Ministry of Water Resources

UN WATER
22 MARCH
WORLD WATER DAY
2024 Water for Peace

WORLD WATER DAY 2024

Water for Peace

“পানির পরিকল্পিত ব্যবস্থাপনাই আমাদের জলবায়ু ও প্রকৃতির ভারসাম্য রক্ষা করাসহ জীববৈচিত্র্য রক্ষায় অগ্রণী ভূমিকা পালন করবে বলে আমি আশা করি।”

بِسۡمِ اللّٰہِ الرَّحۡمٰنِ الرَّحِیۡمِ

রাষ্ট্রপতি
গণপ্রজাতন্ত্রী বাংলাদেশ

বাণী

পানি সম্পদ মন্ত্রণালয় কর্তৃক প্রতি বছরের ন্যায় এ বছরও 'বিশ্ব পানি দিবস-২০২৪' উদযাপনের উদ্যোগকে আমি স্বাগত জানাই।

মানুষসহ পৃথিবীর প্রাণীকূলের জীবনধারণের জন্য পর্যাপ্ত, বিশুদ্ধ, নিরাপদ ও সুপেয় পানি অপরিহার্য। দুষ্প্রাপ্যতা ও দূষণের ফলে বিশ্বের মোট জনসংখ্যার উল্লেখযোগ্য অংশ পর্যাপ্ত এবং সুপেয় পানির অধিকার থেকে বঞ্চিত হচ্ছে। পানির সুষম প্রাপ্যতা নিশ্চিতে পানি সম্পদের সঠিক ব্যবস্থাপনার মাধ্যমে উৎস হতে ভোক্তা অবধি পানির ন্যায়সঙ্গত বন্টন ও টেকসই ব্যবহার নিশ্চিত করতে হবে। জলবায়ু পরিবর্তনের প্রভাব এবং পানি সম্পদের পরিমিত ব্যবহার, সংরক্ষণ ও টেকসই ব্যবস্থাপনার বিষয়ে বিশ্বব্যাপী জনসচেতনতা বাড়াতে হবে। বৈশ্বিক স্থিতাবস্থা, শান্তি ও সমৃদ্ধি নিশ্চিতকল্পে পানির অপরিহার্য ভূমিকার বর্তমান প্রেক্ষাপটে বিশ্ব পানি দিবসের এবারের প্রতিপাদ্য 'Water For Peace' অর্থাৎ 'শান্তির জন্য পানি' যথার্থ হয়েছে বলে আমি মনে করি।

নদীমাতৃক বাংলাদেশে মানুষের দৈনন্দিন জীবনের নানামুখী চাহিদা পূরণসহ কৃষিকাজ, পরিবহন, মৎস্য উৎপাদন এবং নগরায়ন ও শিল্পায়নের জন্য পানির বিকল্প নেই। পানির পর্যাপ্ত সরবরাহ নিশ্চিতের লক্ষ্যে সরকার নদী ড্রেজিং ও ৬৪টি জেলায় খাল পুনঃখননের মাধ্যমে পানি ধারণক্ষমতা বৃদ্ধি, প্রাকৃতিক জলাধার রক্ষণাবেক্ষণ এবং নতুন জলাধার নির্মাণের কার্যক্রম অব্যাহত রেখেছে। এছাড়াও সরকার নদী তীর সংরক্ষণ, জলাবদ্ধতা দূরীকরণ, ভূমি পুনরুদ্ধারের মাধ্যমে মানুষের জীবনমান উন্নয়ন ও পরিবেশগত ভারসাম্য রক্ষার প্রচেষ্টা চালিয়ে যাচ্ছে। অমূল্য প্রাকৃতিক সম্পদ পানির পরিকল্পিত ও পরিমিত ব্যবহার নিশ্চিতকরণে আমি ব্যক্তি পর্যায়ে ও সরকারি-বেসরকারি সকল প্রতিষ্ঠানকে সমন্বিত কার্যকর উদ্যোগ গ্রহণের আহ্বান জানাই।

আমি 'বিশ্ব পানি দিবস-২০২৪' উপলক্ষ্যে গৃহীত সকল কার্যক্রমের সফলতা কামনা করছি।

জয় বাংলা।

খোদা হাফেজ, বাংলাদেশ চিরজীবী হোক।

মোঃ সাহাবুদ্দিন

بِسۡمِ اللّٰہِ الرَّحۡمٰنِ الرَّحِیۡمِ

প্রধানমন্ত্রী
গণপ্রজাতন্ত্রী বাংলাদেশ সরকার

বাণী

'বিশ্ব পানি দিবস-২০২৪' উপলক্ষে আমি নদীমাতৃক বাংলাদেশের সকল জনগণ ও পানিসম্পদ ব্যবস্থাপনার সঙ্গে জড়িত সকলকে আন্তরিক শুভেচ্ছা জানাই। বিশ্ব পানি দিবসের এ বছরের প্রতিপাদ্য-'Water for Peace' যা সময়োপযোগী হয়েছে বলে আমি মনে করি।

'পানি' শান্তি কিংবা সংঘাত ঘটাতে পারে। পানির অসম বণ্টন বা দুস্প্রাপ্যতা উত্তেজনা ও সংঘাত সৃষ্টি করে। সুষম পানি ব্যবস্থাপনার মাধ্যমে জনস্বাস্থ্যের সমৃদ্ধি, খাদ্য নিরাপত্তা নিশ্চিতকরণ এবং অর্থনৈতিক উন্নয়ন সহজতর হলে বিশ্ব শান্তি প্রতিষ্ঠায় তা সহায়ক ভূমিকা পালন করবে। জলবায়ু পরিবর্তনের কারণে সৃষ্ট চ্যালেঞ্জ এবং পানিসম্পদের উপর এর প্রভাব মোকাবিলা করার জন্য সকলের আন্তরিক সহযোগিতা প্রয়োজন। বৈশ্বিক ও আঞ্চলিক শান্তি রক্ষার লক্ষ্যে আন্তঃসীমান্ত নদীর পানি ব্যবস্থাপনায় রাষ্ট্রসমূহের মধ্যে আস্থা ও সহযোগিতামূলক মনোভাব অত্যন্ত গুরুত্বপূর্ণ। পানির প্রতিটি ফোঁটার সর্বোত্তম ব্যবহারই নিশ্চিত করতে পারে পানির সর্বজনীন ন্যায়ভিত্তিক বণ্টন ও ব্যবস্থাপনা।

পানিসম্পদ ব্যবস্থাপনা এবং টেকসই উন্নয়ন একে অপরের সঙ্গে নিবিড়ভাবে জড়িত। আবহমানকাল হতে পানি আমাদের জীবনের সর্বক্ষেত্রে অপরিহার্য উপাদান হিসেবে পরিগণিত হয়ে আসছে। তাই টেকসই উন্নয়নের লক্ষ্যে পানিসম্পদকে দক্ষতার সাথে ব্যবহার করে পরিবেশবান্ধব উন্নয়ন পরিকল্পনা গ্রহণ করতে হবে। পানির পরিকল্পিত ব্যবস্থাপনাই আমাদের জলবায়ু ও প্রকৃতির ভারসাম্য রক্ষা করাসহ জীববৈচিত্র্য রক্ষায় অগ্রণী ভূমিকা পালন করবে বলে আমি আশা করি।

বাংলাদেশের পানিসম্পদ ব্যবস্থাপনা ও উন্নয়নে পানি সম্পদ মন্ত্রণালয় গুরুত্বপূর্ণ ভূমিকা পালন করছে। জলবায়ু পরিবর্তনের অভিঘাত সহিষ্ণু ব-দ্বীপ গড়ে তোলার লক্ষ্যে আমাদের সরকার 'বাংলাদেশ ব-দ্বীপ পরিকল্পনা-২১০০' প্রণয়ন করছে। অভিযোজনভিত্তিক কারিগরি এবং অর্থনৈতিক এ মহাপরিকল্পনায় জলবায়ু পরিবর্তন ও দুর্যোগ ঝুঁকি হ্রাস করে পানি সম্পদের সর্বোত্তম ব্যবস্থাপনা, ভূমি ব্যবহার এবং পরিবেশ-প্রতিবেশ উন্নয়নের অঞ্চলভিত্তিক কর্মপন্থা নির্ধারণ করা হয়েছে। পানিসম্পদ ব্যবস্থাপনা ও পানি ব্যবহার শৃঙ্খলা প্রবর্তনের লক্ষ্যে ইতোমধ্যে পানি আইন, জাতীয় পানি নীতি ও পানি বিধিমালা প্রণীত হয়েছে। পানি সম্পদ মন্ত্রণালয় নদী ব্যবস্থাপনা, বন্যা নিয়ন্ত্রণ, সেচ ও নিষ্কাশন, নদীতীর ভাঙ্গন প্রতিরোধ ইত্যাদি বিষয়ে প্রয়োজনীয় পদক্ষেপ গ্রহণ করে আসছে। এছাড়া ডিজিটাল পদ্ধতিতে বন্যার পূর্বাভাস সম্বলিত প্লাবন মানচিত্র ও আগাম সতর্কবার্তা জনগণের দোরগোড়ায় পৌঁছে দেয়াসহ বিভিন্ন প্রকল্প বাস্তবায়নে আধুনিক তথ্য প্রযুক্তির ব্যবহার করা হচ্ছে, যা স্মার্ট বাংলাদেশ বাস্তবায়নে অগ্রণী ভূমিকা পালন করবে বলে আশা করছি।

পরিবেশবান্ধব ও টেকসই পরিকল্পনা গ্রহণ এবং বাস্তবায়নের মাধ্যমে ২০৪১ সালের মধ্যে উন্নত সমৃদ্ধ ও স্মার্ট বাংলাদেশ বিনির্মাণ করে সর্বকালের সর্বশ্রেষ্ঠ বাঙালি, জাতির পিতা বঙ্গবন্ধু শেখ মুজিবুর রহমানের স্বপ্নের 'সোনার বাংলাদেশ' গড়তে সকলকে সমন্বিতভাবে কাজ করার আহ্বান জানাচ্ছি।

আমি 'বিশ্ব পানি দিবস-২০২৪' উপলক্ষে গৃহীত সকল কর্মসূচির সার্বিক সাফল্য কামনা করছি।

জয় বাংলা, জয় বঙ্গবন্ধু

বাংলাদেশ চিরজীবি হোক।

শেখ হাসিনা

প্রতিমন্ত্রী
পানি সম্পদ মন্ত্রণালয়

বাণী

বিশ্বব্যাপী পানির যথোপযুক্ত ও টেকসই ব্যবহার নিশ্চিতকরণ এবং নিরাপদ ও সুপেয় পানির সংকট নিরসনকল্পে প্রতিবছর ২২ মার্চ 'বিশ্ব পানি দিবস' পালিত হয়ে থাকে। এবারের বিশ্ব পানি দিবসের প্রতিপাদ্য হচ্ছে "Water for Peace".

জাতির পিতা বঙ্গবন্ধু শেখ মুজিবুর রহমান বাংলাদেশকে সোনার বাংলা গড়ে তোলার যে স্বপ্ন দেখেছিলেন, সে স্বপ্ন বাস্তবায়নে তাঁর সুযোগ্য কন্যা মাননীয় প্রধানমন্ত্রী জননেত্রী শেখ হাসিনা ভবিষ্যৎ প্রজন্মের জন্য শতবর্ষব্যাপী দীর্ঘমেয়াদি 'ব-দ্বীপ পরিকল্পনা-২১০০' প্রনয়ণ করেছেন। এই কর্ম পরিকল্পনার সিংহভাগ কার্যক্রম ও প্রকল্প পানি সম্পদ মন্ত্রণালয় বাস্তবায়ন করছে।

ভূ-প্রাকৃতিক অবস্থান ও বৈশিষ্ট্য এবং জলবায়ু পরিবর্তনজনিত কারণে বন্যা, নদী ভাঙ্গন, ঘূর্ণিঝড়, জলোচ্ছাস ও বিভিন্ন প্রাকৃতিক দুর্যোগে বাংলাদেশ প্রতিনিয়ত ক্ষতির সম্মুখীন হয়ে আসছে। এই চ্যালেঞ্জ মোকাবেলা ও ক্ষতিগ্রস্ত মানুষের জীবন ও জীবিকা রক্ষার্থে এবং পানি সম্পদের উন্নয়ন ও সর্বোচ্চ সদ্ব্যবহার, নদীভাঙ্গন রোধ এবং সেচ সুবিধা সম্প্রসারণ, বন্যা নিয়ন্ত্রণ ব্যবস্থার উন্নয়ন, জলাবদ্ধতা রোধ এবং নিষ্কাশন ব্যবস্থা শক্তিশালীকরণের লক্ষ্যে পানি সম্পদ মন্ত্রণালয় বিভিন্ন কার্যক্রম ও প্রকল্প বাস্তবায়ন করে যাচ্ছে।

পানির অসম বন্টন বা অপ্রাপ্যতা বিশ্বের যে কোন দেশে অথবা সম্প্রদায় বা সমাজের মাঝে সৃষ্টি করতে পারে সংঘাত তথা অশান্তি। বিশ্বের ৩০০ কোটির অধিক মানুষ নিজ দেশের সীমানা অতিক্রমকারী পানি প্রবাহের উপর নির্ভরশীল। ১৫৩ টি দেশ যাদের নদী, লেক, ভূ-গর্ভস্থ পানিস্তর পার্শ্ববর্তী দেশের সাথে সংযুক্ত তাদের মধ্যে শুধুমাত্র ২৪টি দেশ আন্ত:দেশীয় পানি বন্টন চুক্তি করেছে। আন্ত:সীমান্ত নদী পানি বন্টন চুক্তি সম্পাদনে সমঝোতার মাধ্যমে বাংলাদেশ সরকার সর্বাত্মক প্রচেষ্টা গ্রহণ করে চলেছে। জলবায়ু পরিবর্তনের অভিঘাত ও চরম দুর্যোগ মোকাবেলায়, বিশ্বব্যাপী ক্রমবর্ধমান জনসংখ্যার প্রেক্ষাপটে সৃষ্ট দারিদ্র্য বিমোচনে এবং পরিবেশ-প্রতিবেশ ও জীব-বৈচিত্র্য সুরক্ষায় পানির সুষম বন্টন ও ন্যায্য প্রাপ্যতা বিষয়ে জাতীয়, আঞ্চলিক ও আন্তর্জাতিক আলোচনা ও সহযোগিতা মানবাধিকার নিশ্চিত এবং টেকসই উন্নয়নের পথ প্রশস্ত করবে।

সবাইকে একসাথে নিয়ে দেশ ও জনগনের নিশ্চিত ভাবনাহীন জীবন গড়ার লক্ষ্যে এবং জলবায়ু পরিবর্তনের প্রভাব ও দুর্যোগ মোকাবেলা করে ২০৪১ সালের মধ্যে মাননীয় প্রধানমন্ত্রীর উন্নত-সমৃদ্ধ-স্মার্ট বাংলাদেশ বিনির্মাণে ঐক্যবদ্ধভাবে কাজ করার প্রত্যয়ে আমাদের অঙ্গীকারবদ্ধ হতে হবে।

বিশ্ব পানি দিবস-২০২৪ এর সার্বিক সাফল্য কামনা করছি ও এর আয়োজনের সাথে সংশ্লিষ্ট সকলকে আন্তরিক ধন্যবাদ জানাচ্ছি।

জয় বাংলা, জয় বঙ্গবন্ধু।

বাংলাদেশ দীর্ঘজীবী হোক।

জাহিদ ফারুক, এমপি

সভাপতি
পানি সম্পদ মন্ত্রণালয় সম্পর্কিত সংসদীয় স্থায়ী কমিটি

বাণী

পানির অপর নাম জীবন। জাতিসংঘের উদ্যোগে ২২ মার্চ ১৯৯৩ সাল হতে বিশ্ব পানি দিবস পালিত হয়ে আসছে। বৈশ্বিক প্রেক্ষাপটে ভূ-গর্ভস্থ সুপেয় পানিকে দক্ষতার সাথে ব্যবহার করে সুষ্ঠু পানি ব্যবস্থাপনা এখন সময়ের দাবী।

এ বছর বিশ্ব পানি দিবসের প্রতিপাদ্য বিষয় হলো "Water for Peace" যা ভূ-গর্ভস্থ পানির টেকসই ও সমন্বিত ব্যবস্থাপনা ও ব্যবহারের মাধ্যমে বিশ্বব্যাপী পানি সংকট নিরসন করে সকল প্রাণীর জীবন রক্ষায় প্রধান ভূমিকা রাখার মাধ্যমে বিশ্বে শান্তি প্রতিষ্ঠায় বিশেষ আবদান রাখবে।

নদীমাতৃক বাংলাদেশে ভূ-গর্ভস্থ পানির উপর নির্ভরশীলতা কমিয়ে বৃষ্টির পানি ধরে রেখে এবং ভূ-গর্ভস্থ পানির সমন্বিত ব্যবহার নিশ্চত করতে পারলে সকল ক্ষেত্রে পানির অপচয় যেমন একদিকে রোধ হবে অন্যদিকে প্রাকৃতিক পানির (বৃষ্টির পানি) ব্যবহারের মাধ্যমে ভূ-গর্ভস্থ পানির উপর চাপ কমবে।

মাননীয় প্রধানমন্ত্রী জননেত্রী শেখ হাসিনার নেতৃত্বে ও পরামর্শে ২০১৮ সালে প্রনয়ণ হয়েছে শতবছরের উন্নয়ন মহাপরিকল্পনা বাংলাদেশ ডেল্টা প্ল্যান-২১০০, যার উদ্দেশ্য হলো নিরাপদ জলবায়ু পরিবর্তনে সহযোগিতা করে সমৃদ্ধ বাংলাদেশ গড়ে তোলা।

জাতির পিতা বঙ্গবন্ধু শেখ মুজিবুর রহমান পানি সম্পদের গুরুত্ব অনুধাবন করে নানাবিধ পদক্ষেপ নিয়েছিলেন। ১৯৭২ সালে প্রতিষ্ঠা করেছিলেন বাংলাদেশ পানি উন্নয়ন বোর্ড এবং যৌথ নদী কমিশন। তাঁর যোগ্য উত্তরসূরী মাননীয় প্রধানমন্ত্রী জননেত্রী শেখ হাসিনা সুষ্ঠু পানি সম্পদ ব্যবস্থাপনায় নিরলস প্রচেষ্টা চালিয়ে যাচ্ছেন।

বিশ্ব পানি দিবস ২০২৪ উদযাপনের সাথে সংশ্লিষ্ট সকলকে আন্তরিক ধন্যবাদ জানাচ্ছি এবং সাফল্য কামনা করছি।

জয় বাংলা, জয় বঙ্গবন্ধু।

বাংলাদেশ চিরজীবী হোক।

রমেশ চন্দ্র সেন, এমপি

সচিব
পানি সম্পদ মন্ত্রণালয়

বাণী

জাতিসংঘ ঘোষিত 'বিশ্ব পানি দিবস-২০২৪' এর এবারের প্রতিপাদ্য Water For Peace অর্থাৎ 'শান্তির জন্য পানি'। পানির গুরুত্ব বিবেচনা করে একুশ শতকের জলবায়ু পরিবর্তনের প্রেক্ষাপটে বৈশ্বিক-আঞ্চলিক শান্তি, সমৃদ্ধি ও স্থিতাবস্থা বজায় রাখতে এবারের প্রতিপাদ্য যথার্থ হয়েছে বলে আমি বিশ্বাস করি।

সর্বকালের সর্বশ্রেষ্ঠ বাঙালি জাতির পিতা বঙ্গবন্ধু শেখ মুজিবুর রহমান দেশের মানুষের শান্তি ও সমৃদ্ধি নিশ্চিত করতে দেশীয় ও আন্তর্জাতিক নদী ব্যবস্থাপনার উদাহরণ আলোকপাত করে বাংলাদেশে নদী ও পানি ব্যবস্থাপনার উপর গুরুত্বারোপ করেন। বাংলাদেশের ভূ-প্রাকৃতিক অবস্থানের বাস্তবতা বিবেচনা করে আঞ্চলিক নদীসমূহের পানি সম্পদ উন্নয়নে ১৯৭২ সালে ভারতের সাথে চুক্তির আলোকে গঠিত হয় যৌথ নদী রক্ষা কমিশন। জাতির পিতা আমৃত্য নিজেকে পরিচয় দিয়েছেন 'পানির দেশের মানুষ' হিসেবে। নদী মাতৃক এ বাংলাদেশের পানি সম্পদের সুষ্ঠু, টেকসই এবং সমন্বিত ব্যবস্থাপনার গুরুত্ব অনুভব করে তিনি ইপিওয়াপদাকে পৃথক করে ১৯৭২ সালে সৃষ্টি করেন বাংলাদেশ পানি উন্নয়ন বোর্ড।

দেশের মানুষের শান্তি, সমৃদ্ধি ও উন্নয়ন নিশ্চিতকল্পে পানি সম্পদ মন্ত্রণালয়ের অধীন বাংলাদেশ পানি উন্নয়ন বোর্ড বাংলাদেশের বন্যা নিয়ন্ত্রণ, নিষ্কাশন ও সেচ ব্যবস্থার উন্নয়নের লক্ষ্যে ব্যারেজ, রেগুলেটর, স্লুইস, ক্রস-ড্যাম, রাবার ড্যাম, বন্যা নিয়ন্ত্রণ বাঁধ, উপকূলীয় বাঁধ, ডুবন্ত বাঁধ ইত্যাদি নির্মাণ, তীর সংরক্ষণমূলক কাজ, ড্রেজিং ও খাল খনন, ভূমি পুনরুদ্ধার প্রভৃতি কার্যক্রম বাস্তবায়ন করে থাকে। এ মন্ত্রণালয় তিস্তা ব্যারেজ প্রকল্প, চাঁদপুর সেচ প্রকল্প, মুহুরী সেচ প্রকল্প, বরিশাল সেচ প্রকল্প প্রভৃতি প্রকল্পের সেচ সুবিধার সম্প্রসারণ করে দেশকে খাদ্য উৎপাদনে স্বয়ং সম্পূর্ণতা অর্জনে অগ্রণী ভূমিকা পালন করছে। নদীতীর সংরক্ষণমূলক কাজ বাস্তবায়নের মাধ্যমে সিরাজগঞ্জ, চাঁদপুর, ভোলা, রাজশাহী, চাঁপাইনবাবগঞ্জ, নরসিংদী, নওগাঁসহ মোট ৩১টি জেলা শহরকে নদী ভাঙন হতে সুরক্ষা প্রদান করা হয়েছে। সমন্বিত পানি সম্পদ ব্যবস্থাপনা কৌশলকে আরো সুদৃঢ় করতে মাননীয় প্রধানমন্ত্রীর নির্দেশনা মোতাবেক নেদারল্যান্ড সরকারের সহযোগিতায় শতবর্ষী মহাপরিকল্পনা বাংলাদেশ ডেল্টা প্লান ২১০০ প্রনয়ন করা হয়েছে। ৮ম পঞ্চবার্ষিক পরিকল্পনার আলোকে সেচ ব্যবস্থার উন্নয়ন, নিষ্কাশন, বন্যা নিয়ন্ত্রণ, নদীর নাব্যতা রক্ষা, দুর্যোগ মোকাবেলা এবং জলবায়ু পরিবর্তনের ঝুঁকি মোকাবেলায় কাজ করে যাচ্ছে এ মন্ত্রণালয়।

সমন্বিত পানি সম্পদ ব্যবস্থাপনায় উৎকর্ষতা সাধনে জাতীয় ও আন্তর্জাতিক প্রতিষ্ঠানসমূহের সাথে নিবিড় যোগাযোগ ত্বরান্বিত করা হয়েছে। স্মার্ট প্রযুক্তি ব্যবহার করে Google Map এ Google Flood Alert Service এর মাধ্যমে উপজেলা পর্যন্ত বন্যার তাৎক্ষণিক তথ্য ও বন্যা পূর্বাভাস সম্বলিত প্লাবন মানচিত্র এবং আগাম সতর্কবার্তা জনগণের দোরগোড়ায় পৌঁছে দেয়া হচ্ছে। আমি বিশ্বাস করি, পানি সম্পদ উন্নয়নে আঞ্চলিক ও আন্তর্জাতিক সমন্বয় এবং সরকারের গৃহীত পরিকল্পনার মাধ্যমে সমাজে অর্জিত হবে কাঙ্খিত শান্তি, সমৃদ্ধি ও উন্নয়ন।

আমি 'বিশ্ব পানি দিবস-২০২৪' উদ্‌যাপন উপলক্ষ্যে গৃহীত সকল কার্যক্রমের সার্বিক সাফল্য কামনা করছি।

জয় বাংলা, জয় বঙ্গবন্ধু।
বাংলাদেশ চিরজীবী হোক।

নাজমুল আহসান

মহাপরিচালক
বাংলাদেশ পানি উন্নয়ন বোর্ড

বাণী

আজ ২২ মার্চ সারা বিশ্বে পালিত হচ্ছে বিশ্ব পানি দিবস। এ বছর দিবসটির প্রতিপাদ্য হচ্ছে 'Water for Peace'।

পানির অপ্রাপ্যতা, দূষণ ও অসম বণ্টন প্রভৃতি কারণে বিভিন্ন সম্প্রদায় এবং দেশের মধ্যে সৃষ্টি হতে পারে অসন্তোষ। পানি একদিকে যেমন হতে পারে দ্বন্দ্ব সংঘাতের কারণ, অপরদিকে একদেশের সাথে আরেক দেশের বন্ধুত্বপূর্ণ সম্পর্ক জোরদার করতে, সংকটকালীন সময়ে আলোচনার দ্বার উন্মুক্ত করতে ও যুদ্ধ বিগ্রহের সময় শান্তির হাত বাড়িয়ে দিতে গুরুত্বপূর্ণ ভূমিকা রাখতে পারে পানি।

হাইড্রোপলিটিক্স এবং হাইড্রো ডিপ্লোম্যাসির ক্ষেত্রে বিশেষায়িত কেন্দ্র হিসেবে পরিচিত জেনেভা ওয়াটার হাব এর একটি তথ্যসূত্র অনুযায়ী ২০২৫ সালের মধ্যে বিশ্বব্যাপী বিভিন্ন স্থানে পানির ওপর দ্বন্দ্ব সংঘাত সৃষ্টি হতে পারে। সশস্ত্র সংঘাতের সময়ে পানি প্রবাহ ক্ষতিগ্রস্ত হলে বিশুদ্ধ পানি এবং স্বাস্থ্যসেবা খাতে বিপর্যয় ঘটে থাকে। এ কারণে যুদ্ধবিরতি এবং শান্তি স্থাপনের ক্ষেত্রে পানি এবং স্বাস্থ্যসেবার বিষয়টি গুরুত্বের সাথে বিবেচনা করা অপরিহার্য।

জাতিসংঘের তথ্য অনুযায়ী, সারা পৃথিবীতে ৩ বিলিয়নের বেশী মানুষ আন্তঃসীমান্ত নদীসমূহের ওপর নির্ভরশীল। বৈশ্বিক জলবায়ু পরিবর্তনের প্রভাব, যুদ্ধ পরিস্থিতি এবং জনসংখ্যা বিস্ফোরণের কারণে মহামূল্যবান পানি সম্পদ রক্ষার্থে বিভিন্ন সম্প্রদায় এবং দেশের মধ্যে সহযোগিতা একান্ত অপরিহার্য। এ প্রেক্ষিতে, বিশ্ব পানি দিবসের এ বছরের প্রতিপাদ্য অত্যন্ত গুরুত্বপূর্ণ এবং সময়োপযোগী।

বৈশ্বিক জলবায়ু পরিবর্তনের প্রভাবের অন্যতম ঝুঁকিতে থাকা বাংলাদেশে একই সাথে বৃদ্ধি পাচ্ছে জনসংখ্যা। বাংলাদেশের জনগণের সুরক্ষায় বাংলাদেশ পানি উন্নয়ন বোর্ড (বাপাউবো) সারাদেশের নদী ব্যবস্থাপনা, সেচ ব্যবস্থার উন্নয়ন, বন্যা নিয়ন্ত্রণসহ দেশের সামগ্রিক পানি সম্পদ অবকাঠামোর উন্নয়নের লক্ষ্যে নিরলস কাজ করে যাচ্ছে। জুন, ২০২৩ পর্যন্ত ৯৭০ টি প্রকল্পের মাধ্যমে বাপাউবো ৬৬.৩৭ লক্ষ হেক্টর এলাকায় সেচ, বন্যা নিয়ন্ত্রণ এবং নিষ্কাশন সুবিধা প্রদান এবং ৩১ টি শহরকে নদী ভাঙ্গন থেকে রক্ষার পাশাপাশি দেশের পানি সম্পদের সুষম বণ্টনে উল্লেখযোগ্য অবদান রাখছে।

উল্লেখ্য, বাংলাদেশের ভবিষ্যত প্রজন্মের জন্য মাননীয় প্রধানমন্ত্রীর অন্যতম শ্রেষ্ঠ উপহার - দেশের প্রথম শতবর্ষী পরিকল্পনা 'বাংলাদেশ ডেল্টা প্ল্যান-২১০০' বাস্তবায়নে বাপাউবো ইতোমধ্যে বিভিন্ন কার্যক্রম হাতে নিয়েছে। এছাড়া, সমন্বিত পানি সম্পদ ব্যবস্থাপনার মাধ্যমে এসডিজির চ্যালেঞ্জ উত্তরণে পানি সম্পদ মন্ত্রণালয়ের আওতায় বাংলাদেশ পানি উন্নয়ন বোর্ড নিরলস প্রচেষ্টা অব্যাহত রেখেছে। তদুপরি, বিভিন্ন মন্ত্রণালয়, সংস্থা, দপ্তর, অধিদপ্তরসমূহে তথ্য-উপাত্ত প্রদানের পাশাপাশি কর্ম-পরিকল্পনা প্রণয়নে সক্রিয় অংশগ্রহণের মাধ্যমে সার্বিক সহযোগিতা প্রদান করছে।

পরিশেষে আমি বিশ্ব পানি দিবস-২০২৪ উদযাপনের সাথে সংশ্লিষ্ট সকলকে আন্তরিক ধন্যবাদ জানাচ্ছি।

জয় বাংলা।

বাংলাদেশ চিরজীবী হোক।

মুহাম্মদ আমিরুল হক ভূঞা

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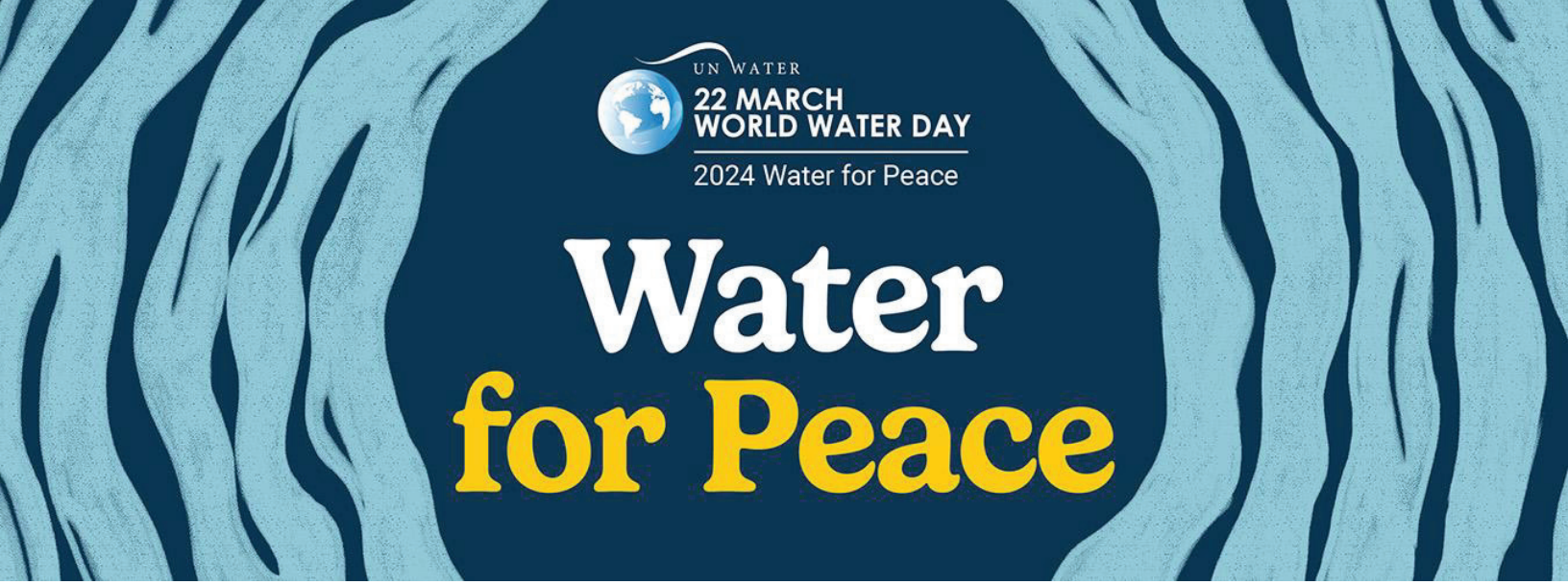

Water is an invaluable resource that sustains life on our planet. However, it has become increasingly scarce due to human activities and the adverse effects of climate change. The water shortage has significant implications, including socio-cultural, economic, political, sometimes military, and diplomatic dimensions. The impact is not only limited to individual nations but can also have regional and international consequences.

As a scarce resource, water possesses the potential to incite conflicts, particularly as water scarcity intensifies due to human-induced factors and climate change. The uneven distribution of water resources and competing demands, compounded by the growing global population, have ignited debates about potential 'water wars.' Climate change further exacerbates water-related challenges, from extreme floods and droughts to rising sea levels and salinity intrusion. A common challenge in lower riparian areas is the imbalance between water supply and demand in upstream and downstream regions. To mitigate these issues, national governments, regional organizations, and international authorities like the United Nations have been working together to create better water management agreements, policies, and legal guidance.

Good water governance is crucial for the fair, efficient, and equitable management of water resources in the broader landscape. This approach should align with national, regional, and international preferences and understanding and strive for sustainable development. A comprehensive but coordinated management strategy can optimize water distribution within and between nations and regions, ensuring efficient use. This would help conserve water as a vital resource and lead to a more resilient path for future generations.

Against the above water vulnerability and security concerns, the UN adopted World Water Day, which is scheduled to be celebrated on March 22 every year to raise awareness of the importance of ensuring sustainable water management throughout the globe. This year's theme is "Water for Peace," highlighting water's critical role in transboundary water cooperation in fostering peace, stability, sustainable development, and global prosperity. The day serves as a reminder for action to overcome water-related issues with problems and prospects. The day also urges integrating innovative technologies, policy changes, public education, and partnerships to manage scarce water resources effectively and sustainably.

In observance of the World Water Day 2024, the Ministry of Water Resources initiated this publication by compiling multi-dimensions of water and sustainable water management issue-focused contents. The articles are expected to provide readers with understanding of the subject from multifaceted perspectives. However, it is to be noted that the views and opinions expressed in the articles do not necessarily reflect those of Bangladesh Government but are presented from an academic standpoint.

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Water Brings Peace:
Resolving a Three-Decade Waterlogging Crisis in the Bhabadah Region

The Hari River's Bhabadah Regulator has been recognized as a symbol of sorrow for the people of the Khulna and Jashore Districts, where water represents pain, hunger, sickness, and death. Around one million people live in three upazilas: Abhaynagar, Manirampur, and Keshabpur, all of which are heavily impacted by waterlogging caused by the Bhabadah Regulator. Suffering began in the early 1980s and has continued to the present day, as the Hari River has been entirely silted up several times over the preceding three decades, producing endless suffering for the residents of Bhabadah. Continuous dredging was used to manage the huge sedimentation in the Hari River in the Bhabadah area. Though the excavation helped to remove accumulated water from the Bhabadah area, it quickly became filled and was unable to function for even a single dry season.

Addressing Waterlogging at Bhabadah in the Delta Plan 2100

The Bangladesh Delta Plan (BDP) 2100 is a long-term, integrated, and holistic vision of water and land management throughout Bangladesh. According to BDP 2100, the major problem of polders is waterlogging due to siltation of the peripheral river, which is likely to deteriorate in the future with the combined effect of precipitation increase, sea level rise, and subsidence. Management of sediment and water-logging in the polders for its long-term sustainability has been recognized as a knowledge gap. In the framework of BDP 2100, a project totalling 1,557 million BDT has been suggested for "Improved Drainage in the Bhabadha Area" to alleviate drainage congestion and flood risks through various river management measures.

Reason of Waterlogging at Bhabadah Area

Polders were constructed under the Coastal Embankment Project (CEP) to prevent tidal flooding and salinity intrusion in vast low-lying land areas between 1960 and 1970. The CEP was credited for transforming the entire region into a

perennial freshwater agricultural land, benefiting the local population, who could farm two or even three rice crops each year. The construction of polders has disrupted the natural sediment management processes, such as siltation in the tidal floodplain, by separating the connection between rivers and the floodplain. Moreover, there was consistent upstream freshwater flow from the Ganges River, which facilitated the removal of incoming sediment halted by the diversion of flow through the Barrage at the upstream location. The riverbed level rose over time due to the ongoing siltation, limiting the conveyance capacity of the tidal rivers, and leading to extensive waterlogging issues within the polders, especially in the districts of Satkhira, Jashore, Khulna, and Bagerhat.

Initiatives for Managing Waterlogging at Bhabadah

The renowned Khulna-Jashore Drainage Rehabilitation Project (KJDRP) was carried out by BWDB between 1994 and 2002 to address the persistent issue of waterlogging in the Khulna and Jashore regions. After the implementation of the project, the prevailing drainage congestion was removed substantially which resulted in increased agricultural production and socio-economic development. However, the northwestern part of the KJDRP area, under Abhaynagar, Manirampur and Keshabpur Upazila, namely the Bhabodah area experienced severe drainage congestion again from October 2005 to the end of 2006.

Figure 1: Silted up Hari River at Bhabadah in 2016

Research on Waterlogging at Bhabadah

The hydrodynamic processes of estuaries in the GBM delta are rarely reported because of their complex morphology, high tidal range, long monsoon season with significant river flows, and lack of infrastructure and technology. The primary challenge within the GBM delta region is the absence of extensive, consistent in situ tidal records essential for gaining a comprehensive understanding of hydrodynamics and sedimentation patterns in tidal rivers.

A research team from the Bangladesh University of Engineering and Technology (BUET) and the Bangladesh Water Development Board (BWDB) conducted a study on hydrodynamic processes and sediment transport dynamics in the Bhabadah area. The study provides valuable information for different types of interventions under the REACH program. An extensive hydraulic and morpho-dynamic research campaign gathered data on water level, velocity, discharge, and sediment concentration along a 70 km reach of the Hari-Ghengrail-Sibsa river system from Bhabadah in the north to Garkhali in the south, at different spatial and temporal (seasonal, spring-neap and diurnal) scales.

The research on sedimentation and river morphology has provided new insights into waterlogging processes and how these can be addressed in the short and long term. Sedimentation risk in rivers is driven by a range of critical factors, particularly the spatio-temporal variation of tidal and sediment dynamics. Sedimentation risks increase when seawater enters the river system over a short period and remains in the river for a long period before flowing back to the sea, called tidal asymmetry. This asymmetric tide allows sediments to deposit onto the riverbed more easily. Tidal asymmetry

(the ratio between the flood tide period and the ebb tide period), which gradually increases in the upstream direction and usually reaches a peak during spring tides, is a major phenomenon in the river system of southwest Bangladesh. Sediments are usually deposited onto riverbeds at and near places with high tidal asymmetry. The higher the tidal asymmetry, the longer the water remains stagnant when the flood tide turns.

The research identified that sediment concentration increases in the upstream direction and peaks ten kilometres downstream of Bhabadah. Sedimentation levels are almost three times higher in the dry season, as compared to the wet season, even though the sediment concentration entering this reach of the river during the monsoon season is three and a half times higher than in the dry season.

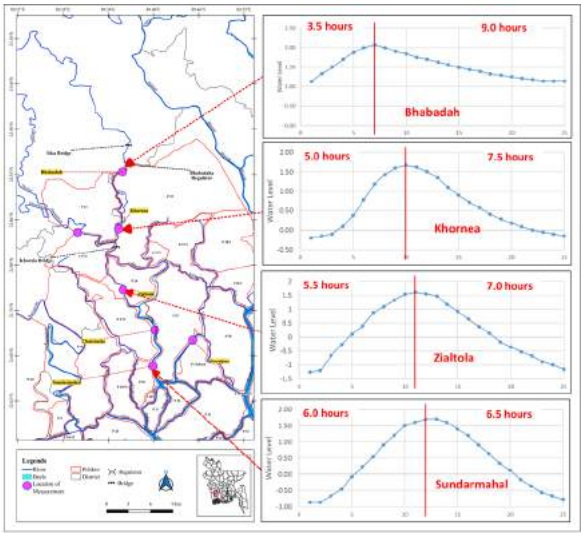

Figure 2: Formation of tidal asymmetry along the Pussur estuary

Flood-ebb fluctuation is the most significant in understanding the residual sediment pattern in an estuary. Increased SSC during flood tides shows that a large amount of sediment was being carried in, whereas lower SSC during ebb tides suggests that a smaller amount of sediment was being removed. During the dry season at Bhabadah, the variance between flood and ebb was alarming. The average sediment concentration at flood tide was 1750 mg/l, 2.6 times that of the ebb tide, and during monsoon, the SSC at flood tide was 1.6 times that of ebb tides. Although the monsoon season has the highest sediment concentration, the most sedimentation happened during the dry season because of the prolonged flood-ebb fluctuation.

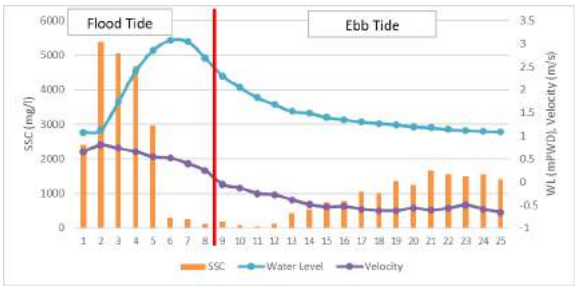

Figure 3: Sediment concentration in a full tidal cycle at Bhabadah

Scientific Impacts

The findings presented above have direct implications for interventions implemented or planned to solve riverbed sedimentation risks and associated waterlogging problems in the polders.

Recommendations regarding interventions include:

- Regular sediment excavation from the Khornea to the Bhabadah riverbed is not sustainable due to the unique hydro and morphodynamics of the system. Excavation of only a few kilometres creates a pond-like feature in a riverbed, which promotes sedimentation and fills up quickly.
- In order to address sedimentation in a system in an effective and sustainable way, it is crucial to implement a comprehensive approach instead of limiting interventions to isolated risk zones. The interventions should aim to reduce the critical sedimentation zones and distribute the sedimentation across a wider reach, thereby minimizing the sedimentation problem for the entire system.
- Restoring connectivity between upstream rivers and floodplains during dry and monsoon seasons can help ease sediment build-up by increasing freshwater flow.

Sustainable Strategy for Sediment Management

This research demonstrates that there was virtually no upstream flow since the ebb discharge was less than the flood discharge. This means that there was less sediment flushing during ebb tide, which led to massive sedimentation in the Hari River. In these circumstances, BWDB started pumping the clogged water out of the Bhabadah regulator downstream. The initial pumping action was started in December 2020 and involved 20 pumps with a 5-cusec capacity. After that, BWDB purchased four more pumps in November 2022, each with a 35-cusec capacity, in an effort to enhance the outflow of logged water.

Figure 4: Inauguration of Pump by Zaheed Farooque, MP, the Hon'ble State Minister, Ministry of Water Resources, Dhaka

Figure 5: Pumping for removing waterlogging at Bhabadah Regulator

The implementation of pumping at the Bhabadah regulator has significantly improved the issue of water logging in the Bhabadah area. During the 2023-24 period, the cultivated land area reached 21,347 hectares, contrasting with 13,698 hectares recorded in 2019-20. In addition to eliminating waterlogging, pumping has resulted in a 2.00m increase in the river's cross section by generating upstream flow that aids in the return of sediment downstream during ebb tide.

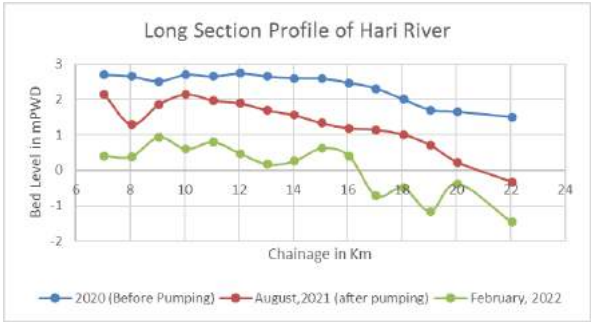

Figure 6: Long Section Profile of Hari River before and after pumping

Conclusion

An innovative strategy implemented by the Bangladesh Water Development Board (BWDB) resolves a three-decade-long waterlogging crisis in Bhabadah. However, the problem of sedimentation in other tidal rivers remains alarmingly persistent. Over the last four to five decades, infilled channels have added approximately 90 square kilometers of new land, equivalent to about 2 square kilometers yearly. Consequently, there has been a 60% reduction in the total channel length, leading to a significant loss of tidal waterways.

To achieve the vision of "Attaining a secure, climate-resilient, and prosperous delta," as outlined in the Delta Plan 2100, it is essential to have a thorough understanding of the impacts of these hydrodynamic alterations. This knowledge will facilitate scientifically informed water, sediment, and tidal energy distribution management.

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Bangladesh Water Development Board

Implications of Sustainable Water Governance as an Adaptive Measures for Ensuring Water for Peace in Bangladesh

Water governance refers to the set of policies, regulations, and smart management practices including the uses of Artificial Intelligence, Information Technology, and Decision support systems that guide the sustainable use, development, participation and protection of water resources. Groundwater governance is essential due to the importance of groundwater as a significant source of drinking water, agricultural irrigation, and industrial water supply. Effective governance is crucial for preventing depletion, maintaining water quality, and ensuring the long-term sustainability of this vital water resource. It plays a significant role in addressing challenges like overdrawing, pollution, and the impact of climate change on groundwater availability.

About 25 Countries of the world belong to the home of One-quarter of the Population, Face Extremely High Water Stress' (World Resource Institute,2023). Worldwide freshwater resources are abundant, with only 9% withdrawn by society. However, available resources are unevenly distributed across regions and within countries including Bangladesh. About 50% of the world's population live under highly water-stressed conditions for at least one month of the year. Water Stress jeopardizes people's lives, jobs, food and economic development. During 2050 Global water demand will increase by 20%-25%, which will threaten to lower global GDP by 6%. About $70 trillion equivalent to 31% of Global GDP exposed to high water stress by 2050. On the other hand, about 60% of the World's irrigated agriculture faces extremely high water stress conditions.

At present global water demand has more than doubled since 1960. Globally, the water demand exceeds that for growing populations and industries. Depending on the country's groundwater withdrawal, most of the countries of the world are facing high to extreme water stress. The Middle East and North Africa region is the most water-stressed area in the world. Considering the above scenarios, sustainable water governance in Bangladesh is a critical issue.

Present Water Perspectives in Bangladesh

More than 2.4 million people in Bangladesh lack access to improved water sources. World Health Organization (WHO) Estimates 13% of the Population without having access to safe drinking water. The water demand in Bangladesh gradually rises due to population growth, food security, and industrial growth. Population growth is expected to increase by 224 M in 2050. Moreover, the area of rice production is expected to increase up to 6.7 M. ha in 2030 with an increasing water demand of about 48%. Supply and demand management will seek extra attention and it is also a big challenge for sustainable water governance.

For proper water budgeting, we need to critically analyse the supply and demand side of water, especially in Drinking Water, Agriculture, Industry, Domestic, Biodiversity, and Power generation as per BWA 2013. BWDB data analysis shows that there are significant gaps in demand and supply among the three major water sectors namely Agriculture, Industry and Domestic Water supply in High Barind, Industrial Zone and Urban areas. The groundwater level is sharply declining in the above-mentioned three hotspots, which is shown below.

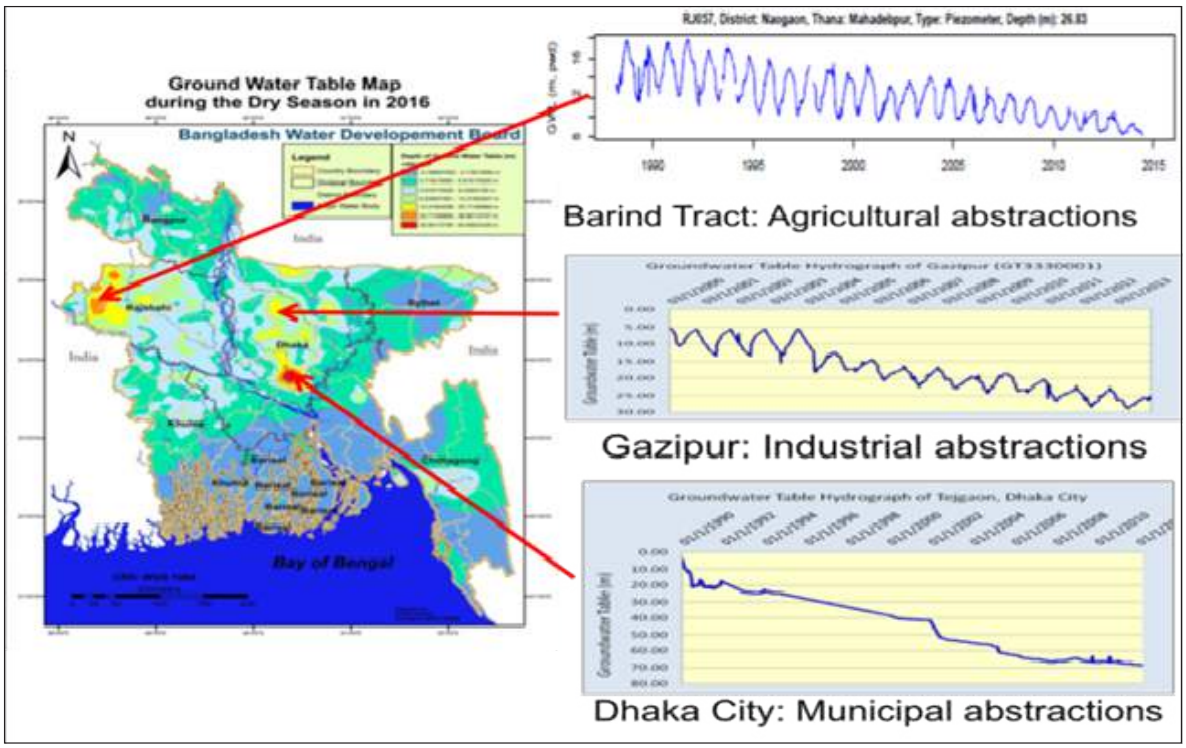

Figure 1: Hotspots in Bangladesh with a sharp decline in groundwater due to over-extraction

Key Components of Water Governance

The major components of water governance include:

(i) Regulation and Legislation: The establishment of laws and regulations that define rights and responsibilities related to groundwater use and protection. This may involve permits, licensing, and compliance mechanisms to ensure sustainable extraction and prevent over-exploitation.

(ii) Sustainable Management: Promoting sustainable groundwater management involves setting extraction limits that prevent over-exploitation, considering recharge rates, and implementing measures to maintain aquifer health over the long term.

(iii) Integrated Water Resources Management (IWRM): IWRM involves considering the interconnectedness of surface water and groundwater systems. Coordination between different water use sectors, such as agriculture, industry, and urban areas, is crucial for comprehensive water management.

(iv) **Monitoring and Data Collection:** Implementing systems to monitor groundwater levels, quality, and usage. This data is crucial for making informed decisions about groundwater management and ensuring compliance with regulations.

(v) **Stakeholder Involvement:** Engaging and involving various stakeholders, including local communities, industries, and agricultural users, in decision-making processes. This inclusivity helps in understanding diverse perspectives and encourages sustainable practices.

(vi) **Water Use Efficiency, Conservation and Quality Protection:** Encouraging water use efficiency in agriculture, industry, and households is a key aspect of groundwater governance. Conservation measures, protecting groundwater quality to prevent contamination from industrial discharges and establishing water quality standards as well as real-time monitoring programs are essential. The polluter-pay principle needs to be adopted.

(vii) **Water Use Planning, Research and Education:** Developing comprehensive plans for the sustainable use of groundwater resources, considering factors such as Managed Aquifer Recharge, Sustainable Safe Yield and environmental protection. Educational programs can help raise awareness about the importance of sustainable groundwater use among various stakeholders.

(viii) **Infrastructure and Technology:** Implementing AI-based technologies, DSS, and Climate resilient infrastructure for efficient and sustainable groundwater management is imperative. Application of 3R- (Reduce, Reuse and Recycle) technologies; Ensure ETP, CETP and Zero Liquid Discharge, Managed Aquifer Recharge, and online monitoring systems need to ensure.

(ix) **Capacity Building, Enforcement and Compliance:** Strengthening the capacity of relevant government agencies responsible for groundwater management is crucial. Establishing mechanisms to enforce regulations, especially BWA 2013 and BWR 2018 and ensure its compliance with established rules.

(x) **Indigenous and Local Knowledge:** Recognizing and incorporating indigenous and local knowledge can enhance the effectiveness of governance strategies and ensure the cultural sustainability of water management practices.

Except for the above key components, depending on necessity, other areas of national interest can be considered based on the country's perspectives.

Water Governance Issues Addressed in Bangladesh Water Act 2013

The Bangladesh Water Act 2013 is designed for the integrated development, management, abstraction, distribution, usage, protection and conservation of water resources in Bangladesh. The Act has provided the appropriate framework for better management of water resources in the country. It also provides provisions for punishment and financial penalty for non-compliance with the Act, including negligence to abide by government policy, and ordinance, non-cooperation with government officials, refusal to present necessary documents, providing false information, affiliation with perpetrators, and protection measures for water resources management. The Act also recognizes the significance of managing all forms of water

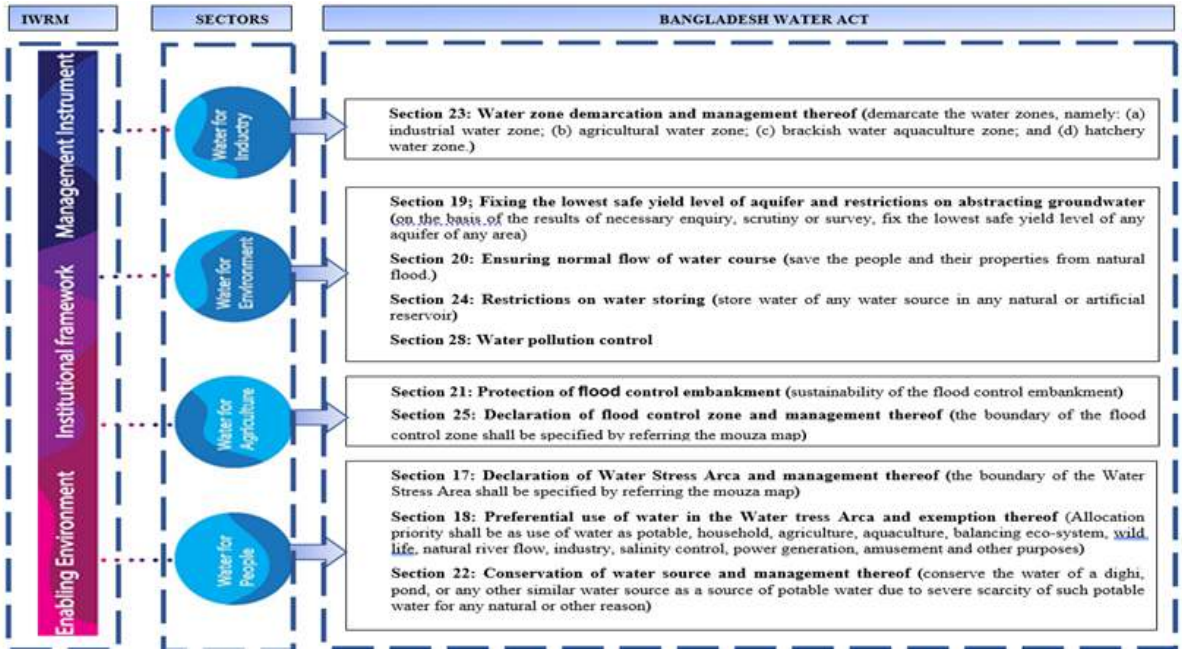

Figure 2: Water Governance Issues addressed in Bangladesh Water Act (BWA) 2013

resources in the context of the natural flow of surface water and recharge of groundwater.

The major water governance issues addressed in the Bangladesh Water Act 2013 are presented in the below diagram.

State of Water Resources Assessment in Barind Tract for Ensuring Equitable Water Governance

Recently WARPO has conducted a study project titled 'Institutionalization of Integrated Water Resources Management (IWRM) process in compliance with Bangladesh Water Rules, 2018' has been implemented to perform a baseline study for identifying the state of surface and groundwater resources in the High Barind region up to Mouza level. The study area is located in three districts namely, Rajshahi, Naogaon and Chapainawabganj Districts.

The case study shows that, among the 215 unions under three districts, about 40 unions are in high water stress and about 47 unions are under Very High water stress zone. The study reveals that about 41% areas of these three districts are under High to very High water stress. The district-wise

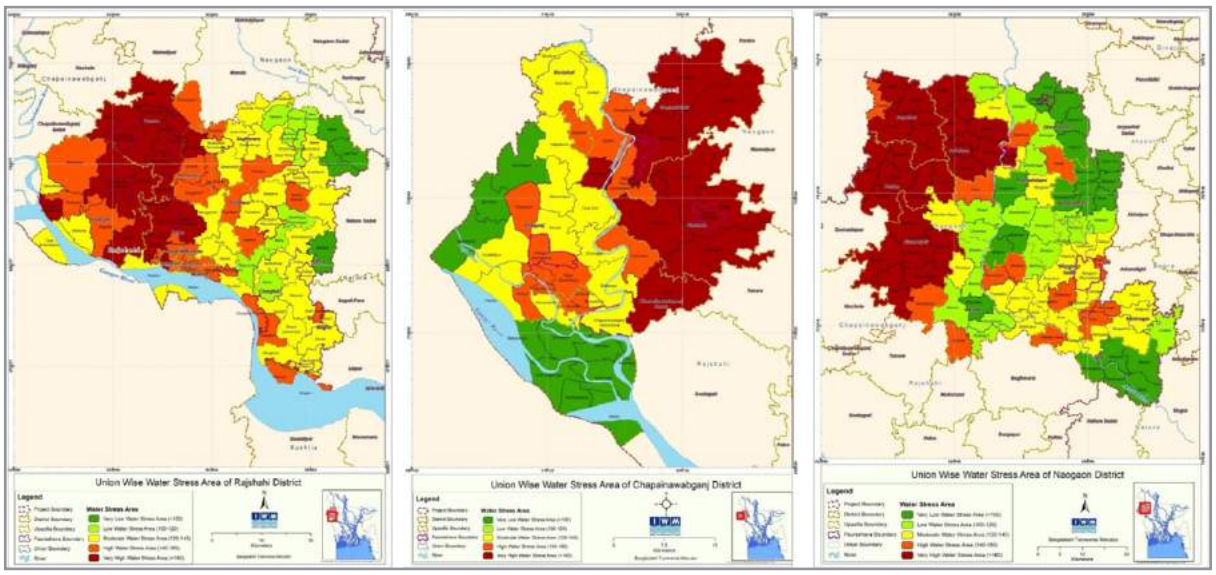

Figure -3: Map showing Union-wise water stress areas in Rajshahi, Chapainawabganj and Naogaon districts (from Left to right)

overall findings on water-stressed areas up to Mouza Level are shown in the following maps.

The important recommendations that have been made from the study are:

1) Installation of new tube wells and extraction of underground water should be limited in water-stressed areas.
2) Out of the public or private ponds leased in water-stressed areas, some ponds should be reserved for drinking water and domestic purposes without leasing them. A signboard will be placed in front of each protected pond with detailed instructions on which pond can be used for which purpose.
3) The necessary number of canals for drinking and domestic water should be excavated in water-scarce areas and there will be detailed instructions on which canals can be used for which purpose by installing signboards in front of the canals.
4) The shortage of water should be met by supplying water from low water-stressed areas to high water-stressed areas.
5) The local people should be informed about the overall status of water resources (availability, demand, use, critical status etc.) in the project area to sensitize the users at various levels and thus ensure optimal uses of water.
6) Projects to be developed for identifying groundwater and surface water problems in 10 districts of the north-central hydrological region of the country by 2026 and the remaining 44 districts by using a modern technology-based and automated monitoring system by 2030.
7) The use of surface water should be increased to reduce the pressure on groundwater. Necessary infrastructure needs to be constructed (pipelines, water treatment plants overhead tanks etc.) to ensure fresh water during the monsoon through constructing reservoirs and storing surface water.
8) To ensure Integrated Water Governance, the Managed Aquifer Recharge (MAR) Center should be established in water-stressed areas on a scientific basis.

Proposed Framework for Water Governance in Bangladesh

As water is a critical element in development, balancing the water with demand and supply, optimizing the use of water for irrigation, industrial use and other uses; water governance often demands a Decision Support System based Governance framework with a holistic perspective of sustainable development.

Integrated water governance challenges conventional, fractional water development and management systems and emphasizes an

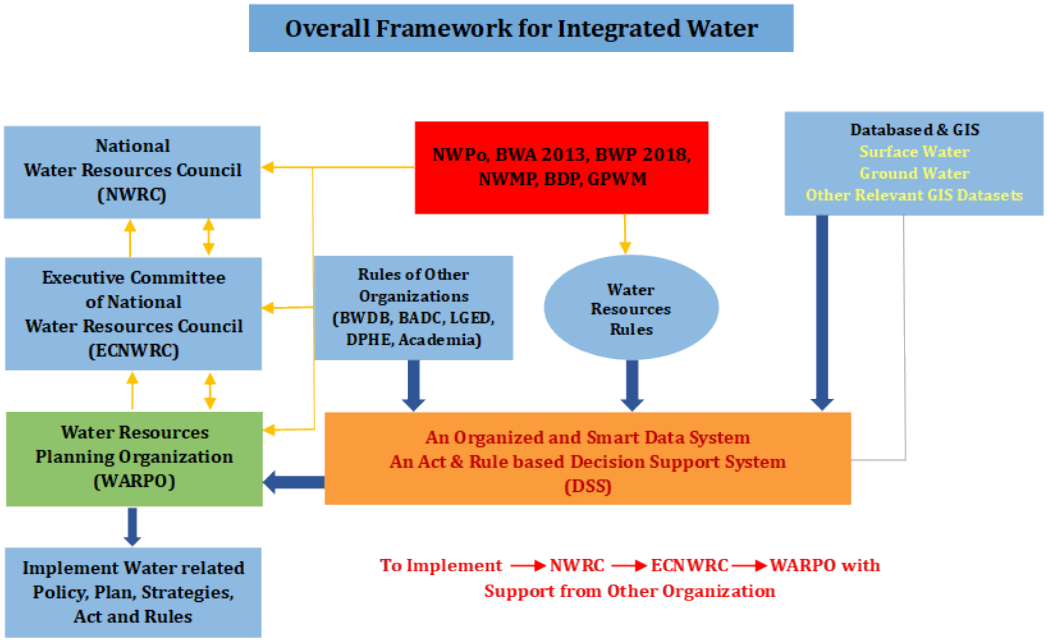

Figure 4: Proposed Integrated Framework for Water Governance

integrated approach with coordinated decision-making across sectors and scales where Policy, Act and Rules will be embedded in the center. To face the growing challenges regarding water rights, protection of resources, water use, and water services management, Bangladesh has enacted comprehensive legal frameworks such as the National Water Policy (1999), the Bangladesh Water Act (BWA) 2013 and Bangladesh Water Rules 2018; that outlines a coordinated and comprehensive regime for the development, management, extraction, allocation, use and conservation of water resources.

The formation of the high-powered National Water Resources Council (henceforth termed the Council) with the honorable Prime Minister as the head implies the importance the government is paying to the management of this precious resource. An Executive Committee under the Ministry of Water Resources will implement the decisions taken by the Council. The intention to take initiatives for a basin-scale, integrated water resources management of transboundary rivers, and exchange of data on flooding, drought, and pollution with co-riparian countries are good steps in the right direction. Water Resources Planning Organization (WARPO) under the Ministry of Water Resources will take the lead coordination role in the framework of water governance as the Secretariat to the Executive committee of the NWRC.

Stakeholder's participation in the framework will play a pivotal role in implementing integrated water resource management. Academia, IT organizations, and the Water User Group will act as dynamic actors in this framework. For Issuing a Project Clearance Certificate in case of Surface Water Projects and No objection Certificate (NOC) for the abstraction of Groundwater by different stakeholders, this framework will provide a holistic view to perform proper management of groundwater based on a Decision Support System which is very dynamic and technology-based approach. The overall framework will be implemented by NWRC, ECNWRC, and WARPO with continuous support from all relevant institutions.

Strategy for Implementing Water Governance

The vision of WARPO is to become an apex organization in macro-level planning for the management and integrated development of water resources in the country. As a central coordinating body, it has to achieve sustainable water resource development by pursuing IWRM. To achieve these vision and mission, the WARPO is proposing some strategic planning for implementing water governance in Bangladesh as follows:

The baseline studies are being played for finding out critical roles for declaration of water stress areas, availability of groundwater, quality of water, determining critical detrimental elements, lowest

Figure 5: Proposed Strategy for Water Governance in Bangladesh

safe yields of aquifer and restricting abstraction of groundwater.

A pilot study of three districts namely Rajshahi, Chapainawbganj and Naogaon water resources assessment up to Mouza level has already been

Mr. Zaheed Farooque M.P, Hon'ble State Minister, Ministry of Water Resources graced the National Workshop on "Operationalizing Integrated Water Resources Management in Compliance with Bangladesh Water Rules 2018 as the Chief Guest; Mr. Nazmul Ahsan, Secretary, MoWR attended as the Special Guest. Mr. Rezaul Maksud Jahedi, DG, WARPO Chaired the workshop held at Pan Pacific Sonargaon on 25 June, 2023

conducted. During the final dissemination workshop of the study, Honb'le Minister of State, Ministry of Water Resources requested to conduct and complete the baseline study of the water resources up to the Country level within 2030. Following the Minister level recommendation and experience from the pilot study WARPO already started the study "Assessment of water resources availability and lowest safe yield of aquifer in 10 districts of the North-Central Hydrological Regions of Bangladesh for effective implementation of Bangladesh Water Act, 2013". A study on remaining hydrological regions is expected to be completed within 2030.

Institutional Cooperation /collaboration is vital for water governance. All stakeholders' participation is urgent in our proposed strategy. Development of policy guidelines as well as updating with new recommendations, real-time monitoring and surveillance, and Managed Aquifer Recharge (MAR) in water stress areas. Policy directives for Industrial and Commercial uses of water, Volumetric Allocation of water, ensuring water quality measures, monitoring & surveillance are being considered as key elements in the proposed strategy.

Awareness raising in water use optimization, Reducing, reusing and recycling of water; continuous training and capacity building with updated knowledge and latest technologies are the key activities in the water governance strategy.

Way Forward

The Bangladesh Water Act 2013 and Bangladesh Water Rules 2018 are essential tools for ensuring sustainable water Governance in Bangladesh. Establishing a legal framework for sustainable and equitable use of water resources through developing a vibrant Decision Support System (DSS), protecting the environment and promoting social equity is pivotal. Based on the experiences of the pilot study of Institutionalization of BWA 2013 and BWR 2018, it is essential to conduct the country-wide water resources assessment up to the Mouza level to ensure sustainable water governance in the country for ensuring peace and prosperity.

Identifying Water Stress Areas, Availability of Water Resources, Water Quality assessment and Determining emerging elements with the

establishment of a Water Governance Center/MAR Center in WARPO for proper utilisation and budgeting of volumetric allocation of water is vital for ensuring water governance.

It is crucial to develop innovative solutions for providing drinking and domestic water in areas

that are facing high water stress. This includes ensuring efficient usage of water, preserving surface water, and integrating water resources data into decision-making processes using DSS tools. Additionally, institutional capacity building of relevant agencies through smart IT and AI-based approaches is necessary.

To ensure sustainable water governance at all levels and maintain peace in the sector, it is critical to properly integrate adaptive tools and enforce national water sector policies, strategies, and regulatory instruments. Regular monitoring and updating of such policies, including BWA 2013 and BWR 2018, is essential.

Md. Rezaul Maksud Jahedi
Director General
Water Resources Planning Organization
Mohammad Alamgir
Principal Scientific Officer
Water Resources Planning Organization
and
M. Aminul Haque
Principal Scientific Officer
Water Resources Planning Organization

How to Resolve Transboundary Water Dispute through Benefit Sharing

In 2001, Kofi Annan made an insightful remark that the *"Fierce competition for freshwater may well become a source of conflict and wars in the future."* Today, his words have become even more relevant as water continues to be a source of political tension between nations across the globe. Countries like Israel, Iraq, and Turkey have long been at odds over access to freshwater resources, as have India and Pakistan, India and China, and America and Mexico. Even the countries sharing the Nile River, Mekong River, and Amu Daria River basin have had to navigate complex water-sharing agreements to prevent conflicts.

Interestingly, water has both the potential to cause conflict and to promote cooperation. While the fear of water wars looms large, it's worth noting that over 145 water treaties have been signed between different countries. These treaties have enabled nations to work together to manage and protect their water resources effectively. Ultimately, the future of water resources and the conflicts they could create will depend on how well nations can balance their competing interests and collaborate to ensure everyone's needs are met.

There are more than 260 transboundary rivers and 450 aquifers, which cover nearly half of the Earth's surface. The basins of these rivers, traversing around 145 countries, are home to 40 percent of the world's population. History tells us that conflict is less often caused by water scarcity than by poor governance or management. Management of these rivers is important for not only the environment, ecology, and economy, but also for easing tension, and creating harmony, and peace.

Several UN agencies such as UNEP, UNDP, UNESCO, WHO, FAO, UNIDO, and the World Bank have water-related issues in their charter. However, none of these institutions have mechanisms for resolving transboundary water-sharing disputes. Though there are various factors for transboundary water disputes, the main reasons are water storage or diversion of water from upstream, which causes the variability of flow (high or low), or scarcity of water downstream. Some other factors such as political,

socioeconomic, or physical circumstances determine the probability of violent conflict.

Various methods are followed to resolve water disputes. The first step is to initiate dialogue or negotiation. There is no fixed method to initiate negotiation rather it depends on the geography, socio-economy, culture, religion, and historical relationship of the riparian countries. The other dispute resolution methods are mediation by a third party, benefit-sharing diplomacy,

international court of justice, and using military power. It has been observed that cooperation, mediation, strong river basin organizations, proper monitoring systems, information exchange, and benefit sharing are the keys to success in most cases.

'Benefit sharing' is a diplomatic term, but its use in transboundary water management has become increasingly popular. It refers to co-riparian basin states that share not only water but also various other forms of benefits from the river.

Traditional conflict resolution such as the judicial method distributes water among different user groups, which means one party gains at the expense of the other. This is known as the 'zero-sum' or 'distributive' solution as it neither increases the overall benefits nor satisfies every party. In contrast, some water and environmental conflict resolutions adopt an alternative dispute resolution method known as benefit sharing. Arbitration, mediation, negotiation, cooperation, and consensus building are the main principles of benefit sharing. The benefit-sharing method is motivated by the possibility of positive-sum games, which aim to optimize benefits, rather than the zero-sum game, which resolves the dispute by simple water sharing. Benefit sharing typically involves sharing water but also countries offering one another various forms of social, political, or environmental benefits, and various mixes of these. If two or more parties claim ownership of the same water sources with a high emotional and political value, it will be tough to resolve the dispute. On the other hand, if costs and benefits change due to changes in ownership/management of water are expressed as monetary values, in many cases, ways to resolve conflicts over the water can be found. By treating water as a tradable good, conflict can potentially be mitigated. A benefit-sharing plan is seen by some to offer an efficient, impartial, and acceptable basis for all basin states in a transboundary water dispute to understand the potential to resolve the dispute. The success of benefit sharing depends on how the riparian countries are willing to cooperate, how much additional benefits the cooperation can bring to each country or how better off each riparian will be after benefit sharing.

Benefit sharing includes four types of benefits: *benefits to the river, benefits from the river, benefits due to the river, and benefits beyond the river.* Benefits to the River are benefits from flow management in a river that do not involve extraction and do not provide direct consumption benefits but provide enhancement of outcomes that humans may value. This includes benefits of ecological improvement such as water quality, floodplain, wetland, and fish biodiversity, and the health and productivity of fisheries. Such management may indirectly provide goods and services that people value such as fish for human consumption, lower water treatment costs, enhanced water-based recreation, and amenity.

Benefits from the river refer to the direct benefits from extracting and consuming water for example

for agricultural production or urban/industrial water supply. This concept also refers to changes in flow management with a primary emphasis on direct benefits often in ways that involve trade-offs with benefits to the river.

Benefits due to the river mean the cost saved because of the river. If there is a good relationship between the riparian countries, they can change policy to self-dependence from self-sufficiency and reduce military expenditure through combined defense. For example, there are many rivers between India and Bangladesh acting as borders. Fewer border guarding and patrolling along such border rivers can save costs. Internationally shared rivers have high political importance.

Benefits beyond the River refer to non-water sector cooperation using the river such as regional cooperation, business opportunities, and exchange of culture. International rivers can act as a catalyst among the riparian countries and thus can promote cooperation in trade, commerce, exchange of technologies, and other various fields.

The Toktogul reservoir in the Syr Darya, Kyrgyzstan, was the cause of political tension between Kyrgyzstan and the downstream countries. It was the biggest hydroelectric power plant in the river basin and produced 91% of all electricity consumed in Kyrgyzstan. Electricity demand is highest during the winter whereas irrigation demand in downstream Uzbekistan is highest during summer. Therefore, Kyrgyzstan wants to produce power and discharge water in winter, but Uzbekistan requires more water during the summer. Interestingly, downstream countries have greater material and non-material power than upstream countries. Then an agreement on the "Use of Water and Energy Resources in the Syr Darya Basin, 1998" was signed to compensate coal, gas, or money to upstream countries for energy loss. The agreement included the Kayrakum reservoir in Tajikistan in 1999.

According to the agreement, water allocations from the Toktogul dam and the amount of energy are determined yearly.

Bangladesh has too much water during the monsoon causing flood and scarcity of water during the dry season. So, a water storage reservoir upstream can store water during the monsoon and release it during the dry season. Moreover, all the riparian countries can improve the flood forecasting system by exchanging hydrological information and technology. Therefore, a possible win-win solution for the problems is very important for the good relationship among the neighboring countries. The benefit-sharing method has been successful in resolving transboundary water disputes in many countries of the world.

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Joint Rivers Commission, Bangladesh

Water Can be a Tool for Sustainable Development in Bangladesh

Water is essential for human life, and it is a finite resource. Access to drinking water is a human right. Roughly half of the world's population is experiencing severe water scarcity for at least part of the year (IPCC, 2022). These numbers are expected to increase, exacerbated by climate change and population growth (WMO, 2022). Climate change, population growth, and increasing water scarcity will put pressure on the food supply (IPCC, 2014) as most of the freshwater used, about 72% on average, is used for agriculture (UN-water, 2023). There is an urgent need to work together to protect and conserve our most precious resource. We must use water as a tool to create a more peaceful and prosperous world for all. We must realize that water is not only a resource to be used and compete for but also a human right, intrinsic to every aspect of life. In view of that, the River Research Institute (RRI) has been providing planning and design support for good water management to water resources development projects, which leads to sustainable development in Bangladesh.

Bangladesh is a riverine country and a flat deltaic region having a unique and uncommon system of rivers, tributaries and distributaries which play an important role in its agriculture, communication, economic development, social and natural environment. But these river systems are getting silted up gradually each year along with the shifting of the shoreline, which is causing navigational, communication, transportation and irrigation & drainage problems. Bangladesh experienced excess water in the monsoon but suffers scarcity of water in the dry season. In addition, Floods and river bank erosion are perennial occurrences in Bangladesh, and it takes away a huge toll on lives and valuable properties every year, which affects our microeconomy severely. The increasing landless people due to bank erosion is one of the main reasons of poverty in Bangladesh. Drought is also a severe problem for the country that affects our food production. The devastating effects of floods, drought, river bank erosion, and sedimentation must be controlled for

the rapid development of the country. Water resources should be utilized properly to increase food production and generation of hydro-electricity. Crops as well as crop land, must be protected from saline water inundation and river bank erosion, respectively. To overcome this prevailing situation, the rivers need to be trained and dredged to increase their hydraulic efficacy and to protect river banks from erosion. Irrigation, drainage, and communication systems should be developed by constructing hydraulic structures to increase food production & healthy economy, and rivers need to be restored to develop the biodiversity of the natural environment. Bangladesh Water Development Board (BWDB) is the responsible organization for implementing such types of water resources development projects. The country expenses huge amount of money to construct hydraulic infrastructures like barrages, bridges, embankments, revetments, spur/groin, dams, sluice gates, culverts, etc., to mitigate floods, drought, river bank erosion, to protect crops & lands, and to develop irrigation, drainage and communication system.

It is true that river problems are very complicated and requires extensive scientific investigation, research, and study in order to arrive at the correct engineering solution before actually taking up/launching a project or scheme in the field, which is generally very costly. RRI is responsible for providing planning and design support to the water resources development projects. RRI has been providing planning & design support of hydraulic structures to the planners and designers through the research, investigations, and studies by means of both Physical and Mathematical Model studies to make the project sustainable and cost-effective. The research, investigations, and studies on the river and other hydraulic problems result in the economization and sustainability of the different projects of water resource development and guard against waste from huge expenditures. The expenditure involved in carrying out research and investigation is very insignificant compared to the total cost of the development projects.

Since it was established, RRI has successfully conducted more than 200 physical model studies under different water resources development projects related to flood mitigation, river bank erosion, irrigation and drainage system development, communication system development, and river restoration. In addition, concrete materials, soil & water, and sediment samples have been tested in RRI for maintaining the quality of hydraulic structures and for

determining its foundation details. The modeling and test results have played an important role in the sustainable design and planning of the allied projects.

The River Research Institute (RRI) is a government-funded research organization in Bangladesh that specializes in providing physical and mathematical modeling services to its clients. This unique organization offers a wide range of services, including the development of river modeling software, the analysis of river flows, and the design of water management systems.

RRI is well-known for its hybrid modeling approach, which combines physical and mathematical models to provide more accurate and reliable results. This approach enables RRI to offer specialized services from a single source, resulting in lower costs and faster delivery times for clients. In addition to its modeling services, RRI also plays a significant role in the development of sustainable water resources in Bangladesh. This is especially important in a country where water serves as a stabilizing force and a catalyst for sustainable development. By helping to make projects sustainable and cost-effective, RRI helps to ensure that the people of Bangladesh have access to clean water and can continue to develop in a sustainable way. Its unique approach to modeling and water management is helping to shape the future of water resources management in the country.

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Flowing Forward: Bangladesh's Path to Sustainable Water Conservation Strategies and Peaceful Prosperity

In the contemporary global landscape, the management of water resources emerges as a critical imperative. The dwindling reservoir capacity per capita worldwide underscores the pressing need for sustainable water conservation strategies. Not only does the expansion of reservoirs fail to keep pace with population growth, but the storage capacity of existing reservoirs also faces challenges. Recent studies highlight concerning trends, particularly in regions like the Tibetan Plateau, known as the Water Tower of Asia, where climate change-induced impacts lead to significant depletion in Terrestrial Water Storage (TWS).

The hurdles to extensive water storage efforts are particularly pronounced in Bangladesh, a nation intricately interwoven with its waterways. Its predominantly flat and low-lying terrain and highly disparate water availability between dry and wet seasons pose multifaceted obstacles. The nation's water consumption, predominantly geared towards irrigation, heavily relies on groundwater, constituting 80% of annual usage. With projections indicating a steep rise in domestic and industrial water demand by 2050, the necessity for sustainable water management practices becomes increasingly apparent.

Water Conservation: Policy Directives

Bangladesh's water management approach is deeply entrenched in regional collaboration and strategic policy directives. The Cooperation Framework between Bangladesh and India, 2011, particularly Article 7, underscores joint efforts in water management for mutual benefit. This framework extends across various domains, including power, connectivity, and sustainable development, emphasizing shared project development and financing arrangements.

At the national level, initiatives like the Bangladesh Delta Plan 2100 outline ambitious infrastructural interventions, such as constructing barrages on the Ganges River, to harness multiple benefits like flood mitigation and enhanced water availability.

Furthermore, collaborative studies with neighboring countries like Nepal and Bhutan aim to identify potential sites for water reservoirs, reflecting Bangladesh's commitment to leveraging transboundary resources for collective prosperity.

Domestically, policy frameworks like the National Water Policy and the National Water Management Plan provide strategic guidance for sustainable water resource utilization. These policies prioritize preserving Bangladesh's unique waterbodies while emphasizing balanced economic development and environmental conservation.

Water Distribution (GBM Basin and Bangladesh)

Bangladesh's hydrological landscape, shaped by the intricate network of the Ganges-Brahmaputra-Meghna (GBM) river systems, plays a pivotal role in water distribution across the country. Annually, Bangladesh receives approximately 1200 billion cubic meters (BCM) of flow and 1.0 billion tons of sediment through the GBM river systems, including 57 trans-boundary rivers, with highly skewed spatial-temporal flow patterns, wherein 80% of the flow occurs within 8 months. The country is endowed with a total of 694 rivers, categorized as major (5 rivers), medium (40 rivers), and the rest being small rivers. Among these, 28% are located in the southwest (SW) region, 26% in the northwest (NW) region, and 25% in the northeast (NE) region, according to an analysis by the Center for Environmental and Geographic Information Services (CEGIS). The total length of rivers in Bangladesh is approximately 27,474 kilometers. Additionally, Bangladesh boasts 129,962 hectares of waterbodies, including haors, beels, and ponds, among which 36% are situated in the eastern hill region, 27% in the northeast region, and 14% in the southwest region (CEGIS, 2023).

Existing Water Storage in Bangladesh

Bangladesh's existing water storage infrastructure comprises diverse natural and artificial reservoirs, barrages, and wetlands. The Kaptai Lake, spanning 688 square kilometers, stands as a testament to the country's capacity for artificial reservoirs, supporting hydroelectric power generation and serving as a vital water storage facility. In addition to artificial reservoirs, barrages like the Teesta Barrage and the Tangan Barrage play crucial roles in regulating river flow and managing water resources, particularly in regions prone to water scarcity and flooding. These barrages help optimize water distribution, ensuring equitable access to water for irrigation, domestic use, and industrial purposes. The Sundarbans mangrove forest, a UNESCO World Heritage Site also serves as a crucial habitat for biodiversity and contributes to water storage, acting as a natural buffer against storm surges and tidal flooding. The intricate network of rivers, including the Padma, Meghna, and Jamuna, further facilitates water storage and distribution, with numerous tributaries and

distributaries contributing to the country's hydrological resilience. Moreover, Bangladesh's extensive network of haors, beels, and ponds collectively contributes to water storage and distribution, supporting irrigation, fisheries, and other economic activities essential for livelihoods across the country. These natural waterbodies play vital roles in maintaining ecological balance, supporting biodiversity, and mitigating the impacts of climate change-induced events such as floods and droughts.

In urban areas, reservoirs and water treatment plants ensure reliable water supply for growing populations, with strategic investments in infrastructure to enhance storage capacities and improve water quality. Community-based initiatives, such as rainwater harvesting and pond excavation, also contribute to local water storage efforts, empowering communities to manage water resources sustainably.

By leveraging natural and artificial water storage infrastructure, Bangladesh has made significant strides in enhancing water security and resilience. However, continued investments in infrastructure, coupled with robust management practices and policies, are essential to address evolving challenges and ensure sustainable water management for future generations.

Potential Water Storage in Bangladesh

Bangladesh has significant untapped water storage potential, particularly in regions like Chalan Beel and the southwestern and south-central parts of the country. Addressing challenges such as siltation and seasonal variations in water levels presents opportunities for enhancing water storage capacities through innovative solutions and strategic interventions. In regions like Chalan Beel, which experiences notable changes influenced by seasonal variations in rainfall and water flow, the implementation of water control structures and conservation measures can significantly augment water storage capacities. Similarly, leveraging natural features like haors and baors presents promising opportunities for enhancing water storage during dry periods and ensuring resilience against water-related challenges.

Collaborative efforts with neighboring countries to develop upstream water storage projects offers additional benefits, including flood control, groundwater recharge, and improved navigation facilities. By harnessing the collective potential of these resources, Bangladesh can enhance its water security and resilience, ensuring sustainable development and prosperity for future generations.

Additionally, the potential volume of water storage in Chalan Beel is estimated to be approximately 150 million cubic meters, assuming a stored water depth of 1.5 meters. Similarly, the potential volume of water storage in the southwestern and south-central regions, leveraging baors and perennial beels, is estimated to be around 100 million cubic meters, assuming a stored water depth of 1 meter. The haors covering an area of 859,000 hectares serve as natural reservoirs,

capable of storing approximately 230 million cubic meters of water during the monsoon season, assuming a stored water depth of 1.5 meters. These numerical estimates underscore the immense potential of Bangladesh for water storage, highlighting the critical role that strategic planning and collaborative initiatives can play in

harnessing this resource for sustainable development and resilience against water-related challenges.

Benefit of Water Conservation

The World Water Forum has recommended the construction of storage reservoirs to store monsoon water, offering a range of benefits such as flood control, augmentation of dry season flows, groundwater recharge, enhanced agricultural productivity, improved navigation facilities, increased fish production, environmental improvement, and the maintenance of ecological

flow. Bangladesh is engaged in discussions with co-riparian countries to jointly develop water storage projects in upstream regions, ensuring equitable sharing of benefits.

Example of Good Practices of Water Storage

In Bangladesh, several initiatives exemplify good water storage and management practices, showcasing innovative approaches and community engagement. One such initiative is the Blue Gold Program, which has made significant strides in enhancing water resilience in the region. Through the construction of 29 regulators/sluices, 535 kilometers of re-excavation of khals, and the installation of 17 drainage outlets, this program's comprehensive efforts resulted in a significant 40 million cubic meters of total water storage, contributing to improved water resilience in the region.

Another notable example is the River Re-excavation Project, implemented across 64 districts, 375 upazillas, and 2 city corporations in Bangladesh. This comprehensive endeavor involves the re-excavation of 668 rivers, khals, and waterbodies, including 109 small rivers and 533 khals, with a total re-excavation length of 5,262 kilometers. The planned re-excavated Earth Volume is estimated to be 160.8 million cubic meters, contributing significantly to water storage (65Mm^3) during the dry season.

Conslusion and Way Forward

Bangladesh is at a crucial stage in its journey towards sustainable water management and conservation. The country has an extensive network of rivers, wetlands, and water bodies, which provides significant potential for water storage and distribution. However, unlocking this potential requires a collective effort based on strategic policy directives, collaborative partnerships, and innovative solutions.

Moving forward, Bangladesh must prioritize the development of region-specific strategies tailored to its diverse hydrological landscape. Whether through constructing artificial reservoirs, restoring natural waterbodies, or implementing water control structures, the country must adopt a multifaceted approach to water storage and management. Moreover, community engagement and participation are essential in ensuring the success and sustainability of these initiatives, fostering a sense of ownership and stewardship among local stakeholders.

Furthermore, the promotion of water conservation practices ensures the equitable distribution of this precious resource and fosters peace and cooperation among communities. By recognizing water as a vital instrument of peace and sustainability, Bangladesh can pave the way for a more resilient, water-secure future for all its citizens. Collaboration with neighboring countries in water management endeavors can also strengthen regional ties, promoting mutual understanding and prosperity.

Bangladesh's goal of achieving sustainable water management is not only about fulfilling the present water requirements but also about securing the nation's future and ensuring the welfare of its people and ecosystems. By harnessing the combined potential of its water resources and adopting innovative and inclusive methods, Bangladesh can establish itself as a role model for water management practices worldwide.

Water conservation efforts that align with the "Water for Peace" theme can significantly contribute to promoting peace, stability, and cooperation. Bangladesh, in particular, can play a crucial role in promoting fair access to water resources, mitigating the consequences of water-related disasters, and enhancing ecological sustainability, which can contribute to regional stability and prosperity. Successful water conservation measures can also create opportunities for water export, further enhancing Bangladesh's role as a key player in the global water market.

Through concerted action and innovation, Bangladesh can harness the power of water as an instrument of peace, cooperation, and economic growth, ensuring a sustainable future for generations to come.

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Storage of Rain Water on the Surface and Managed Aquifer Recharge can Mitigate Conflict through the Allocation of Augmented Water Resources

Bangladesh comprises the major part of the Bengal Basin and the Delta. The main issues for water resources management in Bangladesh are flood, drought, riverbank erosion, salinity intrusion, groundwater (both contamination and depletion), land subsidence, drainage congestion, cyclone & storm surges, etc. Over time, some of these issues were exacerbated due to anthropogenic interventions and unplanned development activities, which happened due to a dearth of coordination as well as a knowledge gap. On top of these, climate change including sea level rise and transboundary issues only adds to the complexity of the problems; the magnitude of these problems is going to increase over the period in the near and the future. Given the ambition to be a developed country by 2041, addressing the expected impacts of climate change, there is a need for an integrated approach to future land and water management concerning water safety, agricultural growth and food security.

Water is at the core of sustainable development. Water resources, and the range of services it provides, underpin poverty reduction, economic growth, and environmental sustainability. From food and energy security to human and environmental health, water contributes to improvements in social well-being and inclusive growth, affecting the livelihoods of billions. The largest single reservoir in the hydrologic cycle consists of the world's oceans, which contain over 97 per cent of the water in the hydrosphere (Fetter, 1994), but not suitable due to high salinity. Freshwater lakes and streams together constitute only 0.016 per cent and are susceptible to bacterial contamination. Groundwater contains only 0.61 per cent of all water in the earth and principal source of fresh and safe water. With the growing demand, water scarcity is projected to become one of the main causes of social conflict in the developing world where climate change impact may accelerate this problem. Therefore, each drop of water is powerful and is in demand. Poor people in rural areas will suffer the most from an

increased deficiency of fresh water as they already travel considerable distances to access this basic necessity. Changes in the hydrological cycles can bring longer droughts and more intense rains making wet regions even wetter and arid areas drier. Changes in rainfall and the disappearance of glaciers will result in a considerable reduction of water quantity and quality for human consumption, industries and farming. This in turn creates conflicts amongst sectors and could affect agricultural production and food security. Proper scientific development of available freshwater through adaptation technologies for efficient and sustainable water use and management is, therefore, a key strategy for increasing agricultural productivity and securing safe water supply in these regions including Bangladesh.

Water Resources of Bangladesh and Its Development

More use of surface water, when and wherever available, is highlighted in the National Water Policy (NWP, 1999) of Bangladesh. In the early days agricultural practices of the country were dependent on climatic conditions. Irrigation in the Sub-continent commenced in 1954 and was virtually fully developed by 1963-64. Traditional agricultural practices were followed by farmers till the 1950s. Farmers carried out this task with indigenous methods and equipment. Up to the 1950s, Bangladesh was dependent on traditional means of irrigation, only swing baskets and doans. Swing baskets are capable of lifting water up to 1 m approximately and doans up to 1.5 m. After introducing irrigation machinery, the use of traditional irrigation devices started decreasing day by day. The Ganges-Brahmaputra-Meghna (GBM) basin covers five countries, including India (62.9%), China (19.1%), Nepal (8%), Bangladesh (7.4%) and Bhutan (2.6%). All three major river systems drain to the Bay of Bengal through Bangladesh. The river system of this delta has evolved through various changes in the last 250 years. The large sediment load, coupled with a dynamic hydraulic regime, causes the rivers to be morphologically very active and extremely dynamic. A network of beels, haors, baors, lakes, khals, and ponds exists in the country, comprising a rich source of water bodies. Some of them remain

underwater for the whole year whilst others are submerged in the wet season only. The Haor area in the Sylhet Basin consists of rivers, streams and irrigation canals, large areas of seasonally flooded cultivated plains, and hundreds of haors and beels. This zone contains about 400 haors and beels, varying in size from a few hectares to several thousand hectares. Haors are a vital resource for fisheries, irrigation water, ecosystem functioning and navigation. Beels are usually depressions or topographic lows and are generally smaller and seen all over Bangladesh. A third category is the Baor or oxbow lake, mostly found in the moribund delta as in greater Cumilla, Faridpur, Dhaka and Pabna districts. Kaptai Lake is the largest lake in the country, covering an area of around 777 km2, created after the construction of the Kaptai dam for hydropower generation. The average annual flow in the reservoir is approximately 15,646 million m3. The natural drainage channels are referred to as khals. They are a common feature in all areas and serve several purposes, including navigation, fisheries (both migration and capture), water retention and drainage. An estimated 1.3 million ponds exist in the country, covering some 151,000 ha or 11% of the permanent inland water area. The ponds vary between 0.02 and 20 ha with

an average of 0.30 ha. Renewable freshwater resources of Bangladesh are over 1210 billion cubic meters whereas groundwater is only 21 billion cubic meters.

The Bangladesh Water Development Board (BWDB) was formed as a separate entity and this organization came to play a central part in the development of FCD (Flood Control and Drainage) projects. By excluding flood waters from an area, the basic function of FCD infrastructure for agriculture is to convert land to a shallower flood phase, which facilitates conversion from Broadcast Aman to Transplanted Aman and from Local to High Yielding Varieties. As a result, yields increase. FCD development has thus contributed to the increase in agricultural productivity in the country. FCDI (Flood Control, Drainage and Irrigation) development has however not been only positive. In the coastal areas, polder development has, along with other factors such as a decreased freshwater flow to the Ganges Dependent Area (GDA), contributed to increased waterlogging inside the polders and, by decreasing the tidal flow, siltation of river channels. These impacts should be qualified however and require a more integrated, updated and in-depth (economic) analysis. In addition to the FCDI schemes, the country avails of 4 barrages across the rivers Teesta, Tangon, Buri-Teesta and Manu, which are used as diversion structures for irrigation purposes, and 1 large dam: the Kaptai Dam in the Chattogram Hill tracts. The Kaptai dam, with a total storage capacity of, is used primarily for hydroelectric power generation. Bangladesh constructed a barrage on the Teesta River in 1990 to provide irrigation water for crop production in the Teesta Barrage Project area. As per the NWPo, 1999 LGED focuses on scheme development of areas below 1000 hectares, which may be part of larger BWDB-developed FCD schemes.

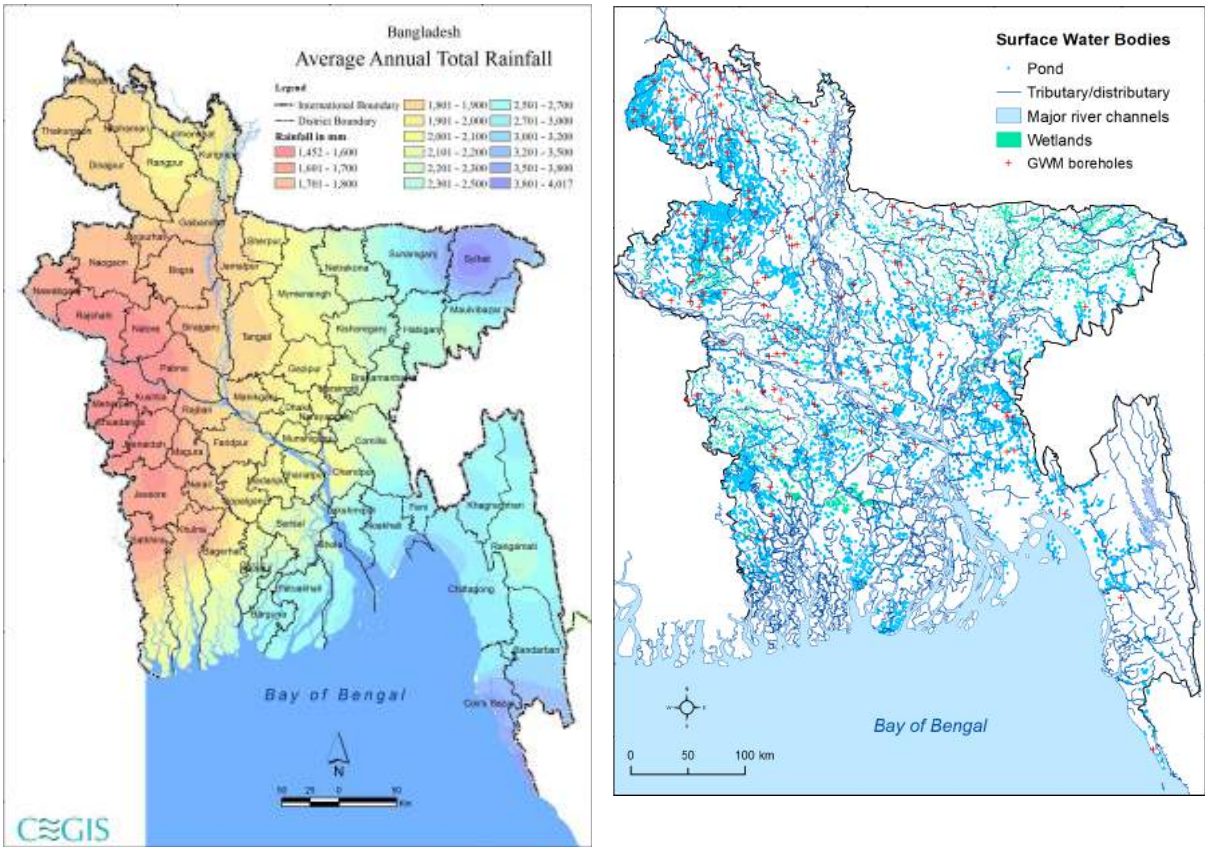

Figure 1. Annual average precipitation of about 2300 mm and surface water bodies offer more use of surface water

About 90% of the total irrigated area of Bangladesh is under private sector-led 'minor irrigation'. Minor irrigation involves different pumping technologies like STW, Deep Set Shallow Tube Wells (DSSTW), DTW, Force Mode Tube Wells (FMTW), Low Lift Pumps (LLP) etc. The majority of the technologies are STW and LLP. In 1972, Bangladesh Agricultural Development Corporation (BADC) initiated capital-intensive methods for DTW installation in Bangladesh and provided well components for rapid expansion of groundwater irrigation. BADC used to install DTWs by reverse circulation drilling method using very costly power rigs and distributed water to farmers, mostly under subsidized projects. Privatization and expansion of minor irrigation and withdrawal of government subsidies in irrigation equipment lead to a very rapid growth of farmer-financed STWs. The manually driven percussion method became popular for STW installation having a depth of 20-45m. Direct circulation rotary drilling method with donkey pumps is another low-cost technology for the installation of up to 300m depth for even larger diameter wells. The electric pump Water Extraction Method (WEM) was developed very recently, but the development of diesel centrifugal pump WEM is older in comparison with the electric pump WEM.

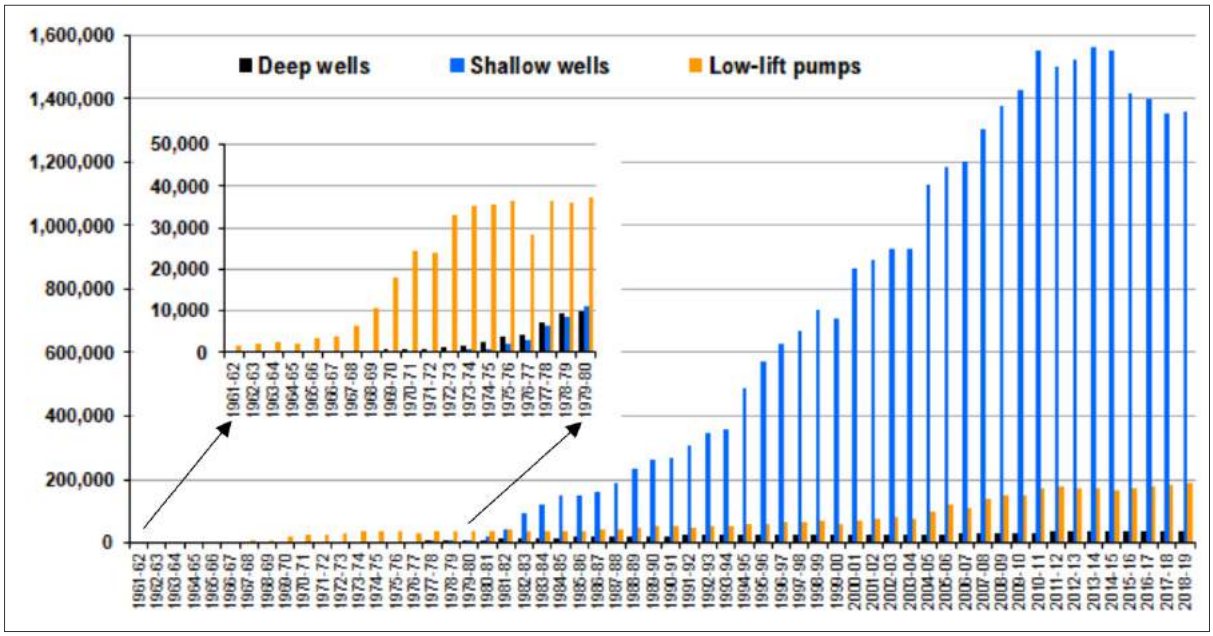

Figure 2. Trends of groundwater irrigation by LLPs, DTWs and STWs in Bangladesh

Incremental increases in dry-season groundwater pumping for irrigation lower groundwater levels and enhance leakage under gravity of surface water from rivers, ponds and canals during the subsequent monsoon. This broad set of recharge pathways induced by dry-season groundwater pumping is described as 'The Bengal Water Machine (BWM)' by Shamsudduha et al. (2023). This study shows that the collective operation of ~16 million smallholder farmers in Bangladesh from 1988 to 2018 has induced cumulative freshwater capture of between 75 and 90 cubic kilometers. However, the research also highlights limitations to the operation of the BWM in areas where induced monsoonal recharge is insufficient to fully replenish groundwater abstracted during the dry season, depleting groundwater storage and rendering groundwater inaccessible to households reliant on shallow wells. Among 465 monitoring well locations, about two-thirds show the non-functionality of the BWM. Therefore, it is vital to assess the suitability of locations for the operation of the BWM to maximize benefits to farmers and minimize the risks of groundwater depletion. The importance of long-term hydrological monitoring to assess the status and trends of the country's groundwater resources is highlighted.

Figure 3. Based on the BWDB groundwater level monitoring data, a study (Shamsudduha et al. 2023) shows that the collective operation of ~16 million smallholder farmers in Bangladesh from 1988 to 2018 has induced cumulative freshwater capture of between 75 and 90 cubic kilometres.

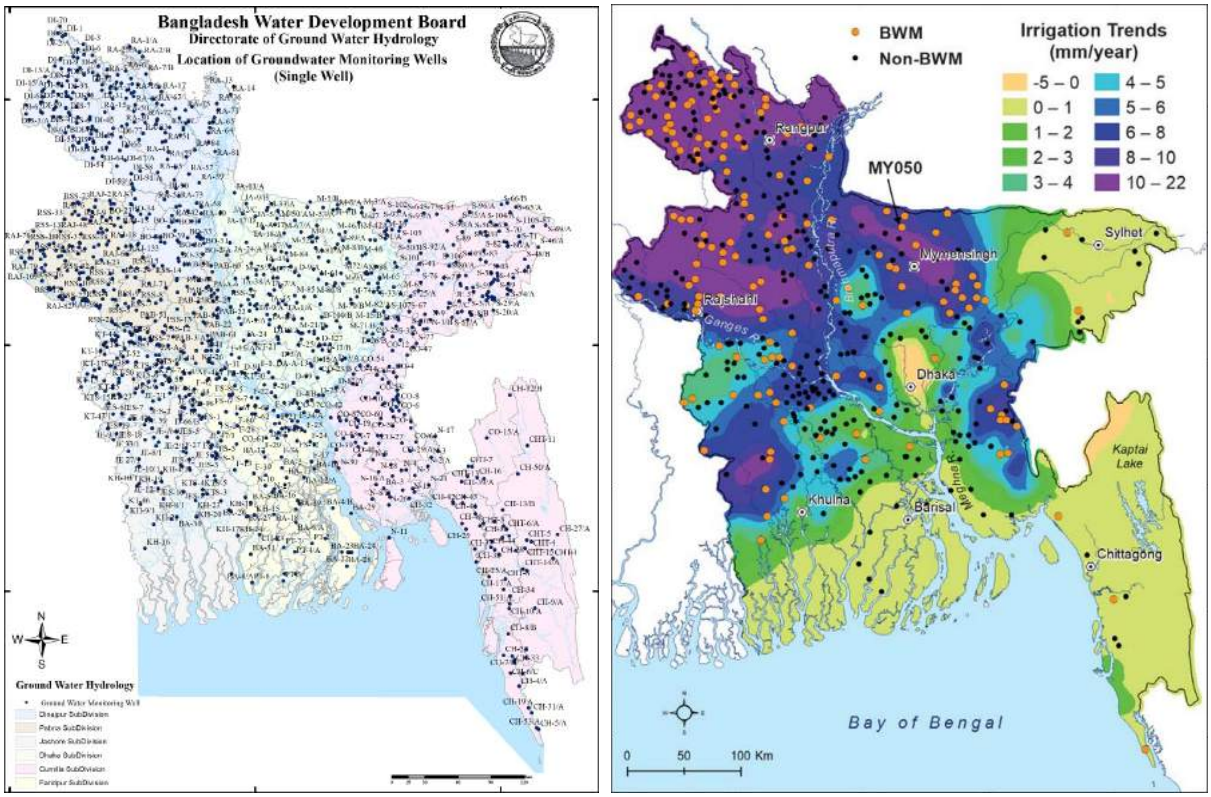

Figure 3. BWDB Groundwater Level Monitoring Stations

However, the research also highlights limitations to the operation of the BWM in areas where induced monsoonal recharge is insufficient to fully replenish groundwater abstracted during the dry season, depleting groundwater storage (non-BWM).

Towards Sustainable Use of Water

Conjunctive use of Groundwater and Surface Water

Groundwater irrigation now surpasses surface water as the main source of irrigation water in Bangladesh and many other regions. Because of the growth in groundwater irrigation, world agriculture now accounts for an estimated 70% of total groundwater use with only 20% and 10% going to industry and residential uses, respectively. It is important to note that groundwater in some hydrogeological settings is not used alone, but in conjunction with surface water, for instance, as a supplement when irrigation schemes are undermanaged and farmers seek reliability and flexibility provided by their wells. Groundwater management is often treated as if it took place in areas distinct from surface irrigation schemes. However, when looking at many such schemes, ranging from India to Pakistan and Bangladesh, farmers use surface and groundwater in conjunction. Bangladesh Water Development Board has many surface water irrigation schemes. But these projects manage only surface water. Groundwater uses within these project areas are done in many cases by the initiatives of individual farmers. Farmers use groundwater within surface water irrigation projects because surface water schemes are not functioning during dry lean periods, not delivering water on time or not timely enough to grow sensitive (e.g. HYV rice) crops. In such cases, the surface water scheme itself can provide groundwater as supplementary irrigation where the areas are at risk of surface water availability during dry lean periods. The opposite applies to the Barind Multipurpose Development Authority (BMDA) project in the north-western part of the country where BMDA has been promoting mainly groundwater for irrigation. Here, BMDA can combine surface water irrigation with groundwater wherever available.

Control of Water Sources

Nearly 40% of the water taken into earthen canals

is lost during conveyance due to seepage and evapotranspiration. Thus huge volume of water is diverted annually; however, a portion of it would reach the water table and again recharge groundwater. But it takes days to years depending on the aquifer type. Therefore, lining canals to reduce these losses should be encouraged. Control of the source of excess water by percolation from the irrigated land also is a difficult and perplexing task. In a few areas, there is so much excess salinity or alkali in the soil and lowering the water table is that it is necessary to solve the drainage problem. The lining of the irrigation canals to prevent seepage losses and more efficient application of irrigation water to reduce or eliminate deep-percolation water losses may result in a satisfactory lowering of the water table in these areas, thus making drainage essential. Canals with concrete bottoms and walls as well as piped distribution systems may protect a significant portion of lost water.

Another portion of the major loss of irrigation water is due to a lack of adequate knowledge

among farmers. Bangladesh National Water Management Plan (NWMP) recommended total water depth for HYV boro rice is between 1200 and 1500 mm per season depending on soil conditions. Considering the maximum value the average water used by farmers was 34 % more than the recommended limit that has no use to the growth of crops (Zahid et al., 2009). Agricultural water-saving measures such as improved irrigation water distribution through low-pressure pipes and drip and micro-sprinkler technology, improved irrigation forecasting, deep ploughing, straw and plastic mulching, etc. can reduce non-beneficial evapotranspiration, seepage loss and loss due to knowledge gap of farmers which may lead to real water savings. Introducing water meter fixed with the delivery line of tubewell and provision of more electric pumps with electricity meters would motivate farmers to avoid misuse of water.

Storage of Precipitated and Flood Water for Dry-season Irrigation

A vast area of Bangladesh suffers from the scarcity of water for irrigating its agricultural lands not only in dry months but also during monsoon. There is considerable scope for the collection of rainwater before huge losses due to evaporation, transpiration, runoff and drainage. Water storage can enhance both water security and agricultural productivity. To reduce the harmful effect of floods and to use the surplus water for irrigation, the Bangladesh Water Development Board has constructed several embankments, barrages and canals.

Ganges-Kobadak Irrigation Project, a large surface irrigation system of the country on the right bank of the river Ganges, better known as G-K Project, covers an area of 197,500 ha in south-west Bangladesh of which 142,000 ha are net irrigable. The G-K Project represents an irrigation system in which water is lifted from the Ganges River by pumps and is distributed by gravity canals. The objectives were to increase food production, improve cropping patterns, increase cropping intensity, and improve the socioeconomic conditions of the farmers. Implementation of the project started during the year 1954-55. In 1962-63, some local varieties of rice were cultivated under this irrigation project for the first time. At that time HYV rice was not available in the area. Afterwards, the cultivation of HYV rice

became popular among the farmers.

A vast area of North Bangladesh suffers from a scarcity of water for irrigating its agricultural lands not only in dry months but also during monsoon when a prolonged spell of scarcity/no rainfall affects crops. Considering this, Teesta Barrage was constructed to increase agricultural production through supplementary irrigation thereby creating employment opportunities. Although the implementation of the project started in 1960, the actual construction of the Barrage was taken up in 1979 and that of the canal system in 1984-85. To derive early benefits, the Project has been phased out viz. Phase-1 and Phase-11. The Phase-1 (restructured) has a command area of 154,250 hectares with a net irrigable area of 111,406 hectares.

Chandpur Irrigation Project located in Chandpur and Lakshmipur district covers a gross area of 54,036 ha. It provides irrigation facilities to 24,291 ha and drainage facilities to 21,578 ha of land. The project started in 1963 and was completed in 1978. The Meghna-Dhonagoda Project is located in the Matlab upazila of Chandpur district. The project provides irrigation water to an area of 14,400 ha. It includes 65 km of flood embankment, 220 km of irrigation canal, and 125 km of drainage channel.

However, these projects have suffered from problems both at the implementation and operational stages. Water use has been considerably higher than anticipated and this has led to reluctance to develop the full irrigable area. Operations to extract water from the Ganges are made difficult because dry-season water levels are significantly below the level for which the pumps were designed and up to one million cubic meters of slit has to be dredged annually from the canal leading from the Ganges to the pump house. In recent years, farmers in the area have turned to tubewells to augment supplies, although they revert to surface water whenever it is available. The surface water provides less than 20% of dry season irrigation. Construction of more surface water irrigation projects can reduce stress on the groundwater environment and face the challenge of seawater intrusion in the coastal belt due to the sea-level rise triggered by climate change. The Government of Bangladesh has emphasized the implementation of the Ganges Barrage Project for sustainable poverty alleviation and environmental

conservation by providing storage water irrigation in the Southwest region of the country.

Managed Aquifer Recharge

MAR (Managed Aquifer Recharge), also known as artificial recharge, is the umbrella term for a range of technologies involving infiltration and injection processes, recharge basins etc. that enable the integrated use and management of surface water and groundwater to achieve a wide and growing range of social, economic and environmental benefits (Dillon et al, 2020; Marta et al., 2019). Artificial recharge i.e. the augmentation of natural infiltration of treated safe and fresh surface water and harvested rainwater into the groundwater system needs to be carried out for overstressed aquifers like the Dhaka aquifer. Traditional approaches to watershed development that stress enhancing recharge to groundwater do not pay adequate attention in developing countries like Bangladesh. MAR is useful for overstressed aquifers subject to falling water levels, salinity encroachment etc. In areas where groundwater is

already over-exploited like Dhaka city and Barind area etc., recharge enhancement has the potential to store excess runoff. Techniques of both direct recharge i.e. water added to the groundwater reservoir in excess of soil-moisture deficits and evapotranspiration by direct vertical percolation through the vadose zone and indirect recharge i.e. percolation to the water table through the beds of surface-water courses, can be introduced to add additional water storage in aquifers. MAR has many benefits but has several risks too, associated with it. If not regulated through proper legal instruments, there is a risk of using water having poor quality as source water and thus impairing the inherent water quality of potable aquifers.

Marta et al. (2019) summarize the method used to generate potentiality maps for artificial recharge techniques in Bangladesh. The method consists of analyzing key variables that contribute to the Physical Potential (PP) and the Demand Urgency (DU) for the aquifer systems in Bangladesh. The identified variables that define the PP are: precipitation intensity and duration; evaporation loss; surface geology; thickness of the aquitard; groundwater depth below the surface in the middle of the monsoon (June); Wells contaminated with arsenic; inundation land type. The variables that define the DU are: population density; depth of the groundwater table below the surface at the driest month (April); poverty; absence of perennial rivers close by; and irrigation demand.

The variables describing these two aspects are analyzed and reclassified according to a set of criteria. Each criterion is then assigned a "suitability score" and the final total potentiality is calculated. Following this method, the potential of a number of MAR techniques are mapped. The highest PP is in the northwest (Barind area) and on the eastern side of Bangladesh. The most influential variables are precipitation and evaporation, which are higher in the east. The map of the DU shows that there is a need for MAR techniques mostly in the western part of Bangladesh. These areas are highly populated, with high poverty, and as a distinctive fact, with a high irrigation demand. The coastal zone, areas where one could also have a high DU, are also highlighted, however, due to a lower population density, the scores for DU are lower. Based on the results, the techniques "infiltration well" and "artificial reservoir" have the highest potential in Bangladesh. Combining the PP and the DU shows that the total potentiality for an infiltration well is higher in the northwest, Barind, and in the central north part of Bangladesh. Some parts in the coastal belt and the Chattogram are also suitable to consider MAR through infiltration wells. There are other techniques, most of them still in the experimental phase, which could also enhance rainwater harvesting during the wet season to

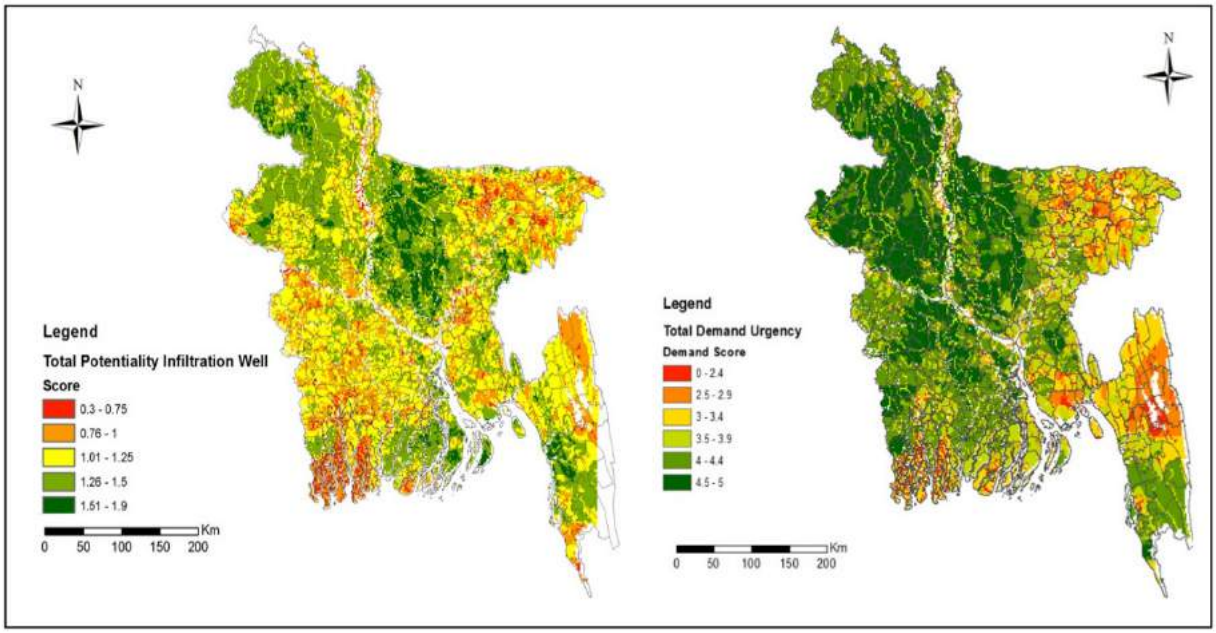

Figure 4. Managed Aquifer Recharge (MAR) potentiality maps: (a) total potential map for the infiltration well; (b) Total Demand Urgency (Marta et al., 2019).

make water available during the dry season. Some of them might be more interesting for irrigation purposes and others for domestic water supply.

The infiltration well is the most common aquifer storage and recovery technique used in Bangladesh. It is mostly meant for domestic water supply. There are several studies researching the potential of this system and monitoring its benefits, however there is no concluding study yet on its impact. There are other techniques, most of them still in experimental phase, which could also enhance the rainwater harvesting during the wet season to make water available during the dry season. Some of them might be more interesting for irrigation purposes and other for domestic water supply. Infiltration pond consists of building a pond in a sandy area where water can infiltrate easily. The pond has a permeable bottom to allow water to infiltrate and recharge the aquifer. This system has been applied in several countries and have proofed to work. Recharge basin connected to the aquifer consists of creating an artificial pond by digging out the surface impermeable material and replacing it by sandy material in order to bring the new sand in contact with the aquifer and enhance the recharge of it. This system is at the moment conceptual and its potential still needs to be tested. Artificial reservoir disconnected from the aquifer consists also of digging out some clay and fill it with sand. In this case the clay thickness us such that the new sand does not come in contact with the aquifer. This technique might be useful to create shallow surface water lenses disconnected from a deeper aquifer that might be contaminated by saline water or arsenic rich water.

Water Budget and Water Allocation Plan

Extension of irrigation is emphasized with efficient management of water resources, increased irrigation coverage, especially to less developed areas and use of more surface water. PRS highlights increasing profit margins from rice irrigation, developing policies for market liberalization to already encourage minor irrigation, rationalising performance and cost recovery, continuing pro-market policies for irrigation development, improving the quality of irrigation water and increasing the profitability of irrigated crops. Rationalized utilization of groundwater is emphasized ensuring the supply of safe water for domestic use, regulation of industrial and agricultural use, and conjunctive use of water. Mainly surface water irrigation projects are under implementation. Conjunctive use or groundwater-surface water interaction has not been considered. To accelerate the PRS Plan, steps have been taken by the government to improve the governance of water resources. For the sustainable management of available freshwater resources without harming the ecosystem, upazila and/or union-level water budget and water allocation plans need to be prepared. Based on the demand

and availability of water resources (surface water, groundwater, rainwater harvesting) water allocation for different uses would be made as per the priority mentioned in Water Act 2013.

Currently, about 98% of drinking water and 80% of dry season irrigation water supply has been provided by groundwater. Global water demand for manufacturing is expected to increase by 400% from 2000 to 2050, the main increases will be in emerging economies and developing countries like Bangladesh. Therefore, there is a need for expansion and improvement of the water supply services to satisfy the basic needs of the people. Given that most of the country's environmental resources are linked to water resources, the

continued development and management of the nation's water resources must include the protection, restoration, and preservation of the environment, its bio-diversity and the water quality. Therefore, this is the time to estimate the availability of water, water demand and water budget with allocation plans for different uses down to the Upazila/Union Level for the sustainable use and governance of the integrated water resources.

Demand calculation for different Uses/Sectors can be done by analyzing data and information sourced from,

- Drinking and Potable (Data source: DPHE, NGOs, population demand calculation, BBS etc.)
- Agriculture: (Data source: BADC, DAE, BBS etc.)
- Environmental flow, groundwater storage and ecosystem
- Others (if any): (e.g. industrial etc.)

Estimation of available freshwater resources can be done by analyzing and modelling data and information sourced from,

- Surface Water: (Data source: BWDB, field survey, LGED etc.)
- Groundwater: (Data source: BWDB, field survey etc.)
- Rainwater (based on reservoir capacity and shortage of surface water and groundwater, if any)

Water Allocation Plans can be formulated based on the priority of water use mentioned in the Water Act 2013. The major water sources to be considered for different sectors are,

- Drinking and potable (Source: groundwater, rainwater and surface water)
- Agriculture (Source: surface water, shallow groundwater and rainwater)
- Ecosystem (e.g. minimum stream flow, biodiversity, protection of groundwater table declination etc.)

Water Allocation Plan (WAP) needs to be prepared to outline the rules for allocation, transfer, and use of available groundwater from prescribed sources. WAP must be consistent with the NWMP and RWRMP. Water licenses and water permits may be given through the development of WAPs for controlling the allocation, use, and management of

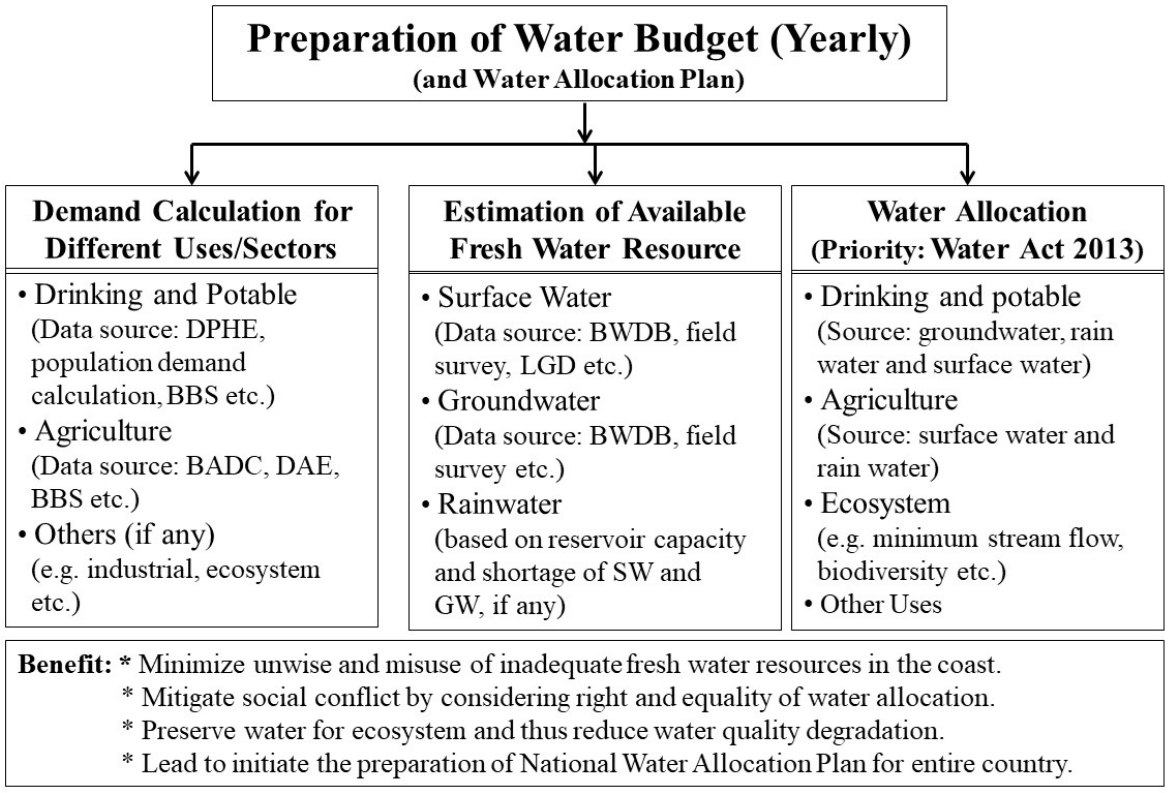

Figure 5: Chart for water budget analysis

water resources in a prescribed area both for surface or groundwater. The WAP also includes an assessment of the quantity and quality of water needed for dependent ecosystems, an assessment of resource capacity, rules to allocate and transfer water for environmental, social and economic needs, resource monitoring etc. A WAP sets the limits on the amount of water that can be taken and used. All of these tools can be implemented under the authority of the enacted Bangladesh Water Act 2013 Water Rules 2018.

Way Forward

Sustainable use of available safe water including groundwater can be planned by analyzing data and information on the components of the hydrologic cycle. In Bangladesh where groundwater is the principal source of irrigation, industrial and potable water supply, regular assessment and monitoring of this resource is very important. Maintaining the water balance of withdrawals and recharge is vital for managing human impact on water and ecological resources. Groundwater resources that can safely be abstracted from both upper and deeper aquifers need to be assessed properly. Because of the increasing water demand and to reduce dependency on limited fresh groundwater resources, utilization of available surface water and conjunctive use should be emphasized as per the National Water Policy 1999 and other guidelines of the Government. Regional modelling of the groundwater systems has to be developed for effective water resource management to plan agricultural, rural and urban water supplies and to forecast the groundwater situation in advance for dry seasons.

Preparation of water budget and water allocation plans are important up to the union level based on available data and information as well as conducting required surveys and investigations. All of these tools can be implemented under the authority of the Water Act 2013 Water Rules 2018. Augmentation of both natural and artificial recharge of groundwater (MAR) can be done in groundwater-depleted and water-stressed areas by implementing appropriate programs and techniques. Extension and upgrading of the existing network of groundwater monitoring wells should be done spatially and vertically in different aquifers for estimating recharge, monitoring fluctuation of the water table and movement of groundwater and water quality assessment. To facilitate the actions for sustainable development and management of water resources of Bangladesh, strengthening and capacity building of appropriate organizations is required.

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Teesta Basin Water Use: Agriculture and Hydropower

The Teesta River, originating in the Himalayas and flowing through India and Bangladesh, faces significant challenges due to water scarcity and competing demands. The Teesta basin, covering Sikkim and parts of West Bengal in India, and several districts in Bangladesh, is characterized by steep terrain, prone to natural hazards like earthquakes and landslides. Besides, the river's flow is highly variable, primarily sourced from rainwater with seasonal snowmelt contributions. However, water diversion projects, such as the Teesta Barrage Project (TBP) in India and the Teesta Barrage Irrigation Project (TBIP) in Bangladesh, have significant implications for downstream water availability and ecosystem services. Diverse water utilization from the Teesta River encompassing irrigation, hydropower generation, domestic water supply, fisheries, and navigation are observed in this river basin. Economic benefits from these uses can be quantified based on data from baseline years, with scenarios reflecting current conditions and proposed water-sharing arrangements.

Teesta River and Basin

The Teesta River originates as Chhombo Chhu from a glacial lake, Khangchung Chho, in the Sikkim, India, at an elevation of 5,280 meters. The Chhombo Chhu, the headstream of theTeesta, flows eastwards, joins the Zemu Chhu and becomes the Lachen Chhu. Then the Lachen Chhu meets the Lachung Chhu and the combined flow becomes the Teesta and flows southward (Noolkar-Oak 2017). Figure 1 shows the Teesta River and its basin area.

The Teesta basin, covering Sikkim's mountainous landscape, faces natural hazards like earthquakes and landslides, with the river flowing swiftly through narrow valleys. As it traverses through West Bengal's plains, the Teesta gathers water from multiple tributaries before entering Bangladesh. Next, the Teesta River spans approximately 414 kilometers, originating in Sikkim and flowing through West Bengal and

Figure 1: Teesta Basin

Bangladesh before joining the Brahmaputra River. The length of the river within Sikkim is about 151 km, then it flows 19 km along the border of West Bengal and Sikkim. Further south it flows for 123 km in the Jalpaiguri and Koch Bihar districts of West Bengal, 121 km in Bangladesh, and ultimately joins the Jamuna or Brahmaputra at Sundarganj/Chilmari. The total catchment area is 20,000 km2 and 48.33% of this area falls in Bangladesh. The catchment area of Teesta River covers five northern districts of Bangladesh: Lalmonirhat, Rangpur, Kurigram, Nilphamari, Gaibandha comprising 9,667 km2, with an estimated population of 9.15 million (The Asia Foundation 2013). The lower Teesta basin (Bangladesh) is densely populated (Table 1).

Table 1: Teesta Basin information

State/Country	Length		Basin area		Population (2011)		Population density
	km.	In %	km^2	In %	In count	in %	No/km^2
Sikkim	118	37	7,039	35.20	610,577	5.31	87
Sikkim-West Bengal border	19	4.6	–	–	–	–	–
West Bengal	112	30	3,294	16.47	1,729,899	15.06	525
Bangladesh	119	29	9,667	48.33	9,150,000	79.63	946.5
Entire basin	368	100	20,000	100	11,490,476	100	687.81

The Teesta River is fed mainly by rainwater, though snowmelt water is the major component for a few lean months. For example, the average flow in August is about fifteen times larger than in February, so there is great flow variation across the year. The complex basin hydrology includes both surface and subsurface flow of water. The groundwater pool in the Teesta basin is unconfined and flows southward to the Bay of Bengal. That's why, even if all water is diverted from the Gajaldoba barrage in the dry season, some flows remain available in Dalia, Bangladesh due to regeneration from groundwater flow.

Agricultural Dynamics in the Teesta River Basin

In the Teesta River basin, agriculture is diverse, catering to various elevations and climatic conditions. In high-elevation areas like Lachen (2,500 masl) and Thangu (4,300 masl), traditional communities engage in mixed farming, cultivating

crops such as wheat, barley, seasonal vegetables, and medicinal plants during the summer. Winter sees migration to lower areas for livelihoods like tourism or uphill for free grazing. Climate extremes, however, have increased vulnerability, impacting livestock populations and agricultural productivity. Efforts by organizations like the Sikkim Institute of Cottage Industry provide alternative income sources such as carpet weaving and souvenir making.

In mid-hills, agriculture dominates as the primary livelihood, with a mix of crops, horticulture, and livestock rearing. Climate changes, particularly hailstorms and erratic rainfall, pose challenges to crop cultivation, leading to declining profitability and outmigration, leaving women and older individuals stressed managing agricultural activities and households.

In the floodplains, agriculture faces limitations due to irrigation water scarcity, declining water tables, and reliance on diesel pumps. Despite challenges, farmers cultivate groundnuts, paddy, seasonal vegetables, and potatoes. In Bangladesh, rice farming predominates, supported by irrigation facilities, leading to increased cropping intensity and production, albeit with challenges from heat waves, fog, and erratic rainfall impacting crop yields.

Additionally, specific figures mentioned include the following: Cropping intensity in the Teesta floodplains in Bangladesh is 200%, while in India, it reaches 233%. Irrigation facilities provided cover 91,226 hectares of agricultural land during the monsoon as supplementary irrigation. Furthermore, 54% of households in the Teesta floodplains in Bangladesh are primarily engaged in farming, with 84% of them being marginal farmers with less than 1 hectare of cultivable land.

Hydropower in India

In 2004, the Central Electricity Authority of India conducted a preliminary feasibility study on 162 new hydroelectric projects with a combined potential of over 50,000 MW. Sikkim, in particular, was found to have a substantial hydroelectric potential, with 10 schemes amounting to 1,469 MW installed capacity as of 2015. A committee formed in 1974 to study Sikkim's hydropower potential concluded that the state could support up to 8,000 MW, with a firm base of 3,000 MW (Rahman, Mamun 2020).

In 2020, there were 47 hydropower projects in various stages of development in Sikkim. Of these, 15 were under construction, with an anticipated completion date by 2022 according to the Draft National Electricity Plan 2018. However, some

Table 2: Teesta river basin area distribution and hydropower potential

State/ Country	River length (in km)	Basin area (in km^2)	Population (in 2011)	Population intensity (per km^2)	Installed capacity (MW)	% of basin's total hydropower potential
Sikkim	170	7,039	610,577	87	5353	65
West Bengal	123	3,294	1,729,899	525	2841	35
Bangladesh	121	2,037	2,221,550	1,091	0	0
Total	**414**	**12,370**	**4,562,026**	**369**	**8194**	**100**

Sources: 1. Rahman, Mamun (2020), 2.Khawas (2016), Rudhra (2018), EDPS (2019)

Table 3: Existing hydropower projects along Teesta River Basin

Project name	Location	Installed capacity (MW)	River	Latest status/Remarks
Ramman II	West Bengal	50	Ramman	In operation. Project completed in 1995
Ranjit III	West Sikkim	60	Ranjit	In operation. Commissioned in February 2000. Project completed by NHPC
Teesta Low Dam III	West Bengal	132	Teesta	In operation. Commissioned in March 2013. Project completed by NHPC
Teesta Low Dam IV	West Bengal	160	Teesta	In operation. Commissioned in August 2016. Project completed by NHPC
Teesta Stage V	East Sikkim	510	Teesta	In operation. Commissioned in March 2008. Project completed by NHPC

Sources:1. Rahman, Mamun (2020), 2. CEA (2016), EDPS (2019), India-WRIS (2018), NHPC (2019).

Table 4: Ongoing Hydropower Projects on Teesta River Basin

Project Name	Location	Installed Capacity (MW)	Latest Status/Remark
Bakchachu	North Sikkim	40	Under survey and investigation by Sanvijay Power and Allied Industries Ltd.
Bhasmey	East Sikkim	51	Under construction by Gati Infrastructures Ltd. As per MoU, commissioning date was December 2013. Progress: ~28%.
Chuzachen	East Sikkim	99	Under construction by Gati Infrastructures Ltd. As per MoU, commissioning date was June 2013.
Dikchu	North/East Sikkim	96	Under construction by Sneha Kinetic Power Projects Ltd. As per MoU, commissioning date was December 2013. COD: March 2017.
Jorethang	South Sikkim	96	Under construction by DANS Energy Pvt Ltd. As per MoU, commissioning date was June 2013. COD: September 2017.
Paanan	North Sikkim	300	Under construction by Himagiri Hydro Energy Pvt Ltd. As per MoU, commissioning date was September 2013.
Rahi Kyoung	North Sikkim	26	Under survey and investigation by Sikkim Engineering Pvt Ltd. DPR under preparation. Public hearing concluded by SPCB.
Ramman III	West Bengal	120	Under construction by NTPC.
Ranjit II	West Sikkim	66	Under construction by Sikkim Hydro Ventures Ltd. As per MoU, commissioning date was May 2013. Progress: ~12%.
Ranjit IV	West Sikkim	120	Under construction by Jal Power Corporation Ltd. As per MoU, commissioning date was July 2015. Progress: ~49%.
Ronginichu	East Sikkim	96	Under construction by Madhya Bharati Power Corpora. As per MoU, commissioning date was December 2013. Progress: ~64%.
Tashiding	West Sikkim	99	Under construction by Shiga Energy Pvt Ltd. As per MoU, commissioning date was September 2015. COD: September 2017.
Teesta Stage III	North Sikkim	1,200	Under construction by Teesta Urja Limited. As per MoU, commissioning date was December 2013. COD: February 2017.
Teesta Stage IV	North Sikkim	520	Under construction by NHPC. Preliminary construction works started. First stage environment clearance obtained.
Teesta Stage VI	North/South Sikkim	500	Under construction by Lanco Energy Pvt Ltd. As per MoU, commissioning date was July 2013. Progress: ~48%.

Sources: 1. 1. Hydropower development along Teesta river basin: opportunities for cooperation by Muhammad Mizanur Rahaman; Abdullah - Al - Mamun

2. CEA (2016), EDPS (2019), NHPC (2019), NTPC (2019).

Table 5: Summary of the upcoming/proposed hydropower projects along the Teesta River Basin

Project Name	Location	Installed Capacity (MW)	Latest Status/Remark
Bhimkyong	North Sikkim	99	Memorandum of Understanding (MoU) or Interagency Agreement (IA) terminated in June 2012. High Court of Sikkim set a new development timeline to 2018.
Bop	North Sikkim	99	MoU/IA terminated in June 2012. High Court of Sikkim set a new development timeline to 2018.
Chakhungchu	North Sikkim	50	Project allocated in 2002. Arbitration case ongoing with Sikkim Government and Amalgamated Trans Power India Ltd.
Kalez Khola I	West Sikkim	27.5	MoU/IA terminated due to non-performance in September 2016
Kalez Khola II	West Sikkim	54	MoU/IA terminated due to non-performance in February 2017.
Lachung	North Sikkim	99	MoU/IA terminated in June 2012. High Court of Sikkim set a new development timeline to 2018.
Lethang	West Sikkim	96	Project denied clearance by National Wildlife Board, Government of India. Cancellation notified in 2012.
Lingza	North Sikkim	120	Project canceled or not initiated due to proximity to Dzongu area and Kanchanjonga National Park.
Ramman I	West Bengal	48	MoU/IA signed with NHPC in July 2015.
Manul and Mangan	North Sikkim	30	MoU/IA terminated due to non-performance in September 2017.
Ralang	South Sikkim	40	Project allocated in 2002. Arbitration case ongoing with Sikkim Government and Amalgamated Trans Power India Ltd.
Rangyong	North Sikkim	80	Project canceled or not initiated due to proximity to Dzongu area and Kanchanjonga National Park.
Rathangchu	West Sikkim	30	Project scrapped due to religious sentiments.
Rechu - Meyongchu	North Sikkim	26	MoU/IA terminated due to non -performance of Planet Infra Projects Pvt. Ltd.
Ringpi	North Sikkim	320	Project canceled or not initiated due to proximity to Dzongu area and Kanchanjonga National Park.
Rolep	East Sikkim	36	Project allocated in 2002. Arbitration case ongoing with Sikkim Government and Amalgamated Trans Power India Ltd.
Rukel	North Sikkim	33	Project canceled or not initiated due to proximity to Dzongu area and Kanchanjonga National Park.
Sada-Mangder	West/South Sikkim	71	MoU/IA terminated due to non - achievement of stipulated milestones by Gati Infrastructures Ltd in February 2017.
Suntaleytar	East Sikkim	40	MoU/IA terminated due to non-performance of Moser Baer Electric Power Ltd/Shreya Powertech Pvt Ltd in February 2017.
Teesta Low Dam I and II	West Bengal	81	MoU/IA signed with NHPC in July 2015.
Teesta Low Dam V	West Bengal	80	MoU/IA signed with NHPC in July 2015.
Teesta Intermediate Stage	West Bengal	84	MoU/IA signed with NHPC in July 2015.
Teesta Stage I	North Sikkim	280	MoU/IA canceled due to proximity to Kanchanjonga National Park.
Teesta Stage II	North Sikkim	330	MoU/IA terminated in September 2018 due to non -performance of Him Urja Infra Pvt. Ltd.
Ting Ting	West Sikkim	99	Project canceled due to non - achievement of milestones as per MoU by T.T. Energy Pvt. Ltd.
Upper Rolep (Nathangchu)	East Sikkim	30	MoU/IA terminated in September 2016 due to non - performance of Cosmic Infrapowergen Pvt Ltd.
Upper Rolep (Tshanguchu)	East Sikkim	30	MoU/IA terminated in September 2016 due to non - performance of Cosmic Infrapowergen Pvt Ltd.
Kalez Khola II	West Sikkim	54	MoU/IA terminated due to non-performance in February 2017.
Lachung	North Sikkim	99	MoU/IA terminated in June 2012. High Court of Sikkim set a new development timeline to 2018.
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Sources: 1. Hydropower development along Teesta river basin: opportunities for cooperation by Muhammad Mizanur Rahaman; Abdullah - Al - Mamun

2.CEA (2016), EDPS (2019), NHPC (2019).

projects have faced financial issues or are still in the planning phase, as indicated in Table 4.

Existing hydropower projects along the Teesta River basin in Sikkim and West Bengal are detailed in Table 3, while ongoing projects in the same region are listed in Table 4. Additionally, Table 5 outlines upcoming or proposed projects along the Teesta River basin, indicating their status and capacity.

Conclusion

The Teesta River has immense significance for Bangladesh due to its vital role in the agro-socioeconomic life of the northern region and its substantial impact on crop cultivation. Similarly, for India, the river is crucial in addressing hydropower needs. In this regard, a draft Framework Agreement on the river was finalized in 2011, paving the way for potential cooperation. Effective implementation of this agreement could serve as a notable example of successful diplomacy in South Asia. Besides, a coordinated development of the Teesta River basin has the promising opportunity to strengthen mutual trust and understanding between Bangladesh and India by addressing water-related concerns, enhancing irrigation capabilities, and ensuring food and energy security. It may even foster broader water cooperation across other river basins in the region.

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Flowing Towards Harmony: Bangladesh's Progress in Integrated Water Resources Management for Sustainable Development

SDG 6, formulated in 2016 with the mandate to "Ensure availability and sustainable management of water and sanitation for all," underpins global efforts towards water security and sanitation. Within this framework, SDG 6.5.1 focuses specifically on assessing the "Degree of Integrated Water Resources Management (IWRM) implementation." Bangladesh, as an active participant in the SDGs, has diligently monitored and reported on SDG 6.5.1 through a self-assessment survey conducted every three years. This effort commenced with the submission of a baseline report in 2017, contributing significantly to establishing the global baseline for IWRM implementation. Subsequent progress reports, including one in 2020, furthered the understanding of Bangladesh's advancements in IWRM implementation. As of 2023, a comprehensive study by CEGIS aims to assess the country's progress in meeting SDG 6.5.1 targets. Bangladesh's commitment to integrating the SDGs within the IWRM framework underscores its dedication to sustainable water resource management.

SDG 6 delineates a set of targets aimed at achieving universal access to clean water and sanitation, which are critical for human health and well-being. These targets encompass ensuring safe and affordable drinking water (TARGET 6.1), ending open defecation and providing access to sanitation and hygiene (TARGET 6.2), improving water quality, wastewater treatment, and safe reuse (TARGET 6.3), enhancing water use efficiency and ensuring freshwater supplies (TARGET 6.4), implementing Integrated Water Resources Management (TARGET 6.5), protecting and restoring water-related ecosystems (TARGET 6.6), expanding water and sanitation support to developing countries (TARGET 6. A), and supporting local engagement in water and sanitation management (TARGET 6. B). These targets provide a comprehensive roadmap for addressing water and sanitation challenges globally, including in Bangladesh.

SDG 6 comprises twelve indicators, each serving as a metric for evaluating progress toward the overarching goals of water security and sanitation. Among these, indicator 6.5.1, overseen by the United Nations Environment Programme (UNEP), specifically measures the "Degree of Integrated Water Resources Management (IWRM) implementation." This indicator is crucial for assessing the effectiveness of strategies and policies aimed at achieving sustainable water resource management. Additionally, indicator 6.5.2 evaluates the proportion of transboundary basin area with operational arrangements for water cooperation, highlighting the importance of collaboration in managing shared water resources.

Integrated Water Resources Management (IWRM) is paramount in Bangladesh due to its heavy reliance on water resources for various sectors such as agriculture, industry, and livelihoods. IWRM entails the coordinated development and management of water, land, and related resources to ensure sustainable water use while safeguarding ecosystems. This approach is particularly pertinent in Bangladesh, given its vulnerability to water-related challenges such as floods, water scarcity, and pollution. By adopting IWRM principles, Bangladesh can effectively address these challenges, promote water security, mitigate conflicts, and foster sustainable development.

The Action Framework for Implementing IWRM encompasses four key components aimed at facilitating effective water resource management in Bangladesh. The first component, 'Enabling Environment,' focuses on establishing policies, laws, and plans to support IWRM implementation and ensure sustainable water resource management. Examples include the Water Policy 1999 and the Water Act 2013. The second component, 'Institutions and Participation,' emphasizes the involvement of various stakeholders, including political, social, economic, and administrative institutions, in supporting IWRM implementation through participatory approaches. The third component, 'Management Instruments,' entails utilizing tools and activities such as monitoring and management programs to enable decision-makers to address IWRM effectively. Finally, the 'Financing' component underscores the importance of budgeting and financing for water resource development and management to support IWRM implementation.

The IWRM implementation status in Bangladesh from 2017 to 2020 reflects a gradual progression, as evidenced by the comparison with other countries in the region. In 2017, Bangladesh achieved a score of 50, indicating a medium level of implementation. By 2020, this score increased to 58, reflecting a move towards medium-high implementation. Comparatively, other countries, such as China, demonstrated a high degree of implementation with a score of 80, while countries like Nepal and Bhutan lagged with scores of 37 and 33, respectively. This progression underscores Bangladesh's commitment to advancing IWRM initiatives, albeit with room for further improvement.

The primary objective of the SDG Indicator 6.5.1 survey in 2023 is to assess the degree of Integrated Water Resources Management (IWRM) implementation in Bangladesh. This assessment aims to evaluate the effectiveness of measures taken to integrate water resource management practices across various sectors. Specifically, the survey focuses on assessing four key components of IWRM: *enabling environment, institutions and*

participation, management instruments, and financing. By evaluating progress in these areas, the survey seeks to provide insights into the effectiveness of policies, strategies, and actions undertaken to achieve sustainable water resource management goals.

The SDG 6.5.1 survey in 2023 involved a systematic process aimed at evaluating the degree of Integrated Water Resources Management (IWRM) implementation in Bangladesh. The steps include understanding the indicators, identifying relevant stakeholders, selecting participants, collecting data, organizing consultation workshops, conducting consensus-building sessions, processing data, validating scores, preparing survey reports, and submitting the final report to the United Nations Environment Programme (UNEP). Following this comprehensive approach, the survey ensures a thorough assessment of Bangladesh's progress towards achieving SDG Indicator 6.5.1 targets.

The SDG 6.5.1 survey findings for 2023 highlighted significant progress in various components of Integrated Water Resources Management (IWRM) in Bangladesh. Enabling Environment, Institutions & Participation, Management Instruments, and Financing have all shown improvement compared to previous years. For instance, Enabling Environment increased from 50 in 2017 to 66 in 2023, indicating advancements in policies and regulations supporting IWRM. Similarly, Institutions & Participation, Management Instruments, and Financing also demonstrated positive trends, reflecting Bangladesh's commitment to achieving sustainable water resource management goals.

Bangladesh has made commendable progress in advancing SDG Indicator 6.5.1, as evidenced by the significant improvements across various components of Integrated Water Resources Management (IWRM). Enabling Environment, Institutions & Participation, Management Instruments, and Financing have all witnessed notable enhancements, reflecting the country's commitment to achieving sustainable water resource management goals. With the overall score projected to reach 81 by 2023, Bangladesh is poised to make further strides towards achieving SDG 6.5.1 targets and ensuring water security for all.

The increase in scores across various components of Integrated Water Resources Management (IWRM) in Bangladesh can be attributed to several key factors. In the Enabling Environment component, initiatives such as the Environmental Clearance Regulation (ECR), the Perspective Plan (PP) 2041, and the National Adaptation Plan (NAP) have contributed to strengthening policies and regulations supporting IWRM. The initiative to upgrade the Haor Master Plan has further strengthened sustainable water resource management efforts. Similarly, improvements in

Institutions & Participation are evident through enhanced coordination among different government agencies, capacity development in IWRM, increased public participation, and greater private sector involvement in decision-making processes. Management Instruments have seen enhancements through efficient groundwater and surface water management practices, supported by policies such as the National Water Policy 1999 and the Bangladesh Water Act 2013. Pollution control measures outlined in the Bangladesh Water Act 2013 and the Industrial Water Use Policy 2019 have also contributed to improved

water resource management. Financing initiatives, including increased national budget allocations for water infrastructure, ongoing basin-wise feasibility studies, revenue generation for IWRM elements, and enhanced financing for transboundary cooperation, have further facilitated progress in implementing IWRM practices. These concerted efforts have led to significant advancements in Bangladesh's water resource management landscape, driving the increase in scores across various components of SDG Indicator 6.5.1.

Despite progress, Bangladesh faces several challenges in achieving SDG 6.5.1 targets. These challenges include coordination gaps and alignment of policies, insufficient institutional capacities, limited participation of women in decision-making processes, inadequate research activities, monitoring and data-sharing issues, financing constraints, and budget limitations for transboundary cooperation projects. Addressing these challenges will be crucial for Bangladesh to sustain its progress towards achieving sustainable water resource management goals and ensuring water security for all.

Meanwhile, Bangladesh has set ambitious targets for achieving sustainable water resource management, aiming for a score of 60 by 2025 and 70 by 2030, which are within reach considering the current trajectory of progress. The latest SDG 6.5.1 status survey 2023 indicates a draft score of 64, with a projected score of 81 by 2030 if the momentum is sustained. These advancements signify the country's commitment to achieving SDG targets and pave the way for fostering peace and stability through water management. To ensure continued progress, it is imperative to periodically review and update water-related legislation, prioritize the establishment of River Basin Organizations to accelerate Integrated Water Resources Management (IWRM), strengthen coordination within the water sector and across other relevant organizations, and enhance data and information sharing among co-riparian countries. Moreover, allocating adequate budgets for basin-wise IWRM projects, enforcing shadow pricing of water, and monitoring irrigation/water use service charge collection are essential steps.

Given the challenges of water scarcity, pollution, and climate change impacts, Bangladesh is vulnerable in terms of sustainable water resource management. However, by developing an Integrated Water Resources Management (IWRM) action plan, Bangladesh can address these challenges and move towards sustainable water resource management. Such an IWRM action plan will involve a comprehensive approach toward water resource management, taking into account the social, economic, and environmental factors. It will also help to identify the different stakeholders involved in water resource management and ensure their active participation in the decision-making process. This approach will help promote regional stability and foster the essence of the theme of *"Water for Peace."*

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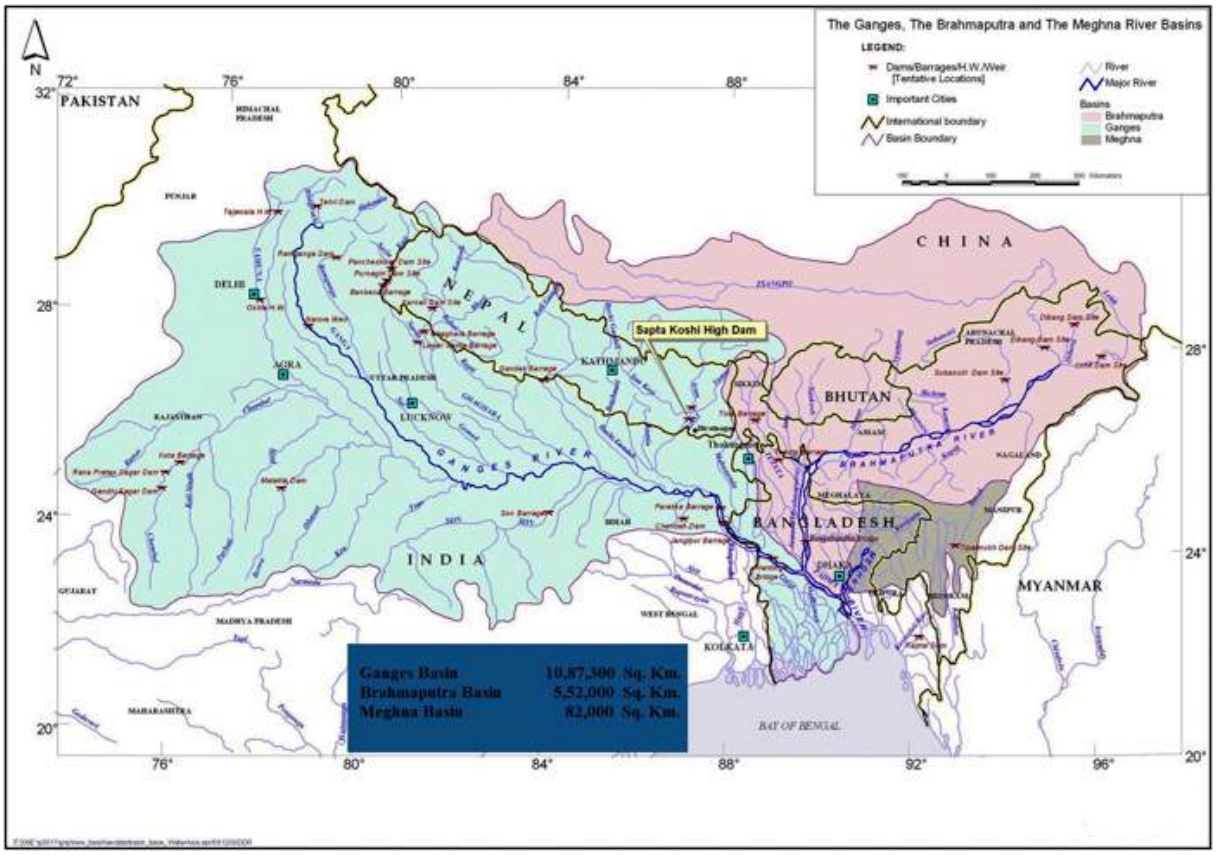
Indo-Bangladesh Water Cooperation and the Way Forward: Perspective Transboundary Rivers

Bangladesh is a great delta formed by the alluvial deposits of the three mighty Himalayan Rivers: the Ganges, the Brahmaputra and the Meghna. There are about 405 rivers in Bangladesh of which 57 are trans-boundary rivers. A trans-boundary river is a river that crosses at least one political border, either a border within a nation or an international boundary. There are presently 260 trans-boundary river basins around the world, covering 45% of the land surface of the earth. Bangladesh is traversed with the greatest number of these rivers, almost exclusively trans-international. A total of 57 trans-boundary rivers, 54 are common with India and remaining 3 with Myanmar. Hydrologically and politically, these 57 trans-boundary rivers are very significant because of two reasons. First one is as they carry a lot of sediments to help land accretion in the estuarine region but also raise riverbeds to cause floods and second one is Bangladesh is as a downstream country which development (environmental, agriculture and water resources) most of the time depends on upstream country's activities. The life and livelihood of the millions of people of Bangladesh have been revolving around waters of these rivers over the ages. The Ganges, the Brahmaputra and the Meghna river systems drain a total catchment area of about 1.72 million sq km through Bangladesh into the Bay of Bengal. Out of this large catchment area, only 7% lies in Bangladesh. For this reason, Bangladesh experienced excess water in rainy season and shortage or scarcity of water in dry season. The other co-riparian countries are India, Nepal, Bhutan and China.

Indo-Bangladesh Cooperation

India and Bangladesh share 54 common rivers. The Joint Rivers Commission was established on a permanent basis through a joint declaration between the Prime Ministers of Bangladesh and India on 19 March, 1972 inter-alia to carry out a comprehensive survey of the river systems shared by the two countries, formulate projects concerning both the countries in the fields of flood control and to implement them, to formulate



detailed proposals on advance flood warnings, flood forecasting, cyclone warning, study on flood control and irrigation projects on the major river systems and examine the feasibility of linking the power grids of Bangladesh with the adjoining areas of India, so that the water resources of the regions can be utilized on an equitable basis for mutual benefit of the people of the two countries. The Statute of JRC was accordingly signed on 24 November, 1972 to maintain liaison between the participating countries in order to ensure the most effective joint efforts in maximizing the benefits from common river systems to both the countries. The JRC is headed by Water Resources Ministers of both the countries.

A new chapter in the Indo-Bangladesh relations opened up with signing of a Treaty by the Prime Ministers of India and Bangladesh on 12th December 1996 on the sharing of Ganges waters based on a sharing formula of the flows measured at Farakka, during the lean season each year, from 1st January to 31st May. The 30-year Treaty is renewable by mutual consent. For monitoring the implementation of the Treaty, a Joint Committee has been set up.

Discussions have been continuing with Bangladesh for sharing of waters of Teesta & Feni rivers besides other six common rivers namely; Manu, Muhri, Khowai, Gumti, Jaldhaka and Torsa. Govt. of India is at its endeavor to conclude the agreement of the sharing of waters of Teesta and Feni rivers with Bangladesh, which is acceptable to all parties concerned and which protects the interests of all stakeholders.

A Memorandum of Understanding was signed on 5th October 2019 between the Ministry of Jal Shakti, Government of the Republic of India and Ministry of Water Resources, Government of the People's Republic of Bangladesh on withdrawal of 1.82 cusecs of water from Feni River by India for drinking water supply scheme for Sabroom town, Tripura, India. Another Memorandum of Understanding was signed on 6th September, 2022 between Ministry of Jal Shakti, Government of the Republic of India and Ministry of Water Resources, Government of the People's Republic of Bangladesh on withdrawal of upto 153 cusecs of water each by India and Bangladesh from the common border river Kushiyara during the dry season for the consumptive water requirements of each country.

There exists a system of Transmission of flood forecasting data on major rivers like Ganges, Teesta, Brahmputra and Barak during the monsoon season from India to Bangladesh. The transmission of flood forecasting information during the monsoon has enabled the civil and military authorities in Bangladesh to shift the population affected by floods to safer places.

Present Scenario of Bangladesh

The water-related impacts of climate change are worsening and a growing global population is placing increasing demand on a finite resource. Within many countries, people's access to safe drinking water is unevenly and unfairly distributed. Between countries, the widespread lack of trans-boundary cooperation on shared water resources poses a risk to the quality and quantity of water supplies and therefore threatens social and international stability like Bangladesh.

Day by day, water is under growing pressure in Bangladesh. Upstream development activities in the Upstream (India), the diversion, use or storage of flows from the trans-boundary rivers is of major importance to downstream (Bangladesh). Impacts on dry and monsoon season flows, salinization, siltation of rivers and sediment deposition in the Meghna estuary are the most important factors. These, in turn, have a direct impact on the ability of the (coastal) floodplains to keep up with sea level rise in the Meghna estuary. The Ganges River has been found to be the most negatively impacted river among the major rivers followed by the Brahmaputra and to a much lesser extent the Meghna River. The most impacted regional rivers are: The Dudhkumar, Dharla, Teesta and Mahananda Rivers.

After establishing JRC in 1972, out of 54 rivers only one river of Ganges water sharing agreement has been made in 1996. Since then the meetings of Joint Committee on sharing of the Ganges flows at Farakka have been continued. Besides this, different meetings at different level have been continued from 1997 to till, such as Joint Committee of Experts on sharing of Teesta waters and other common rivers, Indo-Bangladesh Experts on Flood Forecasting and Warning System, Indo-Bangladesh Joint Scientific Study team etc. But for other 53 rivers, not yet is possible to make any water sharing agreement or treaty. Though Bangladesh has taken attempt several times even for a long time or series of years, but not yet able to make Teesta river water sharing agreement with India. The last meeting of JRC took place in India. 38th meeting of the JRC was held at New Delhi from 25th August, 2022, wherein various matters pertaining to cooperation in Water Resources sector with Bangladesh were discussed. Several times (from 1997 to till), the Water Resources Ministers of both the countries jointly visited some river sites in both countries and discussed issues

relating to riverbank protection, minor lift irrigation and drinking water schemes. But there is none expected progress or none of any happy news for Bangladesh. It is proved that the countries upstream often do not care for international conventions of water sharing and this leads to disputes with complex political implications.

The way forward

Poor provision of water services can delegitimize States. The inability of a government to provide basic water services can lead to a de-legitimization of State institutions and ignite social unrest, especially in the context of food insecurity, high unemployment and internal migration. That's why, there is an urgent need with most importance to work together to protect and conserve our most precious water resource. Upstream country India must use water as a tool to create a more peaceful and prosperous for both country. India must act upon the realization that water is not only a resource to be used and competed over-it is a human right, intrinsic to every aspect of life. In view of that the two countries have a bilateral Joint Rivers Commission (JRC) and they should do work to maintain liaison between the two countries to maximize benefits from common river systems.

Water can be a tool for peace. Over time, there have been many more incidences of cooperation than conflict over water, but there is much more to do. Peaceful cooperation around water-within and between countries-can pave the way for peaceful cooperation in all sectors.

Water can be a stabilizing force and a catalyst for sustainable development. We must act upon the realization that water is not only a resource to be used and competed over- it is a human right, intrinsic to every aspect of life.

- At the local and national level, different water users-particularly water and sanitation utilities, energy, food and industry - must cooperate through an integrated water resources management approach and promote a circular economy that fulfils people's human rights.
- At the basin level, countries should develop agreements and set up institutions to peacefully manage water resources that cross international borders.
- Governments should cooperate on trans-boundary waters bilaterally, regionally or globally, for example through signing up to and implementing the United Nations Water Convention and Watercourses Convention.

Water cooperation creates a positive ripple effect. Water cooperation across borders and sectors generates many benefits including enhancing food security, sustaining healthy livelihoods and ecosystems, helping to address resilience to climate change, contributing to disaster risk reduction, providing renewable energy, supporting cities and industry, and fostering regional integration and peace (UNESCO/UNICEF, 2023).

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Haor Regions: A Unique Ecosystem of Northeast Bangladesh

Haors, with their distinctive hydro-ecological features, constitute vast bowl-shaped floodplain depressions nestled in the northeastern reaches of Bangladesh. Encompassing approximately 1.99 million hectares (19,998 sq km) of land and providing a home for about 19.37 million people, these areas are characterized by a mosaic of wetlands comprising rivers, canals, and expanses of seasonally flooded cultivated plains and beels. Stretching across districts such as Sunamganj, Sylhet, Habiganj, Maulvibazar, Netrakona, Kishoreganj, and Brahmanbaria, there are a total of 373 Haors or wetlands, covering roughly 859,000 hectares, accounting for approximately 43% of the total area in the Haor districts.

Haors, featuring deeply flooded regions that make up around 50% of their total area, are significant contributors to Bangladesh's economy, constituting approximately 6-8% of the national GDP. The Haor regions are renowned for their remarkable resources, sustaining livelihoods and biodiversity alike.

The Haor region boasts an array of distinct attributes. It is a vital agricultural hub, yielding approximately 6.2 million metric tons of rice annually, which accounts for 17% of the country's total rice production and 19% of its Boro production. Furthermore, 63% of the Haor area is irrigated by surface water, with 86% of its population primarily engaged in agriculture.

Haors also play a crucial role in the fisheries sector, contributing 14% of inland fish production and a significant 84% of capture fisheries production. Hosting unique fish species such as Rani, Lasu, Ghonia, Mohashol, Nanid, and Tila Shol, as well as a diverse array of fin fish including 143 indigenous and 12 exotic species, along with various freshwater prawns, the Haor region stands out as a biodiversity hotspot.

Moreover, the Haor ecosystem supports a rich variety of wetland plants, amphibians, birds, mammals, and reptiles, with Tanguar Haor

designated as a RAMSAR Site, attracting up to 60,000 migratory birds annually and housing 207 species.

Disasters in the Haor region present a multifaceted challenge, encompassing early flash floods, rainfall variability, siltation, riverbank erosion, and other environmental hazards. The unpredictability of early flash floods, exemplified by events in 2017 and 2022, inflicts severe damage to infrastructure and agricultural productivity, exacerbating economic losses and threatening livelihoods. Moreover, the region grapples with erratic rainfall patterns and projected increases due to climate change, with estimates suggesting a rise of 0.1-1.4 per cent in the 2030s and 2.4-3.5 per cent in the 2050s, heightening risks of inundation and agricultural disruption. Siltation and sedimentation, coupled with riverbank erosion, further compound these challenges, with the average annual suspended sediment load estimated at 3.7 and 8.6 million metric tons per year for the Surma and Kushiyara rivers, respectively, and a net accumulation of approximately 8 million tons per year. Additionally, extreme temperature fluctuations and associated health risks underscore the complex nature of environmental hazards faced by Haor communities. Addressing these diverse challenges necessitates a holistic approach to disaster management, emphasizing resilience-building measures, sustainable resource management, and community adaptation strategies to mitigate risks and safeguard the well-being of Haor inhabitants.

In conclusion, the Haor region represents a unique and invaluable ecosystem that requires strategic attention and concerted efforts for its preservation and sustainable management. With its significant contributions to agriculture, fisheries, and biodiversity, the region serves as a lifeline for millions of inhabitants. Despite grappling with formidable challenges such as early flash floods, rainfall variability, siltation, riverbank erosion, and other environmental hazards, there is optimism in the existence of comprehensive strategies outlined not only in the National Adaptation Plan (NAP) and the Bangladesh Delta Plan 2100 (BDP2100) but also in the Haor Master Plan.

These strategic frameworks provide a comprehensive roadmap for integrated planning and sustainable management of the Haor region, encompassing measures ranging from improved infrastructure resilience and enhanced flood management systems to the promotion of sustainable agriculture practices and community-based adaptation initiatives.

Additionally, the plans emphasize the importance of adopting experimental bioengineering and eco-engineering techniques for slope stabilization of embankments or banks of canals, reducing erosion risk, and enhancing ecological resilience.

Furthermore, ecosystem-based adaptation initiatives should be undertaken to leverage the natural resilience of the Haor ecosystem. Development of Haor, and wetland-specific WASH (Water, Sanitation, and Hygiene) technologies focusing on serving the needs of people living in Aatis (in Haor) is crucial for ensuring the well-being of communities in these vulnerable areas.

Moreover, strengthening Early Warning Systems (EWS) for flash floods is essential to enhance preparedness and minimize the impacts of disasters. By harnessing these innovative approaches and fostering collaboration among stakeholders, we can ensure the resilience and prosperity of the Haor region, safeguarding its ecological integrity and securing the well-being of its inhabitants for generations to come.

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The Role of Bangladesh Water Act 2013 and Bangladesh Water Rules 2018 towards Developing Resilience and Strengthening Equity in the Water Sector of the Country

When every drop count matter, water, the unique resource, needs much attention. Every living element needs water for survival. Water has competing users and the resource is not abundant. Therefore the distribution and management of water in an equitable manner is challenging and needs a comprehensive and holistic approach. Therefore, the Bangladesh Water Act 2013 and Bangladesh Water Rules 2018 clearly and unequivocally declare the intention of the government that "all necessary means and measures will be taken to manage the water resources of the country in a comprehensive, integrated, and equitable manner".

More than 3 billion people worldwide depend on water that crosses national borders. Yet, out of 153 countries that share rivers, lakes, and aquifers with their neighbors, only 24 countries report having cooperation agreements for all their shared water (UN 2022). Roughly half of the world's population is experiencing severe water scarcity for at least part of the year (IPCC, 2022). Similarly, Bangladesh faces challenges in managing its scarce water resources with appropriate allocation among different cross sectors.

One of the big steps in sustainable water management in Bangladesh is the formulation of the Bangladesh Water Act 2013 and Bangladesh Water Rules 2018. Water is a critical element in development, and many efforts have been made in Bangladesh to improve safe drinking water coverage while optimizing the use of water for irrigation, industrial, and other uses, but these efforts often overlook the holistic perspective of sustainable development. Sustainable solutions to water problems require a paradigm shift from compartmental sub-sector-wise development to holistic water management. Furthermore, to face the growing challenges regarding water rights, protection of resources, water use, and water services management, Bangladesh has enacted a comprehensive legal framework called the Bangladesh Water Act (BWA) 2013. This act directed a coordinated and comprehensive regime

for the development, management, extraction, allocation, use and conservation of water resources. On the other hand the development of the Bangladesh Water Rules (BWR), 2018 clearly demonstrates that Bangladesh has been advancing its goal of the sustainable development of water resources.

Salient Features of BWA 2013 and BWR 2018

The indication of the National Water Policy (1999) is to develop a Water Code to ensure the implementation of policy recommendations. Thus, based on the National Water Policy (1999), the Bangladesh Water Act 2013 is designed for integrated development, management, extraction, distribution, usage, protection, and conservation of water resources in Bangladesh. The Act has provided the appropriate framework for better management of water resources in the country. Bangladesh Water Rules 2018 was also prepared and finalized following Bangladesh Water Act, 2013.

According to the Act, all forms of water (e.g., surface water, groundwater, seawater, rainwater, and atmospheric water) within the territory of Bangladesh belong to the government on behalf of the people. The private landowners will be able to use the surface water inside their property for all purposes in accordance with the Act. A worthwhile initiative is a requirement for permits/licenses for large scale large-scale water withdrawal by individuals and organizations beyond domestic use. Without prior permission issued by the Executive Committee, no individuals or organizations will be allowed to extract, distribute, use, develop, protect, and conserve water resources, nor will they be allowed to build any structure that impedes the natural flow of rivers and creeks. Setting up a priority order for water usage in an area where the water resources are in critical condition is also a significant step. The priority order as depicted in the Act is as follows: drinking water > domestic usage > irrigation > fish culture > bio-diversity > wildlife > in stream flow > industry > salinity control > power generation > recreation > miscellaneous. It should be noted that drinking water and domestic usage are considered basic human rights.

The water Resources Planning Organization (WARPO) under the Ministry of Water Resources has taken the lead coordination role in making it happen and organized a number of consultations with relevant sector actors. The formation of the high-powered National Water Resources Council, with the honorable Prime Minister as the head, is paying to the management of this precious resource. An Executive Committee under the Ministry of Water Resources will implement the decisions taken by the Council.

All sorts of water resources management within the country have been assigned to the Executive Committee under the Ministry of Water Resources, which is another noteworthy decision. The Act provides the legal framework for the development, management, extraction, distribution, usage, protection, and conservation of water resources. It also provides provisions for punishment and financial penalty for non-compliance with the Act, including negligence to abide by government policy and ordinance, non-cooperation with government officials, refusal to present necessary documents, providing false information, affiliation with perpetrators, and protection measures for water resources management. The Act also recognizes the significance of managing all forms of water resources in the context of the natural flow of surface water and recharge of groundwater.

Stakeholder Consultation on BWA 2013 and BWR 2018

About 65 dissemination workshops on BWA 2013 and BWR 2018 have already been held up to

February 2024 at District, Upazilla, and Union levels where the Senior Secretary/Secretary, Ministry of Water Resources, was the Chief Guest at District Level consultation and Director General, WARPO was the Chief Guest in Upazilla and Union Level consultation. On the other hand, the workshop was chaired by the Deputy Commissioner, Upazila Nirbahi Officer of the respective district and Upazillas. The objective of the stakeholder consultation was to make aware of the Bangladesh Water Act 2013 and Bangladesh Water Rules 2018 for effective implementation in the long run.

Stakeholder feedback about the Bangladesh Water Act 2013 and Bangladesh Water Rules 2018

The following recommendation/suggestion is made for future amendments to the Act and Rules. (a) Inclusion of BWA 2013 and BWR 2018 in Mobile Court Act 2009 for conducting the allegation in summary trials depending on the significance of the offences. (b) Sensitizing the stakeholders, including District, Upazilla, and Union level Integrated Water Resources Management Committee Members, for ensuring effective participation in the implementation of BWA 2013 and BWR 2018.(c) Inclusion of Adaptive Delta Management issues in updated Bangladesh Water Act and Bangladesh Water Rules for Implementation of Bangladesh Delta Plan 2100. (d) Issues of Climate Change and Ecosystem Services need to be well addressed in the Act and Rules (e) Inclusion of representatives from different related organizations to ensure active participation in District/Upazilla/Union IWRM committee as per the act.

Respected Secretary, Ministry of Water Resources Mr. Nazmul Ahsan enlighted the BWA 2013 and BWR 2018 Dissemination Seminar as the Chief Guest at WARPO Bhaban

District Integrated Water Resources Management Committee Stakeholder consultation on BWA and BWR at Thakurgaon DC conference room

Implication of Bangladesh Water Act 2013 and Bangladesh Water Rules 2018 at project level

A Project titled 'Institutionalization of Integrated Water Resources Management (IWRM) process in compliance with Bangladesh Water Rules, 2018' has been implemented to perform a baseline study for identifying the state of surface and groundwater resources (water availability, demand, and use) in the High Barind region up to Mouza level. The study area is located in three districts, namely, Rajshahi, Naogaon, and Chapai Nawabganj Districts.

The major study findings are

a) Installation of new tube wells and extraction of underground water should be limited in water-stressed areas.

b) Out of the public or private ponds leased in water-stressed areas, some ponds should be reserved for drinking water and domestic purposes without leasing. A signboard will be

placed in front of each protected pond with detailed instructions on which pond can be used for which purposes.

c) The necessary number of canals for drinking and domestic water should be excavated in water-scarce areas and there will be detailed instructions on which canals can be used for which purpose by installing signboards in front of the canals.

d) The shortage of water should be met by supplying water from low water-stressed areas to high water-stressed areas.

e) The local people should be informed about the overall status of water resources (availability, demand, use, critical status etc.) in the project area to sensitize the users at various levels and thus ensure optimal uses of water.

f) Projects to be developed for identifying groundwater and surface water problems in 10 districts of north-central hydrological region of the country by 2026 and remaining 44 districts by using modern technology based and automated monitoring system by 2030.

g) Use of surface water should be increased to reduce the pressure on groundwater. Necessary infrastructure need to be constructed (pipe lines, water treatment plants and overhead tanks etc.) for ensure fresh water during the monsoon through constructing reservoirs and storing of surface water.

h) To ensure Integrated Water Governance, Managed Aquifer Recharge (MAR) Center should be established in water-stressed areas on scientific basis.

Way Forward

By working together to balance everyone's human rights and needs, water can be a stabilizing force and a catalyst for sustainable development. Public health and prosperity, food and energy systems, economic productivity, and environmental integrity all rely on a well-functioning and equitably managed water cycle, and the BWA and BWR may play significant roles.

Climate change is primarily a water crisis. We feel its impacts through worsening floods, rising sea levels, shrinking ice fields, wildfires, and droughts. However, water can fight climate change. Sustainable water management is central to building the resilience of societies and ecosystems. Everyone has a role to play – individual and household-level actions are vital.

Achieving stability and prosperity in the water sector demands innovation in technology development, implementation, cooperation, and collaboration. It is necessary for water security, climate adaptation, and sustainable water resources management. Sensor technology, artificial intelligence, cloud computing, and big data management can help monitor water quantity and quality. It can also inform operational

decisions for implementing BWA 2013 and BWR 2018. Innovations in water infrastructure planning and management, including nature-based systems to manage water resources can contribute to resilient water management in the country.

As a society, we must acknowledge the fact that water is more than just a resource to be used and fought over. It is a fundamental human right that is essential to every aspect of life. With the increasing impact of climate change and the growth of the global population, it is vital that we come together to protect and conserve our most precious resource.

This World Water Day, let us unite around water, using water for peace, laying the foundations of a more stable and prosperous tomorrow with a fair and equitable distribution of water resources under the BWA 2013 and BWR 2018 framework in the country.

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Sustainable Water Management Strategies for Basin Countries:
A Runoff Scenario Analysis

The Center for Environmental and Geographic Information Services (CEGIS) spearheaded a comprehensive study titled "Runoff Scenario and Water-Based Adaptation Strategies in South Asia," in partnership with Small Earth, Nepal, and the Global Change Impact Study Center (GCISC), Pakistan. This collaborative effort, funded by the Asia Pacific Network for Global Change Research (APN), aimed to address water-related challenges in the region and promote stability and prosperity through sustainable water management strategies.

The primary objective of the study was to generate runoff scenarios and develop water-based adaptation strategies through community engagement. The study sought to achieve the following specific objectives:

- **Runoff Scenario Generation:** The study aimed to generate future runoff scenarios under Intergovernmental Panel on Climate Change (IPCC) scenarios for the short-term (2020), medium-term (2050), and long-term (2080) through hydrological modeling.
- **Exploration of Adaptation Measures:** It endeavored to explore potential adaptation measures and develop community-based adaptation strategies with a focus on water resource management.
- **Dissemination of Findings:** The study aimed to disseminate its research findings among policymakers and stakeholders to serve as a decision support system.

The study focused on three distinct river basins: the Karnali basin in Nepal, the Gilgit basin in Pakistan, and the Ganges-Padma basin in Bangladesh. In Bangladesh, the study covered a substantial watershed area of 46,300 sq. km within the Ganges Padma basin, encompassing regions such as Jashore, Kushtia, Rajshahi, Pabna, Khulna, Barisal, Faridpur, and Dhaka Districts.

CEGIS developed a sophisticated water balance model known as the Soil and Water Assessment Tool (SWAT) to assess water resource variability across thirty-five districts in Bangladesh. Future climate scenarios were simulated using the

Regional Climate Model version 4 (RegCM4) data under Representative Concentration Pathway 4.5 (RCP4.5) of CORDEX-South Asia. To ensure accuracy, the model underwent rigorous calibration and validation against discharge stations at Korotoa River and Mahananda River.

The study unveiled significant changes in runoff patterns across different regions and timeframes. For instance, in the South-Central region, runoff decreased by 12.16% in Rajshahi during the 2030s. Similarly, in the North-West region, Chuadanga experienced a reduction of 7.02% in runoff during the same period.

Adaptation strategies were meticulously developed based on insights from community discussions and informed by global and national policies.

Adaptation Strategies for the Water Sector

- **Establishing Regulatory Frameworks:** This involves formulating and implementing robust regulatory frameworks to govern water management practices. These frameworks ensure efficient water resource allocation, promote sustainable use, and prevent overexploitation.
- **Enhancing Water Storage and Management Infrastructure:** This strategy entails investing in infrastructure development to enhance water storage capacity and improve management practices. This may include the construction of reservoirs, dams, and irrigation systems to capture and utilize water more effectively.
- **Improving Water Quality:** Efforts to improve water quality are crucial for ensuring the availability of clean and safe water for various purposes, including drinking, agriculture, and industry. This can be achieved through the establishment of water treatment plants and the implementation of pollution control measures.

Adaptation Strategies Agricultural Domain

- **Diversification:** Encouraging agricultural diversification involves promoting the cultivation of a variety of crops that are resilient to changing climatic conditions. This helps reduce the reliance on single crops and mitigates the risks associated with climate variability.
- **Sustainable Land Management Practices:** This strategy focuses on implementing practices that help conserve soil and water resources, such as soil conservation techniques, agroforestry, and the use of cover crops. Sustainable land management practices contribute to improved soil health, water retention, and overall ecosystem resilience.
- **Integrated Pest Management (IPM):** IPM involves the coordinated use of multiple pest

control methods to minimize the use of chemical pesticides while effectively managing pest populations. This approach promotes ecological balance and reduces the environmental impact of pest management practices.

- **Facilitating Access to Credit and Agricultural Facilities:** Ensuring access to credit and agricultural facilities such as seeds, fertilizers, and machinery is essential for enabling farmers to adopt climate-resilient practices. This includes providing financial support, establishing agricultural cooperatives, and improving market access for smallholder farmers.

Adaptation strategies are tailored to address specific challenges associated with high or low runoff conditions. For instance, in regions experiencing high runoff, strategies may focus on infrastructure development and flood management measures to mitigate the risks of inundation and waterlogging. Conversely, in areas with low runoff, emphasis may be placed on water augmentation techniques and the cultivation of drought-tolerant crop varieties to cope with water scarcity and ensure agricultural productivity.

The study underscores the critical importance of integrating runoff scenario analysis and adaptation strategies into policy and planning frameworks. It emphasizes the imperative of collaboration among basin countries to ensure effective basin-wide water management. The findings of this study serve as a valuable resource for policymakers and stakeholders, offering insights to facilitate the sustainable management of water resources in the region and contribute to the overarching goal of fostering stability and prosperity in water basin countries. The collaborative nature of this study highlights the significance of international cooperation in tackling shared water challenges and enhancing geopolitical relations among basin countries. By engaging communities, policymakers, and scientific experts across borders, the study fosters a sense of collective responsibility towards water stewardship and resilience-building.

As we commemorate World Water Day 2024 under the theme of "Water for Peace," this study exemplifies the pivotal role of water in fostering stability, prosperity, and conflict prevention. By promoting sustainable water management strategies, the study contributes to building resilient communities, enhancing food security, and safeguarding water resources for future generations.

The findings and recommendations of this study serve as a beacon of hope, guiding efforts towards a more water-secure and peaceful world. Through continued collaboration and concerted action, we can harness the power of water as a catalyst for peace, prosperity, and strengthened geopolitical relations among basin countries and beyond.

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Center for Environmental and Geographic Information Services

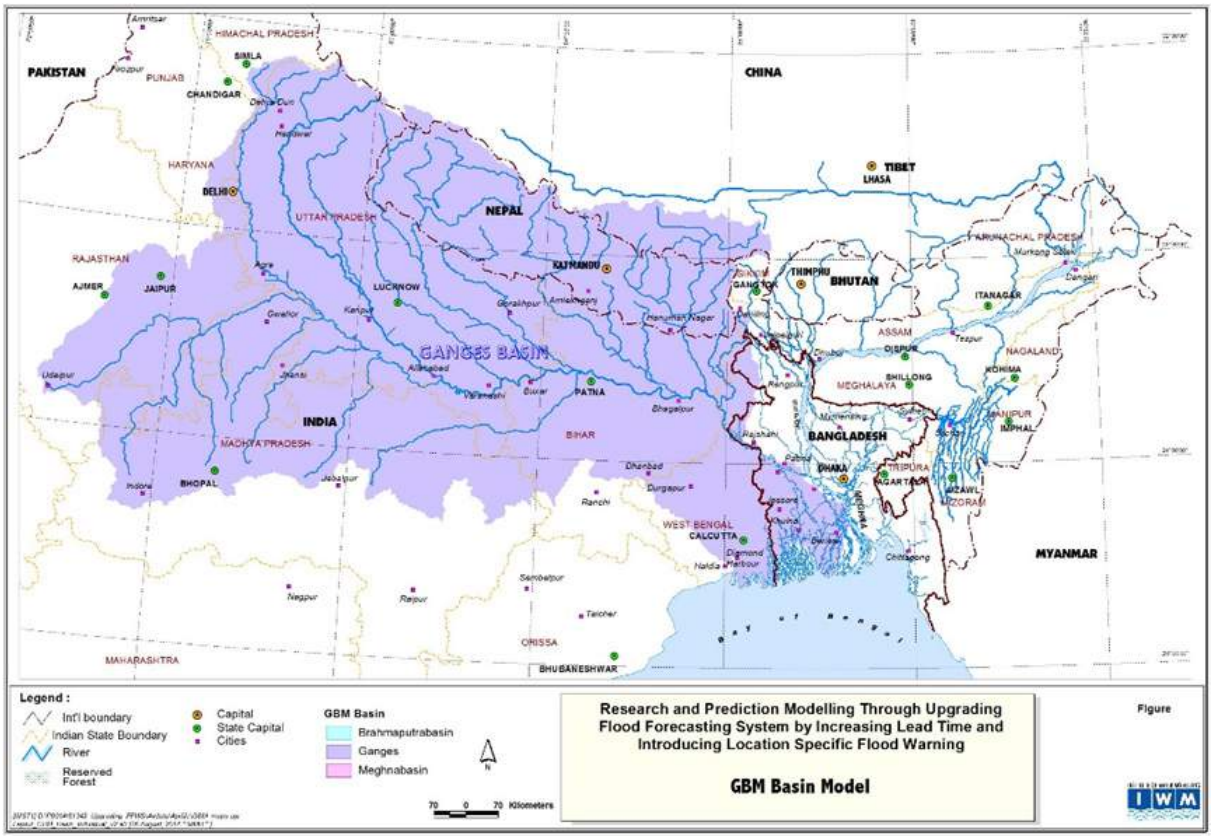
Water For Peace: Regional Cooperation in the GBM Basins

"Anyone who can solve the problems of water will be worthy of two Nobel prizes—one for peace and one for science." This profound statement by President John F. Kennedy encapsulates the multifaceted significance of water, transcending boundaries and disciplines. As we observe World Water Day 2024 under the theme "Water for Peace," the quote resonates deeply in the context of the Greater Ganges-Brahmaputra-Meghna (GBM) Basins, where water intertwines with socio-economic development, environmental sustainability, and geopolitical dynamics. This essay explores the imperative of regional cooperation in addressing transboundary water issues, river transportation, and tourism, harnessing the blue economy's potential, hydropower sharing, and disaster-related data sharing with a focus on Bangladesh.

Transboundary Water Sharing

According to the UN-Water, sixty percent of freshwater flows worldwide occur in transboundary waters. 592 transboundary aquifer systems and 286 transboundary river and lake basins contain territory belonging to 153 different countries. However, agreements for collaboration covering all shared water are only in place for 24 countries.

Transboundary Rivers such as the Ganges, Brahmaputra, and Meghna are lifelines for millions across the GBM Basins. However, equitable sharing of water resources remains a contentious issue. The 1996 Ganges Water Sharing Treaty between India and Bangladesh is a beacon of successful cooperation, ensuring minimum flow and addressing water-related challenges. This treaty showcases the potential of safeguarding the interset of the people of two nations and signifies an accomplishment of collaborative approach in maintaining transboundary water resources.



Maritime Boundary and Blue Economy

The maritime boundary between Bangladesh and India and Myanmar is significant for several reasons. Bangladesh shares a maritime boundary with India in the Bay of Bengal, governed by the United Nations Convention on the Law of the Sea (UNCLOS). The boundary dispute between Bangladesh and India was resolved through international arbitration in 2014, resulting in a clear delimitation of the boundary. This agreement has facilitated cooperation in maritime security, fisheries management, and resource exploration.

As the theme of World Water Day 2024, "Water for Peace," resonates deeply in the Bay of Bengal, fixing Bangladesh's maritime boundaries with India and Myanmar holds immense significance. Securing freshwater resources is crucial, but the potential of the blue economy can also be unlocked by enabling sustainable fisheries management, exploring marine resources, developing maritime infrastructure, and promoting investment and trade. Achieving this requires continuous diplomatic efforts, regional cooperation, and investment in capacity building, paving the way for a peaceful and prosperous future where the Bay of Bengal becomes a beacon of shared prosperity.

Hydropower Sharing

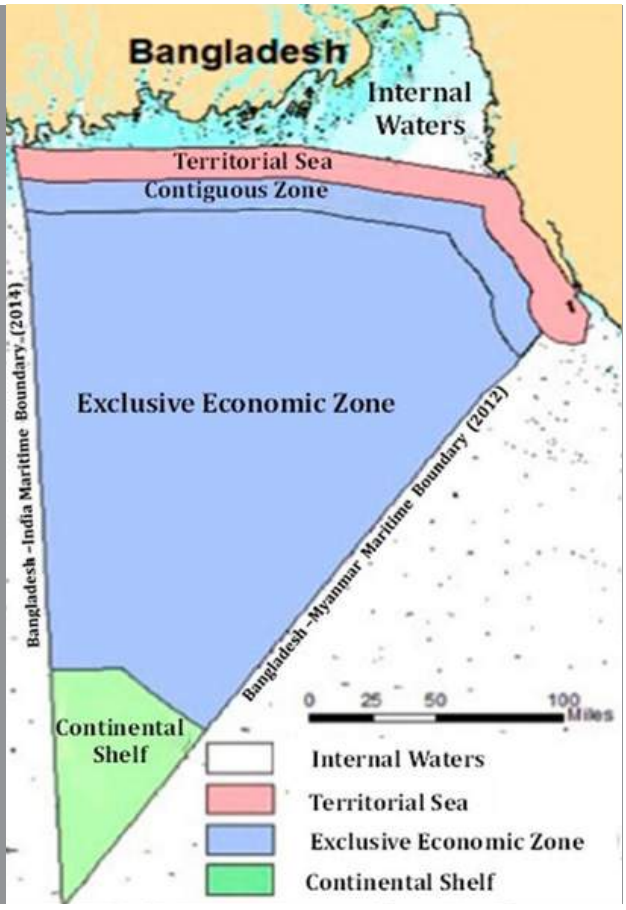
Hydropower sharing among Bangladesh, Bhutan, India, and Nepal holds immense potential for ensuring regional cooperation and energy security. With abundant water resources and hydropower potential, the countries in the region can benefit from collaborative projects that harness clean and renewable energy sources. Bhutan and Nepal possess significant hydropower potential in their mountainous terrains, while Bangladesh and India offer substantial demand for electricity.

By fostering mutual agreements and joint ventures, the countries can optimize the utilization of water resources, promote cross-border electricity trade, and enhance energy access for millions of people. Hydropower-sharing initiatives also contribute to poverty alleviation, economic growth, and environmental sustainability by reducing reliance on fossil fuels and mitigating greenhouse gas emissions. Moreover, such collaborations foster trust, diplomatic ties, and regional stability laying the foundation for broader cooperation in water resources management and transboundary issues. As the countries explore opportunities for hydropower development and

sharing, they pave the way for a greener, more interconnected future, benefiting both present and future generations.

Transboundary Water Pollution

Transboundary water pollution between Bangladesh and India poses a significant environmental threat, particularly along shared rivers. Industrial discharge, agricultural runoff, and untreated sewage contribute to deteriorating water quality, endangering ecosystems and public health in both countries. Addressing this challenge requires bilateral cooperation, joint monitoring, and robust regulatory frameworks. Bangladesh and India must engage in collaborative efforts to track pollution sources, assess water quality, and implement effective pollution control measures. Strengthening regulatory enforcement, investing in pollution treatment infrastructure, and promoting community engagement are crucial measures to reduce transboundary water pollution and protect shared water resources. Bangladesh and India can effectively address this issue by prioritizing dialogue, mutual cooperation, and sustainable practices. This entails fostering partnerships, sharing expertise, and implementing solutions that prioritize the health and sustainability of ecosystems and communities reliant on shared rivers. Through joint efforts and concerted action, both countries can mitigate the adverse impacts of pollution, ensuring the availability of clean and safe water resources for present and future generations.



Disaster-related Data and Knowledge Sharing

Disaster-related data and knowledge sharing among GBM countries is imperative for the region's effective disaster preparedness, response, and mitigation efforts. Given the shared vulnerability to natural hazards such as floods, cyclones, and river erosion, collaborative sharing of data, information, and expertise is essential for enhancing early warning systems, risk assessment, and disaster management strategies. By exchanging insights on past experiences, best practices, and lessons learned, Bangladesh, Bhutan, China, India, and Nepal can collectively strengthen their resilience to disasters, minimize loss of life and property, and accelerate recovery efforts in the aftermath of emergencies. Recently, there has been an increase in disaster-related data sharing among these countries.

Encouraging across borders collaboration, organizing joint training programs, and sharing technology can help to create a smooth flow of information and knowledge. This, in turn, can promote a culture of solidarity, cooperation, and mutual support between GBM countries during times of crisis. As the region faces the increasing threat of climate change and its associated risks, it is crucial to establish robust mechanisms for sharing disaster-related data and knowledge. These mechanisms are essential tools for building a more resilient and prepared GBM communities.

Conclusion

Achieving water peace in the GBM Basins require collaborative efforts. Sustainable development and

regional cooperation depend on transboundary water sharing, river transportation, and tourism, utilizing the potential of blue economy, hydropower sharing, transboundary water pollution management, and disaster-related data sharing. Bangladesh, located at the confluence of the Ganges, Brahmaputra, and Meghna rivers, has a crucial role in shaping the future of water governance and peace building in the region.

As we commemorate World Water Day 2024, let us reaffirm our commitment to harnessing the power of water as a catalyst for peace, prosperity, and sustainability. Through dialogue, mutual respect, and shared vision, we can navigate the currents of uncertainty and chart a course toward a more equitable and harmonious future for generations to come.

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