

HYDROLOGICAL EFFECTS OF CLIMATE AND LAND USE CHANGES IN REGULATED vs. UNREGULATED HEADWATERS OF SOUTHERN CALABRIA

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Aims of the study

The hydrological response of two forest torrent headwaters (“Vacale”, regulated by check dams built in ‘1950-60s, and “Serra”, not regulated, both in Southern Italy) has been evaluated using the Soil and Water Assessment Tool (SWAT) model under different land uses and climate change scenarios. This study aims at providing indications about the runoff generation capacity after conversion of forests to alternative land uses (cropland or pasture) under forecasted climate forcing and the effectiveness of torrent control works in limiting these effects.

Short description of methods

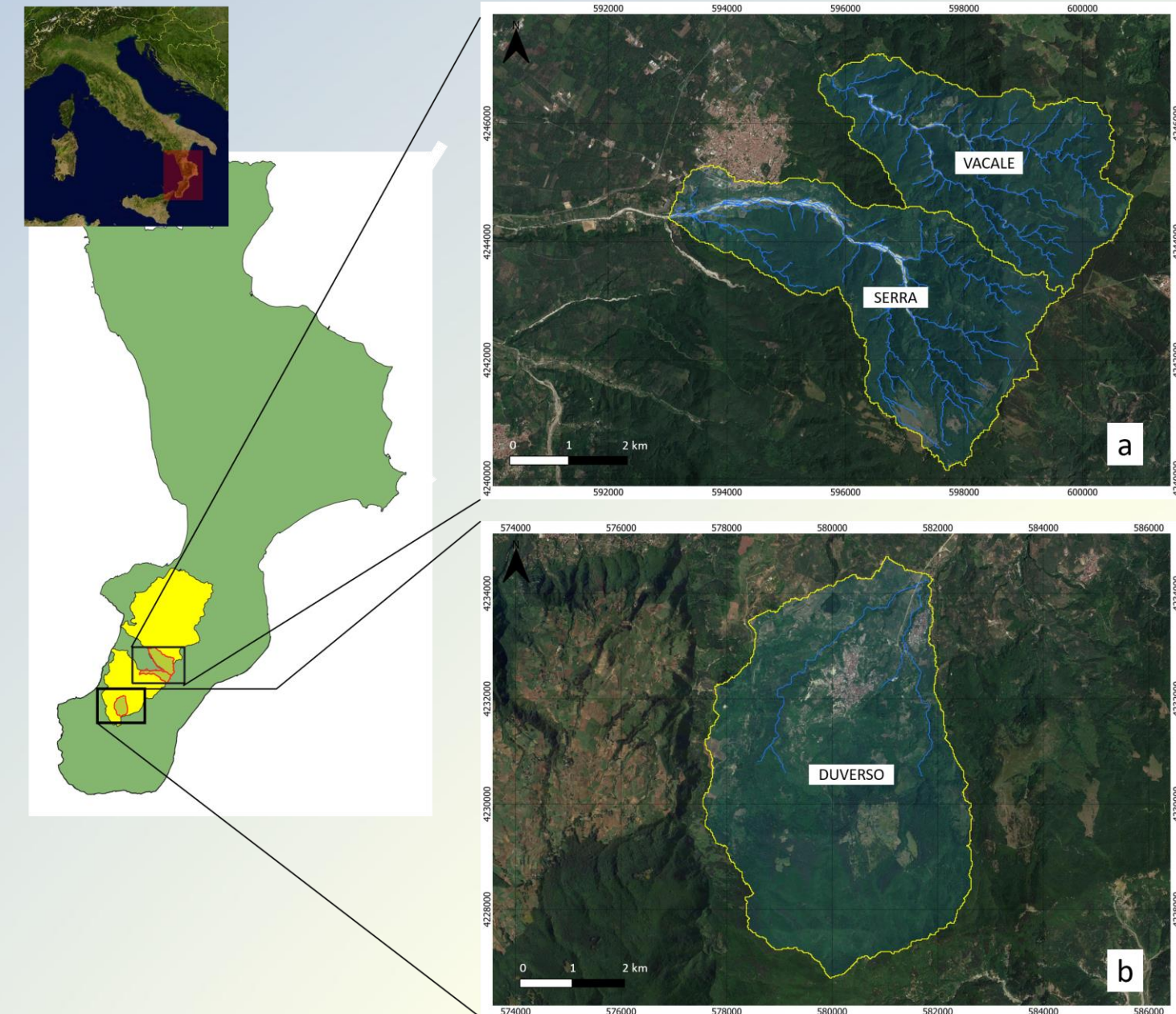


Figure1. The selected sub-catchments in Calabria, Southern Italy

Table 1. Main characteristics of the selected sub-catchments (Calabria, Southern Italy)

Characteristics	Sub-catchments		
	Duverso	Serra (UNREG)	Vacale (REG)
Average annual air temperature (°C)	16.7	16.3*	16.3*
Average annual rainfall depth (mm)	1503	1467	1467
Area (km ²)	12.5	14.6	11.3
Maximum altitude (m·a.s.l.)	630	650	600
Minimum altitude (m·a.s.l.)	450	400	400
Length of main stream (km)	5.2	6.6	4.7
Longitudinal slope (%)	7	6	7
Main aspect of vegetation	Broad leaved forest		
Main land use	Woodland		
Main texture	Sandy loam		
Main type	Humic Dystrudept		
Main lithology	Granites and granodiorites		
Number of check dams	0	0	15
Average annual discharge (m ³ s ⁻¹)	0.80		

The SWAT model was previously calibrated (using the SWATCUP program) in a third gauged (hydrograph) torrent (“Duverso”) with land characteristics that are very similar as the two other modeled sub-catchments.

The forecasted climate change scenarios were modeled according to the two following global circulation models (GCMs):

- MIROC5 (Atmosphere and Ocean Research Institute, University of Tokyo, National Institute for Environmental Studies and Japan Agency for Marine- Earth Science and Technology, Japan)

- GISS-E2-H (NASA Goddard Institute for Space Sciences, USA).

both running under representative concentration pathways (RCP 2.6 and RCP8.5) of GHG emissions

For each GCM and RCP, the monthly precipitation as well as maximum and minimum temperatures were forecasted throughout four 20-year periods (2020–2039, 2040–2059, 2060–2079 and 2080–2099), in order to simulate the surface runoff and peak flow rate under forest, pasture and cropland land uses

Summary of results

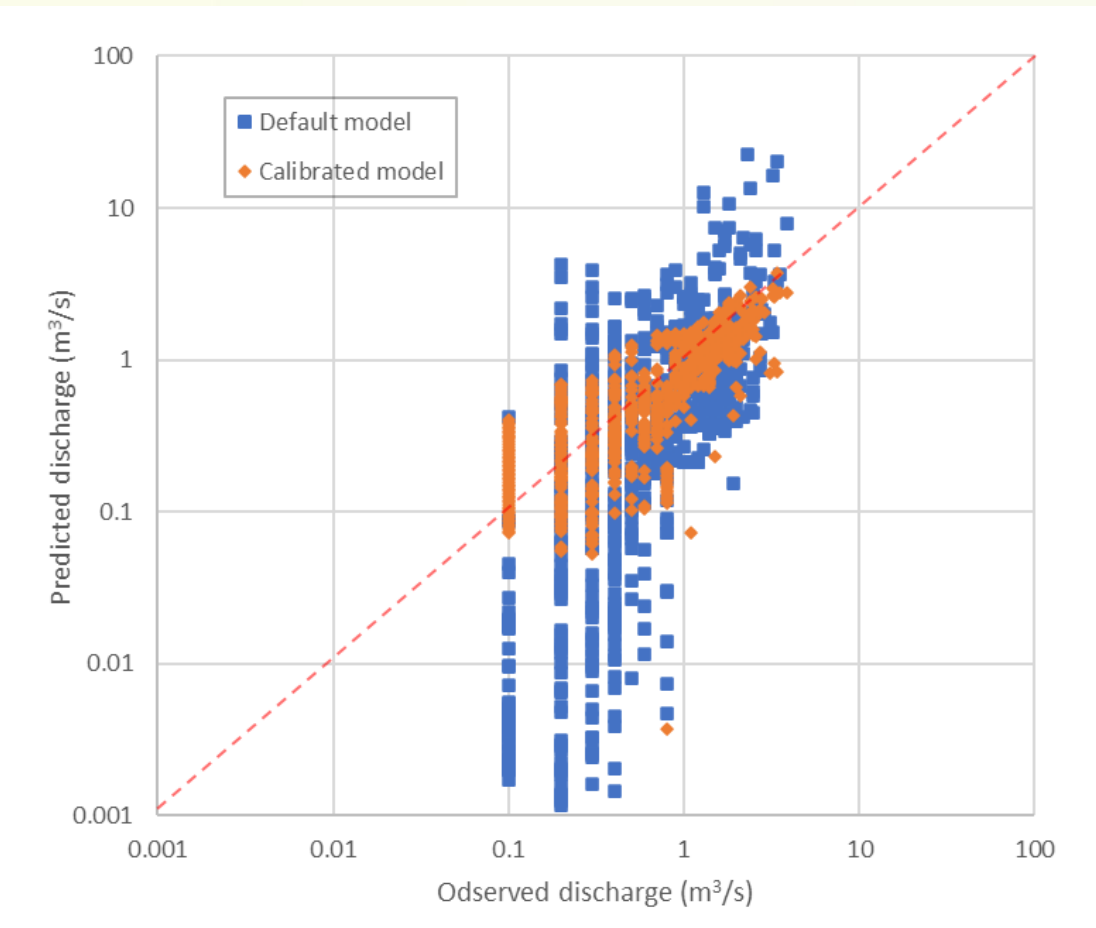


Figure 2. Scatterplot of water discharge observed at the Duverso torrent and predicted by the SWAT model using the SWATCUP program

Table 2. Mean ± std.dev. of the runoff coefficient calculated under different land use and climate change scenarios and RCPs in the regulated and unregulated torrent headwaters

LAND USE	Condition	GCMs	Mean Runoff coefficient			
			Miroc 5 (RCP 2.6)	giss_e2_h (RCP 2.6)	Miroc 5 (RCP 8.5)	giss_e2_h (RCP 8.5)
Forest	Reg		0.145 ± 0.07	0.141 ± 0.08	0.141 ± 0.06	0.155 ± 0.08
	Unreg		0.138 ± 0.07	0.147 ± 0.08	0.146 ± 0.07	0.171 ± 0.09
Agricultural	Reg		0.163 ± 0.07	0.152 ± 0.08	0.143 ± 0.07	0.155 ± 0.09
	Unreg		0.163 ± 0.07	0.152 ± 0.08	0.143 ± 0.07	0.155 ± 0.09
Pasture	Reg		0.170 ± 0.07	0.157 ± 0.09	0.132 ± 0.07	0.175 ± 0.10
	Unreg		0.170 ± 0.07	0.157 ± 0.09	0.132 ± 0.07	0.175 ± 0.10

- Compared to forest, the alternative land uses will give higher runoff generation (also in this case with small differences), which indicates the key role of tree canopy cover and forest vegetation as mitigating factor of surface runoff.

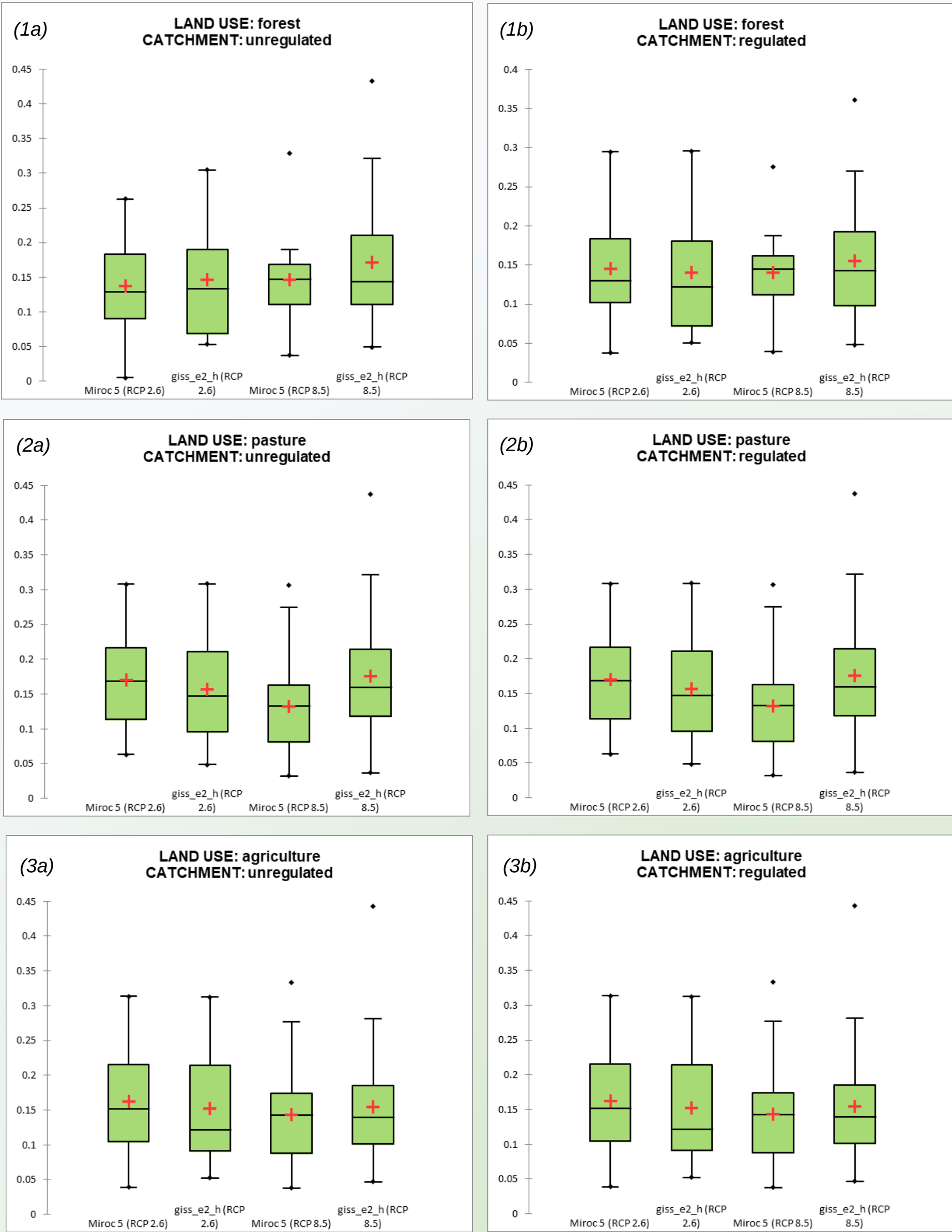


Figure 3. Box plots of runoff coefficients simulated by SWAT model in the regulated and unregulated torrent headwaters under different climate change scenarios and RCPs as well as land uses: (1a, 1b) forest, (2a, 2b) pasture and (3a, 3b) agriculture.

Acknowledgments

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