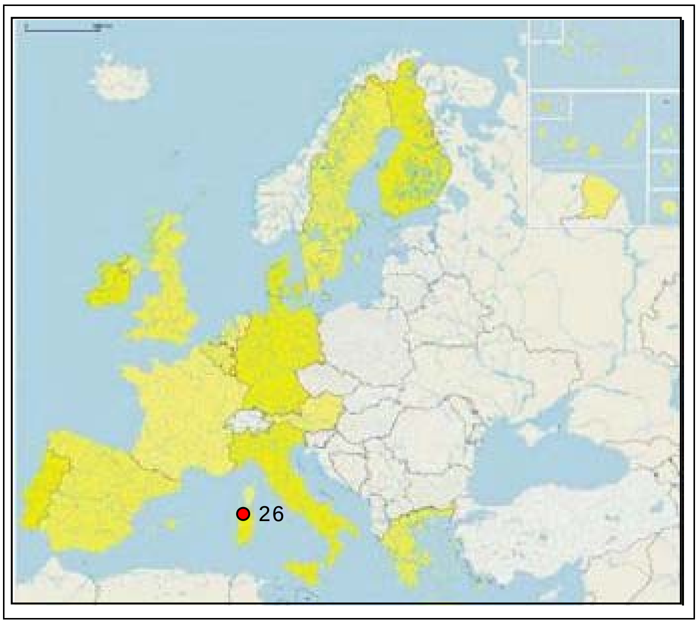
LU LITTARONI-LA LICCIA
ISLE OF SARDINIA
(ITALY)



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1. INTRODUCTION

The coast under study has been subdivided into 5 physiographical units (Fig. 1). The southern area (between *Punta Di Li Francesi* and *Capo di Monti Russu*) is represented by the beaches at *Vignola*, *Lu Tuvunatu* and *Naracu Nieddu - Lu Litarroni*, while in the northern area we find the beaches of *La Colba* and *La Liccia - Rena Majori - Bureddaggia* (between *Capo di Monti Russu* and *Capo Testa*).

Using the anemometric and meteo-marine data collected at the coastal stations of *Asinara* and *Guardia Vecchia* from 1951 to 1970, the sectors of prevailing winds and the effective fetches were determined and a mathematical model for the calculation of the offshore wave (C.E.R.C., 1984) was applied. Finally the annual transport alongshore for each of the above mentioned beaches was calculated.

The winds that give origin to the prevailing waves are those coming from the IV quadrant (Fig. 2). All physiographical units under study present maximum exposure to the winds and waves from west and north-west, except for the beach at *Vignola* (western sector) that is greatly exposed to the winds and waves of the I quadrant, and the beach at *La Colba*, that is more exposed to those of the III quadrant.

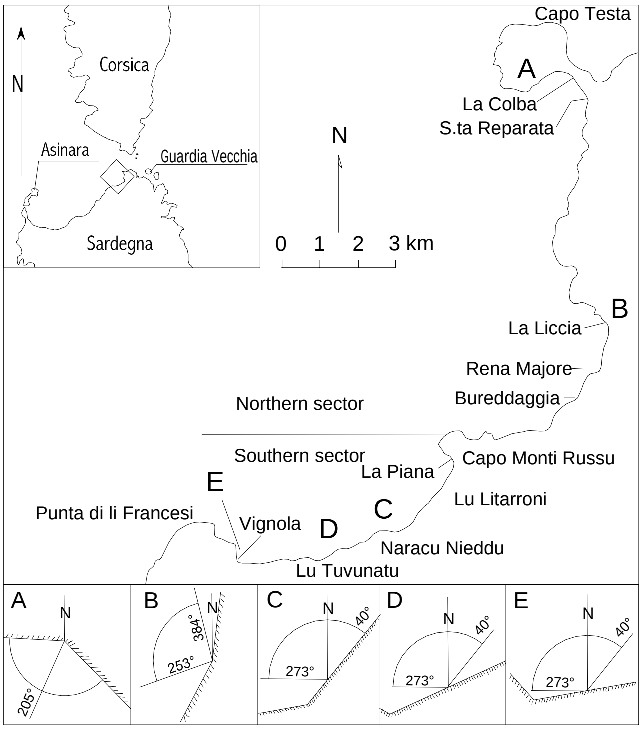
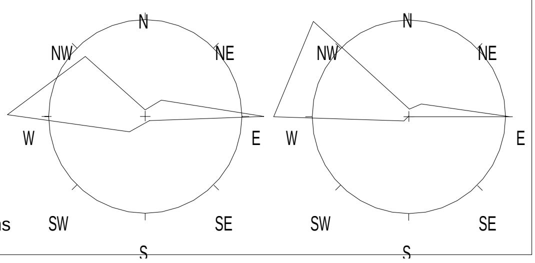


Fig.1: Location of the sites.

Month	Duration (hours)	Conditions of the sea	Direction
Dec./	190	6-7	E
Dec./	110	6-8	W
Feb./	105	6-8	NE
Feb./	100	6-8	NW
Feb./	100	6	NW
Feb./	95	6-8	W
Oct./	90	6-8	E
Oct./	90	6-7	W
Nov./	88	6-8	W
Apr./	82	6	E
Mar./	75	6-8	E
Sept./	75	6	NW
Oct./	75	6-8	W
Oct./	72	6-7	E
May/	70	6-7	NW
Oct./	70	6	E
Nov./	70	6-8	NW
Dec./	68	6-7	NW
May-June/	66	6-8	E
Nov./	66	6-7	NW
Dec./	66	6-7	W

Month	Conditions of the sea	Frequency (days)	Direction
Dec./	8	10	5 E - 1 W - 4 NW
Dec./	8	16	4 NE - 3 W - 9 NW
Feb./	8	11	5 E - 1 WNW - 5 NW
Feb./	8	6	1 NE - 2 E - 1 W - 2 NW
Feb./	8	2	2 NW
Feb./	8	3	3W
Oct./	8	3	3W
Oct./	8	1	W
Nov./	8	2	1 E - 1 W
Apr./	8	14	1 NE - 5 E - 6 W - 2 NW
Mar./	8	11	4 E - 4 W - 43 NW
Sept./	8	10	1 E - 8 W - 1 NW



Direction and provenance of the gales and of the sea-storms

Fig. 2: Wind climate of the zone.

Wave refraction was calculated by the programme REFRCT modified by Brambati (1987) using a 250 x 250 m GRID on 1:25,000 bathymetric paper integrated by recent specially prepared bathymetric profiles. In selecting the initial directions of wave ray propagation, the directions corresponding to the prevailing winds in the study sector were considered.

As far as regards the slopes, the reader is referred to the morphological study on the bar and trough zone (Brambati & DeMuro, 1992). In that study it was pointed out that the morphology of the submerged beaches of north western *Gallura* is strongly affected by the outcropping of the crystalline basement that determines its geomorphological arrangement (through its lode, joints, faults, etc.) its dispersion and transport modalities. In particular, it became necessary to map, by direct diving, areas where the beach morphology was uneven and the refraction strongly affected, for example, by the presence of outcropping beach-rocks that are not mapped in conventional cartography.

1.1 Geographical and geological setting

The physiographic area under examination includes about 22 km of coastline, 10 of which of sandy beach, 5 of low rocky coast and 7 of cliffy coast. The outcropping rocks are those related to the Hercynian cycle, with the typical sequence of intrusive events represented by tonalites, granodiorites and leucogranitic plutons. The lithology varies between biotitic granites and two-mica granites. They show a heterogeneous texture ranging from a facies with large K-feldspar phenocrysts to more femic compositions and microgranites. In the area under study metamorphites also outcrop with gneiss and arteritic migmatites.

The dike and lodes set is made up of granitic porphyries and aplites, rhyolites and diabases with subordinate hydrothermalites, arranged along the late-Hercynian fracture lines defining the morphostructural arrangement of the entire region. The wave-cut (cliff) stretches of coast, oriented according to these lineations are considerably fractured and crossed by tectonic lines perpendicular to the coast, on which processes of linear erosion and deep valleys have evolved. The distribution of the dike set strongly affects coastal morphology by creating natural barriers to longitudinal transport, defining physiographic entities and creating tombolos and isolated rocks. The Paleozoic basement presents outcroppings of Miocene fossiliferous arenaceous-siltstone sediments (Figure 3 Geological Sketch) terraced alluvial deposits, aeolianites and Quaternary shore sediments.

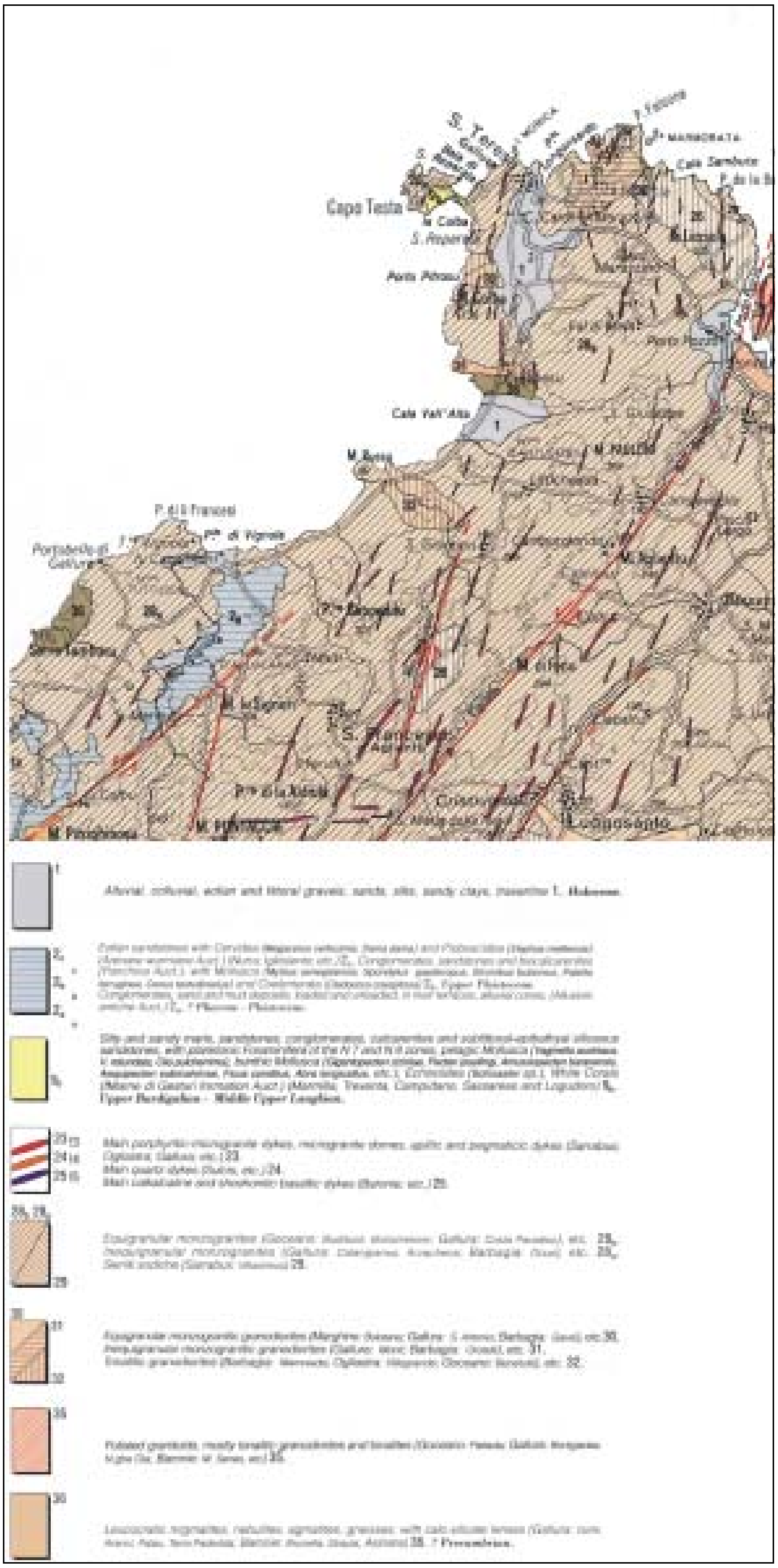


Fig. 3: Geological sketch of the zone.

1.2 Methodology

For the morphological analyses of the bottom, bathymetric profiles were carried out transversally to the shoreline. An echographer model ELAC-LAZ 51 with a frequency of 30 khz and transducer LSE 131 (450 w) was used. The bathymetric profile was recorded at constant velocity (2-3 knots) while the echographic paper was set at maximum scrolling speed. Direct sampling by diving was made on particularly rough morphologies or in parts of the sea bottom that were not documented by bathymetric maps. Particularly at each station a thorough geomorphological-sedimentological survey of the seabed was made by sections, readings of the direction of the ripple marks, photos and sampling of the sediments (Brambati & DeMuro, 1992). In order to determine the sedimentological regimes of the coast, reference was made to the slope of the most dynamical zone of the submerged beach (Brambati & DeMuro, op. cit). It has been shown that the mapped and documented morphologies (DeMuro 1990 - Brambati & DeMuro op. cit.) affect the coast dynamics by determining the type and development of submarine bars. For the above reasons, before carrying out an analysis of the transport alongshore as well as a sedimentological analysis, the geomorphological characteristics of the "dynamic zone of the submerged shore" were studied in detail and the data from the underwater survey and from the most significant underwater stations have been reported (DeMuro and Brambati & DeMuro op. cit.).

1.2.1 Tables for the various directions and periods

In selecting the initial directions of wave ray propagation, the three directions corresponding to the statistically prevailing winds, that give origin to the swell in northern Sardinia and particularly in the sector west of *Capo Testa*, have been considered.

Since the meteorological data attribute periods of 4 to 10 seconds and directions prevalently from west, north-west and north to the waves under study, twelve refraction tables have been prepared (Fig. 4, 5 and 6). The first four report the wave rays from the north for periods of 4, 6, 8 and 10 seconds. The next four refer to the refractions of the rays from west for periods of 4, 6, 8 and 10 seconds. The last tables report the refractions of the wave rays from the west for the four considered periods.

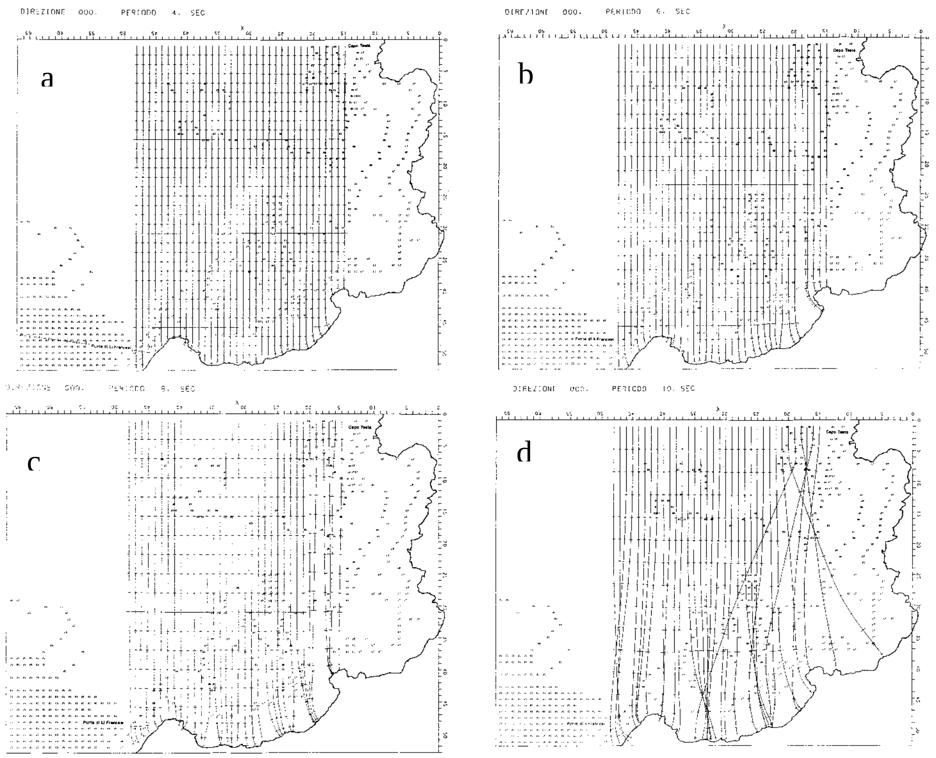


Fig. 4: Table refraction a, b, c, d; direction 000°; a: period 4 sec.; b: 6 sec.; c: 8 sec.; d: 10 sec.

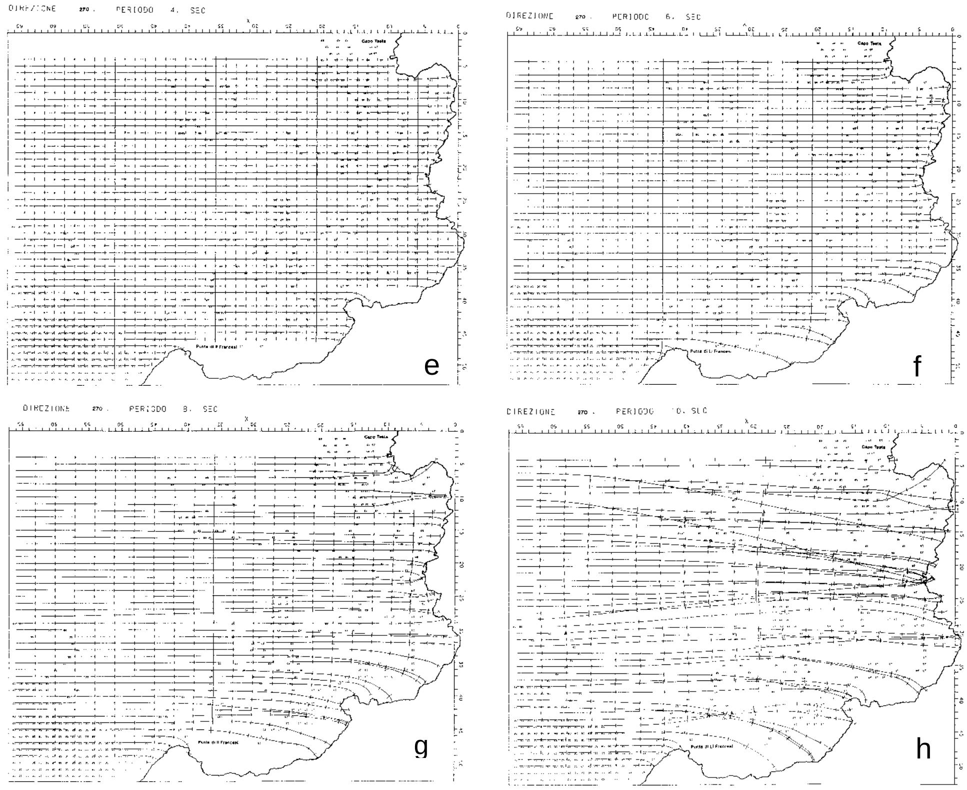


Fig. 5: Table refraction e, f, g, h; direction 270°; e: period 4 sec.; f: 6 sec.; g: 8 sec.; h: 10 sec.

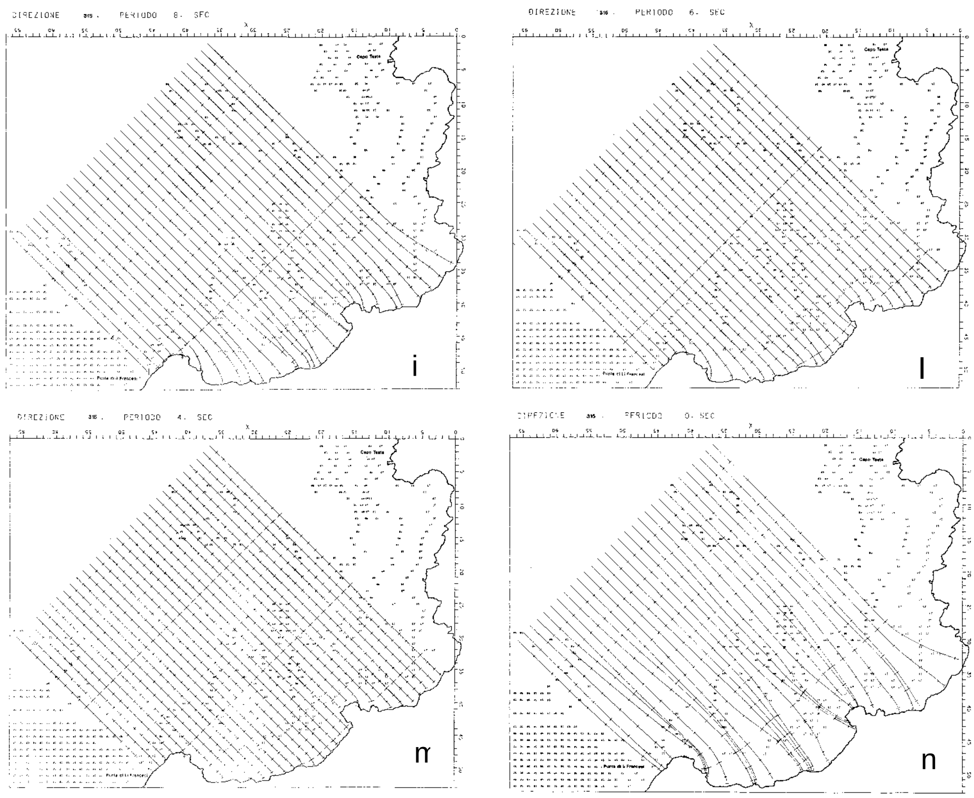


Fig. 6: Table refraction i, l, m, n; direction 315°; i: period 4 sec.; l: 6 sec.; m: 8 sec.; n: 10 sec.

The coastal area under study has been subdivided in 82 cells (Fig. 7) to visualize the energy released by the swell. The reference number of each beach is reported in the bottom left corner of the figure containing the histograms (Fig. 8).

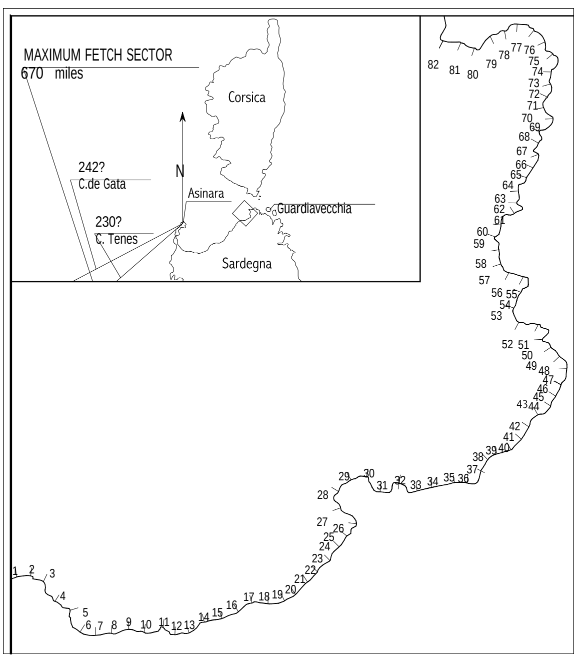


Fig. 7: Subdivision of the coastal study area in 82 cells.

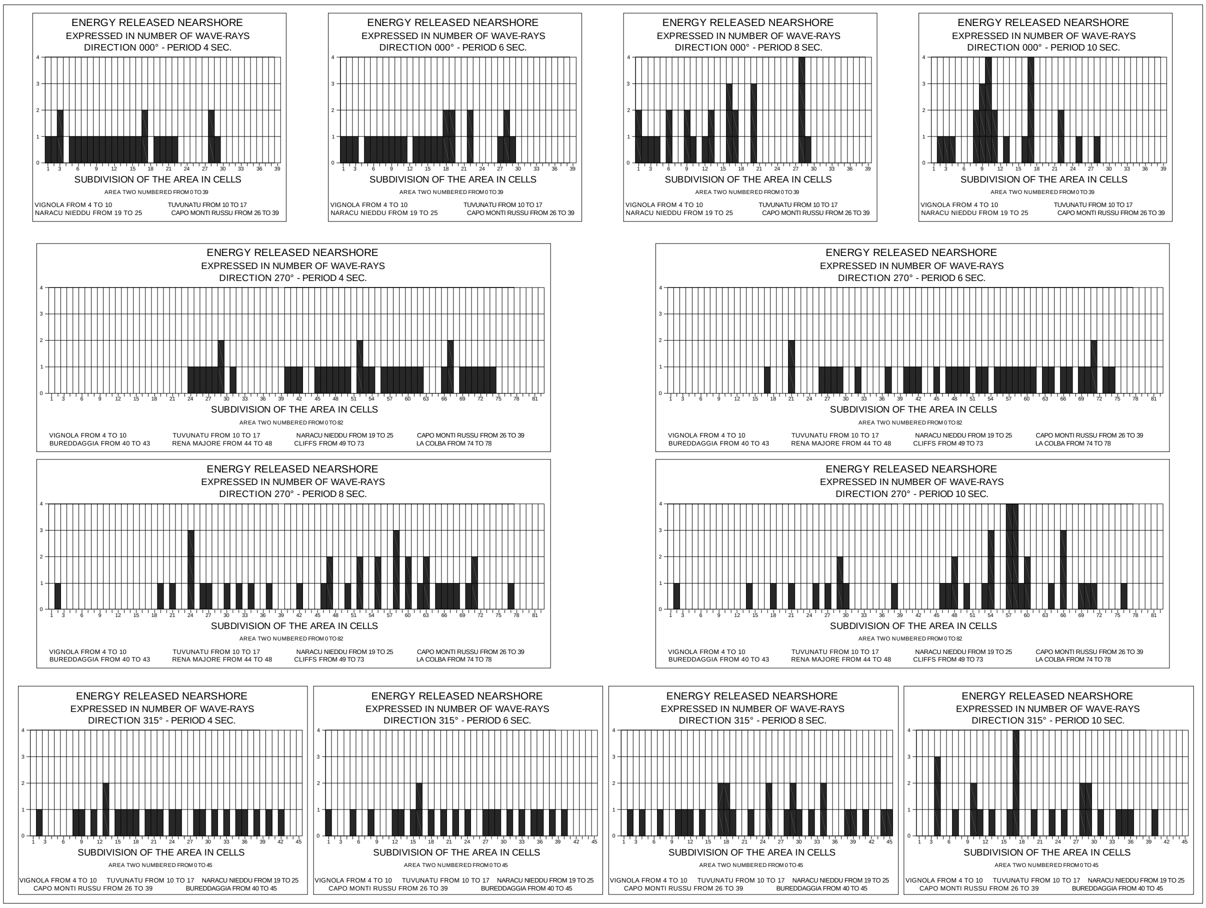


Fig. 8: Histograms.

1.2.2 Calculation of transport alongshore

Having analyzed the texture and mineralogical characteristics of the sediments in the entire area, and having defined the source and dispersion of the sands, also with the help of a detailed geomorphological survey (DeMuro 1990, DeMuro, Ferrara, Follesa & Ibba this issue), the wave refraction was analyzed graphically. In the following we examine the calculation of solid transport alongshore.

Since this is a first approach to a quantitative analysis of transport, we have applied the formula proposed by C.E.R.C. in 1975, which we have adapted with a correction factor (Brambati 1987).

The data obtained with this methodology do not represent the volumes actually moving longitudinally along a coast. They are therefore not intended to be an exact representation of the actual quantity of material transported by swell alongshore. Nevertheless, they give an indication of the order of magnitude and especially allow confrontation with volumes measured by calculating potential contributions by means of Gavrilovich's formula (1991).

In the following, for contribution deficits of between 16,000 and 22,000 m^3, the balance is considered poorly negative and the beaches substantially in a state of equilibrium. We can not help pointing out a strong anomaly in the balance of the beach at *La Colba*. In fact, in contrast with the situation of substantial stability which would appear from a field observation, this beach is in a state of heavy erosion.

Though it is not possible to provide a logical explanation for this, it is possible that the values referring to the solid contribution have been underestimated. This was due to the fact a well-defined hydrographic network was lacking, especially in the northern sector, and therefore it was not possible to assess the global contribution of interfluvial areas not included in the catchment basin proper - areas that are often characterized by eolian sands also on high slopes.

As has been observed in the paragraph about the sectors of prevailing winds and the effective fetch, the study area has been subdivided into 5 units characterized by a different shoreline azimuth.

In order to apply the transport formula (C.E.R.C.) we have used climate data (direction of origin, height and wave period) of the swell recorded at the meteomarine coastal station of *Asinara*.

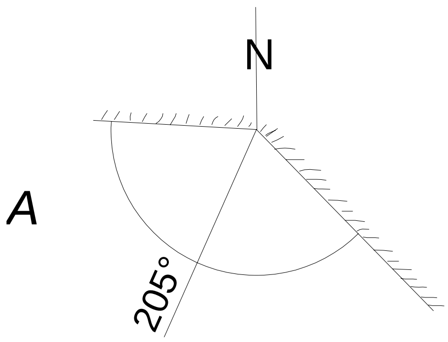
La Colba beach (A)

The net incident energy flow on this beach is the highest in the whole northern sector. The transport values were around 239.609 m^3, and the comparison with the volume of solid fluvial transport shows a marked disequilibrium. The contribution of the small streams flowing into this beach reaches a total of only 82.304 m^3 of solids per year. A confrontation between these values shows an extremely negative balance with a deficit of 157.305 m^3, which should lead to phenomena of fast erosion. On the contrary, judging from three years' in situ measurements no variations have been observed, except what can be defined as seasonal.

In this case the calculation of alongshore transport seems overestimated and not comparable with data relating to the solid contribution. Nevertheless, the other plausible hypothesis is that the river input has been underestimated, since from the surveys carried out it is not clear whether an error has been introduced due to the fact that it is impossible to assess efficiently the contribution of terrigenous deposits from areal leaching of the extensive dune rocks along the coastal area and/or diffuse streaming involving the interfluves. Moreover, a geomorphological and sedimentological study of the coastal area shows a significant contribution of sands due to the demolition of cross stratified Würmian eolian sandstones that characterize the *Capo Testa* cliffs and of the coastal area between *La Colba* and the beach of *La Liccia*.

At the present state of the research, it is difficult to assess the volumes of material demolished from the cliffs and redistributed each year, but it can reasonably be stated that they can significantly reduce the estimated deficit bringing the balance down to parity.

La Colba beach



LOWER SECTOR LIMIT = 205°
FETCH = 19.000 m
DIRECTION = 210°
FETCH = 24.000 m
DIRECTION = 240°
FETCH = 234.000 m
DIRECTION = 270°
FETCH = 29.500 m

UPPER SECTOR LIMIT = 289°
FETCH = 271.000 m
Beach in low erosion Direct WE Plx

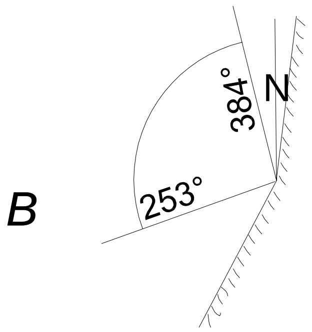
Angle between north and normal of beach (main direction) = 227°
Corresponding weight = 59
Angle between north and normal of beach (secondary direction) = 185°
Corresponding weight = 41

MEAN ANNUAL ENERGY FLOW DISEQUILIBRIUM (left - right) 19,01 kg/m/s/m
LONGITUDINAL SOLID TRANSPORT = 239.609 m^3
Poorly exposed beach, liable to intense swell with very intense NW-SE net energy flow

La Liccia, Rena Majori and Bureddaggia beaches (B)

These three beaches have been considered as one single physiographic unit because of their morphological continuity and textural homogeneity. Three streams flow into this sector with a total contribution of 98.300 m^3 per year. The solid contribution of the southern stream, called *Riu Sa Faa*, is 20.211 m3. The intermediate stream, *Riu Lu Cantaru*, transports into the system about 27.561 m^3 and the *Riu Giuchessa* 50.528 m^3 per year. In their terminal tract these two rivers flow on the Holocene eolian deposits in the district of *Rena Majori*.

The net energy flow on this tract of coast is rather low, i.e. 12,34 kg/m/s/m. Longitudinal solid transport alongshore was evaluated at 155.534 m^3. This value is within the average observed for the southern beaches and allows to consider the balance as slightly negative with a deficit of 47.234 m^3. From the surveys carried out, however, it has been pointed out that the beaches show substantial stability with strong seasonal variations and intense modifications of both the longitudinal and the transversal profiles.



LOWER SECTOR LIMIT = 253°
FETCH = 238.000 m
DIRECTION = 270°
FETCH = 336.000 m
DIRECTION = 300°
FETCH = 406.000 m
DIRECTION = 330°
FETCH = 181.000 m

UPPER SECTOR LIMIT = 348°
FETCH = 74.000 m
Beach in good equilibrium conditions direct SW-NE Plx

Angle between north and normal of beach (main direction) = 299° Corresponding weight =61
Angle between north and normal of beach (secondary direction) = 277° Corresponding weight = 39

MEAN ANNUAL ENERGY FLOW DISEQUILIBRIUM (right - left) 12,34 kg/m/s/m
LONGITUDINAL SOLID TRANSPORT = 155.534 m^3
highly exposed beach, liable to very intense swell with modest SW-NE net energy flow

<u>Naracu Nieddu and Lu Litarroni beaches (C)</u>

Two streams flow into this physiographic unit transporting about 96.854 m^3 of detrital material per year into the system. The northernmost stream is *Riu Sperandeu* that transports about 73.427 m^3 per year. The other stream, *Riu Lu Litarroni* transports 23.427 m^3/year of solid material into the southernmost tract of the coast. For most of the basin, both streams flow on granitic rocks, and over present dune bodies_only in the final tract.

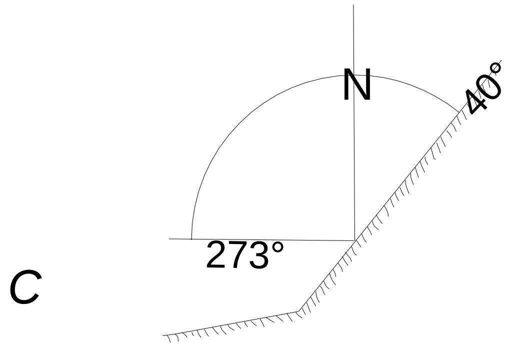
In this beach tract the net energy flow calculated by the C.E.R.C. method was rather low (9,42 Kg/m/s/m), and the material transported south-west in this coastal tract is assessed at about 118.698 m^3/year.

Comparison of these values shows a contribution deficit of about 21.844 m^3/year. Surveys on the emerged and intertidal beach in this physiographic unit have shown remarkable stability, though not without large seasonal morphological variations. From a comparison with the data from the *Vignola* beach it can be seen that the deficit for both beaches, substantially in a state of equilibrium, is in the order of 20.000 m^3 per year. It may be that the method applied for the inputs underestimates the volume of material available for transport in a stream.

It is also possible, however, that this difference, which is not very significative in regional terms, may depend on an overestimation of the longitudinal solid transport calculated with the C.E.R.C. inciding energy flow method.

<u>Naracu Nieddu and Lu Litarroni beaches</u>

LOWER SECTOR LIMIT = 273°
FETCH = 253.000 m
DIRECTION = 300°
FETCH =275.000 m
DIRECTION = 330°
FETCH = 202.000 m
DIRECTION = 360°
FETCH = 41.000 m
DIRECTION = 30°
FETCH = 13.000 m



UPPER SECTOR LIMIT = 40°
FETCH = 10.000 m
Beach in equilibrium mild SW-NE Plx

Angle between north and normal of beach (main direction) = 310° Corresponding weight =72
Angle between north and normal of beach (secondary direction) = 351° Corresponding weight =28

MEAN ANNUAL ENERGY FLOW DISEQUILIBRIUM (right - left) 9,42 kg/m/s/m
LONGITUDINAL SOLID TRANSPORT = 118.698 m^3
Poorly exposed beach, liable to intense swell with mild SW-NE net energy flow

Lu Tuvunatu beach (D)

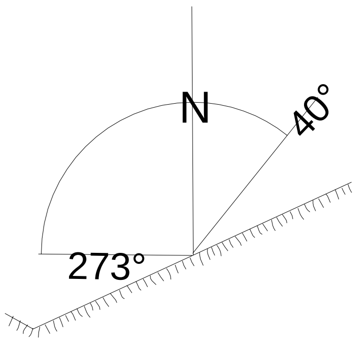
The two streams *Riu di La Foci* and *Riu di li Saldi* flow into this coastal tract. The former contributes about 29.939 m^3 of material and the latter about 50,299. Therefore a total of 80.238 m^3 of solid material are transported to these coastal waters.

The net incident energy flow on this part of the coast is very intense with values up to 28,13 Kg/m/s/m and prevailing southwest transport. The volume of material potentially mobilized in a year is 354.480 m^3. The balance is therefore strongly negative with an annual deficit of 274.242 m^3. These values point out to a situation of severe erosion with a clearly negative sedimentological balance.

The surveys carried out in this area show a very exposed sector seldom characterised by fine sands and prevalently made up of a low rocky coast with small bays of pebbly deposits (with deep gradient) and extended granite abrasion platforms. Moreover the refraction tables show that for all directions a large number of ray waves are concentrated in this study area. The energy released on the coastline is among the highest in the whole area.

LOWER SECTOR LIMIT = 273°
FETCH = 253.000 m
DIRECTION = 300°
FETCH =275.000 m
DIRECTION = 330°
FETCH = 202.000 m
DIRECTION = 360°
FETCH = 41.000 m
DIRECTION = 30°
FETCH = 13.000 m

D



UPPER SECTOR LIMIT = 40°
FETCH = 10.000 m
Beach in strong erosion very intense direct WE Plx

Angle between north and normal of beach (main direction) = 336° Corresponding weight = 92
Angle between north and normal of beach (secondary direction) = 42° Corresponding weight =0,8

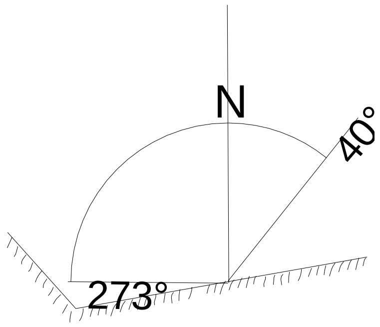
MEAN ANNUAL ENERGY FLOW DISEQUILIBRIUM (right - left) 28,13 kg/m/s/m
LONGITUDINAL SOLID TRANSPORT = 354.480 m^3
Exposed beach, liable to intense swell with remarkable WE net energy flow

Vignola beach (E)

From the obtained data, it is clear that the contributions of *Riu di Vignola*, that flows into a beach having the same name, correspond to about 261.832 m^3 of solid detrital material per year. Solid transport due to swell calculated by the C.E.R.C. method and based on the flow of energy along the coast corresponds to about 277.525 m^3 per year with a negative balance of 15.693 m^3 per year. The net flow of energy is remarkably strong (22,02 kg/m/s/m) in a prevailing WE transport.

In agreement with what was said above on the accuracy of calculated volumes, we believe that for the coast under study such a balance represented a sedimentological situation of substantial equilibrium, since input values are quite similar to transport values. Moreover, this is confirmed by the fact that repeated measurements of the morphological profile of the emerged beach have shown that the studied beach is substantially stable, notwithstanding the remarkable though expected seasonal changes it undergoes in a year (erosive and depositional cycles).

LOWER SECTOR LIMIT = 273°
FETCH = 253.000 m
DIRECTION = 300°
FETCH =275.000 m
DIRECTION = 330°
FETCH = 202.000 m
DIRECTION = 360°
FETCH = 41.000 m
DIRECTION = 30°
FETCH = 13.000 m



UPPER SECTOR LIMIT = 40°
FETCH = 10.000 m
Beach in equilibrium Direct WE Plx

Angle between north and normal of beach (main direction) = 352° Corresponding weight = 75
Angle between north and normal of beach (secondary direction) = 51° Corresponding weight = 25

MEAN ANNUAL ENERGY FLOW DISEQUILIBRIUM (right - left) 22,02 kg/m/s/m
LONGITUDINAL SOLID TRANSPORT = 277.525 m^3
Poorly exposed beach, liable to intense swell with remarkable EW net energy flow

1.3 The socio-economic lines of development

In the area of the insular regions of the Mediterranean sea, tourism represents one of the predominant sectors of the local economic systems and has influenced all other forms of the use of those parts of coast and sea, who have oriented themselves towards an organisation suitable for the needs of tourism. By that way, tourism has not only reduced possible matters of dispute along with risks of use, but has also increased the level of sensitivity of the marine and costal ecosystem, which caused grave repercussion as far as the integrity of the resource “environment” is concerned, the base of all these tourist activities.

In the specific case of the community of Aglientu (coast between Punta di li Francesi and Capo di Capo Testa), the development of bathing tourism has founded one of the principal factors for the change of the complete situation of coastal areas. During recent time the coastal strip has become the part of land on which the interests of tourists and of local and non local entrepreneurs have been meeting.

Tourist activities differ from tourist demands (temporary concentration), because demands aim at the precedence of the marine typology “bathing” (concentration in typology), they almost exclusively benefit from the coastal area (concentration in space) and they depend on season-related aspects (during summer time).

Talking about tourism does not mean to only refer to the sector of accommodation-related capacities, but furthermore to the numerous producing sections directly connected to mountain and valley, which represent an assembly line with the final destination to fulfil the demands of tourists with its production.

Tourist activities include, as far as this meaning is concerned, among the economic activities more directly connected, like housing and transport, various compartments of quality of the agricultural nutrition sector (to think about wine, cheese, bread and so on) and furthermore traditional and artistic trade or craft (fabrication of baskets, carpets, ceramics, knives, leather, wooden objects etc.). Above this we have to consider the various services that become more and more relevant when dealing with specific aspects of tourist demands: Cultural, environmental, recreational, sportive, archaeological and nautical services.

That is why tourism represents the primary “export-oriented” industry of the islands, deeply rooted and widely spread in the territory and why it does without concurrence, represent the cash cow of the economy of the Aglientu territory (coast between Punta di li Francesi and Capo di Capo Testa). The fact, that tourism necessarily deals with a question resulting from abroad, is of vital importance in order not to mix it up with any negative characteristic of local economy.

It is in fact obvious, that one of the principal limits to the producing facilities is the limitedness of the local market and its “poverty”, which leads it to be less representative in respect to the vertically diverging preferences characterizing foreign demands. This problem is accompanied by difficulties faced by local economists to reach the big foreign markets, because of a lack of knowledge about them, a lack of knowledge about the consumers´ taste and because of a lack of knowledge about technologies. To put it in other words: The local market can henceforth not function as a “training facility” for entrepreneurs who desire to open themselves to foreign concurrence. So a vicious circle is formed, with the evident problems of a market failure caused by incomplete information, an a lack of convinced external impact.

The tourist sector turns out to be partially immune to this failure, for it takes advantage of meeting foreign demands directly arising “in place”, attracted above all by the beauty of nature available in the area. That is why the contact between foreign demand (widely spread, rich, quality-oriented) and local supply emerges easily and creates those mechanisms of affection to the product, that e.g. led to transformation, the increase in worth and the growth in exports that has characterized the sector of Sardinian viniculture within the last years.

The problem of the season dependent change and the concentration of the arrivals of tourists on summertime, remains to be solved. This imbalance can be perceived in particular in places like Aglientu (coast between Punta di li Francesi and Capo di Capo Testa), where it is very present, with immediate consequences resulting from the collapse of service and accommodation related structures, especially at the level of support for natural environment.

The great importance of the landscape of the territory consisting in the interior of the SIC and of the areas of the mountains, unites the historic and cultural richness of their centres and bordering places, who mark the point of this area. However, we have to mention the fact, that the structures of service and accommodation, apart from rare examples, turn out to be inadequate. Big expectations are connected to the initiatives on re-conversion of town centres of major coastal locations (e.g. Rena Majori, Vignola, Portobello) and, especially, to the observant cultivation of the coastal area, of “agriturismo degli stazzi”. Of fundamental importance is the analysis of “progettualità” deriving from the socio-economic energies used for planning, programming (in particular of the local development programs, the instruments for urban development) and from those which regard actions in the area of the Quadro Comunitario di Sostegno also with the recent instrument of "Progettatione Integrata Territoriale" (PIT).

With these reports it will be possible to verify a new scheme of territorial order, which directly originates from knowledge about the intentions of the local administration and the economic world in relation to the two principal objectives of development:

- Strengthening and re-establishing entrepreneurship by productive investments in principally tourism-related activities.
- Realisation, alignment and completion of infrastructural devices to be provided by the public (water pipes, the net of sewers, recycling...) and services.

These initiatives are not only going to be apt at forming a "modernisation" and inducing new vitality into the socio-economic web with steering lines, which move along with the great territorial necessities (accessibility, water resources, territorial and environmental reforms, esteeming cultural goods, productive investments), they also outline new perspectives for local development by forms of co-operation within the people responsible for the interests of the territory and for communal themes.

1.3.1 The themes of socio-economical development

From the activities of valorisation and realisation result inevitable thoughts, which will be the dominant element of integrate socio-economic development, along with the valorisation of important communitarian sites. Within these, the principal lines of development become evident:

Esteem and protection of the environment

- Esteem of the areas where nature predominates.
- Hydro-geological rehabilitation.
- Regain and re-establishment, within borders, of products of the forest heritage.
- Solving the problems of drinking water supply in particular for civil an agricultural use.

Re-evaluation and new ignition of tourist supply

- Gaining structures of service (especially light "infrastructure-isation") and of tourist devices.
- Creating diversity of supplied goods.
- Increasing the standards of coastal and non coastal settlements (legal circulation of second homes, "agriturismo degli stazzi").
- Getting into contact with tourist landing zones of the area (Santa Teresa Gallura, Isola Rossa,...).
- Agencies for coordination and integration of tourist services.

Tourist Guide plans as integrated systems

- Archaeological sites
- Natural reservations

- Harbours and roadsteads
- Urban centres
- Agriculture and handicraft
- Cultural activities (fairs, exhibitions)
- Guides to agricultural nourishing (“itinerari agroalimentari”) connected with tourist guides.
- Increasing the value of tourist “panorama routes” (of the landscape and at the beaches) by improving the streets useful to agriculture.
- Promotion of light “infrastructure-isation” and of activities for enhancing tourist capacities.

Enforcement of productive structures

- Enforcement of the productivity of agricultural zones.
- Support and rationalisation of cattle breeding.
- Rationalisation and revitalisation of “local knowledge”.
- Guided support for craft and commerce.
- Support of IT-development.
- Providing service for business.
- Various services (sanitarian, on social aid, cultural, professional education on high level).
- Territorial promotion (territorial marketing).

To finally give the correct answer for a plan of action, connected to become an instrument of this environmental decision making process, the “Life natura Juniper Dunes” offers itself; we have to refer to all of the phenomenons that define the status of an environmental steering system, constituted of biotic and a-biotic components of clearly visible naturality and of components of anthropoid impact.

Such a system of environmental management offers itself to be read and offers itself to guide the development of a territory towards the lines of development and protection. The sudden environmental pressure in the aforementioned territory varies, from the qualitative point of view on the one hand and from the view of the intensity in which it presents itself on the other. Also the differences, which lie between the one period of the year and the other, during which the tourist phase lasts, are indeed remarkable – anticipating that we are allowed to talk about phases. But in the long and middle season, some of the common guiding lines reappear, on whose realisation the politics of tourist planning could concentrate.

The programmatic lines could be the following:

- Reducing the clumsy structures at the coasts.
- In consequence, getting abandoned or not fully used real estate heritage restored and into use again, both in the inhabited centre and in the villages near the coastal band.
- Favouring, by the promotion of a nature-, archaeology-, and cultural-oriented tourism in general, an integration between the phases of a tourism mainly concentrated on the coastal band.
- Favouring tourist guides and catalogues in order to offer short-time holidays and especially during the so called “mesi spalla”.

- Try out the effects of restricting access in most endangered areas or at least implement forms of control to the masses of people enjoying nature.
- Enable the foundation of a territorial network of tourist syndicates, able to promote an integrated offer as an instrument of quality-implementation.
- Promoting actions on territorial animation for the respect of the culture of the villages.
- Favouring the environmental certification of the villages and operators.

The planners and operators who have the vocation to intervene in the local contest, will have to be aware of the fact, that control and respect of the territory does not necessarily implicate the reduction of the complex flows of tourists, but furthermore the beginning of a different rationality governing their action, that has so long missed.

Overcoming the model of exploitation that, generally speaking, has revealed outstanding indications of consumption of natural resources in Sardinia, is indispensable for the conservation and the reinforcement of natural, historical and cultural characteristics of the villages, who are a heritage that prevail to any target of tourist use.

Table 1: Territorial indicators of synthesis.

(SISTEMA LOCALE DEL LAVORO DI SANTA TERESA GALLURA - 745)

Istat.-Code 90062	AGLIENTU	Sassari	Region	Italy
Territorial Surface (Km^2)	149	7.520	24.090	301.341
Resident Population	1.093	460.891	1.661.429	57.563.354
Families	467	154.106	569.533	21.642.350
Inhabited accomodation	430	145.114	516.139	19.735.913
Demographic density (Resident Population / Territorial Surface)	7	61	69	191
Balance of migratory movement	-1	2	-1	2
Subscribers of Television	333	121.471	427.061	16.071.964
Subscribers of telephone in private use	691	148.293	498.161	19.276.904
Registered motor vehicles	591	225.733	749.658	29.665.306
Consume of electric energy domestic use per user	3.038	3.198	3.134	2.467
Number of farm	197	28.037	117.871	3.023.337
Agricultural surface in use	6.953	453.209	1.358.229	15.045.525
Agricultural surface in use per farm	35	16	12	5

Total number of enterprises	88	**25.015**	**84.745**	**3.301.551**
Total Number of occupied people	252	**118.784**	**409.509**	**17.976.421**
Local units per inhabitant	11	**7**	**6**	**7**
Occupied people per inhabitant	23	**26**	**25**	**32**
Occupied people per local unit	2	**4**	**4**	**5**
Second homes	1.169	**47.119**	**102.233**	**2.711.423**
Camping sites, tourist villages, hostels – Number of Guests	4.200	**31.405**	**65.771**	**1.311.006**
Camping sites, tourist villages, hostels Number of units	5	**42**	**91**	**2.375**
Guest houses, Tourist residences – Number of beds	46	**33.816**	**69.442**	**1.782.382**
Guest houses, Tourist residences – Number of units	2	**304**	**675**	**33.540**

Indicators of burden capacity

Tourist pressure:

- Tenable tourist population/Resident population: 7.8.
- Tenable tourist population/length of coast (units per km) : 255,5.
- Balance of bedplaces/potential bedplaces according to the "Piani Territoriali Paesistici": 14.925.
- Houses not occupied/houses inhabited: 2,72.
- Houses not occupied in relation to kilometres of sandy beach (unit/km): 103.
- Index of season related change (July to August/total presence in structures with changing use): 81 %.

"Quality" of the sea:

- Analysis of bathing waters (Number one in bathing quality) 100%

Naturality of the costal environment

- Length of free coast/total Length of coast: 35%

Functional benchmarks of sewer purification

- Degree of satisfaction of purification needs: 70%
- Degree of the completion of the sewer net: 100% (In urban areas, not considering singular housing in the country)

Pressure on water resources:

- Loss of water (Percentage of water lost of total influx into the net) 11,6
- Structural deficit of water (difference between water supply and demand of the resident population; estimated with 250l per day and inhabitant) –14,8%
- Deficit of water during main season (difference between water supply and demand in the period of full occupation of tourist facilities) –75,8%

2. EFFECTS AND LESSONS LEARNT

The refraction of the wavefront on nearing the coast was calculated by means of a modified version of the programme REFRCT (John Hopkins University) on the basis of anemometric and meteo-marine data from the coastal stations of *Asinara* and *Guardia Vecchia* for 1951-1970. The refraction tables obtained show the areas mostly subjected to energy transfer on the coastline for three directions and four periods.

The most important beaches were divided into five physiographical units and the annual alongshore transport was calculated on the basis of the inciding energy flow according to modified C.E.R.C. formulas.

The balance of the five physiographical units was calculated by comparing the alongshore transport and the solid contribution of the waterways in each unit. It emerged that of varying degrees all the examined beaches presented deficits (Table 2).

Table 2: Physical characteristics of the beaches.

BEACH	**A** **La Colba**	**B** **La Liccia** **Rena Maiore Bureddaggia**	**C** **Naracu Nieddu** **Lu Litarroni**	**D** **Lu Tuvunatu**	**E** **Vignola**
STREAM	Riu Li Sarri Riu Licianeddi	Riu Sa Faa Riu Giuchessa Riu Lu Cantaru	Riu Lu Litarroni Riu Sperandeu	Riu La Foci Riu di Li Saldi	Riu di Vignola
TOTAL SOLID INPUT	82.304 m^3/y	98.300 m^3/y	96.854 m^3/y	80.238 m^3/y	261.832 m^3/y
HEAVY MINERALS	Aug. – Brook – Oliv.	Epid. – Gra – Aug. – Oliv. – Tit.	Epid. – Stau. – Sill. – Brook.	Epid. – Gra.	Epid. – Horn. – Gra. – Tit.
ENERGY FLOW	19,01 kgxm/s/m	12,34 kgxm/s/m	9,42 kgxm/s/m	28,13 kgxm/s/m	22,02 kgxm/s/m
LONG. SOLID TRANSPORT	239.609 m^3/y	155.534 m^3/y	118.698 m^3/y	354.480 m^3/y	277.525 m^3/y
DEFICIT	157.305 m^3	47.234 m^3	21.844 m^3	274.242 m^3	15.693 m^3
STATE OF THE BEACH	Low erosion	Equilibrium	Equilibrium	Strong erorion	Equilibrium

The most significant unbalance refers to the beach of *Lu Tuvunatu*, that presents a deficit of 274.242 m^3. From field observations it was possible to confirm the state of heavy erosion in this coastal tract in corroboration of the calculated results.

A highly negative balance, 157.305 m^3, was also observed for *La Colba* beach. In this case, however, an analysis of its regime on the basis of the slope of the submerged beach together with direct observation on the emerged beach, are in contrast with the substantial stability of its transversal and longitudinal profile, even though, as is usually the case, remarkable seasonal changes have been observed (poor erosion in the winter followed by depositional phases in the summer).

At the present state of the research, it is believed that the unbalance pointed out in the calculations is due to failure in assessing the yearly sediment input into the system from the demolition of extensive outcroppings of Würmian eolian sandstones, that characterize the cliffs of *Capo Testa* and of the coast south of *La Colba*. If this is the case, as is most probable, the observed large deficit is only apparent, and mainly corresponds to the direct contribution of cliff erosion to the regime of the beach.

Previous studies (DeMuro and DeMuro & Brambati op.cit) of a geomorphological and sedimentological character have shown presence of grains of an eolian origin along the studied coast. As a matter of fact the waves affecting the cliffs of the beach at *La Colba* cause the Würmian sandstones to collapse.

Further terrigenous deposits not included in the calculations of fluvial solid transport, are most probably attributable also to the widespread streaming and leaching of the extensive Holocenic eolian sandy cover that characterize the interfluves in the coastal areas east of the beach at *La Colba*.

Moreover, from a comparative analysis of the sedimentological balance of the five studied beaches and their regime on the basis of the slopes of the dynamic zone of the submerged beaches of the southern beaches, it has emerged that the calculation of the contributions to the system appear generally underestimated.

From field observations (periodical emerged and submerged beach profiles during a three-year study) the beaches at *La Liccia*, *Rena Majori*, *Bureddaggia*, *Naracu Nieddu* and *Vignola*, appear to be in a state of substantial equilibrium, and show a slight deficit with values ranging between 15.693 m^3 (*Vignola*) and 21.844 m^3 (*Naracu Nieddu*).

If underestimation in calculating the fluvial contributions is to be considered plausible, having ascertained that at a deficit of less than 21.000 m^3 the beaches are substantially at equilibrium, the comparison between the depositional and/or erosive regimes defined by the two methods (balance and study of the slope of the bar and trough zone) seems to point out substantially consistent results for the five physiographical units.

In particular, from the data obtained with the two different methodologies, it can be observed that the beaches liable to erosive regime are those mostly in deficit in terms of terrigenous contributions from waterways and mostly liable to exposition (prevailing winds) to the largest inciding energy flows.

The beaches in equilibrium show a poor negative sedimentological balance (in the order of 21.000 m^3) and mild incident energy flows The energy released on the coastline is always less than that found in beaches submitted to erosive regimes.

In this study area there are not coastal protection measures. The scientific information of which we dispose needs to be enhanced especially for what concerns the protection measures necessary for the safeguarding of the coastal systems.

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