Interregional Study on Restoration of SaltWorks

ALAS Project

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July 2002

CONTENTS

1. INTRODUCTION

Modern societies have recently undergone profound social changes at all levels, particularly in relation to systems and means of production. Long after the Industrial Revolution, the economies of the peripheral regions, which include much, if not all, of southern Europe, have been organised around the optimisation of local resources, adapting technologies to circumstances, always from the point of view that to produce locally was better than to import.

This kind of protectionism, either coming from institutional mechanisms (legislative measures) or resulting from the peripheral situation itself, survived the first waves of globalisation. However, even before the advent of the real global economy and the accession of the Iberian countries and Greece to the European Community, many activities based on the transformation of locally produced raw materials were extinct or reaching the limits of survival.

Silk is probably the best example of this. It was a flourishing industry in many southern European regions until the end of the 19th century but later went into a long period of decline. More recently, there have been many other examples, like woollens, tinned food, linen production and weaving.

Salt production obviously did not escape this fate. First, the producers introduced mechanisation and industrialisation to reduce production costs; later on production was concentrated internationally and transnationally.

This process did not follow the same course in the various regions and countries, but followed the social circumstances and the characteristics of the different markets. In France, mega-companies were created or expanded, making the country into one of the world's largest producers. In Spain, Italy and Greece the industrialisation process was less concentrated in terms of production units, though in some cases it took on monopolist characteristics. In Portugal, the industrialisation process was much more modest, but some companies evolved from simple family concerns to enterprises of some size, allowing them to invest gradually in the mechanisation and consolidation of small saltworks.

However, independently of this process, some artisanal-style production units survived in several regions, maintaining techniques that dated back hundreds or even thousands of years. These examples should not be seen only from an archeological perspective – in this case they would be nothing more than living fossils of a technology, with a function limited to mere demonstration. They should be considered as alternative salt production sites **exclusively for consumption in food**, because it makes no sense to compete in the industrial markets.

To this end, artisanal saltworks should seek certification in the framework of local and Community legislation, which will only be possible when each local typology is well characterised in terms

of a topographic description of the saltworks, their respective productive processes and a detailed analysis of the salt produced.

1.1 Why restore?

At present, a good proportion of traditional saltworks still surviving are either abandoned or exploited in a different way from the genuine artisanal production processes, mainly because of inadequate maintenance. Therefore, any project of traditional salt development necessarily involves the restoration of the saltworks where it is produced.

This development must always start with the specific characteristics of authentic artisanal processes, as happens with cheese, jams, honey and many other agricultural products, processed or not, which have certification of quality and origin.

1.2 The difficulties of restoration

As artisanal saltworks are the result of adaptations to the local topography and different climatic, ecological and social factors, it is impossible to provide ready-made solutions. At the same time, as saltworks are located in wetlands formed of poorly permeable muddy substrata, often subject to erosion by currents and waves and also to invasion by the local vegetation, their restoration will be difficult and slow. In these areas the movement of soil involves higher costs because of the greater weight per cubic metre and difficulties in accessing the sites.

Another difficulty lies in the fact that most processes and techniques involved in the restoration are highly labour-intensive or depend on materials that were formerly cheap and easy to obtain locally, but are no longer competitive against other materials (a good example is wood and PVC).

Following economic logic, like any other productive activity, artisanal salt production constantly faces the problem of higher production costs than industrial production, having to reduce this difference through a series of tricks that obviously include the lack of maintenance of saltworks and the use of operation and management methods and instruments that could compromise the landscape and environmental quality associated with artisanal saltworks.

2. THE PURPOSE OF THIS STUDY

The purpose of this study is to provide some hints in order to make the restoration processes easier and more economical, without compromising the techniques and exploration processes characteristic of the various regions. It is important that these processes should be thoroughly described in each region, because only in this way is it possible to know how to match the means to the ends, which will also entail detailed estimates of the work that needs to be done.

From the productive point of view it is important to remember that innovations are always possible. Traditional or artisanal are not necessarily synonymous with stagnation. The wood-lined Figueira da Foz saltworks are nowadays part of our image of Figueira and, from the landscape point of view, their scenic effect is better than those with simple mud divisions. The use of wood appeared at the

end of the first half of the 20th century and at the time it was an important development in salt production, allowing a better use of local processes.

Therefore, rather than providing solutions that would be difficult to implement, this study examines some specific cases of restoration, aiming to gain some benefit from these experiences and, in the light of the difficulties encountered, sets out to consider some innovative approaches.

3. EXPERIENCES IN RESTORATION

3.1 Western France / Guérande

The salt-marshes of Guérande and Mès lie in southern Brittany, just north of the Loire estuary. The area covers 2000 hectares of artisanal salinas, where the salt is collected in the same way as it was done 2000 years ago. The salinas are small structures and one salter manages about 5-6 hectares. The salters are independent farmers, most of them members of a dynamic co-operative.

Due to previous abandonment, many of the salinas in Guérande have been totally rehabilitated during the last 25 years. For everyone involved or interested in traditional saltworks, Guérande is not just a case study but an example of a successful intervention that deserves special attention, which is why it is frequently and extensively cited in the studies and publications of the ALAS project.

We should however bear in mind that even compared to the rest of Europe or the Community space, Guérande benefited from particularly favourable conditions in economic, social and cultural terms, factors which are not always easily transferable to other places and times. Nevertheless, as a means of drawing parallels and finding solutions, it is worth listing some of the factors that were important for its success and have made it to some extent a leading light in traditional salt production:

- A strong, deeply-rooted tradition in the economic activity and cultural identity of the region
- The interest shown by local and regional authorities in maintaining the activity
- A dynamic regional economy
- Consumer interest in traditional activities and products
- The readiness of producers to form associations and cooperatives
- The ability to attract new saltworkers, both through promotion of training courses and through financial support for those entering the profession (some from regions and activities not involved in salt production, which has helped bring about a degree of renewal and opening up)
- Legislation designed to help commercialisation, providing for certification and designation of origin
- The willingness of different agents in the region - local government, owners, saltworkers, technical staff and associations - to organise joint actions to promote the development of the saltworks
- The growth in tourism, with the saltworks and salt production being seen as additional attractions

- An ongoing process that asserts the social identity of the saltworkers and salt production that is completely unparalleled

in the salt-producing regions of Europe.

Figure 1 - Entrance to the headquarters of the Guérande Salt Producers' Cooperative

Much has been done to restore the saltworks, not only at Guérande but also at Noirmoutier and on _le de Ré. The majority of these restoration projects were carried out using the labour of the saltworkers themselves, who often organised themselves on the basis of mutual assistance to carry out this task. All the restoration work, as well as the routine work of maintenance during the winter, are done manually.

The main part of the work is naturally concentrated in the crystallization area, which is made up of rectangular units, each of 70 m², called *oeillets* (see figure), the number of which varies from saltworks to saltworks.

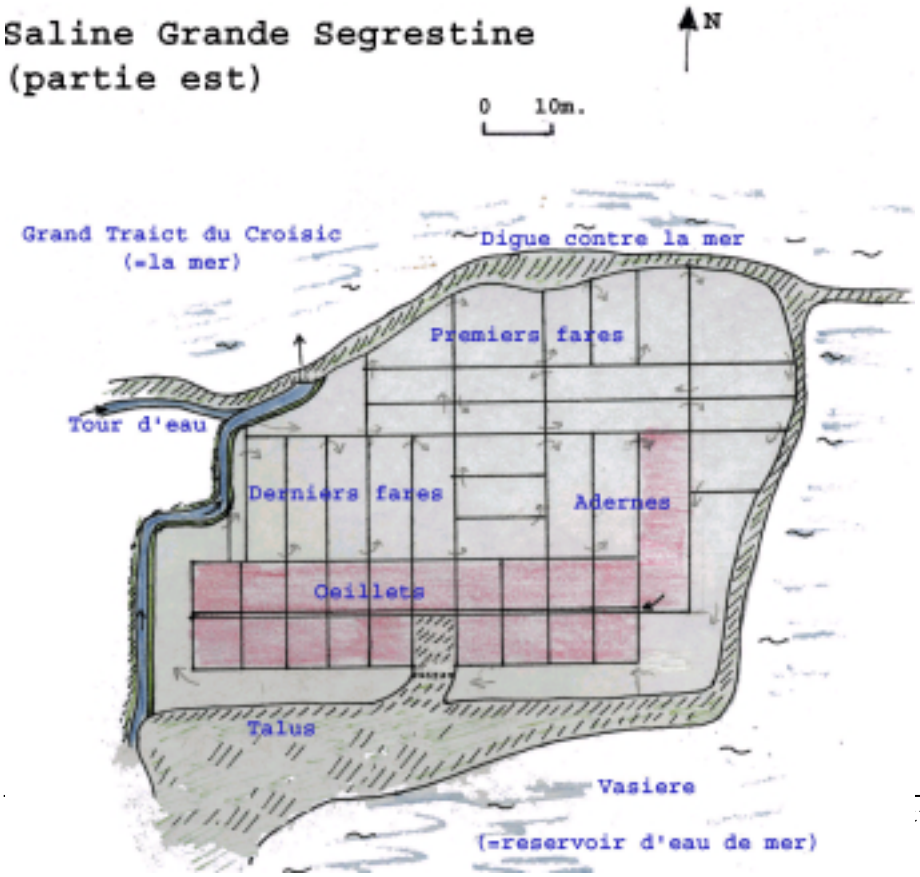


Figure 2 - Plan of *La Grand Segrestine* saltworks

.works

The data that we present in Table 1 refer to the restoration of *La Grande Ségestine* saltworks, with 19 *oeillets*, carried out under the supervision of Hjalmar Dahm in 1986. The works were carried out during winter, spring and early summer according to a well-defined chronological schema:

- opening the internal water canals ("tour d'eau"),
- cutting away invasive vegetation (*Suaeda vera* and *Salicornia sp.*)
- emptying the crystallizing pools from liquid silt (use of a motor-pump),
- making the levels of the evaporation pools ("fares" and "adernes") and reinforcing the dikes between the pools,
- adjusting (digging out and adding new clay) the bottoms of the crystallizing pools,
- building the dikes around the crystallizing pools,
- flattening the bottoms of the crystallizing pools.

Table 1 - Actions and labour required in the restoration of *La Grand Segrestine* saltworks

Action	Period	Man-hours	No. of workers
Emptying the *oeillets*	Jan	35	2
Repairing walls of the *adernes* and *fares*	Feb - Apr	200	2
Renovation of drainage channel of the *oeillets*	Feb	10	2
Cleaning the *oeillets*	Mar	110	22
Repairing walls of the *oeillets*	May	60	16
Finishing walls	Jun	50	14
Second cleaning of the *oeillets*	Jun	80	20
Compacting beds	Jul	60	20

This work required over 600 man-hours, roughly equivalent to 75 days, often involving more than a dozen workers. Of course, this type of mutual assistance springs from the great dynamism that brings to modern times the traditions of communal work that used to exist in Guérande, as they did in fact in most salt-producing regions.

Figure 3 - Restoration work at *La Grande Ségestrine* saltworks

The *marais salants* (saltmarshes) of Guérand cover about 2000 hectares. During the last 20 years 300 hectares of abandoned salinas have been totally restored, all in the traditional way.

3.2 Piran - Slovenia

Text: Peter Derzek

The salt works on the Slovenian coast are part of our natural riches that we have to restore and maintain as the patrimony for our grandchildren, retain their natural function and preserve the cultural heritage located in an outstanding landscape, so characteristic of the Slovenian Istria.

In 1990, based on the Decree issued by the Piran Municipal Council, the area of the saltpans in Se_ovlje was proclaimed a landscape park, including several natural reserves.
In 1993 the saltpans were entered in the Ramsar Site List as an internationally important wetland. For reasons of nature conservation, the Slovene Government passed a decree by which the entire salt marshes became state property. At present, a management plan of the park area is under preparation and its implementation will start soon in this year. Meantime the salt-producing company "SOLINE, Pridelava soli d.o.o." has been acting as the trustee of the natural park. The company has won the concession awarded by the government to produce the sea salt, and the concession for the management of the protected area (since July 2002).

1. The vital activities required to support biodiversity, the cultural heritage and the function of Se_ovlje salt works include:
- upkeeping the salt-production
- controlling the water regime
- maintenance works on water management infrastructure (ditches, anti-flooding measures)
- habitat management and monitoring
- visitor management
- safeguarding the seawater from deterioration, monitoring the water accumulation of the three brooks running to the Gulf of Piran, from where the water is supplied to the salt works.

2. The interactions between natural and cultural heritage in the Saltworks:
Traditional salt production is an essential pre-condition for both the preservation of the natural function and cultural heritage as well. Underlying for the salt production is to prepare the needed background and infrastructure. This includes »on-site« activities (such as preparation of basins, controlling the water inflows and outflows, ground-works, "petola" growing etc.), as well as other

activities on a wider scale (anti-flooding measures preventing the flooding of the saltpans, maintaining the system of channels etc.). All these activities are carried out in a traditional manner and directly support the traditional culture of salt production (the use of traditional techniques and tools, maintenance of infrastructure facilities, high quality of salt etc.). The management of water regimes and habitats is also essential for the production of salt, but it is vital for habitats and species. Without (traditional) management the area would be gradually overgrown or flooded, which would affect its cultural landscape and natural potential.

3. The socio-economic aspects affecting the above two questions in the Salinas of Se_ovlje:

· (traditional) salt-production is hard to be competitive with industrial and imported salt prices and this leads into abandonment of salt-working activities and thus to unemployment of (local) salt-workers;

· not enough younger people are interested in working as salt-workers (as it is almost impossible to work on a permanent or long-term job contract, due to inadequate financial resources of the salt production enterprise);

· the saltworks company is running out of money for covering the costs of low profitable salt-production – the state authority responsible for the (protected) site has no (permanent budget line) resources to cover operational and maintenance costs. The responsibilities within the Ministry should be more clearly defined (who is responsible for what, including the financial part)

· other activities (in line with the conservation goals) will have to be brought to the area; the company has got the »concession management authority«, supporting the nature-based tourism and introducing a thalassotherapeutic centre in the neighborhood of the salt-works. However, this still does not guarantee a revival of local communities and especially the traditional salt-production unless the local stakeholders and local people are actively involved in this process.

· Due to the »small-scale size« of the park it will be difficult to survive pressures from other big stakeholders (especially tourism, airport development, recreational pressures etc.)

The traditional coastal salt production is one of the rare economic activities with a minor impact on the natural environment, with favourable influence on the conservation of the biotic variety and on the natural equilibrium the area. The daily manual collecting of the salt, produced from the marine saturated brine with the help of the solar energy in the pans that have the bottom covered with a layer of the biosediment - 'petola', is a method centuries old. Along with the necessity of the navigable canals, that had shaped the characteristic image of the saltpans. This kind of collecting salt is still used in the saltpans of Se_ovlje and Strunjan, that were renewed in the year 1904, when the Istra Region was administered by the Austro-Hungarian monarchy. The working saltpans offer the living space to various

plant and animal species that are endangered by the vanishing of the natural wetland in the Mediterranean. Though an artificial formation, the saltpans with the salt water regime set up the conditions that suit all of these plant and animal species.

Manual work prevails in the saltpans. The use of up-to-date light machinery mechanization is limited to some areas in the evaporation surfaces for the maintenance of the dikes, and to the sea defenses where the work can be done by using special seaworthy mechanization. The traditional production of salt is, considering the work, intensive and markedly seasonal: with the high expenses for the production and the maintenance of the infrastructure it is, if compared with other methods of the production, uncompetitive because of its costs. In spite of some advantages of the salt that is gained that way, it brings losses to the salters. The annual quantity of the salt, grown in the saltpans of Se_ovlje and Strunjan, depends on the weather. On unsettled areas it reaches 3000 to 5000 tons per year. In the time of prosperity the saltpans yielded up to 20.000 tons of salt per year. Today's amount is insignificant if compared with the approximately 100.000 tons of the annual consumption in the state.

The activities of gaining salt in the saltpans of Piran are threatened with the closing down, but without them the place would lose all its natural and cultural function within a short time. Generations of families of small farmers and part-time farmers living in the surroundings have adapted their lives to the seasonal work on the saltpans, important for their family budget. The salter's knowledge was transmitted from generation to generation. In the last years the interest for the occasional work in the solar pans is turning up within the unemployed population. However, there are fewer experienced salters from year to year. The continuation of this trend poses a risk of losing the knowledge of the trade that can be acquired only with the transmission of the experience. It is necessary to search for financial and business solutions for the current economic crisis of the saltworks holder and to preserve the tradition underlying for the existence of the local patrimony of the coastal area.

BASIC CHARACTERISTICS OF TECHNOLOGY

The seawater used for the salt production comes with the high tide from the Gulf of Piran. The affluence of external waters is prevented with deep channels and dikes.

Within the borders of the salt mining area there is a surface of approximately 593 ha. For the traditional salt production an area of 435 ha is used, divided into two fields - Fontanigge and Lera. The field of Fontanigge is used for the production of main brine. The field of Lera was renewed in the year 1904 into a saltpan with all main elements that are required for the production:

- the feeding channel Lera used also as a seawater deposit for the periods of low tide;
- the evaporation area with the clay bottom and compartments: pre-basins, evaporation ponds of low, medium high salinity, all is conducted and separated by canals, manually operated gates, sluices, dikes, bridges, aqueducts;
- the crystallizers with 'petola' on the bottom, small enough to be operated by one or two persons;
- a system of water conveyance, supported by a water pump station and used in the periods of low tides;
- a cartage system for conveying the salt to an open-air deposit;

· repair workshops for the maintenance;
· reservoirs for the brines.

LIFE PERIOD OF THE CONSTRUCTION AND OF THE EQUIPMENT

Dikes with stone wall	50 years
wooden equipment on the crystallizers	15 - 20 years
Machine-made dikes	6 years
Hand-made dikes	2 years
Gutter and feeding parts of the wooden gates	1 year

SUMMARY OF THE AREAS

·	Lera channel	4,960 ha	
·	LERA Sector - evaporation areas:	213,992 ha	
	- first evaporation area		125,292 ha
	- second evaporation area		55,900 ha
	- third evaporation area		32,800 ha
·	LERA Sector - crystallization area:	32,707 ha	
	- Net crystallization surface		19,582 ha
	- servings		11,200 ha
·	LERA Sector - active evaporation surface:		244,775 ha
·	Reservoirs	10,290 ha	
·	road, pathways, repair workshops	1,564 ha	
·	Total LERA sector	263,513 ha	
·	FONTANIGGE Sector - partial usage	175,000 ha	
Se_ovlje - used areas:		**435,025 ha**	
Total surface of Se_ovlje Saltpans:		**593,000 ha**	

CAPACITY OF THE BRINE RESERVOIRS

R1	80.000 m^3
R2	4.000 m^3
R3	8.000 m^3
R4	20.000 m^3
Total	112.000 m^3

The basic structure of the saltpans consists of recent sediment compiled by the local brooks running into the Gulf of Piran. It is arranged in the way to make good use of the given natural conditions for the traditional production of saturated brines and of natural sea salt with an intensive live labour.
Sea water of the salinity of $3,5^0$ Be (areometer Baume_; 1Be corresponds to approximately 1 % of salinity) pours into the highest evaporation areas by the high tide. Regarding the intensity of the evaporation, the quantity of the water-flow with the free-fall through the evaporation areas, is manually regulated with wooden barriers (gates). Water-pumps are mainly used to empty the saltpans (in case of major rainfall) and to shift the strong brine to pre-basins on the crystallization facilities where saturation is achieved: the required evaporate is nearly 90% of the initial volume of the sea water.
In good weather conditions, the production of brines is higher. The surplus of the produced brines (22 – 23 ^{0}Be) is preserved in reservoirs for the activation after heavier rainfall or at the beginning of a new season of salt production.
Salt crystals are segregated by natural evaporation of the saturated basins in the crystallization pans (cavedini) that are covered on the surface with a stratum of petola. The petola is a stromatolitic weeded carpet that takes part in the process of the salt crystallization; it is composed of gypsum, carbonate minerals and blue-green algae. That way the salt is neat, has a pleasant taste and contains traces of the elements of the marine water that are favourable for the organism. Petola is a particularity of the saltpans of Se_ovlje and Strunjan (Dr. J. Schneider: Study of the stromatolitic environment of the North Adriatic). **Traditionally produced salt, when correctly produced, doesn't need washing and retails its original properties.**

Another particularity of the saltpans of Se_ovlje and Strunjan is the daily manual harvesting of the crystallized salt in the basin with wooden scrapers - 'gaveri'. In the layer of the basin the salt is scraped or raked with "gaveri" into heaps - 'grumi'. In them the salt partially strains, then with spades it is laden on hand-driven carts led on tracks, and hand pushed to the small deposits, manually unladen and shaped into heaps with a ridge and natural incline, so it can strain. Strained salt is sorted and carried away to the main deposit. Selected salt that is to be used for nutrition is stored in a warehouse with a wooden floor where it can dry in a natural way. The other salt is stored in opened deposits and covered with a robust foil. The salt has a uniform middle thick crystals and a small dry bulk weight.

The utilized main brine - 'aqua madre' is poured off into the assembly channel - 'lida' where it is diluted and pumped into the sea. A part of the main brine is stored in a concrete deposit for balneal therapeutic purposes in tourism in local health resorts.

The traditional salt making also provides the saline mud - 'fango' and quality main brine. In fact, the saltpans of Se_ovlje have an abundant area for the crystallization and sufficient flows of strong brines, and abundant quantities of intense black, tiny grained saltern mud with a special structure are deposited in the main crystallization channel. This mud is used for balneal therapeutic purposes (Institute for the water chemistry and balneology of the Technical University of Munich: "Expertise about saltern mud from the salt-works Soline Lera near Portorose" and "Expertise about main brine (acqua madre) from "Droga Saline Lera" near Portorose").

THE INFLUENCE ON THE TECHNOLOGICAL PROCEDURE

- The saltpans layout and the appropriate ratio between the net crystallization area and the brine production area, adequate to the climatic conditions in the available site. In Lera sector, where the saltpan area is complete, the ratio is 1:12, in the whole active area the ratio is 1:19.
- the initial density of the seawater that is used in the production of basins. The summer average density in the Gulf of Piran ranges from 3,4 to $3,6^0$ Be.
- the utilization interval of the saturated water on the crystallization facility, which is in table salt harvesting limited to the saturation degree of bitter salt secretion, that is 29^0 - 30^0 Be.
- the required density of the basins at the last stage in the production of brines from 22 to 24^0 Be
- the intensity and the quantity of natural evaporation in the season of salt production that is in the climatic conditions of the northern Adriatic on the average of 7 to 8 mm of net evaporated water per day;
- the quantity of rainfall and their distribution in the season of salt production;
- the quality of the local material for the construction of the salt pans regarding the impermeability;
- the height of the saltpans compared with the sea level average, and the gradient layout on areas that usually conform to the given ground;
- the span of the high and low tide;
- the time required to prepare the working basins' brine concentration;
- the expertise and physical ability of the employees;
- the quality of the salt basins' infrastructure.

THE QUANTITY OF THE SALT CROP

The traditional production of salt is a seasonal activity; the quantity of the salt crop depends upon weather conditions and on the crystallization area available, the salters' knowledge and the salt basins maintenance.

THE QUALITY OF THE SALT CROP

The quality of the salt produced depends upon the condition and maintenance of salt basins, and even more on the preparation of the crystallization process and facilities covered with a layer of petola. This work needs the know-how that can be acquired by experience, or transmitted by it.

WORK AND COST OF THE TRADITIONAL SALT PRODUCTIOIN, OR
SUSTAINABLE USE OF SALTPANS AND BIOTIC DIVERSITY PRESERVATION

- The major part in the traditional salt making is the crystallization. There are many reasons, including two particularities of the saltpans of Se_ovlje: the *bio-sediment* – 'petola', and the daily manual collection of the crystallized salt. Petola on the surface of the crystallization pans (cavedini) is a living biotype and requires care over the whole year to keep it in a sound condition, with integral and compact layers. The crystallization area is the lowest area of the saltpans, utilizing the natural flows and passes, and is therefore most sensitive to flooding in heavy rains. Flooding causes erosion and deposits of sediments, under which petola begins to decay unless the deposits are removed as soon as possible. The crystallization facility consists of sediment, like other facilities, and requires continuous maintenance and consistent administration with the water regime on the whole area of the saltpans.
- The whole year's work in the saltworks, comprising the preparation of the traditional process in salt making and the preservation of biotic diversity and sustainable use (economic usage) of the saltpans, requires 86% of live labour - manual work, and 14% of machine-aided work, not comprising salt collecting, cartage and storage.
- the crystallization takes the major part of costs, namely 56,70%, thereof 53,50% are manual work costs and 3,20% machine work costs (transport of the mud), not comprising salt collecting, cartage and storage.
- The analysis of the process and operations in crystallization shows that the major part of the labour costs falls on seasonal additional supplying and feeding the cristallizers, namely 45%.
- A part of seasonal processes and operations in crystallization, such as the preparation of the crystallizers, the feeding and additional supplying the saturated basins, can be done by the leaseholders of crystallizers, under the leadership and control of the Company's supervisors and professional salters. The more demanding works, such as the petola's suppuration, the **preparation of the crystallization for the winter**, **the recovery of petola and the maintenance of water regime** over the whole year, as needed for the biosediment maintenance, are performed by the trustee of the protected area.
- If the economic interest for renting the crystallization process of salt production is established and assured, the labour costs in the crystallization falling on the lessee will be 62,86% and the trustee's part thereof will be 37,18%.
- Considering the above division of the work in the crystallization part in the analysis of the work and costs required in the whole process of the traditional production of salt, we come to a division of operations and processes relating to the conservation of biotic diversity (CBD) amounting to 48,95%, and the operations and processes for a sustainable use of the saltworks, or rather for their economic use, (SUS) amounting to 51,05%.
- Considering such division of the work in the crystallization part, which is a priority, the whole operational costs include the CBD share of 43,80% and their economic use (SUS) amounting to 56,20%.
- Such a division of the work can only be introduced step-by-step, allowing to acquire the saltworks know-how, or pass it to the

leaseholders, who ought to be organized in a cooperative society; the society would also need training and stimulation for its economic interest in the traditional production of salt, involving a change of the market position of the salt so produced.

- The saltpans can be run by minimum twenty employees, according to the programme for the cost rationalization as adopted by Droga d.d. on February 2001. The salt producing season was carried out this way, however, the results are udvarse for the condition of infrastructure as well as for the trustee's operation. The abandoned areas will take many years to recover and incur higher costs than today's savings mean. With this number of employees the trustee is not capable to preserve the biotic diversity.
- The second major activity in the saltworks is the maintenance of the saltpan defenses, which are, according to our Mining Act /Zrud/, also a mining acquisition area. By the Order on the protected areas in Se_ovlje Saltworks (KPSS), these works are classified as water management services within the Ministry of Environment. The infrastructure location and model, the working procedures, the geo-mechanical characteristics of the land, the condition of dikes, the destructive power of the sea in extreme weather conditions, and intervention operations in fighting against the force majeure, or the recovery of the operating condition resp. require the attention of a waterworks construction team in the plant. The main unit is a seaworthy dredger (excavator) and appropriate light mechanization, that can be conveyed to the site of work by means of a watercraft; however, the key importance remains on the know-how in relevant special operations. The machinery possessed by the plant is not sufficiently occupied through the year, except in occasional interventions on the coast and on the seashore. The team can renew the dikes and channels according to a long-term operations programme, for which the financial resources are allocated, and in accordance with the underlying objective - the preservation of the biotic diversity, and the sustainable use of the saltpans. The pre-conditions for the continuation of operation, i.e. the adoption of the restoration programme on main saltworks structures, the allocation of financial resources for a gradual renewal, and the availability of a qualified team for the implementation of work with the main contractor, which is not fully used in terms of operation, the contractor has the opportunity to win these works and improve the operation and management of the National Park Se_ovlje Saltworks (KPSS). Approximately equal annual values of investments by the water management sector (Ministry of environment) as in the years 1992-1994 can be expected, that is about 136.000 EUR per year.

CAPITAL OUTLAYS (INVESTMENTS) IN THE RECONSTRUCTION OF THE SALTWORKS INFRASTRUCTURE

The estimate for the renewal of the high water defences is about 8,670.000 EUR.

The duration of renewal work, provided that the Ministry invest nearly the same amount as in the years 1992 to 1994: 8,67 mio EUR : 0,136 mio EUR/year = 61 years

The annual maintenance regarding the value of the renewed facilities is estimated at 151,268 EUR - the amount needed for depreciation.

For the improvement of the demolished and dangerous sections - urgent renewal works in the first phase - are needed 147,727 EUR. The amount for the urgent renewal works are not comprised in the total renewal estimate for high water defences, the works are listed separately because of their relevance and urgent execution. The demolished sections are, due to overflowing waters flooding the areas behind them, the cause for an increased erosion, they endanger the salt production and the biotopes /habitats.

The Saltworks' infrastructure is in a very bad condition, the renewal works are included in the regular maintenance costs of the following structures:

- Machine-made dikes
- Hand-made dikes
- gutters and feeding parts of the wooden barriers.

The value of the renewal works is estimated at 1,19 mio EUR, thereof the amount of 60.000 EUR has to be immediately invested in the renewal of water management equipment, whose main part are pumps purchased in the year 1955 that are important for the water regime maintenance in the period of heavier rainfalls, involving the risk of flooding the saltpans.

The renewal of the remaining part of the infrastructure can be executed by the salt production contractor within 6 to 10 years, provided that there is normal operation.

PROCEEDS AND OPERATIONS

The price of salt considered in this calculation is the average purchasing price of the raw unrefined sea salt, produced in the Mediterranean and brought to the Slovenian port by a bulk carrier, namely 28,00 EUR/ton.

THE OPERATION WITH PROCEEDS THAT CAN BE GENERATED WITH AN OPTIMAL UTILIZATION OF THE TRADITIONAL SALT MAKING PROCEDURES WITH THE CURRENT ORGANISATION OF WORK – THE SALT HARVEST QUANTITY FROM 3000 TO 5000 TONS

PROCEEDS (in EUR)	237.636	to 293.636
PRODUCTS		
Sea salt	84.000	to 140.000
Fango and brines	36.364	
SERVICES		
trusteeship	90.909	
(excl. VAT)		
water-	13.636	
construction works		
tourist pathways	3.636	
Rentals	2.273	
Berths	6.818	
OPERATION		

PROCEEDS (in EUR)	237.636	to 293.636
EXPENSES	640.680	
LOSS	259.771	to 350.680

THE OPERATION WITH PROCEEDS THAT CAN BE GENERATED WITH AN OPTIMAL UTILIZATION OF THE TRADITIONAL SALT MAKING PROCEDURES AFTER A GRADUAL START (INITIAL PUSH) OF THE SALT COOPERATIVE SOCIETY IN CRYSTALLIZATION - THE SALT HARVEST QUANTITY FROM 3000 TO 8000 TONS.

The underlying sustainable salt production, hand in hand with the environmental protection and preservation of the cultural landscape, it is rather difficult to effectively organize the traditional salt production, with chiefly manual and seasonal work, as currently in use.

In the adopted scenario of the Long-term development vision of the Se_ovlje Saltpans Natural Park, there are defined the development objectives. In order to find a rational development way, the Outline of organization and marketing mix was drawn up in October 2000, in which a limited liability cooperative society is foreseen as an open organization allowing the entry to legal entities and natural persons showing interest in cooperation within the scope of feasible economic activities, as acceptable for the Se_ovlje Saltpans (KPSS) and its surroundings, and the most appropriate form for the inclusion of local subjects and entities interested in the commercial use of the saltpans.

The cooperative society SOLINE PIRAN z.o.o. (Cooperative with limited liability) was founded on 18 July 2001, its aims comprise the preservation of the sustainable use of Se_ovlje and Strunjan Saltpans, of the river basins of San Bortolo, Valdrniga, Dragonja and the Strunjan Brook, the professional associations and providing training for the members of the cooperative society, the improvement in the quality of products and services, and the development of business culture.

If the economic interest is assured and the cooperative society takes over the salt production in the crystallization stage, the survival of the traditional salt making will be guaranteed. The traditional branch of salt making, which is considered as an agricultural activity in the most of the European countries, is ranked to the mining industry in Slovenija. This aggravates the legal aspect of work organization with the lessees of the saltpans, in the stage of crystallization. The listing of traditional salt making as a traditional trade could increase the interest for the trade.

Due to the gradual renewal of the crystallization facilities, and a gradual introduction of the cooperative society, all the currently used forms of renting the crystallization facilities will be used in the transitional period. For the operational calculations, the final financial situation has been taken into account.

In the calculation of the proceeds from the sea salt production, we considered the average crops yielded in unfavourable seasons

(weather condition), i.e. 3000 tons, and the average crop in good seasons, i.e. 8000 tons, as well as full occupancy of the crystallization facilities.

The total operational costs of 640.680 EUR are reduced by the labour costs in the crystallization, amounting to 135.728 EUR, and by the cost of salt collecting and handling (conveying to deposit), amounting to 69.404 EUR.

PROCEEDS (in EUR)	237.636	to 377.636
Sea salt	84.000	to 224.000
Other items unchanged	153.636	
OPERATION		
PROCEEDS (in EUR)	237.636	to 377.636
EXPENSES	435.548	
LOSS	57.912	to 197.912

THE OPERATION WITH PROCEEDS THAT CAN BE GENERATED WITH A MINIMAL OPERATION OF THE TRADITIONAL SALT MAKING PROCEDURES AND DECAYING SALTWORKS STRUCTURE - SALT HARVEST QUANTITY 1000 TONS - according to the Working Plan - variant B

PROCEEDS (in EUR)	148.091
Sea salt	27.273
Other	120.818
OPERATION	
PROCEEDS (in EUR)	148.091
EXPENSES	261.582
LOSS	113.495

CONCLUSIONS

1. The figure of proceeds already comprises the trusteeship funding in the amount as in the year 2001.
2. Three very different approaches to further organization of work in the traditional salt production and trusteeship for the maintenance of the biotic diversity in the protected area show an operational loss.
3. The lowest operational loss in the minimal operations of traditional salt production and trusteeship involves the risk of much higher expenses for the renewal of the internal salt structure and for the maintenance of biotic diversity that may incur at a later stage, or even a bigger risk of a final loss of interest for the conservation of the traditional salt production.
4. The start up of the saltworkers cooperative society is a more favourable possibility for the Se_ovlje Saltworks Natural Park

(KPSS) from the business, developmental, socioeconomic and safeguarding point of view.

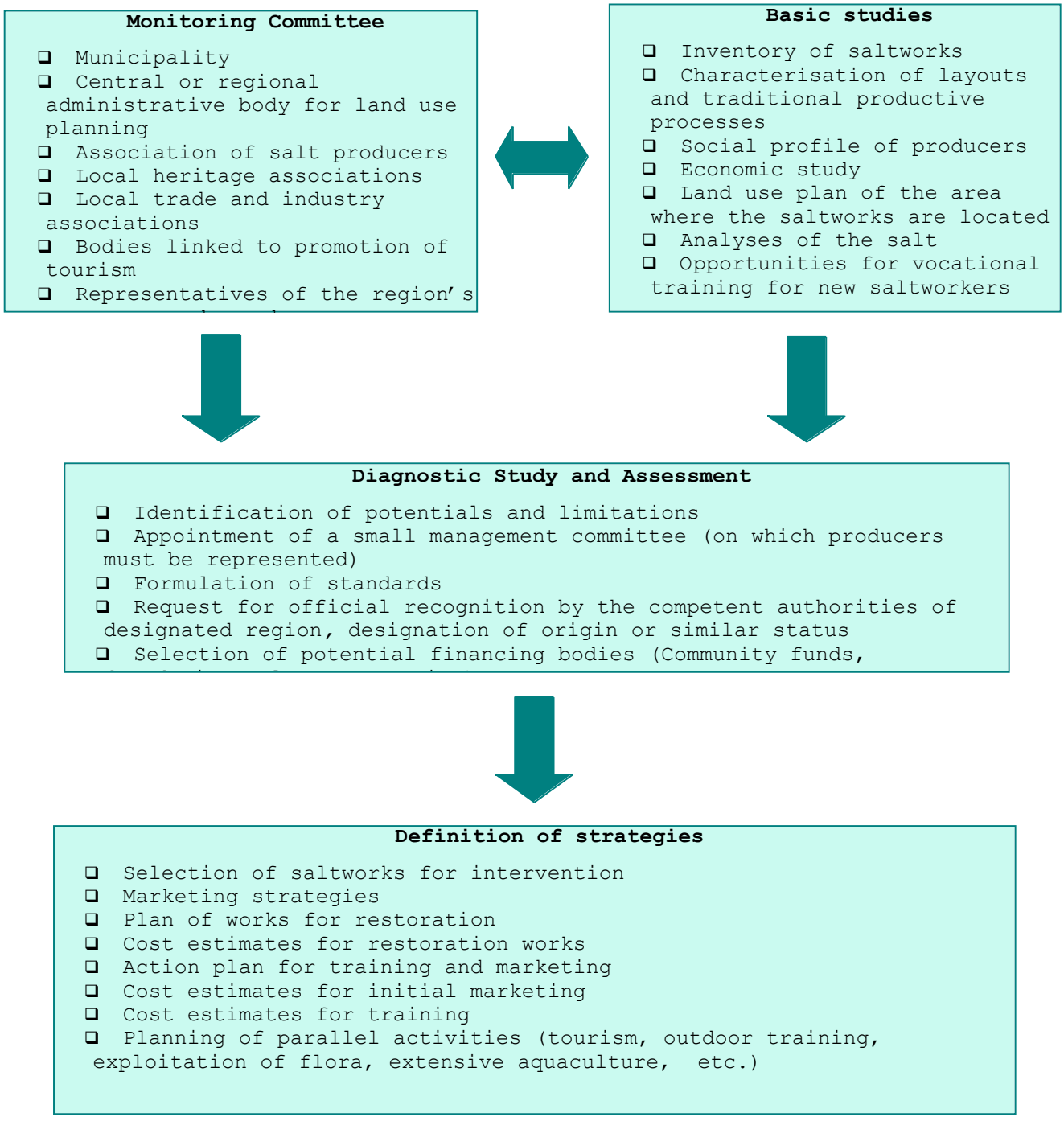
5. All of the three approaches require an additional funding for the operation and a joint business direction for all the players in the KPSS, aiming at achieving the goals of the Long-term vision statement for the area concerned.
6. The assessment of business efficiency of the activities foreseen in the Vision on the proceeds (in EUR):

Fango, main brine (increased quantities)	36.000	
Commercial Berths in the Jernej Channel for 200 boats, at the average price of 680 EUR	136.000	
Waterwork construction services according to the high water defence renewal plan	113.000 136.000	to
tourist pathways	13.000	
Total	298.000 321.000	to

Underlying for a quality tourism along an orderly landscape park that will yield favourable effects as foreseen in the long-term development vision, are a well preserved surrounding area and hinterland, without any unnecessary intense urbanization and rough interventions.

4. STRATEGY FOR THE RESTORATION OF SALTWORKS

From the experience gained so far under the scope of the ALAS Project in Figueira da Foz and from similar activities carried out in other places, particularly in France, it seems to us essential that any restoration work should begin with a planning and implementation stage, based on the agents and instruments set out below. While it has not been possible to follow this scheme in its entirety in Figueira da Foz, it seems to us to be the most suitable for projects of this nature.



Community programmes and initiatives that provide for the restoration of saltworks

For some years, nature conservation, sustainable local development, preservation of cultural heritage and social cohesion have been priority issues in European policy. Since artisanal saltworks are linked to all these priorities, it is theoretically possible to include restoration projects in Community programmes and other initiatives aimed at these areas, as long as they are integrated into wider actions. The most relevant programmes and initiatives are the following:

LIFE-Nature *– This is a fund specially designed for nature conservation (in EU countries or in those whose application to join has already been accepted), with priority given to actions in the areas listed in the Natura 2000 network and to bird species listed in Annexe I of Directive 409/79 as being a priority for conservation. Various projects have been implemented or are being prepared under the scope of this programme that involve the restoration or management of saltworks (Trapani and Comachio in Italy and the Tagus and Sado estuaries in Portugal).*

LIFE-Third Countries *– This programme has the same objectives but is open to other countries, particularly those around the Mediterranean basin.*

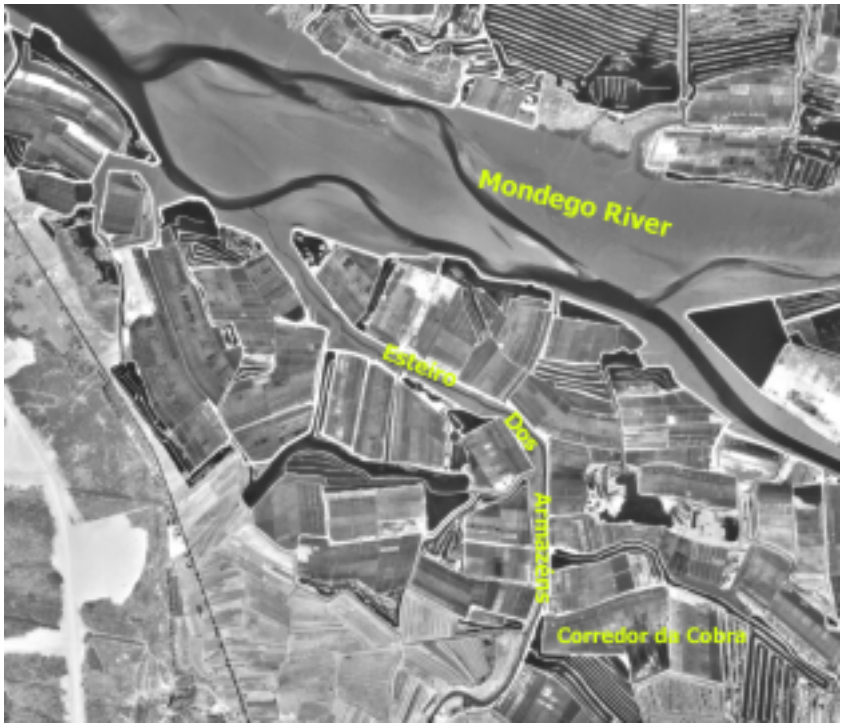
Interreg - *An interregional cooperation initiative that is designed to foster balanced development. Since it is aimed at cross-border cooperation (including maritime borders) and actions designed to develop small communities and local activities, the restoration of saltworks can be included in this programme, integrated into wider projects, as long as they relate to neighbouring countries.*

EQUAL *– EQUAL is a transnational Community initiative for the promotion of employment and social integration. Vocational training actions that include exchange of experience may be eligible for support.*

5 . CASE STUDY - RESTORATION OF THE *CORREDOR DA COBRA* SALTWORKS

5.1 Geographical location and system of operation

The *Corredor da Cobra* saltworks was acquired by the Municipal Council of Figueira da Foz in November 2000 to serve as a demonstration unit for the Salt Museum. It has all the characteristics of the original saltworks with an adjacent warehouse; part of the Lavos group of saltworks (southern area of the Mondego estuary), it is fed by the *Esteiro dos Armazéns*



('warehouse creek' - see map), with an area of around 7.44 hectares.

Figure 4 - Aerial photograph of the Lavos Group

At the time of acquiring the saltworks it had lain abandoned for approximately five years, during which there had been no management or maintenance. It should be noted however that its location protects it from erosion, since the area beside the creek is separated from the water by a road, and the other sides border on stable land, either the banks of other saltworks or agricultural land. Restoration work began in April 2001 with the hiring of two saltworkers, assisted when necessary by other workers from Lavos Parish Council. Between April and June 2002, two more workers were hired, and at the time of preparing this report (July 2002) around 70-75% of the restoration work had been completed.

In order to better illustrate the work of restoration, it is necessary to describe the saltworks in detail in terms of its compartments, divisions, channels and operating processes. We thus have (see plan):

Boundary, supply system and warehouse

1- External wall (*mota*) - encloses the whole saltworks and is between 2 and 3 m high.

2- Warehouse - constructed entirely from wood with a tiled roof, it can store 300 tons of salt.

3- Sluice and *greiro* - The *greiro* is the concrete structure that supports the wooden sluice.

Figure 5 - The *greiro* of *Corredor da Cobra* saltworks

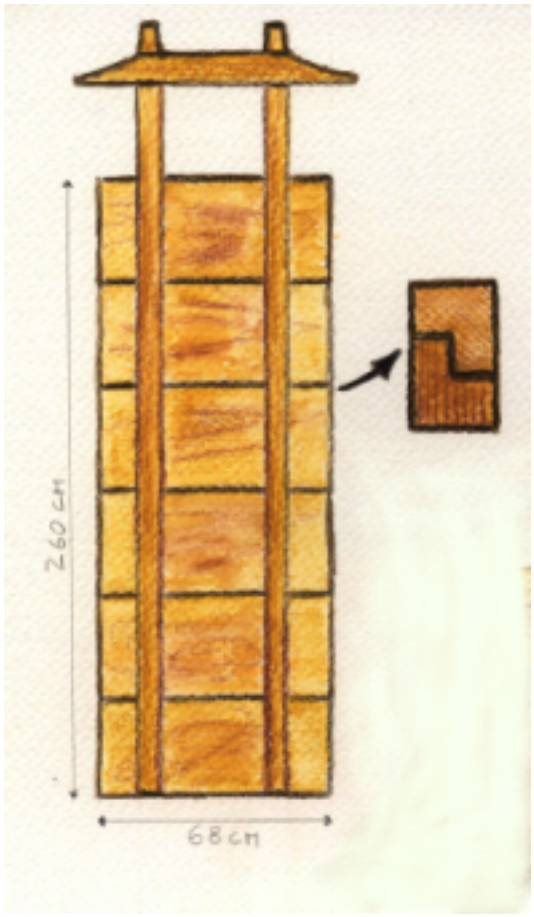


Figura 6 - Wooden sluice

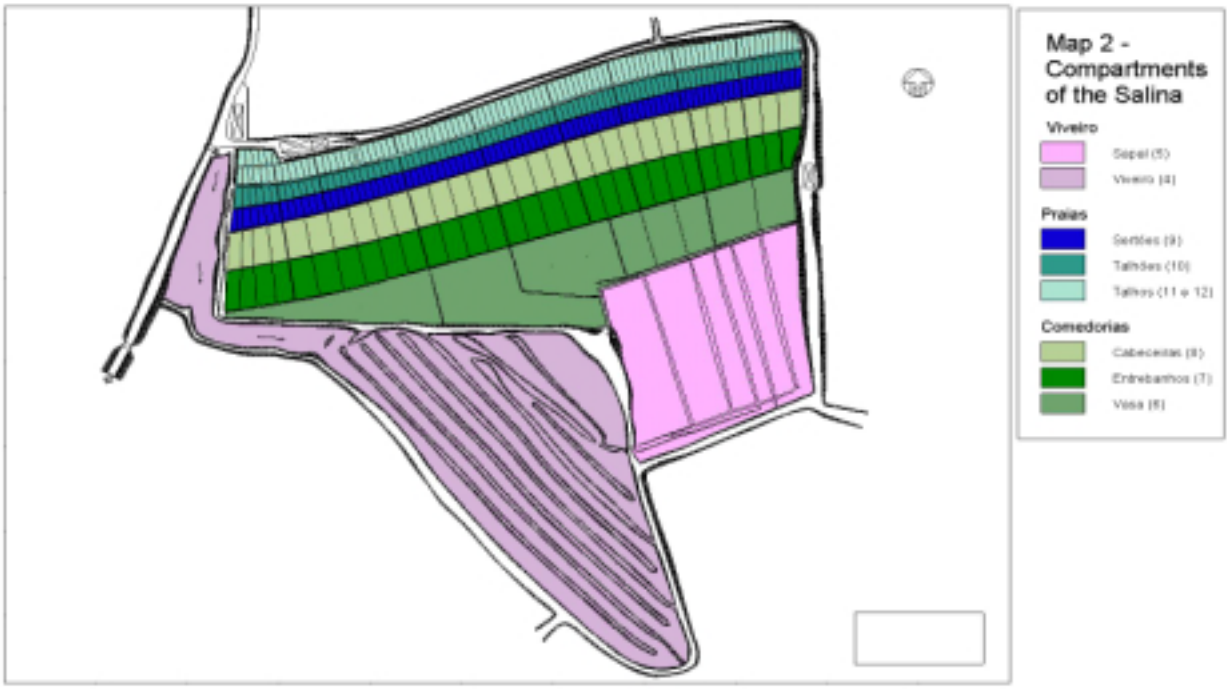


Figure 7 - Compartments of *Corredor da Cobra* saltworks

Compartments

4- *Viveiro* - The main reservoir of a saltworks; in the case of *Corredor da Cobra*, the *viveiro* is designed to supply this particular saltworks only, an unusual situation in Figueira da Foz since the majority of *viveiros* there are common to several saltworks. Inside the *viveiro* there are nine long narrow *ruas*, roughly parallel to each other, which force the water to take a winding course until it reaches the *sapal.*

5- *Sapal* - Roughly square in shape, this has six divisions.

6- *Vasa* - Irregular in shape, this is composed of eight units.

7- *Entrebanhos* - Here appear the more regular shapes associated with saltworks; there are 31 units.

8- *Cabeceiras* - The same number of divisions and of the same size as the above.

9- *Sert_es* - 88 units, each set of three covering one *cabeceira*.

10- *Talh_es* - These are similar to the above units and line up with them; in favourable conditions, the process of crystallization starts here.

11- *Talhos* - The same number as the above, lining up with them, these constitute the real crystallization area of the saltworks, and as such are the most compacted and most carefully maintained.

12- *Talhos da praia de baixo* - Only six units, on the western corner.

The group composed of *vasa, entrebanhos* and *cabeceiras* is collectively known as the *comedoria*. The *sert_es, talh_es, praias do meio* and *praias de baixo* form another group called *praias*.

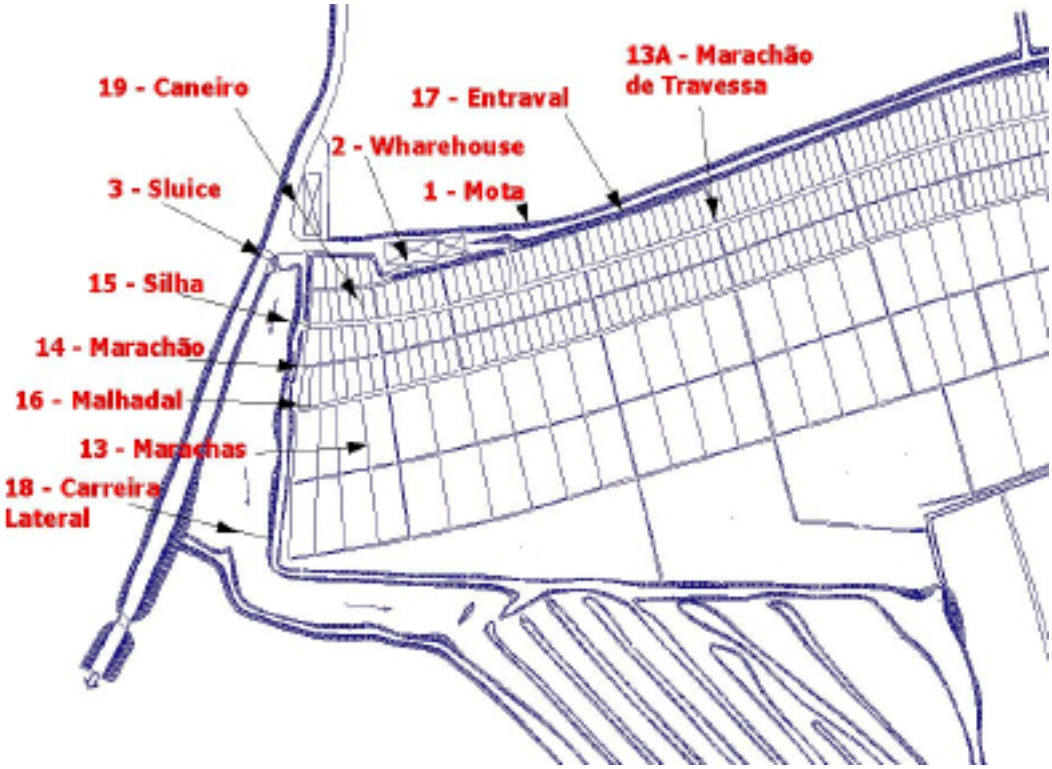


Figure 8 - Channels, divisions and complementary structures

Divisions

13- *Marachas* - These are the divisions between the various units within the same compartment.
13a- *Marach_es de travessa* - Located in the *praias* area, each dividing a group of 10 units, these run parallel to the *marachas* and their basic function is to enable the saltworkers to cross from one part to another.
14- *Marach_es* - These separate the different types of compartment.
15- *Silha da praia do meio* - This is a type of *marach_o*, but wider, that separates the *talh_es* from the *talhos*, and is used to deposit the salt as it is harvested; in this saltworks it is covered with wooden boards, and is therefore called a *passadeira* ("walkway").
15a- *Silha da praia de baixo* - This separates the *talhos* from the *entraval* (the channel that marks the end of the saltworks); it is narrower than the previous one and is not covered with wooden boards.

Channels

16- *Malhadal* - A channel, about 25 cm wide, that runs between the *cabeceiras* and the *sert_es* at right angles to them, and is thus parallel to the *marach_es* and *sillhas*.
17- *Entraval* - This is of the same width and runs in the same direction as the *malhadal*, between the *silha da praia de baixo* and the *mota* (the external wall of the saltworks). The water is drained from the saltworks through this channel and flows into the creek via the *cubo* (wooden pipe).

18- *Carreiras* – These are channels at right angles to the *malhadal* and *entraval*, running along the sides, from the *vasa* to the *entraval*.
19- *Caneiros* – These are small channels located between the *marachas* (divisions) of the *sert_es*, *talh_es* and *praias*, whose function is to flood these compartments from the *malhadal*.

Water circulates by gravity between all the compartments via small sluicegates in the *marach_es*. These are called *vasotes* and are traditionally made of wood, but they have been progressively replaced by PVC pipes, stopped with a wooden plug. In this saltworks the technique of using *vasotes* is still used in the *praias*. In the *comedorias* the water passes through 3-inch PVC pipes.

Figure 9 – Passage of water through PVC pipe

Water-raising apparatus

20- *Bomba* (Pump) – The pump is a manually-operated apparatus designed to raise the water from the *entraval* to compartments or channels located at a higher level. It is entirely made of wood and consists of a kind of wide trough, fitted with a gate that allows the water to flow in but not out. The pump goes up and down, balanced on its axis, and this movement makes it dip into the 'well', which is a trough dug in the ground around 65/70 cm deep, 195 cm long and 80 cm wide. The walls of this trough are lined with wood and it is connected to the *entraval* via an underground pipe placed at an appropriate angle so that the water begins to flow as soon as the pump starts to work. Each movement of the pump raises approximately 25/30 litres of water. There are four such pumps in this saltworks.

Figure 10 – Wooden pump

5.2 State of conservation and programming of restoration work

In order to better illustrate the operation of the saltworks and the state of its structures, we present a photograph taken before work began, with a diagram showing the viewpoint, together with Table 2 which describes the state of conservation of the main structures and compartments.

Figure 11 - General view of the saltworks on 1 April 2001

Figure 12 - The same view as in figure 11, in July 2002

Figure 13 - Diagram showing the viewpoint of the photograph in **figures 11**and **12**

An essential element in the planning of the works was a detailed topographic survey (scale 1/500), which immediately enabled some estimates to be made and certain initial options to be defined regarding the strategies to be adopted; these are summarised in Table 3. The survey also showed that the water circulation system was somewhat defective, mainly in the area of the *praias* (*sert_es*, *talh_es* and *talhos*), as can be clearly seen in the following diagram which shows the minimum and maximum levels of each compartment (in metres), as well as the high degree of silting of the *viveiro*.

Viveiro	0.97-1.40										
	Sapal	1.18-1.29									
		Vasa	1.22-1.33								
			Entrebanhos	1.24-1.28							
				Cabeceiras	1.17-1.25						
					Sert_es	1.02-1.06					
						Talh_es	0.95-1.09				
							Talhos	0.94-1.04			
								Cubo (outlet)			
								0.88			

Table 2 - State of *Corredor da Cobra* saltworks in November 2000

Sector	State of conservation/Description
Mota	Good
Warehouse	At risk of collapsing. Roof in poor state, timbers in extremely bad condition
Greiro	Good
Sluice	Poor, does not close completely
Viveiro	Partially silted up, proliferation of algae, circulation system (*serpentina*) blocked at various points
Sapal	Tanks invaded by vegetation
Vasa	Invaded by vegetation (*Salicornia*)
Cabeceiras and *entrebanhos*	Invaded by vegetation to some extent, large quantities of sediment, wood of divisions in poor condition, but still usable
Sert_es, *talh_es* and *talhos*	Large quantities of sediment, mollusc shells and algae, wood of divisions in poor condition, but still usable
Marachas and *marach_es*	Variable condition, from reasonable to poor
Malhadal	Reasonable state of conservation
Entraval and *carreiras laterais*	Poor condition, heavily silted up, vegetation from the *mota* encroaching onto the bank
Silha	Around 80%-90% of the wood considered unusable
Caneiros	Poor condition but still usable
Bombas (Pumps)	Completely destroyed
Cubo	Functioning
Water conduits and internal sluices (*vasotes*)	Highly variable condition, from destroyed to reasonable

Table 3 - Estimates for certain works

Work	Estimate		
Cleaning and compacting *praias* area	Total area (ha): 1.18	Estimated m^3 to be removed: 400/500	Labour and resources required: 2 full-time saltworkers + casual labour and dumper
Cleaning *comedorias*	Total area (ha): 2.69	Estimated m^3 to be removed: 125/200	Labour and resources required: 2 full-time saltworkers + casual labour and dumper

Cleaning and consolidation of *entraval*, *malhadal* and *carreiras laterais*	Length (m): 800	Labour and resources required: 2 saltworkers (when required + 2)
Consolidation of *marachas* and *marach_es*	Length (m): 3080 (*comedorias*) 6335 (*praias*)	Labour and resources required: 2 saltworkers (when required + 2)
Cleaning *viveiro* and *sapal*	Construction of basin Excavation of channel Cleaning *arruelas* Cleaning *sapal*	Labour and resources required: 15-17 days with excavator
Improvement and consolidation of access ways	Length (m): 720	Labour and resources required: 3 days with machinery (excavator and backhoe)
Reconstruction of *silha da praia do meio*	Length (m): 330	Labour and resources required: 20 days with a team of 3 carpenters
Construction of new access *silha-sapal/viveiro*	Length (m): 100	
Construction of pumps	Carpenters: 6-7 working days (2 carpenters)	
Erecting pumps and reconstructing pipework	Saltworkers: 8-10 working days	
Construction of new sluice	Carpenters: 1.5-2 working days (1 carpenter)	
Reconstruction of warehouse	Working days: 25-30 (teams of 4-7 carpenters/day)	

Given that the saltworks is divided into an increasing number of divisions from the *viveiro* onwards, all directly linked to adjacent divisions by the supply system, the work was planned in order to take advantage of this structure, thus enabling the saltworks to begin partial production. However, for operational reasons, particular attention was paid in 2001 to the *praias* area rather than the *comedorias*. In that year work in the *viveiro* was kept to a minimum, with some channels being reinforced in order to allow the required circulation of water and a new sluice being constructed to ensure the system was leak-proof .

Figure 14 - Works I – Cleaning and improving access ways (red line); sediment deposited for observatory (green); construction of new *silha* (yellow line); reconstruction of pumps (red squares); sedimentation tank (yellow area)

5.3 Description of works

A - Cleaning and compacting *praias* area

This was one of the most time-consuming tasks, due not only to the volume of sediments that had to be removed but also to the fact that this part of the saltworks requires the greatest care during compaction.

In the past this saltworks operated with two saltworkers working in two different areas, each with its own independent supply and drainage system. These areas are called *c_modos* (the west *c_modo*, comprising 14 *entrebanhos* and *cabeceiras*, 36 *talh_es* and *sert_es* and 36 *talhos da praia do meio* and 6 *talhos das praias de baixo*, and the east *c_modo* consisting of 17 *entrebanhos* and *cabeceiras*, and 52 *sert_es*, *talh_es* and *talhos da praias de baixo*). This made it possible to stagger operations, with restoration work in the *praias* beginning in the west and moving towards the east.

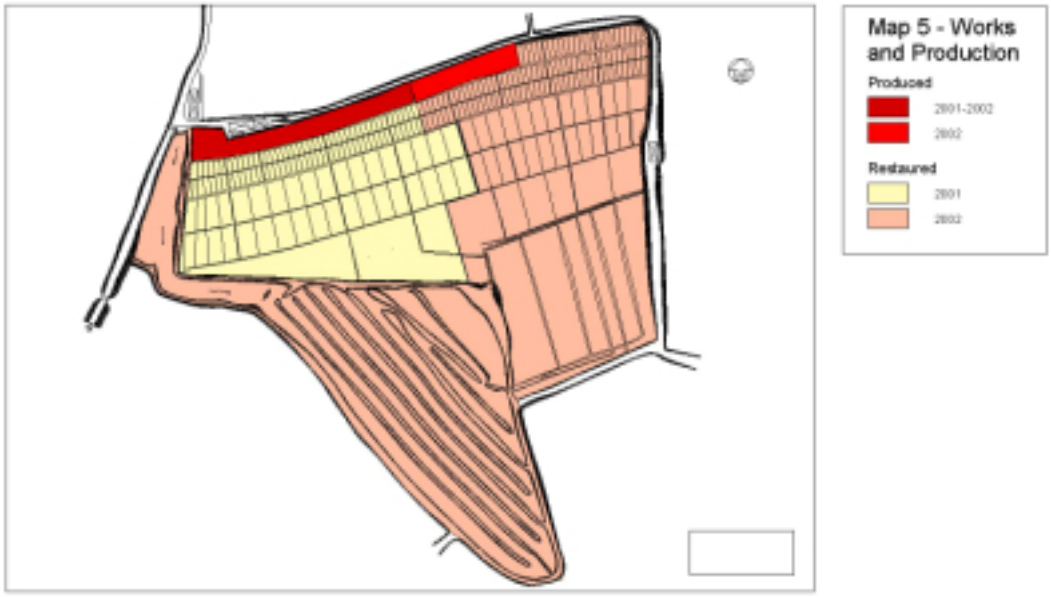


Figure 15 - Works II – Areas in production and areas restored in 2001 and 2002

The sequence of works was as follows:

- Raking out the algae
- Cleaning out sediment with an *ugalho* (toothless rake) and shovel

This material was first piled up in small pyramids in the tank itself, allowing the water to drain away at the bottom, and then it was placed on the *silha*, where it remained for several days.

This operation leads to a considerable reduction in the weight of material to be moved, thus making its removal much easier. It was then loaded into a dumper with modified axles adapted to the width of the *silha*. This means of transport, also used to remove the salt from the *silha* during harvesting, represents a considerable saving in labour.

Figure 16 - Cleaning out mud deposits from the *talhos*

Figure 17 - Mud deposits drying on the *silha*

In this particular case, disposal of this material did not pose a major problem since the local restoration project provided for the construction of a raised platform which will serve as an observatory overlooking the saltworks, all the material having been moved to this area during the first phase (spring and summer of 2001), while during the second phase (spring and summer of 2002) the material was used for the construction of an access between the *silha* and the platform. It should be noted however that in the absence of such a solution, the disposal of this material would represent an additional problem for any restoration project.

- Compacting the beds

As soon as the beds had been cleared, consolidation work began, which was obviously also dependent on certain works upstream and downstream, such as cleaning the *malhadal* and *entraval* of the corresponding sectors and constructing the first pump. The operation of compacting the beds is known locally as *cura*, and it is a task, like so many others in traditional salt production, that requires practical experience and depends on the prevailing weather conditions. The tanks are left to dry out, and the saltworkers keep them under observation to note any change in colour and the appearance of small cracks, which will reveal the degree of dryness. To prevent them drying out excessively, the saltworkers water the beds frequently, using a bucket with a long handle called a *cabaço*. In the case of the *talhos*, the beds are further compacted using a wooden cylinder, known locally as a *c_rcio*, that weighs approximately 100 kg and is rolled over the beds.

Figure 18 - Controlling the degree of dryness

Figure 19 - Compacting with the *c_rcio*

Use of mud deposits and algae

In the past, sediment and algae cleared from saltworks were much sought after by farmers for use as fertilizer in market gardens and orchards. Today they are only used in Portugal by saltworkers who cultivate small plots along the walls (motas) of saltworks. Broad beans grown in this fashion are famously found in all salt-marshes in Portugal.

Apparently this mixture of material - algae and sediment rich in organic matter - has excellent qualities as fertilzer, only requiring a period of desalination. This is done by leaving it out in the open air, preferably for at least one whole winter (in climates with less rainfall, such as those in a large part of the Mediterranean basin, this period would of course be longer).

At a time when organic farming is becoming increasingly popular, it is important to revive the use of this material as fertilizer - a practice of which the majority of farmers now engaged in this type of agriculture are unaware. This would also have positive consequences for the restoration and maintenance of saltworks, since in certain places these operations can generate large quantities of this material, which is regarded as waste matter or surplus material that has to be disposed of in landfills, incurring increased transport costs.

It is therefore desirable that associations of salt producers contact organic farmers' associations as, at least in countries in the European Community, this type of farming complies with specified standards and certification procedures that include a list of products authorized for use as fertilizer.

B - Cleaning the *comedorias*

These compartments require considerably less compaction than the *praias*; the sediment was collected in the same way, surplus

material being used for the same purposes (to build up the observatory area and to construct an access way between the *silha* and the platform and a new access way over the *viveiro*).
A further problem was the removal of vegetation, mainly composed of *Salicornia* sp. (glasswort), known locally as *cachelro*.

Control of Vegetation

Plants found in saltworks are usually species adapted to high levels of salinity, conditions which are unfavourable for the growth of most other species. Such plants are known as halophytes, and their adaptive evolution has allowed them to colonise large areas of brackish water, salt-marshes and saltworks. Some species are short-lived, taking advantage of certain seasonal variations to complete their life cycle rapidly, while others, able to withstand the alterations in the annual cycle, survive several years.

Among the different plant species, some are of particular importance to saltworkers. Such is the case with the hardy cachelros (glassworts) (Sarcocornia perennis and Salicornia ramosissima), whose aggressive invasion of saltworks tanks makes them undesirable residents and the target of relentless eradication campaigns, which can include the use of chemical weapons such as potent herbicides. However, peaceful co-existence is possible and some communities traditionally use this group of plants as part of their diet.

In the case of the saltworks of Figueira da Foz, the fact that these plants have never been used as human food, and that the struggle to eradicate them is a long-standing one, means that this problem may require delicate handling. In the present situation it seems preferable to resort to the traditional way of solving the problem, adapting the means to the desired ends.

The basic issue is how to optimize the operations of the saltworks in order to obtain a top-quality product, an objective that the proliferation of plants such as the cachelros (glassworts) can make difficult or even impossible. For saltworks in continual operation (allowing for the annual cycle), this is less of a problem since growth during the off-season can be easily managed by taking various measures to control it. However, in saltworks that have spent some time inactive, the natural vegetation, particularly these types of plant, progressively grows back.

Handling the problem in an environmentally-friendly manner is generally a lengthier process but it has clear advantages in terms of the quality of salt produced, the risks to public health, and most especially of the importance of the ecological impact on natural flora. This approach can be successful if account is taken of relevant factors such as the life cycle of the plants involved and the annual cycle of salt production.

Cachelros (glassworts) flower, seed and mature during the summer and beginning of autumn. However, in active saltworks

this period coincides with part of the production cycle and therefore seeds that germinate in saltworks are either produced during the autumn or come from the banks that surround the tanks.

A management strategy aimed at simply controlling the amount of vegetative plant growth can be based on an annual cutting back before the salt harvest, that is during spring when the tanks are prepared and before the plants have reached their maximum development. The consequent reduction in the number of seeds produced will mean the plant will be less likely to invade in the next growing season.
The best means of eradicating this group of plants is to uproot them, or alternatively simply cut them back. Herbicides should be totally avoided, even if there is a guarantee of rapid degradation. Uprooting may have the disadvantage of seriously disturbing the bottom of the tanks but it has the advantage of reducing the number of emerging plants over a longer period. Cutting back has the advantage of being simpler and there are a great many machines available on the market suitable for the purpose. The use of waterproof materials to line the tanks is not really compatible with the traditional form of maintenance that is intended.

Exploitation of spontaneous flora

Other indigenous plants that take on a different significance in saltworks operations are sea lavenders (Limonium spp., particularly Limonium ferulaceum). These plants generally have very small flowers growing in branch-like spikes, the flowers themselves retaining their colour even when dried, one reason they are popular in traditional flower arrangements. Their spontaneous growth in the saltworks of Figueira da Foz has contributed to their popularity with home gardeners and they are even grown commercially for the local market. Some species of this genus are widely used in floriculture.

Developing the potential of indigenous species is compatible with traditional ways of managing saltworks and could represent added value to complement salt production. For this, it would be necessary to cultivate such plants under conditions appropriate to their biology, with a profitable level of production being set according to the reproductive potential of the species.

The local species of the genus Limonium are multi-branched herbs that generally bloom between June and August. Sustainable cultivation of these plants would begin with the collection of seeds to be sown later on the wider banks of the saltworks once the soil had been treated. Making cultivation of these plants profitable could involve more active intervention.

Firstly, in order to achieve a high rate of germination, it is advisable to sow the seeds initially in nursery beds. Although the exact method would have to be later refined to optimize the process, sowing at the beginning of winter

should produce excellent results. Only once the young seedlings have grown should they be transplanted outdoors. In order to increase the success rate of this stage, the area to be used should be harrowed. The ideal time for this is assumed to be spring, since it is an appropriate time for transplanting and the harrowing will have eliminated more vigorous competing plants.

Since they are perennials, they can be used for more than just one year, and so harvesting the blooms should be based on selective cutting as opposed to uprooting the whole plant. The plants' own growth dynamic may allow a second year of production without problems, or it may even be the case that harvesting may not be advisable at all in the first year, but light hoeing in spring around the cultivated plants may improve and facilitate the harvest.

In any event, an annual collection of seeds should be planned so as to always ensure new stocks. Apart from the work of preparing the seedlings, transplanting and harvesting, cultivating the crop appears fairly easy, as well as allowing for some mechanisation. These characteristics mean it is an inexpensive crop that requires little labour, and is therefore likely to be attractive from a financial point of view.

C - Cleaning and consolidation of the *entraval*, *malhadal* and *carreiras laterais*

Work in these areas involves removal of sediment and cutting back the vegetation that overhangs from the banks (in the case of the *entraval* and *carreiras laterais*). Of fundamental importance is the question of drainage, with a need at all times to check that this is operating correctly. The final stretch of the *carreira lateral* on the east side was channelled through an underground pipe.

Figure 20 - Cleaning the *entraval* (foreground restored)

D - Consolidation of *marachas* and *marach_es*

Much of this work involves rebuilding part of these structures. For those made from mud, some consolidation work is required by

covering them with a clay paste, obtained by adding water to a mixture of dry material from the banks (*terra s_*). As for the wooden structures, consolidation basically involves removing and replacing the wood, or reverting to the old system of divisions made totally of clay. In the particular case of *Corredor da Cobra*, replacement was not required except in a few places, since the wood was still usable, at least in the *marachas* and *caneiros*. However, the question of replacement will arise in the very near future, since the material is near the end of its usable life, showing many signs of deterioration.

Divisions of wood or mud?

Up until the mid-1940s divisions in the saltworks of Figueira da Foz (marachas, marach_es, marach_es de travessa and silhas) were built exclusively of mud. From then on, saltworks began to appear in which the marachas, silhas and caneiros (small divisions similar to the marachas but in which the water passes through a narrow channel), were built totally of wood, with the sides of the marach_es and marach_es de travessa lined with the same material.

At the time, this innovation was considered extremely useful, since it avoided the risk of contaminating the salt (the main quality associated with salt from Figueira has always been its whiteness), as well as excessive trampling in the talhos (the crystallization areas) from maintenance work on the mud divisions, which in turn would naturally lead to more work to compact the beds every year. It should be noted that given the abundance of timber in the region and the low cost of labour, replacing the mud structures with wooden ones was relatively cheap (around 2 cents per linear metre in 1953).

The change to wooden structures was gradual: in 1953 only 30 out of 229 saltworks used wood, but by the beginning of the 1970s it was used almost everywhere. At the present time, a good proportion of these structures are at or very near the end of their useful life (the Corredor da Cobra saltworks is not alone in this), and it is therefore important in future restoration projects to evaluate which is the best method to use by carrying out a cost/benefit analysis.

Building divisions from mud represents zero cost in terms of material since it comes from the saltworks itself (normally from the banks), being mixed with water until it acquires a paste-like, but strong, consistency. This task, when performed by two experienced saltworkers, is relatively quick, since each maracha of the talhos (approximately 10 to 12 metres long) is built up in around 20-30 minutes, those of the caneiros taking a little longer (around 45-50 minutes). The divisions of the talhos are triangular in section, 6.5 centimetres at the base and 8 cm high. Those of the talh_es and sert_es, while slightly bigger (9 cm by 10), take more or less the same time to build.

The construction process is as follows: the saltworkers tie a rope between two poles, which serves as a guide to construct the maracha along the length of the talho; they

then line up a wooden rule, rectangular in section, with the guide-rope, fixing it in position by means of poles set at a slight angle; the paste is placed against the wood and carefully smoothed down; the wooden rule is then detached from the paste with the help of a knife. A caneiro is constructed in the same way in a double row, but the rule is positioned with the inner face upright so that it makes a right angle, which will then form the channel.

Once built, both types of structure have to go through a drying process, the duration of which will vary according to the weather conditions; they are then copiously sprinkled with water and the saltworker passes an implement over them, which functions as a mould and which will compact and smooth the paste. After a further period of drying, the structure is ready for use.

If built properly, it will easily withstand the winter and the period when the saltworks is flooded; the following season it is only necessary to smooth the surface again with the mould and clean out the caneiro with an implement in the form of a wedge, known locally as a tamanco.

Building with wood is considerably more complicated, since apart from the initial task of sawing the lengths and cutting the joints, it requires a carpenter aided by a saltworker to put them in position. The process of measuring and marking them out must be extremely precise, since the wood goes into the ground in previously-prepared grooves and is then supported by poles fixed in holes along the sides. Great care must also be taken with the joints in the boards so that they do not come apart in the future. Fitting them involves practically twice the number of man-hours as the mud structures, in addition to the cost of the wood and of the sawmill operations.

Taking into consideration the methods used and their respective costs, future restoration projects will be more viable using the former system of divisions in mud/clay. It should be noted however that today there are few saltworkers who know this technique and have the appropriate tools for the construction and maintenance of this type of division (sliding moulds).

Figure 21 – a) Placing the guide to build up the *maracha* and b) filling in

Figure 22 - Shaping with the mould

Figure 23 - A completed *maracha*, replacing a wooden one

Figure 24 - Replacing a *caneiro*

Figure 25 - Shaping with the mould

Figure 26 - A completed *caneiro*

E - Cleaning the *viveiro* and *sapal*

Over time *viveiros* have a natural tendency to accumulate sediment and to silt up. At *Corredor da Cobra*, as in the majority of saltworks in Figueira da Foz, sedimentation occurs mainly along the banks of the *ruas* or *arruelas* (the large mounds of earth, long and narrow in shape, located inside the *viveiros* and between which the water circulates). As a consequence, there is a progressive invasion of vegetation from the banks, which tends to block the system. The same happens, though to a lesser degree, in the *sapal*. In the case of this particular saltworks there were additional problems.

The restoration plan envisaged a two-stage operation for this problem. The first was a corrective measure, which consisted of using an excavator to remove the sediment and vegetation from all the banks of the *viveiro* and from the borders of the *sapal*. In order to minimize the impact on communities of nesting birds, this operation was carried out from the end of June to the middle of July.

The second stage of the operation was designed to prevent silting up in the future. To this end, the initial section of the *viveiro* was separated off by a bank (which will serve as a link from the road to the observatory, allowing the latter to be used during the periods when the saltworks is flooded). A 100-cm diameter cement pipe was positioned in the centre of the bank, the idea being that this area would act as a sedimentation tank, thus making cleaning operations much easier and cheaper than if the whole of the *viveiro* were involved.

It should also be noted that immediately after the outlet from the sedimentation tank and before the inlet to the *arruelas* a channel was opened up with a view to increasing flow at the inlet.

Scheduling the restoration work

Since saltworks are sites of ornithological interest, it is important to schedule any restoration work in accordance with the phenological characteristics of the birdlife found there. Given that birds are particularly vulnerable during the breeding season, all heavy work should be avoided during this period, especially operations involving earth-moving equipment or cutting back vegetation.

The breeding season varies considerably depending on the species and the geographical location of the sites involved. As a general rule, resident species nest earlier than migratory ones. In any event, work of this nature is inadvisable from the end of March to mid-June. When there are breeding populations of Anatidae (ducks), this exclusion period should begin in mid-February. These general guidelines should not be understood as exempting those involved in possible restoration works from seeking prior advice from experts and local nature conservation organisations, who will certainly be able to provide information on any situations not covered by this basic rule of good practice.

F - Improvement and consolidation of access ways

These operations involved the access described above (from the road to the observation platform) and the *motas* (the banks that delimit the saltworks) on the south and east sides. This work was intended to provide easy access for all types of machinery (dumpers, tractors and excavators) to various strategic points in the saltworks, with the aim of facilitating future production and maintenance operations. The herbaceous vegetation was cut with a tractor fitted with a hedge-trimmer, while excavators were used to level the ground and deposit earth on certain bends to improve manoeuvrability.

G - Reconstruction of the *silha da praia do meio*

Since part of the wood was still in reasonable condition, this operation was limited to taking up and replacing those boards that were not usable. The boards are 2.2 cm thick, 170 cm long and 20 cm wide. Even though during the reconstruction work the *silha* was found not to have been built properly (the side pieces had not been fixed in the ground and the upper supports were inadequate), it was decided to keep to the original plan, since removing the whole of the existing *silha* and building a new one would have involved a considerable delay (more than a year to restore the *praias*).

Figura 27 - Replacement of boards on the *silha*

This is a simple operation, consisting of nailing 220-cm wooden boards to the *silha*, with an overhang on each side; once a stretch of 30 or 40 boards has been fixed in position, a line is drawn marking the edges of the *silha* and the boards are cut to size using an electric saw.

H - Construction of new access between *silha* and *sapal/viveiro*

The idea of this access was basically to enable visitors to move with ease around the saltworks, as well as to avoid possible damage to divisions and channels. It was decided to make this

access of a similar structure to a *silha* since it is linked to the actual *silha* of the saltworks. It was therefore planned accordingly, with a width of 2 metres to allow greater manoeuvrability for the dumper.

The earth base was constructed in May and June of 2002, and at the end of the summer it is planned to begin work on fixing the wooden structure, using traditional techniques. This will involve making grooves in the ground to fix the side pieces, which will be reinforced by uprights (also driven into the ground). Crosspieces

will be placed at regular intervals, which will also be fixed to the side pieces. Only after this will the structure be ready for the wood covering to be fitted on top.

Figure 28 - Construction of the new *silha*

What machinery should be used in the maintenance and operation of saltworks?

One major problem that saltworks face is the cost of labour and the difficulty in obtaining it. At the same time, much of the maintenance and production work requires a high level of physical effort. Transporting soil is a prime example of this, but the mere shifting of the salt from the crystallizing pans to storage areas is also a process that requires continuous effort throughout the harvest.

One possible solution is to mechanise some of these processes, since nowadays there is a wide range of small machines available, whose manoeuvrability and versatility make them easily adaptable to traditional saltworks. Another relevant factor is that, at least in Portugal, such equipment is available for hire, with some firms offering rental packages on a daily, weekly, monthly or six-monthly basis.

Although there are other manufacturers, by way of example a list is given below of Caterpillar equipment, since this company has a world-wide distribution and their products and services are available in virtually all European countries.

It should also be noted that some of these machines, particularly the mini-loaders, come with a wide range of tools and additional accessories that may be extremely useful in many maintenance tasks.

Type of machine / model	***Characteristics***
Mini excavator 301.5	*17HP, Reach/depth 2.33 m, maximum width 2.30 m*
Mini loader 226	*54 HP, Capacity 0.36 m³, maximum width 1.67 m*
Mini loader 236	*59 HP, Capacity 0.44 m³, maximum width 1.82 m*
Mini dumper 150 DGX4	*Capacity 1200 kg, maximum width 1.19 m*

Dumpers have been used locally for some years; the one used at Corredor da Cobra has had its axle width modified to enable it to manoeuvre on the silha (1.70 m wide). Experience with this machine has demonstrated the great utility of such equipment.

Figure 29 - Using a dumper to remove sediment

Another important question in mechanisation is the type of fuel to be used since using polluting machinery could compromise future certification. However, since the machines mentioned use diesel, they can easily be adapted to run on LPG.

I - Construction of pumps

These were built by local carpenters, closely following the design and construction method of those that existed in the saltworks, a design which is moreover common to the whole of the Figueira da Foz salt-marsh.

J - Installation of pumps and reconstruction of pipework

The pumps were installed by saltworkers and the *poços* (the 'wells' from which the water is to be pumped) were cleaned and relined with wood. In previous times the water was channelled through a square-section pipe made of wood, but this was replaced by 5-inch PVC piping. The angle at which the pipe is to be positioned is arrived at by trial and error, the saltworkers running water through the pipe and adjusting the angle until an appropriatee flow is achieved.

Figure 30 - Rebuilding the *poço* for a pump

K - Construction of a new sluice

The new sluice was built by local carpenters, using the techniques common to the whole Figueira da Foz salt-marsh.

L - Rebuilding the warehouse

The state of conservation of the timbers and roof was such that they were not reusable. It was therefore dismantled, with detailed drawings being made of the joints and other technical aspects so that the new structure would have exactly the same characteristics as the old one. The type of wood chosen was the same as the original structure, maritime pine (*Pinus pinaster*) from the pinewoods on the region's dunes. As in the past, the builder picked out trees in the woods of an appropriate size and shape for specific elements in the construction, particularly the roof support beams and the upper fixings of the corners. Certain details that had fallen into disuse, for example wooden locks, were reintroduced.

Figure 31 - Constructing the warehouse, still at the carpentry stage

Figure 32 - The new warehouse

Figure 33 - The warehouse locker

6. CONCLUSIONS

From the experience gained, particularly in restoring *Corredor da Cobra*, it can be concluded that the process of restoration is lengthy and expensive. Any project to restore traditional saltworks must therefore consider certain basic factors that could prove crucial for the success of the enterprise, in particular:

Assembling multi-disciplinary work teams - While there should be relatively small operational committees, any intervention must bring together different political and social agents and actors, whose task will be to define the content of the work areas and to function as the project's monitoring body.

Careful selection of areas to be restored - Saltworks whose structures are seriously degraded, or that are subject to a high degree of erosion, pose additional problems. Their system of operation may not be entirely clear, since certain elements of their structure may have disappeared; furthermore, erosion is a complex phenomenon, and is frequently a recurrent problem that requires constant remedial action, which in some cases may make it impossible to resolve.

Selection of personnel involved in the restoration - Technical problems frequently arise during the restoration process, and these can only be solved by people with a thorough knowledge of the local techniques, since some processes require on-the-spot modification (diverting the water flow, altering the original layout, and so on).

Figure 34 - Temporary circulation system

Programming of works - For technical, financial and environmental reasons a rigorous programme of works is required. It seems to us important that the programme of works, while dependent on the size of the saltworks and local technology, should aim from the outset for a rapid return to salt production, even if only in a small

area. Such a measure will immediately enable a series of situations to be assessed and taken into account in restoring the whole of the saltworks.

Use of machinery - There is a range of machines designed for small-scale tasks currently available on the market (for purchase or hire) that are highly suitable for restoration and maintenance work in saltworks.

Construction of primary sedimentation tanks in *viveiros* - At sites where there is a large influx of sediment, these tanks could be useful by delaying silting up of the *viveiros*, since cleaning them out is a major task.

Finally, it should be stressed that restoration only makes sense with a view to the production and commercialisation of the product. While not calling into question the artisanal methods which give this salt its special character - a difference which will need to be appreciated and accepted by consumers through promotion campaigns - factors related to its transport from the saltworks to packing plants, and the size of the latter in terms of individual producers or cooperatives and associations of producers, must also be taken into consideration from the outset. Further information on technical solutions for specific cases can be obtained at www.serramachinery.com, the website of the Serra Salt Machinery company, the market leaders in equipment for saltworks, whose working methods include a preliminary plan that analyses needs, costs and financing options.

7. ACKNOWLEDGEMENTS

This study would not have been possible without the cooperation of the saltworkers of Figueira da Foz, particularly Manuel Oliveira and José Rolinho who were the main workers involved in the restoration of *Corredor da Cobra*. Special thanks are also extended to Carlos Mendes, member of the current board of directors of *FozSal* (the local salt-producers association), for his ready availability to answer queries. Finally, our thanks to Hjalmar Dahm for all his assistance and helpful criticism.

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