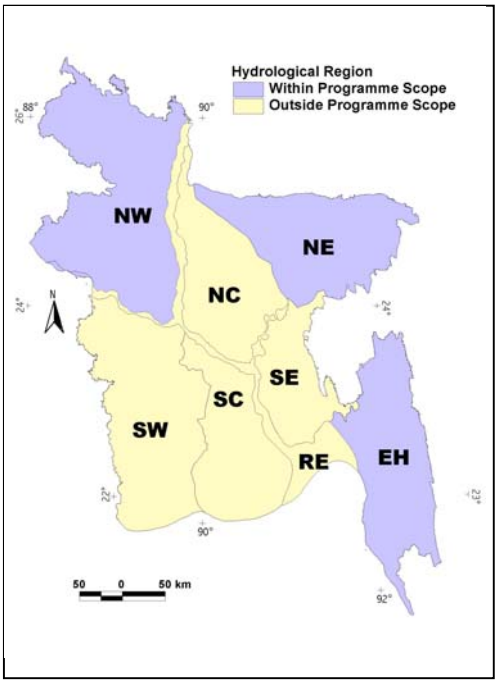
Hydropower Development and Upgrading Ref: **MR 012**

Basic Data

NWMP Sub-sector **Main River Development**

Region(s) **Predominantly in EH Region, possibly in NE and NW Regions**



Relevance to NWPo

NWPo Article 4.11 recognises that Bangladesh has limited potential for hydropower (HEP), due to its flat terrain and lack of suitable reservoir sites, but identifies the possibility of mini-HEP plants at small dam and barrage sites. Such structures may, however, cause adverse downstream and fish migration impacts. Mini-HEP plants can be developed provided that they are economically viable and environmentally safe.

Purpose of Programme

Apart from generating electricity, mini or micro-HEP generation in the Eastern Hills (the Chittagong Hill Tracts (CHT)) and, possibly, NE and NW Regions, could bring substantial socio-economic benefits to the rural population, especially in the remoter areas of the CHT.

Programme Outline

HEP development opportunities are limited to upgrading existing facilities at Kaptai Dam in EH Region, the only major HEP plant in Bangladesh, incorporating generation facilities at barrages, and mini or micro-HEP in the Eastern Hills and, possibly, NE and NW Regions. At this stage the feasibility of such developments cannot be confirmed. An important factor is the relatively low cost of gas-fired thermal electricity generation in Bangladesh. Based on long-term contract prices agreed by independent power producers (IPPs) in Bangladesh, and other sources, the NWMP Project estimated the generation cost of gas-fired electricity to be only Tk1.71 (3.5 US cents) per Kwh at 1998/99 prices. This is well below the long-run marginal costs assumed in the past, before the technology improvements in gas-fired generation (e.g. combined cycle gas turbine (CCGT) plants) in recent years. Even though the prices of gas-fired electricity may increase as a result of the recent rise of world energy prices, they may still be too low for HEP generation to be economically competitive.

1. **Expansion of Kaptai generation capacity**

   It may be possible to increase the generation capacity of the existing Kaptai Lake HEP plant on the Karnaphuli River in EH Region. The only on-going HEP project in the country is the rehabilitation of Kaptai Unit 3, due for completion in 2002 at a cost of Tk621M. In the 2000/01 Annual Development Programme, however, there is also an

"Unapproved" project, without an estimated cost or allocation of funds, for the expansion of Kaptai HEP station (Units 6 and 7).

Such developments are a matter for the Power Development Board (PDB). The aim would be to improve power output using existing storage facilities, with no increase in retention level. The only water management issue is the release pattern, to ensure that flows in the lower Karnaphuli River are maintained as required for water supply, salinity control and fisheries/environmental interests downstream. For Plan costing purposes a provision of Tk4,000M at mid – 2000 prices has been made for possible Kaptai HEP expansion, during Years 6 to 10. O&M costs would be recovered from consumers through the electricity tariff.

2. **Integrated development of the Sangu and Mathamuhuri Rivers**

NW Hydraulic Consultants proposed in their 1983 report integrated development of the Sangu and Mathamuhuri Rivers, a theme first developed by in the 1960's when two dams were proposed at Tarasa Chara and at Champathali in the Eastern Hills Region. A more recent paper by SWMC (March 2000) reviewed and developed the concepts further. The GoB has already discussed with the Government of China taking up a feasibility study.

The study proposed by the GoB would look into the potential for developing each river from the perspective of hydropower, dry season flow augmentation for multi-purpose use and amelioration of flash floods. Earlier studies indicated that some 175MW of power could be generated and 48,000ha of irrigation taken up. Lessons learnt from the study would have useful application also for development of other hilly rivers and streams. Provision is made for these studies and subsequent developments of these two rivers.

3. **Power generation at barrages**

Barrage studies by the ESG (Expert Studies Group) in the early 1980s considered the inclusion of low head, high volume turbine units in major barrages. Generation opportunities at river barrages are generally limited, as there is either little head (in the monsoon) or little through-flow (in the dry season). Generation would be possible at a Brahmaputra Barrage, but probably uneconomic, but on the Ganges could be based on flows diverted down the Gorai, and could be useful to supply a seasonal load, such as a pump station.

In the OGDA (Options for the Ganges Dependent Area) Draft Report of July 2001 an assessment was made of the feasibility of HEP generation from a Ganges barrage. Electricity could be generated both at the barrage and at the Gorai offtake headworks, using the high flow and low head at both structures. Power generation would be possible for 6 to 7 months of the year. Generation potential would depend upon ponding levels and flow. To estimate the benefits of possible power generation a pond level of 12.5m PWD and a flow of $300m^3/s$ through the barrage power station and $200m^3/s$ through the Gorai headworks was assumed. This would give a total generation capacity of 28 MW for the Tagorbari barrage and 34 MW for the Pangsha barrage.

The results of the OGDA economic analysis are shown below. With economic rates of return around 6% for both barrages, much below the GoB stipulated threshold rate of 12%, the value of the power generated would clearly be insufficient to pay for the

investment in plant and equipment required. Returns would be even less if flows dedicated to power generation were lower than assumed. The analysis also does not take into account the effect of flow variations.

Estimated Ganges Barrage Hydropower Costs and Benefits (US$M)

Item	Tagorbari site	Pangsha site
Total cost (incl. Gorai works)	43.87	50.39
Annual value of output generated:		
- at US$ 0.035/kWh	3.87	4.70
- at US$20/tonne of CO_2 emissions saved	0.95	1.15
Economic internal rate of return (EIRR):		
- at US$ 0.035/kWh	5.9%	6.6%
- at US$20/tonne of CO_2 emissions saved	-6.6%	-6.2%

In view of these unfavourable economic results, no provision for barrage HEP development has been included in the Plan at this stage. At a later stage, if any barrage development goes ahead, the feasibility of HEP generation there should be assessed in detail. Social and environmental impacts are unlikely to be significant.

4. **Micro-HEP Development**

In 1980-81 BWDB and PDB set up a working committee to study mini-HEP generation in Bangladesh. Four areas were considered: Chittagong and the CHT, and the Sylhet (NE Region), Mymensingh – Jamalpur (NC Region) and Rangpur – Dinajpur (NW Region) areas. Some 20 potential sites were identified, mostly in the 10 to 50kW capacity range. Reconnaissance surveys were conducted at seven sites in EH Region, but no detailed studies or analyses were undertaken. As yet, none of these plants has been built.

Micro rather than mini-sized river schemes are the only ones which are likely to be viable. Availability of suitable sites, adequate dry season stream flows (with the pronounced seasonality of rainfall, stream base flows are low), and a local market for the electricity generated are the key factors. At present, no decision on the feasibility of any potential micro-HEP scheme can be made, but in the Plan a provision has been made for Tk1,000M (mid-2000 prices) to be spent on such schemes, this being spread over Years 3 to 15. O&M costs would be recovered through user charges, as in the on-going and successful nation-wide Rural Electrification Programme. Environmental impacts are unlikely to be significant. Social benefits in the remoter parts of the CHT could be substantial.

Financing Arrangements

Capital cost financing would be by GoB or possibly local government, major NGOs or the private sector. There would be full recovery of OMR (O&M and replacement) costs from the consumers.

Objectives and Indicators

Objective	Suffix	Indicators/Means of Verification	Due
• Comprehensive management plan for physical works and institutional measures	I1	• Physical programmes agreed with BWDB • Report agreed by GoB	2003
• Cost-effective project implementation	I2	• Project reports • Audit reports	2016
• Profitable hydropower generation	K	• Project records • Audit reports	2025
• Bangladesh's main and regional rivers comprehensively developed for sustainable multi-purpose use	D	• Returns per unit of water • River maintenance costs • Quality and Quantity of in-stream flows	2025

Institutional Arrangements

Kaptai HEP expansion would be undertaken by the PDB. Integrated development of the Sangu and Mathamuhuri rivers could be carried out by PDB for hydropower and BWDB for other elements. Micro-HEP development could be carried out by local government, by major NGOs, as in Nepal, or by the private sector. If larger mini-HEP plants were developed, construction of civil works could be by BWDB.

Existing Documentation

NWMP DSR Section 6.11; OGDA Draft Final Report; Mini-HEP Generation in Bangladesh: Report of the Working Committee, BWDB/PDB, 1981; Integrated Development of the Sangu and Matamuhuri River Basins, NW Hydraulic Consultants 1983 and SWMC 2000; ESG barrage studies, 1984.

Linkages

The main linkage would be with Programmes MR 003 to MR 005, if main river barrages were to be built and HEP plants were to be installed.

Risks and Assumptions

If an increase in Kaptai generating capacity were to involve a rise in Kaptai Lake levels or a substantial change in reservoir operating rules, there could be serious adverse environmental impacts. Similarly, development of storage on the Sangu and Mathamuhuri Rivers could cause significant social and environmental impacts in the reservoir area, requiring rigorous assessment. Micro-HEP is possible only where flows are reliable, and micro-HEP plants are at risk unless carefully designed to withstand flash floods and constructed in one dry season, to avoid flood damage to the works in progress. There may also be serious institutional risks, because of possible difficulties in organising the construction and O&M of a plant and ensuring its financial viability.

Hydropower Development and Upgrading

Ref : **MR 012**

Cluster :	**Main Rivers**	Region(s) :	**EH, NE, NW**
Focus/Foci :	**Hydropower**	Location :	**EH, NE, and NW regions**
Start Year[1] :	**2002** Duration[2] : **15 year(s)**	Agency(s) Responsible :	**PDB** **(Lead)** Private Sector (Supporting)
Short Description :	The purpose of this programme is to review in detail the potential for further investment in HEP, identify suitable modalities of development and provide for the necessary downstream investment. The study would focus on: expansion of Kaptai generation capacity; integrated development of the Sangu and Matamuhuri rivers for hydropower generation and other uses; power generation at barrages; and micro-HEP schemes. Micro-HEP appears particularly worthy of pursuit, especially in more remote areas, such as in the CHT, where early exploitation of local resources of power generation could bring high social benefit.		

MIS Links

Cost Calculation :	MR Programme costing.xls	Map :	MR 012 Map.jpg
Disb't Schedule :	MR Programme costing.xls	Description :	MR 012 PgP.doc

Finance

	Costs		Funding (%) Private	GoB	Beneficiaries	Expected by Programme Year
Total Capital[3]	**4,750.00**	MTk	**0%**	**100%**	**0%**	**15**
Ultimate Recurring	**235.00**	MTk/yr	**n/a**	**0%**	**100%**	**16**

Date of Data : **31** (dd) **07** (mm) **01** (yy)

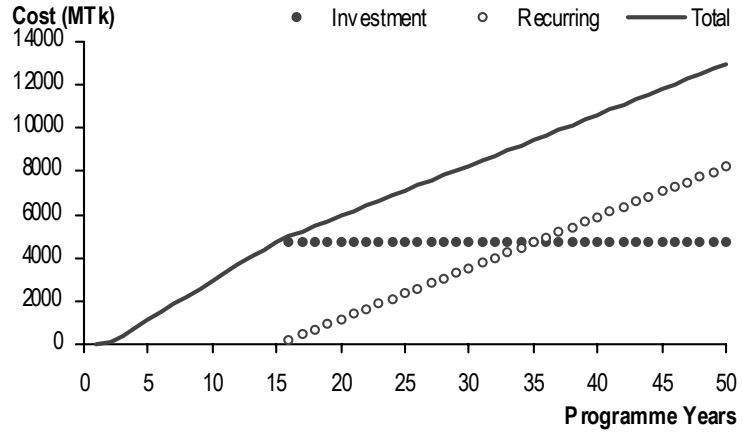
Status : **Identified**

Financial Base Year: **mid-2000**

Planned Expenditure (to date) : **0** MTk

Actual Expenditure[4] (to date) : **0** MTk

Stacked Cumulative Cash Flow Chart



Monitoring

Objective	Indicator	Present Status[5]
• Comprehensive management plan for physical works and institutional measures	• Physical programmes agreed with BWDB • Report agreed by GoB	NYD
• Cost-effective project implementation	• Project reports • Audit reports	NYD
• Profitable hydropower generation	• Project records • Audit reports	NYD

Notes : 1. Indicative 2. Until commissioning 3. Inclusive of planning, design _supervision 4. For future monitoring purposes and NWMP updates
5. Present Status keys: NYD- Not yet due, IP- In progress, D- Done

National Water Management Plan

Programme Costing Sheet

Programme Ref	**MR 012**
Title	**Hydropower Development and Upgrading**

Assumptions:

Taka/US$ 51.000 | TA duration 2.0 years | Investment duration 13.0 years | All prices in mid-2000 values

Item	Unit	Quantity	Rate US$	Rate Tk'000	Amount TkM	O&M %	O&M/yr TkM
Technical Assistance	Preparatory studies						
Expatriate consultants (all-in rate)	p-m	12.0	20,000		12.2		
Senior National consultants (all-in rate)	p-m	36.0		150	5.4	*0.0%*	-
Mid-level National consultants (all-in rate)	p-m	71.0		90	6.4	*0.0%*	-
Sub-totals					24.0		-
Other general TA programme costs		*25%*			6.0		-
Specific other TA programme costs					20.0	*0.0%*	-
Total TA Costs					**50.0**		**-**
Other Programme Costs							
1. Provision for upgrading Kaptai (subject to study and EIA)					2,700.0	*5.0%*	135.0
2. Provision for integrated development of the Sangu and Matamuhuri Rivers for hydropower					1,500.0	*5.0%*	75.0
3. Provision for hydrolelectric plants in barrages	Contained in barrage estimates				-	*0.0%*	-
4. Provision for micro-hydrolelectric plants					500.0	*5.0%*	25.0
5.					-	*0.0%*	-
6.					-	*0.0%*	-
7.					-	*0.0%*	-
8.					-	*0.0%*	-
9.					-	*0.0%*	-
10.					-	*0.0%*	-
Total Other Programme Costs					4,700.0		235.0
Overall Programme Costs					**4,750.0**		**235.0**

Notes:

The above investment costs are provsional sums and include provisions for feasibility studies. Upgrading of Kaptai based on cost of Tk621M for one unit recently rehabilitated. Allowing for further new units at approximately two times the cost of rehabilitation. Estimates would be prepared of likely costs in the specified study.