TITLE: LIFE LAGOON REFRESH. Ecological restoration in Venice Lagoon (Italy): concrete actions supported by numerical modeling and stakeholder involvement.

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KEY POINTS

- *The project recreates the typical salt gradient in an area of the northern Venice Lagoon*
- *Recreation of reedbeds to improve the ecological status of habitat and species in SCI IT3250031*
- *Concrete actions are hydraulic and morphological interventions, reed and seagrass transplantation.*
- *Hydraulic and morphological interventions are supported by numerical models*
- *Stakeholders are involved in concrete actions and monitoring activities*

1 PREMISE

The LIFE LAGOON REFRESH project foresees the diversion of a freshwater flow from the Sile river into the lagoon, necessary for recreation of the typical salt gradient of buffer areas between lagoon and mainland, for restoration of the reedbed habitat, strongly reduced until XX century (D'Alpaos e Carniello, 2010), and for improvement of the Lagoon environment and its biodiversity.
ISPRA (Italian National Institute for Environmental Protection and Research) is the Partner Leader, whilst the Environmental Direction of Veneto Region, the University of Venice, the Interregional Superintendency for Public Works in Veneto – Trentino Alto Adige – Friuli Venezia Giulia (OOPP), and IPROS Ingegneria Ambientale Srl. are the Association Partners.
The project started on September 2017 and it lasts for 5 years.
The Project involves the restoration, in the northern Venice Lagoon, SCI IT3250031, of the ecotonal environment, typical of microtidal lagoons. This environment is characterized by a marked salt gradient and large intertidal areas vegetated by reeds (mainly Phragmites australis), whose presence has been greatly reduced by historic human intervention.
The project aims to exploit the ecosystem services provided by this environment to achieve the following objectives:

1) to improve the Degree of Conservation of habitat 1150* - Coastal lagoons:
   a) recreating the typical estuarine oligo-mesohaline environments, in order to counteract the depletion of macrobenthic and fish communities in the Lagoon. Indeed, during last years, the brackish species have been replaced by those from the sea;
   b) reducing the degree of eutrophication, thanks to reed phytoremediation function, favoring the presence of sensitive species and aquatic plants of high ecological value. These characteristics are typical features of habitat 1150 * in good/high level of preservation;
2) to improve, within the Venice Lagoon - SPA IT3250046, the status of bird species included in annex I of the Birds Directive (Dir. 2009/147/EC) and using the reed environment during the winter period and /or for breeding, foraging or nesting: *Phalocrocorax pygmeus**, *Botaurus stellaris**,

Ardea purpurea, *Ixobrychus minutus*, *Circus aeruginosus*, *C. cyaneus*, *Alcedo atthis*.
3) to increase the presence of the fish species *Pomatoschistus canestrinii*, included in the annex II of the Habitats Directive (Dir. 92/43/EEC), attracted by low-salinity environments.

The project actions to restore the typical ecotonal environment in the transitional zone between mainland and lagoon, involve:

- diversion of a freshwater flow of approximately 1000 l/s from the Sile river into the Lagoon, necessary for the recreation of oligo-/mesohaline areas;
- restoration of the intertidal morphology through the implementation of structures made by biodegradable geotextile, properly arranged in order to slow down the fresh water dispersion and to favor the reed development according to the project configuration;
- planting of turves and rhizomes of *Phragmites australis*, in order to accelerate the development of the reedbeds, and transplantation of small dumps of *Ruppia cirrhosa* and *Zostera noltei*, in order to achieve the general object of improving the degree of conservation of habitat 1150*- Coastal lagoon and preserving target species of birds and fishes.

Technical details, strictly connected with planning, will be defined according to data collection, results of surveys and modelling activities.
Project activities will be followed by an environmental monitoring aimed to verify the achievement of expected results through the application of quality indices and assessment methods which integrate biotic, abiotic parameters and modeling analysis.
Fishermen and hunters will be involved in the reed and seagrass transplant actions

2 MATERIALS AND METHODS

2.1 Numerical modelling

Numerical modelling was used as a supporting tool to investigate the circulation pattern and to define the most suitable project configuration. In particular, two- and three-dimensional hydrodynamic models were used to optimize the freshwater flow and the morphological configuration, in terms of salinity diffusion and hydraulic effects.
The effect of diversion on saline wedge intrusion on Sile river was also assessed. Details of setup, calibration and results of numerical modelling will be presented.
Scenarios of increasing discharge of fresh water input (from 0 to 1000 l/s) have been evaluated in term of currents and salinity, investigating different morphological configuration.

2.2 Stakeholder involvement

Fishermen and hunters, who regularly frequent the SCI IT3250031, will be involved in the reed and seagrass transplant actions, thus raising awareness on the conservation and restoration of habitats and species.

A training course will be organized in order to involve about thirty stakeholders. The content will regard:

- Project objectives
- Basic knowledge about lagoon environment, reed and seagrass ecology
- Transplantation methods
- Fish and birds species recognition.

3 RESULTS AND DISCUSSION

The Project, started in September 2017, is in its early stage. At the moment numerous meetings have been held with competent authorities to explain the Project and to share its choices in order to obtain regular and formal authorizations.

Project plans of hydraulic and morphological works are in progress and concrete actions are not started.

During the phase of project definition, numerical results have been used in order to define the most suitable project configuration.

In Figure1 a map of salinity diffusion of fresh water input from Sile into the project lagoon area, obtained from numerical simulation, is presented. In particular, the ebb tidal phase, during which the diffusion of fresh water is maximum, is reported. Actually, the mean value of salinity in the area is about 30. Expected results, in term of extension of salinity diffusion, are 5 hectares with salinity minor than 5, 25 hectares with salinity between 5 and 15 and 70 hectares with salinity minor than 25.

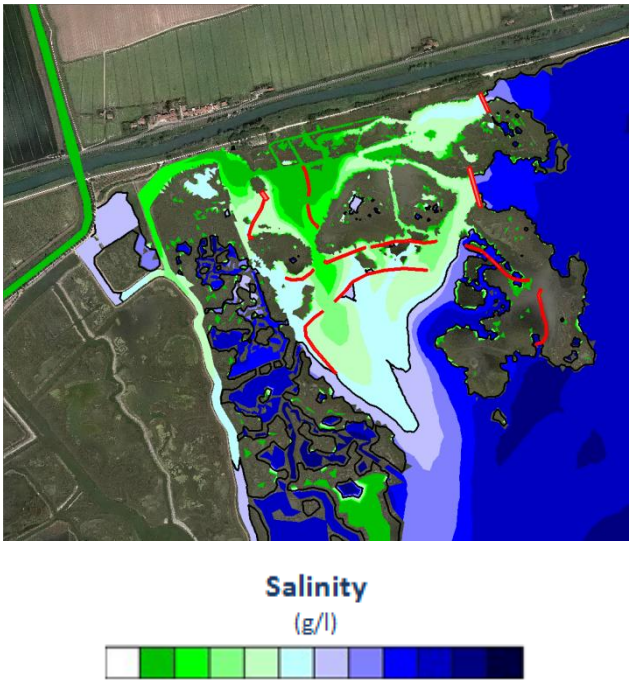

Figure 1. Map of salinity diffusion of fresh water input from Sile into the project lagoon area, obtained from numerical simulation. Red lines represent the configuration of the morphological structure

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