THE SOUND OF SILENCE:

STORIES ON CLIMATE CHANGE IMPACTS FROM RURAL COMMUNITIES IN HIMACHAL PRADESH

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Submitted to Dr. Ingrid Shockey (WPI), Dr. Uma Kumar (WPI), and Dr. Shyamasree Dasgupta (IIT)

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Indian Institute of Technology Mandi

The Sound of Silence: Stories From Rural Communities in Himachal Pradesh

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by

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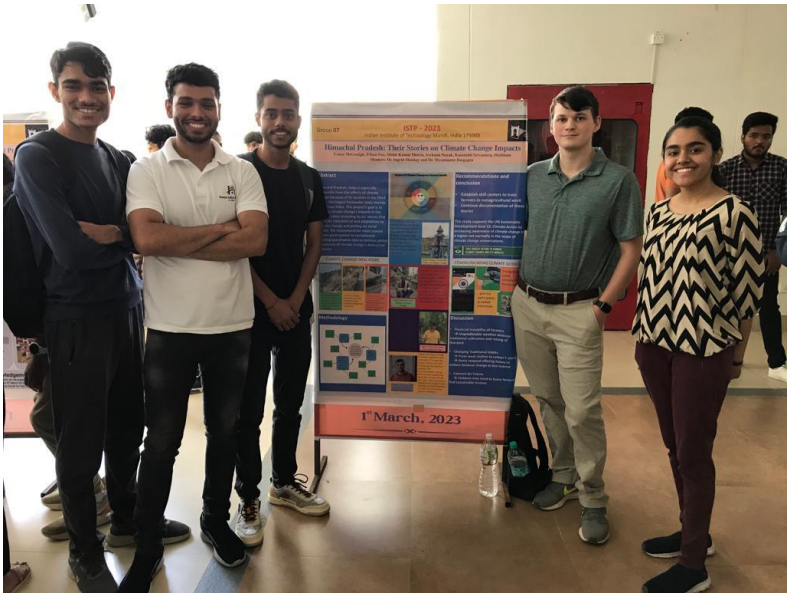
Abstract

Himachal Pradesh, India is especially vulnerable to climate change. Its location in the Third Pole region, the glacial Himalayas, is also home to the largest freshwater body outside of the North and South Poles. Our goal was to amplify the impact of climate change using Instagram to illustrate indicators of and adaptations to climate change in this region. We recommend more citizen science participation and the establishment of skill centers to secure future livelihoods threatened by these impacts.



Our group presenting at IIT's Open House on Sat. April 29th, 2023

A group photograph after our interview at Prashar Lake

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- And especially **all interview participants** who volunteered and shared their stories on how climate change has impacted them!

Authorship

Ethan Fox contributed to the writing and editing of this report; the recording of interviews; the analysis of the recorded interviews; and the design of some of the Instagram posts.

Conor McGonigle contributed to the writing and editing of this report; to leading the interviews; the analysis of the recorded interviews; and the design of most of the Instagram posts.

Mohit Kumar Meena contributed to conducting interviews and to translating responses from Hindi to English.

Archana Nayak contributed by coordinating with participants to schedule interviews; translating questions from English to Hindi, and responses from Hindi to English; conducting additional interview questions; and helping edit the Instagram videos.

Kaustubh Srivastava contributed by posing additional questions during interviews and translating responses from Hindi to English.

Shubham contributed by adding questions during the interviews and translating responses from Hindi to English.

This work is original to the project authors and study participants and was not generated or assisted using ChatGPT or AI tools.

Meet the Team: (L to R): Shubham, Kaustubh S., Archana N., Mohit K.M., Conor M., Ethan F.

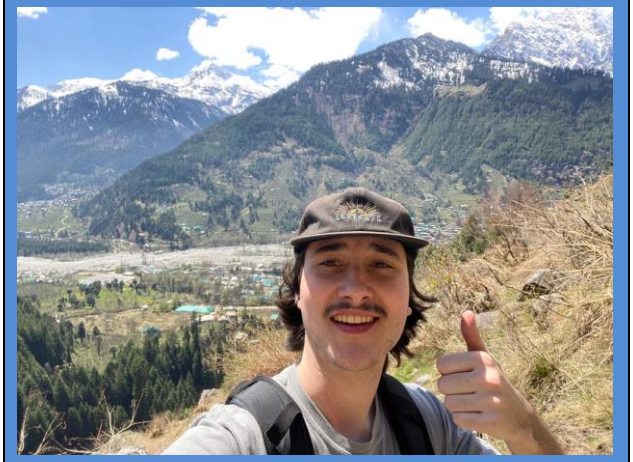
Meet the Team

"I am excited to experience Himachali culture, and how climate change is affecting the local people and to share their stories. I hope to become more aware of climate change's impacts on vulnerable communities"

– Ethan Fox

"I am excited to learn about the everyday life and the traditional practices of the local Himachal Pradesh people, and how climate change has changed those practices forcing them to adapt. I find it important to hear these stories so that they can be put out to the world to spread awareness of an important topic"

– Conor McGonigle



"I was fascinated by the climate of Himachal Pradesh – multiple weather phenomena in the same day, lush green forests, and snow-clad peaks. Seeing these threatened by the changing climate is what worries me and motivates me to work on something related to this"

– Mohit Kumar

"I had always lived and observed effects of climate change in urban plains. I am really excited to look at unique perspectives of climate change, by focusing on rural areas in the hills of Himachal Pradesh. I'm glad to get a chance to address the challenges faced by those local communities and listen to individuals share their personal stories and experiences to get a deeper understanding of the impacts of climate change on a local level, in contrast to the usual narrative of climate change from less diverse perspectives"

– Archana Nayak

"I have always been involved in sports and fitness-related activities. What motivates me to take up this project is the ill-effects of climate change on the physical health and wellbeing of people. Also, I have taken environment-related courses in the past, which adds to my reasons to taking this up"

– Kaustubh Srivastava

"Growing up in the plains, I had never had a first-hand experience of how serious climate change is; but, having spent the past year in the Himalayas, I know this is a serious problem. Back-to-back landslides and irregular precipitation, I have seen people bear direct impacts and suffer from this issue. Also, being IITians, we need to do something for the people, and this is my chance to contribute to the society as a student"

– Shubham

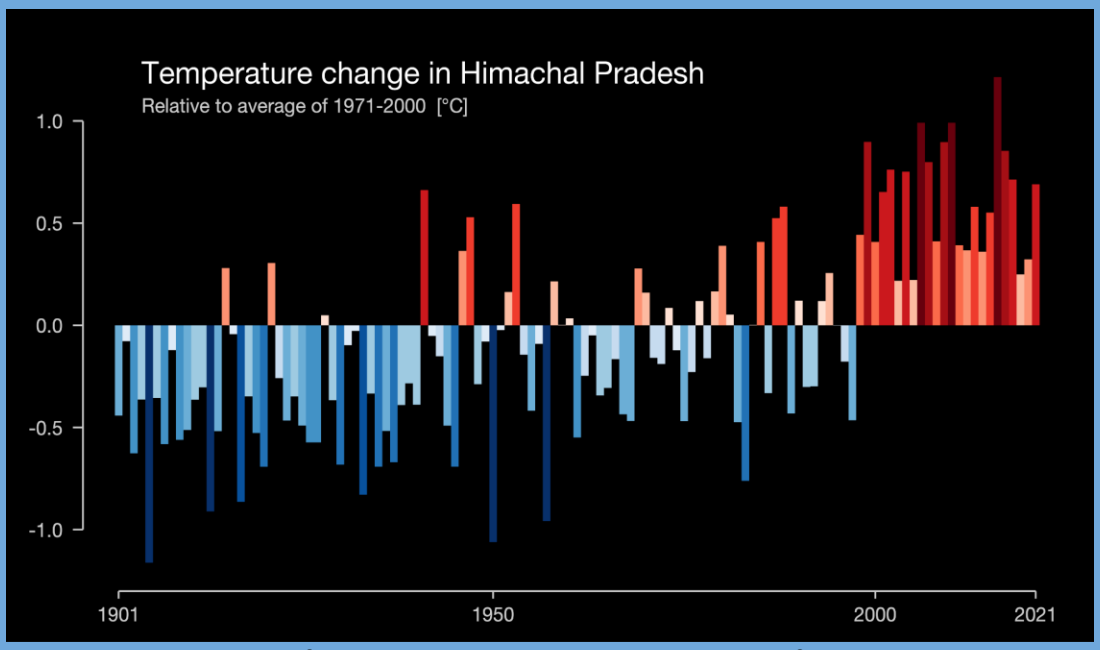
Executive Summary

Citizen Scientists as a Form of Climate Science Communication

Himachal Pradesh, an Indian state located in the Himalayan Arc, is also located in the Third Pole. The Third Pole, which encompasses the Himalayas, the Tibetan Plateau and Hindu Kush, holds the largest quantity of freshwater outside the Polar Caps and is especially vulnerable to climate changes. Data collected at the Third Pole has helped scientists understand climate change's impacts on ecosystems and the environment, however, little is known on its impacts on residents living in the region.

These scientific data collected in Himachal Pradesh has generated clear indicators of climate change in the state. These numbers, however, do not illustrate the entirety of climate change for local residents. Lived experience offers individualized stories that can connect quantitative data to clear and visible indicators like landslides and dried springs, which affect residents on a daily basis.

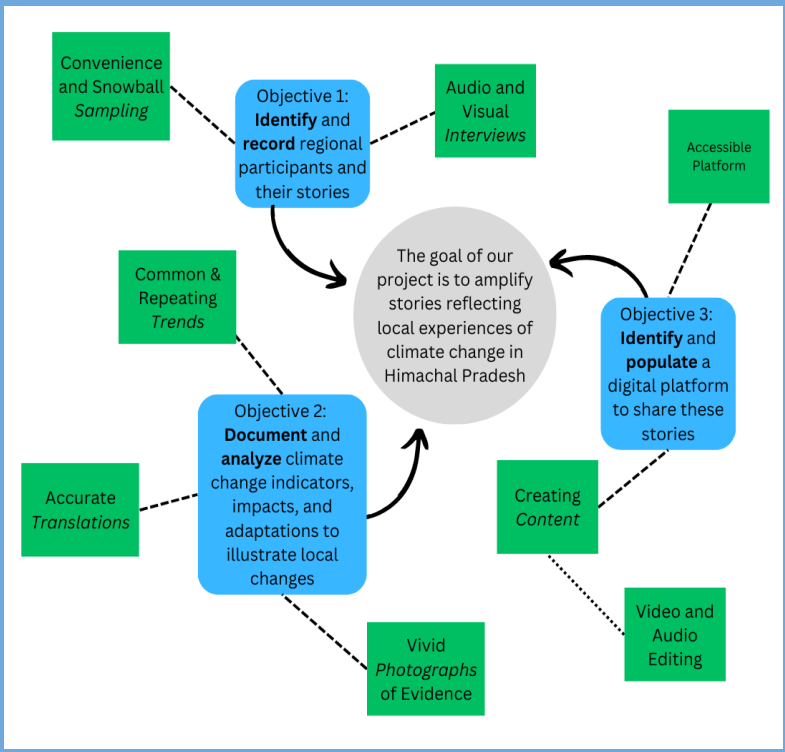
Climate change science communication is commonly depicted with modeled images of the ocean's rising levels, maps with dramatic shifts in climate patterns, and news reports of extreme weather phenomena around the world. These changes deeply impact ecosystems and livelihoods, forcing policymakers to fund and develop adaptation strategies. While regional scientific monitoring provides critical baseline information, these shifts in climate impact Indian communities every day at local scales.



Quantitative data collected from Himachal Pradesh showing significant warming over the past 20 years (Hawkins, 2021).

Therefore, there is a rich opportunity in the power of the shared human experience to learn more and to refine our approach to regional impacts. Climate change narratives provide the pathos necessary to amplify the range of known climate change indicators – affecting the

lives of ordinary people more. Perhaps these narratives in layman's words can help other common folk understand climate change's severity and spark individuals and organizations with authority to continue climate change mitigation.



Methodological approach to our project using a mind map.

We conducted interviews based on questions in Appendix A and recorded responses either on video or audio recorders. These recordings were then translated, analyzed, edited, and uploaded to our project's Instagram page.

Results from Their Stories and Indicators

Both agriculturalists and shepherds agree that changes in precipitation and temperature patterns have been detrimental to their crops and livestock production. While listening to a Gaddi shepherd tending to his sheep, we learned

"[climate change] has only had a negative impact on me. Not just me, it has also negatively affected farmers and (apple) gardeners on a huge scale. Due to shortage of rainfall, there has been a negative impact not just on us Gaddis, but also farmers and apple gardeners because there was no rain – a state of drought – so for every scenario it has been a problem only. It is very important for there to be rainfall, so if it doesn't, I think there is no benefit for anyone" (interview 3, Kataula).

Furthermore, we learned about the impacts of climate change on the livelihoods and routines of local residents. All interviewees expressed concern for the welfare of their children because they were unsure as to how climate change will impact their ability to continue family occupations. All agreed that climate change has negatively impacted their families' traditional practices; however, one interviewee mentioned that changes to his family's farm allowed him to move and seek a better job off the farm.

Indicators found show similarities to recent studies in mountainous Third Pole regions. Respondents report that they are aware that the climate is changing and can provide multiple indicators through their stories. They also mention, however, that there is little that individuals can do to help mitigate the effects of climate change in the area.

Team fieldwork conducting interviews with residents on their experiences with climate change (Photo credit: Fox, 2023).

Recommendations and the Path Forward

Our first recommendation is for municipalities to establish a trash collection system. Although litter is not a cause of or result from climate change, this program will help communities minimize waste dumping in wildlife areas and water systems, creating a healthier ecosystem and cleaner water. To achieve this, we recommend local residents to contact Pradeep Sangwan, founder of the nonprofit organization Healing Himalayas, who has been collecting and appropriately disposing litter in Himachal Pradesh since 2016. He has established garbage pick-up and disposal programs in communities around the state. Sangwan manages a verified Instagram account called @HealingHimalayas which posts updates frequently.

Our next recommendation is the establishment of centers around Himachal Pradesh that provide skill training and education for rural people who believe they may have to start off-farm jobs because of challenges caused by climate change. These centers will enable rural residents to find sustainable jobs in urban areas, or to start non-agricultural work on their farms like weaving and pottery. IIT Mandi's Catalyst, a department focused on start-up programs, will be ideal to start these centers and manage their functions. These centers will alleviate local residents' concerns for the future if their children can learn new skills to sustain their families.

We also recommend that more studies on climate change incorporate a greater proportion of citizen scientists to complement existing scientific data. This combination of quantitative and qualitative data will provide a larger and clearer picture of climate change's harmful impacts on lived experiences in communities.

Finally, we recommend for these storying climate change projects to continue not only across Himachal Pradesh and WPI's other project centers, but also other potential sites located in the Third Pole. As mentioned previously, these other locations in the Himalayas can provide additional understanding on the impacts of climate change on vulnerable communities.

In the course of this project, the people that met with us welcomed the opportunity to share their perspectives on climate change. They answered any questions we had. It was to our expectation that area residents might not be as open to reflect about such issues, especially during their busy workday, however, all the participants we interviewed not only felt climate changes significantly, but they realized it was anthropogenic and described what they saw in their own communities that contributes towards climate change.

This project supports the UN's Sustainable Development Goal 13 for climate action. Our hope is that further studies on climate action are conducted in this vulnerable region as a basis for strengthening the conversation on the severity of global climate change in Third Pole Himalaya including in India's neighboring counties.

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Introduction and What We Know

Record breaking temperatures, heavier rainfalls, and overall extreme weather events are clear indicators of climate change. In the Indian Himalayas, communities are experiencing dramatic consequences from these events. Climate scientists monitoring the integrity of the North and South Poles as an indicator for global climate health are now recognizing a third glacial region located in the Himalayas as the "Third Pole" (TheThirdPole.net). In fact, the Himalayan watershed found in the Hindu Kush Himalayan region and the Tibetan Plateau is a vital source of freshwater for approximately two billion people and is essential for livestock, hydropower, agriculture, inland navigation, and even religious pilgrimages (Ahmad, 2021). The Third Pole, as with its siblings in the north and south, is experiencing warming temperatures and melting of glaciers. It is expected that within the next century Himalayan glacier mass loss will reduce to "35% [in] the Karakoram, 45% in the Pamir mountains, and as high as 60 – 95% in the eastern Himalayas" (Ahmad, 2021, p.6). There is no doubt that a change in climate is leading to the loss of the Third Pole ecosystem, which will not only decrease available freshwater to billions of Asians, but also introduce dangerous secondary impacts including destructive glacial lake outburst floods or GLOFs in the area (Ahmad, 2021; Dema, 2019).

Climate change science communication is commonly depicted with modeled images of the ocean's rising levels, maps with dramatic shifts in climate patterns, and news reports of extreme weather phenomena around the world. These changes deeply impact ecosystems and livelihoods, forcing policymakers to fund and develop adaptation strategies. While regional scientific monitoring provides critical baseline information, these shifts in climate impact Indian communities every day at local scales.

Therefore, there is a rich opportunity in the power of the shared human experience to learn more and to refine our approach to regional impacts. Climate change narratives provide the pathos necessary to amplify the range of known climate change indicators – affecting the lives of ordinary people more. Perhaps these narratives in layman's words can help other common folk understand climate change's severity and spark individuals and organizations with authority to continue climate change mitigation.

Figure 1: Regional panchayat officials at a meeting to share local climate change indicators in Katuala, H.P. (Photo credit: McGonigle, 2023).

This project was an addition to a larger series of projects from Worcester Polytechnic Institute (WPI) that has been storying climate change across multiple research sites spanning many years with a goal to amplify stories reflecting local experiences of climate change in Himachal Pradesh. To meet this goal, we completed the following objectives: 1) identified and recorded regional participants and their stories; 2) documented climate change indicators, impacts, and adaptations to illustrate local conditions populated a digital platform to share stories; 3) populated a digital platform to share stories. This work highlights the impacts of climate change in vulnerable areas in order to continue efforts to share knowledge and actions in response to its effects.

Current Baselines in Climate Science Data

Climate change is defined in the simplest terms through "long-term shifts in temperatures and weather patterns" (United Nations, 2022). These types of changes can occur naturally through variations in the solar cycle, but the data clearly show a strong anthropogenic factor in recent decades. In fact, it is well documented that "since the 1800s, human activities have been the main driver of climate change, primarily due to burning fossil fuels like coal, oil and gas" (United Nations, 2022). The burning of fossil fuels creates green-house gasses that rise into the Earth's ozone layer, adding an overwhelming amount of CO_2, methane, nitrous oxide, and other harmful gasses. This overabundance of green-house gas traps heat in the ozone from the sun (NASA, 2023), causing an abnormal rise in temperature here on Earth.

Although green-house gas emissions as a whole are affecting the climate, carbon dioxide or CO_2 is overwhelmingly more abundant. The United States Environmental Protection Act or EPA's global greenhouse gas emissions database states that in 2020, 79% of anthropogenic greenhouse gas emissions in the U.S stem from CO_2 (US EPA, 2020). A similar trend can be seen globally. In Himachal Pradesh, however, those data are in contrast to life in the low impact rural villages, as shown below in Figure 2.

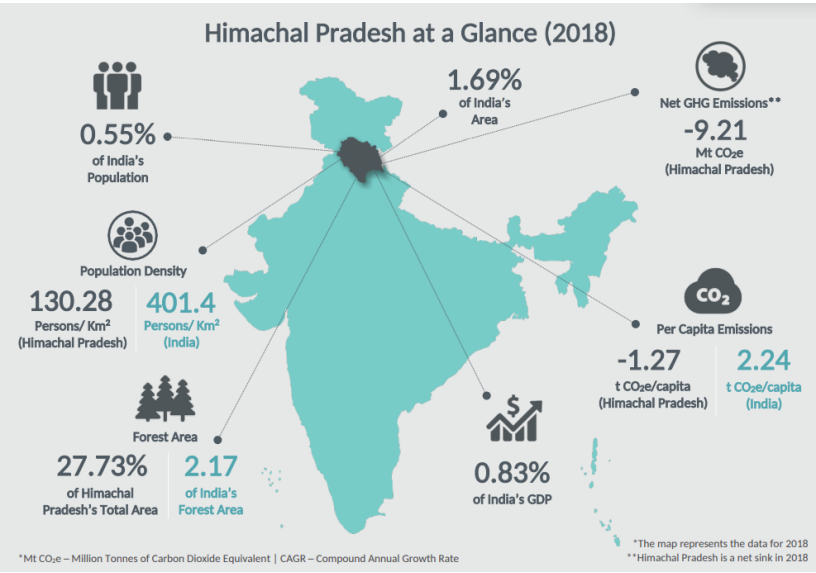

Figure 2: A general overview of Himachal Pradesh demographics including greenhouse gas (GHG) emissions (GHG Platform India, 2018).

The rise in CO_2 levels around the globe has increased since the late 1800's (Ritchie et al., 2020). Since the mid 1900's, "annual emissions from burning fossil fuels have increased every decade, from an average of 3 billion tons of carbon (11 billion tons of CO_2) per year in the 1960s to 9.5 billion tons of carbon (35 billion tons of CO_2) per year in the 2010s, according to the Global Carbon Update" (Lindsey, 2022). This is reflected in the amount of CO_2 in the atmosphere where "global average atmospheric carbon dioxide was 414.72 parts per million (ppm) in 2021" reaching a record high, as dramatically illustrated in Figure 3 (Lindsey, 2022).

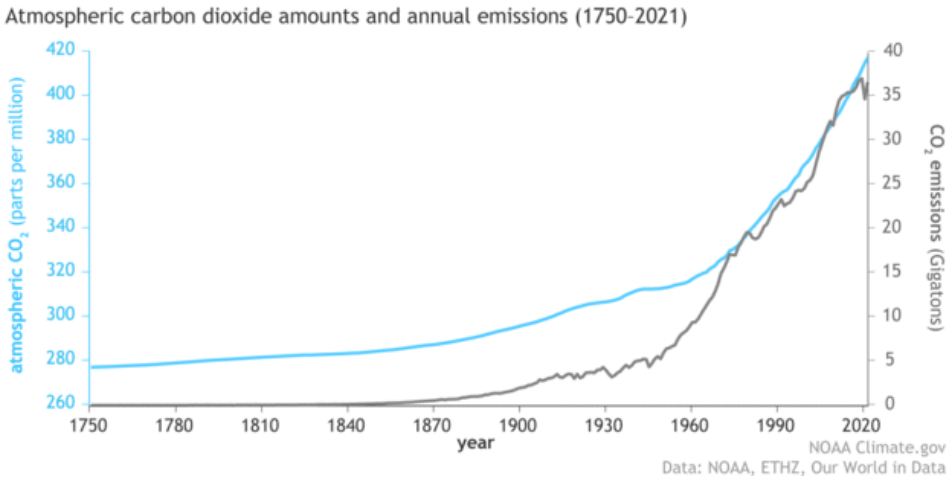

Figure 3: Global atmospheric CO_2 and CO_2 levels reported in the span of 270 years (NOAA, 2022).

With CO_2 emissions this abundant, the Earth's climate is only getting warmer because this greenhouse gas traps radiating heat from the sun in the earth's atmosphere. Warmer temperatures are causing glaciers to melt and ocean water to expand (NOAA, 2022), which in turn creates oceans to rise. From 1900 to 1990, there was an estimated four to five-inch rise in the average global sea level, and from 1990 to 2015, this global tide gauge network revealed a three-inch rise in the average global sea level. (NOAA, 2022). This means that currently, sea level is rising about one-eighth of an inch per year and is forecasted to continue to rise. These data points have alerted climate scientists to call for action, mitigation, and adaptation in order to avoid catastrophic consequences to our food security, health, and livelihoods; but there is evidence that climate data can be too abstract. Climate change is felt differently in various places around the globe, and exposure to climate change indicators varies.

To reach a wider audience, some climate scientists are using new strategies in science communication to attract interest and concern. Their approaches have included activism, art, and especially the visual representation of data to convey the severity of the information. As shown below, climatologist Ed Hawkins has spent his career developing infographics that better display the immediacy of these concerns.

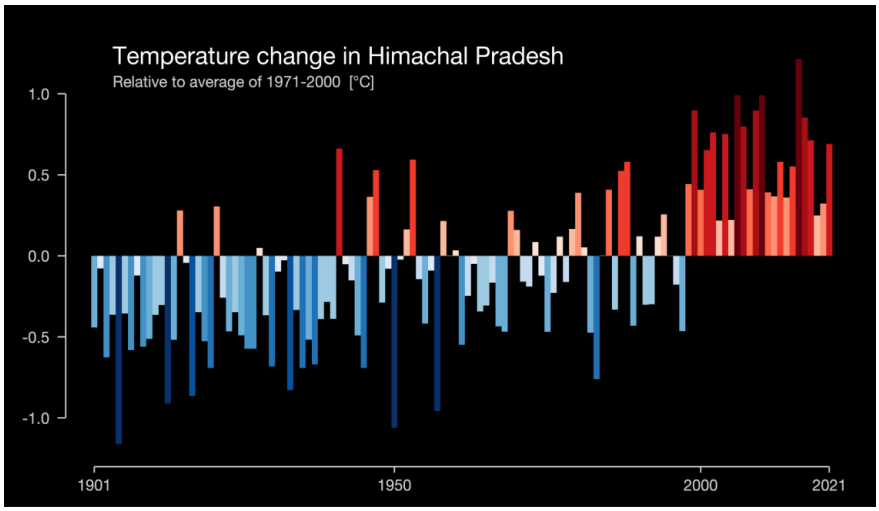

Figure 4: Climate stripes of Himachal Pradesh by climatologist Ed Hawkins from the University of Reading, UK (Hawkins, 2021).

Hawkins, from the University of Reading UK, wanted to simplify visuals to help people understand the drastic temperature changes across the globe. The red bars show increased average temperature while the blue bars show decreased average temperature.

We know that weather variability is significantly impacting the lives of many and will only get worse. Changing weather patterns and rising sea levels affect a huge range of secondary day-to-day resources that humans depend on like freshwater, energy, transportation, wildlife, agriculture, biodiversity, and human health. Drought can harm food production and human health. Flooding can lead to disease spread and damage to ecosystems and infrastructure. Human health issues can increase mortality, impact food availability, and limit worker productivity (NOAA, 2022). Although climate change indicators can be seen all over the world, these indicators vary depending on the location. Therefore, our focus on Himachal Pradesh included climate indicators in those areas respectively.

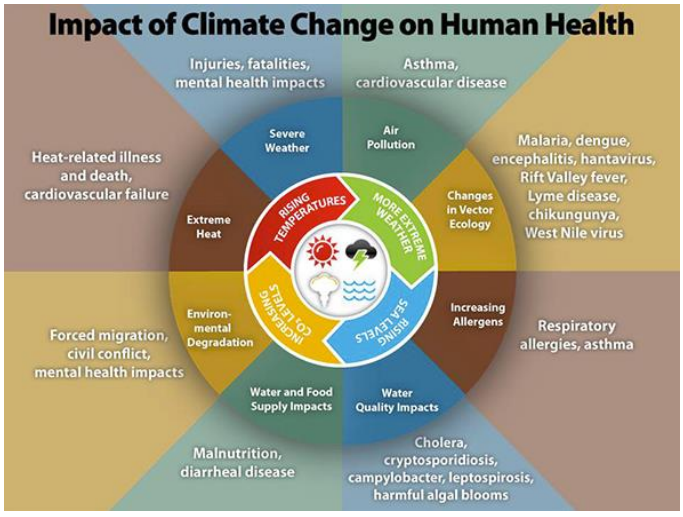

Figure 5: Connecting climate change to human health degradation (CDC, 2022).

Himachal Pradesh is located in northern India alongside the arc of the Himalayas and is no stranger to strong indicators of climate change. In addition to the monsoon precipitation over India, the winter precipitation (December, January, and February) over the Western Himalaya plays a significant influence, particularly in Himachal Pradesh and neighboring locations where the ice and snow store enough water for crops in the summer rather than drain downhill (Kishore, et al., 2022). In comparison to other locations, the Western Himalaya region has had a disproportionate rise in precipitation during the winter, with a rate of 2.6 (3.3) mm/dec between 1901 and 2015 (Kishore, et al., 2022).

These increases in temperature and changes in precipitation over India and the Himalayan regions are a major concern for the health of snow cover and glaciers in the region (Negi, et al.). For instance, the Bhaga basin is a section of the Chenab River Basin in Himachal Pradesh's Lahaul-Spiti district. It is located on the Pir Panjal range of the Western Himalaya's northern ridge (Kaushik, et al., 2020). NASA's Landsat satellite imaging shows a total 7.3 km^2 of glacier area has been lost in the last four decades with total glacier area shrinking from 238.0 ± 9.8 km^2 to 230.7 ± 7.0 km^2 between 1979 and 2017. These glaciers lost 0.39% of the total area between 1979 and 1989, 0.70% between 1989 and 2000, 1.02% between 2000 and 2010 and 0.98% between 2010 and 2017 (Kaushik, et al., 2020).

At the same time, the Third Pole is a source for 10 major river systems that nearly 1.9 billion people (24% of the world's population) rely on for irrigation, drinking water, and power (The Third Pole, 2023). Changes in precipitation, increasing temperatures, and the melting of glaciers due to climate change are greatly affecting the livelihoods of people in the region, more specifically their agriculture practices.

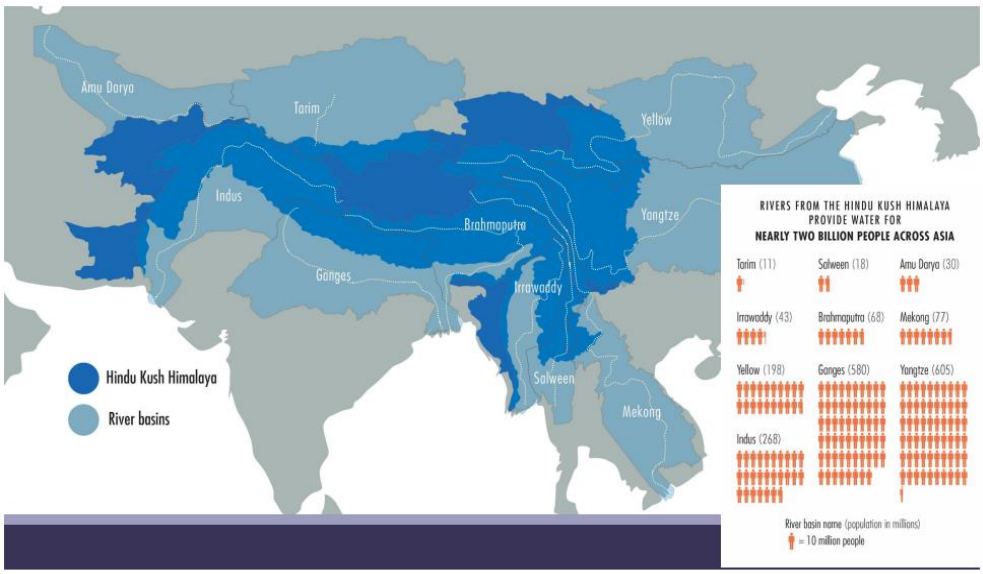

Figure 6: Freshwater rivers originating from the Third Pole providing for ~2 billion people (ICIMOD, 2019).

Land-based Livelihoods: Himachali Agriculturalists and Shepherds

To understand the impact of climate change in Himachal Pradesh, it is important to understand that this is largely a rural state dominated by people who rely on agriculture for their principal source of employment. In fact, "a majority of farmers in [Himachal Pradesh] belong to marginal and small-holding categories (87.03%)" (Choudhary, 2016). These mountain

ecosystems and economics are fragile in many ways. A recent report from the Indian Council of Agricultural Research (ICAR) found that “though the overall income for agricultural households has increased during the last two surveys, their income from the production of crops or allied activities has declined in real terms” (ICAR, 2022). In addition, a 2016 survey found that 89% of farmers in the low-hill zone had the opinion that under the climate change conditions, more off-farming activities are being adopted to meet livelihood needs as an alternative (Loria and Bhardwaj, 2016). This can be seen below in Figure 7. In short, it seems likely that many agriculturalists in Himachal Pradesh will need to adapt to climate change or else they will be forced to move to urban regions for support.

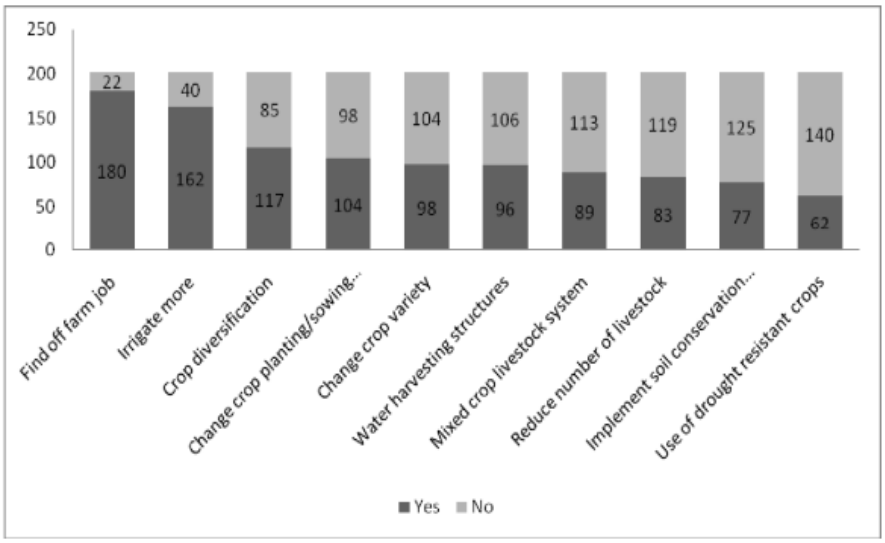

Figure 7: Responses by farmers on adaptation strategies (Loria and Bhardwaj, 2016).

Alongside agriculturalists who depend on the land are communities who engage in ancient land management practices. Most of these types of livelihoods derive from herding livestock, including the Gaddi and Gujjar (nomadic buffalo herders) people who practice transhumance, or the seasonal movement of shepherds who move to higher elevation in the summer and the valleys during the winter. This livelihood for many generations balanced seasonal grazing and impact on watersheds and the health of livestock through more nutritious feed. However, researchers in Chamba District in 2021 interested in the Gaddi shepherds and their relationship with climate change conducted a survey of 46 households and found that the “young Gaddi population are not willing to continue with this traditional occupation as a livelihood option” because of “harsh terrain and adverse climate conditions that prevail in mountain regions" (Mishra et. al., 2023). The aforementioned data on increased temperature and precipitation variability introduce harsher conditions that Gaddi must face to continue their transhumance practices. Most of the younger generation do not want these challenges caused by climate change and are pursuing other practices to support their livestock and livelihoods.

Figure 8: Gaddi shepherd tending sheep in rural pastures (Photo Credit: Nayak, 2023).

In addition to supporting farmers, the Third Pole region hosts massive quantities of freshwater trapped in ice sheets and glaciers. The free running meltwater generates hydroelectric power. In recent decades, hydropower plants have sprung up along these major rivers in an effort to help countries like India and China propel themselves toward carbon neutrality by the end of the 21st century (Gupta, 2022). The climate-induced melting Himalayan glaciers are forcing these countries to start building dams to ensure enough water is flowing to power these hydropower plants.

Bearing the brunt of these scenarios are the multigenerational agriculturalists who make up a large proportion of the population in Himachal Pradesh. They rely on the natural rivers and streams to irrigate their crops and water their livestock. As India builds dams and diverts water, these natural rivers and streams will change and force farmers to adapt. Farming livelihoods are at risk as the integrity of the Third Pole bioregion is critical for them to continue to support their households as agriculturalists.

Communicating Climate Science

The measures and statistical data that track climate trends in the region are crucial for big-picture depictions, but they overlook the citizens' own critical opinions and lived experiences of climate change. Taken together, scientific data and narratives can be connected in a way that deepens empathy and comprehension for audiences. By amplifying these local experiences, storytelling links people to one another and original knowledge perspectives. This connection builds care about the issue, and an increase in awareness of the given problem. The channels that people can use to express their stories have expanded in accessibility, reach, and influence in the age of globalization and digitization.

The solution to effectively communicating science may lie in viewing stories as facts encased in feelings (Joubert et al., 2019). Because of this, science communicators have focused more on the potential of storytelling as a tool when attempting to help people understand scientific findings and translate that awareness into action. According to the Journal of Science

Communication (JCOM), there is currently plenty of data to support the claims that stories can be an effective approach to encourage interest in science and that they can aid readers in understanding, processing, and remembering scientific information (Joubert et al., 2019).

The experiences of people are significant data in themselves. Their stories help individualize their own exposure and understanding of the world, but also connect with people who share similar feelings. Back in October 2012, an Instagram account named @humansofny started to post photographs of New York residents along with an anecdote from the resident. Now, the account has accumulated over 12.6 million followers and still highlights New Yorkers and their remarkable narratives. This amount of exposure these stories have to the public is healthy storytelling that climate science needs to share its data with the world.

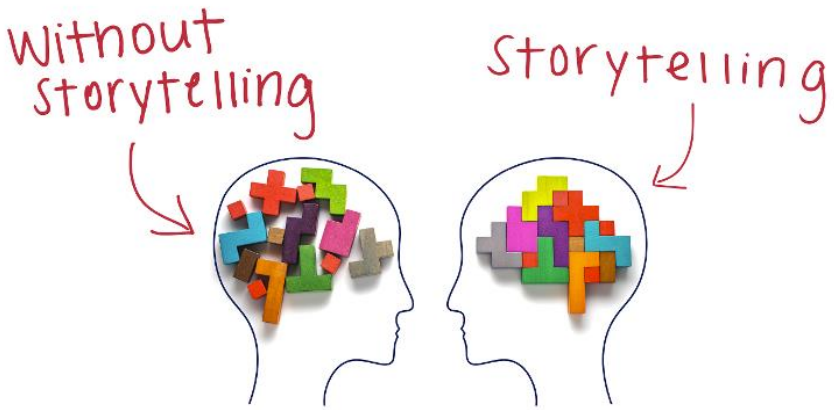

Figure 9: Storytelling is the bridge between science and experience (Quance, 2020).

Summary

In sum, the literature clearly shows that climate change in Third Pole regions will have catastrophic impacts in the next several years. The lives of residents in rural communities that are dependent on steady climate conditions are threatened. Stories from these threatened communities can advance the global conversation and pressure policy makers and activists to take action.

Methodological Approach

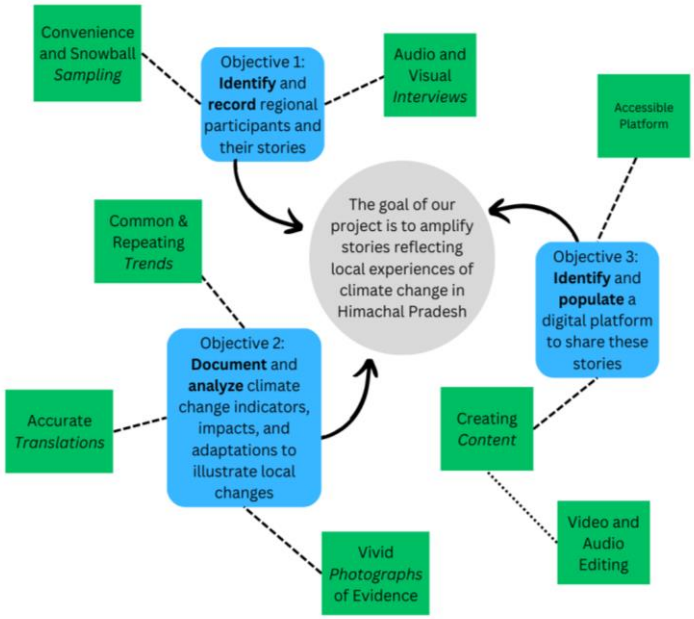

Figure 10: The approach used to accomplish our objectives in fulfillment of the project's goal.

Objective 1. Identify Participants and Record Regional Stories

To meet objective 1, we primarily focused on narrative stories from rural villagers. We conducted site assessments and informed mapping of rural communities to identify candidates for interviewing. We narrowed our focus to Himachali agriculturalists and shepherds while also taking some supporting interviews from local residents who worked on the campus of the Indian Institute of Technology Kamand campus in Mandi (IIT Mandi). These staff members from convenience sampling aided us in not only locating more potential interviewees from their home villages via snowball sampling, but also provided us with their personal experiences regarding climate change and how it has affected them personally. Our prompts asked about changes in weather patterns that have affected everyday life and livelihoods. Interviews were conducted between March and May of 2023.

The interviews were open-ended and documented with audio and/or visual equipment to record their stories. We used a guide with open-ended questions to orchestrate the interview smoothly. We solicited participant consent through verbal validation in the recordings. Data from our devices were transferred to an SSD card borrowed from WPI's ATC and used in post-production (see Table 1 for our equipment list).

Table 1. University equipment on loan from the Academic Technology Center (ATC).

Equipment Used	**Purpose**
Zoom H5 Handy Recorder	For audio recordings
GoPro Hero 7	For video recordings
Personal Smartphones	For photographic records of the interviews and landscape (**NOT ATC)
Manfrotto Tripod	Hands-free video recording
512GB SSD	To store video, audio, and photos

Objective 2. Document and Analyze Climate Change Indicators and Impacts

Indicators were documented alongside primary story interviews or recorded independently. We recorded indicators and impacts digitally to document the observations based on the stories, anecdotes, and our own observations.

Objective 3. Populate a Social Media Platform

These ethnographic stories were edited for use on Instagram where they were designed to inform a wide audience. We noted that the popular social media site TikTok was prohibited in India in June 2020 due to concerns over Indian national security. Therefore, our focus was on building media clips no more than 10 minutes long plus multiple captioned photos that can be used on the Instagram page @wpistoryingclimatechange first created by WPI students in Fall 2022. This page serves to consolidate future climate change storytelling projects so interested groups do not have to search for multiple social media pages when looking for previous projects.

Results and Discussion

Objective 1: Record Regional Stories

Our fieldwork revealed a few themes as participants were prompted to share their stories. Among the most common trends in our interviews were reports of a dramatic decrease in seasonal snowfall and rainfall – a popular and common indicator for climate change in the Himalayan region (Interview 1, Shegli; Interview 2, Kalang; Interview 3, Kataula; Interview 4, Bandi). In part, this could have reflected the time of year for our study, in spring after an unusually dry winter, but these changes were described as dramatic. Precipitation in general was a common theme.

Both agriculturalists and shepherds agreed that changes in precipitation and temperature patterns have been detrimental to their crops and livestock production. While listening to a Gaddi shepherd tending to his sheep, he said:

"[climate change] has only had a negative impact on me. Not just me, it has also negatively affected farmers and (apple) gardeners on a huge scale. Due to shortage of rainfall, there has been a negative impact not just on us Gaddis, but also farmers and apple gardeners because there was no rain – a state of drought – so for every scenario it has been a problem only. It is very important for there to be rainfall, so if it doesn't, I think there is no benefit for anyone" (Interview 3, Kataula).

Jeevan Thakur, a priest from Bandi village, practices apple cultivation and agreed that climate change challenges rural people who are highly dependent on the land. He mentioned the lack or surplus of rain- and snowfall and the introduction of damaging pests because of shifting seasonal patterns.

"A lot has changed. For example, our farming. Insufficient rains, or rainfall we don't require, like now during the flowering season of apples – I practice apple farming. So, this has a direct impact on our farming. At this time, we don't need rains. We needed rainfall about a month ago. We used to have apple trees the size of walnut trees! 20-25 years ago, the old trees dried up. The gardens that produced more than 10 boxes now don't produce enough for self-consumption. The snow also prevented the growth of pests. Now these pests start to eat the tree from inside and within two years, the tree grows hollow and falls. The farmers do spray the garden with pesticides, but that in turn harms the overall health and production. Apple trees are sensitive; you need to take care of it like a baby" (Interview 4, Bandi).

Himachal Pradesh is a central apple producer for India. Changes to the climate have brought additional expenses and investments for farmers trying to protect their trees from storms and extreme temperatures. Another apple farmer from Shegli Village listed similar difficulties with his orchard because of rising average temperatures and shifting rain patterns. He responded that because of climate patterns, many other apple farmers near Shegli are switching to vegetable farming which is less sensitive to climate changes (Interview 1, Shegli).

The fact that warming climate has affected apple production as a livelihood in the area is a big concern. Orchardists across the area are forced to plant apple trees at higher altitudes than normal to gain the necessary chilling time according to the apple cultivators from Shegli Village. As noted across multiple interviews, warmer temperatures are leading to less snowfall and random rain variability which is also greatly affecting apple growth and quality, which in turn has implications for sales. To highlight the changes in precipitation, Jeevan stated,

"We HAD 5-6 feet of snow. Slowly, over time, in 14-15 years, everything seems to be diminishing. From 5-6 feet of snow to 4 and 3 feet, and from the past few years, we're receiving as low as 1 or even half a foot of snow" (Interview 4, Bandi).

Rain variability has also caused many villages to undergo periods of droughts which further hinder the growth of apples and other crops. Farmers are attempting to grow dwarf varieties of apple trees because they require less time and water to grow than full-sized trees.

Climate change indicators are often secondary and tertiary to weather. Reports from farmers included evidence that canker (tree cancer/fungus) growth in apple trees also has been more prevalent due to the combination of drought and warmer temperatures. This in turn pushed farmers to use more pesticides, fungicides, and herbicides to prevent apple tree canker and pests through chemical applications rather than relying on cold weather to deter these diseases and pests. Among the stories, we learned that there are farmers who have stopped apple production and switched to vegetable crops to alleviate the challenges of specific conditions needed for apples. There are also farmers, however, that have stopped farming as a livelihood altogether and were forced to move from their village and find work in some other way. Climate change migration, which is often thought of in terms of large-scale movements, can be tracked in these early phases with single individuals or families leaving farms that have been in production for hundreds of years.

Villagers we spoke with also mentioned that climate change not only changed the way residents raise crops and livestock, but also the way they care for themselves. A gentleman from Shegli Village explained that 5-6 years ago people wore wool clothes to keep warm, but now most people in his community are wearing cotton T-shirts because of the warmer weather (Interview 1, Shegli). Both the shepherd from Kataula and Jeevan the priest expressed concern for the welfare of their children. Their families living with limited means, however, makes each man believe that their children will have to do more manual labor to survive because changes in the climate are forcing changes to their traditional livelihoods (Interview 3, Kataula; Interview 4, Bandi). On the other hand, Chetan from Kalang believes that while children of farming families are less likely to continue farming because of climate change, this change in livelihood can provide children an opportunity to move to the city, earn an education or skill, and take-on a better job as he has done (Interview 2, Kalang).

We asked our participants about their belief on what is causing climate change, and interviewees agreed that humans were the principal cause. While pollution is related more indirectly to climate change in terms of air emissions, this kind of response was common. According to Thakur (the priest),

"All of this is happening due to pollution – the lack of snow this year. A lot of wars going on, vehicles, all of these contribute to pollution and have impacts on our farming. Old sources of water are either drying or are simply no more due to some reason" (Interview 4, Bandi).

The shepherd from Kataula points to human actions and impacts on the mountain forests as an overall way to frame the increasing distance from ecosystem health. He said,

"Humans only indulge in deforestation, start these forest fires, and illegally steal wood from these dense forest trees. I feel these illegal activities are very wrong; we even get oxygen from these forest covers and people destroy them without a thought. Illegal mining also leads to soil instability and landslides. We have no one else to blame – it is humanity's fault" (Interview 3, Kataula).

At IIT Mandi, one of the canteen owners, Paras, also linked climate change to negligent and diminishing concerns in environmental behavior. He believes that the loose garbage that

people discard into the streets and river is melting snow and preventing water absorption into the mountain. The saturated earth then waters the plants for many months which prevents landslides which are mainly caused by dry, loose earth not held-in by strong plant roots. (Interview 5, Kamand). He also mentions a unique indicator that shows that temperatures are higher than when he was a child.

"Never used to be summer here, but now it is getting pretty hot here. People putting on air conditioners is the biggest thing I see. I have never seen an air conditioner in my house since I was born. Still, we don't really have [A/c] in the city. If you ask nearby villages, they have installed air conditioners which were never required here" (Interview 5, Kamand).

Objective 2: Document Visual Indicators

Our team observed and identified multiple visual indicators that support the responses in our interviews. Some examples include nonexistent snow on high altitude mountain peaks, landslides that destroy and block roads, and extreme weather conditions like cloud bursts. These indicators were difficult to photograph because our short stay in Himachal Pradesh prevented us from capturing time-dependent indicators to compare indicators. Therefore, we rely on respondents on when to expect weather conditions like temperature and precipitation levels and compare these reports to what we observe in March-May. Below, we have collected a sample of common indicators from our fieldwork.

Figure 11: According to Thakur, the snow here at Prashar Lake would be several feet at this same time of year in March (Photo credit: McGonigle, 2023).

Figure 12: Dry mountain slopes from long periods of lacking rain and snowmelt tend to lead to more landslide activity (Photo credit: Fox).

Figure 13: A beach once existed on the bank of this river but is now covered in rocks due to landslides such as the one seen falling from the road. A local had once played with his son on this beach when he was younger but is now unable to (Photo credit: Fox, 2023).

Figure 14: Example of dramatic landslide that had disrupted road traffic just outside IIT Mandi's campus in Kamand (Photo credit: Fox, 2023).

Figure 15: Erosion causing a landslide on a local mountain road making it dangerous for drivers (Photo credit: McGonigle, 2023).

Figure 16: Saturated thunderstorm clouds quickly cover the sky over IIT's North campus bringing heavy rains and hail (Photo credit: McGonigle, March 2023).

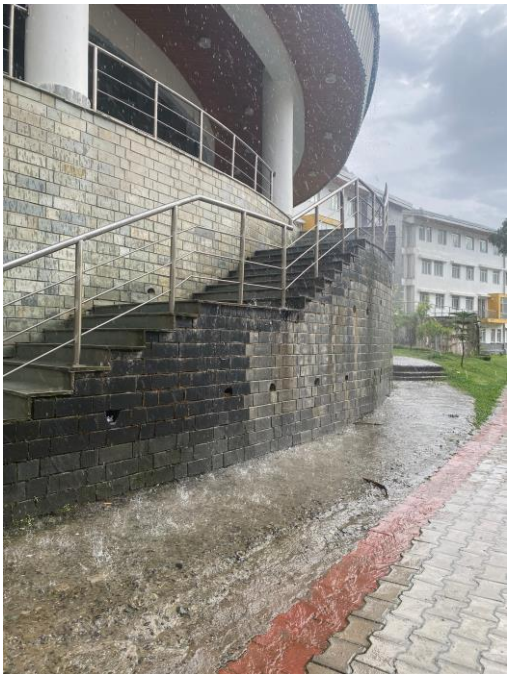

Figure 17: Rainfall during the months of March-May is uncommon but Himachal Pradesh has accumulated a significant amount of irregular rainfall (Photo credit: McGonigle, March 2023).

Figure 18: Hailstones falling on the lawn in front of the Pine Canteen on the North campus of IIT Mandi (Photo credit: McGonigle, March 2023).

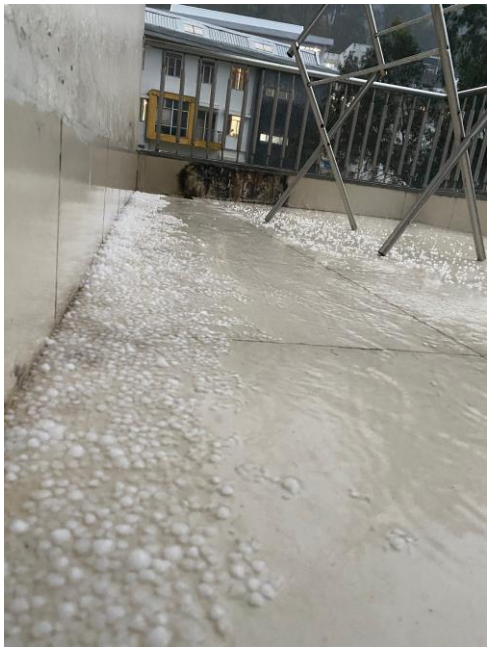

Figure 19: Large quantity of hail landing on a balcony of one of the hostels in the North campus of IIT Mandi (Photo credit: McGonigle, March 2023).

The above indicators are all from nature like snow lines, hail, and landslides. As mentioned in Objective 1: Record Regional Stories, however, there are other indicators like a change in wearing clothing material and more use of air conditioning in villages and urban areas.

Objective 3: Social Media Sharing

Our first post to the shared Instagram page @wpistoryingclimatechange was an introduction to the team followed by summarized portions of the project to serve as vignettes from our fieldwork. These posts were designed using the free online editor Canva. To share on Instagram, we had to digitally record the interviews. We either filmed the interview using a GoPro on a tripod if the ground was flat, or by holding a smartphone if the ground was rugged. For our first and fifth interviews, we decided to only record audio using smartphones because of limited space or because we were mobile.

Figures 20 and 21: Our group conducting interviews in the field either using a GoPro on a tripod (left) or voice memo recorder on personal smartphones (right) (Photo credit: Fox).

We then edited the footage in the free software OpenShot Editor to be uploaded. The footage was initially cut to keep important parts of the interview while keeping the final videos short. English subtitles were then added to keep the original audio responses. Finally, Canva was used to create thumbnails for the videos. The link to this Instagram page is https://www.instagram.com/wpistoryingclimatechange/.

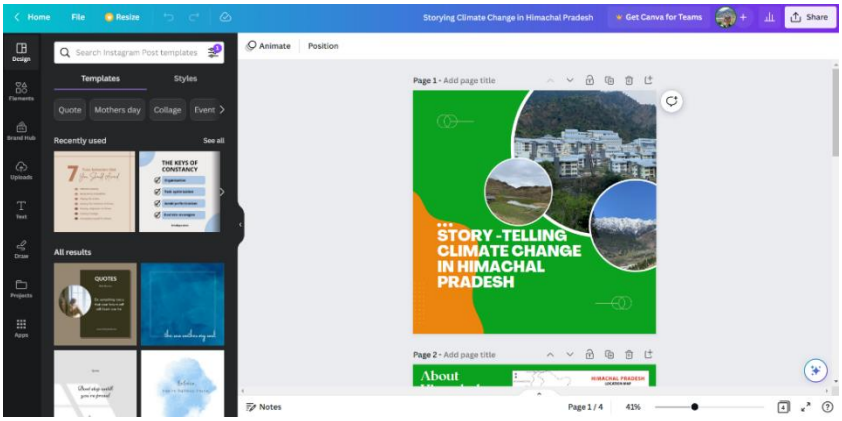

Figure 22: Screenshot of Canva where we design Instagram thumbnails and other posts.

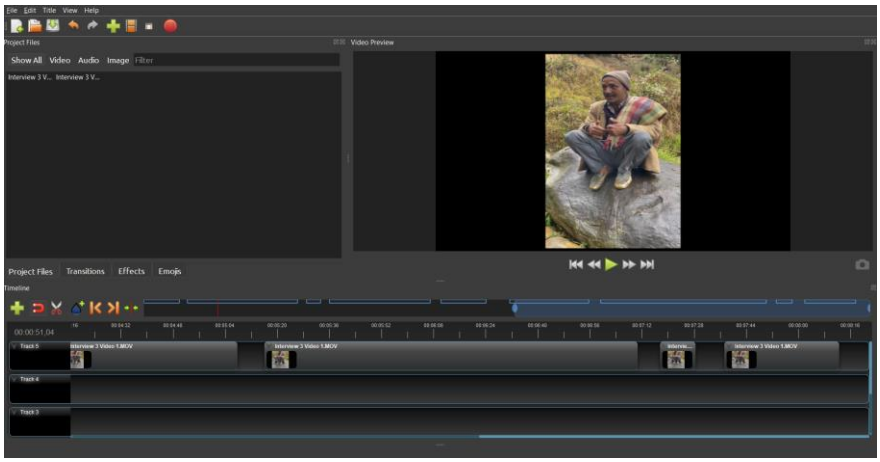

Figure 23: Screenshot of video editing for an Instagram post using OpenShot video editor (Photo credit: McGonigle, 2023).

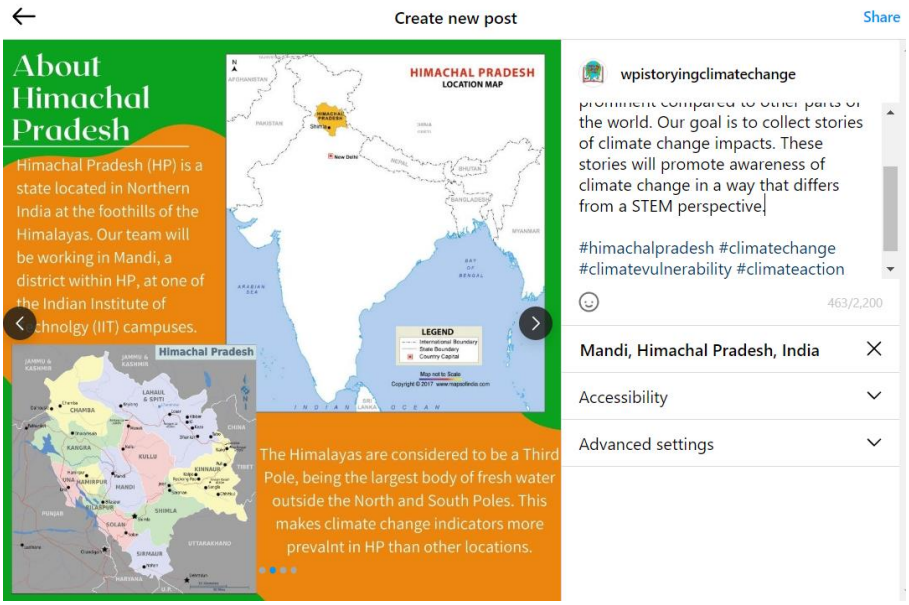

Figure 24: Screenshot of Instagram where we upload our Canva designed posts and write captions alongside other details.

Discussion

From our interactions with residents in the region, we heard two major areas of climate change impacts in Himachal Pradesh. The first concern came through stories about their financial stability, in a community supported primarily by crops and livestock that rely on predictable landscapes and weather conditions. Climate change has clearly lowered the productivity of these two agricultural staples with the state of variable precipitation and temperature patterns. These patterns are dramatically different from what residents experienced in the last century. These variabilities in seasonal patterns have ruined traditional practices of growing cash crops like apples and has forced shepherds to seek more scarce grasslands higher on the mountains. These combined hardships force families to decide whether to continue farming using more expensive techniques like chemical fertilizers and pesticides, or to move their families down the mountain into urban areas where they hopefully find bare-minimum paying work.

Interesting responses seem to point to climate change for changing cultural practices of the local residents, including traditional habits and include projections forward to the future for their children. All our respondents showed concern for the welfare of their children and their futures in general, in that they were unsure how climate change will impact their ability to pass on family businesses. Furthermore, all agreed that this has negatively impacted intergenerational practices; however, one interviewee mentioned that changes to his family's farm allowed him to move and seek a better job off the farm. It was also an interesting detail from our first interview to learn that changes to traditional practices included the way they dress. Residents are moving away from traditional thick wool clothes, traditionally worn year-round, to western styles like T-shirts and sweatpants because of the warming temperatures.

Another more obscure change foreshadowed some alarming developments in habitat such as in grasslands and bloom cycles. This was reported as fewer bees being raised in these villages. A common practice no longer witnessed was for a host to offer visitors a jar of honey (Interview 1, Shegli; Interview 3, Kataula) and this was no longer done.

As learned in previous studies collecting climate change stories in Himachal Pradesh, residents are aware that the climate is changing and can provide multiple indicators through their stories. They also mention, however, that there is little that individuals here in Himachal can do to help. One participant observed,

"We have lived our life somehow, managed ourselves in our time that has passed, only some time left now. So, I think about my kids, but that's all we can do – worry about them – hope for them. I cannot do anything about [climate change]" (Interview 3, Kataula).

Study Limitations

We were only able to interview a few people across the Mandi District, which is a small fraction of Himachal Pradesh. However, we believe that it is likely these perspectives are shared across many parts of the Himalayan Arc in the country.

Translators were a necessity for these interviews as local residents spoke in a Mandyali dialect or in Hindi. The IIT side of our team were more than happy to fill this role. Accurate translations are important when recording stories because many people use proverbs or sayings that normally do not translate appropriately to other languages. These proverbs hold weight in their meanings, and if they are lost in translation, then the participant's message is misunderstood. Translation is often imperfected and we note this limitation as a precaution.

Recommendations

From listening to rural villages reflect on how climate change has impacted them, we understand that they cannot make an impact on climate change. Our recommendations, however, will address a concern they had that only has minor implications for climate change, but really addresses attitudes around ecosystems. Many respondents noted an increase in trash and a disconnect from sustainable ecosystem management. Therefore, our first recommendation is for municipalities to foster conversations about options for communities facing this problem.

Recommendation 1: Ecosystem Preparedness

This would minimize the dumping of waste in wildlife areas and water systems, creating a healthier ecosystem and cleaner water. To achieve this, we recommend collective efforts to boost awareness of systemic ecosystem wellbeing. One organization, the nonprofit foundation Healing Himalayas, has been collecting and appropriately disposing litter in Himachal Pradesh since 2016. Its founder Pradeep Sangwan has established garbage pick-up and disposal programs in communities around the state, including transforming Manali and other more remote areas with regional trash collection. Sangwan manages a verified Instagram account called @HealingHimalayas which posts updates frequently. Together with these visual initiatives, Third Pole regions need to consider the value of reforestation. More trees will restore wildlife and plant life while also possibly leading to less landslides. We fully recognize that the carbon footprint of the local communities is negligible compared to industrial plants located throughout the country and world, but Third Pole regions also stand to suffer the impacts of extreme weather events disproportionately to other locations. Preparedness is key in ensuring future security in communities.

Recommendation 2: Job Training Preparedness

As many farmers are worried for their children's financial stability as they may have to move from their villages and find off-farm work, we recommend local administrations to establish career centers. These career centers will teach basic soft and technical skills to better equip people searching for jobs. If people wish to stay in their mountainous villages, then these centers can also provide training in nonagricultural work like weaving and pottery. To achieve this, we recommend IIT Mandi to explore and establish such programs on their campus through the IIT Mandi Catalyst department as soon as possible. These career center programs will provide security for people that could possibly be forced off their farms due to climate change.

Recommendation 3: Media Amplifying Citizen Scientists

We recommend that Third Pole regional studies on climate change continue to incorporate the experiences of citizen scientists to complement existing scientific data. This combination of quantitative and qualitative data will provide a larger and clearer picture of climate change's harmful impacts in vulnerable communities. By using social media, citizen scientists can document and share their observations with professional scientists across the world who can encourage more action by capable authorities in power to combat climate change. Social media also enables communities across the Himalayan Arc to connect and share their experiences which fosters more conversation on climate change in these Himalayan countries.

Conclusion

During this project, the residents and participants in our study met with us and welcomed the opportunity to share their perspectives on climate change. They answered any questions we had. It was to our expectation that area villagers might not be as open to reflect about such issues, especially during their busy workday, however, all the participants we interviewed not only felt climate changes significantly, but they realized it was anthropogenic and described what they saw in their own communities that contributes towards climate change.

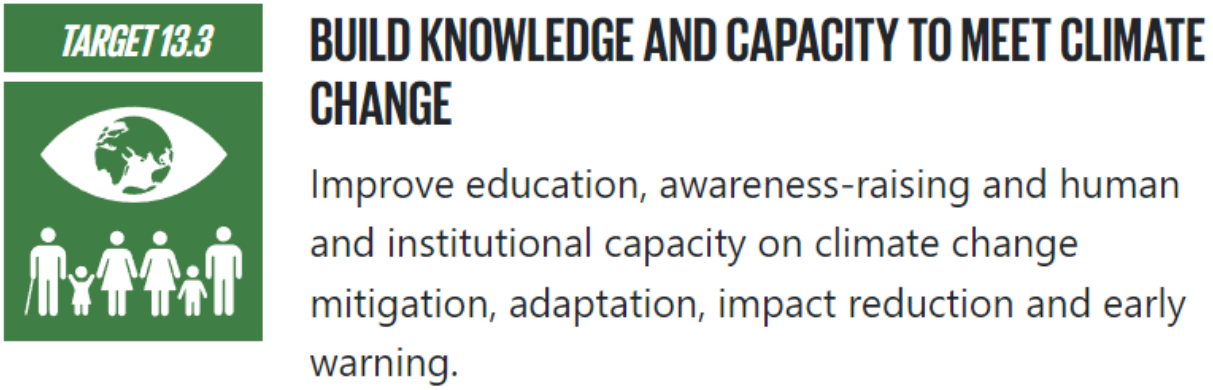

Figure 25: Goal 13.3 of the UN's Sustainable Development Goal 13: Climate Action (The Global Goals, 2023).

Our hope is that further studies on climate action are conducted in this vulnerable region as a basis for strengthening the conversation on the severity of global climate change. This project supports the United Nation's 13th Sustainable Development Goal: Climate Action by increasing awareness of climate change in a region not normally in the scope of climate change mitigation conversations. The Third Pole encompasses all the Himalayas and spans over multiple countries. Similar studies looking at climate change impacts on vulnerable communities in India's neighboring counties may yield additional insight to further push global leaders to continue mitigation efforts.

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Appendix A: A Guide of Questions for Interviews

Preliminary Sample Questions for Warm-up

- What is your name? The name of your village? Do they have a meaning?
- What is your occupation? Have you been having a good year so far?

Interview Questions for Farmers

1. Do you fear for the future of this village? If so, what prompts these fears?
2. Have you noticed any changes to your livelihood or the livelihood of your neighbors?
3. How has water availability compared over the years? Have you noticed any pattern changes?
4. How do seasonal temperatures compare to previous years? Are summers hotter and winters colder?
5. Have you heard of the terms "climate change," "global warming," or the Third Pole?"
6. Has your local government shown concern over these topics?
7. Do you believe there is a risk of landslides or flooding in this area? How has their frequency changed over the years?
    a. Have there been any changes to your routes/trail used for herding? If so, why?
8. Can you show us something in your village that you believe is evidence of climate change?
    a. Has there been an increase in flooding or landslides along your popular routes/trails? If so, where?

Appendix B: Consent Forms for Media Capture and Research

We are a team of undergraduate students from Worcester Polytechnic Institute (WPI) in the United States. We are participating in a project to collect experiences and perceptions of climate change around the world. If you are willing to participate in this project, please read and note your preferences on this form. The final results will be made public, and can be found at the following link: https://www.instagram.com/wpistoryingclimatechange/.

Do we have your permission to audio record an interview?

Yes ☐ | No ☐

Do we have your permission to video record an interview?

Yes ☐ | No ☐

Will you allow us to use your words and image for use on public website platforms?

Yes ☐ | No ☐

I understand that these interviews will be published at WPI for educational purposes and made available to the public. Images and film clips may also be shared to social media platforms including Instagram and other outlets designed to amplify the experiences of climate change.

Sign: Print: Date:

We are a group of students from Worcester Polytechnic Institute (WPI) in the United States. We are conducting interviews to learn more about the experience and perceptions of climate change. Your participation is voluntary.

Do we have your permission to record this interview?

Yes ☐ | No ☐

Do we have your permission to include your photo?

Yes ☐ | No ☐

Will you allow us to include your name and other identifying information?

Yes ☐ | No ☐

Sign: Print: Date:

Appendix C: Link to Instagram Posts

The following link is to the Instagram page where our project posted interview videos and other posts: https://www.instagram.com/wpistoryingclimatechange/.