

Daniele Defendi

Reclamation and Restructuring of Santa Gilla Lagoon



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local population. Its waters were once the natural habitat for an endless variety of fish species. As traditional farming and fishing has yielded to rapid industrialisation, stagnation set in and the lagoon grew smaller and shallower.

This project involved the reclamation, restructuring and hydraulic and environmental regulation of the production structures for the fishery activities in Cagliari's Santa Gilla lagoon. The aim was to bring back the fish life to the lake by restoring the circulation of fresh water and improving the exchange of fresh and salt water. The design firm of Dr G Ritossa, engineer, was brought in as project supervisor, and Dredging International was asked to execute the dredging works involved.

Abstract

Sardinia is a large island in the Mediterranean Sea, with Cagliari as its capital. Throughout history Santa Gilla lagoon, to the west of Cagliari, has been the site of intense commercial activity. Over the course of time geological developments have modified the lagoon's outline and reduced its depth, resulting in deterioration of the natural environment. In 1977 the Bureau of the Environment conducted a preliminary investigation. As ecological disaster and hygienic problems grew worse, the Autonomous Regional Government of Sardinia, Bureau of Environmental Defence and the European Fund for Investment and Employment decided to provide funds to this area to reverse this situation and save the lagoon.

The primary aim of the project was to improve considerably the environment of the lagoon and the surrounding living areas by restoring the circulation of fresh water and the exchange of fresh and salt water for the benefit of fishing activities.

Introduction

From earliest recorded times, the Santa Gilla lagoon near Cagliari in Sardinia has been the site of intense commercial activity. In addition the lagoon has always supplied the raw materials for the sustenance of the

THE SHRINKING LAGOON

The Santa Gilla lagoon covers approximately 1,500 hectares and is located to the west of the city of Cagliari. Originally the lagoon covered a much larger area than at present and it was considerably deeper (Figure 1).

Over time various geological developments have modified its outline and reduced its depth. The initial cause of the deterioration of the lagoon area can be traced to the end of the 1920s when the Macchiareddu salt works project was initiated. As a result, the size of the lagoon was reduced by 2,000 hectares, and its natural balance was altered considerably, which resulted in the reduction of the sea-lagoon (salt-sweet) water exchange rate.

The subsequent construction of a commercial port and the enlargement of the runways at the Elmas airport further reduced the surface area of the lagoon and its water-exchange rate.

With the continuing industrial developments of the 1960s, the lagoon began to be used as a dump site. What is more, the construction of an industrial port in the 1970s pushed the shoreline marine current approxi-

mately 2 kms away from the lagoon's inlet, further diminishing the already reduced water and salt exchange.

The city of Cagliari, the ENEL's super power plant, the industrial area and the airport area, as well as the towns of Elmas and Assemmini, plus all the small inhabited areas that had grown up along the coast, contributed heavily to the pollution of the lagoon. Urban and industrial wastes were dumped into its waters with a polluting potential corresponding to a population of two million inhabitants.

SIGNS OF DETERIORATION

The first signs of deterioration included the persistent presence of putrid water and the dying-off of an immeasurable quantity of fish and other forms of plant and animal life. In addition the lagoon bottom was silting up and becoming filled which led to a drop in fishing production. This created serious financial problems for many families in the area whose economic well-being was tied principally to fishing. In addition, during the hot summer season the smell of putrefaction was intolerable and frequently dead fish drifted ashore.

In 1974 the presence of heavy metals (chrome, lead and mercury) in the bottom sediment and in the fish, plus a number of cases of cholera amongst the population of Cagliari, led the Port Authorities to issue an ordinance prohibiting fishing and subsequently closing the lagoon. This area could no longer be considered a part of Sardinia's lagoon resources, having become nothing more than an unhealthy area destined to disappear forever.

GOVERNMENT INTERVENTION

Similar ecological disasters caused alarm amongst politicians and private citizens, not only in Sardinia but throughout the world. It drew the attention of specialists in various fields, as well as of university institutes, institutes of national research councils and other international organisations dedicated to environmental protection and the defence of the land, all with a single objective: to bring the Santa Gilla lagoon back to life. On April 28, 1977 under Regional Law No. 15 the Bureau of the Environment performed the preliminary work for the reclamation of the crippled lagoon.

In a resolution passed on February 9, 1984 the Bureau of the Environment of the Autonomous Regional Government of Sardinia approved the initial stages of the reclamation project.

In 1984 the European Fund for Investment and Employment provided financing for the reclamation



Figure 1. Italy, with Sardinia and its capital Cagliari.

work, with the objective of restoring the hydraulic and biological balance of the lagoon. An allocation of some 90 billion Italian lire would make it possible to carry out all the different phases of the reclamation project.

The purpose of funding the project was to create new jobs and increase local income levels. To achieve this solutions had to be found for the problems plaguing the lagoon:

- reclamation of the lagoon from a hygienic-environmental point of view;
- creation of an advanced fisheries system;
- restoration of a highly important environmental resource for tourism;
- restoration of the resource for scientific activities; and
- cultural and tourist utilisation of a number of important archaeological areas.

DREDGING THE LAGOON

In 1985 Dredging International, having won the international tender, began the formidable volume of dredging work called for in the contract. The initial phase included the construction of:

- one canal beneath the lagoon, plus
- two peripheral canals referred to as "circumference canals".

The canal beneath the lagoon runs lengthwise through the entire lagoon at a diminishing depth of 3 to 2 metres. The two circumference canals, at a depth of -1.5 metres run around the perimeter of the lagoon. The purpose of these canals is to promote the drawing-off of flood waters in winter, as well as to increase the water-exchange rate between the sea and the lagoon

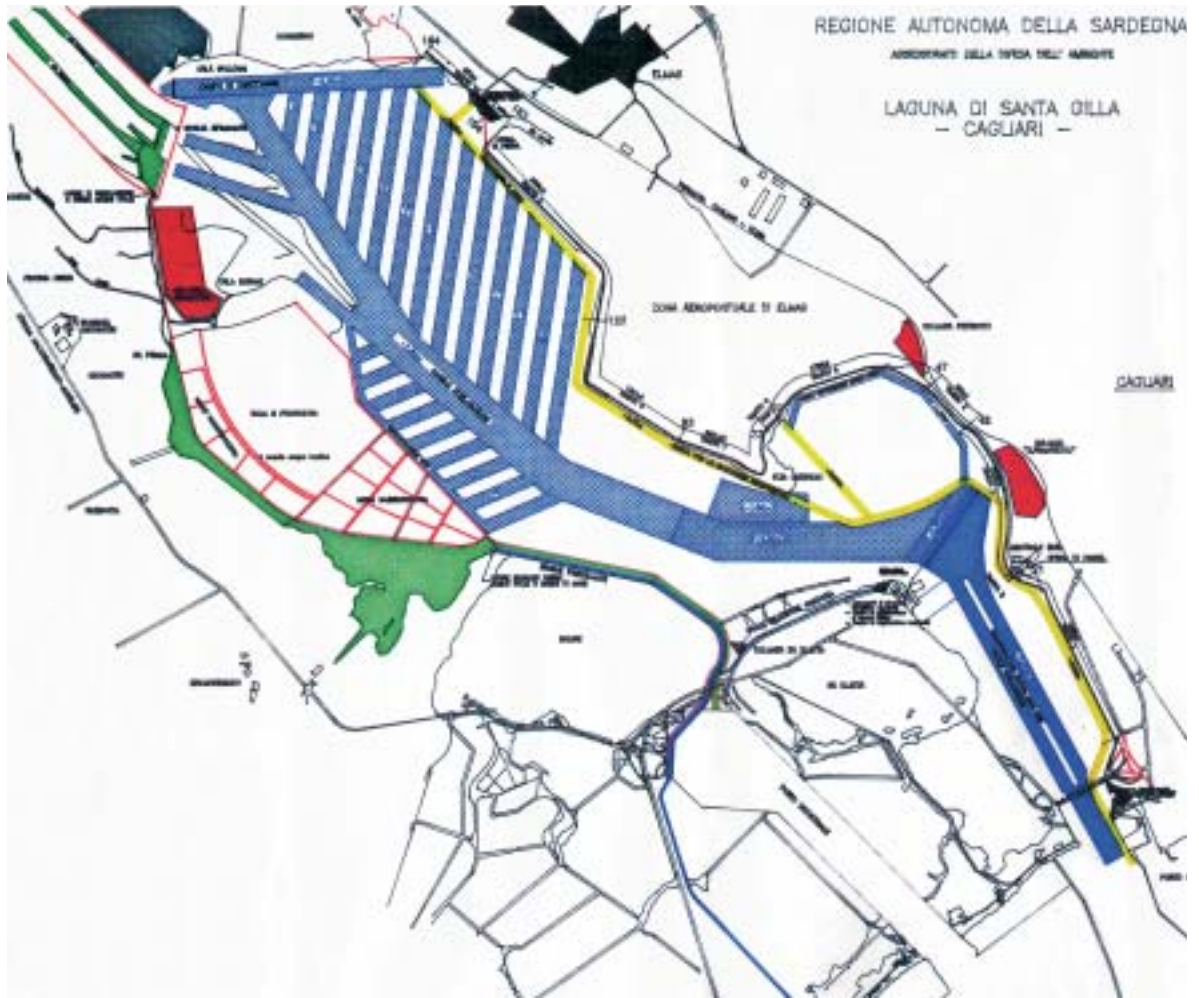


Figure 2. A schematic drawing of the system of canals devised to clean the Santa Gilla lagoon, which lies west of the city of Cagliari and the airport. Yellow, the circumference canals. Blue, the canals designed in a so-called fishbone pattern.

(Figure 2).
The cutter suction dredgers *Santa Gilla* and *Concorde*, stationary reflux vessels with installed horsepower of

Figure 3. One of the two cutter suction dredgers which were modified in order to be able to dredge in the very shallow waters of the lagoon.



2100 and 5200 hp respectively, were utilised. Significant modifications were made to the hulls of both ships and to the structures of the vessels so they could operate in such shallow waters (Figure 3).

During a later phase, a series of canals designed in a fishbone pattern were built branching off the canal beneath the lagoon. These run northeast through the lagoon, linking up with the northern circumference canal. These "fishbone" canals, 1.5 metre deep and 100 metres wide were alternated with parallel strips presenting natural bottoms.

This work made it possible to remove the layer of polluting sediment, creating the type of optimal situation needed to ensure constant movement of the water. The dredged material which was removed to deepen the bottom and create the channel was severely polluted in only a few parts of the lagoon. It was however very rich in organic matter as well as nutrients from sewage which unfortunately give off terrible odours. The improvement of circulation of the water was therefore the prime goal. Capping techniques

whereby reclaimed silt was covered by clean soils were not implemented. Instead the contaminated layer of dredged silt was mixed up with a much larger volume of non-contaminated silt, resulting in an “acceptable” average degree. The construction of the retaining dykes was executed in a simple way without filters or polyurethane lining.

Enormous reclamation areas were created to hold the materials produced by the dredging. Millions of cubic metres of mud, sand, gravel and shells were pumped at times for significant distances. In a number of cases it was necessary to use an intermediate pumping station in order to reach distances of more than 6000 metres (Figure 4).

Together with the dredging work, a drainage canal was constructed parallel to the perimeter of the lagoon. This canal, in part an open air structure (Figure 5) and in part a pressurised conduit, collects the water of the Rio Sestu, running along the entire airport area, as well as that of the power plant carrying off urban and industrial waste formerly dumped into the lagoon.

The Autonomous Regional Government of Sardinia had been performing studies on the Santa Gilla lagoon area for some time regarding the possibility of creating industrial fisheries for a wide variety of species. For that reason, Dredging International took an even broader approach to the problem by designing a breeding area for mussels, oysters and clams (Figure 6). Following the initial experimental stage and given the positive results of the increase in growth of shellfish, the intention is to intensify production and develop more breeding areas covering an area of some 100 hectare. This requires further study.

Conclusion

The Santa Gilla lagoon was threatened by a severe ecological disaster. Without reclamation and restructuring the Santa Gilla lagoon would have simply ceased to exist.

Through government intervention, funding was made available that allowed the lagoon to be dredged and an intricate system of canals to be built under water and around the circumference of the lagoon. This created a situation in which water would circulate optimally and be refreshed. A drainage canal now carries waste away from the lagoon, and government studies indicate that it should be possible to construct industrial fisheries which will bring further economic vitality to the region. However, whilst the intervention has reversed the situation of an extremely stagnated lake, averted an ecological disaster, and drastically restored quality and cleanliness to the water, the fishing industry has not profited as much as was hoped from the improved water quality. This problem is currently under investiga-



Figure 4. Millions of cubic metres of mud, sand, gravel and shells were pumped sometimes as far as 6,000 metres.



Figure 5. The drainage canal which was constructed to collect the water of the Rio Sestu and carry the urban and industrial waste away from the lagoon.



Figure 6. Breeding area for the cultivation of shellfish.