

# RIVER ANTHROPIZATION: CASE STUDIES IN REGGIO CALABRIA, ITALY

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## ABSTRACT

The considerable anthropic pressure that has affected most of Italian territory in the last 60 years has altered natural conditions of coasts and river, thus increasing exposure to environmental risks. For example, increase in soil waterproofing caused a reduction in hydrological losses with a rise in flood flows (with the same rainfall conditions), especially in urban areas. This issue is important in territories like Mediterranean region, that are prone to flooding events. From this point of view, recent advances in remote sensing and geographical information system (GIS) techniques allow us to analyze morphological changes occurred in river and in urban centers, in order to evaluate possible increases in environmental risks related to the anthropization process. This paper analyzes and describes the effects of anthropization process on some rivers in the southern area of the Reggio Calabria city (the Sant'Agata, Armo and Valanidi rivers). This is a heavily anthropized area due to the presence of the airport, highway and houses. The analysis was carried out using QGIS, through the comparison of cartography data of the last 60 years, which consists of aerophotogrammetry of 1955, provided by Italian Military Geographic Institute, and the latest satellite imagery provided by Google Earth Pro.

*Keywords: river anthropization, flooding risk, GIS, cartography data, Reggio Calabria.*

## 1 INTRODUCTION

The advance in anthropogenic pressure observed in Italy over the last 60 years [1], [2] has increased vulnerability of territory under the action of natural events such as floods [3]–[5], debris flow [6], [7], storms [8], [9] and coastal erosion [10], [11]. In fact, the anthropization of the territory has enhanced the impervious surfaces and the flooding effect due to the reduction in hydrological losses and in flow resistance [12], [13]. Furthermore, the anthropization rises the discharge and the runoff volume, and reduces the concentration time [14]–[16]. Moreover, the increase in anthropogenic pressure has altered the river dynamics due to the constriction of the riverbeds to build houses, roads, economic activities etc., that increasing the flooding risk, especially in urban areas [17]–[19]. This issue is important in territories like Mediterranean region, that are prone to flooding events [20]–[22]. Other important factors for alteration of river dynamics are construction of hydraulic structures, which interferes with fluvial dynamics such as levees, dams [23], [24], the inert drains from river beds, and soil erosion by water [25], [26]. Alterations of river dynamics, and therefore of river transport, has also modified coastal dynamics [27]. Indeed, shoreline position is an important factor in coastal dynamics [28]–[30] and it is related to natural and anthropogenic factors [31], [32]. The most important anthropogenic factor [33] is construction of buildings, infrastructure, ports and coastal defence works [34]–[40]. Among natural factors, the most important are the action of wave motion [41]–[45] and interaction between longshore and river transport [46]–[50]. Therefore, an accurate knowledge of river [51], [52] and coastal morphodynamics [53], [54] and of its natural and anthropogenic causes [55]–[57] are important for river and coastal zone planning and management [58], [59].

This paper analyzes and describes the effects of anthropization process on some rivers in the southern area of the Reggio Calabria city (the Sant'Agata, Armo and Valanidi rivers). The analysis was carried out using QGIS, through the comparison of cartography data of the last



60 years, which consists of aerophotogrammetry of 1955, provided by Italian Military Geographic Institute, and the latest satellite imagery provided by Google Earth Pro.

## 2 SITE DESCRIPTION

The study area is located in the Southern part of the Reggio Calabria city (Italy) and it is characterized by the presence of both sea and mountains very close to each other and by the presence of “*fiumare*” (Fig. 1). These are typical rivers of southern Italy with torrential and irregular regime: in summer these fiumare are often completely dry [60]. In Reggio Calabria there are more than 10 rivers and in this paper Sant’Agata, Armo and Valanidi are analyzed (Fig. 2). The largest of these is the Sant’Agata river, whose basin has an area of over 50 km<sup>2</sup>, while Valanidi and Armo rivers have an area of 30 and 15 km<sup>2</sup>, respectively. Moreover, the final part of Valanidi river forks in two reaches. The study area is heavily anthropized due to the presence, especially, of the airport, between Sant’Agata and Armo rivers, a sports center, in the Sant’Agata river, a highway, interfering especially with Valanidi river, and various industrial activities (Figs 3 and 4).



Figure 1: Study area location.



Figure 2: River present in the study area.



Figure 3: Detail of the Sant'Agata river.



Figure 4: Detail of the Armo and Valanidi rivers.

### 3 ANALYSIS OF THE ANTHROPIZATION EFFECTS

The analysis was carried out using QGIS, through the comparison of cartography data of the last 60 years, which consists of aerophotogrammetry of 1955, provided by Italian Military Geographic Institute, and the latest satellite imagery provided by Google Earth Pro. Shapefiles were created to identify rivers, roads and buildings.

Fig. 5 shows the 1955 aerophotogrammetry of the entire study area, showing the created shapefiles, in particular are shown in blue the rivers, in red the streets and in yellow the



buildings. Fig. 6 shows, instead, the last available satellite image, of September 2017, in which the created shapefiles were superimposed.

From the comparison of these two figures it is possible to observe how in 1955 the study area was not very anthropized, with very wide river beds, especially in the terminal parts, and with few infrastructures interfering with them. The airport had already been built, although it was partially obscured in the aerophotogrammetry, but it was entirely included between the Sant'Agata and Armo rivers without interfering with them.

At present, however, the territory is almost totally anthropized. In particular, with regard to the Sant'agata river, it is possible to observe that the final part, of a length of about 3 km and included between the highway and the mouth, has been restricted, from over 200 to about 20 m, and channeled through a concrete channel. Inside the river, a sports center has built and the extension of the airport runway on the north side passes over the river itself (Fig. 7). Also the final part of Armo river has been restricted, from more than 150 to about 30 m, and has been slightly diverted to extend the airport runway on the south side, which passes over the river as for Sant'Agata river (Fig. 8). Regarding Valanidi river, its two reaches have not undergo relevant narrowing but the highway, that connects Reggio Calabria with Taranto crossing the entire Ionian Calabria, passes below the riverbed through two tunnels (Fig. 8).

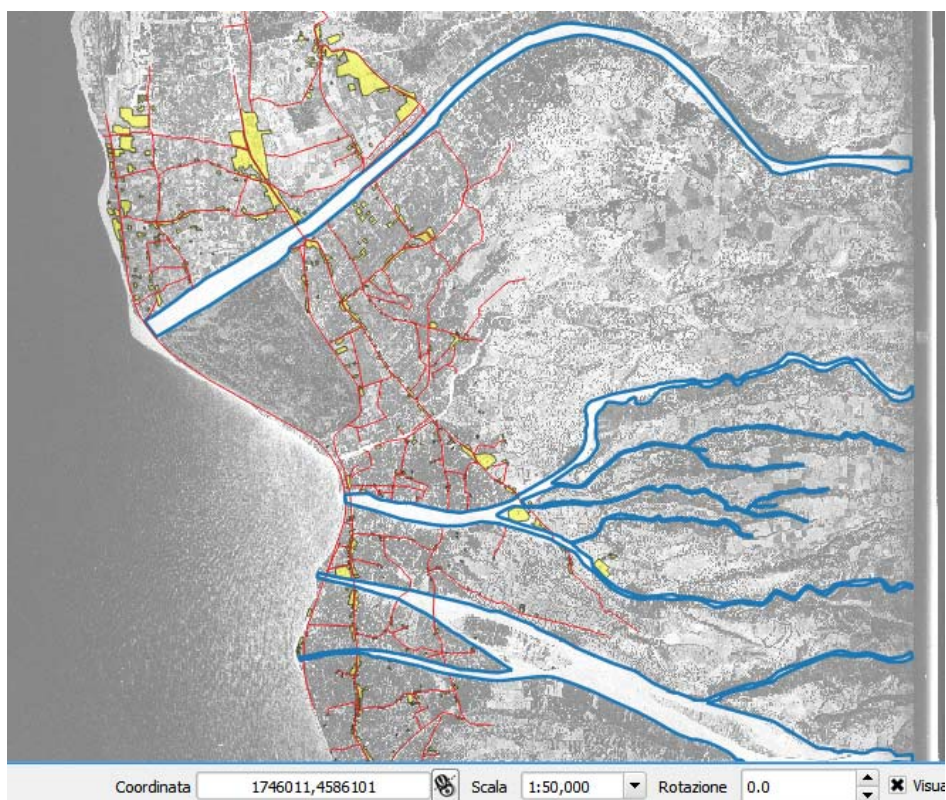


Figure 5: Aerophotogrammetry of 1955 of the study area. Legend: blue: rivers; red: roads; yellow: buildings.



Figure 6: Shapefiles of rivers, roads and buildings of 1955, with the latest satellite imagery background. Legend: blue: rivers; red: roads; yellow: buildings.



Figure 7: Shapefile of Sant'Agata river of 1955, in blue, with the latest satellite imagery background.





Figure 8: Shapefiles of Armo and Valanidi rivers of 1955, in blue, with the latest satellite imagery background.

#### 4 CONCLUSIONS

The paper analyzes and describes the effects of anthropization process on some rivers in the southern area of the Reggio Calabria city, in particular the Sant'Agata, Armo and Valanidi rivers. The analysis was carried out using QGIS, through the comparison of cartography data of the last 60 years, which consists of aerophotogrammetry of 1955, provided by Italian Military Geographic Institute, and the latest satellite imagery provided by Google Earth Pro. Shapefiles were created to identify rivers, roads and buildings.

The analysis described in this paper showed how the study area has been strongly anthropized over the last 60 years. In fact, the 1955 aerophotogrammetry shows the presence of few buildings, most of which are distant from the rivers, which were characterized by very large beds.

At present, however, most of the areas adjacent to the rivers are very anthropized. In particular, the airport runway, built at the end of the 30s, has been extended both to the north, passing above the Sant'Agata river, and to the south, passing above the Armo river. Moreover, near the Sant'Agata river mouth, the riverbed was narrowed and channeled and a sports center was built inside the old river bed of 1955. Finally, with regard to the Valanidi river, a highway passes below the river itself through two tunnels.

The situation described above involves an increase in the flood events consequences and can alter the river dynamics contributing to increase the flooding risk. Therefore, the methodology described above is of interest in the fields of flood risk assessment and management and in the field of urban planning.

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