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Irrigation channels of the Upper Rhone valley (Switzerland). Geomorphological analysis of a cultural heritage

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The Upper Rhone valley (Canton of Valais, Switzerland) is characterised by dry climatic conditions that explain the presence of an important network (about 800 km) of irrigation channels – called Bisses in the French-speaking part of the canton or Suonen in the German-speaking area – dating back to the Middle Ages. This network constitutes a cultural heritage and during the last 30 years these agricultural infrastructures have sparked a renewed interest for tourist and cultural reasons. Indeed, the paths along the channels are used as tourist trails and several abandoned channels have been renovated for tourist use. Based on an inventory of the Bisses/Suonen of Valais, the proposed communication has three aims: (1) to analyse the geomorphological context (morphometric analysis, structural geomorphology, main processes) of various types of channels and to show the impact of the geomorphological context on the building techniques; (2) to identify particularly active processes along the channels; (3) to classify the Bisses/Suonen according to their geomorphological value and to their geomorphological sensitivity, and to propose managing measures.

Structural and climatic conditions influence the geomorphological context of the channels. In a structural point of view, irrigation channels are developed in three main contexts: (1) in the Aar Massif crystalline basement; (2) in the limestone and marl cover nappes of the Helvetic Alps; (3) in the metamorphic cover nappes of the Penninic domain. The Rhone River valley is boarded by two high mountain ranges: the Penninic Alps in the South and the Bernese Alps in the North. Because of rain shadow effects, the climate is relatively dry and, between Brig and Martigny, annual rainfall is not more than 600 mm at 500 m ASL and 800 mm at 1600 m ASL. Nevertheless, due to important vertical precipitation gradients annual rainfall totals are high at high altitudes. On the southern facing tributary valleys, the dry climatic conditions are accentuated by high insulation and evaporation. Finally, foehn events are quite common. In a climatic point of view, the area can be divided in three main zones: (1) Upstream of Brig, the climate is characterised by cold and wet conditions, and irrigation is not necessary; (2) between Brig and Martigny, the rain shadow effect is responsible of irrigation needs in the lower altitudes, whereas at high altitudes rainfall is sufficient for plant growing without irrigation; (3) downstream of Martigny, the climate is wetter and irrigation is not necessary. In a palaeoclimatic point of view, the Rhone River catchment was characterised by numerous glaciations during the Quaternary. Quaternary glaciers have shaped the valleys (U-shaped valleys, hanged valleys) and the postglacial hydrographical network had to adapt to the glacial valleys (presence of numerous waterfalls, hanged valleys, postglacial gorges, alluvial fans).

By crossing climatic and structural contexts, three groups of geomorphological contexts of irrigation channels can be highlighted: (1) In the tributary valleys situated South of the Rhone valley (Penninic Alps) the irrigation channels are simply dug in the valley slopes; several of them are affected by landslides typical of metamorphic rocks of Penninic Alps; (2) In the short tributary valleys of the crystalline Aar Massif – in the valleys North to the city of Visp –, the geomorphological context is characterised by steep slopes both in the tributary valleys and in the south-facing slopes dominating the Rhone River valley. In this area, water channels are cut into the rocks and in some parts they are built in wood pipes hanged along the rock walls; (3) In the tributary valleys of the Helvetic domain – North of the Rhone River between Leuk and Sion – the geological context highly influences the building techniques: due to geological dipping towards Southeast, the tributary valley are dissymmetric: in the dip slopes channels are simply cut in the soil, whereas in the steep opposite sides, they are hanged on the limestone rock walls. In the south-facing slopes of the main valley, differential erosion by the Rhone glacier has formed a complex alternation of hills, depressions and gently dipping slopes very favourable to agriculture; the irrigation network had adapted to this complex geomorphological context.