Ice Stupas in Chile: Freezing Glaciers for People and the Planet

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Abstract

Chile's glaciers are retreating and taking the nation's water supply along with them. Conical water caches, known as "Ice Stupas", due to their similarity in appearance to Buddhist shrines, were created as a solution for the climate-induced drought conditions and increasing unreliability of water reserves in the Chilean Patagonia. This case study examines how a group of engineers- team Nilus- are working to establish these water preservation systems in Chile to tackle water use issues, preserve indigenous cultural practices, and slow down the rates of glacial melt happening in glacial areas. It is critical to understand the complexity of the water scarcity in Chile, as this critical issue is both a sociopolitical and environmental problem.

Background

- **12 MILLION** rely on the meltwater of Chile's 26,169 glaciers.
- Chile holds **80%** of South America's glaciers
- However, most of Chile's population resides in **arid-or semi-arid climates** where access to water is severely limited
- Team Nilus' Ice Stupa project employs **potential energy to transport glacial meltwater to stupa sites,** where the water freezes in a conical shape to maximize surface area

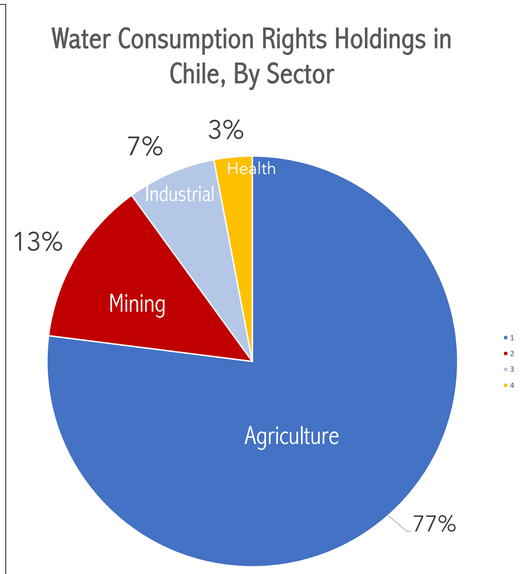

Figure 1. Data taken from Chilean Defense Movement for Access to Water, Land and Environmental Protection (MODATIMA) 2020.

Stakeholders

Indigenous Chile Communities	Aymara, Atacameño peoples: petitioning for preservation of their cultural lands and heritage through these water caches
Chilean Water Companies	profit from the privatization of the land and natural resources, so would be hurt by the establishment of these caches
Environmentalists	helping slow glacial retreat can help slow both the rate of sea-level rise from glacier meltwater and the habitat destruction associated with this phenomenon
Team Nilus / Foreign Engineers	Recognize the profitability of this new technology and how it would make a major impact, thus being in high demand
Chilean citizens (non-indigenous)	In favor because Ice Stupas would provide access to more fresh water

Details and Data

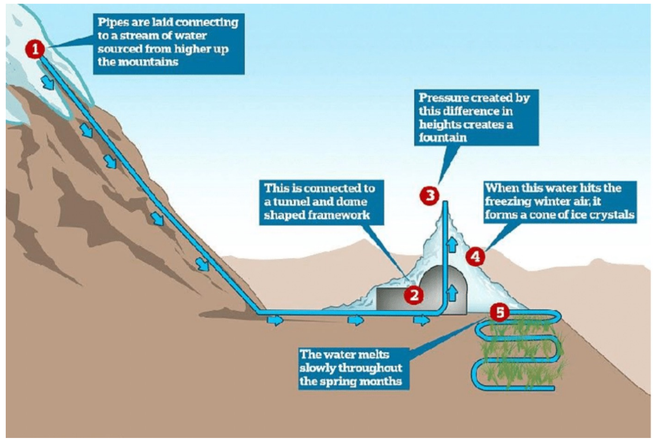

Figure 2. This is the typical process of ice stupa formation. The water from glacial melt is transported via pipes to an area of lower altitude, wherein the pressure created by the water creates a spout that sprays water into the air. The water freezes into a conical crystalline structure, preserving the water for the warmer months and preventing it from dissipating into the soil before it can be used.

Advantages	Challenges
• Low-tech and easily replicable • Each stupa could supply up to **10M Liters of water per year** • irrigates up **to 25 acres of land / stupa** • Water only needs to flow **60m downhill** to form a 60m tower • Community engagement	• Roughly 80% of water sprayed on Stupas is lost • Currently expensive- around $1-2,000 per stupa. However, researchers want to reduce the cost to only $200-400 per formation • Glacial retreat could create a need for more pipes • Climatic conditions impact success

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Goals of Team Nilus

Including socioeconomic and historical contexts
- Why are water shortages happening in the first place?
- Who would be affected by these structures, for better / worse?
- Socioeconomic contexts are critical to analyze before proceeding

Increasing community participation and public access
- Indigenous community participation is crucial for the development of these solutions
- Needs to be community engagement at every step even in areas where ecological restoration precedes water storage as a goal

Establishing structurally sound climate response engineering
- Delicate balancing act- technology is not the only answer!
- Use the technology to get to the root cause of the glacial melt, not an in situ solution
- Push the barriers of AI in green technology

Analysis, Discussion and Conclusions

•The Nilus Project showcases the potential for replicable, low-tech solutions to address water scarcity issues and mitigate the impact of climate change in vulnerable regions.

•The crux of the Nilus Project rests on involvement with the traditional practices of Chilean residents. It has actively engaged the local community in Chile, encouraging their participation and ownership of the project.

• By creating these conical ice structures (stupas) during the winter months, this technology could efficiently store and preserve water. When the ice melts in the spring and summer, it provides a vital source of water for agriculture, thus mitigating water scarcity issues in the Chilean glacial regions.

Teaching the Case

Pre- Class Assignment: Analysis of Case Study
- Students will read through the case study and answer questions regarding the various stakeholders
- create an initial recommendation for Nilus Engineers

During Class 1: Cost Benefit Analysis
- After evaluating data provided, students will create a cost benefit analysis for different water management practices
- divided into stakeholders and given different information

During Class 2: Discussion of Results
- Students will bring their cost benefit analysis to a pre-determined Board of Engineers
- discuss with group what best course of action is
- answer the question: public or private?