

BART CALLAERT AND JAN VAN DEN BOGAERT

THE TAPARURA PROJECT: SUSTAINABLE COASTAL REMEDIATION AND DEVELOPMENT AT SFAX, TUNISIA

ABSTRACT

The Taparura project, part of an action programme designed by Tunisian government authorities and supported by the European Investment Bank, is an effort to rehabilitate a port area which had been heavily polluted by industrial development. The Taparura project focuses on the sustainable socio-economic remediation of the coastal area around the city and harbour of Sfax, Tunisia's second most populous city. Since the 1960s commercial and industrial development at Sfax in the southern part of Tunisia had been emphasised and the coastal area had been neglected. Especially the processing of phosphates to produce fertilizers had left stockpiles of phosphogypsum which are 6 metres above the sea level and cover 50 hectares. The objective of the rehabilitation is to construct a mixture of public and private spaces, including residential areas and to restore several kilometres of the coastline and create new beaches, reconnecting the city of Sfax to its beaches and encouraging the development of tourism.

The Taparura project is divided into two phases: 1) decontamination of the area and development of land in the sea (420 hectare); and 2) development of the area and

construction a new urban centre. The first stage of the project, which entailed the decontamination and the rehabilitation of the entire site, is now completed. This was a complex multidisciplinary project and as such provided a challenge for everyone involved including the financiers, managers, engineers, environmentalists, contractors, consultants and government authorities.

INTRODUCTION

The Taparura project is a typical example of the challenges for sustainable development and ecological aspects of port cities and their surroundings. It is part of a wider action programme put together by the Tunisian authorities to tackle the primary sources of pollution in the region. The site is located along the northern coastal area of Sfax city near the harbour and includes the rehabilitation of a former industrial site complex, the clean-up of beaches and complete restoration and development of the area.

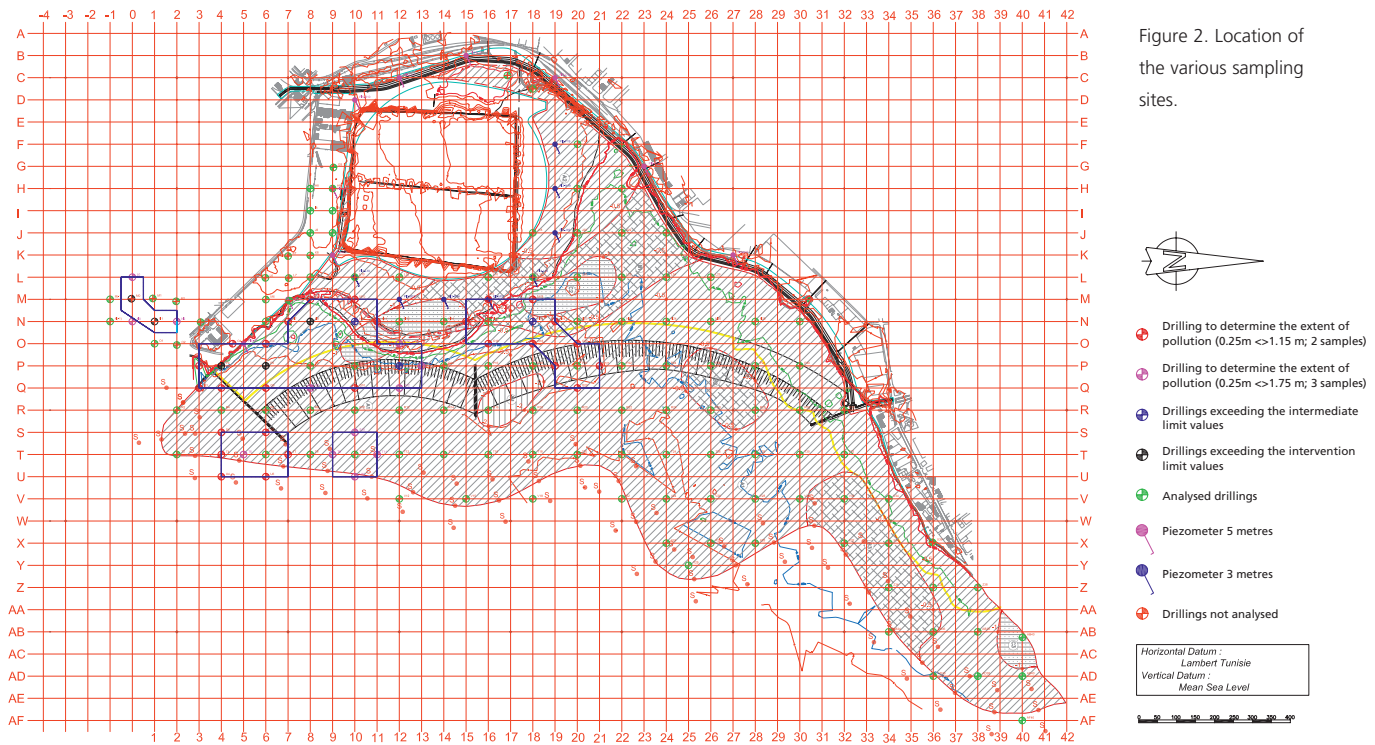
Above: Artist's rendering of the projected new area north of Sfax. The remediation of this highly polluted industrial area will allow the construction of new housing projects, urban parks and the restoration of beaches for residents and tourists.

LOCATION AND HISTORY OF THE POLLUTION

Located 270 km southeast of Tunis, the city of Sfax was founded in AD 849 on the ruins of Taparura and is the capital of the Sfax governorate. It is a Mediterranean port on the Gulf of Gabes, a gulf on Tunisia's east coast in the Mediterranean Sea (Figure 1). The gulf is 600 kilometres long, with the Kerkena



Figure 1. Location of the city Sfax, Tunisia.



Islands on the northeast and Djerba Island on the southeast. It has a large tidal range, 2.0 metres at spring tides. Sfax municipality, often described as Tunisia's second city, has a population of 260,000 inhabitants and is an industrial centre for processing phosphates. The port is the largest in Tunisia and

specialises in the export of phosphates from big mining complexes in the region. The coastal area, some 150 hectares, is adjacent to the harbour and has suffered pollution from various types of solid and liquid wastes for years. Especially phosphogypsum, the residue from phosphate treatment, has been stored in

an unregulated manner along the coastline, covering a surface area of 50 hectare piled 6 metres high. The pervasive pollution from this site was threatening the beaches and coastal waters of Sfax, hampering further development and economic growth, such as tourism, as well as presenting a health problem.

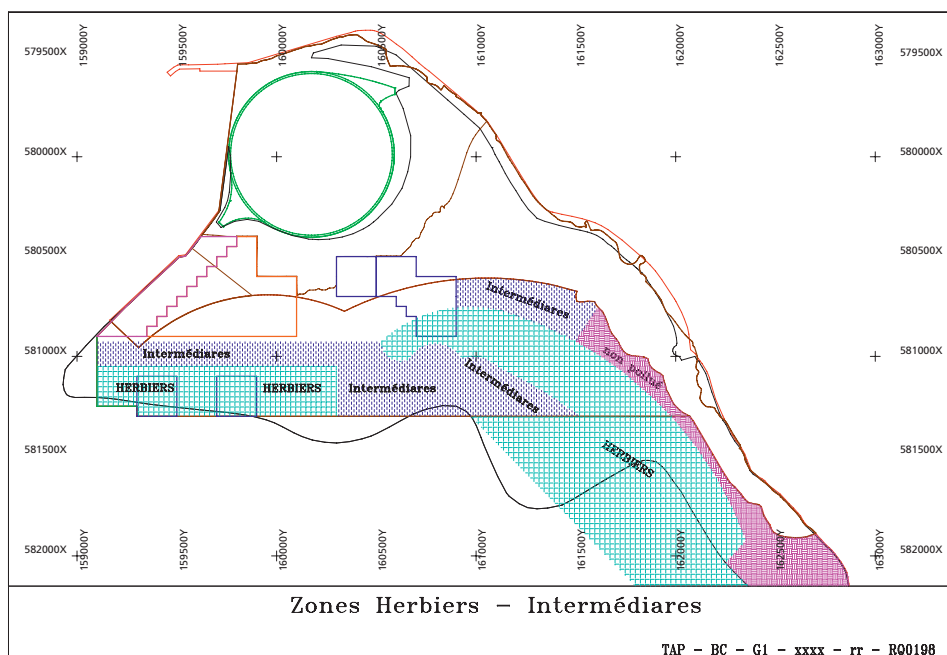


Figure 3. Excavation boundaries and the sea grass spread.

THE TAPARURA PROJECT

The Taparura project forms part of a global action programme developed by the Tunisian authorities to tackle the sources of pollution and to improve the overall environment of the Sfax region. The project promoter is the Tunisian Ministry for Equipment, Housing and Land Use Planning and the actual client is "Société d'Etude et d'Aménagement des Côtes Nord de la Ville de Sfax"; an autonomous government company under supervision of the Ministry for Equipment, Housing and Land Use Planning. This company is responsible for continuing the policy of pollution abatement and development of public and private industrial parks. The beach and landfill restoration will create a mixed space for new public and private activities, such as recreational complexes of beaches, parks and sports grounds, and educational, health and museum infrastructures, as well as the implementation of social housing programme.



BART CALLAERT

(MSc, MBA) is Head of International Projects of Envisan N.V. and is responsible for the acquisition and coordination of international projects. His experience in civil, dredging and environmental works spans 20 years, of which the last 15 years in the environmental industry. He has been project manager for several major remediation and environmental dredging projects abroad and is currently responsible for the international activities of Envisan N.V.



JAN VAN DEN BOGAERT

(MSc) is an Agricultural Engineer with over 20 years of experience in the management of international projects, most of which are related to environmental issues. He joined Jan De Nul Group in 2005 and worked as project manager for Envisan N.V. and as an assistant project manager for Jan De Nul on the Taparura Project. In addition to the general management of the project, his input was primarily focussed on the HSE issues.



Figure 4. Backhoes excavating the contaminated sediment. Close up of the precision backhoe fitted with an environmental bucket.

ENVIRONMENTAL STUDIES AND FEASIBILITY STUDIES

Various studies were executed during the 1990s and several samples were taken both on land and in the seabed (Figure 2). The planners emphasised a reconciliation of the city with its littoral by creating beaches and a new urban area, largely reclaimed from the sea to extend the city. The central issue was what to do with the polluted industrial site and how to dispose of the approximately 3,000,000 m³ of phosphogypsum. The solution ultimately selected creates a central piece in the whole area, a pyramidal shaped park covering a total area of approximate 55 hectare.

IMPLEMENTATION

On 30 March 2006, the Joint Venture Jan De Nul (Belgium), Envisan (Belgium) and Somatra-GET (Tunisia) signed a contract for the remediation and the rehabilitation of the entire site (Figure 3). Joint Venture was awarded the contract based on its competitive price and capability to implement a solution on short notice. The project consists of different stages:

- A detailed site investigation both on- and offshore.
- The excavation of approximately 1.7 million m³ on land, including 1.25 million m³ of phosphogypsum plate around the toe of the landfill (Figure 4).
- Dredging of approximate 450,000 m³ contaminated sediments below sea level, with a water depth of approximate 0.5 to 1.5 metres. All wet polluted material was stockpiled and dewatered in a specially designated area on top of the existing landfill (Figure 5).
- The rehabilitation of this pyramidal phosphate dome comprises the reshaping of the slopes, the installation of a vertical bentonite-HDPE (high-density polyethylene) screen along the perimeter in order to create a confined area, including the installation of a cover layer with land-based

material and a new topsoil layer. The remediated area was reclaimed with 6.75 million m³ of sand, dredged by means of trailer suction hopper dredgers with material sourced at a distance of approximately 18 km (Figure 6).

The entire contract period was set at 2.5 years with an approximate project value of 73.5 million euros. The European Investment Bank (EIB) contributed approximately 50 percent of the financing with the other 50 percent coming through export credit facilities sourced from Belgium and France. These included a concession and a direct commercial loan.

The three stages during the implementation were: Site investigation, remediation works and rehabilitation and civil works.



Figure 5. Aerial view during the excavation works. Insert, depot with sand fill.



During the first stage, site investigation, various surveys and samplings were conducted on land and offshore, for instance in the Kerkennah Channel, along the coastline of the beach and on the whole beach itself. Borings were also executed along the toe of the existing landfill to the depth of the impermeable layer. All samples were sent for analyses to a laboratory in Belgium. At the end of the site investigation stage, detailed excavation and dredging plans were elaborated and were entered onto the computers onboard the dredging equipment.

During this time, all land and offshore equipment was mobilised. These included dumpers, excavators, pontoons and other auxiliary equipment. Also prior to the start of the dry excavation and the dredging activities, the necessary infrastructure and road access was built. Once all this had taken place, remediation of the area began.

Dredging was performed in shallow water (water depth 0.5 to 1.5 metres). With storage space for contaminated sediment at a premium, over-dredging was held to a

minimum by high accuracy dredging and close attention to the environment. A high precision backhoe fitted with an environmental bucket was used. The dredged sediments are temporarily stored on top of the existing landfill, where they are dewatered. Then the dry sediment is used to re-shape the confined disposal facility (CDF). During the remediation



Figure 6. Dry excavation of the contaminated material via bunds.



Figure 7. Connecting floating pipelines to the TSHD James Cook for the rehabilitation works.



Figure 8. Before (left) and after (right) the rehabilitation works.



Figure 9. Aerial photo taken at the beginning of the works, during the wet and dry removal of the contamination.



Figure 10. The area after the remediation when clean sand was being spread (phase I) and phase II was in progress with dry transportation of sediments.

stage, some civil works were performed including the creation of embankments, a drainage canal and a vertical screen surrounding the CDF. The screen was constructed from cement-bentonite slurrywall with a high-density polyethylene (HDPE) foil. The remediated area onshore was reclaimed with sand pumped from the Kerkennah Channel using two TSHDs, the James Cook and the *Alexander Van Humboldt* (Figure 7).

The remediation of the area by removal of the phosphogypsum offered immediate health and safety improvements as the sediment contained arsenic, lead, cadmium, chromium, fluoride, zinc, antimony and copper at levels dangerous to human health (Figure 8).

Figure 9 shows the site at the beginning of the works. With the completion of the remediation, the next phase is ready to start: the development of the urban centre Taparura (Figure 10).

CONCLUSIONS

After years of studies in the 1990s to determine the feasibility of a clean-up project in the city of Sfax, the conclusion was reached in 1997 that the so-called Taparura project would be cost-effective and technically possible and that the benefits to the community in the southern Tunisian city of Sfax would be significant and long-lasting. The aim of the Taparura project is to transform the North coasts of the town of Sfax, affected by the industrial wastes, into an urban quarter where life could be pleasant and in which all sources of pollution have been eliminated or made neutral. Moreover, the project will ensure that the town of Sfax will be reconnected with its coastline through the creation of new beaches.

The ecological aspects of such a project in and around port cities is always a major challenge to all those involved: planners, financiers, engineers, environmentalists, contractors, consultants, authorities and many others. The execution of the remediation project took 2.5 years from mid-2006 to 2008 and laid the groundwork for the following phase to begin. The development phase for the Taparura urban centre, 420 hectares of reclaimed land with parks, a 5-kilometre-long beach and a residential area with housing for more than 20,000 people is now underway. The socio-economic benefits for the community and the city of Sfax are clear and will provide a significant improvement in the quality of life for its citizens as well as an economic boost through increased tourism.