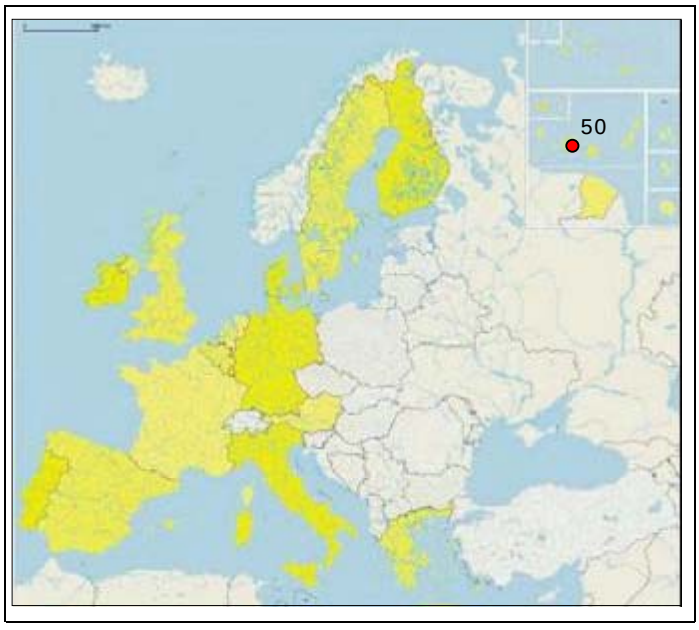
EL MEDANO
CANARY ISLANDS
(SPAIN)



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1. GENERAL DESCRIPTION OF THE AREA

The Montaña Roja Special Nature Reserve (Canary Island Natural Areas Act 12/1994, 19 December) is found in the municipality of Granadilla de Abona and has a surface area of about 166ha. The Nature Reserve extends 3km along the coast in the southern part of the island Tenerife.

The Nature Reserve is named after the volcanic cone (Montana Roja) which is found in the Reservation. Leocadio Machado beach is situated on the eastern flank of the reserved area whilst the southern boundary marked by low water mark as far as to the eastern end of La Tejita beach.The Nature reserve is 75m inland from the coast and with flat land in the northern flank running from El Médano to Los Abrigos.

Fig. 1: Position of the study area.

1.1. Physical processes

1.1.1 Classification

- GENERAL: barrier island coast
- CORINE: beaches
- Coastal Guide: coastal plain, beach

1.1.2 Geology

The presence of Series III (recent series) pyroclastic basalt rocks, basalt flows of the same series and salic pumice tufa is determined by the volcanic nature of the coastal area. Geomorphologically, Along side the two volcanic cones, Montaña Roja (171m) and Montaña Bocinegro (36m), various types of sand formations are found. Sandy beaches are situated on both sides of Montaña Roja (Leocadio Machado beach and La Tejita beach – see Figures 2 and 3). Fossilised dunes situated in a wider area at the eastern and south-eastern base of Montaña Roja. The dunes or sand banks are currently threatened by human activity.

Fig. 2: Leocadio Machado beach and El Médano town.

On average 36% of the 5km coastline (including the area unaffected by the protection regime) is made up of beaches of wind-blown sand, largely consisting of pumice material, black basalt, grey trachyte and, to a lesser degree, magnetite (see Geological map of the zone in Figure 4). These sandy ecosystems are formed due to pyroclastic flows from the two volcanic cones at both ends.

Fig. 3: Montaña Roja mountain and La Tejita beach.

Fig. 4: Geological Map (Garcia et al., 1996).

1.1.3 Morphology

The front of Montaña Roja forms a sloping coastline, with a rocky base, flanked on both sides by sandy pocket beaches (see Figure 5).

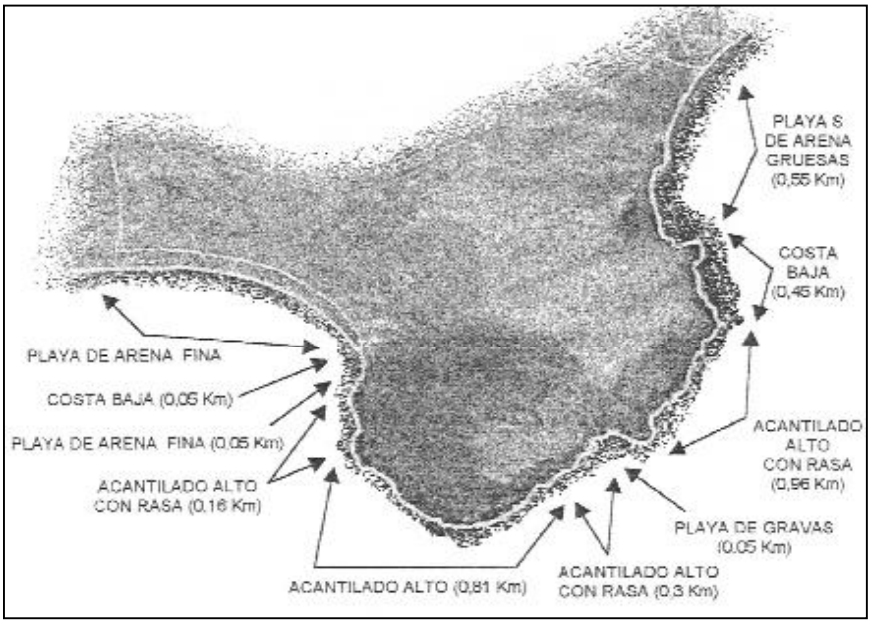

Fig. 5: Coastal typology (Cruz, 1998).

1.1.4 Physical processes

Climatology

According to Köppen's classification for the Canary Islands, this area has a warm desert climate, with dry summers. The dominant characteristics of the area are, basically: (a) regular temperature, (b) high atmospheric humidity and, (c) scarce rainfall. The intense sunshine and evaporation makes the precipitation 10 times higher than under the normal situation. The average annual temperature is about 21ºC, with average annual rainfall of 132.5mm, an average 33.3 days of rain a year and relative annual humidity averaging 65%.

Winds

The trade winds constantly blow from NNE and along the coast with a frequency of around 22% in summer and 25-30% in winter. The winds are strongly felt on the northern side of Montaña Roja, but less so on La Tejita beach because of the protective effect of the mountain.

Coastal dynamics

The study area is on the south-eastern coast of the Island of Tenerife, with an E-SE orientation. The predominant wind and wave direction is NE, with storms from the third quadrant. Net transport is towards the south (Figure 6).

The pyroclastic volcanic gravel has the quality of retaining wind-blown sand without the need for constructing obstacles. These barriers have retained sea and wind-borne sand, forming beaches of fine sand and gravel and sloping dunes (fossil and recent) with halo-psammophytic vegetation.

The sediments originate from the north on the salic pumice coast, on the beaches of Callaos and on Montaña Pelada. In the protected area, the erosion of the compacted sand is found due to the uncovering during the mineral extraction carried out in the 60s.

The active sediment drains are on Tejita beach, where the wind-blown sand goes into the sea and is deposited on the bottom inshore or transported further to the south, into deeper water. The beaches, current and fossil dunes, can be considered as seasonal drains.

The high percentage of carbonate in the sand or “jable” (a term that in this case refers to light-coloured, and less compacted sand that has a high calcium content) has a marine origin. The coralline, free seaweed that developed on the shallow sea beds in the past, are eroded and transported to the beaches and the slopes of Montaña Roja by the prevailing dynamic.

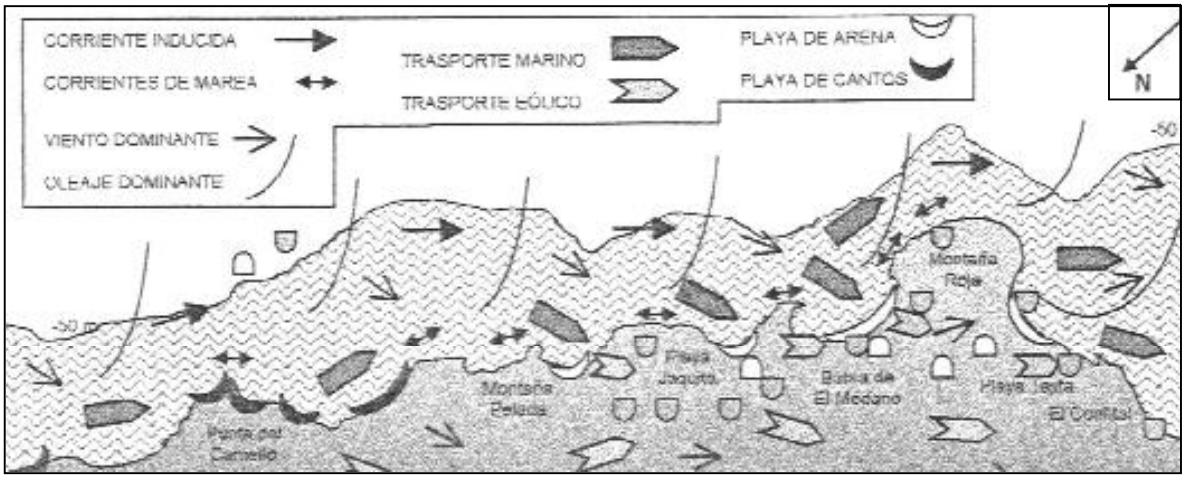

Fig. 6: Sedimentary Dynamics (Cruz, 1998).

1.2. Socio-economic aspects

1.2.1 Population rate

Granadilla is the most important urban centre in the area. The municipal population data for 1996 shows 18,508 inhabitants.

1.2.2 Major functions of the coastal zone

- **Tourism:** this forms the main activity around the reserve. The beaches of Montaña Roja – Leocadio Machado beach and La Tejita beach are visited frequently by the local population and people from outside the municipality. The unusual landscape and its ecological and environmental values lead to the gradually increasing presence of tourists. Windsurfing conditions provided by continuous buffeting NE trade winds, especially on Leocadio Machado beach attracts lots of surfers. In addition, the extensive network of paths criss-crosses the coastal area is a strong attraction for visitors, given the variety of walking routes they can choose culminating on the tops of both volcanic cones.

Fig. 7: Leocadio Machado beach. Down it sets El Médano town, important zone for tourism.

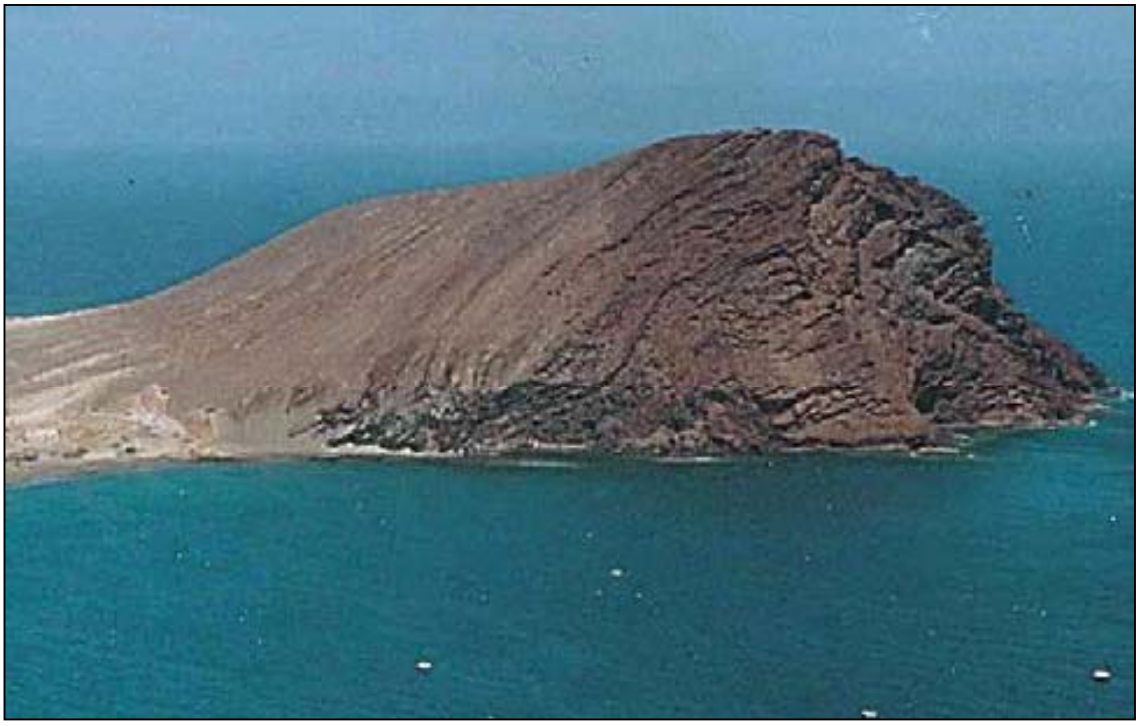

Fig. 8: Montaña Roja mountain.

Fig. 9: La Tejita beach.

- **Agriculture and Farming:** These two activities have been forbidden by Montaña Roja Management Plan and the provisions of the Canary Island Natural Areas Act 12/1994. This is because of their devastating impact on the environment Even though these activities played an important role in the area's economy in the past,the introduction of tomato-growing in the 1940s, led to the breaking up of part of the soil on the northern part of Montaña Roja and the northern flank of La Tejita beach. Livestock rearing activity involved pasture, largely of goats and sheep, since pre-Hispanic times. This activity continued down to the 20th century, when it prove to have severe impact on the northern base of Montaña Roja.

- **Fishing:** although officially with a marginal economic impact, fishing forms part of tourism in El Médano and is largely characterised by spot fishing including rod fishing in the rocky area of Las Puntitas and Montaña del Bocinegro. However, nocturnal shellfish gathering has been observed as well as the capture of small and medium-sized species using illegal methods.

- **Extraction industry:** Exploitation of the pans and quarries (mineral resources) for sand has practically disappeared in the area around the Montaña Roja Special Nature Reserve. This activity has had a notable effect on the geomorphological and landscape transformation of this natural area. Heavy sand extraction in the period 1964-1977, gave an estimated volume of 200,000m^3, largely destined for the many public and private construction works.

1.2.3 Land use

Given the protection regime regulated the study area, land use is affected by the provisions of the Canary Island Natural Areas Act 12/1994, 19 December and, in accordance with its Article 34.1, by the provisions of the corresponding management plans.

Land use is regulated in three different categories:

- **Use Permitted:** which basically refers to all uses compatible with the protection regime.
- **Use Prohibited***:* Uses including all kinds of private construction that are that are not scientific and do not respect the landscape and environmental values of the area. Prohibited uses also include all kinds of extraction, especially of sand and dry materials; livestock rearing and agriculture in any form, among others.
- **Use with Authorisation***:* this is limited to the establishment of infrastructure in the public interest.

2. PROBLEM DESCRIPTION

2.1.1 Impact factors

Crops

Channels constructed during the tomato growing period are now dilapidated and eroded and can be seen in the fields at Roja and Tejita.

Pasture

In the period of the aborigines small plant species grew on the hill slopes after every rainy season. These species are largely “corazoncillo” (lotus sessilifolius) and they often covered wider areas. The elimination of this incipient vegetation due to pasture has retarded the natural processes of evolution of the ecosystem since then.

Sand extraction

Sand extraction in the 1960s from the eastern side of El Médano and La Tejita beach caused a greater environmental impact including the disappearance of the vegetation and the soil leaving pumice rocks and compacted dunes uncovered.

Landing strip

The construction of the runway in the 1940s (during the tomato plantation period) in Tejita area created landing facilities supported by landing strip on the Roja plain. The construction of the airstrip has caused the removal of fields with sand dunes.

2.1.2 Current impacts

Indiscriminate uses

User pressure on the area has increased since the 1960s, Largenumber of cars causing the unregulated construction of tracks. In addition, the uncontrolled number of walkers and hikers has caused land erosion visible as narrow cavities. Secondly, the absence of management controlin the period of clandestine mineral extraction in the area and the dumping of junk and rubbish has resulted into erosion at La Tejita and in the eastern part of the area.

Impacts derived from use of the seashore is evident and includes collecting shellfish, fishing, collecting) beach franchises (deck chairs, parasols), and the cleaning of the beaches of La Bahía and El Médano, with accumulations at the end of the beach.

Pollution

The geological structure and texture of the substrate as an obstacle to sea and wind transport leads to the floatation and accumulation of rubbish effluent from El Médano. The risk of fuel spills in the sea inlet at La Tejita beach and the impact generated by boat traffic and industrial activities with spillages at sea, are brought in towards La Bahía. and in the west because of the effect of the dominant winds and sea currents.

3. SOLUTIONS / MEASURES

3.1. Policy options

The initiatives to protect the natural area can be dated back to 1982, with the inclusion of Montaña Roja in the "*Special Plan for the Protection and Cataloguing of Protected Natural Areas*" (PEPCEN).

The protection activities increased notably in 1987, with the approval of the "*Declaration of Canary Island Natural Areas Act 12/1987"*

Currently the regime has been reclassified as a Special Nature Reserve with the coming into force of the "*Canary Island Natural Areas Act 12/1994, 19 December".*

In Article 34, of the "*Canary Island Natural Areas Act 12/1994* Act, it is laid down that a planning and management instrument for the Special Nature Reserve must be drawn up in the form of a management plan.

The annual publication of the management plan includes a series of actions structured as a five-year plan and directed towards protecting, restoring and conserving the Montaña Roja Special Nature Reserve, whose financial report includes an estimate of the financial cost of the specific activities considered to have impact on the budget.

The strategy followed in the management plan goes for minimum intervention, leaving the natural processes of the area to self-regeneration from specific while at the same time reducing the pressure on the environment using the legal regime it is provided with.

Programmes included in the management plan

The development of the management plan for the Montaña Roja special natural area includes basic research as the first step towards the recovery of the area. There is a double objective: on one hand making an inventory of the ecosystem's natural resources and discovering its dynamics. On the other, avoiding the development of recovery activities that might generate unwanted impacts and harmonising and adapting investment to the specific criteria determined by the diagnosis for the area.

Study and research programme

Aimed at gaining an in-depth knowledge of this natural area and establishing a diagnosis enabling the precise identification of the factors affecting its regeneration and conservation.

Environmental restoration programme

This programme covers two specific aims: reducing the impact on the landscape caused by human activity and occupation and beginning the ecological restoration of the area favouring the regeneration of potential vegetation.

- Landscape Restoration

This attempts to improve the quality of the reserve's landscape by restoring areas of land affected by mineral extraction or uncontrolled tracks, eliminating existing infrastructures generating this kind of impact and rehabilitating constructions that might form part of the public use of the reserve.

- Ecological restoration

Aimed at restoring the Roja plain and the eastern base of Montaña Roja from its northern flank to the side that links with the base of Bocinegro mountain, encouraging the dune formation process and the gradual establishment of potential plants and animals.

Wildlife action programme

This includes the complete prohibition of any kinds of activity in the area, studies the impact caused by the introduction of foreign and domestic species, prevents access to bird nesting areas and controls and promotes an appropriate use of pesticides in the farms surrounding the area.

Monitoring programme

The programme affects both bird populations, with special reference to those linked to the dunes and marine habitats, and the monitoring of plant formations, with special reference to those linked to the dunes (psammophytic).

Secondly, it also includes a monitoring and evaluation plan for management actions as well as for the coastal dynamics of sand (dunes and sand banks), the levels of pollution on the coastal strip and the impact of users in relation to the information/interpretation programmes to be developed.

Public use programme

This is intended to organise cultural, education and recreational activities that can be carried on in the reserve, laying down which ones are compatible with protecting the natural resources and with its own protection objectives.

This programme identifies priority actions in relation to the infrastructures that the area has to support in order to facilitate and promote proper use of it by users and visitors.

Among the measures included, the following should be mentioned because of their effect on the conservation of the natural area: the signalling of routes with the aim of regulating passage through areas of restricted use and channelling and controlling the educational and recreational use; the installation of access control points and landscape viewpoints; the equipping of service areas to meet public needs, and a programme of nature information and interpretation based on the use of various publications and the signing of the footpath network.

3.2 History of the restoration

In 1991, in the context of a course at the College/Workshop for Recovering Coastal Areas of El Cabezo (El Médano), the possibility was suggesting of carrying out a dune regeneration experiment.

The idea consisted of placing surpluses of various types of materials including marine material – seaweed, sea grasses – ripped up by the currents and wave action and which tend to be deposited on the sea shore on the bare areas on the eastern side of the natural area.

The material was covered with sand, in the hope that it would serve both to gradually retain more sand and for the germination on the organic material of vegetation that would allow the newly built up dune to become fixed.

Although the rainfall system was not very generous, making plant germination difficult, from the beginning of the experiment to the drawing up and carrying out of the Pilot Study (1997) it could be determined that sand was retained and that some plant species, like the "uvilla de mar" (Zygophyllum fontanesii), whose seeds are very tolerant of salt water, did develop.

In 1995 another experiment was begun also aimed at recovering eroded soil. In this case, it was decided to have small obstacles in a completely bare exposed area. This experiment was carried out scattering of $2m^3$ of volcanic gravel of the same material as part of the eastern slope of Bocinegro mountain. The experiment is based on the volcanic gravel's capacity to retain sand, on which plants germinate, beginning the process of soil regeneration and dune formation.

Both experiments enabled the development of new initiatives, among which the Pilot Regeneration Study is most important.

Pilot regeneration study

This study began in 1997 and is included in the initiative for carrying out basic research included in the development of the management plan for the Montaña Roja Special Nature Reserve as a first step towards the recovery of the area.

The aim is to overcome the situation of ignorance applying to the Canary Island dune ecosystems in order to produce scientific and expert information to support decision-making on action for recovery, and the financial provision for it.

The specific aim of the study was to attempt various methods of dune field recovery and landscape correction on sample plots representing the problems in the area and to monitor their development. This was an attempt to lay the foundations for future action to recover the landscape.

Action for recovery

The pilot study covered an area including the eastern sector of Montaña Roja, specifically El Bocinegro, the eastern slope and the Roja plain.

The action area includes 12,770m^2 and is divided into three types of intervention: 1) removing open tracks crossing the land on two limited plots, 2) regenerating soil by means of depositing volcanic gravel, plant material and mounds, which was carried out on eight plots structured in 10x10m squares, 3) recovering the appearance of the landscape on two large plots through treating the soil in two of the areas most degraded by mineral extraction. The colour contrast was corrected with the provision of material with similar characteristics to the surroundings (basically volcanic gravel).

Soil regeneration

This is based on the 1995 experiment, consisting of having small obstacles in a bare area. Basically, volcanic gravel was used, together with other materials.

Dune regeneration

A method based on the natural and unusual qualities of the dune landscape, created by native vegetation was used, as well as the genetic material available for regenerating these communities. These actions were based on the artificial creation of mounds of sand that contained organic material to fix the dune and provide it with vegetation.

Fig. 10: Field of regenerated dunes.

Fig. 11: Detail of a regenerated dune.

3.3 Financial aspects

The cost of the recovery programmes already carried out amounts to €123,207.48, with the following breakdown:

- Scientific management of the work: €15,025.30
- Mobilising means and materials: €108,182.18

A recovery programme with an approximate cost of €600,000.00 is currently awaiting approval. However, the management plan includes a “financial document” including a financial estimate of the specific action covered by it, with the aim of securing financial provision.

This financial document reveals the economic environment in which the management plan operates. It has a five-year period and includes the monitoring, evaluation and adjustment of the finance programme in relation to the effectiveness of the action taken.

These financial data are subject to variations that might be experienced concerning dates of carrying out work, taking into account that the management plan is currently at its approval phase.

Table 1: Estimated Expenditure (Euros).

ACTIONS	INVESTMENT		CURRENT EXPENDITURE		TOTAL EUROS
	REAL	INTANGIBLE	STAFF	OTHER	
ENVIRONMENTAL RESTORATION		500,438.74			500,438.74
WILDLIFE ACTION		8,348.06			8,348.06
MONITORING PROGRAMME				48,080.97	48,080.97
INFORMATION STUDIES		81,244.82			81,244.82
INFRASTRUCTURE AND PUBLIC USE	64,067.89				64,067.89
ADMINISTRATIVE MANAGEMENT			12,020.24		12,020.24
	64,067.89	590,031.62	12,020.24	48,080.97	714,200.72

4. EFFECTS AND LESSONS LEARNT

4.1. Effects in the Pilot Study

The monitoring and evaluation reports from the pilot study allow us to draw a series of conclusions on the impact of the action:

The physical environmental processes have acted as catalysts for the expected effects of the action for recovery, especially the climatic ones, as during the monitoring period (1997-1999) the study area twice underwent a severe drought which impeded plant and dune development, bearing witness to the sedimentary stability of the pilot plots.

- The retention and accumulation of sand has stabilised, above all on the smaller obstacles. The basic explanation points to the height, aggregation and extent of the obstacles, which are smaller in the plots.

- The quantity of sand accumulated depends on the location of the plot, with some areas having a greater flow of sand and some less.

- The germinated vegetation was lost because of lack of rain and moisture in the environment and soil.

- The restoration project has led to positive effects, in accordance with the aims of the intervention. However, there are also less positive effects deriving from ignorance and consequent lack of criteria for this action on the ground.

4.2. Conclusions

The study area is one more example of the need for direct intervention by public authorities in the common effort to recover, protect and conserve natural areas. The importance of this intervention is determined both by legal aspects affecting the protection of the area and planning for its recovery and conservation, and by the scientific and technical complexity surrounding any kind of action in sensitive natural areas undergoing direct human pressure.

So, the management plan is a basic instrument for the future of the natural area, both from the point of view of preserving its natural values and concerning the uses to which it can be put by the population and its users.

The strategy of subordinating any intervention to the evaluation of the capacity of the natural environment to regenerate itself more than justifies the initial cost borne by the pilot study, as it has enabled a series of important conclusions to be drawn with a view to carrying out future actions.

The aim sought in the environmental planning and management of the area correlates with the criteria of sustainability. The erosion and degradation of the soil through the effects of occupation and indiscriminate use by human beings limits in a determining way the future economic, educational and social benefits that can be drawn from the land. So, it is a question of returning the land to its condition as a support for life, correcting the physical impacts of human activity and restoring the balance between the various beings that use its resources, including human beings.

5. REFERENCES

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