Reviewed research article

The value of satellite retrieved snow cover images to assess water resources and the theoretical hydropower potential in ungauged mountain catchments

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Abstract — *The estimation of water resources in ungauged areas is of major importance to develop adequate and sustainable water management strategies. Hydrological modelling can provide a powerful tool to assimilate hydro-meteorological data and estimate the total amount of water available from ungauged areas. Satellite images provide important information on the snow cover area in inaccessible mountain areas. The Hydrologiska Byråns Vattenbalansavdelning model (HBV) was used to estimate the total amount of snow, ice and rainfall runoff in two ungauged areas in north-eastern Iceland (Leirdalshraun, a 274 km^2 area above 595 m a.s.l. and Heljardalsfjöll, a 946 km^2 area above 235 m a.s.l.) that could potentially be used for hydropower production. The model parameters were determined using a multiple dataset calibration (MDC) relying on one year of satellite derived snow cover images and discharge data of gauged sub-catchments. Runoff from the ungauged area potentially used for hydropower exploitation was estimated using the parameter sets of the gauged sub-catchments. Snow cover in the ungauged areas as well as discharge in the gauged sub-catchments were validated over a 10 year validation period, revealing a robust simulation of snow melt in the entire area. The total amount of snow-melt, ice-melt and rainfall runoff available in Leirdalshraun and Heljardalsfjöll amounts up to ∼690 M m^3 a^{-1} and ∼1190 M m^3 a^{-1}, respectively. The theoretical potential energy of these water resources would account for up to 1.9 TWh a^{-1}, a tremendous hydropower potential if the water could be collected in respective reservoirs and be deviated to turbines at sea-level. While the results are only valid for the specific case study, the modelling approach can be applied to any remote mountain area dominated by snow melt runoff.*

Keywords: Hydropower, model calibration, runoff, alpine hydrology, ungauged catchments, water resources.

INTRODUCTION

Large scale hydrological modelling that includes areas with limited data availability has been identified as one of the key challenges facing hydrological research in the coming decade (McMillan *et al.*, 2016). Indeed, large scale modelling could provide valuable information about vital water resources for a wide variety of stake holders (Gupta *et al.*, 2014), ranging from drinking water supply to hydropower production to name just a few. Realistic modelling tools can help optimize water resources management of large watersheds (Wu *et al.*, 2015). Such evidence- based information could help develop resilience-based policies, leading to a sustainable usage of this vital resource (Rockstrom *et al.*, 2014; Xu *et al.*, 2015). In the scope of global climate change, research on water resources and associated hydropower production in remote areas with limited data availability is of eminent importance to anticipate upcoming challenges.

One way of assessing runoff from ungauged catchments is by regionalizing model parameters and applying parameters sets form gauged catchments to catchments with similar characteristics (Merz and Bloschl, 2004; Sefton and Howarth, 1998; Seibert, 1999). This is a valuable method as long as representative catchment characteristics can be identified