THE MEDITERRANEAN SEA

ENVIRONMENTAL BALANCE AND WASTE DISCHARGES

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the wastes resulting from urban and industrial activities of man [*]

This paper has been prepared to illustrated the ability of the Mediterranean sea to accept biologically degradable wastes resulting from urban and industrial activities of man. In the past few decades a vast data base has emerged for the Mediterranean Sea that can be used to determine the present ecological balance of the sea. Population and industrial pressures in the area are well documented and statistics are available on the historical yield of commercial fisheries and other resources.

Population statistics and industrial centers have been described and estimates made of the waste material introduced into the shoreline environments. In general the surface and water column of the central parts of the Mediterranean basins are in good ecological balance, whereas the shoreline has not been properly managed and in some areas is highly polluted by human and industrial wastes introduced directly along the coasts and into the rivers and lakes.

While this paper will illustrate the general environmental balance of the Mediterranean Sea it will focus on the environmental state and problems of the Campania and Naples areas of Italy.

It is impractical to trace directly the impact of mans activities throughout the historical development of the civilizations of this inland sea, however knowledge of the historical rise of the Roman Empire and details of the construction of buildings roads, aqueducts etc. suggests a population of citizens and slaves almost equivalent to todays population. In the 2nd and 1st centuries BC, the most important Roman port was at Pozzuoli then known as Puteoli.

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[*] CONTRIBUTO DI CARL H. OPPENHEIMER – ROBERTO BLUNDO – PROFESSOR OF MARINE SCIENCES, UNIVERSITY OF TEXAS, AUSTIN - settimane di studio 20 e 21 febbraio 1987 – Fiera del Mediterraneo, Palermo

Later in the 14th century, the large harbor at Naples was built. The region of Campania was known from early times to be one of the most fertile areas of the Mediterranean and was highly developed as an agricultural area.

The name comes from the ancient town of Capua and the variety of soils from carbonate, volcanic ash and lava and alluvium, plus an abundance of water, permitted the cultivation of a wide range of agricultural and dairy products.

Thus the Campania region has been a focal point for extensive agricultural, industrial, and human activities for the past 3000 years. During this period very little effort was made to control the impact of mans activities on the coastal waters of the area.

Air, solid and liquid wastes were introduced into the rivers and directly along the shores causing an alarming impact to the coastal environment as shown in the photograph in Figure l illustrating the accumulation of solid wastes along a portion of the Campania coast. The accumulation of floating plastics is significant as these inert compounds are not degraded by nor- mal microbiological activities.

Figure 2 illustrates air pollution over the city of Naples and Figure 3 shows a sewage outfall along the shore of Ischia near the beach at Figure 4. Also as in the past, the coastal area was and is extensively used by tourist and for recreation as shown in Figure 5, illustrating the large numbers of tourists traveling to Ischia and the clutter of solid floating wastes in the harbor in Figure 5 and 6. Figure 7 shows the recreational use of a rock beach in Capri.

Thus the negative impact of air, solid and liquid wastes along the shore has increased to a point of great public alarm and significance to public health.

The relatively recent rapid growth of the plastic industry is of special concern because of the resistance of this inert material to degradation and the side effects of the toxic gases produced by burning. The plastic float and accumulate along the shore, and the above Figures are a major portion of the solid wastes illustrated.

These plastics can be eaten by marine organisms causing intestinal problems leading to death or may impair swimming activity by entanglen1ent. The problem of plastic accumulation is becoming so acute around the world that it is imperative that steps be taken to replace plastic throwaway containers by biodegradable materials.

In 1976 the Merli Law passed in Italy, providing environmental control parameters for effluents from industrial and municipal sources. This law provided a rather uniform set of parameters to be applied to the entire coastline of Italy. As will be shown in the following document, the shoreline of Italy is not uniform environment.

It fluctuates continually creating changes in wave action, runoff, circulation, currents, depth, temperature, nutrients, oxygen and other parameters that must be understood before rational pollution controls are implemented.

As a result of the inflexible parameters, little has been accomplished with respect to pollution control in the Campania Region. Inflexible laws, not allowing compensation for different environmental situations may re- quire costly control technology that may not be necessary.

Figure 1

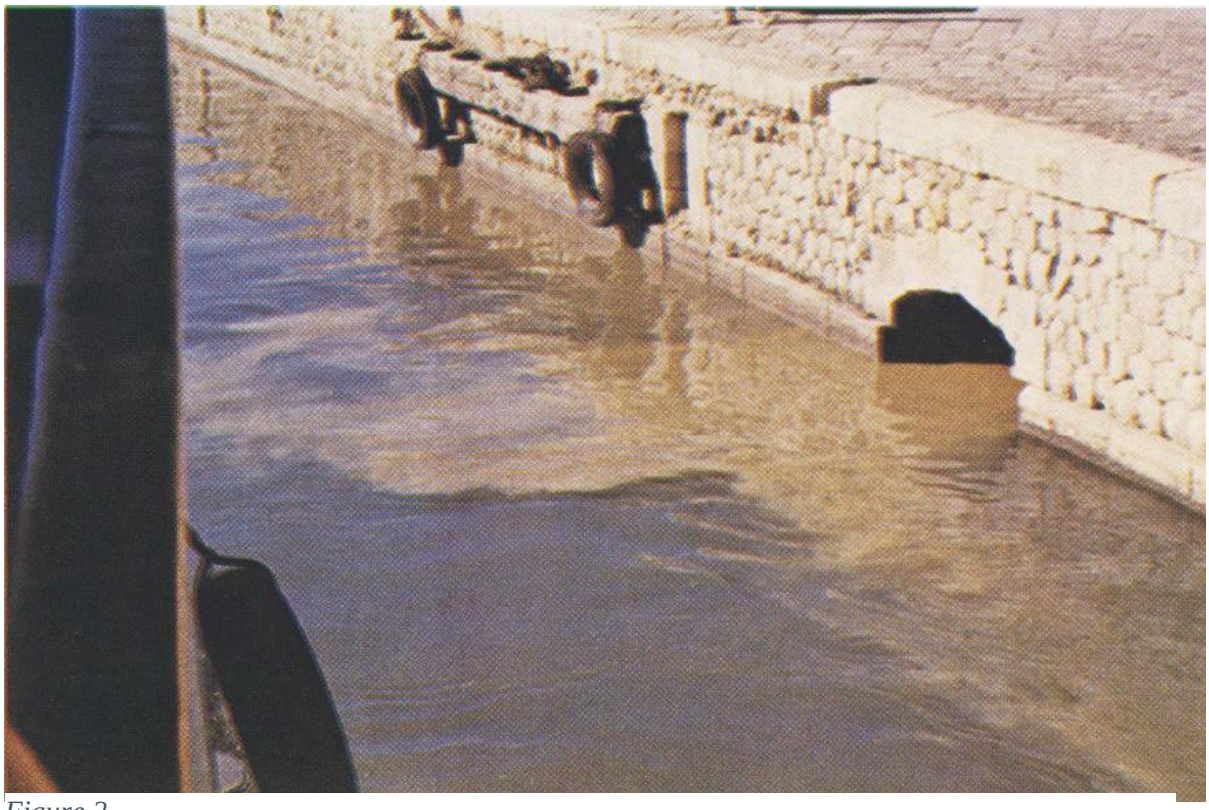

Figure 2

This can be reflected in prices for products in a competitive society. Thus in some instances, it is more economically convenient to pay a small fine for not complying to the law rather than spend considerable resources to provide for adequate pollution control.

States can impose laws for pollution control but it is up to man to comply to the laws.

Because the Merli Law was not successful we learn that a new set of parameters are being developed for effluent control. It must be emphasized that the coast of Italy is so variable from the top of the Adriatic Sea to the Port of Genova, and the coast of the Islands, that for a law or parameters to be effective it is necessary to start, not from Rome, but from the individual coastal units.

In this way parameters for pollution control can be set to the environmental balance of the various coastal regions. While this would require a significant input from the scientific community to identify coastal regions, it would put pollution control on a more secure financial basis where the pollution control requirements are patterned after the environmental balance of an area. The identification of specific coastal environments can be determined by proper scientific input and I have essentially accomplished this for the coast of Texas in a 1972 publication called the Biotopes of Texas.

This publication was expanded by the State of Texas to provide a complete environmental description of the coastal regions of the State that is used to show future changes and to regulate coastal development.

The Mediterranean Sea (Figure 8) has been studied extensively since the first writings of Plino the Elder in the list century AD. The Sea is the result of a relatively recent geological process relating to the breakup of Pangia approximately 200 thousand years ago and in

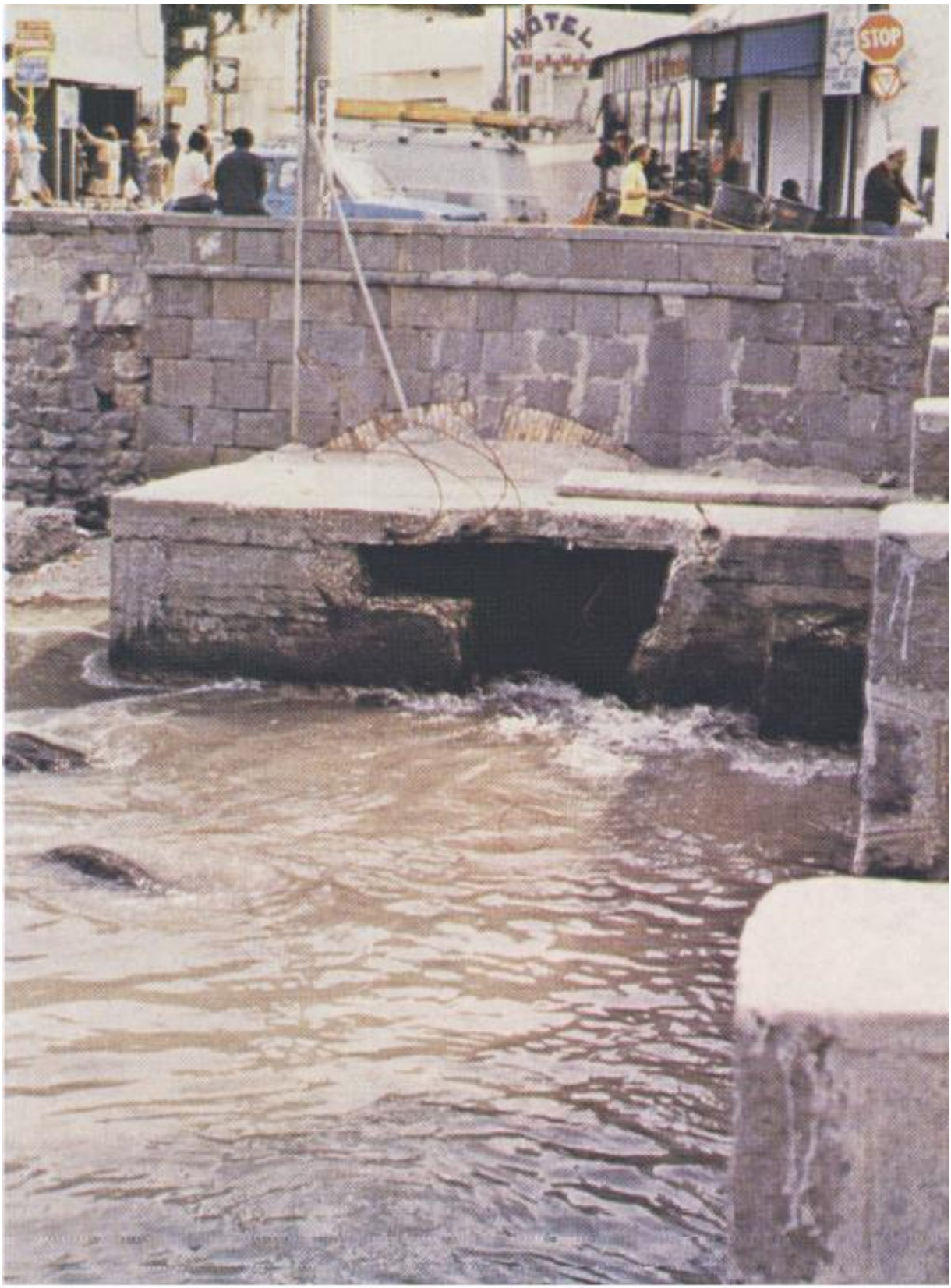

Figure 3

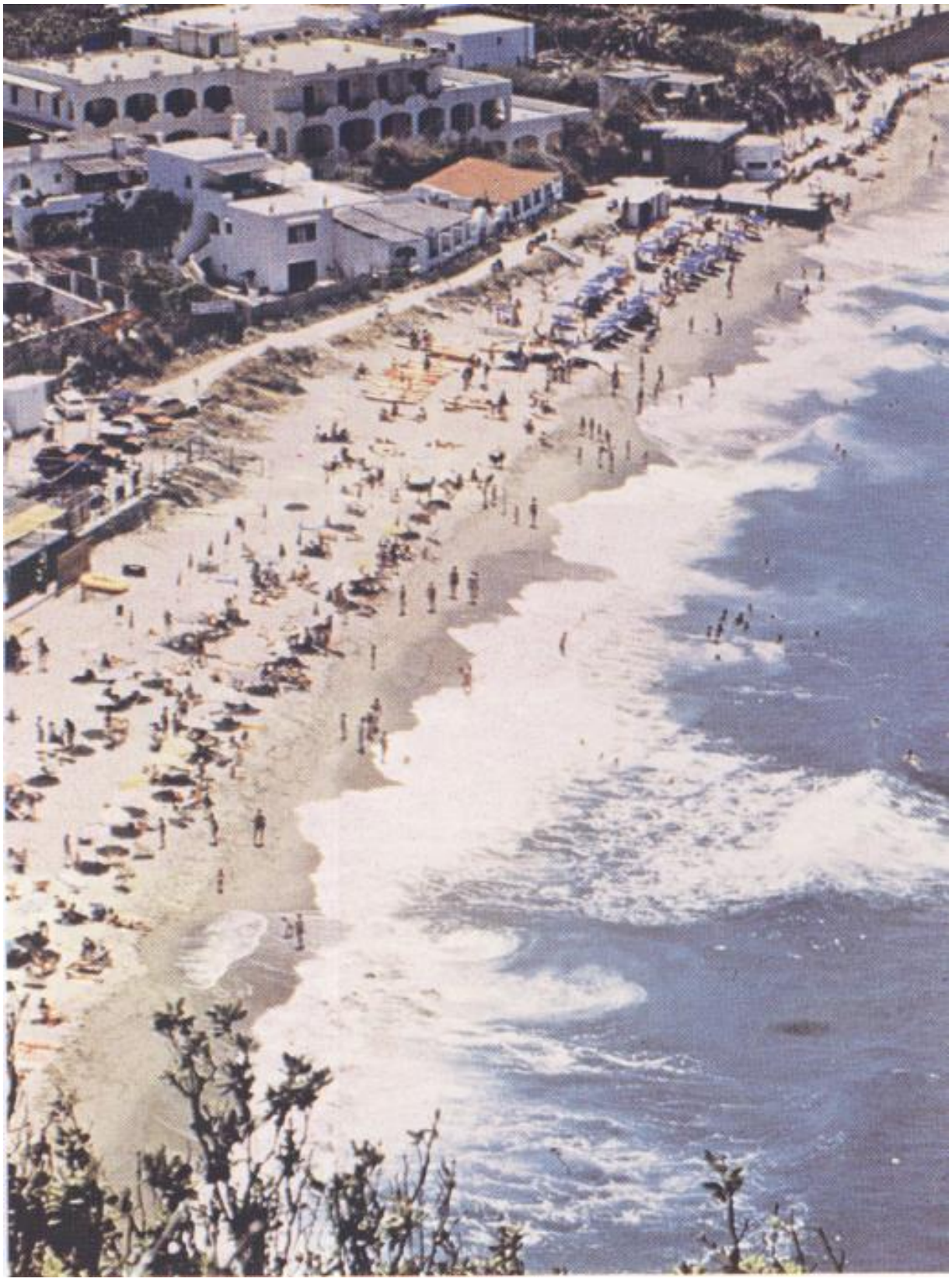

Figure 4

Figure 5

Figure 6

Figure 7

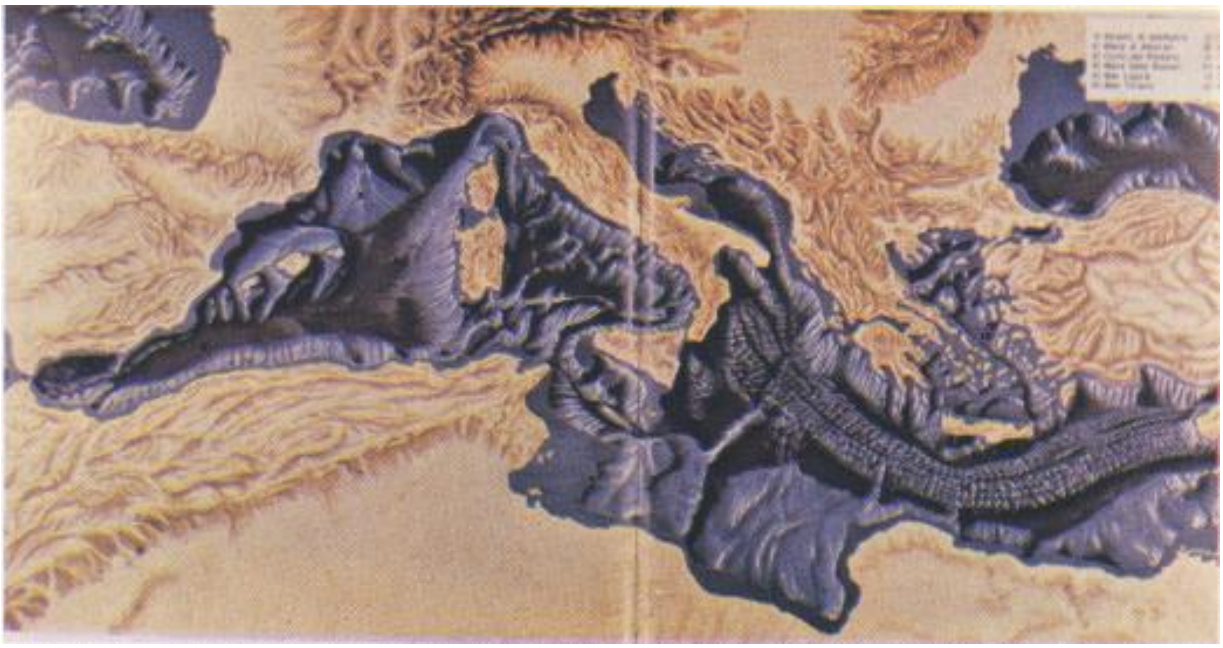

Figure 8

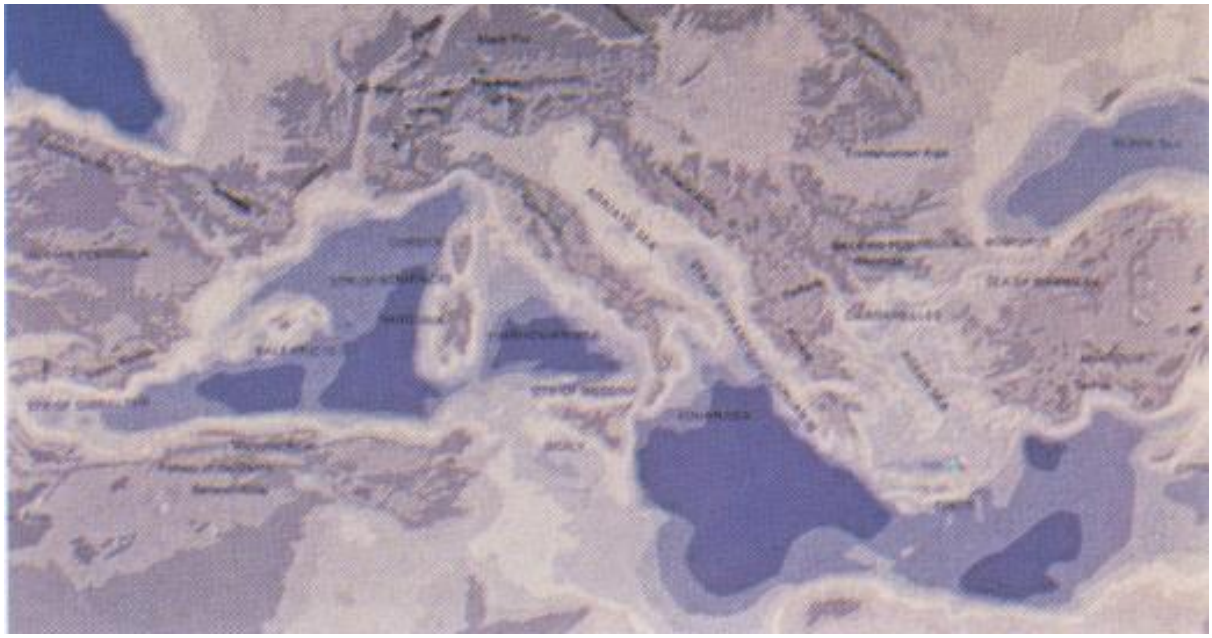

Figure 9

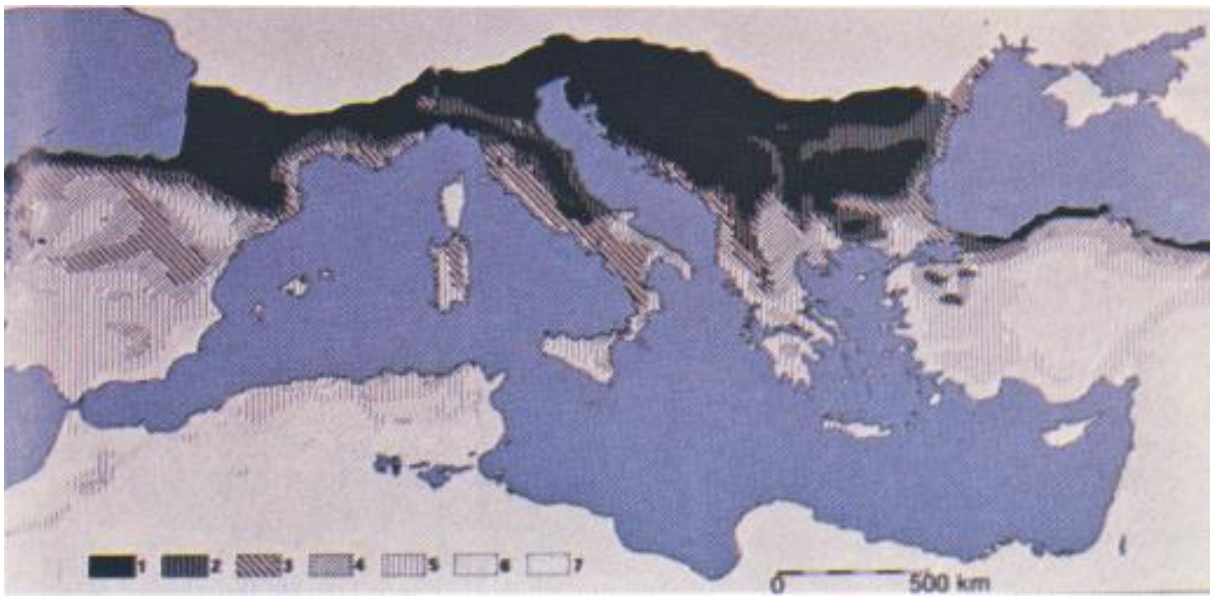

Figure 10

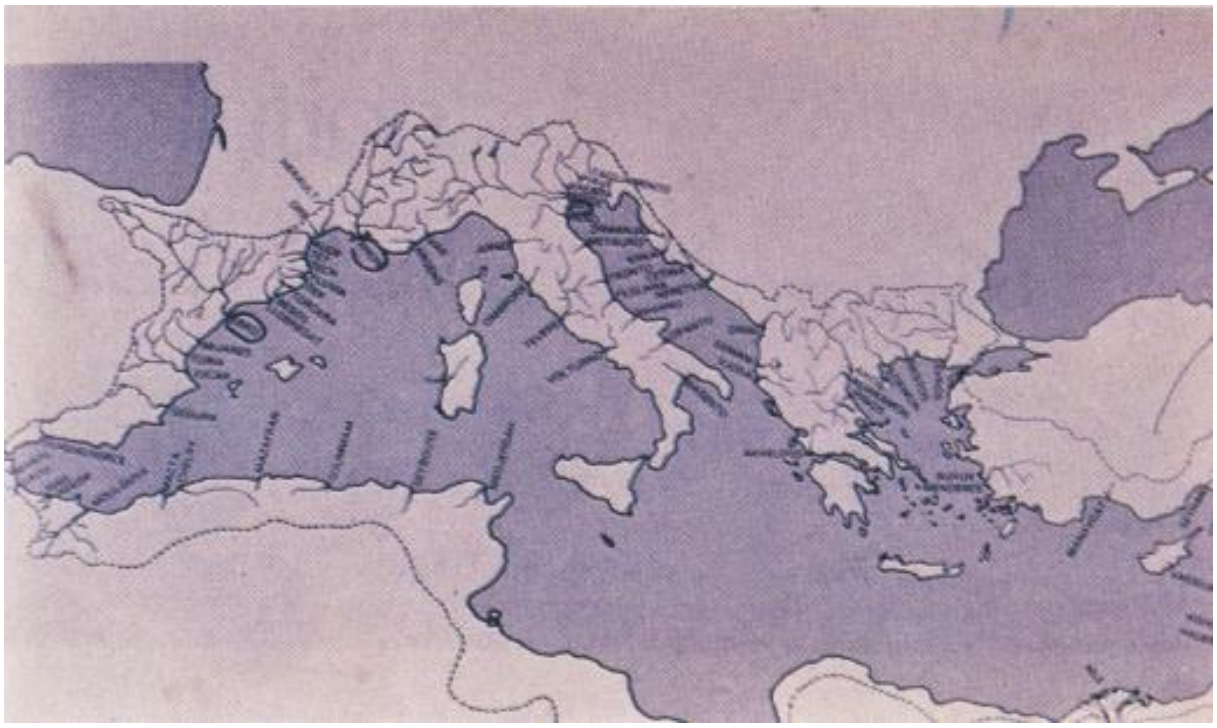

Figure 11

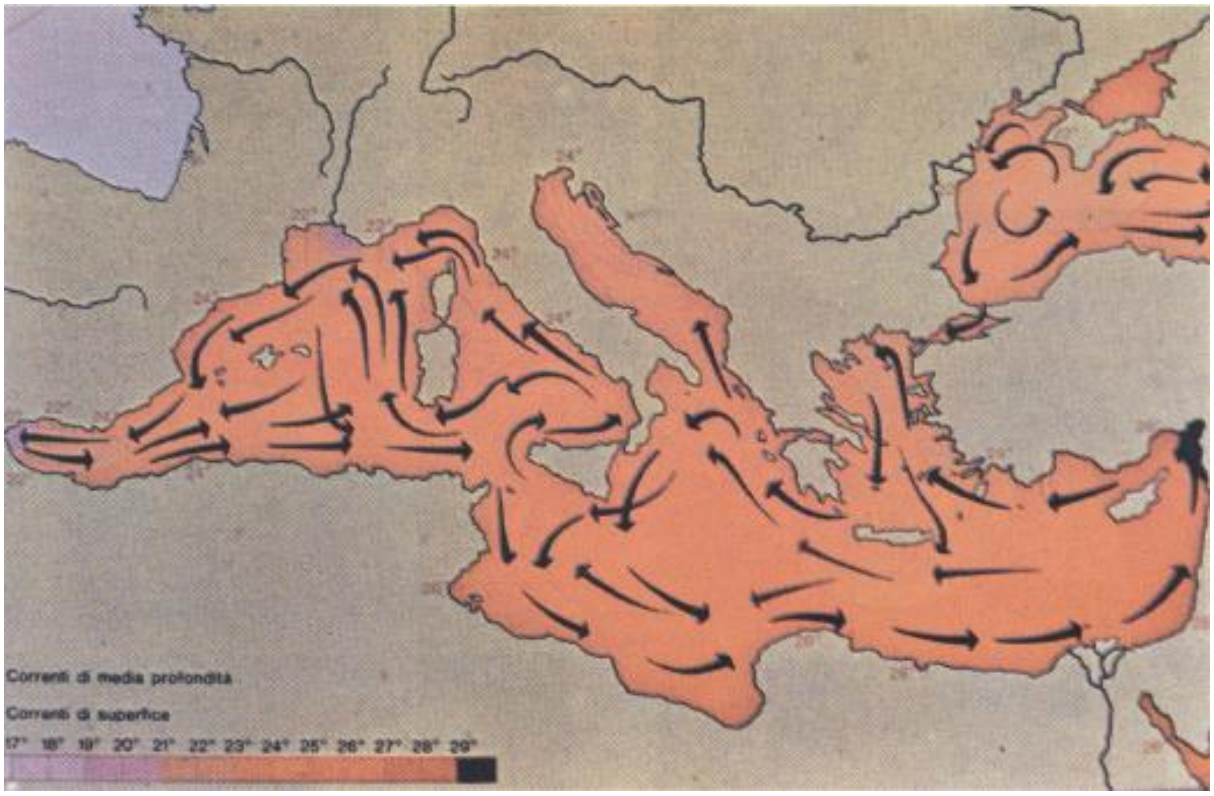

Figure 12

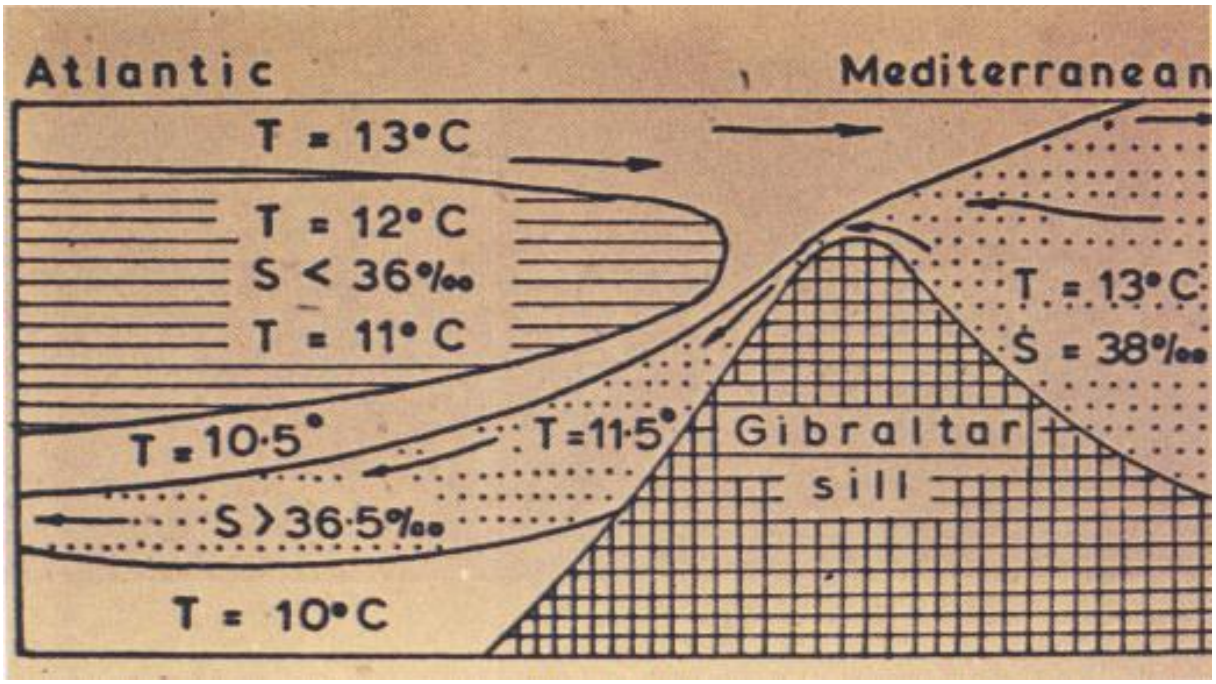

Figure 13

Figure 14

Figure 15

Figure 16

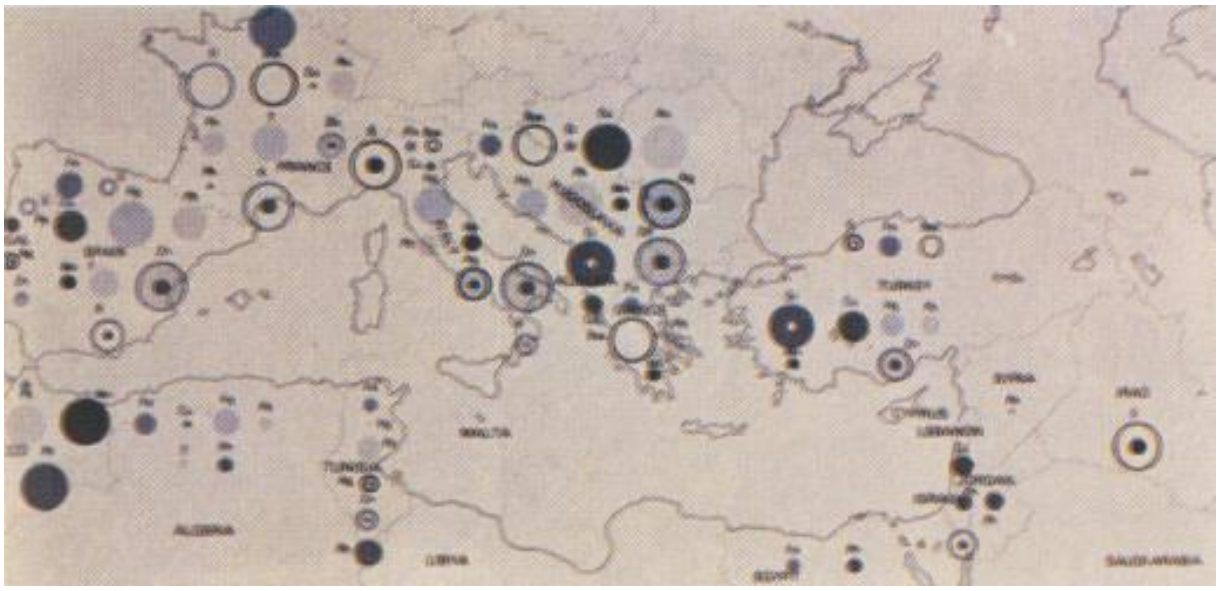

Figure 17

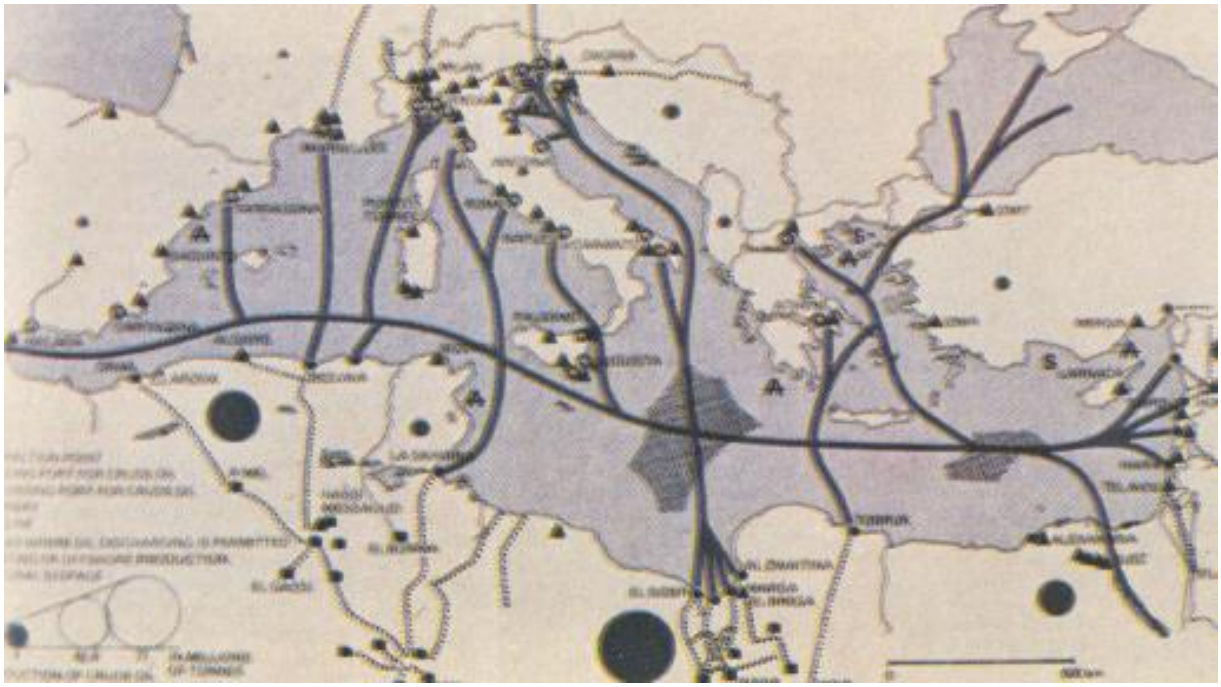

Figure 18

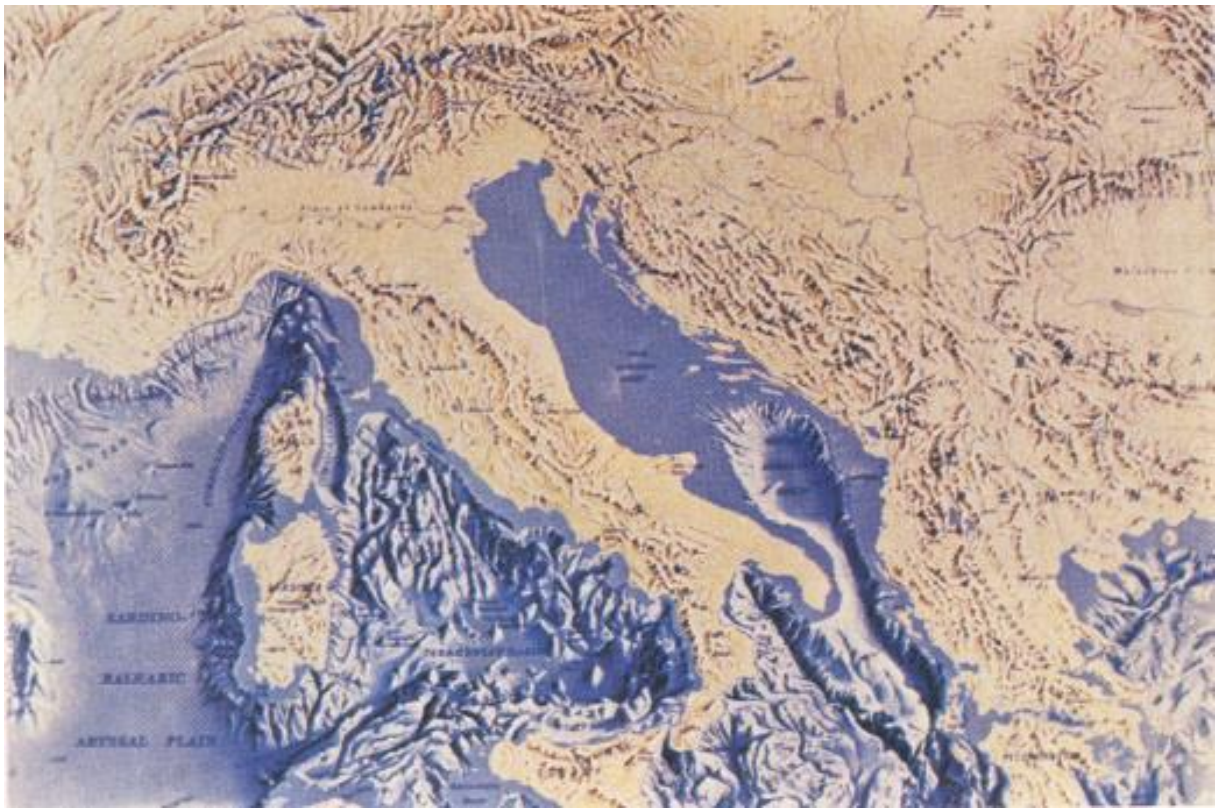

Figure 19

Figure 20

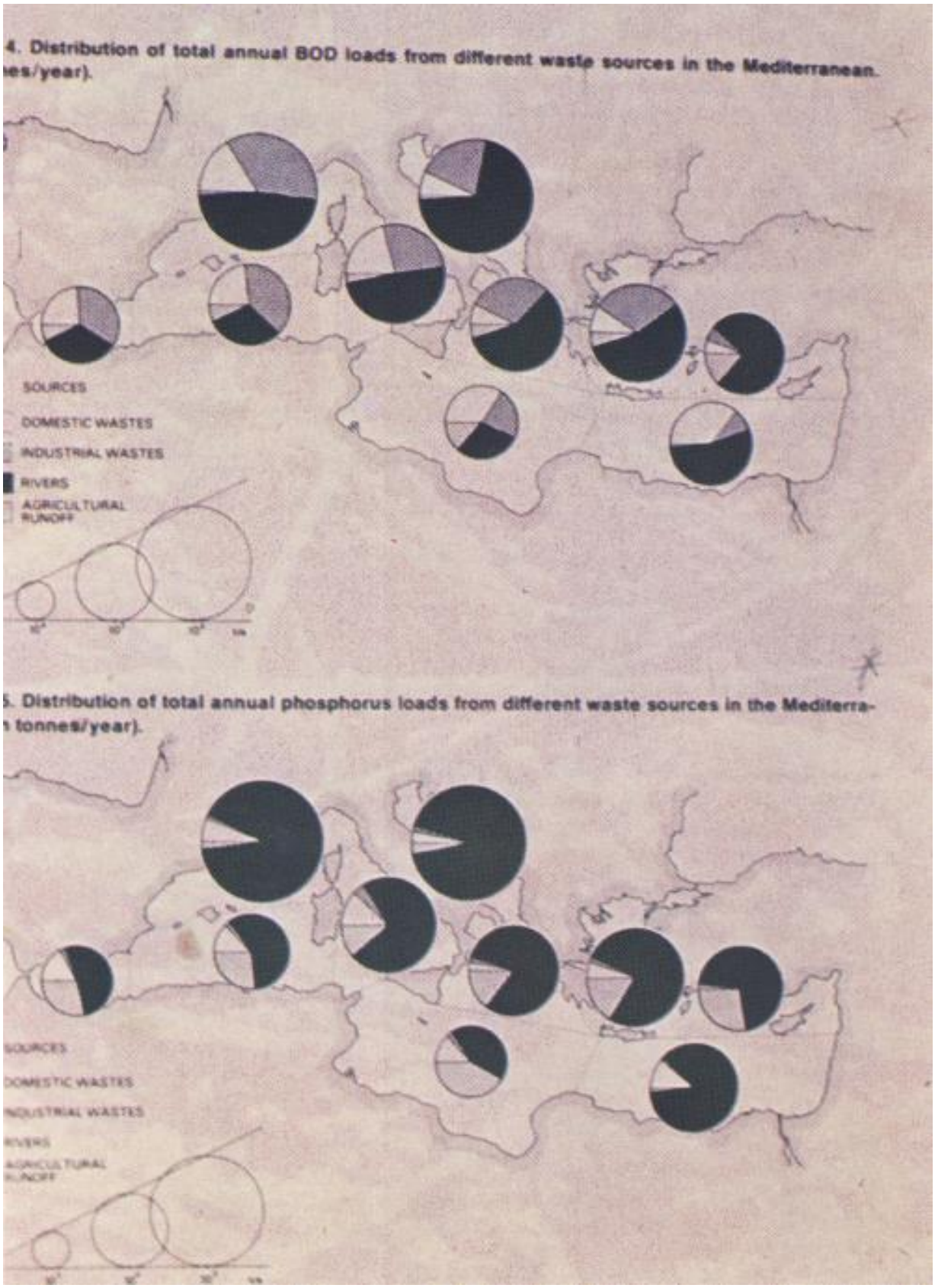
4. Distribution of total annual BOD loads from different waste sources in the Mediterranean.
es/year).
SOURCES
DOMESTIC WASTES
INDUSTRIAL WASTES
RIVERS
AGRICULTURAL RUNOFF
5. Distribution of total annual phosphorus loads from different waste sources in the Mediterra-
tonnes/year).

Figure 21

Figure 22

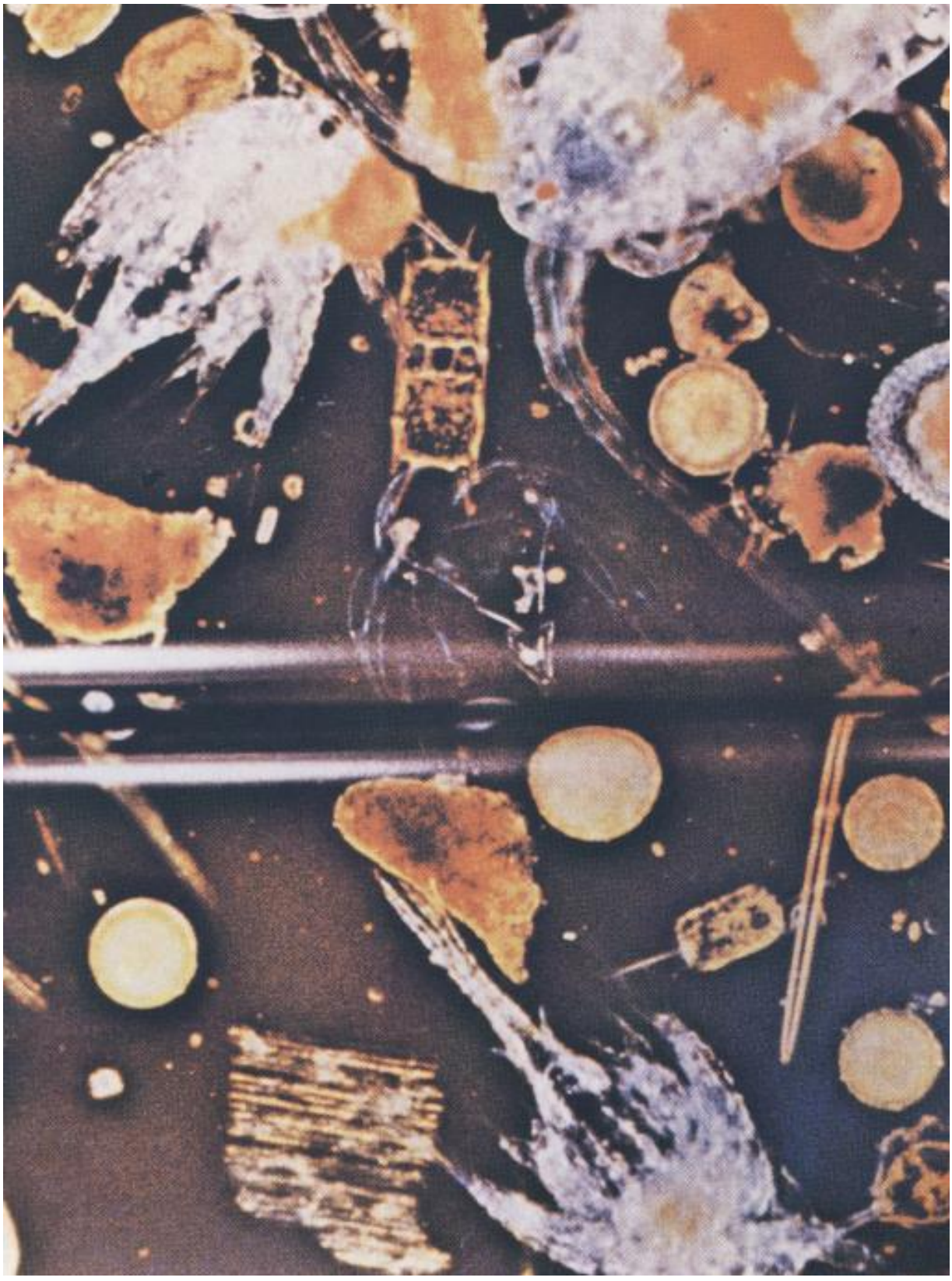

Figure 23

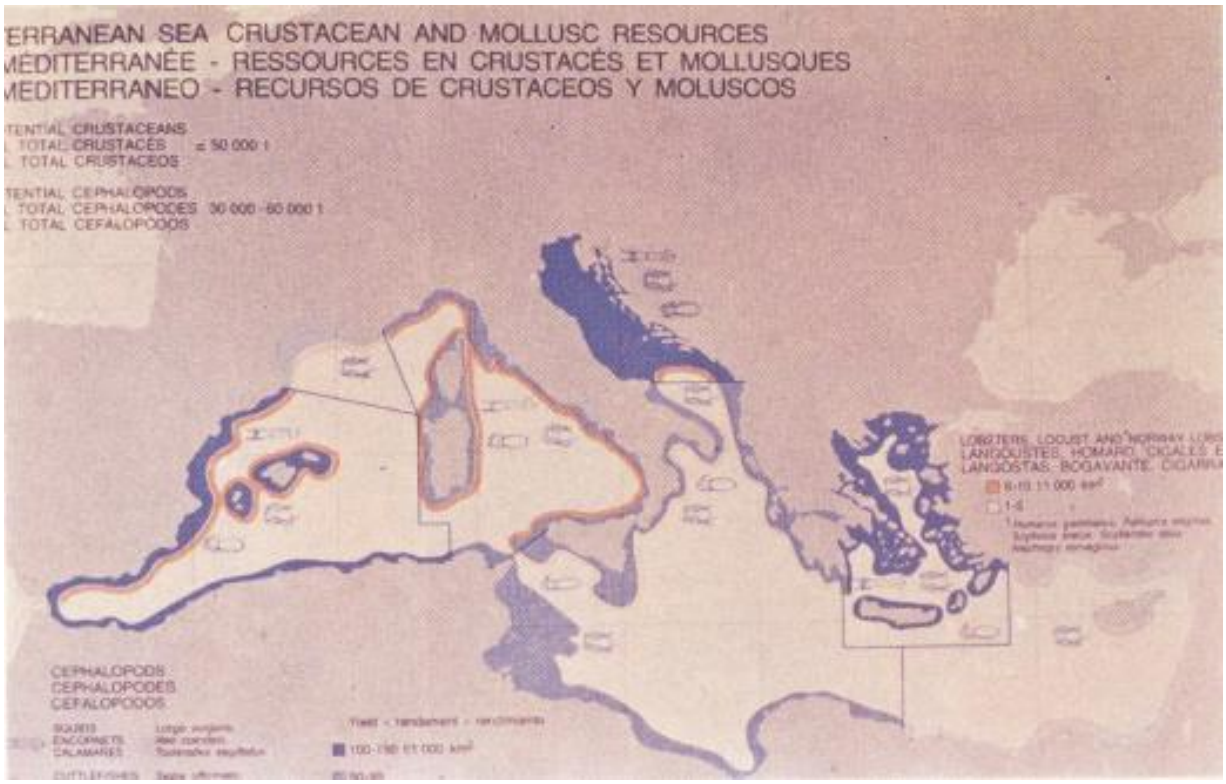

Figure 24

Figure 25

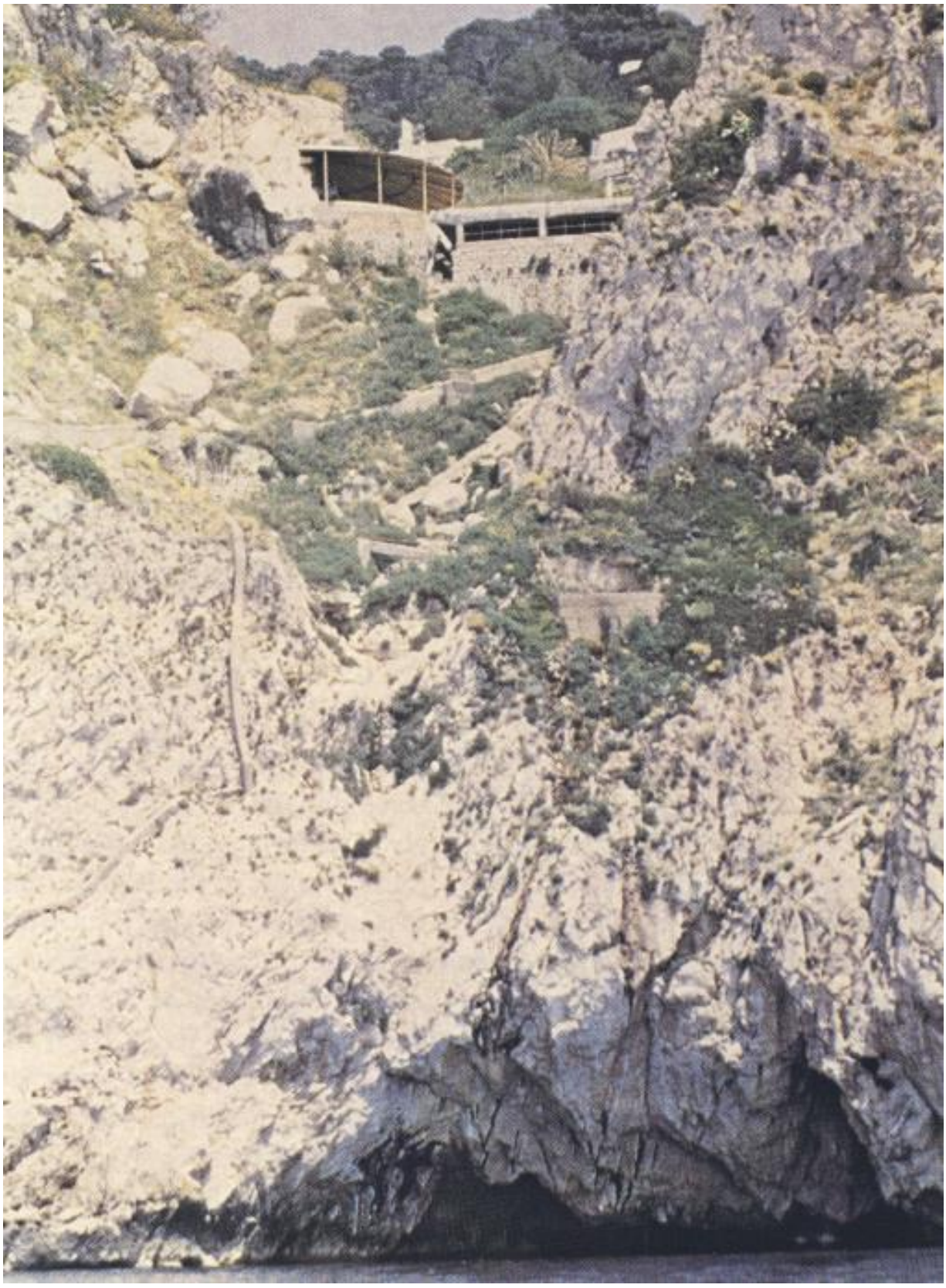

Figure 26

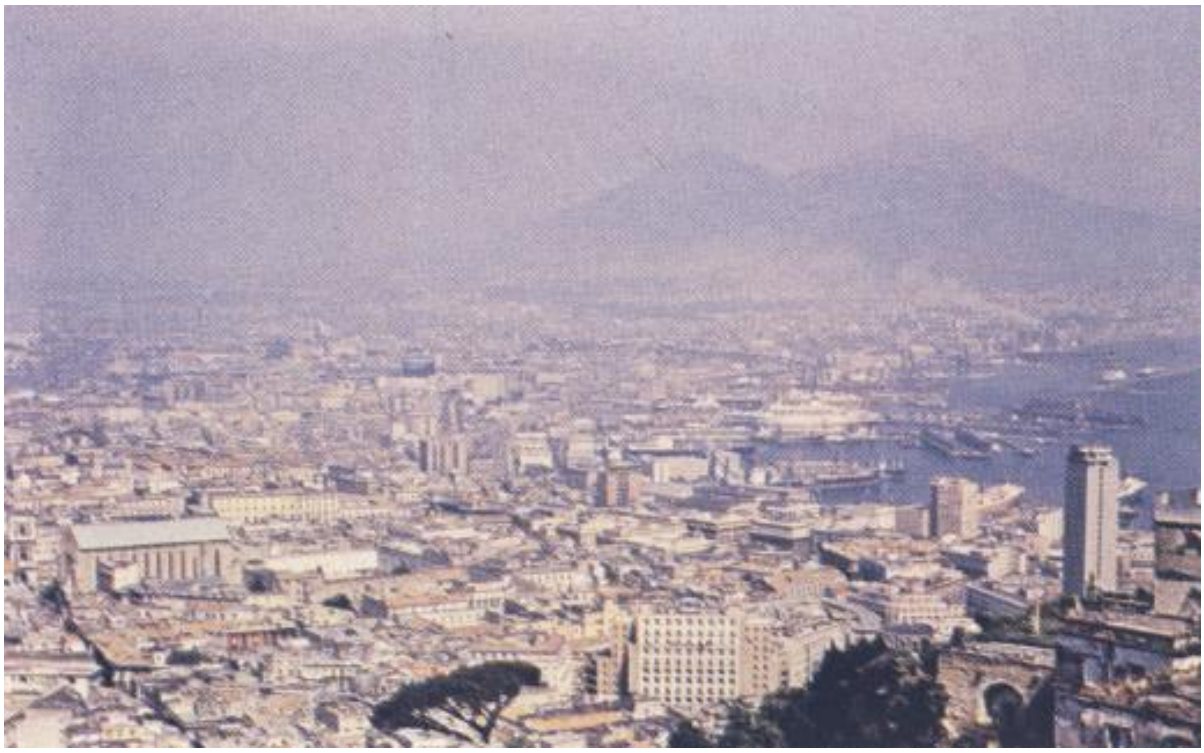

Figure 27

which tectonic processes continue today ad evidenced by the volcanic and earthquake activity of the northern borders. As recent as 10.000 years ago portions of the present sea bottom was a dry desert due to eustatic changes in sea level.

During recent geological history, this semi-enclosed body of water has been subject to a wide range of ecological events that has evolved to the current ecological balance. It has been populated extensively far the past three thousand years and with modern industry beginning in the middle nineteenth century.

Tectonic pressures along the northern border produce recurrent seismic and volcanic activity resulting in localized impact of disrupted waste lines and volcanic materials. Civilizations have altered the vegetation patterns, deforestation has created extensive soil erosion and agricultural activities have resulted in soil erosion and the runoff of chemicals and fertilizers into adjacent waters.

The general features of population pressures can be shown in the following figures and tables. The sea (Figure 9) is divided into two general regions separated by the peninsula of Italy and Sicily. Five separate basins are isolated by the land masses, bottom sills and ridges. The rainfall pattens show a concentration in the north central region of Italy (Figure 10). The principal rivers are show in Figure 11.

The Nile River flow was regulated by the Aswan Dam constructed in 1956, that changed the flow pattern and restricting the inflow of floods of water, sediments and nutrients which are now generally trapped by the dam. The Dolomite mountains in the northern area, the desert sands of the southern area and the low river input into the Mediterranean sea has resulted in a restricted input of nutrients by runoff.

The evaporation in the eastern Mediterranean is greater than the rainfall and river input and that produces an increase in salinity in the eastern basins. As a result the lowering of sea level and development of a more dense eastern basin water, produces a dense bottom current flow-ing to the west. As a result there is an outflow of water through the bot- tom of the strait of Gibraltar and in inflow from surface Atlantic water (Figure 12 and 13).

Population statistics for both adjacent states and costal areas are shown in Figures 14 and 15. Industrial centers are shown in Figure 16, the distribution of mineral industry is shown in Figure 17, and oil distribution in terms of total transportation and use are given in Figure 18. These figures and data indicate those areas along the coast where urban and industrial pollution may be expected to be more concentrated.

The general pattern of circulation and low influx of nutrients by river distribution and flow, results in a net loss of nutrients by bottom water through the straits of Gibraltar. The major rivers of the total system enter into the black sea where the nutrients are trapped in the dense saline and low temperature bottom water. The transfer of nutrients between the Black Sea and the Sea of Marmara are minimal.

The Nile no longer provides a significant source of nutrients. As a result the Mediterranean sea is a rather poor sea as compared with other marginal seas, and as a result has an annual fish catch of only approximately 1.2 million tons per year.

This catch is less than half of that the Gulf of Mexico based on catch data per unit surface area. This fish catch in the Mediterranean has been generally increasing through the years indicating no loss that can be attributed to pollution. In fact the growth of coastal populations and a concurrent small increase in fish yield may be attributed to an input of urban or industrial wastes that are acting as nutrients.

Approximately 50 percent of the Mediterranean fish catch originates in the Adriatic Sea due to the input of nutrients from the river Po. The river enters into the shallow northern of the Adriatic sea (Figure 19), where at certain times of the year localized areas of eutrophication does occur. However the general overall circulation and oxygen distribution partners provide environmental conditions fora high primary productivity resulting in the high proportion of Mediterranean fish caught each year in this location.

Figures 20 and 21, show the introduction of pollutants BOD and phosphorous by region. These figures and the earlier figures for population and industrial density show that Italy is in the center of an area where pollution may be expected to beat a maximum.

The publication by Oppenheimer et al. 1981, on the environmental balance of the Gulf of Naples clearly illustrates the extent of pollution of the coastal environment. In some areas such as the Island of Capri and other cities, sub marine outfall pipes has removed pollution from the shoreline. However other areas still introduce wastes directly into rivers, the harbor of Naples or the shoreline.

The giant waste treatment plant of Cuma only serves a limited portion of the population and introduces its effluent directly along the shore at Cuma, a shallow environment with little coastal currents that has resulted in localized coastal eutrophication odors and general esthetic pollution.

Pollution is a man made term to identify areas where the introduction of wastes exceeds the natura! process of self purification. The several! million natura! organic molecules are generality degraded and mineralized or recycled by microorganisms. If the proper

concentration and types of microorganisms are present and time is sufficient, all natural organic compounds are degraded to their mineral components. This does not include highly polymerized plastics. As microorganisms are highly ubiquitous, mineralization is a rapid process. Figure 22 il- lustrates a surface of a marine algae and the colonization of several types of microorganisms ready for their mineralizing activities after the death of the plant.

The released inorganic materials are then available to the plants to produce organic matter using sunlight energy and are subsequently available to higher filter feeders shown in Figure 23. Ali productivity is related to the nutrients nitrogen and phosphorous and Figure 24 shows the density of crustacean and mollusc catch in the mediterranean and the significant catch in the Adriatic Sea. Figure 25 illustrates the intense tourist use of the Adriatic Sea during the peak of summer.

The very large data base available for the Mediterranean Sea and data and information from other parts of the marine environment, pro- vides a basis for evaluating the present state of pollution or environmental balance of both the Mediterranean and the Italian coast.

The open parts of the Mediterraneo, while poor in relative primary production, ap- pear to be within normal balance for oxygen concentration, one of the prime parameters used to indicate unbalance of any aquatic system. Oxygen concentration along with the continuously increasing fish and shellfish catch provide the basis to state that the sea is in general environmental balance.

While the open sea is in balance, the shorelines are highly polluted in areas of mans activity. The practice of releasing solid and liquid wastes directly into the shore waters has lead to both eutrophication and public health problems. Figure 26 shows a waste treatment plant in Capri that discharges its effluent near the shore and Figure 27 shows the direct release of sewage and street runoff in the Harbor of Naples.

What is solution to the pollution problem. The state of the art advanced secondary water treatment plants and the disposal of solid wastes in sanitary landfill or burning are very costly and while eliminating some problems, create others. Burning produces air pollution and the water and sludge of waste treatment plants still require disposal. There is an alternative that may reduce both initial and operating costs for disposal and not unbalance the shore environment.

Offshore disposal of wastes has been in practice for decades and there is a large body of literature on the «pros and cons» of such open coastal water disposal. However these comments are related to conventional systems. There needs to be a new approach to the disposal of wastes using the scientific knowledge of chemistry, physics and biology. We understand through satellite and *in situ* studies, the coastal currents and dilution that may result from coastal dynamics.

Il one could transform wastes to very fine particles, flash pasteurize the material, mix it with sea water and reinoculate with active degrading microorganisms and this product placed in_ an area of proper dilution, a new concept of waste disposal emerges that is compatible with both economics and the environment.

If modern advances in colloid chemistry and the use of microbial communities designed for maximum activity of decomposition, are applied to wastes, it is possible that degradable wastes could be changed during the process to available nutrients in the disposal area.

This concept is entirely feasible, when one merges the concept of ocean outfalls, a change of state of the waste materials, a knowledge of the toxicity potential and dilution required to reduce toxicity, proper disposal in an oceanographic area and the application of microorganisms.

An examination of the scientific literature involving biology, geology, chemistry and oceanography of both the Mediterranean and the Campania Region suggest that biodegradable wastes can be accepted if properly distributed in the offshore areas. The low values of nutrients present away from the coast and the extensive nearshore current structure support this evaluation. Properly designed areas with the proper currents, dilution, temperature and chemical balance, can accept biodegradable wastes from both industry and urban sources from the entire Campania Region.

In the above information I have shown only a few examples of in- formation on the dynamics of the Mediterranean Sea and the Campania region to illustrate bow one can use such information for environmental disposal of wastes and to show the relative areas of maximum loading in in the sea... I have also suggested a new approach for the open ocean disposal of compostable, non-toxic, liquid and solid wastes that in- volves a change of state of the waste, the application of active populations of microorganisms to accelerate degradation, a concept of removing possible disease organisms and the disposal in an area of optimum dilution.

The combination of these processes is designed to change the wastes to nutrients that will enhance biological populations along coastal environments.