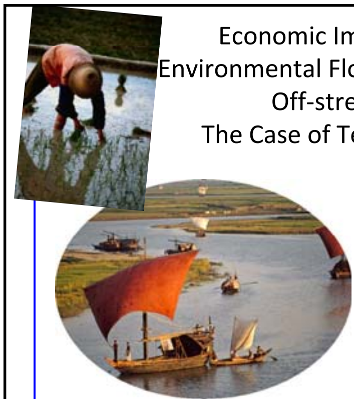

Economic Implications of Meeting Environmental Flow Requirements to In- and Off-stream Water Users: The Case of Teesta River, Bangladesh

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AIT
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Background

Traditional water resources management principally focused on

- Sectoral and fragmented approach
  - Both for cost and benefit estimation
  - Not all uses are considered; e.g. cultural and environmental use
- Managing infrastructures
- Protecting water bodies from mainly point source pollutions

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Background

- Such management have brought humanity many benefits; however,
  - Wreck river-human linkage
  - Degradation of river health, loss of ecosystem goods and services leading to significant economic damage to society

"…The poor, who depend the most on these (FW ecosystem) goods and services for their survival, tend to suffer the consequences…" - Carmen Revenga (from WRI in 2003)

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Background

- Need to ensure water for the river (environmental flow)
  - EF provides several benefits to the society and maintain ecosystem integrity
  - More competition between users (agriculture vs environmental use would be the most critical one)

"It is possible to reduce water scarcity, feed people and address poverty, but the key trade-off is with the environment" – David Molden, IWMI Deputy Director

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Problem statement

- Considerable advances in understanding and recognition of instream water requirements
  - However, successful implementation is rare
- Recent researches argue that improved understanding of socio-economic benefits and costs is necessary in this process
- Tradeoffs are necessary to attain conflicting targets

Question is - How?

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Objective

- This research aims to estimate the tradeoff while allocating the available discharge among the competing off- and in-stream demands using an optimization model
  - Marginal value of sectoral water use is applied as the allocation criterion

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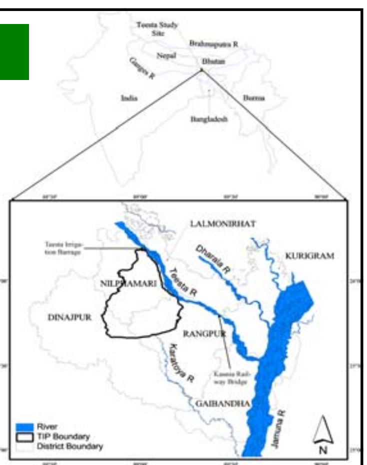
Study site, Teesta River in BD

- Teesta is the 4th main river in BD
- Originated in Sikkim, India
- Enters BD at Chatnai, Nilphamar district
- Length around 113 km in BD
- Draining to the Jamuna
- High seasonal variability in flow
- Main source of water at drought-prone N—W region of BD
- Flow has been regulated since 1987 when India constructed a barrage
- BD constructed another barrage i 1990 to supply irrigation water to Teesta Irrigation Project (TIP)



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Water uses in the Teesta

- The river supplies water to TIP
  - Irrigated area 111,732 ha; situated to the right side of Teesta, only one diversion point
  - Monsoon rainfall, >90% in May to Oct, Irrigation is required for Nov to Apr
  - No return flow to Teesta
- Instream uses are
  - Capture fishery
  - Small scale navigation
- Instream uses are livelihood for a large part of riparian poor

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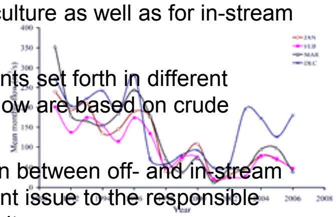
WRM for Teesta

- Drastic reduction in flo… the Teesta has been observed
- Alarming situation in a…culture as well as for in-stream users
- Instream water require…nts set forth in different management plans un…ow are based on crude judgment only
- Therefore, water alloc…n between off- and in-stream uses is a critically imp…nt issue to the responsible water management au…rity

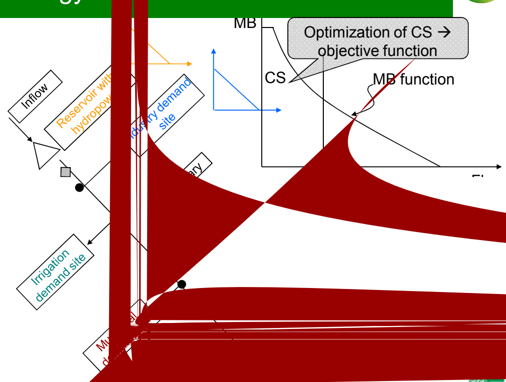


Flow above the Teesta Barrage

Methods

- A hydro-economic modeling approach
- Three module: economic, hydrologic and optimization
- Economic module establishes MB function for water uses
- The model is schematized as a node-link network
  - Nodes represent the demand sites and links represent the linkage between river reaches for hydrologic simulation.
  - Flow balances are calculated for each node at each time period
- Consumer surplus of each water use is maximized in the optimization module from the pre-established MB functions
- Monthly EF requirements are estimated using IHA software and considered as constraint

Methodology



Estimating TB & MB for irrigation

- First estimated irrigation water requirement for rice using water balance approach
- CROPWAT 4.3 for other dry season crops
- Irrigation water benefit is estimated by residual imputation method

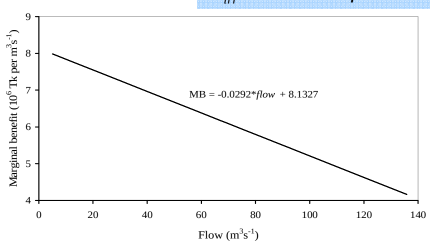
[illegible]

-

Results - Irrigation water use benefit function

- Max water requirement 1890 mm ≈ 136 m^3/s
- Max benefit 587 million Tk per month
- The TB function

$$TB_{irr} = -0.0146 * flow^2 + 8.1327 * flow - 247.97$$



MB function for Irrigation water use

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Estimating TB & MB for in-stream water use

- Respondents identified three seasons in a year while answering the questions related to income:
  - Dry or low flow (December to March),
  - Wet or high flow (June to September) and
  - Intermediate flow season (April, May, October and November)
- The average daily income in a season of an individual is considered uniform over the entire season
- For boatmen
  - Highest income in high flow season and the lowest in the dry season
- For fishermen
  - Dry season is favorable and wet season is not favorable

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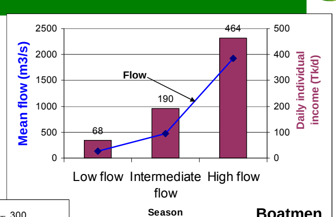
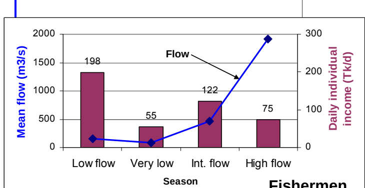
Income pattern for boatmen and fishermen





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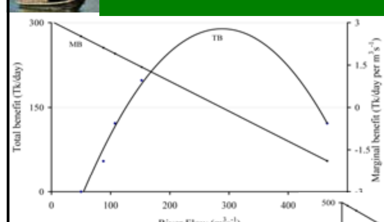
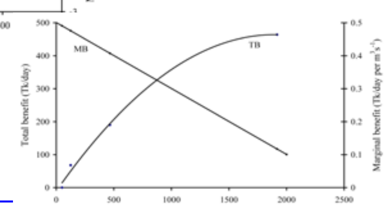
Benefit function of instream water uses



TB & MB function for instream fishery

TB & MB for navigation



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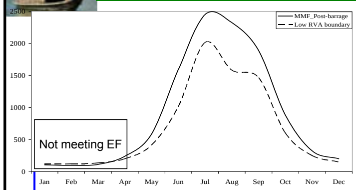
Benefit from water allocation & Tradeoff



Flow at downstream of Teesta

Benefits obtained in water allocation without and with provision of EF

	Total Irri supply (mm)	Irri benefit (10^6 US$)	Instream benefit (10^6 US$)	Total benefit (10^6 US$)
Without EF	**1,637**	**43.242**	**0.588**	**43.830**
With EF	**1,325 (↓19%)**	**33.893 (↓ 22%)**	**0.690 (↑ 17%)**	**34.583 (↓ 21%)**

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Discussion and Conclusion

- Off-stream benefits are observed considerably higher than in-stream benefits for Teesta case; however,
  - In-stream flow is critically important for local and regional socio-economy
    - In-stream flow provides livelihood to about 1,000 people without requiring massive capital investment nor O&M cost. In contrary irrigation project needs massive investment and O&M cost
  - Even allowing minimum EF helps sustaining livelihood for a considerable number of people, which will eventually leads to pro-poor water management
- Cost of water allocation with environmental or river health protection is about 9.25 million US$ annually.
  - However, indirect and non-uses benefits of in-stream water have not been accounted (so called Ecosystem Services).

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Discussion and Conclusion

- Arguing for minimum flow as instream is in fact indicative of the resistance to allow water for in-stream uses. Consequently,
  - River ecosystems struggle with low flow and ultimately decline, which subsequently affects both the poor's livelihood and the environment
- Teesta irrigation Project is providing livelihood to around 0.3 million farmers which indicates per capita income of 0.4 $ daily whereas per capita per day income of instream (direct) users is 1.61 $
  - Such figures will help realizing the actual value of water for each use and subsequently guarantee river flow for all uses
- Indirect benefits usually drawn from EF (biodiversity value, socio-cultural value, river ecosystem services etc.) are not considered. Those may generate high benefits to society and change drastically the diagnosis on EF economic scope, magnitude and impact.

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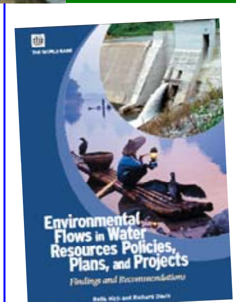

Thanks for your attention

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