

SUPPLEMENTARY MATERIALS – STUDY AREA

Aosta Valley, the smallest Region of Italy, is located in the north-west of the country, surrounded by the highest massifs of the Alps. The average altitude of the Region is 2,106 m a.s.l. and about 80% of the surface is located above 1,500 m above sea level (Cerutti, 1995; Janin, 1982; Vauterin, 2007). The year-round habitable areas, represents only 8.7% of the Region's total area (Cerutti, 1995).

The Utilised Agricultural Area is about 56 thousand hectares, with 98% of which are grasslands (9,500 hectares) and pastures (45,000 hectares), while the rest is made up of orchards (280 hectares), vineyards (370 hectares), and other minor crops such as potatoes, cereals, and vegetables. Livestock farming thus forms the core of the agricultural production system in the Aosta Valley, characterised by the breeding of native dual-purpose cattle breeds for the production of DOP Fontina cheese. (Trione, 2020).

The climate can be classified as semi-continental cold temperate, strongly influenced by the topography. In fact, the mountain ranges surrounding the Aosta Valley prevent access to Mediterranean or Atlantic masses of moist air (Mercalli, 2003). Seasonally, the highest precipitation occurs in spring and autumn, while summer and winter are drier seasons (Zucaro & Seroglia, 2009).

The Region's low precipitation, especially in summer period, makes irrigation essential. Irrigation is entrusted to WUAs, private non-profit organisations of irrigation water users, who voluntarily cooperate to manage and satisfy the water supply needs for irrigation (Zucaro & Seroglia, 2009). Land ownership in Aosta Valley is highly fragmented and pulverised. There are currently about 160 WUAs (Zucaro & Seroglia, 2009) that manage the irrigation of areas spread over the 74 municipalities of the region. The participation of WUA members in the management of the common property resources also takes the form of *corvées*, an ancient system whereby users provide labour for the regular maintenance of irrigation networks by cleaning canals, drains and streams, and for extraordinary interventions such as repairing storm damage (Bréan, 1950).

WUAs cover their management costs through regional contributions and the collection of quotas. The quota represents the contribution to management costs, required from all landowners and irrigation water users for the benefits they derive from the services provided by the WUA. As such, it is therefore not considered a tariff (i.e., a full recovery of the costs of water use) under the WFD. Quotas contribute to cover only the financial costs, dividing among the beneficiaries the expenses related to the management, operation and maintenance of the irrigation system administered by each WUA, while environmental and resource costs are not considered.

However, agriculture and related irrigation practices in a mountainous area such as the Aosta Valley do not only benefit farmers, as they provide ES and environmental benefits that are enjoyed by the entire community (Zucaro *et al.*, 2020). Indeed, Aosta Valley is highly dependent on tourism: during summer, thousands of tourists trek along the local trails. The presence of farms in the area, which mow, graze and irrigate meadows and pastures, maintains the attractiveness of the mountain landscape (Zucaro & Seroglia, 2009) and its usability for tourists (Mazzocchi & Sali, 2022). In addition, the *corvée* system ensures the regular maintenance of irrigation channels, with important effects in terms of soil protection, prevention of hydrogeological instability events and mitigation of flood events (Mazzocchi & Sali, 2022), since the capillary network of small canals, dug along contour lines to allow surface irrigation of grasslands even on the steepest slopes, helps regulate excess water that accumulates during intense storm rainfall, which are increasingly frequent because of climate change.

REFERENCES

- Bréan, J. (1950). *Anciens rus de la Vallée d'Aoste; La charte des franchises de la Vallée d'Aoste*. Impr. valdotaine.
- Cerutti, A. V. (1995). *Le pays de la Doire et son peuple*. Musumeci Editore.
- Janin, B. (1982). Circulation touristique internationale et tourisme étranger en Val d'Aoste. *Revue de Géographie Alpine*, 70(4), 415-430.
- Mercalli, L. (2003). Atlante climatico della Valle d'Aosta. Regione Autonoma Valle d'Aosta. *Direzione Protezione civile, ufficio Meteorologico*
- Trione, S. (2020). L'agricoltura nella Valle d'Aosta in cifre 2020. *Rome: CREA*.
- Vauterin, G. (2007). *Gli antichi rû della Valle d'Aosta: profilo storico, agricolo, tecnico e ambientale dei canali irrigui in una regione di montagna*. Le château.
- Zucaro R. & Seroglia G., 2009. Monitoraggio dei sistemi irrigui delle regioni centro settentrionali. Rapporto sullo stato dell'irrigazione in Valle d'Aosta. Rapporto sull'irrigazione.