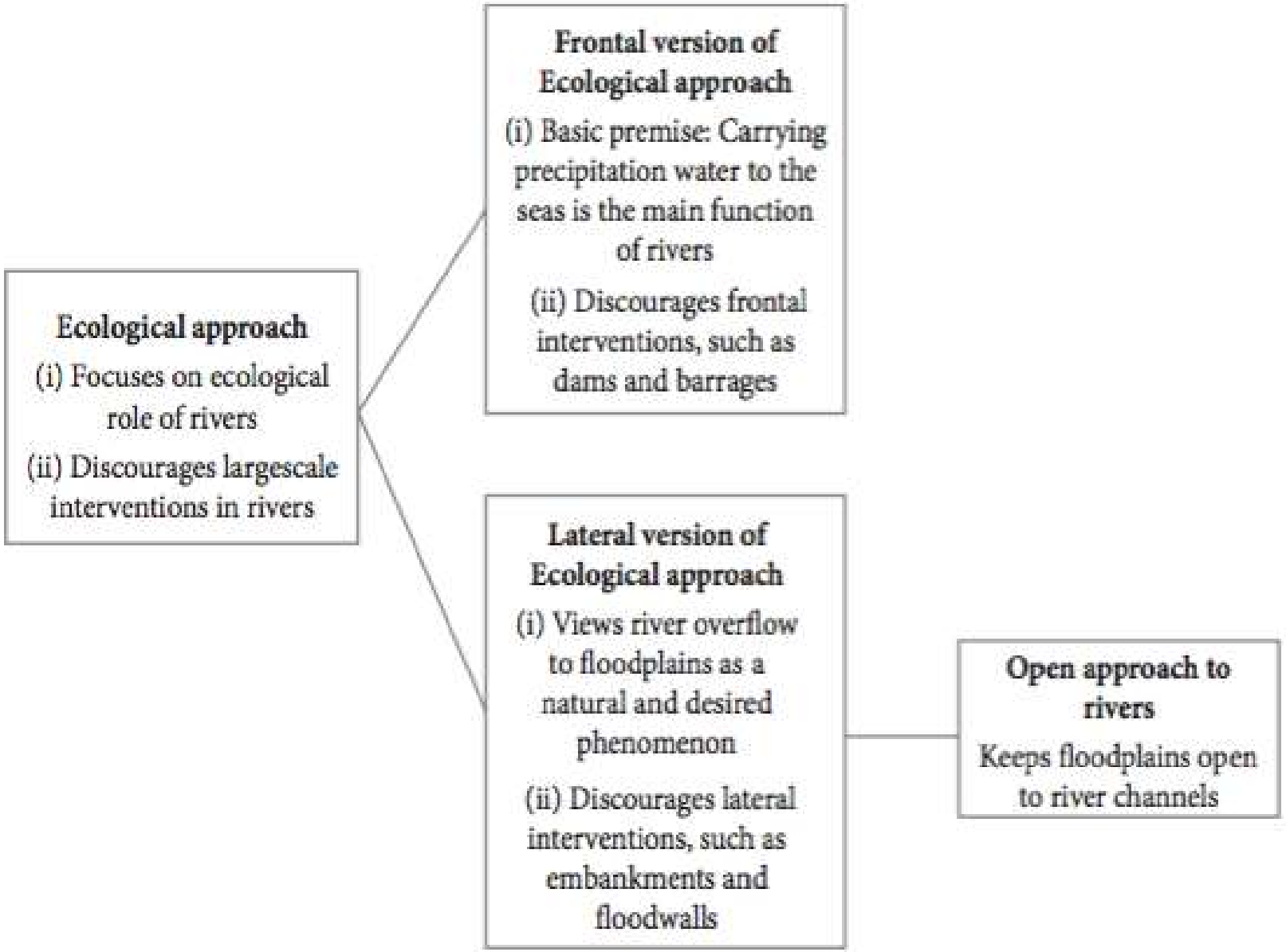
Source: BWDB (2001) and Islam, Rafiqul (2006, p. 8)

Figure 3.1 Commercial approach to rivers



Source: Author

Figure 4.2 Ecological approach to rivers



Source: Author

Figure 4.3 Dams removed in the United States

Source: American Rivers

Figure 4.4 Dams removed in Europe

Source: Ajit Bajaj and downtoearth.org.in

Figure 5.1 Railways in Bangladesh constructed during the British period

Source: Compare Infobase Limited

Figure 5.2 Krug Mission Report cover

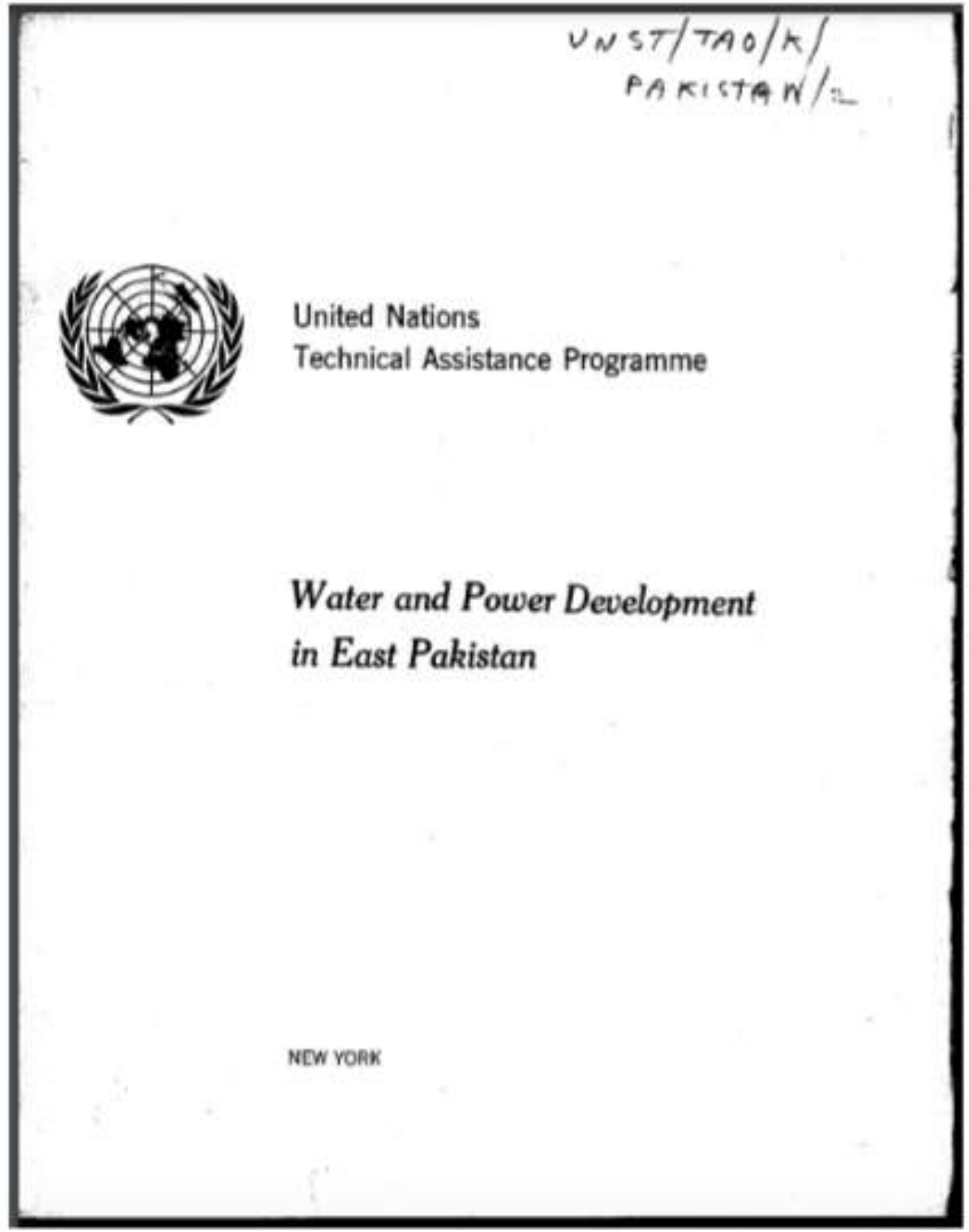


Figure 5.3 IECO Master Plan cover

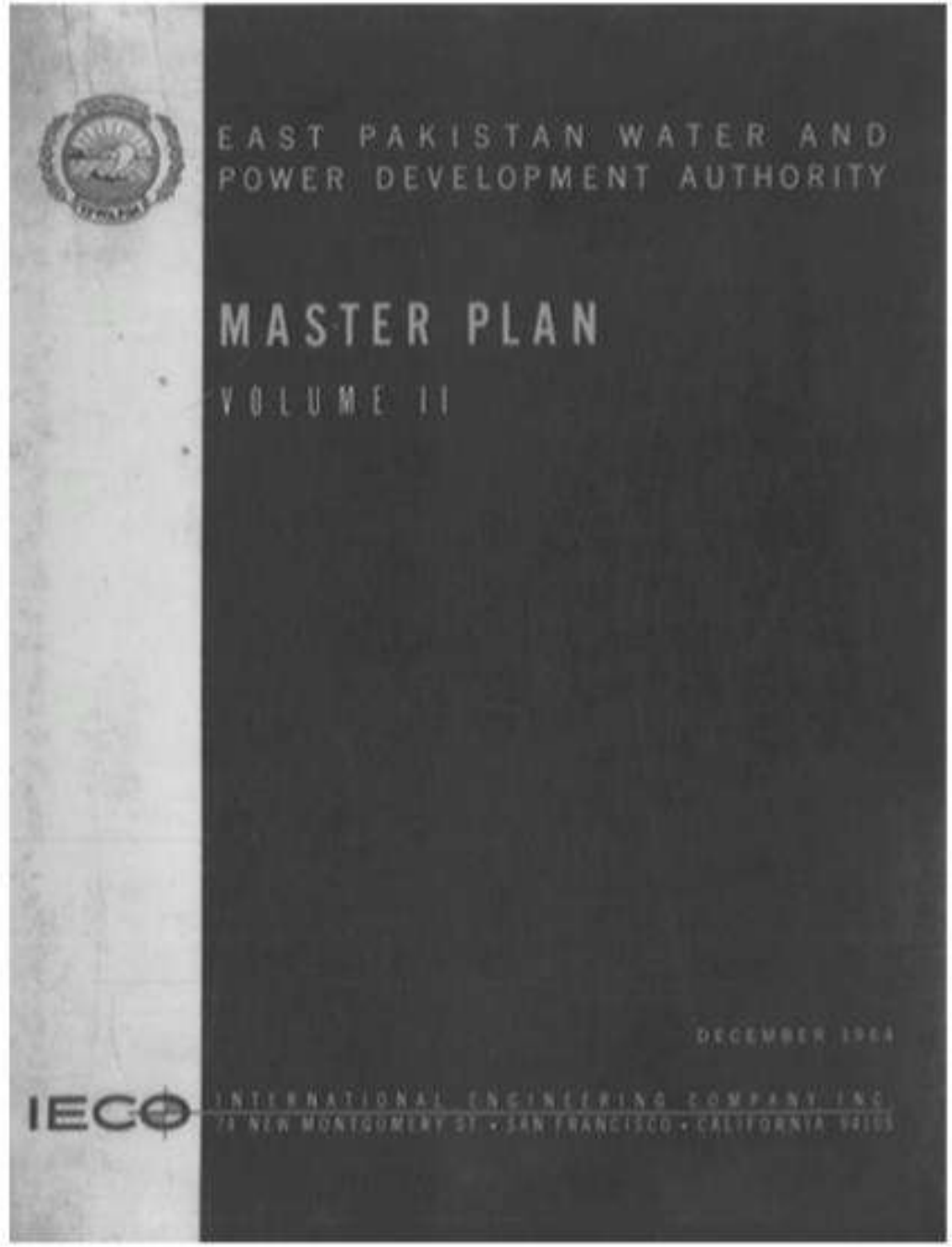


Figure 5.5 IECO view of Bangladesh of 1985

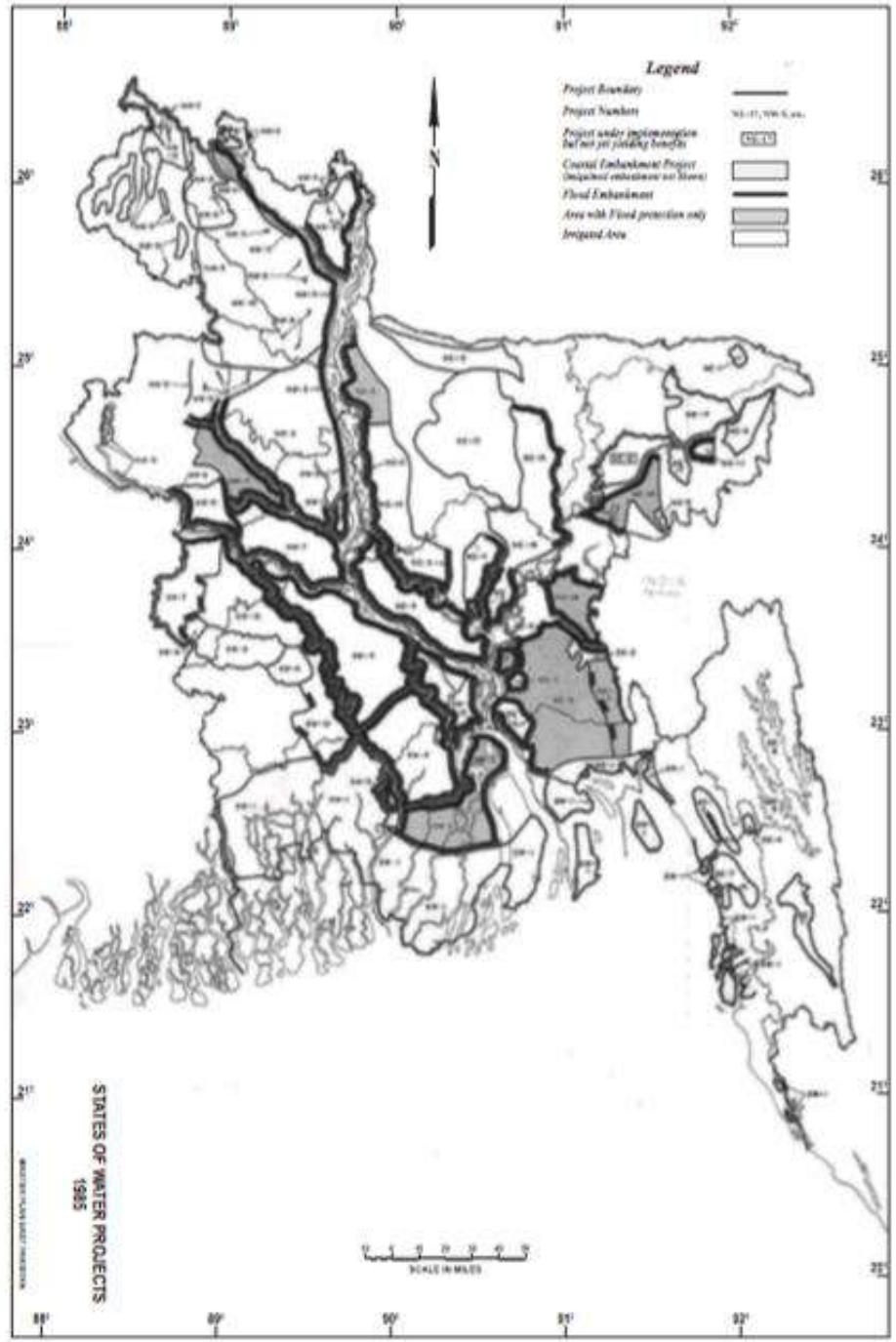


Figure 5.6a Map of Bangladesh, showing the implemented cordon projects

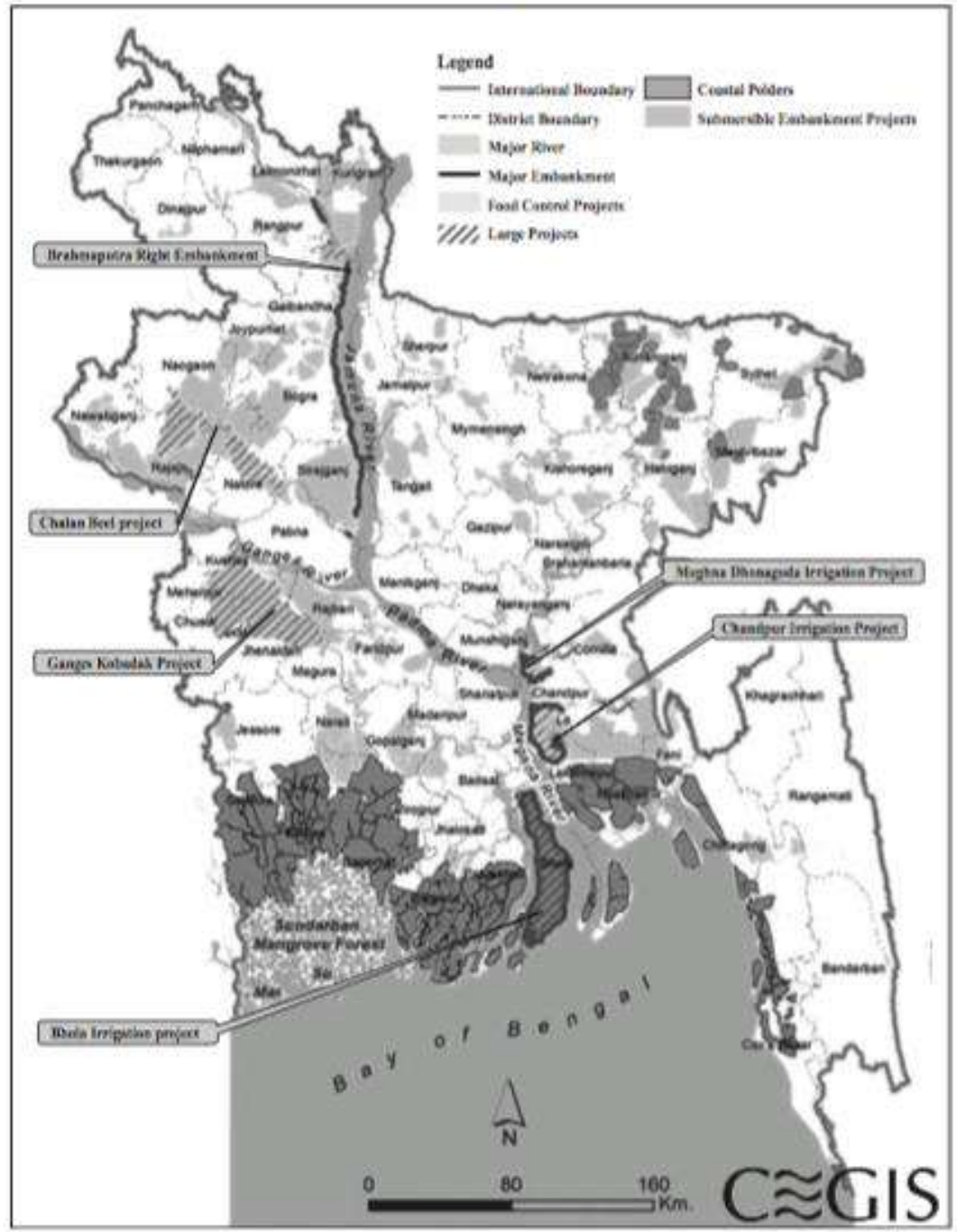


Figure 5.6b Map of Bangladesh, showing cordon projects, distinguished by the decade in which these were implemented

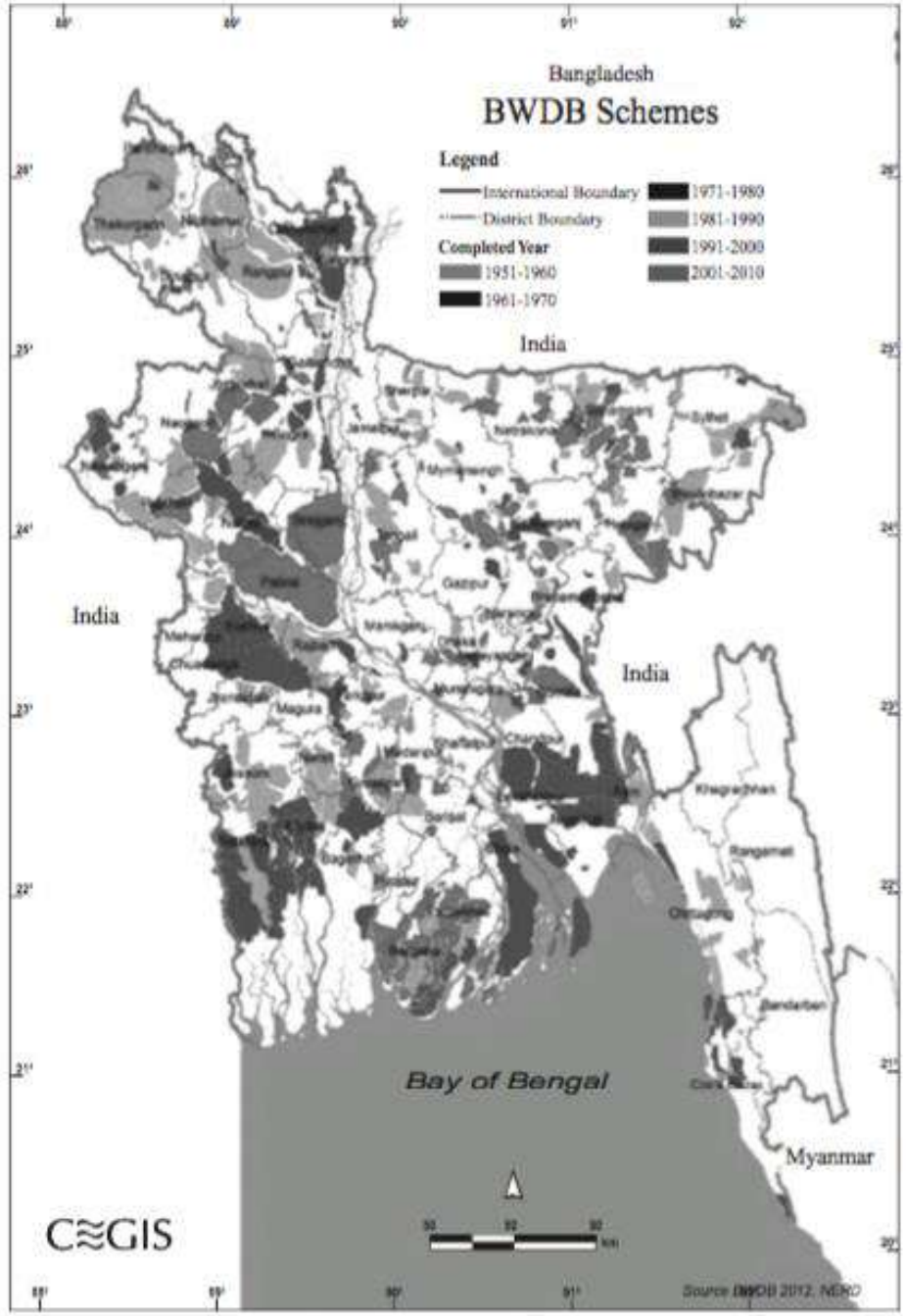


Table 3.1 Classification of cordons

Classification criterion	Types	
Land-use pattern inside cordon	Rural	Urban
Extent of closure of cordons	Full	Partial
Whether it faces sea/ocean	Inland	Coastal

Source: Author

Table 5.3 BWDB's assessment of impact of various project son production

Name of project	Pre-project production (metric ton)	Post-project production (metric ton)	Increased production (metric ton)	Post-project production as ratio of pre-project production
GK project	203,493	628,588	425,095	3.1
Chandpur Irrigation project	30,375	172,491	142,116	5.7
Pabna Irrigation project	10,142	50,893	40,751	5.0
Meghna-Dhonagoda project	13,302	86,579	73,277	6.5
Muhuri irrigation project	27,000	138,375	111,375	5.1
Teesta barrage project	216,186	439,326	223,140	1.6
Total	650,498	1,764,252	1,113,754	2.7

Source: de Heer, Choudhury, Ahmed, and Shams (2018, p. 59)

Figure 6.9 Map of the Ganges-Kobadak Project with all units together

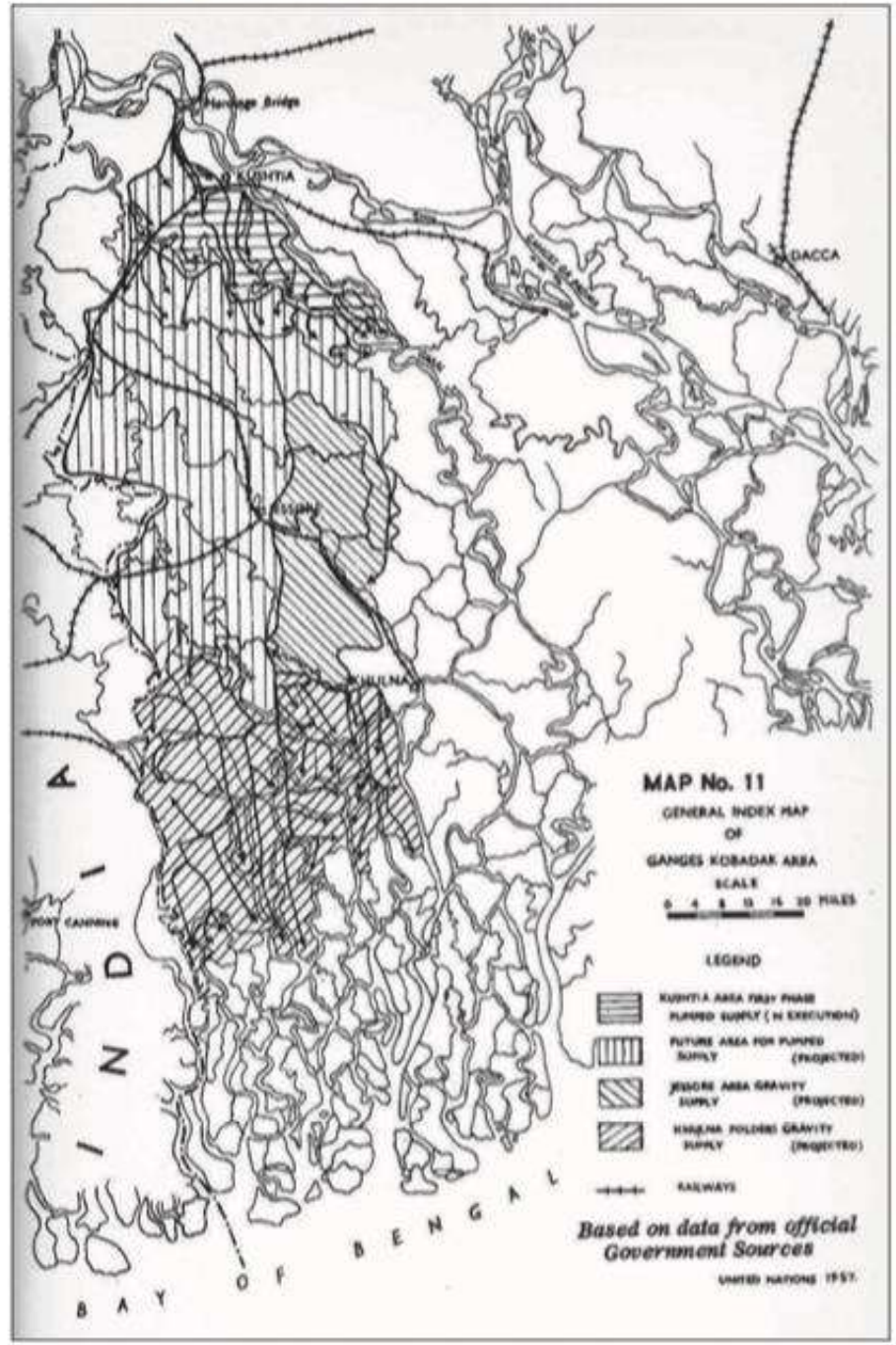
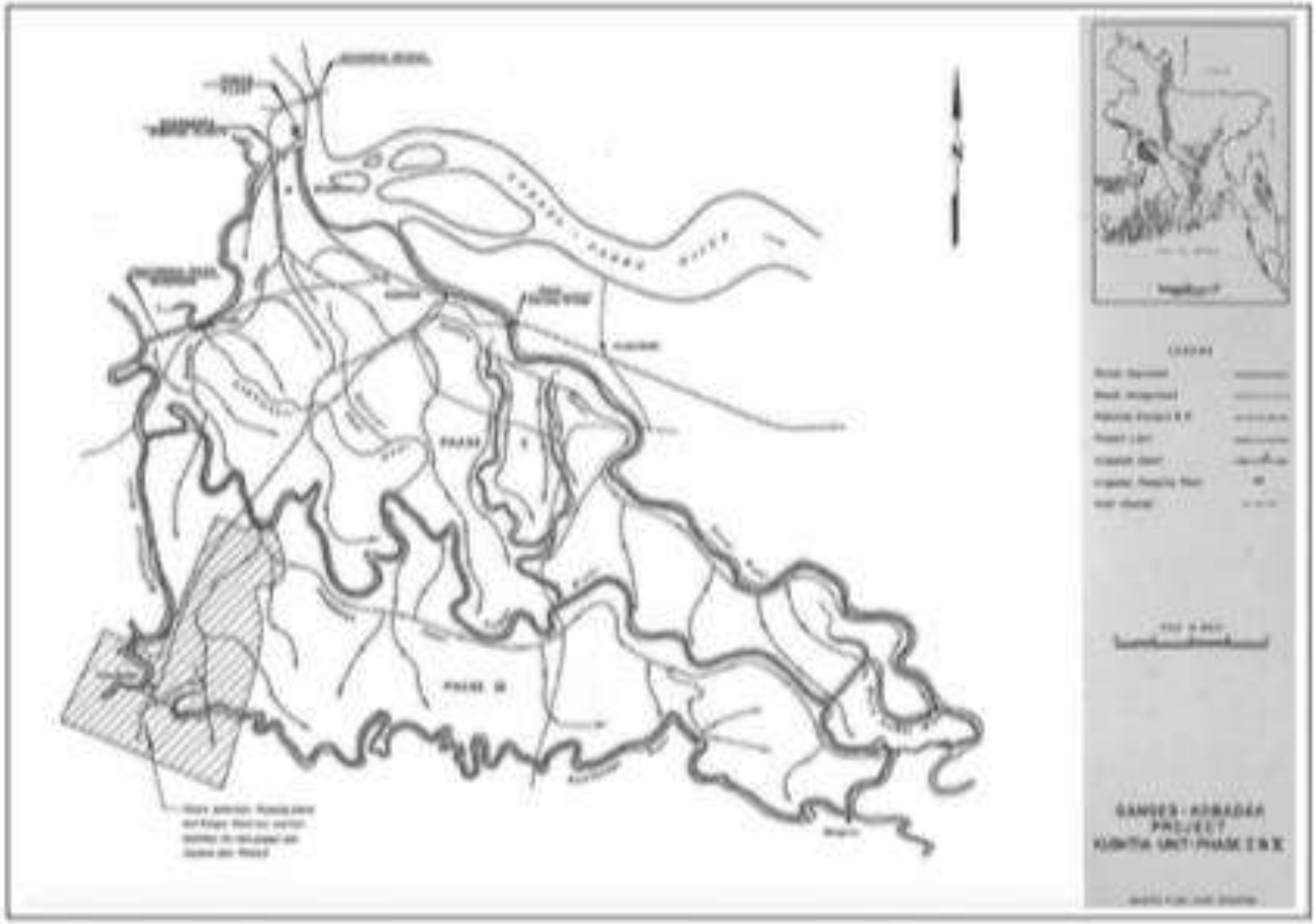
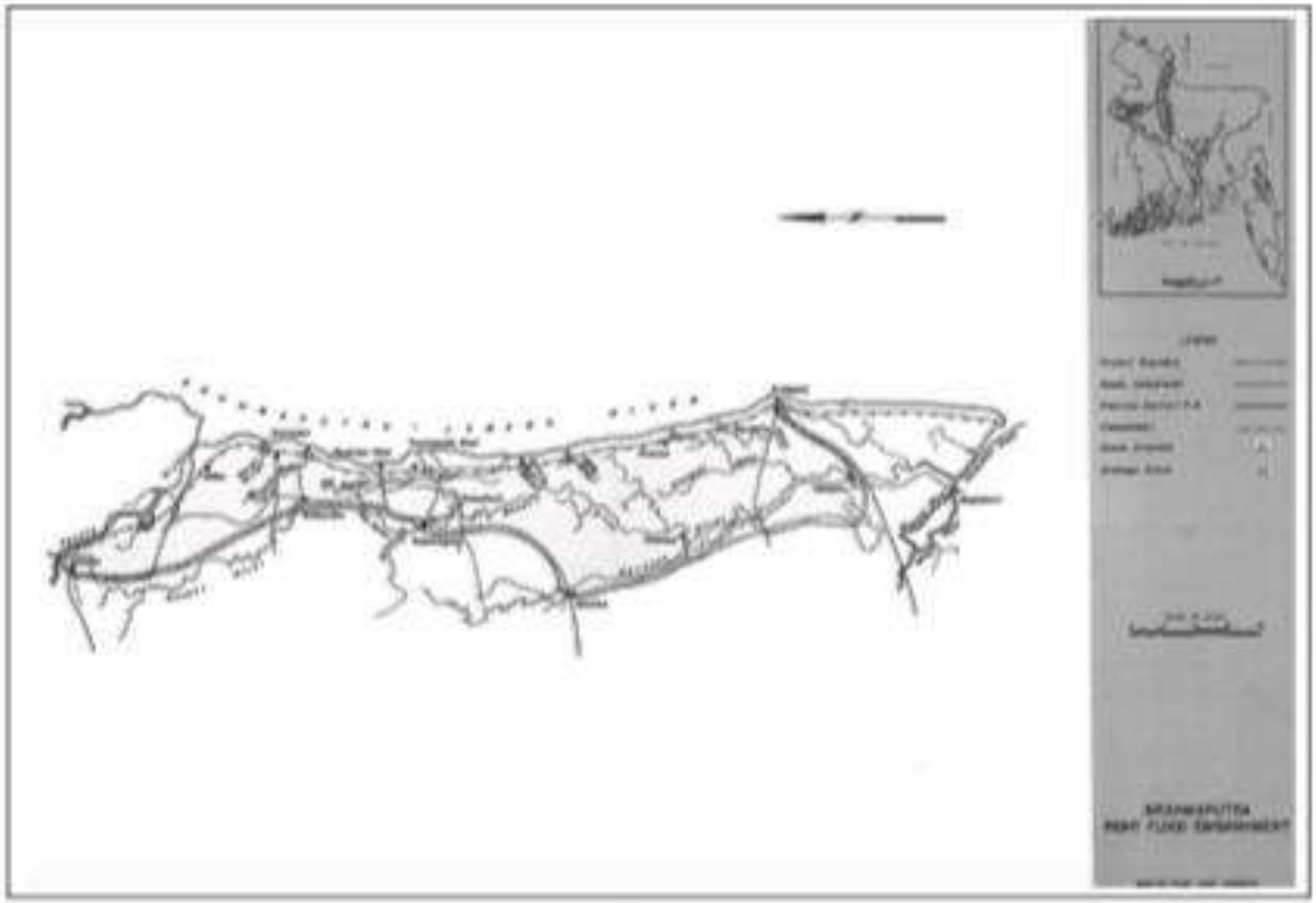


Figure 6.1 Map of the Ganges-Kobadak Project (Kushtia Unit)



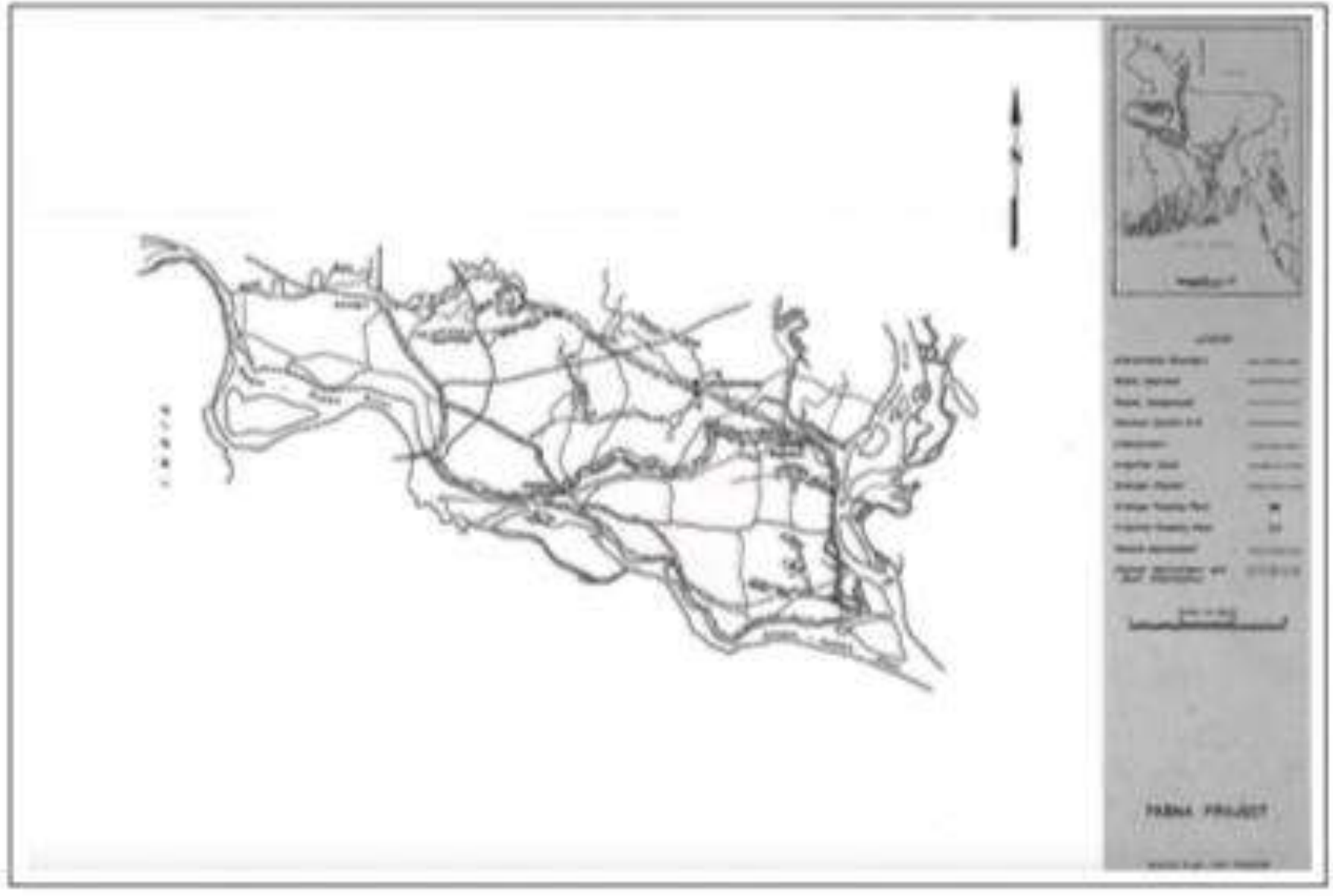
Source: IECO (1964b, p. 322)

Figure 6.10 Map of Brahmaputra Right Hand Embankment Project



Source: IECO (1964b, p. 200)

Figure 6.11 Map of Pabna Irrigation Project



Source: IECO (1964b, p. 210)

Figure 7.1 Dhaka-Narayanganj-Demra Project

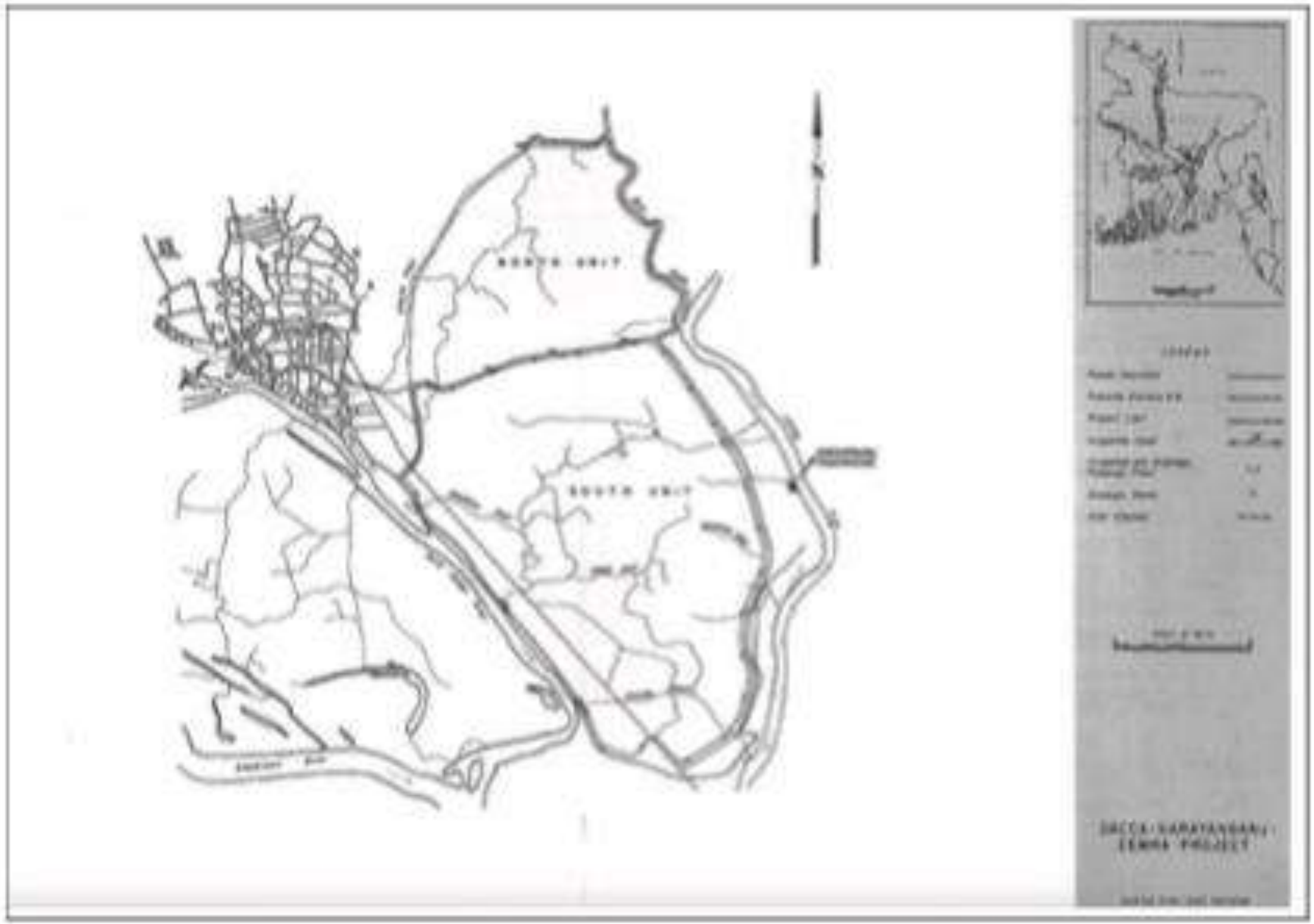
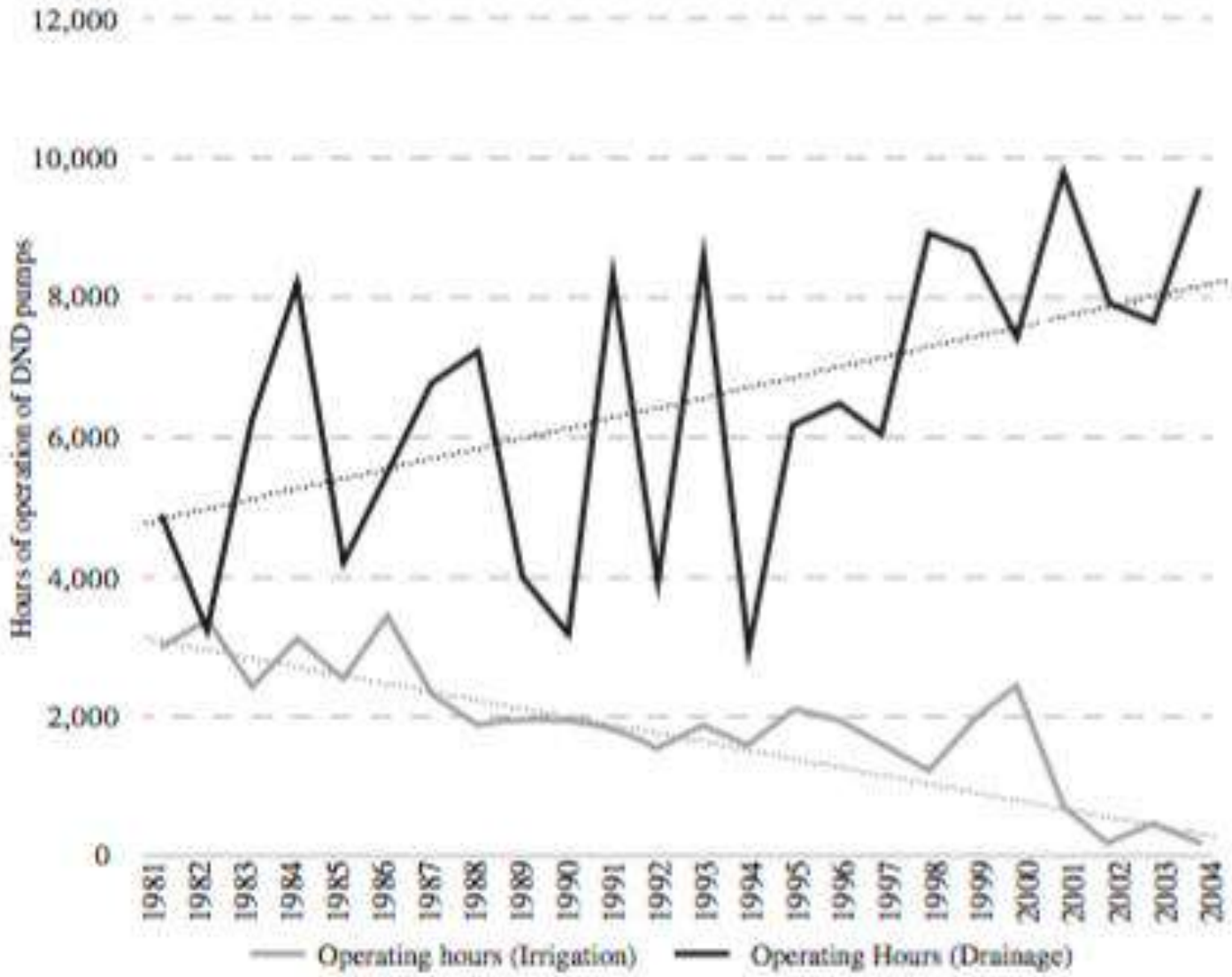


Figure 7.2 Waterlogging inside DND project

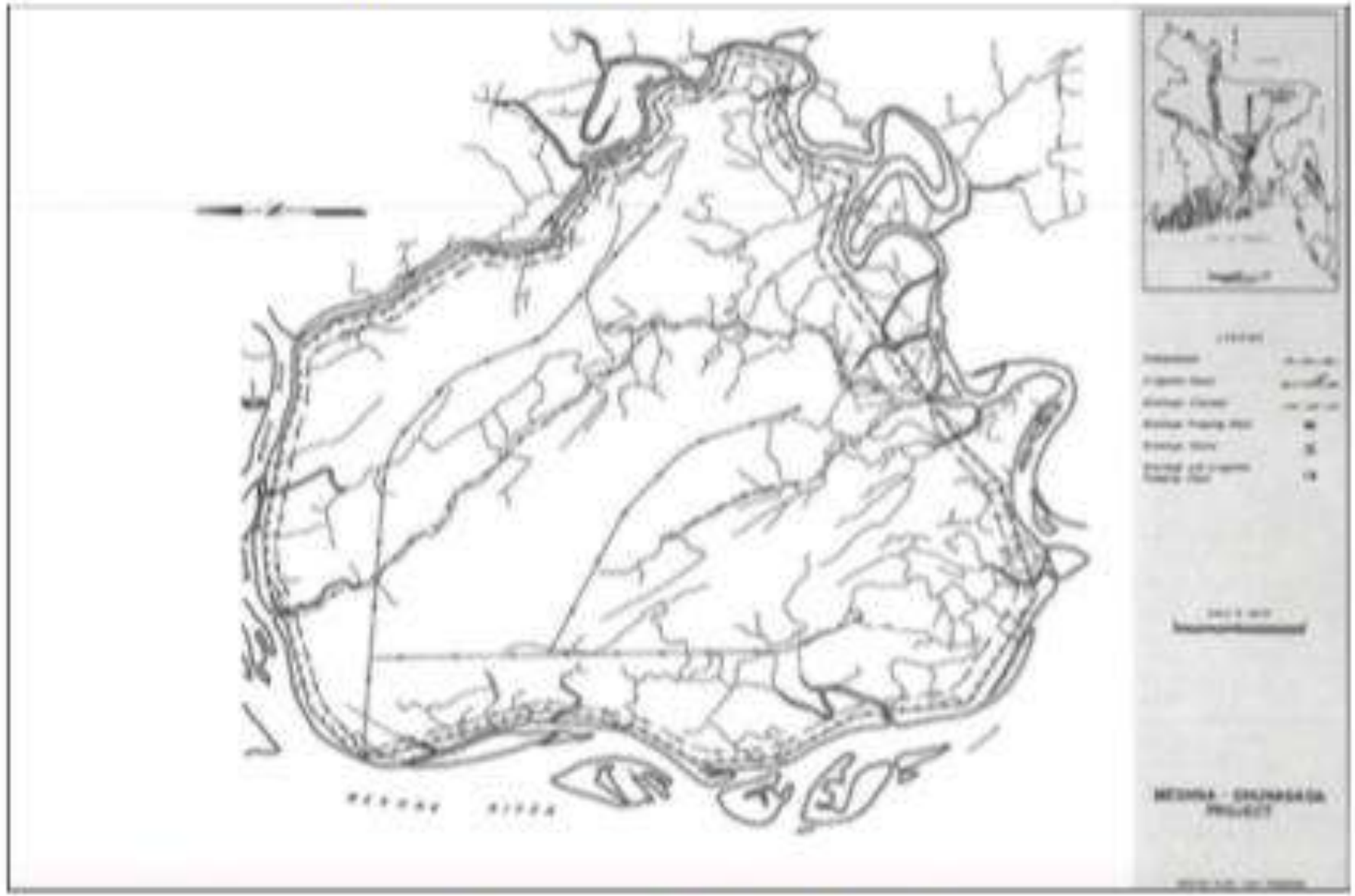
Source: Anisur Rahman, *The Daily Star* (January 1, 2016)

Figure 7.3 Hours of operation of DND pumps for irrigation and drainage



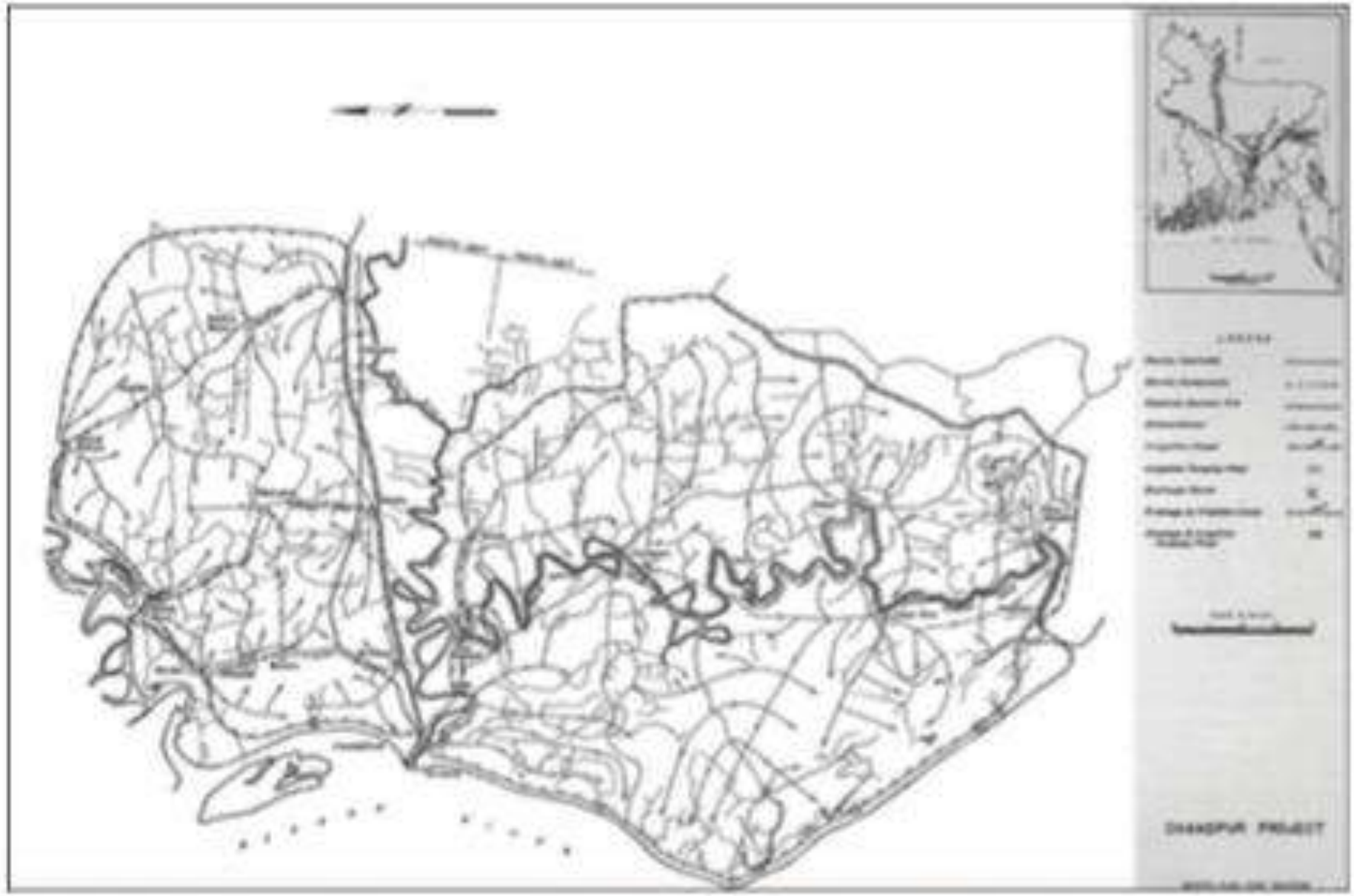
Source: Author, based on BWDB data

Figure 7.4 Meghna-Dhonagoda Project



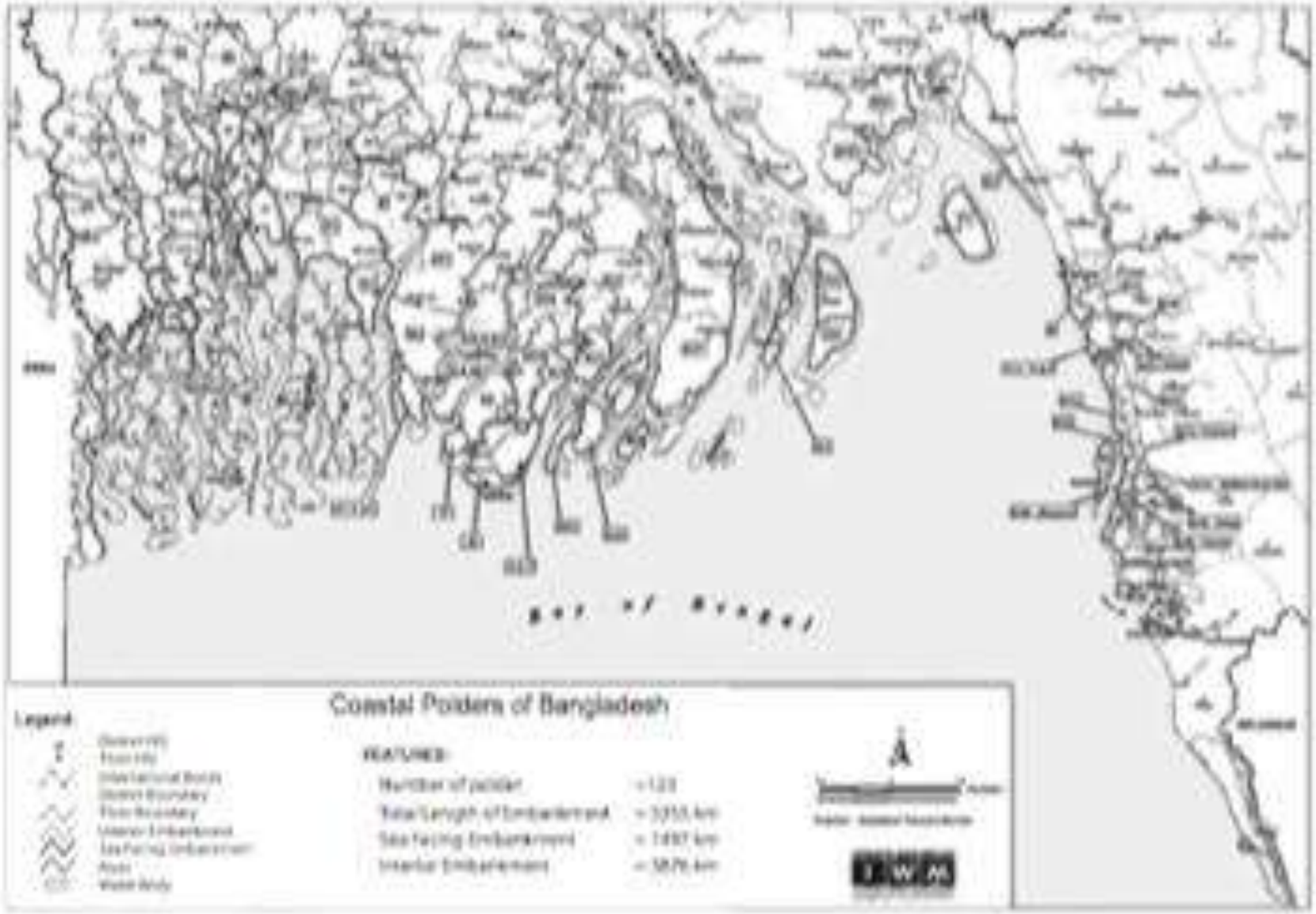
Source: IECO (1964b, p. 351)

Figure 7.5 Chandpur Irrigation Project



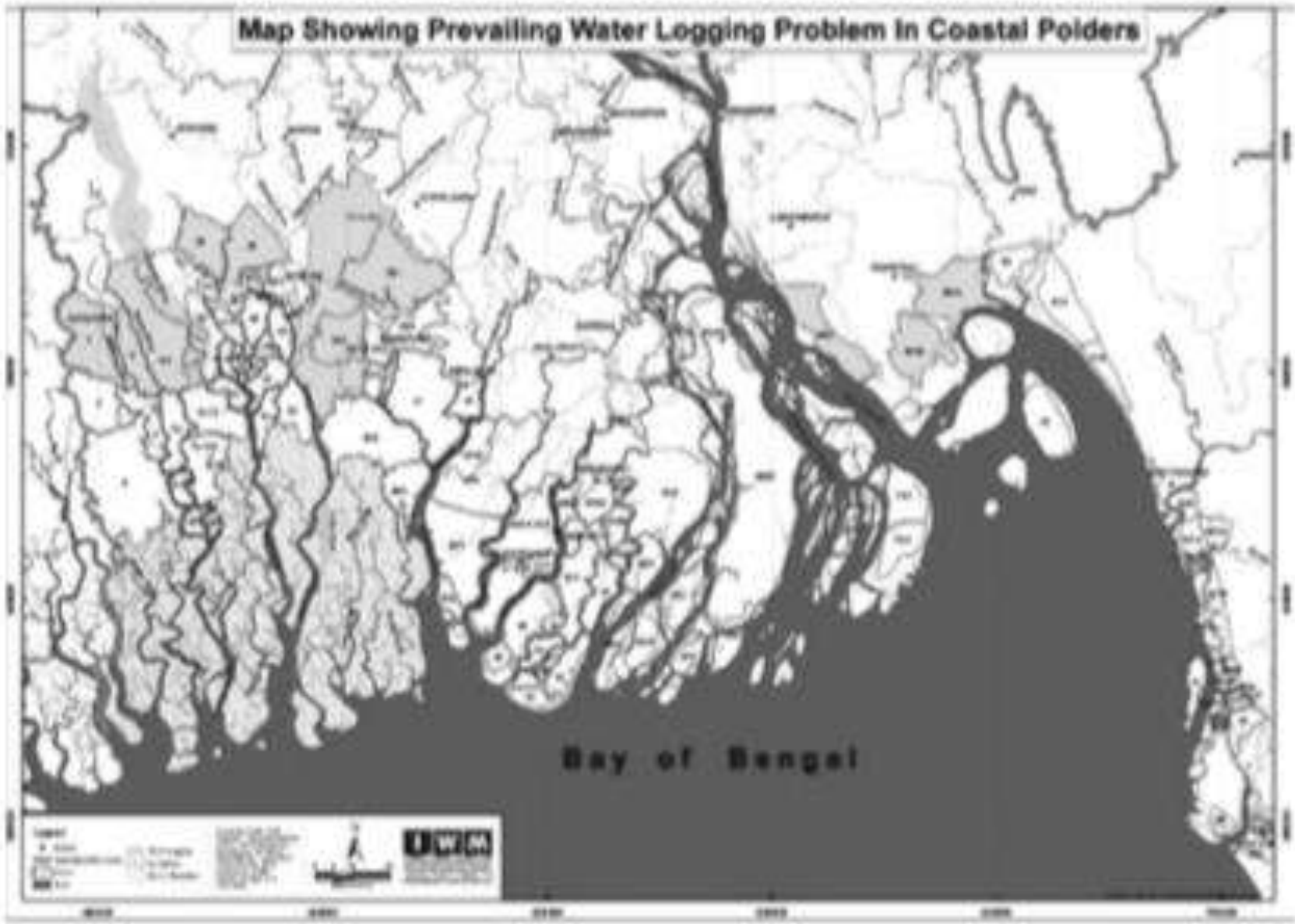
Source: IECO (1964 b, p.333)

Figure 8.3 Coastal embankment project, as implemented



Source: Institute of Water Modeling, Bangladesh

Figure 8.4 Map showing waterlogged coastal polders



Source: Khan, Z. H. (2018, p. 403) and Institute of Water Modeling (IWM).

Figure 8.7: Waterlogged Vabadaha

Figure 8.8: The Hari River bed aggradation caused by the Vabadaha regulator

Figure 8.9: Dysfunctional Vabadaha regulator

Figure 8.10: Police check post established to protect dysfunctional Vabadaha regulator

Figure 8.11: Map of Dacope Upazila of Khulna District

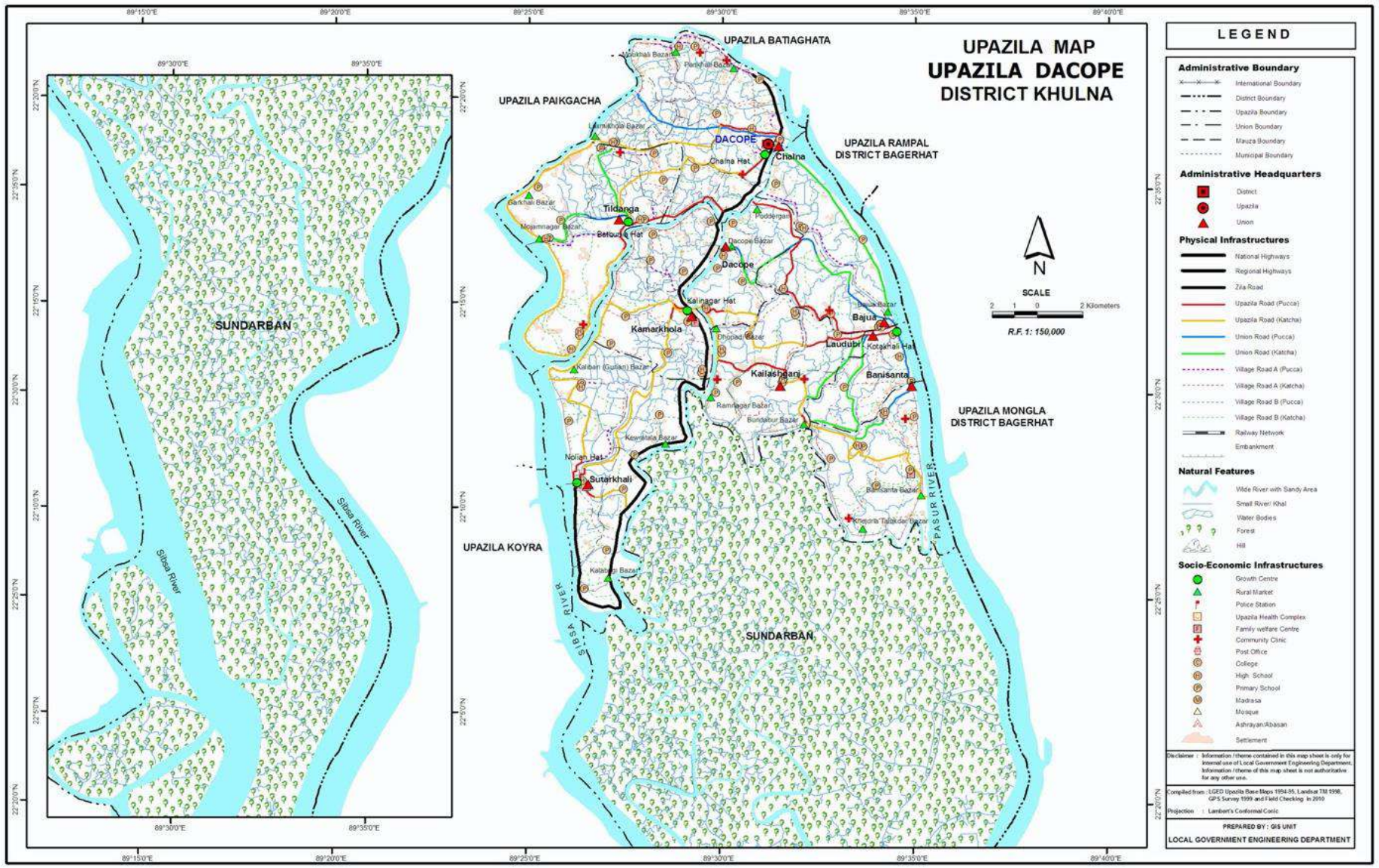


Figure 8.12: Schematic presentation of the difference between Polder 32 and the adjacent Sundarban (Auerbach et al. 2015, p. 3)

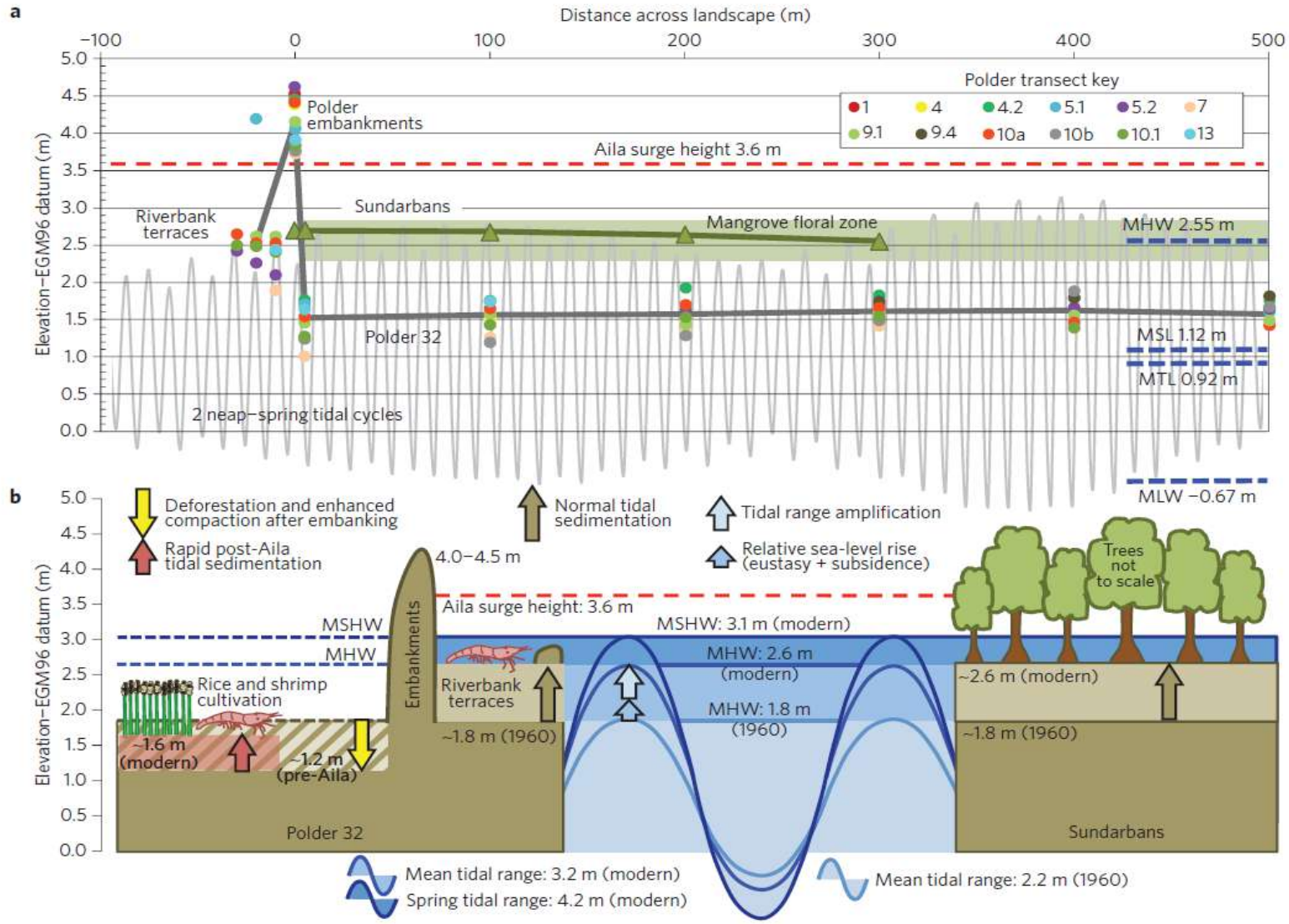


Figure 9.1 Dhaka Integrated Flood Protection Project

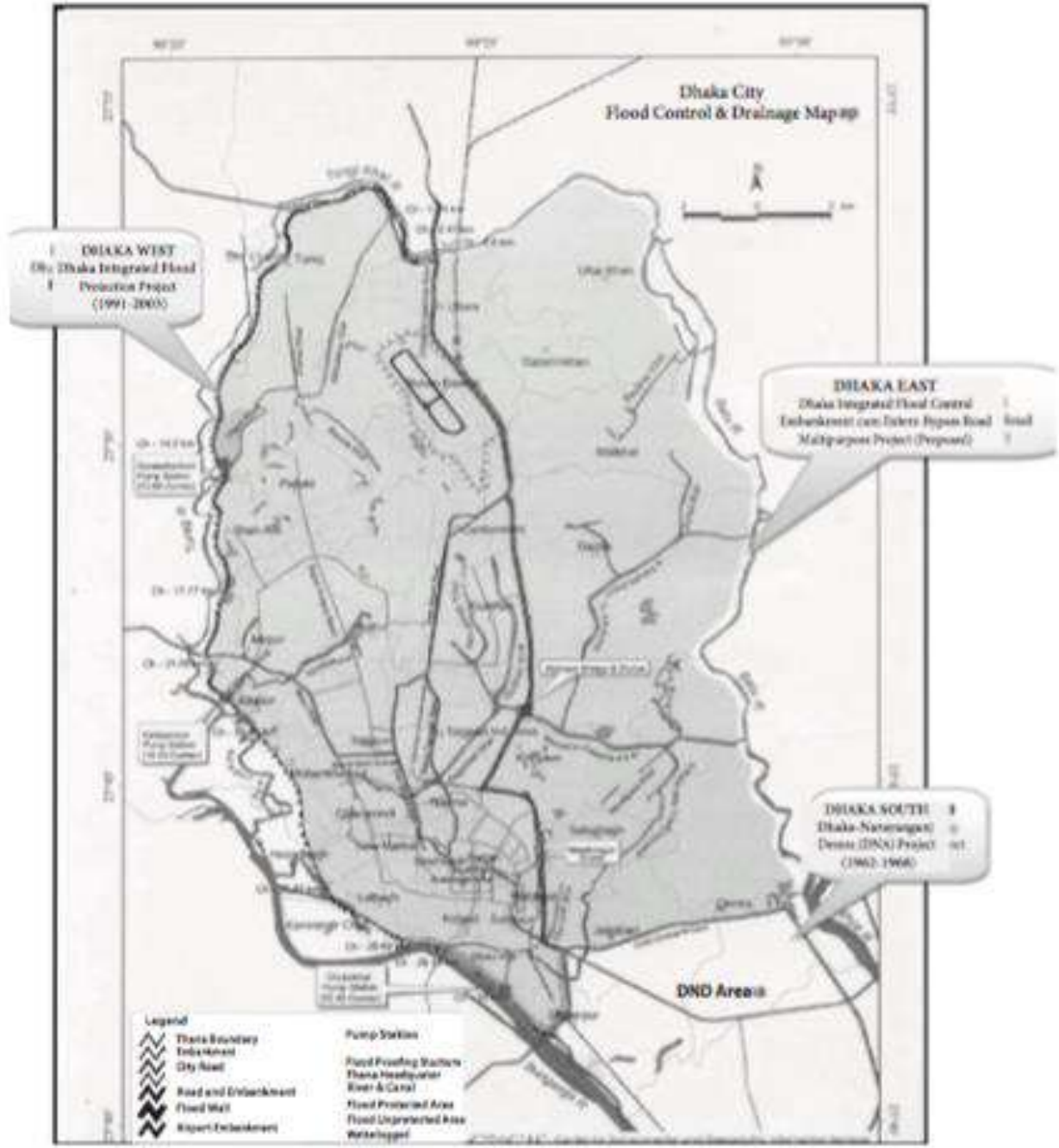
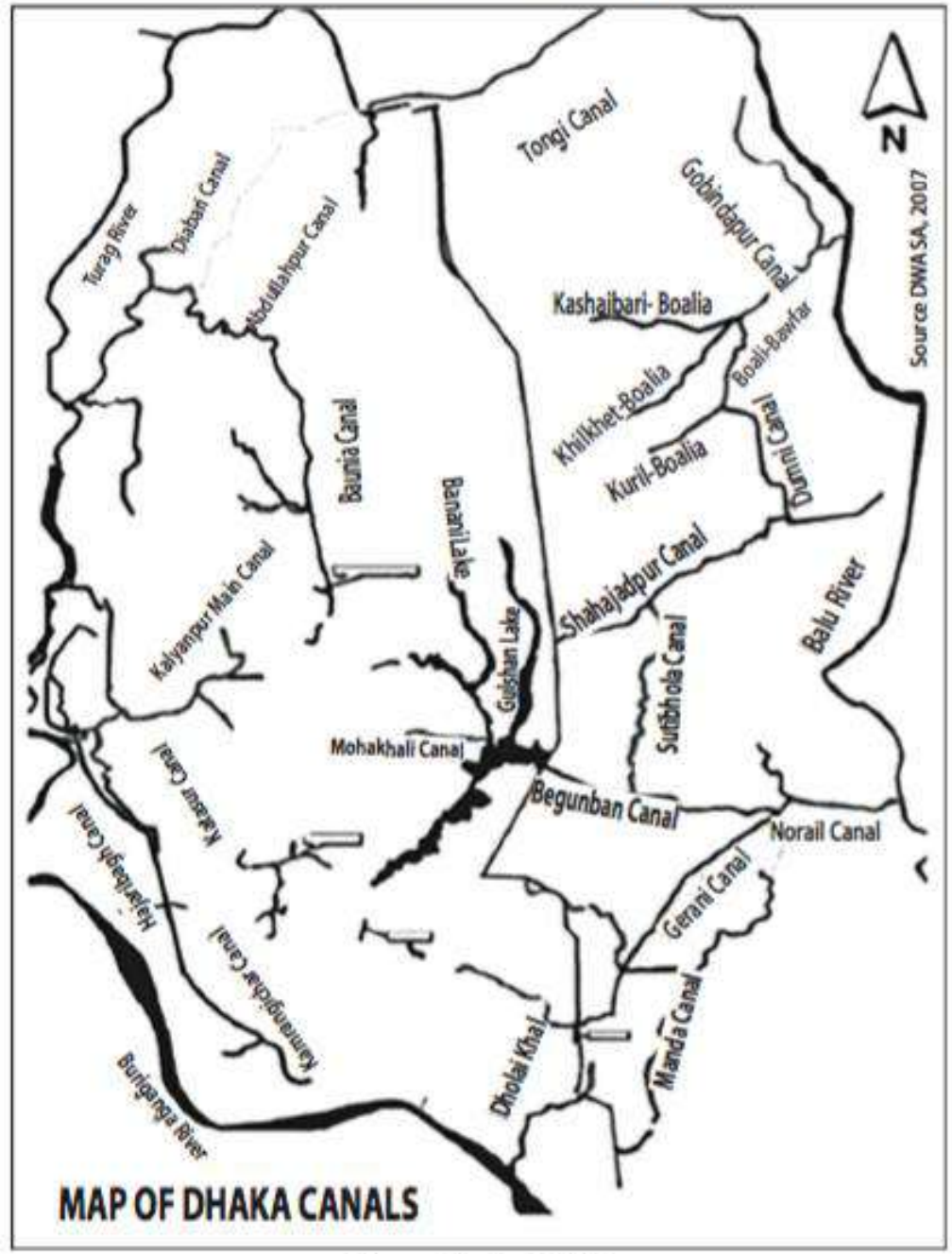
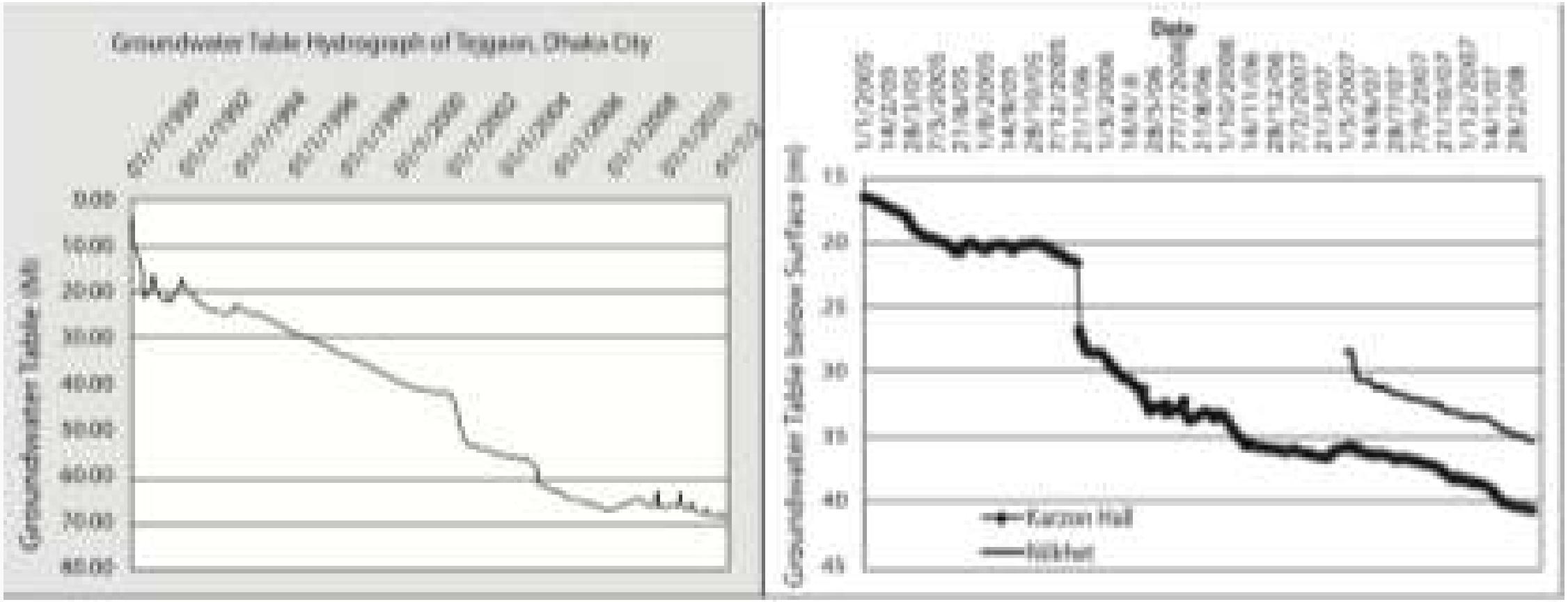


Figure 9.2 Map of Dhaka City's canals



Source: Dhaka WASA

Figure 9.4 Decline of groundwater table of Dhaka city in both upper and deeper aquifers



Source: Zahid (2018, p. 353)

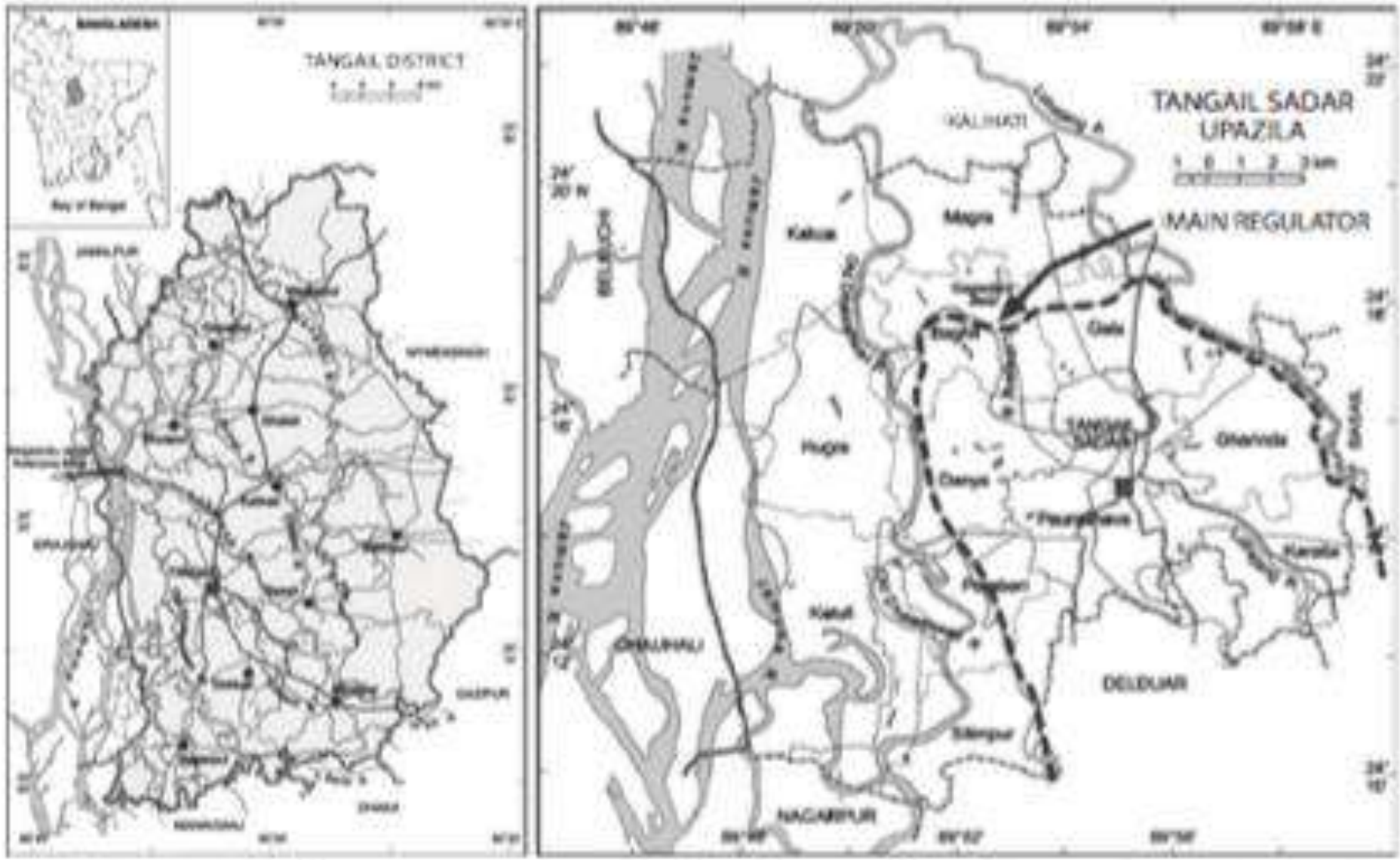
Overall experience of Cordon approach

- Decay of flood and tidal plains
  - Decay of waterbodies, deterioration of soil quality, flora and fauna, etc.
- From regular to catastrophic flood
  - “Below-flood-level settlement”
- Inefficient irrigation
  - From gravity to pumping across embankments
- Waterlogging
- River bed aggradation, bank erosion, and morphological changes
- Transfer flooding
  - “Fallacy of composition”
- Unwarranted metamorphoses of cordons
- Subsidence, submergence, and salinity in the coast
  - *A suicidal process*

Rise of Open approach in Bangladesh

- Successful resistance against FAP
  - “Compartmentalization” Idea (FAP 20)
  - Resistance against FAP 20
  - Disarray of FAP
- Opening up of cordons
  - Opening up of PIRDP
  - TRM – Opening up of coastal cordons
- Open approach-conforming irrigation projects
  - Barisal Irrigation Project
  - Rubber Dam projects

Figure 11.1 FAP 20 (Tangail) – A pilot project of Compartmentalization



Source: Carlos F. Rammelt, Zahed Md. Masud, and Arvid Masud (2018)

Table 12.1 Comparative flood indices inside and outside the PIRDP's Talimnagar and Baulikhola sluice gates in 1995 and 1996.

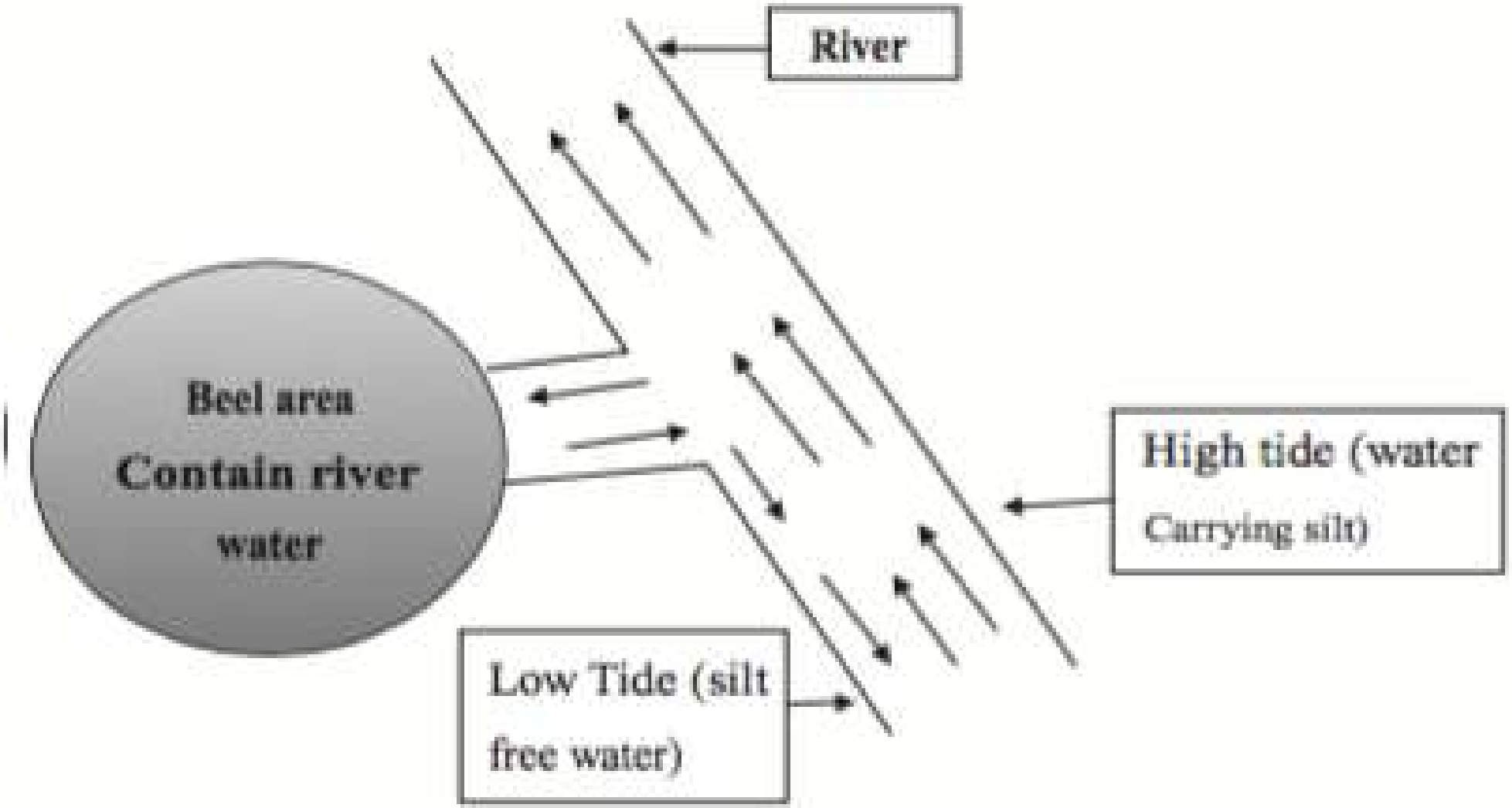
Sluice Gate	Baulikhola		Talimnagar	
Position	Inside	Outside	Inside	Outside
Flood Index (foot-days inundated)	454	667	420	632
Maximum Floodplain Depth (ft)	5.9	9.6	5.8	8.6
Days Floodplain Inundated	111	121	109	129
Year: 1996				
Flood Index (foot-days inundated)	435	535	398	532
Maximum Floodplain Depth (ft)	6.5	8.6	6.4	8.3
Days Floodplain Inundated	97	107	90	115

Source: MRAG (1997, Table 2.3)

Figure 12.2 Local people cut embankments to let water in

Source: Mustafa Alam of Institute of Asian Research (IAR) of University of British Columbia

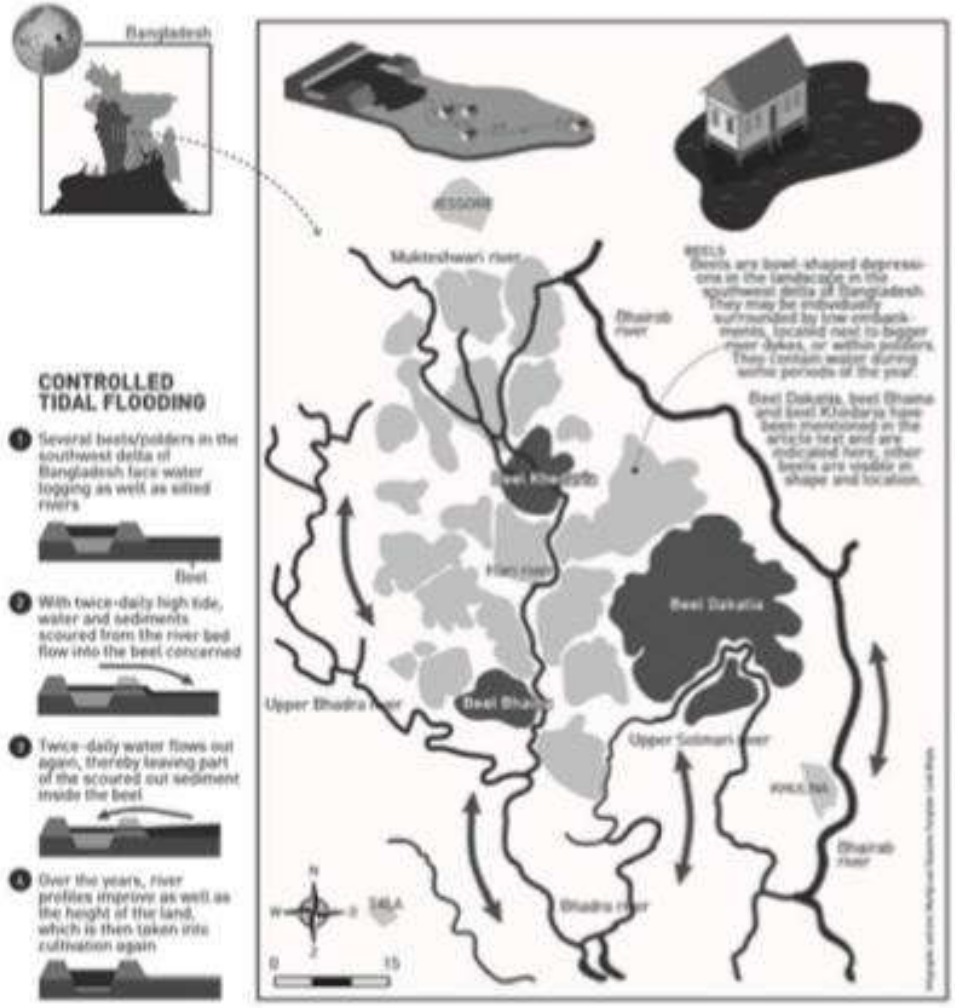
Figure 12.1 Idea of Tidal River Management



Source: Shampa and Ibne Mayaz Md. Pramanik (2012)

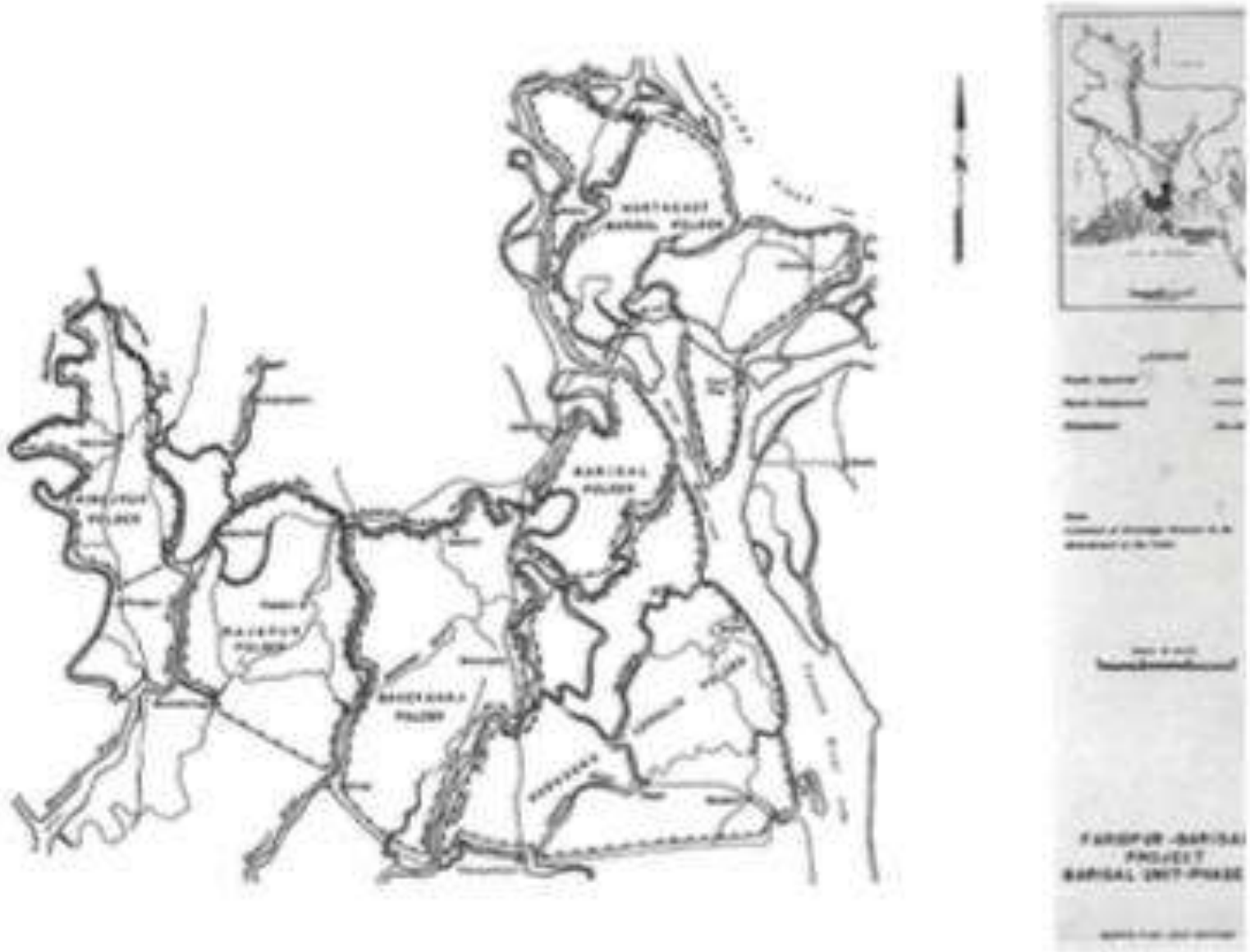
Controlled flooding in beels/polders with Tidal River Management in the Bangladesh delta

Several beels/polders in the southwest delta of Bangladesh face water logging as well as silted rivers ❶. This hampers effective drainage of water as well as agricultural production. Tidal River Management (TRM) involves the temporary (usually several years) removal of an embankment section adjacent to a beel or polder. During the years of tidal in- and outflow, the area is not suitable for agriculture but may be used for aquaculture. With twice-daily high tide, water and sediments scoured from the river bed flow into the beel concerned ❷. Twice-daily water flows out again, thereby leaving part of the scoured-out sediment inside the beel ❸. Over the years, river profiles improve as well as the height of the land, which is then taken into cultivation again ❹.



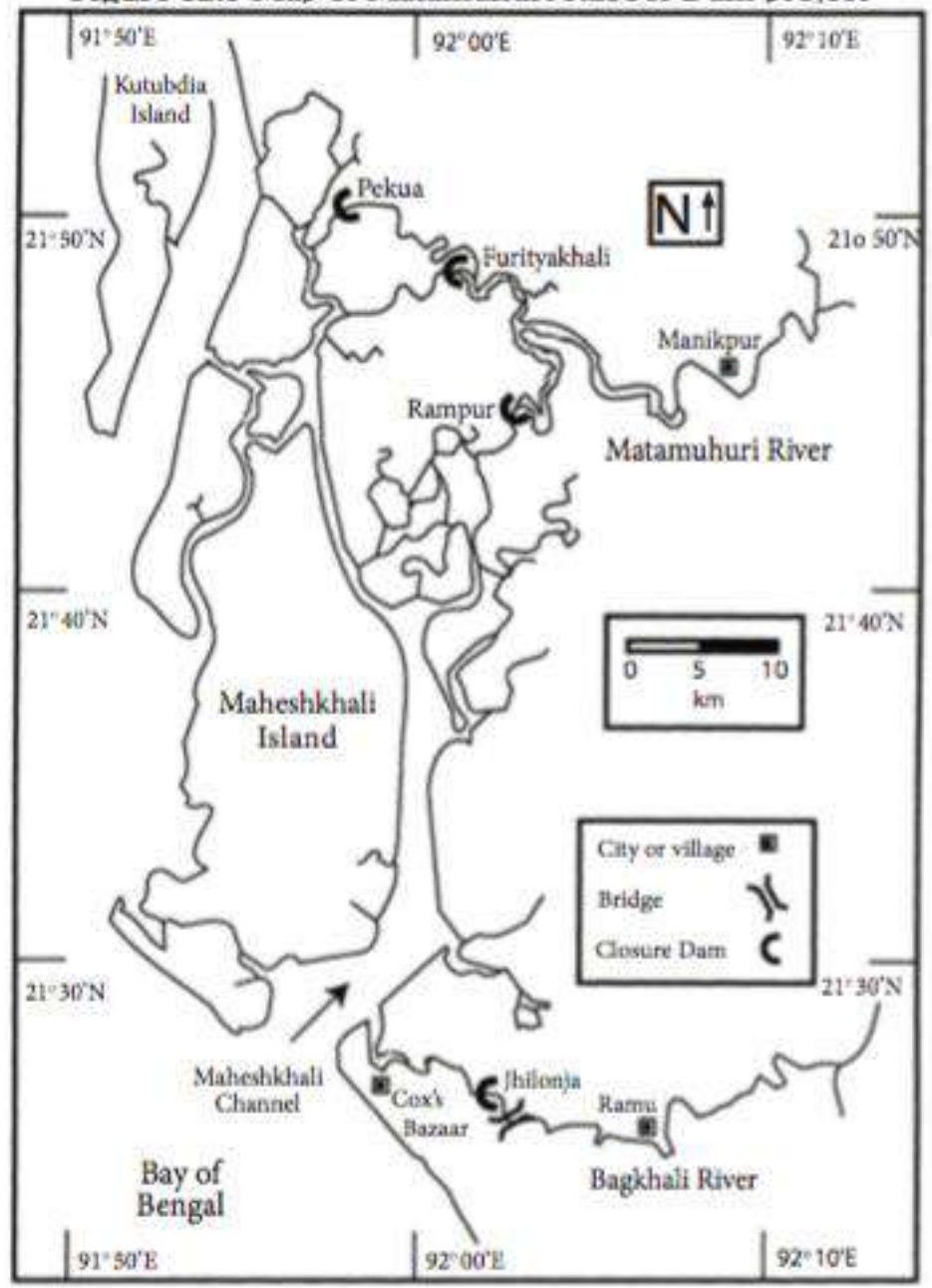
Source: Lock Weijts and Martijn van Stavernan

Figure 12.4a Map of Barisal Irrigation Project – Phase I



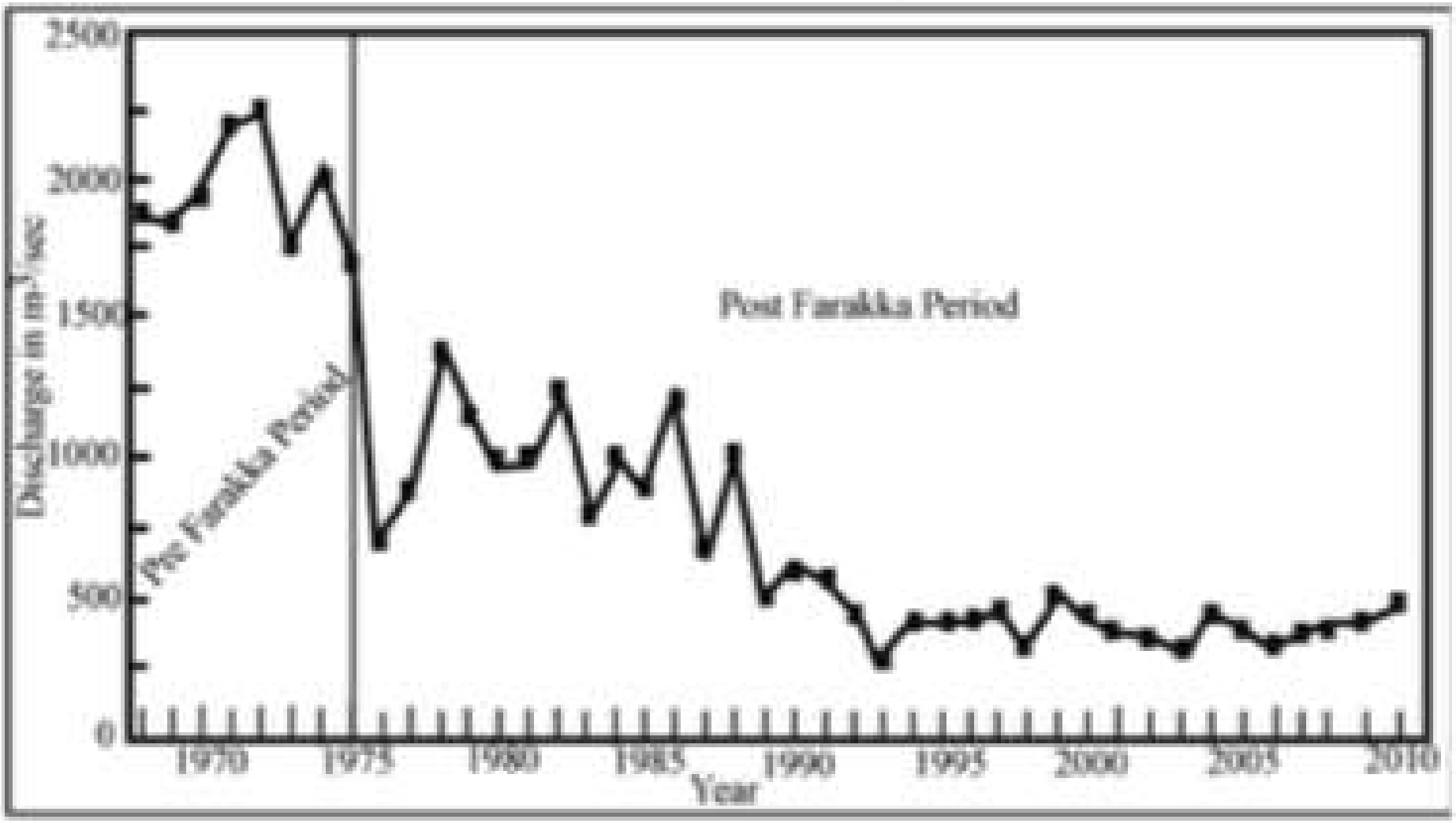
Source: IECO (1964b, p. 283)

Figure 12.5 Map of Matamuhuri Rubber Dam project



Source: Lock Weijts and Matijn van Staverman[12]

Figure 13.3 Decline in the flow of the Ganges River in Bangladesh due to the Farakka Barrage



Source: Gain and Giupponi (2014)

Figure 13.4 Dried up Ganges River in Bangladesh (at HardingeBridge) due to Farakka Barrage

Source: Shamsuddoza Sajen, *The Daily Star* (May 26, 2016)

Figure 13.5 Dried up Garai River, a distributary of the Ganges in Bangladesh, under Garai Bridge

Source: Amanur Aman, *The Daily Star* (August 29, 2016)

Table 13.1 Allocation of the Ganges water at Farakka as per 1996 Treaty

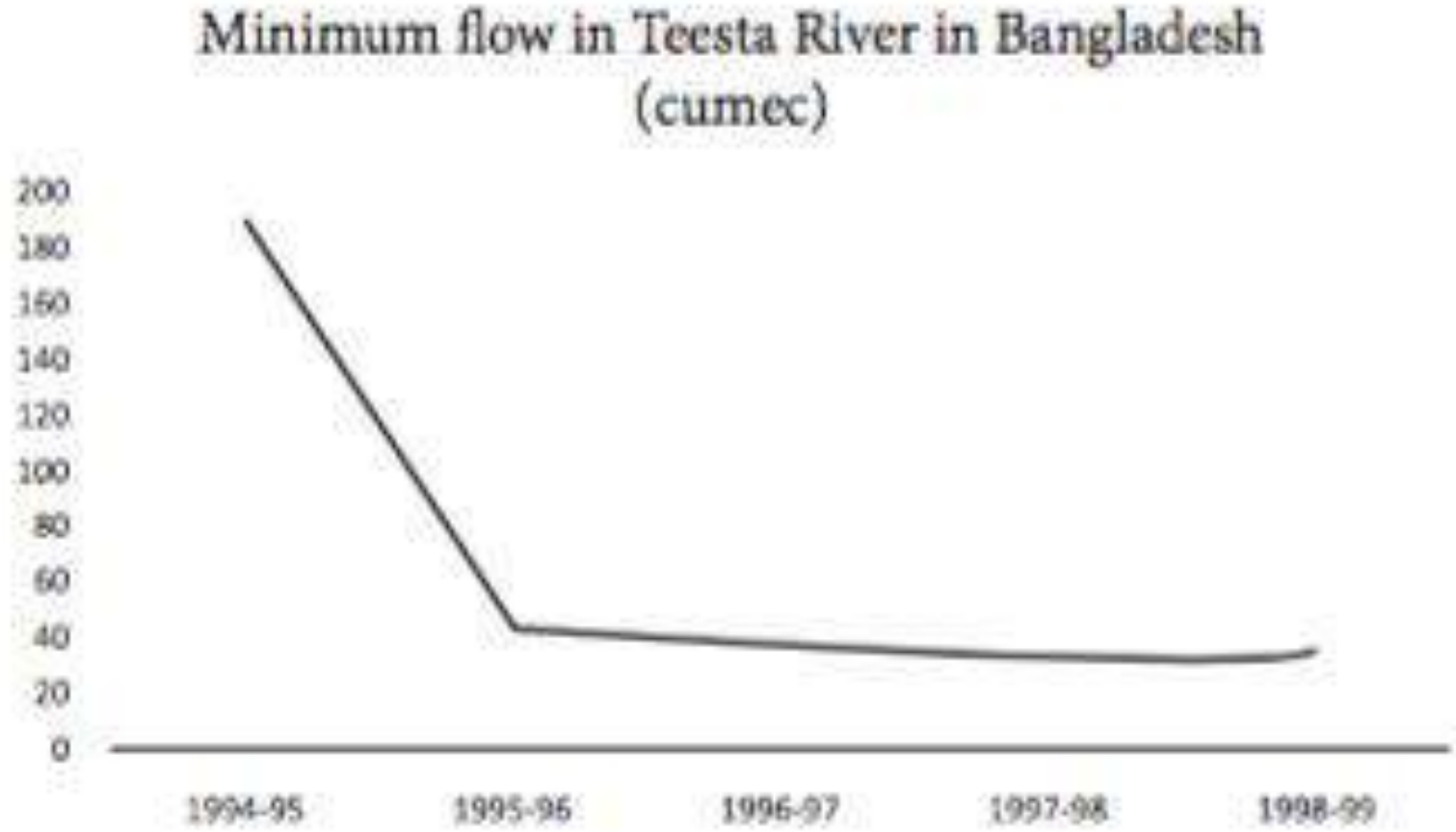
Availability at Farakka	Share of India	Share of Bangladesh
70,000 cusec (1,982 cumec) or less	50%	50%
70,000 – 75,000 cusec (1,982 – 2,124 cumec)	Balance of the flow	35,000 cusec (991 cumec)
75,000 cusec (2,124 cumec) or more	40,000 cusec (1,133 cumec)	Balance of the flow

Source: Government of Bangladesh (1996)

Figure 13.6 Map of Gajoldoba and other dams and barrages on Teesta River in India

Source: Gauri Noolkar-Oak (2017)

Figure 13.7 Decline in the flow of Teesta River in Bangladesh due to India's Gajoldoba Barrage

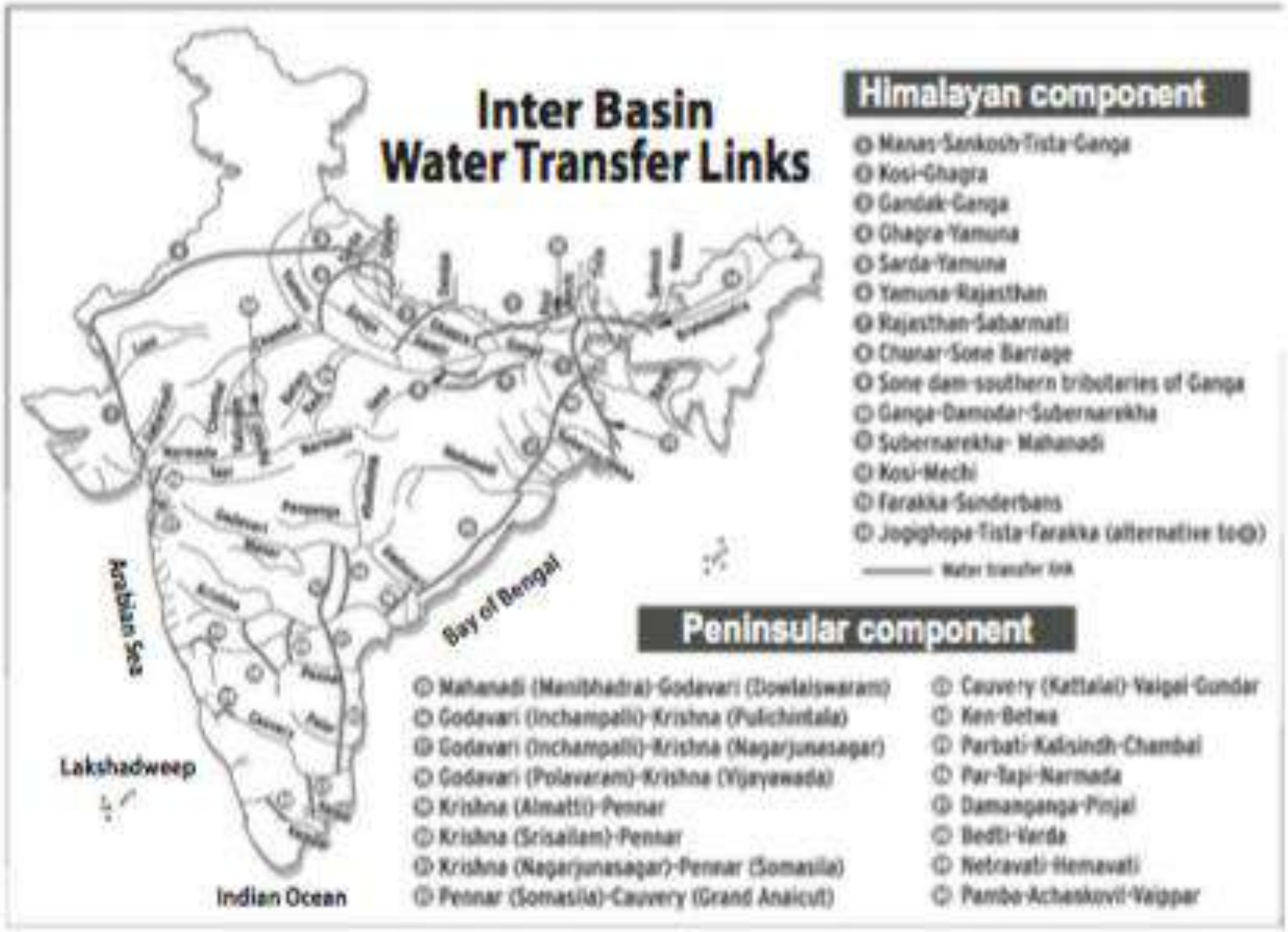


Source: Author, based on data presented in Mukherjee and Saha (2013) and Islam and Higano (1999, 2002) The line shows the mean dry season flows.

Figure 13.8 Dried up Teesta River in Bangladesh due to Gajoldoba Barrage

Source: Rashed Shuman in Pinaki Roy (2013)

Figure 13.10 Map of Indian River Linking Project



Source: India Water Portal

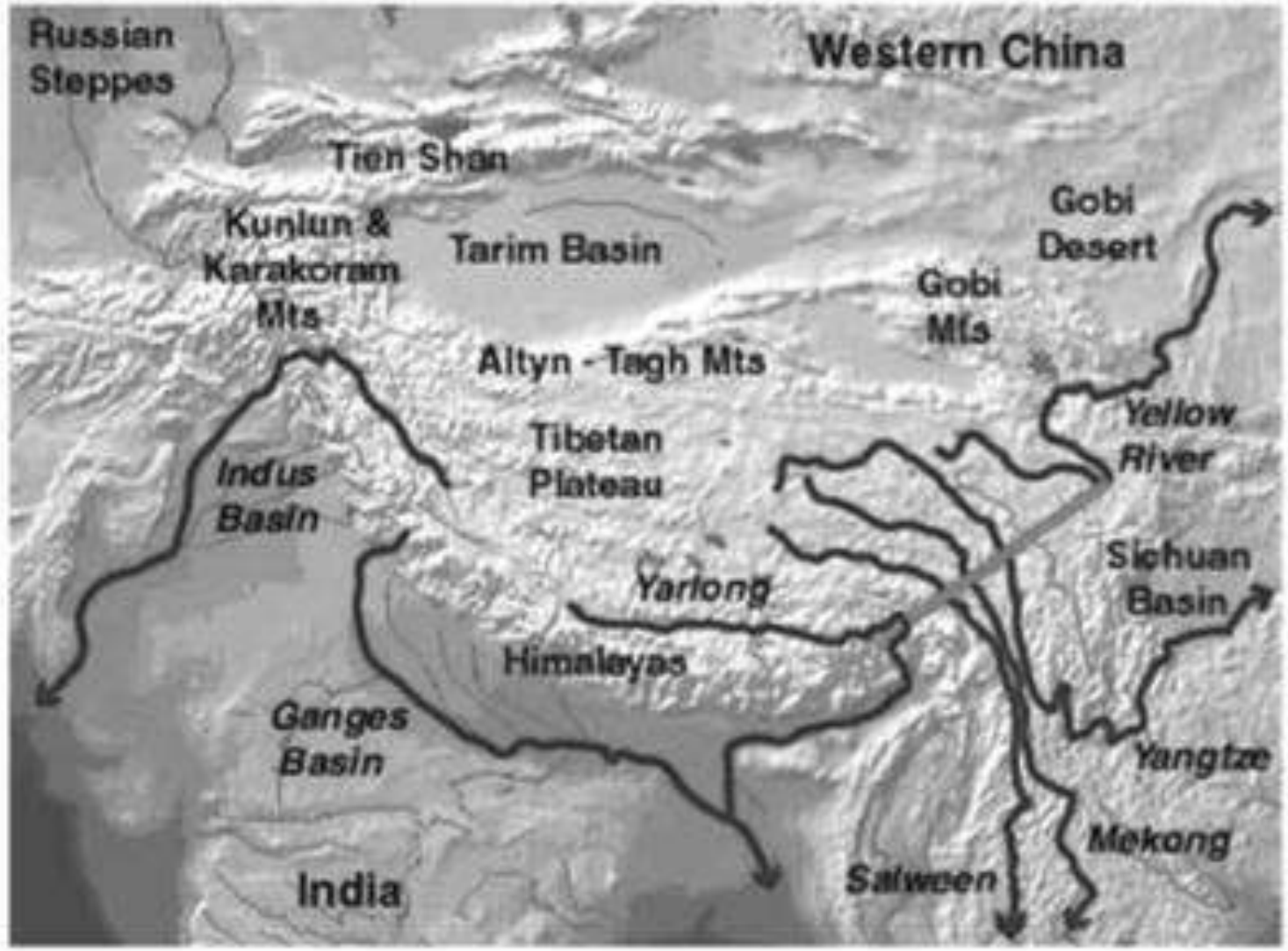
Figure 13.11 China's dams on Upper Brahmaputra (YarlungZangbo)

Source: Sandeep Dikshit (2016)

Figure 13.12 Three routes of south-north transfer of water in China

Source: Baiyu (2020)

Figure 13.13 China's plan to divert water of Upper Brahmaputra (Yarlung Zangbo)

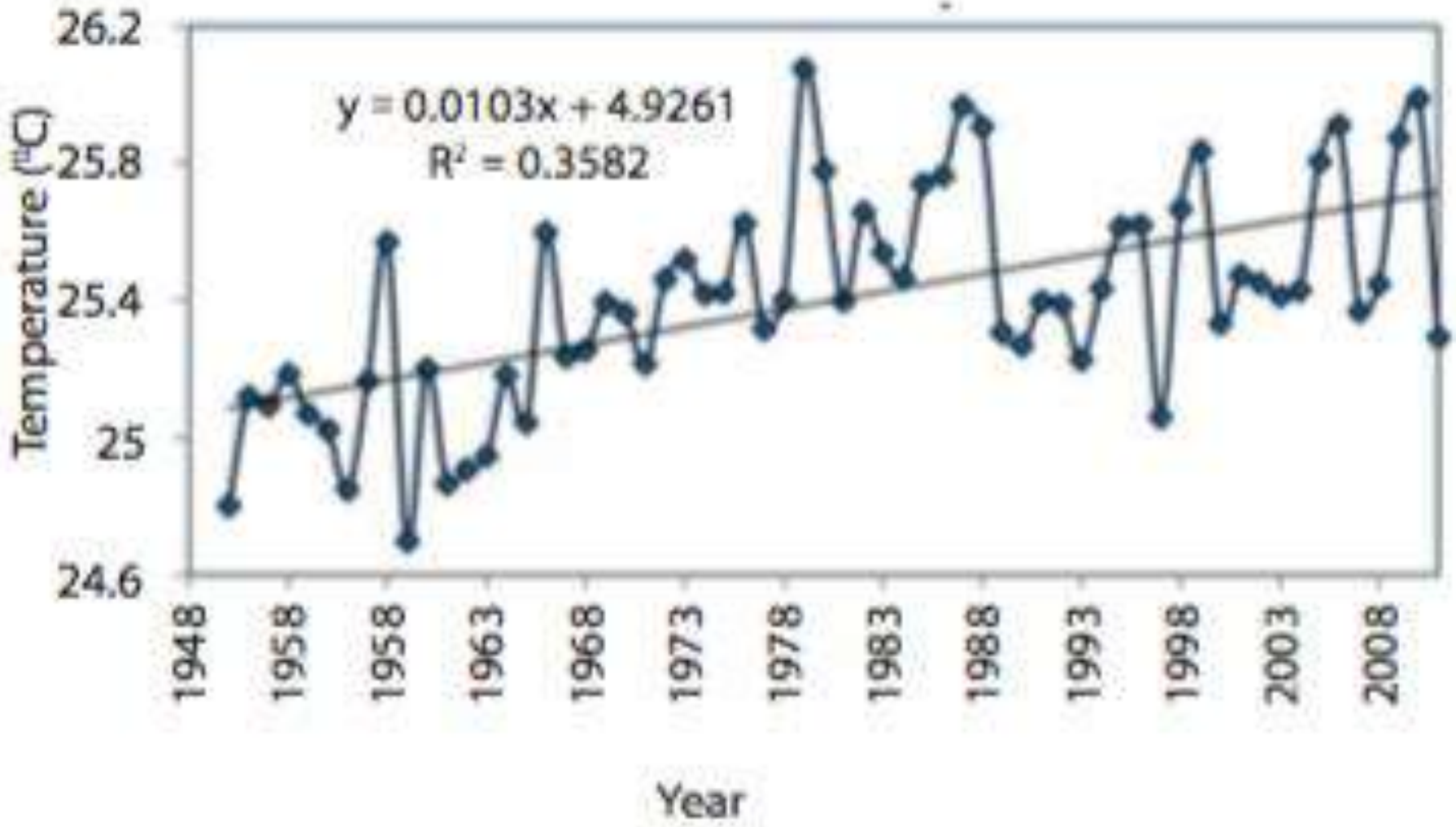


Source: Diganta (2009a) and Ritesh Ghosh (2017)

Ways to deal with the regional challenges

- United Nations Convention on the Non-navigational Uses of International Water Courses, 1997
  - Article 7: No significant harm
  - Article 20: Preserve the ecosystems
  - Article 21: Prevention, reduction, and control of pollution
  - Article 23: Preserve marine environment, including estuaries
- Special obligations regarding protection of the Sundarbans, a World Natural Heritage Site
- “Transit-in-exchange for rivers” – a formula for win-win cooperation in multiple spheres, including adopting a common stand regrading withdrawal of Upper Brahmaputra flow

Figure 14.1 Annual mean temperature in Bangladesh: 1948-2011



Source: Ludgwig, Terwisscha, and Quadir (2018, p. 16)

Table 14.1 Projections of temperature, rainfall, and SLR used in NAPA (2005)

Projection year	Temperature change (°C)	Annual rainfall change (%)	Sea level rise (cm)
2030	1.0	5	14
2050	1.4	6	32
2100	2.4	10	88

Source: Ludgwig, Terwisscha, and Quadir (2018, p. 34)

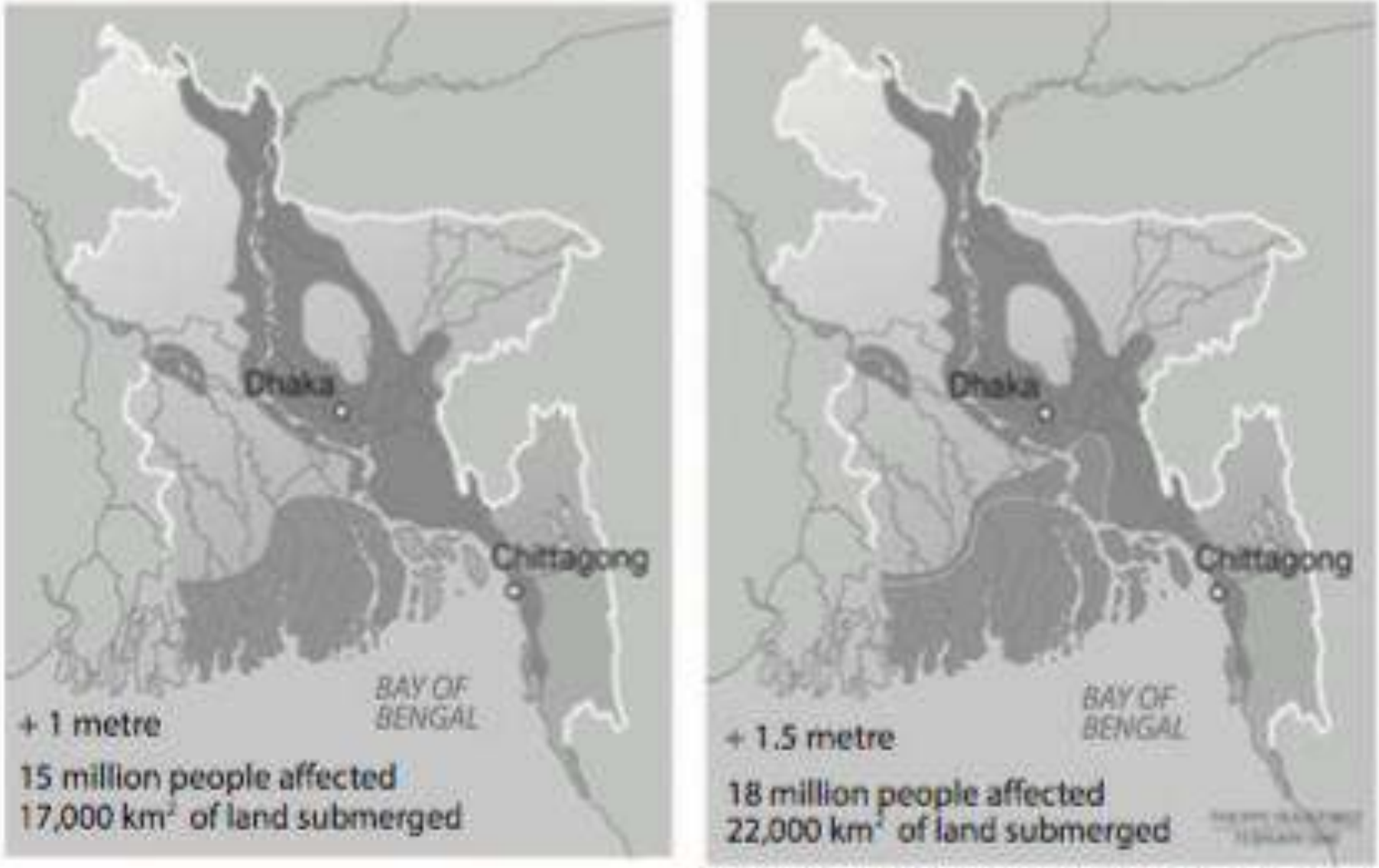
Global threat -- climate change

- Five dimensions of climate effect on Bangladesh
  - Submergence
  - Salinity intrusion
  - Destabilization of rivers
  - Increase in extreme weather events
  - Increased risk of diseases

Conclusion of the analysis

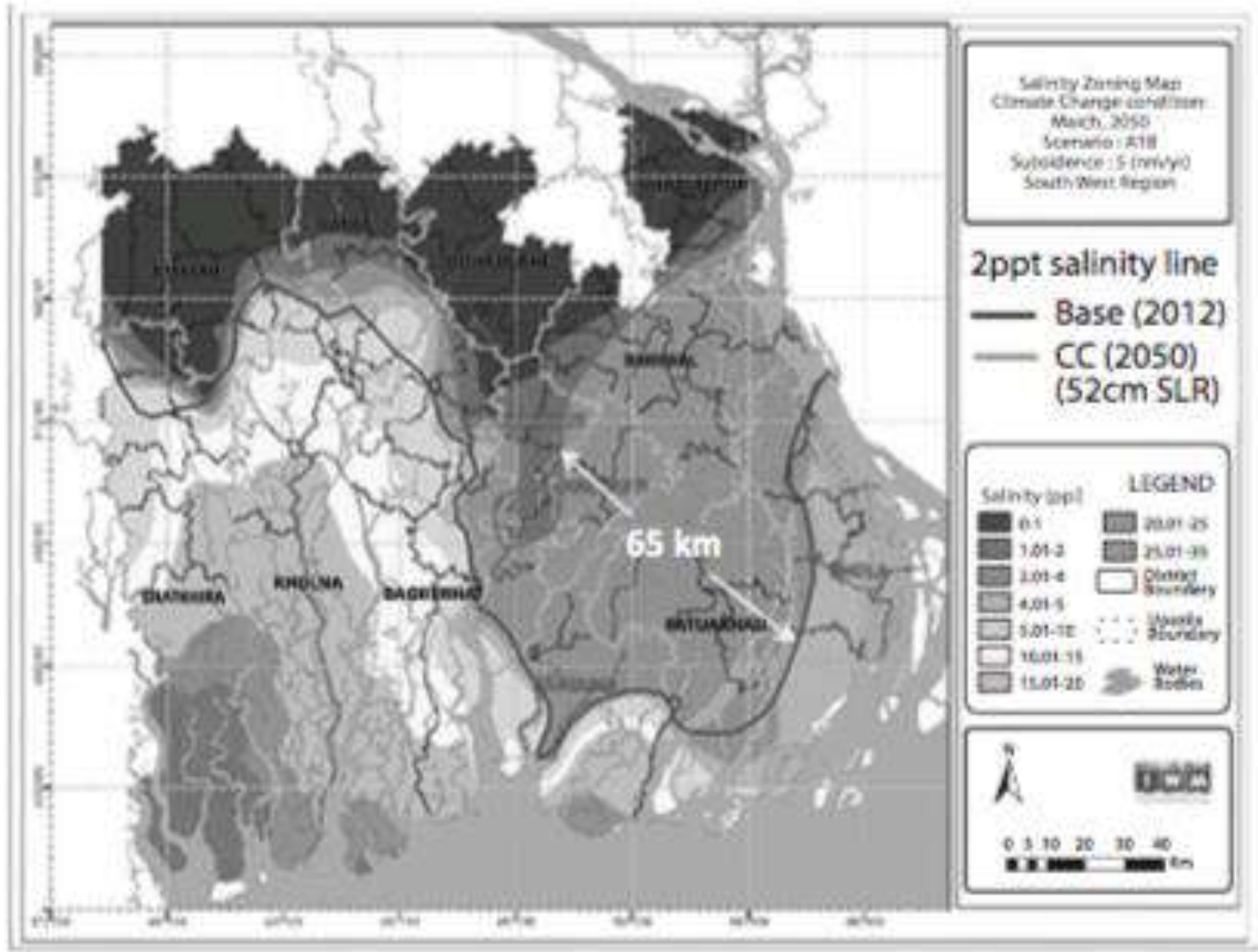
- While Commercial and Cordon approaches aggravate these effects, Ecological and Open approaches can mitigate them

Figure 14.3 Areas of Bangladesh likely to be submerged due to sea level rise



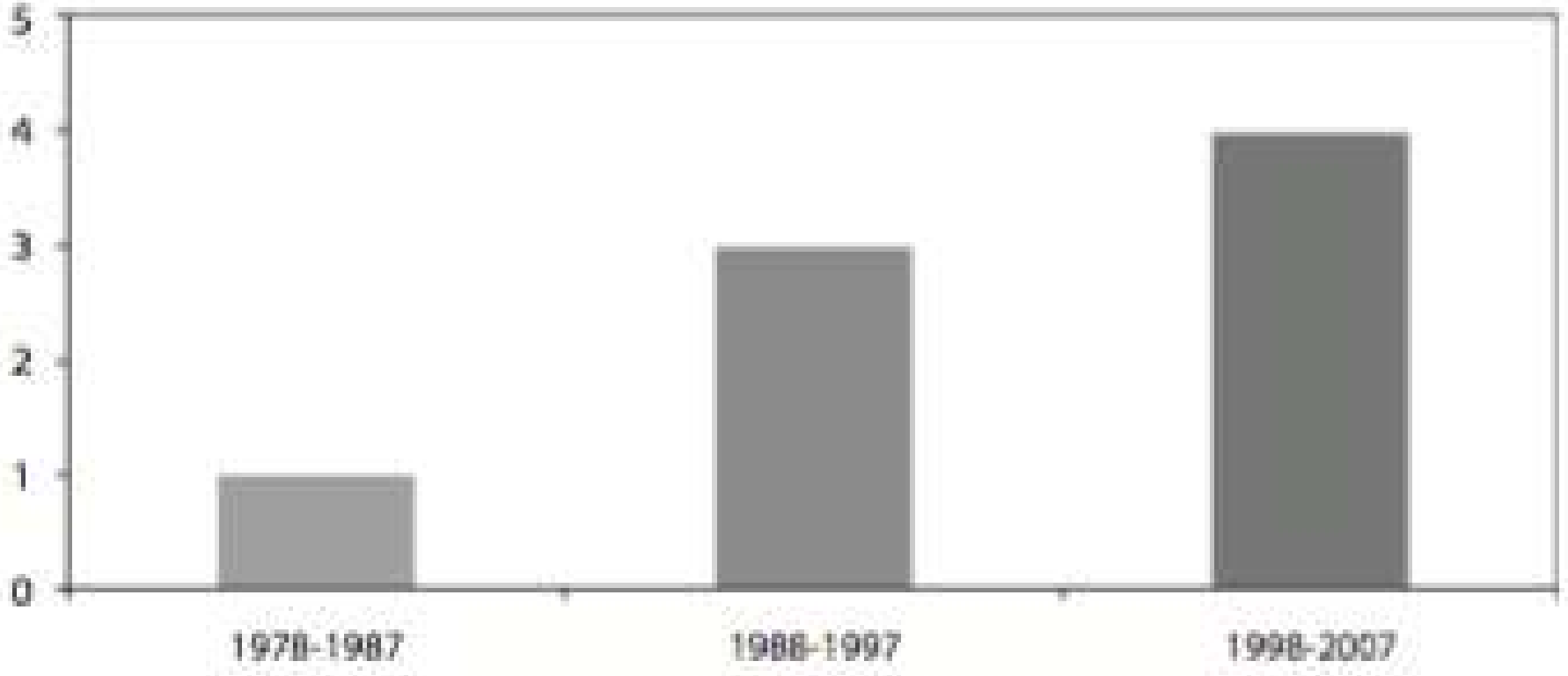
Sources: Dacca University; Intergovernmental Panel on Climate Change (IPCC).

Figure 14.5 Map showing increase in salinity due to climate change (Effect of sea Level on 2 ppt salinity contour (A1B, 2050)



Source: Institute of Water Modeling, Bangladesh and Z. H. Khan (2018, p. 443)

Figure 14.10 Frequency of high intensity cyclones in the Bay of Bengal in recent decades



Source: Ludwig, Terwisscha, and Quadir (2018, p. 28)

Figure 15.1a Padma River devouring a high school building in Bandarkhola

Source: Samakal, July 24, 2020

Figure 15.2a River erosion putting woman at a perilous cliff

Source: Anonymous

Figure 15.3a People of Banaripara demanding protection from river erosion

Source: Samokal, August 24, 2021

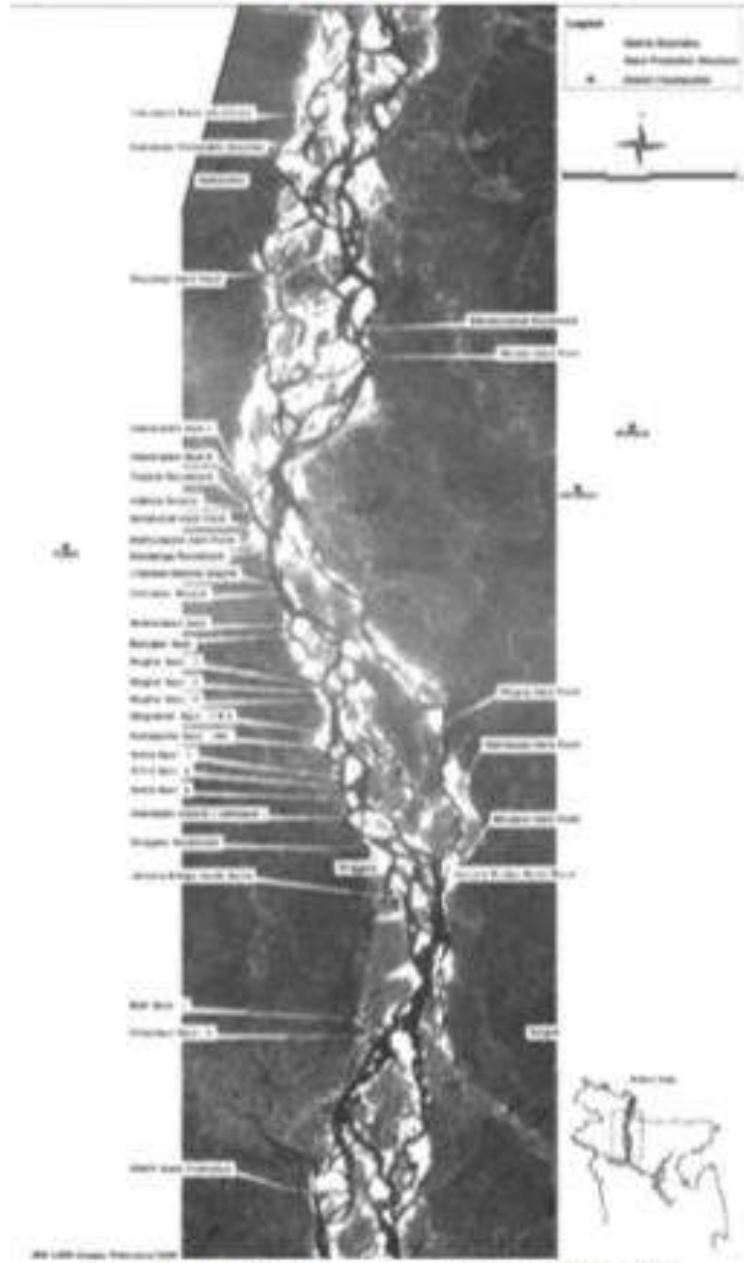
Riverbank protection efforts

- Indigenous methods
  - *Ashtamashi bandhs*
  - *Kata-khals*
  - Bandal bandhs

- Western methods
  - Groynes
  - Spurs
  - Hard points
  - Revetments

- Main features of western methods
  - Focused on spots
  - Reliance on hard structures
  - Fire-fighting character
  - High cost
  - One-off character, little scope for subsequent adaptation
  - Disappointing outcome

Figure 15.4 Location of the protection structures built along the banks of the Jamuna River



Source: de Heer, Choudhury, Ahmed, Shams (2015, p. 75)

Table 15.1 Protection structures built along the right bank of the Jamuna River

Name of structure	Construction period	Exposed to the flow		Comments
		Minor channel	Major channel	
Kazirjuri permeable groyne	1994-95		1995	Major damages
Hasnapara Spur 1	2001-02	2002-03		Performance is not clear as it does not exposed to main channel
Hasnapara Spur 2	2001-02	2002-03		Performance is not clear as if does not exposed to main channel
Tilpara Revetment	2005-06		2005-11	Minor damages but effective
Kalitola	1997-98		1997-11	Minor and major damages but effective
Sariakandi	1997-98		1997-11	Effective
Mathurapara	1999-98		1997-07	
Devdanga Revetment	2005-06		2005-08	Minor damages
Chandaitola (Jhitrorath)	2001-02		2002-08	Damaged
Baniajan Spur	2001-02	2002-03		
Meghai Spur 1	1999-00	2000-01	2004	Damaged in 2004
Meghai Spur 2	1999-00	2000-01		
Meghai Spur 3	1999-00	2000-01		
Singraberi Spur 1	1998-99		2002-03	Exposed for one year, damaged
Singraberi Spur 2	1998-99		2002-03	Damaged in 2002
Shovagacha Spur 1	1999-00		2002-03	Damaged in 2002
Shovagacha Spur 2	1999-00		2002-03	Damaged in 2003
Simla Spur 1	1999-01		2003	Damaged in 2003
Simla Spur 2	1999-01		2005	Exposed for one year
Simla Spur 3	1999-01		2002	Damaged in 2002
Shallabari Groyne	1980-81		1997-04	Damaged in 2004
Sirajganj Revetment	1997-98		1998-11	Minor damages, effective
Bangabandhu Bridge Right Guide Bund	1996-98		1996-11	Effective
Betil Spur	2000-02	2001-04		Damaged in 2004, after repairing damaged again 2007
Enayetpur Spur	2000-02	2001-04		Damaged in 2004, repaired in 2006
PIRDP, Geobag revetment	2004-06		2004-11	Effective

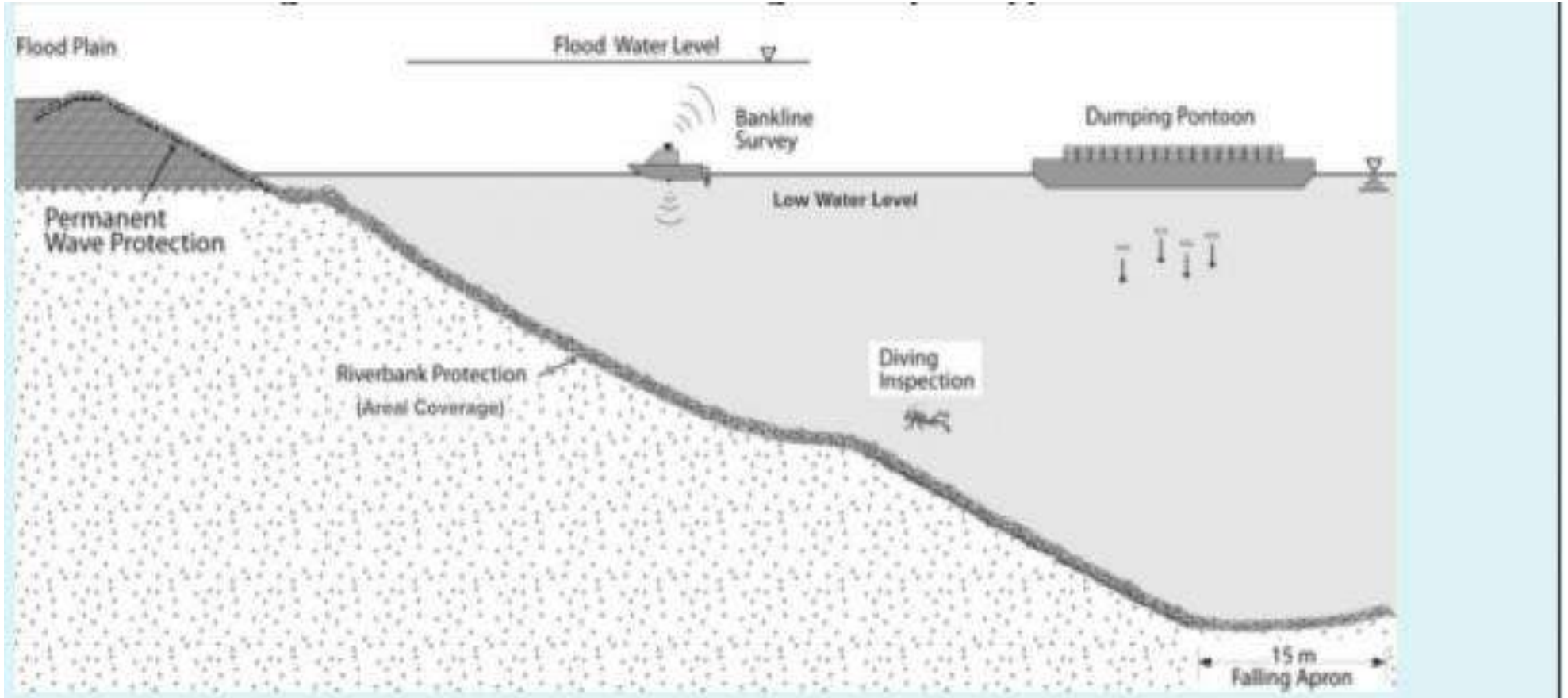
Source: M. H. Sarker, J. Akter, and R. Ferdous (2011, p. 14)

Figure 15.3: Collapse of Sirajganj revetment on June 29, 2021

Potentials and constraints on geo-bag technology

- Attractive features of geo-bad technology
  - Low material cost
  - Transportability
  - Divisibility
  - Additivity
  - Combination of sturdiness and malleability
  - Transparency
- Use of geo-bag technology in
  - Jamuna-Meghna River Erosion Mitigation Project (JMREMP)
  - Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP)

Figure 15.7: Multi-dimensional operations required by riverbank protection using geo-bags



Government of the People's Republic of Bangladesh. 2007. *Jamuna-Meghna River Erosion Mitigation Project Part B. Background, River Erosion Management.*

Figure 15.8: Map of Flood and Riverbank Erosion Risk Mana

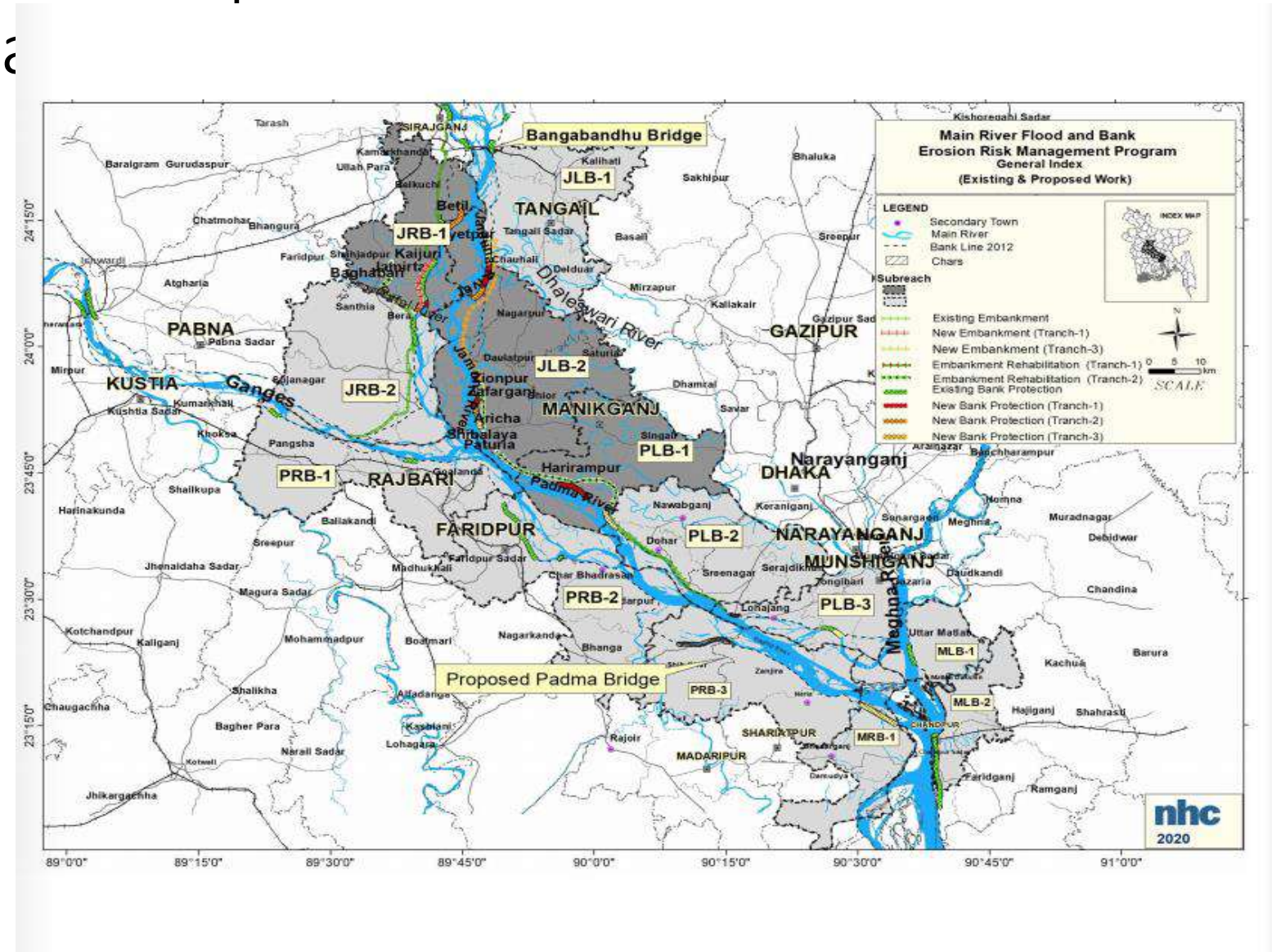


Figure 15.11: Map showing three phases of RBIP

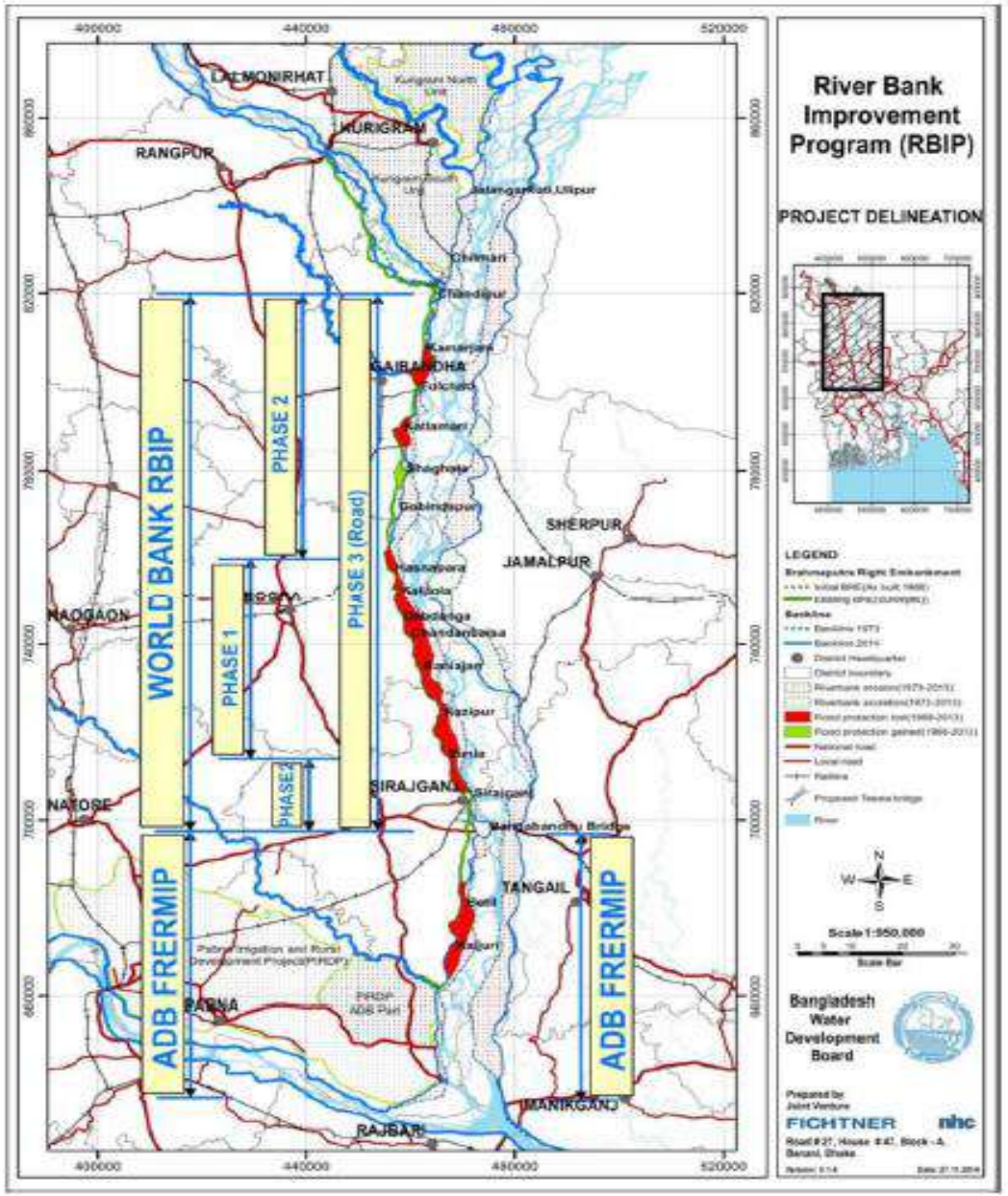


Figure 15.12: Map showing location of physical works of RBIP

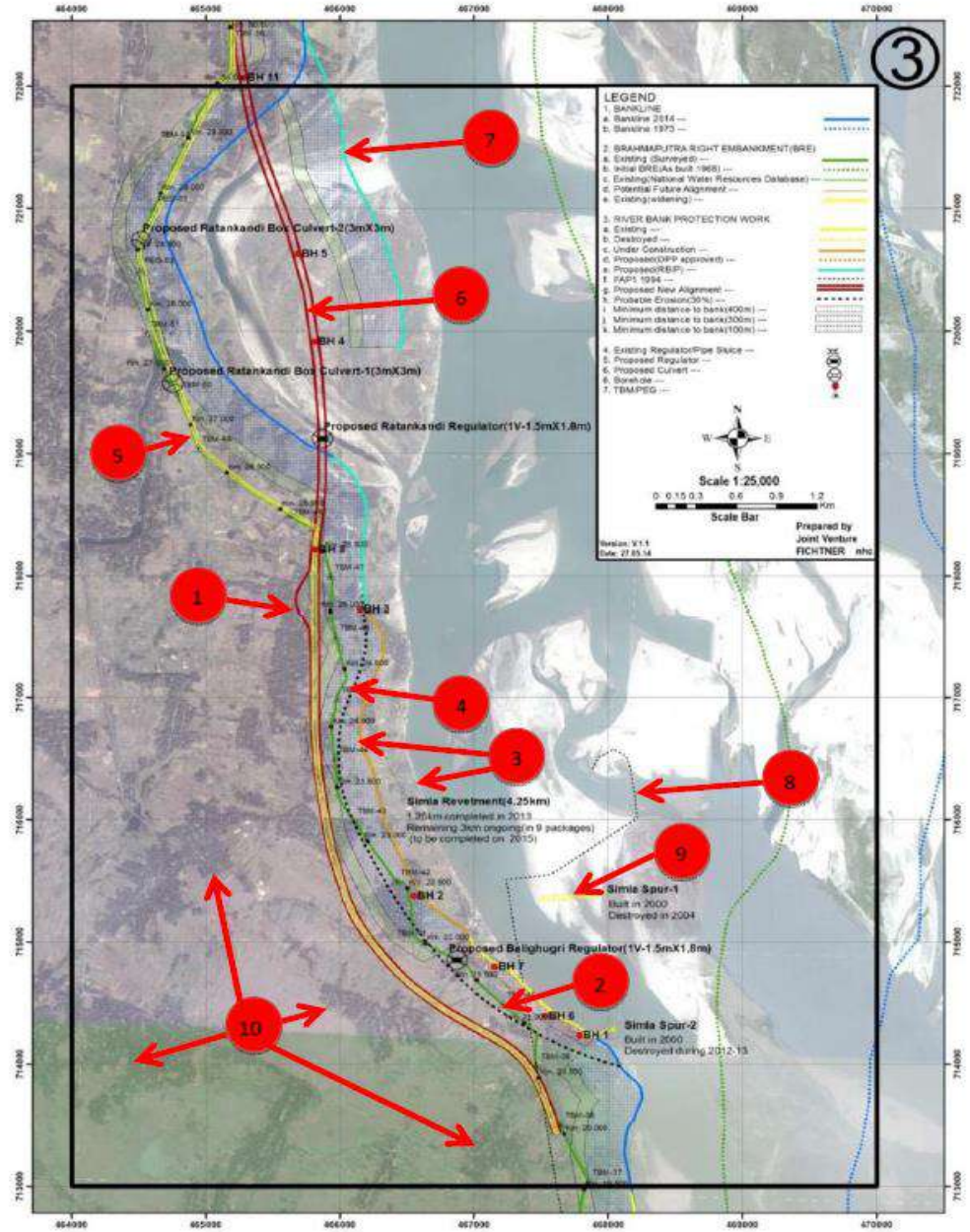


Figure 15.13: Conversion of reconstructed BHRE into a highway under RBIP

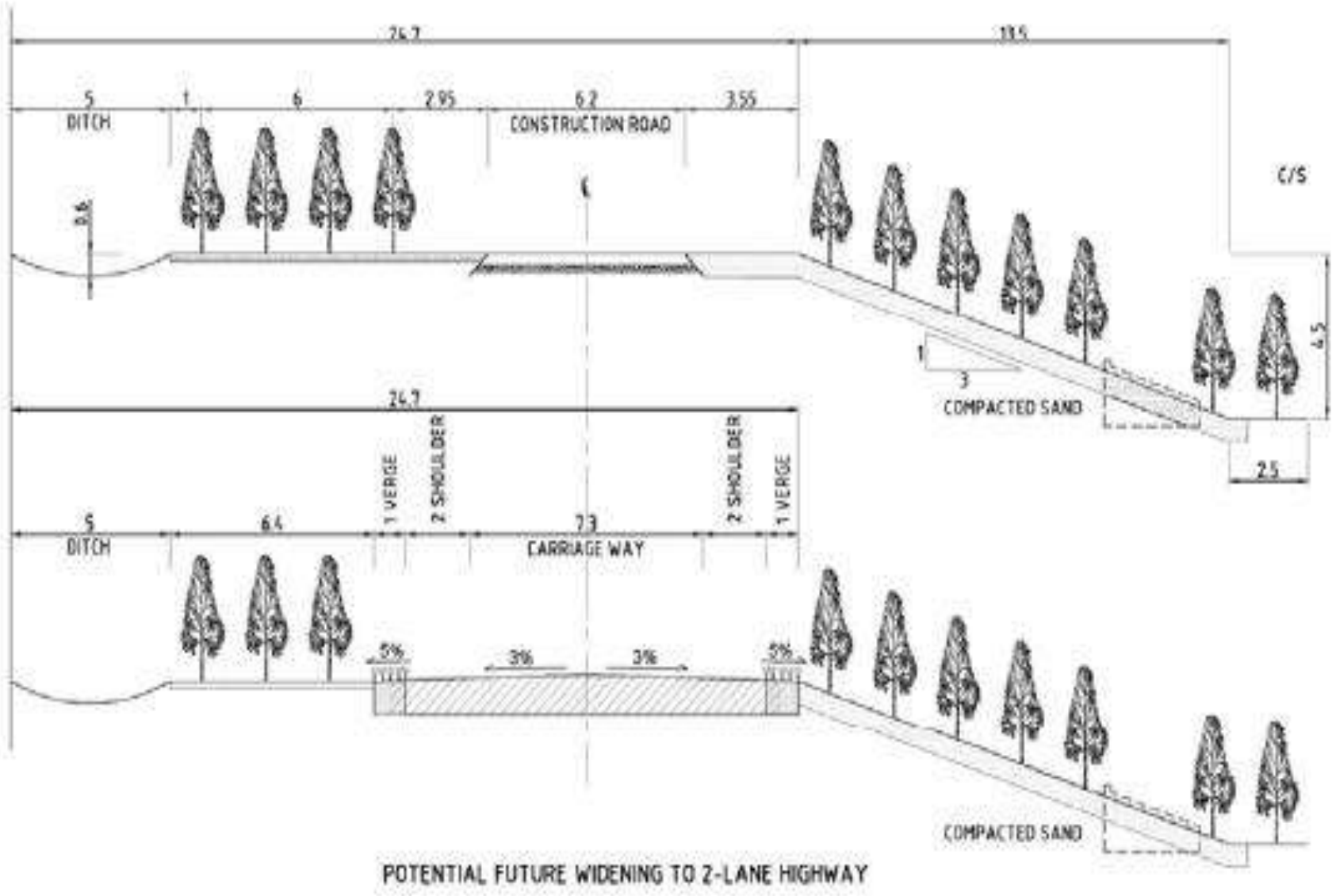


Figure 15.17: Empirical model of dynamics of river width, bed-level, and braiding index in response to the wave of additional bed materials caused by the Assam earthquake (Sarker and Thorne 2006, p. 300)

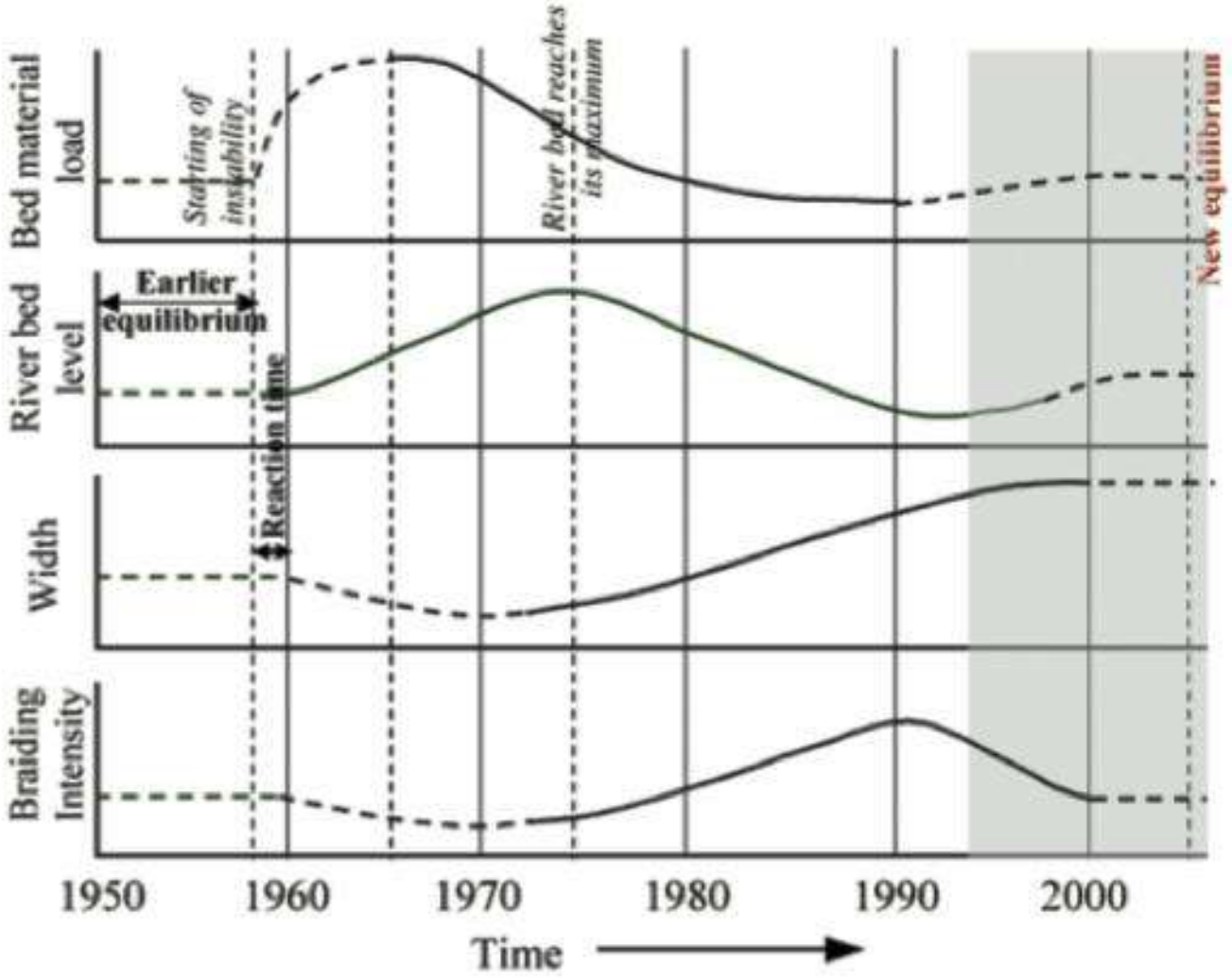
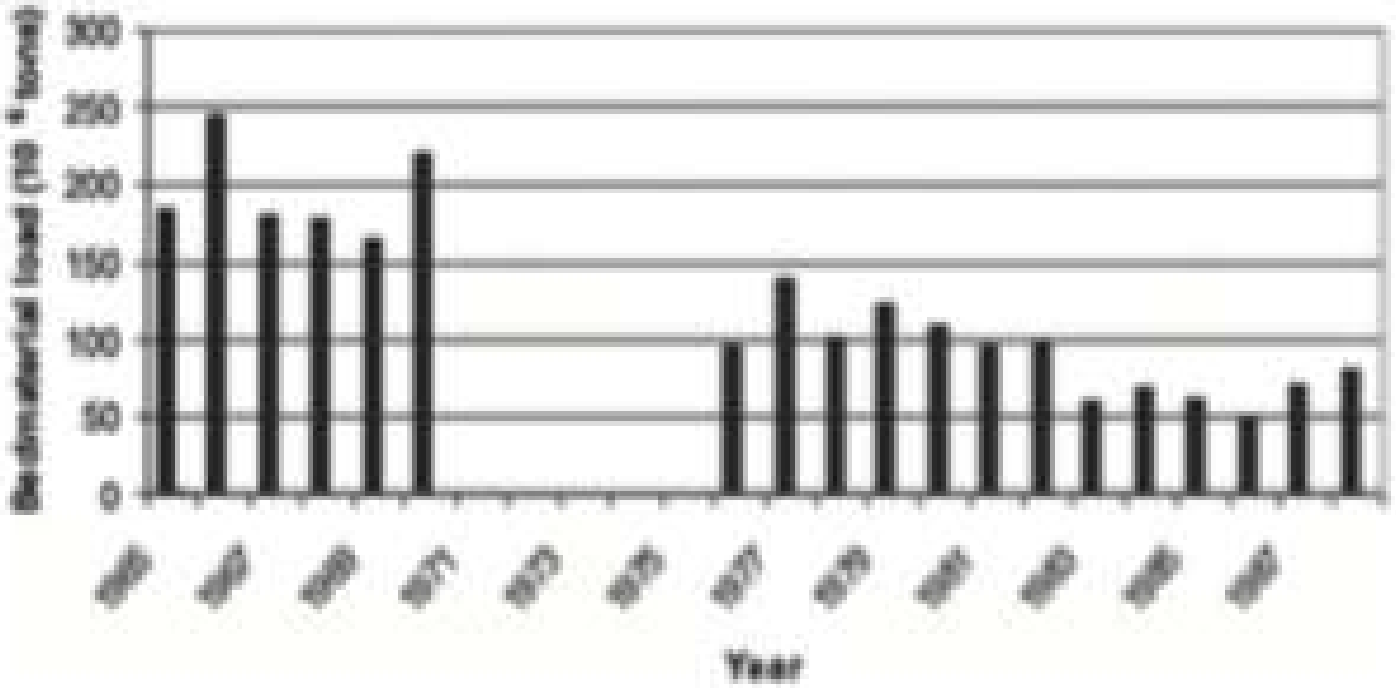
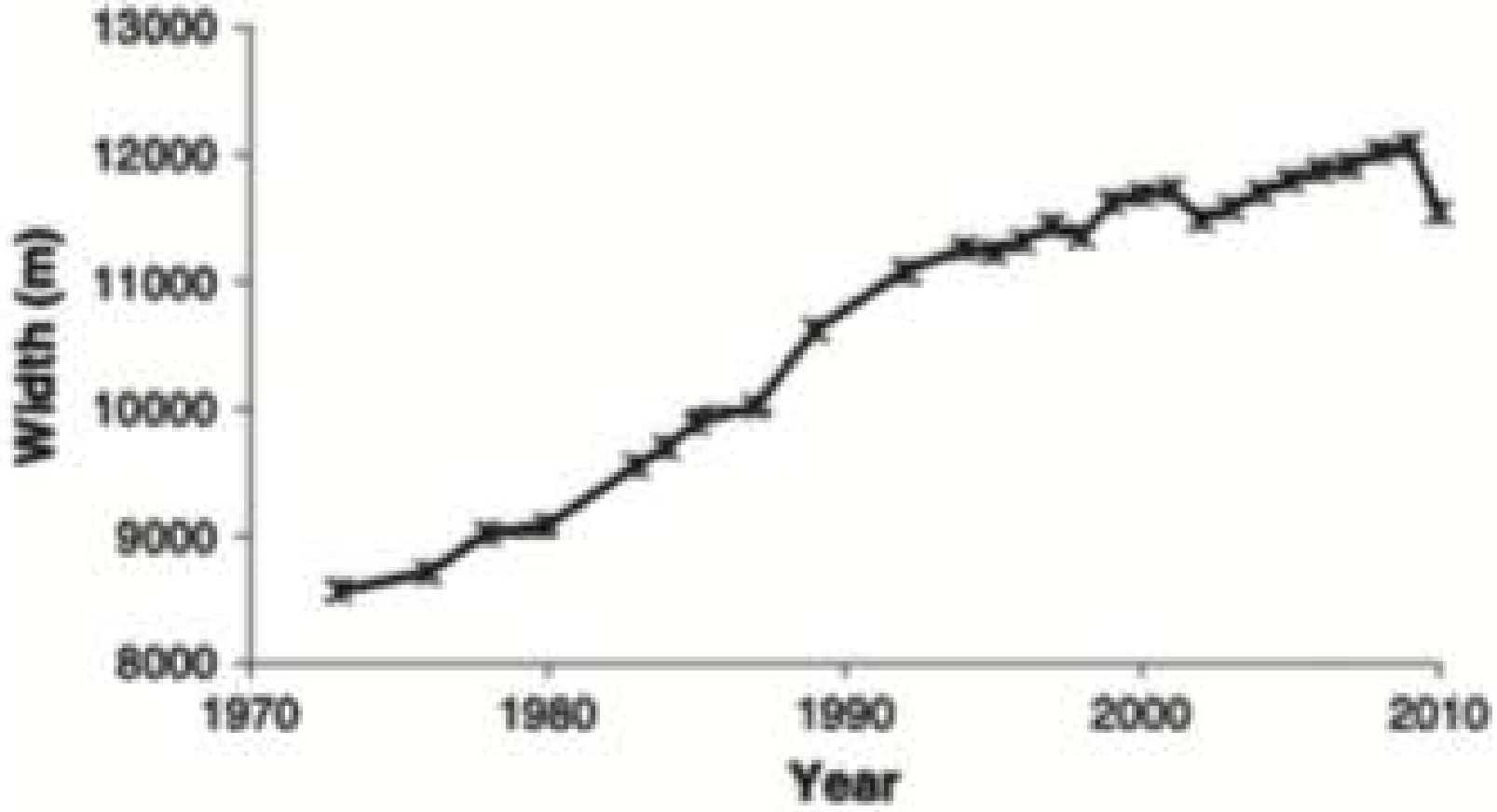


Figure 15.19 Bed materials (coarse sediment) carried by the Brahmaputra River at Bahadurabad



Source: Sarker and Ahmed (2018, p. 535)

Figure 15.18 Average width of the Jamuna River (1973-2010)



Source: Sarker, Thorne, Aktar, and Ferdous (2014, p. 5)

Lateral movement of the length-averaged bank lines and centerline of the Jamuna River (1830-2010) (Sarker 2018, p. 137)

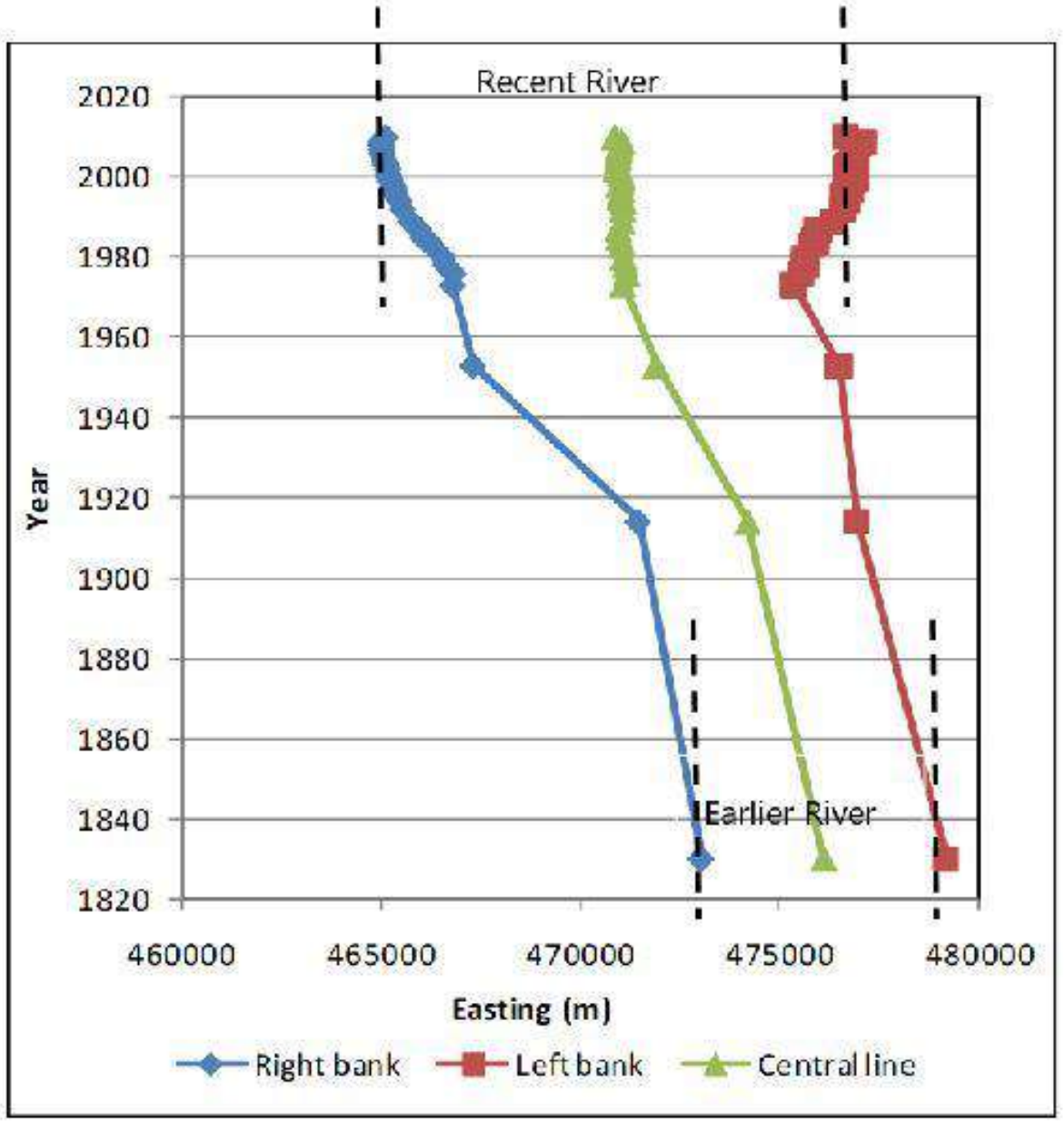


Figure 15.23 : Bankline migration and widening of the Jamuna River (1830-2010) (Sarker 2018, p. 137)

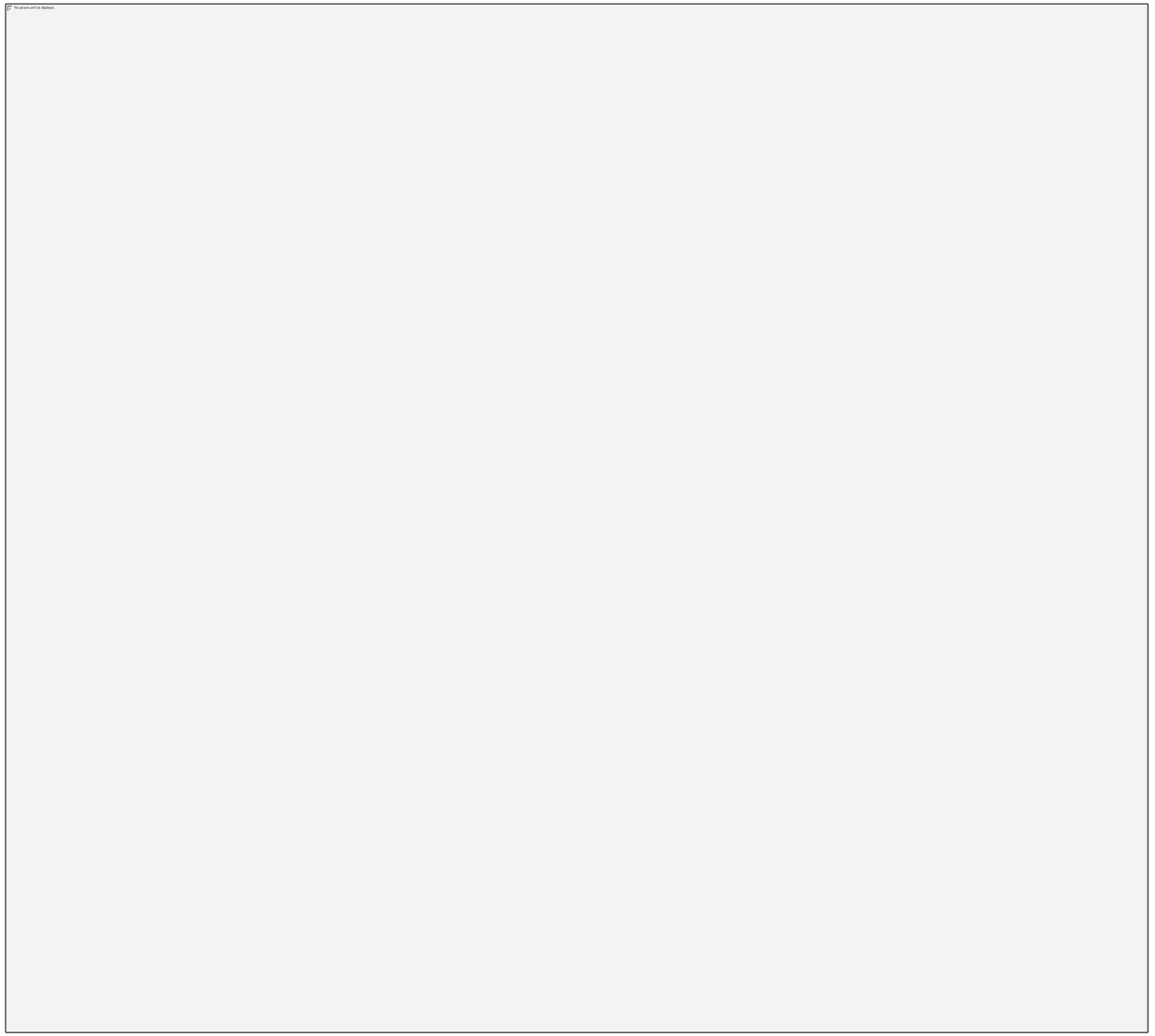
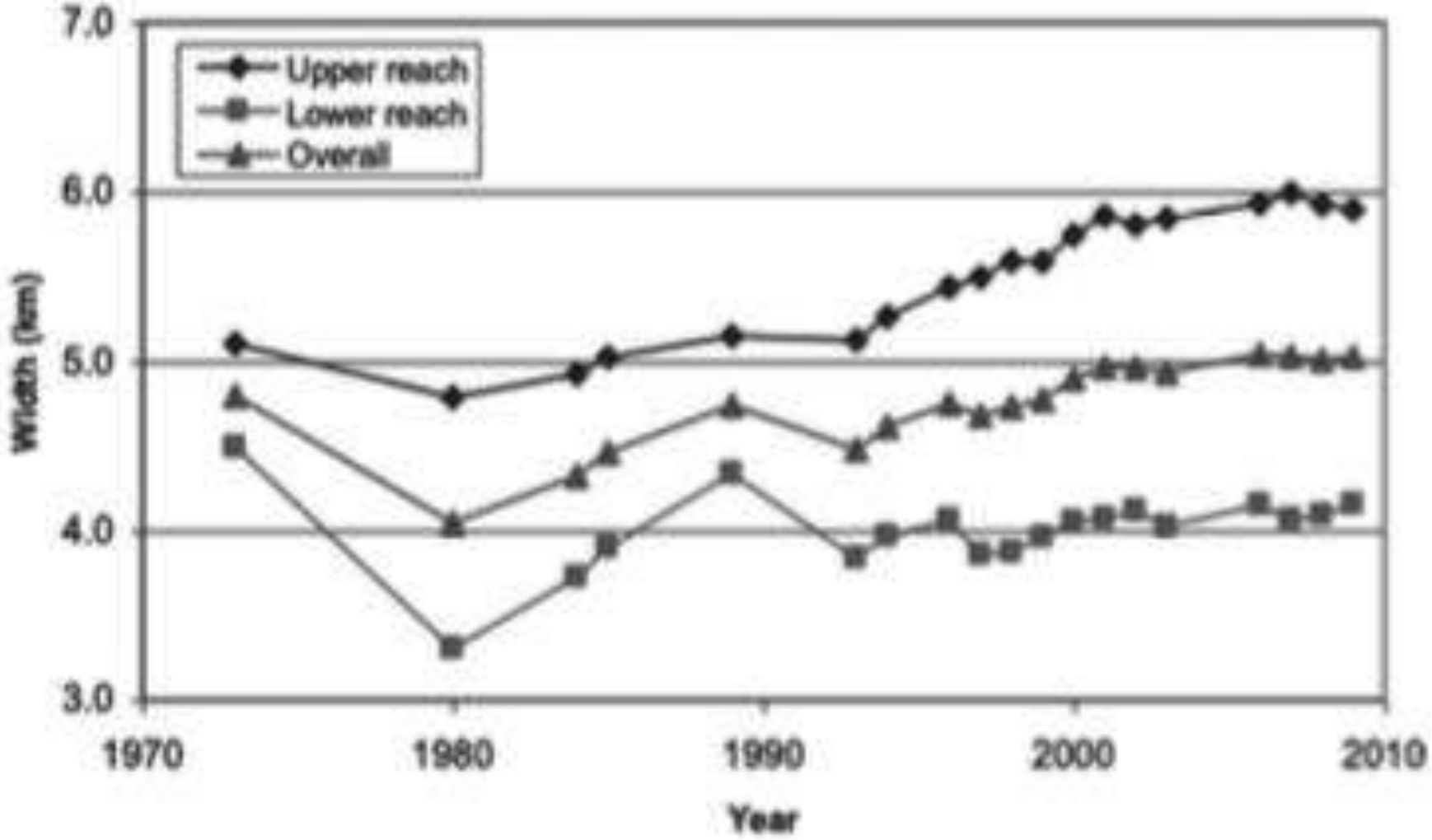


Figure 15.24 Change of width of the Ganges River over time



Source: Sarker (2018a, p. 140)

Positive features of Delta Plan

- Usefulness of long-term perspective (for land and water issues
- Led by Planning Commission
- Transparency
- Willingness to get feedback
- Comprehensive
- Compilation of knowledge

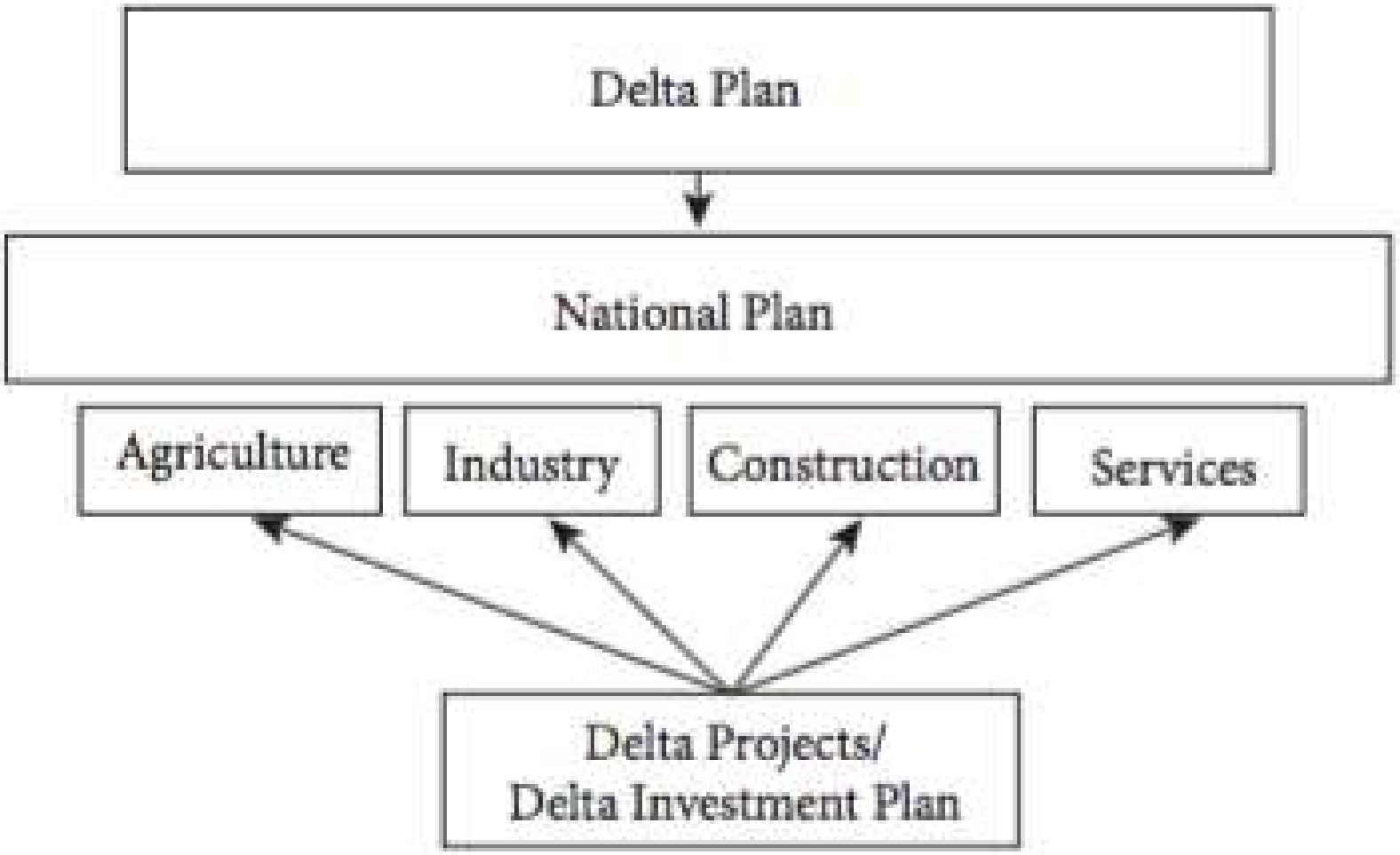
Concerns regarding regarding the Delta Plan

- Problematic conception of the relationship between the Delta Plan and National Plans – Overreaching?
- Uncritical acceptance of implementing agencies' review of the past water development projects of Bangladesh
- Uncritical acceptance of the relevance of the Dutch model of delta management for Bangladesh (Bengal Delta); neglect of the recent changes in Dutch approach to delta management
- Lack of adequate attention to transboundary river experiences
- Eclectic philosophy
- Lack of original research
- Determination of the project portfolio through an extraneous exercise
- Problematic project portfolio (smorgasbord character, including controversial projects)

Different view of the relationship between Delta Plan and National Plans

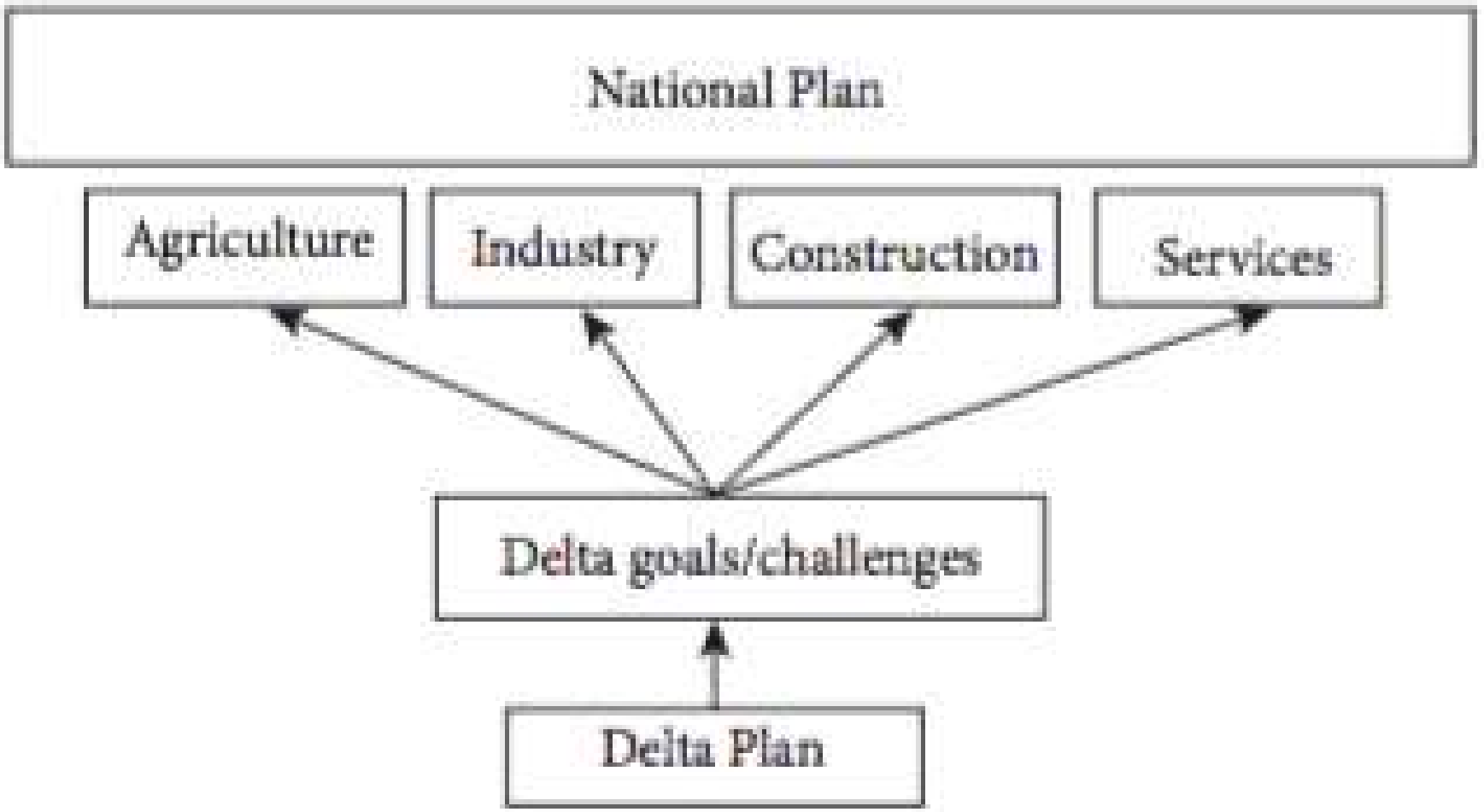
- Supra-view
- Infra-view
- Parallel-view
- Intersection-view

Figure 16.1 Supra view of Delta Plan



Source: Author, based on BDP documents

Figure 16.2 Infra-view of Delta Plan

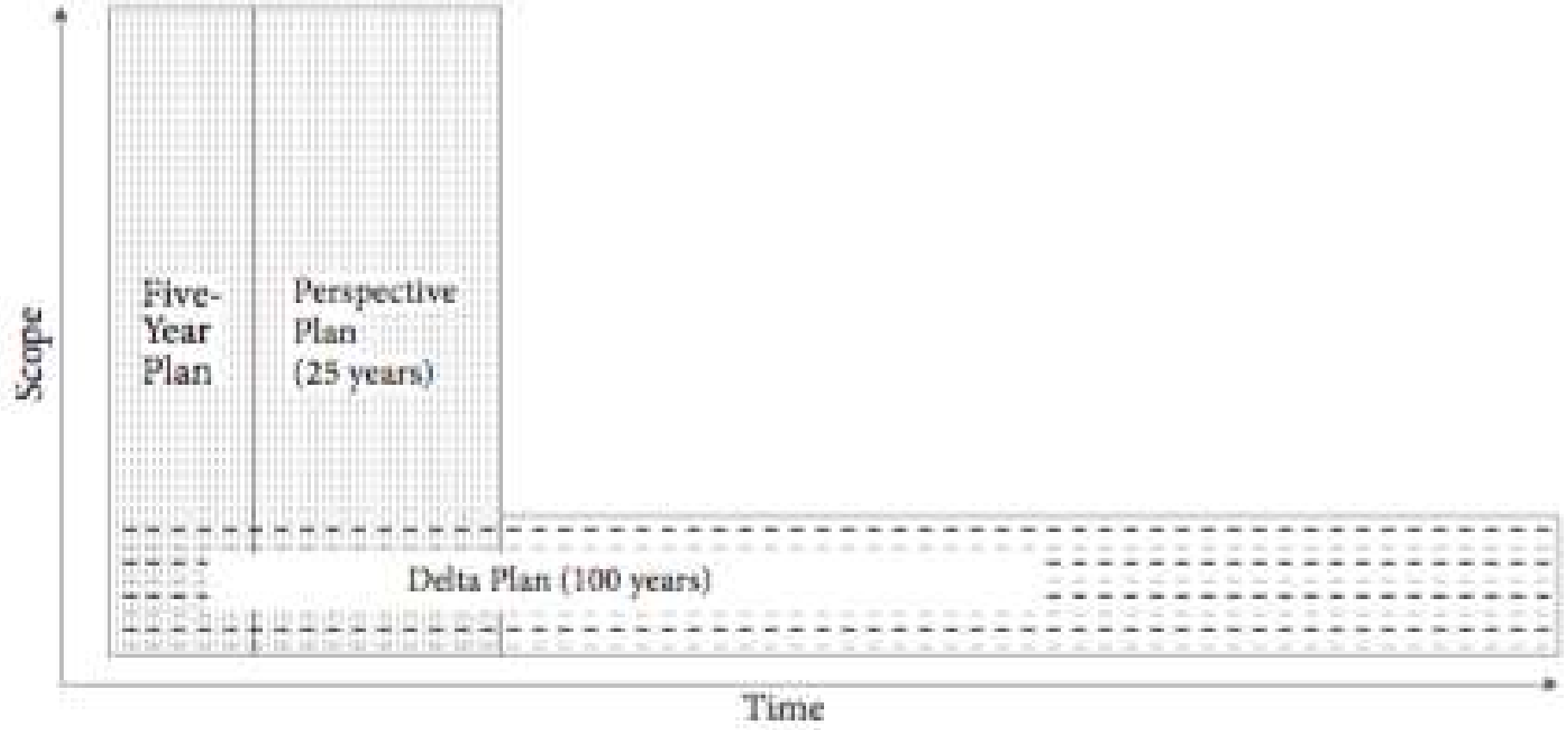


Source: Author, based on BDP documents

Figure 16.3 Parallel view of the Delta Plan and National Plans

Source: BDP, *Inception Report*, p. 10, Figure 2

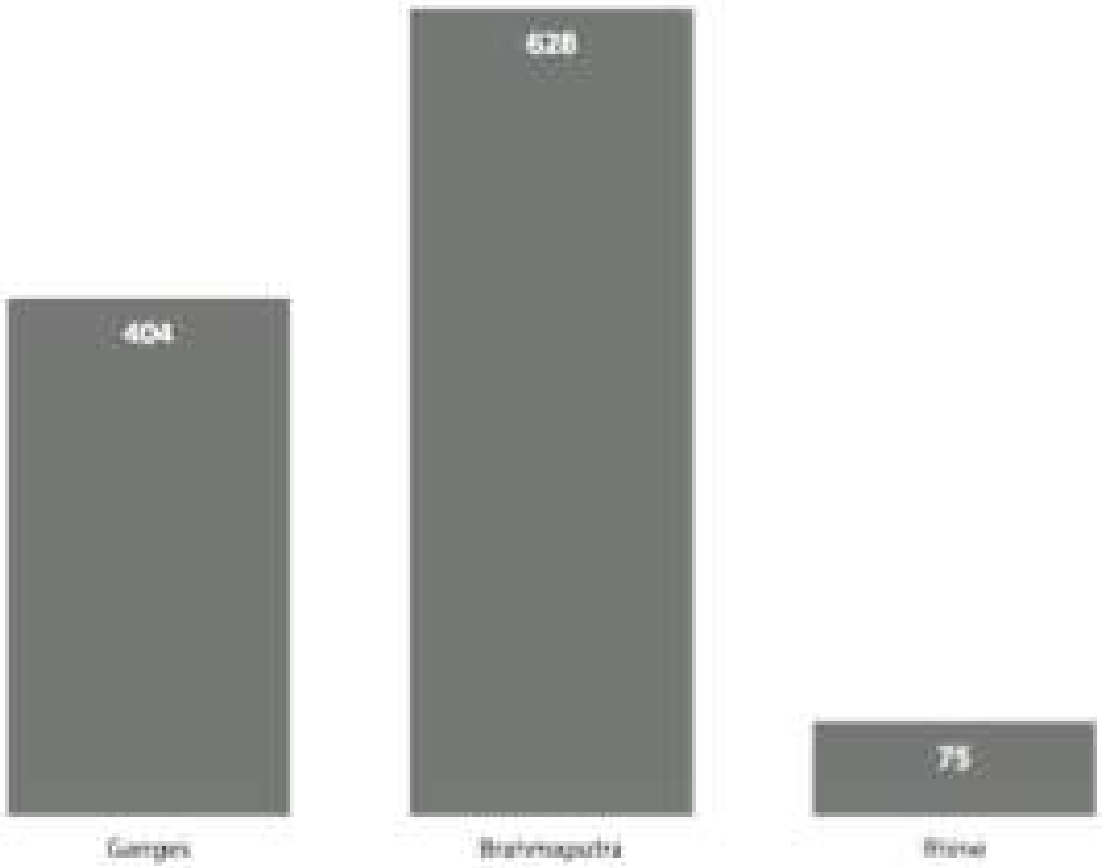
Figure 16.4 Intersection view of the relationship between Delta Plan and National Plans



Source: Author

Note: The widths of different rectangles do not follow the time scale accurately

Figure 16.8 Comparison of annual flows (in cubic km) of the rivers of the, Bangal and Dutch Deltas, and Rhine Rivers



Source: Author, based on data from Dai, Aiguo and Kevin E. Trenberth (2002)

Annual volume of sediment reaching Bengal and Dutch Delta (million tons)

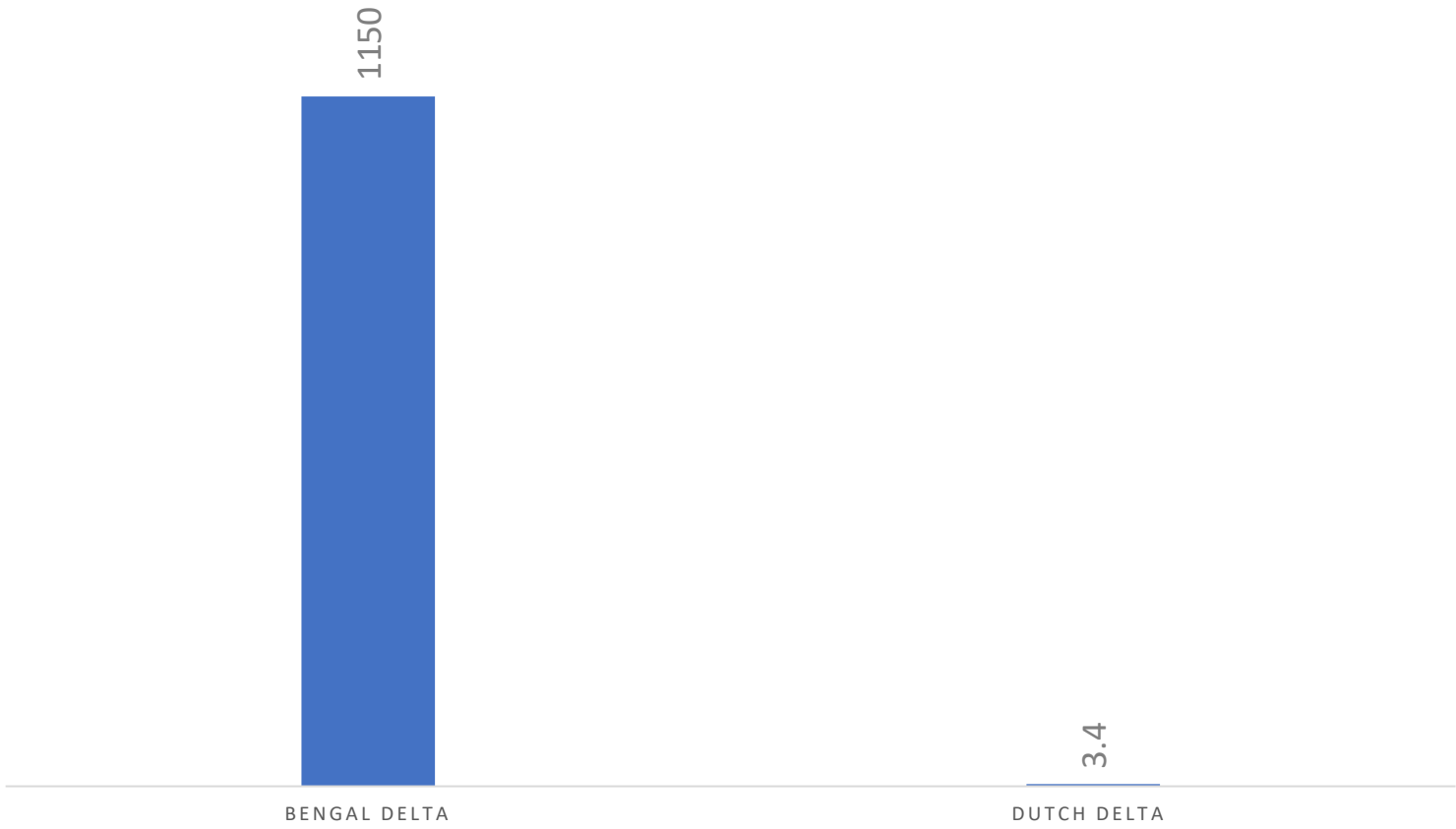
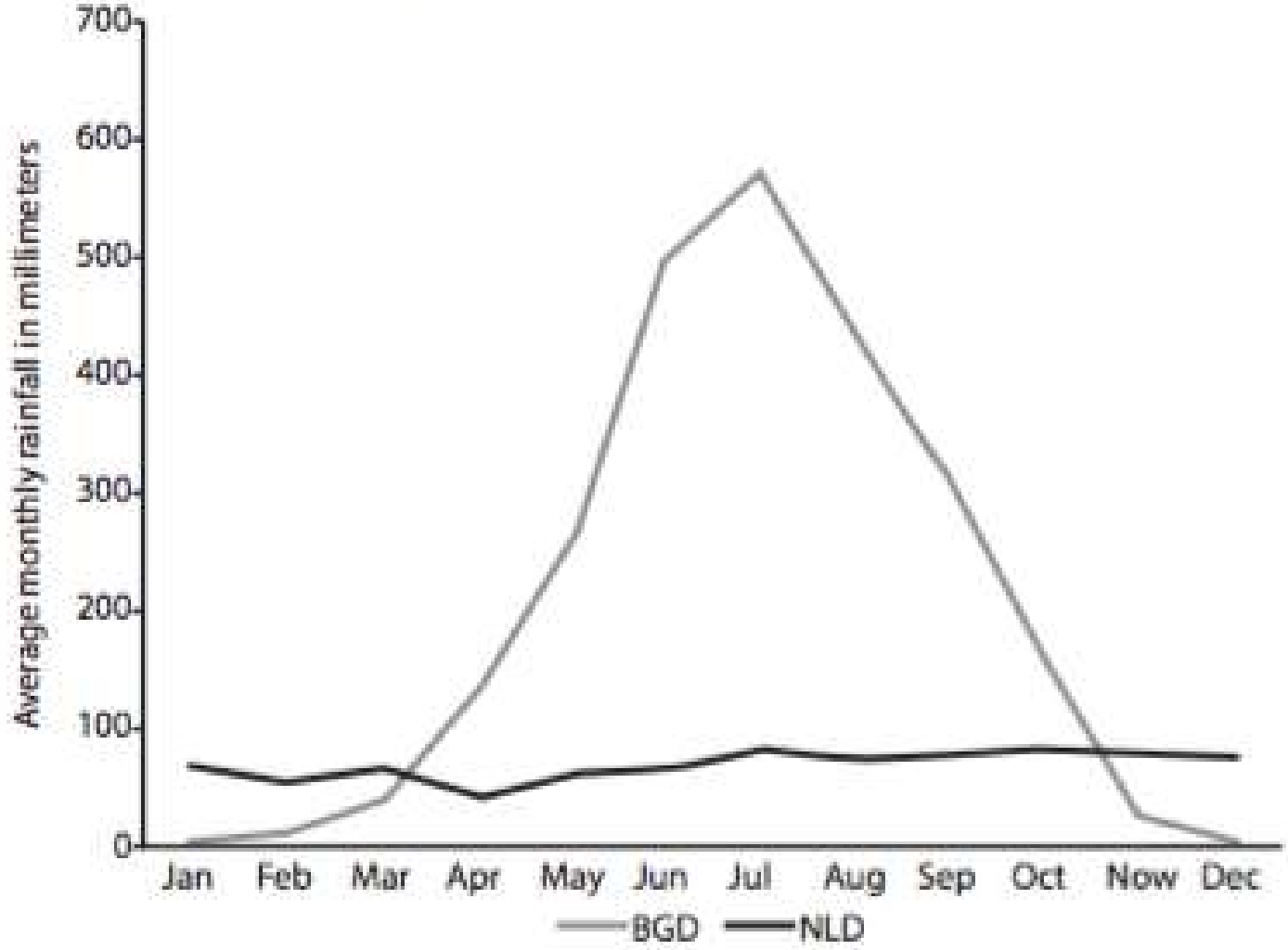
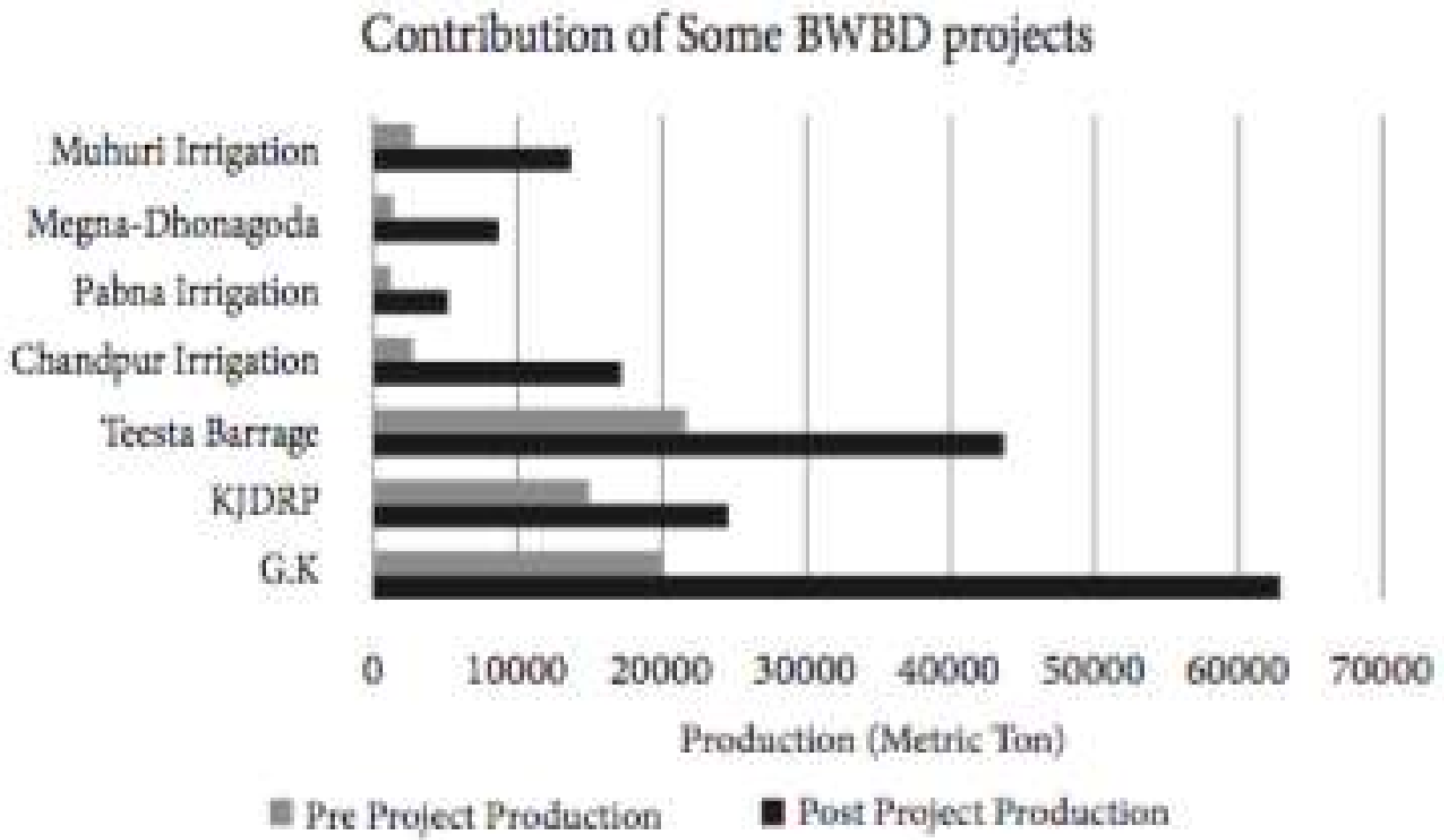


Figure 16.9 Comparison of seasonal variation of rainfall in Bangladesh and the Netherlands
(average monthly rainfall in millimiters)



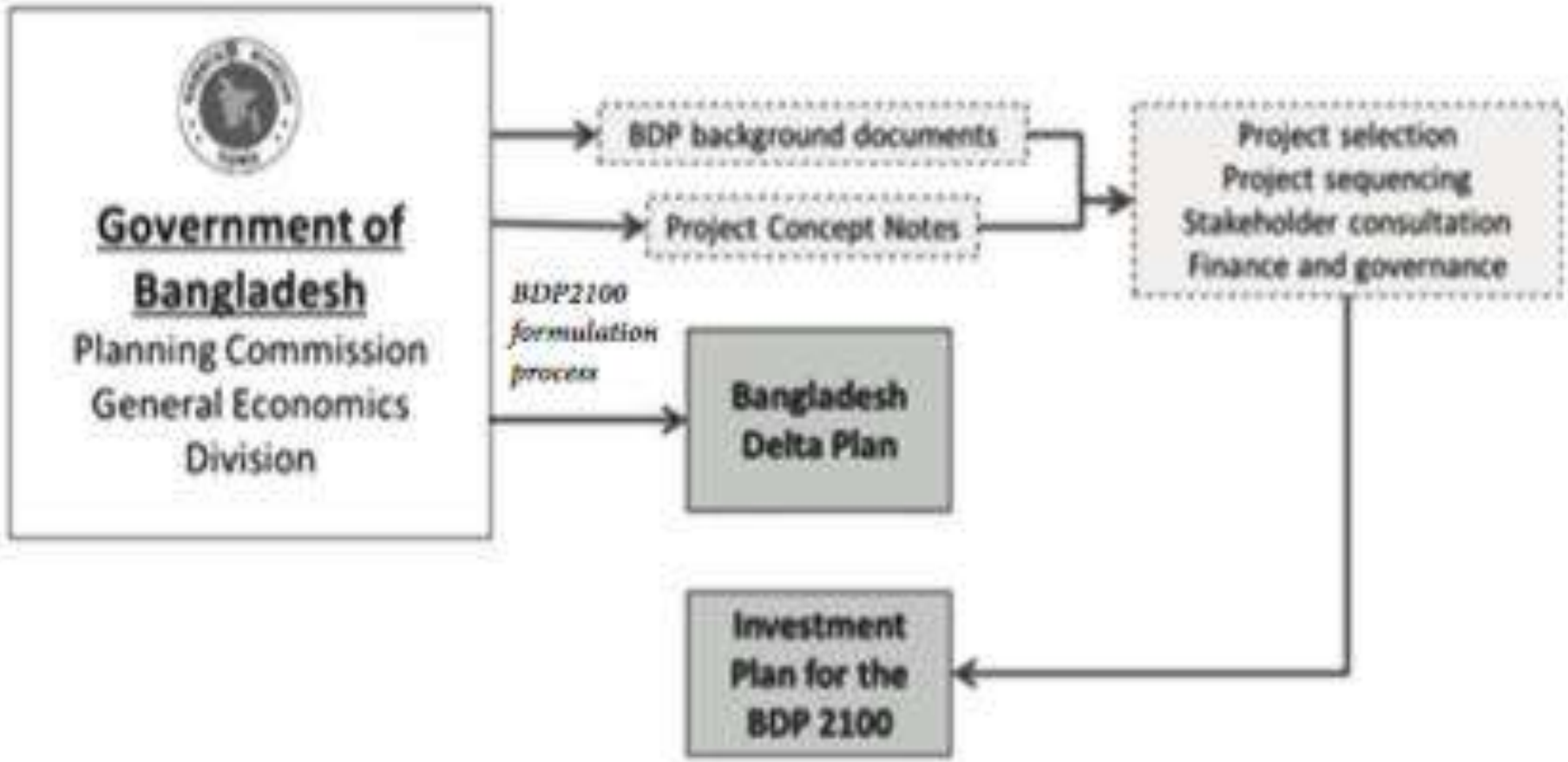
Source: Author, based on data from Dai, Aiguo and Kevin E. Trenberth (2002)

Figure 16.10 Pre-and post-production of rice in some BWDB project areas



Source : der Heer, Chowdhury, Ahmed, and Shams (2018, p.83)

Figure 16.12 Scheme explaining BDP's Investment Plan formulation process



Source: BDP, Vol. 2, Investment Plan, Part 1, p. 4.

Note: There is no arrow going from Delta Plan to its Investment plan

Table 16.8 Classification of Delta Plan project according to their physical nature

Identification	Project type	Project identification number as per Table 16A	No of projects (% of total)	Budget in mln $ (% of total)
BD	Barrage and dams	(19), (20), (23), (59)	4 (5.0)	5,220 (14.2)
CE	Cordon/embankment	(1), (2), (3), (4), (5), (6), (7), (8), (9), (10), (11), (26), (31), (36), (43), (46), (47), (52), (53), (60), (61),	21 (26.3)	9,057 (24.6)
CC	Cordon/channelization	(27), (44), (70),	3 (3.8)	4,802 (13.0)
CD	Cordon/drainage	(32), (33), (34), (35)	4 (5.0)	1513 (4.1)
CI	Cordon/irrigation	(30), (45), (72),	3 (3.8)	736 (2.0)
DE	Dredging/excavation/ khal improvement	(28), (29), (42), (66), (71),	5 (6.3)	2525 (6.9)
GW	Groundwater monitoring/recharge	(77), (78)	2 (2.5)	68 (0.2)
WS	Water supply/sanitation	(37), (38), (39), (40), (41), (55), (73), (74), (75), (76), (79)	11 (13.8)	7828 (21.3)
KM	Knowledge/institutions/ management/ technology	(12), (13), (14), (15), (16), (17), (18), (21), (22), (24), (25), (48), (49), (50), (54), (69),	16 (20.0)	609 (1.7)
OT	Other	(51), (56), (57), (58), (62), (63), (64), (65), (67), (68), (80)	11 (13.8)	4445 (12.1)
	Total		80 (100.0)	36,813 (100.0)

Source : Author, based on BDP Vol. 2 (Investment Plan), Figure 3.2, pp 14-18.

Note: (1) "Other" includes: Agricultural extension, Kaptai lake management, soil conservation and watershed protection, elevated village platform, eco-system and bio-diversity protection, cyclone shelters, fisheries, and livestock.

Teesta River Comprehensive Management and Restoration Plan (TRCMRP)

- Two drivers:
  - (a) Frustration with India regarding Teesta Treaty
  - (b) Chinese offer of loan and technological expertise
- PowerChina-BWDB collaboration, leading to
  - (a) Sustainable River Management Program (SRMP) (new Master Plan?)
  - (b) TRCMRP
- Some general features of TRCMRP
  - (a) Limited information and consultation
  - (b) Led by BWDB/MoWR
  - (c) Contrast with Delta Plan

Main components of TRCMRP

- Narrowing the river to about one-fourth
- Dredging to increase the depth from 5 to 10 m
- Embank the river
- Reclaim land from the riverbed using the dredged materials
- Build groynes and spurs
- Build jetties and terminals

Table 17.1 Main physical components of TRCMRP

No.	*Description of work*	*Quantity*
1	Dredging	140 m. m^3
2	Land reclamation using dredged materials	170.87 km^2
3	Embankment (repair 100.1 km; new 124.2 km)	224.3 km
4	Groyne and spur (repair 15; new 52)	67
5	Transportation and jetty	15
6	Road	224.3 km
7	Environment and social management work	EMP (LAP & RAP)
8	Other	Not specified

Source: BWDB (2019) p. 5

Figure 17.9 Narrowing of the Teesta River under TRCMRP

Source: PowerChina (2019)

Table 17.2 Distribution of the reclaimed land among various uses

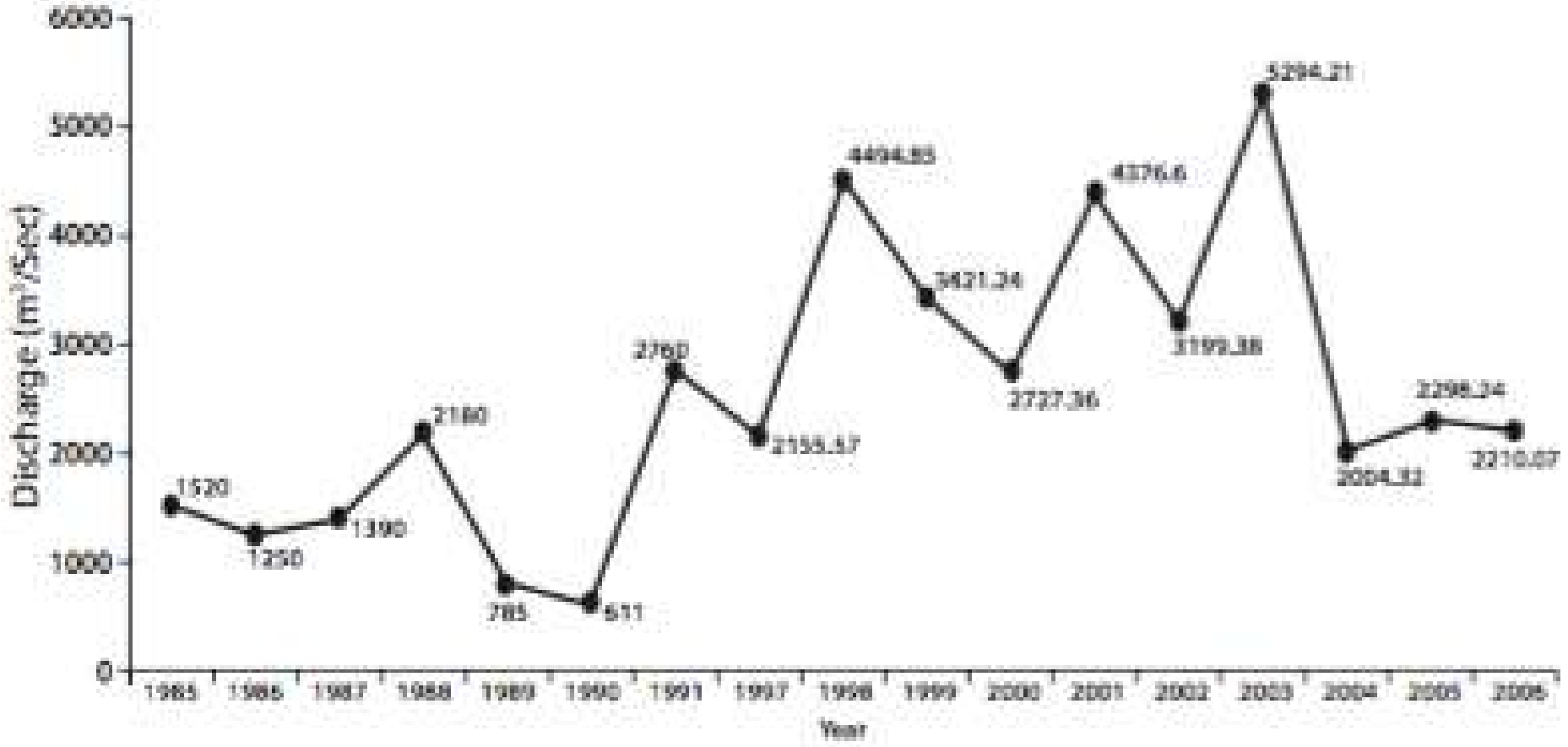
Description	Area km2	Percent of total reclaimed land	Unit rate Including VAT USD/m2	Amount (million USD)
Urban complex land	6.82	4.0	9.193	62.70
Industrial land including photovoltaic power plant	72.93	42.7	9.193	670.46
Agricultural development land	54.67	32.0	9.193	502.58
Resettlement land	36.45	21.3	9.193	335.10
Total	170.87	100		1,570.84

Source: BWDB (2019)

Concerns about TRCMRP

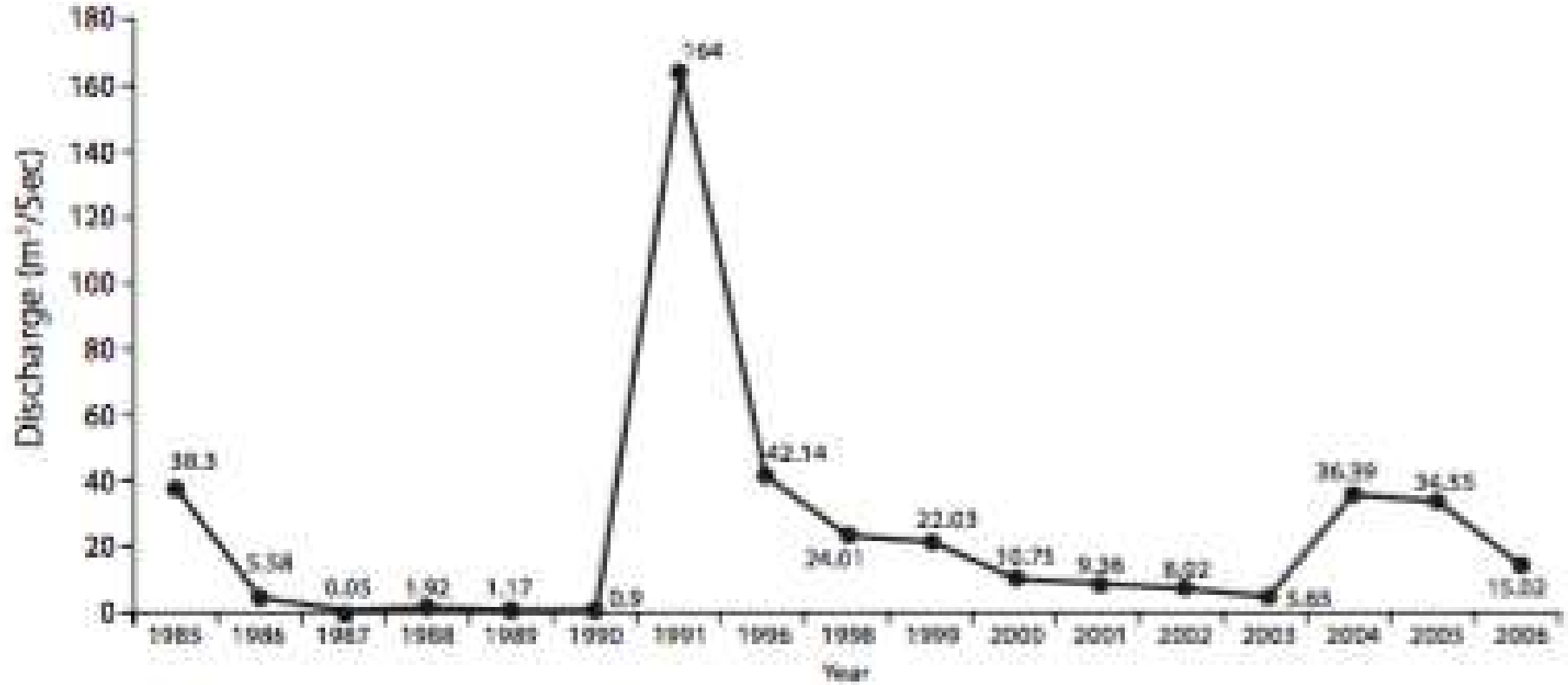
- Limited awareness about destabilization of the Teesta river caused by upstream interventions
- Greater erosion due to increased required velocity
- Greater erosion due to steeper angle of repose
- Limited awareness about the difficulty of holding water in the river
- Limited awareness about the annual sediment flow (of 49 million tons) and the possibility of nullification of increased depth achieved through initial dredging and of the possibility of either
  - (a) collapse of embankments or
  - (b) river-bed aggradation, emergence of “From lower to higher embankment!” vicious cycle, and conversion of Teesta into a “flying river”
- Limited awareness about the role of the Teesta tributaries and distributaries
- Formidable knowledge gaps
- Absence of comparable international experiences

Figure 17.7 Maximum discharge at Dalia station in different years: 1985-2006



Source: Mondal and Islam (2017)

Figure 17.8 Minimum discharge at Dalia station in different years: 1985-2006



Source: Mondal and Islam (2017)

Table 17.3 Increase in stage of Teesta River under TRCMRP

Item	Before TRCMRP	After TRCMRP
Width of the river *(W)*	3,000 m	816 m
Depth of the river *(D)*	5 m	10 m
Cross-section of the river *(A)*	15,000 sq. m	8,160 sq. m
Stage of the river with unchanged velocity	5 m	18.4 m

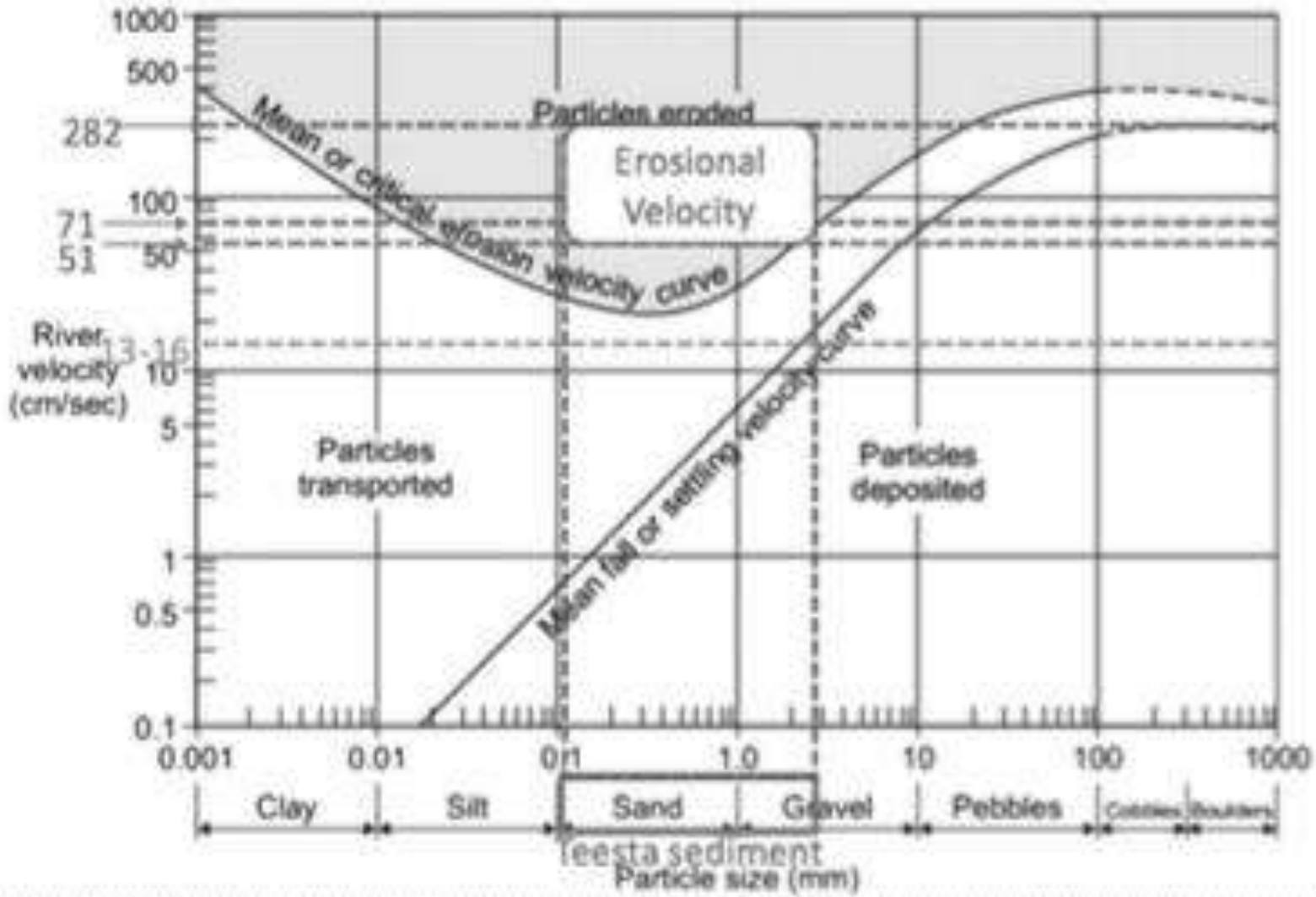
Source: Author[32]

Table 17.4 Velocity of Teesta flow before and after TRCMRP

Item	Before TRCMRP	After TRCMRP
Cross-section of the river	15,000 sq. m	8,160 sq. m
Peak flow (low estimate) (PFL)	4,000 cumec	4,000 cumec
Peak flow (high estimate) (PFH)	5,000 cumec	5,000 cumec
Peak velocity (low estimate) (PVL)	27 cm/sec	50 cm/sec
Peak velocity (high estimate) (PVH)	33 cm/sec	61 cm/sec
Lean flow (low estimate) (LFL)	20 cumec	20 cumec
Lean flow (high estimate) (LFH)	35 cumec	35 cumec
Lean velocity (low estimate) (LVL)	0.13 cm/sec	0.24 cm/sec
Lean velocity (high estimate) (LVH)	0.23 cm/sec	0.42 cm/sec

Source: Khalequzzman (2021), with some modifications

Figure 17.10 Increase in bank erosion under TRCMRP



Source : Khalequzzaman (2021)

Figure 17.11 Bank erosion to attain the natural angle of repose

Teesta Riverbank is composed of natural sandy gravel

Angle of Repose for different sediments

Soil Type	Dry	Moist	Wet
Top Soil, Loose	35 - 40		45
Loam Loose	40 - 45		20 - 25
Peat, Loose	35	45	
Clay/Slt; Solid		40 - 50	
Clay/Slt; Firm		17 - 19	
Clay/Slt; Loose		30 - 35	
Puddle Clay			15 - 20
Slt		19	
Sandy Clay		15	
Sand; Compact		35 - 40	
Sand; Loose	30 - 35		25
Sandy Gravel Compact		40 - 45	
Sandy Gravel Loose		35 - 40	
Sandy Gravel Natural		25 - 30	
Gravel Medium Coarse	25 - 30		35 - 30
Shingle, Loose		40	
Shale, Hard		18 - 22	
Broken Rock	35		45

- The slope of a dredged, narrow, sandy riverbank is likely to sleep (close to, say, 60 degrees)
- Angle of repose (slope) of natural sandy gravel is 25-30 degrees
- Riverbank will erode after dredging to attain the natural angle of repose

Source: Khalequzzaman (2021)

An alternative plan for Teesta based on Open approach

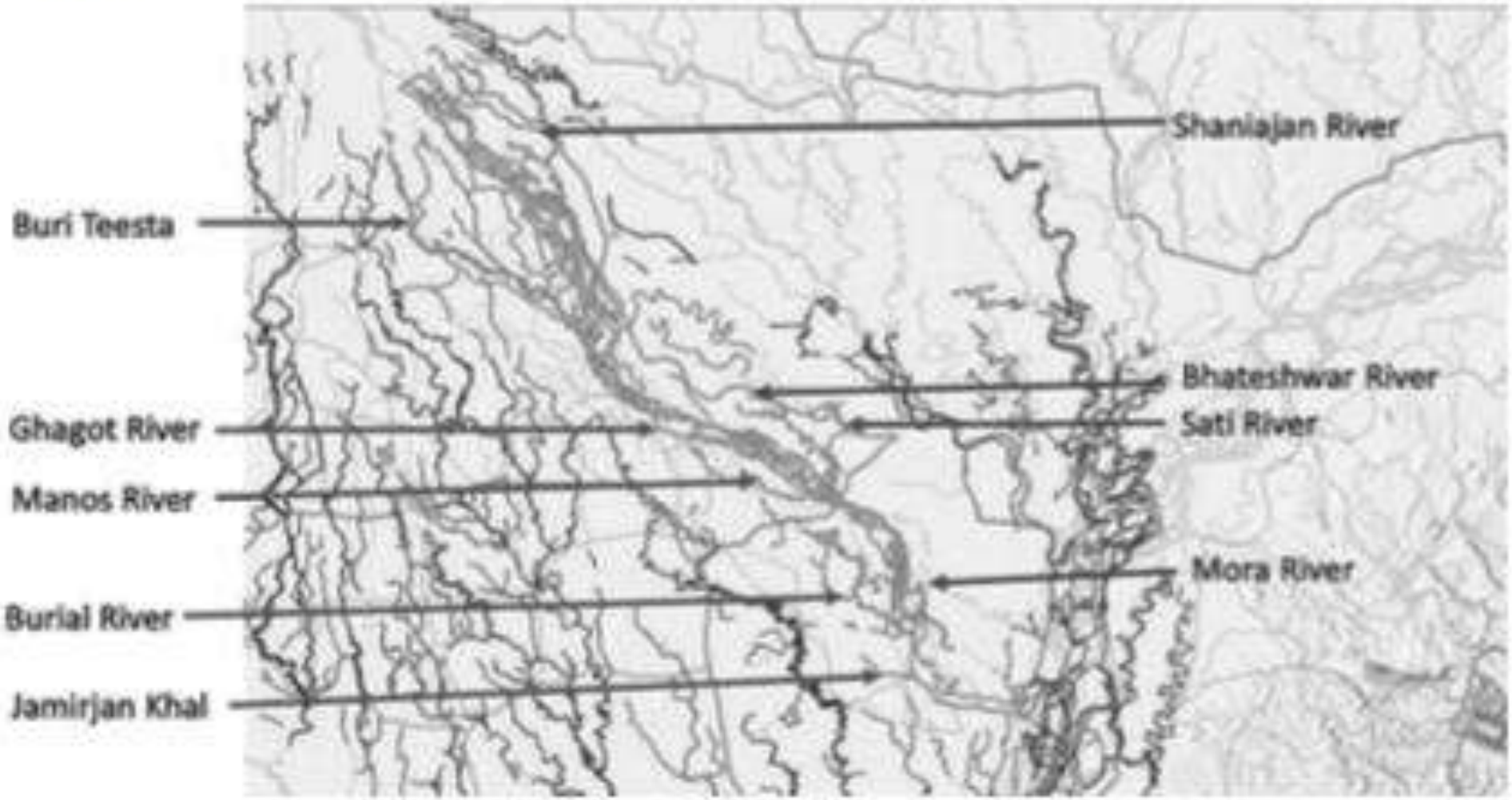
- Rejuvenate Teesta tributaries and distributaries and reconnect Teesta River with them
- Rejuvenate other water bodies in the Teesta Basin to create enough storage space for Teesta overflow
- Insist on India's not only of restoration of lean season flow but also avoiding fluctuations of flows during both peak and lean seasons
- Stabilize Teesta riverbanks using indigenous technologies, such as *kata khals*, *bandal* bandhs, etc.
- Use geo-bag technology to stabilize Teesta riverbank without trying to prevent the river from overflowing on its floodplains
- Adopt a gradual, stage-by-stage approach, working with the nature rather than against it.

Table 17.5 Tributaries and distributary of the Teesta River (From upstream to downstream)

	Right Bank		Left Bank
1	Buri Teesta River (Nilphamari) (Tansboundary river)	1	Shaniajan River (Tansboundary river)
2	Awliakhora River	2	Satidhar River
3	Manas River	3	Sati Sarnamati-Bhateshwari River
4	Harishwer Khal	4	Mora Teesta River
5	Burail Khal	5	Buri Teesta River (Kurigram) (Distributary)
6	Jamirjan Khal		
7	Mirganj Khal		

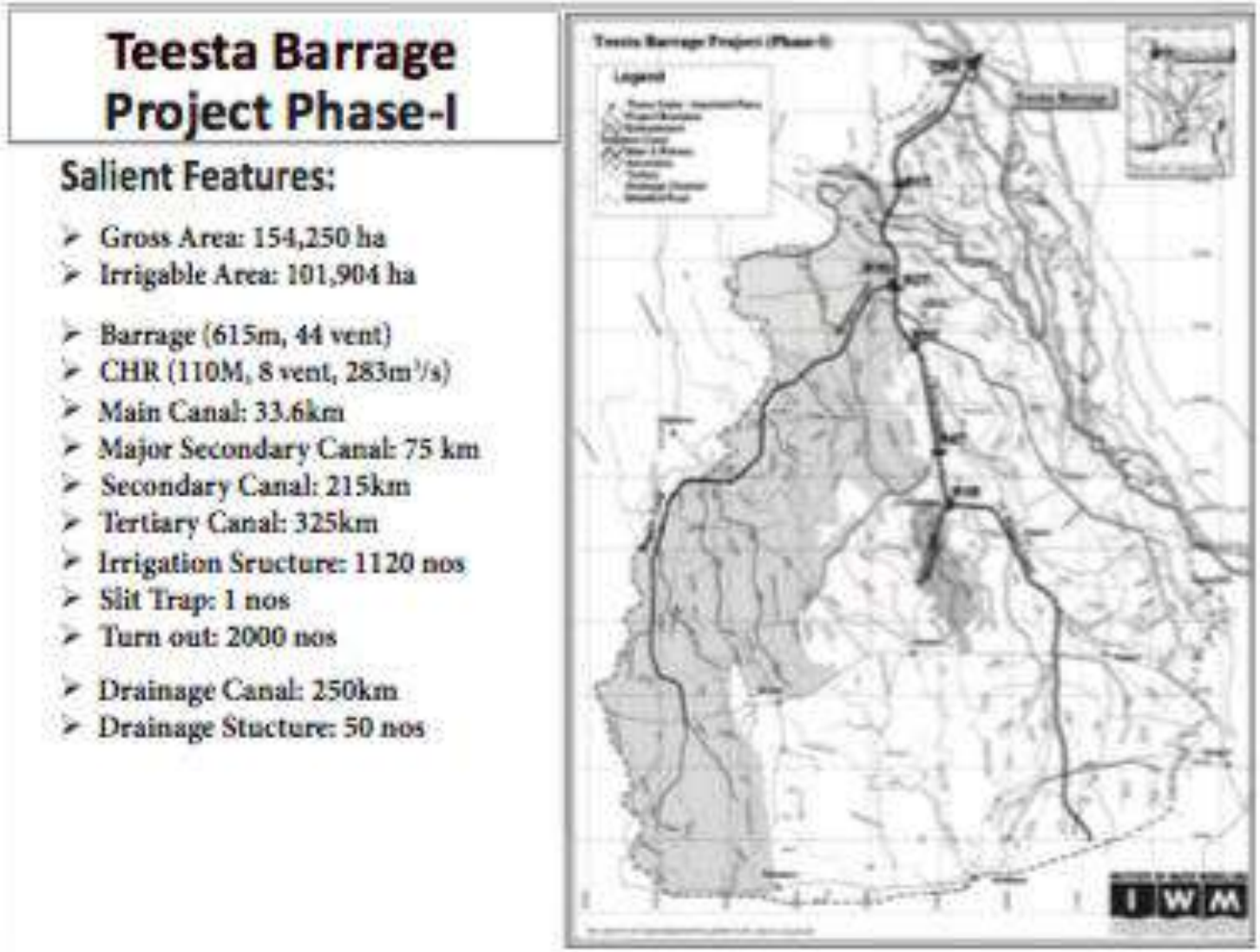
Source: BWDB (2019)

Figure 17.12 Tributaries and distributary of the Teesta River in Bangladesh



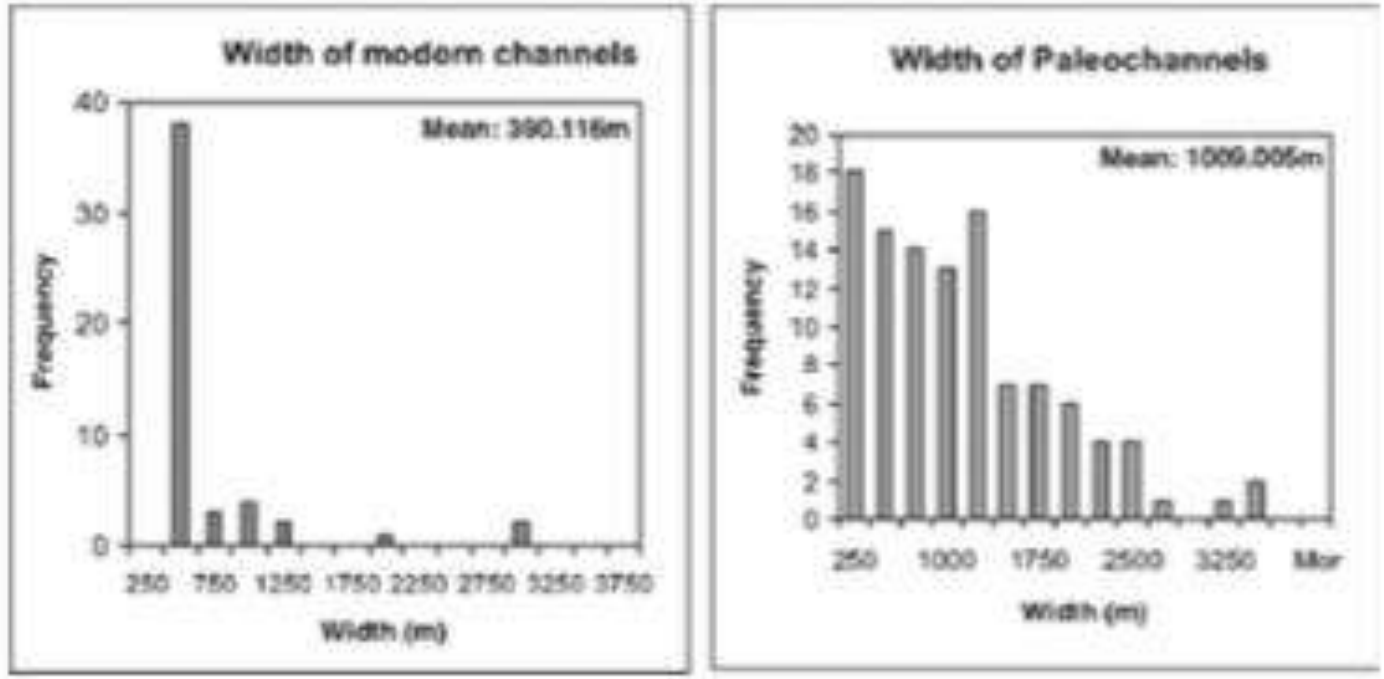
Source: Khalequzzaman (2021)

Figure 17.13 Replacement of the natural river network by artificial network of irrigation and drainage canals under Teesta Barrage Project



Source : Institute of water modeling

Figure 17.14 Modern vs. Paleochannels



Source: Khalequzzaman (2021)

Notes:

(i) Irrigation area in 12 Upazillas = 3,307 sq. km
(ii) Length of irrigation canals = 649 km
(iii) Length of abandoned channels = 532 km
(iv) Density of abandoned channels = 0.16 km/sq. km
(v) Density of channels in Bangladesh = 0.12/sq. km

http://www.bwdb.gov.bd/index.php?option=com_content&view=article&id=132&Itemid=119

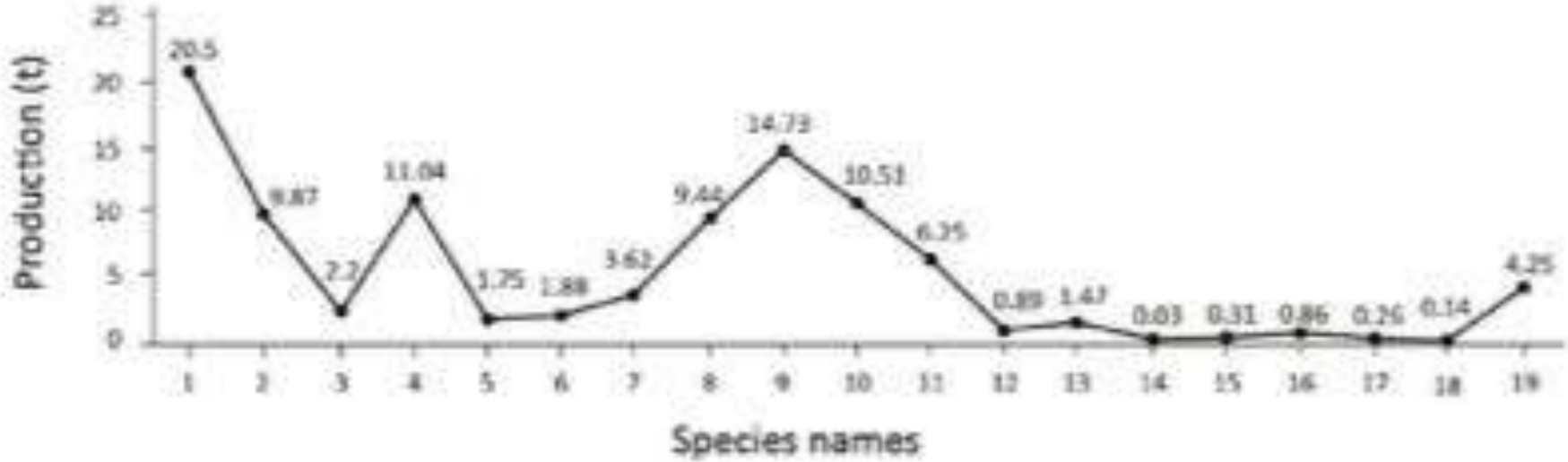
General features of implementation of the Open approach

- General features
- Path dependence
- Case-by-case strategy
- Stage-by-stage or gradual strategy
- People’s enterprise, based on indigenous institutions
- Use of indigenous technologies

Different lines of activities for implementation of the Open approach

- Protection of riverbanks
- Modification of the settlement pattern
- Modification of infrastructure for free passage of water
- Consolidation of settlement
- Land levelling and terracing
- Re-excavation and dredging
- Restoration of waterways
- Revival of capture/open fisheries
- Redirection of cropping research
- Use of discontinuous embankments

Figure 18.1 Species-wise annual fish production in 2014-2015



Source: M. M. Shamszumman, M. M. Islam, N. J. Tania, M. A. Al-Mamun, P. P. Barman, and X. Xu (2017).

Note: 1. Major carp, 2. Exotic carp, 3. Other carp, 4. Pangas, 5. Other catfish, 6. Snake head, 7. Livefish, 8. Tilapia, 9. Other inland fish, 10. Hilsha/Illish, 11. Shrimp/Prawn, 12. Sardine, 13. Bombay duck, 14. Indian salmon, 15. Pomfret, 16. Jewfish, 17. Sea catfish,18. Shark/Skate/Ray, 19. Other Marine fish

Particular issue of implementation of Open approach

- Modification of partial rural cordons
- Modification of full rural cordons
- Modification of coastal cordons
- Modification of urban cordons
- Open approach in *haor* areas

Figure 18.2a Meeting of the author with community leaders of Vabadaha

Source: Nazmul Islam

Note: Meeting held on January 8, 2020 at the office of the Principal of Mashiahati College of Vabadaha

Figure 18.2b Meeting of the author with community leaders at Jessore regarding Vabadaha

Source: Nazmul Islam

Note: Meeting held on January 8, 2020 in Jessore City.

Similarity with the task faced by Willcocks

Political economy of water policies

- Two drivers of policy choice
  - (a) Knowledge
  - (b) Material interests
- Two types of beneficiaries
  - (a) Immediate-beneficiaries
  - (b) End-beneficiaries
- Role of external influence
- Role of public discussion

Figure 19.1: Anatomy of policy choice

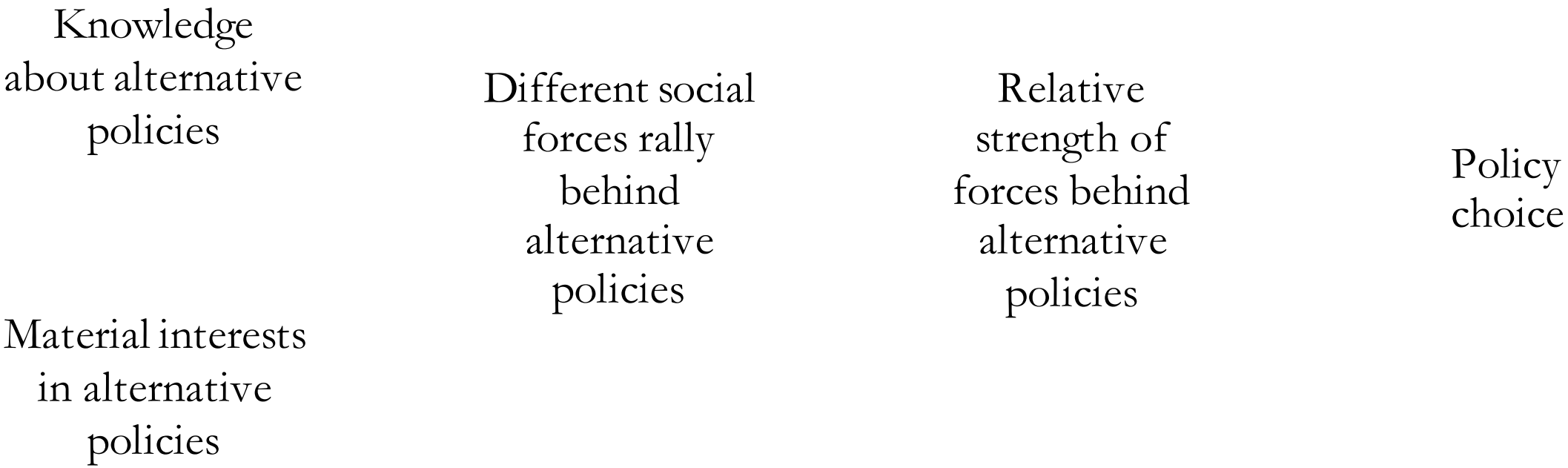
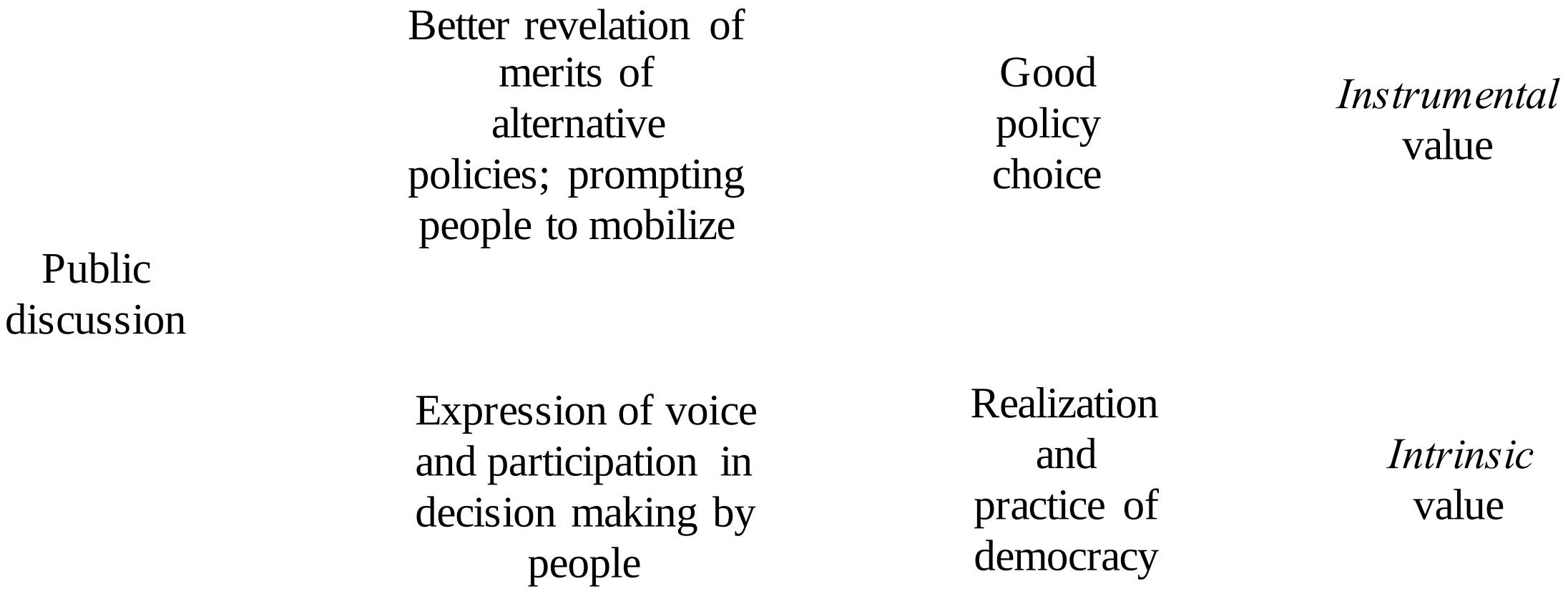


Figure 19.2: Anatomy of water project choice

Water projects	*Immediate-beneficiaries*: whose benefits do not depend on or wait till the completion of project	(a) Few in number; (b) Large and certain per capita benefit choice; (c) Difficult to shirk cost of joint action; (d) Easy to exclude from benefits	Easy to mobilize and mount joint action
	End-beneficiaries: Whose benefits depend on and wait till completion of project	(a) Large in number (b) Smaller and uncertain per capita beneit (c) Easy to shirk cost of joint action (d) Difficult to exclude from benefits	Difficult to mobilize and mount joint action

Figure 19.3: Amartya Sen's view of dual function of public discussion of policies



Obstacles to adoption of Open approach

- Two obstacles to adoption of Open approach
  - Knowledge deficit
  - Mobilization deficit

- Ways to overcome knowledge deficit
  - More technical research
  - Popularization of knowledge

- Overcoming mobilization deficit
  - Rise of the environment movement
  - Rise and progress of the river movement
  - Role of the media
  - Role of the judiciary
  - Role of the political leadership
  - Role of external influence

Figure 20.1a: Public gathering held in Chatmohor in 2011, demanding opening up of the Baral River: Mizanur Rahman, Convener of *Baral Bachao Andolon* speaking

Figure 20.1b: Public gathering held in Chatmohor in 2011, demanding opening up of the Baral River: S. Nazrul Islam, author, speaking

Figure 20.2a: 200 km long human chain demanding opening up of Baral River: School children participating at the bank of the river

200 km long human chain demanding opening up of Baral River: People participating in Chatmohor town

Table 20.1 Some recent rulings of the High Court aimed at protection of rivers and other wetlands

Date of announcement, publication, or reporting of verdict	Justices	Petitioners	Highlights of the verdict
July 18, 2021 Dec 2, 2020	Ashraful Kamal and Razik Al-Jalil	BELA	*Protection of water bodies* 11-point directive; Directs to form a separate ministry for protection, development and management of water bodies; Declares setting up of Sonargaon Resort City and Sonargaon Economic Zone illegal.
June 20, 2021	J. B. M. Hasan Razik Al-Jalil	Abu Taher (resident of the affected area)	*Protection of the Dakatia River* Declares unacceptable silence of government authorities in face of encroachment and pollution of the river and construction of structures inside it.
Oct 10, 2020 March 5, 2020	Enayetur Rahman Md. Mostafizur Rahman	HRPB	*Protection of wetlands* Orders ponds recorded under private ownership to be reclassified as natural wetlands under Article 2(f) of the Wetlands Protection Act of 2000; Reclassification to be published through gazette and implemented within one year by the Secretary of the Ministry of Forests, Environment, and Climate.
August 6, 2020 (Supreme Court) Feb 3, 2019 (High Court)	Moinul Islam Chowdhury and Ashraful Kamal The HC verdict was upheld by the Supreme Court with some modifications	HRPB	*Rights of rivers* Declares rivers as living entity and legal or juristic person; Directs NRCC to be made more independent and effective and serve as the "person in loco parentis" (guardian) of rivers; Suggests modification of 2013 NRCC Act, giving it necessary authority to uphold rivers' rights and requiring encroachers (i) receive severe punishment; (ii) pay compensation for removal of encroaching structures, (iii) be disqualified for receiving bank loans; and (iv) disqualified for being candidates in elections; Requires publication of a list of encroachers, preparation of an electronic database, using satellite-based information, of all waterbodies, and making the list public.

Date of announcement, publication, or reporting of verdict	Justices	Petitioners	Highlights of the verdict
April 7, 2013	Quazi Reza-ul-Hoque and ABM Altaf Hossian	HRPB	*Protection of canals* Directs DCs and SPs of all districts to take effective steps within 7 days to protect canals from encroachment
July 31, 2012	Mirza Hussain Haider and Kazi Md. Ejarul Haque Akondo	PoBA	*Protection of the Dhaleswari River* Directs DoE not to issue any environment and site clearance to Hallmark Group for establishing industrial park encroaching the river in Savar.
March 6, 2012	AHM Shamsuddin Choudhury Manik and Jahangir Hossain Selim	HRPB	*Protection of the Kirtankhola River* Directs government to stop earth filling, plot distribution, and encroachment of the river within 48 hours; Orders authorities to demarcate the river as per CS and RS within three months.
Jan 30, 2012	AHM Shamsuddin Choudhury Manik and Jahangir Hossain Selim	*Suo motu*, in response to report in Prothom Alo	*Protection of the Nayaner Khal* Directs the government to take immediate effective steps to stop encroachment of this *khal* of Munshiganj.
June 25, 2009	A.B.M. Khairul Hoque and Md. Momtaz Uddin Ahmed	HRPB and BELA	*Protection of four rivers around Dhaka City* Directs the government to demarcate by the end of 2009 the original territory of the four Dhaka rivers: Buriganga, Turag, Balu, and Shitalakhya on the basis of CS and RS records and maps along with Land Records and Survey Department; Ordered to set up boundary pillars along demarcated boundaries by November 2010; Directed the government to dredge the river sources to get water from the Jamuna into the Dhaleswari, from the Dhaleswari to the Buriganga, and from the old Brahmaputra to the Bangshi river and bring back navigability in the four rivers; Pointed out the limitation of the minister-led river task force and asked the government to set up effective national river commission.

Source: Author, based on newspaper reports

Notes: BELA: Bangladesh Environmental Lawyers' Association; HRPB: Human Rights and Peace for Bangladesh (Manzill Murshid); CS: Cadastral Survey; RS: Revised Survey; PoBA: Poribesh Bachao Andolon

Table 20.2 Open approach-conforming pronouncements and directives by Prime Minister Sheikh Hasina

Date of reporting	Venue/audience	Highlights of the speech
Nov 17, 2020 (*Daily Samakal*)	ECNEC meeting	*Silt-laden river flows need to be allowed in* River flows to floodplains have to be ensured, because they bring silt, which is necessary to increase crop production; River channels need to be kept open in order to mitigate bank erosion.
Sept 1, 2020 (*Daily Samakal*)	ECNEC meeting	*Indigenous varieties of fish need to be protected* Indigenous varieties of fish, in particular the fish varieties of open water bodies, such as *khals, beels, and haors,* need to be protected.
July 27, 2020 (Awami league website)	Cabinet meeting	*River inundation makes soil fertile; necessity of living with floods* "If aman production is hampered by the ongoing flood, it could be covered up by bumper production of ropa aman following the deluge that makes soil fertile."
Aug 20, 2019 (*Prothom Alo*)	ECNEC meeting	*Against sluice gates* "There is no need to construct any more sluice gate as those get damaged quickly."
April 11, 2019	World Water Day address at BICC	*Connections of rivers with floodplains and restoration of river channels through dredging* "Our once mighty rivers have died due to various reasons. Our rivers have been filled up due to the construction of unplanned dams and roads, upstream sediments and river erosion. As a result, water retention capacity and navigability of many mighty rivers have been lost. We have taken various initiatives to bring back the navigability and restore channels of the major rivers through dredging. Besides, strong coastal dams have been built and connection of rivers has been made with floodplains. Various programs have been implemented with special emphasis on the development of buffer zone along the banks of rivers in order to safeguard environment and eco-system"
March 2, 2019 (*Dhaka Tribune*)	Speech at 59th convention of Institution of Engineers, Bangladesh (IEB)	*Technologies have to be suited to local conditions* Urged engineers to concentrate on technologies that suit more to Bangladesh's local soil, water, climate, and people.

Date of reporting	Venue/audience	Highlights of the speech
Aug 28, 2017	Cabinet meeting	*All obstructions to river and tidal flows need to be removed* The PM herself initiated the discussion about the flood situation. She noted that human-made obstructions are a major reason why flood water cannot quickly pass to the sea. These structures act as barriers to natural rivers and tidal flows and are a major cause of waterlogging. She therefore ordered demolition of all structures that obstruct river and tidal flows. In particular, she wanted unobstructed in- and out-flow of tidal water to be ensured. The PM asked the cabinet secretary to send necessary instructions to all District Commissioners.
May 13, 2016	21st National Convention of the Institution of Diploma Engineers, Bangladesh (IDEB)	*No indiscriminate construction of embankments and sluice gates* Asks engineers not to take and adopt indiscriminate projects of embankment and sluice gates as they not only waste money but harm rivers and wetlands.

Source : Athour, based on newspaper reports and other sources

Conclusions

- About 70 years ago a water development strategy, known as the *Cordon approach*, was imposed on Bangladesh, primarily by external agencies
- This strategy did not serve Bangladesh well.
- The regional and global threats to Bangladesh's rivers have made the situation worse.
- The way out from this predicament is trough adoption of the *Open approach*.
- There are both knowledge- and material interest-related obstacles to the adoption to the Open approach.
- Both these deficits need to be overcome to put Bangladesh on a path toward an effective, pro-people, and sustainable water development.
- This book is expected to help to bring about that transition.

Thank you!

Joy Bangla!