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After the Flood: Fish Farming and Climate Change Adaptation in Chitwan, Nepal

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Abstract:

Last summer, Nepal's Terai region experienced some of the worst flooding in recent memory. Climate change is expected to increase the number of natural disasters that Nepal experiences in coming years, and more vulnerable demographics will be more adversely affected. Fish farming is a highly profitable and slowly growing industry based primarily in the Terai, that many believe is less vulnerable to climate-related risks than conventional forms of agriculture, and thus a possible livelihood adaptation strategy. In this study, I conducted semi-structured interviews with ten farmers in Madi, Chitwan, to understand the daily challenges and threats to fish farming, the impact of recent flooding, and the degree to which farmers are adapting to the threat of future flooding. I was also eager to understand how traditional gender roles may render women fish farmers more vulnerable to risks. The core findings of this study are that most fish farmers perceive a variety of risks—from wild animals, de-oxygenation, lack of roads or electricity at pond sites, flooding, and lack of government support for aquaculture. The impact of the flooding on farmers' fish ponds depended on proximity to the Rue River, suggesting that even within a small community, climate-risks may affect households differently. This exploratory study contributes to a relatively new and small field of work considering climate-related risks in addition to political, economic, social, and structural risks in the context of a specific agricultural industry.

Key words: fisheries and aquaculture, disaster management, flooding, gender

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Introduction

"We will do what we have always done. We will start over." He says this to me without malice, rather with the resigned acceptance that this is how the world works. Every ten or so years, a devastating flood comes. And every ten or so years, he and other farmers start over.

The Johannesburg Declaration on Sustainable Development states "the adverse effects of climate change are already evident, natural disasters are more frequent and more devastating, and developing countries are more vulnerable." This is most definitely true for Nepal. This past summer, people across the Terai experienced some of the worst flooding in recent memory. According to one report, more than 150 people were killed and 90,000 homes destroyed. Another report tallies 130 dead, 7,000 homes destroyed, and 18,000 people displaced—as well as damage to the agricultural, industrial, and trade industries based in the Terai, and loss of flora and fauna in and around Chitwan National Park.

The Terai is also home to a slowly growing but extremely promising industry in Nepal: aquaculture. Roughly 94% of Nepal's fish ponds are found in the Terai (FAO 2005). And although Nepal is a landlocked country, it has inland water resources in grand abundance. Aquaculture is considered a highly profitable industry, and fish consumption in Nepal is on the rise. There is even reason to believe fish farming may be an appropriate livelihood adaptation strategy for people living in flood-prone areas—especially as disastrous flooding may occur more frequently because of climate change.

In Chitwan, flooding is not a new event; there are records of devastating floods dating back to at least 1954, and usually there is some minor flooding each year for one week during July or August (ICIMOD, forthcoming). However, devastating flooding is expected to increase. Heavy downpours of rain, not only in

Chitwan district, but also upstream in hill regions contribute to flooding in downstream Chitwan. Instances of flash flooding in Chitwan may also be increasing as sediment deposits force the course of the Rue Kholaa to change course, sometimes bringing it closer to settlements, and as vegetation along the riverbanks is chopped down or swept away.

When particularly devastating floods come, they sweep away the years' crops and cause damage to homes, leaving the family with massive damages and without the years agricultural income. A ICIMOD report on the Chitwan region (forthcoming) tells the story of one farmer who switched to fish farming and discovered after a disastrous flood in 2009 that, while the flood had destroyed his and his neighbors' crops, it had not swept away the fish from his ponds.

I set out on my field study the understand the experiences of fish farmers in Madi, a uniquely isolated municipality in Chitwan district to answer the question, is fish farming a viable climate change adaptation strategy? I aimed to understand what it meant to be a fish farmer, the reasons they began farming and the challenges they faced—and how flooding or other climactic changes may impact fish farming as a livelihood. I was curious to understand their perception of risks related to climate change, and the degree to which they have prepared for future flooding. I was also curious to understand how fish farmers' genders may have influenced their vulnerability to climate change and capacity to rebuild or prepare for future climate-related disasters.

Literature Review

Much academic literature exists on gendered impacts of climate change, and even on fish farming in Nepal, but few sources tie together all these concepts.

Bhujel, Shrestha, Pant & Buranom (2008) focus on women's involvement in aquaculture in Chitwan, Nepal, but less so on perceptions of climate change or climate-related risks. In the project, 26 women farmers were provided training to dig one fish pond each but left to choose how large to dig their pond, which type of fish to stock it with, and at what point to harvest. Men participated as well, especially during pond construction, preparation, diverting water from canals to fill ponds, fingerling transportation, and fish harvest. As the pilot project expanded, the project noted the creation of five women's groups in the area and stronger relationships between community leaders, government extension officers, and academic researchers. The study also noted that once ponds are constructed, women need spend less time and effort than they would tending other forms of livestock. The study also cites the benefit of integrating small scale fish production with vegetable gardens. The pond water can irrigate the vegetables and store irrigation water during the dry season, and vegetable waste are used to fertilize the ponds, reducing the need for external fertilizers. Some women in the original pilot study shifted from subsistence to commercial fish farming, often either expanding the size of the pond or cultivating high value species like freshwater prawns, which can be sold directly to hotels or restaurants. The authors note that the flexibility and expandability of fish farming is particularly promising. Depending on available resources and technical knowledge, a women fish farmer may cultivate fish only, fish and vegetables, fish and prawns, or fish, prawn, and vegetables for family food security and/or commercial sale. Their study is relevant in the focus on Nepali women in fish farming, and noting the promise of scalability within fish farming; people may cultivate fish for consumption only, or scale up and use fish farming as an income-generating activity.

Several studies explore how farmers' climate risk perception affect their decision making, risk management strategies, and longer-term adaptation strategies, but Lebel et al. (2015) is one of the few to focus on climate risk perception in aquaculture. In a study that included interviews with 663 farmers in northern Thailand, they draw attention to climate-related risks and sensitivities in aquaculture—an agricultural activity, they note, that has often been assumed to be "relatively less vulnerable to climate variability and change (18). The core finding is that, in northern Thailand at least, climate-related risks are perceived as important by fish farmers. Furthermore, the way climate risks are understood and perceived by fish farmers is important because it can influence their risk managements practices, and thus adaptation to climate change. Lebel et al. (2015) also called for further studies into the ways market, financial, political, and social risks interact with climate-related risks to influence perceptions of risks and people's decisions on how to respond. Though I did aim to complete as targeted of a study as Lebel et al. (2015), my field study seeks to provide a comprehensive view on farmers' perspectives of challenges and risks in a variety of areas—naturally occurring and market-related. Although my study focused on freshwater pond aquaculture rather than the Thai river-cage system, I also tried to build a greater understanding of the vulnerability of Chitwan's aquaculture industry to climate change.

Methodology

For my field study, I wanted to understand the farmers' experiences with fish farming, the impacts of recent flooding on fish farming, and the degree to which people are responding or preparing for future flooding. I was also curious to understand the degree to which a respondent's gender may have impacted his or her vulnerability to flooding and capacity to rebuild and respond. To answer to

these questions, I spent nine days in Madi, Chitwan, and four days in Sauraha, Chitwan, interviewing local fish farmers and observing fish farming in practice.

Study Area

I selected Madi as my study site because I wanted to follow-up on the fieldwork conducted for the initial ICIMOD case study. But Madi is an interesting study site for a variety of reasons. Nestled between Chitwan National Park and the Nepal-India border to the north and south, Madi is relatively isolated from the rest of the district. The entire municipality did not receive access to electricity until 2016 (Himalayan Times, 2016). However, it is home to nearly 40,000 people of a variety of ethnic groups, including Tharu and Magar peoples (Central Bureau of Statistics). I conducted interviews in five different interviews in Madi—Simara, Gopalnagar, Shivadwar, Krishnanagar, and Basantapur (see Appendix: Figure 1). The first four of those five villages lie on the banks of the Rue Kholaa, the river that flooded last summer and forms the border of the national park. Residents routinely deal with intrusion of wild animals from Chitwan National Park, which lies directly to the north of the municipality. I also found after arriving in Madi that there are twelve community fishery groups, making it an appropriate site to study fish farming.

Data Collection

Over the course of my fieldwork, I conducted 14 interviews with 10 different respondents. I spoke with seven men and three women, though I had initially intended to speak with an equal number men and women. One key informant interview was conducted in Sauraha with the Ramesh Pandey, the president of the Chitwan chapter of the Fishing Association of Nepal. All interviews were conducted in Nepali without a translator. Most interviews were structured or semi-structured, mostly due to my language ability and the difficulty of conducting a fully

unstructured interview in Nepali. Questions covered individual reasons for starting fish farming, perception of problems, responsibilities while fish farming, impacts of recent flooding, among other things.

I selected interview participants based on prior contacts' knowledge and who was available at a given time. Sometimes chance was the greatest factor; I was able to interview Haripashad Gimare, the very first fish farmer in all of Madi, by chance. He happened to be riding his bike in Gopalnagar while I was conducting interviews with other farmers outside a local shop; they flagged him down and asked if he would speak with me.

The language barrier was likely the most prominent obstacle to my field study. Despite being able to communicate well in Nepali, the regional accent and grammatical structure proved difficult for me to understand. As such, asking follow-up questions during interviews proved challenging. I responded to these challenges by preparing a wide variety of questions beforehand and proceeding through them in a way to build from the flow of conversation as best I could. I also obtained verbal consent from my interview participants to record the interviews, so that I could listen again to glean greater understanding and receive translation help from SIT staff. I considered hiring a translator, but could not find anyone in my community who spoke fluent English, and the distance I traveled to conduct each interview would have made bringing a translator and additional logistical challenge.

The second main obstacle to my field study was my own mobility and the distance from several interview sites. Madi itself is a municipality of approximately 38,000 people scattered in villages throughout the valley. I visited five different villages to conduct interviews, but often had to travel 3-4 km by bicycle to reach my interview sites. This proved a challenge because I could not always observe fish

farming in action and often could not easily return to the same place or find the same people to conduct follow-up interviews. I also discovered that some of my research questions were easier to answer than others. It was relatively easy to learn about fish farming in general, but harder to learn people's perceptions of climate change or gender dimensions.

Biases and Limitations

In my initial field study proposal, I had intended to spend all my time within a single community and interview fish farmers and other community members alike, to gain the perspective of people who had not started fish farming and try to understand why, perhaps, they had decided against it or were unable to begin fish farming. In practice, however, every person I interviewed was in fact, a fish farmer. Given that fish farming requires a somewhat significant upfront investment, this means I may have inadvertently selected for interview participants who already had the capacity to begin fish farming. This means I did not learn as much about the accessibility of fish farming as a livelihood as I had wanted to.

Some interviews were conducted in community spaces, with either the participant's family or peers observing, and many others were conducted with my homestay father present. Having an audience for their interviews may have influenced participants' responses in some way, perhaps to undersell the degree of difficulty their household experienced with fish farming or due to the recent flooding. However, my questions were primarily expository and did not require respondents to divulge sensitive information. Yet, in these 'public-space' interviews, I refrained from asking questions about income since that is often a somewhat uncomfortable topic.

Bias may also have been introduced by my very identity as a foreigner and a woman. As a clear outsider to the communities in Madi, farmers may have neglected to tell me information they would have readily offered to an 'insider.' That being said, I was lucky to have several contacts and previous informants reach out to future informants, adding to my legitimacy and the community's trust in me.

Results

To be a fish farmer

Fish farming is rarely a household's only source of income. Most of the fish farmers I spoke with did other forms of agricultural work as well. The family I stayed with in Shivadwar, for instance, cultivated rice, potatoes, and vegetables; raised chicken, ducks, and a water buffalo; cultivated *simaal* timber in the community forest; and ran part of the Shivadwar community homestay program—in addition to fish farming in three ponds. This seems typical of livelihood approaches in rural areas; diversifying sources of income and wellbeing to achieve a stable livelihood. The farmers I spoke with had a variety of reasons for beginning to fish farm. Several said that their land was swampy or otherwise unsuited for conventional agriculture. Others said that wild animals pose less of a threat to fish ponds compared to rice fields. Others said they knew that aquaculture was a more profitable industry. Whatever their reasons, there were certain common characteristics of Madi fish farmers that continued throughout all my interviews.

Most farmers had around three to four fish ponds, and had started aquaculture work in the last ten years. I did speak to a couple farmers who had been farming for more than twenty years, and one who had been farming for more than forty years, but their answers did not differ significantly from those of less-experienced fish farmers. Most farmers I spoke with dug their ponds with an

excavator, though two who have been fish farming for more than 15 years spoke of digging the initial ponds without any machine help. Many farmers took out agricultural loans to do so. Fish farming work entails feeding the fish every day and routine pond maintenance. Farmers add powdered rice husk (*Dhuto*), the caked remnants of mustard after it has been pressed for oil (*pinaa*), and chemical fertilizers like diammonium phosphate (DAP) and urea, a nitrogen fertilizer. These fertilizers are important in stimulating aquatic plant growth and thus dissolved oxygen content within the ponds (see *Challenges*).

Almost all farmers within Madi municipality cultivate the same six types of fish, all within the carp family: Silver carp, Bighead carp, Grass carp, Common carp, Rohu and Naini or mrigal carp. Carp are well-suited to cultivation is stagnant water (Kepenyes & Varadi 1984). I was also told that those six types of fish form an "ecosystem" within the fish ponds. The fish swim at different levels of the water, and have different diets. The silver carp eats zooplankton, the bighead eats phytoplankton, the grass carp eats fodder, rohu eats both plankton and fish food *(daana*), common eats bugs and fish food, and naini eats biomass and compost materials. Most fish farmers sell their fish for Rs. 250 per kilogram (~USD$2.50) to a businessman, who transports the fish to Bharatpur, Kathmandu, or Pokhara for sale. A few fish farmers take their own fish to market. This transportation is often an expensive and difficult process, because fish are kept alive in tanks in the trucks.

Most farmers I spoke with had received some form of training. _____ of the 10 farmers I spoke with had completed at least a seven-day training in Janakpur. Others had received a short training program

There are twelve registered fish farming groups in the Madi municipality. The process for starting a fish farming group is relatively standard: a committee is

formed, bylaws are written, meeting minutes are prepared and submitted to the district fisheries office in Bharatpur. Once certified, the group can provide members with funding aid to dig new ponds, access to a generator, wire to build stone gabon boxes (*jaali*), and sometimes access to small irrigation programs for water. The Gopalnagar Fish Farming Group (*Gopalnagar Maachhaa Paalan Samuha*) is the largest in Madi. It comprises 35 hectares, 200 fish production ponds, 90 nursery ponds, and 102 members—60 men and 42 women. In Shivadwar, the local aquaculture group has 40 members—15 men and 25 women. One farmer attributed the majority female aquaculture group to the trend of men migrating abroad for labor work.

***Farmer spotlight*: Pipla Bandari and Gendered Dimensions of Fish Farming**

Pipla Bandari lives in Krishnanagar, Ward no. 9 within Madi municipality. She started fish farming eight years ago because her land was swampy and unsuited for normal agriculture. Friends recommended that she begin fish farming, so she decided to start not only her own farm, but a local fish farming group as well. She describes the first two years as a very difficult time. She had trouble convincing other people in her community to begin fish farming, even after she had gone to the Agriculture Office on her own, collected necessary documents to register the group, and receive subsidies. Her first batch of fish was difficult to sell because they were not uniform size, and she had to take them door-to-door on her bicycle. She received seven days of training (unclear where), but since she can neither read nor write, she was unable to take notes on anything that she had learned. As such, she had no idea how long to cultivate the fish before harvesting or the proper strategies to make her fish grow larger. She admits she did not know which kind of fish was best or how many fish she could successfully stock in her ponds. In those first years, she made no

profit, only selling enough fish to cover the costs of the food and fertilizers. Slowly, as she gained experience, she began to make a profit.

Bandari has 5 ponds—three for production and two nursery ponds. She raises the same six types of fish prevalent throughout Madi. She usually works on the ponds for two hours each day, feeding the fish around 10a.m. and again later in the day. At the time of harvesting, she sells her fish to a middleman for Rs. 250 (regardless of type of fish), and generally receives Rs. 2-2.5 lakh profit from aquaculture work. The ponds' land is under both her and her husband's names.

After our initial interview, I asked Pipla if I could observe her feeding her fish and she said yes. Carrying a half-full sack of fish food (*daana*) and a woven basket, she led the way as we picked our way between tilled fields awaiting potato planting. I quickly understood one problem she had described—no clear path to the ponds; it would make harvesting and transporting fish back to the main road a significant challenge. At the pond, she took several handfuls of fish food and tossed in into the green-brown water. The *daana* floats (not all varieties do, I learned) and soon many common carp swam to the surface to gobble the dog food-like morsels. Apparently, in the morning when the water is cold, only Common carp swim to the surface for food. She has to return to the ponds again in the afternoon to feed the other kinds of fish then. I helped toss food into three of the ponds, thanked her and biked on to the next location.

Challenges while Fish Farming

The farmers I spoke with cited a wide range of problems that arise throughout the fish farming process, both from the natural world and from Nepal's specific developmental and economic context.

Wild Animals

Some farmers, especially in near the edge of Chitwan National Park, cited wild animal intrusion as a main problem. Crocodiles (*gohi*), otters (*ot*), snakes (*sarpa*), turtles (*kachuwa*), ducks (*haas*), and other migratory birds (*charaa*) all enter the ponds to eat the fish. One farmer in Krishnanagar also mentioned wild elephants walking around the edges of her ponds had damages the pond structure. Farmers have responded in some areas by stringing wires across the ponds to inhibit birds from diving in to catch fish, with limited effect. Given that most animals enter the ponds at night, it is difficult to prevent their intrusion. However, many farmers said that one advantage fish farming had over conventional agriculture was that it attracted fewer wild animals. As many of the communities in Madi are at the edge of the National Park, they regularly experience intrusion from deer *(chittal*), rhinos *(gaidaa*), and elephants coming to eat harvested rice (*daan*) crops.

Oxygen deficiency

But while wild animals may consume a significant portion of a farmer's fish stock, there's another problem that can kill the entire pond of fish in a single night: de-oxygenation. Fish, like any other aerobic organism, need oxygen to live and they rely on the dissolved oxygen (DO) in the pond, but if the pond's reserve of dissolved oxygen is exhausted, all the fish may die.

A variety of factors affect dissolved oxygen content. Water plants and phytoplankton produce dissolved oxygen as a byproduct of photosynthesis. Fish, plankton, and other aquatic organisms consume oxygen in the process of respiration. Some oxygen is fixed, or stored, in mud at the bottom of the pond, and some oxygen is dissolved into the pondwater from the atmosphere. Dissolved oxygen content varies over 24 hours, mostly due to changes in light conditions and

thus photosynthetic processes (see Appendix, Figure 7). Essentially, if the pond receives high solar radiation over the course of the day, a higher quantity of DO is produced by the photosynthetic processes of the plants. That quantity is usually enough to meet the oxygen demand from fish or other aquatic organisms during the night. But, if solar radiation is less intense during the day (perhaps due to cloud cover), less oxygen is produced and there is a smaller oxygen reserve to sustain the night's oxygen demand. Sometimes, the oxygen reserve of the pond can be exhausted. This can kill all the fish in the pond in a single night (Kepenyes & Varadi 1984).

Almost every farmer mentioned de-oxygenation as a major challenge while fish farming. One respondent said he visits his fish ponds at 5:30 a.m. every morning to check for signs of de-oxygenation. Loss of fish is a loss in investment, since the fish farmers are then unable to take their fish to market.

Kepenyes and Varadi (1984) note that as the intensity of pond aquaculture increases, and farmers attempt to maximize the amount of fish they can cultivate in a given pond, "the natural oxygen supply becomes more and more insufficient and will be a limiting factor in production." So how does one ensure there is enough oxygen in the pond? Wind can naturally diffuse oxygen into the pond, as it helps mix layers of water. (Kepenyes & Varadi (1984) suggest that the prevailing wind direction should be taken into account when constructing new fish ponds to take advantage of natural oxygen diffusion.). Oxygen content can be artificially bolstered by increasing the flow rate of water (generally considered an unsuitable strategy for intensive aquaculture) or aerating the pond. Aerating devices could be as basic as a sprinkler, paddle wheels, or artificial water falls; all devices increase movement and mixing of water and contact of water with air at the surface. Or, aerators could pump

air to the bottom of the pond and diffuse it, allowing oxygen to be absorbed from the bubbles are they move towards the surface (Kepenyes & Varadi 1984). Of course, to run an aerating machine, electricity must be available at the pond site; this is not the case for every pond site I visited in Madi. Meanwhile, other problems don't lie in the natural world at all.

Structural problems

Getting fish to market poses a significant problem to many fish farmers. Most fish farmers sell their fish to a businessman (*byaapari*) who transports the fish to larger markets in Kathmandu, Pokhara, or Bharatpur. That transportation is difficult for a variety of reasons. The trucks required for fish transport are specialized and expensive: they need to be able to supply oxygen to tanks of live fish for the duration of the transport. Nepal's road system is prone to long delays, and sometimes fish die from the same de-oxygenation problem that can happen in the fish ponds.

But farmers face many problems before handing over their fish to the middleman. Most fish ponds I visited in Madi were significantly set back from the main road, or even from any road navigable to a large truck. Fish farmers need to quickly harvest fish and transport them by hand or by bicycle to the main road, and hope that the fish survive that process. (I was not able to observe the harvesting process, but I did ask farmers to describe the process in interviews). A woman fish farmer in Krishnanagar claimed remoteness as a main problem. Krishnanagar lies deep inside the Madi valley. Most people who visit the municipality come via Bharatpur, and enter Madi from the west; Krishnanagar is to the far east of the valley. The woman I interviewed said that sometimes, the fish buyer does not even visit Krishnanagar if he can find all the fish he needs in a more accessible place.

Farmers also cited lack of inputs, like high quality fertilizers or fish food (*daana*), as a limiting factor of production. Most fish food is imported from India, and it takes about two months in transit. After 15 days, the food pellets begin to attract mold, damaging the nutritional quality and inhibiting fish growth. One farmer I spoke with made his own fish food from egg, corn, and wheat. Other inputs, like electricity at pond sites, were also lacking. Madi only received electricity last year, and the electricity available rarely reaches the ponds that are usually set back from the main roads or homes. Electricity is important for running aeration machines that could the alleviate the threat of de-oxygenation that can kill an entire pond's worth of fish overnight. And then, of course, there is the flooding.

After the Flood

Last August, Madi experienced the worst flooding in recent memory—the same flooding that make headlines for its devastating inundation of northern India and Bangladesh. Remarkably, no one in Madi died from last summer's flooding, but the destruction of crops and property, and the impact on livelihoods was profound.

Damages

In Gopalnagar, Krishnagar, and Shivadwar, farmers' fish ponds lie close to the Rue Kholaa. The last flooding washed away entire ponds, and all of their contents. For Harispashad Gimare in Gopalnagar, Flooding swept away Rs. 2 lakh worth of fish, and another 12 quintals of fish died in following days from de-oxygenation. For Pipla Bandari, the flood washed away 10 katha (8.4 acres) of ponds, along with 4000 fish fry (*bhura*). The *bhura* had already consumed 5 quintal (500 kg) of fish food pellets and she had just put 2 quintal (200 kg) of fertilizer materials into the ponds. Nothing is left of those ponds. All the land is barren. For

Lalit Karka of Gopalnagar, the flooding swept away only about half the fish in his ponds. Maniram Chaudhari of Simara describes similar effects; the flooding caused Rs. 10 lakh in damages and took some of, but not all, his fish. For Ramesh Pandey, a commercial fish farmer in Sauraha with 10 fish ponds, told me he lost Rs. 35 lakh (USD$35,000) from this year's flooding, and it would take at least two to three years to recover those loses. He told me that 22 lakh (2,200,000) *bhura* were swept away from his four nursery ponds. Another Krishnanagar farmer, Renuka Ranabhat, told me that in past flooding, her ponds were damaged, and all fish were washed away. However, during last summer's flooding, only the fish that swim in levels of water closer to the surface were swept away.

In Shivadwar, a community forest previously buffered the village from the Rue River. Local people planted *simaal* trees, an investment because *simaal* trees are good quality timber. The community forest also sheltered grazing spots favored by rhinos, and to which Shivadwar villagers could bring tourists from the community homestay project. The flooding last summer literally swept the community forest away. Approximately 50 *bigha* (~34 ha) of community forest land and 20 *bigha* (~14 ha) of other land. One local farmer told me that of the 60 *simaal* trees he had planted on his plot of community forest land, only three remained after the flooding. There are plans to replant the forest, but he was not hopeful. The Rue river has changed course and now flows through much of the land that was previously community forest, and the rest of the land is strewn with stones and sand.

Recovery Processes

In the three months since the flooding, most visible damages have been cleaned up. Farms are generally neat and organized and life seems to be proceeding as normal. Only on the edges of the new course of the Rue river does one see the

remnants of ponds washed away, some of them resembling sawed-off bathtubs. I asked most farmers if their community fishery groups were disbursing recovery funding, and all responded negatively. Pipla Bandari, chairperson of the Krishnanagar fish farming group, told me that there are plans for disbursement of recovery funds. After many ponds were washed away in the flooding, officials from the Fishing Association of Nepal came to observe damage to the ponds and will soon send funds based on estimated damages. However, so far information has only been collected on damaged ponds, not the value of fish swept away in the flooding. One other female fish farmer, Renuka Ranabhat, said that while she lost Rs. 2 lakh of fish, the FAN sent her a single sack of fish food.

Adaptation to Future Flooding

Apparently, the United Nations Development Program (UNDP) and Nepal's Terai Arc Landscape program ran a joint flood-preparedness training in Madi last year, before the floods came. The training included lessons on how to wear life jackets, where to find them, basic swimming training, who to call in case of emergency, and how to install a flood early warning system. I received some conflicting information about the existence of a flood early warning system in Madi. One respondent, Mohan Bahadur Punmagar, in Shivadwar, said that all people receive an SMS message warning them to evacuate if necessary. Another respondent in Basantapur, Netra Ale, told me that sirens announce the flooding as well, whereas Pipla Bandari of Krishnanagar told me that Krishnanagar the main flood detection instrument is far away from Krishnanagar. I wanted to ask more about who received the UNDP-TAL training and who received the training, but I did not understand the answers. However, most people I spoke with said that, because of that training and the early-warning system, no one died in Madi as a result of last summer's flooding.

But while trainings can save lives from flooding, they can do little to save livelihoods.

I asked several farmers what they will do if another large flood comes. Most simply said that they would once again start over. There are some plans at the local governmental level to build stone gabon boxes along the riverbanks, and some farmers spoke of raising the sides of their ponds. Pipla Bandari told me that the municipality has Rs. 3 crore (Rs. 30 million, or ~USD $300,000) to reinforce and raise the sides of the riverbank to protect the village from future flooding. Other repairs or rebuilding the villagers will do themselves.

Ramesh Pandey, the president of the Chitwan chapter of the Fisheries Association of Nepal, told me that the only thing to be done against future flooding is to take out an insurance policy. He did not seem enthusiastic about this idea, but seemed to think it was the only thing to be done if flooding were to become more frequent. However, he is also one of the wealthier fish farmers in Chitwan, with both the financial capital and financial literacy to take out an insurance policy. It remains to be seen if rural disaster insurance is a viable option for smaller fish farmers, and especially for women fish farmers.

Discussion

Throughout my field study, I was trying to connect a variety of factors to a specific context. I was curious to understand how climate change—this macro-process affecting people the world over—is impacting the lives of a specific community. I was curious to understand how different people's ascribed social roles rendered them more or less vulnerable to those climate risks, or the challenges generally associated with that livelihood. I was curious to understand those complexities in the context of the fish farming industry, and to see if I could verify

the claim that fish farming may be less vulnerable to climate change risks than conventional agriculture. There was much that I wanted to observe or find out during my field study that I was not able to observe. My study was necessarily limited in scope. I spent only two weeks in the field, and conducted interviews with less than 15 farmers. I learned much about fish farming and farmers experiences, but discovered it was extremely difficult to answer my initial research questions.

How accessible is fish farming as a livelihood? It's still challenging to say. In Madi, aquaculture is becoming an increasingly popular livelihood strategy, with many community organizations to support new farmers entering the field. That being said, the initial investment required is still pretty high, which may still disenfranchise poorer would-be fish farmers. Moreover, many community fishery groups require proof of citizenship and land registration for membership, which may disenfranchise those without formal documents or land titles. I had wanted to find individuals who were not fish farmers, but considering starting such a livelihood to interview, but unfortunately was unable to conduct interviews with those types of individuals. And, Ramesh Pandey in Sauraha commented that new fish farmers would not be able to sustain fish farming because they lacked patience; only people who have been doing this for a while could make a profit.

How does farmers' perception of climate change compare to their perception and response of other risks? Most farmers I spoke with seemed to perceive wild animals as a greater threat than flooding. This is perhaps unsurprising. Floods as large as last summer's, though devastating, seem to come in a decade at most. Wild animals, on the other hand, pose a threat to livelihoods every day. Wild elephants routinely emerge from the jungle to feast on harvested rice crops or banana plants. Many farmers cited otters, crocodiles, and birds as the greatest threat to their fish.

And the community has adapted, to the extent that it can, to these threats. Near Gopalnagar, a tall electric fence stands between farms and fish ponds, and the looming jungle. Wires strung across ponds fish ponds in some places to deter diving birds. In Shivadwar, noise-making contraptions are placed in some fields, and every night, people take turns occupying watch towers scattered throughout the fields, ready to shine powerful lights, bang noisemakers, or sound sirens to warn off a visiting elephant. These communities certainly seem capable of mobilizing, of collective action, of adaptation necessary to live at the border of one of the most biodiverse national parks in the world. But the perception of the imminence of the threat seems to matter. It's also likely, of course, that only three months after the worst flooding years, the communities in Madi are still focusing on recovering and recouping losses, and haven't yet considered long-term adaptation strategies.

Is fish farming an appropriate climate change adaptation strategy? It is still difficult to say. Ramesh Pandey told me that if water in ponds reaches above 34 degrees Celsius, fish will not eat the food given to them, and cultivation becomes challenging. Most aspects of changing weather—changing rains or foggy days—seem unlikely to impact fish cultivation to a significant degree. The impact of severe flooding on a farmer's ponds was highly dependent on the proximity of the ponds to the Rue River. Ponds that were very close to the river were structurally destroyed; entire ponds were washed away, along with all the fish and any hope of income from fish farming that year. Other farmers only lost portions of their fish, leaving them with fish stock to sell in market or consume for their own food security in the aftermath of destructive flooding. Digging "deep" fish ponds (5 ft.) seems to be the norm throughout Madi, so more research on other factors is important is gauging the success of fish farming as a climate change adaptation strategy.

How might fish farming women be more vulnerable than fish farming men? From what I observed, fish farming did not add a disproportionate labor burden to women rather than men—although more study is definitely needed. I unfortunately was not present in Madi to observe the harvesting of the fish, because I suspect that may be the situation where women fish-farmers are disenfranchised of the benefits of their work. I suspect that, at harvesting time, the man of the household actually conducts business dealings with the middleman who comes to buy the fish, and the fish farming women may not directly receive the payment. However, I did not observe this process or speak about it during interviews, so that thought remains only speculation. It does seem that women have fairly equal representation in community groups, and even leadership positions. However, as in the case of Pipla Bandari, other inequities like lack of education may disadvantage women moreso than men, if those inequities are gender-specific.

What can be done to improve the situation of fish farmers? All I say here is speculation, but expansion of rural electrification in Madi, and increased access to affordable generators and aeration machines iis likely to alleviate some of the problems associated with oxygen deficiency. There is also, perhaps, the opportunity for some form of rural disaster insurance program to help farmers recover their losses from severe flooding, but much research would be needed on the feasibility and appropriateness of that idea.

Conclusion

Most farmers started fish farming because of its high profitability or because their land was unsuited to conventional agriculture. Farmers perceive a variety of risks—from wild animals, de-oxygenation, lack of roads or electricity, flooding,

unfair competition with India, and lack of government support for aquaculture. Women and men seemed to be nearly equally represented in community fish farming groups, possibly as a result of male migration abroad for labor work and the resulting femininization of agriculture. The flooding devastated most farmers and set them back several years saving to fund repairs. For some, the floods swept away entire ponds, calling into question the claim that ponds are better suited for climate-risks like flooding. For others, the flooding swept away roughly half their fish, causing severe damage but not entirely destroying fish farming as a source of income. The impact of the flooding on a farmer's ponds was highly dependent on the proximity of the ponds to the Rue River. Three months after the flooding, farmers are still trying to recover. There are some plans to rebuild ponds or raise riverbanks to protect farmers from future flooding, by the most farmers seem resigned to the idea that when another flood comes, they will once again start from the beginning.

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Appendix

Figure 1. Map of Madi valley with field study sites

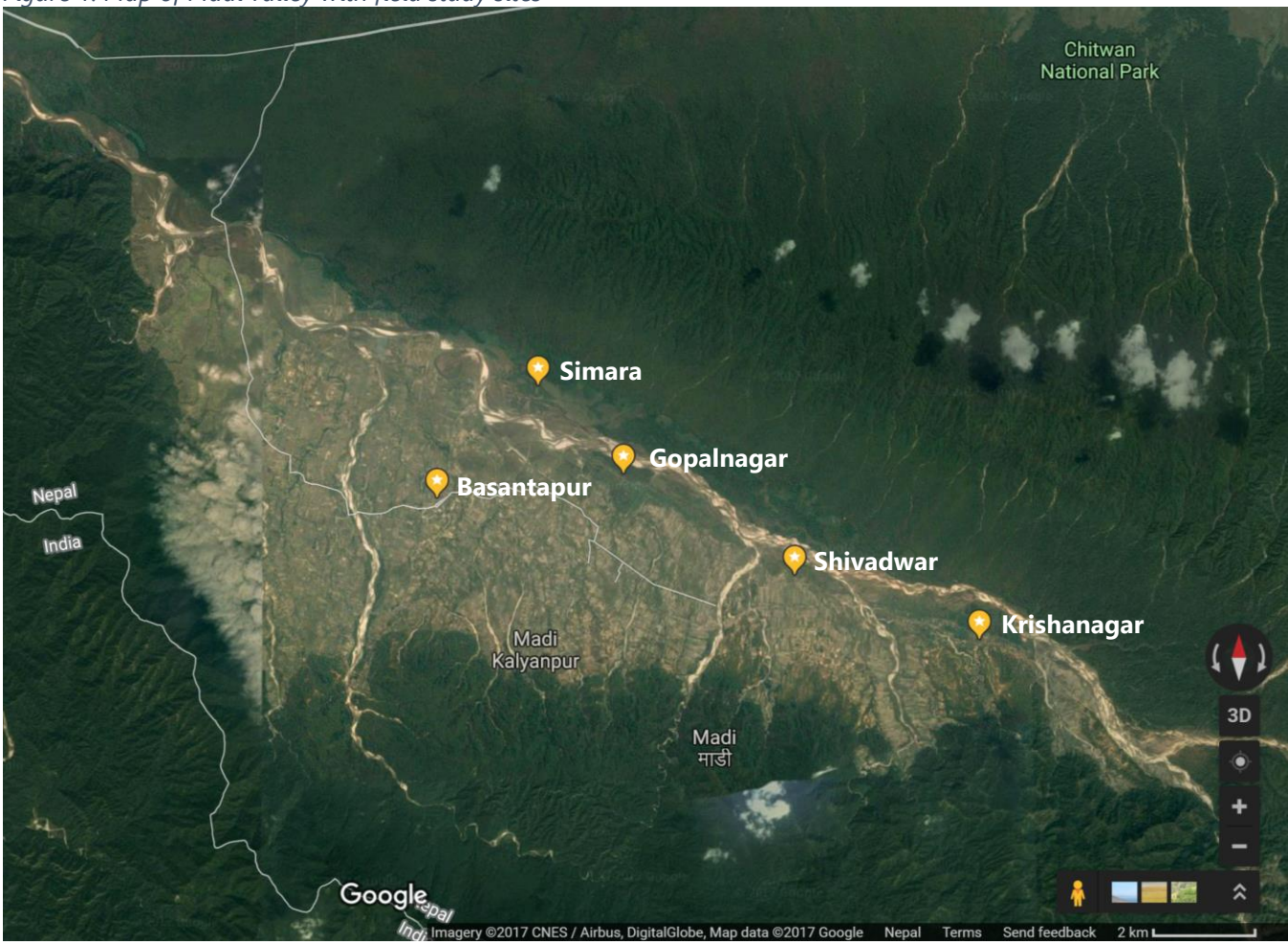

Figure 2. Map of Madi, Chitwan (Source: Local Governance and Community Development Program, Nepal)

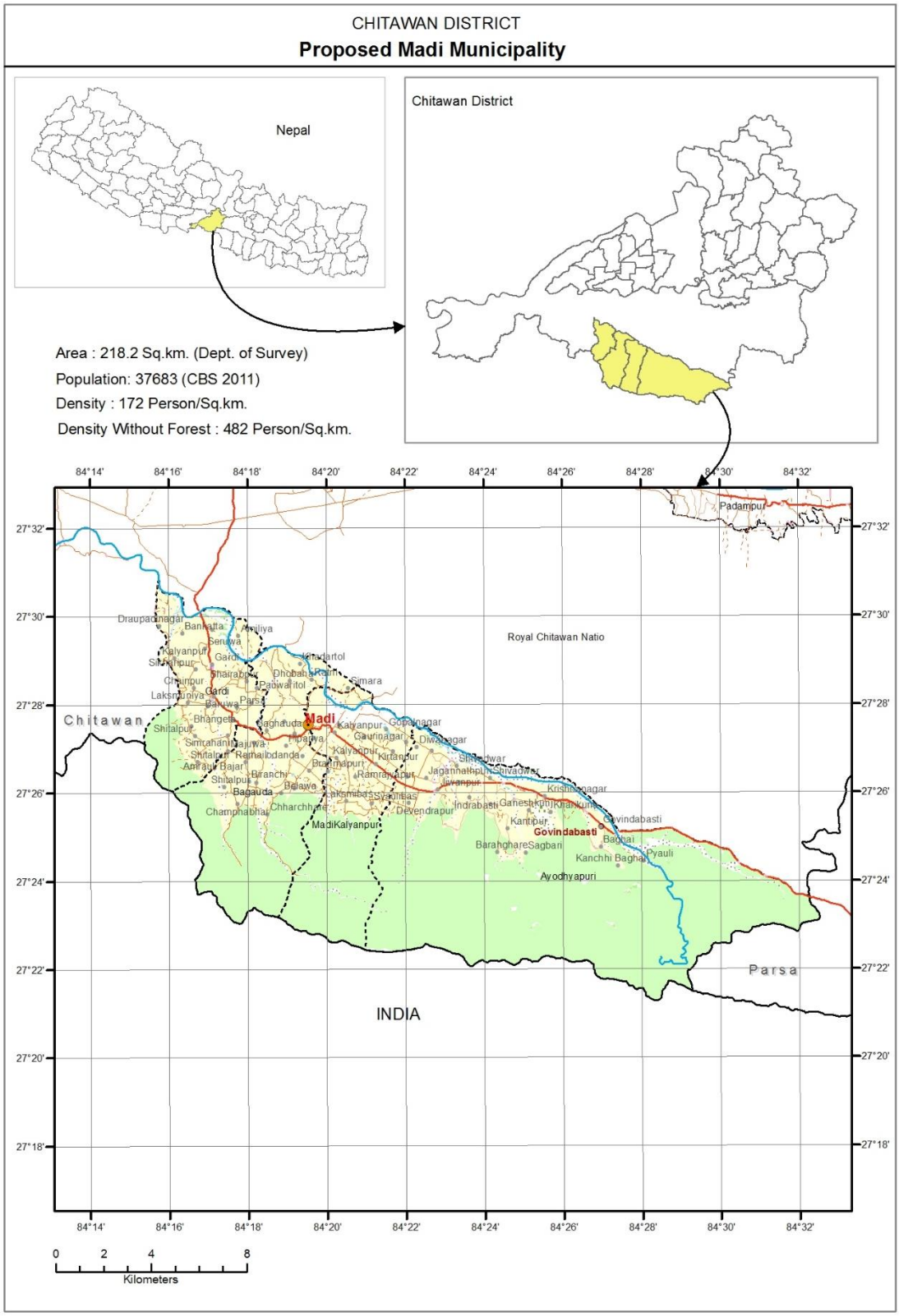

Figure 3. Fish ponds in Gopalnagar, Madi. Gopalnagar is the center of fish farming in Madi municipality, with over 200 fish production ponds and 90 nursery ponds.

Figure 4. In Krishnanagar, Pipla Bandari walks the "path" to her fish ponds to feed her fish. She told me that the lack of a road to her ponds was one of the biggest challenges at the time of harvesting. The hills of Chitwan National Park can be seen in the background.

Figure 5. Fish ponds in Gopalnagar built up against the edge of forestland on the edge of Chitwan National Park.

Figure 6. Yearly Fish Consumption per capita in Nepal

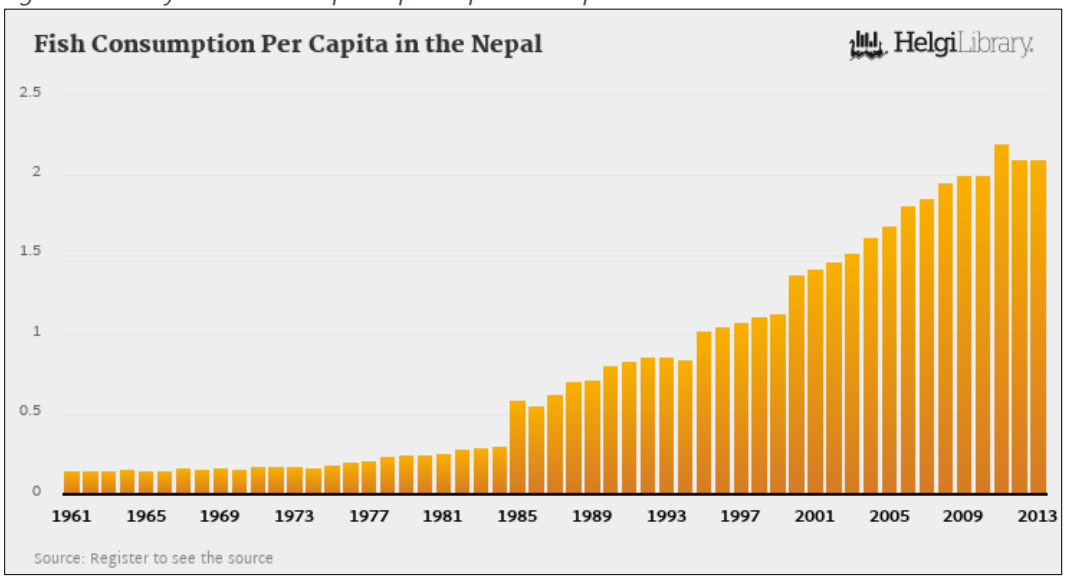

Figure 7. Diurnal change of the dissolved oxygen concentration in intensive fish pond (Source: Kepenyes & Varadi, 1984)