PREDICTING SUMMER RUNOFF IN THE HEIHE RIVER WATERSHED IN CHINA ON THE BASIS OF MODIS SNOW COVER DATA

Jules Henze\textsuperscript{1,2}, Haijing Wang\textsuperscript{1}, Wolfgang Kinzelbach\textsuperscript{2}

\textsuperscript{1}hydrosolutions Ltd.; \textsuperscript{2}ETH Zürich; hennej@student.ethz.ch

1. ABSTRACT
This study looks into the relationship between the total runoff volume in summer and the snow covered area during winter months of the Heihe river watershed. The snow covered area is derived from MODIS Terra and Aqua Snow Product MOD10A1 and MYD10A1 for the year 2001 to 2011. Two cloud correction methods were applied in order to receive continuous time series of snow cover. Gauging station observations were used to calculate runoff volume. A linear relation between runoff volume and integrated negative change of the SCA was confirmed with reasonable correlation values of r=0.85 (Qilian) and r=0.67 (Zhamashike).

2. INTRODUCTION & OBJECTIVE
Research area
- Heihe watershed, located in the Qilian mountains.
- The upper watershed includes two main sub-catchments: Qilian and Zhamashike.
- Heihe river is mainly fed by snow melt water\textsuperscript{1}.

Motivation
- Mid-reach river oasis Zhangye is heavily depending on irrigation water supplied by Heihe river.
- Zhangye is an important agricultural producer.
- Better knowledge about variation in annual runoff volume can enhance water management practices.

Study objective
- Examining the relationship between snow covered area during runoff and runoff volume in summer of both sub-catchments Qilian and Zhamashike.

3. METHODS

Cloud correction II
- Goal: continuous time series of snow covered area (SCA).
- To pixels with no ground information for the current time step due to cloud cover, the value of their last known observation is assigned. (Cloud Gap Filled method, GCF)\textsuperscript{2}

\[ \text{SCA} = \text{land} + \text{cloud} + \text{snow} \]

\( \text{land} \) and \( \text{cloud} \) are the variables from Terra and Aqua products.

\( \text{snow} \) is the snow area from MODIS.

- All available observations are part of the corrected time series. The course of SCA does not react to cloud cover anymore.

Linear correlation analysis
- Summer runoff volume \( V \) is defined as the integrated water discharge, measured by the gauging station, from March 12th to October 21st.
- From the SCA time series, the variable melted snow area \( P_M \) is derived. It is defined as the integrated negative change of SCA.
- The relevant winter weeks for snow melt are unknown. Correlation Analysis is therefore done for different starting dates \& end dates.
- The following linear relation is defined:

\[ V = a + b \times P_M \]

4. RESULTS

Correlation
- Qilian: The best correlation is found for \( P_M \) calculated from Dec 16th to March 14th with n=0.85
- Zhamashike: The best correlation is found for \( P_M \) calculated from Oct 16th to March 14th with n=0.67

5. CONCLUSION
- Although cloud cover poses a difficulty for the use of MODIS Snow Cover maps, two simple correction methods helped to produce continuous time-series of SCA with minimal cloud interference.
- The correlation analysis has shown, that already in late October, snow melt in Zhamashike contributes to runoff formation for the next summer. This leads to the conjecture, that melt water is strongly retained in the catchment, possibly due to permafrost layers\textsuperscript{1}.
- A deeper look into runoff processes in the Qilian mountains should be considered in order to prove the above theory.
- The generated prediction model can help to support risk assessments for irrigation water management with only MODIS Snow Cover maps as input\textsuperscript{2}.
- The results could be strongly enhanced by the measurement or estimation of snow water equivalents, which were not available for this study.

6. MAJOR REFERENCES