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# IMPLICATIONS OF CLIMATIC CHANGES ON THE ALBANIAN COAST

## DRAFT

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## EXECUTIVE SUMMARY

The study on Implications of Expected Climatic Changes on the Albanian Coast is undertaken within the framework of the Coastal Area Management Programme (CAMP) of the Coordinating Unit for the Mediterranean Action Plan.

The analysis of existing information and the evaluation of the implications of the predicted climatic changes was undertaken by a Task Team of national and international experts. The study is based on the scenarios of future climate developed by the University of East Anglia The objectives of this study were.

1. to identify and assess the possible implications of expected climatic changes on the terrestrial, aquatic and marine ecosystems, populations, land use and sea-use practices, and other human activities;

2. to determine the areas, systems and activities which appear to be most vulnerable to the expected climate changes;

3. to give recommendations for planning and management of coastal areas and resources, as well as for planning and design of major infrastructure and other systems;

4 to provide an input into other projects and developments relevant to the subject of the study.

The climate of Albania is typically mediterranean, mild winters with abundant precipitation and hot dry summers. It is also influenced by depressions of Genova Bay and Siberian and Azore anticyclones. The mean annual temperature variates between 14.7-17.6°C, increasing from north to south and from west to east. The total precipitation oscillates from 900 mm in the middle to 1900 mm to the northern part of the zone.

According to the scenarios of climate changes the annual temperature is expected to increase less than the global level from south (0.7-0.9°C per degree of global warming) to north (0.9-1°C) along the coast and toward the inland by 2030. The change in annual precipitation is expected to be small and decreasing from north to south.

The seasonal patterns as a result of global warming, especially that of summer and autumn, are different from the annual one. A more detailed discussion is presented in Annex I.

These climatic changes and the sea level rise (+16 cm) by 2030 are expected to haven't any significant impact. There is a possibility for both natural and managed systems to adapt in new conditions.

The difficulties will probably arise from the expected changes by 2100, taking into consideration, at the same time, the influence of other non-climatic factors, such as the increase of population due to movement toward the coastal zone.

Concretely, the expected increase in temperature and the precipitation shortage in summer will worsen the water availability problems, whereas the increase in autumn precipitation will increase the water turbidity. On the other side, sea level change might influence the increasing of the content of saline water into aquifers and fresh water resources of the coastal area. Durrës Plain and less Velipoja and Vlora Plains are expected to suffer the increase of salinity.

As a result of expected sea level rise, the advance of sea in certain areas, changing them in flooded areas or ligatines might be expected. For instance, Patoku Lagoon might suffer the destruction of existing barriers, increase in sea level in Ceka Lagoon, formation of a new ligatine around the Mati Delta etc., are expected. Although a very significant exchange of the coastline would not occur, a more

active water exchange between lagoons and sea is expected. The other consequences in lagoons, such as high temperature and salinity, less dissolved oxygen etc., would cause considerable changes in vegetation and ecosystem around. The vegetation will change in favour of halophile-hygrophile or salt marches, and the characteristic vegetation will transfer in the internal part of the territory. The agricultural production and the forestry must be adopted to the expected soil and atmospheric conditions (increased temperature and evaporation, scarcity of precipitation, increased salinity, pests, etc.), that would result as natural consequences of climate change.

Along the rocky coast the expected rise of sea-level will be accompanied with the transfer of hind littoral towards the terrestrial area and mediolittoral towards the hind littoral. The transfer will understandably occur with their constituent biocoenosis. Temperature rise may affect the growth of thermophile elements of coastal flora and fauna or their spread in north. There might be expected a slight change in the existing ratio Rhodophyta/Phaephyta. Changes can be expected even in the composition of plankton and especially in its seasonal dynamic as well as in the arrival and departure timing of the migratory species.

The rise of winter temperature is expected to be of positive influence for agriculture. It will likely favour the cultivation of early agricultural products in open air or greenhouses.

The temperature change and concentration of the precipitation toward the spring at 2100 may influence the exchange of soil moisture during the vegetation period, on the evapotranspiration as well as on the possible prolongation of summer season

The summer with expected higher temperature (up to 2.8°C) and a shortage of precipitation (from -68 to +13%) might cause deteriorate effects for agriculture, unless the irrigation problems be solved properly. Also, crops which have great water demands (such as vegetables, olive groves, etc.) will suffer the consequences of precipitation decrease, hence, the use of more xerophilic crops might be required.

The similar problems might arise concerning the forest species. Those species that resist against the high temperature and severe long dry season should overlive, probably in higher flats; those that need moisture (silver fir, etc.) are in danger to be limited or disappear and the others that produce many seeds (Pinus, etc.) are likely to spread on the sea level altitude.

In forests and pastures, the fires would be more frequently and too much dangerous; also, many pests that might be appeared and grown in the heat conditions will be too much dangerous for forest trees (*Cnethocampa pityocampa, Evetria buoliana, Limantria dispar, etc.*).

Concerning to the energy problems, it is to be pointed out that the less energy consumption during winter due to expected warming is likely to be compensated by the higher demand of energy in summer. Increasing demand for ventilation and air conditioning will influence the increasing of outside temperatures during the "prolonged summer". It may cause some other problems for other activities in open air.

The significant decrease of precipitation and the possible increase of salinity of coastal aquifers, due to sea level rise, could lead to greater difficulties not only for the industries using mainly fresh water, such as food industry, but also for the population, tourism, health and recreation activities. It assumes an increased demand for energy for the water treatment before use.

Insect -borne diseases may well become widespread in the future warmer climate conditions, either because the vector will be able to survive better at higher latitudes or because parasites may be able to complete their life-cycle more easily. Temperature increases will lengthen the breeding season and survival rates of a number of insect vectors, including species of anopheles mosquito.

Not only the problem of drinking water will become especially keen during summer, but also the liquid and solid waste, going directly into the sea will destroy the sea flora and fauna. Without solving the two last problems the impacts of climate change would deteriorate the health conditions of the Albanian population living not only in the coastal zone.

However, it is very difficult to distinguish the impact of climate change on the socio-economic structure from the reverse one, that of human activities in climate change.
In order to prevent and mitigate in proper time the impacts of expected climatic changes, the task team recommends among others a number of activities, which should be part of the national plans and strategies ought to be undertaken:

A. A strategy to prevent and avoid in proper time the impacts of climate changes, keeping in mind the continuity of these changes is required.

   1. The local inventories of impacts of temperature and precipitation changes and sea-level rise on water, ecosystems and socio-economic activities must be prepared. The precise identification of the territories that possibly will be implicated by climate changes is recommended.

   2. The impacts of climate changing must be taken into consideration by developing integrated planning.

   3. The using of renewable energy, as a resource that does not cause pollution ought to have priority.

   4. The information about possible consequences of climatic changes and the need to take the necessary steps for their avoidance must be distributed to all levels of economic and political decision makers.

   5. A cost benefit analysis is important to be made in order to evaluate the feasibility of the expenditures for mitigation and the vulnerable effects of climate change.

### 1.1 Background

Changes in global climate are dominated by the increase of greenhouse gas concentrations (the greenhouse effect) due to human activity. The greenhouse effect means that the average temperature on Earth is 33 degrees Celsius higher than it would have been in the absence of what is a natural phenomenon.

This effect is one of the most important processes which take place in the atmosphere. It exists because a number of gases, the greenhouse ones, which occur there naturally, allow sunlight to pass through virtually unhindered. The Earth absorbs heat, part of which is re-radiated. Part of this re-radiated heat is retained by the gases, which causes the atmosphere to warm up. The process has been going on for centuries without problems.

But the greenhouse effect does become a problem if it become enhanced. Such an enhancement does exist because the humankind emits enormous quantities of greenhouse gases. For this reason carbon dioxide, methane, nitrous oxide, ozone and CFCs occur in the atmosphere at higher than natural concentrations.

According to the 1990 Assessment of the Working Group of the IPCC (for a "business as usual" scenario) the predicted increase in the global temperature is to be about 1°C at 2025 and 3°C before the end of the next century. It is also estimated that the magnitude of sea-level rise could be about 20 cm at 2030 and about 65 cm by the end of the next century. The 1992 IPCC update (Houghton et al., 1992) confirmed the 1990 estimate of a 0.3°C temperature increase per decade, but reduced the range of uncertainties for a doubling of $CO_2$ on the basis of a large number of newly assessed physical and societal scenarios. The "best estimate" average warming is of 2.5°C (range 1.5-3 C) for a doubling of $CO_2$; the sea-level rise estimate is for a mean +12.5 cm by 2030; mean +22 cm by 2050; and a range +28-60 cm by 2100.

The 1994 Report of the Scientific Assessment Working Group of IPCC reconfirmed the amount and the positive contribution of the gases carbon dioxide, methane, nitrous oxide and halo carbons which are increased through human activities, since pre-industrial times, $CO_2$ has increased from about 280 to 356 ppmv and has the largest contribution to greenhouse gas radiative forcing (1.56 $Wm^{-2}$), which is the effect that gas has in altering the energy balance, the increase of methane ($CH_4$) from 0.7 to 1.7 ppmv, contributes about 0.5 $Wm^{-2}$ to radiative forcing; the increase of nitrous oxide from about 275 to 310 ppbv contributes about 0.1 $Wm^{-2}$; the increasing of atmosphere concentration of different halocarbons contributes positively to radiative forcing.

The changes in concentrations of ozone and aerosols and the natural factors, such as the sun and volcanic eruption (Mt. Pinatubo in June 1991) are believed to contribute positively and negatively to radiative forcing, but a detailed analysis of this theme is beyond the subject of our study.

Substantial global warming is virtually certain, but the attending changes in climate at the regional level are uncertain. At present, it is difficult for scientists to prove when the effect of climate change are expected to occur. Climatic changes that impact the environment such as air temperature, precipitation and sea-level change are well defined, but change in other aspects, such as vegetation, soil, water, ecosystems etc. are not precisely determined

Analyzing the case studies for the Mediterranean countries will require the government to take the necessary financial steps to prevent the deterioration effects of climate change. There will be new investments (Jeftic et al.) for reducing the impact of sea-level rise as well as for insuring adequate water amounts for agriculture and the population of a given area. The relation between greenhouse effects and problems of energy, agriculture, urbanisation and environment in general will require that new strategies for socio-economic development, technology environment protection against pollution etc. to be developed. As this is such a complex and important problem, the government and the decision makers must not wait until the effects of climate change appear.

The objective of this study is to examine the possible consequences of temperature and sea-level rise, and of the changed climate for the Albanian coast, to estimate its possible implications on the terrestrial, aquatic and marine ecosystems, population, land use and other human activities. The team report represents the efforts of a multidisciplinary Task Team to identify the impacts of the predicted climate changes and sea-level rise, to determine the most vulnerable areas and ecosystems and to suggest necessary policies to avoid and mitigate the negative effects.

Although the magnitude of the expected impacts of climate changes cannot be predicted exactly in this report, it is of great importance for the decision makers to come to a good understanding of the processes which are changing the climate and the environment in Albania.

### 1.2 Basic facts about Albanian coast

Geographical position and population

Albania lies on the west side of the Balkan peninsula. To the north and north-east Albania is bounded by former Yugoslavia and to the south and south-east by Greece. To the west and southwest it is bordered by the Adriatic and Ionian Seas.

Albania extends over an area of 28,748 square kilometres; the population in January 1993 was estimated at 3,166,025. More recent estimates indicate that the 1992 population was 3.3 million.

Relief

Albania is mainly a mountainous country; 76.6% of the land is mountains and hills, while the plains up to 200 metres above sea level occupy only 23.4% of the land.

Albania's coastline is 447 km long. Along the coastline are many lagoons, sand belts and sand dunes. Three main climax vegetation zones can be recognised in the coastal region: xeromediterranean *sclerophyllic maquis* (Karaburun peninsula and Sazan Island), eumediterranean evergreen forest (mainly in the central coastal area), and submediterranean *xeric* broadleaf forest (mainly in the northern coast). Extensive pine forests have been planted along the sandy coastal strips. A series of valleys, which lie across the country, link its coasts with the interior of the country. The lowlands of the Adriatic coastline, previously covered with marshes and swamps, have now been converted into arable land.

The Adriatic section of the coastline is under constant dynamic change due to river inputs and the seismic profile of the area and is considered as accumulative. The Ionian coast is rocky with small beaches and limited sandy areas. The majority of freshwater sources in the Ionian section of the coastline are underground with outlets directly to the sea

Climate

Albania is situated in the Mediterranean climatic belt, with a hot dry summer, a generally mild winter and abundant rainfall.

The climate is warmest in the south-western part which is mainly under the influence of the warm air masses from the sea. The winter is moderate with average temperatures rarely falling below zero and the summer is hot (absolute maximum July temperature recorded is 44 °C ). The climate is coldest in the north-eastern part which is mainly under the influence of continental air masses. The winter is cold with frequent minus temperatures (absolute minimum temperature recorded is -35 °C).

Rainfall in Albania is abundant. Average annual rainfall is over 2,000 mm in the Alps in Northern Albania and 650-700 mm in the valleys of the interior. 40% of the annual precipitation falls in the winter. Summer droughts are more pronounced towards the southwest.

Rivers and lakes

Due to the rugged relief of the land, rivers are torrential with a high erosive power. Rivers originate from the high mountain regions, open out into the plains and flow into the Adriatic Sea. The normal river flow is an average of 33 litres per second. The longest rivers are the Drini river, on the eastern coast of the Adriatic (285 km long), Mat, Shkumbini, Semani and Vjosa.

The rivers of Albania constitute an important source of hydroelectric power. Three hydro-power stations have been constructed on the Drini river while it is intended to turn the river into a series of lakes to serve the already existing hydro-power plants or those to be constructed on it. Hydro-power plants have also been constructed on the Mat and Bistrica rivers.

The lakes are of varying origin: glacial lakes in the highlands, karstic lakes on the hills, tectonic lakes (Shkodra, Ohri and Prespa) which are the largest and most important in terms of fisheries, and lakes of the lagoon type which are large fishing reserves.The lakes of the hills and highlands are also used for irrigation purposes.

Specially protected areas

Eleven coastal protected areas are known for Albania:
Kune; Vaini; Rushkull; Fushe Krujë; Pishë Poro; Karaburun Llogara; Divjakë; Velipojë; Nartë; Butrinti.

Rare, endangered and endemic species

The Albanian flora and fauna includes a considerable number of endemic and sub-endemic species.

Most rare and threatened species of plants belong to the *Ranunculacae Compositae* and *Orchidaceae* families.

With regard to vertebrates available information is scarce for defining their present status.

The Dalmatian pelican (*Pelecanus crispus sterna albinforms*) is a threatened species and the world population is assessed to be 700-1,100 individuals. The Karavasta lagoon is the only nesting site in Albania with about 50 nests in 1992.

The curlew (*Numenius sp.*) is very rare in the Mediterranean and seems confined to Albania. It was sighted on several occasions in the Fushe-Kuqe Patok Nature Reserve.

The pygmy cormorant (*Phalacrocorax pygmaeus*) nests in the Ceke and Merxhani lagoons, and in "Franc Joseph" Island (close to the outlet of the Buna River) among mixed colonies of night herons (*Nycticorax nycticorax*), little egrets (*Egretta garzetta*) and glossy ibis (*Plegadis falcinellus*).

The presence of sea turtles is well established along the Albanian coast. The existing population number may be grossly underestimated. The loggerhead turtle (*Caretta caretta*) has been sighted along the Ionian coast (Karaburun peninsula). The presence of the green turtle (*Chelonia mydas*) is not excluded.

The brown bear (*Ursus arctos*) seems to inhabit mainly the high forests throughout the country; the most important populations are recorded in the following areas: Lurė (Peshkopi), Germenjė (Kolonjë), Cangonj (Korçe), Hondisht and Llengė (Pogradec).

The population of the wolf (*Canis lupus*) is assessed at about 400 individuals distributed mainly in the Albanian Alps. This carnivore is hunted because it seems to cause damage to livestock.

The jackal (*Canis aureus*) is rare and seems to have disappeared from the coastal plain.

The otter is widespread throughout most of the country but the animals' range is restricted to the central area, the coastal plain and the Korçė Plain. It occurs mainly in the uplands but considerable populations are also encountered in some lowland areas and coastal marshes (Lezhė Lagoons).

The polecat (*Mustela putorius*) is becoming rare and the pine marten (*Martes martes*) seems to be scattered in range (from the Albanian Alps to the Gramsh district). The weasel (*Mustela nivalis*), stone marten (*Martes foina*) and badger (*Meles meles*) are rare.

The lynx (*Lynx lynx*) and wild cat (*Felis silvestris*) are rare and very restricted in range; for the first species the Thethi National Park and surrounding area seem to maintain the best population. About 50 lynxes have been observed.

The monk seal (*Monachus monachus*) was sighted in the 1980s in the Butrinti and Karavasta lagoons. It is possible that resting and breeding sites are present along the coastline between the Vlora gulf (Karaburun peninsula) and Saranda gulf. There seems to be a colony of between 5 and 10 individuals at the level of the Karaburun peninsula.

Sites of historic interest

Albania has a rich cultural heritage and several monuments and objects of archaeological interest are scattered throughout the country.

Archaeological finds are much diversified and include prehistoric settlements, burial sites, monuments, dwellings and necropolis of Illyrian towns, and ruins of castles of the early Albanian Middle Ages.

The most important prehistoric finds have been excavated close to the built-up area of Maliq, Tren, Podgorie, Vashtëmia, Dunaveç, Kamnik, Barç Kuçi i Zi, Prodan and Rehova, in southeast Albania. Excavations have been carried out in graves of Kruma, Keneta and Cinamak in northeast Albania, of Cakran and Patos in the coastal plain, and of Vajza, Dukat, Xara and Cuka in southern Albania.

Several necropolis of the ancient Illyrian period have been discovered in Ploça (Amantia), Antigonia, Krotina (Dimallum), Hecal (Byllis), Selca, Poshtëme, Apollonia, Durrës (Epidamnos, Dyrrachium), Butrinti (Butrorum) etc. In Byllis, one of the biggest Illyrian towns, a theatre of about 7,500 sets has been discovered.

As regards early Middle Age settlements, important finds have been found in Lezhe, Koman, Krujë, Berat, Ballsh, Kosine, Peshkopi etc.

Agriculture

Agriculture is the Albanian economy's most important sector in terms of value added and employment. In recent years the sector accounted for about 20% of exports and 50% of employment. In 1990 about 705,000 people were employed in agriculture and forestry and an additional 100,000 in related sectors.

Emphasis is placed on the production of cereals. Major crops include sugar beet, cotton, grains, beans and sunflower seeds. The olive tree is also considered as a most suitable exportable product. The country possesses around 6 million olive trees of which the 4 million are productive. Livestock provides almost half the value of production.

During the period from July to March 1992 the agricultural sector was severely affected by input and foreign exchange shortages, social upheavals linked to the privatisation of cooperative land and assets throughout the country, and disruptions caused by the absence of alternative distribution and allocation mechanisms to replace the collapsing centrally planned system. Social and economic chaos led to rapidly falling living standards for the vast majority of the population, especially in poor rural areas. Agricultural surpluses dwindled to almost nothing as Albania's 380,000 new private farmers concentrated on ensuring the subsistence of their families.

Industry

Industry in Albania is predominantly small-scale with a bias towards engineering, chemicals, construction materials, food processing and other agro-allied industries.

Until the recent political and economic crisis, the industrial sector was, along with agriculture, one of the main contributors to the Albanian economy, accounting in 1990 for 23% of the total employment and 58% of the gross national output. At that time, heavy industry, the food industry and light industry accounted for about 31%, 28% and 20% respectively of the total industrial production.

The chemicals sector which includes 5 main factories producing soda and PVC, nitrogenous fertilisers, pesticides, pigments and paints uses outdated Chinese and Albanian equipment and technology with a low performance due to design faults, poor maintenance and shortages of national and imported raw materials. Several of the chemical plants, in particular the phosphate fertiliser and caustic soda plants are hazardous to their workforce and release significant amounts of gaseous and liquid wastes loaded with toxic substances into the environment.

Oil extraction and refining is very important for the national economy, employing about 20,000 workers. At present there are about 3,500 operational oil wells out of which 2,000 are concentrated in the onshore oil fields near Patos (Fier). The oil produced has a high density (0.94 to 1.0) and quite a high sulphur content. The aggregate capacity of the four refineries at Ballsh, Fier, Kucova and Cërrik is about 2.7 million tons per year although the present level of utilisation averages 23%. Most of the refined products are for domestic use.

Despite considerable efforts to revive the industrial sector after April 1992 which resulted in the rehabilitation of several enterprises, the Albanian industry remains in the grip of financial collapse due to heavy debts.

Tourism

Tourism in Albania is only at a very early stage of development. However, the country exhibits considerable potential for the development of tourism due to the extensive coastline, the interesting scenery of Albanian lakes and mountain regions and the generally pristine countryside.

Without excluding the possibility of the development of large-scale tourism, the potential for the development of high quality small-scale tourist villages to be harmoniously integrated with existing villages and for the development of echo-tourism is being considered.

Several contracts for the construction of hotels and tourist villages including the construction of a tourist port and airport have already been signed with major Austrian, French and Italian companies involving investments of up to 280 million US$ and the prospect of a further investment of 50 million US$ through a contract with a Swiss company. Negotiations are also under way with American, German, Kuwaiti and other companies.

Energy

The electric power system of Albania is supplied mainly by hydroelectric power plants, which account for about 85% of generating capacity and 95% of total generation. The total generating capacity is 1,662 MW of which 1,444 MW are hydroelectric.

Ten hydro-power plants are currently in operation. The three largest power plants form a cascade system on the river Drini in northern Albania.

The major thermal power plants are fuelled either with crude oil or natural gas although the supply of natural gas has been almost non-existent since 1983 due to a serious accident and fire at an oil well which produced associated natural gas. The present supply of crude oil has a very high sulphur content.

Several smaller thermal units for combined heat and power generation are located in the cities, including Tirana. Such plants generally burn brown coal. The reported sulphur content of brown and bituminous coals is 3-5% and about 7% respectively. The risk of air pollution is therefore very high.

Summary of the present state of the economy

Albania ranks as one of the poorest countries in Europe. Low levels of productivity and capital investments combined with shortages of skilled labour are major constraints of the growth.
The economy in Albania is in the midst of a deep crisis with an annual inflation rate in 1992 of 300%, a foreign debt exceeding 800 million US$, an output decline of 75% compared to 1989 and a budget deficit three times larger than in 1991. The macro-economic situation during 1994 is improved in comparison with the former years. Thus, the GDP is increased by 7.4%, the inflation was 15.8%, and

the internal financing of budget deficit exceeded 8%. Of the estimated 364,641 jobless in the beginning of 1993, about 20% of the labour force, 3.5% were university graduates, 45% had completed high school and 51% had only eighth grade education indicating that at least 80% of the unemployed lack basic training.

There are more than 400,000 spread throughout Europe and in other parts of the world each having provided substantial amount of foreign currency to their families in Albania over the past two years.

Agricultural surpluses have dwindled to almost nothing as the 380,000 new private farmers have concentrated on ensuring the subsistence of their families. The industrial sector is functioning at a very low level of production with most of the plants presently out of production, with very limited possibilities of being put again into operation and competing in the "free market" economy. At the same time the Albanian industry also remains in the grip of financial collapse due to heavy debts.

Overview of major known environmental problems

There are no restrictions on the use of chemical herbicides, pesticides and fertilisers in agriculture resulting in the contamination of rivers, canals and groundwater

Waste waters of industrial origin are usually directly discharged into rivers and the sea with very little, if any, treatment.

Waste waters of urban origin are also directly discharged into canals and rivers due to the lack of sewage treatment facilities.

Damage to aquatic life and incidents of eutrophication have been reported due to the improper disposal of industrial wastes into the aquatic environment and unsustainable agricultural practices.

Preliminary results of the National Monitoring Programme indicate that the microbial quality of bathing waters is inadequate in a number of locations along the Albanian coast.

Air quality is a very serious environmental concern particularly around industrial settlements and urban areas. Thermal power plants, coke plants and electric furnaces are hot spots of air pollution. Very high concentrations of soot, sulphur dioxide and carbon monoxide in the atmosphere exist as a result of a combination of the bad quality of raw materials, polluting technologies adopted in the industrial process and a lack of pollution control.

Gases from the smelting process containing high concentrations of sulphur dioxide are damaging the forests over a wide area. Rainwater may reach a high level of acidity, thereby magnifying the effect of deforestation for fuel wood and cultivation. Albania has lost about 20% of its forest land in the last 20 years and soil erosion is becoming a major concern.

Hazardous industrial wastes are disposed of along with domestic waste, or stored, without any procedure for the protection of the surrounding environment.

Fishing practices which are prohibited in other Mediterranean countries, such as the use of drift nets, are occurring in Albanian waters, mainly by foreign trawlers.

Most of the Albanian nature reserves and national parks situated near the coast are used for shooting by foreign hunters and are liable to some poaching mainly from local people. No national laws refer to the protection of endangered species except from a list of 27 protected species, in relation to shooting regulations, which does not seem to apply any more.

## 1.3 Methodology and assumptions used in this study

This report is the result of the collective efforts of a multidisciplinary Task Team to identify the possible impacts of changed climate on ecosystems, socio-economic structures and human activities within Albania, to determine areas which appear to be most vulnerable to the expected changes, and to give recommendations for planning and management of coastal areas and resources.

To attain this aim, each member of the Task Team has worked in preparing one or more chapters of this report, which are discussed at some joint and particular meetings. Two meetings held until now with the participation of UNEP experts were constructive and very useful for the continuation of the work for this report.

Particular attention was paid to the definition of the coastal zone in terms of existing data and their time series. The zones under study, according to the official division of 1990 consist of the following districts: Shkodra, Lezha, Kruja, Durres, Tirane, Fire, Lushnje, Vlore and Saranda.

The analysis of the present situation was made on the basis of existing information (wherever possible, long term data series are used to evaluate the trend) and of the general knowledge of each economic section or ecosystem.

Whenever possible the opinion of other specialists (non-members of the Task Team) were consulted. Some other reports (not in final form) in the framework of CAMP Albania, such as ICAM Durres-Vlore, Blue Plan, etc., are consulted too. In many cases the possible impacts are described qualitatively, because of impossibility to describe them quantitatively.

According to the scenarios prepared by Palutikof et al. (Annex I) two time horizons (2030 and 2100 years) are taken into consideration. Scenarios for future temperature and precipitation as well as sea-level changes are presented on an annual and seasonal basis.

The expected changes set at respective time horizons are given in Table 1.

## 1.4 Temperature and precipitation scenarios for Albania

Kim et al (1984) looked at the statistical relationship between local and large- scale regionally averaged values of two meteorological variables: temperature and precipitations [Palutikof J., 1994]. They then used these relationships, developed using principal component analysis techniques, to look at the response of local temperature and precipitation to the predicted change at GCM grid points. The area of study was Oregon State. Although the paper contains certain statistical flaws, the underlying idea of relating local and large-scale data statistically is sound. The method of Kim et al. has been extended and refined by Wigley et al. (1990) and by Wilks (1989).

The methods of Kim et al. have been modified for application in the Mediterranean region. In the model validation exercise carried out for the Mediterranean region by Palutikof et al. (1992), it was established that no single GSM can be identified as being always the best at simulating current climate. This being the case, there is little merit in presenting scenarios based on only one model. Presentation of scenarios for each of the four models avoids the issue, since the task of deciding which model is 'best', and/or of synthesizing the information to obtain a best estimate, is left to the impact analyst. Therefore, the information from the four models into a single scenario for each variable, according to the method described below, is combined.

The problem with scenario constraction based on a number of models is that the results may be biassed by the different equilibrium responses of the individual models. The global warming due to $2xCO_2$ for the four GCMs ranges between 2.8°C for the OSU model and 5.2°C for UKMO model run. We would therefore expect that the warming indicated by the UKMO GCM for the Mediterranean Basin will be greater then that suggested by the OSU model, even though the sensitivity of the region to climate change when compared to the global sensitivity might be the same. The individual model perturbations have therefore been standardized by the equilibrium (global annual) temperature change for that model, prior to the calculation of the four-model average.

A generalized computer program was required that would be applicable throughout this geographically complex area,and could be used with meteorological records of variable length and density. After investigating a number of approaches to the problem, the procedure summarized below is adopted.

A. Data sets of monthly mean temperature and total precipitation have been complied for the area surrounding the Mediterranean Basin. Stations used in this study of Albania are listed in Appendix I. *Where possible, each record should be complete for the period 1951-88. Any station with a record length less then 20 years in the period 1951-88 for over six months out of twelve was immediately discarded.*

B. Then, for every valid station, the temperature and precipitation anomalies from the long-term (1951-88) mean were calculated. For this part of the work, which is the first step in the construction of the regression equations (the calibration stage), only the data for 1951-80 were used. The 1981-88 data were retained to test the performance of the regression models (the verification stage,see Palutikof et., 1992). For the calculation of the temperature anomaly $At_{ij}$, the simple difference was used:

$$At_{ij} = t_{ij} - T_j$$

where $t_{ij}$ is the mean temperature of month j in year i, and $T_j$ is the long -term mean for month j. The precipitation anomaly $Ap_{ij}$ was expressed as a ratio of the long term mean:

$$Ap_{ij} = (p_{ij} - Pj)/P_j$$

where pij is the monthly total precipitation in month j of the year i, and $P_{ij}$ is the long-term mean for that month. If $P_{ij}$ is less than 1 mm, than this equation is modified to:

$$Ap_{ij} = (p_{ij} - P_j)/1.0$$

The individual station anomalies are used to calculate regionally-averaged anomalies.
A rigorous investigation of the validity of the method has been carried out. In particular, Palutikof et al. (1992) have looked at :

A. the use of other predictor variables in the regression equations
B. performance and verification of the regression equations
C. autocorrelation in the data
D. multicollinearity in the predictor variables.

These aspects are discussed in detail in Annex I, which justifies the approach and also presents sub-grid-scale scenarios for the Mediterranean Basin.The temperature perturbations are presented as the model average change, in degrees Celsius, per °C global annual change. The precipitation perturbation are given as the percentage change for each 1°C global annual change. The results for Albania are listed in Table 1.

Table 1
Scenarios of future climate in Albania deduced from IPCC and UEA

| Scenarios | | Time horizon 2030 | 2100 |
|---|---|---|---|
| IPCC GLOBAL | | | |
| | Temperature | + 1.8°C | + 2 to +5°C |
| | Sea level | + 18 cm +/- 12 cm | + 65 cm +/- 35 cm |
| IPCC Southern Europe | | | |
| | Temperature | + 2°C winter<br>+ 2 to + 3°C summer | |
| | Precipitation | + 0 to + 10 % winter<br>-5 to + 15 % summer | |
| | Soil moisture | - 15 to - 25 % summer | |
| UEA for Albania | | | |
| Annual | Temperature | 0.7 to 0.9 °C | 2.0 to 2.5 °C |
| | Precipitation | -2 to-5 % | -5 to +13 % |
| Winter | Temperature | 0.7 to 0.9 °C | 2.0 to 2.5 °C |
| | Precipitation | -10 to +2 % | -28 to +5 % |
| Spring | Temperature | 0.6 to 1.1 ° C | 1.8 to 2.8 °C |
| | Precipitation | -22 to +5 % | 0 to 0.18 % |
| Summer | Temperature | 0.6 to 1.0 °C | 1.8 to 2.8 °C |
| | Precipitation | -22 to +5 % | -60 to + 13 % |
| Autumn | Temperature | 0.6 to 1.1 °C | 1.8 to 3.0 °C |
| | Precipitation | 0 to 19% | 0 to 0.53 % |
| Sea level change | | + 16 cm | + 48 cm |

## 2.1 Climate

### 2.1.1 General features

The main orographic element of the area under the study is the coastal plateau, the eastern part of which is hilly (100-400 m above sea-level). The climate of this area, as well as of all the territory of Albania is typically mediterranean. It is characterised by mild winters with abundant precipitation and hot and dry summers.

There are uniform climatic conditions over this area, mostly, due to meso- and microclimatic factors. Variations in particular characteristics are apparent. The northern part of the area is colder than the south with abundant precipitation. The climate of the southern part (which is situated in the eastern Ionian Sea) has the characteristics of a subtropical climate.

The atmospheric conditions affecting the climate of Albania are mainly depressions coming from the North Atlantic, those developed in the Mediterranean Sea, especially that of Genova Bay, as well as Siberian and Açore anticyclones.

The frequency of occurrence of cyclonic and anticyclonic weather has a distinctive annual pattern. The cyclonic weather with high frequency belongs to the cold period. It is associated with clouds and frontal rain. While anticyclonic weather conditions are most frequent present during the warm season of the year [Klima e Shqiperise 1975]. For this reason during the summer, weather conditions are dominated by the high pressure fields, clear sky with occasional cloud and low precipitation. During this period some years have been characterised by 2-3 months without rain. The observed temperature values are high especially in the inner part of this area where the cooling effect of the sea is weaker.

During transitory seasons (spring, autumn) the rainfall is the result of combined operation of the upper atmospheric instability and low level forced convection [Mustaqi 1986]. For this study the meteorological data for 37 stations (Figure 1) distributed over the area under study are analysed. In the following tables and figures only some of them are presented.

### 2.1.2 Atmospheric Pressure

The atmospheric pressure records of the following stations Tirana, Shkodra, Vlora are taken into consideration in this analysis for the 1961-1990 period. All the pressure records are reduced to sea-level by using a standard procedure.

The atmospheric pressure variates during the year. From the presented values (Table 2) one may conclude that the atmospheric pressure in the Albanian coastal region has a maximum value in winter and a minimum one in summer. The minimum value is registered in April. The absolute maximum values of the recorded atmospheric pressure are : Shkodra 1037,.4 HPa, Durres 1035.8 HPa, Tirana 1025.8, Kucova 1033.8 HPa and the absolute minimum ones respectively are 974.2 HPa, 979.1 HPa, 970.7 HPa and 978.2 HPa.

The graph (Figure 2) shows for Tirana a trend towards higher annual mean atmospheric pressure, which means a positive gradient.

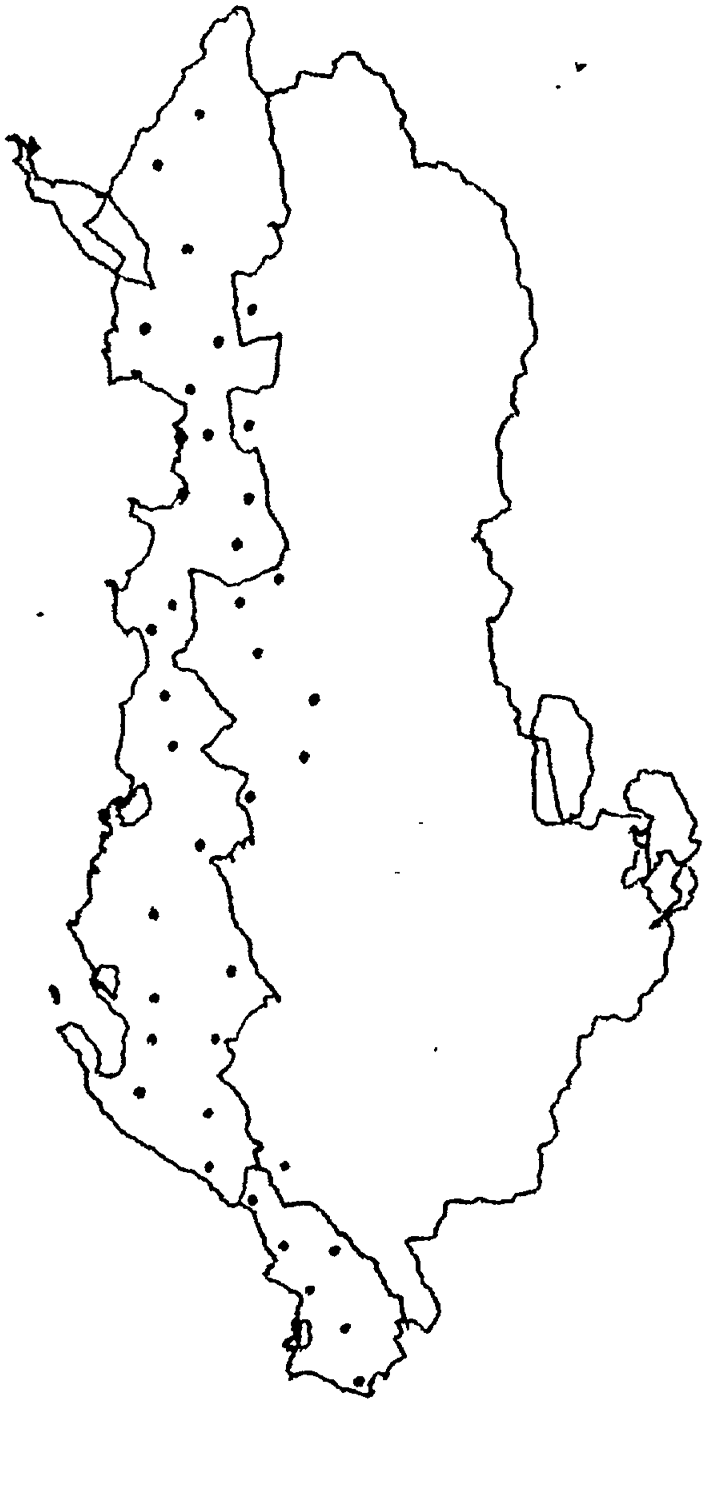

Figure 1 -The distribution of meteorological stations over the zone under study

Table 2
Mean monthly atmospheric pressure reduced to sea-level

| Months Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tirana | 1016.4 | 1015.7 | 1015.3 | 1013.8 | 1014.8 | 1014.5 | 1014.2 | 1014.1 | 1016.7 | 1017.8 | 1017.6 | 1015.8 | 1015.6 |
| Shkodra | 1019.2 | 1017.3 | 1016.5 | 1014.7 | 1015.6 | 1015.4 | 1015.9 | 1015.2 | 1017 1 | 1019 3 | 1019.0 | 1018 3 | 1016.9 |
| Vlora | 1016.7 | 1015.3 | 1015.3 | 1013.5 | 1014.6 | 1014.6 | 1014.2 | 1013 8 | 1016.8 | 1017.7 | 1017.3 | 1016.6 | 1015.0 |

Table 3
Mean monthly temperature (period 1961 - 1990)

| Station | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tirana | 6.5 | 7.7 | 10.0 | 13.3 | 18.0 | 21.7 | 24.2 | 23.6 | 20.1 | 15.6 | 11.2 | 7.8 | 15.0 |
| Shkodra | 4.8 | 6.5 | 9.7 | 13.5 | 18.3 | 22.0 | 24 8 | 24 0 | 20.4 | 15.4 | 10.4 | 6.4 | 14.7 |
| Vlora | 9.0 | 9.7 | 11.5 | 14 5 | 18.5 | 22.0 | 24.4 | 24.1 | 21.1 | 17.5 | 13.7 | 10.5 | 16.4 |
| Durrës | 8.3 | 9.0 | 11.0 | 14 2 | 18.2 | 21.8 | 24.8 | 23.9 | 21 4 | 17.6 | 13.3 | 9.8 | 16.0 |
| Sarande | 10.3 | 10.6 | 12.4 | 15.3 | 19.4 | 22.9 | 25.4 | 25.8 | 23.3 | 19 4 | 15.2 | 11.8 | 17.6 |

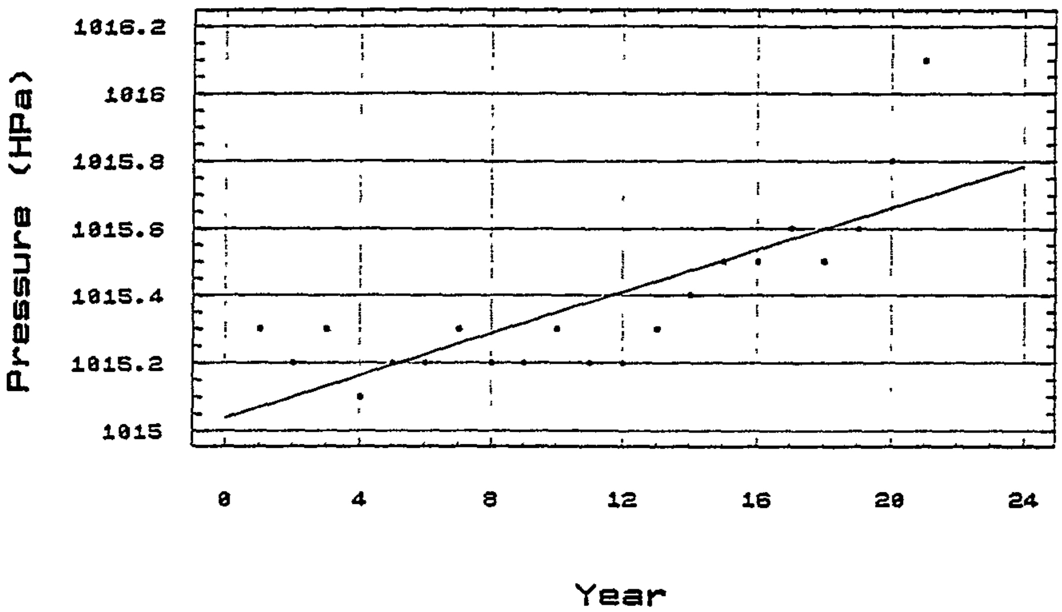


Figure 2 - Ten-year running average and trend of pressure (sea-level)
(Tirana (1961-1990)

2.1.3 Temperature

The air temperature in the coastal region of Albania displays a simple annual curve with a mean annual value of 14.7-17.6°C increasing from north toward the south. The annual course of air temperature has a maximum in July or August and a minimum in January.

Mean maximum and minimum air temperatures have a similar annual seasonal cycle to that of mean monthly temperature. The mean maximum values of temperature variate from 27.6°C in the north up to 31.4°C toward the south, while the minimum values variate from 1.0°C to 6.0° respectively.

In the majority of stations of the eastern part of the area (17) the absolute maximum temperature higher than 40°C are recorded in July or August. The expected maximum temperature values in this zone are presented in Table 4. Relatively lower values recorded in the seaside are a consequence of the cooling influence of the sea. The expected maximum temperature values in this zone reach 39-45°C.

All through the year, except January and December, days with temperatures >25.0°C are registered. Although this region is near the sea, the temperature below zero are still observed during the cold months. The absolute minimum temperature oscillates between -13°C in the north and -5.0°C in the south. In Table 5 one may see the expected absolute minimum temperatures for this coastal region. The mean number of days with temperature below zero is 5-10 days/year in the seaside and 25-30 days/year in the inner part of this zone, increasing toward the north. The running mean method of analysis was applied to the data of temperature in order to detect trends [Borici *et al.*, 1993].

The graphs in Figures 3, 4, 5 and 6 indicate the existence of trends in mean annual and seasonal temperature. The annual mean temperature indicates a negative trend of about 0.5°-0.8°C during the period into consideration. During this period one might see intervals with different trends. Concretely, during the first and last 12 years, an obvious increasing trend (about 0.1°C/year) is observed. The negative tendency is the result of decreasing tendency of temperature during spring, summer, autumn seasons, more marked in autumn.

In contrast with this for most of the stations the winter curves show an increasing tendency about 0.5°C over the 60 year period.

Table 4
The expected values of absolute maximum air temperature °C for different return periods (years)

| Station | Return period (years) | | |
|---|---|---|---|
| | 20 | 50 | 100 |
| Tirana | 41.1 | 42.5 | 43.6 |
| Shkodra | 41.9 | 43.9 | 45.4 |
| Durres | 37.8 | 39.2 | 40.3 |

Table 5
The expected values of absolute minimum air temperature °C for different return periods (years)

| Station | Return period (years) | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 5 | 10 | 20 | 50 | 100 |
| Tirana | -5.5 | -7.4 | -8.6 | -9.3 | -11.2 | -12.3 |
| Shkodra | -5.2 | -8.3 | -10.4 | -12.4 | -15.0 | -17.0 |
| Vlora | -2.2 | -4.2 | -5.6 | -6.9 | -8.6 | -9.8 |
| Durrës | -5.5 | -6.9 | -8.0 | -9.0 | -16.4 | -11.4 |

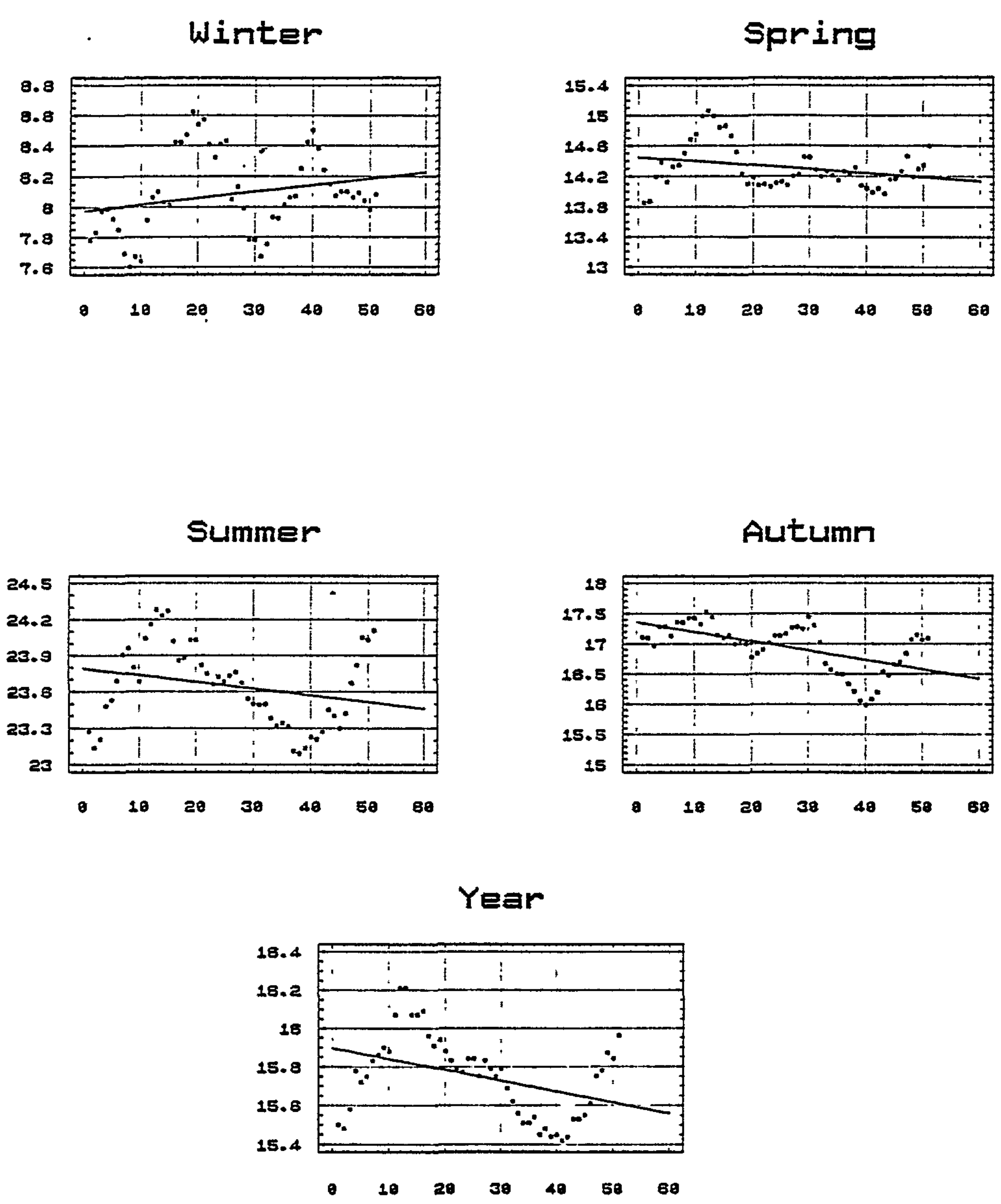


Figure 3 -Ten-year running mean and trend of temperature for the station of Tirana (period 1931-1990)

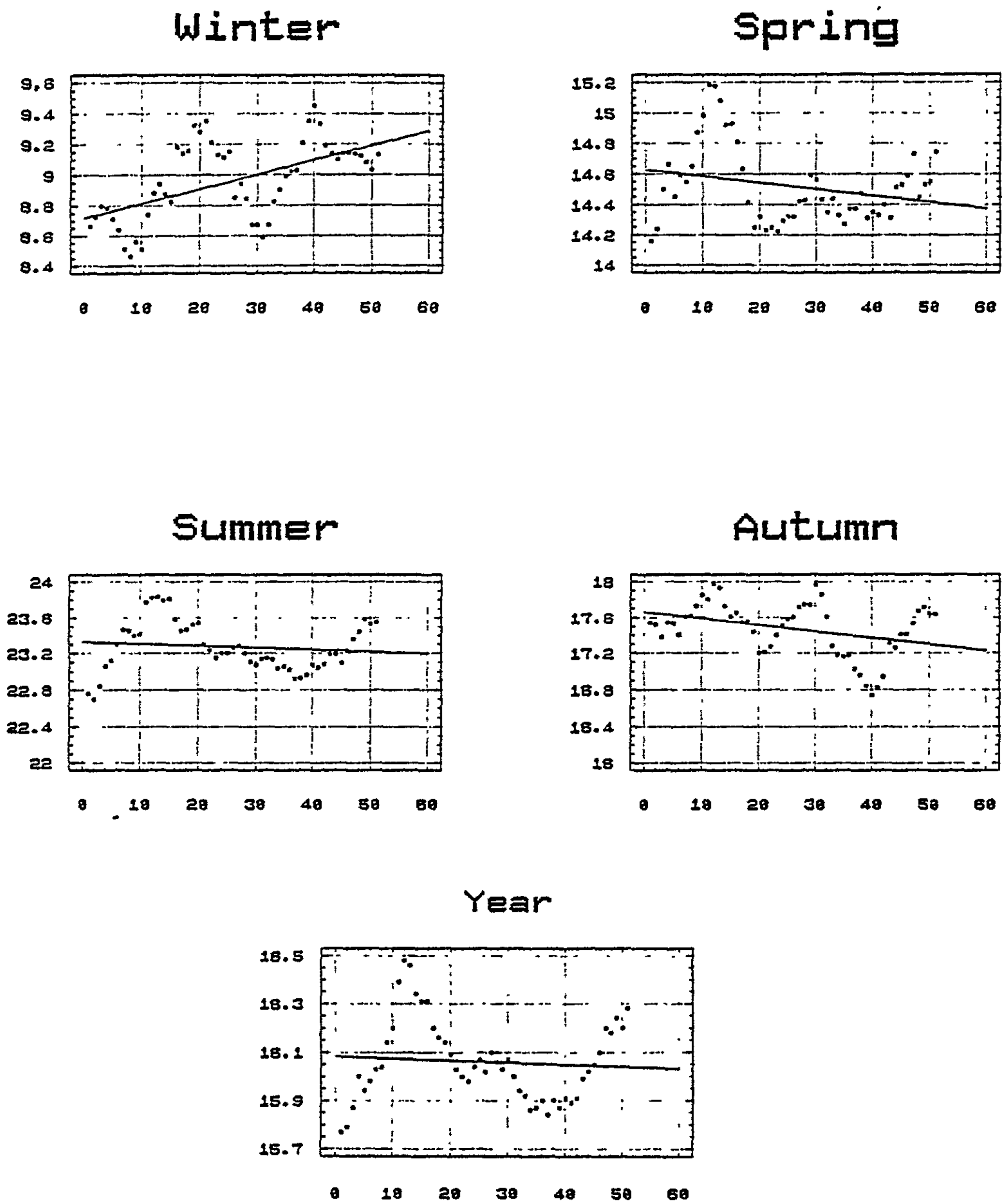


Figure 4 - Ten-year running mean and trend of temperature for the station of Durres
(period 1931-1990)

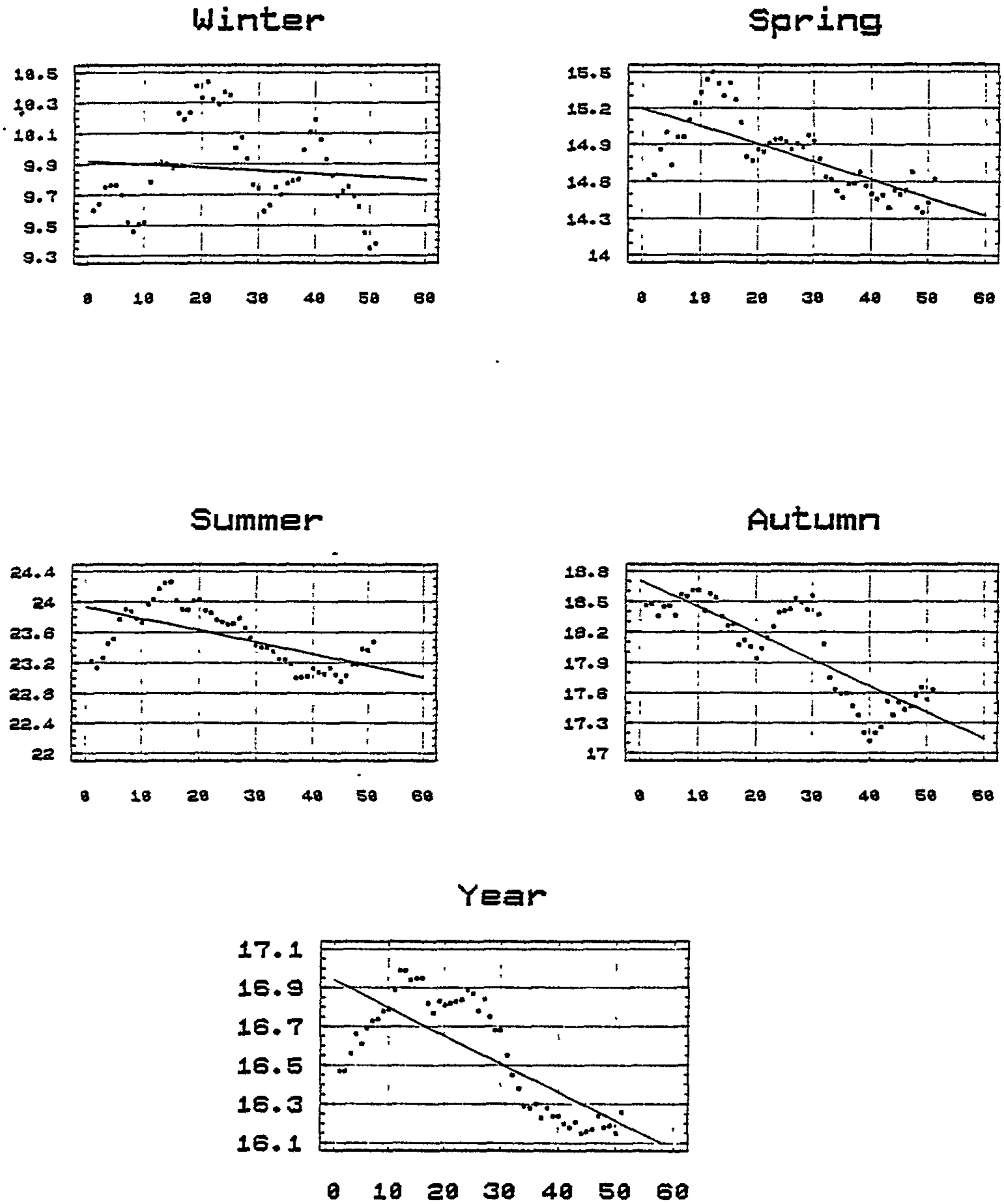


Figure 5 -Ten-year running mean and trend of temperature for the station of Vlore (period 1931-1990)

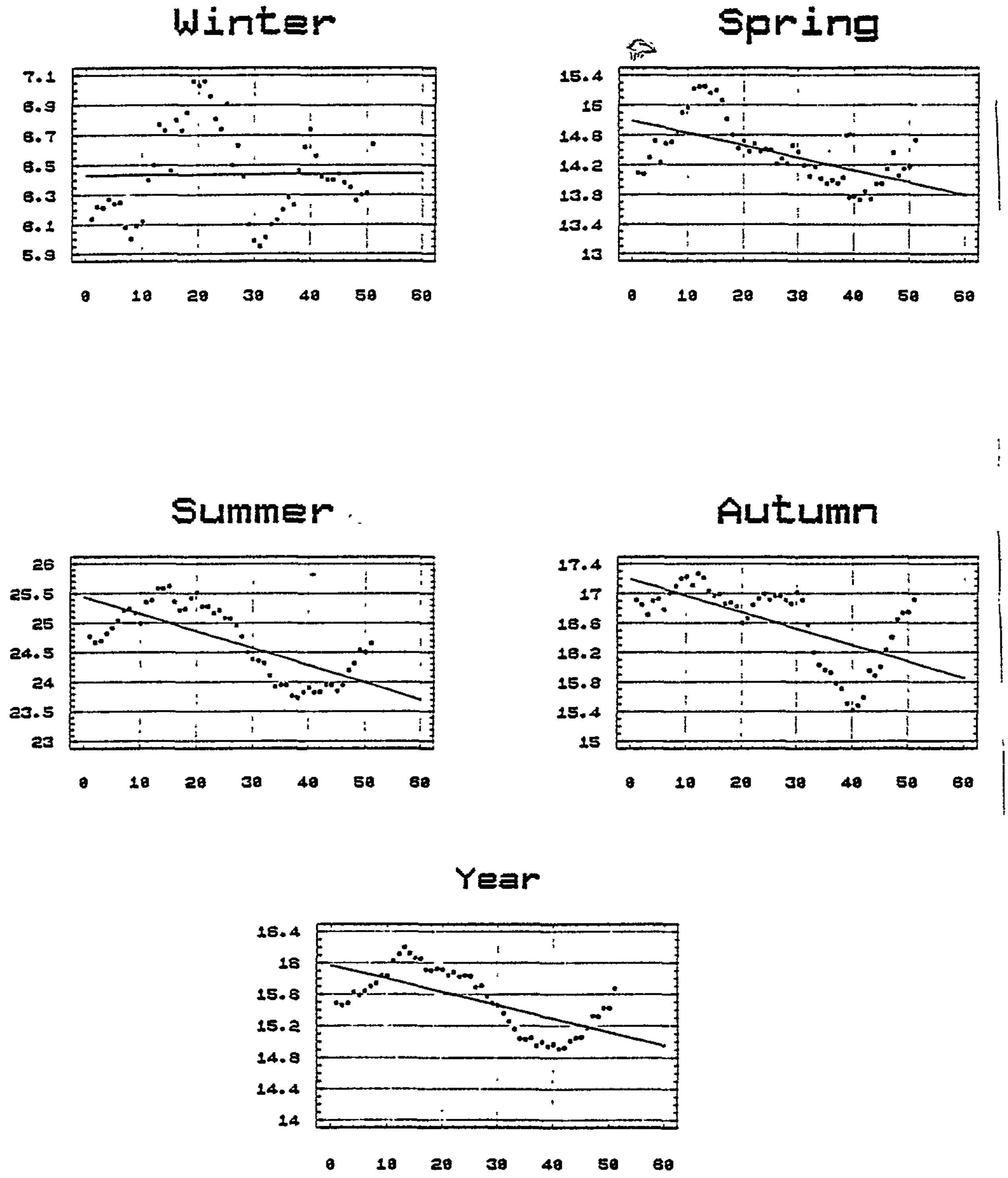


Figure 6 -Ten-year running mean and trend of temperature for the station of Shkoder (period 1931-1990)

### 2.1.4 Precipitation

The total mean annual precipitation (period 1961-1990) in this area oscillates in wide limits, from 900 mm in the middle of the area to 1900 mm in the northern part (Figure 7). This difference is a consequence of the relief. The northern part is situated on the foot of the Albanian Alps, whereas the southern one is bordered by high mountains (up to 2000 m above sea-level).

During October-March the region receives about 75% of annual rainfall. The month richest in precipitation is November and the poorer one July (Table 6). The number of rainy days (>0.1 mm) in this area oscillates between limits 100-130 day/year. The time and space distribution is quite similar to that of precipitation. About 65-70% of rainy days are registered during the cold period. Over the northern part of this area about 130 rainy days are observed. The intensity of precipitation is high.

Their expected values for 100 years return period may reach up to 300 mm (day).

The trend analysis of seasonal and annual precipitation changes for the four stations: Tirana, Durres, Shkodra and Vlora over the period 1931-1990 is represented in Figures 8-11. From these figures one may observe a decreasing trend of annual precipitation during this period. In total it is 1.6 mm/year for the Tirana station, 5 7 mm/year for Vlora, 0.4 mm/year for Shkodra and 1.5 mm/year for Durrës. To the decrease of annual precipitation contributes mainly the decrease during autumn and winter. In contrast it is observed that there is an increase during the spring and summer. But, the statistical tests certify that the trend in these seasons is not yet significant, while the decreasing trend of autumn and winter seasons is significant.

Analyzing these figures results that, periods with different trends can be observed. Particularly we can mention two periods. The last 20 years when the decreasing tendency is very emphasised (for example this decreasing is about 20.0 mm/year for the Tirana station, 16.0 mm/year for Shkodra etc.) and the period 1951-1970 when a clear increasing tendency was observed.

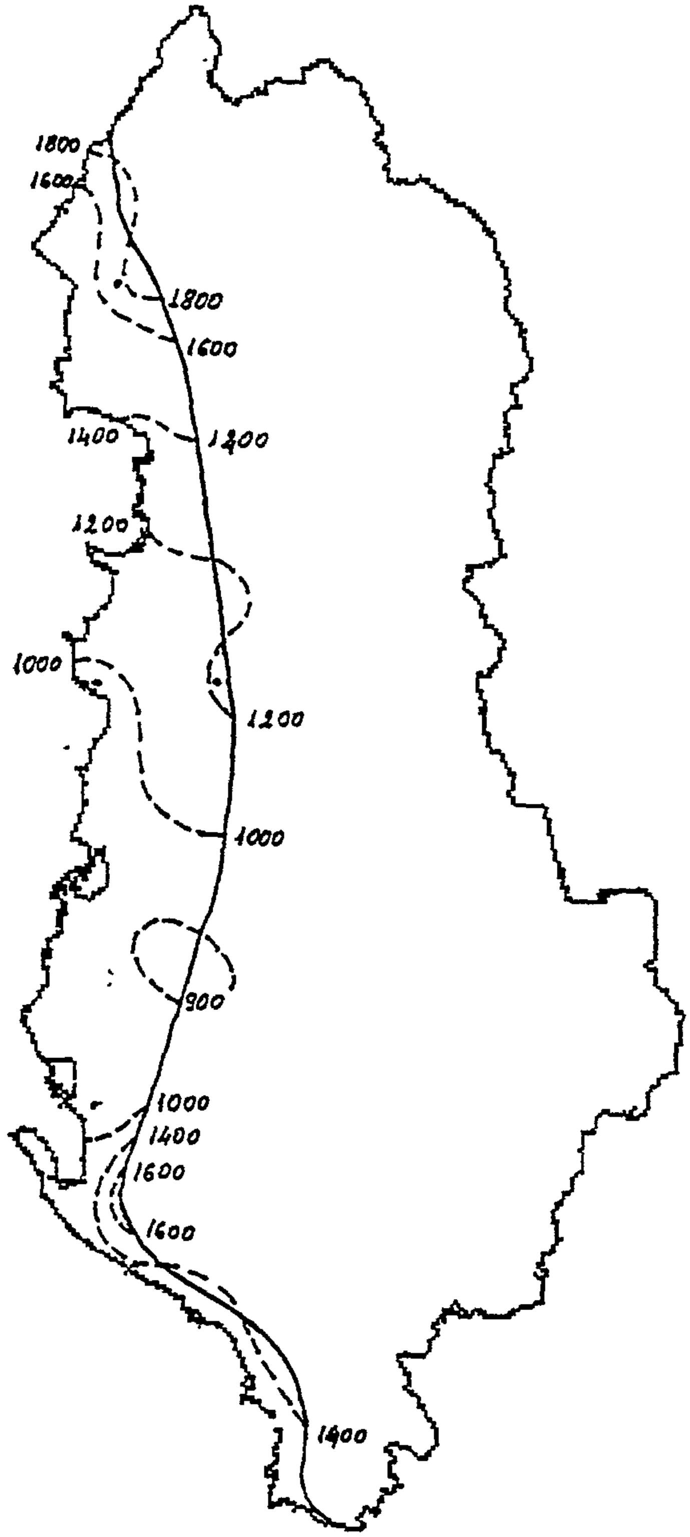


Figure 7 - Total yearly mean precipitation (mm)

Table 6
Total monthly precipitation (1961-1990)

| Station | Month | | | | | | | | | | | | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | |
| Shkodra | 216.9 | 175.3 | 166.1 | 158.0 | 104.3 | 70.5 | 39.1 | 79.2 | 161.7 | 195.0 | 265.2 | 253.1 | 1884.4 |
| Durrës | 110.6 | 91.4 | 95.2 | 76.3 | 50.8 | 38.7 | 23.9 | 34.8 | 62.5 | 101.5 | 132.9 | 113.0 | 931.2 |
| Tirana | 129.4 | 118.9 | 121.0 | 103.1 | 54.6 | 67.8 | 40.8 | 50.5 | 83.2 | 107.0 | 157.5 | 146.1 | 1219.1 |
| Vlora | 103.0 | 86.2 | 84.7 | 61.4 | 49.8 | 23.1 | 16.2 | 27.2 | 64.4 | 108.3 | 138.2 | 129.4 | 892.0 |
| Sarande | 145.4 | 137.9 | 112.4 | 74.4 | 48.1 | 21.8 | 9.1 | 25.4 | 76.8 | 154.8 | 204.9 | 185.4 | 1196.4 |

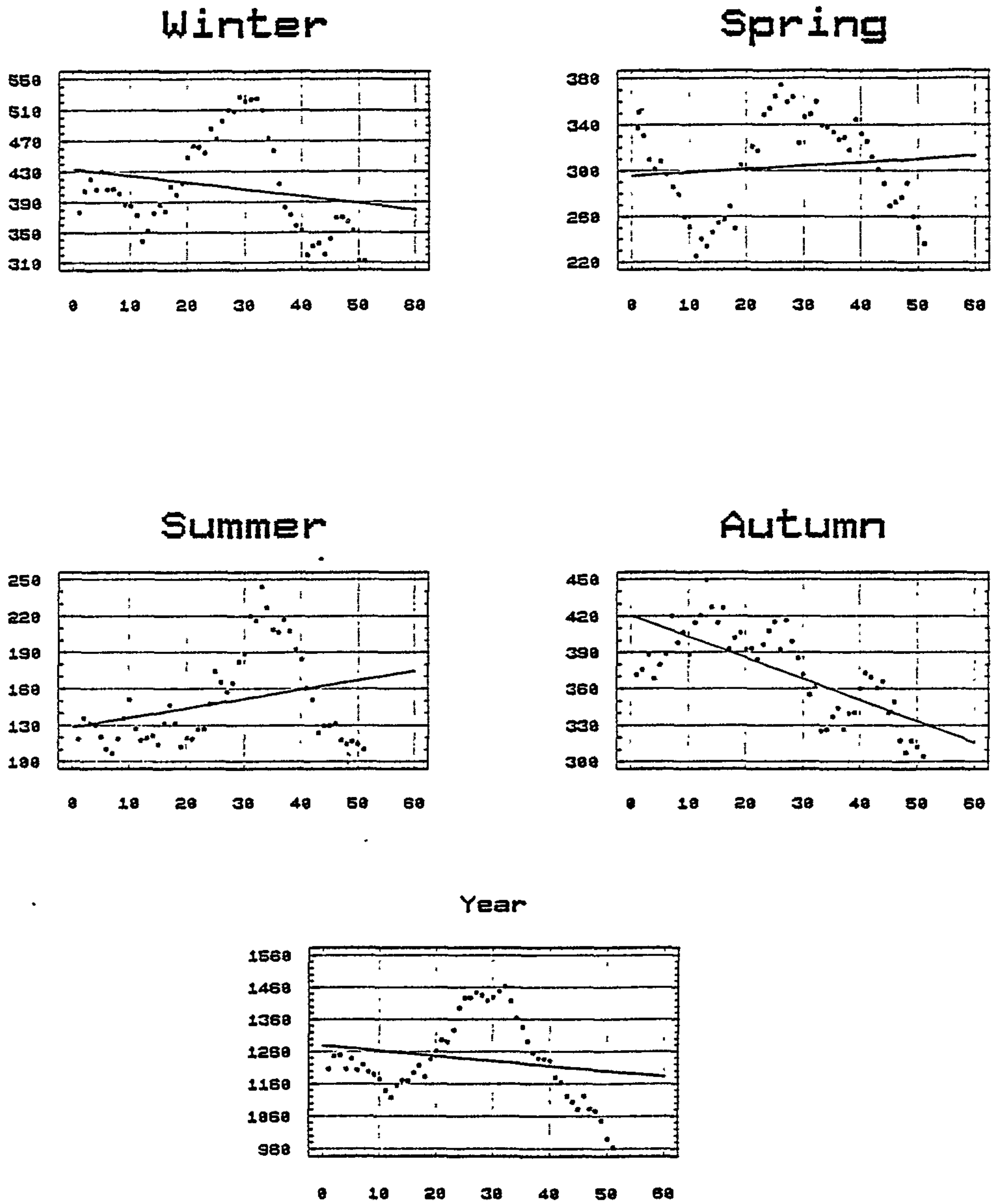


Figure 8 - Ten-year running mean and trend of precipitation for Tirana (period 1931-1990)

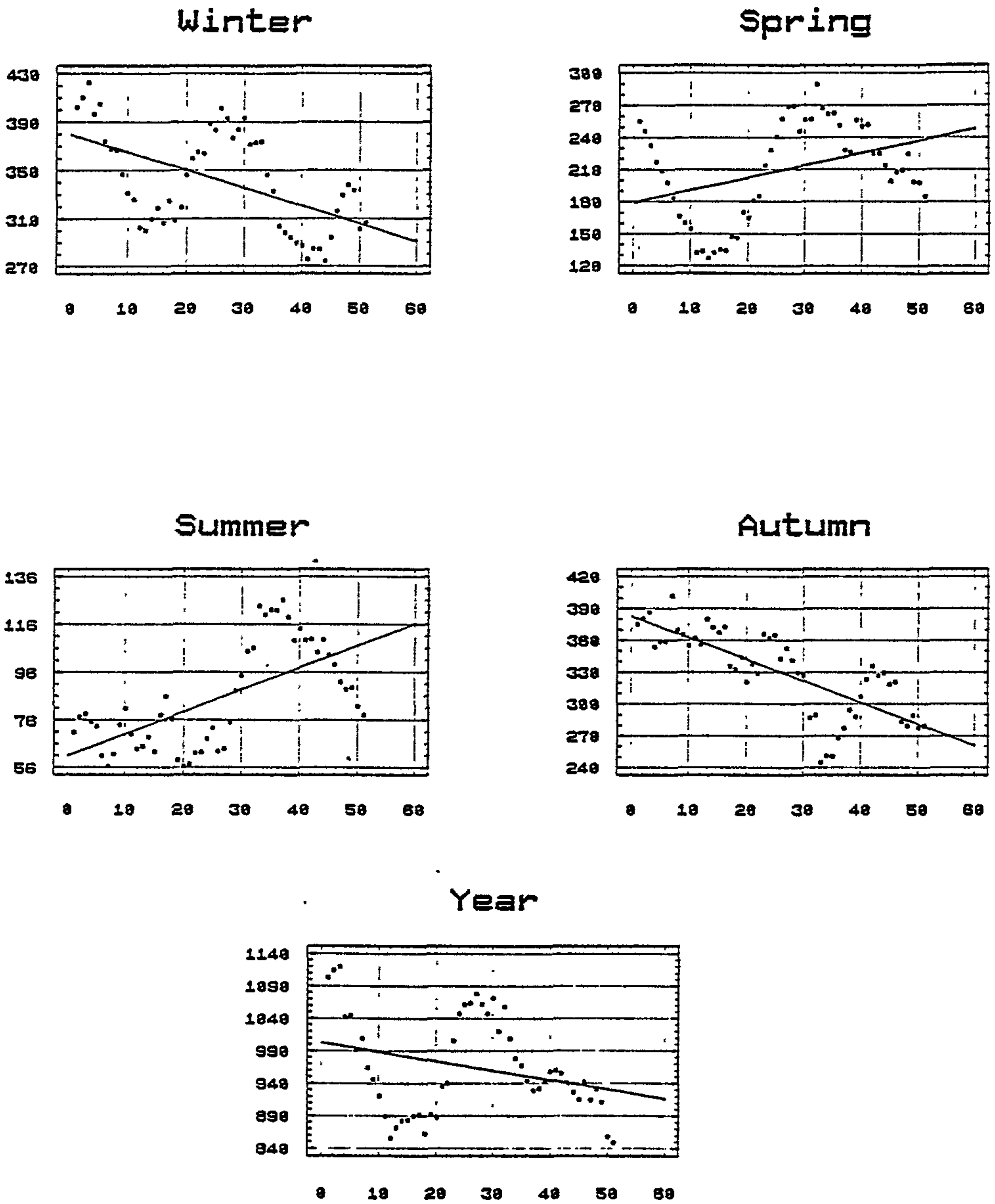


Figure 9 - Ten-year running mean and trend of precipitation for Durres (period 1931-1990)

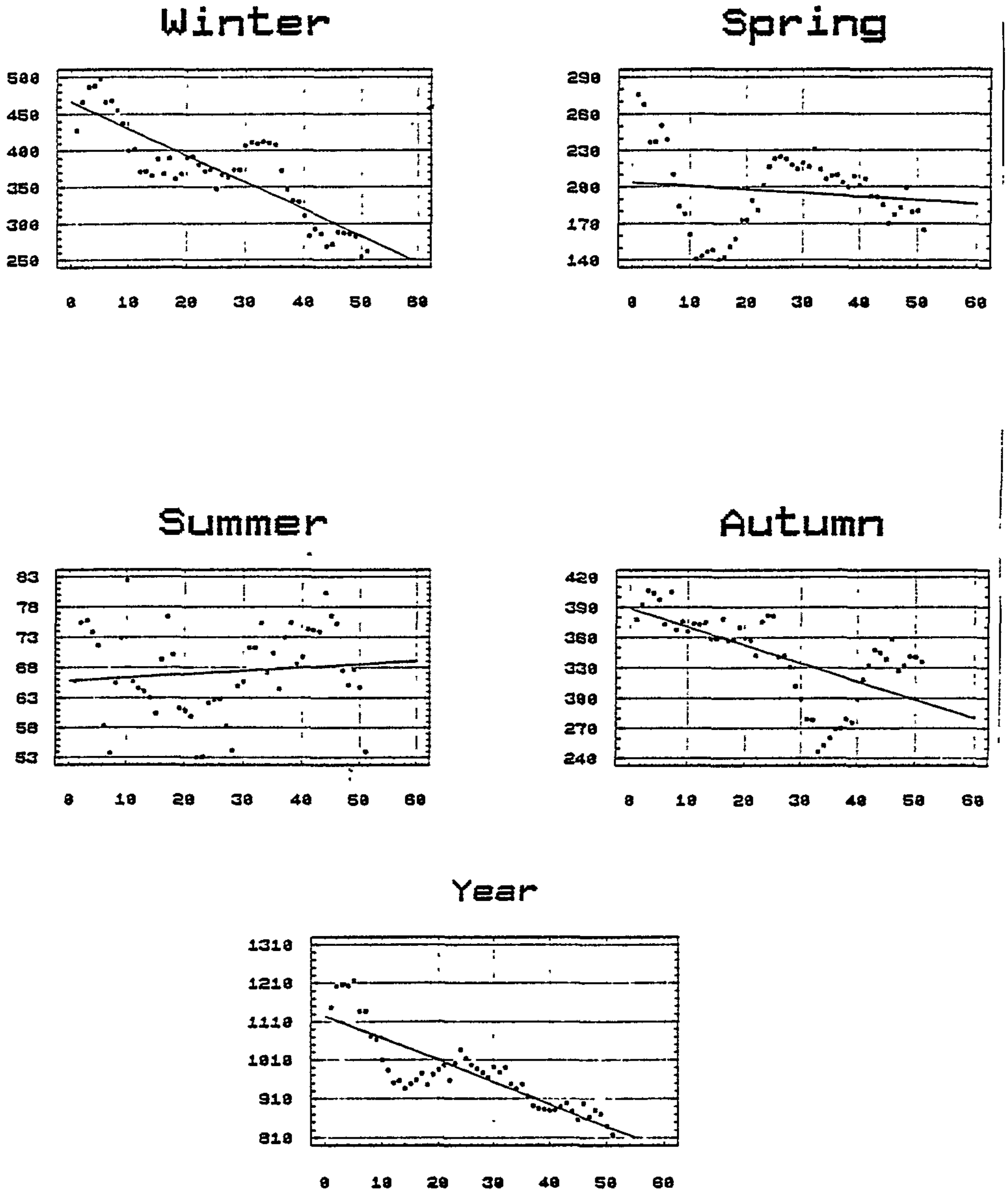


Figure 10 - Ten-year running mean and trend of precipitation for Vlora (period 1931-1990)

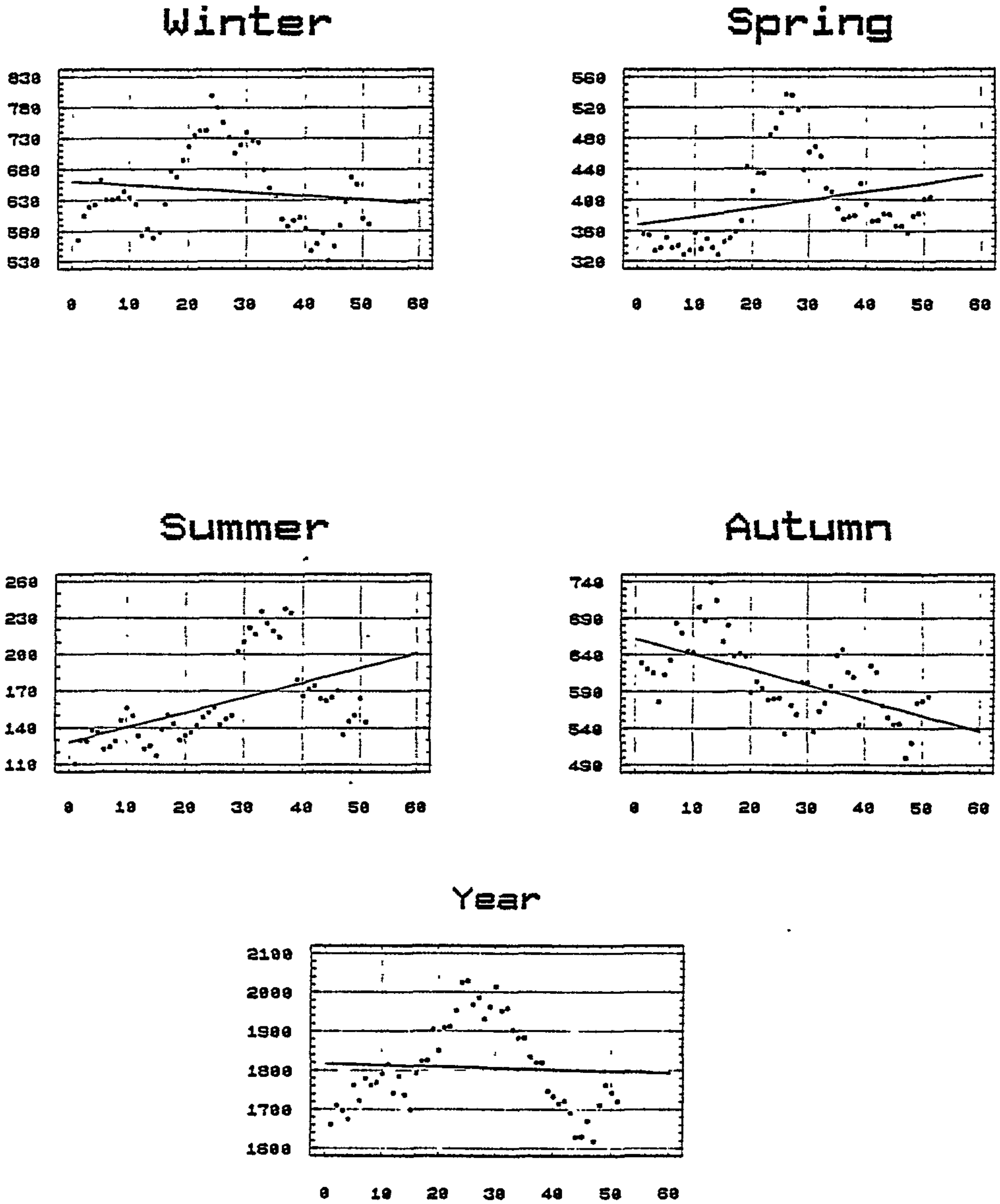


Figure 11 - Ten-year running mean and trend of precipitation for Shkodra (period 1931-1990)

### 2.1.5 Winds

Wind field depends on the distribution of the pressure gradients as well as the local topography (Figures 12, 13).

The prevailing direction in Tirana station in January, when the influence of the sea breeze is weak, are southeast and northwest, which correspond to the axes of valley where it is situated, while in Shkoder and Vlora eastern winds predominate (Figure 12). A distinct frequent increment of western and northwestern winds is observed in July when the sea breeze predominates the wind field (Figure 13).

The influence of sea breeze is felt up to the inner part of the area under study. It is a cool and moist wind [Jaho S *et al.*, 1985]

The mean annual wind speed oscillates from 1.3 m/s in Tirana to 3.6 m/s in Durres. Higher values are observed in winter, while the lowest one in summer when the anticyclonar weather predominates, in comparison with the other seasons. The highest wind speeds are observed when wind is blowing from the sea. Strong winds are registered in this area, especially near the seaside, where wind speed reaches up to 35-40 m/s.

Seasonal characteristic winds (except sea breeze) are Bora which blows in the northern part of the area, up to Lac city. It is a dry and cold wind that reaches the speed 25-30 m/s and is observed in winter [Jaho S *et al.*, 1985]. Sirocco, which is a warm wind and brings about weather deterioration. Generally this wind blows from the south and southwest.

### 2.1.6 Other Meteorological Parameters

Global Radiation has an important role in radiation balance as it is related to the sunshine and to the sun elevation respectively, the maximum amounts are achieved in summer and the minimum ones in winter (Table 7).

Sunshine By analyzing Table 8 it is not difficult to conclude that the Albanian coast has a considerable amount of sunshine hours. The maximum number of sunshine hours registered in the summer is 370 hours/month and the minimum one in the winter is 105 hours/month. This means that the area is of interest from a tourist point of view.

Cloudiness The average cloudiness in the winter season establishes 6/10 level in this region (60%). By analyzing Table 9, one may see that average cloudiness is higher in winter and lower in summer (about 3/10). The greatest number of clear days is observed in summer and that of cloudy days in winter.

Snow is a rare phenomenon for the most part of this region. It must be considered as an extraordinary event. The maximum number of snow days (3/5 days/year) is observed over the northern part, while the minimum one over the south (less that 1 day/year). The maximum layer of snow recorded in the severe winters is 40 cm at Shkoder, 5 cm at Durres, 15 cm Tirana and 9 cm at Vlora.

Hail occurs during the year particularly in winter. There are registered meanly 3-8 hail days during the year.

Relative Humidity of air presents a simple annual course. The maximum and minimum monthly values occur respectively in the cold period (about 80%) and July (56%) the mean annual values is 70% (Table 10).

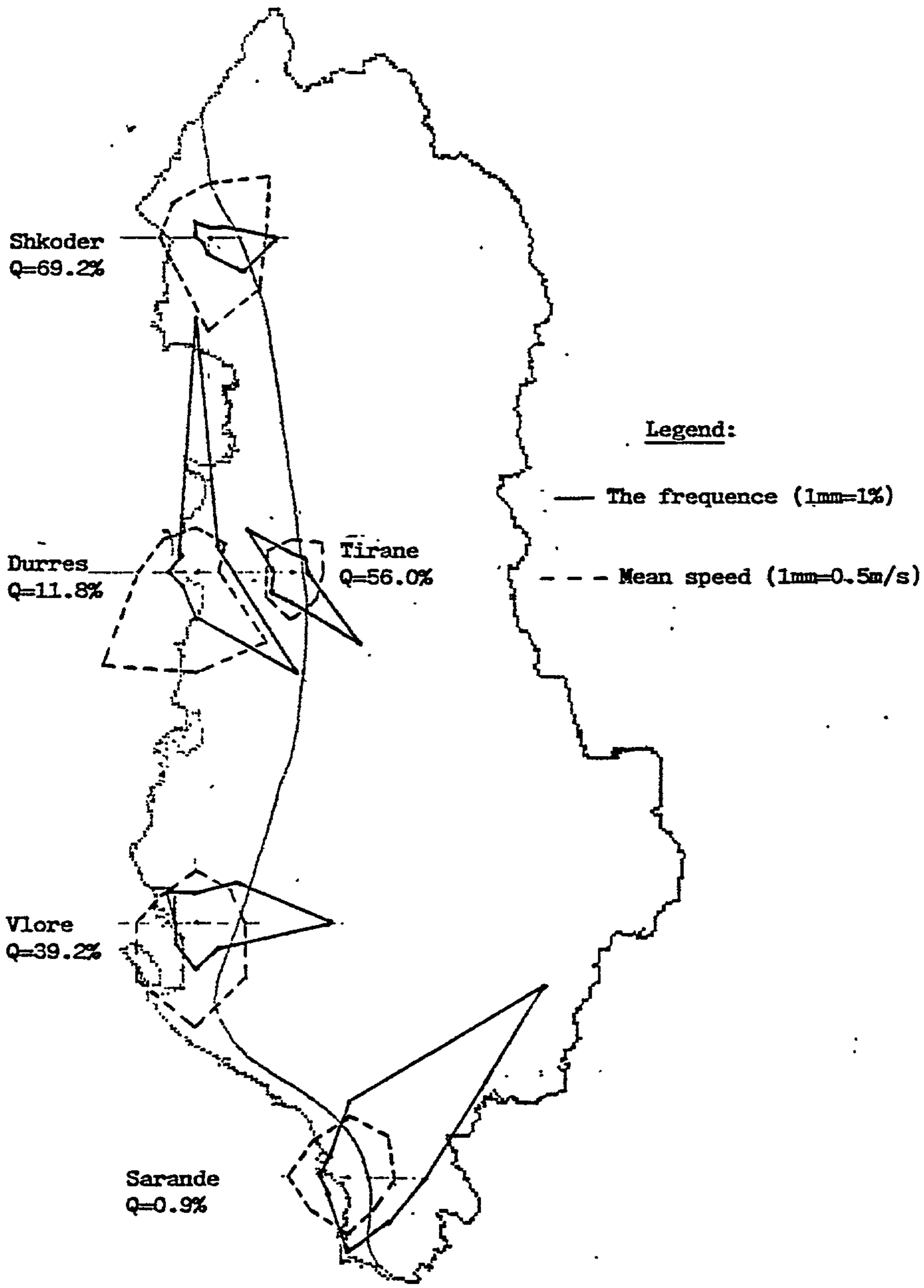


Figure 12 - Wind roses (January) (Period 1961-1990)

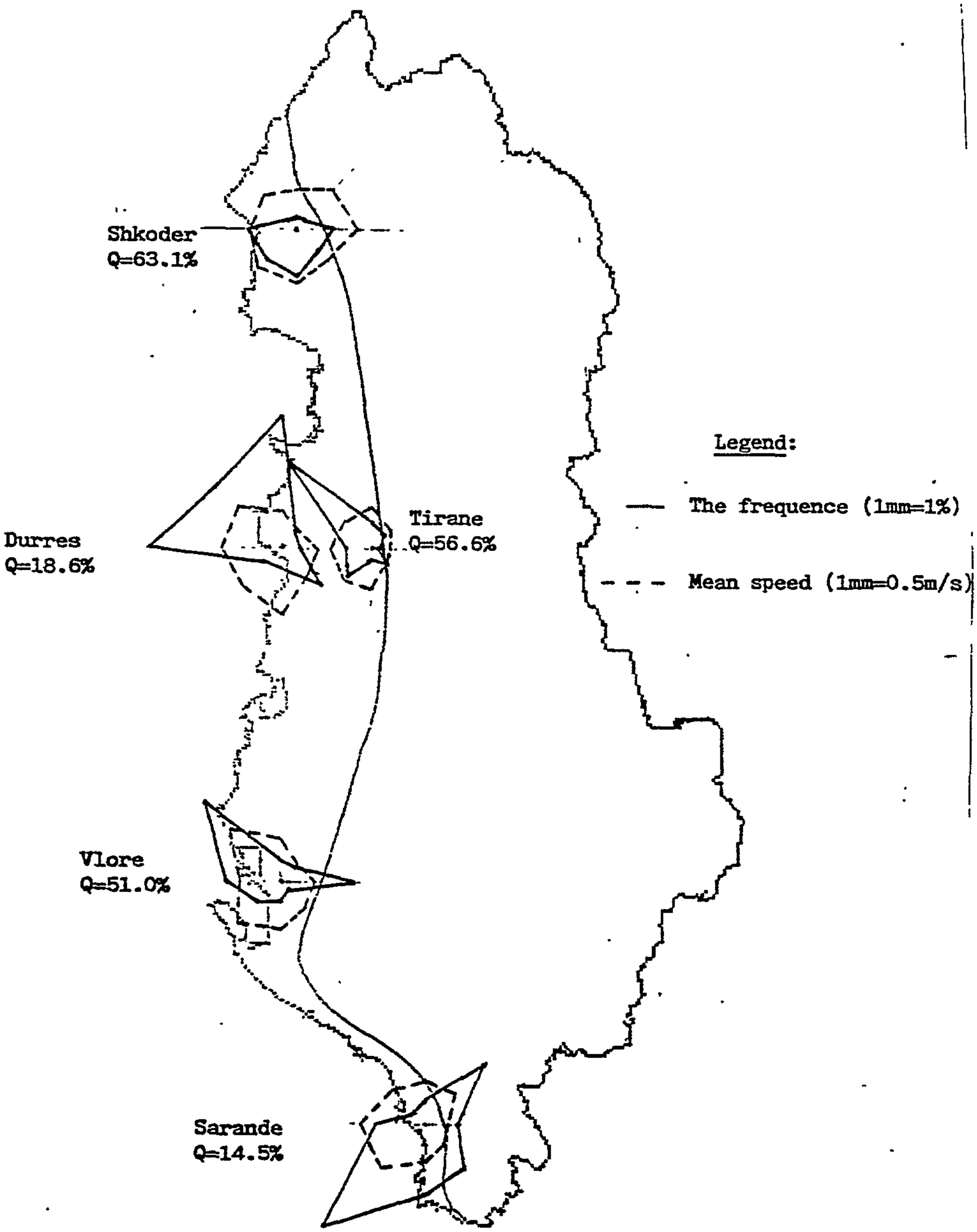


Figure 13 - Wind roses (July) (Period 1961-1990)

Table 7
The global radiation (kwh/$m^2$ day)

| Station | Month | | | | | | | | | | | | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | |
| Tirana | 1.97 | 2.60 | 3.35 | 4 35 | 5.57 | 6.49 | 6 69 | 6.12 | 4.74 | 3.29 | 2.33 | 1.94 | 4.12 |
| Shkodra | 1.79 | 2.43 | 3.30 | 4.29 | 5.25 | 6.09 | 6.45 | 5.63 | 4.52 | 2.94 | 2.15 | 1.80 | 3.88 |
| Vlora | 2.26 | 2.54 | 3.29 | 4.81 | 5.80 | 6.81 | 7.15 | 6.74 | 5.44 | 3.81 | 2.78 | 2.56 | 4.50 |
| Durrës | 2.28 | 2.75 | 3.31 | 4.76 | 5.62 | 6.41 | 6.92 | 6.46 | 5.55 | 3.81 | 2.66 | 2.32 | 4.40 |

Table 8
Sunshine (in hours) (Period 1961-1990)

| Station | Month | | | | | | | | | | | | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | |
| Tirana | 124.8 | 124.4 | 162.2 | 191.3 | 255.6 | 297.0 | 350 0 | 328.2 | 257.3 | 207.2 | 124.5 | 107.9 | 2531.6 |
| Shkodra | 116.2 | 116.8 | 167.3 | 188.7 | 248.1 | 292.5 | 341.5 | 316.0 | 245.5 | 194.8 | 110.5 | 104.7 | 2442 4 |
| Vlora | 131.3 | 137.8 | 179.2 | 219.6 | 281.2 | 323.6 | 370.5 | 343.9 | 269.9 | 218.2 | 140.3 | 118.8 | 2734.3 |
| Durrës | 127.0 | 136.7 | 179.5 | 213.3 | 269.9 | 306.7 | 354.7 | 331.4 | 269 6 | 218.8 | 130.8 | 108.8 | 2647.1 |

Table 9
Mean monthly cloudiness (tenths) (Period 1961-1990)

| Station | Month | | | | | | | | | | | | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | |
| Shkodra | 6.1 | 6.4 | 6.0 | 6.0 | 5.3 | 4.2 | 2.5 | 2.4 | 3.5 | 4.7 | 6 4 | 6 0 | 5.0 |
| Tirana | 6.2 | 6.6 | 6.3 | 6.2 | 5.6 | 4.3 | 2.5 | 2.4 | 3.7 | 4 8 | 6.3 | 6.2 | 5.1 |
| Vlora | 5.9 | 6.1 | 5.6 | 5.2 | 4.4 | 3.1 | 1.6 | 1.5 | 2.6 | 4.3 | 5.8 | 5.8 | 4.3 |

Table 10
Mean monthly and annual values of relative humidity (Period 1961-1990)

| Station | Month | | | | | | | | | | | | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | |
| Tiranë | 73 | 71 | 71 | 72 | 71 | 66 | 61 | 64 | 70 | 72 | 76 | 76 | 70 |
| Shkodër A | 75 | 72 | 68 | 68 | 67 | 63 | 56 | 56 | 64 | 70 | 76 | 76 | 68 |
| Vlorë | 67 | 66 | 67 | 68 | 68 | 64 | 62 | 63 | 67 | 68 | 69 | 68 | 66 |
| Durrës (S) | 75 | 75 | 75 | 76 | 76 | 71 | 69 | 71 | 75 | 76 | 78 | 77 | 74 |

## 2.1.7 Extraordinary events

The climate of the zone under study, generally, is not characterized by extreme meteorological conditions. Nevertheless, there are not excluded the cases of extreme events which brought about damages in the economy.

Heavy rain

We may mention the heavy rain falling down during 24 hours over the Shkodra zone on October 2nd, 1949, which caused the flooding of a part of Shkodra city and the field around it. The total precipitation registered that day was 398.0 mm. To be mentioned is the flooding of Myzeqeja field on the October 20, 1981, when the precipitation height arrived 344.7 mm. During the time intervals 1, 2, 6 hours have fallen down respectively 60.0, 100.0 and 233.4 mm.

Strong winds

In the zone under study, the observation of strong winds is not a rear phenomenon.There are registered some cases when wind speed arrived the value 40 m/sec ore more. They are often accompanied by falling of high tension pillars, uprooting of trees, damages of agriculture etc. The zone between Lezha and Laci is particularly influenced by strong winds. They caused serious damages in the high tension pillars in 1966 and 1974 in this zone.

Drought

Summer in Albania is characterized as a dry season in Albania and the presence of drought in some particular years has brought about the damages in agriculture. So, it is to be mentioned the prolonged droughts in 1978 (about 100 successive days without precipitation), in 1975 (about 94 days), in 1985 (about 83 days) and in 1986 (about 80 days).

Atmosphere

The atmosphere is defined as the envelope of air that surrounds the earth and is held in place by gravity. The main constituents of the atmosphere are nitrogen and oxygen with lower amounts of water, methane, hydrogen, ozone etc.

In this natural atmosphere is added the pollution from human activity which is more concentrated in urban areas. This is favoured from the lack of atmosphere diffusion over 3000 m above sea-level and lateral diffusion from the geomorphologic obstacles. On the other hand the atmosphere is a self-cleaning resource. For example, the oxygen is continuously replaced through photosynthesis at the expense of carbon dioxide, or precipitation acts to clean the atmosphere from dust particles and gases. Small dust particles and aerosols filter sunlight, decreasing its amount and can effect cloud formation and the chemical composition of rain.

Because there are only a few measurements of the atmospheric composition over Albania (see Table 11), conclusions have been drawn from the analysis of meteorological data for the period 1953-1990. Ten year running means and the trend for atmospheric pressure, sunshine cloud cover, relative humidity are presented in Figures 2, 14, 15 and 16.

First of all, the analysis of atmospheric pressure indicates an increasing trend (Figure 12), which is linked with the increasing of anticyclone conditions over Albania and consequently with the augmenting of the incident of low level temperature inversions. This meteorological situation causes the increasing of relative humidity (as it can be seen from Fig. 14) and obstructs the dispersing of suspended particles, including pollutants, vertically as well as horizontally, because of the absence of winds. (Because of low pressure gradients in the anticyclonic conditions the winds are very weak.)

Table 11
Some data on air pollution (1981-1989)

| Districts | Soot ($\mu g/m^3$) | $SO_2$ ($\mu g/m^3$) |
|---|---|---|
| Shkodra | 33.4 | 19.0 |
| Durrés | 71.9 | 40.9 |
| Lac | - | 190.4 |
| Fier | 55.9 | 36.7 |
| Vlora | 54.3 | 16.4 |
| *Sanitation normal* | 50 | 150 |

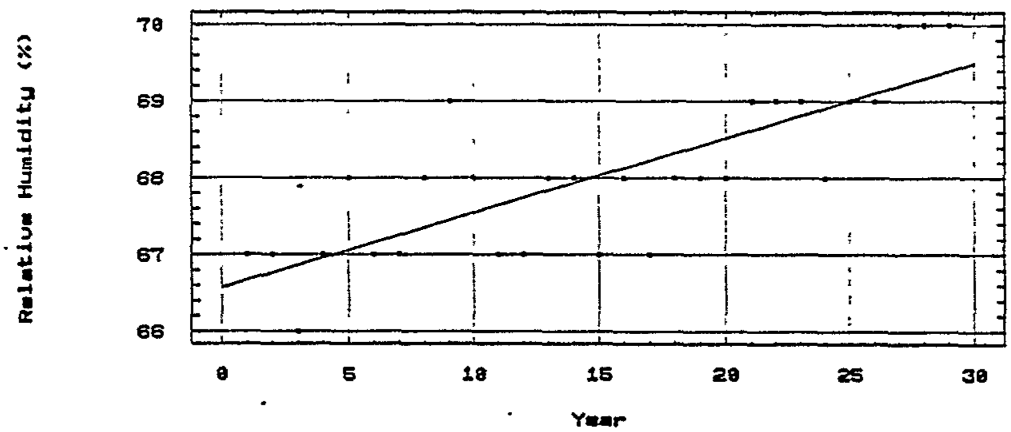


Figure 14 - The trend of relative humidity for Tirana station (1953-1990)

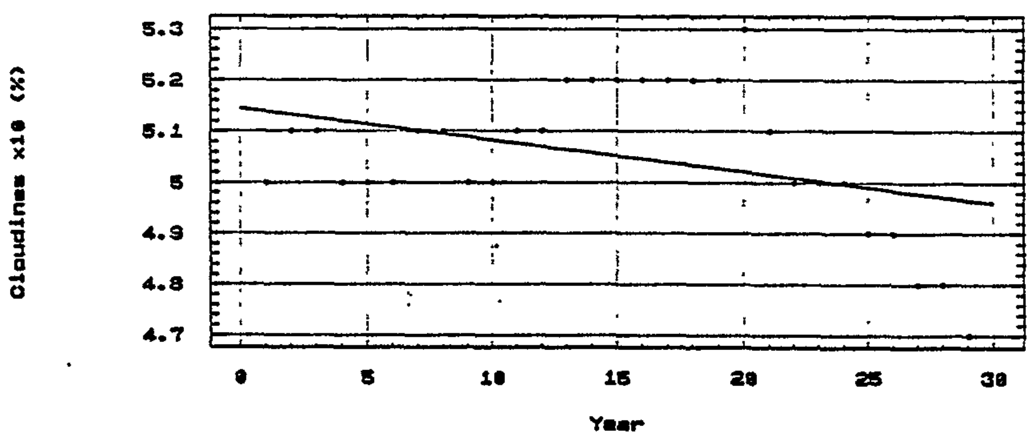


Figure 15 - The trend of cloudiness for Tirana station (1953-1990)

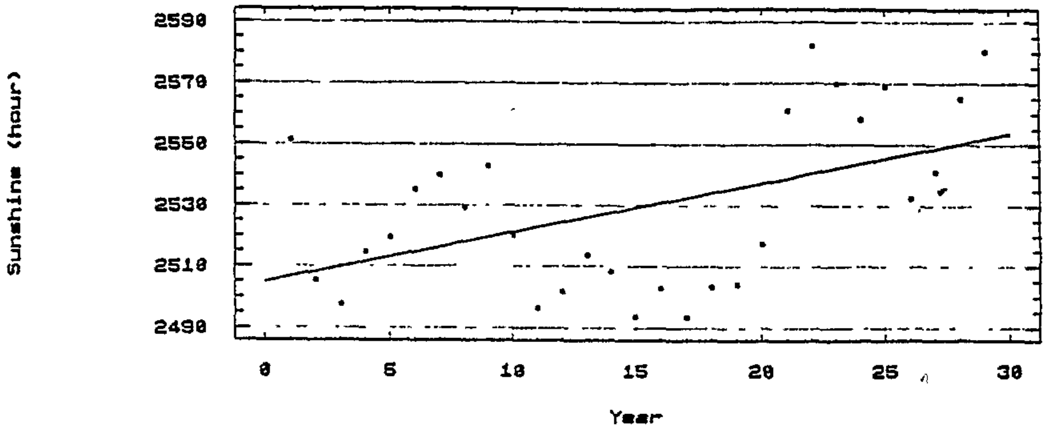


*Figure 16 - The trend of sunshine for Tirana station (1953-1990)*

Atmospheric pressure is also related to the decreasing of cloudiness (Figure 15). The final result of the influence of these factors is reflected in the number of bright sunshine hours demonstrated in Figure 16. From this figure it can be seen that there is a positive trend during the period 1959-1990. It means that the effect of decreased cloudiness is more significant than the decreased effect on sunshine from possible pollution.

Smog is present in the zone under study, especially over the big cities. So if one want to see Tirana from Dajti Mountain, he may notice the presence of smog every morning. However, it is to be pointed out that there are not regular observation on smog.

Fog is a rare phenomenon for this zone. The number of foggy days oscillates between 2 and 9 days/year in its eastern side. Usually, the time interval with smog is no longer than 2-3 hours, but in some cases longer intervals are observed, such as in Shkodra on February 9,1954 (15.5 hours), in Tirana on January 29, 1968 (11.7 hours) etc. [Jaho et al. 1985].

Referring to the measurement in Tirana (period 1974-1984) results that the annual quantity of precipitated dust from the atmosphere is 90 Ton/km$^2$.year. [Dautaj H.,1987].Due to the drastically increasing of the vehicle number during the last years, the dust content in the atmosphere is increased in a considerable way, but the measurement do not exist.

## 2.2 Lithosphere

### 2.2.1 Geology

Being a constituent part of the Dinande-Albanides-Helenide arc, in the geologic-tectonic evolution of Albanides the following stages are observed: the late stage of the Varisic tectogenesis, the recent Alpine rifting during the Lower and Middle Triassic, the oceanic opening during the Jurassic, the tectogenesis stages related to period limits such as between Jurassic and Cretaceous at the end of the Cretaceous, at the end of Eocene, Oligocene, Pretortonian and Pliocene-Quaternary [Shall M 1983].

The magmatic activity of Albanides during this evolution is expressed by the acid and basic volcanism of the normal-subalkaline series of the Ordovician-Devonian, by the basic, intermediate and acid subalkaline volcanics of the Lower and Middle Triassic and by the Jurassic ophiolites. The structure of the Albanides is complicated by folds of various orders of mainly submeridional strike and western-south-western dip It is also complicated from the overthrusting over-burdening and near vertical block-like disjunctive faults. The Albanides are intersected from two main transversal faults: Shkoder-Peje and Fier-Elbasan-Diber.

The Albanides may be separated in Inner and External parts. The inner Albanides characterised by the extensive development of the magmatism but in the External zones the magmatism is limited. The Inner Albanides comprise the following tectonic zones; Korabi, Gashi and Mirdita. The External Albanides comprise the zones of the Albanian Alps, Krasta-Cukali, Kruja, Ionian and Sazani (Figure 17).

In the northern part of the zone under study up to Durres consists of three types of lithological deposits·

1. The Quaternary deposits occupy extensively all coastal plains to the foothills up to 10 m above the sea level;

2. The Neogene deposits are mostly found at the hill chain between Lac and Milot and at Rodoni Peninsula;

3. The Cretacean and Jurassic deposits occupy the Renci Mountain range at the mountain border of the coastal region.

The general geomorphology of the northern coastal region is mainly characterized by the presence of rivers (Buna, Drini, Mati and Ishmi), a narrow plain (Velipoja), a mountain range near and along the coast (Renci and Rodoni Peninsula).

There are found three main shore types in this region: rocky shores (Shengjini up to Ishull Lezha) which consist of limestones with a few terrigenous materials and are subject to erosion, river deltas and sandy beaches with dunes (Velipoja, Shengjini, Kune Tale and Patoku areas) The sandy shore from Velipoja to Shengjini extends over 20 km, while Kune, Tale and Patoku beaches extend over 12, 3 and 5 km respectively.

The central part of the coastline from Durrés to Vlora consists of beaches and cliffs. There are three types of beaches :

1. created permanently by solid deposits from rivers;

2. poorly fed from rivers (small in size, located inside the bays or coves, always with the rocky backset);

3. residual beaches (originally formed by rivers, once as their mouths).

The cliffs consist of active (sea in direct contact with the rocks) and inactive ones (particularly protected from the sea by the small beaches.

There are four physiographics units present over this coastal area:

1. Ishëm river mouth-Rodoni cape consists of mildly recessing cliffs (active ones). The low and medium-high cliffs are intersected by small lateral valleys. Their slopes are composed by soft terrigenous materials and therefore exposed to erosion. Rights of Erzeni river mouth is the remaining erosion zone in the Lalzi bay. The erosion tends to move southward as a consequence of the shifting of the rivers mouth rather than the decreasing transport of the sediment.

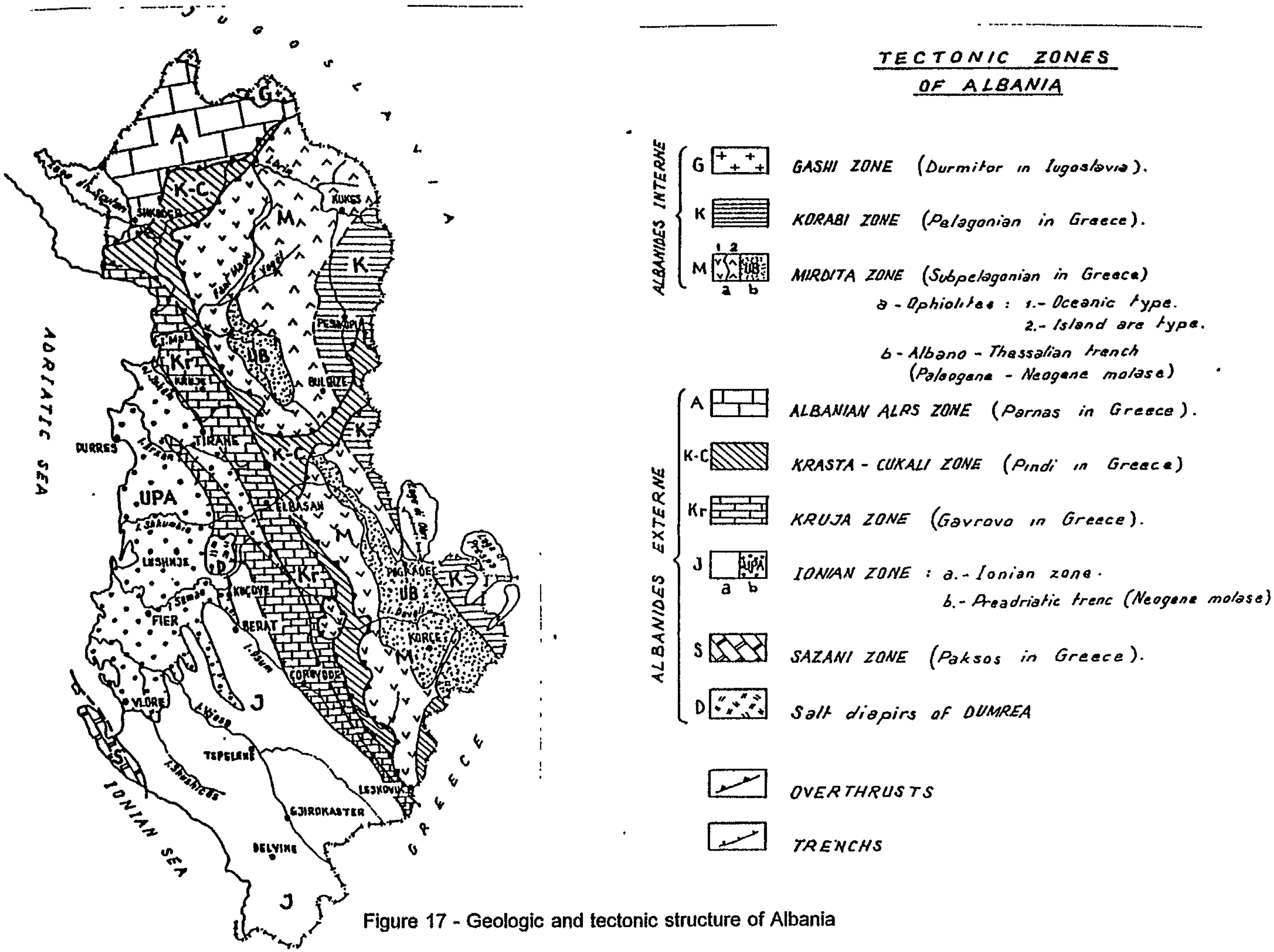

Figure 17 - Geologic and tectonic structure of Albania

2. Bishti i Pallės - Durrės Cape is an unstable unit, since the beaches are attached by erosion and the lands tends to slight down the cliffs.Progressive erosion has been observed at the beach between Karpen and Golem. The only stable section of the coastline is the one between the Durrės harbour and Golem beach.

3. Durres Cape - Vlora Bay is the most dynamic part of the albanian coast. The evolution of the coast line is linked to the fluvial dynamics of solid sediments, which cause the spreading of the river mouths, the beach advancement toward the sea, development of the sand dunes etc.

4 Orikum plain is created by alluvial and sea deposits. The erosion processes have endangered the coastal road.

The southern coast consists of rocky wave-cut cliffs (slopes from Vlora to northern part of Dhërmi); the narrow plain with mountains falling to the shore (Dhërmi-Saranda coast); few cliffs and stream outfalls at the south of Butrinti.

This area includes the following geological complexes:

1. The Quaternary deposits (Mursi Plain and Butrinti Lake)

2. The Neogen complex (between Piqerasi, Lukova and Nivica)

3 The cretaceaus and Jurassic (carbonate rocks) and Neogen calcareouses (limestone rocks), including caves, wells and karstic forms.

In the Figure 18 is represented the dynamics of the coastline. Almost 70% of the coastline is in erosion process

2.2.2 Soils

The loose sediments or soils are deposits of Quaternary age, which present a wide spread over the older rocks and consist of various genetic types (Figure 19).

The alluvium deposits are spread alongside the river valleys passing through this zone and present a general direction east-west similar to the rivers flow. These deposits are clearly seen when drilling holes for water exploration. Their content is mainly gravels and sands, which in the last part of the flow turn into fine sands and subsands. The thickness of such deposits tends to increase from east to west and varies from 150 to 180 m.

The marine deposits are spread throughout the coast starting from Buna delta up to the Vlora gulf. The width of such deposits varies in a wide range and reaches up to 3-8 km from the coast. The marine deposits consist of fine sands up to dusty sands. In general those that are laid over the other Quaternary deposits and their thickness varies between 20 and 40 m. These deposits mainly construct the beach zone and further towards the land are found in the shape of dunes.

Swampy and swampy-lagoon deposits present a mixed character and are spread in the western part of the depression. They are encountered in the rear part of dunes and are formed due to swamps and/or lagoons. Such deposits are found in the valleys of Narta, Karavasta and in the zone of Durresi. The deposits of these formations present intercalation of clay and sub-clay layers with silt and sub-sand.

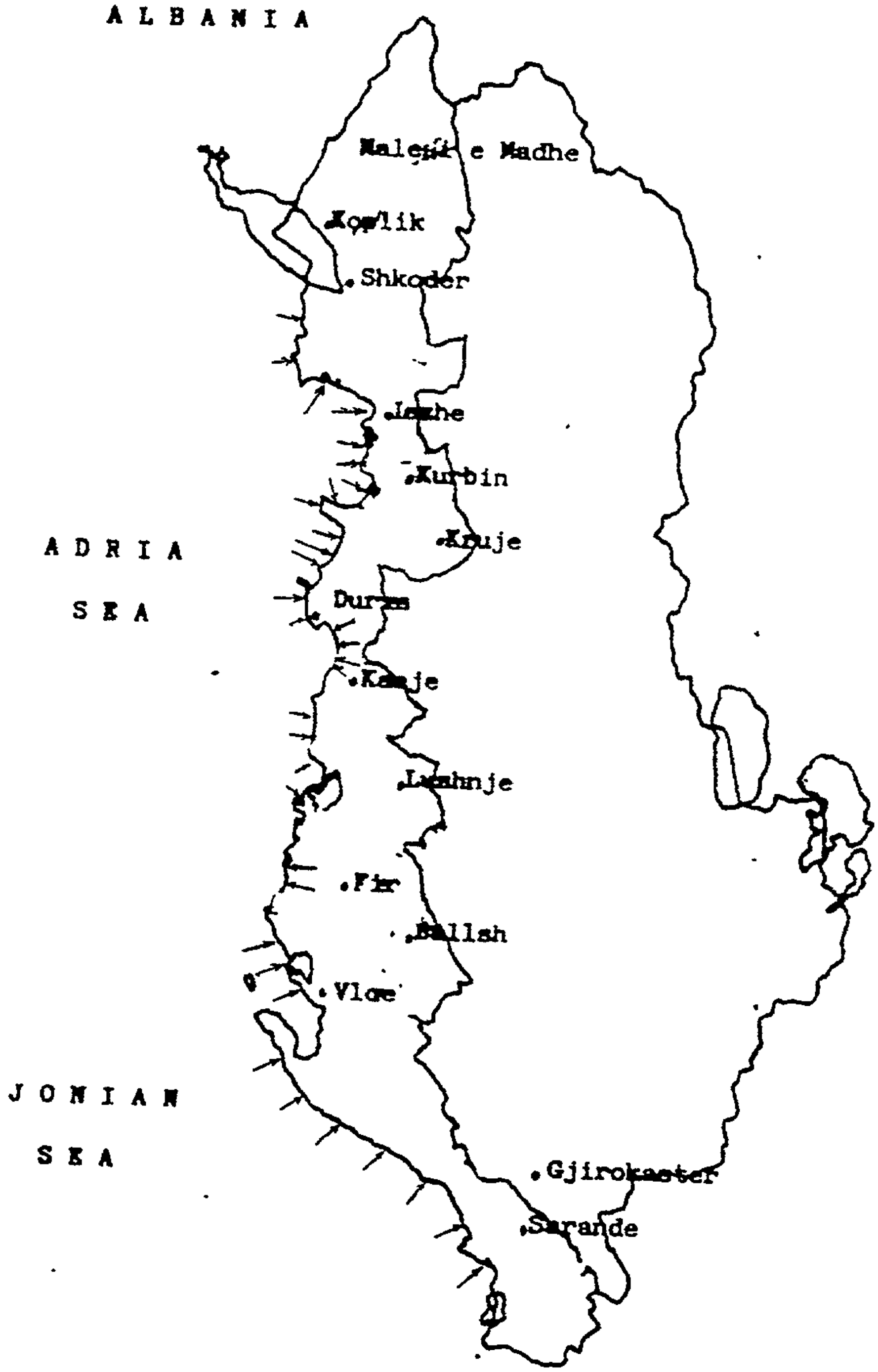


Figure 18 - Dynamics of the coastal line

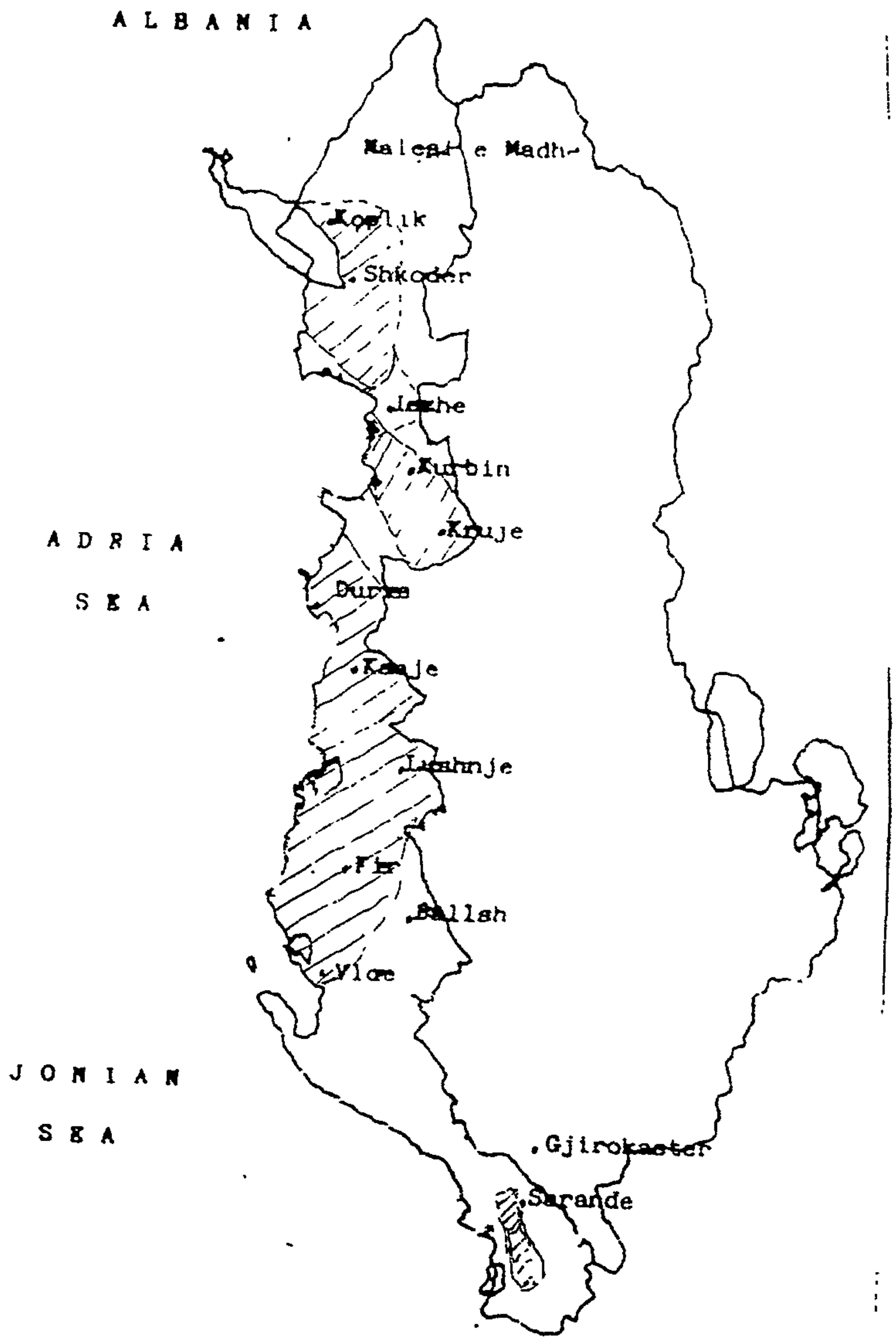


Figure 19 - The spread of loose deposits

The prolluvion and delluvium deposits present a lesser extension in comparison with other kinds of deposits. Those more widespread in the inner part of the Depression and over the slopes of hills surrounding the marine deposits. Their origin derives from the weathering of the host rocks and transportation of resulting loose material over the slopes or bottom of hills. The thickness of such deposits varies in a wide range and can reach up to 10 or 20 m.

Salinization

The salt soils in Albania lie in the western region of the seaside, especially in the Durres, Hoxhare. Narte, Karavasta and Velipoje areas. They occupy about 35000 ha, about 20%, with a high salt content (12-16%) and others have a medium or low content of salt.

From physical analysis salty soils have a different mechanical content from sub-clays than heavy clays Heavy soils occupy about 35% of these regions, especially in Durres, where the clay achieves 70-90%. The porosity is 50-55% and volumetric mass is 1.3 - 1.5 gr/cm$^3$. The content of salt on these soils, like in the Durres, Hoxhara Narte, Bregu i Mates, changes from 1% in the surface to 3.5% in the 2.5 m depth.

The soils of little or middle salinization, such as in Lushnje, Berat, or Fier, have 0.3-1.5 salt. The soil near seaside consist of clorur salts (ratio $Cl:SO_4$ equal 6:1) and the soils away from the seaside have a salinization of sulphate's nature where ratio $Cl:SO_4$ is about 3:1.

In the Figure 20 the map of the salt soils distribution is represented.

## 2.3 Hydrosphere

### 2.3.1 Surface Water

The main rivers that are discharged in the Adriatic Sea are: Buna (in which the Drini river is discharged), Mati, Ishmi, Erzeni, Shkumbini, Semani and Vjosa. The rivers discharging in the Ionian Sea are: Bistrica and Pavla (Fig. 21).

All main rivers of Albania have the same direction, from east to west. The mountainous zone represents the high part of the catchment area, the hilly and the coastal ones represent respectively their middle and low part. In the coastal zone the rivers run down slowly and wind until they are discharged into the sea.

There are 32 hydrological stations in this zone. Some general characteristics of the hydrological stations in the mouth of the rivers discharging in sea are given in table 12. During the wet period of the year the value of total annual precipitation in the coastal zone is lower than in the middle and high part of the catchment area. So, there is a small contribution of this zone in the water flow forming. The contribution of the rivers discharging in the Adriatic Sea (95%) is very large in comparison with the rivers discharging into the Ionian Sea (5%).

Tables 13 - 15 represent long term water flow values and their distribution for all the rivers discharging into the seas (Fig. 22).

The long term average discharge in the Mediterranean is $Q_o$=1244 m$^3$/sec$^{-1}$. The total volume of water flow is $W_6$=39186 10$^6$ m$^2$ year$^{-1}$

The water flow of Buna and Drini river represents about 54% of the total water volume of this hydrographical network discharging into the Mediterranean and Vjosa 15%, Semani 7%, Mati 7%.

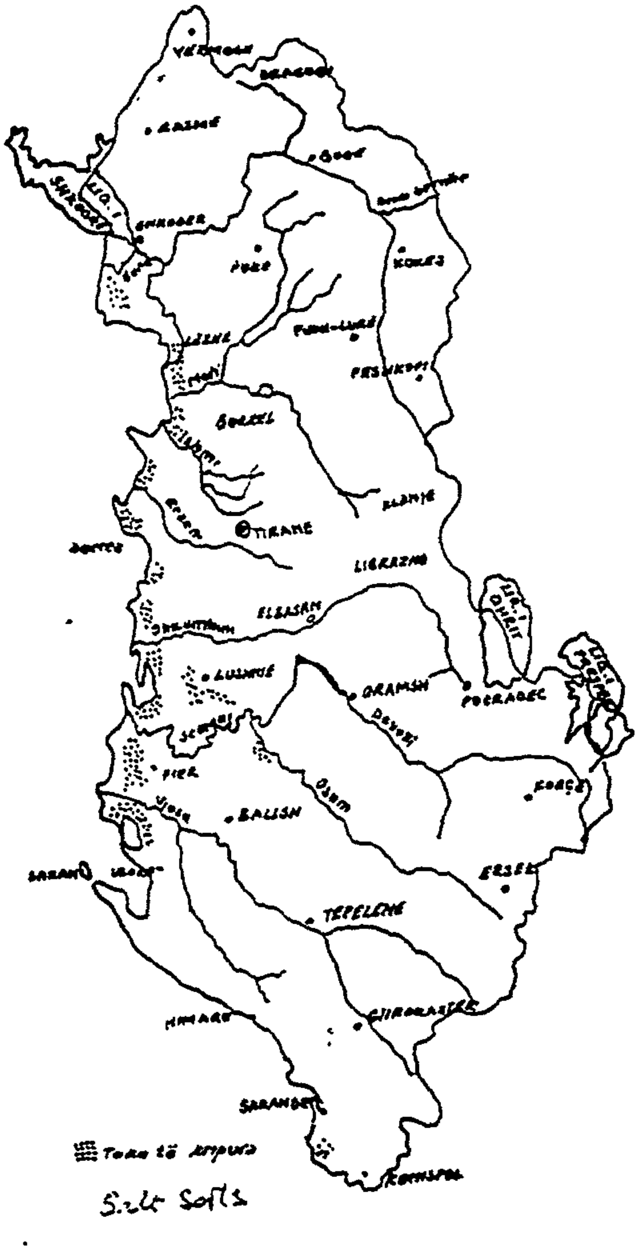


Figure 20 - Salt soils distribution

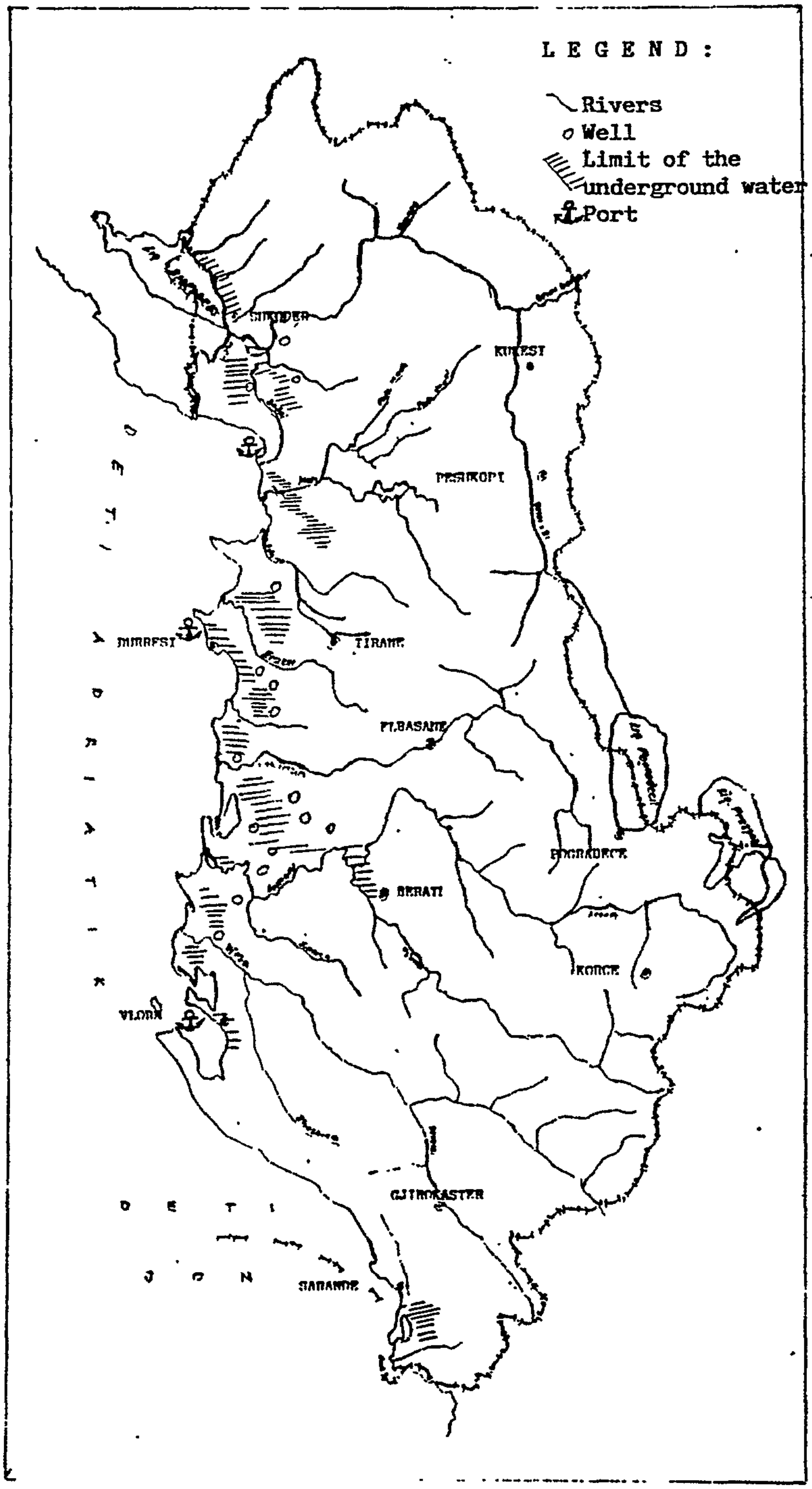


Figure 21 - Water resources of the Albanian coastal zone

Table 12
General characteristics of the water flow discharging into the sea

| River basin | Area ($km^2$) | Station and period of measurements | Mean annual discharge ($m^3/sec$) | Mean annual volume ($m^3.10^6$) |
|---|---|---|---|---|
| Buna | 19582 | Dajc (1958-1985) | 675 | 21263 |
| Mati | 2441 | Fani Rubik (1951-1986)<br>Mati Shoshaj (1949-1987) | 87 4 | 2753 |
| Ishmi | 673 | Sukth Vendas(1968-1992) | 19 8 | 624 |
| Erzeni | 760 | Sallmonaj (1949-1992) | 16.9 | 532 |
| Shkumbini | 2440 | Rrogozhine (1948-1991) | 58.7 | 1849 |
| Vjosa | 6710 | Mifol (1948-1987) | 189 | 5954 |
| Semani | 5649 | Mbrostar (1948-1987) | 86 | 2709 |
| Bistrica | 447 | Krane (1949-1987)<br>KalasaBlerim. (1949-1987) | 32.1 | 1011 |
| Pavla | 374 | Bogaz (1951-1991) | 6.7 | 210 |
| Other small rivers | 4028 | | 72.1 | 2271 |
| Total | 43104 | | 1244 | 39186 |

Table 13
Long term water flow discharge and the annual distribution

| River basin | Disch. m3/s | Month | | | | | | | | | | | | wet period X-V | dry period VII-IX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | XI | XII | I | II | III | IV | V | VI | VII | VIII | IX | | |
| Buna | 675 | 420 | 723 | 1053 | 1037 | 859 | 851 | 899 | 899 | 575 | 334 | 214 | 238 | 6741 | 786 |
| Mati | 87.4 | 47.9 | 116 | 153 | 137 | 137 | 125 | 124 | 93.3 | 48.5 | 21.9 | 16.5 | 28.8 | 933 | 67.2 |
| Ishmi | 19.8 | 11.4 | 25.9 | 30.4 | 32.1 | 36.1 | 31.1 | 24.7 | 17 | 9.03 | 5.91 | 5.46 | 8.46 | 209 | 19.8 |
| Erzeni | 16.9 | 7.95 | 20.7 | 27.2 | 30.8 | 32.2 | 26.6 | 20.9 | 16.4 | 8.9 | 3.71 | 2.72 | 4.75 | 183 | 11.2 |
| Shkum | 58.7 | 27.8 | 64.4 | 82.4 | 87.3 | 93.7 | 89.5 | 95.1 | 85.2 | 40 0 | 15.0 | 9.30 | 14.7 | 625 | 39 |
| Vjosa | 189 | 86.2 | 222 | 333 | 352 | 336 | 268 | 247 | 177 | 92.3 | 55.1 | 49.2 | 50.1 | 2021 | 154 |
| Semani | 86 | 38.9 | 96.1 | 125 | 140 | 147 | 146 | 137 | 106 | 47.1 | 17.6 | 11.5 | 20 | 936 | 49.1 |
| Bistrica | 32.1 | 21.8 | 34.6 | 47 | 54.7 | 58.9 | 45.5 | 34.6 | 25.7 | 18.7 | 14.7 | 13 | 16.1 | 323 | 43.8 |
| Pavla | 6.69 | 2.85 | 7.58 | 14.2 | 14 6 | 14.1 | 9.8 | 6.8 | 3.9 | 2.7 | 1.5 | 0.98 | 1.2 | 73.9 | 3.7 |
| o.s.river | 72.1 | 39.6 | 85.3 | 116 | 120 | 120 | 104 | 95.6 | 75.7 | 42.5 | 23.5 | 18.2 | 24 6 | 756 | 66.3 |
| Total | 1244 | 704 | 1396 | 1981 | 1973 | 1834 | 1696 | 1685 | 1499 | 885 | 493 | 341 | 407 | 12768 | 1241 |

Table 14
Long term water flow (%) and the annual distribution

| River basin | Discha. | Month | | | | | | | | | | | | wet period X-V | dry period VII-IX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | XI | XII | I | II | III | IV | V | VI | VII | VIII | IX | | |
| Buna | 100 | 5.18 | 8.92 | 13 | 12.8 | 10.6 | 10.5 | 11.1 | 11.1 | 7.1 | 4.12 | 2.64 | 2.94 | 83.2 | 9.7 |
| Mati | 100 | 4.57 | 11.1 | 14.5 | 13.1 | 13.1 | 11.9 | 11.8 | 8.9 | 4.62 | 2.09 | 1.57 | 2.75 | 89 | 6.41 |
| Ishmi | 100 | 4.8 | 10.9 | 12.8 | 13.5 | 15.2 | 13.1 | 10.4 | 7.15 | 3.8 | 2.49 | 2.3 | 3.56 | 87.9 | 8.35 |
| Erzeni | 100 | 3.92 | 10.2 | 13.4 | 15.2 | 15.9 | 13.1 | 10.3 | 8 08 | 4.39 | 1.83 | 1.34 | 2.34 | 90.1 | 5 51 |
| Shkum | 100 | 3.95 | 9.14 | 11.7 | 12.4 | 13.3 | 12.7 | 13.5 | 12 1 | 5.68 | 2.13 | 1.32 | 2.08 | 88 8 | 5.53 |
| Vjosa | 100 | 3.8 | 9.81 | 14.7 | 15.5 | 14.8 | 11.8 | 10.9 | 7.81 | 4.07 | 2.43 | 2.17 | 2.21 | 89.1 | 6.81 |
| Semani | 100 | 3.77 | 9.31 | 12.1 | 13.6 | 14.2 | 14.1 | 13.3 | 10 3 | 4 56 | 1.71 | 1.11 | 1.94 | 90.7 | 4.76 |
| Bistrica | 100 | 5.66 | 8.99 | 12.2 | 14.2 | 15.3 | 11.8 | 8.98 | 6.66 | 4.85 | 3.82 | 3.38 | 4.17 | 83.8 | 11.4 |
| Pavla | 100 | 3.55 | 9.44 | 17.7 | 18.2 | 17.6 | 12.2 | 8.52 | 4.88 | 3.3 | 1.86 | 1.22 | 1.53 | 92.1 | 4.61 |
| o.s.river | 100 | 4.58 | 9.86 | 13.4 | 13.9 | 13.9 | 12 | 11.1 | 8.74 | 4.9 | 2.7 | 2.1 | 2.82 | 87.5 | 7.62 |
| Total | 100 | 4.73 | 9.38 | 13.3 | 13.2 | 12.3 | 11.4 | 11.3 | 10.1 | 5.95 | 3.32 | 2.29 | 2.73 | 85.7 | 8.34 |

Table 15
Long term water flow volume and the annual distribution

| River basin | Discha. % | Month | | | | | | | | | | | | wet period X-V | dry period VII-IX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | XI | XII | I | II | III | IV | V | VI | VII | VIII | IX | | |
| Buna | 21263 | 1103 | 1898 | 2764 | 2722 | 2255 | 2234 | 2360 | 2360 | 1509 | 877 | 562 | 625 | 17696 | 2064 |
| Mati | 2753 | 126 | 305 | 402 | 360 | 360 | 328 | 326 | 245 | 127 | 57.5 | 43.3 | 75.6 | 2452 | 176 |
| Ishmi | 624 | 29.9 | 68 | 79.8 | 84.3 | 94.8 | 81.6 | 64.8 | 44.6 | 23.7 | 15.5 | 14.3 | 22.2 | 548 | 52 |
| Erzeni | 532 | 20.8 | 54.3 | 71.4 | 80.9 | 84.5 | 69 8 | 54 9 | 43.1 | 23.4 | 9.74 | 7.14 | 12.5 | 480 | 29.4 |
| Shkum | 1849 | 73 | 169 | 216 | 229 | 246 | 235 | 250 | 224 | 105 | 39.4 | 24 4 | 38.6 | 1642 | 102 |
| Vjosa | 5954 | 226 | 583 | 874 | 924 | 882 | 704 | 648 | 465 | 242 | 145 | 129 | 132 | 5306 | 406 |
| Semani | 2709 | 102 | 252 | 328 | 368 | 386 | 383 | 360 | 279 | 124 | 46 2 | 30.2 | 52.5 | 2458 | 129 |
| Bistrica | 1011 | 57.3 | 90.8 | 123 | 144 | 155 | 119 | 90.8 | 67.5 | 49.1 | 38 6 | 34.1 | 42.3 | 847 | 115 |
| Pavla | 210 | 7.48 | 19.9 | 37.3 | 38.3 | 37 | 25.7 | 18 | 10 3 | 6.96 | 3.91 | 2.57 | 3.23 | 194 | 9 71 |
| o.s.river | 2271 | 104 | 224 | 305 | 315 | 315 | 273 | 251 | 199 | 112 | 61.7 | 47.8 | 64.6 | 1986 | 174 |
| Total | 39186 | 1848 | 3664 | 5200 | 5266 | 4815 | 4453 | 4424 | 3938 | 2322 | 1295 | 895 | 1069 | 33609 | 3259 |

There are two characteristic periods in the year in terms of the water flow in the hydrographical network: a) wet period (October-May) and b) dry period (July-September). 86% of annual water flow is discharged during the wet period and 8% of the annual water flow is discharged during the dry one. June belongs to a transitory period with 6% of the annual water flow, 39% of annual water flow belongs to winter, 33% to spring, 17% to autumn and 11% to summer. The months with the highest value of water flow is December (13.3% of annual water flow) and it is followed by January (13.2%), February (12.3%). The months with the lowest value of water flow is August with 2.29%. Water flow is formed in the general catchment area of the Albanian hydrographical network and also represents the water potential that this catchment area discharges into the Mediterranean Sea. Changes within wide limits, during long term periods (respectively from 19.5 $10^9$ $m^3$ in a dry year (P=99%) to 73 $10^9$ $m^3$ in wet year (P=1%). The variation coefficient is 0.30 (Table 16,17).

Figure 22 shows clearly the annual variations of the total water flow that is discharged in the Mediterranean Sea. 1963 is the wettest year (Q = 2023 $m^3sec^{-1}$) and 1954 is the driest one (Q = 704 $m^3sec^{-1}$).

There is a decreasing trend of the total water flow for the period 1952-1985. The slope of this trend is too small (8.15 $m^3$/sec during 34 years) in comparison with the total water flow, which is Q = 1244 $m^3$ $sec^{-1}$. Precipitation has a significant effect on the water flow. The precipitation trend (see Figures 8-11) shows similar characteristics to the water flow trend (figure 24), the lower precipitation, the lower water flow. The effect of the precipitation on the water balance is explicit.

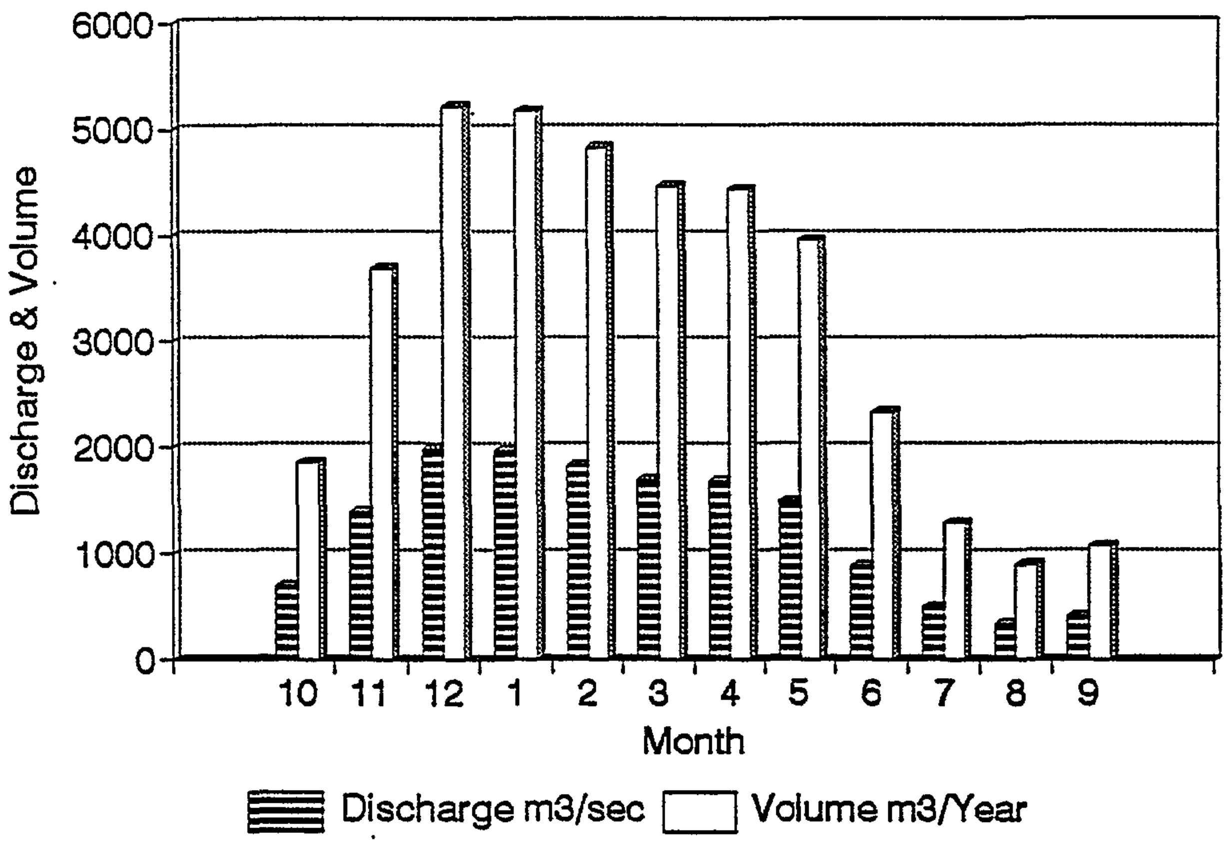


Figure 22 - Long term monthly distribution of the total water flow

Table 16
The parameters of the probability distribution for annual water flow

| River basin | Disch. m3/s | Probability (%) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 5 | 10 | 20 | 50 | 75 | 90 | 95 | 98 | 99 | Cv |
| Buna | 675 | 1212 | 1120 | 998 | 913 | 814 | 655 | 527 | 469 | 423 | 377 | 352 | 0 244 |
| Mati | 87.4 | 135 | 129 | 120 | 112 | 102 | 85.7 | 74.3 | 64.7 | 59.4 | 54.1 | 50.7 | 0.210 |
| Ishmi | 19.8 | 42.2 | 37.5 | 33 | 29.1 | 24.9 | 18.8 | 14.9 | 12.0 | 10.6 | 9 33 | 8.50 | 0.343 |
| Erzeni | 16.9 | 38.2 | 34.2 | 29.2 | 25.5 | 21.6 | 15.8 | 12.4 | 9.8 | 8 55 | 7.34 | 6.54 | 0.364 |
| Shkum | 58.7 | 124 | 112 | 98.2 | 87 | 71.8 | 55.4 | 43 | 35.3 | 30 7 | 26.6 | 24 | 0.324 |
| Vjosa | 189 | 386 | 350 | 305 | 270 | 232 | 181 | 146 | 120 | 108 | 94 | 86.7 | 0.297 |
| Seman | 86 | 184 | 166 | 143 | 128 | 109 | 81.2 | 63 5 | 51,4 | 49 1 | 38.1 | 34.6 | 0 329 |
| Bistric | 32.1 | 52.4 | 48.5 | 44 6 | 40.8 | 37.2 | 31.4 | 27.9 | 24 2 | 22 3 | 20.1 | 18.9 | 0 203 |
| Pavla | 6.69 | 17.4 | 15 6 | 12.9 | 11 | 8.99 | 6.11 | 4.44 | 3.42 | 2.88 | 2.4 | 2.16 | 0.390 |
| o.s.rive | 72.1 | 126 | 117 | 106 | 97 6 | 88 0 | 69 9 | 58.2 | 49 | 42 9 | 38.1 | 35.8 | 0 270 |
| Total | 1244 | 2317 | 2130 | 1890 | 1714 | 1509 | 1200 | 972 | 839 | 757 | 667 | 620 | 0 297 |

Table 17
The parameters of the probability distribution of the annual water flow

| River basin | Volume $m^3 . 10^6$ | Probability (%) | | | | | | | | | | | Cv |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 5 | 10 | 20 | 50 | 75 | 90 | 95 | 98 | 99 | |
| Buna | 21263 | 38178 | 35280 | 31437 | 28760 | 25641 | 20633 | 16601 | 14774 | 13325 | 11876 | 11088 | 0.244 |
| Mati | 2753 | 4253 | 4064 | 3780 | 3528 | 3213 | 2700 | 2340 | 2038 | 1871 | 1704 | 1597 | 0 210 |
| Ishmi | 624 | 1329 | 1181 | 1040 | 917 | 784 | 592 | 469 | 378 | 334 | 294 | 268 | 0 343 |
| Erzeni | 532 | 1203 | 1077 | 920 | 803 | 680 | 498 | 391 | 309 | 269 | 231 | 206 | 0.364 |
| Shkum | 1849 | 3906 | 3528 | 3093 | 2741 | 2262 | 1745 | 1355 | 1112 | 967 | 838 | 756 | 0.324 |
| Vjosa | 5954 | 12159 | 11025 | 9608 | 8505 | 7308 | 5701 | 4599 | 3780 | 3402 | 2961 | 2731 | 0.297 |
| Semani | 2709 | 5796 | 5229 | 4505 | 4032 | 3434 | 2558 | 2000 | 1619 | 1547 | 1200 | 1090 | 0.329 |
| Bistrica | 1011 | 1651 | 1528 | 1405 | 1285 | 1172 | 989 | 879 | 762 | 702 | 633 | 595 | 0.203 |
| Pavla | 210 | 548 | 491 | 406 | 347 | 283 | 192 | 140 | 108 | 90.7 | 75 6 | 68 | 0.390 |
| o.s.river | 2271 | 3969 | 3686 | 3339 | 3074 | 2772 | 2202 | 1833 | 1544 | 1351 | 1200 | 1128 | 0.270 |
| Total | 39186 | 72986 | 67095 | 59535 | 53991 | 47534 | 37800 | 30618 | 26429 | 23846 | 21011 | 19530 | 0.297 |

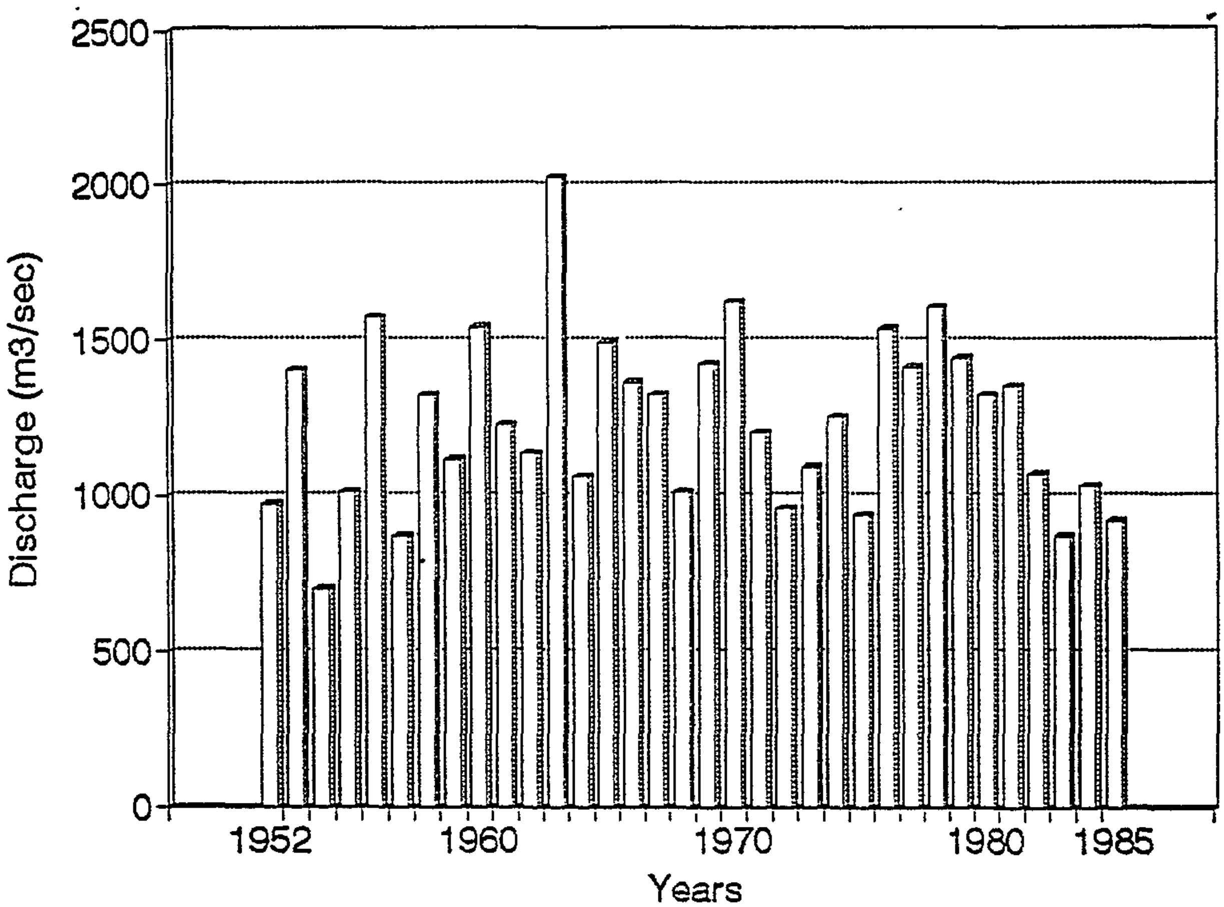


Figure 23 - Long term average annual discharge of all the rivers

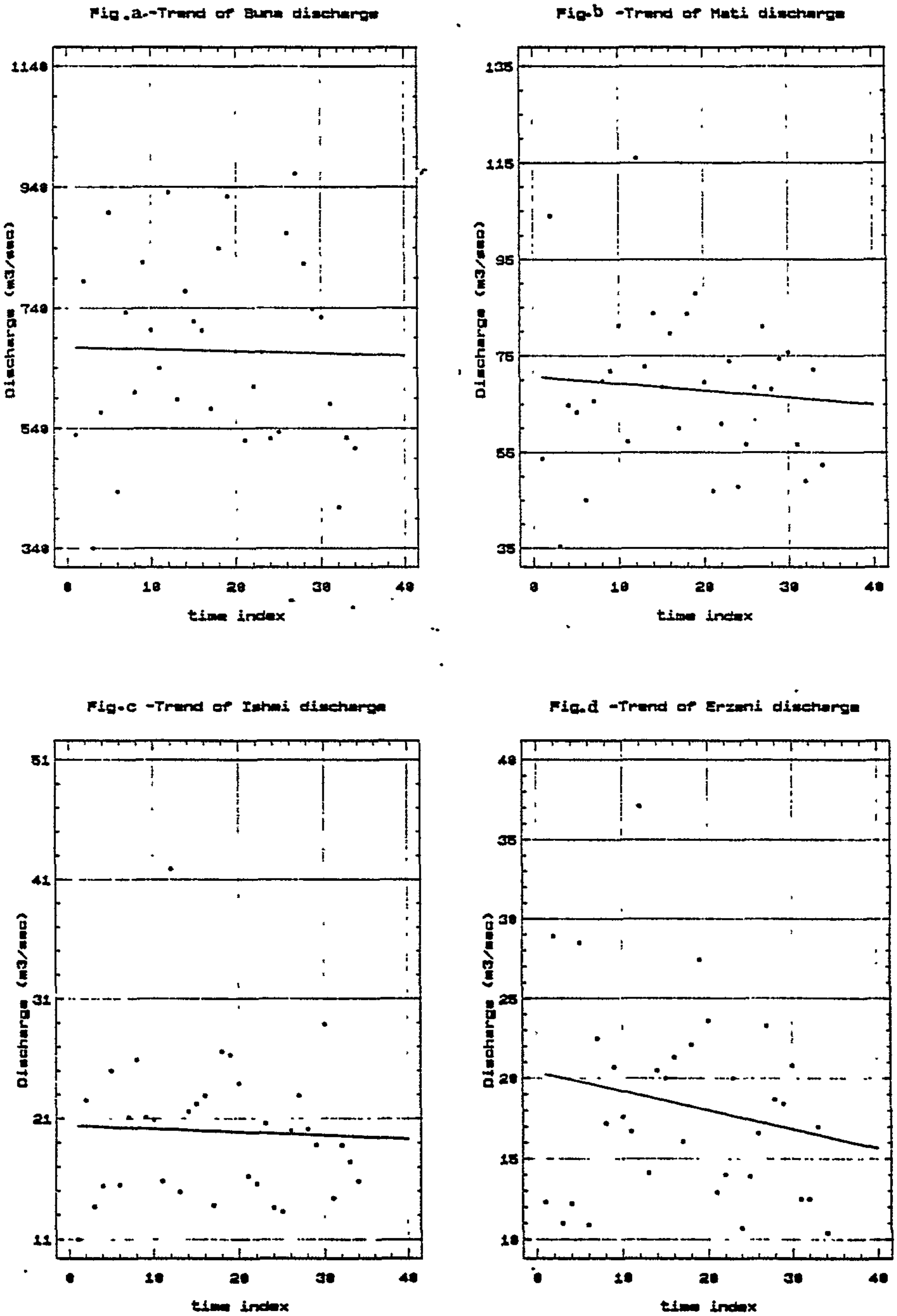


Figure 24 - Trend of discharge for different rivers (1951-1985)
a-Buna; b- Mati; c- Ishmi; d- Erzeni

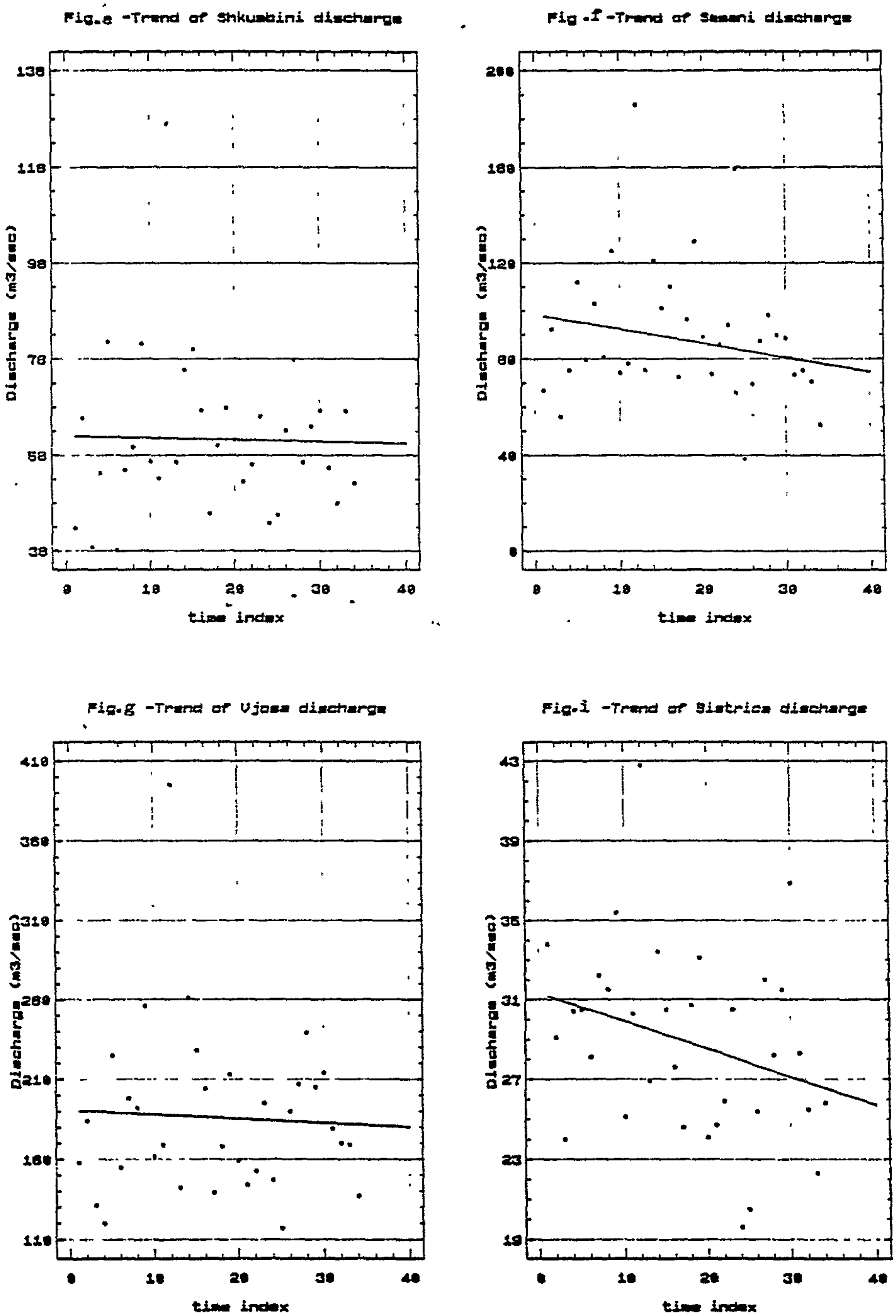


Figure 24 - (Continue) e- Shkumbini; f- Semani; g- Vjosa; i-Bistrica

Fig.k -Trend of Pavla discharge

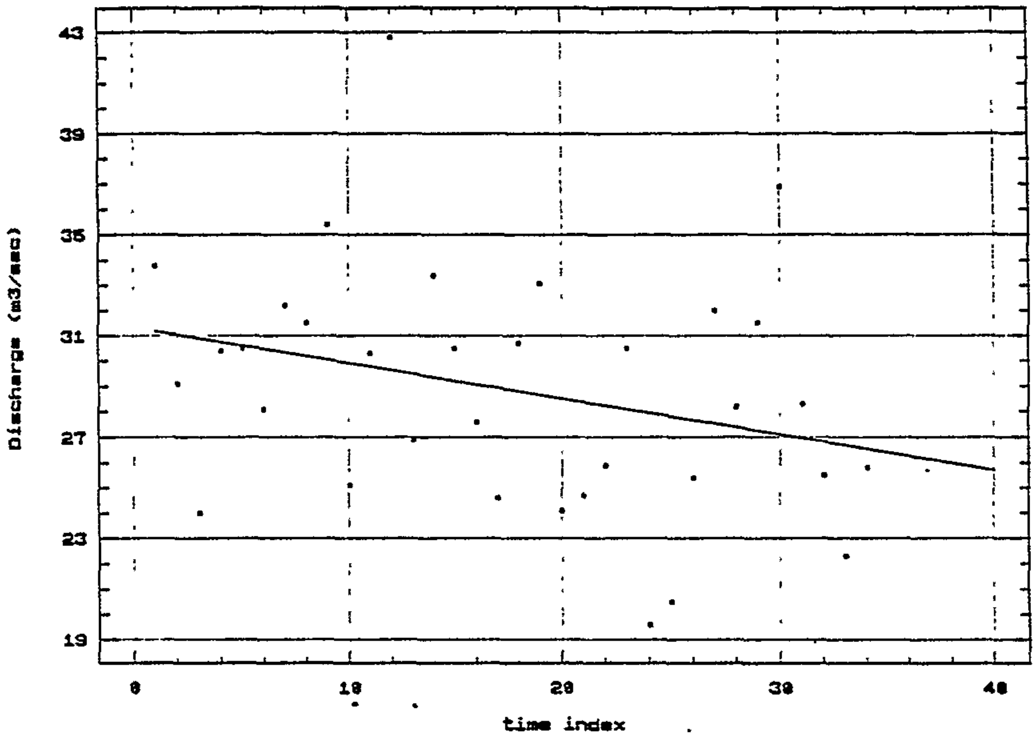


Fig.t Trend of Total discharge

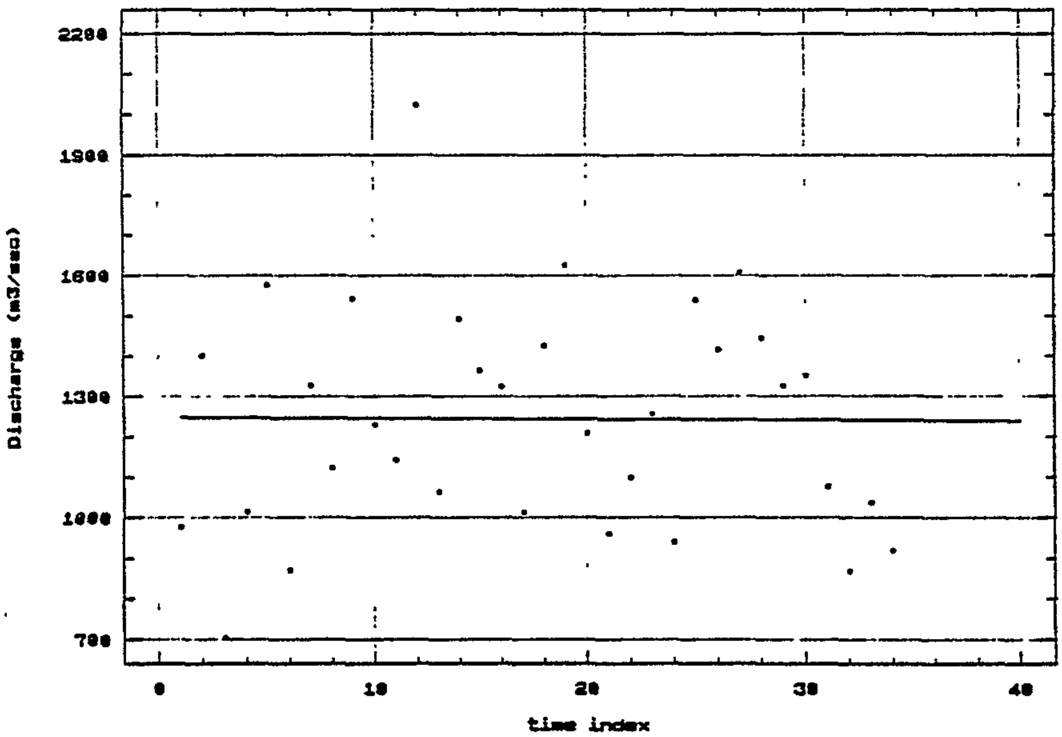


Figure 24 -(continue) k- Pavla; t- total discharge

Temperature has its effect on the water flow as well, but its effect is implicit. The higher temperature during the dry period (june-september) is accompanied by the higher potential evaporation, evapotranspiration. The water flow during the same period is small, so the actual evaporation or evapotranspiration is small. During the wet period (october- may) the volume of water flow is too large, but the temperature is low, so the potential or evapotranspiration is low.

Although the precipitation and temperature are the main factors that effect on water flow, man's influence can not be ignored. The building of artificial lakes has increased the evaporation surface and also the evaporation value.

We do not have any methodology to distinguish man's influence from climatic effects on water flow. It is also important to keep in mind that the time series is about 40 years long, and it is rather short to find definitive accurate conclusions.

Consequently, there is no important trend on the water flow (period 1952-1985) because the trend is less than standard deviation.

**Suspended matter** - The volume of suspended matter which is transported through river networks is $W_p$ = 53.2 $10^6$ ton/year, 18% of it is discharged from Drini river, 16% from Semani, 13% from Vjosa river.

The average module of annual flow of the suspended matter discharged in Mediterranean Sea through our coastal zone, is 480 ton/km$^2$year. This fact certifies a big erosion in the general catchment area.

The total volume of the suspended matter discharging in the Mediterranean Sea oscillates from $W_p$ = 2.57 $10^6$ ton/year in dry years to $W_p$ = 16.64 $10^6$ Ton/year in wet years.

**Water Quality** - River water that is discharged in the Adriatic Sea belongs to the biocarbonative class and also the calcium group

Biological Oxygen Demand (BOD) values are 0.5 - 2 mg/l. The waters of these rivers have a Ph value from 7 2 to 8.4. The dissolved oxygen value is 12 mg/l and the $CO_2$ value is 15 mg/l. River waters are not aggressive.

To assess the impact of river pollution by all industries on the sea water quality, the monitoring at the river mouths is being performed. The results show considerable quantities of nutrients and organic matters.

All domestic and industrial waste water is discharged into the rivers, drainage system and the sea without any treatment, because there are not sewage treatment facilities.

*The results of pollution monitoring suggest :*

1. Buna river is contaminated by Kiri river ( Shkodra District ), which is contains carbonates, chlorines, alkaline hydroxides, sulphates, suspended matters and other organic matters.

2. Mati river is contaminated by copper production.

3. Tirana river, a part of Ishmi River is very contaminated by industrial and domestic waste. It is observed that maximum BOD value is 100 mg O/l. The respective value for Ishmi river is 5090 T/y.

4. Less polluted than above mentioned rivers is Erzeni.

5. The waste of Metallurgical Combine in Elbasani zone and sewage disposal of city Shkumbini river have brought about the heavy pollution of Shkumbini river.

6 Semani river is heavily contaminated with industrial and municipal liquid waste from Ballsh, Patos and Fier cities as well as leakage from the oil fields. Urban and industrial liquid wastes from the chemical fertilisers and power plants are discharged into the Gjanica river, a tributary of Seman.(ICAM Durres-Vlore)

7 Vjosa is the only major Albanian river which seems unpolluted by industrial or urban waste.It is polluted, though, by agricultural runoff (ICAM Durres-Vlore).

Concerning to the rivers discharging into the Ionian Sea, the state of pollution is not a problem. There are no big cities, big industrial enterprise in this zone and the climatic and geographical conditions are very different from the other part of the coastal zone. There are two small rivers: Pavla and Bistrica. The mineralisation of these rivers is decreasing from the origin to mouth. Water has a high level of oxygen, and what is more important the water of these rivers does not contain nitrogen or phosphor. The only river influence on the Ionian Sea is the decrease of the salinity in this zone. It is observed that during a long term period the salinity of Saranda bay is about 20%o.
Consequently, pollution of the rivers affects the coastal area, particularly the shallow waters in the vicinity of the river mouths.The three rivers which largely contribute to the problem are: Ishmi, Shkumbini, Semani. Samples of water analysed in 1989 from Buna, Mati, Erzeni, Vjosa rivers indicated that the level of pollution of these rivers is low and they have not influenced the quality of the sea water (ICAM Durres-Vlore).

2.3.2 Marine Waters

a) Monthly variations in sea-level are caused by the non-uniform influence on the hydrometeorological factors.

The highest levels are observed during the period November-December because strong southern winds present at this time lead to the elevation of sea-level. Lowest levels are observed during July-August which is the quietest period of the year (Figure 25). The levels stability arouses interest for practical uses (Figure 26).

Of great importance to sea-level are extremes caused by strong winds from sea to land and vice versa, especially during the action of strong southern winds which have great velocity and long duration. They vary from the minimal value of (-60 cm) to the maximum one of (+175 cm). [Hidrologjia e Shqipense, Tirana 1984].

b) Waves along the Albanian coastline are generated by the deep area of the sea. Changing waves along the coast are mainly dependent on interaction between the wind and the sea surface where morphometric characteristics play an important role as well.

SW and W directions appear to be dominated by waves of altitude over 0.5 m whereas higher waves come from SW quadrate. The height of the waves varies from 3.5 m in the bays up to 4.5 m in the open sea, their length reach 80 m. The principal wave approach is bimodal: WNW-NW (autumn-winter) and SW (summer-spring) [Pano N., Selenica A.,1985]. It creates littoral currents and sediment drift either to N or to S in some places.

The tide oscillations are irregular ones and their return period is 12 hours. Taking into account the mean tide amplitude, it follows that tides along the Albanian coast are weak. The mean amplitude of daily oscillations varies from 20 cm to 30 cm. [Vecorite klimatike dhe hidrologjike te Ultesires Perendimore; Tirana 1985].

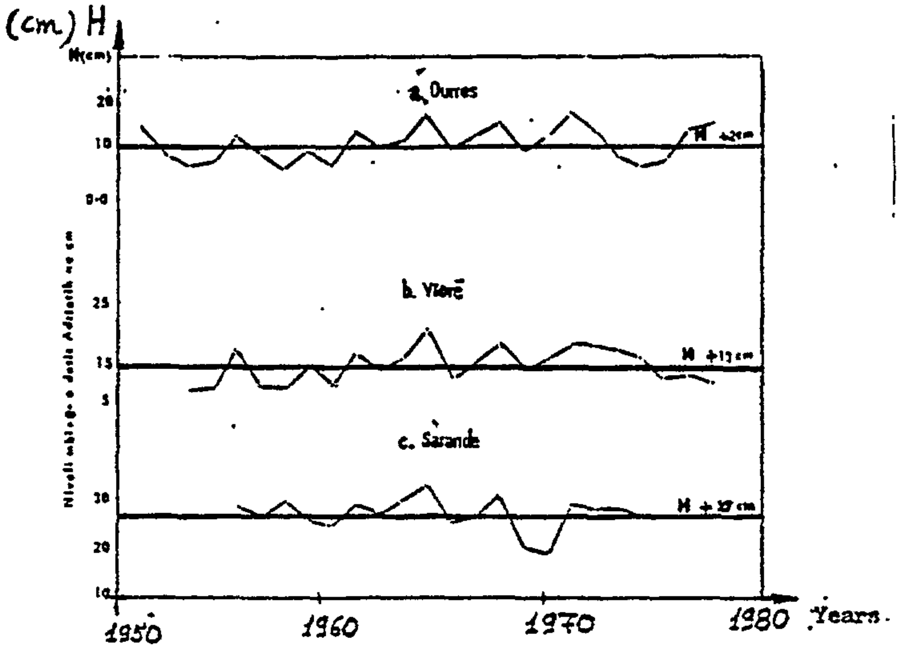


Figure 25 - Long-term variation of mean annual levels

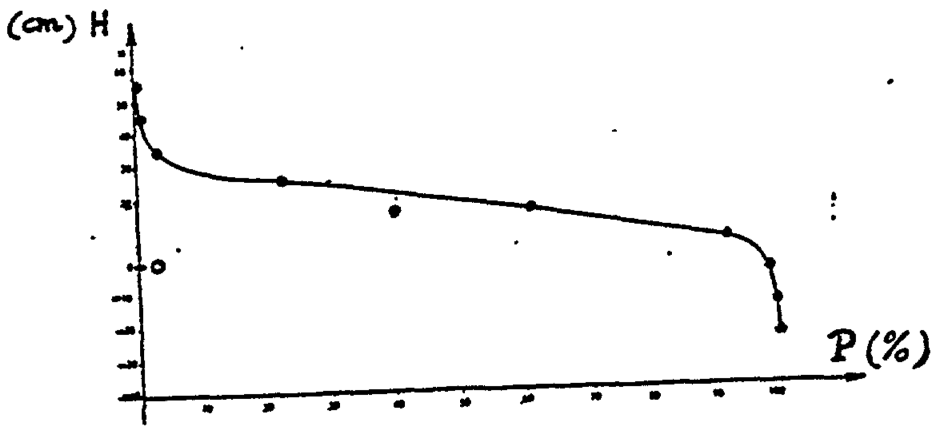


Figure 26 - The stability curve of mean daily levels

The tidal range is low (max. 30-50 cm), wave energy moderate storms are infrequent. Seiche is calculated by means of an advanced explicit method of finite elements. Its highest value reaches 35-55 min.

c) The temperature of the sea water is mainly determined by the solar radiation. But temperature is also subjected to the influence of sweet waters, winds, marine currents, waves, etc. The highest temperatures are observed during the period July - August when the solar radiation has its maximum value and minimal temperatures are observed in February (Figure 27). [Hidrologjia e Shqiperise Tirana 1985 and Archives of IHM]

The salinity of the sea water is 30 %o in winter and 39 %o in summer. The pH value varies between 8.05 and 8.40, so, our marine water is alkaline. The value of dissolved oxygen is 9.6 mg/l in summer and 12.0 mg/l in winter. This fact indicates the poorness of biogen materials.

Dynamics processes

Dynamics processes of the marine waters include aspects of the thermohaline circulations, water mass formation and transformation, dispersion and mixing. The fresh water of Atlantic origin enters through the straits of Sicily to Ionian and Adriatic Seas As it circulates, driven by the wind and other forces, disperses at depth down to a few hundred meters In the Adriatic Sea occurs the process of deep water formation, which produces bottom water. The Southern Adriatic, which is several meters deep, serves as a site for this deep water formation in winter. Very cold and dry air storms apparently cause deep convection throughout the water column. The detailed formation process is not yet known [Robinson A., 1987]. The newly formed deep water exits then the Adriatic through the straits of Otranto, plunges to the bottom and moves off along the deep western boundary of the Ionian basin. It is found that the water formed in Adriatic is a mixture of surface and intermediate water [Pinardi N., 1988]. The main current entering Adriatic through Otranto straits along the Albanian coastline is "deflected" westwards the Italian coast according to the general circulation in the Mediterranean. The wind driven currents are forced by monthly mean climatological stresses. The response is clearly seasonal, with a winter to summer change in flow features including reversals induced by the wind stress the curl annual harmonics

The tidal currents dynamics is treated by means of the weighted residual method using two-step Lax- Wendrof scheme. It is showed that water mass is nearly conserved over tidal currents which in general have a short duration (half a day).

2. The main lagoons of the Albanian coastline are the Karavasta the Narta and the Butrinti Lagoon.

a) The Karavasta Lagoon has an area of 41.8 km$^2$ and is separated from the sea through a slimy narrow land of sandy dunes. Its average depth is 0.8 m and the maximum one 1.15 m.

Canals are the water passages connecting the lagoon to the sea and water exchange owing to tide will happen. This means that the lagoon water is salty. The volume transports during one lagoon-sea water-exchange is about 20-30 m$^3$/sec.

Running temperatures of Karavasta water has the same pattern, like the air temperature. There is also a little influence from thermal advection. Owing to nonuniform dispersion of the wave, the salinity is 48-49%o on western side and about 60% .....on northern and eastern ones (Figure 28).

The lowest value of dissolved oxygen (5.9-9.85 mg/l) in Karavasta lagoon corresponds to the dry period and the highest one (11.30-12.75 mg/l) to the wet and cold period of the year.

b) The Narta Lagoon has an area of 45 km$^2$. Owing to a high evaporation and the sea-lagoon water exchange, salinity varies from 36%... during the wet period of the year to 78.5%.... during the dry period.

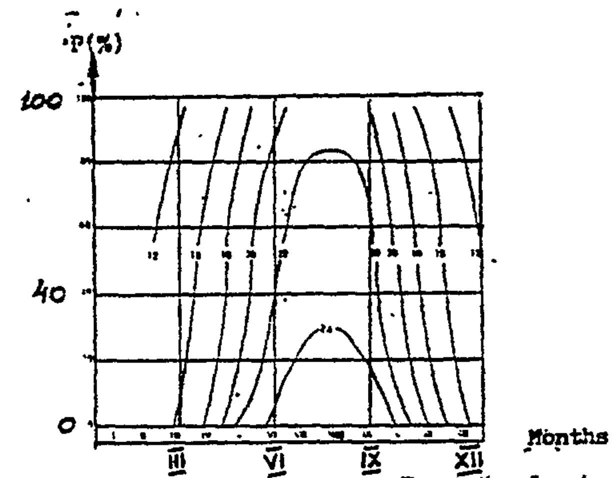


Fig. 248 Shperndarja vjetore e temperatures se ujit, vendmatja e Durresit

Figure 27 - Annual temperature of the sea water

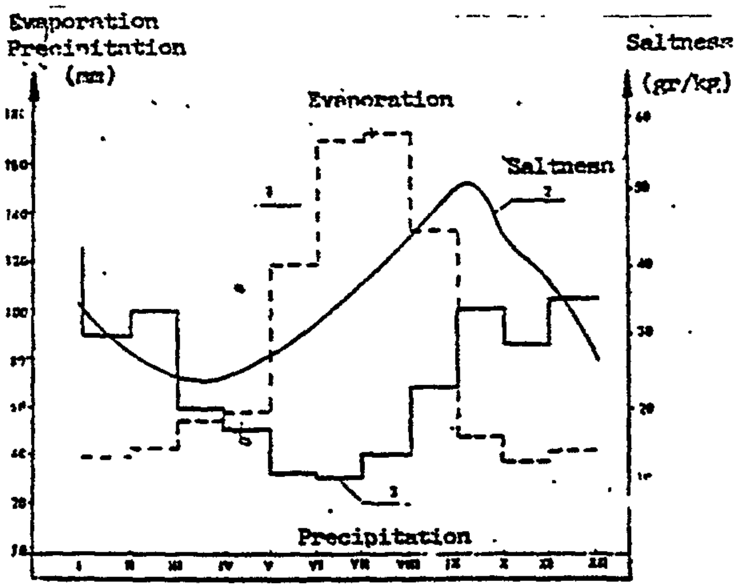


Fig. 250 Shperndarja brenda vitit e karakteristikave fiziko-kimike te ujerave te Karavastase : 1) Avullimi, 2) Reshjet, 3) Reshjet

Figure 28 - Annual level, precipitation, evaporation and saltiness for Karavasta lagoon

Water temperature variation follows that of air temperature (Fig. 29). The lagoon level is mainly determined by both precipitation and evaporation but during the wet period only tide is found to make sure the lagoon existence.

c) Butrinti Lagoon has an area of 16 $km^2$ and the Butrinti canal is the water passage connecting the lagoon to the Ionian Sea which makes possible an active water exchange between lagoon and sea. The lagoon has an average depth of 14 m and the maximum one of 21.4 m. The Butrinti canal has a width of 80-160 m and a depth of 6 m. The water level undergoes fluctuations of up to 20 cm due to both the tide and meteorological factors. Also salinity varies from 22%o during the wet period to 26%o in summer

*Water temperatures depend on both the regions climate and the water mixture (Figure 30).* pH values vary from 8.7 (summer) to 10.2 (winter) and dissolved oxygen content reaches the values 7.2 mg/l and 10.2 mg/l in summer and winter respectively. [Hidrologjia e Shqiperise, 1985 and Archives of IHM].

2.3.3 Groundwater

Ground waters are subjected to climatic morphometric hydrologic and geographic factors. (Ground water means unconfined water in this section).

The most important factor on which ground water levels depend is precipitation. The ground water levels vary approximately as running precipitation (Figure 31). There are also good hydraulic relationships between rivers and ground waters.

The ground water level oscillation depends not only on natural factors but also on the artificial ones, such as man' s influence. Over the zone under study, they are located as follows:

1. Zadrima plain is situated in the south part of the Shkodra city between Gjadri river and Buna river. In this plain the highest level is about 50 cm during the wet period and the lowest level is about 450 cm during the dry period. The amplitude of levels oscillates from 50 to 150cm during the wet period and from 150 to 450 cm during the dry period.

2. Long-term observing data of Mabe, Gramsh and Gjader villages ( Zadrima plain) in Lezha district show that the highest level is 30-50 cm during January, February, March. The lowest level is about 240-280cm during August and September. The amplitude of levels oscillates from 200 to 250 cm. The highest level is near the earth surface and the lowest one is located between 300 and 340 cm in the case of extreme events.

3. In Thumana plain the highest level reaches about 30 cm during February and March and the lowest one about 90-100 cm during September and October. The amplitude of levels is about 80 cm for each year. The highest level comes near the earth surface and the lowest one moves to 170-230 cm in extreme years.

4. Durrës Plain is formed by the marine and continental sedimentary deposits. During the period July - September the lowest level comes to about 70 - 100 cm, whereas in the case of extreme events it reaches 150 cm. During November - April the highest level is 20 cm, and it is found near the earth surface during January and February in extreme cases. The amplitude of the levels variates between 80 - 150 cm, and in peculiar places up to 200 cm.

5. One of the most important agriculture zone in Albania is Lushnja Plain.It is situated between Shkumbini and Semani rivers. The levels of ground waters are depended on the precipitation during the wet period. The highest level, variating from 60 cm up to very close to the surface, is observed during January, February, March. In April the level begins to go down till September and its value reaches 300 cm,and in particular cases even 445 cm.

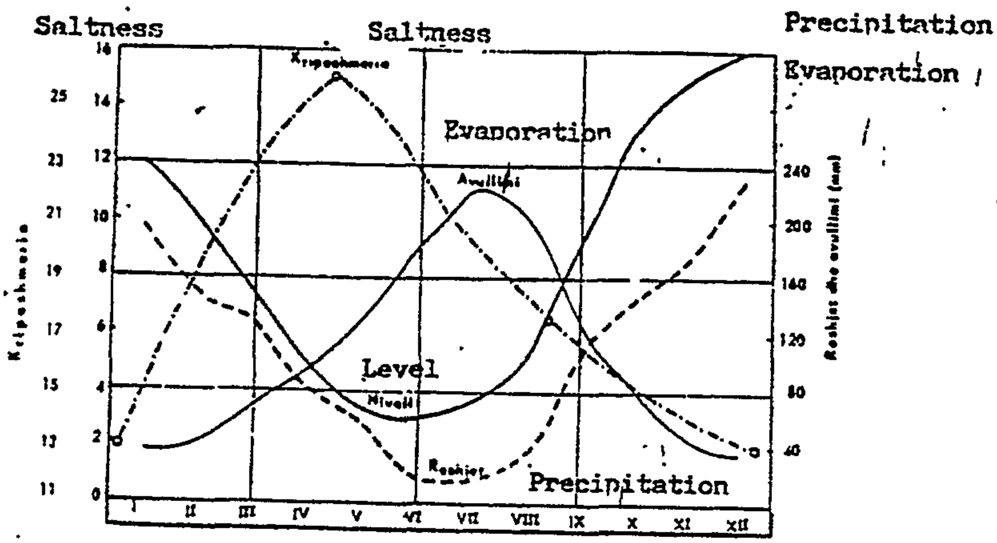


Figure 29 - Running annual level, precipitation, evaporation and saltiness for Narta Lagoon

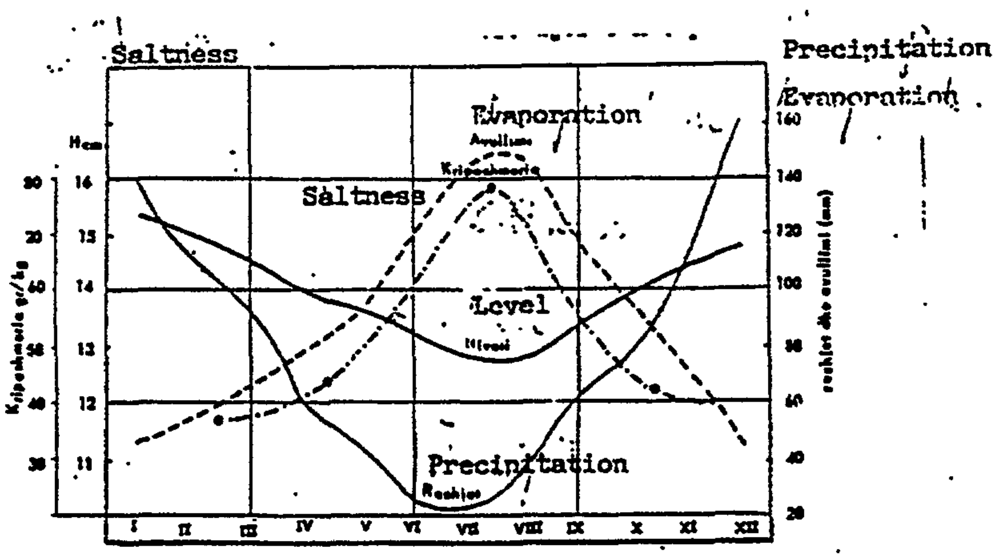


Figure 30 - Running annual level, precipitation, evaporation and salinity for Butrinti Lagoon

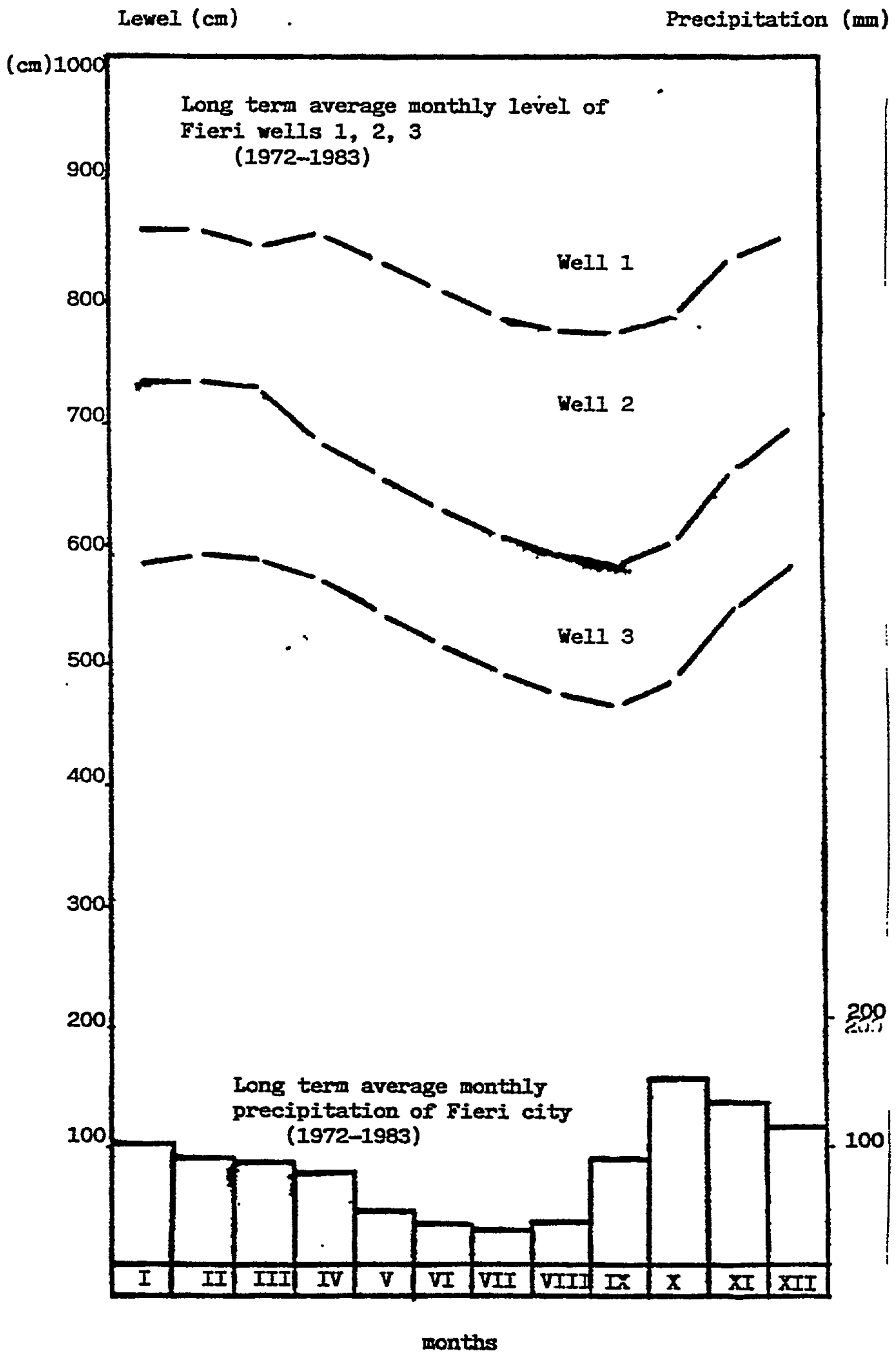


Figure 31 - Long term average monthly level of Fieri Wells 1, 2, 3 (1972-1983)

6. Fieri Plain is located between Semani village, close the coastal area, and Suk-Strume to the east of the region.The long-term level (Semani-Fieri zone) varies from 40 - 110 cm ( February and March), whereas the lowest one, from 260 to 300 cm in September and October. In extreme years the lowest level reaches to 340 cm whereas the highest one to 20 cm.The long-term levels for Fieri-Suk-Strume zone vary from 40-80 cm (the highest) to 200-260 cm (the lowest).The lowest level reaches to 320 cm whereas the highest level comes too close the surface.

The problem of drinking water supply is resolved using underground resources (according to two principles, gravity and attractive flow ). The drinking water is of good quality (according to the national standard and the directives of WHO). Only in cities (see Table 18) the supply with drinking water is done through a centralised water supply and distribution network up to the consumer. This water supply network poses problems in terms of meeting the technical requirements in the source points, especially in well drillings, but generally problems lie within the distribution network. The old ages of the pipelines of the distribution network have been the cause of a big loss of drinking water quantities, e.g. in Tirana the losses amount to 40% of the total.

Environmental damage caused by overfertilizing as an effect of agricultural water runoff with high concentration of herbicides and pesticides affecting the quality of the ground water and surface water. This has been identified as a major environmental problem. The ground water reservoirs in Zadrima Plain are close to the surface (4m). Contamination of ground water must be high, according to the water quality of Kiri river and the nature of industries located in the region.

The gravely alluvial, karstic aquifers and the sandstone conglomerates aquifers of Rrogozhina formation have the salinity limit for potable water expressed in TDS (total dissolved solids ) which is lower than 1.0 gr. / l and the limit for hardness expressed as Fe content which is lower than 0.3 mg / l (in German degrees). The pollution risk is greater in the Rrogozhina area, due to the pollution of the Shkumbini river from iron works in the area of Elbasan.

In generally the quality of water of gravely aquifers near recharge source is good, such as in the Vjosa and Shushica plain, the Cerma sector of the Lushnja Plain and in the Shkumbini valley.

Table 18
The supply of drinking water

| Districts | Water resources | Quantity litter/ sec |
|---|---|---|
| 1. Shkodra | Water supply network Rjoll, Dobrac, Bahcallek<br>" " " for the population | 152.5<br>75 |
| 2. Durres | Drilling well Fushe Kuq, water supply Pjesez | 625 |
| 3. Kavaja | Drilling well | 65 |
| 4. Lushnja | Drilling well<br>Drilling well for the population | 180<br>140 |
| 5. Fieri | Drilling well<br>Drilling well for the population | 970<br>250 |
| 6. Vlora | Water supply network | 700 |
| 7. Gjirokastra | Drilling well | 110 |
| 8. Saranda | Water supply network | 70 |

## 2.4 Natural ecosystems

There are several basic ecosystems along the Albanian coast, which we may group into:

1. Terrestrial ecosystems
2. Fresh water ecosystems
3. Lagoon ecosystems
4. Marine ecosystems

The natural ecosystems of the albanian coast represent various values, such as economic, recreational, biological and in some cases international too.

Among the economical values to be mentioned are the development of agriculture and tourism, development of fisheries in lagoons and seas, hunting, using of the other natural resources as combustibles, the medicinal and the industrial plants, etc.

The presence of some beaches constitute one of the recreational values, whereas the presence of some specially protected areas and lagoons, that reserve rare endemic and migratory animals and plants (Annex II), is to be mentioned among the biological values.

The human influence on ecosystems, especially the last years, has been very sensitive. The demographic movement from northeastern and central zones of Albania towards the coastal one, development of various industrial, agricultural, construction and communication activities haven't positively influenced on natural ecosystems. To be mentioned are the decrease of wetland surface through the reclamation to profit new arable land, the cutting down of trees to be used for construction and warming, removing of sand and gravel for construction and beach creation, building without license and out planning, uncontrolled hunting and fishing, sometimes using explosives, etc.

The missing of legislation and regulations as well as non-performance of those in force, have brought about the damages in the ecosystems.

### 2.4.1 Terrestrial Ecosystems

Terrestrial ecosystems consist of:

a) Sandy dunes
b) Mediterranean pine forests
c) Machia and Phryganas

a) Sandy dunes

Sandy dunes lie mainly along the Adriatic coast and a few of them along the Ionian. Along the Adriatic sea with some intersections by the river mouths, they extend along all its length. Their altitude varies from 1-2 m to 4-5 m. Numerous dunes and very high ones are found in Zhuk-Poro, Velipoje, Divjake etc.

The sandy belt along the coastal line is completely bare of vegetation to a length sometimes extending up to 30 m. The lack of vegetation life in this belt corresponds to an active life of terrestrial and aquatic species as *Coleopteran, Amphipoda, (Talitrus sp.) etc.*

The phanerogamic vegetation appears after this denuded belt, in a sandy belt already washed away by the considerable amounts of salts as a result of rain waters. Pioneer species, *Cakile maritima, Salsola kali, Xanthium strumarium subsp./italicum,* at the beginning isolated become more frequent when leaving the coast.[ Mullaj A., 1989 ]

Gradually going away from the coast line and as the height of sandy dunes is increased, the physiognomy of vegetation is imparted by the species - *Elymus farctus, Cyperus capitatus, Sporobolus pungens* that pertain to a more evolved phase of psamofil vegetation. This type of vegetation represents a stable "potential" of the sandy banks from Velipoja to Vlora.

The increase of dune height is accompanied as well with the gradual change of the physiognomy of this vegetation. *Elymus farctus* has succeeded *Ammophila arenaria*, which is overwhelming in the duna vegetation. The presence of this specie is an important factor in impeding the movement of sand quantities pushed away by the sea winds towards the continent.

Out of this type of vegetation extended all over the Adriatic coast there are noticed two evolutive lines:

i) Stabilisation of sandy masses, their compactness and less permeability creates possibilities for the appearance of a more suitable association for this environment, the physiognomy of which is determined by the domination of Ephedra distachya. This association is extended over the coastline fragmentarily from Kavaja Rock in the north to the discharge of Dracit stream in the south of Golemi beach.

This association constitutes the last most evolved phase of the vegetation of sandy dunes or the borderline between duna vegetation and the Mediterranean pine forests.

ii) The line starts with the degradation of sandy dunes and the formation of depressions. The end of depressions is closer to the level of salted ground waters. The ground becomes wetter and a different vegetation grows from that of dunes, dominated by coniferous species.The uncontrolled sand quarrying is threatening the natural balance of the beaches, particularly along these sections which are affected by the natural erosion process. It is to be expected that the quantities of excavated sand will rapidly increase with the growing construction activity. If not stopped, this undesirable activity could deplete some of the beaches and, after the intrusion of sea water, irreparably damage the protection belt of pine trees

b) Mediterranean Pine Forests

Mediterranean pine forests occupy a considerable part of the Adriatic coast concentrated mainly by movable substrata (sandy dunes). Out of the whole area covered by these forests only less than half of it is held interesting from the geobotanic viewpoint and especially the forestry belt extended over the discharge point of Shkumbini river and Vjosa river (Divjaka, Pishe-Poro). The rest of this coniferous formation as in Velipoje, Shengjin, Rrushkull, Kavaja rock, Golem, Spille, Vlora Old Beach is relatively young cultivated recently in order to stabilize the sandy dunes and protect the agricultural lands.

Out of the above mentioned formations the most interesting ones are Divjaka and Pishe-Poro forest which form the delta of Shkumbini river to the south of Vjosa river delta.

Divjaka forest is situated in the north of Shkumbini delta up to the south of Seman delta. It has a length of about 10 km and a width of some hundred meters up to 1-1.5 km and an overall area of around 11 km². In the east it is bordered by agricultural lands and the Karavasta Lagoon, whereas in the west by the sandy beach.

This forest represents an important and interesting ecosystem with regard to the diversity of its structure and the beauty of the created recreational environments. Being considered as National Park since 1966, it has been comparatively well-preserved, so, the growth of a rich natural flora and fauna is enabled. "The heart" of the park is constituted by the reserve located in the northern part of the park. The reserve has an area of about 7 km² including the water areas and the non-productive lands as well [Gjiknuri L., 1994].

The physiognomy of this forest is imparted by the species *Pinus halepensis* and *Pinus pinea* which here and there are mixed up with falling-leaves species as *Ulmus minor, Quercus robur, Populus alba, Alnus glutinosa etc.* The sub-forest is represented by typical Mediterranean species which occasionally occur to be very dense. The most spread bushes in this formation are: *Myrtus communis, Erica manipuliflora, Pistacia lentiscus, Juniperus oxycedrus subsp. macrocarpa*[Mullaj A., 1989].

This floor (strata) in many cases is presented interwoven with the numerous elianas as *Smilax aspera, Hedera helix, Clematis flammula etc.* The high density of trees and bushes has made the grassy stratum to be represented relatively poorly. The most common species are: *Vulpia fasciculata, Asparagus acutifolius, Asphodelus aestivus.*

There are ligatine microhabitats known by name "struga" in the forest, where a typical hydro-higrorilic vegetation is developed. Special interest in this forest present the endemic species such as *Aster albanicus subsp. papanstoi, Orchis albanica* as well as a hybrid form *Orchis xpaparisti (O. albanica x O coriophora)*[Mullaj A.,1989].

The forest fauna is rich and comparatively well preserved especially in the reserve. The most common mammals are: *Lepus europeus, Vulpes vulpes, Meles meles, Mustela nivalis etc.* One can find in the reserve *Capreolus capreolus* as well as 170-180 "wild" cows. Living for many years (several generations) freely they have acquired clear morphological and etological features.

The forest has a rich ornitofauna. Besides the aquatic fowls one can come across other kinds as Columbia oenus, C. palumbus, Picus viridis, Galerida cristata, Oriolus oriolus, Silvia varie sp., Phyloscopus varie sp., Passer varie sp., Carduelus, Emberiza, Athena noctua, Tito alba, Cricus earuginosus. It is worth mentioning the presence at a free status of the pheasant (Phasianus colchiccus) acclimatized after 1955. One may come across a lot of reptiles and amphibians, like Emys orbicularies, Testudo hermani, Ophisaurus apodus, Triturus vulgaris, Bufo bufo, B. viridis etc.

The forest has also a rich entomophone characteristic for these surroundings. The mosquitos *Culex* and *Anopheles* are so many during the summer that they cause disturbance and uneasiness for the men in this surrounding of rare beauty.

The forest of Divjaka, in comparison to other coniferous Mediterranean forests, has suffered less damages during the transition period that Albania is facing with.

Because of its manyfold values, together with the lagoon of Karavasta which lies on the other side, it is lately (22/8/94) declared as a Strictly Protected Natural Ecosystem and thus included in the Ramsar Convention. Actually, some projects for its better management, as well as the development of a proper ecotourism, have been approved.

The forest of Pishe-Poro lies on both sides of the discharges of the Vjosa river situated on sandy dunes. It is dominated by *Pinus halepensis, P. pinea* and *P. pinaster.* It is younger than the forest of Divjaka and has a similar physiognomy to that.

The fauna is relatively poorer than that of Divjaka. There have been noticed damages to the forest by the inhabitants of the area around who use the pine wood for heating and building.

c) Machia and phryganas

Machia is the most characteristic formation of Mediterranean flora and with the widest spreading on the coastal region of our country (about 60 km²). There are many bushes with green leaves that resist the dry weather like *Arbutus unedo, A. andrachne, Erica arborea, Quercus coccifera, Pistacia lentiscus, Asparagus acutifolious, Cistus incanus, C. salvifolius, etc.* The plants that need warmth for growing are more widespread in the south and middle of Albania than in its northern part. The most spreadable shrub formation in the machia area is *Quercus coccifera*, which grows in rocky ground almost uninhabitable, with a typical degradable structure. It represents the degradation phase of the formations with ilexes (*Quercus ilex*), from the evaluative point of view. The groupings with ilexes (*Quercus ilex*) are rare in Ksamil and islands, although they should potentially cover more or less, without interruption the upper altitudinal belt, to a level of 400-500 m above the sea-level.

*Quercus coccifera* represents a great altitudinal amplitude, as it is touched by the coast to a 800-1000 m forming floristic groupings. They are mostly found in Jonufer, Sazan, Dukat, in the Karaburun Peninsula. Quite often they are presented in a bush status 3-4 m high and occupy great areas on compact limestones. It may be found on flishes reaching a point of substitution with *Phlomis fruticosa* and *Salvia triloba*.

Another variation of machia in our coast is that of the domination of *Arbutus unedo* and *Erica arborea*, that is met in the previous bioclimatic area but always on silicon substrata, as in Vlora, Turra Castle, Kavaja, Ishem, etc.

Besides *Arbutus unedo* and *Erica arborea*, there are bushes and woods with evergreen and also falling leaves in this grouping. Those that are firstly encountered are: *Juniperus oxycedurs, Cistus incanus, Phillyrea latifolia, Pyracantha coccinea, Pistacia lentiscus* and secondly encountered are *Carpinus orientalis, Fraxinus ornus, Cotinus coggygria, Pistacia terebinthus.*

*Laurus nobilis* (laurel) is one of the most interesting and earliest variants of the makia in Albania and it is spread over the hills of the Turra Castle in Kavaja. This ancient formation in Albania, pertaining to the tertiary period, represents one of the numerous miracles of Albanian nature with considerable historical, biological, ecological values. Its preservation for the country constitutes an indispensability.

The principal components of the phryganas are the xerophile shrubs, typical for the regions with hot and dry summer as in the case of the Ionian Sea. The bushes and shrubs which form the phryganas are *Phlomis fruticosa, Salvia officinalis, Salvia triloba, Calicotome villosa, Euphorbia dendroides, Anthyllis hermanniae* and *Thymus capitatus.*

Mixed phryganas are found especially in the foot of the mountains bordering the Ionian Sea, whereas along the Adriatic coast they are rare.

The associating fauna of these families are Leguminosae, Rosaceae, Euphorbiaceae, Compositae.

Phriganas found in Albania are:

1 Associations of *Phlomis fruticosa*:
This is the most widespread phrigana in Albania especially along the Ionian coast up to the altitude 500-600 m. *Phlomis fruticosa* in most of the cases forms simple associations, but is accompanied with mediterranean xerophile bushes and shrubs as for example: *Salvia officinalis, S. triloba, Cistus incanus, Thymus capitatus.*

2. Associations of Salvia officinalis
It is widespread mainly in the Albanian coast along the Ionian coast and in the mountains of Kakarriq and Rrenci.

3. Associations of Cistus incanus, C salvifolius, C monspeliensis
They form mixed associations with the bushes which cover a considerable and often dry area as on the bare slopes of the Durres mountain.

4. Associations of Erica manipuliflora
In contradiction with the *E. arborea* it is a calcious plant and is met frequently on limey soils as on the mountains along the Ionian Sea.

### 2.4.2 The ecosystems of fresh waters and deltas

Important elements of the Albanian coast are the ecosystems of the river delta.. Almost all the deltas of these rivers are of a simple kind, because they are composed only of one river discharge. The only one exception is that of the delta of Buna which has only two discharges and surrounds two little sandy islands: Ada and Franc-Joseph.

The most complicated and bigger delta is that of Drini. It is composed of many forms of labyrinths; like sand belts and arrows, gulfs, godillas, lagoon and islands (Kune) Since 1963 following the construction of the Hydropower stations on the river of Drini and its deviation to the river of Buna, solid flows decreased.

In all the rivers there exist not only new discharges but also old ones which are many kilometres away. The most typical are those of Shkumbini river, bay of Durres, Seman and that of Vjosa. The big solid flows are characteristic for all the rivers which are discharged into the Adriatic especially at the period of the rains. This is a consequence of high erosion which is noticed in Albania, due to deforestation, the opening of terraces and new lands in mountainous and hilly areas.
Out of the polluted rivers we may mention Ishëm, Shkumbin, Seman because there are industrial plants which discharge their wastes in these rivers. Bistrica and Pavla are noticed for the less solid discharges and pure and unpolluted waters.

The discharges of the rivers and their surroundings are places preferred by the water-fowl who seek suitable conditions for food, shelter, reproduction. The fowls which frequent the discharging of the rivers are those of these families *Ardeidae (Eggreta garzeta, E. alba, Ardea cinerea etc.), Sternidae (Sterna albifrons), Phalacrocoracidae carbo (Ph. pygmaeus etc.), Laridae (Laurs argentatus, L. melanochefalus, L ridibundus).* Flocks of curly Pelican (*Pelecanus crispus*) have been observed in the discharges of Shkumbin, Seman and Vjosa.

The ictiofauna of the discharges is represented by euryhaline fishes like those of the *Mugilidae* family. The aquatic fauna of these surroundings is not very much studied. Fishing through a balance-sheet is applied in the mouths of the main rivers.

The discharges of the rivers are characterised by a very rich and interesting flora. There are many factors that have favoured its development and among them we can mention the intersections of fresh and salty waters.

The most important floristic groupings that we can mention are: hygrophilic forest dominated by these species *Alnus glutinosa, Fraxinus angustifolia, Ulmus minor, Quercus robur, Populus alba* in the discharges of the rivers of Buna, Drini, Mati, Erzeni, Bistraca. Also there are floristic groupings with the dominations of marina (*Tamarix dalmatica, T hampeana*) which are found in all the discharges of the rivers; the groupings of *Phragmites communis, Scirpus maritimus* and *Typha angustifolia* which follow their flow especially when the currents do not meet.

### 2.4.3 Ecosystems of Lagoons

These are the most characteristic elements of the Adriatic coast. The main lagoons of the Albanian coast are: Viluni, the lagoon of Lezha (Ceka and Merxhani), Patoku, Karavasta, Narta and Dukati with a total surface of 150 $km^2$[Gjeografia fizike e Shqipërisë,1990].

In the Ionian coast there is only one such ecosystem, the lake of Butrinti which acquired the characteristics of a lagoon, only after 1959 with the deviation of the Bistrica river for the reclamation of the Vurgu field. The formation and evolution of the lagoons is connected with the very big solid floods of the rivers and the dynamic processes of the sea. This is still an active process.

Next to these ecosystems, there are forestry formations which are proclaimed shooting reservatus and national parks. Next to Vilun there is the reserve of Velipoja, next to Ceka of Merxhan there is the reserve of Kune-Vaini, near Patok there is the reserve of Fushekuque, near Karavasta there is the National Park or Divjaka and near Butrinti there is the forest bearing the same name. The existence of these ecosystems adds to the bio-ecological values of the lagoons themselves.

While most of the lagoons have one or two communicating channels with the sea, with a considerable flood to normally ensure the biological life in those ecosystems, the problem lies with the lagoon of Narta, where the flood is very limited. There is a water stratification which is expressed in the temperature figures as well as in that of the oxygen and the salt content. This is the reason why at a depth of 7m one can see the existence of $H_2S$. Referring to the figures, this lake seems to have entered into the phase of eutrophication

The aquatic flora of the lagoons is mainly represented by *Zostera noltii* and *Ruppia cirrhosa* which form homogenous populations made up of one single species. They have the character of an underwater meadow covering the whole areas in the alluvional bottoms of the lagoons.

The alga vegetation differs according to the salinity and depth. Macrophyte algas have the largest distribution: *Chaetomorpha linum, Cladostephus verticillatus, Laurencia sp., Cladophora sp. etc.* Even the phytoplankton is to some extent rich, of which the largest part belongs to the diatomeas.

There have been sudden blossoms of the colonies of *Chaetoceros wighamii and of the Peridines, like Prorocentrum minimum, P.micans, Scrisppsiella sp. etc,* which shows that this ecosystem has entered the process of eutrophication.

These kind of flora colonies, together with ecological groups of accompanying species, mainly algas, represent one of the richest biocenosis of benthos having a threefold importance: biological, ecological and economical. They represent the main resource of oxygen release for the waters of the lagoons, as well as food for the fish. The oxygen is necessary for the existence of the aquatic flora of these surroundings.

Another aspect is noticed in the sandy lands around the lagoons of Albania. During the hot season, the area of land in these surroundings is covered with a thin layer of very transparent salt as well as with a great number of halophilic species. In the stations with the highest degree of salinity and level of underground waters the most dominant flora species are: *Arthrocnemum fruticosum, A.glaucum, Salicornia europaea, Limonium vulgare.* Characteristic for these groupings is the great floristic scarcity and the tendency to come to pure monophytic colonies. The further evolution depends on two basic factors, the degree of salinity and the hydrologic conditions.

Moving away from the coast the decrease in the level of underground waters causes the above mentioned species to gradually leave space for another kind of groupings: *Juncus maritimus, J acutus, Salsola soda, Tamarix dalmatica, Vitex agnuscastus etc.* Between these groupings are groupings of a cosmopolite hygrophilic nature with a very wide ecological amplitude, like those of the domination of *Phragmites australe, Scirpus maritimus etc.* These groupings can resist even in surroundings where the degree of salinity is somewhat high.

*Characteristic for all the lagoons is the existence of an euryhaline ilitiofauna. Fish of the Mugilidae family: (M. cephalus, L. ramada, L. saliens), Anguilla anguilla, Dicentrachus labrax, Sparus auratus, Pagellus erythrtimus, Solea sp., Aphanius fasciatus, Gobius bucchichi etc.*
In all the lagoons the crab *Carcinus aestuarii* is present, while in the lake of Butrinti, there is the bivalve molluscum *Mytillus galloprovincialis.* The shellfish represents a very important industrial source for this lake.

The Albanian lagoons represent a very important place for the aquatic fowl some of which nestle in their shores. The most important fowls are those of the *Phalocrocoracidae* family (*Ph. carbo* and *Ph. phygmaeus*), *Sternidae* family (*Sterna albifrons*), *Ardeidae* family (*Egretta garzeta, E. alba, Ardea* *cinerea Fulicaatra, Rallus aquaticus, Laridae (Laurus argentatus, L.melanochephalus, L ridibundus), Anatidae (Anser anser, Anas platyrhynchos, A. crecca) etc.*

The lagoon of Karavasta is of special importance because the curly pelican (*Pelicanus crispus*) and the Sterna albifrons nestle there. For the pelicanus, Karavasta is the most western point of its distribution area. It is represented by a colony of 60 couples. Not long ago this colony had more than 100 couples. The main reason for this decrease in number, is no doubt the unfriendly attitude of the fishers, who consider their competitors.

2.4.4 Marine Ecosystems

Ecosystems of smooth and solid beds (bottoms) are present in the coast of Albania. According to the nature of the beds the composition of biocenosis changes. Biocenosis of smooth beds (sand, sand-mould) are found mostly in the Adriatic Sea, whereas those of solid beds are found in the Ionian Sea.

The soft beds of infra littoral are populated from sea phanerogam *Posidonia oceanica and Cymodocea nodosa*, which form many underwater meadows. These meadows are very widespread in the Ionian Sea too, up to 30-40 m in depth. In these depths algae *Caulerpa prolifera* and more rarely *Padina pavonica* are found.

*The fauna of smooth beds is dominated by bivalve molluscum such as genus Venus, Donax, Cardium, Mactra Tapes, Solen, Scorbicularia, Tellina, Solencurtus. etc; Cnidars (Alcyonum palmatum); Cucumer (Sticopus regalis); Ascidies (Pallusia mamillata); fish of the families Soleidae, Signatidae, Triglidae, Mullidae, Sirenidae, Raidae, Torpedinidae etc. Many other animals of pelagic life are found, such as the fish of families Sparidae, Mugilidae, Clupeidae etc, meduz (Rhizostoma pulmo); cefalopod (Sepia officinalis) etc.*

Industrial pollution in the bays of Vlora and Drini in the recent years and urban pollution in coastal towns has had an affect. In the past the prawn was found in the bay of Drini and mostly in the discharges of the Drini river. Today, this is only a very rare faunistic element. This rarefying of the prawn has happened because of the discharges of the paper mill in this bay. Ihtik Fauna has incurred obvious reduction. There are many obvious changes in benthonic biocenose of the bay of Vlora because the remains from the soda and PVC Factory are discharged in the bay of Vlora.
It is of special interest to mention bioceneoses of solid beds. The mediolittoral of these beds is characterised by the growing of *algae Tenaren undoluza, Litophylum trochanter, L. tortuosum etc.*, whereas the algae genea *Cystoseira, Padina pavonica, Acetabularia acetabulum, Laurenzia obtusa, Corallina elongata, Halimeda tuna, Cladophora proliphera* gives to infralittoral its physiognomy. In the ports and their surroundings a nitrofil vegetation is dominated by *Ulva rigida* and from species of genus-*Enteromorpha, Pterocladia etc.*

Bentonic fauna is composed of sponges of different genus (*Condrosia etc*); *Cnidars* of the genus (*Actinia, Paromuricea, Eunicella, Cladocora etc.* from anelidet polichete of the genus (*Protula, Sabellia, Spirographis etc.*) from gasteropods of the genus (*Conus, Columbella, Cerithium, Vermetus, Monodantha, Gibbula, Patella, Haliotis etc.* from poliplacofors *Chiton*; from crustaces of the genus (*Eriphia, Xantho, Pachigrapsus, Porcellana, Dromia, Eupagurus, Cibanarius, Schyllarus, Palinurus, Homarus etc.*) from echinoderms of the genus (*Ophiothrix, Ophioderma, Holothuria, Coscinasteria, Echinaster, Marthasteria, Asterina, Sphaerechinus etc.* and especially sea-urchin like *Paracentrotus lividus* and *Arbacia lixula*. There are echiurid *Bonelia viridis* and fishes of these families: *Blenidae, Gobidae, Murena helena, Epinipheles*, cefalopod *Octopus vulgaris etc.* in the gaps of the rocks. There are fishes of *Sparidae* family and the multicolored fish *Serranus scriba etc.* which swims in the gaps of the rocks.

According to some data, the seal *Monacus monacus* is seen in the coast of Karaburn and Saranda.

Characteristic of the rocky coast of Ionian is the existence of some kind of thermophile which can not be found in the Adriatic Sea as (*Ophidiaster ophidianus, Hacelllia athenuata*). The western rocky of coast of Karaburun and the bay of Porto Palermo having been for a long time a military zone and away from industrial pollution have a very pure and in tact flora and fauna. At the same time there are many underwater caves and other different cultural-historical objects. It is suggested that all these zones have the right to the status of protected zones and of sea parks.

## 2.5. Managed Ecosystems

### 2.5.1 Agriculture

Agriculture is the Albanian economic most important sector in terms of value added and employment. In the recent years this sector accounted for about 25.1% of total social product, 35.9% of national income In Albania over 60% of population is living in rural areas, dealing with agriculture.

The study area with 2872 km² of arable land seizes 41% of the total arable land of the territory and produces about the half of total agricultural production. Field crops constitute about 83% of the total arable land, the rest consists mainly of orchards, olive groves and vineyards (Table 19). Not only the favourable natural conditions, such as soil content, climate and abundance of water resources, which offer suitable conditions for cultivating different crops, but also the human efforts have influenced for the land to become arable, increasing so, the agriculture production.

Through desiccation of some marches in the coastal area and investments for the drainage ystems about 60% of soil is rehabilitated. The level of salty phreatic water got lower. There are actually 13 pumping stations working at the coastal districts to drainage the soil. It is not only the coastal lowland drained and arable, but also the forested hilly slopes are changed into cultivated areas. Also, under the desalinisation process are about 29.33 km² in Lezha, Kavaja, Lushnja, Vlora and Saranda districts.

The Adriatic coastal part of the territory consists of about 30% cinerary brown, 33% meadowy cinerary brown, 22% alluvial soils. The rest is divided among turf-marshy and salty soils. There are alluvial or brown mountainous soils, meadowy cinerary soils and cinerary forest soils in the Ionian coastal area. From the agricultural point of view cinerary brown soils, meadowy cinerary soils and most turf-marshy soils are of high productive capacity. Alluvial soils are considered of good quality, as well, whereas salty soils have very low capacity. It seems that the majority of soils in the study area is of good quality, which favours the development of agriculture.

Table 19
Structure of arable land in Albania (000/ha)

| | 1990 | 1993 |
|---|---|---|
| Field crops | 579 | 577 |
| Orchards | 60 | 60 |
| Olive groves | 45 | 45 |
| Vineyards | 20 | 20 |
| Total | 704 | 702 |

In Table 20 is represented the distribution of arable land after the coastal districts (the new district division), the irrigation capacity and the arable land /per capita.

Table 20
The surface of arable lands (ha) and irrigation capacity

| Districts | Arable land (ha) | Field crops (ha) | Irrigation total (ha) | capacity % | Arable land 1000m²/inh. |
|---|---|---|---|---|---|
| Shkodra | 30243 | 25159 | 8720 | 28.8 | 1.5 |
| Lezha | 18583 | 16945 | 14050 | 75.6 | 2.0 |
| Lac | 10228 | 9011 | 8040 | 78.6 | 2.0 |
| Kruja | 15231 | 12311 | 3915 | 25.7 | 2.5 |
| Durrës | 26405 | 22639 | 18600 | 70.4 | 1.6 |
| Kavaja | 25134 | 20898 | 11500 | 45.8 | 3.0 |
| Lushnja | 51136 | 46390 | 25000 | 48.9 | 3.7 |
| Fier | 57031 | 49092 | 49600 | 87 | 2.7 |
| Vlora | 37812 | 26046 | 18900 | 50 | 2.2 |
| Saranda | 15359 | 10298 | 8900 | 57.9 | 2.9 |

The production (%) and the yield (kv/ha) of main agricultural crops in the study area during 1960-1990 is evaluated in Table 21.

During the period 1990-1995, after political and economical changes, the structure of agriculture plants grown in this area was changed ensuing the supply and demand in the newly established market economy and the tourism development in this area. The structure of sown surfaces and the crop yields after districts for 1993 are given in Tables 22,23.

Table 21
Production and yield of main agricultural crops (period 1960-1990)

| Crops | production (%) | yield (kv/ha) |
|---|---|---|
| wheat | 30 | 28 |
| maize | 10 | 40 |
| dried bean | 10 | 11 |
| vegetables | 10 | 160 |
| fodder | 35 | 170 |
| industrial plants | 5 | 9-15 |

Table 22
The structure of sowing surfaces after crops (ha) (1993)

| Districts | cereals | wheat | maize | rye |
|---|---|---|---|---|
| Shkodra | 9348 | 5382 | 3966 | - |
| Lezha | 7215 | 4429 | 2786 | - |
| Lac | 3688 | 2066 | 1622 | - |
| Kruja | 5509 | 3769 | 1740 | - |
| Durrés | 9991 | 7308 | 2683 | - |
| Kavaja | 7706 | 5783 | 1919 | - |
| Lushnja | 22550 | 17118 | 5432 | - |
| Fier | 21124 | 15218 | 5906 | - |
| Vlora | 10427 | 8201 | 2226 | - |
| Saranda | 2488 | 2115 | 370 | 3 |

Table 22 (continue)

| Districts | vegetab. total | potatoes | Dried beans | tobacco | sun flower | soybean | fodder |
|---|---|---|---|---|---|---|---|
| Shkodra | 2413 | 298 | 566 | 898 | - | 10 | 9445 |
| Lezha | 1115 | 180 | 735 | 25 | 6 | - | 5335 |
| Lac | 1167 | 76 | 800 | 10 | - | 100 | 2887 |
| Kruja | 1014 | 194 | 585 | 15 | 80 | 347 | 3715 |
| Durrës | 2129 | 356 | 1570 | 103 | 210 | 302 | 6580 |
| Kavaja | 2880 | 211 | 1448 | 123 | 540 | - | 5753 |
| Lushnja | 2887 | 333 | 2864 | 527 | 452 | 60 | 11406 |
| Fier | 3169 | 583 | 2879 | 1109 | 200 | 20 | 13490 |
| Vlora | 2103 | 464 | 824 | 180 | 132 | - | 7332 |
| Saranda | 374 | 172 | 84 | 7 | - | - | 3423 |

Table 23
The yield of agricultural crops (kv/ha)

| Districts | cereals | wheat | maize | rye |
|---|---|---|---|---|
| Shkodra | 29.6 | 30.5 | 36 | - |
| Lezha | 31.3 | 33.3 | 28.2 | - |
| Lac | 25.5 | 29.1 | 21 | - |
| Kruja | 29.5 | 32.4 | 23.2 | - |
| Durrés | 30.1 | 33.7 | 20.4 | - |
| Kavaja | 34 6 | 34.2 | 35.8 | - |
| Lushnja | 33.7 | 35.8 | 27.1 | - |
| Fier | 32.1 | 34.3 | 26.4 | - |
| Vlora | 27.8 | 28.3 | 26 | - |
| Saranda | 31.7 | 29.6 | 44 | 10 |

Table 23 (continue)

| Districts | vegetab. total | potatoes | dried beans | tobacco | sun flower | soybean | fodder |
|---|---|---|---|---|---|---|---|
| Shkodra | 180 | 124 | 12 | 12.6 | - | 10 | 240 |
| Lezha | 190 | 97 | 10 | 8.5 | 10 | - | 215 |
| Lac | 170 | 9.6 | 8.2 | 10 | - | 7 | 200 |
| Kruja | 177 | 94 | 9.3 | 9.2 | 9.4 | 9.2 | 210 |
| Durrës | 188 | 119 | 17.8 | 13.5 | 9.5 | 6.5 | 225 |
| Kavaja | 185 | 104 | 13.8 | 12.6 | 8.3 | - | 220 |
| Lushnja | 200 | 110 | 14.3 | 12.6 | 9.6 | 10.6 | 270 |
| Fier | 195 | 89 | 12.4 | 8.3 | 4.8 | 6 | 230 |
| Vlora | 175 | 108 | 9.8 | 11 | 8 | - | 185 |
| Saranda | 175 | 107 | 14 | 8.9 | - | - | 210 |

The olive plantations are situated in Saranda, Vlora, Fier, Lushnja and about 6% in Kavaja, Durrës and Kruja. Over 99% of citrus plantations lay in Vlora and Saranda.The number of trees, yield and production for olives and citrus are given in Table 24.

Table 24
Number of trees, yield and production for olives and citreous

| | | Olives | | Citrus | |
|---|---|---|---|---|---|
| | | 1991 | 1993 | 1991 | 1993 |
| Total | (x1000 trees) | 5606 | 3129 | 1068 | 364 |
| In production | (x1000 trees) | 3294 | 2313 | 768 | 305 |
| Yield | (kg/tree) | 10.7 | 10.9 | 14.1 | 43.6 |
| Production | (x1000 ton) | 35.3 | 25.3 | 11.0 | 13.0 |

Another agricultural activity in the study area is livestock production. Their number distributed after the districts is presented in Table 25.

Table 25
Distribution of livestocks number (x1000)

| Districts | Cattle | small ruminants | poultry | pigs | perissodactyls |
|---|---|---|---|---|---|
| Shkodra | 37.3 | 128.6 | 192.0 | 11.8 | 6.6 |
| Lezha | 15.9 | 45.3 | 89.7 | 11.9 | 3.1 |
| Lac | 9.1 | 18.4 | 56.1 | 4.9 | 1.4 |
| Kruja | 14.6 | 37 8 | 97.3 | 4.6 | 2.8 |
| Durrës | 24.0 | 34.4 | 124.9 | 3.9 | 4.4 |
| Kavaja | 26.7 | 50.1 | 111.5 | 1.7 | 6.5 |
| Lushnja | 43.4 | 65.5 | 239.6 | 8.7 | 5.2 |
| Fier | 44.0 | 73.7 | 251.3 | 4.8 | 8.6 |
| Vlora | 21.7 | 263 9 | 155.7 | 1.1 | 9.9 |
| Saranda | 5.3 | 193.4 | 47.3 | 2.1 | 4.1 |

### 2.5.2 Fishery

Fishing and aquaculture activities are relatively new and the tradition in these activities cannot be compared with those in agriculture.

<u>Marine resources</u>

The shelf of albanian coast is wider in the northern part (Adriatic Sea),up to 40 km across and narrower in the south (Ionian Sea), 3-4.8 km width. The sea bottom varies from north to south. In the northern part the shelf is larger and the slope less step up to the 200m isobath, so, it is easier to trawl. The Ionian part, where the depth rapidly reaches 200m, is uneven and covered with rocks. Thus, it is difficult for trawling.

The sea fish fauna with commercial interest consists of various species and groups of demersals, small and big pelagic fishes, crustaceans and molluscs.

Sardine (Sardina pilchardus sardina) is the most important fish for the processing industry. It is found along the whole coast, but mainly in the area from Shëngjin to Vlora, at 30-80 m depth.

Different species of sharks are populating the sea waters along the coast from north to south in a depth from 5 to 300 m. The main species are those of Squalus spp.,Carcharhinus spp., Mustelus spp.,etc.

Angelsharks such as Squatina spp.,Torpedo spp., Raja spp.,etc. are met all along the albanian coast at 5-300 m depth.

Anchois (Engraulis encrasicholus) is another small pelagic fish with a particular importance, which is found at 100-300m depth.

European hake (Merluccius merluccius) is, also, one of the industrial fishes, living at the depth 50-300 m, with a particular importance for trawling.

Surmullets (Mullus barbatus and Mullus surmuletus) are found along the coast; the first ones along Adriatic (20-150 m depth) and the second along the Ionian rocky area (5-6 m depth).

At the depth of 2-30 m are living sea bass (D; labrax), sea bream (S. auratus), Diplodus spp., Pagellus spp., Dentex spp.

Different molluscs, such as carpet shells Tapes spp ,clams Donax mussel (Mytilus galloprovincialis) etc., cuttlefishes (sepia spp.), squids (Loligo spp., Octopus spp.), etc. people all albanian coast.

Lagoon resources

The main features of the coastal lagoons along Adriatic, such as depth, salinity, water temperature and oxygen content (see 2.3), influence on the trophic status and fish production. The main species are mullets (Mugil spp.,Liza spp., Chelon spp.,) sea bass (Dicentrarchus labrax), eel (A. anguilla), sea bream (S. aurata), sand smelt (Atherina hepsetus) etc. The average yield in the last years varied from 40 to 80 kg/ha.

Beside the above-mentioned fish species, the increase of trophic status has created optimal conditions for mussels rearing.

Inland water resources

Fishing activities in the inland water are practised mainly in the three big lakes: Shkodra, Ohri and Prespa, Albanian part of which accounts for a total surface of 250 km². Only Shkodra lake lies in the zone under study. The main fish species in Shkodra lake are carps (C. carpio, H. molitrix, C.idella, A. albidus alborrela), eel, mullets etc.

Fishing organisation

The fishing activity in coastal area (seas, lagoons, inland water) is implemented through various forms and several structures. The former system was completely based on state-owned vessels. There were only 4 enterprises involved in marine fisheries and 16 other ones dealing with aquaculture, inland and lagoon fishing. Now, the fisheries (about 95%) and aquaculture sectors are privatised.

The fishery sector in Albania might be classified in three main activities:

1. fishing in the sea
2. artisanal fishing at coast
3. inland water fishing

The fishing fleet consisted originally of 110 vessels. During the upheavals in 1991 a number of them was disappeared, were sunk or damaged without repair. During 1992-1994 private associations, persons and entities have bought fishing boats. Actually, their number accounts for 168. The fleet, distributed after the harbours is as follows:

| | |
|---|---|
| Shengjin | 20 vessels |
| Durres | 64 vessels |
| Vlora | 62 vessels |
| Saranda | 22 vessels |

which are divided on these main types (1994):

Table 26
The fishing fleet (1994)

| Class | No | Eng. power (Hp) | Fishing method |
|---|---|---|---|
| Inshore | 53 | 80-140 | Lines,gillnets etc. |
| Purse seiners | 15 | 150-300 | Purse seiners,trawlers seiners |
| Trawlers | 100 | 200-600 | Trawlers |

About 300 small boats which belong to private groups are currently carrying out traditional (artisanal) fishing with gillnets, hooks and other selective gears along the coastline and in lagoons. There are gillnets and fixed fish barriers based on the principle of V-shaped traps of plastic pipes in the main channels of the lagoons. A part of the boats are situated at the lagoons, harbours and other places alongside the coastline Shkodra-Vlora There do exist about 100 boats equipped with engine (out of board).

Fish catch

During the eighties Albanian fishery sector has traditionally caught 10000-15000 tons/year fish and shellfish from three main subsections:

| | |
|---|---|
| Marine fisheries | 7000 ton |
| Fresh water fisheries | 3000 ton (500 tons from aquaculture) |
| Molluscs | 3000 ton |

The socio-economic changes, which Albania has been faced with, brought about changes in the fisheries production as well. Establishing the market economy and export liberalisation had their influence on the fish catching methods. Thus, the fishing of high value fishes as well as trawling and artisanal are prevailing. The last years statistics are approximately figured as follows:

Table 27
Fish catch in the last years

| Years | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|
| Fishing (ton) | 10400 | 3200 | 3000 | 2000 | 1200 |

The last years particular fishermen or groups have exported a great amount of fish extending a total value of 13-14 million USD.

### 2.5.3 Aquaculture

Aquaculture activity begun at the end of sixties with the establishment of state fish farms located in different areas all over the country. The main fish species were common carp (C. carpio), silver carp (H. molitrix), bighead carp (A. nobilis), grass carp (C. idella). There were 16 fish farming centres with a total water surface of 4 km². Ten of them are situated at the coastal area, with a water surface 3 km². The yield was 200 ton/km² fish for consumption and about 10 million fingerlings/km².

There are actually four types of aquaculture practised in Albania:

1. Cypriniculture of fresh water (carps family), 16 fish farms

2. One trout farm of raceways (0.052 km²), near Saranda

3. The shrimp culture farm in the fish farm of Kavaja (0.2 km²)

4. The mussel culture in the Butrinti lagoon with 80 frames installed in different areas of the lagoon. The yearly production accounts for 3000-4000 tons.

Judging by the country's water resources, climate, biologic potential, real possibilities to develop this important sector toward mariculture in floating cages, do exist.

2.5.4 Forestry

Forest exploitation in our country has begun since ancient times (from greeks, illyrians and romans) and continues until today. Because of overexploitation and deforestations many forests are disappeared. The names of some places, such as Shkozet (hornbeam forest) or Orikum (port of wood) give evidence that these places were covered by forests. The forest harvesting continued even during the first half of this century (by italian companies). The deforestation and planting of a considerable territory withoranges, olives, agriculture crops etc. (Lukova, Jonufri, the hills of Divjaka, Kavaja, Durrës, Ishmi etc.) is carried out during the second half of our century, as well.

Numerous cases of forest fires, both natural and man-made, are registered. The fires and the overhunting have diminished the biodiversity and have stimulated the degradation and desertification phenomena.

The coastal forests perform a protection function of preventing the salt sea winds to penetrate the territory. They are used in construction, wood industry and to meet the population needs for fire-wood.

Along Albanian Coast new forests are planted, with the aim to protect the agriculture from sea winds and to green the territory (Saranda mountain). Some experiments are performed to plant the fast-growing exotic species such as Monterey pine, red pine,eucalyptus sp., etc.

The forests in the study area cover a surface only 33,700 ha or 3.2% of the forest surface of the country. They are extended, over a surface 12,700 ha or 37.6% of the coastal forest surface along the Ionian coat and over a surface 21,000 ha or 62.4%, along the Adriatic coast. These forests have a standing wood stock 2.756.000 m³ or 3.4% of the stand wood stock of the country forests. The biggest forest massives are: mixed conifers and broadleaves species forest in Llogara and single broadleaves species forest in Karaburun-Vlora. The Oak forests in Gradishta, Gjeneruk-Lushnje, Ishmi-Durres, Renci-Lezhe and in Shkodra; Quercus aegilops forests in Mile, Kakome, Himare, Karabuun and Tragjas; the forests with Mediterranean pines (Aleppo pine and Stone pine) in Poro-Vlora and Fier, in Divjaka-Lushnje and all manmade forests principally established with mediterranean conifers to fill the coastal sheltbelt on Kume of Vlora, in Seman coastal of Fier, Spille and Golem-Kavaje, Bisht Kamez and Rrushkull-Durres, Fushe kuqe-Lac, Tale, Kune, Vain, Shengjin-Lezhe and Velipoje-Shkoder and the shrubs which are mainly extended along Ionian [Karadumi S., 1992].

The trees of the coastal forests until 141 years old, have diameters of 0.3-72.0 cm and the heights 0.15-28.0 m; they belong to the production classes from first to fifth, with a density corona 0.2-1.0 and a covering scale 40-100% [Karadumi S., 1992].

The composition of the forests in the study zone after species is given in the Table 28.

Table 28 - The forests distribution after species

| Species | Surface | | Stand wood stock | |
|---|---|---|---|---|
| | Ha | % | $m^3$ | % |
| Conifers | 8,351.54 | 24.80 | 668,885.00 | 24.30 |
| - Mediterranean pine (i) | 6,817.54 | 20.20 | 397,485.00 | 14.40 |
| - Silver fir (iii, iv) | 598.00 | 1.00 | 158,700.00 | 5.80 |
| - Black pine (iii, iv) | 847.00 | 2.50 | 103,100.00 | 3.70 |
| - other conifers (Cypress (i), etc) | 89.00 | 0 26 | 9,600.00 | 0.35 |
| Broadleaves | 25,381.66 | 75.20 | 2,087,067.50 | 75.70 |
| - Oaks (Turkey (ii, iii), Macedonian (ii, iii), Chestnut (iii), Pubescent (ii, iii), Hungarian (iii), Holly (i) oaks) | 9,765.39 | 28.90 | 840,197.00 | 30.50 |
| - *Quercus aegilops* (ii, iii) | 2,249.15 | 12.60 | 359,627.50 | 13.00 |
| - Poplar (i, ii) | 1,039.28 | 3.10 | 89,246.00 | 3.20 |
| - Black locust (iii) | 50.00 | - | 5,200.00 | 0.19 |
| - Other broadleaves (Ash (i, ii, iii), Alder (i, ii), Plane (ii), etc) | 3,593.55 | 10.70 | 301,765.00 | 10.90 |
| - Maples (ii, iii) | 225.20 | 0.78 | 39,038 00 | 1.40 |
| - Walnut (i) | 30.00 | - | - | - |
| - Eucalyptus sp. (ii) | 3.50 | - | 269.00 | - |
| - *Acacia saligna* (i) | 10.00 | - | 100.00 | - |
| - Sweetbal (i, ii) | 75.00 | - | 280.00 | - |
| - Willow (i, ii, iii) | 115.50 | - | - | - |
| - Strawberry (i) | 1,878.00 | 5.60 | 121,400.00 | 4.40 |
| - Hornbeam of orient (i, ii, iii) | 319.78 | - | 21,452.00 | 0.78 |
| - Erica sp. (i) | 391.00 | - | 15,900.00 | 0.58 |
| - Myrtle (i) | 82.25 | - | - | - |
| - Box (iii, iv) | 59.00 | - | 17,100.00 | 0.62 |
| - other shrubs | 3,465.06 | 10.30 | 275,393.00 | 10.00 |
| TOTAL | 33,700.00 | 100.00 | 2,756,000.00 | 100.00 |

i, ..., iv correspond to the classification in page 101
Source: Cadastra of forests 1992 - Forest and Pasture Research Institute

Analyzing these figures, one may generally conclude:

- about ¾ of the surface of coastal forests consists of broad-leaves, while the conifer has only ¼. Among the conifer forests, mediterranean conifers (Aleppo pine, Stone pine) extend along the coasts of all districts. The black pine and silver fir forests are localised along the Ionian and Adriatic coasts of the Vlora district. Other conifer forests (mainly Cyprus conifers) extend over a small surface along Vlora and Kavaja district coasts.

- broad-leave oak forests (*Quercus aegilops*, Turkey oak, Macedonian oak, Chestnut oak, Pubescent oak, Hungarian oak and Holly) extend along all the coasts with the exception of Fier and Kavaja districts, while the Quercus aegilops principally extend along the Ionian (Saranda and Vlora districts). The other broadleave forests (Ash, Alder, Plane, etc) also extend along the coast with the exception of the Kavaja district. Poplar forests and plantations are spread only along the Adriatic coast

- plantations of Black locust are spread over a small surface and principally along the Adriatic coast, belonging to the districts of Vlora, Lushnja, Kavaja, Shkoder and, over a smaller surface along the Ionian coast of Vlora district. The maple forests are limited and extend only along the Vlora coast.

- walnut plantations are located only the coast of the Saranda district, eucalyptus only along the Kavaja and those with Acacia saligna only along Vlora. The forest and plantation of sweetball tree extend over a small surface, located along Vlora, Lushnja and Saranda districts coasts. The Willow plantations have a limited extension along the Adriatic coast of Lushnja, Vlora, Fieri and Kavaja districts.

- the shrubs with strawberry extend only along Ionian coast (Saranda and Vlora districts) and of the Adriatic coast (Vlora and Durresi districts).

- the shrubs with Erica sp. extend mainly along Durresi, Saranda, Vlora districts coast, hornbeam of the Orient along Durresi, Saranda, Shkodra, Lezha coasts, shrubs with myrtle along the Adriatic coast (Durresi and Lushnja districts and the box shrubs extend only along Adriatic (Vlora district), Mack privet, tamarisk along the Ionian coast (Saranda and Vlora districts) and along the Adriatic coast (Lezha, Fieri, Shkrodra, Kruja districts).

Over this territory one can see all the vegetation flats beginning with oranges, olives and evergreen forests, continuing with deciduous forests, black pine, silver fir and pinus leucodermic forests and mediterranean alpine pastures on the highest altitude from the sea-level [Karadumi S.,1992].

The vegetation types extend as follows (see Annex III):

i) Eu-mediterranean evergreen forests

This vegetation type is extended from the sea-level until 350 m (Saranda 350 m, Vlora 250 m, Fieri 100 m, Lushnja 50 m) over these places without frosts during all the year.

ii) Deciduous forests with cermes oak

This vegetation type extends from the sea-level to 550 m (Saranda 350-550 m, Vlora 250-450 m, Fieri 100-500 m, Lushnja 50-190 m, Kavaja 0-190 m, Durresi 0-227 m, Kruja-Laci 0-50 m, Lezha 0-200 m and Shkodra 0-150 m). There is a vegetation as well, which demonstrates yet the elements of the Eu-Mediterranean forests together with a falling leaves species group.

iii) Deciduous forests

The falling leaves forests are generally spread over the altitude 150-1250 m (Saranda 550-1250 m, Vlora 450-1250 m, Lezha 200-600 m and Shkodra 150-545 m).

iv) Silver fir (Abies alba Mill) and Black pine (Pinus nigra Arn.) forests.

These forests extend between 1250 and 1850 m altitude above the sea-level (Saranda 1250-1759 m, Vlora 1250-1850 m) over the eu-Mediterranean vegetation.

v) The mediterranean alpine vegetation

This vegetation type extends between 1850-2045 m above sea-level (Vlora 1850-2045 m)

## 2.6 Energy and Industry

### 2.6.1 Energy

The electrical power system is supplied mainly by hydroelectric power plants, which accounts for about 87% of generation capacity. The total generating capacity is 1662 MW of which 1444 MW are hydroelectric.

The three largest power plants are located in the Drin river with a total generating capacity of 1350 MW.

The potential energy generating capacity based on hydropower is estimated to be about $15.10^9$ kwh.

The total generating capacity of thermal power plants is 2218 MW and they are mainly fuelled with crude oil or natural gas. The major thermal power plant is located at Fieri and has a capacity of 160,000 MW. Several small thermal units for combined steam and power generation are located in several cities, burning generally brown coal.

The energy consumed for domestic use in the year 1990, consisted in 6.5% of total generating energy. After the political changes, the consumption of energy for domestic use increased very rapidly, while the energy consumed by industry decreased during the transition period. Due to these changes, the share of domestic use energy increased to 61.5% in the year 1994. A decrease of this ratio is expected for the next year due to the reactivation of industry and using of liquified gases for domestic use.

### 2.6.2 Industry

Until the year 1990 the industry generated 58% of GDP. Since the beginning of the year 1990 the economic situation aggravated rapidly and decreased about 50%. After that the important sectors like chemical, metallurgical and mechanical industry and other branches related to them, almost stopped operating and only by the beginning of the second half of 1992, signs of reactivation were seen. The industrial sector represents one of the weakest points of the present Albanian economy.

The industry is distributed all over the territory of Albania with a higher density in the western area, especially of chemical, metallurgical and paper industry.

In the 1990 the share of total industry production by coastal districts was about 37%. The soda and PVC plant with a capacity of 30,000 t/y $NA_2CO_3$ and 6000 t/y PVC is located at Vlora, near the Adriatic sea. This plant is out of work because of the old technology and bad conditions of maintenance. It is expected that only small and second hand units will operate in the future.

The plant of nitrogen fertilizers with a capacity of about 300,000 t/y is located at Fieri. Today this plant is running at about 15% of capacity due to the lack of methane gas and low demand for fertilisers from agriculture, an increase in production is expected for the next year.
The chemical plant in Durres until some years ago, produced a lot of chemicals, like inorganic salts and pesticides. Today some units are destroyed and some others run at low capacities due to the low demand. An increase of production is expected for future years.

The superphosphate plant with a capacity of 330,000 t/y is located at Lac near the sea. This plant is working at low capacity due to the low demand. A gradual increase of production is expected for the coming years.

The copper production metallurgical plant with a processing capacity of 60,000 t/y of raw materials is located at Laci. Today this plant works at low capacity due to the lack of raw materials and old technology. A reconstruction of copper industry is planned which will lead to a greater production.

The paper industry is located at Lushnje, Kavaja and Lezha with a total capacity of 20,0000 t/y. Because paper factories cause contamination through waste waters it is anticipated that in the future this industry will work with imported cellulose.

The longest oil fields are located in the southwestern part of the country, in the watersheds of Osum and Vjosa rivers, but the majority of wells are closed.
The greatest oil processing plant, with a capacity of 1.2 million t/y is located at Ballshi and is working at low capacity due to the lack of oil. A considerable number of small factories of mechanical, food and light industry are located in the coastal area.

## 2.7 Tourism

Tourism represents a new branch of the Albanian economy. The Ministry of Tourism was founded in April 1992. Before this period, mainly for political reasons, tourism was undeveloped. Tourism activity was ran by ALBTURIST enterprise. Before the creation of the Ministry of Tourism the greatest number of tourists in Albania has been 30,000 in 1990.

Tourism is now considered to be important to Albania with good opportunities for the future. Today there are about 50 private tourist agencies and in collaboration with experts from EC and EBRD the Ministry of Tourism has prepared the "Strategy of Tourism Development from 1993-2010" and other studies, including the environmental points as well. According to this strategy the tourism activity will be mainly concentrated in the coastal zone. There are defined four priority regions for the tourism development in the zone under study : Lalzi and Durresi Bays (Adriatic Coast), northern and southern parts of Albanian Riviera (Ionian Coast).

The Ministry of Tourism has considered as very important the development of high quality small scale tourist villages, which are to be harmoniously integrated with existing villages, and the development of eco-tourism, in parallel with the building of new hotels in Tirana and the renovation of the existing ones the southern part of the country. It is planned for the rural tourism (bed and breakfast) in the southern part of Albania (Saranda and Gjirokastra region) to be developed, by the financial support of PHARE programme. It's considered as a suitable way from the environmental points of view.

In Figure 32 are represented the some statistical data on the tourism in Albania during 1956-1994. The number of tourists is increased after 1987, especially during the last years, in comparison with the former years, but there is not the same situation concerning to the average time of sojourn. The reason consists in the fact that the visits of businessmen are included in the tourism activity and actually in Albania are operating many private touristic agencies. The intensity of visits is influenced by the seasons, so, it is higher in summer than during the rest of the year. There are 14 hotels with 687 rooms and 1288 beds and a couple of small private motels and hotels ones in the zone under study.

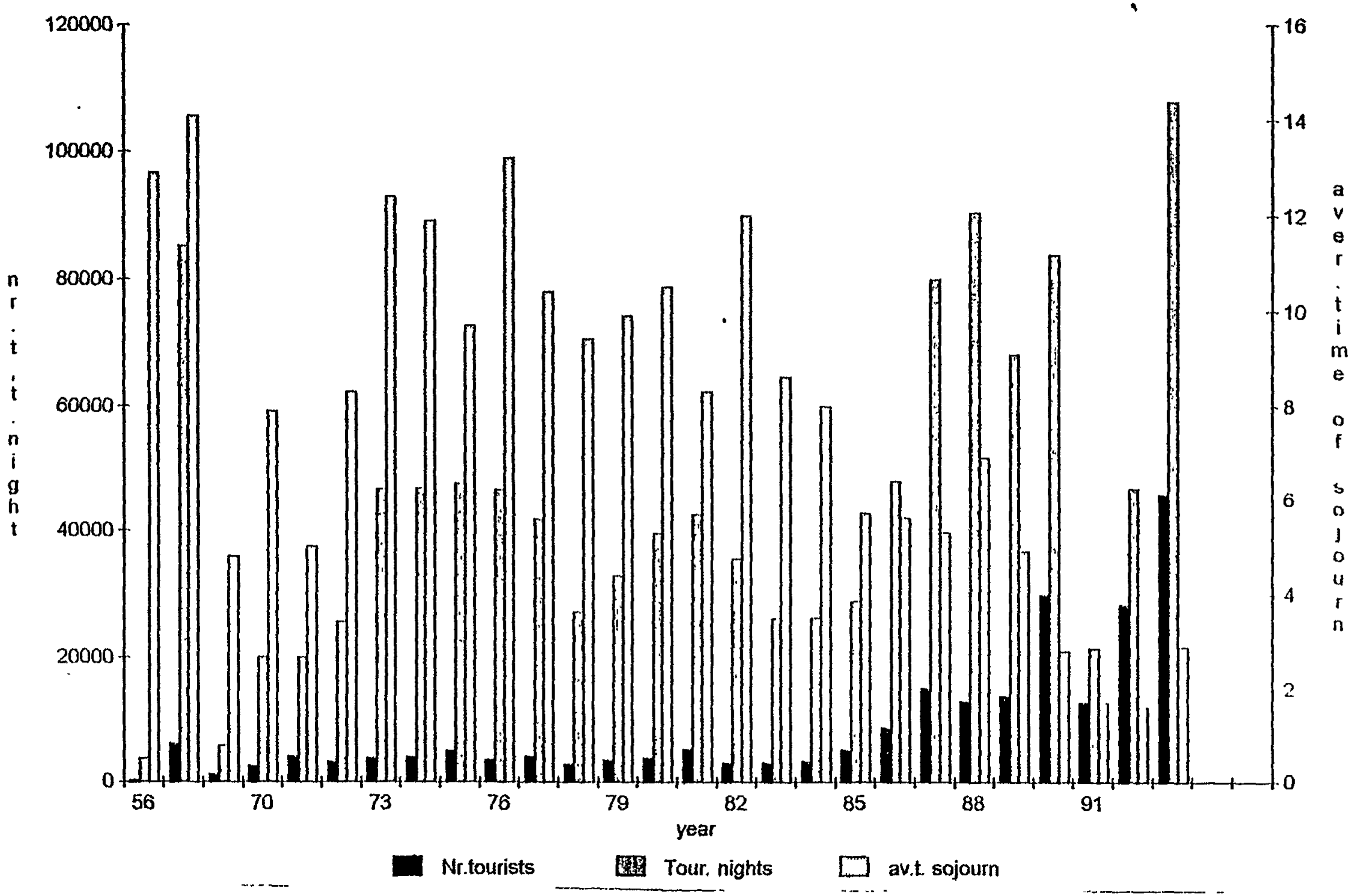


Figure 32 - The international tourists in Albania

## 2.8 Transport

At the beginning of 20th century started the development of road, railway and air transports. The analysis of this development consists in the close analysis of its components, such as infrastructure, traffic, vehicles inventory and its geographical distribution.

Road transport

In 1938 the total length of public roads in Albania was 2540 km mostly unasphalted and situated at the western part of the country. That year the volume of good transport, realised by a limited number of vehicles with a low capacity (5 -10 tons), reached the value 112.000 ton/ km at an average distance up to 80 km.

After 1945 higher development rates in road infrastructure than in the other components are observed. While at the end of 1990 the road infrastructure was greatly on the increase. Nowadays, about 35% of the total road network is asphalted (the study are is completely asphalted). During 1990 the goods transport accounted for about 90 million tons, 40% of which belongs to the coastal area. The passenger traffic has had a greater annual increase, it accounted for about 200 million, 60% of which to study area. The 1990 inventory consisted of 12.000 vehicles, mainly imported from eastern countries and almost very old ones (15-18 years on the road), with a negative influence concerning to the environmental pollution.

The private ownership after 1990 has greatly influenced on the high rates of transport development. About 80.000 vehicles are accounted in the coastal area (7 times more than in 1990). They are relatively new, imported by the Western Europe. but anyway the pollution problems are became more sensitive.

The improving of road network, conditioned by the increasing of vehicles number, tourism and perspective development of the country is became of great priority. The first programme for the rehabilitation of a length of 100 km within two years is undertaken. It will be followed by other middle-term ones, such as the rehabilitation of the main road network of 500 km and of the trans-european roads, the construction of the first highway Tirana-Durrës, etc.

Railway transport

The first railway (44 km length and normal rail gauge) is constructed in 1947. Later, the railway network is gradually strengthened and enlarged toward the biggest economic and agricultural areas. Railway network has a total length of 450 km, 75% of which covers the coastal zone.

The development of industry and agriculture accompanied by the continuous spreading of railways, has brought about a sensitive increase of the volume of goods and passengers transport. So, in 1990, about 6.5 million ton goods and 10 million passengers (respectively 27 and 12 times higher than in 1950.

The decreasing of general production during the transition period (1990 - 1995), the increasing number of private buses and cars, in comparison with the last decade are reflected in the rail transport as well. In 1994 this kind of transport accounted for 0.5 million tons goods and 4 million passengers. In the studies on the development of the railway transport, parallel with the economy development, is foreseen that the goods transport is to be increased approximately two times in comparison with 1994, and the passenger one to remain at the same levels in the coming years, until 2005. Anyway, this kind of transport cannot reach the figures of 1990.

Marine transport and harbours

Marine transport was not well developed until 1950. That time about 100.000 tons goods/year were transported. Gradually, the transport capacity has been increased, it accounts for 67.5 thousands ton in 1990 and 900.000 ton in 1994. But the demands are greater. Only 30% of the volume of loading/unloading work for export - import is realised by albanian fleet.

There are four harbours along the albanian coast: Durres, Vlora, Saranda, Shengjin. The level difference between the sea surface and quays is 1.8 - 2 m. Durres is the biggest one. There are carried out almost all load/unload activities (about 80% of 2 million tons goods in 1990).The quays length is 2028 m and the railway one - 9500 m. There are depositing squares (about 2800 $m^2$) with a capacity 500 000 tons and 31 cranes of different capacities

During 1990-1994 the volume of loading/unloading work has considerably been decreased (700.000 tons), whereas the number of ferries is increased. The number of passengers, travelling by ferry boats reached 188.000 in 1994.

Durrës port will remain the main one and the most important link of Albania-Macedonia-Bulgaria transport line. It is expected for the volume of loading/unloading work to be increased, so, the first phase of reconstruction has begun. This will be followed very soon by the construction of the ferry terminals.

The other ports are not expected to have such a reconstruction in the near future. Ferry services, tourism and trade are to be carried out there.

Air transport

It is established for the first time as inland transport during 1930-1940, connecting Tirana with 4-5 other cities. There were only a couple of small aeroplanes, only Tirana runway was concreted.

In 1957 in Rinas, near Tirana, the international airport has been constructed. Its runway has the dimensions 2700x67 m, but it is too small to overcome the great flux of passengers, which is increased especially during 1990-1994.

Albania has not yet its own airline. There are working 9 European Agencies and one of USA. To overcome the increasing flux of air transport, this year will begin the reconstruction of Rinas Airport.

The perspective of transport will be its harmonic development. The development of road transport is of first priority to meet the increasing demands of tourism, private agriculture, transit transport development, etc. The rate of transport development is planned to be high, especially after 2000 an annual mean increase of 15% is foreseen. A couple of programmes for the rehabilitation of the existing roads and construction of new ones, mainly at the coastal zone are compiled.

There is planned the developing of the other kinds of infrastructure according to the increasing demands of transport and services.

## 2.9 Sanitation and health aspects

### 2.9.1 Sanitation

Under the sanitation topics only a brief description on water supply, waste water and solid waste systems is given.

The problem of drinking water supply is resolved using groundwater resources (according to two principles, gravity flow and attractive flow). The drinking water is of good quality (according to the national standards and the directives of WHO).

As it is mentioned before (see 2.3.3), only in cities the supply of drinking water is done through centralised water supply and distribution networks up to the consumer. These water supply networks pose problems in terms of meeting the technical requirements in the source point, especially in well drillings but generally problems lie within the distribution network. Great deficiencies are detected by the crossing of the drinking water supply pipelines with the waste waters and sewerage systems. The network is obsolete and the crossings especially in Tirana, Durres, Fier, Elbasan have been the cause of water contamination which is expressed with health effects (gastro-intestinal disturbances, dysentery). The old age of the pipelines of the distribution network has been the cause of a big loss of drinking water quantities, eg. in Tirana the losses amount to 40% of the total. Bearing in mind the possibility of penetration of organic pollutants, besides disinfection in the source, drinking water is kept with levels of disinfectant matter up to the consumer.

The drinking water supply in rural areas constitutes another problem, in some area the supply networks do not meet the technical and sanitary requirements In many rural areas where a water supply network is missing, shallow, open wells are being used (close by are discharge pits, animal stables, etc). In the case of hydric outbreaks in rural areas, the state (health authorities) intervene to disinfect the sources of drinking water, while normally they should be disinfected by the farmers.
During 1994 (September) in Albania there was an outbreak of cholera which extended to several districts of the country. In the town of Librazhd (outside the study area), in a rural areas of Peqini and Fier the cholera outbreak was due to drinking water, while in other areas the main cause was judged to be the non-satisfaction of the sanitary measures.

Urban waste is another environmental issue. From the collection in specific spots, their transport and treatment is implemented by using primitive methods in urban areas, while in rural areas this issue is not even taken into consideration as the treatment of urban waste emerging from agricultural activities is done individually, completely neglecting any technical requirement. The usual manner of waste disposal until now has been constituted by composting, but it is not carried out according to the technical, sanitary regulations and procedures.

Urban waste waters, after their collection in trunk sewers, are discharged in surface waters (near rivers when they are located close to the towns, or lakes and sea) without any preliminary treatment. In rural areas, waste waters are collected in septic pits, but in general these pits do not meet the appropriate conditions thus becoming a cause of insect growing. In some rural areas, waste waters are discharged into streams.

The assessment of air quality carried out in the main cities in several years, for indicators such as soot and sulphur anhydride shows that in several area and appropriate periods their levels exceed or overcome the sanitary standards (Table 11). Tirana, Elbasan, Fier and Vlora have had such kind of problems. Albanian industry uses old technology has no facilities to clean gases or industrial water and emits these into the outdoor environment. Unfortunately, knowledge and possibility have not been sufficient to record the effects of pollution in the health of urban populations. At present, industrial activities are almost paralysed, thus it can not be assessed how much they affect the environment.

### 2.9.2 Health aspects

The country's health system is state-dependent, divided into the health care of primary secondary and tertiary levels. The primary health care is extended from rural areas to towns, while health care of second and third level is established in urban areas.
Recently, after the country opened up to democratic changes, the privatisation of some health sectors started, such as the total privatisation of the pharmaceutical network, privatisation of the dental care network (keeping state-owned the dental care for age-groups from 0-18 years) and private labs and small private health clinics. Health insurance will be established for the first time in 1995, apart from the existence of the state social security system.

Health care service includes ways of combatting and preventing infectious diseases and those of hygiene with the relevant laboratories. With the increasing of the population immunity, a series of obligatory vaccines were applied (such as DTP) diphtheria-tetanus-pertus. measles, BCG-antituberculosis and in 1994 the vaccine against viral hepatitis.

In 1991-1994 there was only one case of poliomyelitis in Albania,outside the study zone, diphtheria has generally low values (Table 29) Generally, TB constitutes about 50% of all the diseases for the area under study. Taking into consideration that this area has 35% of the total Albanian population, and that it is of a high density, we consider that the contagious and aerogene diseases are very frequent in this area (Table 29).

Table 29
Dynamics of the infectious diseases

| Diseases | 1991 | | 1992 | | 1993 | | 1994* | |
|---|---|---|---|---|---|---|---|---|
| | Cases | % | Cases | % | Cases | % | Cases | % |
| Diphteria | 10 | 43 | 12 | 28 | 4 | 67 | 0 | - |
| Tetanos | 3 | 37.5 | 3 | 43 | 7 | 39 | 5 | 71 |
| Pertusis | 65 | 24 | 6 | 12 | 32 | 26 | 28 | 16 |
| TBC | 114 | 33 | 85 | 36 | 143 | 48 | 42 | 45 |

The contagious diseases constitute an important health problem which is taken into special consideration, through the statistical surveys and the evaluation of each case. The data on dynamics are given at Table 30.

The data shows that infectious diseases of the gastric-intestinal tract are expressed with more gastro-enteritis, of acute forms and few with a toxic character. From 1988-1933 gastro-enteritis has suffered a drastic decrease from 43 to 31%, while for dysentery this decrease is greater (37-27%). These nosologies (from typhoid to salmonellosis) have been and are expressed always at the summer season, a period that lasts more than 7 months in the study area. The reason for the increase during this period is connected with the environmental conditions, especially with the habitat location, the lack of current drinking water and maybe the absence of the implementation of the hygiene by people themselves in every day life. A very frequent phenomena of this area is scab infection, that from 40% of cases in 1988 has changed to 38% of cases in 1993 (Table 30) while abdominal typhoid infection has a decrease of two times in 1993.

Even the hepatitis viral infection has constituted a serious problem. At the national level the infection of the A and B forms have generally had the same value. A form of hepatitis viral appears more at the age-groups of 4-15 years, while B form is spread more at infantile and old ages. In Albania generally, disposable syringes are not used, so this form of hepatitis is easily spread. Also procedures of sterilisation are not always efficient. The efforts in this field have consisted in making the hepatitis vaccine obligatory for new-born babies, starting May 1991. In 1991, the mortality of children up to 1 year in the area under investigation was 28.17% while at country level this reaches to 34.6%. The newly-born babies mortality has a stability of 30% but it has a considerable decrease compared with 1980.

Table 30
Dynamics of the contagious diseases

| Diseases | 1988 | | 1989 | | 1990 | | 1991 | | 1992 | | 1993 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | cases | % | cases | % | cases | % | cases | % | cases | % | cases | % |
| Typho abdominal | 80 | 44 | 49 | 39 | 47 | 50 | 70 | 69 | 18 | 13 | 13 | 22 |
| Disentery | 1730 | 37 | 1684 | 38 | 1152 | 35 | 655 | 36 | 366 | 31 | 388 | 27 |
| Gastroenterit | 46064 | 43 | 38867 | 35 | 34643 | 30 | 20109 | 30 | 11720 | 28 | 12972 | 31 |
| Dyspepsi acute | 47052 | 44 | 41482 | 39 | 39440 | 38 | 27759 | 44 | 16269 | 37 | 14475 | 39 |
| Dyspepsi toxica | 1387 | 50 | 1128 | 51 | 864 | 55 | 721 | 62 | 775 | 67 | 686 | 58 |
| Salmonelosis | 1556 | 39 | 1557 | 32 | 810 | 31 | 314 | 23 | 194 | 25 | 247 | 30 |
| Scabies | 13806 | 40 | 10980 | 42 | 9096 | 38 | 6887 | 38 | 6696 | 25 | 11993 | 36 |
| Hepatitis viral | 3770 | 32 | 3540 | 37 | 5957 | 53 | 2572 | 41 | 1489 | 32 | 1869 | 33 |

The *infant mortality structure* shows that the pulmonary diseases constitute the most frequent cases and gastro-intestinal cases occupy less. The morbidity level for all the country has not been studied yet, thus it is difficult to collect data for the area under investigation.At country level the respiratory diseases constitute the principal concern, followed by the neuro-central system diseases. These two diseases have been decreasing every year, though the tumoral and blood diseases vary during the year, they have had the same stable level. From the statistical analysis results that in 1989 the incidence of cardiopathic diseases is 16700 per 100,000 inhabitants (50.5%), while the mortality due to malign tumours is 2238/100,000 inhabitants (69.9%).

## 2.10 Population and Settlements

### 2.10.1 Population

According to the year 1990 statistics the coastal area of Albania had 1,099,088 inhabitants. 44.1% of the number belong to the urban areas and 55.9% to the rural one.

During 1945-1990, the migration outside the country was forbidden, hence, the albanian population grew only by natural processes. The state has carefully controlled the moving of population inside the country in accordance with the national strategy of development, but it has favoured the natural increase of the population. The natural increase (%) of the population by districts (year 1990) is represented in Figure 33.

The density of population variated from 81.5 inhabitants/km$^2$ (Saranda district) to 296 inhabitants/km$^2$ (Durrës) [Statistical Yearbook of Albania, 1991].

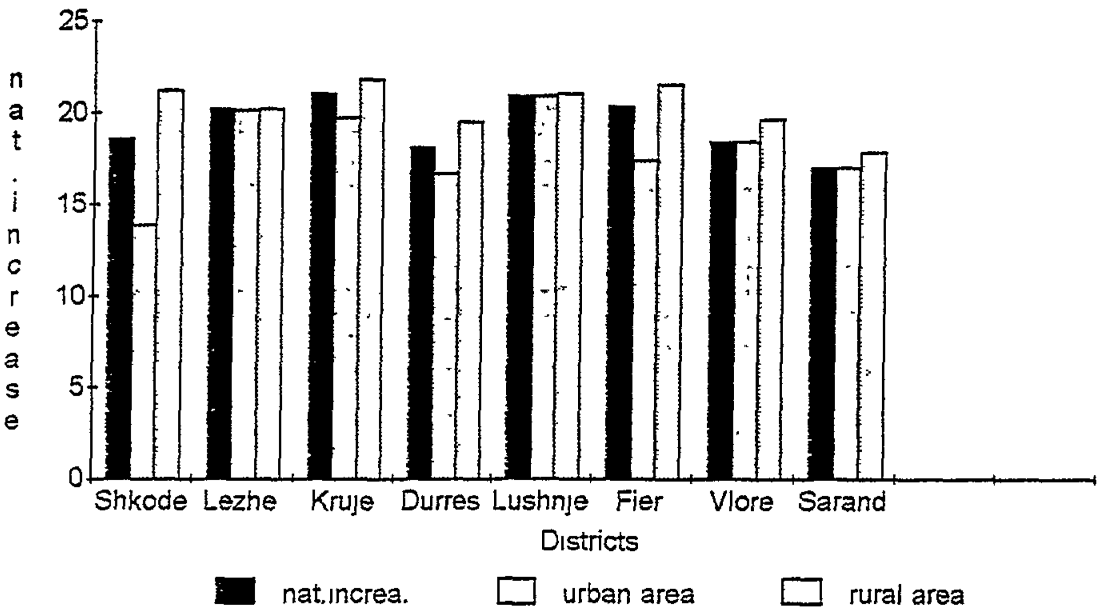


Figure 33 - Natural increase of the population

The last years the situation has changed, because the population growth and distribution depend highly upon social and economic conditions. The population movement tends to follow the opportunities for employment, environmental circumstances as well as cultural development. In the coastal zones the conditions for human activity are better than in other areas of the country, with better quality of land, good opportunity for agricultural activity, better climatic conditions and more chance of employment and activities such as tourism, oil exploration in the Adriatic sea, building of highways, fishing activity, services and other infrastructures.

There was a considerable movement from inland to the Adriatic coastal area after 1991. In general, people from the northeastern part of the country relocated to the Durresi and Lezha district, and people from the southeastern to the Vlora district. On the other side, the emigration phenomenon appeared. Young people from all over the country, particularly from the albanian coastal areas, emigrated in order to find a job to Greece, Italy or other countries. Because of the economic situation the number of births is decreased, as well. As a consequence of jointly acting of these factors, the population in Shkodra, Durrës (including Kavaja), Fier, Lushnja, Vlora and Saranda districts is decreased respectively -0.9%, -1.2%, -16.9%, -0.7%, -5.3% and -4.0%, whereas in Lezha and Kruja (including Lac) is increased 2.5 and 0.7%. Although, in general, an increase of population in the coastal areas is occurred. It accounted for 1,233,470 inhabitants in 1993.

2.10.2 Settlements

(it is expected to be improved)

# 3. POTENTIAL IMPACTS OF EXPECTED CHANGES ON NATURAL SYSTEMS AND SOCIO-ECONOMIC ACTIVITIES

## 3.1 Climate

By analyzing the results of GCM models for Albanian Coastal Area for two time horizons (Table

1) one may notice:

a - Annual scenario

According to the results of annual scenario a change of temperature from 0.7 to 2.5°C might be expected, depending on the time horizons. It means that there does exist a probability for the mean annual temperature the upper limit to oscillate between 17.2 and 20°C, Such an increase is to be taken into consideration. However, a significant precipitation change is not to be expected. The mean annual precipitation for the area under study ranges from 890 to 1880 mm, so, a variation 1000 - 2000 mm is to be expected from south to north.

b - Winter scenario

The expected temperature increase in winter follows the annual one, while the expected precipitation ranges between -28 and 5 %, so a decreasing tendency occurs. This decrease maybe cannot be of great importance because winter precipitation in Albania has the highest value then the other season, which ranges between 105 -215 mm. As evaporation is small during the winter such a decrease of precipitation will have low influence.

c - Spring scenario

According to the scenario the expected spring temperature will change almost at the same limits as the annual one. The spring temperature in this area oscillates between 13.8 -15.7 °C so, a variation between 15.2 - 18.5 °C is expected. A small increase of precipitation ( up to 18 % ) might be expected, which could influence to the agriculture production.

d - Summer scenario

The model estimates the same change of the expected temperature in this zone range between 23.2 - 24.7 °C. Such a change is to be highly taken into consideration. Summer precipitation ranges between 19 - 63 mm. A decrease up to -22 % or - 60 % could seriously influence the hydrology of this area.

e - Autumn scenario

The temperature change range is rather wider then the annual one and the precipitation change could reach up to +53 %.

Concerning the temperature a prolonged summer is to be expected. The seasonal precipitation range between 99 - 207 mm, so such an increase will influence the hydrosphere.

It's very difficult to predict the behaviour of other climatic elements and extreme events, but probably their change caused by temperature change is to be expected. Available scenarios, such as these developed by UEA for Mediterranean and by IPCC for global conditions as well as the conclusions of Sestini et al. (1989) [Jeftic L., et al., 1989] besides the increase in temperature, in sea level, in autumn rainfall and decrease in rainfall in other seasons, in general suggest as follows:

1. decrease in water availability;
2. increase in soil salinity;
3. increased winds;
4. increased carbon dioxide levels and other greenhouse gases;
5. increased incident radiation.

We are not able to say anything about this problem without performing complex studies on these topics.

It ought to be pointed out that the results of UEA scenario for Albania fit relatively good to the actual trend (period 1931-1991) concerning only to the winter temperatures and spring and annual precipitation. But, we cannot say the same for the other parameters. Their change is to be slight similar or reverse to the actual trend. Hence, these scenarios should be considered as indicators of changes that might occur

The annual temperature change is indicated to increase 0.9-1.0°C per degree of global warming, more marked in northern part of the area under study. While the actual tendency of the mean annual temperature (period 1931-1990) results the reverse. It is observed a temperature decrease of 1°C in extreme northern and southern parts and 0.2°C in central part of this area.

An increasing trend 0.7-1.0°C per degree of global warming, more marked in the central part of the area under the study is expected in spring, while the observed tendency of temperature for this season ( period 1931-1990 ) is a decreasing one( 0.3°C/60 years in central part and 0.8°C/60 years in extreme north and south).

The summer pattern is broadly the same as in spring.

By the scenarios, is expected an increasing 0-7 % per degree of global warming for spring precipitation, the same situation to that of period 1931-1990. While in the summer, the expected decrease of precipitation, more marked in the northern part of this area (up to 24 %), does not respond to the observed increase.

In autumn scenarios shows an increasing trend of temperature 0.7-1.2°C per degree global warming and precipitation in whole area under the study, more marked in the northern part ( 21% ). For the period 1931-1990 the observed trend is a decreasing one for the temperature (0.01-0.02°C /year) and precipitation. Hence, these scenarios should be considered as indicators of changes that might occur.

### 3.2 Lithosphere

Scenario of the expected climatic change might have greater effects on Western Lowland than on Ionian Coast, because the problems appear actually in the present days. Referring to the predicted changes of temperature, precipitation and sea level, described in the scenarios of UEA, we might say that more intensive erosion processes and rock or soil alteration is to be expected particularly by 2100.

The erosion will be mainly of physical type and more scattered through rocks of weak stability in terms of atmospheric agents.

To this kind of rocks belong in general the argillites, silts and to a less degree sandstone, which are located mainly at the western part of our country.

By the other side, in argillite-silt rocks will occur the slide phenomenon or the depression of the rock blocks, which may effect to the natural equilibrium of the massifs or rock slopes. These slide phenomena are actually more developed in the western slide of the territory and in the coastal area, for example in Currila (Durrës), Kavaja, Vlora, Bishti i Palles, etc.

Another phenomenon which is expected to occur more intensively in the future is Karst, which is known to be connected with high temperatures and humidity. This phenomenon is more developed in the carbonate rocks (limestone and less dolomites), as well as in the salt rocks and gypsum (Kavaja and Vlora area).

The sea level rise might cause the changing of geotechnical features of soils due to increase of pore pressure.

We would recommend the following engineering steps against these phenomena to be taken: foresting of the Currila (Durres), Vlora, Kryevidh (Kavaja) zones, constructing of the protective wall or pipes, in the sectors with developed landslides, drainage of surface or ground waters etc.
On the other hand, all these protective steps require the compiling at first of a detailed geological map of vulnerable areas and a complex planning of the engineering construction activities, together with complete technical, economical and architectonic studies.

### 3.3 Hydrosphere

#### 3.3.1 Surface waters

Three elements of climatic change (increasing temperature, precipitation and sea-level rise) will influence local water resources.

The evaluation of the implications of the predicted climatic changes on the water flow is based on the water balance. The equation of the water balance is:

I = P - E - ....S
where I - water flow
P- precipitation
E - evaporation
..S - change in storage

The term ... S can be neglected, because the time period is long (respectively 1990-2030 and 1990-2100 ). So, the equation is reduced to:

I = P - E

An expected increase of air temperature [Palutikof et al., 1992] may not have considerable consequences until 2030. The expected air temperature increase (by 2100) will bring about the increase of the sea surface temperature and hence enhance surface evaporation.

Evapotranspiration (ET) and humidity are expected to increase over the land throughout the year. An increase of about 3°C may effect the rise of evapotranspiration in such degree that it may result in decreasing of total amount of water and accelerate reduction and degradation of the water habitats. It may cause problems especially for summer, because the precipitation is expected to decrease significantly (-60 to +13% by 2100), and maybe not so much in autumn because of expected increase of precipitation.

The scenario for Albania shows a reduction of annual precipitation less than 2% in the south and an increase in the north of the study area. Consequently, the water flow in the southern part will decrease more than 2% by 2030 and 5% by 2100. There will not be significant changes in the northern part for the same time horizons. It is important to remember that southern part of the country possesses less than 20% of water flow resources, so, any considerable increase of water flow is not to be expected. The seasonal pattern of precipitation seems to be rather different. So, the expected decrease in precipitation during summer will worsen the water availability problem, while its expected increase in autumn will increase water turbidity exercising so a negative effect at the near-shore vegetation and ecosystems. A deterioration consequence would have either the increase of storm or strong wind frequency, that might increase the sediment inputs and change the profile near shore.

Sea level rise will have as a consequence the increasing of the water level in down river parts. This intrusion is expected to be rather sensitive by 2100. It may be felt especially in Mifol post (hydrometric station in Vjosa river). Also, sea level change (+48 cm at 2100) may influence at the changing of Albanian coastline, increasing the saline water content into aquifers and fresh water resources of the coastal area. Therefore, an increase in the salinity on the ground waters is expected to be occurred. This effect will be more sensitive at Durres Plain ( the altitude is 0.11 m a.s.l) because it has been swamp many years ago. After its reclamation soil has yet relatively high content of salt. The other zones that will be influenced, less than Durrės Plain, are Velipoja ( Zadrima Plain in Shkodra ) and Vlora Plain which are near the sea and respectively their altitudes are 1.67m, 1.83m above sea level. The same conclusion might be drawn for all parts, where salty soils are located. Anyway, it's very difficult to predict accurately the effects of climatic changes on the water balance.

### 3.3.2 Marine waters

In the Adriatic basin summer temperature - salinity stratification may be followed by winter mixing under the influence of the cold and the strong northern winds. So, the transfer of the surface water renews and oxygenates the deep layers. At the same time, they are replaced by less dense deep water. A possible increase of river discharge (if we refer the upper limits of precipitation changes in table 1), could reduce surface salinity and density, but scenarios shows more decrease than increase, so, an increasing of salinity is expected.

According to Schlosser (1989), an increase of 0.7°C of surface temperature and a decrease of salinity of 0.2%o would be sufficient to cause bottom stagnation and the formation of sapropel muds.

Since marine circulation is closely related to climate in the Adriatic basin and the salinity and the temperature system are kept in a steady state by two currents, warming may alter the relations with Ionian and Mediterranean as well as the hydrographic condition of Adriatic (stratification of water masses and water circulation features - gyres, meandering currents, jets, etc.)

The consequences of a possible future rise of sea level for the lagoons appear to be non very significant, largely on account of the low wave energy, and a continued sediment input from rivers and cliff erosion. No very significant extending of protected coastal lakes and lagoons is expected to occur, even by 2100, because of the natural and artificial barriers, and so long as will continue to exist a buffer zone of beaches and dunes. Anyway, a more active water exchange between lagoons and sea would be expected.

Other consequences in lagoons might be the periodical high temperatures, high salinity and less dissolved oxygen which might cause considerable changes of vegetation and ecosystem.

As a result of sea-level rise, the advance of sea in certain areas of coast by changing them into flooded areas or ligatines might be expected (by 2100). In non-protected lagoons the process of accreation will occur is expected, in any case even the destruction of their low partition barrier with the sea. In areas where sandy dunes do exist the destruction or damage of a part of them especially those which will be lower than 0.5 m that time.

Such situations are expected to occur in the north and south (Patok) of Mati delta, in the north of Erzeni delta, in the old delta of Seman, in the zone between Seman and Vjosa and in the south of Vjosa. An increase in sea level is also expected in Ceka Lagoon whereas in the Mati delta, the formation of new ligatines is expected. Patoku lagoon may suffer the destruction of the existing barriers and the change of the lagoon into sea.

Rrushkull in the north of Ishmi river, once a hunting reserve, is expected to be flooded as it is situated below sea-level and is separated from it by a low dune barrier. Karavasta and Narta lagoon are expected to have better communications with the sea in the future. An increase of the ligatine surfaces in the zone between the rivers Vjosa and Seman is also expected.

## 3.4 Natural Ecosystems

The expected increase in temperature by 0.9°C and of sea-level by 16 cm until 2030 is thought to be of slight impact on the natural coastal ecosystems. Whereas the expected increase of temperature by 2.5°C and of sea-level by 48 cm until 2100 will be accompanied with considerable changes in these ecosystems.

Referring to the first or the second case, these changes will be gradual and moreover correlated with the dynamic of changes of the coastal line as a consequence of the accreation phenomenon and accumulation rather than temperature increase.

The increase of communications with lagoons will have a positive effect on the living organisms in these environments, whereas the deterioration of this communication, as in the case of Patoku lagoon should be prevented. The formation of new ligatines will be accompanied with a partial change in vegetation in favour of halophile-hygrophile or salt-marshes. The damage imposed on dunes will affect negatively their characteristic vegetation and will bring about its transfer in the internal part of the territory. The new ligatines as that of Hamallaj and Rrushkull which are foreseen to be formed, will give rise to suitable environments for sheltering, feeding and in some cases even reproducing the aquatic birds.

Along the rocky coast the expected rise of sea-level will be accompanied with the transfer of hind littoral towards the terrestrial area and mediolittoral towards the hind littoral. The transfer will understandably occur with their constituent biocoenosis. Temperature rise may affect the growth of thermophile elements of coastal flora and fauna or their spread in north. There might be expected a slight change in the existing ratio Rhodophyta/Phaephyta. Changes can be expected even in the composition of plankton and especially in its seasonal dynamic as well as in the arrival and departure timing of the migratory species.

As a conclusion we can say that expected changes may occur mainly as a consequence of sea-level rise rather than temperature increase.

Another problem, which is to be taken into consideration concerning to the natural ecosystems is that of the polluted waste water, discharging through surface waters into the sea. The biodegradation of the organic waste water causes the oxygen depletion,deteriorating so the life conditions for natural ecosystems.

## 3.5 Managed Ecosystems

### 3.5.1 Agriculture

There are a lot of inhabitants at the coastal zone of Albania dealing with agriculture, so, the climatic changes may cause considerable impacts in socio-economic status as well.

According to the scenarios no considerable impact at 2030 is expected to occur.

The temperature rise up to 2.5°C and nonsignificant precipitation change at annual scale may impact in water availability and other factors by 2100. So, increase of water shortage, salinity and erosion is to be expected.

The rise of winter temperature is expected to be of positive influence. It will likely favour the cultivation of early agricultural products in open air or greenhouses.

The temperature change and concentration of the precipitation toward the spring at 2100 may influence the exchange of soil moisture during the vegetation period, on the evapotranspiration as well as on the possible prolongation of summer season.

The summer with expected higher temperature (up to 2.8°C) and a shortage of precipitation (from -68 to +13%) might cause deterіorate effects for agriculture, unless the irrigation problems be solved properly. Also, crops which have great water demands (such as vegetables, olive groves, etc.) will suffer the consequences of precipitation decrease, hence, the use of more xerophilic crops might be required.

The precipitation increase in autumn might influence on the moving away of the nutrious substances from the superficial arable soil.

Salinisation increase due to the sea level rise and intrusion of the salt water into the soil may impact directly the growth cycles, harvest time, and the quality of agricultural production.

The temperature rise of 2-2.5°C may also bring about the distribution over land of new harmful parasites and diseases as well as the reducing of their evolution periods.

### 3.5.2 Fisheries

It is very likely that the expected climatic changes and their direct consequences will cause changes within the ecosystem. Existing ecological balances and chains will be broken, and new ones will be formed on significantly different levels. The Mediterranean region is typical of this problem because it contain species that are heterogenous in every individual area, the result of the vastly different biotypes [Jeftic et al.,1992].

The increasing in temperature and decreasing in precipitation in summer (by 2100) would increase the evaporation, consequently, the salinity and sea water temperature should increase. These changes could affect the inflow of nutrients from river runoff or from "upwelling" of deep sea waters. The changes in the physical characteristics also could affect the oxygen solubility in the sea [Jeftic et al.,1992].

Thus, better living condition for existing fish species or migration of other ones are likely to be created, but it is very difficult for us to predict exactly what will happen.

### 3.5.3 Aquaculture

As long as the aquaculture is concentrated in the coastal area it will be influenced by the expected climatic changes, but probably this influence won't significant.

The temperature of sea water will probably increase, but less that of air. The resulting increase in evaporation will bring about the increasing in salinity. These increases in both salinity and temperature of the sea water will result in a decrease of oxygen solubility and increased organic matter decomposition.This may enhance the oxygen depletion and may even create anoxic conditions [Jeftic et al.,1992], especially it may affect the fish bred in tanks.

The increasing of sea water temperature in winter as consequence of expected climatic changes might create favourable conditions for growth of marine organism during this season. So, the rearing time would be shorter and more efficient.

### 3.5.4 Forestry

The distribution of the vegetation according to the flats which are identified by thermal limits calculated by the regression analysis [Glancio O.,1971; Rameau I.C.,1993;Treska Li.,1983] for each coastal district gives the possibility of applying the climatic changes scenario for time horizons 2030 and 2100 and to identify approximately their implications on Albanian coastal forests.
In summary, the vegetation flats distribution according to the altitude above sea level for time horizons 1975, 2030 and 2100 was given in Table 31.

By these figures, getting as a reference point those of time horizon 1975 the following implications might be distinguished:

1. Eu-Mediterranean evergreen forests would adapt the expected climatic changes (temperature, rainfall) and might extend on the coastal parts from Kavaja to Shkodra district (until to 200 m.a.s.l.) where they do not exist actually

   They will extend higher than 150 m.a.s.l by 2030 and two times higher by 2100 (up to 700 m).

1. Deciduous mixed with cermes oak (*Quercus coccifera L.*) would be adopted and extend up to 150-400 m higher (200-700 m by 2030 and 400-900 m by 2100).

2. Silver fir (*Abies alba Mill.*) and Black pine (*Pinus nigra Arn.*) forests would be adapted to the new conditions and extend up to 150-250 m higher (1400-2000 m by 2030 and, 1650-2045 m by 2100).

3. Mediterranean alpine pastures might extend until 2000-2045 m.a.s.l only by 2030.

4. the species that resist against the high temperature and the severe long dry season will be able to overlive; for the species that need moisture (silver fir, etc.) the danger to be limited or to disappear does exist; the species which produce many seeds and have much possibilities to be distributed (*Pinus etc.*) will be able to overlive and to extend on the sea-level altitude.

5. the precipitation changes from -5% over the southern part and to +13% over the northern one of the coastal zone, will favour the growing of the resistant species against dry phenomena in south and of some species of higher flats with high moisture-heat demand on the sea-level altitudes.

Table 31
The vegetation flats after the altitude for time horizons 1975, 2030, 2100

| Vegetation flat | altitude (m) time horizons | | |
|---|---|---|---|
| | 1975 | 2030 | 2100 |
| Eu-mediterranean evergreen forests | up to 350 | up to 500 | up to 700 |
| Deciduous forests with Cermes oak(Q.coccifera L.) | up to 550 | 200-700 | 400-900 |
| Deciduous forests | 150-1250 | 350-1400 | 550-1630 |
| Silver Fir and Black Pine forests | 1250-1850 | 1400-2000 | 1650-2045 |
| Mediterranean alpine pastures | 1850-2045 | 2000-2045 | - |

Note: *The lowest values belong to the northern zones, the highest to the southern*

In forests and pastures, the fires would be more frequently and too much dangerous; also, many pests that might be appeared and grown in the heat conditions will be too much dangerous for forest trees (*Cnethocampa pityocampa, Evetria buoliana, Limantria dispar, etc.*).

1. The expected higher temperatures might favour the stone and the land breaking process, which together with the increased precipitation on the northern part will cause for the soil erosion to be more intensive.

2. If the expected climatic changes are to be realised, a new vegetation extent is to be occur. The implications of other factors, such as fires and wild animals will change its extension. The migratory species particularly birds would change staging-places and therefore the species composition is expected to change, too.

The expected extension of the forests and the vegetation flats in Albanian Coast after districts, forest units and massifs, altitude and the sea level rise by 2030 and 2100, is given in summary in Annex IV

By applying the scenario of the sea-level rise and taking into consideration the altitude of the study area, we might draw the following conclusions:

1. the increase of the sea level of +16 cm and +48 cm won't have any implication on forests of Saranda (Mile-Stillo, Bregdet), Vlora (Gjomollë, Mali i Cikës-Himarë, Ana e detit-Palase, Brinjët e fushës, Karaburun, Llogara, Tragjas-Shëngjergj), Lushnja (Gradishte, Shkumbin Embankment), Kavaja (Kryevidh), Durrës (Kodër Laç-Rrotull), Shkodra (Maja e zezë) districts.

2. the increase of the sea level influencing directly in the increase of the groundwater levels and its composition, would limit the growing of some species that do not need the moisture and salt, such as forests of Vlora (Kumel-Shoshicë, Pishë Poro, Ana e L. Vjosa), Fieri (Pishë, Bregdet-Pishë Poro, Bregdet-Ndernenas), Lushnja (Pisha e Divjakës), Kavaja (Malësi e Kavajës), Durrës (Shijak-Maminas-Bisht Kamëz, Rrushkull), Kruja and Laçi (FushëKuqe), Lezha (Shengjin-Tale) and Shkodra (Dajc-Velipojë) districts.

3. in the National Park of Llogara, the silver fir forest could be replaced with deciduous forests, the silver fir seed stand too; that of black pine seed stand could be replaced by deciduous forests mixed with cermes oak (*Q. Coccifera L.*).

The National Park of Pisha e Divjakes-Lushnje, the seed stand of Pishe Poro-Fier, the nature monuments of Butrinti Forest and Zverneci Island Forest will continue to remain eu-Mediterranean evergreen forests, but the first two will have a limited extend because of the increase of the sea level.

In the seed stand of Golem, Kaladrekajve and Matkeqi Forest will obtain the eu-Mediterranean evergreen forest flat conditions; in the seed stand of Golem and Matkeqi Forest the level and the salinity of the groundwater will decide their existence, also, for the Kaladrekajve Forest (composed by beech), because of the expected higher temperature, the danger to disappear does exist.

In the hunting conservancy of Karaburun the silver fir forest would be replaced with deciduous forest, in hunting conservancy of Pishe Poro ( Vlora and Fier ) and Pisha e Divjakes-Lushnje the Mediterranean conifers forests would continue to exist limited in the eu-Mediterranean evergreen forest flat because of the sea level rise.

In the hunting conservancy of Rrushkull - Durres, FushëKuqe-Kruje-Laç, Kune-Vain Lezhë and Velipoja-Shkoder would be good conditions for the eu-Mediterranean evergreen forest flat but, the increase of the level and salinity of the groundwater would decide on their existence.
The sea level rise in these hunting conservancy would enlarge the water surfaces and therefore, would influence in the increasing of the migratory birds staying capacity.

### 3.6 Energy and industry

The represented climatic changes for Albania by 2030 are not likely expected to have a great influence on the energy and industry. But, it is to be pointed out that the possible changes by 2100 should impact the both fields.

The increase of winter temperature (2 - 2.5°C per degree of global warming) should reduce the need of heating, in the sense that inside temperature will increase, creating so, more comfortable conditions for work and living. The less energy consumption during winter is likely to be compensated by the higher demand of energy in summer. Increasing demand for ventilation and air conditioning will influence the increasing of outside temperatures during the "prolonged summer". It may cause some other problems for other activities in open air.

The significant decrease of precipitation and the possible increase of salinity of coastal aquifers, due to sea level rise, could lead to greater difficulties not only for the industries using mainly fresh water, such as food industry, but also for the population, tourism, health and recreation activities. It assumes an increased demand for energy for the water treatment before use.
The sea-level change will affect the factories, which are located near the sea, such as the salt and soda production plants located at Vlora district.

### 3.7 Tourism

Tourism seems to become a very important branch of Albanian economy. According to the Strategy of Tourism Development, mentioned in the former paragraph (2.7), the tourism activity is to be concentrated along the seaside. It will be primarily oriented on the activities using directly the sea shore, such as swimming and sun bathing, recreational activities etc. Therefore the climate, quality of sea and land are of great importance. So, the expected climatic changes and their impacts could affect tourism as well.

Referring to the results of UEA scenarios, one might conclude that a "prolonged summer" would lengthen the tourism season and increase the number of tourists visiting Albanian Coast. At the same time, the expected high summer temperatures and the possible increase of wind and storms (see 3.1) might cause uncomfortable and unpleasant conditions to enjoy the seaside.

By construction of tourism facilities the possible negative impacts are to be taken into consideration. Being a great user of water and producer of both liquid and solid waste, tourism will suffer the water shortage and the missing of sewerage systems. Higher average summer temperatures could cause problems in agriculture production (3.5.1), which is a part of tourism supply as well. So, it is very important to take the proper precautions to avoid these existing deteriorate problems.

The establishment of marinas is planned to be developed in the future. Therefore is of interest the possible increase of sea level of 48 cm by 2100 to be taken into consideration.

### 3.8 Transport

The impacts of climate changes will be more significant on the harbours than on the roads, railways or airports. Keeping in mind that transport is of great importance for the existing of other branches of economy, the preliminary measurements to eliminate the negative impacts of climate are to be taken.

Firstly, the Government of Albania is taking steps to reduce the emission of greenhouse gases from transport activities, encouraging the population to buy new vehicles and to use lead free petrol for motor vehicles.

A temperature increase ought to require the upgrading of public transport, which actually is not equipped with air conditioning.

The flooding in coastal roads, as result of precipitation change, is not expected.
The sea level change of +48 cm might have a possible negative impact on harbours. It will be taken into consideration by construction of new ferry harbours.

The increasing of frequency of strong winds and storms would influence the maritime transport. There are registered many cases with strong winds or storms, which caused many problems to harbours. It is very urgent the storm warning systems to be installed at the main ports and the telecommunication links with forecasters in country scale to be rehabilitated. The same conclusion could be drawn concerning to the air transport, which is to be developed further.

### 3.9 Sanitation and health aspects

It is very difficult to estimate the implications of climatic changes in health problems, because the impact of other non-climatic factors is greater. Anyway, referring to the changes expected by 2100, we might say that the rise up to +2.8°C and increased frequency of extreme temperatures, as well as the increase humidity (as a result of increased evaporation ) will influence the health of some people suffering from heat stress, hypertonics and cardiopaths.

Insect -borne diseases may well become widespread, either because the vector will be able to survive better at higher latitudes or because parasites may be able to complete their life-cycle more easily. Temperature increases will lengthen the breeding season and survival rates of a number of insect vectors, including species of anopheles mosquito and as a consequence malaria will reappear in Europe [IECCh on Malta, 1994].

It will be an imperative task to rise the health culture of the resident population as well as of the tourists, promoting about possible noxious influence of the environment (as for example excessive sunbathing) especially on the individuals with premorbid conditions or with already developed diseases.

Not only the problem of drinking water will become especially keen during summer, but also the liquid and solid waste, going directly into the sea will destroy the sea flora and fauna. Without solving the two last problems the impacts of climate change would deteriorate the health conditions of the Albanian population living not only in the coastal zone.

### 3.10 Population and settlements

The sea-level change of 16 cm by 2030 cm is not expected to cause any important impact on the dynamic of populations.

The Adriatic coast is composed of flat and sandy beaches. In some considerable parts the width of sandy belts is 100-150 m. There are few settlement tourist structures (mainly in Durrës area) near the seashore, those that do exist are far from the sea. The Ionian coast is rocky and abrasive. The beaches are narrow and so construction of new buildings must be done with care.

The climatic changes are not expected to bring about any important effect on the population distribution. The population growth in the coastal area is expected to follow present trends.

On the Ionian coast the settlements are located at a higher altitudes than the sea level, therefore, its rise won't affect the population. Sea-level rise may cause the rise of salinity of fresh water resources and for this reason it may be necessary to establish better methods of water management.

# 4. RECOMMENDATIONS FOR ACTIONS

## 4.1 Suggestions for action to avoid, mitigate and adapt to the predicted effects

### 4.1.1 Climate conditions

As is pointed out, air pollution is one of most priority problems nowadays, because of its direct deteriorating influence by penetrating into in other media.

In parallel with the impacts of the pollutants in the biota, there is another serious problem of their possible influence on the climate system, through anthropogenic warming and the contamination of the atmosphere with greenhouse gases, which play an important role in changing of the atmosphere composition.

Until now, not only in the study area, but also over Albania, the monitoring system of air pollution does't exist. Only some sporadic measurement for some elements are made. It is very urgent such a system to be established as well as the existing meteorological to be improved, in order that the possible increase of air contamination to be assessed and warned in proper time.

An international scientific co-operation is required, in order to develop general circulation models, taking into consideration also other meteorological elements for an more accurate prediction.

### 4.1.2 Lithosphere

A complex study on the coastal morphology data, such as rates of erosion or accretion, sand budgets, land subsidence, increasing of salinity due to sea water intrusion etc., ought to be carried out. The mapping of vulnerable coastal areas is required.

In order to draw more exact conclusion concerning the dynamics of coastline the Remote Sensing is recommended to be applied.

### 4.1.3 Hydrosphere

The authorities ought to take the appropriate administrative and construction measures to mitigate the possible implications of the climatic changes.

So, investigations on the coastal dynamics to determine changes in the sediment budget as a result of sea level rise and changing output of sediment by rivers, the mapping of vulnerable areas to flooding, the rehabilitation of flooding warning system which is out of function are recommended. In order to prevent the negative erosive effects caused by sea-level rise the set up of artificial barriers in risked areas is recommended. It is of great importance to the preservation of Patoku lagoon to set up these barriers.

The improving of water supply system and the rehabilitation of the irrigation network must be undertaken. Also, the control of land reclamation for reducing the coastal area susceptible to inundation is required.

Another problem to be solved is the monitoring of surface water and groundwater quality and water table elevation as well, the control of groundwater exploitation to reduce subsidence and salt water intrusion

### 4.1.4 *Natural Ecosystems*

The protection of the natural ecosystems from the impacts of climate changes, it's very important task, that needs to evaluate the impacts of the other non-climatic factors also.
It is very important to integrate information from different disciplines to assess the role of vegetation in the hydrological cycle.

Since the expected changes in natural ecosystems may occur mainly as a consequence of sea-level rise rather than temperature increase, some protective measures to prevent the negative influence of sea level rise are to be undertaken, especially near Natural Protected Areas. The protection of Patoku Lagoon is of interest.

Measures to avoid the water pollution of both domestic and industrial waste water is to planned and implemented with the aim to reduce oxygen depletion due to the biodegradation of organic waste water.

### 4.1.5 Managed Ecosystems

The future climatic conditions will require the planting of agricultural production which must adapt the higher winter and summer temperatures and the scarcity of water in summer, etc. So, agriculture development should be adjusted towards enhanced winter productions and towards species that might adopt the expected soil and atmospheric conditions (increased temperature and evaporation, scarcity of precipitation, increased salinity, pests, etc.). The investments for the developing of a modern irrigation system are required. The control of excessive use of fertilisers and pesticides must be enforced.

On the basis of present knowledge is rather difficult to suggest the necessary actions concerning the fishing and aquaculture. Anyway, attention should be paid to avoid or decrease the possible pollution problems, to prevent the degradation or destruction of any species. To prevent and control the overfishing, the monitoring and the fishery inspection is required. The monitoring of water quality and establishing of appropriated sewerage systems.

Amongst the recommendations to avoid, mitigate and adapt to the predicted effects we could give the following proposals:

*The new forest species which ought to be adopted to the new conditions are to be cultivated.* They ought to be resistant against the dry phenomena, fires, pests, groundwater level change, increase of salinity, etc.). The studies to prepare the management plans on the sustainable development of forests, according to these principles are to be undertaken.
The establishment of these *mixed forests in agricultural abandoned lands or in forests with low density* (up to 40%) as well as on the slopes of 22 degrees, would be an effective measure to prevent the forest fires, pests and erosion, too.

The studies on the fire dynamics in such composed forests, on the *rehabilitation* of the existing ones, and on the damages that pests might cause in the future climatic conditions will be of interest.

### 4.1.6 Industry and Energy

To prevent the impact of sea level change by 2100 is recommended that factories located on the sea-shore must be either protected or relocated.

Since the social-economic development of the country has a great energy demand the compiling of an Energy Plan is of great importance. It may consist in determining of strategies for reducing of greenhouse gas emissions, in analyzing of demands in the conditions of the expected climatic changes, in the possibility of using of alternative energies, such as solar and wind, in the control of emissions of the harmful gases from the vehicles, etc.

4.1.7 Tourism

As tourism will be one of main activities of our country a more detailed study on the implication of the climate change on the tourism activities.

Problems created by coastal tourism involve employment, communications, water and food supplies, hence, there is a need for studies, (f.e. an appraisal of the negative impacts of mass tourism) and for planning the integration of the tourist activities with the other ones.

Very useful is the development of educational programmes about protection of coastal and all environment, in order to make conscientious the populations and decision makers to the possible impact of expected climatic changes.

4.1.8 Transport

The expected changes of climate must be taken into consideration by compiling the programmes of road transport development at the coastal area.

The control of emissions of greenhouse gases ought to be of high priority.
The system of storm and flood warning systems are necessary to be establishment to prevent in proper time the hazardous events.

4.1.9 Health and Sanitation

It is very important to take the necessary measures for controlling of drinking water quality and the monitoring of water quality. Permanent control must be exercised in water supply and sewage systems affected by saltwater corrosion and intrusion.

4.1.10 Population

The future trend in population growth and industrial reactivation must be considered, with attendant food supply and commercial and financial implications.

**4.2 Suggestions for follow-up to the present study**

A number of activities should be part of the national plans and strategies:

1. A strategy to prevent and avoid in proper time the impacts of climate changes, keeping in mind the continuity of these changes is required.

2. It is urgent to prepare the local inventories of impacts by temperature, precipitation change and sea-level rise as well as on water, ecosystems and socio-economic activities.The precise identification of the territories that possibly will be implicated by climate changes is recommended.

3. The impacts of climate changing must be taken into consideration by developing integrated planning.

4. The using of renewable energy, as a resource that does not cause pollution ought to have priority.

5. The information about possible consequences of climatic changes and the need to take the necessary steps for their avoidance must be distributed to all levels of economic and political decision makers.

6. The development of controlled and "soft" tourism, that means low buildings, maximum 3-4 stores, in order to have combination with the surrounding vegetation

7. A cost benefit analysis is important to be made in order to evaluate the feasibility of the expenditures for mitigation and the vulnerable effects of climate change.

# REFERENCES


1 Hidrologjia e Shqiperise. Tiranė, 1984
2 Klima e Shqipërise. Hidmet. Tiranė, 1975.
3 Gazeta Shqiptare 8 Shkurt 1995. Janar, Inflacioni rritet 1.8%
4 Grup autoresh 1990 - Gjeografia Fizike e Shqiperise. Vol. I, II.
5 Grup autorėsh 1984 - Hidrologjia e Shqipėrise.
6 Grup autorėsh 1988 - Harta Pyjore e Shqipėrisė.
7 Aliaj Sh., 1966 Vix zone de transition entre les zones externes ionienne et de Karaburun. Bul. USHT. seria shk. nat. Nr. 3.
8 Asszonji Cs., Kapolyi. L. (1972). Rhedogical Basic Relations of Reck Mechanies. Acta Geodaetica, Geophysica et Montanistrca 7/1-2.
9 Aubovisi J., Ndoaj I., 1964 - Regard sur la géologie de l'Albanie et sa place dans la géologie des Diriaridrs. Bull. Soc. Grol. Fr (7) vol. 6.
10 Boriçi M., Demiraj E., 1993. The air temperature and precipitation trends in Albania over the periods 1988 - 1990 and 1931 - 1990. In Precipitation Variability & Climate Change. Proc. of Symp. on Precipitation and Evapora tion. Vol. 2 Bratislava, Slovakia.
11 Bottema, S. 1974 - Late quaternary vegetation History of Northwestern Greece-Groningen.
12 Caslli H., 1967 La structure du massif de roches ultrasiques de Tropoje et la diffusion de mineralisation du chrome. Përmbledhje studimesh Nr.7
13 Giancio, O. 1971 - Sul clima e sull distribuzione altime trica della vegetazione forestale in Cala bria-Annali dell'Instituto Sperimentale per la Silvicaltura Arezzo Estatto dal vol. II.
14 Gjinkuri L., Hoda P., 1994 -*Vlerësimi ekologjik i kompleksit Divjake-Karavasta dhe mundësite poten ciale për zhvillimin e ekoturizmit. Studim i fazes së parė.*
15 Gjinkuri L., Peja N., 1992. - *Le lagune albanesi e l'efetto del sviluppo economico,ed agricolo su di esse*
16 Haxhiu M., 1994 - *Rregullore e studimit urbanistik të zhvillimit të hapesirës bregtare Divjakë-*Karavasta
17 Hodge Ph. G., Prager W., (1951). Theory of Perfectly Plastic Solids. New York
18 Houghton I.T., Jenkins G.I., and Ephraum I.I., (eds.), 1990: Climate Change: the IPCC Scientifie Assessment. Cambridge University Press, Cambridge, V.K.
19 Hovwink R., (1973) - Elasticity, Plasticity and Structure of Matter, Cambridge University Press., Cambridge.
20 IPCC 1994, Radiative Forcing of Climate Change. Summary for Policy makers.
21 Jaho S., Veçori klimatike dhe hidrologjike te Ultësires Perendimore. Hidmet. Tiranė, 1985
22 Jeftic L., Milliman, I.D., Sestini G. (eds.) 1992, Climatic Change and the Mediterranean. UNEP.
23 Karadumi,S. 1992 - Pyjet, shpendet e kafshët e egra të bregdetit shqiptar dhe vlerat peisazhistike e turistike, Tiranė. -Pa publikuar.
24 Lamani F., - Shpendet e Shqiperise (ne fondin e Katedres se Zoologjisė).
25 Mitrushi,I. 1993 - Drurėt dhe shkurret e Shqiperise, Tirane.
26 Muharremi, V. - Parqet, pyjet kombėtare (PPK). Materia li i pėrgatitur pėr krijimin e tyre. Tiranė Pa publikuar.
27 Mullaj A., 1989 - Vegjetacioni bregdetar i Shqiperisė (Disertacion).
28 Mustaqi V., Ecuria vjetore e reshjeve nepërmjet analizes harmonike. Studime Hidmet, Nr. 11.
29 Ndojaj I., 1963 Problèmes du magmatisme en Albanie, Bul. USHT. Sena.shk.nat. Nr.2
30 Ossenbrügge I., 1993, Umweltrisiko und Raumentwicklung. Springer Verlag.
31 Palutikof J.P, Guo X., Wigley T.M.L., Gregory J.M. 1992. Regional Changes in climate in the mediterranean basin due to global greenhouse gas warming MAP Technical Reports Serres N°.66, UNEP.
32 Ramadan Garo, 1985. Tokat e kripura dhe pėrmirėsimi i tyre. Tirane.
33 Rameau,I.C. 1993 - Flore Forestiere Française, Tome 3: Monsion, J. Montagnes Institut pour le développement. Dume, G. Forestier.
34 Remert, H. 1990 - Ecology, A. Textbook, Springer-verlag. Berlin Heidelberg New Jork.
35 Richter R., (1979) - The continuum theory of rock mechanies. Series on Rock and soil Mechanies Vol.4

36 Sabato, S. - Flora e vegetazione di una zona dell Appenino.
37 Schellnhuber I.H., Sterr, H. (Hrsg.), 1993, Klimaanderung und Küste. Einblick ins Treibhaus. Springer Verlag.
38 Shehu R., Xhaska P., Lleshi B., etc. 1981. La structure géologique des Albanides. International symposium on the Hellenic Are and Thench (HEAT), Athens.
39 Tegart W.I., Mbc, Sheldon G.W., Griffiths D.C.,(eds.),1990. Climate Change. The IPCC Impacts Assessment.
40 TEY S.P.A. (1993) - Ingenieria Dell'Ambiente «Environ mental review and environmental strategy».
41 Thirgood, JV. 1981 - Man and Mediterranean Forest, A history of resource depletion Academic press Inc (London) LTD.
42 Treska, Ll. 1963 - Silvikultura. Instituti i Lartë Shtetëror i Bujqësisë, Tiranë.
43 UNEP (1992) Implications of expected climatic changes on Cres/Losinj Islands.
44 UNEP (1994) Implications of expected climatic changes on Kastela Bay.
45 UNEP (1994) Implications of expected climatic changes on the Syrian Coast.
46 UNEP (1994) Implications of expected climatic changes on the Island of Rhodes.
47 Valenziano,S. 1975- Centro Setentrionale (Rincine) 1-Flora Pubblicazioni del centro di sperimentazione Agricola e Forestale, Vol. XIII, Fasc. 3, Roma.
48 Veli Puka (1990) - Monitorimi i cilësisë dhe shkallës së ndotjes së ujrave të lumenjve të Shqipërise
49 Yzuri D., Bakia H., etc. 1980 La carte géologique a 1/100.000 de la zone ionienne. Le fonds qedosique de l'O.Gj.N.G.

Annex I

# TEMPERATURE AND PRECIPITATION SCENARIOS FOR ALBANIA

Report to the UNEP Co-ordinating Unit for the Mediterranean Action Plan

February 1994


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# TEMPERATURE AND PRECIPITATION SCENARIOS FOR ALBANIA

Report to the UNEP Co-ordinating Unit for the Mediterranean Action Plan

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## SUMMARY

We have applied the methods developed by Kim et al. (1984) and Wigley et al. (1990) to construct high-resolution scenarios of climate change for Albania. Regression equations were developed to predict station temperature and precipitation anomalies from regionally-averaged climate anomalies. Using the output from four General Circulation Models, we then substituted perturbed-run minus control-run values of temperature and precipitation in the regression equations to obtain a prediction of the change due to the greenhouse effect at each station. The results were scaled by the equilibrium temperature of each of the four GCMs, and an average for the four models obtained. The procedure was repeated for every station in the data set, and the results contoured to produce a scenario for Albania.

Annual and seasonal scenarios for both temperature and precipitation change were produced. The scenario of annual temperature change shows an increase in the amount of change from south to north along the coast, and from the coast inland. Thus, in the southern coastal region the suggested annual change is 0.7-0.9°C per 1°C global warming (i.e. the warming will be less than the global level). Although further north along the Albanian coast the warming is shown to be greater (0.9-1.0°C per degree global warming), the indications are that it should not exceed the global rate of warming. In the extreme east of the country, however, temperature changes greater than the global level (i.e.above 1.0°C per 1°C global warming) are suggested. This annual pattern is reflected at the seasonal scale.

The scenarios for annual precipitation change indicate wetter conditions in the north of Albania as a result of global warming, and drier conditions in southern areas. The changes are quite small. At the seasonal level, this annual pattern is most clearly replicated in autumn. Precipitation in winter shows an increase due to global warming over most of the country, apart from a small area centred on 41°N at the coast, where a reduction in precipitation is indicated. In spring, the models-indicate that rainfall should increase as a result of global warming over the whole of Albania. However, along the coast the increase is shown not to exceed 7% of present-day values, per 1°C global increase in temperature. The summer pattern is one of increased rainfall inland and along the southern coast, but with lower rainfall along the northern coast as a result of global warming.

The problems associated with the construction of regional scenarios of climate change due to the enhanced greenhouse effect are discussed at length by Palutikof et al. (1992) in their report to UNEP on the construction of climate change scenarios for the whole Mediterranean region. The confidence that we can place in sub-grid-scale scenarios of precipitation is particularly low. In consequence, these scenarios should be considered only as indicators of changes that might occur.

## 1. THE USE OF GCMS IN REGIONAL SCENARIO DEVELOPMENT

It is generally accepted that the results from General Circulation Models (GCMs) offer the best potential for the development of regional climate scenarios. They are the only source of detailed information on future climates which can extrapolate beyond the limit of conditions which have occurred in the past.

GCMs are complex, computer-based, three-dimensional models of the atmosphere which have been developed by climatologists from numerical meteorological forecasting models. The results used here are taken from GCM equilibrium response experiments. That is, the model is first run with a nominal "pre-industrial" atmospheric $CO_2$ concentration (the control run) and then rerun with doubled (or sometimes quadrupled) $CO_2$ (the perturbed run). In both, the models are allowed to reach equilibrium before the results are recorded.

The fact that the GCMs are run in equilibrium mode must in itself be regarded as a potential source of inaccuracy in model predictions. It can be argued that the predicted regional patterns of climate change will differ from those that will occur in a real, transient response world. Results are becoming available from transient response predictions, where the $CO_2$ concentration increases gradually through the perturbed run and where oceans are modelled using ocean GCMs, and which therefore should provide a more realistic estimate (see Gates et al., 1992). These indicate that the large-scale patterns of change are similar to those obtained from comparable equilibrium experiments, scaled down by an appropriate factor. Differences do exist, largely because equilibrium model runs ignore important oceanic processes such as ocean current changes, differential thermal inertia effects between different parts of the oceans and between land and ocean, and changes in the oceanic thermohaline circulation. These differences are greatest in areas where ocean thermal inertia is large, such as the North Atlantic and high southern latitudes (Mitchell et al., 1990). They are relatively small in most regions (and in the Mediterranean Basin in particular).

The four GCM experiments used to construct the scenarios are from the following research institutions: the U.K. Meteorological Office model (abbreviated here to UKMO; the model version used here is as described by Wilson and Mitchell (1987)); the Goddard Institute of Space Studies model (GISS; Hansen et al., 1984); the Geophysical Fluid Dynamics Laboratory model (GFDL; Wetherald and Manabe, 1986); the Oregon State University model (OSU; Schlesinger and Zhao, 1989). The models vary in the way in which they handle the physical equations describing atmospheric behaviour. UKMO, GISS and OSU solve these in grid-point form whereas GFDL uses a spectral method. All models have a realistic land/ocean distribution and orography (within the constraints of model resolution); all have predicted sea ice and snow; clouds are calculated in each atmospheric layer in all models.

One problem with the application of GCMs to the study of climate impacts is the coarse resolution of the model grid. The grid scale of the four models listed above ranges from 4° latitude x 5° longitude (OSU) to 7.83° latitude x 10° longitude (GISS). GCMs of this generation, therefore, have a spatial resolution of several hundreds of kilometres, which is inadequate for many regional climate change studies, especially in areas of high relief. We present here a set of high resolution scenarios for Albania, based on the statistical relationship between grid-point GCM data and observations from surface meteorological stations.

## 2. CONSTRUCTION OF SUB-GRID-SCALE SCENARIOS

Kim et al. (1984) looked at the statistical relationship between local and large-scale regionally-averaged values of two meteorological variables: temperature and precipitation. They then used these relationships, developed using principal component analysis techniques, to look at the response of local temperature and precipitation to the predicted change at GCM grid points. The area of study was Oregon State. Although the paper contains certain statistical flaws, the underlying idea of relating local and large-scale data statistically is sound. The method of Kim et al. has been extended and refined by Wigley et al. (1990) and by Wilks (1989).

The methods of Kim et al. and Wigley et al. have been modified for application in the Mediterranean region. In the model validation exercise carried out for the Mediterranean region by Palutikof et al. (1992), it was established that no single GCM can be identified as being always the best at simulating current climate. This being the case, there is little merit in presenting scenarios based on only one model. Presentation of scenarios for each of the four models avoids the issue, since the task of deciding which model is 'best', and/or of synthesizing the information to obtain a best estimate, is left to the impact analyst. We have therefore combined the information from the four models into a single scenario for each variable, according to the method described below.

The problem with scenario construction based on a number of models is that the results may be biassed by the different equilibrium responses of the individual models. The global warming due to $2xCO_2$ for the four GCMs ranges between 2.8°C for the OSU model and 5.2°C for the UKMO model run. We would therefore expect that the warming indicated by the UKMO GCM for the Mediterranean Basin will be greater than that suggested by the OSU model, even though the sensitivity of the region to climate change when compared to the global sensitivity might be the same. The individual model perturbations have therefore been standardized by the equilibrium (global annual) temperature change for that model, prior to the calculation of the four-model average.

We required a generalized computer program that would be applicable throughout this geographically complex area, and could be used with meteorological records of variable length and density. After investigating a number of approaches to the problem, we adopted the procedure summarized below.

1. Data sets of monthly mean temperature and total precipitation have been compiled for the area surrounding the Mediterranean Basin. Stations used in this study of Albania are listed in Appendix 1. Where possible, each record should be complete for the period 1951-88. Any station with a record length less than 20 years in the period 1951-88 for over six months out of twelve was immediately discarded.

2. Then, for every valid station, the temperature and precipitation anomalies from the long-term (1951-88) mean were calculated. For this part of the work, which is the first step in the construction of the regression equations (the calibration stage), only the data for 1951-80 were used. The 1981-88 data were retained to test the performance of the regression models (the verification stage, see Palutikof et al., 1992). For the calculation of the temperature anomaly $At_{ij}$, the simple difference was used:

$$At_{ij} = t_{ij} - T_j$$

where $t_{ij}$ is the mean temperature of month j in year i, and $T_j$ is the long-term mean for month j. The precipitation anomaly $Ap_{ij}$ was expressed as a ratio of the long-term mean:

$$Ap_{ij} = (p_{ij} - P_j)/P_j$$

where $p_{ij}$ is the monthly total precipitation in month j of year i, and $P_j$ is the long-term mean for that month If $P_j$ is less than 1mm, then this equation is modified to:

$$Ap_{ij} = (p_{ij} - P_j)/1.0$$

3. The individual station anomalies are used to calculate regionally-averaged anomalies. The procedures described from here to the end of Point 6 are station-specific, and must be repeated for each station in the data set.

   A 5° latitude x 5° longitude square is centred over the station for which regression equations are to be developed (the predicted station). All the stations which fall within this square are used to calculate the regional averages. If the number of stations is less than three, for temperature, or four, for precipitation, the procedure is halted. For temperature, the anomalies from all stations in the 5° x 5° square are averaged month-by-month to produce an area-average time series. For precipitation, the substantial degree of spatial variability makes it advisable to area-weight the station anomalies before calculating the regional mean for each month. To do this, the 5° x 5° region is divided into 20 x 20 smaller squares. The precipitation anomaly value assigned to a particular square is that of the station nearest to it (with the restriction that the distance separating a square from its nearest station should be no greater than 1° - where the distance is greater the square is ignored). The area average is then the mean of the values in the 400 (or fewer, if any fail the minimum distance criterion) squares. This method is similar to the standard Thiessen polygon method.

4. Regression analyses were performed using station temperature and precipitation anomalies as the predictands. These analyses were carried out on an annual and seasonal basis: winter (December, January, February), spring (March, April, May), summer (June, July, August) and autumn (September, October and November). By considering the monthly values as separate observations within each season, we were able to extend the number of observations and so preserve a high number of degrees of freedom. The predictor variables are the regionally-averaged anomalies of temperature and precipitation.

5. In order to determine the perturbation due to the greenhouse effect at each station, the results from GCMs were employed. It is assumed that a GCM grid-point temperature or precipitation value is equivalent to a regionally-averaged value derived from observational data. For each of the four GCMs (GFDL, GISS, OSU and UKMO), the perturbed run and control run grid-point temperature (t) and precipitation (p) values are interpolated to the station position. Then, we obtain, for temperature:

$$Atm_i = t_i(2 \times CO_2) - t_i(1 \times CO_2)$$

   where Atm is the perturbation due to $CO_2$ or the 'temperature anomaly' for model i and, for precipitation:

$$Ptm_i = [p_i(2 \times CO_2) - p_i(1 \times CO_2)] \times 100/p_i(1 \times CO_2)$$

   where Ptm is the standardized perturbation due to $CO_2$, or the 'precipitation anomaly'.

   The values for Atm and Ptm for each GCM are then substituted in the regression equations to obtain a prediction for the station perturbation of temperature (°C) and precipitation (%) due to $CO_2$.

6. The predicted change in temperature and precipitation for each model is divided by the equilibrium (global mean) temperature change for that model. The results are then averaged across the four models to obtain a composite value.

7. The procedures from Points 3 to 6 is repeated for each station throughout the Mediterranean. The results can then be plotted and contoured to obtain a map of the expected patterns of temperature and precipitation change due to the greenhouse effect.

In order to arrive at this procedure, a rigorous investigation of the validity of the method has been carried out. In particular, we have looked at:

- the use of other predictor variables in the regression equations
- performance and verification of the regression equations
- autocorrelation in the data
- multicollinearity in the predictor variables.

These aspects are discussed in detail by Palutikof et al. (1992).

## 3. CLIMATE CHANGE SCENARIOS FOR ALBANIA

The sub-grid-scale scenarios, constructed according to the method outline in Section 2, are shown in Figs. 1-5. The temperature perturbations are presented as the model average change, in degrees Celsius, per °C global annual change. The precipitation perturbations are shown as the percentage change for each 1°C global annual change. This procedure is described in greater detail, and the approach justified, in Section 2.

The scenarios are presented as the regional change in a particular climate variable to be expected in response to a 1°C change in mean global temperature. As such, they do not provide any information on when such changes might be expected to occur. However, such information can be extracted from scenarios presented in this form. The results from four transient response GCMs presented in IPCC92 (Gates et al., 1992) show a constant rate of warming in the later decades of around 0.3°C per decade. This is in line with the findings of IPCC90, based on the 'business-as-usual' $CO_2$ forcing scenario and an energy balance atmospheric model coupled to an upwelling-diffusion ocean model (Bretherton et al., 1990). Although the impossibility of placing calendar dates on this figure must be emphasized, it suggests that a 1°C temperature change may be achieved in a period of around thirty years.

It should be noted that the figure of 0.3°C per decade does not take into account possible opposing anthropogenic influences, in particular the forcing from sulphate aerosols and stratospheric ozone depletion. Wigley and Raper (1992) made temperature projections based on IPCC92 emissions scenario IS92a (Leggett et al., 1992), taking into account the ozone-depletion feedback and best-guess sulphate aerosol effects. They used their upwelling-diffusion energy-balance climate model (as used in IPCC90, see above) and found the warming between 1990 and 2100 to be in the range 1.7-3.8°C.

The results from these time-dependent experiments can be combined with the scenarios of the magnitude of change presented in this report, and superimposed on a baseline (present-day) climatology in order to arrive at a scenario of climate for a particular future time. A recent example of the application of this approach to the development of 'snapshot' scenarios for Europe is the ESCAPE project (CRU, 1992). This approach requires that the spatial pattern of the enhanced greenhouse signal remains constant with time, but the available model evidence suggests that this is a reasonable assumption to make (Mitchell et al., 1990; Gates et al., 1992).

### Annual scenarios of climate change

The scenarios for changes at the annual level are presented in Fig. 1. The temperature change for Albania is indicated to increase from south to north along the coast, and from the coast inland. Thus, in the southern coastal region the suggested change is 0.7-0.9°C per 1°C global warming (i.e. the warming will be less than the global level). Although further north along the Albanian coast the warming is shown to be greater (0.9-1.0°C per degree global warming), the indications are that it should not exceed the global rate of warming. In the extreme east of the country, however, temperature changes greater than the global level (i.e.above 1.0°C per 1°C global warming) are suggested.

For annual precipitation, the models show a reduction in the south of the country. However, the suggested amounts are small: less than 2% per 1°C global warming. Rainfall in the north of Albania shows an increase due to global warming.

### Seasonal scenarios of climate change

In the winter months of December, January and February (Fig. 2), the change in temperature due to global warming for Albania broadly reflects the annual pattern. Along the whole coastline the increase indicated by the models is less than the global increase, in the extreme south falling to below 0 8°C per degree global change. Inland, increases greater than the global level are shown, rising to above 1.2°C per degree global change in the extreme east. The spring pattern (March, April, May, shown in Fig. 3) is broadly the same as that seen in winter, except that there is a small area of warming along the coast which exceeds the global increase. Summer patterns are complex (Fig. 4) and, for the first time, we see an extensive area of warming along the coast which is greater than the global amount. This area is in the south; along the northern coast the pattern of warming less than the global level is preserved. The autumn pattern (Fig. 5, for September, October and November) is again similar to the annual pattern, although there are isolated areas along the coast where the warming is greater than the global amount.

Precipitation in winter (Fig. 2, lower map) shows an increase due to global warming over most of the country, apart from a small area centred on 41°N at the coast, where a reduction in precipitation is indicated. In spring (Fig. 3), the models indicate that rainfall should increase as a result of global warming over the whole of Albania. However, along the coast the increase is shown not to exceed 7% of present-day values, per 1°C global increase in temperature. The summer pattern is one of increased rainfall inland and along the southern coast, but with lower rainfall along the northern coast as a result of global warming. with a reduction in rainfall in the south of Albania, and an increase in the north. In autumn, the indicated precipitation changes closely follow the changes suggested by the models at the annual scale: higher rainfall for the northern half of the country as a result of global warming, whereas southern areas show a decrease.

Fig. 1 Regional climate scenarios for Albania annual Upper map shows change in temperature (°C per °C global change) and the lower map shows change in precipitation (% per °C global change)

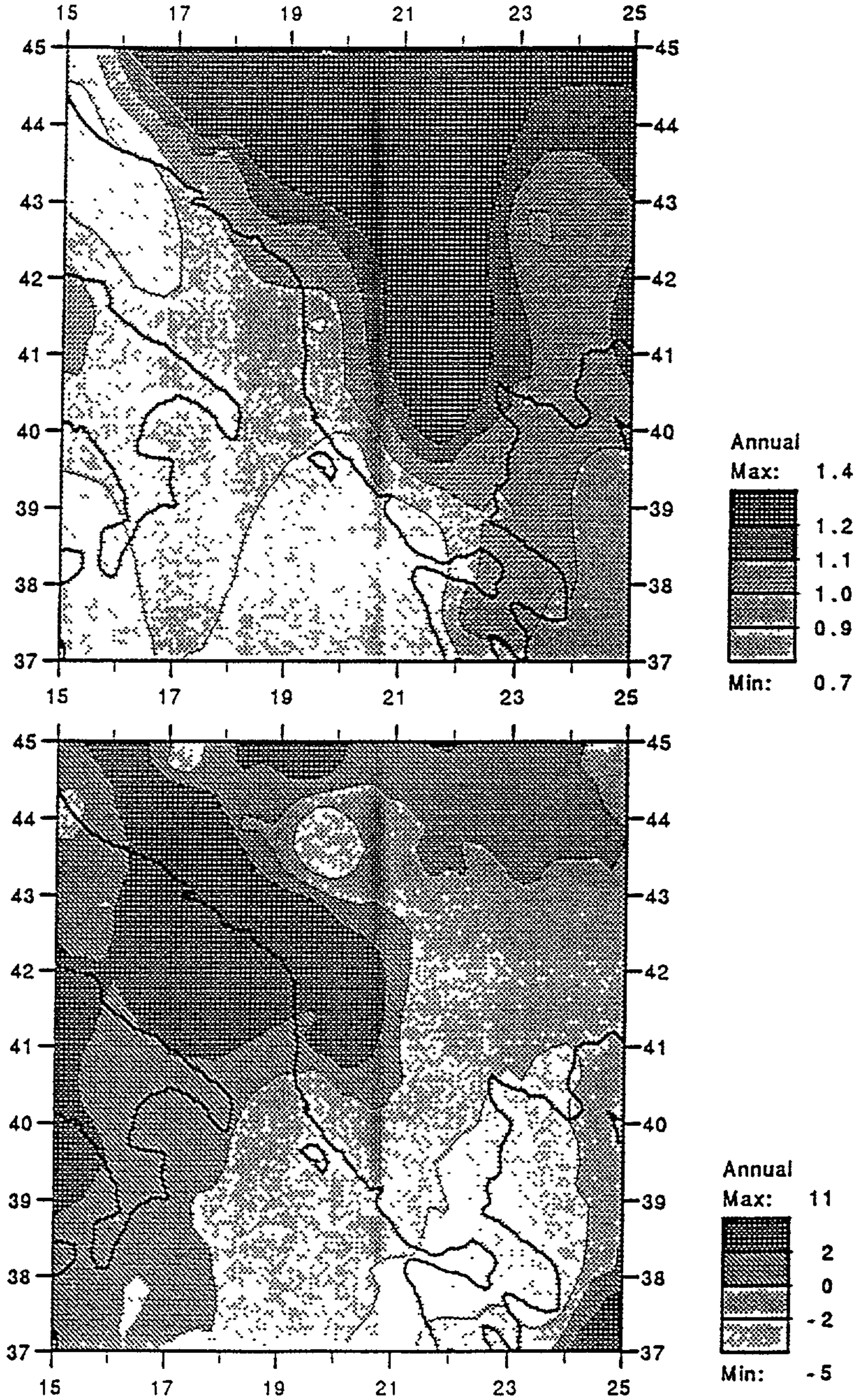


**Fig. 2** Regional climate scenarios for Albania: winter. Upper map shows change in temperature (°C per °C global change) and the lower map shows change in precipitation (% per °C global change)

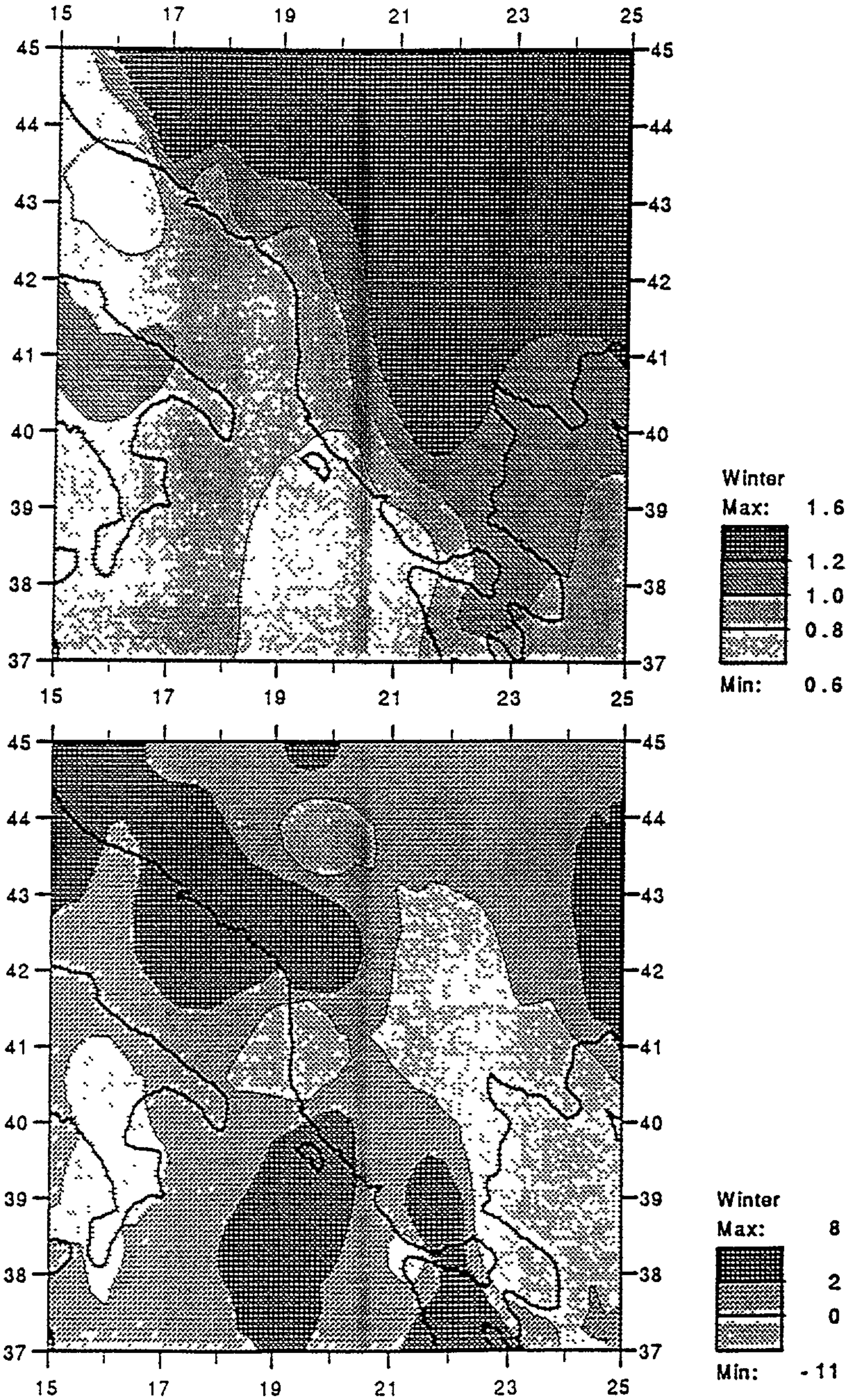


Fig. 3 Regional climate scenarios for Albania spring Upper map shows change in temperature (°C per °C global change) and the lower map shows change in precipitation (% per °C global change)

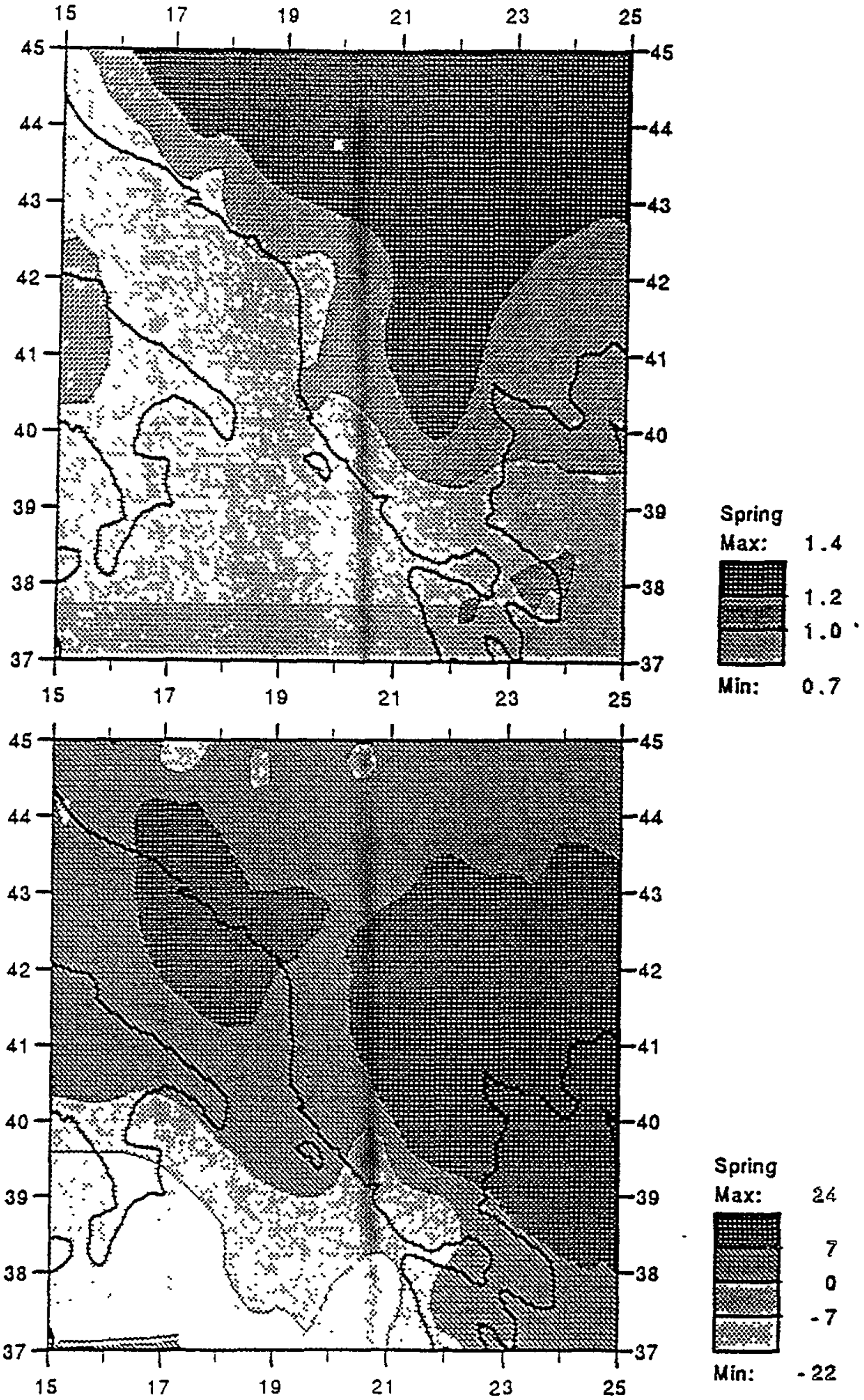


**Fig. 4** Regional climate scenarios for Albania summer Upper map shows change in temperature (°C per °C global change) and the lower map shows change in precipitation (% per °C global change)

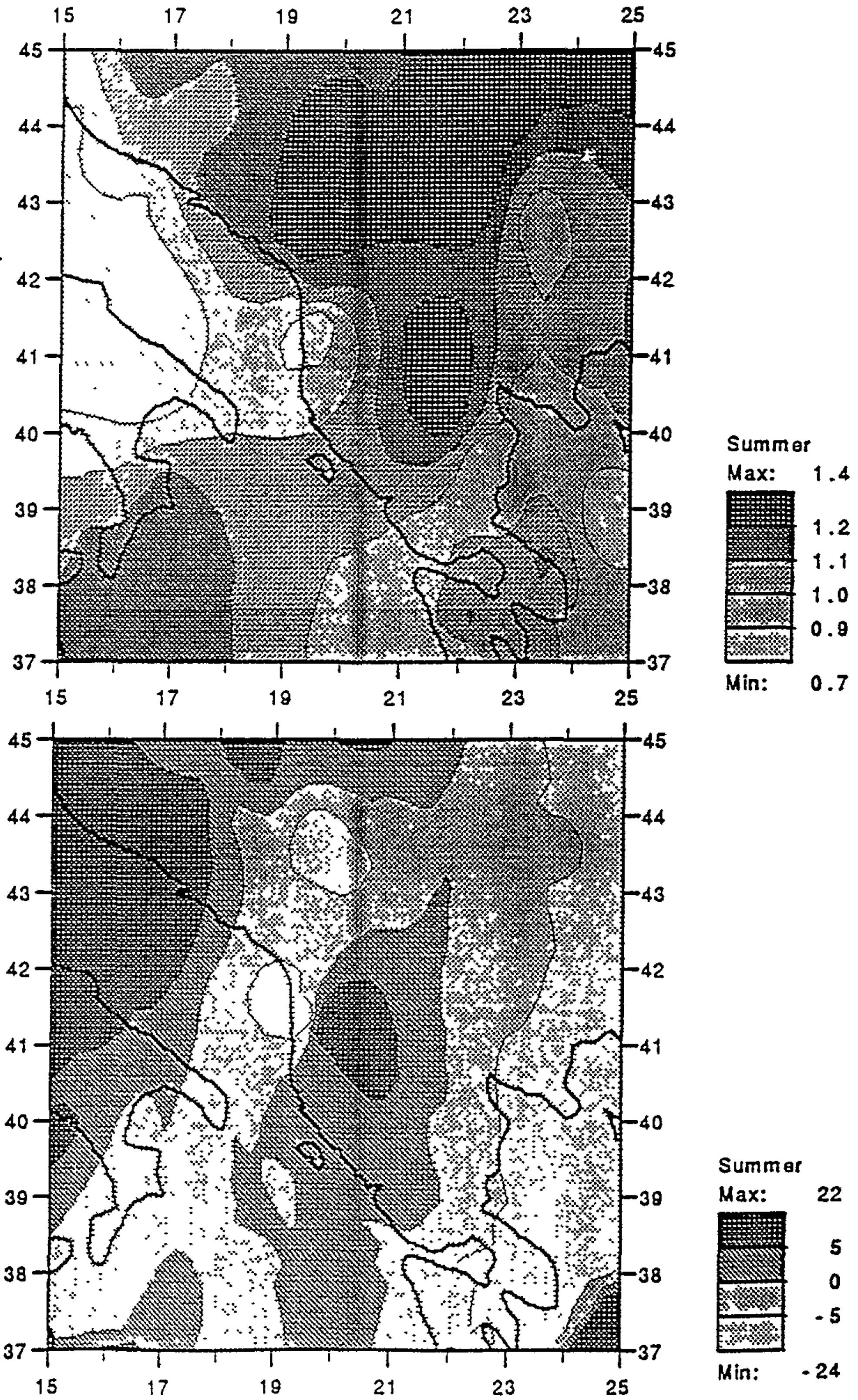
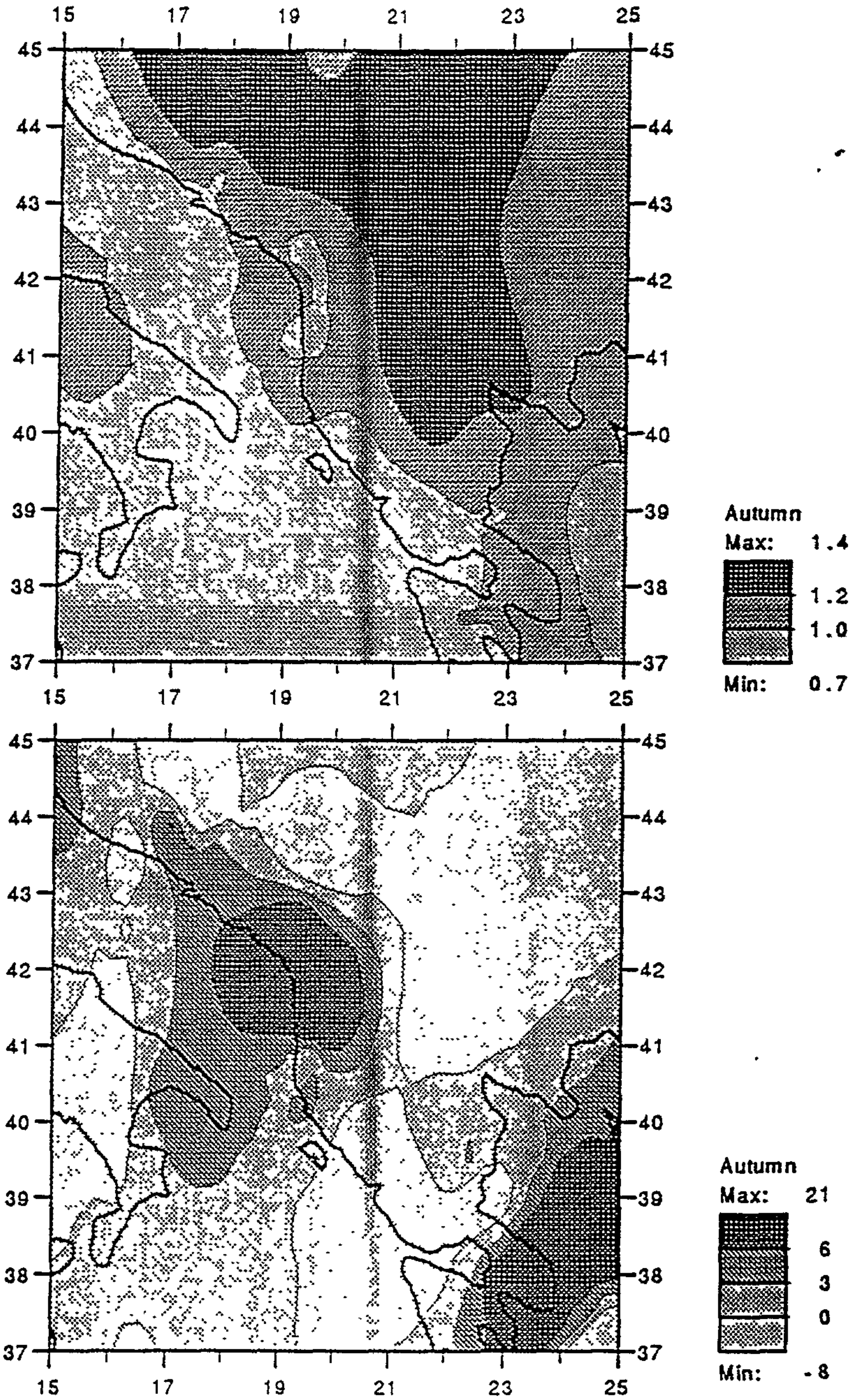


Fig. 5 Regional climate scenarios for Albania autumn Upper map shows change in temperature (°C per °C global change) and the lower map shows change in precipitation (% per °C global change)



## 4. CONCLUSIONS

We have applied the methods developed by Kim et al. (1984) and Wigley et al. (1990) to the problem of constructing sub-grid-scale climate change scenarios for Albania. Regression equations were developed to predict station temperature and precipitation anomalies from regionally-averaged climate anomalies. We proceeded to substitute GCM perturbed-run minus control-run values of temperature and precipitation in the regression equations to obtain a prediction of the change due to the greenhouse effect at each station. The results were scaled by the equilibrium global temperature change of each of the four GCMs, and an average change per °C global change obtained, calculated from the results for the four models. The procedure was repeated for every station in the data set, and the results contoured to produce scenarios for Albania.

Annual and seasonal scenarios for both temperature and precipitation change were produced. The scenario of annual temperature change shows an increase in the amount of change from south to north along the coast, and from the coast inland. Thus, in the southern coastal region the suggested annual change is 0.7-0.9°C per 1°C global warming (i.e. the warming will be less than the global level). Although further north along the Albanian coast the warming is shown to be greater (0.9-1.0°C per degree global warming), the indications are that it should not exceed the global rate of warming. In the extreme east of the country, however, temperature changes greater than the global level (i.e.above 1.0°C per 1°C global warming) are suggested. This annual pattern is reflected at the seasonal scale.

The scenarios for annual precipitation change indicate wetter conditions in the north of Albania as a result of global warming, and drier conditions in southern areas. The changes are quite small. At the seasonal level, this annual pattern is most clearly replicated in autumn. Precipitation in winter shows an increase due to global warming over most of the country, apart from a small area centred on 41°N at the coast, where a reduction in precipitation is indicated. In spring, the models indicate that rainfall should increase as a result of global warming over the whole of Albania. However, along the coast the increase is shown not to exceed 7% of present-day values, per 1°C global increase in temperature. The summer pattern is one of increased rainfall inland and along the southern coast, but with lower rainfall along the northern coast as a result of global warming. with a reduction in rainfall in the south of Albania, and an increase in the north.

The problems associated with the construction of regional scenarios of climate change due to the enhanced greenhouse effect are discussed at length by Palutikof et al. (1992), in their report to UNEP on the construction of climate change scenarios for the whole Mediterranean region. The confidence that we can place in sub-grid-scale scenarios of precipitation is particularly low. These scenarios should be considered only as indicators of changes that might occur.

## REFERENCES

Bretherton, , F.P , Bryan, K. and Woods, J.D., 1990: Time-dependent greenhouse-gas-induced climate change. In *Climate Change 1992: the Supplementary Report to the IPCC Scientific Assessment* (eds. J.T. Houghton, B.A. Callander and S.K. Varney), Cambridge University Press, 173-193.

Climatic Research Unit, 1992: *A Scientific Description of the ESCAPE Model.* Climatic Research Unit, Norwich, 126pp. (plus appendices).

Gates, W.L., Mitchell, J.F.B., Boer, G.J., Cubasch, U. and Meleshko, V.P., 1992: Climate modelling, climate prediction and model validation. In *Climate Change 1992: the Supplementary Report to the IPCC Scientific Assessment* (eds. J.T. Houghton, B.A. Callander and S.K. Varney), Cambridge University Press, 97-134.

Hansen, J.E., Lacis, A., Rind, D., Russell, L., Stone, P., Fung, I., Ruedy, R. and Lerner, J., 1984:: Climate sensitivity: analysis of feedback mechanisms. In: *Climate Processes and Climate Sensitivity.* (eds. J.E. Hansen and T. Takahashi), Geophysical Monograph 29, Maurice Ewing Vol. 5. American Geophysical Union, Washington, D.C., 130-163.

Kim, J.M., Chang, J.T., Baker, N.L., Wilks, D.S. and Gates, W.L., 1984: The statistical problem of climate inversion: determination of the relationship between local and large-scale climate. *Monthly Weather Review 112*, 2069-2077.

Leggett, J., Pepper, W.J. and Swart, R.J., 1992: Emissions scenarios for IPCC: an update. In *Climate Change 1992: the Supplementary Report to the IPCC Scientific Assessment* (eds. J.T. Houghton, B.A. Callander and S.K. Varney), Cambridge University Press, Cambridge, 69-95.

Mitchell, J.F.B., Manabe, S., Tokioka, T. and Meleshko, V., 1990: Equilibrium climate change - and its implications for the future. In *Climate Change: the IPCC Scientific Assessment.* (eds. J.T. Houghton, G.J. Jenkins and J.J. Ephraums), Cambridge University Press, Cambridge, 131-172.

Palutikof, J.P., Guo, X., Wigley, T.M.L. and Gregory, J.M., 1992: Regional changes in climate in the Mediterranean Basin due to global greenhouse warming. *MAP Technical Reports Series No. 66*, UNEP, Athens, 172pp.

Schlesinger, M.E. and Zhao, Z.-C, 1989: Seasonal climate changes induced by doubled $CO_2$ as simulated by the OSU atmospheric GCM/mixed-layer ocean model. *Journal of Climate 2*, 459-495.

Wetherald, R.T. and Manabe, S., 1986: An investigation of cloud cover change in response to thermal forcing. *Climatic Change 8*, 5-23.

Wigley, T.M.L. and Raper, S.C.B., 1992: Implications for climate and sea level of revised IPCC emissions scenarios. *Nature 357*, 293-300.

Wigley, T.M.L., Jones, P.D., Briffa, K.R. and Smith, G., 1990: Obtaining sub-grid-scale information from coarse-resolution General Circulation Model output. *Journal of Geophysical Research 95 (D2)*, 1943-1953.

Wilks, D.S., 1989: Statistical specification of local surface weather elements from large-scale information. *Theoretical and Applied Climatology 40*, 119-134

Wilson, C.A. and Mitchell, J.F.B., 1987: A doubled $CO_2$ climate sensitivity experiment with a global climate model including a simple ocean. *Journal of Geophysical Research 92(D11)*, 13315-13343.

## APPENDIX 1

## STATIONS USED IN SCENARIO CONSTRUCTION FOR ALBANIA

Note that not all these stations will necessarily be used in the final scenario construction. They must first fulfill the criteria for acceptance laid down in Section 2 of this report, and by Palutikof et al. (1992).

**ALBANIA**

| Station | E | N | HT | PRN | TEM | P% | T% |
|---|---|---|---|---|---|---|---|
| 1. SHKODRA | 19.5 | 42.1 | 28 | 1951-1988 | 1951-1988 | 100 | 100 |
| 2. TIRANA | 19.8 | 41.3 | 89 | 1951-1988 | 1951-1988 | 100 | 100 |
| 3. VLORA | 19.5 | 40.5 | 1 | 1951-1988 | 1951-1988 | 100 | 100 |
| 4. DURRES | 19.5 | 41.3 | 15 | 1951-1988 | 1951-1988 | 100 | 100 |
| 5. FIER | 19.5 | 40.7 | 12 | 1951-1988 | 1951-1988 | 100 | 100 |

**BULGARIA**

| Station | E | N | HT | PRN | TEM | P% | T% |
|---|---|---|---|---|---|---|---|
| 6. VRATZA | 23.5 | 43.2 | 360 | 1951-1970 | 1951-1970 | 92 | 92 |
| 7. LOM | 23.2 | 43.8 | 33 | 1961-1989 | 1961-1979 | 43 | 41 |
| 8. PLEVEN | 24.6 | 43.4 | 75 | 1951-1970 | 1951-1970 | 92 | 92 |
| 9. KOLAROVGRAD | 26.9 | 43.3 | 198 | 1951-1971 | 1951-1971 | 89 | 90 |
| 10. VARNA | 27.9 | 43.2 | 41 | 1961-1989 | 1961-1979 | 44 | 39 |
| 11. SOFIA | 23.3 | 42.7 | 564 | 1951-1989 | 1951-1979 | 67 | 72 |
| 12. PLOVDIV | 24.8 | 42.2 | 160 | 1951-1970 | 1951-1970 | 92 | 92 |
| 13. BOURGAS | 27.5 | 42.5 | 28 | 1951-1989 | 1951-1979 | 63 | 70 |

**GREECE**

| Station | E | N | HT | PRN | TEM | P% | T% |
|---|---|---|---|---|---|---|---|
| 14. KERKYRA | 19.9 | 39.6 | 2 | 1955-1987 | 1951-1988 | 100 | 96 |
| 15. YANENA | 20.7 | 39.6 | -999 | 1956-1987 | - | 100 | 0 |
| 16. AGRINION | 21.7 | 38.6 | 47 | 1956-1987 | - | 99 | 0 |
| 17. ARAXOS | 21.4 | 38.2 | 23 | 1955-1987 | 1951-1970 | 100 | 100 |
| 18. ZAKYNTHOS | 20.9 | 37.8 | 8 | 1956-1982 | 1951-1982 | 89 | 79 |
| 19. KOZANI | 21.8 | 40.3 | 627 | 1955-1987 | 1955-1987 | 100 | 100 |
| 20. MIKRA | 23.0 | 40.5 | 61 | 1951-1989 | 1951-1987 | 96 | 100 |
| 21. LARISSA | 22.4 | 39.6 | 74 | 1955-1987 | 1951-1987 | 100 | 100 |
| 22. AGXIALO | 22.8 | 39.0 | -999 | 1956-1987 | 1956-1987 | 100 | 100 |
| 23. TRIPOLIS | 22.2 | 37.6 | 660 | 1957-1987 | 1957-1987 | 100 | 100 |
| 24. KALAMATA | 22.1 | 37.0 | 5 | 1951-1989 | 1951-1988 | 92 | 95 |
| 25. METHONI | 21.7 | 36.8 | 34 | 1951-1987 | 1951-1987 | 100 | 99 |
| 26. TANAGRA | 23.5 | 38.3 | -999 | 1957-1986 | 1957-1986 | 99 | 99 |
| 27. ATHENS | 23.7 | 38.0 | 107 | 1951-1986 | 1951-1988 | 100 | 97 |
| 28. HELLENIKON | 23.7 | 37.9 | 10 | 1951-1989 | 1951-1987 | 97 | 100 |
| 29. KYTUIRA | 23.0 | 36.2 | -999 | 1955-1987 | 1955-1987 | 100 | 100 |
| 30. SKYROS | 24.6 | 38.9 | 5 | 1955-1987 | 1955-1987 | 100 | 100 |
| 31. MILOS | 24.5 | 36.7 | -999 | 1955-1987 | 1955-1987 | 99 | 99 |
| 32. ALEXANDROUPOLI | 25.8 | 40.9 | 3 | 1951-1987 | 1951-1987 | 100 | 100 |
| 33. MITILIA | 26.4 | 39.2 | -999 | 1955-1987 | 1955-1987 | 100 | 100 |
| 34. NAXOS | 25.5 | 37.1 | 9 | 1955-1987 | 1955-1987 | 100 | 100 |
| 35. SOUDA | 24.1 | 35.6 | 161 | 1958-1986 | 1958-1986 | 97 | 97 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 36. ANOGIA | 24.9 | 35.3 | -999 | 1951-1985 | - | 96 | 0 |
| 37. HIRAKLION | 25.2 | 35.3 | 48 | 1955-1986 | 1951-1988 | 100 | 97 |
| 38. IERPETRA | 25.8 | 35.0 | -999 | 1956-1987 | 1956-1987 | 99 | 99 |
| 39. SITIA | 26.1 | 35.2 | 28 | 1951-1985 | - | 87 | 0 |
| 40. KARPATHOS | 27.2 | 35.5 | 20 | 1971-1988 | 1971-1988 | 95 | 95 |
| 41. RHODES | 28.1 | 36.4 | 12 | 1955-1988 | 1955-1988 | 99 | 100 |

**ITALY**

| Station | E | N | HT | PRN | TEM | P% | T% |
|---|---|---|---|---|---|---|---|
| 42. TRENTO | 11.1 | 46.1 | 312 | 1951-1976 | - | 100 | 0 |
| 43. UDINE | 13.2 | 46.0 | 92 | 1967-1989 | 1967-1980 | 93 | 95 |
| 44. VERONA | 10.9 | 45.4 | 67 | 1961-1989 | 1961-1985 | 98 | 100 |
| 45. PADUA | 12.0 | 45.4 | 13 | 1951-1974 | - | 100 | 0 |
| 46. VENEZIA | 12.4 | 45.4 | 17 | 1951-1989 | 1951-1988 | 98 | 100 |
| 47. TRIESTE | 13.8 | 45.7 | 20 | 1951-1989 | 1951-1988 | 98 | 100 |
| 48. PARMA | 10.3 | 44.8 | 56 | 1951-1977 | 1951-1976 | 100 | 100 |
| 49. PISA | 10.4 | 43.7 | 2 | 1961-1989 | 1961-1980 | 97 | 100 |
| 50. FLORENCE | 11.3 | 43.8 | 75 | 1951-1977 | 1951-1970 | 100 | 100 |
| 51. ANCONA | 13.5 | 43.6 | 104 | 1951-1978 | 1951-1978 | 98 | 98 |
| 52. PESCARA | 14.2 | 42.4 | 9 | 1961-1989 | 1961-1980 | 97 | 100 |
| 53. ROME | 12.2 | 41.8 | 2 | 1951-1989 | 1951-1988 | 98 | 99 |
| 54. NAPOLI | 14.3 | 40.9 | 88 | 1961-1987 | 1961-1987 | 99 | 99 |
| 55. BRINDISI | 18.0 | 40.7 | 15 | 1961-1989 | 1961-1980 | 98 | 100 |
| 56. MARINA | 16.9 | 40.4 | 12 | 1967-1989 | 1967-1980 | 96 | 95 |
| 57. MESSINA | 15.6 | 38.2 | 51 | 1961-1989 | 1961-1980 | 98 | 100 |
| 58. TRAPANI | 12.5 | 37.9 | 79 | 1961-1989 | 1961-1980 | 98 | 100 |
| 59. CATANIA | 15.1 | 37.5 | 65 | 1961-1987 | 1961-1987 | 98 | 99 |
| 60. AVEZZANO | 13.6 | 42.0 | -999 | 1951-1970 | - | 100 | 0 |
| 61. BOLZANO | 11.3 | 46.5 | 241 | 1961-1985 | 1961-1985 | 99 | 100 |
| 62. GROSSETO | 11.1 | 42.8 | 5 | 1961-1985 | 1961-1985 | 99 | 100 |
| 63. PERUGIA | 12.5 | 43.1 | 208 | - | 1967-1985 | 0 | 97 |
| 64. FALCONARA | 13.4 | 43.6 | 12 | - | 1961-1985 | 0 | 96 |
| 65. CAMPOBASSO | 14.7 | 41.6 | 793 | 1961-1985 | 1961-1985 | 99 | 100 |
| 66. BARI | 16.8 | 41.1 | 34 | - | 1961-1985 | 0 | 99 |
| 67. POTENZA | 15.8 | 40.6 | 823 | 1961-1985 | 1961-1973 | 99 | 96 |
| 68. CROTONE | 17.1 | 39.0 | 155 | - | 1961-1985 | 0 | 100 |
| 69. PALERMO | 13.1 | 38.2 | 21 | - | 1961-1985 | 0 | 100 |

**LIBYA**

| Station | E | N | HT | PRN | TEM | P% | T% |
|---|---|---|---|---|---|---|---|
| 70. ZUARA | 12.1 | 32.9 | 3 | 1951-1988 | 1954-1988 | 98 | 72 |
| 71. GHARIAN | 13.0 | 32.2 | -999 | 1951-1988 | - | 96 | 0 |
| 72. HOMS | 14.2 | 32.6 | -999 | 1951-1989 | - | 92 | 0 |
| 73. TRIPOLI | 13.2 | 32.7 | 84 | 1951-1989 | 1951-1988 | 90 | 91 |
| 74. MISURATA | 15.1 | 32.4 | 6 | 1951-1988 | 1954-1988 | 100 | 95 |
| 75. TUMMINA | 15.1 | 32.2 | -999 | 1951-1989 | - | 36 | 0 |
| 76. BENINA | 20.3 | 32.1 | 132 | 1951-1989 | 1951-1988 | 85 | 88 |
| 77. BENGHAZI | 20.0 | 32.1 | 10 | 1951-1973 | - | 100 | 0 |
| 78. SHAHAT | 21.9 | 32.8 | 625 | 1951-1988 | - | 98 | 0 |
| 79. DERNA | 22.6 | 32.7 | 9 | 1951-1988 | 1951-1988 | 31 | 56 |
| 80. TOBRUQ | 24.0 | 32.1 | 14 | 1951-1973 | - | 100 | 0 |

MALTA

| Station | E | N | HT | PRN | TEM | P% | T% |
|---|---|---|---|---|---|---|---|
| 81. LUQA | 14.5 | 35.9 | 80 | 1951-1989 | 1951-1988 | 96 | 99 |

RUMANIA

| Station | E | N | HT | PRN | TEM | P% | T% |
|---|---|---|---|---|---|---|---|
| 82. ORADEA | 21.9 | 47.1 | 135 | 1951-1970 | 1951-1970 | 100 | 99 |
| 83. BISTRITA | 24.5 | 47.1 | 366 | 1951-1988 | 1951-1980 | 98 | 99 |
| 84. IASI | 27.6 | 47.2 | 103 | 1951-1988 | 1951-1980 | 98 | 99 |
| 85. CLUJ | 23.7 | 46.8 | 415 | 1951-1988 | 1951-1980 | 98 | 99 |
| 86. TIMISOARA | 21.3 | 45.8 | 91 | 1951-1988 | 1951-1980 | 98 | 99 |
| 87. SIBIU | 24.3 | 45.8 | 452 | 1951-1988 | 1951-1980 | 98 | 99 |
| 88. SULINA | 29.7 | 45.2 | 9 | 1951-1988 | 1951-1980 | 98 | 99 |
| 89. BANEASA | 26.1 | 44.5 | 92 | 1951-1984 | 1951-1980 | 78 | 76 |
| 90. FILARET | 26.1 | 44.4 | 82 | 1951-1988 | 1951-1980 | 74 | 85 |
| 91. CONSTANTA | 28.7 | 44.2 | 32 | 1951-1970 | 1951-1970 | 100 | 100 |

TUNISIA

| Station | E | N | HT | PRN | TEM | P% | T% |
|---|---|---|---|---|---|---|---|
| 92. TUNIS | 10.2 | 36.8 | 3 | 1951-1988 | 1951-1988 | 100 | 97 |
| 93. KAIROUAN | 10.1 | 35.7 | 60 | 1951-1988 | 1964-1974 | 100 | 95 |
| 94. SFAX | 10.7 | 34.7 | 21 | 1951-1988 | - | 100 | 0 |
| 95. GABES | 10.1 | 33.9 | 4 | 1951-1988 | 1951-1974 | 100 | 95 |
| 96. DJERBA | 10.6 | 33.8 | 0 | 1951-1988 | - | 100 | 0 |
| 97. MEDENINE | 10.3 | 33.3 | 117 | 1951-1972 | - | 100 | 0 |

TURKEY

| Station | E | N | HT | PRN | TEM | P% | T% |
|---|---|---|---|---|---|---|---|
| 98. EDIRNE | 26.6 | 41.7 | 48 | 1929-1989 | 1929-1988 | 96 | 98 |
| 99. CANAKKALE | 26.4 | 40.1 | 3 | 1951-1989 | 1951-1988 | 96 | 98 |
| 0. IZMIR | 27.3 | 38.4 | 25 | 1929-1989 | 1929-1988 | 97 | 98 |
| 1. MUGLA | 28.4 | 37.2 | 646 | 1951-1989 | 1951-1988 | 94 | 96 |
| 2. ISTANBUL | 29.1 | 41.0 | 40 | 1929-1989 | 1912-1988 | 98 | 99 |
| 3. BURSA | 29.1 | 40.2 | 100 | 1951-1989 | 1951-1980 | 95 | 97 |

FORMER YUGOSLAVIA

| Station | E | N | HT | PRN | TEM | P% | T% |
|---|---|---|---|---|---|---|---|
| 4. PULA | 13.9 | 44.9 | 30 | 1951-1980 | 1951-1980 | 100 | 100 |
| 5. ZADAR | 15.2 | 44.1 | 1 | 1951-1980 | 1951-1980 | 100 | 100 |
| 6. HVAR | 16.4 | 43.2 | 20 | 1951-1980 | 1951-1980 | 100 | 100 |
| 7. VARAZDIN | 16.4 | 46.3 | 169 | 1951-1980 | 1951-1980 | 100 | 100 |
| 8. DARUVAR | 17.2 | 45.6 | 161 | 1951-1980 | 1951-1980 | 100 | 100 |
| 9. BANJA-LUKA | 17.2 | 44.8 | 160 | 1951-1980 | 1951-1980 | 100 | 100 |
| 10. BUGOJNO | 17.5 | 44.1 | 562 | 1951-1980 | 1951-1980 | 100 | 100 |
| 11. MOSTAR | 17.8 | 43.4 | 99 | 1951-1980 | 1951-1980 | 100 | 100 |
| 12. TUZLA | 18.7 | 44.6 | 305 | 1951-1980 | 1951-1980 | 100 | 100 |
| 13. SREMSKA | 19.6 | 45.0 | 81 | 1951-1980 | 1951-1980 | 100 | 100 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 14. | ZRENJANIN | 20.4 | 45.4 | 82 | 1951-1980 | 1951-1980 | 100 | 100 |
| 15. | ZLATIBOR | 19.7 | 43.7 | 1029 | 1951-1980 | 1951-1980 | 100 | 100 |
| 16. | ULCINJ | 19.2 | 41.9 | 30 | 1951-1980 | 1951-1980 | 100 | 100 |
| 17. | NIS | 21.9 | 43.3 | 196 | 1951-1980 | 1951-1980 | 100 | 100 |
| 18. | PRILEP | 21.6 | 41.3 | 661 | 1951-1980 | 1951-1980 | 100 | 100 |
| 19. | ZAGREB | 16.0 | 45.8 | 163 | 1951-1989 | 1951-1988 | 98 | 99 |
| 20. | SISAK | 16.4 | 45.5 | 98 | 1951-1970 | 1951-1970 | 100 | 100 |
| 21. | BEOGRAD | 20.5 | 44.8 | 132 | 1951-1989 | 1951-1988 | 98 | 97 |
| 22. | SPLIT | 16.4 | 43.5 | 129 | 1951-1989 | 1951-1988 | 98 | 99 |
| 23. | LIVNO | 17.0 | 43.8 | 730 | 1951-1970 | 1951-1970 | 100 | 100 |
| 24. | SARAJEVO | 18.4 | 43.9 | 637 | 1951-1989 | 1951-1988 | 97 | 99 |
| 25. | TITOGRAD* | 19.3 | 42.4 | 33 | 1951-1989 | 1951-1988 | 97 | 98 |
| 26. | SKOPJE | 21.5 | 42.0 | 240 | 1951-1989 | 1951-1988 | 97 | 98 |

**E** - latitude
**N** - longitude
**HT** - height above sea level (m)
**PRN** - length of precipitation record
**TEM** - length of temperature record
**P%** - percentage of precipitation record present
**T%** - percentage of temperature record present

* now renamed PODGORICA

# Annex II

## List of endemic, rare and endangered species on the Coastal Area of Albania

Plant species

- Quercus robur
- Capparis marina
- Ephedra distachya
- Juniperus comunis
- Laurus nobilis
- Lotus cytisoides
- Matthiola tricuspidata
- Pancriatum maritimum
- Quercus ilex
- Salvia officinalis
- Sarcopoterium spinosum
- Viburnum tinus
- Aster albanicus subsp.paparistoi endemic
- Brassica incana
- Colchicum cupanii
- Crocus boryi
- Daphne gnidium
- Euphorbia dendroides
- Leucojum valentinum subsp.vlorense endemic
- Limonium anfractum Micromeria myrtifolia
- Orchis albanica endemic
- Petteria ramentacea
- Sinapis pubescens
- Stachys decumbens
- Teucrium fruticans

ANIMALS/VERTEBRATES
MAMMALS

- Capreolus capreolus
- Bos primigenius ( living in the wild,Divjaka )
- Lutra lutra
- Martes foina
- Meles meles
- Canisaureus
- Vulpes vulpes
- Mustela nivalis
- Myotis myotis
- Myotis blythi
- Nyctalus noctula
- Nyctalus leisleri
- Eptesicus serotinus
- Pipistrellus pipistrellus
- Pipistrellus nathusii
- Pipistrellus kuhli
- Plecotus austriacus
- Plecotus auritus

BIRDS

Pelecanus crispus
Plegadis falcinellus
Platalea leucorodia
Ardeola ralloides
Ardea purpurea
Nycticorax nycticorax
Cygnus cygnus
Cygnus olor
Anser albifrons
Anser anser
Branta ruficollis
Anser erythropus
Anser fabalis
Anas querquedula
Netta rufina
Mergus merganser
Mergus albellus
Oxyura leucocephala
Marmaroneta angustirostris
Milvus milvus
Milvus migrans
Haliaeetus albicilla
Aquila clanga
Aquila pomarina
Buteo lagopus
Falcoperegrinus
Falco naumani
Crex crex
Porzana pusilla
Charadrius hiaticula
Calidris alba
Scolopax rusticola
Tringa ochropus Tringa nebularia
Arenaria interpres
Tringa erythropus
Larus fuscus
Larus melanocephalus
Larus audouinii
Larus minutus
Sterna caspia

REPTILES

Emys orbicularias
Clemys caspica
Testudo hermani
Ophiosaurus apodus
Coluber jugularis
Elaphe quatuorlineata
Erix jaculus

AMPHIBIANS

Rana balcanica
Rana lessone
Rana dalmatina
Bombina variegata scabra
Bufo b . spinosus
Bufo v . viridis
Hula a . arborea
Triturus cristatus carnifex
Triturus vulgaris graceus
Salamandra s . salamandra

## LIST OF PROTECTED AREAS AND THEIR STATUS

| Zone name | | Present status | Proposed status |
|---|---|---|---|
| **A.** | **MARINE ZONES** | | |
| 1. | Peninsula of Karaburun and Sazan Island | | |
| 2. | Porto-Palermo | | SPA |
| **B.** | **COASTAL ZONES** | | |
| 3. | Bay and Lake of Butrinti, River Pavla | | SPA |
| 4. | Mouth of Buna (S. Josef) and Vilipoja Lagoon | Hunting Reserve Cat. A | SPA |
| 5. | Divjaka-Karavasta and mouths of Shkumbini and Semani | National Park and Hunting Reserve Cat. B RAMSAR SITI | SPA Cat. II (in future biosphere reserve) |
| 6. | Narta Lagoon Pishe-Poro Forest Mouth of Vjosa | Hunting Reserve Cat. A and B | SPA 10CN 6th Cat. Differential areas have to be spotted. |
| 7. | Kune-Vain, Lagoons of Lezha, Mouth of Drini | Hunting Reserve Cat. A and B | SPA |
| 8. | Patok Lagoon, Mouth of Mati and Fushe-Kuqe | Hunting Reserve Cat. A | SPA |
| 9. | Mouth of Erzeni (Rrushkull-Rrotull, Ishmi Forest) | Hunting Reserve Cat. A IUCN 4th Cat. | SPA IUCN 6th Cat. |
| 10. | Lagjit Cape (Turra Castle) | - | IUCN 5th Cat. |
| 11. | Orikumi Lagoon | - | IUCN 5th Cat. |

# Annex III

## Species after the vegetation flats

### i) Eu-mediterranean evergreen forest
(up to 350 m a.s.l.)

The principal species are: Holly Oak (Quercus ilex L.), Cermes oak (Quercus coccifera L.), Strawberry (Arbutus unedo L.), Mastich (Distacia lentiscus L.), Mack-privet (Pillyrea media L.), Olive (Olea europaea L.), Orange (Citrus aurantium L.), Erica L. Sp, Cistus L. Sp, Sweetbal (Laurus nobilis L.), Largefruited juniper (Juniperus macrocarpa S.), Aleppo pine (Pinus halepensis Mill), Stone pine (Pinus pinea L.), Seaside pine (Pinus pinaster Sol.), Roman cypress (Cupressus semprervirens L.), Myrtle (Myrtus communis L.), Privet (Ligustrum vulgare L.), Smilax (Smilax aspera L.), Ivy (Hedera helix L.), Travellers jay (Clematis vitalba L.), Sumac (Cotinus Coggygria Scop), Spanish broom (Spartium junceum L ), Hornbeam of orient (Carpinus orientalis L.), Thorn (Crataegus L. Sp), Common Judas (Cersis siliquastrum L.), Blackthorn (Prunus spinosa L.), Common oak (Quercus robur L.), Ash (Fraxinus L. Sp.), White poplar (Populus alba L.), Common dog wood (Cornus sanguinea L.), Bladder senna (Colutea arborescens L.), Common elm (Ulmus foliacea Gilib.), Walnut (Juglans regia L.), Common alder (Alnus glutinosa L.), Tamarisk (Tamarix L. Sp), Acacia saligna, Salix viminalis (13, 23, 25, 26, 33, 36).

### ii) Deciduous forest with Cermes oak
(up to 550 m a.s.l.)

The following species might be found: Cermes oak (*Quercus coccifera L.*), Olive O*leaeuropaea L.*), Sweetbal (*Laurs nobilis L.*), *Quercus aegilops L.*, Macedonian oak (*Q. trojana Webb*), Pubescent oak (*Q. pubuscens Willd*), Turkey oak (*Q. cerris L.*), Common oak (*Q. robur L.*), Hornbeam of orient (*Carpinus orientalis L.*), Hophornbeam (*Ostrya carpinifolia Scop.*), Maples (*Acer L. Sp.*), Flowering ash (*Fraxinus ornus L.*), Common elm (*Ulmus foliacea Gilib.*), Terepentine (*Pistacia terebinthus L.*), Christ's thorn (*Paliurus spina Christi Mill*), Almond (*Amygdalus L. Sp.*), Pear (*Pyrus L. Sp.*) Cornel (*Cornus L. Sp.*), Rose (*Rosa L. Sp.*), Berry (*Robus L. Sp.*), Common Judas (*Cersis siliquastrum L.*), White poplar (*Populus alba L.*), Common alder (*Alnus glutinosa L.*), Oriental plane (*Platanus orientalis L.*), *Eucalyptus camaldulensis Desf, Salix viminalis* (13, 23, 25, 26, 33,36)

### iii) Deciduous forests
(from 150 to 1250 m a.s.l.)

Among species one might distinguish: *Quercus aegilops,* Pubescent oak (*Q. pubescens Willd*), Hungarian oak (*Q. fraineto Ten.*), Turkey oak (*Q. cerris L.),* Chestnut oak (*Q. petrea Liebl*), Macedonian oak (*Q. cerris L.*), Hornbean of orient (*Carpinus orientalis Mill*), Hop-hornbeam (*Ostrya carpinifolia Scop.*), Ash (*Fraxinus L. Sp.*), Spring maple (*Acer obtusatum Waldst et Kit.*), Norway maple (*Acer platanoides L.*), Tartarian maple (*Acer tataricum L.*), Elm (*Ulmus L. Sp.*), Privet (*Ligustrum vulgare L.*), Box (*Buxus sempervirens L.*), Black pine (*Pinus nigra Arn.*), Silver fir (*Abies alba Mill*), Berry (*Rrubus L. Sp.*), Traveller's jay (*Clematis vitalba L.*), Cermes oak (*Q. coccifera L.*) on the lowest places forms underforest, Holly (*Ilex aquifolium L.*), Dogrose (*Rosa canina L.*), Common yew (*Taxus baccate L.*), European forsythia (*Forsythia europaea Deg. et Bould*), Black locust (*Robinia pseudoacacia L.*), Salix incana Schrank, Plum (*Prunus domestica L.*), Holly oak (*Quercus ilex L.*), Prickly cedar (*Juniperus oxycedrus L.*), Bladder Senna (*Colutea arborescena L.*), Shop-sage (*Salva officinalis L.*), Sage (*Phlomis fruticosa L.*), Garland flower (*Daphne cneorum L.*), Goats leave (*Lonicera caprifolium L.*), *Siderites raeseri Boiss et Held, etc.* (13, 23, 25, 26, 33, 36).

**iv) Silver fir**
(1250 - 1850 m a.s.l.)

It consists of the following species: Silver fir (*Abies alba Mill*), Black pine (*Pinus nigra Arn.*), Box (*Buxus sempervirens L.*), Holly (*Ilex aquifolium L.*), Dogrose (*Rosa canina L.*), Common yew (*Taxus baccata L.*), Hop-hornbeam (*Ostrya cartpinifolia Scop.*), European forsythia (*Forsythia european Deg. et Bould.*), Shop-sage (*Salvia officinalis L.*), Maple (*Acer L. Sp.*), Garland flow (*Daphne cneorum L.*), Goats leave (*Lonicera coprifolium L.*), *etc.* (13, 23, 25, 26, 33, 36)

**v) The mediterranean alpine vegetation**
(1850 - 2045 m a.s.l. )

It consists principally of graminaceae, leguminoseae and compositeae, Marjaram (Origanum vulgare L.), Chincoma officinalis L., Tutsan (Lavandula angustifolia Mill), Meadow saffran (Colchicum autumnale L.), Siderites raeseri Boiss et Helder, Sesleria (Sesleria Scop Sp), Andropogon L. Sp., etc. (13)

# Annex IV

## Table I
## Forests and vegetation flats after the altitude

| Districts<br>Forest unit | Vegetation flat | Altitude | | |
|---|---|---|---|---|
| | | 1975 | 2030 | 2100 |
| **1. IONIAN COAST** | | up to 2045 | up to 2045 | up to 2045 |
| **1.1 Saranda** | | up to 1400 | up to 1400 | up to 1400 |
| 1.1.1 Forest of Mile-Stillo | Eu-Mediterranean evergreen forests | | | |
| | Deciduous forests with cermes oak | 350-550 | 500-700 | 700-800 |
| | Deciduous forests | 550-800 | 700-800 | - |
| 1.1.2 Forest of Bregdet | Eu-Mediterranean evergreen forests | up to 350 | up to 500 | up to 700 |
| | Deciduous forests with cermes oak | 350-550 | 500-700 | 700-900 |
| | Silver fir and Black pine forests | 1250-1400 | - | - |
| **1.2 Vlora** | | up to 2045 | up to 2045 | up to 2045 |
| 1.2.1 Forests of Gjomollë | Eu-Mediterranean evergreen forests | up to 250 | up to 400 | up to 650 |
| | Deciduous forests with cermes oak | 250-450 | 400-600 | 650-850 |
| | Deciduous forests | 450-1200 | 600-1200 | 850-1200 |
| 1.2.2 Forest of Mali I Cikës-Himara | Eu-Mediterranean evergreen forests | up to 250 | up to 400 | up to 650 |
| | Deciduous forests with cermes oak | 250-400 | 400-600 | 650-850 |
| | Deciduous forests | 450-1250 | 600-1400 | 850-1650 |
| | Silver fir and Black pine forests | 1250-1850 | 1400-2000 | 1650-2045 |
| | Mediterranean alpine pastures | 1850-2000 | 2000-2045 | - |
| 1.2.3 Forest Ara e detit Palasë | Eu-Mediterranean evergreen forests | up to 250 | up to 400 | up to 650 |
| | Deciduous forests with cermes oak | 250-450 | 400-600 | 650-850 |
| | Deciduous forests | 450-1250 | 600-1350 | 850-1350 |
| | Silver fir and Black pine forests | 1250-1350 | - | - |
| **2. ADRIATIC COAST** | | up to 1464 | up to 1464 | up to 1464 |
| **2.1. Vlora** | | up to 1464 | up to 1464 | up to 1464 |
| 2.1.1 Forest of Brinjët e fushës Karaburunit | Eu-Mediterranean evergreen forests | up to 250 | up to 400 | up to 650 |
| | Deciduous forest with cermes oak | 250-450 | 400-600 | 650-850 |
| | Deciduous forests | 450-1250 | 600-1350 | 850-1350 |
| | Silver fir and Black pine forests | 1250-1350 | - | - |
| 2.1.2 Forests of Ilogara | Deciduous forests with cermes oak | - | - | 655-850 |
| | Deciduous forests | 655-1250 | 655-1400 | 850-1464 |
| | Silver fir and Black pine forests | 1250-1464 | 1400-1464 | - |

| Districts Forest unit | Vegetation flat | Altitude | | |
|---|---|---|---|---|
| | | 1975 | 2030 | 2100 |
| 2.1.3 Forest Tragjas-Shengjergj | Eu-Mediterranean evergreen forests | 90-250 | up to 400 | up to 650 |
| | Deciduous forests with cermes oak | 250-450 | 400-600 | 650-850 |
| | Dediduous forests | 450-1000 | 600-1000 | 850-1000 |
| 2.1.4 Forest Kumet-Shashice | Eu-Mediterranean evergreen forests | up to 250 | up to 400 | up to 650 |
| | Deciduous forests with cermes oak | 230-450 | 400-600 | 650-700 |
| | Deciduous forests | 450-700 | 600-700 | - |
| 2.1.5 Forest of Pish Poro | Eu-Mediterranean evergreen forests | up to 7 | up to 7 | up to 7 |
| 2.1.6 Forest of Ara e L. Vjosës | Eu-Mediterranean evergreen forests | up to 5 | up to 5 | up to 5 |
| **2.2 Fieri** | | up to 7 | up to 7 | up to 7 |
| 2.2.1 Forest of Pishë | Eu-Mediterranean evergreen forests | 2-5 | 2-5 | 2-5 |
| 2.2.2 Forest of Bregdeti Pishë Poro | Eu-Mediterranean evergreen forests | up to 2 | up to 2 | up to 2 |
| 2.2.3 Forest of Bregdet Ndernenas | Eu-Mediterranean evergreen forests | up to 7 | up to 7 | up to 7 |
| **2.3 Lushnja** | | up to 190 | up to 190 | up to 190 |
| 2.3.1 Forest of Gradisht-Gjeneruk | Eu-Mediterranean evergreen forests | 20-50 | 20-50 | 20-50 |
| | Deciduous forests with cermes oak | 50-190 | 50-190 | 50-190 |
| 2.3.2 Forest of Fusha e Divjakës | Eu-Mediterranean evergreen forests | to 6 | to 6 | to 6 |
| 3.3.3 Forest of Argjinatura e Shkumbinit | Eu-Mediterranean evergreen forests | 0.9-1.0 | 0.9-1.0 | 0.9-1.0 |
| **2.4 Kavaja** | | up to 190 | up to 190 | up to 190 |
| 2.4.1 Forest of Kryevidh | Eu-Mediterranean evergreen forests | - | up to 190 | up to 190 |
| | Deciduous forests with cermes oak | up to 190 | - | - |
| 2.4.2 Forest of Mali I Kavajës | Eu-Mediterranean evergreen forests | - | up to 10 | up to 10 |
| | Deciduous forests with cermes oak | up to 10 | - | - |
| **2.5 Durrësi** | | up to 227 | up to 227 | up to 227 |
| 2.5.1 Forest of Shijak-Maminas-Bisht-Kamez | Eu-Mediterranean evergreen forests | - | up to 150 | up to 150 |
| | Deciduous forests with cermes oak | up to 150 | - | - |
| 2.5.2 Forest of Rrushkull | Eu-Mediterranean evergreen forests | - | 5 to 3 | 5 to 3 |
| | Deciduous forests with cermes oak | 5 to 3 | - | - |
| 2.5.3 Forest of Kodër Dac-Rrotull | Eu-Mediterranean evergreen forests | - | up to 227 | up to 227 |
| | Deciduous forests with cermes oak | up to 227 | - | - |
| **2.6 Kruja, Laci** | | up to 50 | up to 50 | up to 50 |
| 2.6.1 Forest of Fushe-Kuqe | Eu-Mediterranean evergreen forests | - | up to 50 | up to 50 |
| | Deciduous forests with cermes oak | up to 50 | - | - |

| Districts Forest unit | Vegetation flat | Altitude | | |
|---|---|---|---|---|
| | | 1975 | 2030 | 2100 |
| **2.7 Lezha** | | up to 600 | up to 600 | up to 600 |
| 2.7.1 Forest of Shëngjin-Tale | Eu-Mediterranean evergreen forests | - | 1--15 | 1--15 |
| | Deciduous forests with cermes oak | 1--15 | - | - |
| 2.7.2 Forests of Mali I Rencit | Eu-Mediterranean evergreen forests | - | up to 200 | up to 400 |
| | Deciduous forests with cermes oak | up to 200 | 200-350 | 400-550 |
| | Deciduous forests | 200-600 | 350-600 | 550-600 |
| **2.8 Shkodra** | | up to 545 | up to 545 | up to 545 |
| 2.8.1 Forest of Maja e zeze | Eu-Mediterranean evergreen forests | - | up to 200 | up to 400 |
| | Deciduous forests with cermes oak | up to 150 | 200-350 | 400-545 |
| | Deciduous forests | 150-545 | 390-945 | - |
| 2.8.2 Forest of Dajc-Velipojë | Eu-Mediterranean evergreen forests | - | up to 100 | up to 100 |
| | Deciduous forests with cermes oak | up to 100 | - | - |

**Table II**
**The National Parks, Nature Monuments,seed stand forests and the vegetation flats after the sea level highs**

| National Parks Nature Monuments Seed Stands | Vegetation flats | Altitude (m) | | |
|---|---|---|---|---|
| | | 1975 | 2030 | 2100 |
| 1. Llogara, Vlore | Eu-Mediterranean evergreen forests | - | - | 475-650 |
| | Deciduous forests with cermes oak | - | 475-600 | 650-850 |
| | Deciduous forests | 475-1250 | 600-1400 | 850-1650 |
| | Silver fir and Black pine forests | 1250-1850 | 1400-2000 | 1650-2045 |
| | Mediterranean alpine pastures | 1850-2045 | 2000-2045 | - |
| 1.2 Pisha e Divjakës, Lushnjë | Eu-Mediterranean evergreen forests | up to 6 | up to 6 | up to 6 |
| 2.1 Pylli I Butrintit-Sarandë | Eu-Mediterranean evergreen forests | 10-50 | 10-50 | 10-50 |
| 2.2 Pylli I ishullit të zvernecit-Vlore | Eu-Mediterranean evergreen forests | 10-30 | 10-30 | 10-30 |
| 2.3 Pylli I Kalajdrekajve-Durrës | Eu-Mediterranean evergreen forests | - | 50-150 | 50-150 |
| | Deciduous forests with cermes oak | 50-150 | - | - |
| 2.4 Pylli I Matkeqit-Lezhë | Eu-Mediterranean evergreen forests | - | up to 1 | up to 1 |
| | Deciduous forests with cermes oak | up to 1 | - | - |
| 3.1 Rezervati farorë I Bredhit Llogara-Vlorë | Deciduous forests | 900-1250 | 900-1340 | 900-1340 |
| | Silver fir and Black pine forests | 1250-1340 | - | - |
| 3.2 Rezervati farore I Pishe Zeze Llogara-Vlorë | Eu-Mediterranean evergreen forests | - | - | 610-650 |
| | Deciduous forests with cermes oak | - | - | 650-800 |
| 3.3 Rezervati farorë I Pishë Poro Fier | Deciduous forests | 610-800 | 610-8000 | - |
| | Eu-Mediterranean evergreen forests | up to 1 | up to 1 | up to 1 |
| 3.4 Rezervati farorë Golem-Kavajë | Eu-Mediterranean evergreen forests | - | up to 2 | up to 2 |
| | Deciduous forests with cermes oak | up to 2 | - | - |

**Table III**
**The Hunting Conservancy and the vegetation flats after the sea level highs**

| Hunting Conservancy | Vegetation flats | Altitude (m) | | |
|---|---|---|---|---|
| | | 1975 | 2030 | 2079 |
| 1. Karaburun-Vloré | Eu-Mediterranean evergreen forests | up to 250 | up to 400 | up to 650 |
| | Deciduous forests with cermes oak | 250-450 | 400-600 | 650-850 |
| | Deciduous forests | 450-1250 | 600-1350 | 850-1350 |
| | Silver fir and Black pine forests | 1250-1350 | - | - |
| 2. Pishe Poro-Vloré | Eu-Mediterranean evergreen forests | up to 7 | up to 7 | up to 7 |
| 3. Pishé Poro-Fier | Eu-Mediterranean evergreen forests | 3 to 7 | 3 to 7 | 3 to 7 |
| 4. Pisha e Divjakés-Lushnjés | Eu-Mediterranean evergreen forests | 1.25-2.50 | 1.25-2.50 | 1.29-2.0 |
| 5. Rrushkull-Durrës | Eu-Mediterranean evergreen forests | - | 0.5-2.7 | 0.5-2.7 |
| | Deciduous forests with cermes oak | 0.5-2.7 | - | - |
| 6. Fushé Kuqe-Krujë-Lac | Eu-Mediterranean evergreen forests | - | -0.5 to 1.0 | -0.5 to 1.0 |
| | Deciduous forests with cermes oak | -1.5 to 1.0 | - | - |
| 7. Kune, Vair-Lezhé | Eu-Mediterranean evergreen forests | - | -0.8 to 2.0 | -0.8 to 2.0 |
| | Deciduous forests with cermes oak | -0.8 to 2.0 | - | - |
| 8. Velipojë-Shkodër | Eu-Mediterranean evergreen forests | - | -1.6 to 1.2 | -1.6 to 1.2 |
| | Deciduous forests with cermes oak | -1.6 to 1.2 | - | - |