

Technical note about the monitoring of hydromorphological management of the Adige River (Autonomous Province of Trento, Italy)

PAT - Autonomous Province of Trento



1. General presentation of the study sites

The Adige is the second longest river in Italy, rising in the Alps in the Autonomous Province of Bolzano of near the Italian border with Austria and Switzerland, flowing 410 kilometers through most of North-East Italy to the Adriatic Sea.

In the territory called Adige valley the current river course is the result of heavy anthropic interventions of rectification done in the mid 1800's. This heavy hydromorphological alteration induced protection of the floodplain against floods, and consecutive agricultural development in the floodplain. On the other hand, rectification decrease the morphological and environmental quality of Adige river from several point of view. Artificial embankments and river straightening induce hydraulic and morphological alteration as increase of stream velocity that increase of bed erosion processes and inhibit natural processes.

In 2011 the Province of Trento made a river restoration activities on Adige River, directly downstream respect to Noce confluence (46° 8'24.15"N - 11° 4'33.44"E) in order to reactive some fluvial dynamics. The restoration project consists in a river widening using the floodplain area present in the left river side. This project led to the current configuration of the case study, characterized by two distincts parts, a riparian area to the north and a secondary channel to the south.

Since 2006 the restoration site is part of the biotope "Foci dell'Avisio" (IT3120053), in those years the high naturalistic interest of the area produce the extension of the protected area to the north until Noce junction.

biotope "Foci dell'Avisio" was extended until the Noce junction, therefore the restoration site is now part of the protected area.

Monitoring and evaluation of the project results are actually the main objective that, in case of necessity, could suggest a project revision. During the restoration activities made in 2011 have been carried away 70,000 m³ of sediment, the sediments extracted were used in landfills for a capping operation .

Another open question is the management of residues of potential new excavation on floodplain, this operation have to be made in a sustainable way from several points of view, economic, environmental, legislative,... that take into account also sediment management. Monitoring results could also suggest to reinsert part of the terrain in the river, that is probably affected by erosion induced by low sediment supply from upstream.

Pilot Sites	Adige River - Ischiello
Drainage area at the monitoring reach (km ²)	~ 8,500
Location	Downstream to the confluence with Noce river
Length of the study reach (km)	~ 1-2
Active channel width (m)	~ 100
Channel slope (m/m)	~ 0,01
Planform morphology	single-thread
Lateral confinement	Artificial confined
Dominant substrate	gravel-bed

Table 1. Main physical features of the pilot site(s)

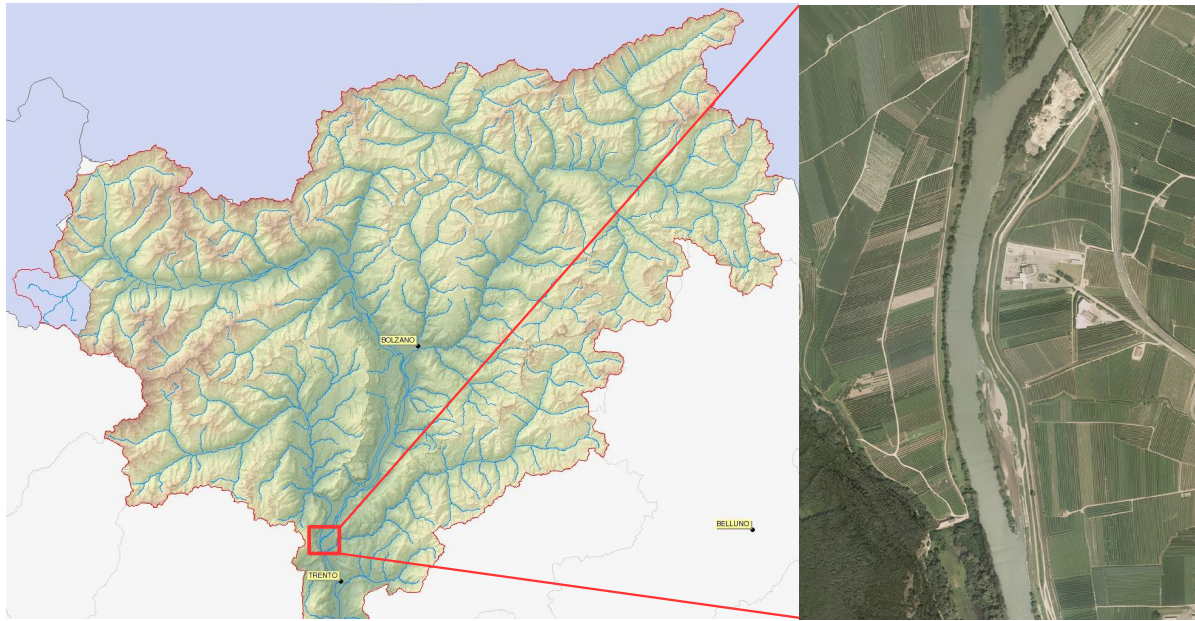


Fig. 1 : restoration site

2. Hydromorphological restoration

The restoration carried out in 2011 was done with the goal of returning to the river a part of the territory taken in the past. The widening position was chosen with a compromise between technical feasibility and availability of territory.

The project consists in the demolition of a part of the historic embankment of the river and in removing and remodeling of the terrain in the floodplain in a river reach 500 meters long. During the restoration was estimated that 70,000 m³ of sediment was removed to the site in order to create a secondary channel that hydraulically activities only with consistent flow condition in Adige river. Almost 500 meters upstream respect to this work, near Noce junction, another minor part of the restoration was done with the creation of an artificial riparian area 100 meters long and 30 meters wide connected with a channel against the direction of the current with Adige river.

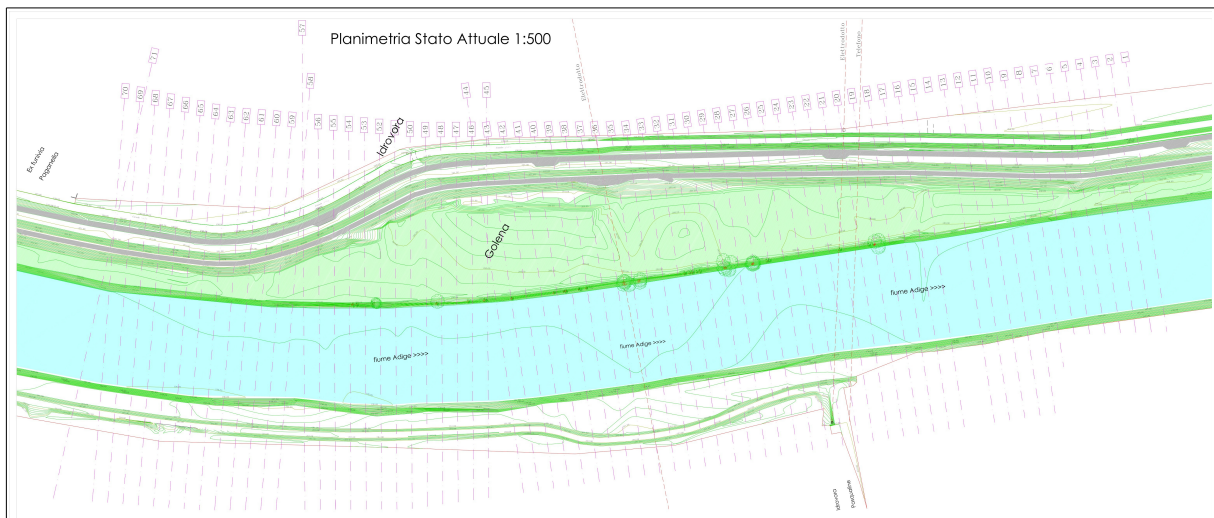


Fig. 2: planimetry before river restoration

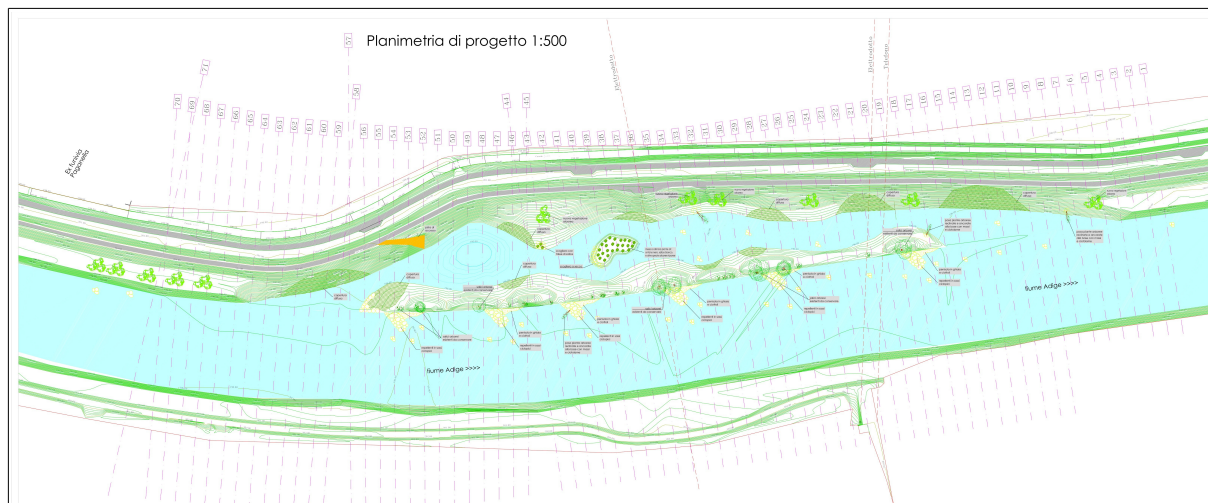


Fig. 3: planimetry of river restoration project

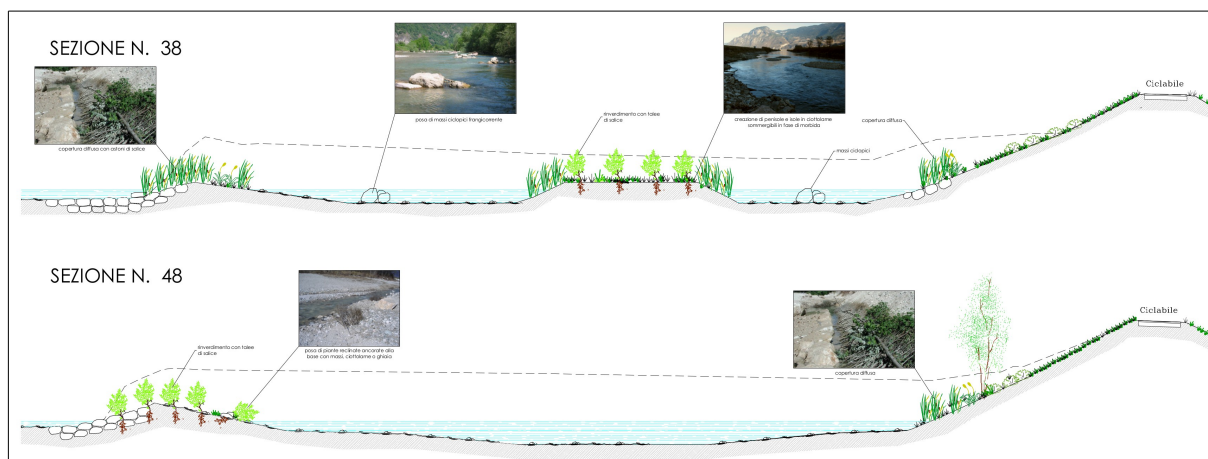


Fig. 4: Cross section typology

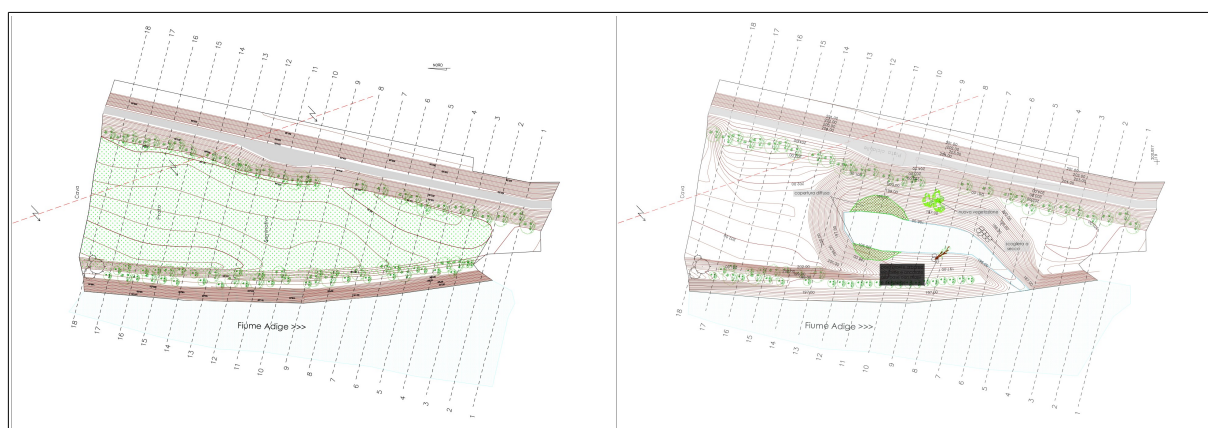


Fig. 5: planimetry of the spot near Noce junction before and after river restoration



Fig. 6: Ischiello in the middle of restoration work



Fig. 7: south part of the case study site before (2006), during (2011) and after (2015) river restoration work

3. Monitoring activities

3.1. General objectives of the monitoring program

The main objectives of the monitoring activities is the evaluation of river widening using the floodplain area present in the left river side. The results should also suggest an improvement of the river restoration that can be done in the future.

In particular the activities aims are:

- estimate the reactivation of morphodynamics;
- estimate morphological stability and evolution of the restoration project geometry, related in particular to hydrological condition;
- estimate morphodynamics influence of upstream Noce junction;
- estimate ecological response and the improvement of habitat;
- estimate the ecosystem services improvement.

3.2. Physical monitoring

In order to answer to the proposals in this pilot site the follow activities will be done repetitive topographic survey of the pilot site area, information are obtained by different techniques carried out in different time.

Date of the survey	Type of survey	Before/after restorian
2008	airbone LiDAR	pre - restoration
november 2009	Restoration project (topographic survey)	pre - restoration
june 2010	River cross section (200 m)	pre - restoration
2014	Airbone LiDAR	post - restoration
2016	main channel bathimetric longitudinal survey	post - restoration
january 2018	UAV survey (photogrammetric)	post - restoration
winter 2019	UAV survey (photogrammetric)	post - restoration

Table 1. Topographic surveys

Existing topographic data will be integrated with new high resolution digital elevation models in order to estimate river morphodynamics evolution.

High resolution DEM will be obtained from a SfM elaboration of image acquired by drone. Water depth generally affect the results of this analysis, in order to avoid these problems the survey will be done in low flow conditions when secondary channel and riparial area are dry. During HyMoCARES project at least two of this survey will be done, one at the beginning of 2017 and one at the beginning of 2018.

Results of this survey will be use as input data for hydrodynamics and morphodynamics numerical modeling. This analysis will be applied in order to understand the pilot site evolution, some preliminary simulations have already been made in a master thesis with the numerical model BASEMENT (student: Stefano Pellegrini, supervisor: Walter Bertoldi, year: 2013-2014, title: "Modellazione numerica dell'evoluzione idromorfologica applicata ad un progetto di riqualificazione sul fiume Adige").

Physical monitoring is crucial to understand the sustainability of the river restoration during time, after 6 years we observe a progressive deposition of fine sediment in the area that can

affect some objective of the project. The analysis can suggest a project revision or create guidelines for new floodplain modeling with the same typology.

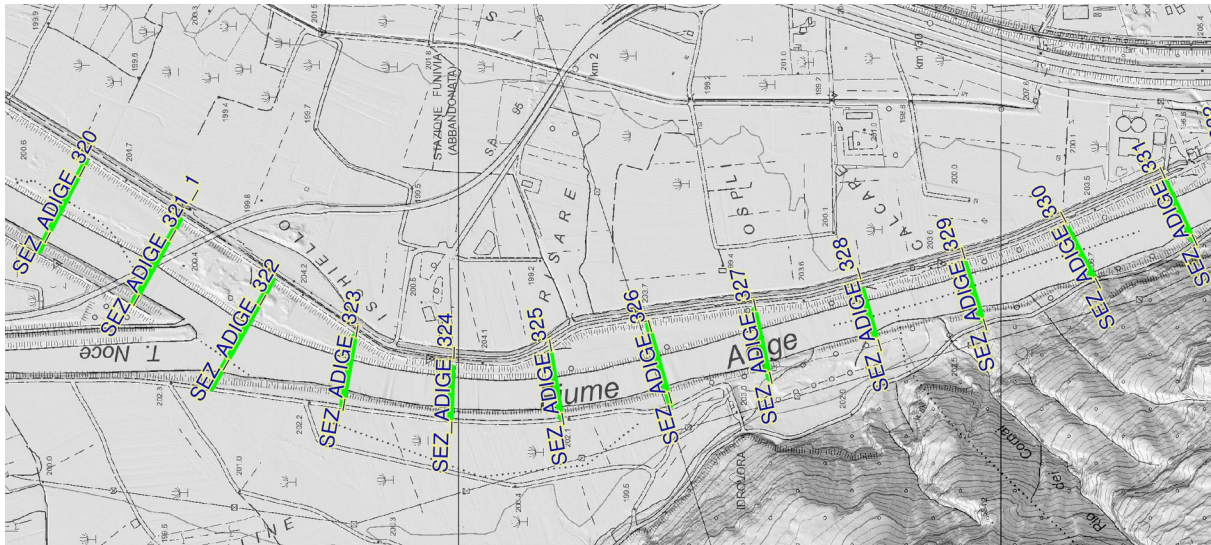


Fig. 8 : cross section positions (2010)

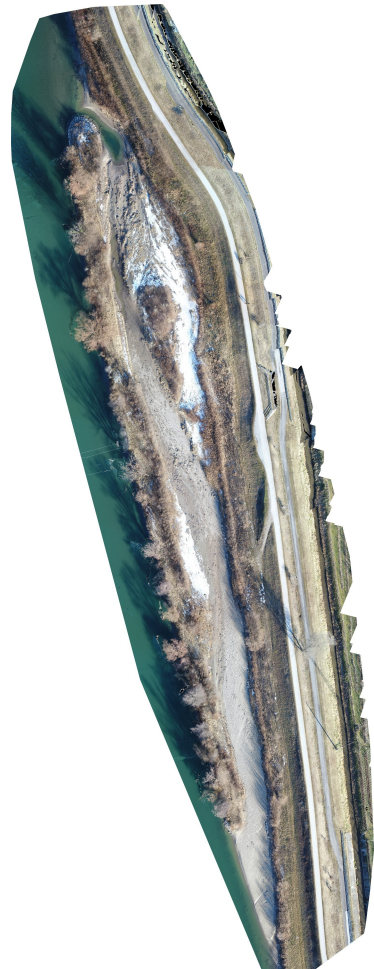


Fig. 9 : pilot site orthomosaic reconstruction (UAV survey - January 2017)

3.3. Ecological monitoring

Adige river in the pilot case location is included in the biotope "Foci dell'Avisio". The protected area include Adige river reach between Noce and Avisio river and 1,5 km of the Avisio alluvial fan. The naturalistic interest of the Foci Biotopo dell'Avisio is mainly focused on the presence of an extraordinary wealth of wildlife, this Biotopo is a sort of "oasis" located along a completely altered valley floor. There are numerous species of fish, amphibians and birds that live in the waters of the Biotopo despite the problems suffered by both the Adige and the Avisio. The ecological monitoring must carefully consider the particularities of this area.

In order to estimate the ecological response of the river restoration will be compared the pilot site with the nearby area that represent the situation before river restoration. Planned monitoring activities are:

- macroinvertebrate sampling;
- fish and terrestrial fauna habitat analysis and fish tax estimation;
- vegetation surveys and correlation with sediment composition (summer 2018).

High resolution image obtained from UAV could also be use to produce vegetaion mapping of the study site.

Vegetation survey aims to characterized the plant species in the area and hypothesize the possible future evolution. In that case crucial important the link between morphodynamics evolution and habitat availability. From a practical point of view will be made an analysis of the species present in the site area, recognizing invasive species and native species whose conservation is needed. The output will also be reported in a map in order to discriminate the difference between restoration area and the those near.

In the final report of the vegetation survey are provided guidelines for a specific vegetation treatment and monitoring.



Fig. 10: secondary channel (august 2017)

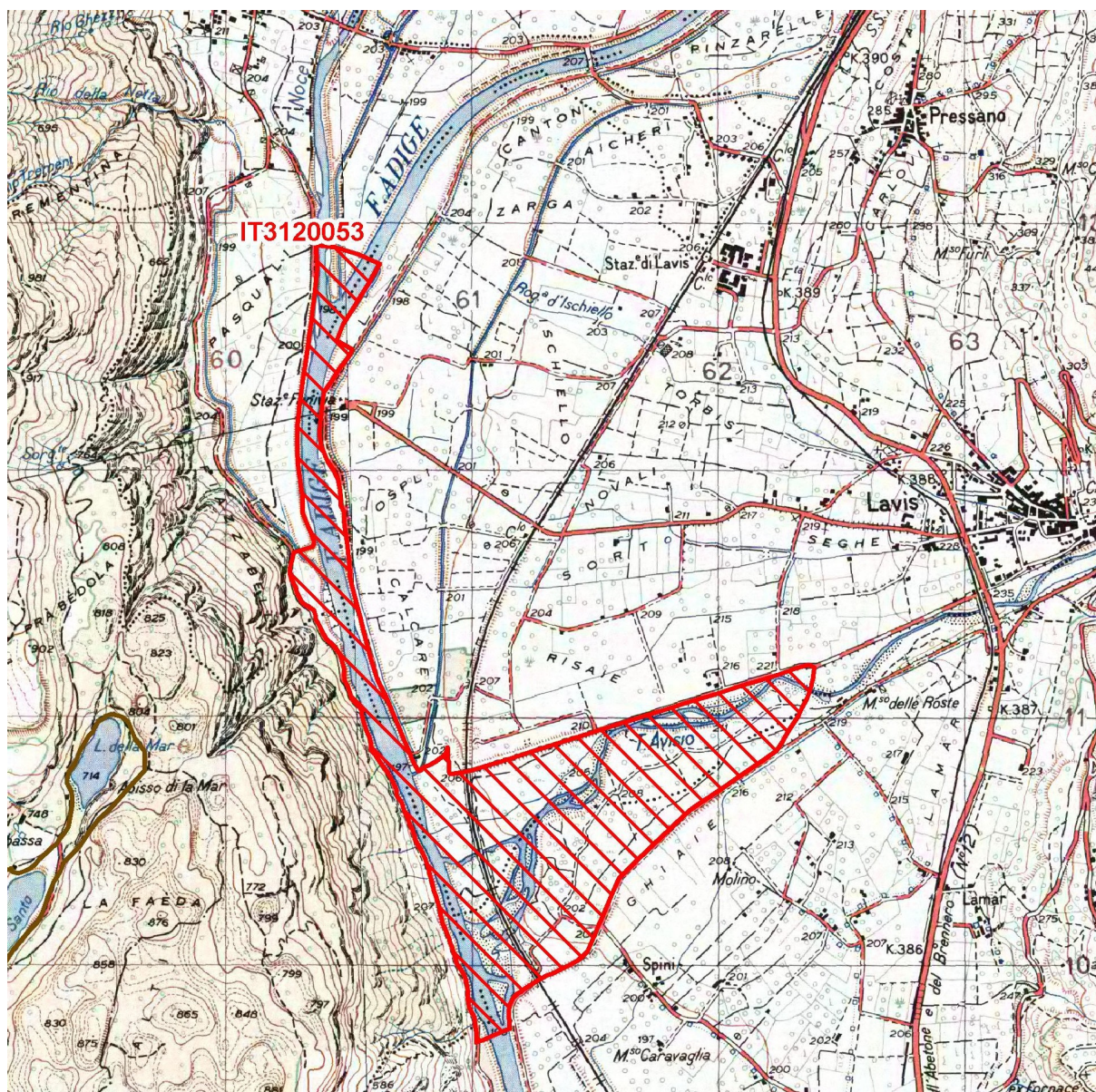


Fig. 11: Protected area "Foci dell'Avisio"

4. References