Val Roseg: A Glacial Flood Plain in the Swiss Alps

The upper Val Roseg valley in the eastern Swiss Alps hosts a hydro-morphologically diverse stream ecosystem that is strongly influenced by glacial runoff. The distinctive geomorphic feature of the Roseg River corridor is a large glacial flood plain that was subject to a comprehensive ecosystem study.

The effects of future climate change are expected to severely affect alpine stream ecosystems [1] in addition to current human impacts such as tourism, flood protection and water abstraction for power production. Knowledge on the structure and function of alpine streams has been limited until recently (see also p. 3). In the past few years, however, alpine stream ecology has attracted major attention [e.g., 2]. In 1996, the limnological department at EAWAG initiated a comprehensive investigation of the glacial floodplain system in the upper Val Roseg (Fig. 1), a catchment providing a unique diversity of stream types and being accessible throughout the annual cycle. The studies were directed to understand spatial and temporal patterns of periphyton, benthic and hyporheic fauna, production and decomposition of organic matter, and nutrient dynamics in the harsh alpine environment. Some results from the Val Roseg Project will be presented in the following five articles in this EAWAG news issue. This article summarizes some important characteristics of the Val Roseg such as geomorphology, hydrology, temperature regimes, and channel dynamics.

An Alpine River Corridor

The Val Roseg is located in the Bernina Massif of the Swiss Alps. Some important area statistics are summarized in Table 1. Elevations range from 1981 m a.s.l. at the downstream end of the glacial flood plain to 4049 m at the top of Piz Bernina. The Roseg River (mean annual discharge = 2.8 m^3/s) is primarily fed by meltwater from Roseg glacier, which ends in a proglacial lake, and the Tschierva glacier. Five major stream reaches can be distinguished along the corridor of the Roseg River (Fig. 2):

- a 650 m long proglacial reach below the Tschierva glacier,
- a 900 m long lake outlet system below the proglacial lake,
- a 700 m long single-thread channel incised in glacial till downstream of the confluence of the proglacial stream and the lake outlet,
- a 2600 m long and 150–500 m wide main glacial flood plain, where elevation ranges from 1981–2055 m,
- a 7.2 km long reach constrained by valley slopes.

The flood plain include an impressive diversity of different alpine stream types that range from glacial streams to springs [3] (see also p. 14).

Terrestrial vegetation – a potential energy source for benthic organisms (see also p. 18) – varies from almost no vegetation

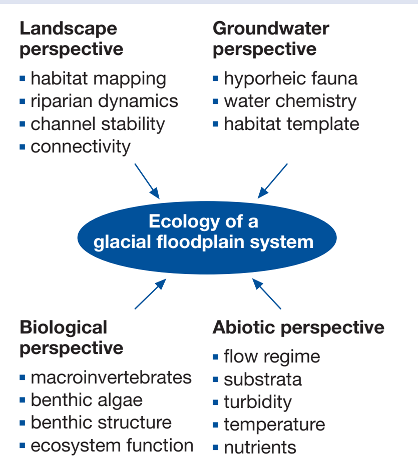


Fig. 1: The multifaceted nature of the Val Roseg Project.

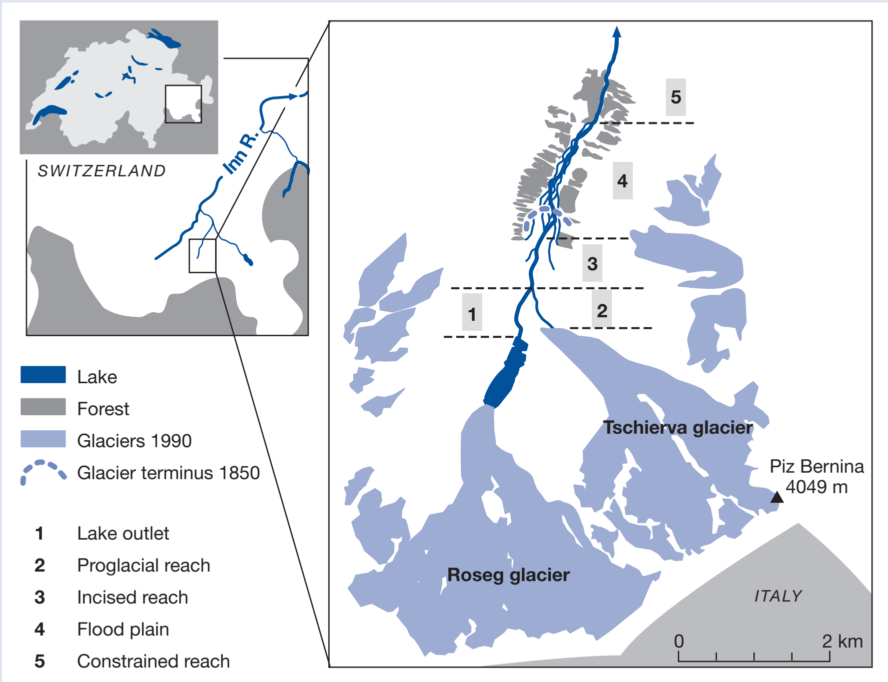


Fig. 2: Upper Val Roseg catchment.

	%	km²
Glaciers	41.7	20.6
Rock	32.3	16.0
Grassland	18.4	9.1
Forest	3.6	1.8
Flood plain	3.4	1.7
Lake	0.6	0.3
Total area		**49.5**

Tab. 1: Area statistics of the upper Roseg valley. Contribution of different landscape elements.

close to the terminus of the Tschierva glacier to subalpine forests covering the valley slopes along the flood plain. The elevation of the treeline ranges from 2100–2300 m a.s.l. In the flood plain, channel dynamics resulted in a dynamic mosaic of different terrestrial vegetation. Bare gravel or gravel with initial stages of pioneer plant communities dominated in 70% of the active floodplain area. The flood plain is free from trees, but contains a few scattered shrubs in relatively small areas not affected by channel migration for more than 30 years.

Flow Dynamics

The glacial flow regime, which is a major factor structuring the physical habitat template of the floodplain system, is characterized by a distinct annual flow pulse. Daily discharge increases from about 0.16 m^3/s in April to more than 10 m^3/s in July and August then declines from late September to November to 0.2 m^3/s (Fig. 3). Superimposed on this highly predictable flow pulse are aperiodic and periodic flow variations. Diel pulses reflect enhanced freeze-thaw cycles during summer. Heavy rainfall results in flow peaks (e.g., in June, August and November 1997, Fig. 3) whereas periods of cold weather reduce the meltwater production (e.g., July and August). The annual flow pulse results in dramatic cycles of habitat expansion, contraction and fragmentation, and affects habitat properties such as water chemistry, turbidity and temperature (see also p. 14) [4, 5].

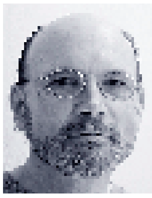
Thermal Heterogeneity

Temperature is a key factor regulating community structure of aquatic invertebrates and ecosystem function. In addition, there is a strong link between temperature and flow in this glacial system. In spring, air temperature and solar radiation augment water temperature throughout the flood plain. With the onset of snowmelt and icemelt in early June, water temperature in the main channel and in channels with upstream connections to the main channel begins to decrease. In channels lacking upstream connection to the main channel, water temperatures continue to rise until August/September. This results in a high thermal heterogeneity of habitats across the flood plain. Unlike many glacial streams, aquatic habitats with relative high temperature occur in close proximity to the glacier (Fig. 4).

An Alpine Stream Ecosystem in a Changing Climate

Evaluation of aerial photographs taken between 1947 and 1999 showed that about 25% of the channel network is renewed annually [6]. Disconnection and reconnection of former channels in the upper part of the Roseg flood plain induce major changes in the network of wetted channels. There is some evidence that such modifications occur after floods with substantial bedload transport. Roseg and Tschierva glaciers are rapidly retreating like most glaciers in the Alps. In 1934, the Tschierva glacier separated from the Roseg glacier. The Roseg and Tschierva glaciers end today about 3 km and 1.5 km from the terminus of the little ice age in 1850 (Fig. 2). The growing proglacial area below the Tschierva glacier stores large amounts of unconsolidated sediments that are susceptible to fluvial transport into the flood plain during high flow. Increased sediment supply, however, is assumed to accelerate the channel turnover in the flood plain [4] and as a consequence to reduce the average life span of habitats.

Air temperature records from stations in the Alps show an increase in daily minimum temperature of 2 °C since 1901 [7, 8]. The response of stream temperatures to this trend is presumably small unless amplified by receding glaciers. Between the current glacier termini and the 1850 terminus water temperature increases today on the average by about 3 °C during summer. One may infer that since the end of the little ice age, the main channel and surface connected floodplain channels became more favorable habitats, at least with respect to temperature. If the current trend of glacier recession continues, some floodplain channels will continue to warm up whereas channel stability is expected to decline.



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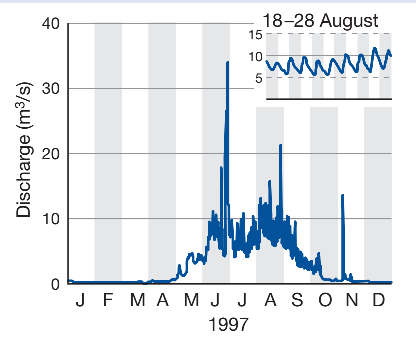

Fig. 3: Hydrograph of the Roseg River. Diel flow variations in August reflect enhanced freeze-thaw cycles during warm weather.

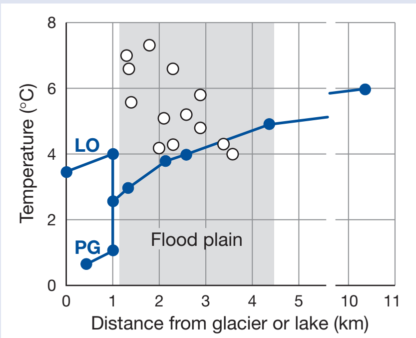

Fig. 4: Average water temperatures in July along the Roseg River corridor. Filled circles = main channel sites, open circles = floodplain channels excluding main channel. LO = lake outlet reach, PG = proglacial reach.

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