A Simple Approach To Model Artificial Ice Reservoirs ("Ice Stupas") Based On A Temperature-Index Model

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With climate change and the associated recession of glaciers, water security, especially in regions depending on the water supply from glaciers, is threatened. Artificial Ice Reservoirs (AIR) have been developed to fill the gap of water shortage by storing water during winter, and releasing it in spring. In this context, the understanding of the storage capacity and the process of the growth and melting behaviour of a so-called Ice Stupa, is an important contribution for the improvement and further development of this type of AIR.

To contribute to a better knowledge, this study tried to develop, apply and evaluate a method for modelling the ice volume of Ice Stupas in Switzerland. Experiments were undertaken at two study sites: Guttannen and Schwarzsee. By the application of a temperature-index model, including a simplified parametrisation of freezing and melting processes, an attempt was made to model the evolution of the ice mass. The validation was carried out using drone images. The temperature-index model known for its wide simplification of physical processes was deliberately chosen: This thesis aimed to descry the greatest possible simplification of a set of complex processes, by using proportionality constants linking negative temperature to freezing (FDF) and positive temperature to melting (MDF).

Due to unfavourable weather conditions, the method could be fully applied at one study site only. In spite of the various uncertainties, the method is believed to obtain reasonable results regarding the total ice volume estimation of the AIR. The model has been shown to be a valuable tool for the estimation of the melt and freezing rate and can certainly be applied to other study sites as the approach is based on rather simple principles. However, further improvements and adaptions on the methodology are necessary to obtain more reliable results.

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