ACTION BRIEF: Measuring Near-Surface Soil Water Content with Ground-Penetrating Radar (GPR)

PROJECT TITLE: RECAST URUMQI (Urumqi, China)

CODE: URUM-AB6
CROSSCUTTING TOPIC(S):
RESSOURCES
CAPACITIES

SITUATION

The city of Urumqi is located at the edge of the Gurbantünggüt Desert, where water is a scarce resource. A schematic overview of the hydrologic system of the region is shown in figure 1 (adapted from Klenk et al, 2012). Currently, Urumqi is supplied mainly by surface runoff from precipitation and particularly glacial melt water from the Tian Shan mountains. However, providing for an ever growing water demand warrants the extraction of an increasingly large portion of groundwater from aquifers below the city.
So far, approximately 89% of available surface runoff is used on the spot. In addition, around 50 % of Urumqi's water supply has already been extracted from groundwater resources. Not surprisingly, falling groundwater tables have been reported all over the region. The fact that these reports can be found not only in the press (see e.g. http://www.zj.chinanews.com/detail/971644.shtml), but even in official statements released by the authorities (see Water Affairs Bureau Urumqi, Water report 2005 and 2007) points to the gravity of these issues. The resulting crucial questions are manifold. Where do the scarce water resources come from exactly? What are the processes controlling their distribution and availability? How do these processes change under the regional impacts of global climate change?

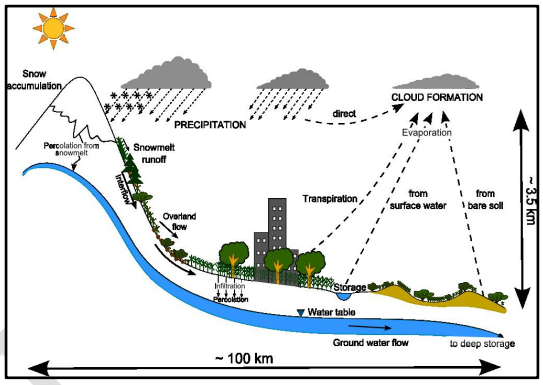

Figure 1: Schematic overview of the Urumqi regional watershed


Figure 2: GPR measurement in the Semi-Desert Area


Figure 3: Capacity Building: Explaining the measurement system in the field.

OBJECTIVES / APPROACH / RESULTS

In order to answer the questions formulated above, we

- demonstrated state-of-the-art tools for measuring near-surface soil water contents with focused local field measurements in the Urumqi region
- implemented a system for monitoring the spatio-temporal structures and variations of near-surface soil water contents at characteristic sites throughout the region of interest
- carried out joint field campaigns with Chinese partners from the Chinese Academy of Sciences
- have a strong focus on capacity building through joint data evaluation, lectures and hands-on courses in Ground-Penetrating Radar and other related methods in the course of the field campaigns in China
- organized a six month research stay for a Chinese PhD student in Heidelberg

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IMPACTS

PURPOSE:	Long term monitoring of soil water content change in the Urumqi region	
	SHORT-TERM IMPACT (VERIFIED)	**LONG-TERM POTENTIAL (ANTICIPATED)**
ECOLOGY	The applicability of Ground-Penetrating Radar for measuring near-surface soil water contents has been thoroughly investigated at field sites representative of approximately 70% of the region. The overall monitoring possibilities have been demonstrated. For more details, please refer to: Klenk et al, 2012: Exploring Spatial Patterns of Soil Water Content in the Urumqi Region with Ground-Penetrating Radar (10.1109/ICGPR.2012.6254954)	The Chinese Partners have acquired a corresponding GPR system and thus are able to carry out future monitoring measurements and the corresponding data evaluation without the immediate presence of German experts Implementation of a long term monitoring scheme will help to address the tremendous eco-hydrologic challenges the region faces.
ECONOMY	-.-	-.-
SOCIAL / CULTURAL / POLITICAL	Continued scientific exchange has raised the awareness of pertinent stakeholders to eco-hydrologic issues.	Stipulating further hydrological and geophysical research in the region.

LESSONS LEARNT

- GPR methods are suitable for efficient high-resolution mapping of a large variety of distinct soil water content characteristics in a highly structured watershed.
- GPR ground wave measurements provide a stable proxy for soil water content. This stability opens the door for interpreting the observed changes in terms of the different generating processes of the soil moisture field.
- No single evaluation scheme is universally applicable, so a monitoring scheme will always have to take into account the distinct site characteristics.
- For most regions of interest, direct field access with state-of-the-art equipment (GPS, Laser Tachymeter) and data access are next to impossible under current Chinese policy. This limited the action radius for this project in developing technology and capacity building.

RECOMMENDATIONS

- Continuous intensive interaction with local partners essential
- Impacts of difficult data access can be ameliorated through efficient capacity building

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