Project Description

Addressing Climate Change-Induced Drinking Water Scarcity in Coastal Bangladesh via Water Entrepreneurship

Ahmed Mushfiq Mobarak
Yale University (Department of Economics and School of Management)

Islamul Haque
Yale Research Initiative on Innovation and Scale (Y-RISE)

Hasan Mahmud Reza
Department of Pharmaceutical Sciences, North South University, Dhaka Bangladesh

April 24, 2024

Contact: ahmed.mobarak@yale.edu

The Problem

Rising sea levels, tidal flooding and storm surges in southern coastal Bangladesh are causing sources of freshwater to be contaminated by saltwater, creating a critical shortage of drinking water for over 20 million people (Caretta et al., 2022; Hoque et al., 2016; SRDI, 2010). Salinity levels in most coastal aquifers and ponds in southwest Bangladesh average 1800-3000 mg/L - a level 3 to 5 times higher than the limit considered safe for human consumption (Jamei et al., 2022). People exposed to moderately saline (≥2000 mg/L) drinking water have a 42% greater chance of hypertension (Nahian et al., 2018), a major risk factor for cardiovascular diseases (Escober, 2002). Pregnant women drinking water with salinity above 600 mg/L are 4.4 times more likely to get preeclampsia (Khan et al., 2014), a major risk factor for maternal mortality (Goldenberg and McClure, 2011). Hence, developing a sustainable, scalable solution to provide 20 million people with fresh drinking water has become urgent. Millions of people in other low-lying deltaic regions of the world are facing similar challenges (Rahman et al., 2019; Van Engelen et al., 2022), so identifying and testing a scalable solution can have wide applicability.

Why a Small Entrepreneur-Based Solution

Delivering clean drinking water at scale to rural households of developing countries is challenging to begin with, but the added complexity of saltwater intrusion in aquifers and surface water sources makes this a harder problem to solve. First, despite the massive costs of providing piped water from a centralized treatment plant, it has been found ineffective in delivering health benefits (Devoto et al., 2012). Moreover, the presence of high levels of sediments in the river system - one billion tonne annual sediment load (Raff et al., 2023) - makes centralized water treatment and desalination plants prohibitively expensive in our context (Price and Heberling, 2018). Second, while in-home treatment using chlorine or disinfectant tablets has proven cost-effective for decontamination (Kremer et al., 2023; Dupas and Miguel, 2017), this simple chemical-based technique addresses pathogenic contamination, but not the salinity problem. Desalination requires expensive reverse osmosis equipment, making it impractical for household-level implementation. Rainwater harvesting (Bobonis et al., 2022; Ghosh and Ahmed, 2022) can partially address drinking water needs during the monsoon season, but the structures that poor people reside in (low, thatched roofs) limit water storage capacity, and it is both insufficient to meet year-round water needs and cost-ineffective. Small-scale, household-level solutions for drinking water popular in the development economics literature are therefore not the best fit in this context. After exploring the problem and solutions landscape in partnership with BRAC through extensive fieldwork, we have settled on an entrepreneurship-based approach to deploying reverse osmosis (RO) plants on a large scale as the most promising strategy to address drinking water needs in this region at scale, in a way that would be financially self-sustaining. Reverse Osmosis (RO) technology is used to remove sodium, magnesium, lead, arsenic, and other harmful substances from water by pushing them under pressure through a semipermeable membrane. It requires about USD 10,000 for equipment, land, and installation of a 1000L/hour capacity reverse osmosis plant that can serve the drinking and cooking water needs of 400 households for the entire year.

Central to this strategy is identifying, training, and providing financing to local profit-motivated entrepreneurs who have the capacity, the space, and the willingness to invest in the RO technology to start a business producing and selling fresh drinking water at affordable prices. Many such potential entrepreneurs currently lack the technical knowledge and financial resources needed to start a new water business. To fill this gap, Yale Research Initiative on Innovation and Scale (Y-RISE) and BRAC - one of the largest NGOs in the world, are introducing a program to facilitate the creation of such water businesses. The Climate Change program and the Water, Sanitation, and Hygiene program at BRAC will help identify potential water entrepreneurs and provide them business and technical training in collaboration with Y-RISE staff in Bangladesh. The BRAC microhfinance team - a for-profit arm of the NGO that accounts for 75% of the annual revenues of this extremely large organization - will provide business loans of up to US$10,000 to each entrepreneur to launch water businesses. The microfinance team has had a positive experience with >90% repayment rate and 96% business success in their small-scale pilot with a handful of entrepreneurs in the region. This encouraged them to participate in this trial where they would provide loans totaling nearly USD $2 million to a couple of hundred water entrepreneurs. Y-RISE will lead the design and implementation of a randomized controlled trial to generate rigorous evidence on the effects of this program - on entrepreneur business outcomes, water consumption outcomes, and population health outcomes - in order to inform future scaling decisions. If the results from this study look promising, BRAC has the capacity to scale up this program to reach the 20 million people affected by salinity intrusion in coastal Bangladesh. The model could also be replicated in other low-lying areas (such as the Mekong River Delta) where salinity intrusion has affected hundreds of millions of people (Van Engelen et al., 2022).

A key advantage of the proposed approach is that profit-motivated entrepreneurs have the right incentives to ensure continued maintenance of the RO plant. Many donor-funded programs have installed some rainwater harvesting units (RWHs), Pond Sand Filters (PSFs), and other technically-effective solutions in the region, but these programs lacked incentive-compatible schemes to ensure continued maintenance of these facilities. These projects appear successful at the installation stage, but break down when nobody takes responsibility for continued operations. Coastal areas of Bangladesh is littered with non-functional RWHs, PSFs, and RO plants from donor-funded charitable programs. We aim to experiment with a business model to create a financially and operationally sustainable solution.

Furthermore, the entrepreneurship model has several scaling advantages over household-specific charitable solutions. First, reverse osmosis (RO) technology is subject to large economies of scale. An entrepreneur can sell water to a community at a substantially lower per-household cost than solutions that are individually tailored at the household level.

Second, poor households in this region are severely credit-constrained, and would not be able to purchase either RO or rainwater harvesting equipment at market prices. Either charitable donations or loans would be required, but BRAC microfinance is unwilling to lend to individual households for their consumption (as opposed to business/investment) needs. Third, there are economies of scale in the provision of technical support and training. A few hundred water entrepreneurs can be served by a cadre of BRAC technicians employed in that region who can assist water entrepreneurs with technical questions, ongoing maintenance, and parts replacement.

This approach centralizes the generation of clean water at a few RO plants, which creates a new challenge to marketing and scalability: the delivery of water from the RO plant to each individual household. Our project will explore the best ways to establish that market linkage by facilitating the creation of water delivery businesses. Further, ultra-poor households may be unable to pay for clean water. This project will need to devise a solution to serve that segment of the market.

Study Design

We will implement a clustered randomized controlled trial to evaluate the effects of launching this water entrepreneurship program on profits and other business outcomes for the entrepreneurs, as well as health and socioeconomic outcomes for the ultimate beneficiaries who get access to clean water. Figure 1 describes our multi-arm 2x2x2 experimental design involving three cross-cutting sets of interventions:

(i) Train, support, and finance new water entrepreneurs. We will randomly vary the density of water entrepreneurs in each community - either one or two - to study market competition and pricing, and explore questions about the right-sized solution for a given community.
(ii) Facilitate the creation of downstream water delivery services (or not),
(iii) Develop a subsidy scheme for ultra-poor households, by incorporating a discount coupon system within the water businesses.

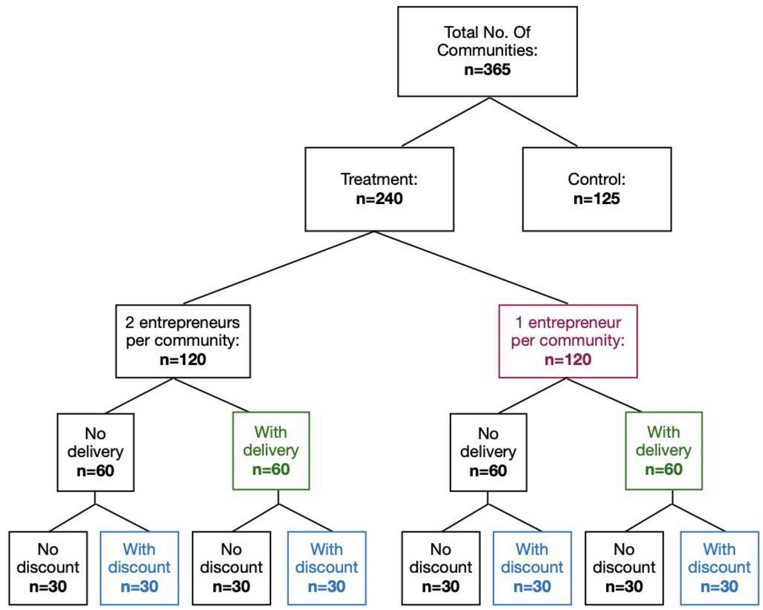

Fig 1: Study design for the proposed randomized controlled trial.

All treatments will be randomly varied at the community/market level. In treatment communities, BRAC will identify 1 to 2 potential water entrepreneurs through consultation, train these individuals on RO technology, provide $5,000-10,000 business set-up loans, and assist them in procuring and installing the relevant technology. BRAC will also hire technicians in the region to provide ongoing technical support.

The number of households in these communities varies between 300 to 600, and there are, on average, 5 individuals in each household. Community-scale RO plants will range in capacity from 500L/hour to 1500L/hour and can cover the year-round drinking and cooking water needs (4 liters per person per day) of 200 to 600 households, respectively. Larger-scale plants have a lower average cost per liter of water produced, because of economies of scale. Given the tension between availing the benefits of economies of scale and the risks of accruing excessive market power versus profitability and financial sustainability of each RO plant, it is important to experimentally study the question of right-sized solutions for a given community by varying the number of RO entrepreneurs installed to serve a given community. Hence, we will offer the loan to 1 entrepreneur in randomly divided half of the treatment communities and 2 entrepreneurs in the other half of the community.

These treatment communities will be randomly assigned to two additional cross-cutting interventions. In a randomly chosen half of the treated communities, BRAC will facilitate the creation of water delivery businesses linked to each water entrepreneur. The water delivery services will take large cans of freshwater from the entrepreneurs and deliver them door-to-door to paying customers. In another independently randomly chosen half of communities, BRAC will provide discount coupons to households that can be redeemed at the water entrepreneurs' sites. The entrepreneurs will have to be compensated by our project against the presentation of the vouchers they collect. These coupons will provide households different levels of discounts to the households enabling us to estimate the price elasticity of water demand.

These three cross-cutting interventions create a total of 8 (2x2x2) different types of treatment communities. We will collect data from an additional 125 control communities that will not receive any intervention. We will conduct the same first-step exercise to identify potential entrepreneurs in the control communities (explaining that they may be engaged in the future if the project extends to those communities) so that we have the appropriate counterfactual for measuring business outcomes for our water entrepreneurs.

Outcome Measurement and Power Calculations

To analyze the full range of impacts of the entrepreneurship programs, we will conduct detailed household and entrepreneur-level surveys in treatment and control communities before and after the intervention. We will collect data on three sets of outcomes. First, we will collect data on the quantity and quality of water consumed by households to determine the effect of the program on water access. The quality testing would include tests for salinity levels and microbiological contaminants. The water access module will also include data on time and money spent collecting drinking water. Second, we will collect data on the water market, including the price of water, the profits and markups of water businesses, and other business outcomes to understand the industrial organization of the water businesses that emerge. These data will allow us to more deeply understand the economic forces driving the water access results. Lastly, we collect data on health, economic, and social variables that are affected by water access. These include health outcomes such as the prevalence of hypertension, preeclampsia, stunting and wasting among children, etc. The economic indicators include labor force participation, income, consumption, etc. These outcomes will help us better understand the full welfare impacts of alleviating water scarcity.

To conduct power calculations, we used hypertension as the main outcome variable of interest. This is because the medical literature has established direct links between sodium intake and hypertension through a series of randomized clinical trials (He and MacGregor, 2013; Aburto et al., 2013; Huang et al., 2020). People exposed to slightly saline (1000–2000 mg/L) and moderately saline (≥2000 mg/L) drinking water are found to have, respectively, 17% and 42% higher chance of being hypertensive compared to those drinking freshwater (Nahian et al., 2018). Given the mean, standard deviation, the intracluster correlation coefficient of the prevalence of hypertension in coastal communities, and a cluster size of 30 households, our power calculations indicate that we would need 240 treatment communities and 125 control communities to detect a 0.1 standard deviation change in hypertension. This corresponds to a 4.3 percentage point decline in hypertension prevalence, which would be approximately a 17 percent decline from the baseline prevalence rate. Providing fresh drinking and cooking water is expected to reduce 24-hour urinary sodium excretion by at least 6000 mg (130 mmol), which should result in more than a 17 percent decline in hypertension prevalence if we extrapolate from the best-available clinical trial data in the medical literature (Huang et al., 2020). We conducted our power calculations using hypertension as the outcome because our intervention is expected to have a larger impact on other variables of interest in the causal pathway - e.g., quantity and quality of water consumption, time spent on water collection, entrepreneur business outcomes - and those will therefore be statistically easier to detect. They are also much cheaper to measure than hypertension biomarkers, so it will be easier to expand the sample sizes for those outcomes within each cluster.

We will allocate a larger portion of the total sample to treatment (240) rather than control (125) communities because the treatment areas are subdivided into multiple interventions to study business and water access outcomes in the 2x2x2 design, as illustrated in Figure 1.

Take Up

There are reasons to believe that consumers will be more accepting of RO-based desalinated water than water decontamination treatments (e.g., chlorine) currently popular in development interventions (Kremer et al., 2023). The take-up rate for chlorine is only 40% even when it is distributed for free (Dupas et al., 2023). This is likely because microbiologically contaminated water often does not have unpleasant odor or taste, but many users dislike the taste and odor of chlorinated water (Osler 2022, Dupas et al., 2023; Crider et al., 2017). Taste and odor are salient factors in drinking water choice. RO-based desalination produces the exact opposite effect. Saltwater intrusion makes water salty, bitter, and unpleasant, and switching to RO water actually improves taste.

On the other hand, RO water is expensive relative to chlorine bottles. Our calculations suggest that delivered RO water is 3-5 times as expensive as the cost of collecting and chlorinating water. Whether rural Bangladeshi households would be willing to pay that price remains to be seen, and this is an important unknown that our research will address. We remain cautiously optimistic, both based on our piloting results and other recent research. In Burlig et al.,[1] direct delivery of electro-chlorinated water to households in India resulted in take-up of 88%, 83%, 87%, and 88% at discounts of 0%, 10%, 50%, and 90%, respectively, when the discounts were implemented as exchangeable entitlements.[2]

We expect a high take-up of RO water by households receiving discount coupons in our experimental design. The discount coupon treatment arm guarantees that we will have a strong first stage to study the effects of salinity on hypertension. Given our concern about take-up at market prices, we have selected a large enough sample size for the discount coupon group so that the second-stage effects on hypertension prevalence and health outcomes can be statistically detected from this study arm alone in case the take-up rate is too low in the study arms with no discount coupons.

There is also a question of whether access to RO water will make a meaningful difference to the quality of the water consumed if the control group also has reasonably good access to clean, Desalinated water. This is why we have decided to start the project in water-scarce areas without pre-existing RO plants in close vicinity.

---

[1] This study is not available as a working paper yet and was made available to Y-RISE on special request. Please reach out directly to islamul.haque@yale.edu for further information.
[2] Where households are automatically paid varying amounts of cash per unclaimed litres of water.

Protocol for Measuring Health Outcomes

Protocol for Blood Pressure Measurement: Both systolic and diastolic blood pressure (BP) of all study subjects will be measured using arm type digital sphygmomanometer by trained staff following WHO guidelines. All participants will be asked not to take soda or caffeinated drinks such as tea, coffee, or carbonated beverages at least 30 minutes before BP measurement and must take rest for at least 10 minutes. Each time BP will be measured thrice (left arm, right arm, then left arm) with an interval of 5 minutes in a sitting position with arms supported. The mean value of the three BP measurements will be considered as the final BP. We will measure the BP of all consenting adults (age 21 and older) from each household every time.

Protocol for urine sample testing: We will collect 24-hour urine samples from two consenting adults (age 21 and older) per household. Each participant will receive a 4-L plastic container for 24-hour urine collection and a small plastic container to collect the voided urine each time. The participants will be instructed to discard their first-morning urine and start collecting from the second-morning void until the next morning urine into the 4-L plastic container. The volume of the 24-hour urine samples will be noted at the household premise by the trained staff and 25 mL urine from each container will be collected and transported at 2–8 C within 6 hours of collection to the local field laboratory for testing. Urine sodium and potassium will be measured using an electrolyte analyzer and urine calcium and magnesium will be measured using a biochemistry analyzer. Furthermore, we will measure urine total protein and creatinine using a biochemistry analyzer. We will perform routine quality control for all tests using standard quality control reagents, and a random 5% sample will be cross-checked in a separate laboratory approved by Y-RISE.

Links to Climate Change, and Future Relevance

The current state of the scientific body of evidence is strongly suggestive of links between climate change and salinity intrusion in low-lying coastal areas like our study sites in southwest Bangladesh. Salinification of coastal freshwater ponds and aquifers is linked to a changing climate through multiple mechanisms. First, tidal surges directly contaminate freshwater ponds and shallow aquifers along the entire coast when ocean waves pierce the embankment barriers and the saltwater encroaches human-made ponds and other surface water sources people traditionally rely on for drinking, bathing, and livestock water provisions. This was directly observed on a large scale immediately after natural disasters like Cyclone Aila in 2009 (Islam and Hasan, 2016; WFP, 2009). According to the latest high-resolution forecasts from a group of scientists at MIT, the frequency of such storms is expected to increase 19.8-fold (from once in 494 years to once in 25 years), and the heights of the associated tidal surges are expected to increase from the present 6.5m (CI: 6.1 m to 6.9 m) to 10.3 m (CI: 8.3 m to 12.5 m) by the end of this century in coastal areas of Bangladesh (Qui et al., 2023). The salinity problem our project addresses is therefore expected to intensify over time.

Second, separate from salinization through tidal surges and other natural disaster events, coastal Bangladesh has experienced a long-term secular increase in high water levels by about 18 mm per year since 1973 (Feist et al., 2021, Pethick and Orford, 2013). As a result of this increased pressure from semidiurnal tides, more and more freshwater aquifers in coastal Bangladesh have been contaminated with seawater over time (Jamei et al., 2022). Moreover, multiple studies linking climate change-induced sea level rise and saltwater intrusion have found that salinity levels are expected to increase between 20 to 40 percent due to sea level rise in coastal aquifers of Bangladesh by the end of this century (Chun et al., 2018; Priyanka & Mahesha, 2015).

Saltwater intrusion into drinking water sources has emerged as an important public health challenge in coastal areas of all major river deltas (Van Engelen et al., 2022). A meta-analysis of 133 randomized clinical trials has found that a 50 mmol reduction in 24-hour sodium excretion is associated with a 1.10 mm Hg reduction in Systolic Blood Pressure (SBP) and a 0.33 mm Hg reduction in Diastolic Blood Pressure (DBP) (Huang et al., 2020). Our proposed study is not an attempt to re-establish medical/epidemiological links between water quality and health outcomes, but we are more focused on an aspect of the problem about which we don't yet know much: Is it possible to assemble the technological, entrepreneurial, and marketing capabilities to supply fresh drinking water at large scale and at a price point where extremely poor, credit-constrained families living under harsh environmental conditions will get access to drinking water? And will that price point also support financially sustainable businesses for small entrepreneurs, such that this solution can be implemented at a large scale without the need for external philanthropic support? Given the evolving scale of the problem with tidal surges and sea level rise induced by climate change, it has become imperative to experiment with promising solutions now, before the water crisis becomes even more acute for the 20 million people living in coastal Bangladesh.

Broader Impacts

The results of the evaluation will directly inform BRAC and the Bangladesh government about the efficacy, cost-effectiveness, sustainability, and scaling potential of an entrepreneurship-based solution to a massive drinking crisis linked to a changing climate. If the results from this study look promising, BRAC has the capacity to scale up this program to reach all 20 million affected populations in coastal Bangladesh leveraging its network of branches in all the coastal subdistricts. BRAC microfinance is disbursing about two million dollars in entrepreneur loans as a part of this project, and the rigorous evidence generation through this proposed project will inform the allocation decisions for millions of dollars in future entrepreneur loans.

But the larger impact of this study will be on population health, not loan disbursements. Globally, hypertension is estimated to cause 7.5 million deaths annually, accounting for 12.8% of all deaths and a reduction of 57 million disability adjusted life years (DALYS) or 3.7% of total DALYS (Dai et al., 2021; WHO, 2023). Expanding access to fresh drinking water through this program can potentially reduce the prevalence of hypertension across coastal areas of Bangladesh by 20 to 40 percent (Nahian et al., 2018). A scaled-up version of this program would potentially serve 20 million people in Bangladesh alone and thereby avert millions of DALYs.

Moreover, the impact of this project would extend beyond Bangladesh and BRAC, with the potential to influence the strategic policies of WaterAid, World Bank, USAID, UNDP, and other entities where water access is part of the organization's mandate. A successful water entrepreneurship program can be replicated in low-lying coastal areas of other low and medium-income countries (LMICs) that are vulnerable to climate change. World leaders need to identify cost-effective mitigation strategies for poor populations vulnerable to climate change, and our study will add to that evidence base.

While sharing evidence with global actors to inform future programming is critical, it is important to emphasize that the project we are implementing is a wholly home-grown and locally implemented indigenous solution that is not reliant on external donor funding. We are only fundraising for evidence generation to enhance the broader impact of this approach, and not for the implementation itself. This is in contrast to popular prevailing approaches to drinking water provision, which are typically small-scale and implemented at the household level, heavily reliant on external subsidies. Such programs frequently falter at the conclusion of donor-funded projects, impeding their ability to scale effectively. In contrast, our water entrepreneurship model takes advantage of the economies of scale in the technology for water purification, which allows us to strive for financial sustainability and scalability. We have designed a post-research policy impact plan that aims to persuade large multilateral organizations and governments to adjust their water programming in alignment with the rigorous evidence we generate using the NSF research funding.

Outreach Strategy

We will employ a multifaceted plan to effectively disseminate our findings to policymakers. The entity with the greatest potential to scale up the approach we are trialing will be intimately involved in all aspects of the project, including implementation, loan disbursement and recollection, and research design. So the most consequential knowledge transfer will be immediate and internal. But we will maintain academic rigor by publishing findings in high-impact journals, and ensure broad pre-publication exposure within the scientific and research community by uploading a trial registration and a pre-analysis plan in the American Economic Association repository. Post-publication, we will implement a systematic outreach plan to policymakers by identifying key local and global stakeholders working on water and climate change, and we will translate the results of the research into actionable policy briefs. We will also actively disseminate findings through customized webinars for policy audiences. Critically, we will develop a comprehensive toolkit for implementers that outlines the process, financing, and implementation considerations, to serve as a practical implementation guide.

To reach diverse audiences and generate widespread awareness and interest in the problem and intervention, we will also engage in a series of structured mass-media communications, including op-eds in print media, appearances on select news channels, etc. The exact same team collaborated to implement a similar strategy during the COVID-19 pandemic which quickly transformed research findings on masking to quickly distribute protective facemasks to over 100 million people across South Asia.

History of Collaboration with BRAC

This project is part of a broader collaboration between Y-RISE and BRAC that aims to scale up evidence-based policies to improve livelihoods and public health in Bangladesh. Y-RISE is a global research initiative that studies the complexities of scaling up policy interventions. BRAC is one of the largest NGOs in the world, started in 1972 and serves 80 million people in Bangladesh through its health programs alone, with reach in all 64 districts of Bangladesh. 2 out of 5 people in Bangladesh received some form of support from BRAC in 2022, with over half of these being women. BRAC Microfinance (MF) program runs multiple different loan schemes for micro, small, and medium entrepreneurs. With 11 million clients, BRAC MF disbursed USD 6 billion in microloans throughout Bangladesh in 2023. BRAC also operates various social enterprises at scale in collaboration with the Government of Bangladesh.

This partnership combines the implementation capability of BRAC with the research expertise of Y-RISE. This is designed as a multi-year learning partnership comprising specific projects that are a high priority for Bangladesh, and strategically important to both BRAC and Y-RISE. The two organizations have quickly established a track record of successfully scaling up evidence-based programs, such as an RCT that demonstrated the efficacy of community-wide mask distribution in rural Bangladesh (Abaluck et al., 2021), which BRAC and Y-RISE jointly implemented within months to reach 80 million people in Bangladesh before the Delta and Omicron variants spread in the country. Masks were distributed by this team in over half the country, and the effects of Delta in Bangladesh were muted compared to neighboring India. The proposed project grows out of the trust and partnership that was established during this collaborative effort, wherein the organizations jointly brainstormed about the other high-priority areas where such evidence-based joint work streams can be deployed. Addressing the salinity intrusion problem in coastal Bangladesh emerged as the leading contender.

The proposed project is part of a broader initiative to accelerate climate change adaptation in coastal Bangladesh. Bangladesh is a low-lying deltaic plain, often labeled as "ground zero" of climate change. In addition to the salinization of drinking water sources, the amount of farmland with soil salinity level above 8 desi-siemens per meter (dS/m) - a level known to be disastrous for traditional crops - has increased more than 15-fold since 1974. Over 1.05 million hectares of coastal farmlands where rice was traditionally grown now suffer from low productivity due to salinity intrusion (SRDI, 2010). Hence, millions of farmers in coastal areas are now forced to leave their land fallow during the dry season or switch to aquaculture - which is not as labor intensive. As a result, there has been increased migration pressure from this region. In light of these challenges, BRAC and Y-RISE are working to co-develop and test programs that can accelerate livelihood adaptation to climate change at scale in coastal Bangladesh. Given the massive organizational capacity of BRAC to scale programs, the early climate battleground in coastal Bangladesh provides us with a unique opportunity to identify scalable solutions to multi-faceted climate adaptation problems that can be applied to other regions of the world in the near future.

Management and Implementation

The research activities will be implemented by a combination of a research team based at Y-RISE, research operation staff of Y-RISE in Bangladesh, and a contracted survey firm in Bangladesh. The project will be directly supervised by the Principal Investigator, Professor Ahmed Mushfiq Mobarak, the faculty director of Y-RISE. The research team will also include a senior research manager, a postdoctoral associate, and a research assistant from Y-RISE who will closely develop research protocol and measurement tools and supervise the fieldwork in Bangladesh. The Y-RISE management team also includes two Bangladesh-based research implementation consultants, who have years of experience managing day-to-day survey firm partners, data quality, and research implementation. This team will manage the contracted survey firm in Bangladesh, which is selected through a competitive process for both cost and capacity. The data collection platform is held by Y-RISE and directly overseen for quality by Y-RISE researchers and research associates. Y-RISE also works collaboratively with the survey firm to develop project-specific ethical protocols and safety measures for staff and respondents.

Risk Mitigation

One potential risk with RO plants is the negative externalities from brine that are generated as a waste product from the desalination process. This discharge can potentially increase the salinity level of the water bodies, aquifers, and soil areas regardless of where it is released. One potential solution could be to figure out alternative household or commercial use of brine so that it is not discharged into the local environment. For example, brine could be used in processing animal hides in the tannery industry and cooling electricity-generating equipment in thermoelectric power plants. Our implementation protocol will include a careful plan for the collection and safe discharge of brine.

Timeline

The start date for the project is August 1, 2024, and the end date is July 31, 2026. Below is the timeline of the major activities of the project.

Months (from the start of the project)	Activities/Milestones
1-3	Identifying communities and potential water entrepreneurs for the area
3-4	Conducting Household census
5-7	Baseline survey - both Household and Entrepreneurs
12-15	Implementation of the Interventions
19-21	Endline Surveys
22-24	Data Analysis and dissemination of results