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Space-support to improve land and water management on the ground

Summary

Knowledge of up-to-date cropping patterns supports sustainable land and water management and is therefore important for water managers in charge of regional water supply. In this ZUR, we present a methodology combining satellite images and models on crop water demand aiming at achieving a regionally differentiated water-saving potential in Khorezm, Uzbekistan.

Background

Sustainable and economical use of irrigation water is crucial to irrigated agriculture in Central Asia. Within the ZEF/UNESCO project in Uzbekistan, several water saving options on field and regional levels have been developed to support land and water management (e.g. ZUR 1, 7, 11, 14, 18). The potential of remotely sensed images for supporting land management was demonstrated too (ZUR 11, 19). In our ZUR, the focus is on improving resource use efficiencies. A method was developed to detect the crop cover percentage for each field, calculate regional water demand and examine the water saving potential taking the actual crop cover into account. In this way, irrigation demand can be reduced for unused or less intensively used fields and hence increase efficiency. For example, figure 1 and table 1 show cotton fields and water requirement at different stages of intensity during field cultivation in the year 2009: fully (e.g. field number
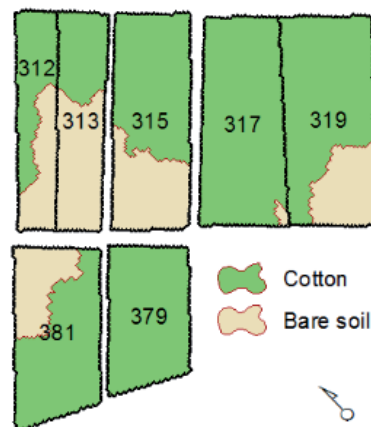

Figure 1: Fractions of bare soils in cotton fields. The numbers indicate the cadaster numbers of the black bordered fields.

# Cad.	Bare soil [%]	WD plan [th.m³]	WD actual [th.m³]
312	41.9	33.9	19.7
313	59.3	38.5	16.3
315	36.0	61.2	39.3
317	1.4	45.5	44.3
319	24.2	67.7	51.2
379	0.0	38.9	38.8
381	28.3	55.0	39.5

Table 1: Bare soil fraction and water demand for cotton fields (WD=Water demand).
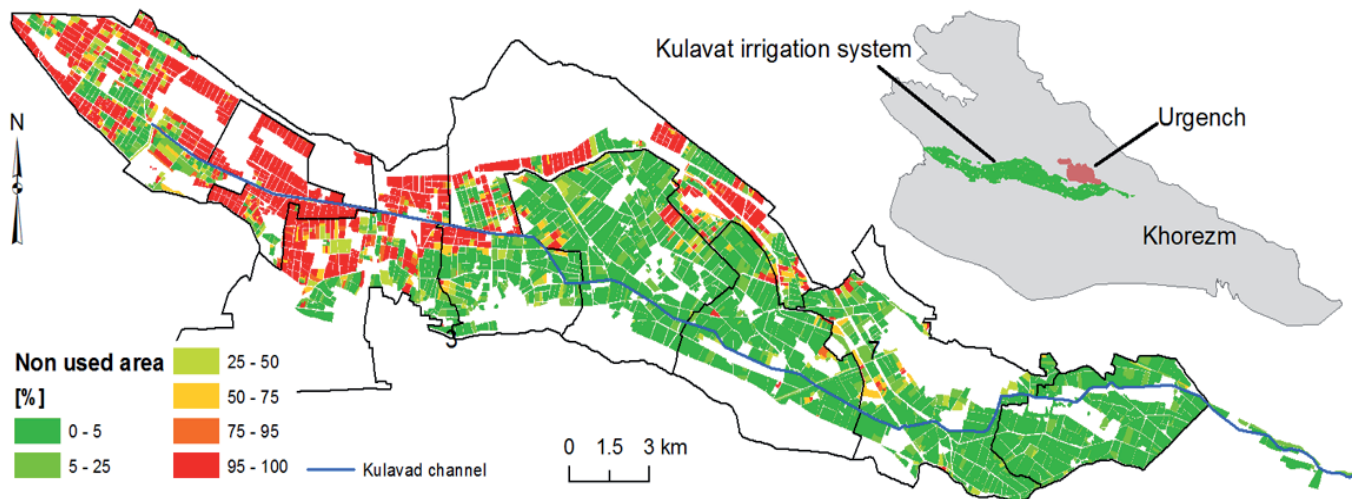
Figure 2: Proportions of non-used areas in agriculture fields for the Kulavat irrigation system. The numbers indicate the Water User Associations (WUAs).

379, 317), half (381, 315) and sparsely covered (312, 47% cover; 313, 60 %). The sparseness of the cotton cover is caused by a lack of water, land degradation, or mismanagement, all of them productivity-reducing factors. By detecting and discarding such fields from the irrigation plan, especially during periods of water scarcity, water use efficiencies can be improved and losses minimized. When excluding fields such as 312 and 313, the regional water demand can be reduced by 21% (70th.m³) as compared to the case when all fields are irrigated.

Land use classification was carried out with multitemporal high resolution satellite data as documented previously (ZUR 19). The method developed allows the separation of cotton, rice, wheat and crop rotations like wheat-rice but also of minor classes like sorghum, trees and non-used areas within fields. The classification achieved an accuracy of 86%. To calculate the water demand, the daily water demand model from the FAO (Food and Agriculture Organization of the UN) was utilized. Subsequently, it was adapted for the soil types and climate data from the region and finally compared to those estimated by institutions in Uzbekistan (e.g. the Scientific-Information Center of the Interstate Coordination Water Commission of Central Asia (SIC ICWC).

Outcome and Recommendations

The method was developed for the Kulavat irrigation system in Khorezm. The proportion of non-used lands within the fields (bare soil) and the spatial gradient of unused land within irrigated agricultural fields can now easily be extracted (Figure 2). Homogenous fields with hardly any bare parts are at the head of the Kulavat channel. Here, rice and wheat-rice rotation fields are dominating and water delivery is regular and certain. At the tail end of the channel, where cotton is the main crop being cultivated, we find underdeveloped crops and open areas. The downstream situation indicates uncertain and irregular water supply, despite the presence of feeder channels, which deliver water from other irrigation subsystems.

Based on the outcome of such sub-field analyses, we can develop scenarios for years with water shortage. For example, fields with a high proportion of bare soil can be detected within the season and –assuming the fields are unproductive- removed from the irrigation plan. The water saved by this option, as calculated with the

demand model, is made visible in the format of maps. When leaving out unproductive fields from irrigation, up to 11% of the seasonal irrigation water can be used for alternative options. In this balance, water supply for leaching and losses in channels remained unconsidered.

The presented approach has a great potential for improving land and water management in the region since it allows identifying land use - including unused areas- on sub-fields level. Water demand calculations can support the decision making process, especially in case of water shortage when water needs to be distributed efficiently. This can be done by re-scheduling water to other fields or reducing the water requirements of the region resulting in an overall increase in water use efficiency in the region. What needs to be done now is raising awareness for this new methodology. Introducing maps indicating water demand based on satellite-derived land use classifications to stakeholders can be a first step. In addition, carrying out trainings and workshops on the spot will help to increase the acceptance and use of such modern tools for land and water management among users and relevant decision makers in the region.

Acknowledgments