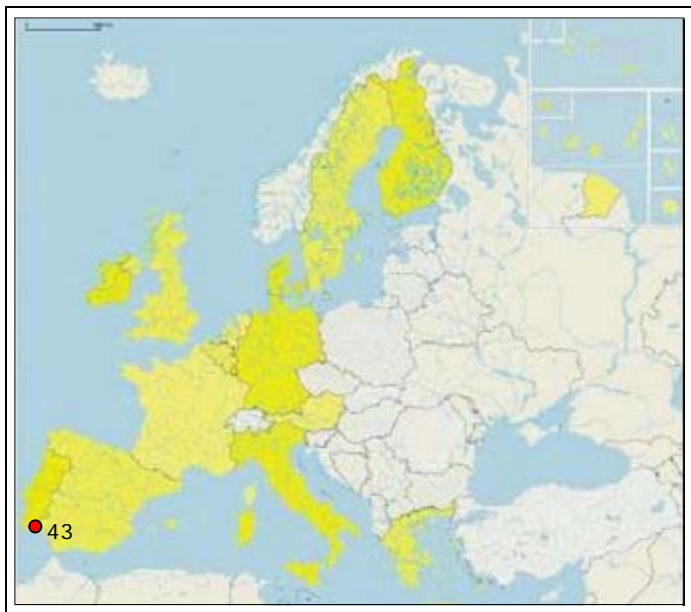


VALE DO LOBO (PORTUGAL)



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1. GENERAL DESCRIPTION OF THE AREA

Vale do Lobo beach is located on the South Portuguese Coast in Quarteira - municipality of Loulé, between Albufeira and Faro, about 5 km East from Vilamoura, Figure 1.



Fig. 1: Vale do Lobo location.

1.1 Physical Process Level

1.1.1 Classification

Vale do Lobo beach is a high and cliffed beach of about 5 km length, as seen in Figure 2.



*Source: Dragapor – Dragagens de Portugal, S.A.

Fig. 2: Vale do Lobo beach.

1.1.2 Geology

The cliffs of Vale do Lobo beach are almost vertical formations of red sands of the plio-plistoceno, Figure 3.



*Source: Dragapor – Dragagens de Portugal, S.A.

Fig. 3: Red sand cliffs.

1.1.3 Morphology

This shoreline stretch is characterized by a set of high cliffs made of small cohesion and very fractured formations, with a narrow subjacent beach.

The base of the cliffs is often hit by the wave breaking especially during winter. The subjacent beach width is the main factor of which depends the evolution of the cliffs, as it is the main protection against wave breaking directly on the cliffs.

1.1.4 Physical processes

Along the South Portuguese coast the sea currents generated by the wind or the tides are negligible in relation to the drift currents generated by the waves. Even so, the wave breaking currents are comparatively low in the intervention area, in the range 0.25 to 0.5 m/s. On the downdrift area the wave breaking currents can reach values around 2 m/s. The typical values for tides are the following (INAG, 1997):

Medium level: + 2.00m (HZ)

Spring tides:

- Maximum high tide: + 3.75m (HZ)
- Minimum low tide: + 0.40 m (HZ)
- High tide: + 3.35m (HZ)
- Low tide: + 0.70m (HZ)

Neap tides:

- High tide: + 2.65m (HZ)
- Low tide: + 1.40m (HZ)

The wave climate exhibit the dominant directions are of the W – SW quadrant (~68%) and with low probability around the E – SE quadrant. The wave heights are in approximately 90% of the cases lower than 2 m of which the majority is lower than 1m. Even so with less probability, 5 to 10% the wave heights can reach the 2.5 m to 3.5 m range. The typical wave period is around 5 s, although there are some few cases of periods reaching 13 s and more. The tide and wave values indicate that, in general, this is a mesotidal, wave-dominated coast.

Longshore transport is dominant along the shoreline and is mainly wave induced. The dominant direction is from West to East. The Aeolian transport is negligible.

1.1.5 Erosion

Type

Beyond the decrease on the beaches width, the coastal erosion on this coastal stretch can also be noticed on the cliffs, which are also suffering an important retreat. The following three different processes dominate the cliff evolution of the Quarteira Region (Marques, 1997):

- Superficial erosion due to rain.
- Ravening erosion.
- Landslide movements.

Erosion Causes

Since 1974, as a direct consequence of the construction of the Vilamoura marine and the Quarteira coastal defences, which interrupt the longshore littoral drift, that coastal erosion has significantly increased downdrift (Marques, 1997).

As it can be observed in Figure 4 this erosion have reached Vale do Lobo beach between 1980 and 1983 after the retreat of approximately 30 m between 1976 and 1980 at the New Fort cliff, updrift Vale do Lobo. This erosion have threatened the Vale do Lobo Resort and motivated the construction of coastal defences between 1983/84.

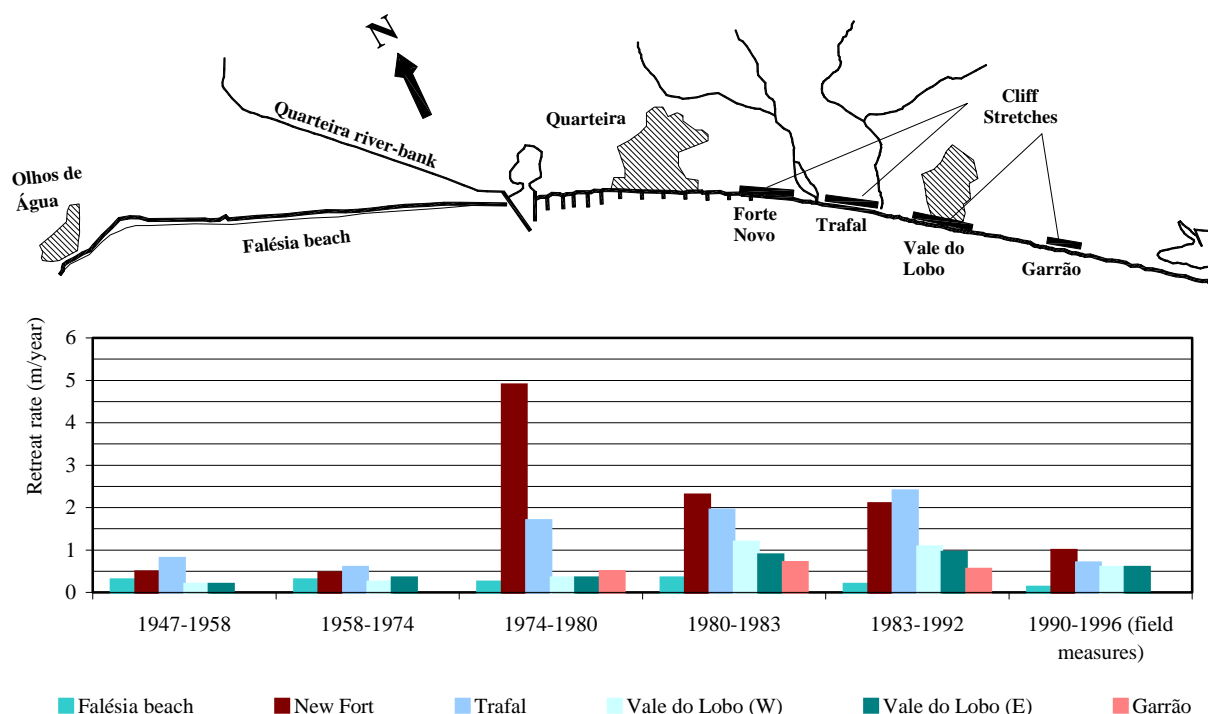


Fig. 4: Retreat rates of the cliffs of the Quarteira Region (adapt. Marques, 1997).

After the intense erosion period of the seventies the retreat rates have diminished to values around 0.6-0.7 m/year (between 1990 and 1996), these values are slightly higher than the ones registered in the fifties and sixties before the construction of the sea works. This fact suggests that the littoral system has reached a situation near the equilibrium, after two decades of changes in depth (Marques, 1997).

Another cause that has been pointed out as being responsible for increasing the vulnerability to erosion of the cliffs is the watering. In particular, golf course watering. Indeed, watering increases the probability of landslide movements to happen.

1.2 Socio-economic aspects

The Portuguese Algarve region, where Vale do Lobo beach is located, is ~6% of the Portuguese total area which corresponds approximately to 5.000 km². Algarve is limited to North by Alentejo region, to East by the Spanish Region of Andalucia and to South and West by the Atlantic Ocean.

1.2.1 Population rate

The Region is characterized by a mild climate with Mediterranean influences; the annual average temperature is 17°C. In addition to the beautiful beaches, the climate is one of the region's charms that serve to attract not only tourism but also people to settle. In fact, since the seventies Algarve is the Portuguese region demographically most attractive. As it can be seen in Table 1 Quarteira has a density population significantly high when compare to the density population of the country and even when compared to the Littoral density population. In 10 years the population of Quarteira has almost duplicate – 10275 inhabitants in 1991 to 18634 actually.

Table 1: Area, resident population and density in Quarteira.

	Area (km ²)	Resident Population (Inhab)	Density (Inhab/km ²)
Quarteira	37.8	18.634	426.2
Littoral	15999.7	3.907.117	244.2
Portugal	92141.5	10.355.824	112.4

*Source: National Statistics Institute (INE), preliminary results of the 2001 Census

1.2.2 Major functions of the coastal zone

Regarding the economy of the region, the main economical sectors of activity are the following:

- **Tourism:** the main “engine” for economical development, dragging the development of other activities such as the commerce and civil construction; it is responsible for 38% of the Regional GAV (Gross Add Value).
- **Agriculture:** there is still the coexistence of traditional practices mainly for subsistence and modern/profitable practices; the agriculture activities are limited by tourism through the competition for labours and land.
- **Fishery:** with an important national role, has been suffering a drop on its output due to technological retard and over exploitation of resources.

In the Loulé Municipality and in Quarteira the employed population structure per sectors in 1991 was the one included on Table 2. In this table one can conclude that the tertiary activities related to tourism are the main source of income. It is expected the evolution in this last 10 years to show a growth on the employed population in tertiary sector and to a diminishing of the employed population on the other economical sectors of activity.

Table 2: Employed population per sectors.

	Primary Sector	Secondary Sector	Tertiary Sector
Quarteira	12.1	17.0	70.8
Loulé	12.6	23.7	63.6

*Source: <http://www.ccr-alg.pt/loufreg.html>

1.2.3 Land use

In what concerns Vale do Lobo it must be noticed that even though it has the same socio-economic characteristics of the region it has also some particularities due to the type of services and facilities offered. In fact, Vale do Lobo is Portugal's biggest luxury golf and beach resort and therefore it has a very specific target. In addition to the high quality of the existent facilities, Vale do Lobo has also to offer the natural beauty of the surrounding environment, especially the pine forests and the beaches.

1.2.4 Assessment of capital at risk

All in all this is a magnificent resort located in a splendid coastal stretch unfortunately very vulnerable to erosion, which means that there is significant capital at risk, Figure 5. Even so the promoters of the resort have been able to take advantage of the cliff erosion through the famous 16th hole in which the players are required to have a great skill to carry out over the two chasms in the stunning cliffs, Figure 6.



Fig. 5: Vale do Lobo beach resort.



Fig. 6: The famous 16th hole.

2. PROBLEM DESCRIPTION

2.1 Eroding sites

The erosion happening in Vale do Lobo is mainly a direct consequence of human activities. The cliff has been retreating further and further threatening people and buildings, Figure 7.



Fig. 7: Examples of eroded areas along Vale do Lobo beach.

2.2 Impacts

The mentioned retreat mainly results of:

- The beach narrowing due to the updrift interception of the littoral sand transport in Quarteira marine and subsequent defence structures.
- The rill and gully erosion after heavy storm episodes.
- Golf course and gardens watering.
- And it can be easily observed all along the shoreline.



3. SOLUTIONS/MEASURES

3.1 Policy Options

This is a tourism area of major importance with a significant built structure that in face of its high vulnerability has to be protected. In this way, the adopted policy option is clearly to Hold the Line and there have been important investments, both public and private, to attain this goal. However it must be noticed that there are some effects that cannot be satisfactorily dominated and it is therefore essential to plan adequately the human occupation of this area and to considerer the human settlement more inland.

3.2 Strategy

The engineering option for the coastal defence of Vale do Lobo beach is essentially soft, complemented, in short extensions, with hard measures. The strategy is to maintain as much as possible the natural aspect and width of the beaches and cliffs, one of the most valuable aspects of the region, even though it inevitable the need for coastal protection. The maintenance of the beach width will avoid a more direct action on the cliffs.

3.3 Technical measures

3.3.1 Type

The aim of the project "Artificial Sand Nourishment of Vale do Lobo beach – Algarve 97" was to stabilize the coastal stretch of Vale do Lobo that has been showing pronounced and in some cases irreversible coastal erosion (INAG, 1997).

3.3.2 Technical details

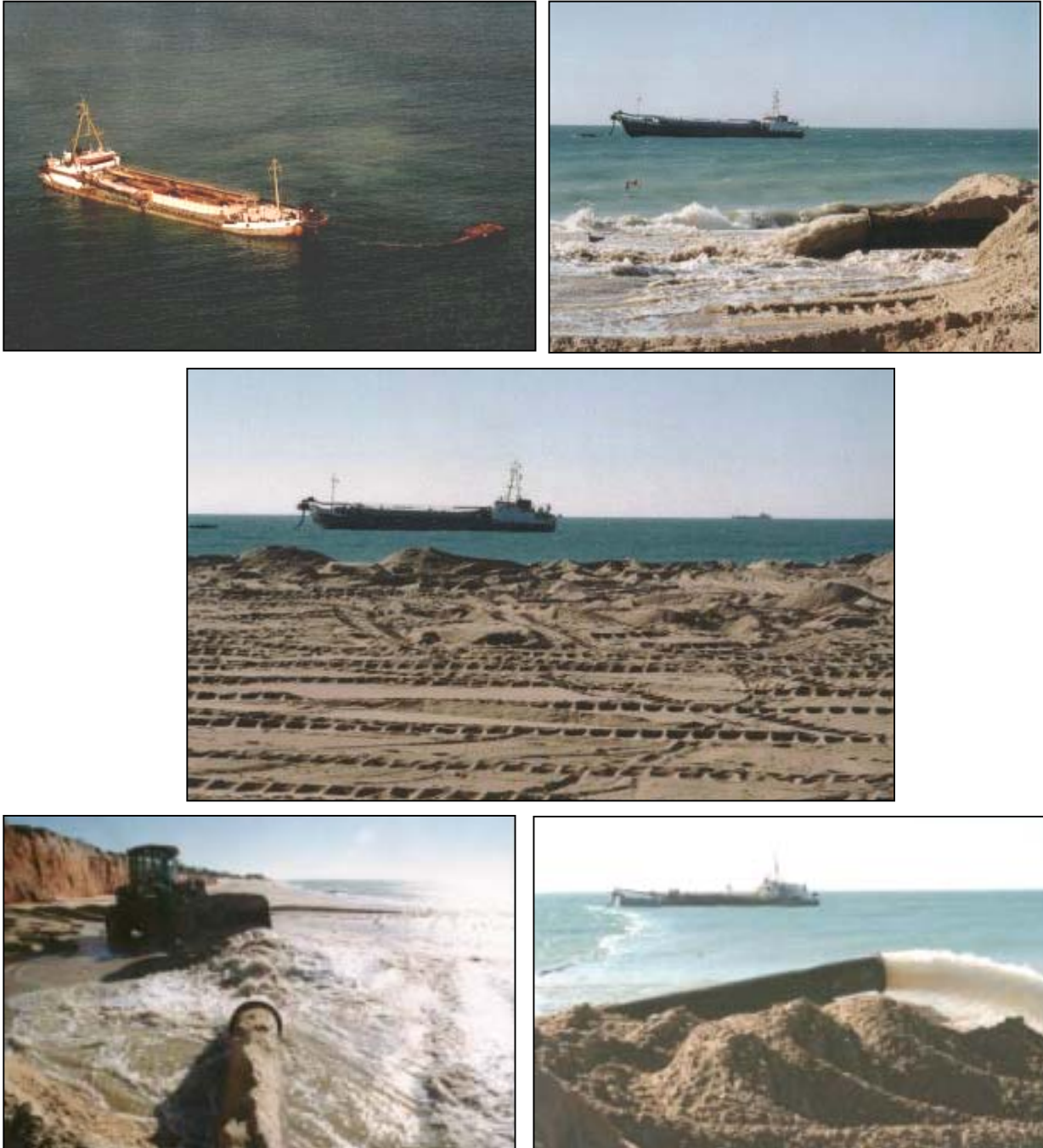
According to INAG, 1997, the main goal of the programmed intervention was to create a "new" beach on Vale do Lobo, 2 or 3 m above the existent level in a extension of 1400 m and a beach width growth of approximately 80 m. The sand needed ($\sim 700.000 \text{ m}^3$) for this operation was obtained by offshore dredging in a predefined zone.

This operation consisted of the dredging of the 700.000 m^3 on the shoreline band frontal to the beach and its repulsion to the beach through a floating pipe so that the designed beach platform could be created, Figure 8. The dredging area was located at the approximately distance of 4 km from the beach and approximately 20 m depth. The dredging equipment was a trailing suction hopper dredger, Figure 9.



*Source: Dragapor – Dragagens de Portugal, S.A.

Fig. 8: Floating pipe.



*Source: Dragapor – Dragagens de Portugal, S.A.

Fig. 9: Dredging operations.

This operation started in October 1998 and has finished on the first week of January 1999, when the desired volumes were reached. Complementarily to the artificial sand nourishment operations, the existent adherent works were reinforced, namely the one protecting the swimming pool. In addition, some rocks were placed on the foot of the cliffs that clearly shown signs of instability. The drainage system was also improved.

3.3.3 Costs

The estimated cost of this operation was evaluated in 1997 on 3.2 M Euro that would partially supported by public and private investments, Figure 10. At the moment, is running a juridical litigious between the society that manages the Vale do Lobo beach resort and the Water Institute.



*Source: Dragapor – Dragagens de Portugal, S.A.

Fig. 10: Advisory placates.



4. EFFECTS AND LESSONS LEARNT

4.1 Effects related to socio-economic aspects

Vale do Lobo beach is suffering from important erosion problems that affects significantly local economy, because of its impacts on tourism and threatens the existent constructions. Indeed, beach thinning contributes significantly to cliff erosion thus contributing to the actual risk situation that several buildings of Vale do Lobo resort are. This is a high densely edified area where most of the existent buildings have high economic value and are located in a shoreline band highly vulnerable to erosion.

4.2 Effects in neighbouring regions

No information available.

4.3 Relation with ICZM

No information available.

4.4 Conclusions

The situation of Vale do Lobo beach is similar to others happening along the entire Portuguese coast. In effect, there is significant capital at risk due to coastal erosion and there is a demand, from the owners of the menaced properties to the government, in which are requested coastal defence measures. However, the motivating interests are mostly private and therefore, on one hand it is unfair that all contributors pay for those works without all profiting but, on the other hand, these works are very expensive, due to the required frequency for sand renourishments, to be only supported by private funds.

4.4.1 Gaps in information

There is no information regarding the actual situation of Vale do Lobo beach since no monitoring has been done after the artificial sand nourishment, finished in January 1999. As previously mentioned, it is running a juridical litigation between the society that manages the Vale do Lobo beach resort and the Water Institute on the volume of sand placed during the artificial sand nourishment operations. Indeed, short time after the finish of the Vale do Lobo beach nourishment the sea has removed a great amount of sand from the beach this causing the resort society to understand that the work was not ready – on the contrary to the Water Institute.

4.4.2 Possible undesirable effects

Believing that the work was not finished since the volume of sand that remain on the beach after that first storm event was less than the one predicted on the project, the managing society of Vale do Lobo beach resort decided to interrupt the payments of its responsibility. The juridical litigation on this matter continues. This way, the planned nourishment reloads and execution of artificial dunes over the nourished beach, which was agreed to be of the

total responsibility of Vale do Lobo beach resort society and would permit the maintenance of a good beach area, were never made.

The long term effect of the artificial sand nourishment of Vale do Lobo beach in terms of stopping the existent erosion can only be reached if new reloads are made periodically. Indeed, the effect of the nourishment operation is temporary and even though they have proven to be effective in the sense of slowing down the process of cliff erosion it is necessary to be aware that this is an exposed area – in open coast – thus the frequency in which new interventions are needed is always going to be a essential aspect to be considered.

4.4.3 Effectiveness

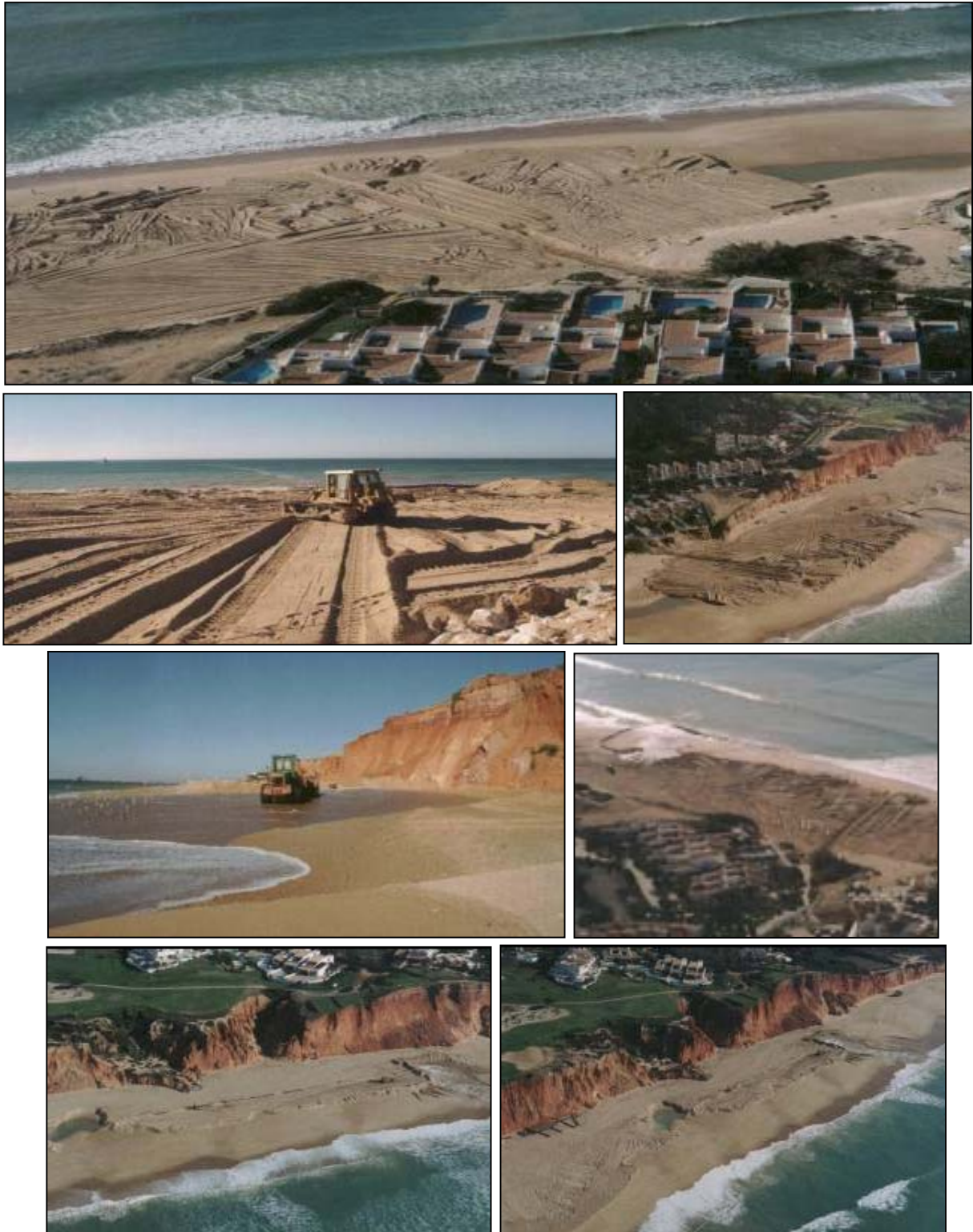
In effect, as proven short time after the nourishment operation in 1999, the high erosive strength of the sea has taken in great part the sand volume placed artificially on the beach. This way, it is expected that, due to the severe wave climate, the need for new reloads will be frequent thus increasing the costs with low efficiency warrant.

Figures 11 to 13 show a sequence of pictures of Vale do Lobo beach before, during and after the operation of artificial sand nourishment.



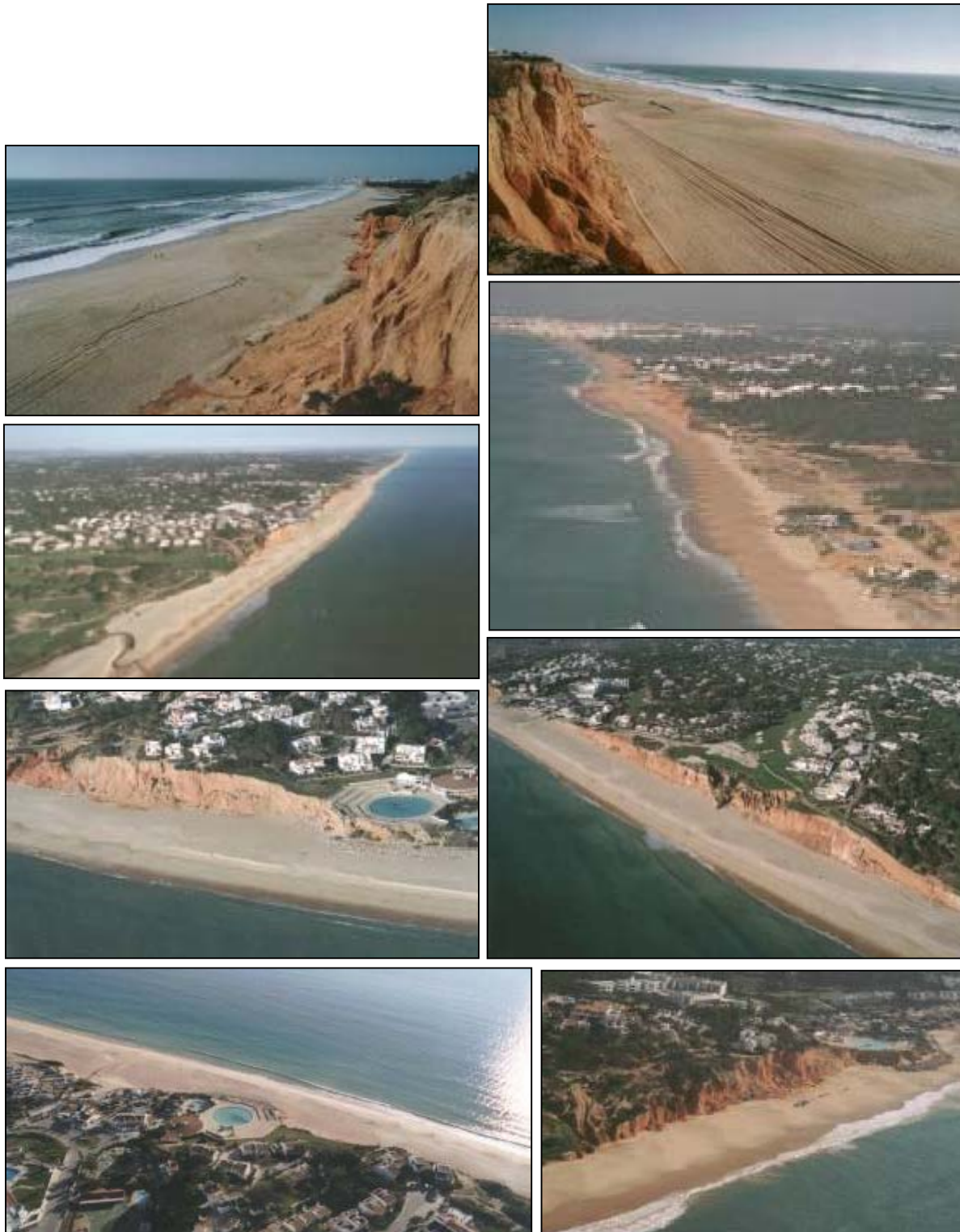
*Source: Dragapor – Dragagens de Portugal, S.A.

Fig. 11: Vale do Lobo beach situation before the artificial sand nourishment operation.



*Source: Dragapor – Dragagens de Portugal, S.A.

Fig. 12: Vale do Lobo beach situation during the artificial sand nourishment operation.



*Source: Dragapor – Dragagens de Portugal, S.A.

Fig. 13: Vale do Lobo beach situation after the artificial sand nourishment operation.



5. REFERENCES

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