Maximum 9 pages total (excluding appendix), double-spaced, Times New Roman 12-point font, 1-in margins.

Introduction and background

While the effects of climate change are felt throughout the world, low-lying areas such as deltas are particularly vulnerable. The Mekong Delta of Vietnam is no exception, as the increased salinity of the surface water due to sea level rise and subsidence has already forced local farms to change their production processes. In particular, many farms now produce shrimp, which can tolerate saltier water than rice (which was, until recently, the dominant crop in the area). However, large shrimp-producing farms release pollution into shared waterways as part of their production process, creating both environmental and economic consequences. Since smaller farms bring this (polluted) water into their shrimp ponds, and, unlike the larger shrimp farms, do not have enough resources to purify the polluted water before using it, the pollution that the larger farms emit likely decreases their productivity.

In addition to generally increasing, salinity levels have also become more variable. This is partially due to energy politics, as China has constructed a number of hydropower dams in the Upper Mekong Basin. These dams change the sediment available in the Mekong Delta, as well as (generally) increasing water flows in the dry season and decreasing flows in the wet season. These changes in water flow have altered the traditional salinity patterns to which farmers had become accustomed. Additionally, rainfall patterns, the other major factor affecting water flow and salinity, have become increasingly variable. The wet season in Vietnam is now generally more intense and briefer than it was historically, leading to quicker-than-expected decreases in surface water salinity levels once it begins.

With the help of a Travel Grant from the Weiss Fund, I visited Vietnam to begin research with the Mekong Conservancy Foundation (MCF) into the consequences of, and potential solutions to, this water pollution issue. That project, which I fill refer to as “the pilot survey”, was my first opportunity to lead a quantitative data collection effort, and our preliminary results helped inform this grant proposal. Based on my experience in the field and discussions during my trips to the area with members of MCF and local experts at Can Tho University, the leading university in the Mekong Delta region, for this project I propose to study whether an intervention that provides information to small farmers can improve their productivity. Specifically, I propose to provide smaller shrimp farms with real-time information on water quality and salinity levels in nearby waterways. Providing the smaller farms with real-time water quality information may allow them to adjust their production in such a way as to minimize the effects of the pollution. For example, they can choose to exchange less water between their ponds and the neighboring waterways when the waterways are especially polluted.

Methodology and research approach

I plan to use a field experiment to evaluate my proposed intervention. The intervention will need to be randomized at the group level to address the possibility of spillovers. For example, small farmers who are in the control group, but who have neighbors in the treatment group, may obtain the real-time pollution information through their connections with the farmers in the treatment group, thereby biasing the estimated effect of the intervention downwards if these spillovers are not accounted for.

The main outcome variables are measures of take-up (participation in the treatment through taking water quality measurements, receiving measurements from a neighbor, and changing farming practices in response to the measurements), crop yields, and profitability. The main water quality measurements that will be provided to farmers are the levels of dissolved oxygen (DO) and salinity. Measurements conducted during the pilot survey show that only 30% of the samples (twenty-seven out of ninety) had DO levels in the recommended range at the time that the measurements were taken. There were nearly as many samples (twenty-four) that were classified in the "harmful" range due to their very low oxygen levels. Additionally, DO levels varied significantly across space, even for sampled locations that were quite close to each other.

Though not a pollutant, field interviews have revealed that farmers would also highly value information on the salinity content of the water. Due to the effects of climate change, among other things, water salinity levels in the Mekong Delta have become more variable than they were in the past. Shrimp thrive in brackish water, in which the water is neither too salty nor too fresh, so targeting this parameter is quite important to farmers.

Farmers have the ability to adjust their farming methods to information about salinity and DO levels. Small shrimp farms are equipped with sluice gates, which control whether water can flow between the shrimp pond and the adjacent waterway. Whether the water flows into or out of the ponds depends on the relative water levels of the ponds and the waterway, which is influenced by the tides. Farmers generally exchange water between their ponds and the waterway a few times a month. Armed with the measurements of pollution and salinity, though, farmers could decide when it would be best to exchange water based on the levels of salinity or DO in the waterway relative to in their pond. In particular, they can choose to forego water exchanges when the water quality outside their ponds is especially poor.

Both DO and salinity can be measured using handheld devices. Using the funding from the Travel Grant, my team has already conducted water pollution measurements in waterways throughout the Mekong Delta region. The key distinction between the pilot survey and the proposed project is that, in the proposed project, the farmers themselves (or a local agricultural extension officer) will conduct the pollution measurements, instead of a member of our team.

Our team will provide the farmers with relevant training on how to use the device when the intervention is introduced to them.

The second set of main outcome variables are the shrimp yields and profits of the small-scale farmers. I have measured these variables for harvests from 2022 for all farmers in our pilot survey. To determine how large the effect of the water quality information is on yields and profits, I plan to compare the profits and productivity between small farms that are in the treatment and control groups of the experiment. I will also ask the farmers how, and how frequently, they made use of the pollution measurements, to further investigate how the farmers used this information, and what adjustments they made to their production process.

To design the treatment and control samples for the intervention, I first had to conduct power calculations. I started by using the mean and standard deviation of yields measured during the pilot survey. The measured mean and standard deviation of yields among small farmers in my sample were 0.879 and 1.877 tons of shrimp per hectare per crop, respectively. For the purpose of the power calculations, I chose to set the power to 0.8 and the probability of a type-I error to 0.05. I also decided that I would like to be able to detect an effect whose size is 0.3 of a standard deviation.

Additionally, this treatment will be assigned in clusters, instead of individually, as discussed earlier. I chose a cluster size of five farmers. An important parameter for power calculations in a cluster randomized design is the intraclass correlation. For this, I used the data from the pilot survey, as the sampling from the pilot survey was conducted in geographic groups. The results of this analysis indicated that the upper bound of the 95% confidence interval of the intraclass correlation was 0.14, so I conservatively used 0.14 as the intraclass correlation coefficient.

Putting all of these parameters together, I used Stata's built in "power" command to determine the number of clusters I would need. The results of the power calculation indicate that for two-sample means test in which I test that the mean yield is different in the treatment and control groups with a cluster randomized design, I would need fifty-five clusters in each of the treatment and control groups, for a total sample size of 55*5*2=550 farmers, to detect an effect size of 0.3 standard deviations.

For sample stratification, I intend to first stratify the sample based on geographic area. Then, I will proceed to stratify based on the level of the main outcome variable, which is the yields of the small farmers, as well as on the education levels of the small shrimp farmers, since education levels may affect the take-up level of the intervention. Since this design include randomization at the group level in addition to stratification, the strata will depend on the mean level of the stratifying variables at the group level, instead of the individual values of these variables. Additionally, once I have taken baseline measurements from each group, I will examine the heterogeneity across and between groups in the stratifying variables to determine how many strata to create.

Pathway to scale

Policymakers want to improve the environmental quality of the Mekong Delta ("Master Plan"). Little of the sizable body of research about environmental issues in the Mekong Delta has been translated into concrete policy changes – possibly due to feasibility issues. In response to this, I created my proposed interventions with policy relevance in mind, and it is designed to be simple and easy to implement. As such, I intend to leverage my contacts at Can Tho University to make my research findings available to policymakers. In fact, my contacts at MCF have informed me that they are already planning for me to present the findings of the pilot research survey that I conducted using my Travel Grant at a meeting of local shrimp farmers and government officials. I look forward to such an opportunity, and believe that the connections I make there will further facilitate disseminating the results of this proposed study to relevant policymakers and the target population in the future.

Additionally, as part of this proposed research project, I will measure the relative change in profitability of small farms in the treatment and control groups, to determine whether the intervention causes any changes in profitability. If the intervention is profitable, or nearly profitable, net of implementation costs, then it should be easier to scale up.

Given the interest that policymakers have shown in improving the environmental quality of the Mekong Delta, I think that this research will quickly attract the attention of policymakers. While policymaking in Vietnam may take some time, given the level of exposure of the region to climate and environment-related issues, I think this issue may be acted on relatively quickly. When it is acted on, hopefully our results will indicate that the proposed intervention can have meaningful impacts on the lives of those who depend on surface water in the Mekong Delta for their livelihoods.

Timeline and budget

The timeline will be relatively condensed. A key consideration governing the timeline is the timing of the shrimp cropping season in the region. The wet season begins in May or June, around which time the small-scale shrimp farmers begin to intake water for their upcoming crop. Due to the effects of El Nino and La Nina on weather in the area, the beginning of the season may occur slightly later than usual next year. I want the baseline survey to occur slightly before the farmers begin their activities, so that I can introduce the intervention right before they start to fill their ponds for the first time.

The project will occur in two main waves, though each wave will have several sub-components. First, I will define the sample. I will concentrate on the shrimp-producing regions of the Mekong Delta, and will likely randomly sample small farmers in a number of districts based on administrative lists that include all shrimp farmers in those districts. In the baseline survey, I will gather information from the sampled small shrimp farms about their previous harvest, as well as demographic information. The information from the baseline surveys will be used in creating the sample strata. After the baseline information has been collected, the strata have been formed, and the random sampling conducted, I will introduce the intervention.

Second, I will follow-up at the endline survey, right after the small farmers have harvested their crop. I will compare the yields and profits of smaller farmers who were in the treatment and control groups of the experiment to determine the effect of the intervention. The endline survey should take place in the late summer or early fall of 2024.

As for the budget, the bulk of the funding I am requesting from the Weiss Fund goes towards fielding the surveys as well as implementing the intervention. Given the power calculations, the sample size will need to be relatively large, which is why I have asked for funding to conduct surveys of 550 small farms. Almost all of the requested funding goes towards the field costs, meaning that the marginal dollar of funding allows me to directly expand the sample size.

The other main cost is for providing the equipment to measure pollution levels. Each cluster will need its own equipment. The cost of one device is approximately $200 USD, which, multiplied by the 55 treatment clusters, gives a total cost of $11,000. I do not expect any monetary or in-kind contributions from my research partner on this project.

If I receive the requested $46,763 in funding from the Weiss Fund, I plan to complete the project as proposed. If I receive additional funding, I will further increase the sample size. Absent funding from the Weiss Fund, I may try to use any other funding I receive to conduct a pilot of this intervention. If limited to a smaller budget without funding from the Weiss Fund, I would not be able to conduct the full-scale intervention since I would not be able to achieve the sample size necessary to fully evaluate the intervention, given the results of the power calculations discussed above. If I were able to successfully conduct the pilot intervention, and the results were promising, I would then apply again for additional funding in order to rigorously evaluate the intervention.