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Artificial Ice Reservoirs

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High mountain environments are particularly vulnerable to climate change effects. All long-term observations of the cryospheric variables clearly document that current changes are strong and fast. As a consequence, the main alpine cryospheric components snow, glaciers and permafrost are expected to change their water storage capacity with major consequences for downriver water supply. The challenges brought about by these changes are especially important for mountain communities situated in dry high alpine environments, which directly rely on the seasonal snow and glacial melt cycle for their farming needs.
Although many villages have been benefiting from Artificial Ice Reservoirs(AIR) for a couple of decades, to date there have been very few scientific investigations on their design and favorable conditions used to construct them. Major decisions like when, how or where to refreeze water have been made on a trial and error basis. Nevertheless, interventions mainly in the region of Ladakh, India have been able to support the local water resources management (WRM) strategy by storage of millions of liters of water every winter using these techniques.
The main purpose of AIR is irrigation. The water contained in the ice reservoirs should be released during the growing season. Therefore, AIR are designed to store water in the form of ice as long into the summer as possible. To fulfill these requirements, AIR are usually constructed in higher altitudes, in shadowed zones and shaped into a conical form. Especially this recently innovated conical design has further increased the lifetime of the AIR.
AIR has three strong advantages in comparison to many other local WRM strategies. First, AIR is economically feasible even for poor communities, second the construction of AIR does not need any special education for the builders and third, it is energy neutral, not using any additional energy resources from renewable or fossil origin. These advantages have strong multiplier effects making AIR a great asset for climate change adaptation measures.
Therefore, this project aims to quantify the effectiveness of the strategies used by means of statistical analysis of field measurements and physical-based modelling of the surface energy balance. This is done in two phases. In the first phase, we attempt to quantify the significance of the various environmental factors that favor freezing and cause melting. In the second phase, we compare melting duration amongst AIR of various shapes to understand how far just structural changes can delay melting.
This project stimulates new research paths in the field of applied glaciology, especially in the domain of climate change adaptation. Moreover, if AIR storage are shown to match the requirements, then this could trigger various developments in required engineering systems further advancing the efficiency of the nascent water storage technology. Although this intervention does not compensate the reduction in annual runoff seen, it will still serve as a lifeline for several mountain villages of the world still coming to grips with the harsh realities of climate change.