Building a Web of Water Security: One Kumaoni Village's Effort to Buffer Themselves from the Effects of Climate-Exacerbated Scarcity through the Construction of Water Storage Tanks

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This article is based on field visits and interviews conducted with residents of Pata and Galla villages in Nainital District, Uttarakhand, India from May 18-19, 2018.

High in the hills of the Kumaon region of Uttarakhand, India, Pata is a village where people have been creatively modifying their livelihoods and local agricultural practices to adapt both to a changing physical environment and local economy. This village of 80 households, which is situated at approximately 6,000 feet in elevation, has been a horticulture centre for apple production since the British introduced this crop in the 1860s to the hills surrounding their summer headquarters in the district capital of Nainital. Since the local climate makes Pata ideally situated for orchards and because of its relative close proximity to markets, this is one area in the region where agriculture and land-based livelihoods continue to remain economically viable and men are not forced to migrate to the plains and other parts of India for wage labor. As a result, it is more common in Pata for families to work together in their small-scale orchards and fruit nurseries, with both women and men participating in most activities related to cultivation.

Figure 1. A view of Pata village with various polythene-lined water tanks visible with their green covers.

Yet, as in much of the Himalayas, climate change is having its impacts on Pata's orchards and on villagers' livelihoods. Dwindling rainfall, particularly low intensity rains over extended periods that are the most useful for agriculture, has impacted crop production. Like most villages in the region, Pata has traditionally practiced rain-fed horticulture, and until recently has been wholly dependent on precipitation for a successful harvest. This makes farmers particularly vulnerable to climate change as rainfall has become increasingly more intense and intermittant in the Himalayas. Rising temperatures have also affected agriculture and horticulture in the region. Over time, apples, which prefer cooler climates, have become less productive and preffered by villagers in the region. Warmer temperatures are better for peaches, plums, and apricots, so over the past 20 years, villagers in Pata have begun to replace their apple trees with these fairer-weather fruit trees, and shift their apple orchards to higher terraces.

Figure 2. One of Pata's upper terraces where potatoes have been planted under young apple seedlings.

Interestingly, the topography of the region with its steep hills and narrow terraces countoring the mountain sides seem to provide diverse micro-climates at varying elevations which people can use as an adaptive advantage by adjusting the elevation at which they plant different crops. Pata residents are also experimenting in their nurseries with developing new local varieties of fruit trees that are better adapted to the local climate and that also have higher market values. Alongside these efforts, residents with the support community organizers have been working for the past three years to get their fruit certified as organic. Although local horticultural practices have always depended on organic composting and non-chemical pest

control, this recognition and certification is in many ways evidence of communities' own adaptive strategies and creativity to better compete within a changing market economy.

Figure 3. Fruit crates sitting outside a home waiting to be filled with produce to send to markets in Haldwani.

In addition to these efforts, Pata provides an inspiring case study to examine how one village is adapting to the changing patterns and growing unreliability of rain associated with climate change through the construction of water storage tanks that help ensure a timely and regular water supply. This year, with support from the Almora-based NGO Uttarakhand Seva Nidhi Paryavaran Shiksha Sansthan (USNPSS), the villagers of Pata constructed 90 plastic-lined water tanks in their village in the course of only three months. The idea for this intervention came from the villagers themselves who had been discussing in community forums organized by the NGO the various challenges that they face each year with sparse rainfall in the months leading up to monsoon. This winter, in particular, the village had not received any precipitation since monsoon ended in August and people were concerned about what this would mean for their livelihoods come spring. USNPSS had previously experimented with building water storage tanks in the neighbouring village of Galla and offered to work with Pata to attempt a similar intervention informed by their past experience. Inspired by the opportunity to protect themselves from the erractic and fickle nature of rains, every household of Pata mobilized themselves and enthusiastically constructed 90 tanks. By the end of February, everyone had built at least one reservoir, working together to make this feat possible before the agricultural season began.

While USNPSS provided the plastic polythene lining and synthetic green covers, villagers did all of the labor and construction themselves. This involved each household hand digging a 10,000-liter tank (approximately 10x10x4 feet deep) over the course of two to five days, usually on their uppermost terrace, and then plastering the walls with six to seven layers of mud and cow dung. This technique, used in the traditional construction of homes and terraces, ensured a smooth surface on which to lay the polythene tarp. Those villagers who had previously built their own water tanks out of concrete had found this material vulnerable to cracking and not sufficiently flexible for the region's intermittent seismic acitivity and fluctuating temperatures. It was also expensive and difficult to repair (a concrete tank might cost 20,000 to 30,000 rupees to build while the price of replacing a polythene tarp for a tank of this size was one tenth this price).

Figure 4. USNPSS community organizer, Mahesh Singh Galia, uncovers one of the new polythene tanks in Pata.

Based on this experience, residents opted to build their tanks with lower cost and more flexible materials and use local technologies in construction. While neighbors laboured together to carve each other's tanks out of the rocky soil, the village organized a committee to visit each household to check that the reservoirs were being properly constructed before the polythene tarps and tank covers were distributed by USNPSS.

"It was like a festival in Pata when everyone was digging tanks," shared community organizer, Bachi Singh Bisht. "Everyone was working on something together."

By March 2018, the whole village had completed the construction of their tanks and they were ready to connect them to Pata's four perrenial springs and fill their reservoirs with water. As USNPSS did not provide the community with pipes, but rather allowed the villagers to coordinate their own connections, this was done through a gravity-fed system of plastic piping and some small electric pumps that already existed in the village. Before this intervention, 25 of the community's wealthier households had already invested in their own personal (mostly concrete) water tanks and pipelines, and so after the construction of the 90 tanks, these personal pipelines became the shared infrastructure securing the entire village's water needs. The villagers formed several linear chains down the terraced hillsides from these 25 pipelines, whereby the upper most tanks were filled directly from the spring and then these households distributed water to the tanks of the neighbors below them. As one community organizer and local volunteer described it, the result was a tangible manifestation of the village's connectivity—both the physical infrastructure of the pipes linking the 90 water tanks and the village relationships that made this network possible.

Figure 5. A cracked concrete tank that has been repurposed and lined with polythene as part of the project.

Having this access and capacity to store spring water for irrigation enabled the people of Pata to flood and soften the earth prior to planting this year, increasing soil moisture and ensuring adequate water for their sensitive cash crops like peas. In just this season alone, residents have experienced an immediate economic benefit from the tanks and competitive edge in selling their crops, since they had access to water for irrigation when neighboring villages without reservoirs were forced to wait for the fickle summer rains. While only the first crop has been harvested since the tanks were built, many villagers reported having more than doubled their income in terms of

the amount and quality of the peas that they were able to sell this year compared to last. While local leaders claim that most villagers made around 35,000 rupees in pea sales this year (a rough estimate that needs to be verified), some households were able to generate as much as one lakh (100,000) rupees in sales—an amount unheard of prior to the construction of the polythene ponds.

In addition to irrigating their fields, orchards, and fruit tree nurseries, people have also been able to use their tanks for washing and watering animals, as well as accessing drinking water in ways that they had never been able to before. This is particularly beneficial for those households who did not have the economic resources to make their own tank or finance a personal pipe connection before. In Pata there is no reliable piped government drinking water. A scheme in the early 2000s to pump water from the stream in the valley below failed as access was intermittant and most of the water was captured and consumed by wealthy developers who have built private cottages on the ridgeline, leaving very little to trickle down to villages below. With the new polythene tanks and pipe connections, however, people can now also store springwater in household vessels when it is their turn to fill their tank, reducing the amount of time and labor that women expend walking to the spring and transporting water. While these water storage tanks are most crucial for irrigation during the pre-monsoon months from March to June when rainfall is scarce, Pata farmers plan to also use them as a buffer throughout monsoon particularly during dry spells and long stretches without rain, which are becoming more common with climate change.

Figure 6. A household tank being field to enable continued irrigation throughout the agricultural season.

In these ways, Pata is a community that has essentially built in the course of a few months, an entire network of irrigation infrastructure in a place where this was never previously necessary. Unlike other arid places of India and the Himalayas where water has always been scarce and people have rich histories and traditions of capturing water during times of plenty to cope with scarcity, the foothills of Uttarakhand never had such explicit traditions of water harvesting and distribution. In some places, villagers dug *khuls* or *ghuls* (earthen canals) to irrigate their fields, but for the most part rainfall was sufficient and people could depend on regular water delivered by the skies. In this way, adaptation to a changing climate requires new innovation, and in places like Pata and the surrounding hills of Kumaon, possibly even making entirey new physical systems and social structures for managing, harvesting, and distributing water. Pata's industrious construction of 90 water tanks and collective system of distribution developed during this past year, with its flexible pipes and plastic-lined tanks, use of local construction technologies, and repurposing of cracked concrete tanks, is a prime example of the kind of adaptation and innovative coping strategies that will have to occur in the coming years. This is particularly true if viable agriculture-based livelihoods—subsitence, cash-crop or otherwise—are to be maintained amidst a changing climate.

Figure 7. In neighboring Galla village, a man packs organic peaches in pine needles for transportation to market.

Yet, I would argue that depsite this project's immediate success and the way in which it can—and already is—inspiring neighboring communities to execute similar projects, it is important to consider both the limits of this kind of adaptation as well as some of the subtle inequalities in how an intervention like this serves individuals within the broader community. Those individuals with whom I was able to speak and who were also most active in organizing and

executing the project insisted that there were many more conflicts and issues with water sharing prior to the intervention which essentially built more equity into the community by supporting each household in building their own water storage tank. Before this project, only the wealthiest and most enterprising households could afford to construct their own reservoirs, purchasing pumps and private pipelines to divert water from the collectively-owned spring to their personal fields and orchards. While this project certainly does not equalize uneven wealth within the community, those most actively involved in community meetings and organizing expressed how through this kind of grounded social work they were able to build better relationships among neighbors and collective ownership of the project. As a result, people with more resources and access to water distribution infrastructure (pipes, electic pumps, etc.) were willing to share and put it to use not only for themselves, but also for the benefit of their neighbors.

Figure 8. Pipes snaking to the base of one of Pata's four springs serving the village's new irrigation system of tanks.

While this community solidarity speaks to the hard work of USNPSS staff and volunteer organizers, I wonder how sustainable this social connectivity and sense of altruism will be unless the villagers decide to create some mechanism to institutionalize equal access and set water sharing rules. After all, there is certainly the possibility that the current system of individual tanks and pipe connections could enable a more self-interested turn toward competitive exploitation of limited water resources. While USNPS's intervention has been able to build greater equity in terms of people's capacity to store water for irrigation, the fact remains that a tank itself is useless unless one has the means to access and deliver water to it.

In this way, whether one has a pipe or not is preciesely what determines access and shapes the uneveness of distribution. In the system that currently exists, one fills his or her tank depending on personal use on a first-come-first-serve basis. When one finishes all the water in his reservoir, he either connects his own pipeline directly to the spring or to his neighbor's tank. As there is no current rotation or turn-wise system, each resident's capacity to frequently refill is determined by her or his proximity to the spring (i.e. if one can easily go to check when the tap is free) and capacity to access it (having one's own pipeline versus depending on the altruism of neighbors). For example, one enterprising man with his own connection had been able to fill and use the water in his tank nine times this season, while two other men, for various reasons, had only managed to utilize two tanks.

Currently, there is reportedly enough water flowing from the springs so that all villagers can fill their tanks and those with pipes are happy to share when their reservoirs are filled. However, the uppermost households closest to the springs are able to fill their tanks in 24 hours or less, while lower households further from the source, described having such limited flows that they left their private pipes flowing continuously and could only afford to disconnect them and share water with their half a dozen dependent neighbors only when others were totally out of water. This reality illustrates inequalities in access to water within the village depending on how one is physically situated in relation to the water source as well as the resources one has to 'buy' a private connection. While this is easy for the wealthiest households with earnings from extensive orchards and land holdings, the average cost of a pipe is 20,000 to 50,000 rupees for 1,000 to 3,000-meter connecton; a substantial investment especially for less affluent families.

Figure 9. Local women disconnect an irrigation pipe to get a drink of water when passing by a spring in Pata.

This raises the question: if rainfall and spring discharge continue to dwindle and there is no longer sufficient water to meet the new demands of irrigation, will the people of Pata develop new structures of water sharing or rather opt for a system of individual competition to exploit a dwindling resource? I ask this, because I have found that even in places like Ladakh where irrigation infrastructure and social systems have existed for hundreds of years to equitably manage and distribute scarce water resources, the impacts of climate change along with a growing trend towards individualism and participation in a cash economy, have begun to erode collective systems of ownership, maintenance, and cooperation. If this is the case in a place that has strong traditions of water management, I wonder whether a village like Pata that never had systems for managing water collectively and does not currently think that establishing some form of governance is necessary will decide later to respond to scarcity through an equitable water sharing system.

One community organizer assured me that life in a village requires people to share and support one another and that because of this, institutionalizing water sharing norms is unnecessary. However, I wonder to what extent this only romanticizes village life and a moral economy of social cohesion and goodwill that may or may not have ever exisited, and that from a social justice perspective, I would argue should not be taken for granted in the future. Even if this project has been able to create more equity in access and better water sharing between villagers, this cohesiveness and comunal sharing, at least to me, seems precarious. Particularly, if the income generated from produce grown on irrigated land this year continues to be strong and people recognize the value of having and controlling access to water in their fields, people could become less interested in sharing with one another and decide to keep more water for themselves. As it is, even with pathetic flows to less-well positioned tanks, the people of Pata want to build at least 25 more reservoirs in the coming years. If discharge continues to dwindle, what might an extension of the current system mean for those with less access and means to bring water to their tanks?

Figure 10. A man connects his pipe to a puddle of 'wastewater' rather than compete with for access to the spring.

I pondered this while standing by one of the springs supporting Pata's new irrigation system with a group of villagers and NGO workers active in the project. While several villagers had assembled to present their appreciation of and benefit from the project, I could not help but turn and follow the flow of water down the *nalla* with my eyes. There, in several places below the spring where there was only a trickle in the canal, people had scraped away small depressions and had sunken their pipes with weighted stones into the puddles like straws. When I asked why these many pipes snaking up the *nalla* did not simply wait for their turn at the spring, someone explained that this 'wastewater' was "easier and free to access" compared to competing for time connected to the main source. This, I think, reveals how equity does not inherently emerge in water sharing without its intentional structuring. Yet, the reality is that no NGO can ensure this or build new social systems for water sharing, if people do not create and choose to live by them themselves.

Figure 11. In the canals below Pata's springs, people try to syphon whatever water is left in puddles to their fields.

Additionally, for better or worse, this project and the extensive system of water storage tanks that it has extended creates the new issue of competing water uses. While villagers previously relied only on rainfall for watering their crops, the 90 tanks and piped infrastructure built this year in Pata, put more demands on water sources that previously only had to fulfill the village's drinking water requirements. Although villagers insist that use of the springs for drinking water purposes takes precedent over irrigation and that people retain the right to disconnect anyone's pipe to fill their water vessels, as the economic value of being able to irrigate one's fields and orchards becomes established, I wonder if new conflicts over competing uses will emerge and how they will be managed. Just as this intervention became necessary to build and extend physical irrigation

infrastructure in a place where it never previously existed, the same kind of need may emerge for the establishhment of a governance structures to balance use as well.

Figure 12. Women and children in the neighboring village of Galla wait in line to fill their jugs with drinking water.

Fundamentally, the fact remains that regardless of how innovative and successful Pata's whole system of water tanks and piping is in terms of the economic benefits that it has been able to provide to participants, without a healthy spring, the current system let alone an expansion, is not possible. The health of Pata's springs is affected both by climate change and development patterns, both of which have exacerbated dwindling discharge and neither of which the community has much control over. Village women, for example, reported a direct connection between declining rainfall in the last 10 to 15 years, and the vegetation of forests which contribute to recharge and the amount of discharge exuded from springs. In the same period of time, there has been extensive development of roads and cottages for tourism along the ridges above their springs. These developers, which have sunken bore wells and fashioned private pipes to local water sources for their resorts and summer homes, have affected groundwater directly through exploitation and by disturbing the hydrology of the mountain tops and ridges which recharge village springs below.

Residents of Pata and nearby villages have tried to resist the negative impacts of development and exploitation of water resources in their headwaters through legal battles at the District Magistrate's office in Nainital. This activism began with the construction of the Cloud 9 resort in 2005 which had attempted to block and pump water from one of the village's local springs to service its 150 summer cottages strung along the ridge. This led to the formation of several informal women's groups and later a larger federation that has remained active in working on

issues of water, soil, and forests directly connected to their agriculture and horticulture-based livelihoods. Although the villagers of Pata were successful at protecting their right to local springs from Cloud 9 developers, the reality is that they essentially managed to only displace the exploitation of water resources from surface resources in the upper watershed to other forms of extraction through borewells and private pumping systems.

Figure 13. Here Cloud 9 is visible in the distance on the ridge above Pata. This is only one of many resorts erected in the past 15 years that now compete with local people to fulfill their water needs.

While this is a battle that will have to continue to be fought, for the time being, the people of Pata seem to see solutions, or at least ways that they can intervene in securing their water resources, in the management of their *van panchayat*, or local forests. In Pata, residents are currently discussing interventions that they can make in their 850-hectare forest to recharge springs and protect vegetation. Together, with USNPSS's community organizers, they are developing a plan to harvest rainwater and recharge springs by digging trenches and infiltration ponds in the forests that they have direct control over. If the community can manage to get the technical expertise to make this intervention effective and support from other organizations that have spent decades in nearby watersheds developing methods for training local people to assess their own local geo-hydrology and place infiltration pits accordingly, this project has the potential to support the existing irrigation infrastructure Pata residents have built and perhaps even allow for the expansion of more tanks. However, it is also necessary to recognize that people have limited control over their watershed, particularly with the rapid development of more than 100 hectares of privately-owned forests on the surrounding ridges. Therefore, if water scarcity is to be solved in a

place like Pata, these other players who now depend on and extract from the local ecosystem will also have to become part of the solution.

Thus, even in the midst of celebrating the success of an adaptive, creative and energetic community like Pata in trying to cope with climate change and protect its most important natural resources against development, it is important to acknowledge the limits of local adaptation and the capacity of villagers to protect their own forests and springs alone against the entangled forces of change. After all, while Pata has been able to design and innovate a decentralized form of water distribution to more efficiently put to use its limited water resources and buffer itself against changing precipitation patterns, other villages like neighboring Galla have less options for adaptation with fewer springs located below the village and greater dependence on the government's intermittant piped drinking water scheme. This recogition, I think, in terms of what is and can be achieved is important when NGOs come into communities to work on local problems. Too often big promises are made to both villagers and donors, when a more grounded discussion about small adaptations that can be taken locally while also recognizing that real solutions must also be structural and extend beyond village boundaries, may be more productive.

Of the many NGOs that I have interacted with working on climate adaptation and water management in India, USNPSS is perhaps one of the most honest about what its interventions are able to achieve and careful in its role facilitating community-owned and identified projects. USNPSS is clear that building 90 water tanks in Pata will neither save their world nor fundamentally solve villagers' more basic water problems. True solutions to challenges as big as these—water security, climate adaptation—cannot be assembled overnight by even the most hard-working of institutions and also cannot be solved within individual villages alone. No community, however rural, is isolated from the forces of change, both climactic and developmental, around it. Yet this project has, as USNPSS director Dr. Lalit Pande asserts, "given people something to do"—a project to labor on that they can own, see a direct benefit from, and that brings them a small step closer to water security as a community. This, in itself, is something worth celebrating.

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