

Sustainable coastal groundwater management and pollution reduction through innovative governance in a changing climate



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#### Description

The case study is located in a 60 km<sup>2</sup> area under the domain of of the Consorzio di Bonifica dell'Oristanese, a local consortium controlled by the Regional Administration which is responsible for the distribution of the irrigation water supplied by the Eleonora d'Arborea dam, one of the biggest in Europe. In the 1930s the land was drained and reclaimed for agricultural production, mainly irrigated crops. Today, Arborea is the main dairy cattle district of the island, with over 300M€ of yearly gross income, and a nitrate vulnerable zone (NVZ). The agricultural system is also characterized by other activities, ranging from rice growing (over 3,000 ha) to horticulture, including artichokes, melon and many other high-value crops. Water is therefore key to the district's economic development. Arborea is facing a double-bind situation, struggling to maintain high levels of productivity while also ensuring environmental protection. Restrictions were imposed on animal effluent management, which resulted in increased costs for dairy farmers already facing increased costs due to the surge in milk prices, feedstuff, and mineral fertilizers.

### **Stakeholder mapping**



#### Sepecific problems

Despite the high natural water deficit in the summer, water availability is not perceived as an issue by farmers because of the very high capacity of the dam. However, latent and apparent waterrelated conflicts arise among local stakeholders. Arborea is facing a double-bind situation, struggling to maintain high levels of productivity while also ensuring environmental protection. Restrictions were imposed on animal effluent management, which resulted in increased costs for dairy farmers already facing increased costs due to the surge in milk prices, feedstuff, and mineral fertilizers. In this scenario, the crisis is intensified by climate change. Top-down measures to mitigate nitrate pollution have proved ineffective, thus calling for alternative social learning-based, participatory approaches to governance.

#### Water gouvernance system in Arborea



#### **SUSTAIN-COAST results**

## **Groundwater Vulnerability Index values\***



The Groundwater Vulnerability Index values of the Arborea Coastal Aquifer range from 0.077 to 0.251. Groundwater pollution sensitivity in Arborea is relatively higher than in other study areas. Almost half of the extremely study has high area sensitivity potential and 20% has high sensitivity. In areas of high sensitivity, groundwater shallow is at very depths. These areas mostly are irrigated crop areas with low land slopes.

\*The groundwater vulnerability index is a method of assessing the vulnerability of aquifers to surface contaminants

## Variability of groundwater in terms of water equivalent thickness



The global database from the Gravity Recovery and Climate Experiment (GRACE) mission was used to assess the groundwater level change and implement the cost benefit analysis.

# **Cost- benefit analysis**



Arborea, Italy	2021	2031	2041
Groundwater use	30%±2	39%±6	27%±2
Surface water use (reservoir)	47%±3	38%±7	51%±3
Other sources e.g., treated wastewater	23%	23%±8	22%8

Aquifer recharge/% of groundwater use	75% ± 5	71% ±9	68%±10
Financial benefit compared to groundwater use	23%	19%	21%
only			

Considering the available information and applying the proposed cost-benefit analysis methodology, results show that beyond 12 overpumping violations when groundwater is only used. However, mitigation measures (groundwater and surface water used together) are more affordable compared to intensive groundwater use only. The proposed mitigation measures consist of the balanced use of available water resources (groundwater, reservoir water and treated wastewater) according to the calculated values presented in the table. In addition, the projected water use balance for the next decades is presented.

# **Climate change analysis**

The climate scenarios, a combination of Regional Climate Models (RCMs) and General Circulation Models (GCMs) – 6 scenarios produced

Climate scenarios were based on the Representative Concentration Pathways (RCPs) 4.5 and 8.5

Precipitation and temperature data, recorded at Oristano Santa Lucia from 1976-2005, were used to correct the systematic errors in the outputs of the Regional Climate Models

2021-2098 is the scenario period: time-variant groundwater recharge in 5 areas deduced from predicted rainfall



Only in the area of the upconing aquitard strong groundwater fluctuations (see P40ar). Otherwise, hydraulic heads computed in the Nitrates Vulnerable Zone not vary strongly over

time as the ground water table is constrained by the dense network of artificial ditches

Long term perspective (2081-2098) : mean annual rainfall increased (6%) for RCP 4.5 and decreased (4%) for RCP 8.5 → Referenced to January 2021, hydraulic heads decreased significantly (by several tens of cm) for RCP 8.5 compared to RCP 4.5

Groundwater level variation and zero Nitrate application : December 2040, hotspots are damped out, but concentrations at several observations wells exceed still the limit of 50 mg/L

