Climate change impact on irrigated agriculture in the Alpine valley Baltschieder

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***Abstract* – Mountain agriculture provides important ecosystem goods and services (EGS). However, future climate and socio-economic changes put the provision of such EGS at risk. In dry mountain regions, the availability of water for irrigated agriculture is of specific interest since climate change will affect the hydrological cycle. We study the impact of climate change on the availability of water for irrigated agriculture in the Alpine valley Baltschieder and assess the consequences for the provision of agricultural EGS. An interdisciplinary framework linking a hydrological and an economic land-use model is applied. Changes in EGS provision are derived from the simulated land-use pattern using indicators. We integrate knowledge from institutional studies addressing the traditional water allocation in Baltschieder to our findings. First results underline the sensitivity of the local hydrosystem, strongly dominated by snow- and glacier-melt, on climate change. With respect to land-use, results imply that without water shortages grassland can profit from an increased vegetation period. However, socio-economic constraints superimpose this effect resulting in less intensive land-use. This has ambiguous effects on agricultural EGS provision. In a next step, the two models will be linked and concomitant changes will be quantified and discussed with respect to the institutional water allocation regime.**

INTRODUCTION

Mountain agriculture provides important ecosystem goods and services (EGS) such as the production of food, the maintenance of open cultural landscapes, the conservation of biodiversity, the protection of fertile land or the protection from natural hazards. The provision of these services, however, is at risk. In general, climate and socio-economic impacts are predicted to increase the vulnerability of mountain ecosystems worldwide. This holds also for the Baltschieder valley, which is located in the Valais (Switzerland). On the one hand the central Valais is characterised by continental inner Alpine conditions. Thus, climate sensitivity is pronounced especially with respect to droughts. As a consequence, agricultural production and the associated EGSs strongly depend on irrigation, which has a long tradition in the Valais (Zurwerra, 2010). On the other hand structural change in agriculture is also pronounced in the Valais. The annual decrease of farm numbers accounts for nearly 3% associated with a total loss of agricultural land of 4.8% over the last 10 years (2000-2010).

RESEARCH QUESTIONS

The guiding questions of our study are: a) How is water availability for irrigated agriculture affected by changing climate conditions; b) how will land-use change taking into account both, the change in water availability and alternative socio-economic futures; and as a consequence, c) how will this alter the provision of agricultural EGS.

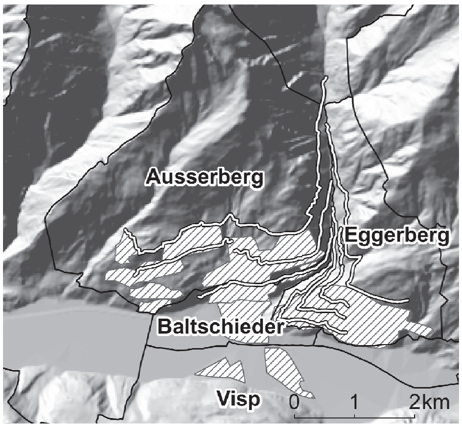

Figure 1. Case study area, bold lines: irrigation-channels; hatched polygons: irrigated areas (Data source: swisstopo)

The valley of Baltschieder, situated in the central Valais (Switzerland), drains through the Baltschieder stream. The catchment area is classified as a glacio-nival hydrological regime. Maximum runoff is dominated by snow- and glacier-melt and occurs generally in June and July. For centuries the water from the Baltschiederbach is used to irrigate steep meadows in the agricultural area of the communes Baltschieder, Ausserberg, Eggerberg and Visp (Figure 1). The water flows through permanent water channels called Suonen (or Bisses in French) to different water distribution points. The agricultural irrigation-rights are managed by the communes as official lists imposing repeating irrigation-cycles (Liechti, 2012). For a great majority of local farmers, agriculture is a secondary occupation (mostly sheep-breeding) and the economic significance of their production is small. However, the remaining full-time farmers are willing to grow and to intensify

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their production especially in areas with good agricultural production conditions (Huber et al., 2012).

Methods

For site specific scenarios of future land use patterns we combine a hydrological model and an agricultural land-use model. The hydrological model PREVAH (Viviroli et al., 2009) calculates the supply of water available for plants and irrigation. The results of this simulation are transferred to the land-use model ALUAM (Briner et al., 2012) in which yields and the demand for irrigation water are calculated. ALUAM is a spatially explicit economic land-use model that optimizes the income of the farmers in the case study region. The model has recently been extended to incorporate different land-use agents thus taking also into account the specific interests of part-time farmers (Huber et al., 2012). Through the coupling of the two models, seasonal periods of water shortage will be detected. As a result, the simulation shows the impact of concomitant climate and socio-economic impacts on land-use pattern and the corresponding EGSs. The existing models are adapted to the specific context in Baltschieder using communal data and survey data from qualitative interviews with farmers and other local stakeholders. The model outcome will also be qualitatively assessed in the context of the existing water allocation regime.

Preliminary Results

Figure 2 shows average monthly runoff in an A1B scenario for the time period 2021-2050 simulated in different climate change models (Bosshard et al., 2011). These simulations show that runoff-peak is higher compared to the control period (1980–2009 black line in Figure 2) and that seasonal period of maximum runoff is predicted to occur up to three weeks earlier in the year.

The first is mainly caused by strong glacier melt due to increased air-temperature. The seasonal shift is linked to the decrease of wintry snow accumulation and earlier start of snowmelt in spring. The simultaneous runoff decline in summer solidifies expectations of seasonal water shortage.

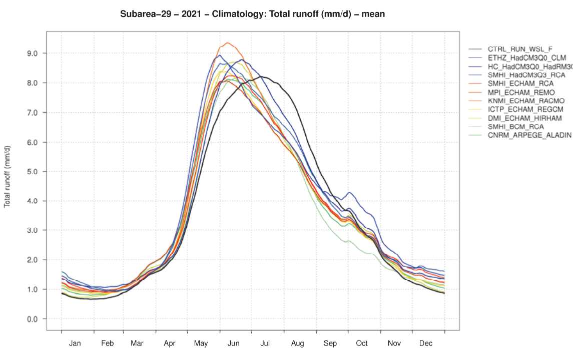

Figure 2. Average monthly runoff in the valley Baltschieder for the simulation period 2021 – 2050 (Data source: Zappa, M., WSL).

Figure 3 shows the effect of an A1B scenario in ALUAM without the consideration of water shortages in the agricultural production process on the provision of food (Indicator: wheat equivalent index). Corresponding land-use is predicted to be much less intensive and the overall provision of food is reduced. However, the continuation of area based direct payments in our simulations guarantees that still the same amount of land is cultivated. Thus, EGS associated with less intensive land-use such as habitat or landscape provision, are predicted to be improved.

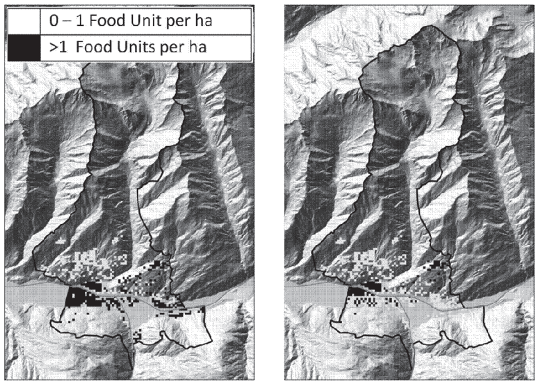

Figure 3. Provision of food units in 2000 (left) and 2080 (right) based on an A1B scenario (Data: adopted from Briner et al., 2012).

Next Steps

With available and surveyed data describing local agricultural structure, the projection of the specific conditions with ALUAM will be improved and combined with the hydrological model-results. In addition, we will link our findings also to discuss the existing water allocation regime in the valley of Baltschieder.

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