Spring Development in Sikkim

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Introduction

Water is an inherent human need and global climate change has put this finite resource in jeopardy in India. The Himalayas, generally considered to have an abundance of water, are suffering from seasonal drying and extinction of its springs- the main source of water for many people living there. Growing population and development in the Himalayas has led to water scarcity in the summer. Traditional techniques used to manage this resource are no longer enough and new solutions need to be found to guarantee clean drinking water year round to the people of the Himalayas.

With a growing population and global climate change occurring, water management is moving to the forefront of government policy. In the case of Sikkim, the springs which function as the main source of water for the rural people are increasingly drying up. A policy is needed in which the springs can be recharged. However, as other cases have shown, the top down approach to water management rarely works since there are so many variable factors from place to place. Therefore a decentralized water management scheme is needed to recharge the springs and put the local people in charge of their own water and their own livelihoods.

The idea of creating "spring sanctuaries" to protect a spring's recharge zone is an upcoming solution to the issue of dying springs. This concept consists of involving the community in using traditional knowledge of plants that assist with groundwater recharge as well as other techniques to turn the often barren land in the spring recharge zone into an area

that will hold water and allow it to percolate down into the soil. This then allows the groundwater to stay at a more stable level, and since springs are groundwater flowing to the surface, increase the discharge of the spring throughout the year.

Methods

I conducted various interviews to gather the majority of my information. I interviewed various officials working with the Dhara Vikas program as well as villagers. The villager interviews provided insight into the current situation in Sikkim as well as explaining the cultural significance of springs. While the other interviews provided insights into the current and future Dhara Vikas works. I also visited many springs to see the condition they were in and talked to the villagers who rely on them as their main water source. I spoke with Panchayat members and both men and women of all ages. My secondary sources were mostly found online, as this is all very recent work.

Background

Global climate change is becoming increasingly more apparent, especially in the Himalayas. The global average surface temperature has increased 0.76 degrees Celsius since 1850, but the Himalayan average temperature is increasing faster than that[1]. This means that the glaciers are melting faster than normal, leading to increased floods during the summer months and the possibility of water shortage in the winter seasons[1]. By 2050, it is estimated

that 2/3rd of the world's population will face water shortages[2] due to the fact that the Indus, Ganges and Brahmaputra rivers all stem from Himalayan glaciers[1] along with various rivers in China. In the Himalayas it is undeniable that the climate is changing and it will have an effect on the water supply of millions of people. It is also estimated that for every 1 degree C rise in temperature the agricultural water demand will rise by 6-10% [1]. This means that demand for water will go up along with water scarcity, especially in the dry, winter months. This will have an effect on all of the people who depend on the Himalayan glacier's melt water, but especially the people actually in the mountains that depend on rainfall for their livelihoods, as global climate change has also been affecting rainfall patterns[2].

The Himalayan state of Sikkim is the second smallest state in India, but it has the highest and steepest landscape in the country with an elevation variation ranging between 300 to 8598 meters[3](Figure 1). The majority of the population lives in rural areas. The average slope is forty five degrees and therefore only 11% of the land is under agricultural use[2]. Access to rivers in the valley bottoms is very difficult due to the steepness of the slopes and landslips are very common[2]. Most farmers are involved in agricultural and horticultural activities as well as animal husbandry[2]. The southwest monsoon, from the months of July to September, is responsible for 80% of the total annual rainfall in the state[2]. The people of rural Sikkim are almost entirely dependent on springs for their livelihood.

The only site were there has been consistent reliable data collected over the years in regards to climate change in Sikkim is Gangtok in East District[3]. This data shows that the

maximum temperature in Gangtok has been rising at a rate of 0.2 degrees Celsius every year and that the annual rainfall has increased at a rate of 50 millimeters per every 10 years[3]. This indicates that Sikkim is in fact undergoing climate change in the form of temperature rise and increased rainfall during the monsoon. Even though the data is only available in Gangtok, it is still a good indication of the climate shift that is going on throughout Sikkim.

Even though the area has adequate rainfall during the monsoon, the high surface runoff means that the water ends up at the valley bottom. Therefore most farmers and their terraced fields are still highly dependent on rainfall[2]. Due to climatic change in the Himalayas the monsoon rains are coming in shorter bursts and the winters are becoming longer and drier[2]. This means even higher surface runoff, which not only means less moisture is absorbed into the soil but also that nutrient rich topsoil is being moved downhill, adversely affecting crops. The lack of water has forced many farmers to change their cropping patterns and leave some of their fields barren[4]. Barren fields also do not allow for percolation of water into the soil and only perpetuate the problem. Farmers that live below 1000 meters used to have dual cropping seasons, but now with the dryer winters only one monsoon crop is capable[3]. Farmers at higher altitudes that only had one cropping season to begin with are suffering even more so with the lack of water in the winter. This very negatively affects the agricultural based livelihoods of the people of rural Sikkim.

Springs are of crucial importance in rural Sikkim. Almost 80% of the 80,000 rural households in Sikkim are dependent on springs for drinking water[2]. On average, a household

consists of 5-6 members[5] and that means about 384,000 people entirely dependent on springs. With the changing rainfall patterns, these springs are drying up because their aquifers are not getting adequately recharged. This is forcing people to walk two or more kilometers to get their water from other sources[4]. In some areas there is such a scarcity that it is causing quarrels over drinking water between families that have lived next to each other for generations[6].

There are other factors that are causing the springs to dry up, such as population increase, construction and deforestation[2]. The growing population is increasing demand on the water from these springs. Road and building construction contributes to the lack of percolation of rainwater into the groundwater to recharge the springs. Any sort of cement works also has the same effect. Deforestation due to these projects also leaves the ground bare allowing rainwater to move swiftly downhill. Therefore an inadequate amount of water is percolating down into the aquifers, preventing the spring's recharge during the monsoon season and causing it to essentially run out of water during the dry winter season. The changing rainfall patterns causes the rain to come in shorter, heavier bursts and the changes in land use is preventing appropriate percolation to happen and the springs are left with less water to draw from, especially in the dry months. Approximately less than 15% of rainwater has a chance to percolate down into the groundwater[2]. This leads to an excess of water during the monsoon months and a shortage of water during the dry winter season.

Springs are points in which groundwater comes into contact with the surface[7]. Springs are common in the lesser Himalayan region due to the steep terrain. Springs can be perennial or seasonal and can range from the temperature of the air to boiling temperatures[7]. There are

several different types of springs that occur in different geologic situations. Depression springs occur when there is a dip in topography (like in the mountains) that allows the groundwater to come into contact with the surface[7]. Contact springs occur in between rocks of high permeability are in contact with rocks of low permeability[7]. The water percolates down through the highly permeable rock and is stopped by the rock of low permeability[5]. The water travels along on top of the impermeable layer until it reaches a change in the topography and comes in contact with the surface[5]. Contact springs usually occur all in one line across this hillside because of this[5]. Fault springs occur at faults, which can put impermeable rock in contact with an underground aquifer[7]. Fracture springs occur when fractures or joints in the rock come into contact with shallow or deep aquifers[7]. The land above a fracture spring is usually in the shape of a 'V' with the spring at the tip of the 'V'[5]. Karst springs are springs that flow from limestone[7].

The South District is the driest of the state because it is in the rain shadow of the Darjeeling Himalaya (Figure 2), with the West District closely following[3]. In South Sikkim the average rainfall is 1370 millimeters which is 47% less than the state average of 2894 millimeters[2]. There is almost no rainfall in the winter months of November to March[2]. This puts the South District first on the list for new government water schemes. While the water quality from the springs in South Sikkim is at acceptable standards for drinking water[2], the quantity available in the dry season is inadequate.

The survival of the rural people is currently dependent on whether or not they can adapt to the new water situation. Different areas are more vulnerable that others to these changes. People living higher up are actually gaining from climatic and temperature changes because it has "provided opportunities for new crops, higher production and early ripening"[3]. However, they still have to face challenges in the availability of water. As living solely on agriculture is no longer adequate with the reduced availability of water, rural people have begun supplementing their lifestyles with non- agricultural activities such as tourism and trade, "and in extreme cases even migration"[3]. The ability to adapt to this new situation proves to be largely dependent on the remoteness of the village[3]. Villages with "lack of physical connectivity also showed high illiteracy and poverty resulting in weak adaptive capacity," while villages close to urban areas and with good roads connecting them are shown to adapt more easily[3]. People are also adapting to these changes by improving water storage infrastructure and building overnight water storage tanks[3].

Immediate intervention is needed in Sikkim to restore the health of the springs. The groundwater is not getting recharged because of lack of protection of the catchment area. The springs need to be appropriately protected in order to supply an adequate amount of water to the people of rural Sikkim so they can maintain their agricultural lifestyle and continue to thrive in the lesser Himalayas.

Local Perspectives

Traditional knowledge and beliefs are an essential part of the health of springs. Since the people of Sikkim are almost entirely dependent on the water from springs for drinking and irrigation, there are many traditional beliefs in place to protect the springs[2]. It is believed that water comes out where the goddess (Devithan) dwells[5] and goddess worship is commonly done near springs. Devithan Dhara in Dwarey Village in the South District of Sikkim is an example of such a site where pooja is done during the Hindu New Year in the month of Baisach[5]. Also, there are strict rules at most springs against polluting because they are considered holy sites[5] (Figure 4). This is extremely effective at keeping biological contaminants out of the villager's drinking water and therefore water from the springs is very clean. Near Tholu Dhara, also in South District, there is a small temple where goddess worship is also done[4]. Superstition helps create fear against polluting and actually helps protect springs from contamination. The presence of these small temples and worship sites are very common near springs because the water from these springs is so integral to the livelihoods of these people that they have become of real cultural importance.

Springs are considered a community resource and not the property of the landowner[4]. In this case it is the community's responsibility to protect the spring and usually members of the community are involved in planting near the spring. Planting of specific kinds of trees near the spring is believed to attract water. Plants such as the Dockeray plant, Kaizel tree, and Kabra tree are very commonly seen near springs[4]. The Kaizel ("anywhere water") tree is believed by

locals to attract water[5]. The Lampati ("long leaves") tree and the foleta plant are also very good for water conservation[4]. The banana plant is also very commonly seen near springs and is believed to attract water by locals but unfortunately it actually extracts a lot of water from the soil instead[5]. Another measure taken by the local people is to build up protective areas around the spring (Figure 3). These, while they do protect the immediate area near the spring do nothing to protect the actual water supply. That kind of protection needs to take place over the much larger, catchment area.

While these religious and cultural beliefs and practices have done a great job protecting the springs in the past, in many areas the "well forest catchments are increasingly being reduced to a single fig tree or a bamboo clump"[2]. With development and changes in land use, protective areas around springs have diminished in size and effectiveness. There are fewer trees planted in catchment areas and protection is often limited to the immediate area around the spring. Traditional measures are becoming inadequate in the changing climate and increasingly more populated and developed areas to protect these springs and their catchments.

However, this does not mean that the local people's opinions should be disregarded. They are the ones most aware of both their water needs and the conditions of their water sources. Water users often know why the springs near them are decreasing in discharge and can link that change to certain events, such as decreased rainfall or the construction of a road.

Villagers are aware of the changes and often have very viable input as to how to increase the water flow of the springs.

Gitthey Dhara is located in Shyamdas Village in South Sikkim. Villagers say that the spring's discharge started decreasing 10 years ago and has decreased by nearly 80%[4]. It is either a depression or contact spring[4]. It is now functioning as more of a well than a spring and the discharge is approximately four liters per minute[4]. It is a perennial spring and there are 7-8 households dependent on it, but more use it as a supplement to other water sources[4]. In a conversation with a village member, ex-panchayat president Prabiter Rai, about the spring, which her family uses in addition to other water sources, she said that the spring's discharge started decreasing about 15 years ago when the spring's landowner removed a Kabra and Baraf tree[8]. These trees are known by locals for their water attracting qualities. She noticed an immediate decrease in discharge from the spring after the removal of these trees[8]. Another event marked a significant change in the spring's discharge and that was the construction of a road in the catchment area about 10 years ago[8]. Prabiter was very concerned with plantation in the catchment area[8]. She herself planted a Kaizel tree near the spring in hopes of improving its discharge[8].

Hosh Dhara in Sumbuk Village, South Sikkim is a depression spring that has undergone a drastic decrease in discharge in the last 10 years[4]. Balbahadur Rai, a user of this spring, said that about 12-14 households are now dependent on this spring, but previously 15-20 households were using the spring before the decrease started[9]. He attributed the change to

decreasing rainfall, temperature rise, and decrease in tree cover in the surrounding area[9]. These changes have forced the villagers to change their cropping patterns; they used to grow a lot more vegetables, but now those fields are left barren because there is not enough water[9]. He believes that the solution to water shortage is the plantation of appropriate species of trees near the spring[9].

Prabiter Rai had mentioned a dried up hilltop lake as a possible cause to the change in spring discharge on the hillside[8]. Alay Lake in Sunthali Village was a small hilltop lake that is completely dried up and is now just being used as grazing land[4]. There have been proposals to divert rainwater into the lake to recharge it and use it as a giant percolation pit to recharge the springs downstream, but that has been temporarily put to a halt because of a few landowners not allowing diversion structures on their property[4]. Bhakta Batur Lepcha, a man who lives near the dried up lake, said that the lake dried up approximately 80 years ago[10]. It used to be so full that it would overflow and the local belief is that so many people drowned in it that they invited a local spiritual man to chant mantras until the lake dried up[10]. Other villagers had different opinions about why the lake dried up, such as pollution of the water by the people that lived nearby[11]. At the time, the population in the area was so small that the lake was not used for drinking water or household uses: only for irrigation and livestock[10]. He also mentioned that the springs downstream (like Hosh Dhara and Gitthey Dhara) were not in existence until after the lake dried up[10,11]. This is evidence that it is very important to speak with local people when addressing spring discharge. Knowing the connection between the lake drying up and the condition of the springs downhill shows that they are somehow linked

geologically and that needs to be considered when thinking about spring recharge plans in the area.

Devithan Dhara in Dwarey Village is a fracture spring that is also used for goddess worship$_4$. Villagers perform pooja there at the start of the Hindu year in the month of Baisach, which usually falls in March or April$_5$ (Figure 4). There are also strict rules against polluting here. An older woman, Durgadevi, said that the discharge started decreasing about 5-6 years ago$_{12}$. Before that, the discharge of this spring was so high during the monsoon that they could not cross it; it became a stream$_{12}$. The spring is moving downhill and attributed that to the hillside slipping$_{12}$. In 1968 there was extremely high rainfall resulting in landslides all over Sikkim, especially in South District$_4$. It was devastating and the majority of Sikkim was cut off because of roads being blocked or destroyed$_4$. Some springs disappeared and others popped up in new places$_4$. The woman's husband, Baji, joined the conversation and also attributed the spring's movement to the 1968 landslides$_{11}$. He also claims the land is slipping downhill and showed us the cracks in his courtyard$_{12}$. They have been planting vegetation in hopes of stopping the land from creeping downhill but they are going to move to more stable ground uphill$_{12}$. They attributed this movement to the spring's discharge decreasing$_{12}$. They say the spring's waters are disappearing underground and the movement is causing the spring to slowly disappear$_{12}$. Once again, this shows the information that can only be gained by receiving local knowledge and opinion.

Santi, the panchayat secretary, also spoke about Devithan Dhara[13]. She believes the decrease in discharge could have also been caused by cement works and construction in the catchment area above the spring[13]. She also agreed that the whole hillside was slipping downhill and that could have had an effect on the spring[13]. She was in support of planting dockeray and other plants in the catchment area to recharge the spring[13]. She was aware of the Dhara Vikas program and thinks it would be appropriate to implement that on this spring[13]. Though this spring in particular would need a hydrogeological study to determine if it would be possible: especially because of the slipping land and the fact that it is a fracture spring[4].

Thulo Dhara is a contact spring in South Sikkim[4]. It is considered a critical spring because of the decrease in discharge in the past 5 years or so but it is a lot better off than the other springs in the area because there are paddy fields in the catchment area[4]. Paddy fields are designed to hold water from the monsoons just like percolation pits, so effectively the concept of Dhara Vikas was already at work there[4]. Arjun Pradhan, a villager who uses the spring, said that about 80 households are dependent on this spring[14]. The discharge started to decrease about 4-5 years ago and he believes it was because of the decrease in rainfall[14]. He was unaware of the Dhara Vikas program and was very much in support of planting more water attracting and water holding species of trees and plants[14]. A group of villagers also said that the spring was decreasing because of decreased rainfall and less tree cover in the catchment area[6]. They also made an interesting comment about how on the higher areas there is such scarcity of water that families are quarrelling over drinking water; even though the discharge from springs in the lower areas is decreasing they still have enough to drink.

From talking with the villagers themselves, it was apparent that there has been significant change in the discharge of these springs without any sort of scientific study. Springs are drying up and the causes are mainly linked with construction of new buildings and roads in the catchment area and less tree cover. They are very much in support of plantation in the catchment area to recharge their water sources. The local people provide great insight into not only the problems surrounding the springs but viable options to increasing spring discharge.

This is also evidence to the fact that traditional knowledge has hit its limit in how much it can protect these springs. The climate is changing, the rainfall patterns are changing, the population is growing and there is increasingly more development works going on. All of this has effects on the springs' discharge and more needs to be done in order to supply an adequate amount of water for the lifestyles of these people. Currently there is not enough water and the current trends show that it is only going to get worse, so in order to improve the discharge of these springs and mitigate the effects of climate change in the Sikkimese Himalaya immediate action needs to be taken. Both barren lands and agricultural fields need to be adjusted to retain water long enough for it to percolate into the soil. Trees need to be planted to slow the run off of both nutrient rich top soil and the monsoon rains. Measures such as these need to be taken in order to provide an adequate water supply to the people of the hills.

Also in South Sikkim, the government had put in a hilltop cement collection tank earlier as a method of rainwater harvesting[4]. Approximately seven lakh rupees were spent on

implementing it and now it is completely dried up[4]. The cement prevents water from percolating down into the soil, so basically the water would be collected and then simply remains there until it evaporated. Removal is also proving to be a problem as there is no place to put the cement once it is torn up[4]. This is an example of how government intervention without consulting the people or having scientific studies is not effective.

Collaboration between the local people and the government is needed. As traditional knowledge is no longer enough to protect the springs in this increasingly more populated area and as climate change is making the rainfall patterns change, additional scientific methods need to be applied to recharge these springs. As demonstrated, the government alone cannot implement water resource projects without the input of the local people. It just does not work. A combination of traditional knowledge and new methods of spring recharge needs to be applied to this area to save the springs. A decentralized system of water management would allow people to be in charge of their own water resources. However, at the same time, they need to be given adequate training and information to manage these sources effectively.

Dhara Vikas

In the search for an effective, widespread and feasible solution to the lesser Himalaya's water problems, the concept of "spring sanctuary" has been developed[15]. The spring's catchment area needs to be protected from grazing and tree cutting. The catchment area needs to change into land that can slow or hold the flow of water to give it a chance to

percolate down and recharge the aquifer. Only if this is done can the water scarcity in the Sikkim winters be resolved.

Dhara Vikas (spring shed development) is a government sponsored program, with the help of NGOs and other institutions, to increase the discharge of springs in rural Sikkim. It is modeled with the idea of protecting a spring's catchment area and provided recharge of its aquifer. Its implementation system requires community involvement and it is an example of decentralized water management. The project was conceptualized in 2008, 2009 was spent in capacity building and the first project was implemented in 2010[16]. It is a system of village level water management that facilitates communities improving their own water supply through spring shed development. This project is only just beginning and real results that will determine the effectiveness of this strategy should be available in the next couple of years.

The technology behind the Dhara Vikas program is based on slowing the movement of water down slope. With the change in rainfall patterns mentioned earlier, soils are not absorbing enough water during the monsoon season and the groundwater is not being adequately recharged. To solve this problem and increase the discharge of springs in winter, the water needs to be slowed down enough to percolate down and recharge the spring aquifers. The installation of trenches in barren lands and drains in cultivated land, gives rainwater a place to rest and percolate down into the ground water[4]. The drains (Figure 5) in the cultivated land provide additional water to the crops, as well as catching the soil and nutrients that have run off from other terraced fields[4]. The drains are one foot in width, 1.5

feet in depth and run the length of the field[4]. In the barren fields the trenches (Figure 6) are 2 meters by 0.8 meters with a depth of 2.5 feet[4]. The trenches are built along contour lines and are staggered between contours so the maximum run off collection occurs[4]. If the slope is less than 30 degrees then there is a 12 foot vertical gap, if it is 30-40 degrees then there is a 10 meter gap and 40-50 degrees there is an 8 meter gap[4]. If the slope is greater than 50 degrees then trenches cannot be built and plants are planted in hedgerows to slow the flow of water[4]. In Dhara Vikas, the intervention in the catchment area starts at least 20 meters above the spring[4]. The mechanical and vegetative measures are taken along with social measures such as bans on grazing, firewood cutting and "social fencing of the recharge area"[2]. An example that proves that this technique will work is the paddy fields at Thulo Dhara. Even though the lack of rain has reduced Thulo Dhara's discharge, but the situation there is not nearly as dire as the ones at other springs. Paddy fields retain water just the way the trenches and drains will do and therefore the spring below the fields is still discharging a lot of water. The Dhara Vikas technology is designed to function much the same way and will retain water and give it a chance to recharge the spring.

Springs designated for development works have to first be determined critical or not[16]. A spring is critical if it fulfills three criteria: firstly how many households are dependent on it[16]. Development efforts should be spend on the springs that affect the largest number of people as to more efficiently allocate government money. Secondly, the amount that the discharge is decreasing needs to be considered[16]. It is important that the springs that are getting worse receive treatment first. The third criterion is that the landowners of the catchment area have

to agree to the development works being implemented on their land, even though the effects will be seen downhill from them[16]. Which springs receive treatment is the decision of the Field Facilitator of the Block, based on those criteria[16]. Once the landowners agree to the project they have to commit their land to it for future generations as well, but considering that the sons are usually the ones more willing this has not been a problem[4]. After clearing the project with the landowners, the Field Facilitator presents the proposal to the Gram Sabha and, if it is approved, the project can then be implemented. The labor for the works is funded by the Mahatma Gandhi Rural Employment Guarantee Scheme[4]. Local people are trained to recognize contours and where to place the trenches and drains so they can direct the project implementation without the Field Facilitator present[4].

Part of the Dhara Vikas program is also to set up Village Water and Sanitation Committees (VWSC) for every Gram Panchayat Unit (GPU) to manage the village's water resources[4]. The committees should consist of two NGO workers, two retired government officials and two ASHAs (Accredited Social Health Advocate)[17]. The VWSCs are to come up with a village action plan for maintenance of springs and are in charge of allocating the water user charges to different projects[2]. The VWSCs are the local governing body when it comes to water management for a GPU. While they are recently set up and are not quite functioning as such yet, but they will be an excellent example of decentralized water management. This puts the decision making power in the local people in regards to their water resources. This will be much more effective because, as demonstrated earlier, local knowledge is required when implementing water projects.

Mallagiri Dhara in Kamery Village in South Sikkim is one of the pilot projects for Dhara Vikas. Its name comes from a rare tree that used to grow there that has high medicinal value[4]. It is either a depression or contact spring. The catchment area consists of mostly phyllite, but there is no rock exposure so the dip or direction cannot be measured[4]. The pH of the water is 5.6, the total dissolved solids (TDS) is 35.4 mg/L which indicates that the aquifer is nearby and the salinity is 25.6 ppm[4]. Forty-five households are dependent on this spring and the 13.24 hectare catchment area belongs to 19 landowners[4]. Convincing this many landowners to donate their land to a cause that will not directly benefit them proved very difficult[4]. Seeing as the benefits of spring shed development are seen only by the people downstream adequate compensation needs to be paid to the landowners[4]. The Field Facilitator put on many educational and awareness programs to convince the landowners[4]. Another effective convincing technique is the local belief that giving water is the highest dharma[4]. In the case of Dhara Vikas, the government will plant any type of trees in exchange for digging trenches and drains on their land[4]. Most farmers request plants that provide an extra source of income such as orange trees, cardamom, broom and fodder plants, and Chinese teak[4]. These trees also have very high survival rates because they are planted either in between trenches or three meters below them, so they get plenty of water[4]. Still a lot of awareness and education had to take place with the land owners before they were convinced[4]. The work at Mallagiri Dhara started on February 6th, 2010 and weekly discharge rates are recorded[4]. Results will not really be known until February 2011 when the discharge rates of Mallagiri Dhara can be compared before and after the implementation of the project.

While Mallagiri Dhara is only a pilot project, there are plans to upscale Dhara Vikas so that it can be applied to the most critical springs throughout Sikkim. The plan is to apply this method to 50 new springs every year[16]. The RMDD is asking for money for 30 of these 50 new springs a year from the central government's Ministry of Water Resources[16]. The project proposal plans to increase the discharge of 81 critical springs in South Sikkim by at least 20% with Dhara Vikas in the next three years[2]. Mallagiri Dhara did not have much baseline data taken before the project was implemented so the proposal also asks for some of the resources to be given early so baseline data can be taken this winter for other springs[2]. The goal is to also set up and facilitate the education and training of Village Water and Sanitation Committees to manage these springs and the projects around them[2]. This plan has the potential to be spread to a larger scale and is an excellent example of how decentralized water management proves beneficial to the communities of Sikkim.

The main thing slowing down the implementation of this project on a larger scale is the lack of trained people to implement the project at the village level[16]. Currently there are very few people trained and at least 7-8 people are needed at the block level statewide[16]. More awareness programs also need to be conducted because many of the villagers were not even aware of the Dhara Vikas program. The local people need to be convinced that Dhara Vikas works and is a viable option to recharge their water sources, but they first need to know it exists. Water User Groups need to be organized and the Village Water and Sanitation Committees need to be trained so they can become functional. The Dhara Vikas program is

good because it is a form of decentralized water management but if the village level water governance is not doing its job properly than the whole system does not function. Since this program has just begun, most of these issues should be solved with time. As the program grows, more people will be trained, more villagers will know about it and the local water governance facilities will start to function as they are designed.

Dhara Vikas, while it is only in the beginning stages of implementation, appears to be a very effective solution to springs drying up in Sikkim. Both the science behind it and the decentralized implementation plan are well thought out and have examples to prove that this project will function the way it was designed. From the "spring sanctuary" approach to protecting and redesigning the catchment area to retain more water to the decentralized water management of the Village Water and Sanitation Committees, Dhara Vikas appears to be on the right track and is a very viable solution to water scarcity in rural Sikkim.

Conclusion

It has become apparent that climate change has had a drastic effect on the springs of Sikkim. The changing rainfall pattern and land use changes are not allowing the spring aquifers to get adequately recharged. Methods previously used to protect the springs and their catchments are either no longer enough or have been altered by deforestation and construction. Therefore extra measures need to be taken. Local knowledge, while extremely

valuable in this situation, needs to be supplemented with new technology to return these springs to their healthy state.

With climate change, increased rural development and the ever growing population, the springs in Sikkim are in desperate need of help. Dhara Vikas provides an avenue in which the people can help themselves revitalize their water sources. Its form of decentralized, community based water management allows for the program to function all over the state and address each area's specific needs. While conclusive data on the effectiveness of the Dhara Vikas technique is not available on the scientific level quite yet, all evidence, including the paddy fields at Thulo Dhara, indicates that the trenching technique will be effective at recharging springs. And while the Village Water and Sanitation Committees are not yet functioning, they will provide an avenue to manage water resources at a local level. Dhara Vikas appears at this stage to be an effective solution to the state of Sikkim's growing water problems.

Endnotes

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Future Work

While Dhara Vikas seems like it is on the right track, the main problem with my research is that I was visiting the project sites and studying all of this a year or two too early. Coming back a year later and studying the new discharge data on Mallagiri Dhara would be very informative as to whether or not this method works scientifically. Since this data was not available when I was visiting, actually analyzing the effectiveness of the catchment treatment was impossible. In February 2011 the discharge of the spring will be measured and compared to February 2010, and then there will be quantitative data indicating the effectiveness of this method.

Another possibility for future research is to study how the Village Water and Sanitation Committees and the Water User Groups function when they are up and running. In a few years, going back to see how the local water governance is actually functioning will give indications if the Dhara Vikas program is effective at the water management level. The VWSCs and WUGs were not functioning and were very newly formed when I was there. It would be extremely interesting to go back and not only analyze how they are working, but compare their functionality across different GPUs. If they are working effectively, it would be an extremely good example of how decentralized water management could work, not just in Sikkim but throughout India.

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Figure 1

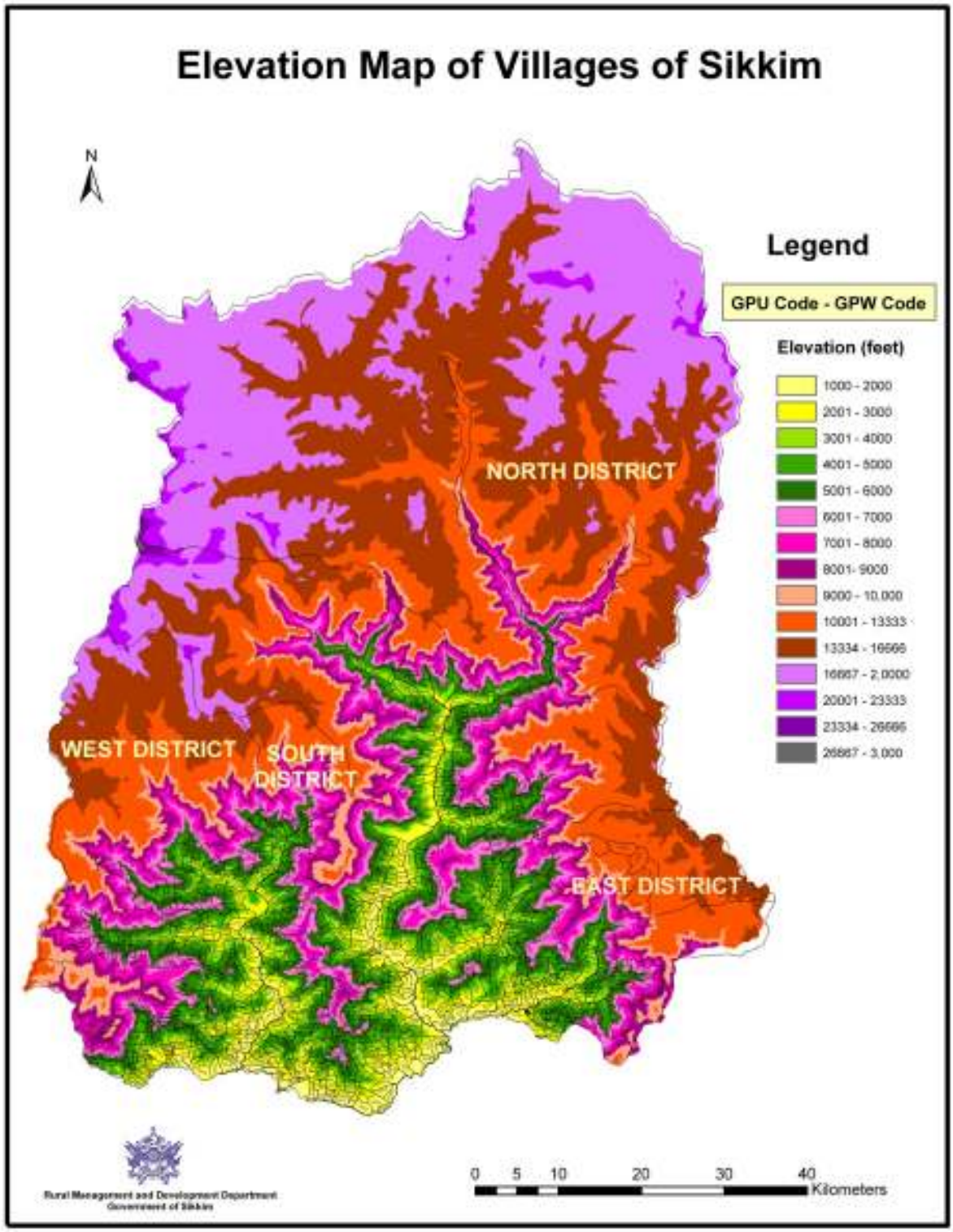
Elevation Map of Villages of Sikkim
N
Legend
GPU Code - GPW Code
Elevation (feet)
1000 - 2000
2001 - 3000
3001 - 4000
4001 - 5000
5001 - 6000
6001 - 7000
7001 - 8000
8001- 9000
9000 - 10,000
10001 - 13333
13334 - 16666
16667 - 2,0000
20001 - 23333
23334 - 26666
26667 - 3,000
NORTH DISTRICT
WEST DISTRICT
SOUTH DISTRICT
EAST DISTRICT
Rural Management and Development Department
Government of Sikkim
0 5 10 20 30 40
Kilometers

Figure 2

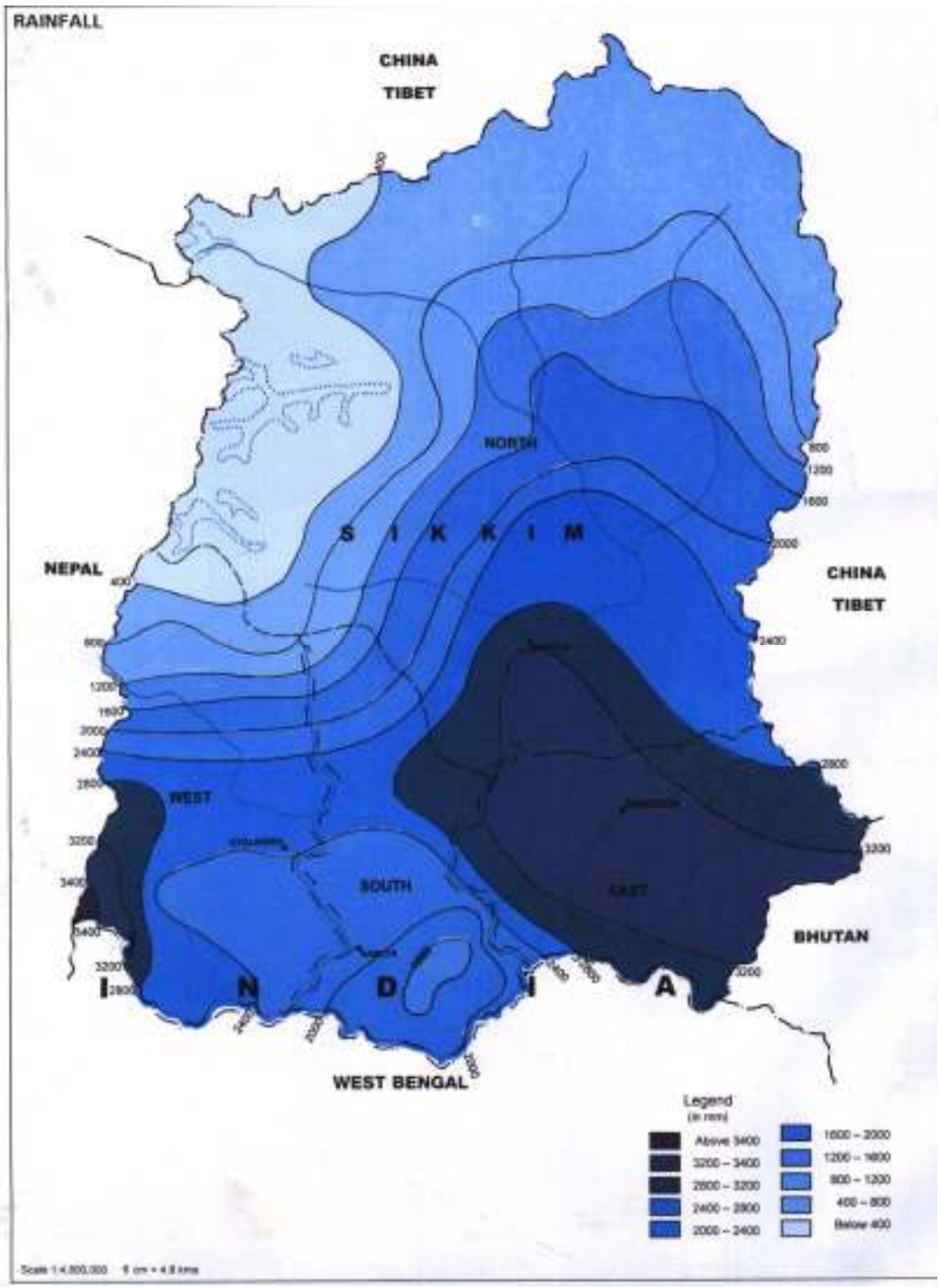
RAINFALL
CHINA
TIBET
NORTH
S I K K I M
NEPAL
CHINA
TIBET
WEST
SOUTH
EAST
BHUTAN
I N D I A
WEST BENGAL
Legend
(in mm)
Above 3400
3200 – 3400
2800 – 3200
2400 – 2800
2000 – 2400
1600 – 2000
1200 – 1600
800 – 1200
400 – 800
Below 400

Figure 3

Figure 4

Figure 6

Figure 7