MASTER THESIS

A SELF-GOVERNANCE APPROACH TO SOLVING THE WATER CRISIS IN LADAKH, INDIA: THE *ICE STUPA* PROJECT

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ABSTRACT

The region of Ladakh in India is currently undergoing a water crisis, caused by an unprecedented influx of tourism in this remote and ecologically fragile region of the arid higher Himalayas and by the glacial retreat due to climate change. The geopolitical situation of the region surrounded by disputed international borders further complicates the governance and management of water resources in the region. In such a setting, local entrepreneurs, students, engineers and volunteers took matters into their own hands and gave rise to the *Ice Stupa* project, which involves water harvesting methods using alternative artificial glaciers. While the prototype of the *Ice Stupa* has been noted to be successful, the plans for the expansion of the project are still ongoing. This thesis applies a governance assessment tool to assess the governance context around the *Ice Stupa* project in alleviating the water crisis in the region and thereby aims to shed light on the multiple facets of governance conditions of this water harvesting system and its role in water resources management. The analysis reveals that in the governance context of the *Ice Stupa* project, self-governed, voluntary institutions and public participation together form a highly supportive system of governance, by giving power to the people and making them self-reliant in managing the water resources with little or no supervision from governmental actors.

Key words: governance assessment, water governance, water harvesting, artificial glaciers, *Ice Stupa,* Ladakh, India

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LIST OF ABBREVIATIONS

CIT	Contextual Interaction Theory
DROP	Benefit of Governance in Drought Adaptation Project
GAT	Governance Assessment Tool
HIAL	Himalayan Institute of Alternatives, Ladakh
NbS	Nature-based Solutions
NGO	Non-Governmental Organization
SECMOL	Students' Educational and Cultural Movement of Ladakh
UNFAO	United Nations Food and Agriculture Organization
UT	Union Territory

ACKNOWLEDGEMENT

The case selection came naturally to me ever since my dear friend, Varun Singh brought to my attention the water crisis ongoing in a region very close to my heart, Ladakh, India. As an avid traveller and a seeker of adventure, the picturesque and tranquil Ladakh has always been a captivating subject but knowing now of all the problems tourism has caused and how local communities are struggling in the nexus of the hospitality industry versus the decline in natural resource availability, I knew I had to visit the place for research and not tourism, first.

My supervisors, whom I must thank first and foremost, Dr. Gül Özerol and Dr. Maia Lordkipanidze were both fully supportive and very encouraging throughout my thesis period and in guiding me to view the topic through the lens of a researcher, providing me with access to their work with the GAT and its usability. As female researchers and professors in a field which in my country is fairly male dominated, they inspire me to keep working towards the ultimate cause with great zeal. It is with their effort towards my betterment as a researcher and their words of encouragement and critical eye that I embarked upon this journey with an empirical outlook in search of relevant facts and an understanding of how to make sense of them scientifically, in an effort to shed some light on the uniqueness of the Ladakhi situation at hand.

Dr. Kris Lulofs, my Water Governance stream supervisor and an expert in nature based solutions himself, has had a supportive role to play as his interest in my topic selection and keen eye and approval of ideas on how to go about conducting the research were all very welcome additions to my knowledge base and discussions with him, always pleasant. I thank him for his time and supportive role, even though he was not my direct supervisor for this thesis.

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Chapter 1:
INTRODUCTION

The scenic region of Ladakh lies in an ecologically delicate area in northern India, wedged between disputed territories with its neighbouring countries, Pakistan and China. It is a vast expanse consisting of a high-altitude desert-like terrain in the rain-shadow regions of the Himalayan mountain ranges. This region, ordinarily viewed as a respite for avid tourists and adventure junkies, is now facing a plethora of environmental issues, due to an unprecedented influx of tourists over the past decade. The toll of which falls more on the local communities, native to Ladakh (Clouse, 2017; Goeury, 2010).

1.1 Background

When Ladakh first began to open its routes to tourism in the 1990s, it received a footfall of around 500 tourists, annually; all of whom would visit in the summer months of April through August, the only time of the year that the roads to Ladakh are properly accessible from major cities in India. In 2017, Ladakh received an influx of about 250,000 tourists. This exponential growth is owed to both its eclectic culture, scenic beauty and increased accessibility, and also the influence of Ladakh's depiction in film and television, making it appear as a haven for those who seek a break from the hustle and bustle of city life (Schreiber, 2016).

With this alarming number of people entering, unregulated through the administrative capital, Leh, which is a city of 5 km^2, the carrying capacity of an already fragile ecosystem is challenged. The high altitude and lower oxygen levels leave the tourists to consume almost three times as much water than the natives would. This not only causes a stress on the existing water resources but also a hike in plastic pollution due to disposable water bottles sold there. In regions where landfills never were, in the Nubra Valley of Ladakh, there now exists a gigantic garbage dump, taking out waste from the city of Leh. These and other challenges that the Ladakh administrative bodies earlier never had to deal with, came unanticipated to a region which was not prepared for the extent of it. With this also came a shift from the primarily agro-based economy of the region to an economy that is now heavily reliant on tourism (Chopra, 2017; Clouse, 2017).

The region's freshwater supply comes almost entirely from glacial snowmelt. The problem that heavy tourist footfall brings along with it is not only pollution but also a rise in greenhouse gases, at the microclimate level due to vehicular pollution, exacerbating the snowmelt from an already declining glacial mass. With visible effects of climate change, in the form of retreating glacial lakes and streams and the added disadvantage of harsh climatic conditions and rising levels of pollution, Ladakh is now experiencing a multi-faceted water crisis, in terms of freshwater scarcity, water pollution, inequity in distribution, and lack of water for irrigation (Chopra, 2017).

In such conditions, the local activists, students and engineers, along with the pioneering foresight of Sonam Wangchuk, an engineer and environmental reformist and Chewang Norphel, an environmental scientist and engineer, have come up with a novel method of water harvesting, and a sustainable, nature based solution in the form of an artificial glacier, to meet the needs of irrigation water by local farmers, in an effort to reduce water scarcity and greening the desert. The ice structure makes use of the natural flow of water and in the winter months and uses the sub-zero temperatures to construct the conical shape of the ice domes and a mass of branches, wire mesh etc. to give support to this structure. The conical shape helps expose the lowest possible surface area to the outside temperature in summer months, providing a slowly melting and longer lasting artificial ice-reservoir. This structure is called the *Ice Stupa*. The word 'stupa' comes from the conical, dome-like shape of the ice structure, named after Buddhist shrines, which are prevalent throughout the predominantly Buddhist region of Ladakh (Clouse, 2017; Geneletti & Dawa, 2009; Chopra, 2017).

Figure 1: An Ice Stupa in Leh, Ladakh, India (Source: https://mymodernmet.com/ice-stupas-ladakh-himalayas/)

1.2 Problem Statement

While the reasons behind the water crisis in the Ladakh region are not limited to one, the hardest hit has been to the agricultural sector. The attempts made by the team from the Students' Educational and Cultural Movement of Ladakh (SECMOL), the parent organization, the *Ice Stupa* team and Himalayan Institute of Alternatives, Ladakh (HIAL) and their champion, Sonam Wangchuk, have proven to be a self-governed system functioning in a region with limited resources and disorganized yet complex administration. The *Ice Stupas* of Ladakh represent a climate adaptive landscape instilling water husbandry in the water-stressed region and is an innovative solution that high-Himalayan communities have incorporated as a response to escalating environmental pressures (Clouse, 2017). The existing prototypes have already demonstrated their ability to store tremendous amounts of water, marking a significant irrigation potential, deeming the project, so far, a success (Clouse, 2017). According to experts at the HIAL project, the holding capacity of all the *Ice Stupas*, as assessed in 2016 is between 102 million Litres per year and potentially 189 million Litres per year (Das *et al.,* 2019). A large sense of community engagement is also on the agenda of the project. Besides involving crowdfunding, since 2014 each annual display of the final structures also includes a ceremony where local communities participate and tie prayer flags prominently across the ice masses. Local monks also participate in blessing the project location and *Ice Stupa* structure (Clouse, 2017; Lenin, 2014). Given the potential of the *Ice Stupa* project to solving the water crisis in the Ladakh region, it is crucial to understand the functioning of this system in order to gain insight into the factors that affect the success of the project and its governance context. Once an understanding of these is achieved, it would be prudent to judge how the governance conditions could be enhanced in order to solve the broader water crisis situation in Ladakh.

1.3 Research Objectives

This thesis aims to investigate the governance context around the *Ice Stupa* project and the expansion of such interventions in order to help with the mitigation of the water crisis in the Ladakh region. It intends to shed light on 1) The factors affecting the governance conditions surrounding the *Ice Stupa* project and 2) The gaps and/or facets that require improvement for strengthening the governance context, in order to help future endeavours and their managers, policy makers, entrepreneurs, environmentalists and researchers. It is an effort to understand what restricts and what enables the functionality and operations of such a system of governance. The purpose of establishing this idea through the governance perspective is thus, important because of the uniqueness of the case and the fact that time is of the essence, given that the amount of available runoff water from glacial melt in the summers is decreasing every year.

The application of the Governance Assessment Tool (GAT) to cover the analytical aspect of this thesis is the basis for forming an evaluative conclusion and possible recommendations for the solution of the water crisis. GAT is a theoretical and methodological instrument brought to use in

order to understand if the current conditions inhibit or support the proliferation of the water conservation strategy at play, by means of this project, in order to enhance climate change adaptability in the region. The GAT was developed for the assessment of both water-specific and other cases, in which governance plays a supportive or restrictive role in implementation of strategies and projects (Bressers *et al*., 2016). This thesis will be the first attempt for applying the GAT in a case that focuses on non-conventional methods of water harvesting.

Chapter 2 states the background of the case study based on empirical evidence in literature before reviewing scientific literature on the concepts of governance, tools made use of in this research and their basis, in Chapter 3. The fourth chapter provides a look into the research methodology, stating the research questions and modes of answering them including the series of events adhered to in the conduct of this research before discussing the findings in Chapter 5. Chapter 6 concludes the thesis by summarizing the results based on the answers provided to the research questions and briefly outlines recommendations for improvement before discussing future implications of the *Ice Stupa* project.

Chapter 2:
EMPIRICAL BACKGROUND

At an elevation of 10,000-18,000 ft. above sea level, the region of Ladakh is nestled in the war-torn region of Kashmir, in the state of Jammu & Kashmir, India. It is surrounded by Pakistan occupied Kashmir territory to the west and Chinese occupied areas of Tibet to the east. It is home to a peaceful community residing in a high-altitude desert, in the Himalayan ranges. Due to its cultural heritage and scenic beauty, hordes of tourists are drawn to Ladakh. The region is seasonally isolated from the rest of the country and only accessible by road over the course of three-five months in the summer, leading to a steep rise in the number of people occupying the region, at a time (Dame, 2018).

2.1 Effects of Tourism on Local Conditions

According to the State Tourism Officer, Mehboob Ali (2016), the scenic beauty, Buddhist monasteries, Indo-Tibetan culture, high-altitude lakes, and vast & treacherous trekking routes bring the maximum tourist footfall. It provides a peaceful escape to these Indian and foreign tourists from the busy urban landscape to provide a spiritual and meditative experience.

The economy of Ladakh was primarily agrarian and pastoral, but due to the high influx of tourism, many native Ladakhis have taken to the hospitality sector in order to earn more (Schreiber, 2016). This has contributed to a high demand within the Ladakhi youth to compete for the tourist business in the towns. This has also led to a cultural shift, particularly in Leh, the administrative capital of Ladakh. Ironically, globalization was brought to a region which was originally sought after due to its authenticity and remoteness (Schreiber, 2016). This consequently, has led to the pollution levels rising in Ladakh and leading to poor water quality in the rivers that flow downstream through Leh, in particular. Additionally, there is substantial evidence of the phenomenon of glacial retreat in the Indian Himalayan ranges (Clouse *et al.*, 2017). There is no denying that in the last six decades, the state of Jammu and Kashmir has lost 20% of its overall glacial mass (Grossman, 2015; Mingle, 2015). This presents a twofold problem:

a. Pollution of glacial flow, which is the primary source of water in Ladakh and beyond for domestic and agricultural use.
b. Climate change and local microclimate disturbances leading to lower availability of glacial water due to shrinking glacier mass. (Schreiber, 2016).

Traditionally, in the agriculture-reliant economy, food consumption was primarily based on subsistence-oriented agriculture and local storage facilities, to deal with the short spring & summer. Nowadays, while agriculture and pastoralism remain the primary source of livelihood in the region, most of the year, these traditional sectors have been adversely affected by the

development of tourism and government services (Bhatnagar *et al.*, 2006). More recently, tourism and hospitality-related businesses, in such a time flourish and homestay programs, for example, allow for a large income obtained from tourism in these regions (Dame, 2018).

2.2 Geographical and Hydrological Aspects

Due to its geographical location and high altitude, Ladakh experiences extreme fluctuations in temperature, throughout the year, ranging somewhere between − 30°C to over 30°C (Ahmed, Higgins, & Norphel, 2010; Demenge, 2007). The region inherently poses some physical constraints in terms of water availability and terrain including prolonged winter, scanty rainfall, rugged mountain terrain, and limited availability of fertile land. Agriculture, thus, is mainly confined to the river valleys, which receive glacial melt (Geneletti & Dawa, 2009). Despite these hardships, Ladakh has a rich history of adaptation to harsh conditions and stewardship of scarce resources (Clouse *et al*., 2017). While agriculture accounts for the employment of over 70% of the Ladakhi workforce, the region's high altitude and rugged terrain render a large portion of the land unsuitable for cultivation. The Ladakh Ecological Development Group estimated that only 1% of Ladakh's total area can be considered fit for cultivation, and in such an exacting environment, economic growth has effectively remained constrained for centuries (Humbert-Droz & Dawa, 2004).

Water management practices have shaped and determined the siting of houses and fields, influencing the shape and form of settlements, and ultimately placed upper limits on the community's capacity for development (Clouse *et al.*, 2017). Traditionally, the availability of water has been seen as an important factor in the village life and even in the region's folklore the mention of 'water' is heavily prevalent, indicating its importance in everyday life. The amount of winter snow generally dictates the anticipated supply of water during summer, which further determines whether marginal fields should be sown or not, in spring. The period of spring subsequently determines whether the irrigation water supply will start early or late, since cool cloudy weather would lead to late snowmelt. This directly affects the plowing and sowing time and the sequence in which the crops are sown (Angchok & Singh, 2006). Most villages thus, sit opportunistically, occupying sites within a reliable, gravity-fed watershed (Clouse *et al.*, 2017).

The people of Ladakh have for centuries, mastered their water management in this difficult terrain and climate, and thus, some traditional water management strategies for ensuring availability are noteworthy. For instance, throughout the region, in the summer, the melted snow water from numerous rivulets merges into a stream that flows through a valley, which comprises of many villages that are connected by the main channel (the mother channel). It is built along a mountainside that forms its natural retaining wall, and to ensure water holding capacity, these are lined with clay. This may be seen as the Ladakhi version of a dike. Human interventions including breaking down rocks to allow the passage of water, and in areas where the hills are precipitous or rocks are too hard, a hollow poplar or willow trunk is cut into two equal halves to enable easy passage for the incoming flow (Angchok & Singh, 2006).

While farming communities have successfully managed water in this region for almost 1,000 years, changing weather patterns now demand urgent design interventions (Clouse, 2017). But given their resilient nature and the current challenges, the Ladakhi agriculture, in 2014, was described by the United Nations Food & Agriculture Organization (UNFAO) as a 'globally important agricultural heritage system', due to its remarkable land use systems and landscapes' which demonstrate the 'co-adaptation of a community with its environment and its needs and aspirations for sustainable development' (Pulselli & Pelliciardi, 2014).

2.3 Complications in the Modern Ladakhi Landscape

Currently, Ladakh is experiencing a huge strain on its carrying capacity. This can be attributed to several reasons, including climate change and disturbances in way of life and agricultural activities, which are coupled with extreme seasonality, lack of suitable infrastructure and planning, interference with fragile ecosystems and protected areas, and the indirect stressors due to abrupt and extensive tourism (trail use, waste dumping, camping, pack animal grazing and off-road driving). Since it opened up to tourism in the 1980s and more so since 2009, the region rendered itself more vulnerable, experiencing greater environmental fragility and tourism seasonality. High-altitude ecosystems are inherently fragile and characterized by low resiliency exhibited over a vast range of its resources including soil, water, wildlife & vegetation, all experiencing adverse effects due to this strain on the carrying capacity (Geneletti & Dawa, 2009).

In the midst of all this, while the availability of water in a timely manner is not always easily predictable and it would be expected to find a complex politics of distribution and exploitations at play in this region. Although water distribution is certainly complicated, monopolization or exploitation of the resource is rare. This is a testament to the cultural value and holistic approach of the local communities towards their major limiting resource, water. Streams were from ancient times, considered sacred and local customs would guard them against pollution (Schreiber, 2016). For the distribution of irrigation water, in particular, organized institutional arrangements are present in order to ensure that the scarce resource is available equitably and timely. To this end, a Water Advisor is appointed, who is selected on a rotational basis, taking individual household as a unit. The Water Advisor's responsibility includes arranging and assigning water availability according to a pre-decided traditional order. Additionally, a sort of written agreement exists (locally called 'bandabas'), which has a provision that any matters of conflict on water availability can be taken to formal courts (Angchok & Singh, 2006).

The issue of water availability, particularly for agriculture, has over the years been drastically affected by the two aforementioned major problems. As an adaptation strategy, constructing artificial glaciers has been common in recent times, courtesy of the pioneering engineer, Chewang Norphel, endearingly dubbed, 'Ice Man of Ladakh'. These artificial glaciers were

meant to act as a reservoir and catchment for snowmelt and require little infrastructure (Down To Earth, 2017). However, the use of artificial glaciers in the traditional way, also fell short on the demands of certain areas in Ladakh, particularly in the vicinity of Leh. In such circumstances, the novel method of nature-based harvesting of ice over the winters, to be used easily over the months where water shortage is imminent, has commenced since 2016, in the form of the *Ice Stupa* project.

2.4 Advent of the *Ice Stupa* Project

The *Ice Stupa* project was an ambitious approach which required little infrastructure, in order to form and conserve a longer lasting artificial glacier, engineered by Sonam Wangchuk and Chewang Norphel. It presents a novel water management strategy, in which community involvement, ecological awareness, and religious iconography have been harnessed to conserve and judiciously use a dwindling natural resource, in an effort to green the high altitude desert and allocate ample water for irrigation (Clouse, 2017). The formation of these engineered ice caches is able to provide a critical stopgap solution, enabling farmers to stockpile ice during the winter months for use as meltwater in the spring. It is a structure that requires rebuilding every year. While it cannot impede glaciers from shrinking, it can certainly help people adapt to climate change (Lenin, 2014).

The pilot project was 6 metres high, built on a fully exposed riverbank. It stored 150,000 litres of water at 3,170 metres, the lowest altitude in Leh valley. This, according to Sonam Wangchuk, the inventor of the *Ice Stupa*, proved that these pyramids of ice can be built anywhere in the region (Lenin, 2014). A number of these structures have been constructed in Ladakh after the effects of the success at the pilot project site. Although the *Ice Stupa* is still relatively new to evaluate over the long term, the existing prototypes have already demonstrated their ability to store tremendous amounts of water, marking a significant irrigation potential (Clouse, 2017).

2.5 Community Engagement in the *Ice Stupa* Project & Its Cultural Implications

The first *Ice Stupa* was built with money generated from crowdfunding, and it was blessed by local monks, as requested by the builders of the project (Lenin, 2014). Each annual display of the final structure, ever since the first one in 2014, includes this ceremony where local people also participate and tie prayer flags, across the ice masses (Clouse, 2017). In this way, there has been public participation in the project, throughout. The product was made available to the broader Ladakhi population, propagated via public talks, open-source planning documents, and open discussions with stakeholders. *Ice Stupa* advocates also suggest that new tourism activity would result from these efforts (Clouse, 2017).

This is a project that concerns the local community, religious leaders, security forces, political leaders, the tourism industry, state government institutions and Non-governmental Organizations (NGOs) alike, among others. The *Ice Stupa* requires a significant investment in terms of energy,

pipe infrastructure, and maintenance, all of which are inputs whose renewal must be done annually. The system demands regular attention during winter months, as pipes must be incrementally pushed beyond the crown of the stupa as the ice mass forms, thus, skilled manpower is required in the expansion of the project, as well (Clouse, 2017).

Chapter 3:
LITERATURE REVIEW

In the following sections is presented a review of scientific literature, relevant to the concepts which support and shape the theoretical and analytical framework of the thesis in order to achieve the research objectives.

3.1 Water Governance

The concept of governance involves the relationship between a society and its government and thus, extends beyond just the activities of a governmental body. Governance mediates behaviour by either legislation, informal norms or a combination of these. Thus, while the context of governance encompasses laws, regulations, and institutions, it also refers, possibly more, to policies, actions, domestic activities, and networks of influence which may include international market forces, the private sector and civil society. These would then also be affected by the political systems within which they function, in this all-encompassing delineation (Rogers & Hall, 2003). The definition of governance adhered to in this thesis is based on the description provided by Bressers *et al*. (2016), which is as follows: "A combination of relevant multiplicity of responsibilities & resources, instrumental strategies to actor networks and scales that forms the context which to some degree restricts and to some degree enables actions and interactions."

According to the Global Water Partnership, 'water governance' revolves around a range of political, social, economic and administrative systems that are made functional in order to develop and manage water resources and the provision of water services, among all varied strata of society (Global Water Partnership, 2002). The concept of water governance thus, is distinctive as it involves not only public participation by direct engagement, but also depends on the people's ability to self-organize in a productive way so as to deal with water related issues (Bressers *et al*, 2013).

Deriving from this, the modern concept of governance of water resources involves the problem-solving capabilities of modern democratic societies which call for the engagement of many different actors who may hold rights of ownership, utilization and management over water resources. This strategy of governance results in the synthesis of solutions based on pooling of resources and ambitions of such actors and societies forming a functional system of innovative water management practices for complex problems, with often multi-purpose solutions (Bressers *et al,* 2010). The resultant practices would thus, revolve around a process which engages the co-ordinated development and management of water, land and other resources, in order to maximise the outcome in terms of economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (Rogers & Hall, 2003; Global Water Partnership, 2000) Social participation, therefore, in regard to problems of water uncertainty and

compromised water availability would compose a central component of the process of democratic governance (Castro, 2007).

In the book, 'Governing the Commons' the Nobel laureate author, Ostrom (1990) outlined and pushed for the importance to be drawn on the regional and local institutional arrangements when considering the functioning of common pool resources and advocating for common pool resource arrangements. Clearly, modern governance conditions are receptive of the idea of formal authority being supplemented by an increasing dependence on informal authority. An example of such a cohesion would be through effective public-private coordination and cooperation through strategies that can benefit both of these as well as their intended customers and the general public (Rogers & Hall, 2003).

When we consider self-governance capacities, the process looks at coordination and the various forms of formal and informal types of State and society interactions as well as the role of civil society and policy networks. This opts for a more society-centred and essentially, decentralized way of implementing good governance of water resources. There is, thus, a growing perception that the governance of water resources and water services functions more effectively with an open social structure which enables broader participation by civil society, private enterprises and the media, all networking to support and influence government (Rogers & Hall, 2003).

3.2 Assessment of Water Governance

It is increasingly becoming evident worldwide, that the world water crisis is majorly a crisis of governance. In such times, governance assessments come in handy, because they can help in the identification of challenges in the implementation process and may also be utilized in support of recommendations. They also uncover the complexity of inter-relationships between programmes, regulations and the degree of achievement of an established goal (Castro, 2007; Jacobson *et al*, 2013; Flores *et al*., 2019). While the general consensus about the context of governance, being a system essentially pertaining to issues of financial accountability and administrative efficiency is popular, it misses out on certain other relevant facets. Other concepts may try to be more inclusive of them and focus on broader political concerns related to democracy, human rights and participatory processes. There are also those who look at governance with a focus on the match and mismatch between the politico-administrative systems and the ecological system or in terms of operation and management of services (Rogers & Hall, 2003). To achieve a more effective plan for water governance it is necessary to create an enabling environment, which would work to facilitate an efficient private and public sector initiative and stakeholder involvement in understanding and dealing with their needs. Water policy and the process for its formulation must have as its goal the sustainable development of water resources, and to make its implementation effective, the key actors and stakeholders must be engaged in the process (Rogers & Hall, 2003). An aide to assess the necessary conditions for good governance, according to the Global Water Partnership, would be to consider the degrees of inclusiveness,

accountability, participation, transparency, predictability and responsiveness within the governance context (Global Water Partnership, 2002).

Over the past few decades, many researchers have made the importance of governance assessments more evident which has facilitated the development of many different frameworks for the assessment of water governance (as have been aptly described by Flores *et al.*). The framework used in this research to assess the governance context is the Governance Assessment Tool (GAT) developed by Bressers *et al.* (2013). A major reason for this relies on the ease of applicability of the GAT pertaining to multi-level settings with interdependence among actors. These settings have allowed the utilization of the GAT in analyzing and comparing a large number of cases worldwide (Flores *et al.,* 2019). This attempt would be the first at applying the GAT to a case of self-governance towards the mitigation of water scarcity by the use of non-conventional water harvesting, nature-based strategies in India.

3.2.1 The Governance Assessment Tool

The Governance Assessment tool is a theoretical instrument which by means of a matrix regarding certain evaluation criteria and governance dimensions discusses the quality of a governance regime. It can be applied in order to formulate specific evaluative questions which may be answered by stakeholders in order to arrive at a conclusive judgement of whether a project has had restrictive, supportive or neutral forms of governance. It is an analytical tool which uses a divisive method to gain a better understanding of stakeholders and their motivations that may spur the actors into action, their cognitions about the problem, and their resources, providing them with the capacity to act individually and/or cohesively (Bressers *et al.,* 2016). In this study, the GAT will be used to explore the analytical research questions.

The basis of the GAT lies in the Contextual Interaction Theory (CIT) as described by Bressers *et al*. following the conceptual framework for governance assessment. CIT has been developed over the years with its initial roots in the implementation analysis as described under "policy instrument theory" (Bressers *et al.,* 2016) adding network analysis, multiple scale issues and other governance regime aspects as context (Lordkipanidze *et al.*, 2018).

The GAT expands the concept of a policy describing its actors striving to achieve goals with certain means, and this concept applies to all relevant aspects of the governance context. In this governance context, five governance dimensions and four governance criteria are considered and explored through the evolution of a GAT matrix (Lordkipanidze *et al.*, 2018). Governance dimensions may be used to systematically describe the governance context in a particular region over a certain issue. As depicted in Figure 2, the five dimensions include the following (Bressers et al., 2015):

1. Levels and scales: these may relate to different scales and levels involved in the management of the resource and may correspond to administrative, spatial, hydrological or political scales & levels etc., assuming a general multi-level character for all.
2. Actors and networks: assuming the involvement of multiple actors and actor conglomerates along with their relevant networks engaged in the governance of the situation at hand.
3. Problem perceptions and goal ambitions : assuming a multi-faceted character for problems and ambitions in order to derive multi-purpose solutions to complex problems.
4. Strategies and instruments: assuming a multi-instrumental character operating in the strategy used by the actors & their networks.
5. Resources and responsibilities: assuming a complex multi-resource basis for synthesis of solutions aimed at innovative and functional strategies for implementation.

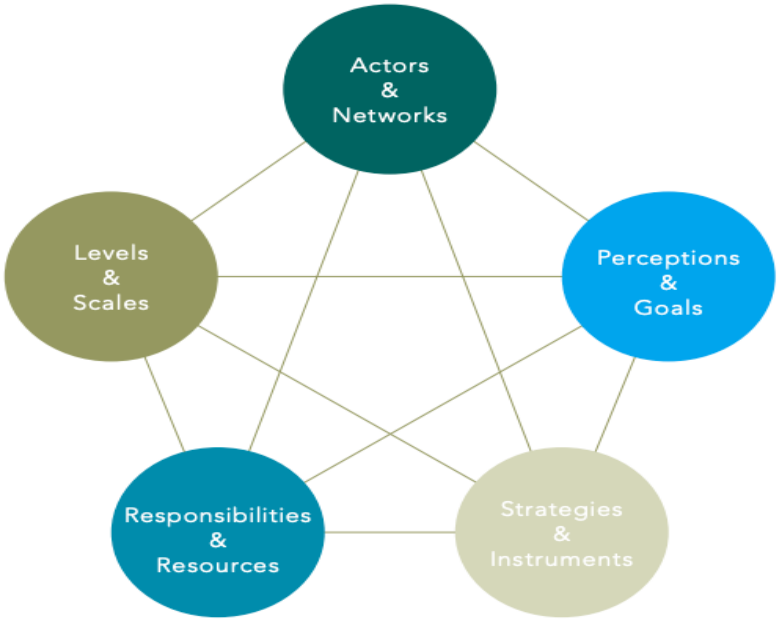

Figure 2: Governance dimensions addressed by the GAT *Source: Bressers et. al., (2015).*

In order to gain a more thorough understanding of the quality and capacity of a governance regime, four evaluation criteria are added to form a matrix together with the five dimensions leading to the synthesis of evaluative questions that form the basis of the assessment process (Lordkipanidze *et al.*, 2018). These quality criteria, according to Bressers *et. al.,* include:

1. Extent: This refers to the completeness and comprehensiveness of issues at hand as it is essential to understand whether relevant aspects of the governance dimensions have been considered.
2. Coherence: This refers to whether elements of the governance dimensions strengthen, or contradict each other while paying heed to separate issues that add to the complexity of the issue at hand.

3. Flexibility: This criterion explores the degree to which the different elements of a governance regime may support and facilitate multiple adaptive strategies for goal attainment.
4. Intensity: This explores the degree to which the elements of the governance context may be supportive or inhibitive towards changes in current developments

The GAT is intended to result in a systematic assessment of all relevant elements and qualities of the governance context. This aids the understanding of specific circumstances which contribute to the success of the implemented strategies (Lordkipanidze *et al.*, 2018). A time dimension, separate but applicable to the GAT may also be explored for a thorough understanding of how things are likely to change during the course of the project in the foreseeable future (Bressers *et al.*, 2013).
When tackling the assessment of a multi-actor governance perspective, it is necessary to consider the possibility that actors that are involved may not always act on their own, but also on behalf of the underdogs or groups with limited resources; interest groups who are present behind the scenes, whom these actors represent. It is relevant to consider the network linkages around actors and the coalitions that exist. (Kuks *et al.*, 2012):

3.2.2 Utility of the GAT

The use of the GAT can be implemented by first understanding the origins of the tool in Contextual Interaction Theory, to understand the dimensions and criteria that form the backbone of the tool and form a matrix for deriving evaluative questions. Based on the response provided by local and regional stakeholders, to those questions, insights would be uncovered based on which a judgment would be constructed, in regard to what extent the governance circumstances are supportive, restrictive or neutral, throughout the project. A visualization with coloured cells of the matrix can then be mapped for easy analysis of the state of affairs in governance for the region in question (Bressers *et al.*, 2015).

The GAT was developed for and subsequently, successfully applied for the assessment of the DROP project, or the “Benefit of Governance in Drought Adaptation” project, which received funding from the Interreg IVB programme of the European Union. It focussed on drought aspects related to nature conservation, agriculture and freshwater. This involved six regions in Northwest Europe, including Twente and Salland in the Netherlands, Eifel-Rur in Germany, Brittany in France, Somerset in the United Kingdom, and Flanders in Belgium (Bressers *et al*., 2015).

The judgements on the DROP project were achieved by assessing each of the twenty cells of the evaluative questions in the GAT matrix by a brief statement and sometimes a score at a three- or five-point scale, followed by a paragraph to page length of observations on which those statements were based. The scores were translated into a graphical visualisation of the matrix

with colours (forming a ‘score card’ of sorts) indicating the value of each cell. These visualisations were meant to enable a quick overview of the results (Bressers *et al.*, 2016). The summaries were derivative of a more robust set of observations and their interpretation. Statements of the different cells and questions of the assessment matrix were screened carefully. Important connecting issues were then highlighted to identify the improvement areas. This was used to develop and structure ideas relevant to the recommendations. Different approaches and experiences could be compared and thus, were used as the basis for further discussion in the DROP project (Bressers *et al.*, 2016). The evaluative questions of the GAT are provided in Table 1.

Governance dimension	Quality of the governance regime			
	Extent	Coherence	Flexibility	Intensity
Levels and scales	How many levels are involved and dealing with an issue? Are there any important gaps or missing levels?	Do these levels work together and do they trust each other between levels? To what degree is the mutual dependence among levels recognised?	Is it possible to move up and down levels (upscaling and downscaling) given the issue at stake?	Is there a strong impact from a certain level towards behavioural change or management reform?
Actors and networks	Are all relevant stakeholders involved? Are there any stakeholders not involved or even excluded?	What is the strength of interactions between stakeholders? In what ways are these interactions institutionalised in stable structures? Do the stakeholders have experience in working together? Do they trust and respect each other?	Is it possible that new actors are included or even that the lead shifts from one actor to another when there are pragmatic reasons for this? Do the actors share in 'social capital' allowing them to support each other's tasks?	Is there a strong pressure from an actor or actor coalition towards behavioural change or management reform?
Problem perspectives and goal ambitions	To what extent are the various problem perspectives taken into account?	To what extent do the various perspectives and goals support each other, or are they in competition or conflict?	Are there opportunities to re-assess goals? Can multiple goals be optimized in package deals?	How different are the goal ambitions from the status quo or business as usual?
Strategies and instruments	What types of instruments are included in the policy strategy? Are there any excluded types? Are monitoring and enforcement instruments included?	To what extent is the incentive system based on synergy? Are trade-offs in cost benefits and distributional effects considered? Are there any overlaps or conflicts of incentives created by the included policy instruments?	Are there opportunities to combine or make use of different types of instruments? Is there a choice?	What is the implied behavioural deviation from current practice and how strongly do the instruments require and enforce this?
Responsi-bilities and resources	Are all responsibilities clearly assigned and facilitated with resources?	To what extent do the assigned responsibilities create competence struggles or cooperation within or across institutions? Are they considered legitimate by the main stakeholders?	To what extent is it possible to pool the assigned responsibilities and resources as long as accountability and transparency are not compromised?	Is the amount of allocated resources sufficient to implement the measures needed for the intended change?

Table 1: The evaluative questions of the GAT matrix (Source: Bressers *et. al.*, 2013)

Another instance of application of the GAT involves the conduction of the Delta Lady project at the Dutch national park of Alde Feanen, the Netherlands. In workshops conducted with various stakeholders involved in the project, the GAT matrix was utilized to figure out ways to enhance the ecosystem resilience within the concerned region. The study addressed the extent to which a concern for ecosystem resilience was found to be embedded in the governance of the region amidst a series of ongoing climate and human disturbances (Lordkipanidze *et al.*, 2018).

3.3 Nature-Based Solutions

As the name suggests, Nature-based solutions (NbS) can be seen as the use of nature and natural structures/processes in tackling challenges involving climate change, food security, water resources or disaster risk management, encompassing a wider definition of how to conserve and use biodiversity in a sustainable manner which must be inspired by, supported by or copied from nature (Balian *et al*., 2014; European Commission, 2015). These represent solutions in the urban and non-urban contexts, which promote green management solutions that possess a significant potential to decrease the vulnerability and enhance the resilience of regions in light of climatic change (Kabisch *et al.*, 2016).

Direct benefits of using NbS predominantly concern the regulating ecosystem services in the region, such as climate regulation measured by temperature reduction, air quality regulation through a decrease of air pollutants, water availability for irrigation and increasing local water retention, increase in biodiversity, by and increase in vegetation cover (Beninde *et al.,* 2015). In this regard, the *Ice Stupa* project checks all the boxes in order to be categorized as being a nature-based strategy for water harvesting as a solution to the ongoing water crisis in Ladakh.

There also exist co-benefits of NbS which are being increasingly recognized as a result of increased provisioning and improved availability of green spaces brought about by the advent of NbS, in different landscapes. Such benefits include, alleviation of resource scarcity contributing to improved quality of life, mental and physical health, and reinforced cultural identities, as well (Keniger *et al.,* 2013; Hartig *et al.,* 2014). Taking this aspect of multifunctionality into account and considering the plethora of co-benefits produced, NbS often end up being the more efficient and cost-effective among solutions to climate change threats as opposed to the traditional practices and approaches towards the same, in a particular region (European Commission, 2015). Thus, in this way, NbS generally contribute to the three major aspects of ecosystem services (Regulating, Provisioning and Cultural). In doing so, NbS become an optimal candidate to be utilized in order to function in an integrative manner with ecosystems to adapt and mitigate the impacts of climate change in a region, conserve biodiversity and improve human health and well-being, providing a wholesome approach towards problem solving (Cohen-Shacham *et al.*, 2016). NbS are considered to be such innovations that, more often than not, require engagement with multiple actors, providing co-benefits that bridge social and economic interests and as thus, can stimulate new green economies and green jobs (Kabisch *et al.*, 2017; Raymond *et al.*, 2017).

NbS are viewed as solutions that are inspired and supported by nature, which simultaneously provide environmental, social and economic benefits and help build resilience in regional growth and stability (European Commission, 2016). Indicators of the effectiveness of NbSs, can often be characterized by considering their integrated environmental performance (including their relation to ecosystem services and disservices), transferability and monitoring (referring to stakeholder

analysis and governance criteria), citizens' involvement and the state of health and well-being which they offer and affect (Kabisch *et al.*, 2016).

3.4 Non-Conventional Water Harvesting Techniques

In terms of mitigating the effects of pollution and water scarcity, infrastructure development should also ideally, be considered a top priority but more often than not, infrastructure development is hampered by difficulty in accessibility and harsh climatic conditions (Singh & Mishra, 2004). The drawing of policies and plans is less effective in Ladakh, because historically these areas may have been of marginal concern for decision-makers, and therefore neglected in development priorities (Messerli & Ives, 1997). Policy implementation, additionally, is undermined by the region's political instability, which is made more complex due to proximity to disputed and international borders (Nepal & Chipeniuk, 2005). In such a terrain the advent of non-conventional water harvesting tools, such as artificial glaciers represent climate smart adaptations (Clouse, 2017).

The use of non-conventional water resources is relevant in such areas to alleviate water scarcity. Non-conventional water resources are either generated as a product of specialized processes such as water harvesting often require suitable pre-use treatment and/or appropriate soil–water–crop management strategies when used for irrigation. In water-scarce environments, such water resources are accessed through harvesting of snowmelt accumulated from glaciers (Qadir *et al.*, 2007). These artificial glaciers aim to meet local irrigation needs in the agricultural season by melting in the scarcity of natural glacial meltwater. At the same time, these ice reservoirs are also framed as an adaptation to climate change, a perspective suggesting that, contrary to popular notions, local knowledge is neither purely local nor disconnected from globally circulating and relevant knowledge about climate change (Nusser & Baghel, 2016).

Chapter 4:
METHODOLOGY

The research design pertaining to the step-by-step resolution of the problem statement and its constituent research questions and sub-questions thereof is presented schematically in this section in order to visualize the methodology behind this study and analysis, post data collection upon utilization of the governance assessment tool described in Chapter 3.

4.1 Research Strategy & Framework

The study can be distinguished by its two complementary phases, including firstly, a descriptive research goal in an attempt at the characterization of the external and internal conditions ultimately contributing to the 'crisis' conditions in Ladakh, in terms of water availability and food security. In the second, a more analytical phase presents the utilization of the Governance Assessment Tool in order to investigate the Governance conditions and the lack thereof, in the adaptation strategy as applied by the use of *Ice Stupas* through the Ladakh Region.
The following steps describe the series of activities involved in the conduct of this study.
Step1: Collection of secondary data on the following issues through a review of scientific and grey literature:

- The Geographical and hydrological features of Ladakh
- The Geopolitical situation of Ladakh
- The abrupt rise of tourism and its consequences
- The state of Agriculture and seasonal variability
- The advent of the Ice Stupa project
- Profile of the Ice Stupa project

Step 2: Analysis of the collected secondary data in establishing the empirical background for the water crisis and characterization of the *Ice Stupa* project, via a case study approach.
Step 3: Analysis of the varied actor characteristics and factors of success of the *Ice Stupa* pilot project and study of possible consequences of expansion and its effects on Ladakh and use of the GAT in order to form a basis of the questionnaires concerning the Governance dimensions and criteria, to be presented to interviewees.
Step 4: Conduction of field work & interviews with

a. **Members of the *Ice Stupa* team**; an offshoot of the SECMOL organization, chaired by the inventor of the Ice Stupas, Sonam Wangchuk
b. **Local environmental scientists & activists and public participants;** from a Ladakhi local communities involved with the *Ice Stupa* competition

c. Representatives of HIAL; volunteers and experts from another one of Sonam Wangchuk's institutes involved in the mitigation of the water crisis in Ladakh

Step 5: Deconstruction and combining of information gathered from the interviews and desk research to apply the Governance Assessment Tool and answer the evaluative questions for the GAT matrix to decipher the evaluation criteria namely, the extent, coherence, flexibility, and intensity.
Step 6: Analysis and compilation of the results of the GAT, as applied to the *Ice Stupa* project and commentary on the ongoing activities towards expansion and mitigation of the water crisis.
Step 7: Compilation of conclusions and possible recommendations

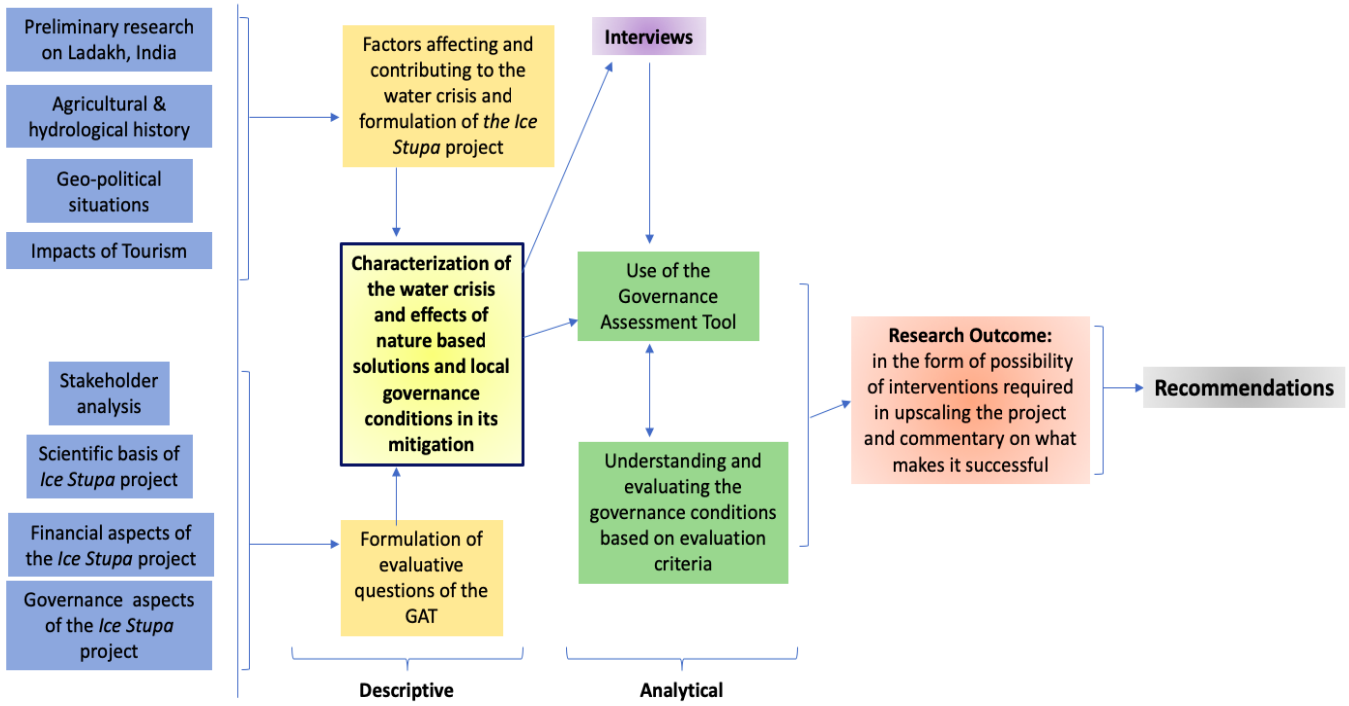

Figure 3: A schematic representation of the research framework

4.2 Research Questions

The main research questions can be seen as a direct inquiry of the problem statement, stated as follows:

(1) To what degree has the *Ice Stupa* project been successful in enabling the local communities to solve the water crisis in the region?

(2) In the governance context what is lacking, which would contribute to more actors' engagement in the expansion of such mitigation measures to curb the crisis?

Sub-questions are formulated as follows:

1. To what degree is the water governance context in Ladakh supportive of the *Ice Stupa* project?

2. Which aspects of the governance context should be improved towards the expansion of the *Ice Stupa* project?

The two sub-questions respectively correspond to the two main research questions, each contributing to a better understanding and means for answering the main research questions.

4.3 Limitations

The area of Ladakh, lies in the high-altitude region of the state of Jammu & Kashmir[1], in India. It is a region which falls under the Hindu-Kush-Himalayan ranges and is thus, not very well connected to the larger, more urban cities besides the district capital at Leh. Some of the interviews to be conducted were thus, subject to degree of acclimatization to the altitude and accessibility of some remote areas on the outskirts of Leh, thus, while some interviews were conducted face-to-face, others were done over the telephone.

Availability of scientific data is also limited to certain regions of Ladakh and only estimations for other such regions may be accessed through governmental databases. Besides these, during the field visit, while internet connectivity in some areas of Leh was generally supposed to be in decent condition, the same could not be said for the most of it and other regions of Ladakh, as a whole.

It is important to note that while the prototype of the *Ice Stupa* project has been deemed a success, providing promising new strategies for water harvesting in this dry desert region, very little data exists to substantiate, quantify, or contradict the project claims (Clouse, 2017). The public participation and primary data collection from the members of the *Ice Stupa* team, representatives of HIAL and SECMOL who are the primary organizations behind the *Ice Stupa* project would be given a higher weightage in the collected data.

4.4 Research Materials and Data Collection

The research material comprising of desk research and fieldwork output was compiled with the intent of applying the GAT in understanding the criteria of extent, coherence, flexibility, and intensity in order to answer the research questions and sub-questions. A brief description of this is provided in Table 2.

[1] NOTE: As of August 5th, 2019, the Indian Government has proposed to break up the State of J&K into two Union Territories (J&K and Ladakh). This would make Ladakh a Union Territory of India without its own legislature in the coming months.

Research Question	Information Required	Research Material	Outcome
1. To what degree has the *Ice Stupa* project been successful in enabling the local communities to solve the water crisis in the region?	Geographical, hydrological and climatic features of Ladakh The geopolitical situation of Ladakh Consequences of over-tourism Data on agriculture and seasonal variability	Primary Data: Interviews conducted with the Ice *Stupa* team, SECMOL/HIAL representatives, local entrepreneurs, and activists Secondary data: Scientific publications, Documentaries, Government reports, Conference reports	Background knowledge gain and simultaneous construction of the Literature review section of the report and a formation of the basis for questions to be considered for conducting interviews
2. In the governance context what is lacking, which would contribute to more actors' engagement in the expansion of such mitigation measures to curb the crisis?	Profile of the *Ice Stupa* project Data on the involved actors, their motivations, cognitions, and resources available	Primary Data: Interviews conducted with the Ice *Stupa* team, SECMOL/HIAL representatives, local entrepreneurs, and activists Secondary data: Ice *Stupa* team's reports, scientific publications, News articles, Documentaries, Government reports, Conference reports	Enumeration of factors and their consequences in the context of the *Ice Stupa* project as a whole and the preparation of the Questionnaires for the specific interviewees.
3. To what degree is the water governance context in Ladakh supportive of the *Ice Stupa* project?	Primary data from the interviews conducted to understand extent, coherence, flexibility and intensity criteria of the assessment matrix. *Ice Stupa* inventing organization's take on the governance conditions and the hindrances	Primary Data: Interviews conducted with the *Ice Stupa* team, HIAL representatives, local entrepreneurs, and activists Secondary Data: Scientific publications, Government reports	Conduction of interviews and assimilation of data into the Evaluation matrix of the GAT along with a gist of them to be conclusions.
4. Which aspects of the governance context should be improved towards the expansion of the *Ice Stupa* project?	The conclusions formed by the application of the GAT to the project and their outcome, in terms of going ahead with expansion and other mitigation strategies to manage the crisis.	Primary Data: Results of the GAT, interviews conducted with the *Ice Stupa* team, HIAL representatives, CSE representatives, and activists. Secondary Data: Scientific publications, Government reports	Reporting the findings of the GAT and resolving loopholes in the pre-existing knowledge gap in order to recommend interventions.

Table 2: Research Material and accessing method

In this study, the interviews conducted were on-site, face-to-face interviews at first and from then on, via telephonic correspondence and emails. The interviewees were selected based on their involvement in the *Ice Stupa* project itself and their efforts towards mitigating the water crisis in Ladakh, as a whole. Correspondence with the *Ice Stupa* team was established prior to site visit to Leh, Ladakh and the first meeting conducted was at the HIAL project location, established roughly 12-15 Kilometers outside of Leh, in May 2019. The meeting entailed a brief interaction with members of both the *Ice Stupa* team and HIAL project to introduce the prospects of this research and involve them in understanding the methodology and purpose. The second meeting thereafter went on to include baseline interview questions and evaluative questions of the GAT matrix. Telephonic interaction from this point on was made possible with the team at HIAL to gain insight into the gaps and existing problems faced in these strategies towards water conservation and ecosystem restoration in June 2019. While on site, interaction with a willing public participant in the *Ice Stupa* competitions was also conducted and paved the way for a formal interview. Thus, interactions with the major actor-groups concerned with the water management practices in Ladakh were made possible.

4.5 Case selection and Research Unit

The *Ice Stupa* project has over the few years since its advent in 2014, been acknowledged globally and received commendation. The lead engineer behind the project, Mr. Sonam Wangchuk is a recipient of the Rolex Award for Enterprise, which now funds the project and is touted to cover the provision of 20 *Ice Stupas*, in order to plant greater vegetation cover in these arid Himalayan regions. The research unit of this thesis is the *Ice Stupa* project, including the different actors involved in it and the governance dimensions (as dictated by the GAT) that may form observation units.

The region of Ladakh, after gaining tremendous popularity, upon being prominently featured in popular films, in India, saw an unprecedented amount of tourist footfall, resulting in this sought after tourist destination's carrying capacity being strained. The cultural identity and the heritage of the region of Ladakh are prominently being given acknowledgement by the UNFAO, and it is necessary to preserve the lands and indigenous community's way of life, which is heavily reliant on water. Given the sensitive political stability and disadvantageous geo-political aspects of the area that Ladakh falls under, it is prudent to look into alternate governance models, such as the one presented by the *Ice Stupa* project, since a top-down approach is hindered and often, not the best solution for a region such as this. The city of Leh, Ladakh, India and location of the *Ice Stupa* project site itself will thus, function as the locus of the research.

4.6 Ethical Considerations

The conduction of this research has adhered to the ethical responsibility in keeping with the principles prescribed by the Ethics Committee, BMS, University of Twente, The Netherlands. The principle adhered to includes the avoidance of exploitation, just distribution of benefits and burdens, respect for the persons being interviewed, respect for human dignity, scientific validity, scientific, societal and/or educational relevance, respect for rights and specific interests of (specific groups of) research participants, and/or the community/society and the safeguarding confidentiality and respecting privacy.

All interviews were conducted upon acquiring informed consent from participants (Appendix III) and the data thus collected has been safeguarded, digitally and otherwise and deleted after the completion of the research period.

Chapter 5:
RESULTS & DISCUSSION

In this section the findings from both, desk research including books and relevant documents and field research conducted through interviews are presented. The results of the interviews were then applied to the Governance Assessment Tool in order to construct a colour coded matrix to comment on the governance conditions and their role as being supportive/accepting or inhibitory, towards the *Ice Stupa* Project and the overall mitigation of the water scarcity in Ladakh, India, by means of nature-based water harvesting strategies.

5.1 The case of the *Ice Stupa* Project

The interviews conducted with members of the *Ice Stupa* team and instructors and entrepreneurs at HIAL, India have provided a basis for the characterization of the Governance conditions surrounding the *Ice Stupa* project. This section details the functioning of the project and its impacts so far.

5.1.1 Operations of the *Ice Stupa* Project

The operations of the project begin with awareness campaigns and educational workshops conducted by the Inventor of the *Ice Stupas*, Sonam Wangchuk and his team of volunteers (henceforth referred to as the *Ice Stupa* team). The *Ice Stupa* team's aims are twofold:

a. The first aim is to alleviate water scarcity within the regions in Ladakh and to make the local communities self-reliant in this endeavour, taking matters into their own hands by implementing these alternative measures towards a more sustainable method of water management in a water scarce region, without having to rely on Governmental intervention.
b. The second aim is to create an atmosphere where tourism is not seen as a burden on the lands of Ladakh by creating value out of the built *Ice Stupas* and promoting income generating activities and winter sports so as to not limit the tourist influx to only the summer months, when the strain on the carrying capacity of the land is greater.

The means by which they conduct the project initially included the voluntary funding of the project by its creator, Sonam Wangchuk using his own reward money from various organizations who have acknowledged his contributions to science and social activism over the years and funds pooled in by the members of the *Ice Stupa* team. From then on, crowd-funding campaigns were conducted after the benefits of building *Ice Stupas* to harvest water during the winter months and use them in the summer months were realized in different regions of Leh, Ladakh. Besides this collaborators such as the irrigation equipment manufacturing company, Jain Irrigation contribute to the project by providing the team with the physical equipment (pipes, drains, pumps etc.)

required for the construction of *Ice Stupas* at subsidised prices which the team, in their workshops would distribute to the participants from local communities, free of cost as they teach them how to build an *Ice Stupa*, its scientific basis and advantages and what is to be done for its upkeep.

The *Ice Stupa* team currently also has a branch in Switzerland (*Ice Stupa* International) in collaboration with researchers and actors who wish to implement Wangchuk's conical artificial glaciers in the MortAlive project along the Morteratsch glacier, Switzerland. The team consults the Indian team for their technical know-how and knowledge of instrumentation in an attempt to incorporate nature based solutions for water harvesting and currently, the R&D for further improvements and upscaling of the parent *Ice Stupa* team is handled by the team of hydrologists and glaciologists in Switzerland in a synergistic relationship. Both the teams conduct workshops in Switzerland and India to encourage public participation and spread awareness regarding the technology and science behind the building of *Ice Stupas*. The Swedish scientists and practitioners closely work with HIAL, in the same manner. The R&D for the upkeep and upscaling initiatives for the *Ice Stupa* project in India currently deal with hindrances pertaining to, a. Physical blockages in pipes, during extreme temperature drops experienced in the region, and b. Finding solutions to the wastage of water which flows downstream during the initial stages of construction of the *Ice Stupa*.

The advent of the *Ice Stupa* project was welcomed first in the village of Phyang where the team would construct the artificial reservoirs and simultaneously educate the local communities on the need for these structures in their area. This focus shifted later (in 2018) to the region of Gangles, Leh. Garnering support from Ladakhi participants from different villages across Leh who collected to attend workshops, the team went on to teach the local populace how to build *Ice Stupas* with equipment provided to them as incentive and the management and upkeep were entrusted to these participants over time. As a way of instigating more enthusiasm within the participating communities, the team amidst fundraisers began to hold *Ice Stupa* building competitions to both, popularize the concept and see how adept the local communities were growing to be in the management of their *Ice Stupas*. The competition was judged by the team in terms of the volume of water output, height, number of participants involved etc. Money from the fundraisers was invested in acquiring the equipment at subsidised rates and then distributing them to competing parties, allocating the remaining amount as award money for the winners. This initiative was accepted widely mainly due to this strong sense of community involvement, an encouragement of the self reliant capabilities of the local community and the notion that ultimately this is for the public good.

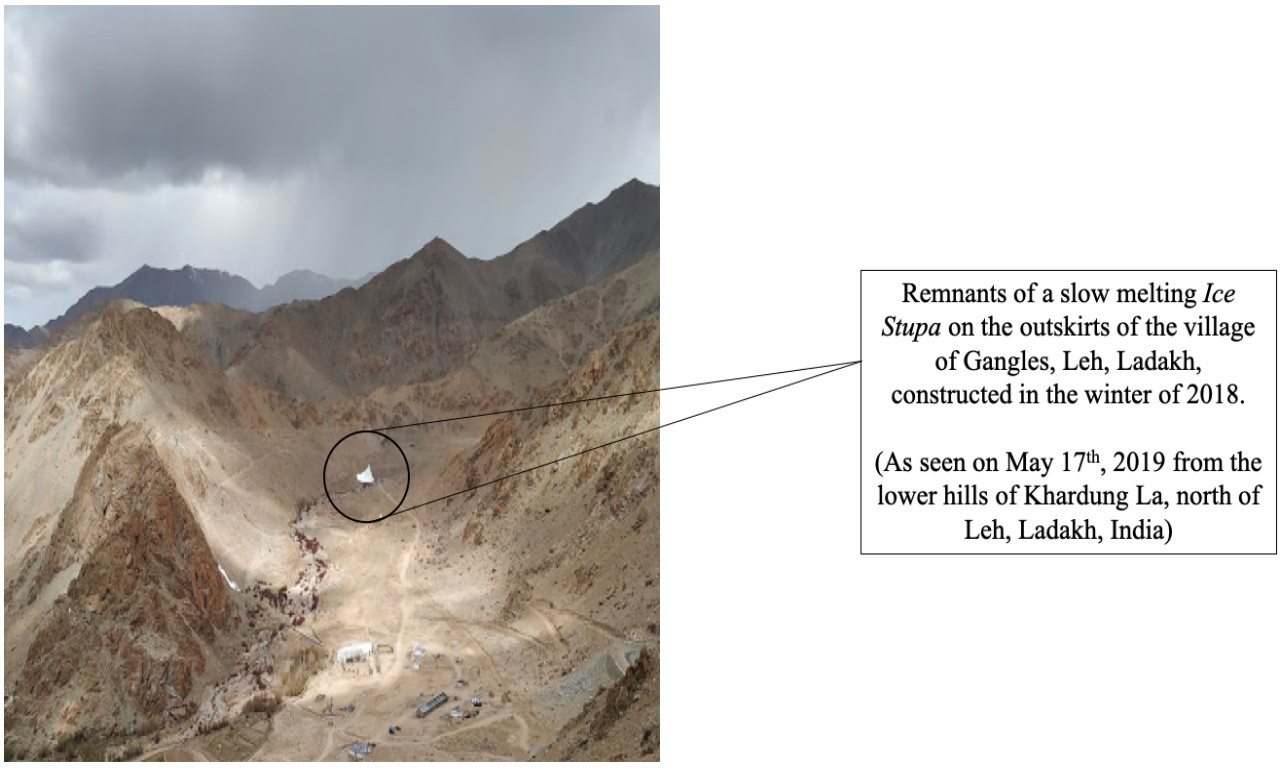

Figure 4: An *Ice Stupa*, west of the village of Gangles, Leh, Ladakh, India

Figure 5: The village of Gangles, Leh, Ladakh, India

According to the project team, there has been immense local support from the participating communities and in seeing the benefits of these artificial reservoirs, more and more participating individuals engaged in trying to be self-sufficient in creating their *Ice Stupas* for their own

villages. In such circumstances, came up the ideas for creating value from the existing *Ice Stupas*, which now besides becoming a tourist attraction, could also invite methods of income generation and support a greater footfall. The "Ice Cafe" opened at the base of an Ice Stupa in Ladakh is one such initiative by local Ladakhi youth, besides which there is an attempt to popularize Ice Climbing, as a winter sport, prospectively starting from 2019.

The evolution of the plan depicting the aims, roles and impact of the *Ice Stupa* project can be visually represented as such, below:

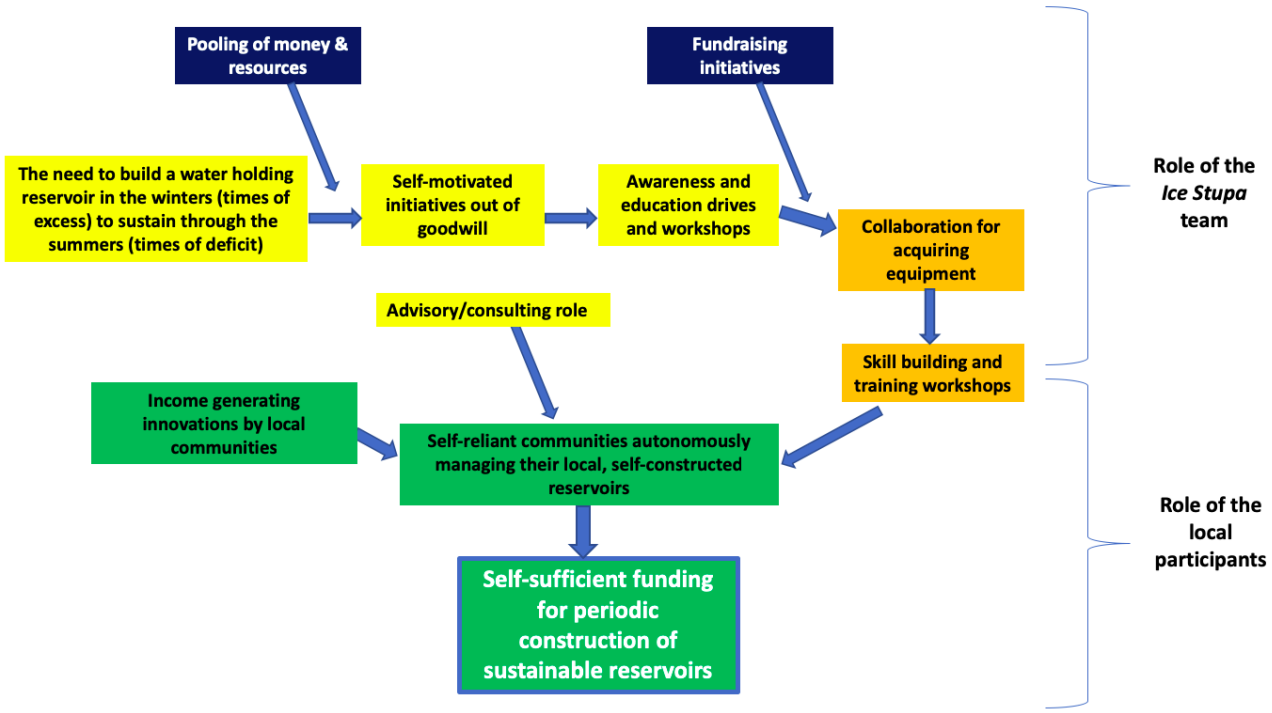

Figure 6: A depiction of the functioning of the *Ice Stupa* project

Considering at face value, the *Ice Stupa* project in Ladakh, the overall picture is that of a supportive self-governed regime with ample stakeholder involvement with minimal inhibitory forces acting against the use of alternative methods of water conservation in such an arid, high-altitude region where the local communities are given the power to take care of their own needs in terms of water availability.
The various Governance dimensions are discussed separately under the following sections, in this regard.

5.2 Governance Context of the *Ice Stupa* Project

The application of the GAT was based on the evaluative questions answered by participants in the interviews conducted for the purposes of this research, learning from the answers given by the Project Managers of the *Ice Stupa* team and scientific literature. Before the construction of the colour coded matrix, the different governance dimensions are described below, to provide an overview of the governance context.

5.2.1 An overview of the governance context

The GAT, through the lens of a multi-actor interaction process focuses on the variables and fluxes in the processes of implementation itself, while putting emphasis on how well the governance context supports or restricts the described implementation process (Lordkipanidze *et al*., 2018). Based on this tool, an analysis of the different governance dimensions with regards to the functioning of the *Ice Stupa* project as discussed with the interviewees (Appendix II) are presented below.

Levels & Scales

The *Ice Stupa* project, being the brain child of Sonam Wangchuk, is carried out under his supervision and upon his directions, based on his and the team's technical know-how. However, it is intended to benefit the people of Ladakh and is thereby heavily influenced by their needs and desires. Due to the great degree of trust between the *Ice Stupa* team and the local populace changes carried out over time have been readily consented to, by the people of Ladakh. This trust exists by way of the collective learning that while the governmental actions do exist at the state level, in trying to conserve water in the region, it is the people themselves who can act as a major stakeholder in this effort towards unconventional strategies for water conservation in these arid, high altitude areas.

The overall hierarchy within the parent organization (*Ice Stupa* team) is fairly linear with fluid roles but assigned responsibilities. The make-up of this structure is presented in Figure 7.

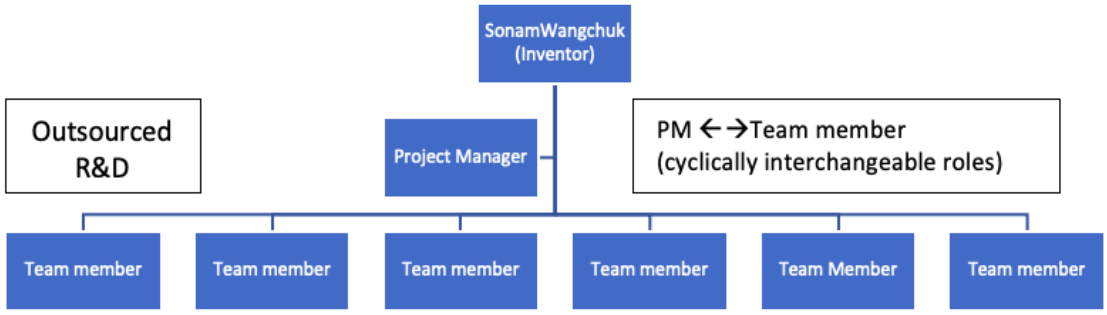

Figure 7: The structure of the *Ice Stupa* team

According to the team, the newer *Ice Stupas* being developed are solely handled by the local participants, who only consult the team regarding management and upkeep but overall, the participating local actors who have attended the workshops in the past are now accountable for their own *Ice Stupas* and their upkeep.

There is a direct effect of the levels of governance and their interaction occurring, in the final status of the project and the extent of its success. In this regard, the management and preservation of a natural resource, such as the snowmelt from glaciers, may be understood not only in terms of a top-down way of public management, but also in terms of civil or social action and self-regulation by an affected society, representing a bottom-up approach (Kuks *et al.*, 2012).

The hydrological levels under consideration include, as of now, only the water that would otherwise be wasted as excess flow from glacial melt, during the winter months, not leaving enough for the summer months, when scarcity occurs. The *Ice Stupa* team aimed at utilizing the natural forces of gravity and below-freezing temperatures occurring during the winter months, in these mountain ranges and valleys to construct the conical shaped 'stupas', so as to leave minimal surface areas exposed to the sunlight, leading to a slow and steady melt during the summers, prolonging the life of this alternate water harvesting reservoir.

Actors & Networks

The major actors involved in the *Ice Stupa* project include:

- *Ice Stupa* team (India); pioneered by Sonam Wangchuk, inventor of the *Ice Stupas.* His team consists of 7 members of whom one member, periodically & cyclically acts as the Project Manager.
- The people of Ladakh; the communities who will benefit from the *Ice Stupa* project and primarily the participants in their educational workshops and *stupa* constructing workshops, who then go on to handle the *stupas* in a manner that is self-reliant, with the *Ice Stupa* team having only a supervisory role after the successful conduction of the water management system at a given location.
- *Ice Stupa* International team (Switzerland); R&D purposes; skill sharing.
- Jain Irrigation Systems Ltd.; A company manufacturing irrigation equipment which they provide to the *Ice Stupa* team at subsidised rates
- Ladakh Rural Development Authority; contacted for permission while selecting locations for constructing an *Ice Stupa*.

While the primary actors were the initiators of the project, the *Ice Stupa* team, their system has over time evolved into a design where the participating Ladakhi communities become the primary actors by learning and developing this novel technique of water harvesting by means of alternative methods and tailoring it to their own needs and aspirations by creating value from it in an effort to make their individual projects self-sustainable. This way, the public good is taken

care of in a self-reliant manner, with no governmental involvement in mitigating the lack of water, they would otherwise be facing.

There is immense trust within the *Ice Stupa* team, where the roles are fluid and so far, the communication and operations have been running smoothly. The same can be said for the relationship between the team and the participating Ladakhi communities. In terms of points of conflict, there were earlier slight differences since some opposition was faced from the people of Phyang, citing the regional petty disputes and prejudice existing between the regions of Phyang and Gangles upon which the location of the new *stupa* sites were shifted to Gangles. Besides that all participating communities and the people of Leh, have been welcoming towards the idea of the *Ice Stupa* project in their region.

There is no Government organization's involvement, besides Rural development authority's occasional role in consenting to let participants use up a certain area in order to construct the *Ice Stupas.*

Considering the time dimension, The *Ice Stupa* team, India is currently hoping to expand horizontally by firstly creating a separate department to internalize the R&D involved in the need of upkeep and management of the project and upscaling it.

Problem perspectives & goal ambitions

Upon conducting workshops with the local Ladakhi populations, the *Ice Stupa* team intends to educate and make aware the local populace, villagers and occasional visitors about the issue of water scarcity that a large chunk of the region of Ladakh is grappling with and how it will only be exacerbated in the coming years due to a. Climate change, affecting the timing and quantities of glacial melt that the region receives and b. The improper use of water and lack of storage reservoirs which lead to a large volume of water being wasted, every year.

Tourism was a force that opened the eyes of a large chunk of the communities towards the acute shortage of water during certain months, where ideally there should have been more. This education and awareness being widespread has led to greater and steady public participation in the *Ice Stupa* project, over the past few years. The idea that it is for the collective good of the local communities and tourists alike, as well as the thought that even in the absence of governmental initiatives, villages can be made self-reliant in dealing with the issue of water availability fuels a greater part of the Ladakhi communities into investing themselves in to this cause.

Thus, an effort which commenced through sheer goodwill and willingness to contribute towards the greater good has now involved many individual stakeholders in coming together to do what is in the public's best interest, giving more power to the people and their abilities to inculcate the

idea of water conservation as a core agenda for local communities in small villages in the region of Leh, Ladakh, particularly without the dependency on state authorities in trying to mend the issue.

After the declaration of the region of Ladakh to be made into a Union territory (UT) in August 2019, policies may change in terms of water conservation, through the region, by Government actors. But currently, similar efforts at water conservation have not been observed to have the same zeal by the Governmental bodies when compared to the efforts being made towards water harvesting exhibited by the local communities and the *Ice Stupa* team. Ladakh's representative Member of Parliament in the Central Government noted the lack of funding and attention paid towards the development of Ladakh, when compared to the development of the regions of Jammu and Kashmir (India Today, 2019). Thus, the UT status comes as a welcome move for Ladakh. Presently, however, the general consensus among the Ladakhi communities is that there has been no change in the Government's status quo so far, given the many years since when water shortage has been a reality in the area. This fuels the Ladakhi communities to work towards the greater good, more so, according to a public participant.

Additionally, there is the element of packaging and clubbing of certain goals being achieved by the same outcomes of the project, such as the promotion of winter tourism in a state where generally tourism influx is limited to 3-5 summer months (the same months when water stress is experienced). The HIAL project also encourages local Ladakhi youth entrepreneurs to expand the popularity of areas in the lower ranges by promoting homestays and eco-tourism initiatives for tourists coming in from the south of Ladakh in an effort to help tourists as well to acclimatize to the high altitude and slowly make their way up to the regions of Leh and beyond. As such, a large chunk of the footfall can be dissipated towards different areas and not be collectively arriving at Leh, as is currently the norm.

Strategies & Instruments

The current strategy involves the *Ice Stupa* team behaving as a catalyst in getting the Ladakhi communities to see the bigger picture and want to invest their time and skill in learning through their workshops, the instrumentation, construction process and management of the *Ice Stupa* as a seasonal water reservoir. Once the invigorated and sufficiently educated villagers are endowed with knowledge and provided free equipment as incentive (in collaboration with Jain Irrigation Systems Ltd.), they are encouraged to make the project at their own site a self-sustaining endeavour.

Besides considering the public good and the mitigation of the threat of water scarcity as a whole, through competition, innovation in the *Ice Stupa*'s management is encouraged in order to keep profitability as a core aim as well, allowing for a periodic revival of the *Ice Stupa* through its own funds.

This way, the local community's dependence on the *Ice Stupa* team is reduced and accountability, increased in the management of their own water resources; leaving the *Ice Stupa* team free to slowly expand to different parts of the region.

Responsibilities & Resources

The project started off by means of pooling together inherently possessed resources by volunteers and eventual team members under the guidance of Sonam Wangchuk inspired by his contributions towards the expansion of his technology. The team included activists, educators, engineers and students who contributed to the technical knowledge required to sustain the *Ice Stupas* as a nature-based solution for water harvesting and spreading awareness among local communities regarding the same. Fundraisers were held post the popularity of Wangchuk's invention and in an effort to expand the benefits of the *Ice Stupa* technique to different regions of Ladakh. After the advantages of building *Ice Stupas* to harvest water during the winter months and use them in the summer months were realized in different regions of Ladakh, efforts were made to endow the local communities with the same resources they would need to run the project on their own, for themselves and eventually, by their own means.

Besides this collaborators such as the irrigation equipment manufacturing company, Jain Irrigation Systems Ltd. contributed to the project by subsidizing physical equipment (pipes, drains, pumps etc.) required for the construction of *Ice Stupas* for the cause, to have the team distribute these to the participants from local communities, free of cost as an incentive to participate in workshops and build *Ice Stupas*. Upon providing an understanding of the scientific basis and advantages and ideas for better management of *stupas*, the local participants then went on to take sole responsibility and ownership of their *Ice Stupas*, in different villages. Income generating innovations were welcome in an effort to ensure self-sustenance of the structure so that no more fundraisers in the future would be necessary for the revival of the *Ice Stupas*, each year.

Over time, the possibility of attracting greater income generating sources could drastically improve the volume of water, overall being saved and conserved for the water stressed months by creating more numerous structures in the same region.

5.2.2. Visualization of the Governance Context using the GAT

Based on the answers obtained from the interviewees (Appendix II) and in response to the evaluative questions of the GAT (presented in Chapter 3), and relevant desk research, the five governance dimensions discussed in the previous section were assessed according to the four governance qualities of extent, coherence, flexibility and intensity of the GAT, as described by Bressers *et. al.* (2013). Derived from those a score of High (+), Medium (0) and Low (-) was assigned to each of these dimensions as an evaluation of the degree to which these qualities were possessed. The intended results of this are an exploration into what could be improved in the governance context in making the situation less of a crisis.

The following table is a visual representation of these scores, colour coded to be green, for 'high', yellow, for 'medium' and red, for 'low'.

GOVERNANCE DIMENSIONS	**GOVERNANCE CRITERIA**			
	Extent	**Coherence**	**Flexibility**	**Intensity**
Levels & scales				
Actors & Networks				
Problem perspectives & Goal ambitions				
Strategies & Instruments				
Responsibilities & Resources				

Table 3: The assessment of governance qualities against governance dimensions

Understanding the situation in terms of the four qualities with regard to the Governance dimensions so studied, the following can be observed:

1. **Extent:**
   In reference to the completeness and comprehensiveness of issues at hand, enquiring the extent to which all relevant aspects of the governance dimensions have been accounted for, the levels and scales are scored 'medium', since there is noticeably an absence of any Governmental involvement in the system. The system's success so far has been solely on the basis of the participant actors, which are all non-governmental forces at play, a large part played by the non-governmental and non-profit organizations along with the local communities of Ladakh. As for actors and networks, the score is 'medium', since the involved actors all play significant roles in the system and there is transparency and fluidity maintained throughout the different phases in the conduct of the project however, any government involvement is missing.
   In terms of problem perspectives and goal ambitions, it is evidently a high score since the different actors and actor communities seem to be on the same page, after attending workshops and training sessions, about the disasters that could be entailed, if the mitigation measures are not taken into their own hands. The project began through goodwill and the idea that this is being done for the collective good. This was a notion made clear to the participating public after properly being made aware of the situation in Ladakh and it seems to resonate at the core of all participating bodies' aims.
   The strategies and instruments receive a high score based on the property that it is a very simple system of education, incentivization and communication which has led to the success of the project. Lastly, in terms of roles and responsibilities, the system gets a 'medium' score since the fluidity of roles is at play. This does benefit the system but considering the time dimension, this could create disbalances and inconsistencies.
   Resources however, since the inception of the project were the personal funds pooling and intellectual faculties of the members of the *Ice Stupa* team and Sonam Wangchuk. This was supported by fundraising campaigns, the reliance on which is now less and less since there is a transition towards the self-sustaining model of *Ice Stupas* which can generate monetary value for themselves, however since its still in transition, at this point the score remains medium. This would change to high when most or all *Ice Stupas* are constructed by way of this self-sustaining model for profitability.

2. **Coherence:** In terms of affecting the overall picture, while slight contradictions do play a part, there is a definite coherence smoothly playing across all the dimensions of governance in question and they do affect the outcome by strengthening each other and not contradicting. There is a seamless transition between one stage to another within different actor networks and their problem perceptions which tie up neatly with the

transitions in roles and responsibilities and resource allocation during the conduction of the *Ice Stupa* Project at any given particular site. In terms of strategies and instruments, historically, while similar strategies have been at play, owing to an early version of an artificial glacier and its rate of success and inevitable limitations, as well as the instance of Government action (which included groundwater development and snow water harvesting), the *Ice Stupa* project has been far more successful than any of these past attempts. It is a more technically sound and modern version of an artificial glacier, offering maximum water storage to tackle the reduced rate of runoff. The technology coupled with the strategy of governance it involves makes for a more coherently functioning system. Thus, this dimension receives a 'high' score. There is mild discrepancy with regards to the people of Phyang village who earlier accepted but then later on opposed the proliferation of the project within the Phyang region. This led to a price being paid by the *Ice Stupa* team and willing participants, in terms of time, effort and resources. This occurred due to pre-existing communal disputes between the villages of Phyang and Gangles and ultimately hindered the project's progress. Because of this reason the score for the 'actors & networks' dimension is 'medium' and not 'high'.

3. **Flexibility:** In all established governance dimensions, the flexibility gets a high score, given how fluid and adaptable the initial strategy remained ever since its inception in 2014. The evolution of the management strategy in terms of accommodating more secondary goals as time has passed, and keeping the scale for them practical and specific to the needs of the people of different participating regions indicates the existence of multiple ways of achieving the ultimate goal, namely water harvesting and tourism dissipation, even accommodating greater proliferation of regional economy. Another indication is the ability to juggle roles and responsibilities within the system in such a manner where the people are given more power towards the end in order to establish a self-reliant group of individuals in each village, responsible for their own water management strategies, free to innovate as they please with only a consulting role left at the end of the primary organization's involvement, easily facilitates multiplicity in ideas and adaptive strategies. The greater degree of flexibility has in ways facilitated the degree of participation under this system given how other initiatives by governmental bodies and independent activists in the past had also focussed on building artificial reservoirs but the adaptability & uniqueness of *Ice Stupas* and majorly, the accessibility and involvement of local communities in the project, in a system where they are made the bearers of responsibility and accountability due to their own engagement in the project, overall makes it not just fascinating but also attractive as a way of taking matters into their own hands. In this way they are not just following orders but they are being educated about their self-interest and benefits in terms of a better environment and given the freedom to innovate.

4. **Intensity**: The intensity and the degree of support for changes in the regime varies currently, through the different governance dimensions. In terms of levels and scale, a medium score has been placed, given that the primary stakeholders are all brought into the fold once awareness is achieved and the back and forth of support in developing the individual projects between these primary stakeholders works seamlessly so far, in this system. However, there is a complete lack of government engagement in this project. The government's own efforts particularly in the Ladakh region of the state of Jammu & Kashmir have been either inadequate or in the least, shortsighted with regard to water conservation and strategies for creating greater water availability. Albeit, this appears to be balanced well by the impressive extent of public engagement with the project.
A low score however has been allotted to the 'actors and networks' dimension owing to the conflict (however mild) between the villages of Phyang and Gangles and the feeling that in comparison Phyang village was at a disadvantage. While the success of the prototypes and the initial few *Ice Stupas* were welcome in Phyang by the local community and even ceremoniously blessed by monks of the Phyang Monastery during the initial days of the project, the proliferation of the project within the region was hampered over the past few years. The wrong notion that a strain is faced by the downstream village of Phyang in comparison to the upstream village of Gangles and the unscientific idea that in the long run, numerous *Ice Stupas* would affect the availability of flowing water during the months where glacial melt is available was cited. The *Ice Stupa* team argued that the *stupas* constructed under their supervision were those using only the excess water that was otherwise being wasted but due to pre-existing differences between Phyang and Gangles and the mild rivalry proved to be disruptive in the outreach of the project.

However, the village of Gangles, closer to Leh, has been very welcoming and allowed for the project to function unhindered by biases, within their region. This was possible since the problem perspectives and goal ambitions of all participating individuals has been looking towards the greater good. This was made possible partly by the involvement of the Leh Phudo society (A cultural welfare society at Leh, India) and their supportive role during fundraisers and awareness campaigns. The widespread awareness of the issues at hand was realized by a majority of people in Leh and in particular the people of Gangles who show great enthusiasm in welcoming the *Ice Stupa* project within their region. Thus, a high score was given in this dimension.
The last two dimensions receive a score of 'medium' in terms of intensity since minimal policy instruments are at play and this could change if sterner policy instruments are brought in, possibly in a disruptive manner. So, while the current flow of activities seems to be running seamlessly, it rests on resources and incentives that may not remain the same in every case and thus, could destabilize the system slightly, if self-sustaining *Stupas* are not popularized. More so, since currently the fundraisers and subsidised

equipment are ample for the rate at which the competitions and the public participation is running, it is currently successful in maintaining the system, while there is a slow transition towards a more financially sustainable model, a medium score is applicable. The system overall, currently is running fairly smoothly and there is lesser reliance on the team's inherent resources while simultaneously there is a shift in dependence being brought about among the two prime actor communities. If self-sustaining and self-reliant models of these unconventional water harvesting methods are in the future brought about in more numbers, the score would be high but until such a time, it remains medium.

The overall governance regime based on this matrix can be seen as being very supportive of the conduct of the *Ice Stupa* Project in trying to mitigate the water crisis in Ladakh, India. It is inhibited only by some physical and social hindrances but to a very small, nearly negligible degree. According to the interviewed local participant from Leh, the number of participants has been increasing and as more and more people are realizing the benefits of water harvesting, technically in their own 'backyard', there is a collective positive reception and a sense of ownership involved in the construction of these structures every year, it is slowly becoming a cultural phenomenon, attracting tourists and researchers from outside of Ladakh as well.

According to the *Ice Stupa* team, there is progress being made in the design of the *stupas* every year as well, since earlier the height of the structures used to range between 70-80 ft., there are now *stupas* standing at 110 ft. as well. The competitions held by the team assess also the volume of water collected from each reservoir, which encourages the participants to save more. More recently, there has been a shift in the way the *Ice Stupas* are modelled by trying to accomodate designs which can create monetary value and in the long run, sustain the *Ice Stupa* project in these regions where it has received success.

The overall success of the efforts of the *Ice Stupa* project in mitigating disturbances in the ecosystem brought about by climate change and heavy stresses on the natural carrying capacity of the land by a large and ill-timed turnover of tourists in the region can be observed in relation to the increase in self-governing capabilities it has instilled in the greatest stakeholder in this water crisis, the good people of Ladakh.

Chapter 6:
CONCLUSION

The region of Ladakh, up in the arid, high-Himalayan mountains is home to a culturally rich and unique community. Environmental ethics are inherent to the principles of the people of Ladakh and respect for nature and life is evident throughout the local populations. The region faces the threat of water scarcity, materializing into a crisis situation in some highly water-stressed areas. This study has been an attempt at understanding the problems classifying the situation of Ladakh into a water crisis and through the governance perspective trying to disseminate the functioning of an effort such as the *Ice Stupa* project, a self-governed system of inspired and strong-willed individuals, trying to make a change for the betterment of the indigenous communities of Ladakh and a region as a whole, in the absence of Governmental involvement.

The following sections present the arguments and answers to the core research questions of this study, in an effort to contribute towards the understanding of the functioning and success behind such a system of self-governance and the identification of possible gaps in the system which could contribute to the improvement of the system, and act as a basis for other such initiatives to learn from and thrive in their efforts towards the collective social and environmental good.

6.1 The materialization of the water crisis in Ladakh

While Ladakh has been welcoming tourism since the 1980s, it was not until 2009 and onwards that the popularity (through portrayal in pop culture and greater accessibility of the region from the mainlands) grew so much that the heavy traffic of tourists flooding the regions of Leh, Nubra Valley, Pangong etc. began to create a strain on the natural carrying capacity of these regions. This situation, exacerbated by climate change and the resulting reduction of runoff from the glacial melt severely, in the summer months, creates a deficit in the water requirements of these over-populated areas during the peak tourism seasons. Water availability, particularly in the regions around Leh was particularly strained and the physiological phenomenon of greater water demand in areas for the tourists acclimatizing to these arid, high altitude terrains not only strains the drinking water availability due to the massive volume of tourism but also has created a great amount of plastic waste being generated from the bottled drinking water consumption. Triggered by external forces and abrupt changes in climatic conditions has led not only to the scarcity of water but to problems with wastewater treatment, river pollution, solid waste disposal, municipal facilities and vehicular pollution, collectively materializing into an environmental ‘crisis’, over fragile lands.

6.2 The success of the *Ice Stupa* project

It is clear that there is a wholehearted support from the local communities around Leh, Ladakh in conducting the *Ice Stupa* project. The popularity and success of the project as a means of establishing nature-based, unconventional water harvesting strategies in these water deficit regions can be owed to the public participation and ever-growing involvement of local population in establishing and taking accountability for these structures, with consistent efforts evident throughout the region in trying to innovate and make the technique their own.
The ultimate aim of the *Ice Stupa* team, being the endowment of a self-reliant local community in managing their own water harvesting needs in times where no real governmental action is taking place, with awareness, technical know-how and monetary means to create a self-sustaining system of water recharge, in order to negate the effects of the water crisis within these regions is so far, being achieved satisfactorily.

6.3 Assessment of the governance context

The use of the GAT in an effort to understand the nature of the governance context surrounding the *Ice Stupa* Project indicated a great degree of supportive governance conditions in the absence of the involvement of governmental actors. Considering its main actors and stakeholders, their engagement with each other and particularly, the flexibility exhibited in the governance context negate the little inhibitory or repressive conditions that do occur. Therefore, in achieving the common goals for the collective good of the people of Ladakh and their lands, this system appears to be prospering.

The expansion of the project and its evolution, with time have created a system where the people are in power and are responsible for their own capabilities of solving the 'water crisis', by using these unconventional methods of alleviating water scarcity from the region. The most evidently supportive and encouraging forces behind the success of this governance system surrounding the *Ice Stupa* project are owing to the very high degrees of flexibility observed throughout all five governance dimensions and similarly, the greater degree of support over all four criteria in terms of problem perceptions and goal ambitions. These appear to form the backbone of the governance regime that support it structurally. Besides this, issues do arise over the criteria of intensity which need to be dealt with through most of the governance dimensions. However, despite this, the majority of dimensions and criteria exhibit a high degree of support in the governance context with regard to the *Ice Stupa* project.

A remarkable feature of this is how the primary actors and benefactors switch roles with the local public after a point, beyond which the local communities are left more empowered with knowledge and the right equipment and the same goals at heart, as the primary organization, from then on, they strive to create a self-sustaining solution to their water availability requirements. The primary organization, (the *Ice Stupa* team) at this point is then present in an

advisory and/or supervisory role, with sole ownership and accountability being passed on to the participating local communities. The degree of dependence of the people of Ladakh on the local government thus, decreases in a synergistic fashion, where it lessens the burden on governmental bodies as well, when the people's needs in terms of water availability are being met. This atmosphere is overall entirely supportive of such efforts as those of the *Ice Stupa* team and the Ladakhi participants open to innovation and willing to take matters into their own hands, in an effort to work for the betterment of the region by solving complex problems with collective action in a mostly self-governed regime.

6.4 Room for improvement within the governance context

The efforts towards improvement within the governance context surrounding the *Ice Stupa* project may be viewed as steps taken to overcome the presently persisting hindrances and avoidance of past setbacks to crop up again. The majority of these are already being taken into consideration by the *Ice Stupa* team and overall, they may be presented as follows:

- Linear expansion of hierarchy within the *Ice Stupa* team (India), in an effort to internalize some of the functions for which they remain dependent on external help, such as a separate department within the team for conducting research & development of the project, as it is known to already be evolving over time. Physical barriers mentioned by the team, including physical blockages in the pipes laid down to form the *stupa*, the excess water lost during the construction of the structure and engagement of fewer Ladakhi youth in remote areas (since many of the younger, educated and able bodied Ladakhi population move out of the villages for better income opportunities to the larger towns), are all issues to be tackled. Currently external consultants and the research team at the *Ice Stupa* International team are engaged in solving these issues.
  This would affect the governance dimensions of both levels & scales as well as actors & networks. To some extent, it would have a more positive effect on resources too.
- Setbacks due to the petty rivalry between the people of Phyang and Gangles over the false claims of water availability being lower for one region than for the other were disheartening to the *Ice Stupa* team and to the eager participants from within the Phyang region. It led to loss of some time and effort and ultimately since the shift had to be made to the village of Gangles, pre-existing prejudice and petty politics led to an opportunity being lost. Nevertheless, with the efforts of the Phudo society and the enthusiastic participation and support from the people of Leh and outsiders, the project could flourish yet. But having a lack of proper awareness and indulging into petty, unfounded reasons to withdraw from the project, led to a disruptive effect on the governance of the situation. A solution to this could be a willingness from the community leaders of Phyang towards an open dialogue against these regional disputes, as ultimately it would become a self-fulfilling prophecy if Phyang were to experience a lack of water resources when compared to Gangles, due to their own actions.

- Subsidised equipment acquired from Jain Irrigation and successful crowdfunding endeavours have been operating well, however a large chunk of the funding still comes from the award money generously pooled in by Sonam Wangchuk and the project team. While it is functioning currently, considering the time dimension, this is not a stable financial model. If not substituted with enough self-sustaining *Ice Stupas*, it could destabilize the system in the long run, leading to a very disruptive effect on the resources, policies and strategies, and on the flexibility of the governance context. A stable and consistent funding system can be achieved, if year by year, most of the project sites incorporate income generating activities. According to representatives of HIAL, this would also lead to a lower concentration of tourism activities within certain regions by dissipating the crowd towards these sites and locations far from the main towns. A focus on making winter tourism activities popular would also lessen the burden on water resources in the summer months.
- According to Das *et al.* (2019), there is a huge potential for the development of renewable energy, such as solar, wind and hydropower, within Ladakh. However, this has not been exploited enough to benefit the region yet. These are core concepts behind the functioning of the HIAL project which aims at establishing a zero water waste, zero energy waste and near-zero food waste lifestyle to form a self-sufficient town on the outskirts of Leh, to lead by example, using *Ice Stupas* for their irrigation and domestic water requirements, as only one such intervention in the system. The possibility of receiving funds for such projects from the government would amount to quicker and more reliable outcomes and would allow all concerned levels and scales to be involved.

6.5 Recent developments and their implications

On August 5th, 2019, the Indian Government declared plans to divide the state of Jammu & Kashmir, of which Ladakh is a constituent into two distinct Union territories, rendering Ladakh a separate UT, under the direct control of the Central Government. The UT status also entails for Ladakh, the ability of non-indigenous people to buy land and property within the region, which was earlier not the case. According to Sonam Wangchuk, while the UT status for Ladakh comes as a welcome news, the threat of greater tourism and migration causing over-population and thus, pollution and possible degradation of an already fragile desert ecology could be disastrous if done in a ‘free-for-all’ manner. One of the solutions suggested by him would be to restrict or limit the resident ownership of migrating individuals in a way that does not harm the ecosystem and in a way that the indigenous people of Ladakh may also retain the ability to safeguard their tribal culture and way of life. The Hill Council present in the region of Ladakh, is an autonomous body that played a pivotal role in safeguarding the fragile environment, and it shouldn’t be hindered in doing so, besides which funding from the central Government must also be allocated towards better management of water and other natural resources in the region (NDTV, 2019).

The genuine concern and actions of local entrepreneurs, activists and volunteers have greatly affected how the people of Ladakh perceive environmental issues and a willingness on their part towards mitigation of water crises, where efforts by governing bodies fall short are imperative to the success of these novel governance conditions concerning the water management within the region. According to experts at HIAL, the amount of snowmelt received by Leh is good for just another decade, at best; lesser so, if the current threats are not mitigated in a timely manner. In circumstances such as these, it is no wonder that the aware and educated local communities endeavour to take matters into their own hands and do so in a supportive and practical self-governed manner. The efforts of organizations like HIAL and the *Ice Stupa* team can be seen as catalysts for better, modern governance strategies aimed at sustainable water resource management. The use of such unconventional water harvesting methods gaining popularity internationally (with the *Ice Stupa* team at Switzerland) will in time add validity to or bring out gaps in the applicability of such a governance regime. Regarding the governance context of the case in question, there appears to be success in implementing these methods and establishing self-governance, so far.

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APPENDICES

Appendix I: Interview Guide

The interviews were conducted with the project manager of the *Ice Stupa* team and experts at the HIAL project in May and June (2019). Before the formal interviews, a brief meeting was arranged collectively with certain members of the *Ice Stupa* Team and representatives of HIAL, at the HIAL project site, on the outskirts of Leh, Ladakh on May 16th, 2019. Thereafter, face-to-face interviews and telephonic correspondence was established with these participants. In this meeting, the purposes, basis and prospects of this thesis were presented to the attendees, leading to an informal interaction about their principles and conduct of their respective projects and an understanding of how the SECMOL organization functions regarding these interrelated projects which seek to not only alleviate the water crisis in Ladakh, but also aim at developing a sustainable town model at the HIAL project site.

Minutes of the meeting:

Date: May 16th, 2019
Place: HIAL project site (outskirts of Leh, Ladakh, India)

Attendees: Researcher, Shraddha Kumar, SECMOL representatives (Including Project Manager, *Ice Stupa* team, Project Manager, HIAL project, instructors and constituent members of the *Ice Stupa* team and experts from HIAL project).

Languages spoken: English & Hindi

1. The topic of the thesis was introduced to attendees including the purpose of this investigation (as stated in Sections 1.3 & 4.2 of the thesis).
2. The attendees responded by congratulating the researcher for the case selection and went on to explain the relevance and gravity of the ‘water crisis’.
3. An instructor from HIAL project quoted facts and figures from the talk conducted by the *Ice Stupa* team-International representatives including hydrologists from Switzerland, who spoke at the same venue a day before this meeting.
4. The researcher began to introduce the Governance Assessment Tool and its functionality, passing around a print of the evaluative questions of the GAT to the attendees.
5. The researcher sought to understand the HIAL project, its relation to the *Ice Stupa* project and questioned the attendees regarding construction activities witnessed on site.

6. The Project Manager (HIAL) explained Sonam Wangchuk's design for insulating bricks made of reused non-biodegradable and earthen materials, with the intent of constructing buildings to withstand the harsh climate of Ladakh in the open expanse of the project site.
7. Experts from both project teams added that the intent of the site construction is to establish a zero-water waste, zero-energy waste and zero-food waste model piece of land where classes and workshops and lodging would take place for participants and volunteers of the HIAL project.
8. *Ice Stupa* team members explained how the water harvested from the *Ice Stupas* to be constructed near the project site would fit into these plans at HIAL.
9. HIAL instructors concluded the meeting on account of having to resume their workshops with the current batch of participants.
10. Project Manager of the *Ice Stupa* team and an expert from HIAL consented to further correspondence and participation in interviews with the researcher; contact details were exchanged.
11. Date, time and venue for a face-to-face interview with the Project Manager, *Ice Stupa* team was decided and telephonic interview with HIAL expert was agreed upon.

Adjournment.

Appendix II: Interview Transcripts & Questionnaires

1. Interview with a representative of the *Ice Stupa* team

(based on evaluative questions of the GAT)

Date: May 20th, 2019
Interview type: Fate-to-face
Place: SECMOL Office, Leh, Ladakh, India
Languages spoken: English & Hindi

Interviewer: Shraddha Kumar (SK)
Interviewee: Representative, *Ice Stupa* team India (IST)

SK: Firstly, thank you so much for meeting with me on your tight schedule.
IST: It's no problem at all. Most of my work today is in the second half of the day. Hope you didn't have much trouble locating the office.
SK: I was lucky to have helpful locals guiding me here.
(exchange of pleasantries)
SK: I hope the questions I handed out the other day were understandable. We'll be going through them, row by row, across the different governance dimensions.
IST: I did have a couple of doubts regarding some but I suppose we can tackle them along the way.
SK: Absolutely. Let's begin with levels & scales. How many levels are involved in dealing with an issue? Would you say there are any important gaps or missing levels?
IST: If we're talking about levels within *Ice Stupa* team, we have Sonam (Wangchuk), who is the inventor and I suppose hierarchically he is at the top. The rest of our team consists of seven members, presently. We all have different backgrounds, engineers, teachers, commerce guys , etc. but we all function at the same level. Even the post of a Project manager is actually something that keeps rotating among us. Externally, we have the people of Ladakh. I guess you could consider them the main stakeholders in all of this so, there's people's participation. At present we involve the experts from Switzerland for our R&D, so externally they are involved with the conduct of the project in India as well. From the private sector, we have had great help from Jain Irrigation. We get all our equipment for constructing the stupas from them. Also, Ladakh Rural Development Authority we contact on and off mainly to discuss that we're planning on utilizing this site, and pipes and drains will be laid down here, or there, etc.
As for missing levels, so presently there is no Government organization's involvement, besides Rural Development Authority's occasional supervision and we contact them for permission but that's it.

SK: Would you say these levels work together & trust each other between levels? To what degree is the mutual dependence between levels recognized?
IST: There is a great amount of trust and co-dependence between these different stakeholders I've mentioned and within our team itself there's a lot of trust and we're all very transparent so if suppose someone has an objection, we all work it out quite effortlessly. I suppose it comes from the idea that we're all in working towards the common goal that has everyone's best interest at heart.
The people of Ladakh also welcome the *Ice Stupa* project to their region wholeheartedly knowing what is our intent and accepting the incentives provided to them out of educational & water conservation needs and tourism impact issues.
On the flipside, the project did experience mild backlash a while ago in the downstream districts by the district authorities, mostly because of internal prejudice and historical animosity (although I don't know if that's the right word for it) between the upstream and downstream districts, whereas no scientific evidence was there to back their claims of the *Ice Stupa* project being a drain on their resources, favoring one district over another.
We had negotiations with them but ultimately it didn't work out so we shifted out site; you must have seen an *Ice Stupa* on your way to Khardung La.
SK: Yes, I did. I take it you're referring to the clash between Phyang and Gangles?
IST: Yes, precisely. It's actually quite disheartening that there are people coming from all over Ladakh to participate and we are getting so much support from outsiders but these petty issues from within the communities involved, whose benefit is being thought of, are the ones holding us back.
SK: Alright, would you say it's possible to move up and down levels (upscaling & downscaling) given the issue at hand?
IST: It is possible to upscale and downscale, since the role of the *Ice Stupa* team, while primary, is also a. interchangeable within ourselves and b. once self sufficent, our local Ladakhi communities are given full charge of the *Ice Stupas* and they are free to expand on them as they will, with only an educational and consulting role by the team from them on. So for instance, you may have heard of the Ice cafe? Yeah, besides that there's Ice climbing etc. that we're still experimenting with. Of course, a lot of this depends on the height and scale of the stupa itself so we're always consulted before these edits to the original *stupa* design but basically, Ice sports, Ice cafes etc. are being held and instituted by participating Ladakhi youth.
SK: Is there a strong impact from a certain level towards behavioural change or management reform?
IST: The *Ice Stupa* project itself is the brainchild of Sonam (Wangchuk) and was carried out under his supervision and upon his directions, however, it is intended to benefit the people of Ladakh and so whatever decisions are made are heavily influenced by their

needs and desires, but overall, whatever is carried out is first consented to by the people of Ladakh and our team, overall handles it accordingly.
SK: Are all relevant stakeholders involved? Are there any stakeholders not involved or even excluded?
IST: Yes, I'd say particularly for how this project is functioning, all participating people represent a stakeholder group that is relevant to the conduct of our project. But as I said earlier, there's no Government organization's involvement, besides Rural development authority's occasional involvement. That's not to say that we're lacking something in our operations but yes, since it is a problem at the regional level, the Government could be considered a missing stakeholder level.
SK: What is the strength of interaction between stakeholders? In what ways are these interactions institutionalized in stable structures? Do the stakeholders have experience working together? Do they trust and respect each other?
IST: Between the Ladakhi community and our team there is immense trust. Jain Irrigation and the *Ice Stupa* team have a partnership through goodwill and so far it is running smoothly. There is a more linear hierarchy within these major actors and participators so really it's all about knowledge transfer, passing on the skills and equipment as a means to let the communities rely on themselves later on, for their own water conservation requirements at the smallest community levels. It's a fairly stable structure, since we in the team pool together our skills and resources and we start by conducting workshops and distributing equipment free of cost as an incentive to engage more people. Once they learn, we help them build the *Ice stupas*. The actual participants from the local communities are very trustful but actually, after the benefits of the Ice stupas are realized, more and more people from the local communities involve themselves and then I think that makes a shared mutual trust operate throughout our functioning. It makes for more success in our fundraisers as well.
SK: Is it possible that new actors are included or that the lead shifts from one actor to another when it is pragmatic to do so? And do all actors share in the "social capital" allowing them to support each others' tasks?
IST: Yes, definitely. In fact both, internally within our team and externally the lead does shift, since our aim is to give more power to the people so that they become self-reliant, I think it's very pragmatic to do so. So, in the end, the lead is shifted to the people even though in the beginning we are the initiators and instructors. I'm not certain I understand the term, 'social capital' correctly, but in terms of supporting tasks, I think of it as a very supportive and interconnected system. So, while we start off trying to support them, their participation in turn, supports our goals and ultimately, the public good is achieved.
SK: That's actually what I was looking for. Alright, next, is there strong pressure from an actor or actor coalition towards management reform?
IST: On the contrary the *Ice Stupa* project's intent is more towards reforming the ideas and roles of the Ladakhi population in becoming more aware, educated and involved in

the implementation of the project, as a way of conserving water and living a more sustainable life. But besides our team, I think while there isn't pressure exerted as such, on the Government, it is already a sort of management reform since we are straying away from the status quo. I mean, the Government definitely is trying to solve the issue of water availability but it's not being done in a proper sustainable way and certainly not at the required rate. A lot of it actually has to do with how the conduct of operations is in parts of this state besides Ladakh too. So like at HIAL they explained how the same sort of buildings with sloped roofs that are in Kashmir were built in this region, but they're so geographically different. We don't need those kind of roofs, we need insulating material. Same way, the water resources are also governed, which is not really in a tailor made manner for Ladakh. That way, maybe there will be management reform since the people are becoming more aware of these issues.

SK: To what extent are the various problem perspectives taken into account?

IST: Tourism, the people's own issues with water scarcity and tourism impact, climate change and its impact, I think they are all taken into account. Also, the fact that education is also one of our primary goals, that has also been considered.

SK: To what extent do various problem perspectives support each other or are they in conflict/competition?

IST: Generally I'd say they're quite supportive and accommodating. No real conflict. As in, we're tackling the much larger issue of water availability in the region and every participating individual sees that. Alongside, the goal or making a properly educated self-reliant group of individuals who don't see tourism as a problem and who can tackle these smaller issues under this umbrella of water conservation, both for irrigation and domestic requirements; it's all very cohesively coming together in that sense.

SK: Are there opportunities to reassess goals or can multiple goals be optimized in package deals?

IST: Yes. Like I said, more sustainable tourism, water storage & conservation and just overall more sustainable practices are all packaged together in achieving our targets. So, primarily, education and water conservation are the goals but then secondarily, there's also awareness and building self-reliance capacities. Besides this, a tertiary goal may be seen as innovations towards more income generating activities, promotion of winter sports so that tourism can be managed more properly, these are all optimizations that have developed through experience. I think besides this there's a strong sense of community building among the people here since people come to practically own their *stupas* and innovate with them as they please. The Phudo society in Leh has been a tremendous help in this regard, by getting together a ton of people to participate and help to spread awareness.

SK: How different are the goal ambitions from the status quo or business as usual?

IST: It's a strong shift from the status quo. It deals with giving more power in the hands of the people and equipping them with the right knowledge, skill set and sense of urgency

making them more self-reliant, not having to wait for the Government bodies to butt in, in times of crisis. And all this comes from a place of goodwill. Business as usual would mean that the strain of tourism remains ever increasing and only the Government's efforts at trying to mitigate the lack of resources would be at play. This is the opposite of the aims of the project.

SK: What types of instruments are included in the strategy? For instance, incentives, like you mentioned, with the help of free equipment etc.

IST: Alright, so in terms of incentives, Jain Irrigation in collaboration with our team provides equipment (piping and drainage) which are required to construct the *stupas* at a subsidized price to us and we then, in our workshops distribute these to the Ladakhi participants, in order to initiate and help more people participate in learning about the technique for water conservation through these alternative means. Besides this there is a crowd-funding element which we need in raising funds for acquiring permits and subsidies and conducting the workshops. We also hold competitions now, so as to engage more people. Then money obtained from the fundraisers is used as a reward. It actually gets more people and ideas engaged. We've even managed to have local participants modify structures in a way that the heights of the *stupas* have increased over time, as an outcome of these competitions. Earlier it used to be around 70-80 ft. and I think we recorded 110 ft. recently.

SK: To what extent is the incentive system based on synergy? Are tradeoffs in cost benefits and distributional effects considered? Are there any overlaps or conflicts of incentives created by the inducted policy instruments?

IST: Very synergistic, I'd say. Though in the long run, it would burden upscaling costs and so, the aim is to make the communities themselves consider the incentives, direct and indirect in participating and constructing the *stupas* on their own, by only handing down to them the right knowledge and tools. There are no real conflicts in incentives, so far, it's been fairly simple, our system.

SK: Are there opportunities to combine and make use of different types of instruments? Is there a choice?

IST: Since the only real policy instrument at play is incentivization and competition, there exists a great opportunity for including more policy instruments in popularizing the concept and upscaling the programs, for instance, subsidies and monetary rewards for the amount of water produced during the summers, through a region wide competition is being considered and while it is not currently mandated, it could possibly be a combination of for instance, irrigated lands made by the Ice Stupas may incur lower priced benefits from the newly formed ecosystem or something. But those are things that haven't been incorporated just yet. There have been talks of tourism taxes but I don't think those would be popular and at least right now, not beneficial, since there will probably be a lot of debate and opposition to it.

SK: What is the implied behavioural deviation from current practices and how strongly do the instruments require and enforce this?
IST: The whole aim is to give the people more control of the water situation and making them self-reliant and able to conserve using alternative strategies which go against the norm. The system of incentives etc. and just largely the conduct of the project itself is something that does sort of impose this. The behavioural change I think comes instantly through education and awareness campaigns and the competitions themselves, too. Besides this we hope that tourism is not seen as a burden and so, winter sports activities which can be planned around the Ice Stupas would help in dispersing the heavy influx of tourists during this particular season as it is currently becoming a burden on the lands.
SK: Are all responsibilities clearly assigned and facilitated with resources?
IST: Yes. Quite so.
SK: To what extent do the assigned responsibilities create competence struggles or cooperation within or across institutions? Are they considered legitimate by the main stakeholders?
IST: I don't think competence struggles have been exhibited, so far. Cooperation exists primarily within the main actors. The only stressors and competence struggles are because of say, road blocks, in the conduct of our project such as the clash between the authorities of Gangles and Phayang districts.
SK: To what extent is it possible to pool the assigned responsibilities and resources as long as accountability and transparency are not compromised?
IST: It functions in a transparent manner completely, and resources are pooled. However, we think that this is something that still needs to be stabilized or rather managed better. We're working on it for the future. A large extent of the issue of pooling of resources could be solved if the income generating kinds of Ice Stupas are popularized. For this we rely heavily on the innovations thought of by the participants. That way year after year, the stupas would pay for themselves.
In terms of transparency and accountability, since we intend to leave the local participants the sole people in charge of their Ice Stupas in the end, we do make them sign a disclaimer, mainly stating that they are participating in the competition after attending the workshops where they learn the technical know-how for construction and management of an Ice Stupa and they shall be responsible for their own product in the competition. The same goes for any injuries incurred during the construction activity etc. since in our workshops, we make sure to teach them all this before actual construction begins. And the people take accountability for their innovations. For example, with the Ice cafe run by Ladakhi youth, they manage everything themselves, now.
SK: Is the amount of allocated resources sufficient to implement the measures needed for the intended change?
IST: Yes, so a large chunk of the initial investment comes from the resources we pool together as a team and Sonam (Wangchuk) has always put in all his monetary rewards

into all these projects we take up under SECMOL. These and of course the fundraising activities are currently, sufficient. But of course, the idea now is to make the Ice Stupas themselves come up as sources of income. If that happens throughout the region, it will be much more helpful and easy going.

SK: I think that answers all my questions for today. Thank you very much!

IST: No problem at all! Good luck with your thesis.

SK: Thank you and I wish the whole team all the very best in their endeavours.

2. Semi-structured questionnaires for expert interviews

The following are the basic structures of the questionnaires adhered to during telephonic conversations with different interviewees. Some questions may have been added or edited during the conversations in response to their answers. The three participants involved were a representative from the Ice Stupa team, a representative from HIAL and a representative from a local Ladakhi community, based in Leh, Ladakh. The conversations were made in both English and Hindi languages.

2.1. Questionnaire for *Ice Stupa* team representative

2. 1. 1 Would you classify the current Governance conditions in Ladakh as being supportive or inhibitory to voluntary efforts as those of the Ice Stupa Project towards mitigating the greater problems of water availability and conservation?
2. 1. 2. Regarding expansion of the project:
a. What in terms of state policy or greater stakeholder/public engagement can be improved towards the expansion of the Ice Stupa Project?
b. For the Ice Stupa team, is there a form of external help through governmental/not-governmental organizations that is being sought in order to upscale the project?
2. 1. 3. In making the local communities self-reliant by taking care of their needs for water conservation and management, would you consider the possibility of involving governmental incentives (milder policy instruments) or mandates (sterner policy instruments) to be helpful towards increasing general participation or would it alternatively hamper the volunteering of individuals?

2. 2. Questionnaire for HIAL project representative

2. 2. 1. What are the greatest challenges (environmental & social) facing Leh, Ladakh today that HIAL intends to tackle?
2. 2. 2. It appears that the institute is currently functioning through the voluntary efforts of a set of independent researchers, instructors and entrepreneurs, backed by a trust fund and occasional crowd-funding activities (as was the case with the Ice Stupa project).
a. Is there a general feeling that there is a lack of Governmental involvement towards mitigating the water situation and impending acute water scarcity throughout the region?
b. Are governmental bodies involved in a supportive/supervisory role?
c. Would initiatives like the Ice Stupa project and the functioning of HIAL, both aiming at the larger issues, affecting every resident in the region, be better off

working either independently or with other non-governmental actors or institutions as opposed to Governmental authorities?
2. 2. 3. Acknowledging that the first batch of students & volunteers enrolled in April 2019, at
this point would you consider the general local consensus to be welcoming/supportive or inhibitory towards the aims of HIAL?
2. 2. 4. In an effort to dissipate the heavy influx of tourists from certain regions and during certain water stressed months, how welcoming are the local communities to the idea of homestays on the outskirts?

2. 3. Questionnaire for Ladakhi participant from local community of Leh in the project

2. 3. 1. Upon participating in the *Ice Stupa* building workshops and in the competition, what changes have you perceived within yourself and your community about having the ability to tackle water shortages? What in your opinion, do you gain out of this and are your goals and ambitions met?
2. 3. 2. Is there a general feeling that the Government's efforts have not been enough in trying to handle the water availability issues your community is facing? What are your motivations for pursuing alternative measures such as the *Ice Stupa* project to tackle these issues?
2. 3. 3. What incentives and benefits do you perceive for yourself and your community out of this project, from the beginning of your participation to your future prospects?
2. 3. 4. What are your thoughts on the management of tourism within this region of Leh, and within Ladakh, in general?
2. 3. 5. Do you feel a sense of ownership and accountability, with the *Ice Stupas*? Is there sufficient knowledge on the water system available? Have any of these changed over time or are likely to change in the foreseeable future?

Appendix III: Consent Form for Individual Participants in Interviews

Informed consent form for individual interviews for thesis studies in MSc MEEM

Research Title: A SELF-GOVERNANCE APPROACH TO SOLVING THE WATER CRISIS IN LADAKH, INDIA: THE *ICE STUPA* PROJECT

I declare to be informed about the nature, method and purpose of the investigation. I voluntarily agree to take part in this study. I keep the right to terminate my participation in this study without giving a reason at any time.

My responses may be used solely for the purposes of this study. In its publications, they may (please tick one of the options):
O be cited with my name or function revealed
O be cited anonymously, thus without identifying context
O only used as information source

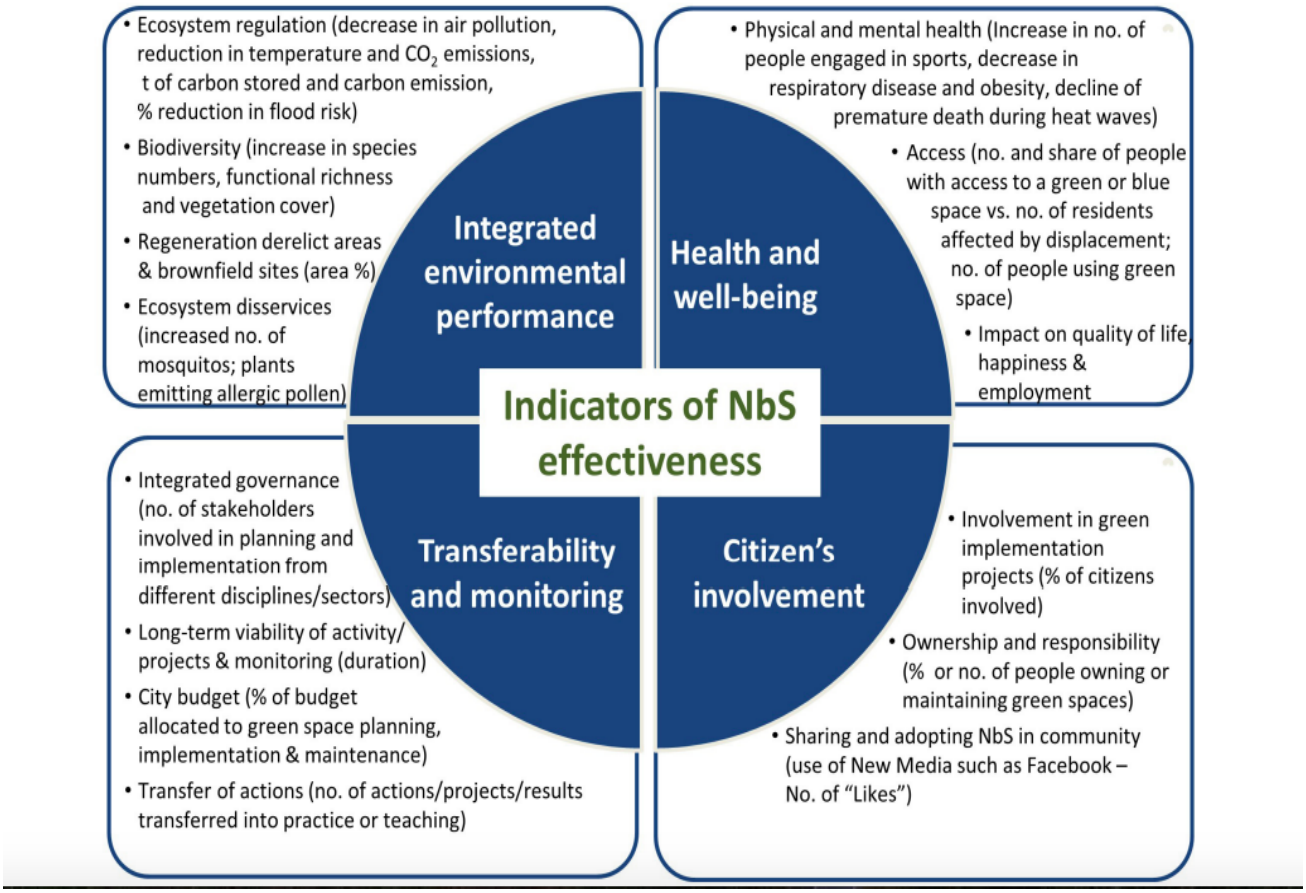
During the course of the interview I keep the right to restrict the use of (some of) my answers further than indicated above.

Name, participant: ….……

Date: ……..……

Signature, participant: …...……

Appendix IV: Framework for Assessing the Effectiveness of Nature-based solutions



Source: Kabisch et. al., 2016.