Nir: A Community-Based Hybrid Water Management and Distribution System

Project Proposal

Submitted by

Team Nir

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Abstract

We have successfully integrated multiple high-potential water solutions into a single, cohesive project. "Nir" (meaning 'water') combines household-level water supply (Module 1) with agricultural-level management (Module 2), all tied together with a smart app, forming a holistic, innovative, and community-led ecosystem. It aims to tackle the Barind region's water crisis, empowering local communities, especially women, and fostering sustainable water practices.

Keywords: Water management, Rainwater harvesting, Fog harvesting, Atmospheric water generator, Greywater recycling, Agricultural water security, Community-led, Digital integration, Barind region, Bangladesh

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1 Executive Summary

The Barind region faces a dual water crisis: over-extraction of groundwater for agriculture depletes aquifers, while domestic shallow wells dry up during the dry season. Nir addresses this by providing a hybrid, community-led water ecosystem that combines:

- **Diversified Water Sources:** Multiple technologies for year-round domestic water supply.
- **Sustainable Agricultural Management:** Tools and incentives for efficient water use in farming.
- **Digital Backbone:** A multi-featured smart app that connects users, manages services, and builds community.

This solution aligns with the hackathon's core criteria: Community-led Co-creation, Tangible Impact, Innovation, Scalability, and Feasibility.

2 Problem Statement

2.1 Challenges in the Barind Region

- **Agricultural Over-Extraction:** Groundwater-fed irrigation constitutes 75–90% of total water use in the Barind tract, leading to rapid aquifer depletion [1, 2].
- **Domestic Water Scarcity:** Shallow wells fail during dry months, forcing women and girls to walk long distances to fetch water. Groundwater levels are declining at rates of 0.23–0.38 meters per year in wet and dry seasons respectively [2].
- **Ecosystem Collapse:** Traditional ponds and canals (kharis) are disappearing, exacerbating water scarcity [4].

3 Project Vision & Core Concept

Nir integrates three pillars to create a resilient water ecosystem:

1. **Diversified Water Sources:** Rainwater Harvesting, Fog Nets, Atmospheric Water Generators, and Greywater Recycling.
2. **Sustainable Agriculture:** Smart ponds, river water supply, drought-tolerant crops, and aquifer recharge.

3. **Digital Integration:** The Nir smart app connects households, farmers, local government, and NGOs for monitoring, maintenance, and community engagement.

4 The "Nir" Smart App: Central Nervous System

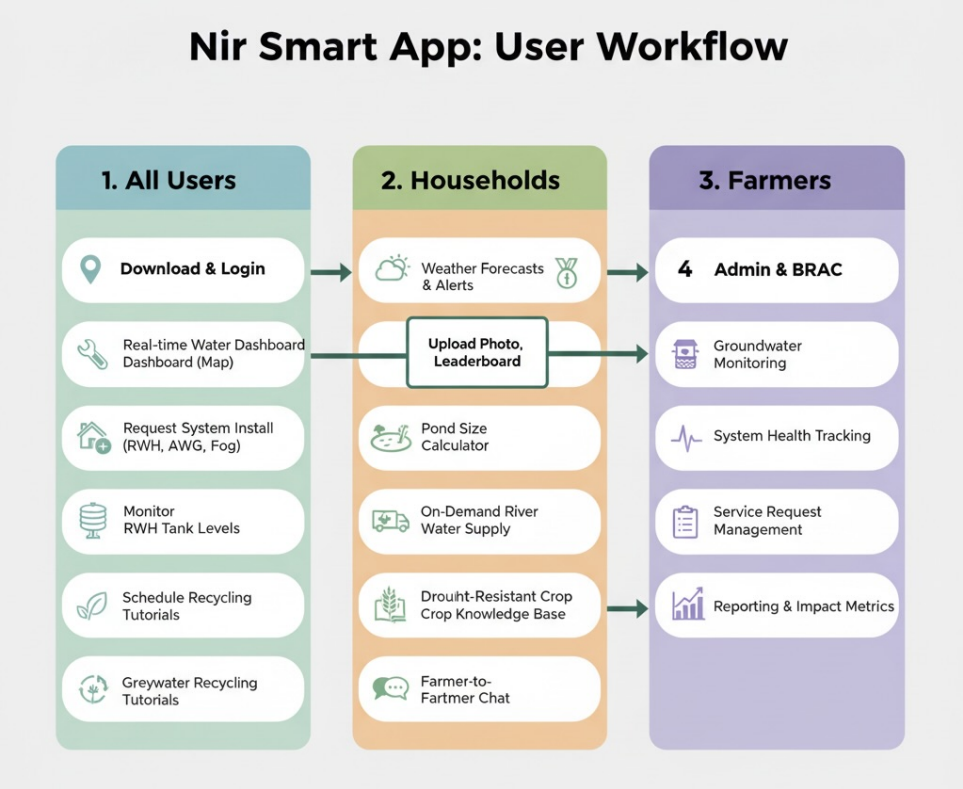

Figure 1: Framework of "Nir"

4.1 For All Users

- Real-time dashboard of local water availability (via Google Maps / weather API)
- Weather forecasts and alerts
- Access to *Jol Joddha* (Water Warrior) community gamification

4.2 For Households

- Request installation of AWG, RWH, or Fog Harvesting systems

- Monitor RWH tank levels
- Schedule maintenance
- Access greywater recycling tutorials

4.3 For Farmers

- Pond size calculator and location recommendation
- On-demand river water supply service
- Knowledge base on drought-resistant crops and AWD methods
- Peer-to-peer Farmer chat

4.4 For Local Government & BRAC

- Groundwater monitoring
- System health tracking
- Service request management
- Reporting and impact metrics

Module 1: Household Water Security (For Local Dwellers)

This module diversifies domestic water supply, reducing the burden on women and girls who traditionally walk miles to fetch water [5].

a. Rainwater Harvesting (RWH)

The Process: We will partner with community households, schools, and clinics to install rooftop RWH systems. Simple guttering will channel rainwater into a central storage tank (e.g., 5,000-liter).

Filtration: For drinking, the tank will be fitted with a simple, low-cost filtration system (like a biosand filter) to remove particulates and pathogens. For other household uses, the water can be used directly.

Strategic Alignment: This is a proven, high-impact solution. BRAC has distributed approximately 4,000 rainwater harvesting tanks in coastal Bangladesh, with each 2,000-liter

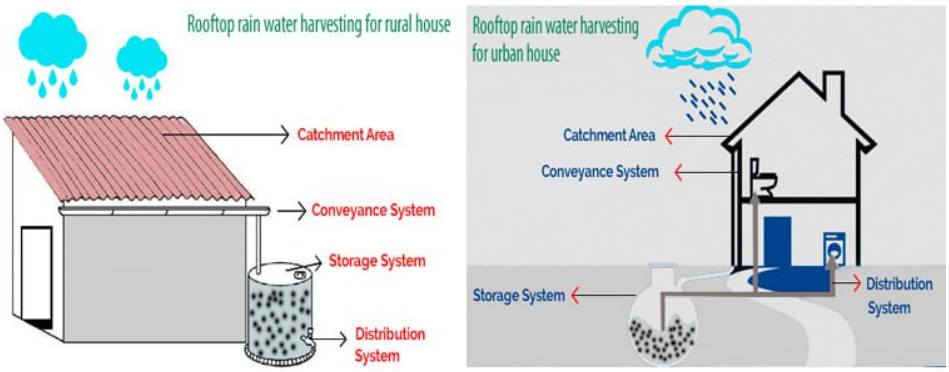

Figure 2: Rainwater harvesting and groundwater recharge system

system capable of providing water throughout dry seasons [6, 7]. WaterAid Bangladesh has installed more than 7,000 rainwater harvesting systems since 2010 [8].

The idea is highly effective in the rainy season, but not that beneficial in other seasons. That's why our 'Hybrid Model' comes.

b. Fog Harvesting

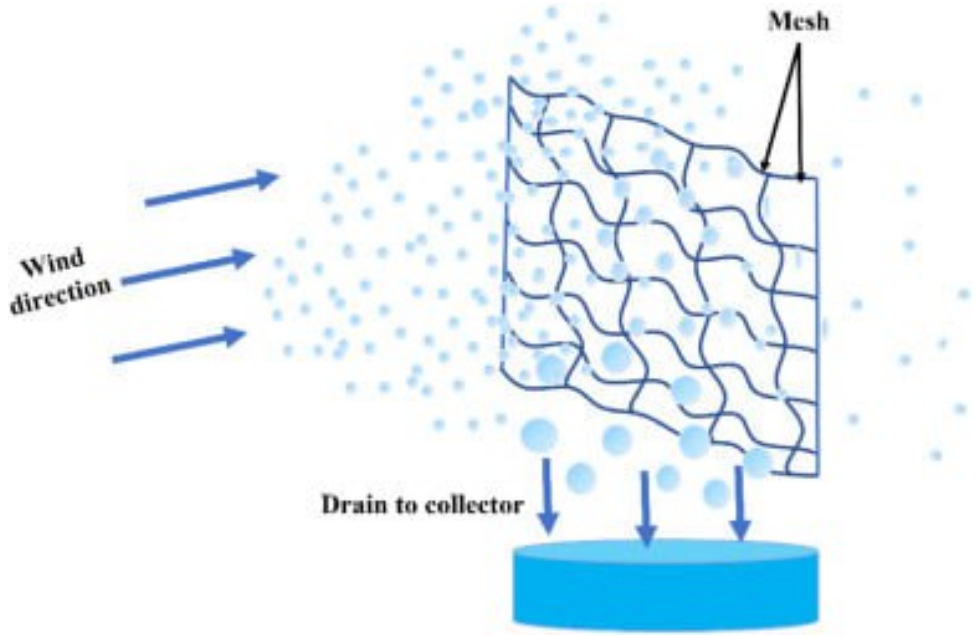

Figure 3: Fog water harvesting setup

The Process: This is a brilliant, low-tech, and high-impact solution. In highland areas of the Barind tract that experience seasonal fog, we will install large mesh nets made of polypropylene or polyethylene. When wind blows fog through the nets, tiny water droplets are trapped, merge, and then drip down into a collection trough below [9, 10].

Fog collectors can produce 150–750 liters per day per panel depending on location and fog density. In Peru's coastal regions, similar systems collect up to 400 liters daily [11]. In Chile's Chungungo village, 100 fog collectors provided 15,000 liters of water annually for ten years with minimal maintenance [12].

Women's Empowerment: This will be a community-led co-creation. We will provide raw materials and training to local women's groups. These groups will be paid to build, stitch, and maintain the fog nets. This creates a "woman-led water entrepreneurship model", providing both water security and a new livelihood [13].

It will only enable people to collect sufficient fresh water during winter, when rainfall is minimal. This idea is directly complementary to our RWH system. Thus, combining these two solutions will facilitate people to get sufficient fresh, drinkable & household-useable water simultaneously in the winter and rainy season by completely natural processes, without using any energy source.

c. Atmospheric Water Generator (AWG)

Figure 4: Basic schematic of the AWG setup

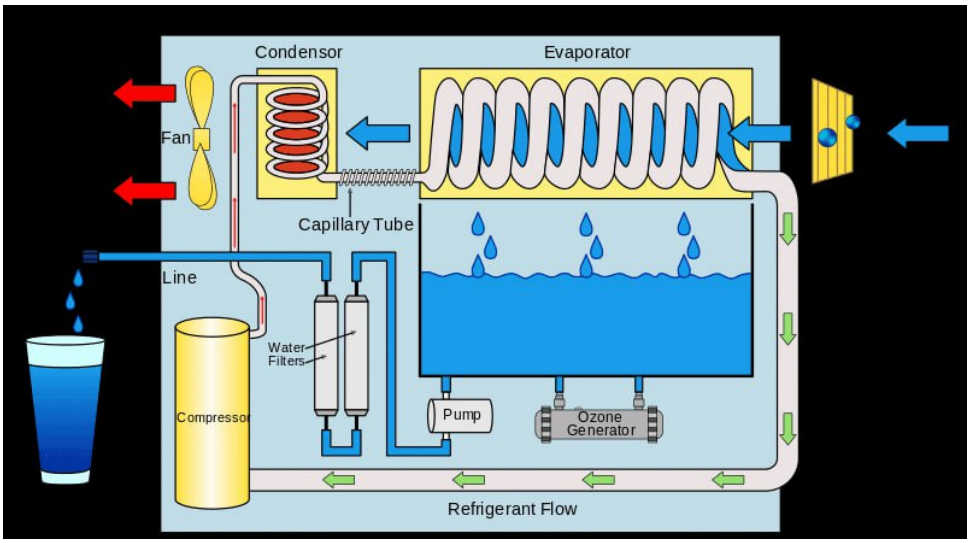

Figure 5: Basic schematic of the AWG setup

Performance in Bangladesh: AWG systems perform best in hot and humid climates with temperatures between 25–32°C and relative humidity of 70–75% [14, 15]. Bangladesh's average humidity conditions make it particularly suitable for AWG technology. Studies show that AWGs can collect water at rates of 0.3–0.95 liters per hour in optimal conditions, with energy consumption of 0.2–0.3 kWh per liter for modern systems [16, 17].

Cost & Implementation:

1. **Install Community Units:** Pilot solar-powered, community-scale AWGs at central points (e.g., a clinic or market).

2. **Showcase Personal Models:** The *Nir* app will feature a marketplace showing costs and benefits of renewable-energy personal models that interested households can purchase, potentially through BRAC's microfinance programs.

d. Recharge Groundwater with Reusable Water System

The Reusable System: This is a household greywater recycling system. Greywater constitutes approximately 58–65% of total household wastewater in Bangladesh, averaging 78.4 liters per person per day [18]. A simple, low-cost "laundry-to-landscape" diverter valve is attached to the drain pipe of the washing or bathing area. This diverts "once-used" water away from the septic pit and into a simple sub-surface irrigation line for a household kitchen garden [19].

Groundwater Recharge System: This is Managed Aquifer Recharge (MAR). People will connect pipes to a specially designed "recharge pit." This pit will collect two sources: (1) overflow from the household RWH tanks and (2) filtered greywater. This water then percolates deep into the ground, actively refilling the depleted shallow aquifer [20, 21].

Long-Term Benefits: MAR has been successfully piloted in the Barind tract, demonstrating significant groundwater level rises when rainwater is infiltrated. Studies show that MAR can restore water tables and improve water quality parameters within acceptable drinking water standards [22, 23]. This dual system has massive benefits—the greywater reuse immediately reduces domestic water demand, while the MAR long-term raises the water table.

Module 2: Agricultural Water Security (For Farmers)

This module attacks the root cause of the crisis—agricultural over-extraction. In the Barind tract, about 80% of agricultural land is supplied by groundwater irrigation, with the Barind region's reliance reaching 90.6% [3, 24].

a. Digging Ponds (Khari Revival)

Figure 6: Pond-based water collection and purification

The Process: Farmers cannot sacrifice too much land. The *Nir* app will have a "Pond Calculator" tool. A farmer can outline their land on a map, and the app will recommend the optimal size and location (e.g., 5% of land area) for a pond based on soil type and topography to maximize rainwater capture.

Strategic Alignment: The Barind Multipurpose Development Authority (BMDA) has already re-excavated more than 3,000 ponds, approximately 2,000 km of kharis (canals) containing about 750 check dams, demonstrating the viability and scale of this approach [4, 21]. These ponds store monsoon water for life-saving supplemental irrigation in the dry season and also contribute to natural aquifer recharge.

b. Water Supply from Nearby River

The Process: This is a "Water-as-a-Service" model.

Figure 7: Water Supply from Nearby River

1. **Request:** A farmer uses the *Nir* app to request a specific volume of water from a surface source (like a river or large community khari).
2. **Dispatch:** The request is routed to a local "Water Entrepreneur" (who we will support). This entrepreneur operates a specialized vehicle (e.g., a small tanker truck).
3. **Delivery:** The entrepreneur collects the water from a designated, sustainable extraction point and delivers it to the farmer's field pond for a fee.

Governance: We will work with the Barind Multipurpose Development Authority (BMDA) and local government to secure extraction permits, ensuring this service doesn't harm the river ecosystem but does reduce pressure on the aquifer. BMDA has successfully implemented double lifting methods for river water irrigation in water-stressed areas [25].

c. Info on Drought-Resistant Crops

The Process: The *Nir* app's "Farmer's Hub" will be a comprehensive knowledge base.

What's Inside: It will provide simple, visual farming guides for high-yield, low-water crops perfectly suited for the Barind region, including:

- **Drought-Tolerant Rice:** BINA-19 and BINA-21, which require no irrigation after seedling transplantation and yield 20–25 mounds per bigha. Other varieties include BINA-17, BINA-18, and BINA-25 [26]. BRRI has also developed BRRI dhan56, BRRI dhan57, BRRI dhan66, BRRI dhan71, and BRRI dhan83 as drought-resilient varieties [27, 28].
- **Alternate Wetting and Drying (AWD):** This technique can save up to 25–30% of irrigation water while maintaining yields [29, 26].
- **Alternative Crops:** Diversification into crops like mulberry, mung beans, chickpeas, and drought-tolerant vegetables [30].

Integration: This info hub will connect farmers to BRAC's existing programs and feature a "Farmer-to-Farmer" chat, where they can share tips and success stories.

Exclusive Feature of Nir App - "Jol Joddha" (Water Warrior) Campaign

This is the "humanity" feature—a brilliant tool for driving the community-led behavior change that technology alone cannot.

The Concept: This feature uses gamification to make water conservation a social and rewarding activity.

How It Works:

1. **Act:** Users perform water-saving actions. This includes providing water for animals (dogs, cats, birds), but also logging actions like "Used my greywater system" or "Cleaned a local pond."
2. **Share:** They upload a photo of this action to the *Nir* app.
3. **Earn:** The user earns points and unlocks "Jol Joddha" badges.
4. **Compete:** A village-level leaderboard fosters friendly competition.

Social Media Campaign: The best user-submitted photos will be featured on social media, creating a powerful promotional campaign that celebrates empathy and builds a region-wide conservation ethic.

5 Implementation Roadmap

5.1 Phase 1: Pilot (Months 1–6)

- 3–5 villages, 50 RWH households, 2 AWG units, 10 demonstration ponds
- Nir app beta and first cohort of Water Entrepreneurs

5.2 Phase 2: Scale (Months 7–18)

- 20 villages, fog harvesting, MAR pits, river water service
- Jol Joddha campaign integrated with BRAC networks

5.3 Phase 3: Regional Expansion (Months 19–36)

- Entire Barind region coverage
- Full Water Entrepreneur network and training center
- Documentation and national scale-up preparation

6 Impact Measurement Framework

Indicator	**Measurement Method**	**Target (3 Years)**
Households with year-round water	App registration + field validation	5,000+
Groundwater stabilization	BMDA monitoring wells	Halt 0.2–0.4 m annual drop
Reduction in women's water collection time	Household surveys	50% reduction
Agricultural groundwater extraction	Farmer app + pump logs	20% decrease
Employment of local women	Payroll + training	150 women employed
Active youth in Jol Joddha	App leaderboard	1,000 members

7 Budget Overview

Item	Estimated Cost (BDT)	Remarks
Rainwater Harvesting (50 units)	500,000	10,000 per unit incl. filtration
Fog Harvesting Nets (10 units)	150,000	Community-built by women's groups
AWG (2 units)	160,000	Solar-powered condensers
App Development	100,000	Prototype with weather API
Training & Workshops	80,000	BRAC facilitation and local events
Monitoring & Evaluation	60,000	Data collection, travel, reporting
Total CapEx + OpEx (Pilot)	**950,000**	Phase 1 budget

8 Why Nir Will Succeed

- Integrates household and agricultural water security
- Community-led with women empowerment
- Combines proven technologies with innovation
- Digital integration enables monitoring and continuous improvement
- Behavioral change via Jol Joddha campaign
- Scalable and replicable

9 Conclusion

The Barind region's water crisis requires an ecosystem approach. Nir delivers a hybrid solution combining traditional wisdom, modern technology, and community leadership. By diversifying household water sources, transforming agriculture, and fostering conservation through the Jol Joddha campaign, Nir builds water resilience for current and future generations.

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A Supporting Figures, Maps, and Data

Figure 8: Conceptual diagram showing Nir's integrated water management modules and app interface.