Feasibility of Improving Sanitation Along Trekking Routes of Himachal Pradesh

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Feasibility of Improving Sanitation Along Trekking Routes in Himachal Pradesh

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Abstract

This report explores the feasibility of improving waste management at trekking sites in Himachal Pradesh. Through stakeholder interviews, on-site data collection, and map generation, we were able to compare different sites and develop benchmarks for ideal sanitation practices. Our data shows that the region's current sanitation systems are insufficient to support the increasing number of visitors. Based on our findings, we developed a set of recommendations which focuses on improving waste education and minimizing unsustainable consumption.

Executive Summary

The goal of this project was to construct a feasibility study for improving sanitation along trekking routes in Himachal Pradesh. Over the years, Himachal Pradesh has seen an increase in adventure tourism. According to the India Brand Equity Foundation, "domestic tourist inflows in [Himachal Pradesh] increased from 11.04 million in 2009 to 17.12 million in 2015" (India Brand Equity Foundation, slide 49). However, the waste infrastructure has not adapted properly to accommodate this new influx of tourists leading to littering and open defecation along trekking routes. The large presence of waste along the trails, detracts from the visitor experience and poses serious environmental concerns.

Background

India has emerged as one of the largest global consumers of pre-packaged snacks. India has the fourth largest snack market of any country in the world ("Snack Food", n.d.). With such a heavy consumption of pre-packaged goods, the disposal of the packaging becomes a waste management concern, especially on trekking routes with an abundance of small snack shops.

To compound this issue, the behavioral practices of many local members of the Indian community makes waste management a challenge. In an article by Evegny Pakhomov of BRICS Business Magazine, the traditions of waste management in India are described. The article mentions that traditionally, waste was thrown outside and left to decompose under the heat of sun. However, in the age of modern packaging, this method of waste disposal is no longer effective. Unfortunately, much of this traditional practice has remained (Pakhomov, n.d.). The increased presence of pre-packaged snacks combined with the traditional waste practices further complicates the waste management challenges on trekking routes.

Litter accumulation along Himachal Pradesh's trails has become a problem due to increased tourism. The massive volume of waste can be noted best by some of the ecotourism groups that work to clean it up. The leader of one clean hiking initiative group, the Green Trails Mission, says that "the villages and the mountains lack a proper waste management system, which has caused open garbage dumping practices within and outside the villages, by both inhabitants and visitors" (Engineer, 2018). Litter continues to pile up each and every day because there is an inadequate waste removal infrastructure in the area.

Methodology

To achieve our project's goal, we focused on the following objectives:

1. Evaluate current waste management systems at trekking sites.

In order to complete this objective, we first worked with Healing Himalayas, a well-known non-government organization (NGO) on a cleanup campaign. Through the Prashar Rishi Lake Cleaning Campaign, we were able to gain an understanding of the waste accumulation and experience first-hand the difficulties with waste collection. We also created two different maps for each site. We used percent distribution maps to determine the waste composition at each site. To create these maps, we divided the entire trail into

five sections of equal distance and collected the first 100 pieces of waste seen in each segment. The collected waste was segregated into six waste-disposal categories, as shown in Figure A. Heat maps were also created at each site to develop relationships between waste accumulation and waste infrastructure. To create these maps, we chose a section of the trail that included a variety of waste infrastructure. Then, a geotagged pin was placed every ten pieces of waste that were observed on the trail. Finally, we divided the section into 50 meter segments and used the geotagged pins to determine the amount of waste on that section. Using this information, the 50 meter sections were color-coded based on the amount of waste within each segment.

2. Understand perceptions from stakeholders

Additionally, we conducted semi-standardized interviews with the flexibility for the interviewee to direct the conversation towards what they find relevant (Berg, 2007, p. 94). We were able to interview a total of 30 individuals from our select group of stakeholders. Many of these questions pertain to how the interviewee views the sanitation conditions and how they believe it could be improved. At the organizational level, we also conducted interviews with local, privately owned outfitters.

3. Propose and assess a plan to improve waste management systems

To create a final recommendation for improving sanitation at trekking sites in Himachal Pradesh, it was important to generate multiple options. This was done by interpreting relationships and data from the previous two objectives. In order to satisfy the stakeholders, our recommendations used a blend between our ideas and their suggestions. A few basic categories for proposed plans may include education, partnerships, facility updating, regulations, etc. After brainstorming different recommendations, we evaluated the benefits and drawbacks of each idea. After this, we finalized our recommendation by combining the best aspects of each plan.

Results

Through our results, we see that the ultimate problem comes down to three categories: education, the practices of the visitors, and the practices of the vendors. At these sites, the sections with the minimum amount of litter were seen in a 50m distance right near a trash bin. After a market area, however, there was a significant increase in the amount of litter. This could be due to people purchasing their snacks, eating them, and then dumping the trash as they continue their trek in the opposite direction of the vendor.

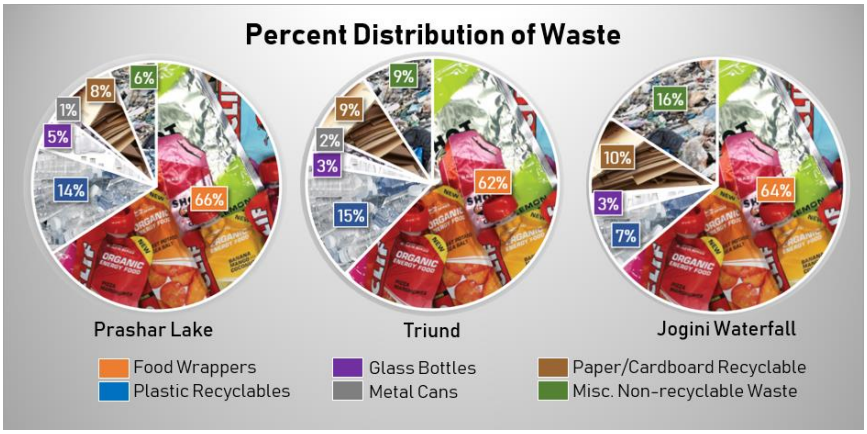

Figure A. Percent distributions of waste

In addition, the areas where the most litter was seen were sections that were, at minimum, 100 meters away from the nearest trash bin, as seen in Figure B. This indicates that even though adding more trash bins would be helpful, it is not feasible to have a trash bin every 100 meters. This also makes it clear that the lack of trash bins is not the only problem - but rather the types of snacks available and the packaging that they are sold in. This is also supported by the percent distribution maps for our three sites. The majority of waste at all three sites was food wrappers (63%), followed by plastic recyclables (12%), as seen in Figure A.

Education and collaboration efforts are also key to the waste management issues seen. The signs located at Triund and Vashisht played a unique role in solving the waste management issue. At Triund and Vashisht, there were different anti-littering signs. Some of these signs had confrontational messages such as "In the forests and mountains, animals don't leave trash. Humans do. Behave like animals". After these confrontational signs, however, the waste accumulation was comparable to the average. Several different stakeholders expressed a need for proper waste education in childhood that would translate to proper waste disposal practices later in life. This also is important for increasing awareness in organizations with influence such as the government. Currently there is little government involvement according to our interviewees. Many shop owners at Prashar Lake referenced how they felt frustrated that their requests for help to properly dispose of their waste and facility maintenance went unresolved.

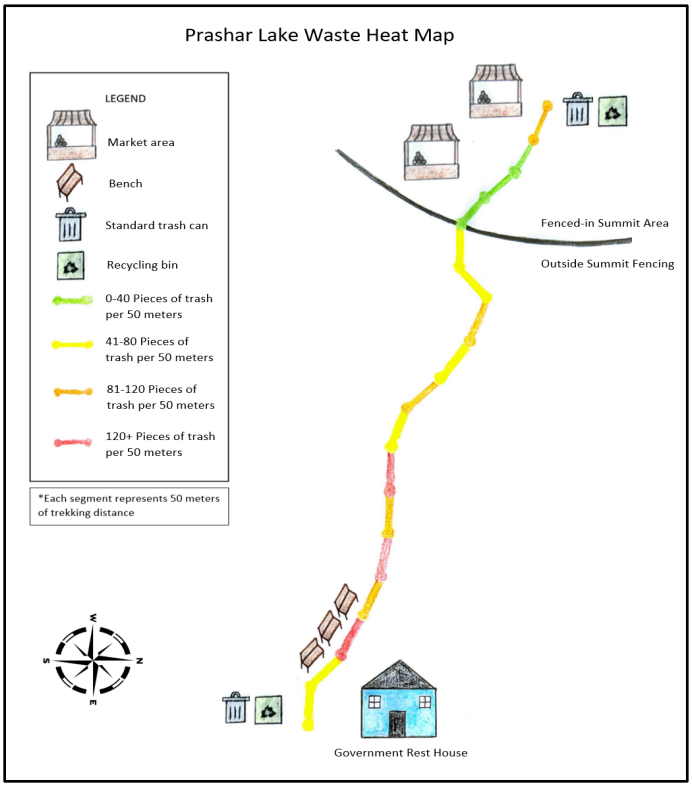

Figure B. Heat map of Prashar Lake

Recommendation

After examining our findings, we came to the conclusion that in order to improve waste management at trekking sites, there needs to be a balance between short term and long term solutions. Some of the solutions involve infrastructure changes, while other can be imbedded in the trekking culture and promoted by vendors and outfitters.

In terms of infrastructure, each site is specific, however a group benchmark can be met. All sites need more trash bins at a consecutive distance that suits them. These trash bins can be provided by NGOs or be built by the community. Restroom facilities also need to be added in the same manner as trash bins. New restrooms should focus on dry composting toilets to provide a positive output and work during the winter. Lastly, all sites should have

signs to indicate the distance to the next consecutive waste facility and proper waste management techniques.

Collaboration between NGOs and the Bharat Scouts and Guides organization could help promote community involvement. Similar to the Boy Scouts of America, this organization looks to introduce children to different aspects of nature through activities like camping and trekking. One main focus of the group is to "understand the need of conserving nature/environment and public properties" (The Bharat Scouts and Guides, 2018). By promoting interaction between NGOs and scouts, the youth could gain a passion of keeping trails clean. These scouts could be given the foundation to become the environmental activists or NGO founders of the future generations.

A more complex fee-oriented incentive is to encourage a partnership between NGOs and vendors that rely on the trekking sites for their business. Similar to Waste Warriors at Triund, sites like Prashar Lake and Jogini Waterfall could adopt a relationship with other NGOs or even governmental agencies. In this scenario, the vendors could pool a small weekly or monthly fee in return for waste removal services from these organizations. This pooled fee could also come from a small entrance fee from visitors that is only returned if they pick up a certain amount of trash. Eventually, the organizations will be able to team up with the communities in an effort to keep the trails clean in the long-term.

To mitigate the littering problem at the root cause, snack vendors could provide traditional snacks in place of pre-packaged snacks. Instead of selling potato chips, the vendors could sell fruit, vegetables or locally-made food like roti, samosas, pakora or siddu. Vendors could sell reusable metal bottles to accommodate the change from single-use plastic bottles to filtered water recharge stations. These snacks and drinks have less of an environmental footprint, but are still easy to consume and transport. The trekkers could carry these snacks along the trek in newspaper bags, which are biodegradable and safely burnable, that are provided by the vendors.

Vendors who sell fruit, vegetables and other biodegradable snacks could manage this waste by composting. Additionally, waste from the aforementioned dry toilets could be added to the compost. Although composting is a hard-to-sell and long-term practice for many vendors, it has an added benefit for them; they could utilize the compost to grow a small garden to become self-sufficient.

Conclusion

Our research and data show that the current sanitation systems at trekking sites in Himachal Pradesh are insufficient to support the increasing number of visitors. This leads to problems such as health issues, harm to aesthetic appeal, and degradation to the ecosystem. We documented different patterns and relationships between trash and waste facilities along our three main sites using maps. We accounted for personal experiences and recommendations by talking to the locals and key stakeholders of the surrounding community. Finally, we actively experienced Himachal's trekking waste management by volunteering with an NGO for a clean-up campaign. We then analyzed all of this information, leading to our final recommendation. Through this plan, these mountainous trekking sites in Himachal Pradesh could be both self-sustaining and eco-friendly.

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Pradeep Sangwan, founder of Healing Himalayas

Associates from Hippie in Hills and Prashar Lake Trekking, trekking outfitters

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Authorship

All team members contributed equally to this study and the writing of this report. The report was written and revised as a group. We would like to recognize the following authors for their specific contributions to the project.

Dhrubodeep Basumatary -- Conducting and translating interviews

Joseph Dainis -- Organizing our field-work trips and documenting our findings

Thomas Hanlon -- Recording data and creating heat maps

Sydney Packard -- Recording data and creating percent distribution maps

Sean Tidd -- Recording audio for our interviews

Stanzin Tsognis -- Conducting and translating interviews

Table of Contents

Abstract i

Executive Summary ii

Acknowledgements vi

Authorship vii

List of Figures ix

List of Tables ix

Chapter 1: Sanitation at trekking sites in Himachal Pradesh 1

Chapter 2: The consequences of waste on trekking sites in Himachal Pradesh 2

Selected trekking sites in Himachal Pradesh 2

The challenges of trekking waste removal in Himachal Pradesh 4

Cultural implications of waste management 4

Chapter 3: Approach 6

Evaluate current waste management systems 6

Understand perceptions from stakeholders 7

Propose and assess a plan to improve waste management systems 8

Chapter 4: Results and discussion 9

Evaluation of current waste management systems 9

Perceptions of local residents, tourists, NGOs and local trekking outfitters 11

A plan to improve waste management systems 12

Discussion 13

Chapter 5: Project outcome 15

Chapter 6: Conclusion 17

References 18

Supplemental Materials: Methodology 20

Sample interview questions for stakeholders 20

Waste data tracking sheet for percent distribution maps 22

Supplemental Materials: Project Outcome 23

Supplemental Materials: Heat Maps 24

List of Figures

Figure 1. Litter along a trekking route in Manali----------1
Figure 2. Aerial view of Prashar Lake---------- 2
Figure 3. Jogini Waterfall---------- 3
Figure 4. Shop selling pre-packaged snacks at Prashar Lake----------5
Figure 5. Flowchart of project goal, objectives and associated methods---------- 6
Figure 6. Interview with a local vendor at the Jogini Waterfall trek---------- 7
Figure 7. Waste Warrior's waste sorting area----------10
Figure 8. Distribution of waste at Prashar Lake, Triund and Jogini Waterfall ---------- 10
Figure 9. Team interviewing Hippie in Hills----------11
Figure 10. Witty and confrontational signs found at Triund and Vashisht----------13
Figure 11. Short-term recommendation schematic---------- 15
Figure 12. Project presentation poster---------- 23
Figure 13. Prashar Lake waste heat map----------24
Figure 14. Triund waste heat map ----------25
Figure 15. Jogini Waterfall waste heat map----------26

List of Tables

Table 1: Summary of sites visited----------9
Table 2: Waste data tracking sheet---------- 22

Chapter 1: Sanitation at trekking sites in Himachal Pradesh

Over the years, Himachal Pradesh has seen an increase in adventure tourism. According to the India Brand Equity Foundation, "domestic tourist inflows in [Himachal Pradesh] increased from 11.04 million in 2009 to 17.12 million in 2015" (India Brand Equity Foundation, slide 49). However, the waste management infrastructure has not adapted properly to accommodate the influx of tourists, leading to littering and open defecation along trekking routes. This problem was highlighted by the ecotourism group, Waste Warriors, who recently collected more than 60 full bags of non-degradable litter at Triund, a popular trekking route in Himachal Pradesh, in the span of only two days (Dasgupta, 2018).

Figure 1. Litter along a trekking route in Manali, March 23, 2019 (Hanlon, 2019)

The large presence of waste along the trails, as seen in Figure 1, detracts from the visitor experience and poses serious environmental concerns. For example, both domestic animals and wildlife can be seen consuming garbage along the trails, causing irreparable damage to their internal organs. There is also the risk of food contamination by chemicals found in plastic waste. Along with harm to ecosystems, open waste can spread infectious diseases, such as cholera, which endangers the lives of many trekkers (CDC, 2019).

The goal of this project was to construct a feasibility study for improving sanitation along trekking routes in Himachal Pradesh and to contribute to the United Nations Sustainable Development Goals 6 and 12. These directives call for the availability of proper sanitation management to all and sustainable consumption to minimize the global material footprint. (United Nations Development Programme, 2019, p. 1). With this in mind, we focused on three objectives: 1. we described and evaluated current waste management systems at trekking sites; 2. we documented the perceptions of local residents, tourists and other relevant stakeholders; and 3. we proposed and assessed a plan to improve waste management systems at trekking sites. We used the results from our site visits and interviews to present a set of recommendations for the trekking community.

Chapter 2: The consequences of waste on trekking sites in Himachal Pradesh

This chapter summarizes the background information necessary to understand the multi-dimensional aspects of trekking sanitation management in Himachal Pradesh. It is important to understand the intrinsic features of Himachal Pradesh's trekking routes, such as their historical, spiritual and environmental significance as well as their geographical beauty. This section also explains in-depth the recent increases in tourism to the state and analyzes the impact of tourism on trekking sanitation management. Finally, we present a discussion of the stakeholders related to our project, and their perceptions and mindsets toward trekking site sanitation.

Selected trekking sites in Himachal Pradesh

The history and culture of Himachal Pradesh is shaped by the region's geography. The remote areas of the region have heightened feelings of isolation, closeness to nature and spiritualism. The landscape alone explains why folklore refers to Himachal Pradesh as the "abode of gods" (Maynard, 2001). In fact, many of the trekking routes that attract both domestic and international tourists formerly served as pilgrimage sites to local temples (Joshi, 2013). Three popular treks are described below that represent how many traditional pilgrimage routes are now re-branded to tourists for adventure trekking. These samples show the range of length, difficulty, and fragility of eco-system commonly found in similar sites in Himachal Pradesh

Prashar Lake is a short trek that has become widely popular for its picturesque features - namely the lakeside Parashar Temple (Figure 2). A large number of religious visitors come during the months of August and September for an annual pilgrimage (Attri et al., 2012). While the spiritual lore surrounding the site is significant, Prashar Lake attracts many secular visitors as well. With a guide, several trails can be used to reach the 2,630m summit within 4 hours. Visitors can rent the Forest Reserve Guest House or stay in a tent near the lake (Sharma et al., 2017). Also, restroom facilities have recently been installed at Prashar Lake in order to accommodate the increasing number of visitors (Sharma et al., 2017). The lake is surrounded by an ecosystem with diverse vegetation and wildlife. The local Gujjar

Figure 2. Aerial view of Prashar Lake, March 30, 2019 (Packard, 2019)

community depends on this environment for grazing their animals and collecting medicinal plants (P. Attri et. al., 2012).

A few hours away from Prashar, a more heavily advertised and visited site, Triund, is also known for its spiritual history and ease-of-access. Triund is located in Mcleodganj, home of the Tibetan Government in exile and His Holiness the Dalai Lama (Wovoyage, 2018). Located near this compelling landmark, Triund is a "small and easy trek" with a summit elevation of 2,850m which can be reached in approximately three hours (Kurra, 2018). Many of these trekkers camp in tents on the hilltop overnight, even though the trek can be completed in a day. Along the trek, chai shops sell tourist-targeted commodities like pre-packaged snacks, drinks in plastic water bottles and toilet paper (Drifter Planet, 2015). According to multiple travel bloggers, there are no toilets on the trek, save a few "makeshift tent toilets" (Kurra, 2018; Reddy, 2017). Triund is unique in that it is surrounded by a vast wet temperate forest, which houses a variety of animal species (Himachal Pradesh Planning, 2009). A majority of this forest is demarcated, meaning it has a set of boundaries by which it can be protected by the Himachal Pradesh Forest Department. The surrounding area of the Triund Trek has the Dal Lake, which provides an interesting addition to the ecosystem in terms of its fauna and animal species.

To encompass a broader range of sites, our study also evaluated a third kind of "trekking" experience targeted for day use and any level of experience. The path to Jogini Waterfall, in fact, is more of a walk than a trek. This walk is located in Vashisht, a small community outside of Manali. Vashisht temple is well-known for its natural hot spring, which is said to have healing powers. From there, a trail through the abutting neighborhood begins to transition to a wooded area, ultimately leading to a breathtaking waterfall, as seen in Figure 3. Unlike the previous treks, the route begins near a popular shopping area. Here, hikers have access to snacks and water bottles both before and during the trek. The valley surrounding Vashisht is "rich in horticulture" and "naturally pure" river water. In Manali, the environment is being used as a commercial resource, as exemplified by the mineral water bottling plants and the development of wholesale fruit orchards. Conserved areas are the "thick Deodar forests around the main town of Manali," which host a wide variety of indigenous and exotic plant species (Department of Town and Country Planning, 2015).

Figure 3. Jogini Waterfall, March 23, 2019 (Packard, 2019)

These sites and others have seen a steady increase in visitors over the years. Originally these sites attracted individuals for religious reasons. Through different forms of promotion and popularity, these sites have a new major group of visitors: adventure

tourists. These sites were originally designed to maintain the waste of a small number of people. With the increase in the number of visitors, the fragile mountain ecosystems at these sites are becoming stressed.

The challenges of trekking waste removal in Himachal Pradesh

Scattered litter along Himachal Pradesh's trails has become a problem partly due to increased tourism, but can also be attributed to the explosion of single-use packaging and snack wrappers from portable foods. These kinds of products are a departure from traditional containers originally carried by pilgrims or shepherd communities. The massive volume of waste can be noted best by some of the ecotourism groups that work to clean it up. The leader of one clean hiking initiative group, the Green Trails Mission, says that consequently, "the villages and the mountains lack a proper waste management system, which has caused open garbage dumping practices within and outside the villages, by both inhabitants and visitors" (Engineer, 2018). Litter continues to pile up each and every day because there is an insufficient waste removal system in the area.

In addition, a consequence of increased tourism on trekking routes in Himachal Pradesh with inadequate bathroom facilities is the presence of human waste along the trails. While there is little information about the extent of human waste accumulation along treks, the assumption is that trekkers will defecate in the open due to the scarcity of bathroom facilities. Trekking routes in India are said to have very low toilet to tourist ratios, meaning there are not enough bathroom facilities for the amount of tourist traffic in the areas. (Mountaineerz Leisure and Adventure, 2019). With the large influx of visitors to trekking trails in Himachal Pradesh and the lack of improvements to waste infrastructure, human waste needs to be addressed to maximize tourist experiences and minimize potential health risks.

Cultural implications of waste management

Historically, the caste system has played a key role in waste management in India, as an entire caste, the Dalit, is seen as responsible for handling all waste (Royte, 2017). In addition, many in the upper classes of Indian society hold a mentality that they have no responsibility for the waste they generate; "anybody who is of a higher caste would find it unthinkable [to] do it themselves" ("An inconvenient truth", 2015, p. 1). This highlights the complexity of delineating cultural boundaries regarding changing waste perceptions and roles. That is not to say that the communities have no motivation for a cleaner India; in fact, many residents and tourists are passionate about the cleanliness of their surrounding environment (Gutin, 2017).

Some Indian activists place precedence on encouraging pride in wanting to help clean the country (Fernandes, 2017). For example, some community members in Karnataka, a state in southwestern India, have set out to convince other villagers to change their mindset concerning waste ("Begging to whistling", 2016). However, the challenges presented may be extremely difficult to overcome. Much like attitudes and behavior around recycling in the United States, actions change slowly and with social pressure from early adopters. It is a difficult task for a set of people to change a cultural practice that they used for so long.

In addition to the caste system playing a role in waste management, the everyday habits of Indian citizens also have an impact. India has emerged as one of the largest global

consumers of pre-packaged snack, ranking as the fourth largest snack market of any country in the world ("Snack Food", n.d.). With such a heavy consumption of pre-packaged goods, the disposal of the packaging becomes a waste management concern, especially on trekking routes with an abundance of small snack shops (Figure 4).

Figure 4. Shop selling pre-packaged snacks at Prashar Lake, March 30, 2019 (Packard, 2019)

To compound this issue, the behavioral practices of many local members of the Indian community makes waste management a challenge. In an article by Evegny Pakhomov of BRICS Business Magazine, waste management traditions in India are described. The article mentions that traditionally waste was thrown outside and left to decompose under the heat of sun. However, in the age of modern packaging, this method of waste disposal is no longer effective. Unfortunately, much of this conventional practice has remained (Pakhomov, n.d.). The increased presence of pre-packaged snacks combined with the traditional waste practices further complicates the waste management challenges on trekking routes.

In sum, there were several important points that guided our work. First, each different trekking site had a unique waste management situation due to the volume of tourists and the current waste infrastructure in that particular area. Another key point was the importance of acknowledging the cultural perceptions of the different stakeholders that contribute to the waste. In order to be successful, the new waste management platform needs to account for these perceptions and work alongside them, rather than to look negatively at them.

Chapter 3: Approach

The goal of this project was to conduct a feasibility study on improving waste management at popular trekking sites in Himachal Pradesh. To achieve this goal, we focused on the following objectives, summarized in Figure 5:

1. Evaluate current waste management systems at trekking sites.
2. Understand perceptions from local residents, tourists, non-government organizations and trekking outfitters.
3. Propose and assess a plan to improve waste management systems at trekking sites.

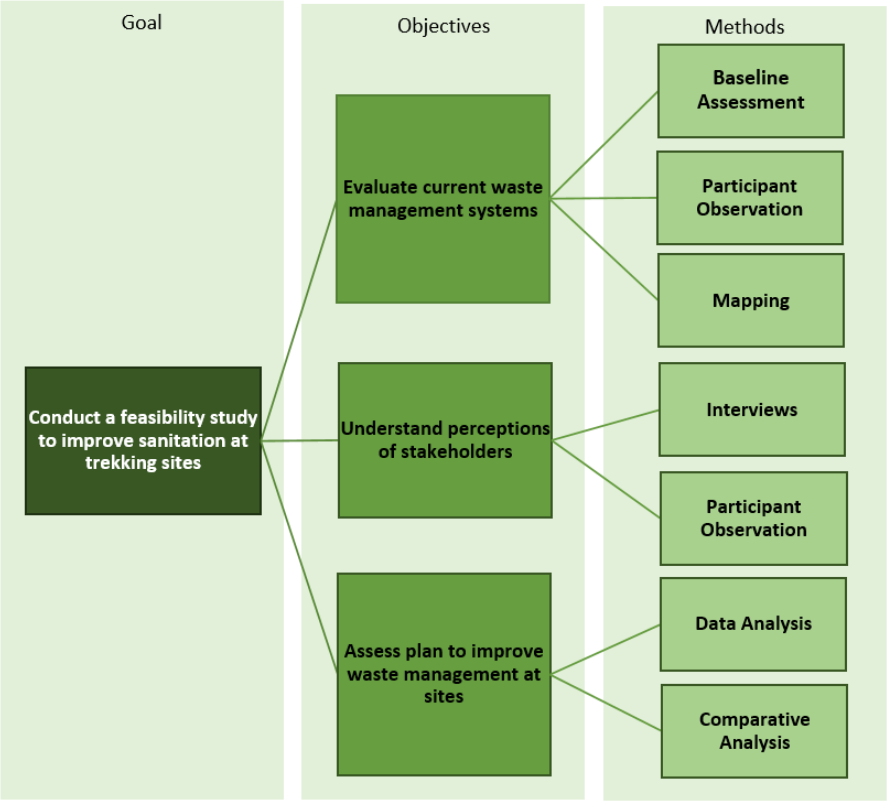

Figure 5. Flowchart of project goal, objectives and associated methods

Evaluate current waste management systems

We first completed baseline assessments, which included trekking on routes in order to observe the current waste management system. Combined with other strategies, "a baseline assessment is a crucial element in formative campaign research and planning, and in any monitoring and evaluation framework" ("What is a baseline assessment", n.d., p. 1).

To better experience waste management challenges, we worked with Healing Himalayas, a volunteer waste cleanup organization, during the Prashar Rishi Lake Cleaning Campaign. We gained knowledge on the amount of different types of waste and assessed the process of waste cleanup. We also evaluated the amount of trash collected versus the amount of available manpower needed.

We also created two different maps for each site. One form of mapping we used for data collection was percent distribution maps. To make these maps, we divided the trail into

equidistant segments and recorded the amount of trash in each section. We segregated the trash into six waste-disposal categories: food wrappers, plastic recyclables, glass bottles, metal cans, paper/cardboard recyclables, and miscellaneous non-recyclable waste. We use this map to determine the waste composition along the trails at each site. In addition, we created heat maps to determine relationships between shops, trash cans and anti-littering signs on waste distribution. To create these maps, we chose a section of the trail that included a variety of waste infrastructure. Then, we put a geotagged pin after every ten pieces of waste observed on the trail. Finally, we divided the section into 50-meter segments and used the geotagged pins to determine the amount of waste on that section. Using this information, the 50-meter sections were color-coded based on the amount of waste within each segment. This information helped us understand waste distribution along the trail.

Understand perceptions from stakeholders

To understand perceptions regarding waste conditions and sanitation management, we interacted with relevant stakeholders: local residents, tourists, non-government organizations and trekking outfitters.

We conducted semi-standardized interviews with the flexibility for the interviewee to direct the conversation towards what they found relevant (Berg, 2007, p. 94). We interviewed from a sample of convenience for an average of 10 individuals per site. Figure 6 shows a typical set-up for our interviews. The interview questions included a mix of yes/no and open-ended questions. These questions were used to understand the waste management opinions and proposed solutions from the interviewees.

Figure 6. Interview with a local vendor at the Jogini Waterfall trek, March 23, 2019 (Dainis, 2019)

At the organizational level, we also conducted interviews with local, privately owned outfitters. Interviews with the outfitters helped us gather information about their personal experiences regarding waste, as well as waste and tourism trends on the trekking routes they supply. Finally, a participant observation in a clean-up campaign at Prashar Lake helped us understand the perceptions of the founder and volunteers of the green initiate NGO, Healing Himalayas.

Propose and assess a plan to improve waste management systems

To create a final recommendation for improving sanitation at trekking sites in Himachal Pradesh, we wanted to generate multiple options. This was done by interpreting relationships and data from the previous two objectives. We linked the quantitative data from the first objective with the qualitative data from the second objective to synthesize common themes. By comparing the variety of data from each site, we were able to better understand the similarities and differences in waste accumulation along each route. Through this, we developed plans that encompassed the broad range of needs for trekking sites in Himachal Pradesh.

Chapter 4: Results and discussion

This chapter presents and evaluates the data and information collected from each objective. After synthesizing the findings across the three objectives, we evaluate the implications and shortcomings of the data in a discussion section.

Evaluation of current waste management systems

After visiting Jogini Waterfalls, Prashar Lake and Triund, we assessed the current waste conditions and available infrastructure. The key findings are shown below in Table 1.

Table 1: Summary of sites visited

Site	**Period of visit**	**Baseline Assessments**
Jogini Waterfalls	March 23, 2019	- Litter concentrated near shopping district - Several anti-littering signs - No visible restroom facilities - One unused waste bin
Prashar lake	March 30, 2019	- 8+ waste and recycling bins - 5 metal waste drums containing burnt waste - Two in-ground waste dumping sites - Multiple seasonal restrooms facilities - Three snack shops at summit
Triund	April 6, 2019	- Multiple shops along trail with waste bins - Trail leading to Gallu Devi Temple more littered than temple area and trail leading to summit - Waste Warriors waste disposal/sorting “center” at Gallu Devi Temple area (see Figure 7). - One restroom at Magic View Cafe with Rs 30 charge

Figure 7. Waste Warrior's waste sorting area, April 6, 2019 (Hanlon, 2019)

During the site visits, we constructed heat maps to evaluate patterns of waste distribution (refer to supplemental materials for heat maps of each site). One main finding from these maps is that trash cans are an effective form of waste management. Within 100 meters of each trash can, the heat maps show below-average waste accumulation. At Triund and Vashisht, there were different anti-littering signs. Some of these signs had confrontational messages such as "In the forests and mountains, animals don't leave trash. Humans do. Behave like animals". After these confrontational signs, however, the waste accumulation was comparable to the average. Finally, about 150 meters beyond a market area, there seems to be an increase in waste present along the trail.

In addition to the heat map, we also created a percent distribution map for each site. Figure 8 shows the distribution of waste at each site. The majority of trash at each site was non-recyclable food wrappers followed by plastics. While the waste composition was very similar between sites, one notable difference was between the waste inside and outside the Prashar Lake summit fencing. Around 80% of the waste inside the fence was food wrappers, while outside the fence had food wrappers at 61%. In addition, there was a significant increase in plastic and glass recyclables outside the fencing.

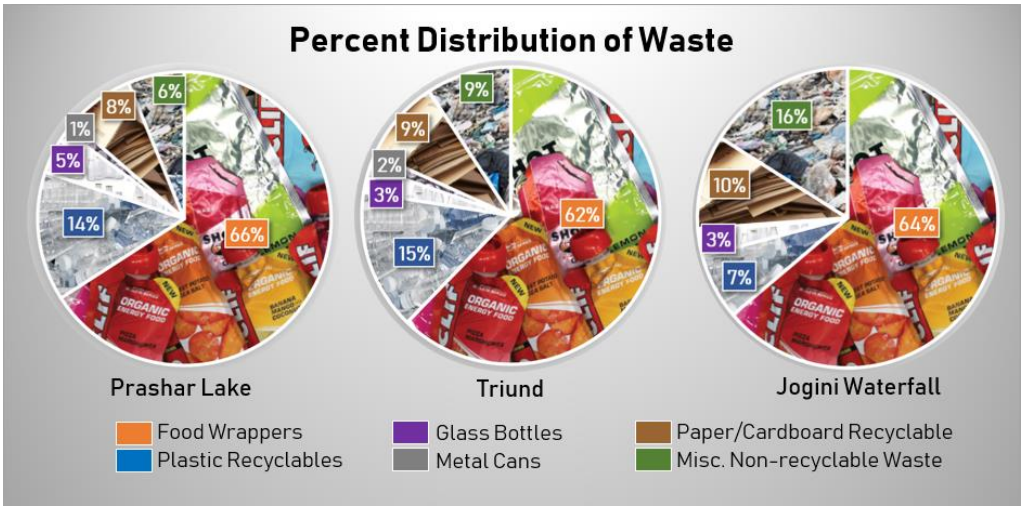

Figure 8. Distribution of waste at Prashar Lake, Triund and Jogini Waterfall

Perceptions of local residents, tourists, NGOs and local trekking outfitters

All three trekking sites have seen an increase in tourism over the recent years. For example, Kishna, a local outfitter for Prashar Lake treks, said that "Prashar Lake never used to be a popular tourist location", but now his business hosts 200-300 trekkers per week, varying seasonally" (Kishna, personal communication translated from Hindi, March 16, 2019). At Triund, a vendor described how the installation of a large cricket field in Dharamshala played a massive role in driving tourists to the area (Personal communication, April 6, 2019).

Based on interviews with trekking outfitters, there is a common opinion regarding the habits of different types of visitors. Overall, the more "serious" trekkers who travel with guides are less likely to litter than casual tourists. According to an interview with Hippie in Hills, an adventure tourism outfitter, 98 percent of their clients who go on multi-day high altitude treks do not litter because they "know the importance of the place" (Figure 9) (A. Kshatriya, personal communication, March 24, 2019). This opinion is supported by Kishna who noted that trekkers who visit on their own, rather than with a tour group, contribute the most towards waste generation - particularly those who visit for religious reasons (Kishna, personal communication, March 16, 2019). In addition, a common finding across many different interviews is that the local and domestic tourists contribute more waste along the routes than international tourists. In fact, a local resident at Vashisht noted that "the increase in tourism is not a threat, but rather the mindset of the Indians who disregard nature" (Personal communication, March 23, 2019).

Figure 9. Team interviewing Hippie in Hills, March 24, 2019 (Dainis, 2019)

From the interviews at the sites, we learned about the behavioral practices of a variety of stakeholder groups. At Prashar Lake, locals mentioned that they make a trip around the fenced-in summit area once a month to collect waste. However, they do not pay much attention to the waste outside of this area. We also observed that at natural resting locations, there was often an accumulation of alcohol bottles. This can be noted by an interview with a vendor at Vashisht, who said that kids often come to the area to party.

Our findings indicate that there are a few primary groups that offer sanitation aid to the sites. While the government does have some involvement in the sanitation at these locations, many people believe that more aid is needed. Respondents have indicated that the government only comes once or twice a year for cleanings at best and often take a while to fulfill requests by the local residents. An individual at Prashar Lake commented that they "demanded for a big dustbin 3 years back to local panchayat (local government at rural level) where the trash could be dumped and later carried by trash carrier trucks, instead of burning and dumping it in a pit. This issue has still not been resolved by the government.

So [they] ultimately need to resort to burning of trash."(D. Kumar, personal communication, March 30, 2019). This can be directly compared to Triund, where a vendor claimed that burning trash is uncommon due to the presence of a municipal dustbin (Personal communication, April 6, 2019). However, despite his claims of no trash burning, we saw another shop owner at Triund using chip bags as kindling for a bonfire. Although many individuals understand the negative connotation behind burning trash, it is still common practice in areas with insufficient waste management systems and few alternative options.

At the local level, trekking outfitters have shown to offer more help to keep trails clean. Since the cleanliness of the trail impacts their business opportunities, outfitters like Kishna and Hippie in Hills both say they pick up and properly dispose of waste found along their routes while trekking. Finally, non-government organizations help clean up the trekking routes through community involvement. NGOs often lead community waste removal treks, like the Prashar Rishi Lake cleanup campaign led by Healing Himalayas (P. Sangwan, personal communication, April 13, 2019). In comparison, the Waste Warriors at Triund will remove a vendor's trash every 7-10 days for a monthly 100 rupee fee. Although there appears to be a common thought across many of the stakeholders that non-government groups are inconsistent in their cleaning, the Waste Warriors organization at Triund has proven that consistent cleanup is possible and beneficial.

A plan to improve waste management systems

While evaluating the data from the previous two objectives, we identified key ideas to improve waste management systems and organized them by theme: education, collaboration, positive reinforcement, and improving facilities.

- Education is one of the most important themes that could be implemented. By educating the youth about proper waste management practices, this will lead to solving the cause of the problem rather than the effect. For example, NGO members could go to schools in Himachal Pradesh to teach children the importance of proper sanitation, and the effects of litter on the environment. This practice would then be passed down from family to family through the years until it becomes a routine in the public mind.
- Collaboration would put less stress on the locals who rely on the trail. Many trekking sites do not receive any help for the maintenance of trash, which is why collaboration is needed. They could build mutually-beneficial relationships with NGOs or government agencies, such as the forest department. While using waste facilities properly is important, it defeats the purpose if these facilities cannot be managed in a responsible manner.
- Positive reinforcement is a useful approach when interacting with visitors at a trekking site. An incentive to carry in and carry out waste would help to promote good habits and keep the area clean. The incentives can be rewards that vary from free tea to entrance fee waiver.
- Updating and adapting facilities at a trekking site could also be useful. This includes adding more educational anti-litter signs, providing more trash bins, and installing more toilets. These facilities do not have to be the same as before. For instance,

composting toilets can be used to promote bathroom usage during the colder seasons.

- Minimizing potential waste attempts to deal with the root issues of waste generation at trekking sites with effects similar to those of education. This specifically calls attention to the different snacks and refreshments that vendors sell which accounts for approximately 80% of trekking waste, as noted in Figure 5.

Discussion

Through our results, we see that the ultimate problem comes down to four categories: education, the practices of the visitors, the practices of the vendors, and lack of outside involvement. Our maps tell an interesting story of how trash is littered along these trails. Much of the data indicates a common behavior from the visitors; they will purchase their snacks, eat them immediately, and then dump the trash as they continue their trek in the opposite direction of the vendor, especially if there is not an available trash bin. In addition, the data from the percent distribution maps indicate that the lack of trash bins is not the only problem - but rather the types of snacks available and the packaging that they are sold in. This shows the need for an innovative solution that can circumvent the snack wrapper and plastic water bottle waste while still providing trekkers with an option for food and water.

We also found that education efforts play a key role in the waste management issues seen. The success of educative solutions would depend on having a reliable set of organizations and participants willing to motivate others to do their part in cleaning these trekking routes. Our findings show that many negative waste management habits are a result of a lack of proper waste education. Our heat maps showed that the confrontational and witty signs seen at Vashisht and Triund, as shown in Figure 10, did not have a significant impact on the waste distribution. However, if the youth of Himachal Pradesh are taught proper waste habits from a young age, then the anti-littering signs would likely be more effective.

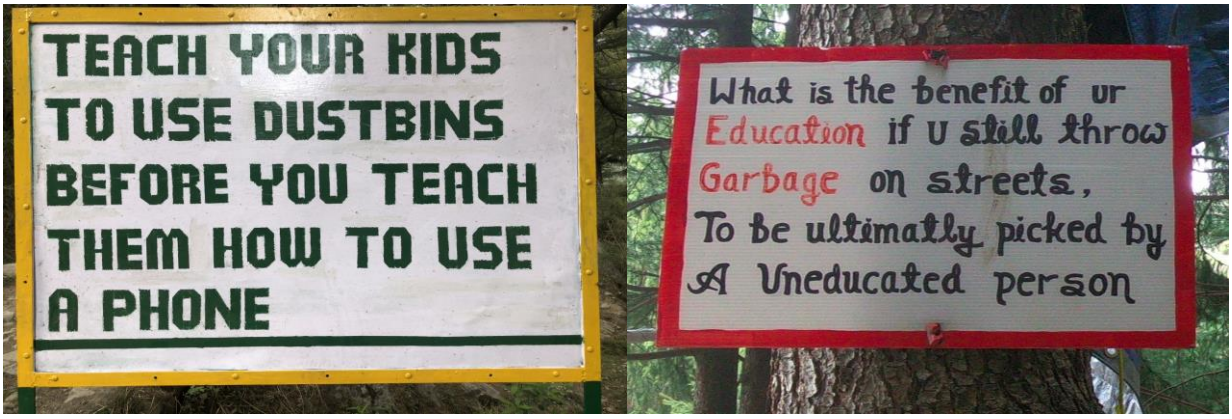

Figure 10. Witty and confrontational signs found at Triund and Vashisht March 23, 2019; April 6, 2019 (Hanlon, 2019; Dainis, 2019)

Our data also highlights a lack of government involvement as a key issue. While we were unable to interview any government agencies due to their busy election schedules, many stakeholders faced issues which could be directly attributed to the level of government involvement. The locals' dissatisfaction with government involvement emphasized the need for a working partnership between local communities and other outside agencies.

Despite the conclusions we were able to draw from the data collected, our study was limited by a few factors, such as access to the sites and interviewee bias. Weather-related concerns such as snow and rain made it difficult to visit many sites. In terms of data collection, our maps were limited in that the entire trail could not be mapped due to weather and time constraints. Also, bias could have played a role in some of the information we received, as some stakeholders, such as trekking outfitters, could have framed their actions in a more positive light. Reliability of personal accounts was called into question when we heard contradicting information from interviewees.

Chapter 5: Project outcome

After examining our findings, we came to the conclusion that in order to improve waste management at trekking sites, there needs to be a balance between short term and long term solutions. Some of the solutions involve infrastructure changes, while other can be imbedded in the trekking culture and promoted by vendors and outfitters (see Figure 11).

Figure 11. Short-term recommendation schematic

In terms of infrastructure solutions, many of our recommendations are site-specific. The most obvious recommendation is to provide more waste bins and restrooms along the trails at distances that are necessary and manageable - but also not distracting from the environment. The waste bins and restrooms could be provided by NGOs, or be built by the community. At Triund, the current placement and number of waste bins is sufficient, however access to restrooms can be greatly improved. Dry toilets made of brick could be installed at trekking sites. Brick is widely available in Himachal Pradesh and these toilets can be used year-round. The waste from these toilets could then be composted.

For the sites with fewer resources than Triund, amended signage could be installed that indicates the distances between waste management facilities. Similarly, existing signs could provide instructions or even materials needed for packing in and out waste - both litter and human-related. In all cases, vendors, outfitters and guides could verbally inform trekkers about the importance of carrying out waste and try to enforce this practice through education and incentives. Examples of such incentives for trekkers who carry out their bag of waste could be a complimentary cup of tea. Another form of incentive could be to charge

trekkers a small entrance fee (Rs 10 to 20), which would act as a deposit that trekkers would get back provided they carry out waste.

A more complex fee-oriented incentive is to encourage a partnership between NGOs and vendors that rely on the trekking sites for their business. Similar to Waste Warriors at Triund, sites like Prashar Lake and Jogini Waterfall could adopt a relationship with other NGOs or even governmental agencies. In this scenario, the vendors could pool a small weekly or monthly fee in return for waste removal services from these organizations. Eventually, the organizations will be able to team up with the communities in an effort to keep the trails clean in the long-term.

Another unique opportunity for a community collaboration is between NGOs and the Bharat Scouts and Guides organization. Similar to the Boy Scouts of America, this organization looks to introduce children to different aspects of nature through activities like camping and trekking. One main focus of the group is to "understand the need of conserving nature/environment and public properties" (The Bharat Scouts and Guides, 2018). By promoting interaction between NGOs and scouts, the youth could gain a passion of keeping trails clean. These scouts could be given the foundation to become the environmental activists or NGO founders of the future generations.

To mitigate the littering problem at the root cause, snack vendors could look into providing traditional snacks in place of pre-packaged snacks. Instead of selling potato chips, the vendors could sell fruit, vegetables or locally-made food like roti, samosas, pakora or siddu. These snacks have less of an environmental footprint, but are still easy to eat and transport. The trekkers could carry these snacks along the trek in newspaper bags provided by the vendors. Unlike plastic food wrappers, the newspaper bags are both biodegradable and safely burnable.

Likewise, the vendors could sell filtered water rather than bottled water. There are several small, non-electric water filtering tanks that could be easily used at hard-to-reach shops. The vendors would only need to find a nearby water source, then they could fill the tank and charge trekkers a small amount to fill their reusable water bottles. If the trekkers do not bring reusable water bottles, the vendors could have metal cups available for use or sell relatively cheap metal bottles.

Vendors who sell fruit, vegetables and other biodegradable snacks could manage this waste by composting. Additionally, waste from the aforementioned dry toilets could be added to the compost. Although composting is a hard-to-sell and long-term practice for many vendors, it has an added benefit for them: they could utilize the compost to grow a small garden. Vendors could sell the fruits and vegetables from this garden, or use them for their own consumption. In an ideal scenario, the vendor's business becomes a self-sustaining cycle: the food the vendor sells turns into composting material, which is ultimately used to generate better soil to grow more fruits and vegetables.

Chapter 6: Conclusion

Our research and data show that the current sanitation systems at trekking sites in Himachal Pradesh are insufficient to support the increasing number of visitors. This leads to problems such as health issues, harm to aesthetic appeal, and degradation of the ecosystem. We documented different patterns and relationships between trash and waste facilities along our three main sites using maps. We gained understanding of stakeholder opinions and experiences through interviews. Lastly, we actively experienced Himachal's trekking waste management by volunteering with an NGO for a clean-up campaign. We then analyzed all of this information, leading to our final recommendation. Through this plan, these mountainous trekking sites in Himachal Pradesh could be both self-sustaining and eco-friendly.

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Supplemental Materials: Methodology

Sample interview questions for stakeholders

[Interview with tourist on-site -- domestic or foreign]

Q: Where are you from?

Q: Why are you visiting this site?

Q: Have you previously visited this site?

Q: Have you visited other trekking sites?

Q: How does your experience at this site compare with your experience at other trekking sites?

Q: Would you return to this site?

Q: Was your experience hindered by the presence of waste?

Q: Do you think this site is well maintained?

Q: Were you aware of any litter, or other waste that stood out to you while trekking?

Q: Have you ever worried about access to restroom facilities while trekking?

Q: How often do you need to use a restroom or washroom facility while trekking?

Q: What improvements can be made to make this trekking site better?

[Interview with volunteer from a waste cleanup organization]

Q: How long have you been volunteering for your organization?

Q: Why did you start volunteering?

Q: What improvements to waste management do you think can be made to the trekking site?

Q: Do you think this site is well maintained? [if interviewing *at* a particular site]

Q: Where do you dump the waste you collect?

Q: What kind of aid would be helpful to improve the current sanitation system?

[Interview with local resident]

Q: How long have you lived here?

Q: Have you noticed any changes in the amount of people who visit this area?

Follow up: Has this change impacted you in any way?

Q: Have you ever visited [insert trekking site name]?

Q: Have you noticed any changes over the years to the trekking site?

Follow up: What has changed?

Q: Which season do the trekkers visit the most?

[Interview with trekking outfitter]

Q: How long have you been working at this site?

Q: How many trekkers visit this site per day?

Q: Which season do the trekkers visit the most?

Follow up: How do you manage the waste and other problems created during those times?

Follow up: Are the locals and trekkers cooperative with your request to pack out trash?

Q: How many changes have you seen to the trekking site over the years?

Q: How many restrooms or washroom facilities are available in this area?

Q: What kind of aid would be helpful to improve the current sanitation system?

Q: Are there any volunteers or PWD cleaners?

Q: How often do NGOs, the forest department or other organizations visit this site?

Q: What role do NGOs or the government play in regulating or developing this site?

Waste data tracking sheet for percent distribution maps

Table 2: Waste data tracking sheet

Location and Site Number:	
Waste Type:	**Amount:**
Food wrappers	
Plastic recyclables	
Glass bottles	
Metal Cans	
Paper/cardboard recyclable	
Misc. non-recyclable waste	

Supplemental Materials: Project Outcome

Project Presentation Poster

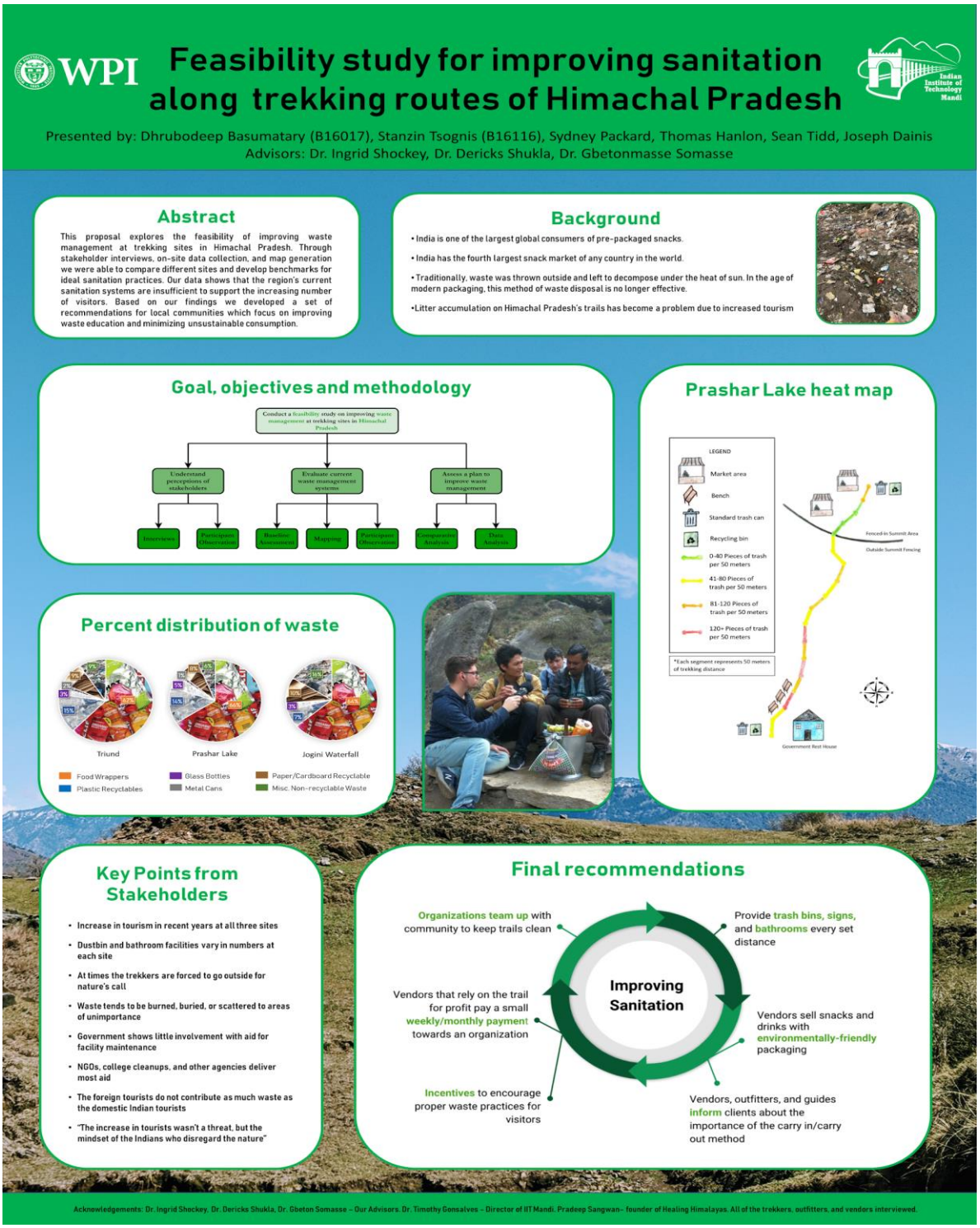

Figure 12. Project presentation poster

Supplemental Materials: Heat Maps

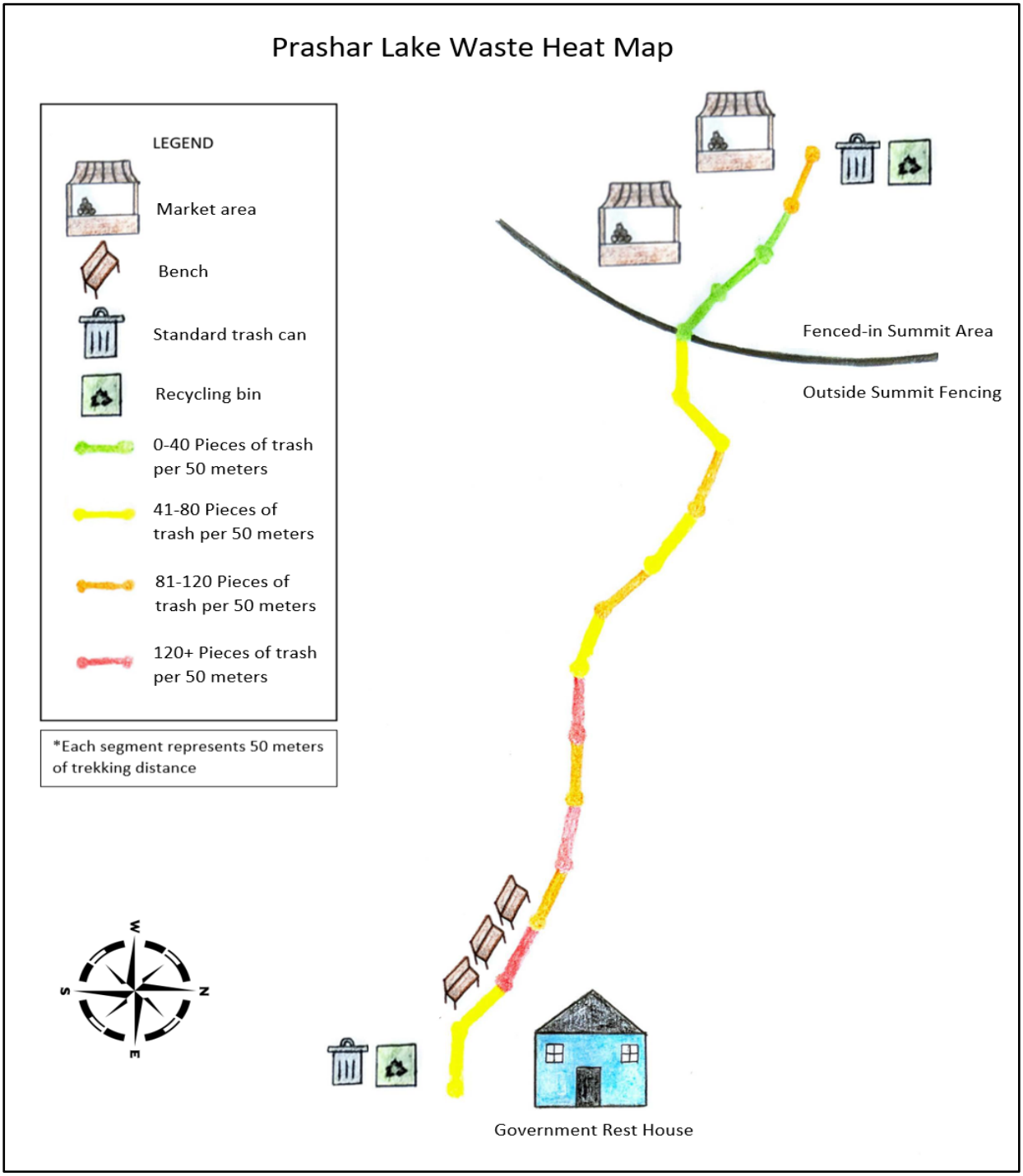

Figure 13. Prashar Lake waste heat map

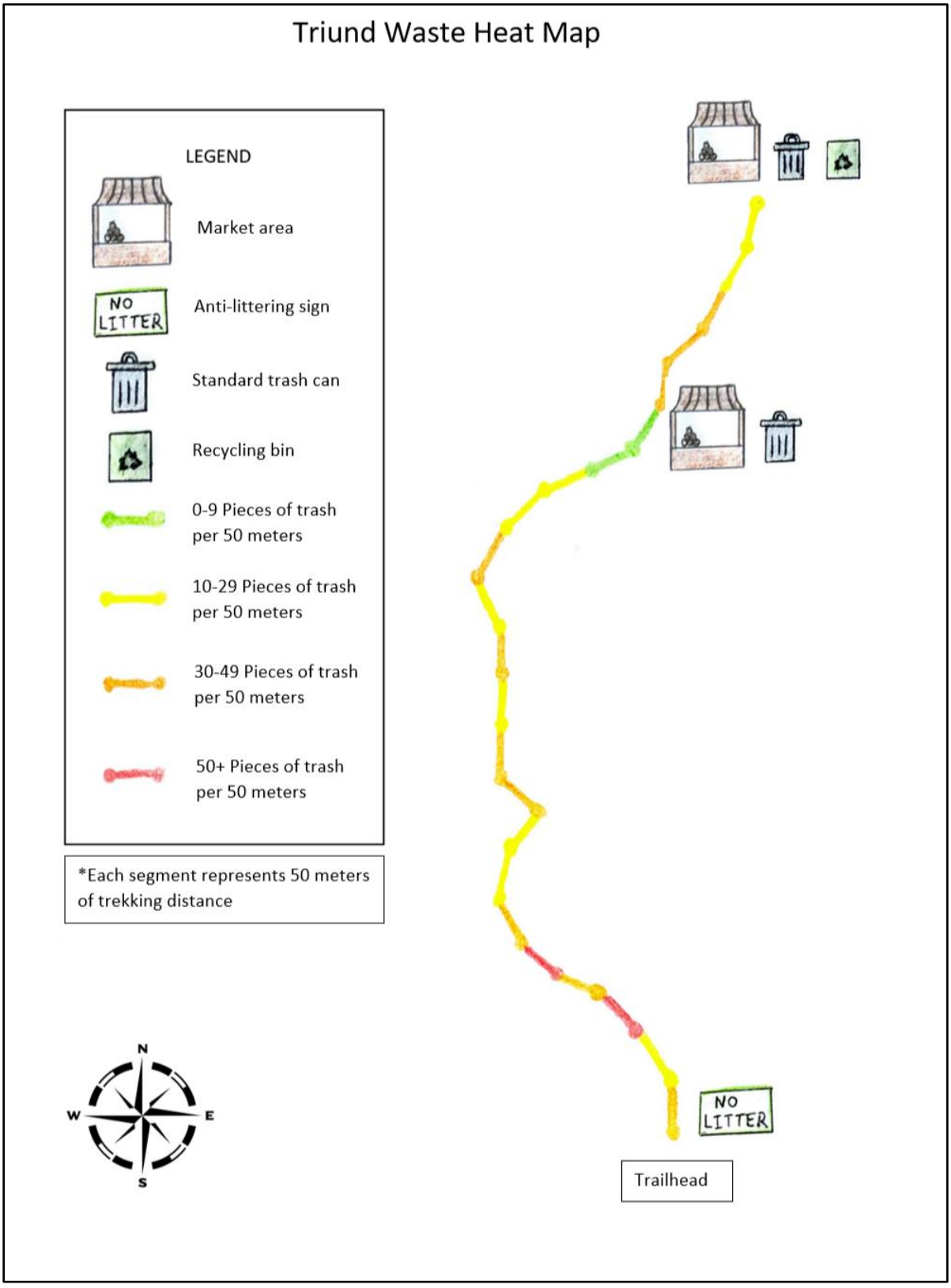

Figure 14. Triund waste heat map.

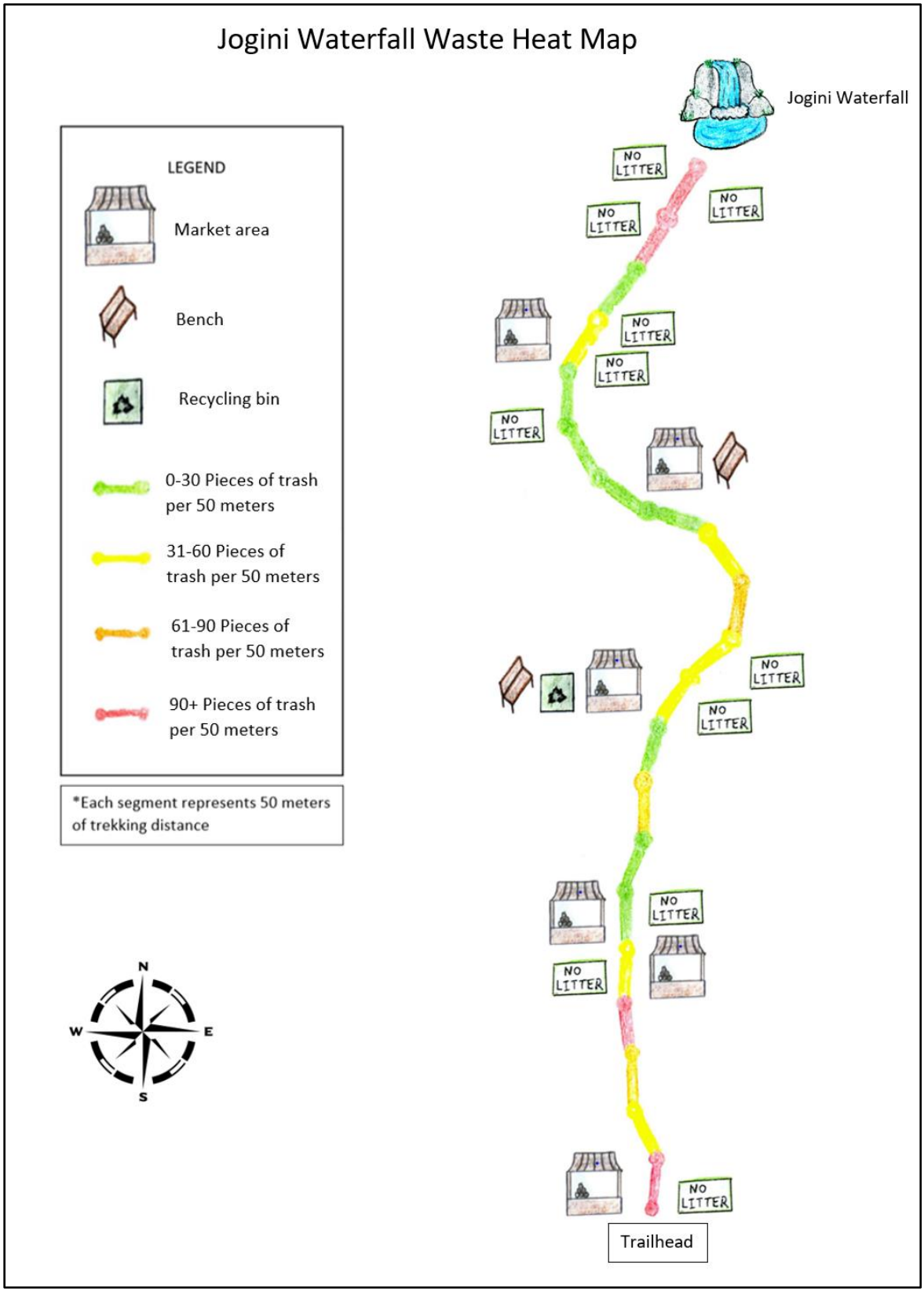

Figure 15. Jogini Waterfall waste heat map.