Fragile Equilibrium:

Environmental Change and Cultural Resilience in the Himalayas

by

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A thesis submitted to the Faculty of Graduate and Postdoctoral Affairs in
partial fulfillment of the requirements for the degree of

Master of Architecture

M.Arch (Professional)

Carleton University

Ottawa, Ontario

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ABSTRACT

This project proposes a series of large-scale phased interventions to help sustain, delay, or distribute water resources in the Himalayas. It is an imagined application of an already tested water storage method, the Ice Stupa. This engineered method of building ice and storing water might be applied as a calculated planning strategy to aid Tibetan communities in their struggles with flooding and drought. In addition, a sited consideration of these stupas might offer additional programmatic functions related to tourism, animal husbandry, and agriculture, the primary economic supports for the villages studied.

Although there is a sense of inevitability about the environmental challenges and changes that Tibetan settlements are facing, it is worthwhile to use an architectural approach to imagine technical interventions, which might also promote cultural preservation and semi-nomadic traditions. Tibetan towns and villages, such as Komik and Burang Town, are located at the source of Asia's major rivers (Indus, Sutlej, Ganges, Yarlung Tsangpo), and are at the nexus of global geopolitical frictions. The environment here is extremely dynamic, moving according to the cyclical growth and melting of the glaciers, a pattern that is becoming

less stable with shifts to global climate. As these giant freshwater cisterns melt, strategic water management will become the foundation of resilience. Architecture is often seen as foreign to such dynamic endeavors. This thesis proposes that design may have a critical role to play in this environment of fragility and severity.

ACKNOWLEDGEMENTS

To my advisor Catherine Bonier, for the irreplaceable advice, direction, wisdom, and always being there through this journey.

To my brothers, for putting up with my garbage and keeping my feet on the ground.

To my buddies since day one, matt, brennan, and jared, who when I said I am doing a thesis responded with “what is that? You gotta fight a minotaur or something?”.

To Krish, for sharing this chapter with me, can’t wait for the rest of them.

Lastly, to my mom and dad for their constant love and support through my entire education and life, always pushing me in the right direction, I owe it all to you guys, thanks eh.

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INTRODUCTION

Glaciers all over the world, from Western Canada to Eastern China, are melting at an alarming rate causing serious concerns and threats to existing ways of life. Discussion and concerns in the western world gravitate around the topic of the potential flooding of many coastal mega cities due to their low lying elevations, such as Miami or New York City in the United States of America.¹

Designers, whether architects, landscape architects, or urban planners, are often focused on solving the issue of flooding and land-loss in these coastal mega cities. The question of what will happen to the inverse settlements, such as small alpine communities at the waters glacial origins gains less consideration. If Miami and other sea-level cities, for example, are concerned with an increase in water resulting in flooding, we can infer that elsewhere there are scientists and settlements concerned with loss of water resulting in drought.

This issue of water security in Himalayan Mountain communities will become, and for many settlements currently is, a severe threat to their existence. Tens of millions of people in hundreds of mountain

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¹ Oliver Millman. "The US cities at risk of flooding - and how they deal with it." *The Guardian: Environment* (Aug.31, 2017), url:<https://www.theguardian.com/environment/2017/aug/31/us-risk-flooding-harvey-boston-new-york-miami-beach>.

communities crossing six countries and territories directly rely on the fresh water provided by the *glaciers* in the Himalayan Mountains to supply their communities with water. Without the *glaciers*, these settlements in the world's water shelf, Tibet, must either find a solution or simply leave their homes and everything they've known for generations.² The thesis will investigate the situation and offer architecture as the bones for a potential solution that can be integrated with life in the region. Not dictating the result or narrative of the inhabitants, but constructing a foundation which the people of the region can narrate their own life from.

Figure 3 Kumik and the remaining slivers of its glaciers. (Photo: <https://www.villagestudies.org/vanishing-ice/>.)

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² Brook Larmer. "The Big Melt" *National Geographic Magazine* (April, 2010), url: <http://ngm.nationalgeographic.com/print/2010/04/tibetan-plateau/larmer-text>.

ORIGIN OF RIVERS

Ch.1

The Himalayas is a topographically and ecologically diverse region and is the origin for almost all the major rivers in Asia. In this vast mountainous region totaling 230,000 square miles, almost all settlements rely solely on agriculture, and therefore, water is of utmost importance.³ Looking at Tibet, eight out of ten Tibetans are farmers, meaning around 2.5 million out of 3.2 million individuals rely on these fragile landscapes for sustenance and occupation.⁴ Chapter two starts to look at the context of Tibet and the Himalayas. The project gains insight into the life and ecology of the region through a series of mappings of human, ecological, meteorological, and infrastructural activities and systems. The chapter continues with an in-depth study of *glaciers*, their processes, and how they function through a diagrammatic exploration from general glacial cycles to more specific details.

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³ Global Forest Atlas, "The Himalayan Forest", *Yale School of Forest and Environmental Studies*.
<https://globalforestatlas.yale.edu/tropical-zone/himalayan-forest>

⁴ Jeffrey Hays, "Agriculture in Tibet," *Facts and Details*, 2008,
<http://factsanddetails.com/china/cat6/sub37/item1693.html>.

MAPPING THE HIMALAYAS

The Western region of Tibet, as shown in the following maps, is a region of semi-arid landscapes, resulting in a lifestyle of nomadic agricultural methods with constantly shifting grazing lands. Due to the high density of *glaciers* along the high alpine region, seen in the *glacier* density map, the settlements are of such high and rocky elevation that grazing lands are sparse and far between. The agriculture map also attests to the nomadic method of the west, resulting in dependence on the landscape as a whole, rather than simply a reliance on one specific area.⁵ The population map is a testament to these facts. Settlements are sparse and few, because the sensitive landscape does not allow an intensity of agriculture or occupation. However, these communities have evolved in balance with this challenging environment, through considerable skill and perseverance.

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⁵ Food and Agriculture Organization of the United Nations. "China case study 3: Pastoral systems, change and the future of the grazing lands in Tibet," *Transhumant grazing systems in temperate Asia: Chapter VIII*, url:<http://www.fao.org/docrep/006/y4856e/y4856e0d.htm>.

Figure 4 Tibet Region Map

TIBET AUTONOMOUS REGION

SETTLEMENT   AGRICULTURE   TRANSPORTATION   CLIMATE   TRADE   LAND-MORPHOLOGY

Figure 5 Tibet Climate Zone Map.

Figure 6 Tibet Glacial Density Map.

TIBET AUTONOMOUS REGION

SETTLEMENT   AGRICULTURE   TRANSPORTATION   CLIMATE   TRADE   LAND-MORPHOLOGY

Figure 7 Tibet Agriculture Map.

Figure 8 Tibet Settlement and Town Map

THE HEADWATERS

Due to the Western region's density of *glaciers*, which contain and store immense amounts of fresh water, the area is home to the headwaters of a series of complex river systems. The region is at the origin of seven major rivers that feed Asia.⁶ As seen in the maps in the upcoming pages, the Western region is the source of critical river systems with a relatively small distance between each other's origin points. Meaning the mountain communities and settlements in the Western region operate at the origin of around half of Southern Asia's major rivers.

The seven major rivers fed by the western region are the Sutlej, Indus, Yarlung Tsangpo, Ganges, Karnali, Brahmaputra, and Arunachal. These rivers are the waters that also feed Pakistan (population of 199 million), India (population of 1.3 billion), Nepal (population of 28 million), Bhutan (population of 798 thousand), and Bangladesh (population of 163 million).⁷ Therefore, these seven glacial fed rivers supply water to roughly 2.46 billion people on top of Tibet, with the average person consuming

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⁶ World Atlas, "Rivers of Asia - Map & Details," *World Atlas*, <https://www.worldatlas.com/webimage/countrys/aslandrivers.htm>.

⁷ Worldometer 2018, "Asian Countries by population (2018)," *Worldometer 2018*, 2018, <http://www.worldometers.info/population/countries-in-asia-by-population/>.

roughly 150 litres of water a day, making up about 32% of the world's population.⁸

Figure 9 Asia's Major Rivers

⁸ Hague Center for Strategic Studies, "Water on the Tibetan Plateau" *Hague Center for Strategic Studies*, June 5, 2009, https://hcss.nl/sites/default/files/files/reports/Water_on_the_Tibetan_Plateau_Ecological_and_Strategic_Implications_for_the_Region_-_030909.pdf

Figure 10 Major Rivers & Himalayan Border

Figure 11 Major Rivers & Countries

Figure 12 Major Rivers & Tibet Border

CHANGING GLACIAL CYCLES

Because these *glaciers* are the source of water for so much of the world's population, understanding how the *glaciers* operate and change over time is paramount to territorial planning for future resilience. By having a graphic understanding of how these massive ever-shifting landscapes of ice operate, this thesis intends to explore more deeply the circumstances fueling the dilemma. This is an effort to understand the ways in which culture and settlement are interwoven with this icy landscape, and how patterns of life have been shaped by living in close proximity with these large masses. Through diagramming the glacial processes, the thesis begins to explain the processes that must underlie the designed project. Glacial processes and structures such as *input/output*⁹, *moraines*¹⁰, *melt water streams*¹¹, and *mass/balance ratios*¹² will need to be understood to make a reasonable and sympathetic proposal as the thesis progresses. The diagrammatic perspective and set of detail drawings on the following page displays the technical research.

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⁹ Mueller, Derek. Brett Shaw. Consultation on Glacial Geology and Cryosphere Environmental Functions. Carleton University, *Geography and Environmental Studies Department*, Nov. 14, 2017.

¹⁰ Ibid.

¹¹ Ibid.

¹² Ibid.

Figure 13 Glacial Mountain Conditions Diagram.

Figure 14 Glacial Condition Detail Diagrams

MODELS OF FRAGILITY

Ch.2

In order to understand the crisis in the Himalayas, this chapter examines the ways in which the landscape and environment have shaped different types of settlements in the region. Section diagrams were developed to create an analysis of several types of settlements, and to demonstrate the different changes predicted for each in the face of climate change. Through a series of illustrations reflecting each scenario, it begins to create a clear outline of the problem in an animated and experiential way. Chapter two continues with experimental conceptual landscape modeling through different mediums to understand and to test the true fragility of the dynamic environmental context where these mountain communities are situated. By exploring the landscape in the digital realm and creating physical models, the uncertainty of the landscape is conveyed and imagined, providing cues for design.

THREE MODELS OF CRISIS

Figure 15 Low Elevation Settlement

The first type of settlement is a lower elevation settlement. In most lower elevation settlements water is abundant, but the more rapid melting of the *glaciers* in these warmer regions is resulting in large scale repetitive seasonal floods that destroy villages and often necessitate resettlement. *Glacial lakes* in the alpine that hold water above these settlements are capsizing. Re-building is an option, but due to the repetitive nature of

these disasters, there is a limit to the feasibility of this strategy. In the end, the villagers are often forced to relocate and leave their homes.¹³

Figure 16 High Elevation Settlement

The second type of settlement [figure 16] is a high elevation settlement. While flooding does occur from *glacier* melting, the floods are often too small to cause serious damage to the settlements and the villages are therefore able to endure. However, since there are fewer frozen reservoirs above these elevated areas, once the *glaciers* that

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¹³ Maharaj K. Pandit and Kamal Bawa, *Life in the Himalaya: An Ecosystem at Risk* (Boston: Harvard University Press, 2017), 228.

provide their water source completely melt, these settlements are plagued by permanent drought. With their water source permanently removed, the entire communities are forced to relocate and leave their homes.¹⁴

Figure 17 Flourishing Settlement

The third type of settlement is a flourishing settlement, adjacent to a sustainable and plentiful water source such as a large *glacial lake*. While life here might be fully independent and sustainable for the near future, water demands from large cities nearby has in several cases resulted in

¹⁴ Daniel Grossman, "As Himalayan Glaciers Melt, Two Towns Face the Fallout," *Yale School of Forestry & Environmental Studies* (March 24, 2015), url: http://e360.yale.edu/features/as_himalayan_glaciers_melt_two_towns_face_the_fallout.

the government damming rivers that feed the village's water supply. This most typically is conducted by the Chinese government as part of other large-scale planning initiatives, which relocate and rehouse residents to shift resource use to support intensified urban development. In this situation the glacial fresh water supply does not prevent the adjacent village from facing the same fate as the previous two settlements. In the end, again, the communities who depend on this stable water source are forced to relocate and leave their homes.¹⁵

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¹⁵ Press Trust of India. "China for more dams on Tibetan rivers instead of Brahmaputra." *The Hindu Business Line: China News*(Nov.23, 2017), url: <http://www.thehindubusinessline.com/news/world/china-for-more-dams-on-tibetan-rivers-instead-of-brahmaputra/article9970509.ece>.

MODELING: DIGITAL FRAGILITY

Figure 18 Digital Fragility Surface Modeling Experimentation

After studying several types of glacial landscapes in section, conceptual exploration began to mobilize this understanding. The above digital surface modeling exploration drapes a Himalayan glacial landscape based on known topographical data with a single digital surface. The region draped with a digital surface is full of *glacial lakes*. Due to their unknown depth, it is impossible for an observer to look at the existing landscape, either physically or through data analysis, and predict the underwater surface. Therefore, the digital surface exploration aims to find the truthful landscape surface hidden beneath the ice and water to

understand the severity of the vertically diverse four square km selected landscape clipping. In the process of the digital exploration, the surface was derived from a curve which interpolated between areas of known depth and slope to estimate the deepest regions of the *glacial lakes* in the alpine. This process produces the elongated blue stretching members apart of the surface that are visible in the drawing. These elongated members of the surface convey the estimated true depth, therefore, constructing a clear, if imaginary, visualization of the vertically radical landscape in the region.

This exercise was a method of portraying the reality of how fragile the environment in the Himalayan Mountains can be, by removing all depth and uncertainty in the environment, projecting an imaginary surface to attempt to locate true depth. The diversity and uncertainty of the environment is echoed through the three transects in the experimental drawing. The three landscape cuts faded in the drawing are section cuts of the mountainous Tibetan plateau. The transect lengths, from top to bottom, are 100km, 50km, and 25km. The transects display the vertical diversity of the environment. It is hard to comprehend how a region's landscape could cross seven different climate zones, four different agricultural production systems, and about every method of mineral and

resource extraction possible, but the exploration provides evidence to this point.¹⁶

The Himalayan landscape is horizontally vast and varied, but it is also incredibly unpredictable vertically and therefore diverse on both axes. The conceptual experimentation above all else gives tangible thought and identifies a mindset to the designer wishing to propose a solution in the dynamic landscape. The exploration brings to light the challenges posed by an environment of such severe realities, with radical differences between sites and contexts that could be located simply four or five km away from each other. While the digital experimentation provides a three-dimensional paper space medium to help in understanding the conceptual landscape, it is not bound by limits. Therefore, the next phase was to physically model the concept of fragility and engage with tangible parameters.

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¹⁶ Food and Agriculture Organization of the United Nations. "China case study 3: Pastoral systems, change and the future of the grazing lands in Tibet," *Transhumant grazing systems in temperate Asia: Chapter VIII*, url: <http://www.fao.org/docrep/006/y4856e/y4856e0d.htm>.

MODELING: TANGIBLE FRAGILITY

Figure 19 Physical Fragility Surface Modeling Experimentation

The physical model begins to tangibly manifest the fragile environment. The model exploration uses craft paper for the surface with a scored tessellated pattern to make a flexible landscape that is dynamic. Through this method the model becomes reactive, and when one part of the model is applied pressure, the entire model shifts to accommodate the weight of the object occupying space. The majority of Tibetans, around eight out of ten, are farmers and therefore, in the production of or practice

subsistence agriculture.¹⁷ Meaning there is a deeply rooted relationship between Tibetans and livestock. This relationship is dominantly portrayed by their relationships with yaks. Yaks have a special place in Tibetan culture, being used for thousands of years for their milk, meat, fiber, beasts of burden, and dropping as fuel and material for various purposes.¹⁸

The critical component for the modeling exploration is that yaks carry all of the Tibetans goods across the plateau when nomadically grazing, resulting in yaks becoming the key of grassland management in this fragile environment by being the consumer and form of transportation.¹⁹ If a farmer can manage the grazing yak herd successfully through their nomadic grazing methods across the plateau, always on the move, then the fragile environment can be sustained.²⁰ Therefore, as the Tibetan livelihood of carefully not overgrazing pastures with nomadic yak herds is their dominant way of life, the yak became the object of pressure in the model.

All the small paper yaks in the physical model apply point loads on the flexible craft paper landscape. When placing the yaks on the

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¹⁷ Jeffrey Hays, "Agriculture in Tibet," *Facts and Details*, 2008, <http://factsanddetails.com/china/cat6/sub37/item1693.html>.

¹⁸ Sonam Tenphel, "The Significance of Yaks for Tibetan People". *Tibet Vista*, 2017, url: <https://www.tibettravel.org/tibet-travel-guide/significance-of-yaks.html>

¹⁹ Ibid.

²⁰ Jeffrey Hays, "Agriculture in Tibet," *Facts and Details*, 2008, <http://factsanddetails.com/china/cat6/sub37/item1693.html>.

landscape it affects the entire flexible surface, forcing the model maker placing the yaks on particular grazing sites to be very careful and strategic concerning the number and location of the placement. Although a simple analog experiment, it becomes a strong reflection and comparison to the reality of agricultural existence in the Tibetan environment. The careful and strategic nature of placing objects of inherent pressure and weight on a surface that is conceptually fragile, the surface representing the Tibetan ecology, is manifested through the physical model. This is infinitely more complex in reality, since the Yaks and human populations are in motion, and the depth of the surface is constantly in flux.

Figure 20 Big, furry climate change contributor (Photo: Frederic J. Brown.)

SITE INQUIRIES

Ch.3

After gaining a thorough understanding of the region and landscape, two potential sites were selected. The sites were chosen based on current glacial loss projections, scale of settlement, location at the origin of Asia's Major rivers, and elevation within the Western Himalayan region. The two sites are Burang Town, Tibet, and Komik, India (40km from Tibet's border). Burang Town is located at the heart for five of the major river origin points including the Sutlej, Indus, Karnall, Ganges, and Yarlung Tsangpo. While Komik Village is centered downstream between the Sutlej and the Indus. The sites represent two of the three previously illustrated models of crisis, a lower elevation settlement and high elevation settlement. Burang Town is a site situated at a lower elevation, while Komik Village is a settlement situated at a high elevation. Burang Town is a fairly large town of around 7,000 - 9,000 inhabitants, thus, an intervention or implementation would be at a regional and local scale.²¹ On the other scale, Komik is a small village of around 130

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²¹ John Snelling, *The Sacred Mountain: The Complete Guide to Tibet's Mount Kailas*. (United Kingdom: East-West Publications, 1990), 74.

inhabitants, therefore any intervention would occur between the local and residential scale.²²

The different scales of the settlements allow the testing of designs that might be applied for each category of concern, whether a low elevation settlement (Burang Town), or a high elevation settlement (Komik). Designing for both scale and settlement typologies provides two cases through which to derive future options for towns facing the same fate of either circumstance. The site plan with the settlements outlined on the following page displays their specific locations in context with the Western Region's major river origin points.

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²² Census 2011, "Komik Population – Lahul and Spiti, Himachal Pradesh," *Population Census 2011*, 2011, <https://www.census2011.co.in/data/village/12501-komik-himachal-pradesh.html>

Figure 21 Site Locations: Burang Town & Komik

NOMADS, AGRICULTURE, PILGRIMAGE AND PRACTICE

Two important practices and two significant architectural symbols of Tibetan culture underlie the design of the thesis interventions. The first is the Tibetan lifestyle of nomadic agriculture. The two sites selected in the Western Himalayan region are settlements reliant on nomadic agriculture.²³ Tibetans have engaged with the nomadic way of life for thousands of years. During the winter the community stays in their static settlement within the plateau. But once the snow melts the nomad farmers are constantly on the move, from spring to fall, travelling throughout the Tibetan plateau searching for grazing lands with livestock herds including yaks, sheep, and various types of cows.²⁴

While this lifestyle is endangered by government threats of relocation, and also at risk due to loss of grazing lands and water, securing their historic nomadic lifestyle has become a movement in itself.²⁵ The nomadic grazing lifestyle means the Tibetan farmers are in rhythm with the landscape and reliant on the environmental constants of patterns, cycles, and seasonal changes. If mobility is key to the nomadic

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²³ Food and Agriculture Organization of the United Nations. "China case study 3: Pastoral systems, change and the future of the grazing lands in Tibet," *Transhumant grazing systems in temperate Asia: Chapter VIII*, url: <http://www.fao.org/docrep/006/y4856e/y4856e0d.htm>.

²⁴ Daniel J. Miller, "The World of Tibetan Nomads", *Vajra Publication*, 2007, <https://case.edu/affil/tibet/documents/TheWorldofTibetanNomadsSept14.pdf>

²⁵ Tibet's History and Culture. "Tibet's History", *Free Tibet*, url: <https://freetibet.org/about/history-religion-culture>.

way of life, being in a relocated static settlement, usually rehoused in apartment complexes without access to land not only destroys the traditional Tibetan agricultural means, but also their way of life.²⁶

Figure 22 Tibetan Nomads (Photo: <http://factsanddetails.com/china/cat6/sub35/item209.html>)

Figure 23 Tibetan Nomad Adventure (Photo: https://snowliontours.com/custom_trips/nomad_Adventure)

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²⁶ Human Rights Watch. "China: End Involuntary Re-housing , Relocation of Tibetans", *Human Rights Watch*, url: <https://www.hrw.org/news/2013/06/27/china-end-involuntary-rehousing-relocation-tibetans>.

The other critical practice of Tibetan culture that influences the design and location of potential interventions is the strong pilgrimage and ritual Buddhist culture. Tibetan pilgrimage is a strenuous process as they walk through extremely harsh conditions for miles at a time through the vertical landscape to reach sacred, usually mountainous, sites and lakes.²⁷ There are many sacred sites, and many within the western region near Burang Town and Komik Village. Due to the nature of the sacred pilgrimage to Mount Kailash, these settlements at times become gateways for the pilgrimage to the sacred site. This is a critical point because in the present day not only traditional Tibetans are making these pilgrimages, but large volumes of tourists are as well.²⁸ In 2013, for example, 15 million tourists visited Tibet, with the peak season during the summer between June and September. The large amount of tourist are greatly increasing every year and are not predicted to slow down but grow.²⁹ This means these communities have the potential to become symbols to promote the preservation of Tibetan practices through global exposure while, more importantly, creating new sites for the Tibetans to engage with on a spiritual level before, during, or after the pilgrimage.

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²⁷ Victoria and Albert Museum. "Buddhist Pilgrimage Sites: Tibet", *Victoria and Albert Museum*. url: <http://www.vam.ac.uk/content/articles/b/buddhist-pilgrimage-sites-tibet/>.

²⁸ Yowangdu, "Mount Kailash: A Walk on Sacred Ground". *Experience the Joys of Tibetan Culture*, 2012. url: <https://www.yowangdu.com/tibet-travel/mount-kailash.html>.

²⁹ Jeffrey Hays, "Agriculture in Tibet," *Facts and Details*, 2008, <http://factsanddetails.com/china/cat6/sub37/item1693.html>.

Figure 24 Site Location: Mt. Kailash Pilgrimage

*Figure 25 Tibetan pilgrims at Gamben Kora
(Photo:<http://www.flickrriver.com/photos/91238686>)*

Figure 26 Kailash Trekking (Photo: Thomas L. Kelly, 2005)

The two key architectural symbols of Tibetan culture that became important to the design interventions are stupas and Tibetan prayer flags. Stupas are sacred houses associated with the Buddha, and are usually hemispherical, with a large central vertical tower. Stupas are monuments to the religious practices of Buddhism and worship of the Buddha is executed by walking around the stupa in a clockwise direction.³⁰ The clockwise direction around the stupa appears as a micro-pilgrimage and a ritual of pathway movement to sacred meaning and cosmic cycles.

Figure 27 Buddhist Monks circle around the Bodhi Tree Stupa (Photo: <https://www.pinterest.co.uk/pin/470204017330206466/>.)

³⁰ Editors of Encyclopedia Britannica, "Stupa: Buddhism". *Encyclopedia Britannica*. url: <https://www.britannica.com/topic/stupa>.

Along with the stupa, Tibetan prayer flags are an important symbol in Tibetan architecture and life. Four critical points are to be understood about the Tibetan prayer flags, each color of the flag, red, blue, yellow, white, green, represents an element. The colors correspond as following: red is fire, blue is wind, yellow is earth, white is air, and green is water. Along with the visual symbolism, the other necessary requirement for prayer flags is that they must never be still. These flags symbolize compassion, strength, and wisdom, and are meant to spread good will by way of the wind blowing these qualities from the flags.³¹ They are always moving in the wind and cannot touch the ground. These flags are placed in two methods, vertical, known as Dar Cho, or horizontal, known as Lung Dar.³²

Figure 28 Heres what the different colours of the buddhist prayer flags signify (Photo: <https://www.scoopwhoop.com/Heres-What-The-Colourful-Prayer-Flags-In-NorthIndia-Signify/#.ezcxgw2dy>.)

³¹ Tibet Relief Fund, "What are Tibetan Prayer Flags", *Tibet Relief Fund*, 2018. url: <http://www.tibetrelieffund.co.uk/tibetan-prayer-flags/>.

³² Neha Borkar, "8 Things You Should Know Before About Tibetan Prayer Flags Before Hanging Them Up". *Indian Times: Lifestyle*, 2016. url: <https://www.indiatimes.com/lifestyle/self/8-things-you-should-know-about-tibetan-prayer-flags-before-hanging-them-up-257899.html>

These symbols and rituals have a large influence on Tibetan daily lives. The potential exploration and design of interventions on the potential sites will need to not only engage with one of these aspects, but all of them. Agriculture, ritual, and visual symbolism are inherently linked in the landscape throughout the region. As seen in the below image, sacred sites are covered in prayer flags by Tibetan farmers on pilgrimages. The way of life is fully intertwined, and these different avenues of culture should be fully integrated into any built form that comes into contact with the Tibetan plateau landscape and site.

Figure 29 Tibetan Prayer flags carry love and compassion (Photo: <https://www.redduckpost.com/tibetan-prayer-flags-carry-love-and-compassion/>.)

BURANG TOWN: FACING THE FLOOD

The large scale and lower elevation of Burang Town as a mountain settlement means the site will go through an environmental crisis with more phases than its higher elevation counterpart. The town is situated in a valley along the Karnali River with large foothills separating the town from the peaks of the Gurla Mandhata Mountains, which hold miles of *glaciers*. As a lower elevation settlement, Burang Town will be required to deal with floods before drought, making flood diversion and protection a key design parameter when analyzing the site and contemplating potential interventions. This section, facing the flood, shows site section sketches with speculative seasonal and environmental data to understand the relationship of the town with the surrounding landscape.³³ The data can be utilized to understand agricultural grazing months, months suitable for construction, speculative estimations for duration before floods and droughts would occur, and other potentially important information to construct a phasing plan.³⁴

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³³ Yeshi Dorje, "Researchers: Tibetan Glacial Melt Threatens Billions". *Voa News*, 2015. url: <https://www.voanews.com/a/melting-tibet-could-threaten-billions-of-people/3075426.html>

³⁴ Accuweather "Burang County Historical Weather," Accuweather, accessed November, 14, 2017. <https://www.accuweather.com/en/cn/burang-county/61353/weather-forecast/61353>.

Figure 30 Landscapes at Burang County (Photo: <http://www.skyscrapercity.com/showthread.php?t=565415&page=235>)

Burang Town Regional View

Image Clipping = 4,800 square km

Burang Town Local View

Image Clipping = 96 square km

Figure 31 Burang Town Regional View

Figure 32 Burang Town Local View with Section Cut

Figure 33 Burang Town Winter Section Sketch

Figure 34 Burang Town Summer Section Sketch

KOMIK VILLAGE: RESILIENCE TO DROUGHT

Komik Village is situated high in the mountains at 4,587m above sea level. The village is remote and the town is blocked off from outside contact for six months of the year due to heavy *snowpack*. There is no direct water source to the village, resulting in inhabitants having to dig channels from nearby rivers to the settlement. Komik is currently undergoing a severe drought, and relocation appears to be inevitable as the glacial region is predicted to be gone within the decade.³⁵ As a higher elevation settlement, Komik Village is not concerned with flooding. The main focus is drought and lack of glacial water, making the potential phases the settlement will go through not as complex as Burang Town, but posing other more immediate challenges. This section, resilience to drought, identical to the previous section methodology, shows site section sketches with speculative seasonal and environmental data to understand the relationship of the town with the surrounding landscape.³⁶

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³⁵ Daniel Grossman, "As Himalayan Glaciers Melt, Two Towns Face the Fallout," *Yale School of Forestry & Environmental Studies*, March 24, 2015, http://e360.yale.edu/features/as_himalayan_glaciers_melt_two_towns_face_the_fallout.

³⁶ Accuweather, "Komik Historical Weather," Accuweather, accessed November, 15, 2017. <http://https://www.accuweather.com/en/in/komik/3018608/weather-forecast/3018608>.

Figure 35 Highest inhabited village in the Himalayas (Photo:Shivya, 2011)

Figure 36 Komik Village Regional View

Figure 37 Komik Village Local View with Section Cut

Figure 38 Komik Village Winter Section Sketch

Figure 39 Komik Village Summer Section Sketch

SITE SOLUTIONS

Ch.4

In 2013 an idea to combat the future drought by glacial loss came into fruition in the Himalayan region just inside the India border adjacent to Tibet. The *Ice Stupa* project is a design that will replace the *glaciers* that are vanishing and melting away. The Ice Stupa is a simple concept: if the *glaciers* are disappearing, then let's simply make our own. In the current state of the Himalayas there is an acute shortage of water in May, and the stupa provides enough water during this acute shortage period.³⁷ However, the reality is that if the *glaciers* vanished completely the project would not be able to support settlements in its current state (largely due to lack of resources).³⁸ Therefore, the Ice Stupa design will need to be enhanced, re-imagined, or planned in a manner that could potentially sustain a permanently drought plagued settlement.

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³⁷ Ice Stupa Project, "Ice Stupa Project," Ice Stupa, <http://icestupa.org>.

³⁸ Mueller, Derek. Brett Shaw. Consultation on Glacial Geology and Cryosphere Environmental Functions. Carleton University, *Geography and Environmental Studies Department*, Nov. 14, 2017.

Figure 40 Ice Stupa (Photo: Suhana Bathia, 2011)

GOVERNMENTAL INTERVENTIONS

While the political battle for water in Asia has begun, upstream versus downstream has become the critical focus. As displayed in the previous maps in the project, Tibet, and therefore China, is the origin point for many of the major rivers that feed Asia. China, as the upstream country, yields an immense amount of power to control the water as it is a transboundary resource.³⁹ The governmental interventions are being constructed in the thousands through the vast river systems in Tibet and China. Government interventions are taking place in the form of large dam projects, resulting in mass displacement of populations and ecosystem destruction.⁴⁰ Essentially these government interventions control the life source for all of Asia, and dams are causing drastic consequences not only to local sites, but also to other countries downstream.⁴¹

Mountains and lakes are sacred in Tibetan culture, and the dams are largely being constructed in the regions of these sacred sites, destroying the nature and the culture that encompasses these cultural and

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³⁹ Daniel Rechtschaffen, "China's Huge Dam Projects Will Threaten Southeast Asia As Water Scarcity Builds Downstream" *Forbes*, May 3, 2017, <https://www.forbes.com/sites/outofasia/2017/05/03/chinas-huge-dam-projects-will-threaten-southeast-asia-as-water-scarcity-builds-downstream/#6ec8358d5f6c>.

⁴⁰ Ibid.

⁴¹ Ibid.

religious landscapes.⁴² A farmer in a Tibetan village was quoted, stating “most would not dare remove so much as a single stone from the mountain Palshab Drakar,”⁴³ in reference to a site of an important mountain pilgrimage for the Tibetans that was blasted through for a new road to be constructed for dam access.⁴⁴

While the government dams may suffice for now at an engineering level, their large scale and imposition on the land seems to fully disregard the culture and way of life in the mountainous plateau. Li Zhaolong, a Tibetan villager, commented that he received 44,000 dollars American for building a home on higher ground to relocate, but at the location he has no other source of income and so it is not feasible.⁴⁵ In similar fashion, the Chinese government will be demolishing five sacred monasteries and relocating them, but their spiritual importance will be erased, stated a Buddhist lama named Lobsang.⁴⁶ Given this information, a sustainable practice of water conservation in the high alpine is needed not only for sustenance and settlement security, but also to maintain the sacred nature of the ecologies being demolished in the name of water security.

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⁴² Agence France-Presse, “China’s dam-building spree disrupts Tibetan communities, threatens sacred sites” *Public Radio International*, June 26, 2017, <https://www.pri.org/stories/2017-06-26/chinas-dam-building-spre-disrupts-tibetan-communities-threatens-sacred-sites>.

⁴³ Ibid.

⁴⁴ Ibid.

⁴⁵ Ibid.

⁴⁶ Ibid.

Figure 41 Strategic Affairs (Photo: <http://www.strategicaffairs.com/details.php?task=special&&id=55>).

Figure 42 China Damming Lhasa River into Artifical Lakes (Photo: Yeshe Dorje, 2016)

ENGINEERING RESILIENCE

Sonam Wangchuk is a mechanical engineer and innovator who invented the Ice Stupa project. Wangchuk was born in India in the mountainous Himalayan region. Not only has he created the *Ice Stupa* project, but he has also founded an engineering school in the mountains to specialize in the production and principles of the project.⁴⁷ He is also a champion of educational reforms in North India, which preserve cultural traditions, and is one of the founders of the Students Educational and Cultural Movement of Ladakh (SECMOL).

Wangchuk designed the Ice Stupa in response to the local water crises, with the hope to develop it as an alternative which might help to maintain local cultures and ways of life. By using local materials, local education, and local workers, the project has become a very familiar object in the Himalayan communities. From being blessed by sacred Buddhist leaders, to being covered in prayer flags growing plant life from the stored water, the Ice Stupa project is now anything but foreign to these communities of tradition.⁴⁸ Limited by physical and economic resources, as well as by physical remoteness, the project under Wangchuk has gotten remarkable attention and praise, winning various awards such as

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⁴⁷ Janaki Lenin, "Ice Stupa Architect Sonam Wangchuk Wins the Rolex Award for Enterprise" *The Wire: Environment*, December 20, 2016, <https://thewire.in/81327/wangchuk-rolex-stupa-secmol/>.

⁴⁸ Ice Stupa Project, "Ice Stupa Artificial Inaugurated...5th of March 2015", <http://icestupa.org/news/ice-stupa-artificial-glacier-inaugurated-5th-of-march>.

the 2016 Rolex Awards for Enterprise⁴⁹ and the 2017 Global Award for Sustainable Architecture.⁵⁰ However, the limitations to the project make its long term future unclear.

The *Ice Stupa* project works simply and without mechanization; the community runs a pipe to high above in the alpine, four feet underground (so the water does not freeze) to a water source (*glacial lake, melt water, snowpack*). The water collected from the source flows by way of gravity down to the Ice Stupa. The Ice Stupa locations are situated at elevations higher than the community, but lower than the water source, so gravity can collect and distribute water to the community without mechanization. The project takes advantage of the drastic verticality of the surrounding environment and uses these elevation changes for increased water-supply pressure.⁵¹

Finding a location is easy due to the vertical nature of the environment as the previous explorations in this thesis displayed. When the pipe coming down from the water source reaches the Ice Stupa location and structure (construction methods shown in following pages), the water enters a pipe curved upwards to any specified distance (i.e. 60m

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⁴⁹ Janaki Lenin, "Ice Stupa Architect Sonam Wangchuk Wins the Rolex Award for Enterprise" *The Wire: Environment*, December 20, 2016, <https://thewire.in/81327/wangchuk-rolex-stupa-secmol/>.

⁵⁰ SCOONews, "Sonam Wangchuk to Receive the Global Award for Sustainable Architecture" *SCOONews: India's Most Preferred School News Network*, May 15, 2017, http://www.scoonews.com/news/sonam-wangchuk-to-receive-the-global-award-for-sustainable-architecture-20171736?fb_comment_id=1177731162352571_1207061999419487#f1df28443b7a048

⁵¹ Ice Stupa Project, "About the Project: Ice Stupa – A Form of Artificial Glacier", <http://icestupa.org/about>.

height). As water always attempts to maintain its level, at the much lower elevation Ice Stupa location, pressure within the pipe is created by the water attempting to reach the same height as its source.⁵² Therefore, because of the immense vertical difference, the pressure forces the water to shoot out at the head of the pipe and rain down on the structure's skeleton. Once the water shoots out, the cold air in the alpine immediately freezes the water on the skeleton, slowly self-assembling a peaked structure of ice. As the ice builds on the man-made substructure, it slowly increases throughout the winter. These ice towers self-construct themselves for eight months during the colder part of the year, and then melt during the acute spring water shortage in the month of May. The Ice Stupa is constructed in a cone shape to reduce surface area and maximize volume resulting in a slower melt. In turn, the Ice Stupa warms and melts during May providing drinking water and agricultural irrigation to the community at a gradual rate.⁵³

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⁵² Ice Stupa Project, "About the Project: Ice Stupa – A Form of Artificial Glacier", <http://icestupa.org/about>.

⁵³ Ibid.

Figure 43 Ice Stupa Assembly Sketch

Figure 44 Ice Stupa Axonometric Assembly & Construction Drawing

OBSTACLES TO EXPANSION

The Ice Stupa project has undergone numerous testing phases at a variety of scales; the thesis will explore two prototypes and how they functioned. The first prototype ever tested was in 2014 in Ladakh, roughly 150km from Komik Village. The Ice Stupa's substructure was only 6m tall, and the Ice Stupa had still not melted when May 1st came. While the temperature outside approached 30 degrees Celsius the Ice Stupa was still standing only 3m tall.⁵⁴ To understand the full potential of the Ice Stupa system, it was constructed at the hottest and lowest point in the Ladakh valley, at an elevation of 3,170m, with a great deal of sun exposure for a worst-case scenario experiment.⁵⁵ The exploration displayed the potential of the Ice Stupa higher up in the mountains as the test succeeded relatively well in the furthest context from optimal conditions.

The second test began January 24, 2015, in Ladakh. The Ice Stupa higher up in the alpine during this phase ran into some minor issues such as pipes freezing, and agricultural livestock breaking pipes.⁵⁶ The pipes

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⁵⁴ Songnam Wangchuk, "Ice Stupa Artificial Glacier Project". *Indiegogo*, <https://www.indiegogo.com/projects/ice-stupa-artificial-glaciers-of-ladakh#/>.

⁵⁵ *Ibid.*

⁵⁶ Ice Stupa Project, "Slow For Sure and Steady Somewhat... 1st February 2015", <http://icestupa.org/news/slow-for-sure-and-steady-somewhat>.

were not adequately covered by soil, which was the cause of the difficulties. However, the pipes were then buried more deeply and in that configuration did succeed to construct an Ice Stupa.⁵⁷ The Ice Stupa was inaugurated on March 5th by his Holiness Drikung Kyabgon Chetsang Rinpochey.⁵⁸ The visit by one of the religious leaders of Tibet displayed the importance of the innovation to the people of Tibet. The 15m in height Ice Stupa continued to provide water until its complete melt at the end of May.⁵⁹

Figure 45 Proof of the (Ice) Pudding is in the heating (Photo: <https://www.indiegogo.com/projects/ice-stupa-artificial-glaciers-of-ladakh#/>)

These initial successes indicate that the environmental conditions and needs of communities can be taken into account to imagine other

⁵⁷ Ice Stupa Project, "Never Give Up!... 18th February 2015", <http://icestupa.org/news/never-give-up>.

⁵⁸ Ice Stupa Project, "Ice Stupa Artificial Inaugurated...5th of March 2015", <http://icestupa.org/news/ice-stupa-artificial-glacier-inaugurated-5th-of-march>.

⁵⁹ Ibid.

potential enhancements to the Ice Stupa project. These vary by scale and resource availability, but when imagining a potential future for the expansion of the Ice Stupa, these first test projects are critical. Three major factors, derived from an understanding of Wangchuk's work and from research into local conditions and ways of life, will play a role in the expansion and re-imagining of the Ice Stupa within this thesis proposal.

Figure 46 Untitled (Photo: <http://icestupa.org/news/ice-stupa-artificial-glacier-inaugurated-5th-of-march.>)

Figure 47 Untitled (Photo: <https://www.indiegogo.com/projects/ice-stupa-artificial-glaciers-of-ladakh#/>)

The first major factor is the harsh dry wind in the region. Dry wind causes *sublimation*, meaning the ice goes directly from its solid state to a

gas without ever entering the liquid phase, therefore losing the water mass to the atmosphere before it melts to enter the water supply.⁶⁰ The second major factor is shading, if the Ice Stupa could be shaded from the sun the mass would last longer, greatly increasing its *output*.⁶¹ The final factor is the lack of master planning. While there have been attempts to cultivate key points in the name of engineering testing, if a master plan were to be designed around existing networks of culture and pilgrimage, the engineered devices might be better integrated into large-scale regional resilience. The research conducted in the thesis found no evidence of master planning proposals for rural alpine Himalayan communities.

Through a combination of understanding the landscape and Wangchuk's fantastic invention, this thesis proposes a re-imagined implementation of the Ice Stupa project. The re-imagined interventions will expand the Ice Stupa project with speculative alternative possibilities of its future. This will be achieved through avenues of re-imagined master planning and architectural design at multiple scales. The following sketches begin to create preliminary ideas of the scope and scale for each town.

The drawing below (figure 48) is an initial preliminary sketch plan to distribute or re-design an intervention at a regional scale to match the

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⁶⁰ Mueller, Derek. Brett Shaw. Consultation on Glacial Geology and Cryosphere Environmental Functions. Carleton University, *Geography and Environmental Studies Department*, Nov. 14, 2017.

⁶¹ Ibid

demands and terrain of Burang Town. The sketch speculates a design narrative of large scale Ice Stupas in the foothills of Burang Town, allowing the engineered ice towers to become important landmarks and a back drop overlooking the community.

Figure 48 Burang Town Preliminary Concept Planning

The drawing below is an initial preliminary sketch to imagine an intervention at a residential scale to match the demands and terrain of Komik Village. The sketch speculates a design narrative of small scale Ice Stupas in the local community of Komik Village, representing a symbol for each individual family unit or multiple houses in a residential area to match their small population and pattern of subsistence agriculture.

Figure 49 Komik Village Preliminary Concept Planning

PLANNING, CONCEPTS, AND SPECULATIONS

Ch.5

The previous chapters addressed the research and explorations which formed the basis for narratives and decisions about scale and distribution of the intervention for the two selected sites. The following chapter constructs a master phase plan for both towns, which is based on prior research and narrative construction. Each town has specific environmental conditions, glacial scenarios, scale requirements, existing or required infrastructure, and architectural opportunities. Through understanding the context and generating a foundational master plan, the durations and phases become a byproduct. This allowed speculation concerning construction schedules and durations for development phases. By devising these specific scenarios, the thesis hopes to imagine a template schedule as a general platform, which might open conversations concerning similar scenarios, as well as beginning to invent an overarching methodology. The chapter continues and ends with various drawings and sketches, which move through the iterative process of site and structure design for both towns' requirements as outlined in the construction schedule. The sketches range in scale, location, form, and

various other aspects to test ideas and iterations on the path towards establishing an architectural proposition for the two settlements.

Figure 50 Taklakot (Burang) (Photo: https://www.tripadvisor.com/LocationPhotoDirectLink-g293890d11661277i277654653Kailash_Journeys_Pvt_LtdKathmandu_Kathmandu_Valley_Bagmati_Zone_Centra.html)

Figure 51 Komik (Kaza,) Spiti (Photo: <https://www.youtube.com/watch?v=Y1Fdws6vML4>)

CONSTRUCTING A MASTER PLAN

The first step for the master plan was enhancing a previous diagrammatic exploration, the site section sketches. The previous chapter included site sections with summer versus winter data, which were developed to understand the general environmental conditions, but the thesis required more specific data to make an educated design speculation and schedule for each town. The following grayscale diagrams titled “Burang/Komik Seasonal Sections” display the speculative environmental and glacial conditions for the towns on a month-to-month basis.⁶² The diagrams inform the schedule for critical dates and durations, including the estimated length of each potential phase, and months suitable and not suitable for construction. While the master plan is highly speculative and fictional, the goal is to create an educated narrative that helps to imagine design scenarios. Therefore, the thesis attempts to outline the components and steps a community would have to take in similar circumstances, creating a speculative master plan.

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⁶² Accuweather, “Komik/Burang Historical Weather,” Accuweather, accessed November, 15, 2017. <http://https://www.accuweather.com/en/in/komik/3018608/weather-forecast/3018608>.

Figure 52 Burang Seasonal Sections September to February.

BURANG SEASONAL SECTIONS

Figure 53 Burang Seasonal Sections March to August.

Figure 54 Komik Seasonal Sections October to March.

Figure 55 Komik Seasonal Sections April to September.

Creating a construction schedule followed upon the sectional tracing of seasonal temperature and glacial variation; each construction schedule outlines the specific requirements given each town's distinct scenario and circumstances. The construction schedule takes into account local context, nearby communities, resource availability, environmental circumstances, glacial conditions, and the duration for each phase. The construction schedule was the critical step before designing, as it creates the foundation for what needs to be designed, when, and by whom. By imagining a schedule, it was possible to determine the comprehensiveness of the designs as well as other the parameters surrounding the design.

BURANG TOWN – NARRATIVE PHASES

Burang Town's construction plan is executed in eight phases over a speculative period of thirty-nine years. The first phase, as there are few individuals trained to construct the Ice Stupas along with other challenges of such a remote location, is to construct a trade school. This educational facility will train individuals to design and construct Ice Stupas, and also advance general building skills to develop a base of workers to execute the various projects the community will need moving forward. The trade school will be constructed within Burang Town, as Burang Town is the major center in the region. The trade school's construction is conservatively estimated to take three years from 2018 to 2021. Due to the harsh climate and snow fall, construction can only operate between late March and early October, totaling twenty-one months of operation over the three year span. Phase two is simply the educational training for individuals to construct the Ice Stupas, operating twelve months of the year for a quick duration of two years from 2021 to 2023.

Phase three "Flood Diversion Infrastructure Construction", is a critical part of the process, and one of the major design focuses of the thesis. Burang Town is an example of a low elevation settlement with large amounts of *glacier*-fed waters, as previously explained. Therefore,

repetitive large-scale floods will be the community's first challenge. The flood infrastructure's construction will take place once the trade school's construction is complete in 2021, transferring the laborers over from the trade school to the flood projects. The duration of the flood structures' construction will take from 2021 to 2027, totaling six years. While the flood structures will not be architecturally elaborate, being comprised of simple earth work and water channeling, the operation is strictly limited to a small yearly construction season of four months from May to August. This short season results in twenty-four months of operation over the course of six years. The infrastructure will be constructed high in the mountains close to the *glaciers* themselves to divert and retain water. Therefore, unlike the trade school's construction, an extra four months will be required to allow the mountain permafrost to thaw and become more workable for excavation projects.⁶³

Phase four is the architectural construction of the Ice Stupa including earthwork, foundations, and other site reconfigurations. Phase four is the major design component of the thesis, sculpting the fundamental narrative, based on the interaction of life between the community and the Ice Stupas. The construction of the Ice Stupa

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⁶³ Stephen Chen, "Melting permafrost flows like lava through valley in Tibetan plateau" *South Morning China Post: Society*, September 14, 2017, <http://www.scmp.com/news/china/society/article/2111247/melting-permafrost-flows-lava-through-valley-tibetan-plateau>.

architecture will take place from 2023 until 2028, operating from April to September. The operation time is shorter than trade school construction timeline due, but longer than the flood infrastructure because much less earthwork will be required. The overall duration will overlap with the flood infrastructure construction in 2023, after two years of the flood-management work being developed. Once the flood infrastructure is complete, including channels diverting the immense flood waters, the Ice Stupa designs will be located at these points, and construction can commence. Once the Ice Stupa architecture is constructed, the community will be able to see the structures in the landscape, not functioning as Ice Stupas for twenty-eight years waiting for the drought to begin before it starts to bloom with ice, similar to observing lilac trees waiting to blossom.

Phase five, “agricultural monitoring,” is an on-going phase, always being discussed and constantly in flux. As the communities rely on nomadic agriculture and livestock production, agricultural grazing patterns will need to be constantly shifting as water is diverted and controlled, as rivers will shift, soils will reduce and increase vegetation growth, and river stability will be in question at times. Therefore, agricultural grazing routes will need to be constantly re-planned and discussed at the community level for successful nomadic livestock preservation during phase six,

“glacial floods begin”. Phase six to phase eight are realities of the circumstances with speculative timelines. The fictional glacial floods will take place for a duration of sixteen years from 2040 to 2056, however in reality the rate of climate change will determine whether and when the final catastrophic period begins, ultimately resulting in an inevitable permanent drought, phase seven. Once the drought hits, the communities will see the Ice Stupa’s blossom in the mountains and begin to be the permanent water source for the communities during the final phase, eight.

Figure 56 Burang Town Construction Schedule/ Phase Plan

KOMIK VILLAGE – NARRATIVE PHASES

Komik Village's construction plan is imagined to take place in seven phases over a speculative period of five years. The first phase, similar to the previous construction plan, is to construct a trade school. The educational facility will train individuals to design and construct Ice Stupas. The trade school will be constructed within Kaza, located 18km away by road from Komik, as Kaza is the major center in the region. The duration of the trade school's construction will take six months from spring 2018 to the start of winter 2018. Phase two is simply the educational training for individuals to construct the Ice Stupas, operating twelve months of the year for a quick duration of two years from 2018 to 2020.

Phase three "Ice Stupa Residential Construction", is one of the major design focuses of this thesis. Komik Village is an example of a higher elevation settlement with a small population.⁶⁴ The scale becomes a smaller intervention designed for the family unit or neighbourhood. The structures to house, contain, or protect the Ice Stupas will begin construction at the same time as the trade school beginning in 2018. However, the structures are completed in two and a half years, allowing more time for the projects. The completion is to be in parallel with the

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⁶⁴ Census 2011, "Komik Population – Lahul and Spiti, Himachal Pradesh," *Population Census 2011*, 2011, <https://www.census2011.co.in/data/village/12501-komik-himachal-pradesh.html>

education training completion, therefore, the Ice Stupas are able to be constructed immediately following the training. Due to the climate and the valley's six month period of isolation as previously mentioned, construction of the residential structures will take place in the months of April to September.⁶⁵ Allowing for eighteen months of construction time over the two and a half year period.

Phase four is the architectural construction of the Ice Stupa. The construction of the Ice Stupa architecture will take place in 2021, operating for a six-month construction period from April to September. The time to construct is substantially shorter than the lower elevation settlement's requirements due to the drastic scale change. The higher elevation settlement Ice Stupas will be much smaller with a completely different environmental dynamic and relationship to the community. Once the Ice Stupa architecture is constructed, the community will be able to see the structures in their community as substructures for Ice Stupas for one year and three months before drought begins.

Phase five, similar to Burang Town, is "agricultural monitoring" and is an ongoing phase constantly shifting as the community relies on

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⁶⁵ Daniel Grossman, "As Himalayan Glaciers Melt, Two Towns Face the Fallout," *Yale School of Forestry & Environmental Studies*, March 24, 2015, http://e360.yale.edu/features/as_himalayan_glaciers_melt_two_towns_face_the_fallout.

nomadic agriculture and livestock production as well.⁶⁶ Phase six and phase seven are realities of the circumstances with speculative timelines. Permanent drought will begin in the speculative year of 2023. Komik Village, as a high elevation settlement with diminishing *glaciers* will suffer drought within the decade and is currently at the brink of crisis, making the time scale greatly different than Burang Town. At the same time the Ice Stupas will begin to take form and permanently supply the village with water becoming a part of the daily lives of the community.

Figure 57 Komik Village Construction Schedule/ Phase Plan

⁶⁶ Food and Agriculture Organization of the United Nations. "China case study 3: Pastoral systems, change and the future of the grazing lands in Tibet," *Transhumant grazing systems in temperate Asia: Chapter VIII*, url:<http://www.fao.org/docrep/006/y4856e/y4856e0d.htm>.

PRELIMINARY CONCEPTS

The following sketches were developed to explore various designs and concepts for the Ice Stupa architecture and additional infrastructures required by Burang Town and Komik Village as previously outlined in the construction schedules and narratives. The sketched designs vary in scale, form, and function. The iterative process of these schematic designs made it possible to imagine various different ways the fictional narrative of both towns might be manifested in a way that engaged but also exceeded pragmatic engineering concerns. The drawings look at both scales, from the residential and communal scale of Komik, to the large and regional scale of Burang.

Figure 58 Burang Town Large Scale Idea 1 Sketch Plan View

Figure 59 Burang Town Large Scale Idea 1 Sketch Perspective

Figure 60 Burang Town Large Scale Idea 2 Sketch Plan View

Figure 61 Burang Town Large Scale Idea 2 Sketch Perspective 1

Figure 62 Burang Town Large Scale Idea 2 Sketch Perspective 2

Figure 63 Burang Town Large Scale Idea 3 Sketch Plan View

Figure 64 Burang Town Large Scale Idea 3 Sketch Perspective

Figure 65 Komik Village Residential Scale Idea 1 Sketch Perspective 1

Figure 66 Komik Village Residential Scale Idea 1 Sketch Perspective 2

Figure 67 Komik Village Residential Scale Idea 2 Sketch Perspective

After the iterative and exploratory sketching of architectural possibilities at the regional, communal, and local scales, it became clear that the intervention should not completely revise the existing construction and method while imposing architecture with cultural symbolism not understood through the scope of this thesis. While the symbolism through the sketches could be a powerful tool, the scope of this thesis is not one of imposition, and after the preliminary sketching the direction was to pursue and re-imagine the existing intervention with a pragmatic lens. The following chapters display the final designs for each town at an attempt to re-envision the structure, life, and culture in a simple and beneficial way to the community.

AGRICULTURE. RITUAL. SHELTER.

Ch.6

The following chapter imagines a future for the two mountain settlements, Burang Town and Komik village. The project re-envisioned the design of the Ice Stupa and develops a master plan for the intervention from the regional to the local scale. By using a vernacular engineering intervention not foreign to local communities, the architecture takes it a step further to create space that engages with local ritual, agriculture, and shelter. The architecture will operate in the realm of daily agricultural life, be a destination and node during pilgrimage, and become a symbol in the Himalayan landscape. The re-design has a central dome and single corridor to match the existing design, but the corridor is flexible and moves with the terrain and necessary orientation in the re-design. The corridor becomes a malleable member projecting through the dome that always orients itself to face Mt. Kailash, making each structure unique in a simple and clear strategy to generate the form.

IMAGINING A FUTURE FOR BURANG TOWN

The design for Burang Town takes form as large-scale interventions scattered throughout the region. The architecture becomes a shelter for livestock in the harsh winter, as well as an agriculture corridor for when the herds are nomadically grazing in the summer. The Ice Stupa re-design provides space for ritual, and all of the intervention locations are visible and adjacent to the largest pilgrimage route in the region, Mount Kailash. Not only does the architecture's location provide visibility from the pilgrimage route, but the interventions can become a part of the pilgrimage itself, being node points for the direction of the route, and spatially orienting the individual moving through the stupas towards Mount Kailash at the exit of each Ice Stupa's corridor. The design envisions a future where the ice stupa is a prominent architecture and space for all communities in the region.

Figure 68 Simple Diagram of Burang Town Ice Stupa Form and Layout (22" x 17" Drawing)

Figure 69 Community Scale Site Diagram of Burang Town and Neighbouring Small Communities including Agriculture, Roads, Rivers, Bridges, and Topography (18" x 24" Drawing)

Figure 70 Community Scale Site Diagram of Burang Town including Phase: 2 & 3, Water Collection/Flood Diversion and Ice Stupa Master Planning (24" x 18" Drawing)

Figure 71 Regional Scale Site Diagram of Burang Town including Phase: 2 & 3, Water Collection/Flood Diversion and Ice Stupa Master Planning (36" x 18" Drawing)

Figure 72 Site Plan of Burang Town (June, 2060) most northern Stupa Design, north of Delalin

Figure 73 Plan of Burang Town most northern Stupa Design, north of Delalin

Figure 74 Transverse Section of Burang Town most northern Stupa Design, north of Delalin

Figure 75 Longitudinal Section of Burang Town most northern Stupa Design, north of Delalin

Figure 76 Site Plan of Burang Town (December, 2060) most northern Stupa Design, north of Delalin

Figure 77 Site Plan of Burang Town (June, 2070) most northern Stupa Design, north of Delalin

IMAGINING A FUTURE FOR KOMIK VILLAGE

The design for Komik Village is a series of small scale interventions for the local community. The architecture, similar to that of Burang Town, provides shelter for livestock in the harsh winter, as well as an agricultural corridor when the herds are nomadically grazing in the summer. The Komik Ice Stupa also provides space for ritual and spiritual practices providing a rammed earth elevated pathway adjacent to the structure for ritual circling of the Ice Stupa. The earthen pathway also creates a barrier wall for wind blocking to reduce ice loss, provides shade to the ice mass, and increases the volume to surface area ratio to slow the melting of ice. The Komik Village Ice Stupa design re-imagines a small high elevation settlement where all inhabitants in the community from Monks and tourists to farmers and livestock engage with the Ice Stupa's space and architecture in daily life.

Figure 78 Simple Diagram of Komik Village Ice Stupa Form and Layout (22" x 17" Drawing)

Figure 79 Scale Site Diagram of Komik Village and Neighbouring Small Communities including Agriculture, Roads, Rivers, Bridges, and Topography (18" x 24" Drawing)

Figure 80 Community Scale Site Diagram of Komik Village including Phase: 3, Water Collection and Ice Stupa Master Planning (24" x 18" Drawing)

Figure 81 Regional Scale Site Diagram of Komik Village including Phase: 3, Water Collection and Ice Stupa Master Planning (24" x 18" Drawing)

Figure 82 Site Plan of Komik Village (June, 2060) South of Komik Ice Stupa (22" x 17" Drawing)

Figure 83 Plan of Komik Village South of Komik Ice Stupa (22" x 17" Drawing)

Figure 84 Transverse Section of Komik Village South of Komik Ice Stupa (22" x 17" Drawing)

Figure 85 Transverse Section of Komik Village South of Komik Ice Stupa (22" x 17" Drawing)

Figure 86 Site Plan of Komik Village (December, 2060) South of Komik Ice Stupa.

Figure 87 Site Plan of Komik Village (June, 2070) South of Komik Ice Stupa

CONCLUSION

Fragile Equilibrium re-imagines and proposes a future for the Himalayan communities of Komik Village and Burang Town with a template that could potentially be applicable to thousands of other communities in similar situations within the Himalayas and other regions around the world. Through the creation of a master plan and re-design of the Himalayan Ice Stupa project, *Fragile Equilibrium* envisions a new Ice Stupa that becomes a work of planning and architecture, engaging with its surroundings. The project strategically locates the various re-imagined Ice Stupas in the landscape through analyzing land coverage, river locations, agricultural fields, pilgrimage routes/corridors, and topography. By surrounding the community in these strategic locations, the Ice Stupa becomes much more than an effective engineering project, it becomes an icon in the vertical and vast landscape, used for pilgrimages, spiritual practices, and special events; it is also a local structure which supports farming, tourism, and daily life.

Fragile Equilibrium takes the purely functional innovation of the Ice Stupa project, designed to increase water security, and pushes it a step

further to become much more than a source of water. As the world enters a phase of environmental uncertainty, ideas to combat environmental threats are being conceptualized by engineers. Interventions are proposed, such as the Ice Stupa project, which are not seen as within the scope of the architect. This project argues that design thinking concerning community engagement, patterns of land use, demographics, local practices, as well as material and spatial conceptions is of the utmost importance. *Fragile Equilibrium* proposes a dialogue between this architectural proposition and Songnam Wangchuk's *Ice Stupa* project. The design evolved from a source of water to a structure towering in the barren landscape, which becomes a destination for a diverse range of life.

GLOSSARY

TERM	DEFINITION
Glacier	a large mass of ice that fluctuates in size
Glacial Input	snow fall that compresses on a glacier and increases a glaciers size (mass)
Glacial Output	melting ice and evaporation from a glacier that reduces the glaciers size (mass)
Moraines	sediment and rock pushed up and left by a glacier
Meltwater	water caused from the glacier melting and losing mass
Mass/Balance Ratio	the size of the glaciers current state comparing the glacial input versus the glacial output
Glacial Lakes	lakes formed by melting glaciers
Snowpack	snowfall in a particular region
Sublimation	when a solid goes directly to a gaseous state without transforming into a liquid first

All definitions are simple explanations by author derived from conversation with Dr.Mueller of Carleton University Department of Geography and Environmental Studies

EPILOGUE

When reflecting on the thesis after defending the project and its positioning, my stance on visual narratives has shifted a bit post-discussion. When visually representing the project people were intentionally left out with the intent to not impose an assumption of lifestyle for the architecture, but otherwise provide the architecture and have local culture make it their own. While I still fully believe making it their own should be, and is the intention, I believe without life in the visual representation of the project the architecture becomes a fixed object void of reality. I believe showing local life in the architecture alters the object to the human condition, which is fundamentally what architecture responds too. As long as this is done with sensitivity and thorough understanding of local narratives and life, it is not only appropriate, but successful.

The other critical reflection I came to was the importance of representation of landscape in fluid environments to work with topography and form, not combat it. The section drawings provided a straight ground plane, not true to the reality of how the structure would come to fruition. In reality, the structure would truncate, bend, and stress as it winded down

the unpredictable and vertical Himalayan landscape. The following drawings and model are my response to this reflection and new understanding of visually representing my thesis, *Fragile Equilibrium*.

Figure 88 Burang Longitudinal Section flowing with Landscape

Figure 89 Section of Structure with Livestock

Figure 90 Section of Structure with People

Figure 91 Photo of Model

Figure 92 Photo of Model

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