MEDITERRANEAN ACTION PLAN

UNITED NATIONS ENVIRONMENT PROGRAMME

IMPLICATIONS OF CLIMATE CHANGE FOR THE ALBANIAN COAST

IMPLICATIONS DU CHANGEMENT CLIMATIQUE POUR LA ZONE COTIERE D'ALBANIE

Prepared by

E. Demiraj (Coordinator)
M. Bicja, E. Gjika, L. Gjiknuri, L. Gjoka Muçaj, F. Hoxha, P. Hoxha, S. Karadumi
S. Kongoli, A. Mullaj, V. Mustaqi, A. Palluqi, E. Ruli, M. Selfo, A. Shehi, Q. Sino

MAP Technical Reports Series No. 98

UNEP
Athens, 1996

Note: The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of UNEP concerning the legal status of any State, Territory, city or area, or of its authorities, or concerning the delimitation of their frontiers or boundaries. The views expressed in the papers of this volume are those of the authors and do not necessarily represent the views of UNEP.

Note: Les appellations employées dans ce document et la présentation des données qui y figurent n'impliquent de la part du PNUE, aucune prise de position quant au statut juridique des états, territoires, villes ou zones, ou de leurs autorités, ni quant au tracé de leurs frontières ou limites. Les vues exprimées dans les articles de ce volume sont celles de leurs auteurs et ne représentent pas forcément les vues du PNUE.

ISBN 92-807-1576-3

For bibliographic purposes this volume may be cited as:

UNEP: Implications of Climate Change for the Albanian Coast. MAP Technical Reports Series No. 98, UNEP, Athens, 1996.

Pour des fins bibliographiques, citer le présent volume comme suit:

PNUE: Implications du changement climatique pour la zone côtière d'Albanie. MAP Technical Reports Series No. 98, UNEP, Athens, 1996.

This volume is the ninety-eighth issue of the Mediterranean Action Plan Technical Report Series.

This series collects and disseminates selected scientific reports obtained through the implementation of the various MAP components: Pollution Monitoring and Research Programme (MED POL), Blue Plan, Priority Actions Programme, Specially Protected Areas, Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea, Environment Remote Sensing and Protection of Historic Sites.

Ce volume constitue le quatre-vingt dix-huitième numéro de la série des Rapports techniques du Plan d'action pour la Méditerranée.

Cette série permettra de rassembler et de diffuser certains des rapports scientifiques établis dans le cadre de la mise en oeuvre des diverses composantes du PAM: Programme de surveillance continue et de recherche en matière de pollution (MED POL), Plan Bleu, Programme d'actions prioritaires, Aires spécialement protégées, Centre régional méditerranéen pour l'intervention d'urgence contre la pollution marine accidentelle, Centre méditerranéen de télédétection et Protection des sites historiques.

CONTENTS

EXECUTIVE SUMMARY

The study on Implications of Climate Change for the Albanian Coast was undertaken within the framework of the Coastal Area Management Programme (CAMP) for Albania of the Mediterranean Action Plan. The coastal area of Albania is the most important and economically valuable part of the country from the development and environmental viewpoints.

For this reason a Task Team composed of national and international experts (Annex I) was established to analyse the existing information and to evaluate the implications of the predicted climate change for the Albanian coast. This study is based on the scenarios of future climate developed by the University of East Anglia (UEA). The objectives of this study were:

(a) to identify and assess the possible implications of expected climate change for the terrestrial, aquatic and marine ecosystems, populations, land-use and sea-use practices, and other human activities;

(b) to determine the areas, systems and activities that appear to be most vulnerable to the expected climate change;

(c) to make recommendations on planning and management of coastal areas and resources, as well as on planning and design of major infrastructure and other systems; and

(d) to provide an input into other projects and developments relating to the subject of the study.

According to the climate change scenarios, the annual temperature is expected to increase less than the global temperature from south (0.7 - 0.9EC per degree of global warming) to north (0.9 - 1EC) along the coast and towards the hinterland, by 2030. The change in annual precipitation is expected to be small and to decrease from north to south (Annex III).

This climate change and the mean-sealevel rise (+16cm) by 2030 are not expected to have any significant impact. There is a possibility for natural and managed systems to adapt to new conditions.

Taking into consideration, at the same time, the influence of other non-climatic factors, the difficulties arising from the expected change will probably appear by 2100.

The analysis of the results reveals that drought (i.e., the prolongation of dry periods during the high-temperature and low-precipitation summer seasons) may be the most important direct consequence of the predicted climate change. The temperature is expected to increase up to 2.8EC and precipitation to decrease by up to 60%. The second most important factor likely to cause, or contribute to, an impact is the predicted mean-sealevel rise of 48cm. Both these factors may lead, or significantly contribute, to a cascade of secondary impacts rated by the Task Team as potentially highly harmful.

Concretely, because of reduced precipitation, especially during summer, a decrease in the refilling of aquifers is expected. This effect and the expected intrusion of saline water into coastal aquifers, owing to sealevel rise will cause a shortage of drinking water of adequate quality. This effect will be stronger at the Fushë Kuqe aquifer, which supplies a large area around it with drinking water. Durrës plain and, to a lesser extent, the Velipoja and Vlora plains are expected to increase in salinity.

Physical soil erosion, especially of the argillite and silt rocks located mainly in the western part of Albania (Kepi i Rodonit-Durrës-Kavaja region, Lushnja-Fier region, etc.) is likely to be another important impact.

Change of coastline because of erosion and increased flooding in coastal areas (ligatines) due to sealevel rise could be expected by 2100.

Such situations are expected to occur to the north and south (Patok) of the Mati delta, to the north of the Erzeni delta, in the old Seman delta, in the area between Seman and Vjosa, and to the south of Vjosa. An increase in sealevel in the Ceka lagoon, and the formation of new ligatines in the Mati delta are expected. Patoku lagoon may suffer the destruction of the existing barriers and the invasion of the lagoon by the sea. Rrushkull, to the north of the Ishmi river, once a hunting reserve, is expected to be flooded, since it is situated below sealevel and is separated from the sea by a low dune barrier. Karavasta and Narta lagoons are expected to have better communications with the sea in the future. An increase in the ligatine surfaces in the area between the rivers Vjosa and Seman is also expected.

The other consequences in lagoons, such as high temperature and salinity, less dissolved oxygen etc., would cause considerable changes in the vegetation and the associated ecosystem. The vegetation will change in favour of halophilic-hygrophilic or salt-marsh species, and the now characteristic vegetation will migrate inland.

Changes can be expected even in the composition of the plankton and especially in its seasonal dynamics, as well as in the arrival and departure times of the migratory species.

The reduction of the area of arable land due to soil erosion and alteration, because of the expected increase in soil salinity, is likely to be a keen problem in the future. It will be followed by an increased need for irrigation of arable land because of the expected water shortage. Crops that have a high water demand (such as vegetables, olives, etc.) will suffer the consequences of reduced rainfall; the use of more xerophilic crops might therefore be required.

Similar problems might arise concerning the forest species. Those species that resist high temperature and a long, severe dry season could probably adapt to a vegetation zone at a higher altitude; those that need moisture (silver fir, etc.) are in danger of being limited in distribution or disappearing; others that produce many seeds (pines, etc.) are likely to spread at the sealevel altitude.

In forests and pastures, fires would be more frequent and much more dangerous. Also, many pests that might appear and grow in the hot conditions will be much more dangerous for forest trees (*Cnethocampa pityocampa, Evetria buoliana, Limantria dispar,* etc.).

The problems of drinking-water supply and the impairment of coastal sewerage systems operated by gravitational flow will become especially keen, owing to mean-sealevel rise. The liquid and solid wastes directly discharged into the sea will destroy the marine flora and fauna. Without a solution to the two last problems, the impacts of climate change would degrade the health of the Albanian population, and not only in the coastal zone.

Among the beneficial impacts of expected climate change, the Task Team distinguished the increased potential for the use of solar energy, an extension of the tourist season into periods of the year presently too cold, and decreased energy demand for heating in winter, etc.

The likely temperature and precipitation scenarios are given in Annex III, and the likely major impacts associated with expected climate change, in priority order, are listed in Annex IV.

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 on climate.

To prevent and mitigate in good time the impacts of expected climate change, the Task Team recommended a number of activities, among others, that ought to be undertaken and should be part of the national plans and strategies:

(a) A strategy should be developed to prevent and avoid in good time the impacts of climate change, keeping in mind the continuity of this change:

- ! it is important to establish a monitoring system to observe the impacts of climate change and of human activity;
- ! it is urgent to prepare local inventories of the impact of changes in mean temperature, precipitation and sealevel on water resources and supply, ecosystems and socio-economic activities; the precise identification of the areas that could be affected by climate change is recommended; and
- ! the impacts of climate change must be taken into consideration in the development of integrated planning.

(b) Information on the possible consequences of climate change and the need to take the necessary steps to avoid them must be distributed to all levels of economic and political decision-making:

- ! the use of renewable energy, as a resource that does not cause pollution, ought to have priority; and
- ! a cost-benefit analysis must be made so as to evaluate the feasibility of expenditures for the mitigation of the effects of climate change.

1. INTRODUCTION

1.1. Background

Global warming by atmospheric heat retention caused by emissions of carbon dioxide and other gases into the atmosphere is currently considered to be the main factor in increasing the temperature of the Earth's surface. There is also concern that human activities, which are mainly responsible for the increase in these emissions, may be inadvertently changing the Earth's climate.

This global warming of the Earth-atmosphere system is brought about by the so-called greenhouse effect. The term stems from the characteristics of a greenhouse, which keeps the inside temperature warmer than it would otherwise be. The natural greenhouse effect means that the average temperature on Earth is 33EC higher than it would otherwise be in the absence of this natural phenomenon.

This effect is one of the most important processes in the atmosphere. It exists because a number of gases, the greenhouse gases, which occur there naturally, allow sunlight to pass through the atmosphere virtually unhindered. The Earth absorbs the incoming radiation, but also re-radiates a part of it which is retained by the gases (and water vapour) in the atmosphere, causing it to warm up. The process has been going on for eons without problems.

The greenhouse effect does become a problem, however, if it becomes enhanced. Such an enhancement exists because mankind emits enormous quantities of greenhouse gases. For this reason, carbon dioxide, methane, nitrous oxide, ozone and chlorofluorocarbons (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 about 1EC by 2025 and 3EC before the end of the next century. It is also estimated that the mean-sealevel rise could be about 20cm by 2030 and about 65cm by the end of the next century. The 1992 IPCC update (Houghton *et al.*, 1990) confirmed the 1990 estimate of a 0.3EC temperature increase per decade, but reduced the range of uncertainty 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 2.5EC (range 1.5 - 3EC) for a doubling of CO_2. The mean-sealevel rise estimate is 12.5cm by 2030, 22cm by 2050 and 28 - 60cm by 2100.

The 1994 Report of the Scientific Assessment Working Group of IPCC reconfirmed the amount and the positive contribution of carbon dioxide, methane, nitrous oxide and halocarbons arising from human activities. Since pre-industrial times, the level of atmospheric CO_2 has increased from about 0.0280% to 0.0356% and makes the largest contribution to greenhouse gas radiative forcing (1.56Wm^{-2}), which is the effect of this gas on the energy balance. The increase in methane (CH_4) from 0.0007% to 0.0017% contributes about 0.5Wm^{-2} to radiative forcing; the increase in nitrous oxide from about 0.0000275% to 0.0000310% contributes about 0.1Wm^{-2}; the increase in atmospheric concentration of various halocarbons contributes positively to radiative forcing (IPCC, 1994).

The changes in the concentrations of ozone and aerosols and the natural factors, such as the sun and volcanic eruption (e.g., Mount 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 the present study.

Substantial global warming is virtually certain, but the attendant changes in climate at the regional level are uncertain. At present, it is difficult for scientists to assert when the effects of climate change will occur. The changes in climate that impact the environment, such as those of air temperature, precipitation and mean sealevel, are well defined, but changes in other aspects, such as vegetation, soil, water, ecosystems etc. cannot be precisely defined.

Analysing the case studies for the Mediterranean countries will require the government to take the necessary financial steps to prevent the negative effects of climate change. There will be new investments (Jeftic *et al.*, 1992) to reduce the impact of sealevel rise as well as to ensure adequate water supply for agriculture and the population of a given area. The relation between the greenhouse effect and problems of energy, agriculture, urbanization and environmental protection against pollution will require new strategies for socio-economic development, and improved methods of environmental protection. Since 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 increases in temperature and mean sealevel, and of the changed climate for the Albanian coast, to estimate its possible implications for the terrestrial, aquatic and marine ecosystems, population, land use and other human activities. This report represents the efforts of a multidisciplinary Task Team to identify the impacts of the predicted climate change and sealevel 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 change cannot be predicted exactly in this report, it is of great importance for decision-makers to acquire a sound understanding of the processes that are changing the climate and the environment in Albania.

This study was implemented in the framework of the Mediterranean Action Plan's Coastal Area Management Programme (CAMP) for Albania which has been carried out since 1993; it contains the following activities which are being implemented:

(a) systemic and prospective analysis, development/environment scenarios for Albania;

(b) preparation of an inventory of land-based sources (LBS) of pollutants, implementation of the LBS and Dumping protocols of the Barcelona Convention;

(c) development of a national system of preparedness and response to accidental marine pollution;

(d) creation of Specially Protected Areas (SPAs) and implementation of the SPA protocol;

(e) marine pollution monitoring;

(f) study of the implications of expected climate change in the coastal region;

(g) protection and management of historic settlements;

(h) integrated coastal and marine area management of the Durrës-Vlore region;

(i) study of water-resource management for the Erzen and Ishem river basins;

(j) development of a Geographical Information System (GIS);

(k) assessment of the national carrying capacity for tourist activities; and

(l) environmental Impact Assessment (EIA).

The main objectives of CAMP Albania are:

(a) overall, to protect and rationally utilise the coastal resources over a relatively long period of time (the task of such a programme is to determine and recommend appropriate management measures with a view to resolving the existing environmental conflicts and establishing the optimum paths for dynamic development);

(b) in the long term, to develop the coastal area of Albania in harmony with the receiving capacity of the environment and to create conditions for the establishment of a system of integrated planning and management of resources in the region; and

(c) immediately, to propose, within the individual activities, solutions to urgent environmental problems which could be implemented immediately (in the elaboration of those solutions, particular attention is to be paid to the strategic objectives of the programme).

In the preparation of this study, the Task Team members consulted experts preparing the other studies in the framework of CAMP Albania, so as to rationalise the collection of information and to ensure the coherence of the analysis and the conclusions.

1.2. Basic Facts about the Albanian Coast

1.2.1. 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 south-west, it is bordered by the Adriatic and Ionian Seas.

Albania covers an area of 28,748 square kilometres; the population in January 1993 was estimated at 3,166,000. More recent estimates indicate that the 1992 population was 3.3 million.

1.2.2. Relief

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

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

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

1.2.3. 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 44EC). 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 below-zero temperatures (absolute minimum temperature recorded is -35EC).

Rainfall in Albania is abundant. Average annual rainfall is over 2,000mm in the alps in northern Albania and 650-700mm in the valleys of the interior. Forty percent of the annual precipitation occurs in the winter. Summer droughts are more pronounced towards the south-west.

1.2.4. Rivers and lakes

Owing 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 (285km long), debouching on the eastern coast of the Adriatic, the Mati, 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 and it is intended to turn the river into a series of lakes to serve the existing hydro-power plants or those to be constructed on it. Hydro-power plants have also been constructed on the Mati and Bistrica rivers.

The lakes are of varying origin: glacial lakes in the highlands, karstic lakes in 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.

1.2.5. Specially protected areas

Albania has eleven protected coastal areas: Kune, Vaini, Rushkull, Fushë Krujë, Pishë Poro, Karaburun, Llogara, Divjakë, Velipojë, Nartë, and Butrinti (Annex V).

1.2.6. Rare, endangered and endemic species

The Albanian flora and fauna include a considerable number of endemic and sub-endemic species (Annex VI).

The most rare and threatened species of plants belong to the *Ranunculacæ*, *Compositæ* and *Orchidacæ* families.

With regard to vertebrates, available information is insufficient to determine their present status.

The Dalmatian pelican (*Pelecanus crispus*) is a threatened species; the world population is assessed at 700 - 1100 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 has been sighted on several occasions in the Fushe Kuqe and Patok Nature Reserves.

The pygmy cormorant (*Phalacrocorax pygmæus*) nests are found in the Ceka and Merxhani lagoons and on 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*) cannot be 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: Lura (Peshkopi), Germenjë (Kolonjë), Cangonj (Korçë), Hondisht and Llengë (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 is thought to cause damage to livestock.

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

The otter (*Lutra lutra*) is widespread throughout most of the country but its range is restricted to the central area, the coastal plain and the Korçë plain. It occurs mainly in the uplands but considerable populations are also encountered in some lowland areas and coastal marshes (Lezha lagoon).

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 biggest 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.

1.2.7. Sites of historic interest

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

Archæological 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 south-east Albania. Excavations have been carried out in graves of Kruma, Këneta and Cinamak in north-east Albania, of Cakran and Patos in the coastal plain, and of Vajza, Dukat, Xara and Cuka in southern Albania.

Several necropolises 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 made in Lezha, Koman, Kruja, Berat, Ballsh, Kosine, Peshkopi etc.

1.2.8. 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 olives are also considered to be a most suitable exportable product. The country possesses around 6 million olive trees of which 4 million are productive.

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.

1.2.9. 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, the heavy, food and light industry accounted for about 31%, 28% and 20% of the total industrial production, respectively.

The chemical sector, which includes five main factories producing soda and PVC, nitrogenous fertilizers, 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 fertilizer and caustic soda plants are hazardous to their work forces and release significant amounts of gaseous and liquid wastes loaded with toxic substances into the environment.

Oil extraction and refining are 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, Albanian industry remains close to financial collapse, owing to heavy debts.

1.2.10. Tourism

Tourism in Albania is only at a very early stage of development. However, the country exhibits considerable potential for the development of tourism, because of its 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 eco-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 US$280 million. There is also the prospect of a further investment of US$50 million through a contract with a Swiss company, and negotiations are under way with American, German, Kuwaiti and other companies.

1.2.11. 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 1,662MW of which 1,444MW 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, owing 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.

1.2.12. Present state of the economy

Albania ranks as one of the poorest countries in Europe. Low levels of productivity and capital investment combined with shortage of skilled labour are major constraints on 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 US$800 million, a 75% decline in output compared to 1989 and a budget deficit three times larger than in 1991. The macro-economic situation during 1994 improved in comparison with the former years. Thus, the GDP increased by 7.4%, the inflation was 15.8%, and the internal financing of budget deficit exceeded 8% (Anon., 1995). Of the estimated 364,600 jobless at 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.

There are more than 400,000 Albanians spread throughout Europe and in other parts of the world. Over the past two years, they have provided a substantial amount of foreign currency to their families in Albania.

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. Most of the plants are actually out of production and with very limited possibilities of being put back into operation and competing in the free-market economy. At the same time, Albanian industry also remains close to financial collapse, owing to heavy debts.

1.2.13. Major environmental problems

There are no restrictions on the use of chemical herbicides, pesticides and fertilizers in agriculture, resulting in the contamination of rivers, canals and ground water.

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, owing to the lack of sewage treatment facilities.

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

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 in 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 do exist as a result of a combination of the bad quality of raw materials, polluting technologies adopted in industry, and the lack of pollution control.

Gases from smelting contain high concentrations of sulphur dioxide and are damaging the forests over a wide area. Rain water 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 methods that are prohibited in other Mediterranean countries, such as the use of drift nets, are practised 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 subject to some poaching, mainly by local people. No national laws refer to the protection of endangered species except for a list of 27 protected species in relation to shooting regulations that do 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 (see Annex I) to identify the possible impacts of climate change on ecosystems, socio-economic structures and human activities in Albania, to determine areas which appear to be most vulnerable to the expected changes, and to make recommendations on planning and management of coastal areas and resources.

The Task Team for the Albanian coast was set up in December 1993 and had its first formal meeting in Tirana, 12 - 14 July 1994. The meeting considered and agreed to work to the time horizons 2030 and 2100, as well as to the scenarios prepared for the Albanian coastal area by the Climate Research Unit of the University of East Anglia (CRU/UEA) (Annex III).

To attain the Team's aim, each of its members worked on the preparation of one or more chapters of this report, which were also discussed at some other joint and particular meetings.

Two other formal meetings, with the participation of UNEP experts, followed the first one, which were constructive and very useful in the development and finalization of this report. The second meeting (Tirana, 21 - 23 March 1995) reviewed the first drafts of chapters and numerous specific suggestions were taken into account. The third formal meeting (Tirana, 21 - 23 November 1995) reviewed the final draft of the report.

The experience gained during the preparation of the other reports for Mediterranean countries (Jeftic *et al.*, 1992; UNEP, 1992, 1994a,b,c,d,e) was very useful. Whenever possible, the opinion of other specialists (non-members of the Task Team) was sought. Some other reports (not in final form) in the framework of CAMP Albania, such as ICAM Durrës-Vlore, Blue Plan, etc., were also consulted.

Particular attention was paid to the definition of the coastal area in terms of existing data and their time-series. The official redrawing of socio-political boundaries, of 1990, was taken into account; accordingly, the area under study comprises the following districts: Shkodra, Lezha, Kruja, Durrës, Tirana, Fier, Lushnja, Vlora and Saranda (Fig. 1).

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

The expected changes relative to the chosen time horizons (2030 and 2100) are given in Table 1.

TABLE 1

Scenarios of future climate in Albania derived from IPCC and UEA

Scenarios		**Time horizon** 2030	2100
IPCC Global			
	Temperature	+1.8EC	+2 to +5EC
	Sealevel	+18cm +/- 12cm	+65cm +/- 35cm
IPCC Southern Europe			
	Temperature	+2EC (winter) +2 to +3EC (summer)	
	Precipitation	0 to +10% (winter) -5 to +15% (summer)	
	Soil moisture	-15 to -25% (summer)	
UEA for Albania			
Annual	Temperature	0.7 to 0.9EC	2.0 to 2.5EC
	Precipitation	-2 to -5%	-5 to +13%
Winter	Temperature	0.7 to 0.9EC	2.0 to 2.5EC
	Precipitation	-10 to +2%	-28 to +5%
Spring	Temperature	0.6 to 1.1EC	1.8 to 2.8EC
	Precipitation	-22 to +5 %	0 to +0.18%
Summer	Temperature	0.6 to 1.0EC	1.8 to 2.8EC
	Precipitation	-22 to +5%	-60 to +13%
Autumn	Temperature	0.6 to 1.1EC	1.8 to 3.0EC
	Precipitation	0 to +19%	0 to +0.53%
Sealevel change		+16cm	+48cm

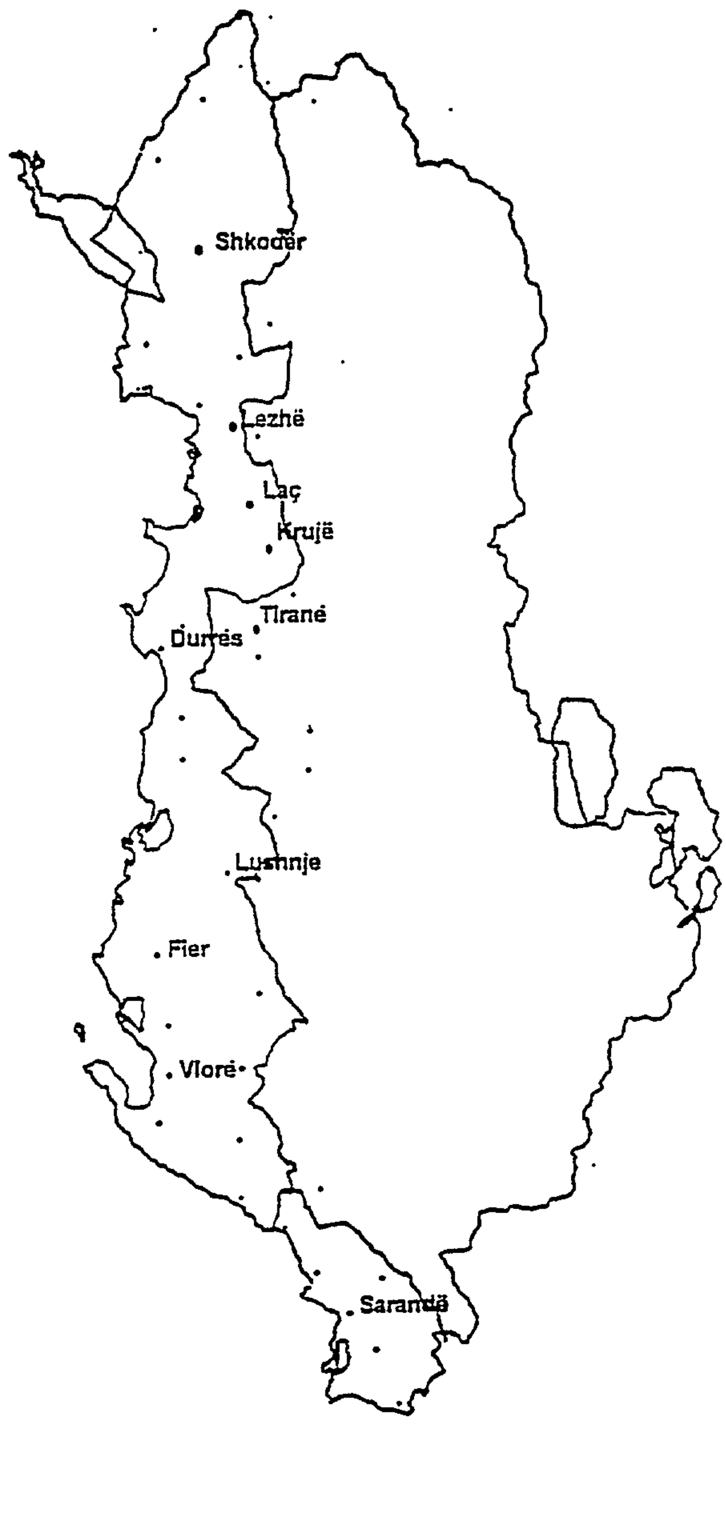


Figure 1 - The study area and the distribution of meteorological stations

In this report, in many cases, the possible impacts are described qualitatively, because of the impossibility to describe them quantitatively, owing to insufficient data.

1.4. Temperature and Precipitation Scenarios for Albania

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 the detailed information on future climates that can be extrapolated beyond the limit of the conditions that have arisen 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 re-run with doubled (or sometimes quadrupled) CO_2 (the perturbed run).

The four GCM experiments used to construct the scenarios are from the following research institutions: United Kingdom Meteorological Office (UKMO); Goddard Institute of Space Studies (GISS); Geophysical Fluid Dynamics Laboratory (GFDL); and Oregon State University (OSU).

A set of high-resolution scenarios for Albania, based on the statistical relationship between grid-point GCM data and observations from surface meteorological stations are presented in Annex III.

A generalized computer programme 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 was adopted:

(a) 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 Annex III. Where possible, each record should be complete for the period 1951 - 1988. Any station with a record length less than 20 years in the period 1951-1988 or for over six months out of twelve in any one year was immediately discarded;

(b) then, for every valid station, the temperature and precipitation anomalies from the long-term (1951 - 1988) 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 -1980 were used. The 1981 - 1988 data were retained to test the performance of the regression models (the verification stage, see Palutikof *et al*., 1992):

- ! the individual station anomalies were used to calculate regionally averaged anomalies;

- ! regression analyses were performed using station temperature and precipitation anomalies as the predictands; these analyses were carried out on an annual and seasonal basis;

- ! to determine the perturbation due to the greenhouse effect at each station, the results from GCMs were employed. It was 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, the perturbed-run and control-run grid-point temperature and precipitation values were interpolated to the station position; and

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

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; and

(d) multicollinearity in the predictor variables.

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

2. IDENTIFICATION OF PRESENT SITUATION AND TRENDS

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 - 400m above sealevel). The climate of this area, as well as that of Albania as a whole, is typically Mediterranean. It is characterised by mild winters with abundant precipitation and hot, dry summers.

There are uniform climatic conditions over this area, mostly, due to meso- and micro-climatic 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 the Gulf of Genoa), as well as Siberian and Azorean anticyclones.

The frequency of occurrence of cyclonic and anticyclonic weather systems has a distinct annual pattern. The cyclonic weather, with a high frequency, belongs to the cold period. It is associated with clouds and frontal rain, whereas anticyclonic weather conditions are most frequently present during the warm season of the year (HMI, 1975). For this reason, during the summer, weather conditions are dominated by the high-pressure fields, clear skies with occasional clouds 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 transition seasons (spring, autumn), the rainfall is the result of the combined operation of the upper atmospheric instability and low-level forced convection (Mustaqi, 1986). The meteorological data for 37 stations (Fig. 1) distributed over the area under study were analysed for the present study. Only some of the data are presented in the following Tables and Figures.

2.1.2. Atmospheric pressure

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

The atmospheric pressure varies 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, 1037.4hPa; Durrës, 1035.8hPa; Tirana, 1025.8hPa, Kucova, 1033.8hPa. The respective absolute minima are: 974.2hPa; 979.1hPa; 970.7hPa; and 978.2hPa.

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

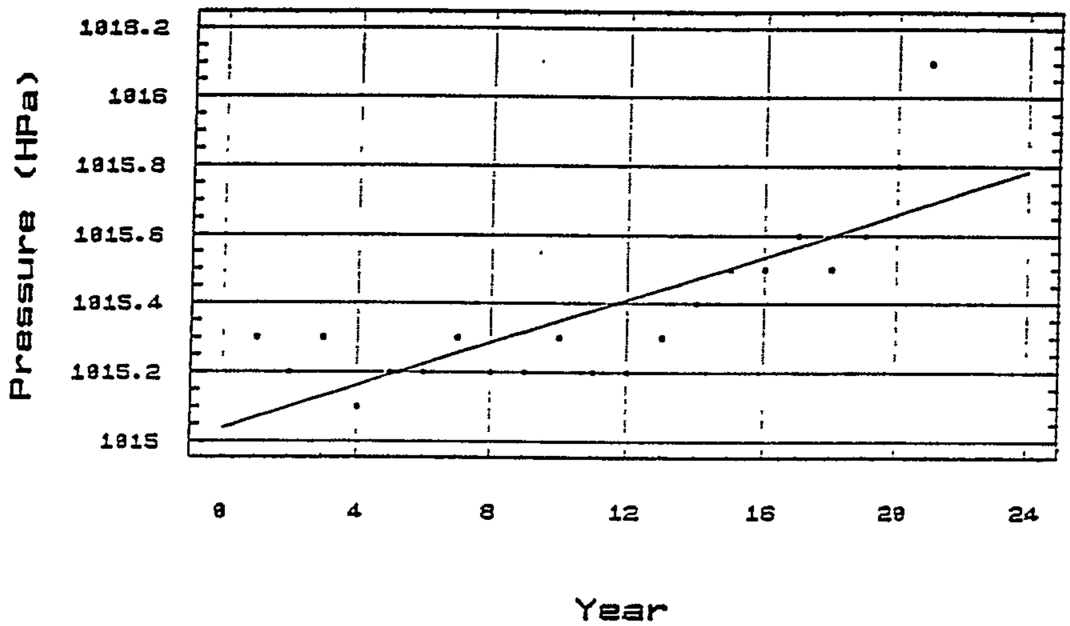


Figure 2 - Ten-year running mean and trend in atmospheric pressure (sealevel) at Tirana for 1961-1990

2.1.3 Temperature

The air temperature in the coastal region of Albania displays a simple annual curve with a mean annual range of 14.7 -17.6°C, increasing from north towards the south. The air temperature reaches a maximum in July or August and a minimum in January (Table 3).

Mean maximum and minimum air temperatures have similar annual and seasonal cycles to those of mean monthly temperature. The mean maximum values of temperature vary from 27.6°C, in the north, up to 31.4°C, towards the south, while the minimum values vary from 1.0 to 6.0°C, respectively.

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

All through the year, except in January and December, days with temperatures >25.0°C are registered. Although this region is near the sea, temperatures below zero are still observed during the cold months. The absolute minimum temperature varies between 13°C, in the north, and -5.0°C, in the south. The expected absolute minimum temperatures for this coastal region are given in Table 5. The mean number of days with a temperature below zero is 5 - 10 days per year at the seaside and 25 - 30 days per year in the inner part of the area, increasing towards the north. A running mean was calculated for the temperature data to detect trends (Boriçi and Demiraj, 1993).

TABLE 2

Mean monthly atmospheric pressure (in hectoPascals) reduced to sealevel

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	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

Source: HMI, 1995

TABLE 3

Mean monthly temperature (EC), for 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
Saranda	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

Source: HMI, 1995

TABLE 4

The expected values of absolute maximum air temperature (EC) 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
Durrës	37.8	39.2	40.3

Source: HMI, 1995

TABLE 5

The expected values of absolute minimum air temperature (EC) 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

Source: HMI, 1995

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 - 0.8EC during the period under consideration, but there are sub-periods with different trends. Concretely, during the first and last 12-year periods, an obviously positive trend (about 0.1EC per year) is observed. The negative trend in between is the result of a general tendency for the temperature to decrease during the spring, summer and autumn seasons, and especially in the autumn.

In contrast, for most of the stations, the winter curves show an increasing trend of about 0.5EC over the 60-year period.

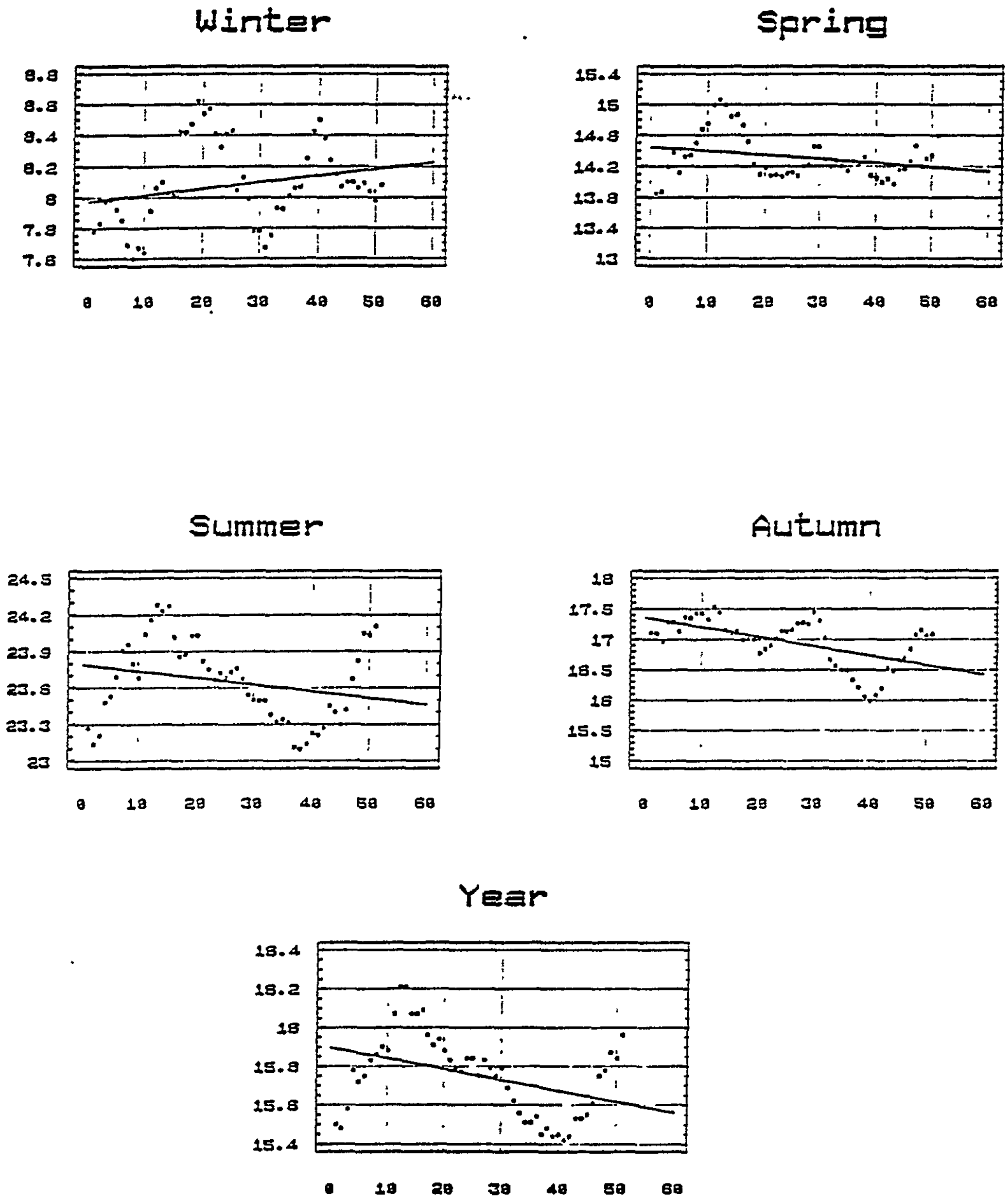


Figure 3 - Ten-year running mean and trend of temperature for Tirana, for 1931-1990

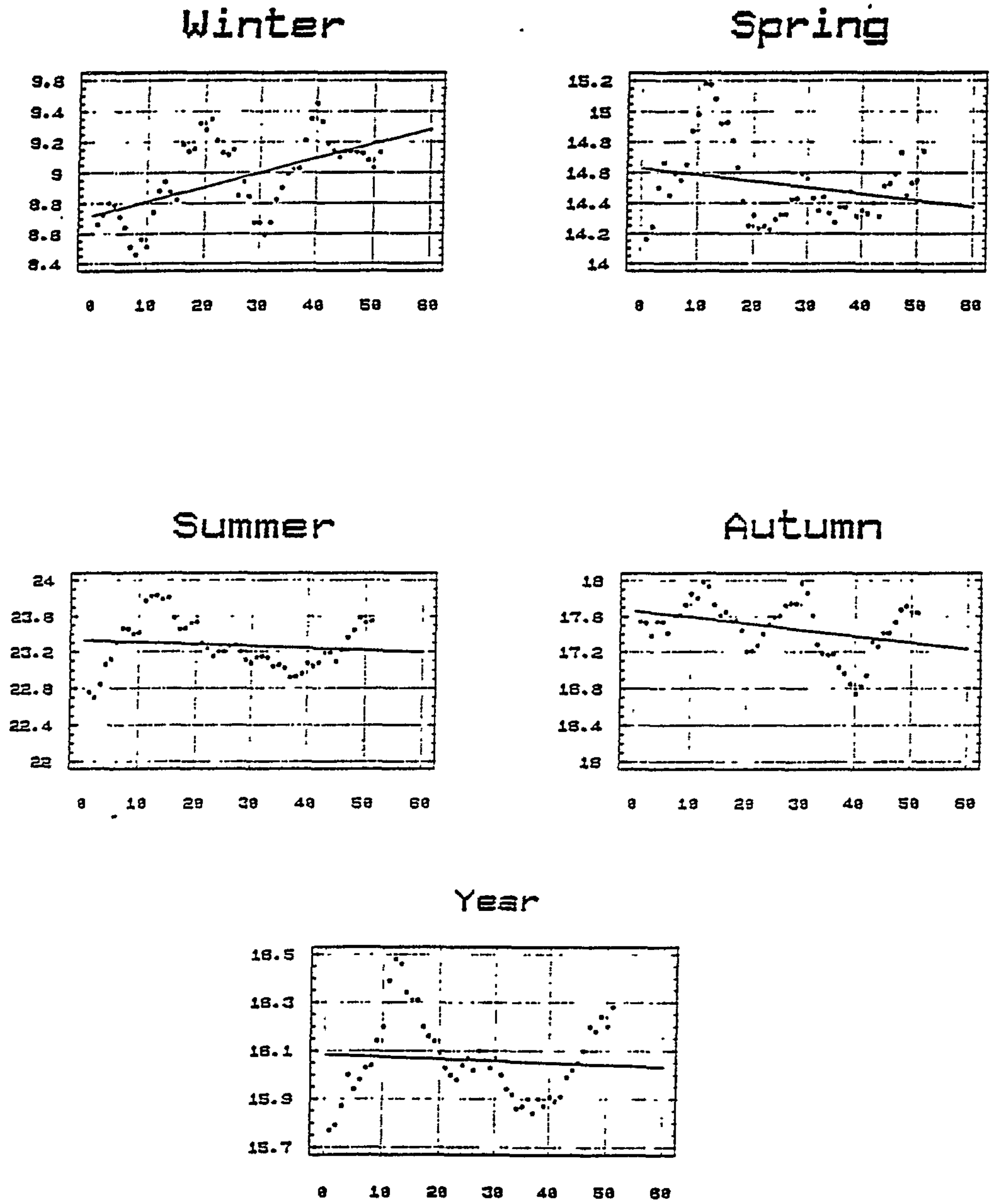


Figure 4 - Ten-year running mean and trend of temperature for Durrës for 1931-1990

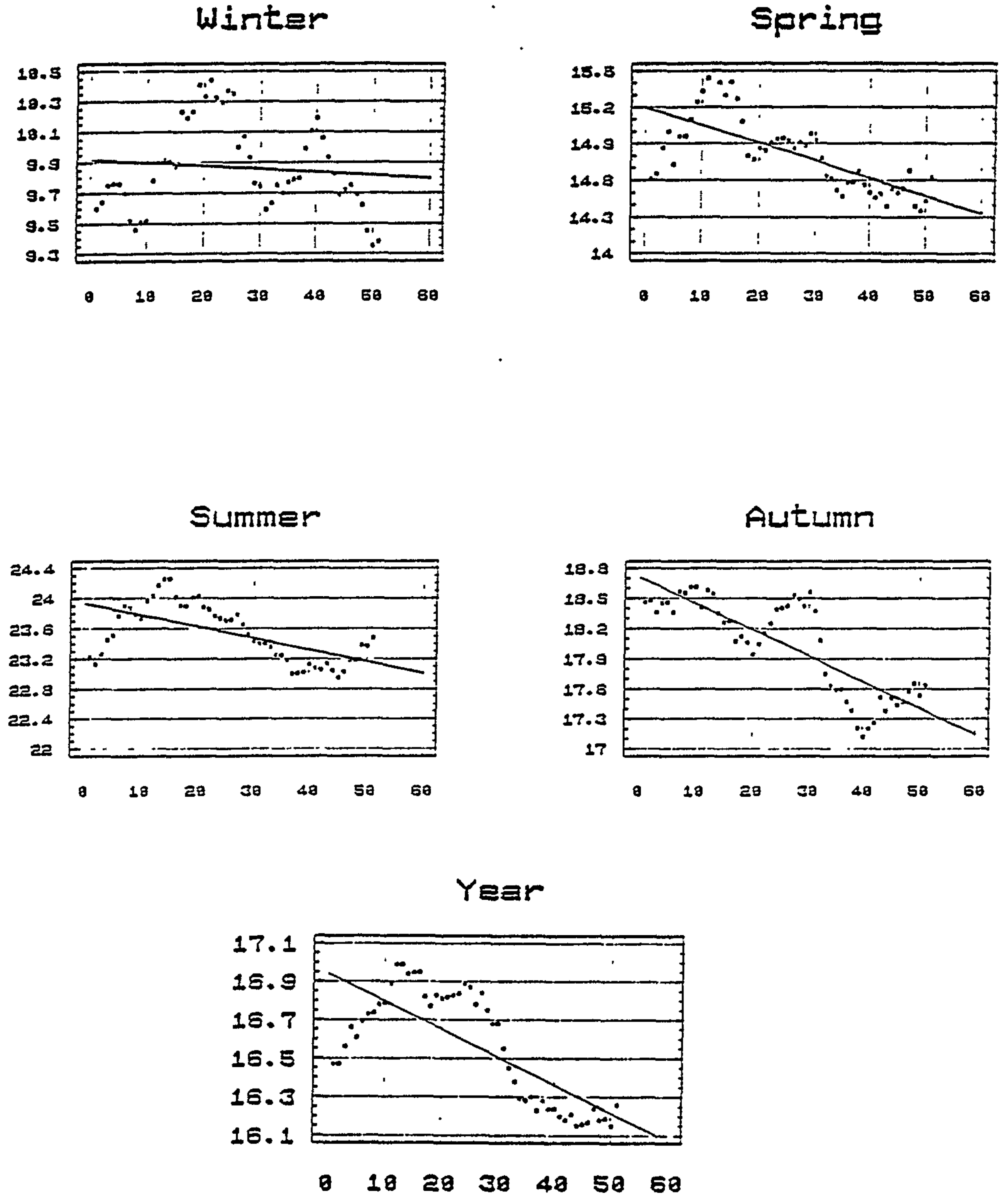


Figure 5 - Ten-year running mean and trend of temperature for Vlora for 1931-1990

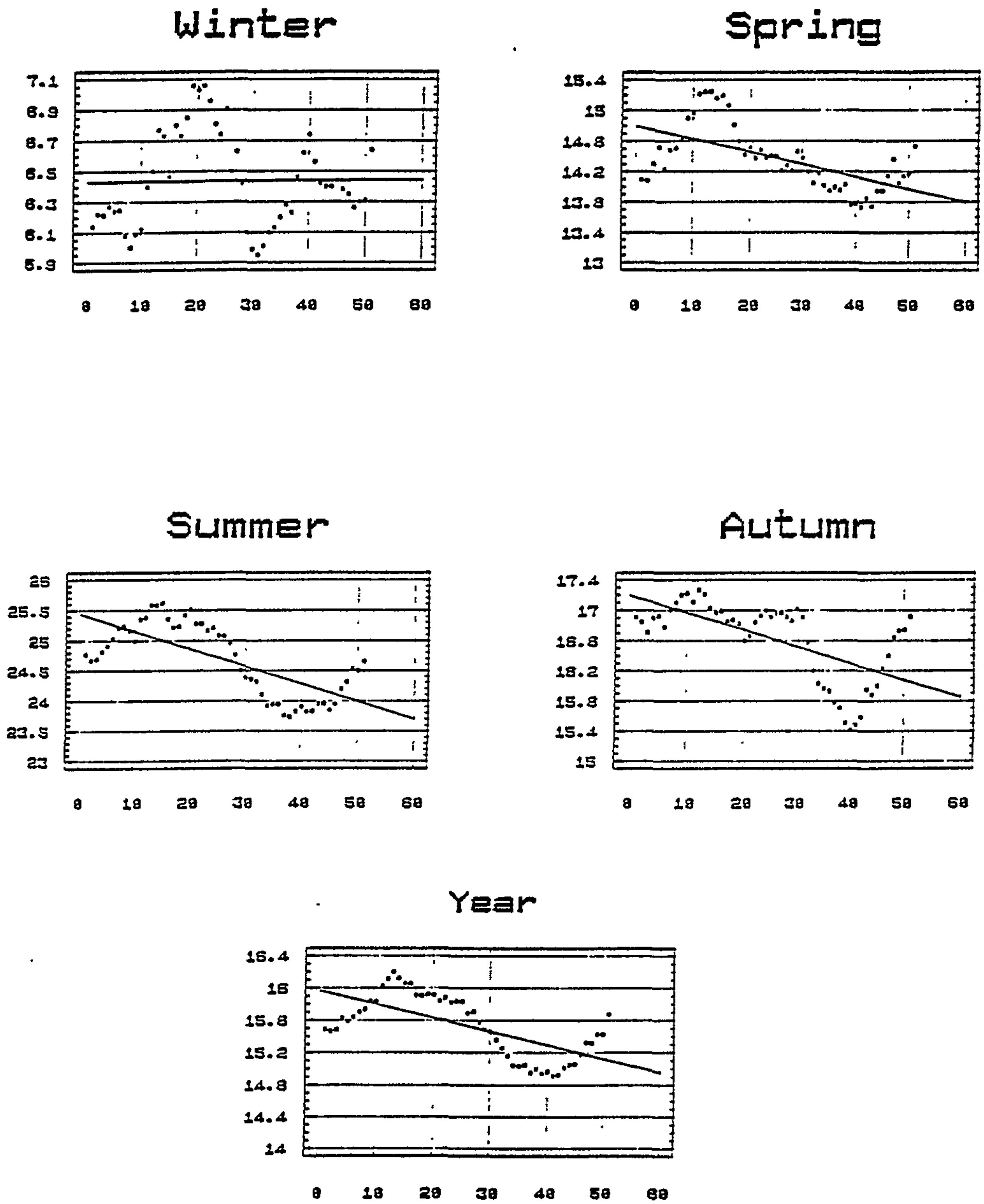


Figure 6 - Ten-year running mean and trend of temperature for Shkodra for 1931-1990

2.1.4. Precipitation

The total mean annual precipitation (period 1961 - 1990) in this area varies within wide limits, from 900mm in the middle of the area to 1900mm in the northern part (Fig. 7). This difference is a consequence of the relief. The northern part is situated at the foot of the Albanian alps, whereas the southern part is bordered by high mountains (up to 2000m above sealevel).

During October-March, the region receives about 75% of the total annual rainfall. The month richest in precipitation is November and the poorest is July (Table 6). The number of rainy days (>0.1 mm) in this area ranges between 100 and 130 days per year. The time and space distributions of these rainy days generally follow those of precipitation. About 65 - 70% of the rainy days are recorded during the cold period. Over the northern part of this area, about 130 rainy days are observed. The intensity of precipitation is high. Its expected value for the 100-year return period may reach 300mm per day.

The analysis of seasonal and annual precipitation trends differs for the four stations (Tirana, Durrës, Shkodra and Vlora) over the period 1931 - 1990 (Figs. 8 - 11). From these Figures, one may observe a decreasing trend of annual precipitation during this period. In total, it is 1.6mm per year for the Tirana station, 5.7mm per year for Vlora, 0.4mm per year for Shkodra and 1.5mm per year for Durrës. The decrease in annual precipitation is due mainly to the decrease during autumn and winter. In contrast, an increase during the spring and summer is observed. The statistical tests confirm that the trend in these two seasons is not yet significant, whereas the decreasing trend for the autumn and winter seasons is significant.

Analysis indicates periods with different trends. Two periods may be particularly mentioned. The last 20 years, during which the decreasing trend is very pronounced (for example, this decrease is about 20.0mm per year for the Tirana station, 16.0mm per year for Shkodra etc.) and the period 1951 - 1970, when a clearly increasing trend was observed.

TABLE 6

Total monthly precipitation (mm), for 1961-1990

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
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	76.2	50.8	38.7	23.9	34.8	62.5	101.1	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
Saranda	145.4	137.9	112.4	74.4	48.1	21.8	9.1	25.4	66.8	154.8	204.9	185.4	1196.4

Source: HMI, 1995

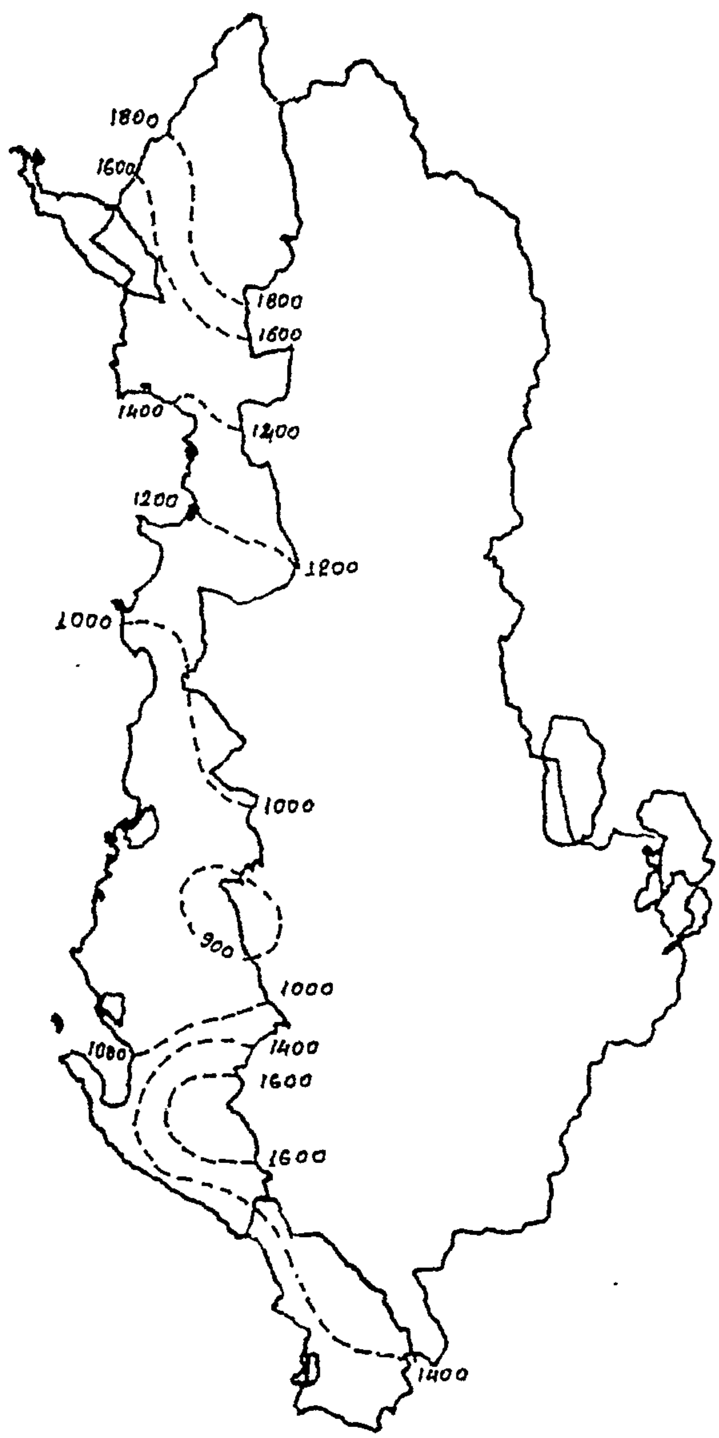


Figure 7 - Total annual mean precipitation (mm)

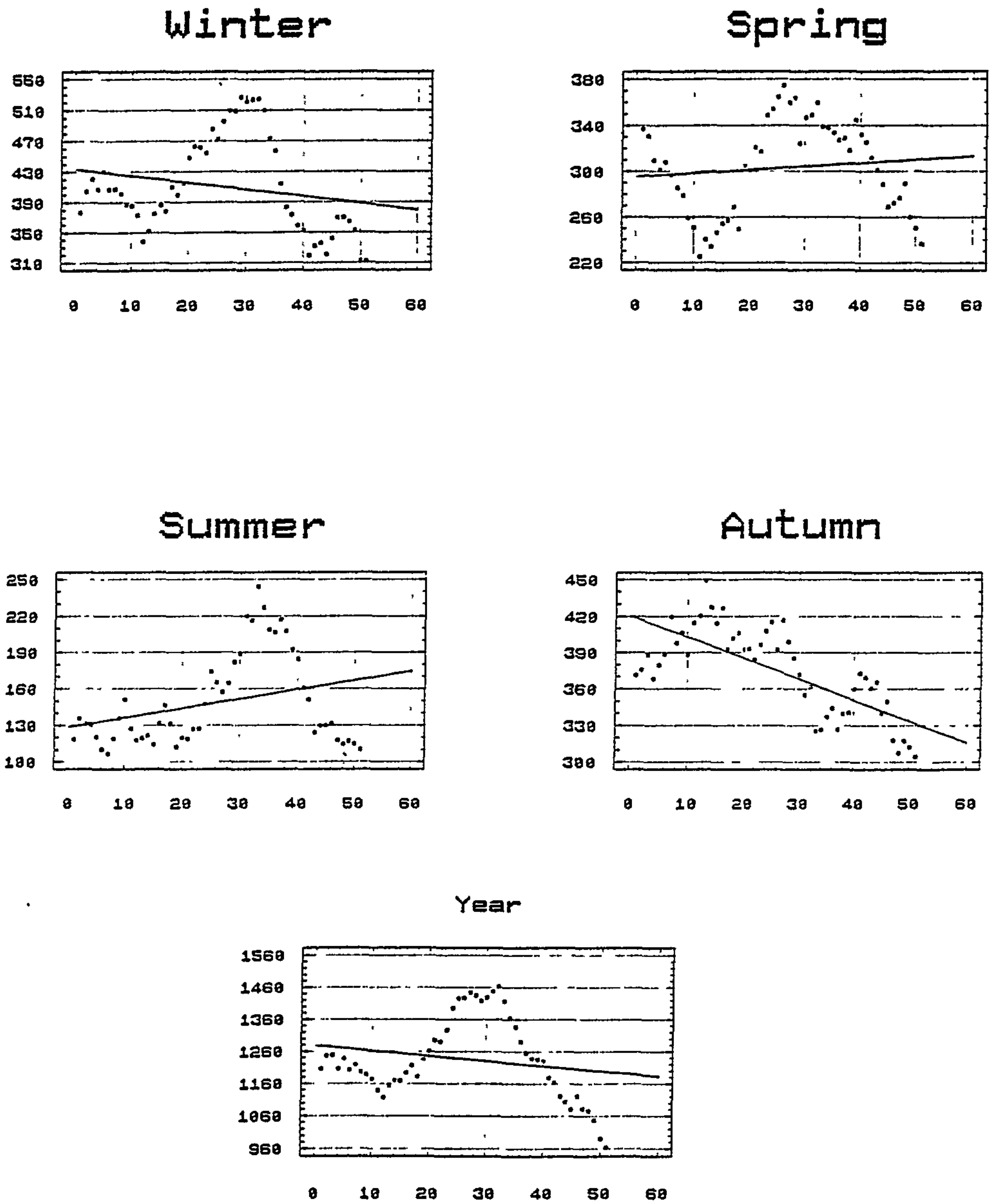


Figure 8 - Ten-year running mean and trend of precipitation for Tirana for 1931-1990

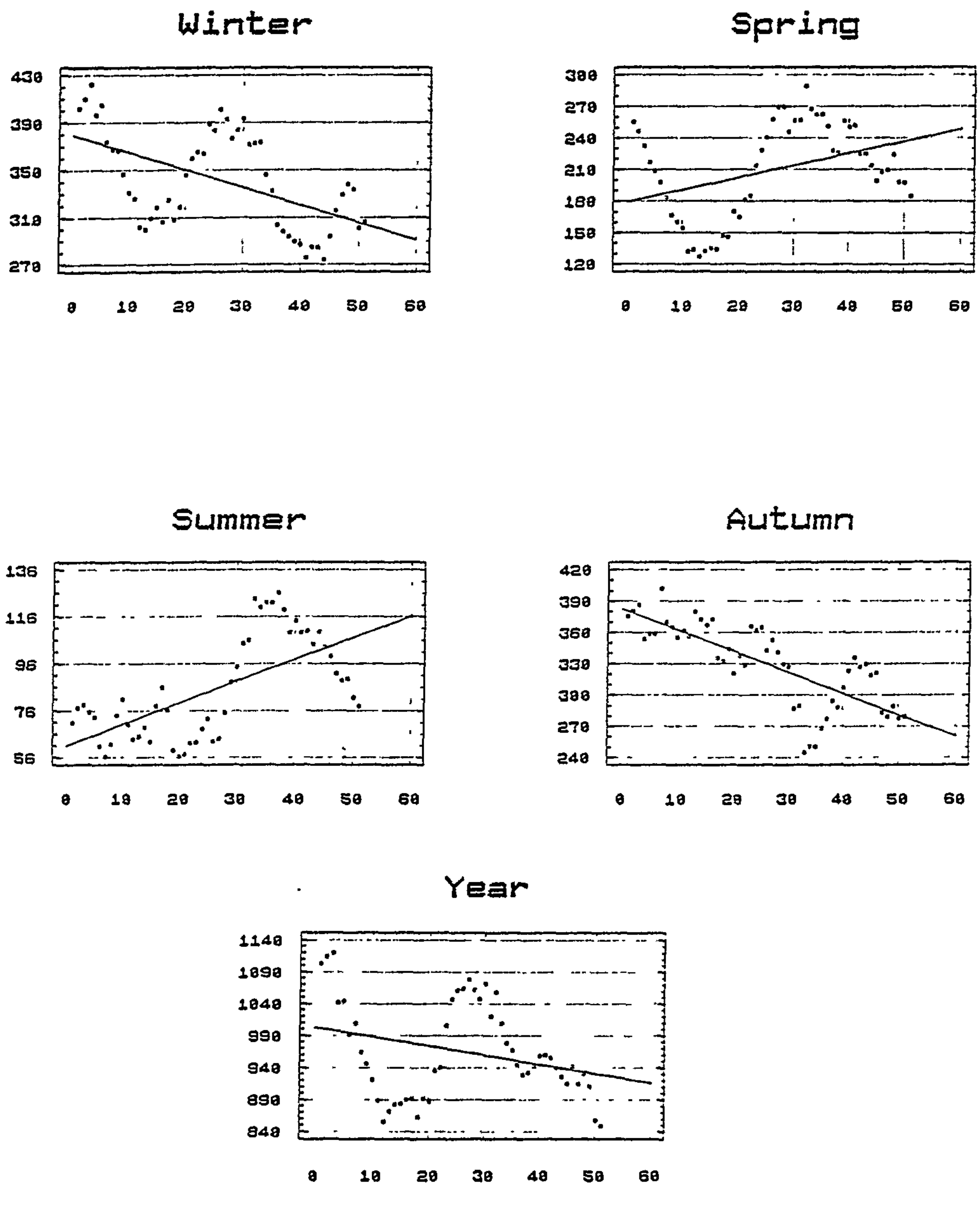


Figure 9 - Ten-year running mean and trend of precipitation for Durrës for 1931-1990

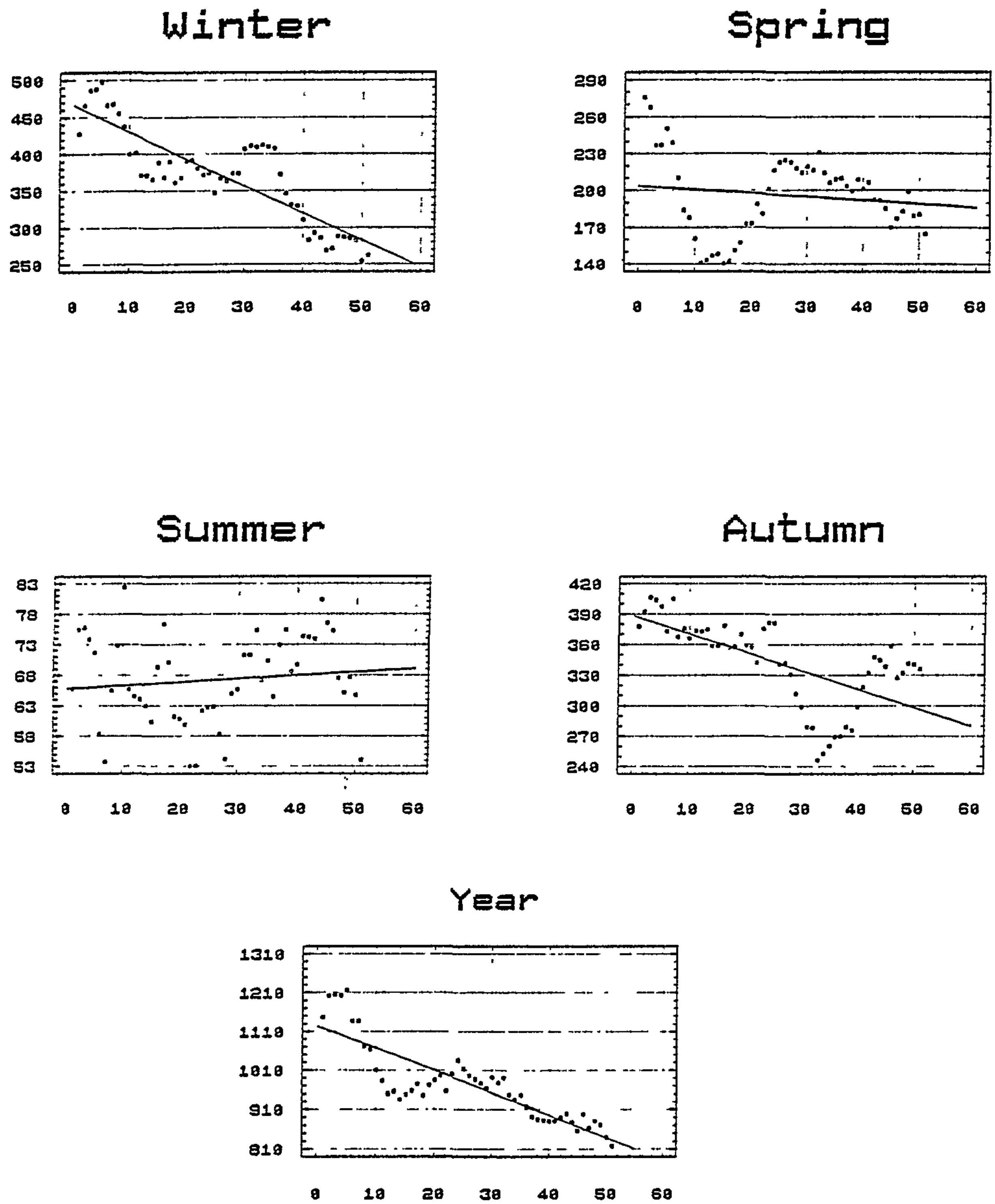


Figure 10 - Ten-year running mean and trend of precipitation for Vlora for 1931-1990

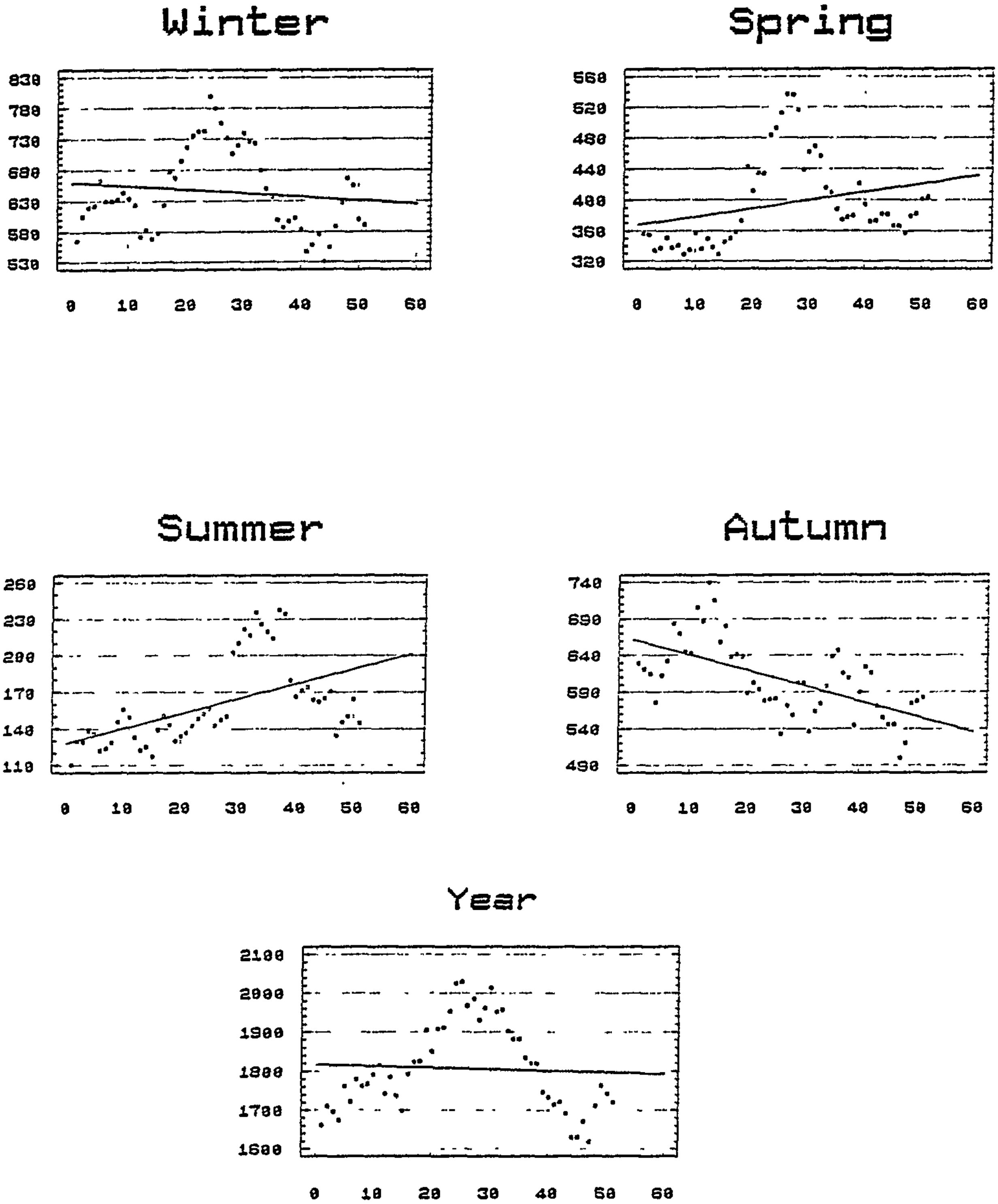


Figure 11 - Ten-year running mean and trend of precipitation for Shkodra for 1931-1990

2.1.5. Winds

The wind field depends on the distribution of the pressure gradients as well as the local topography (Figs. 12, 13).

The prevailing direction at the Tirana station in January, when the influence of the sea breeze is weak, is south-east and north-west, but depends on the orientation of the valley in which it is situated. At Shkodra and Vlora, eastern winds predominate (Fig. 12). A distinct frequent increment of western and north-western winds is observed in July when the sea breeze dominates the wind field (Fig. 13).

The influence of sea breeze is felt up to the inner part of the study area; it is a cool and moist wind (HMI, 1985).

The mean annual wind speed varies from $1.3 m.s^{-1}$ in Tirana to $3.6 m.s^{-1}$ in Durrës. Higher values are observed in winter, whereas the lowest ones are observed in summer when the anticyclonic weather predominates, relative to the other seasons. The highest wind speeds are observed when the wind is blowing from the sea. Strong winds are registered in this area, especially near the seaside, where wind speed reaches 35 - $40 m.s^{-1}$.

Seasonally characteristic winds (except sea breeze) are the bora which blows in the northern part of the area, up to Lac city. It is a dry and cold wind that reaches speeds of 25-$30 m.s^{-1}$ and is observed in winter (HMI, 1985). The sirocco is a warm wind and brings about weather deterioration; it generally blows from the south and south-west.

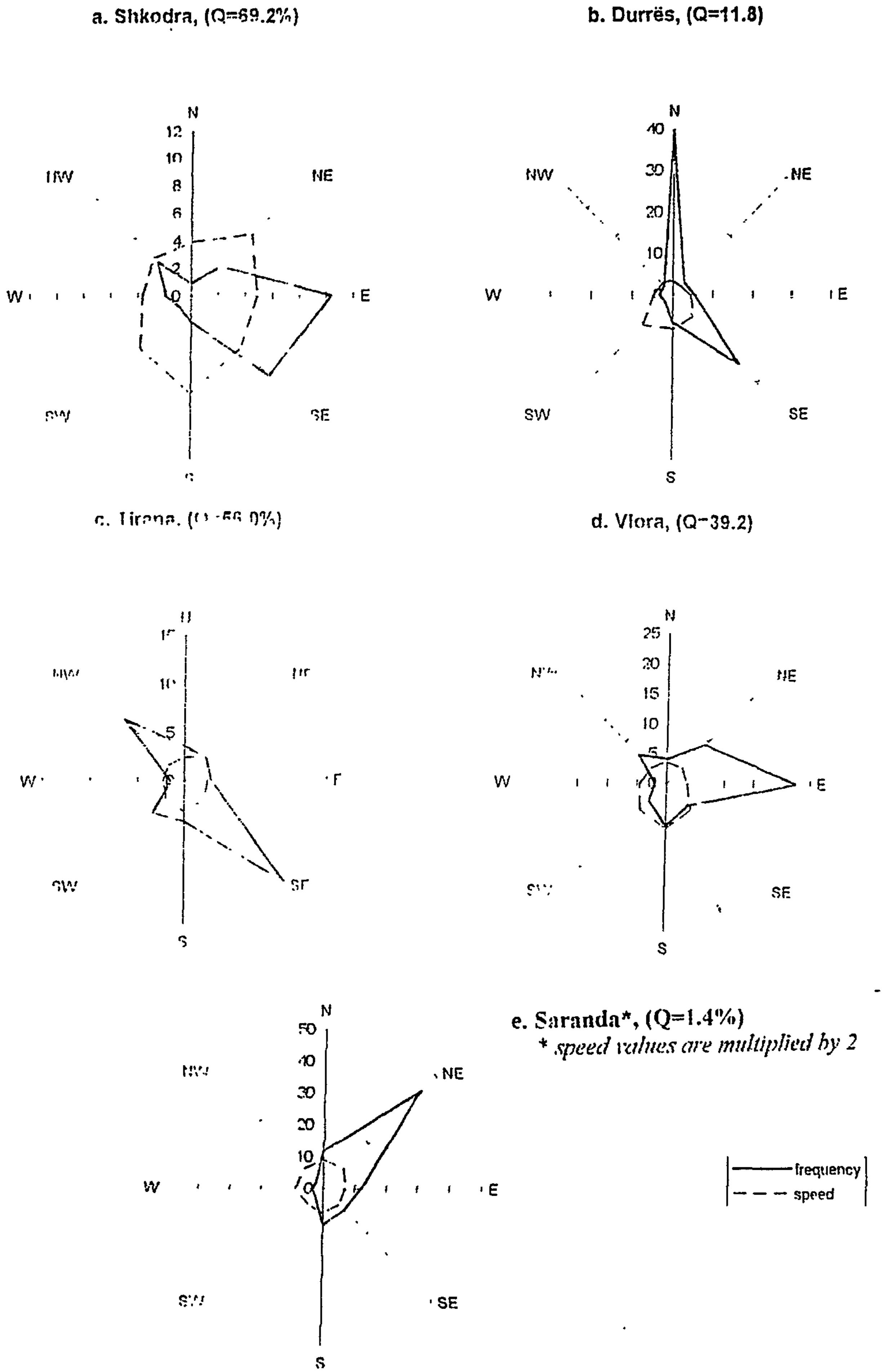


Figure 12 - January wind roses for 1961-1990
(speed - ms^{-1}, frequency - %)

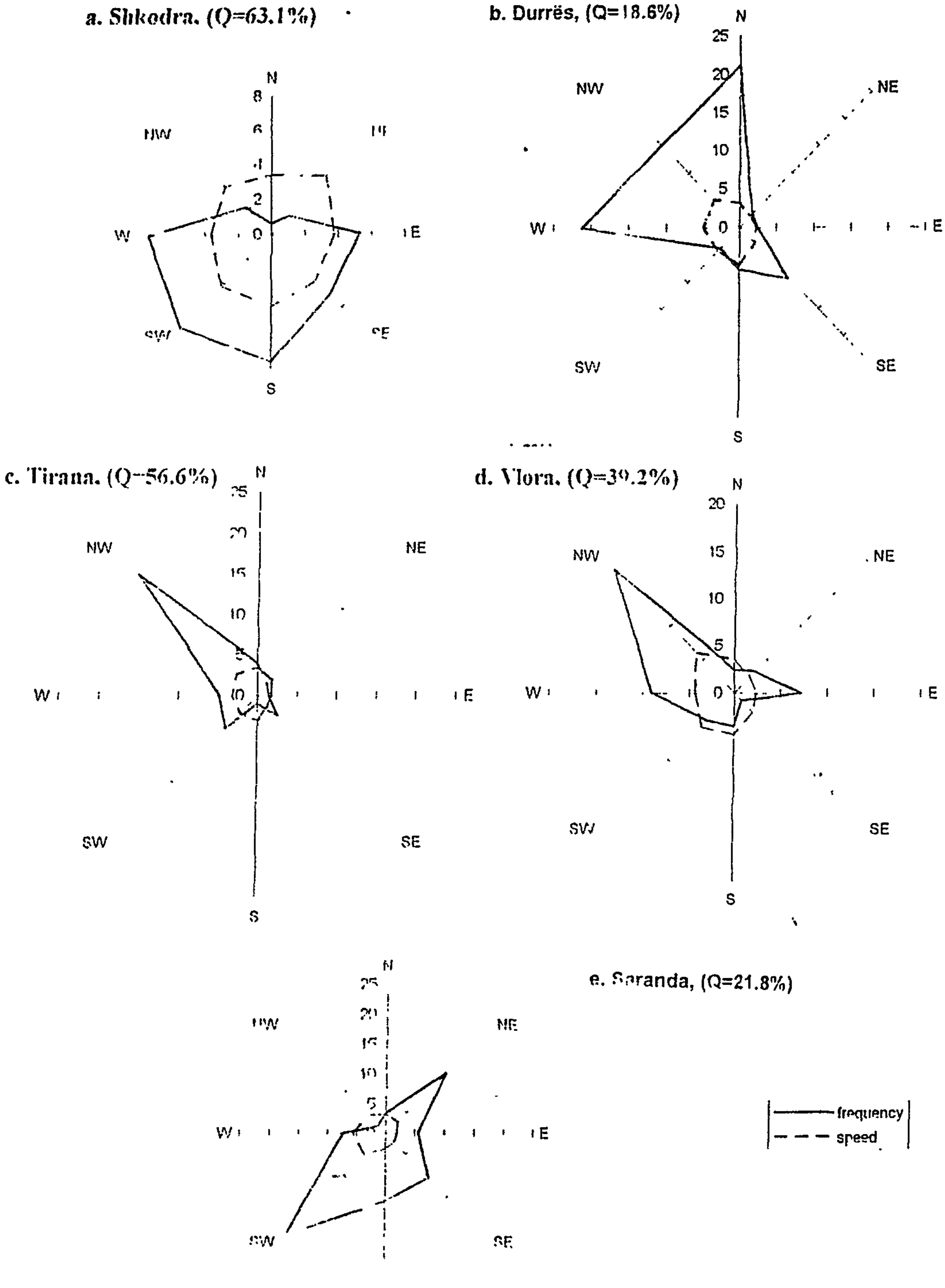


Figure 13 - July wind roses for 1961-1990
(speed - ms^{-1}, frequency - %)

2.1.6. Other meteorological parameters

Global radiation

This has an important role in radiation balance. Since it is related to the solar radiation and to the sun's elevation in relation to latitude, the maximum values are recorded in summer and the minimum ones in winter (Table 7).

Sunshine

Table 8 indicates that the Albanian coast has a considerable number of hours of sunshine. The maximum number of hours recorded in summer is 370 hours per month and the minimum in the winter is 105 hours per month. This means that the area is of interest from a touristic point of view.

Cloudiness

The average cloudiness in the winter is at the 6/10 level in this region (60%). Table 9 shows 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

Snow is a rare phenomenon for most of this region. It must be considered an extraordinary event. The maximum number of snowy days (3 - 5 days per year) is observed over the northern part, whereas the minimum is over the south (less than 1 day per year). The maximum thickness of snow recorded in severe winters is 40cm at Shkodra, 5cm at Durrës, 15cm Tirana and 9cm at Vlora.

Hail

Hail occurs during the year, particularly in winter. There is a mean of 3 - 8 hail days during the year.

TABLE 7

Global radiation ($kwh.m^{-2}d^{-1}$), by month for 1961-1990

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
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

Source: HMI, 1995

TABLE 8

Monthly hours of sunshine for 1961-1990

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Tirana	124.8	124.4	162.6	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	240.3	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

Source: HMI, 1995

TABLE 9

Mean monthly cloudiness (tenths) for 1961-1990

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
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

Source HMI, 1995

TABLE 10

Mean monthly and annual values of relative humidity (%) for 1961-1990

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Tirana	73	71	71	72	71	66	61	64	70	72	76	76	70
Shkodra	75	72	68	68	67	63	56	56	64	70	76	76	68
Vlora	67	66	67	68	68	64	62	63	67	68	69	68	66
Durrës	75	75	75	76	76	71	69	71	75	76	78	77	74

Source: HMI, 1995

Relative humidity of the air

This parameter has a simple annual curve. The maximum and minimum monthly values occur in the cold period (about 80%) and July (56%), respectively; the mean annual value is 70% (Table 10).

2.1.7 Extraordinary events

The climate of the study area is generally not characterised by extreme meteorological conditions. Nevertheless, cases of extreme events that cause significant damage to the economy cannot be discounted.

Heavy rain

Heavy rain falling for 24 hours over the Shkodra region on 2 October 1949 caused the flooding of a part of Shkodra city and the fields around it. The total precipitation registered that day was 398.0mm. The flooding of Myzeqeja field on 20 October 1981, when the precipitation was 344.7mm, may also be mentioned. During the time intervals 1, 2 and 6 hours, precipitation was 60.0, 100.0 and 233.4mm, respectively.

Strong winds

In the study area, strong winds are not uncommon. Sometimes, wind speed reaches $40 m.s^{-1}$ or higher. Such strong winds bring down high-tension pylons, uproot trees, cause damage to agriculture etc. The area between Lezha and Laci is particularly influenced by strong winds, which caused serious damage to pylons in 1966 and 1974.

Drought

Summer in Albania is dry and drought in some years has caused damage to agriculture. Such prolonged droughts occurred 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 much lower amounts of water, carbon dioxide, methane, hydrogen, ozone, etc.

Pollutants from human activity, which is more concentrated in urban areas, are also added to the atmosphere. This is favoured by the lack of atmospheric diffusion over 3000m above sealevel and of lateral diffusion, owing to geomorphological obstacles. On the other hand, the atmosphere is a self-purifying resource. For example, the oxygen is continuously replaced through photosynthesis at the expense of carbon dioxide, or precipitation scavenges dust particles and gases from the atmosphere. Small dust particles and aerosols filter sunlight, decreasing its amount, and they can affect 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 1953 - 1990. Ten-year running means and the trends for atmospheric pressure, hours of sunshine, cloud cover and relative humidity are presented in Figures 2, 14, 15 and 16.

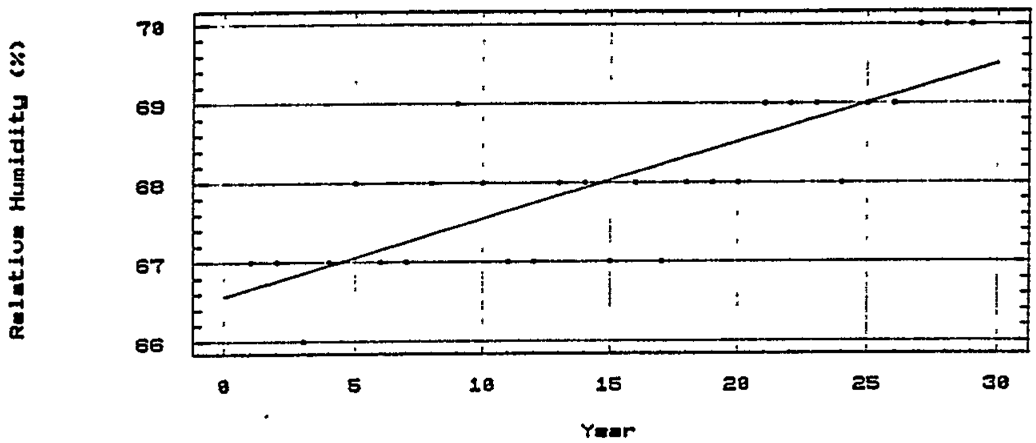


Figure 14 - The trend in relative humidity at the Tirana station (1953-1990)

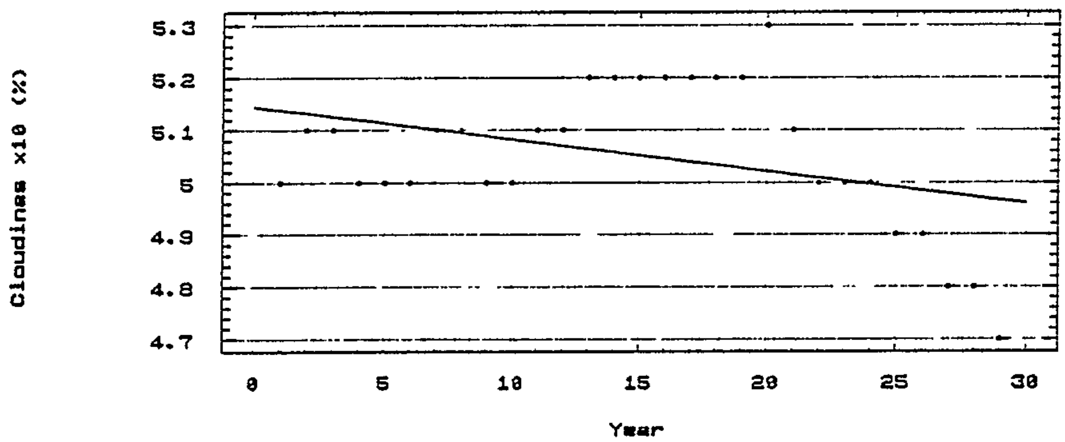


Figure 15 - The trend in cloudiness at the Tirana station (1953-1990)

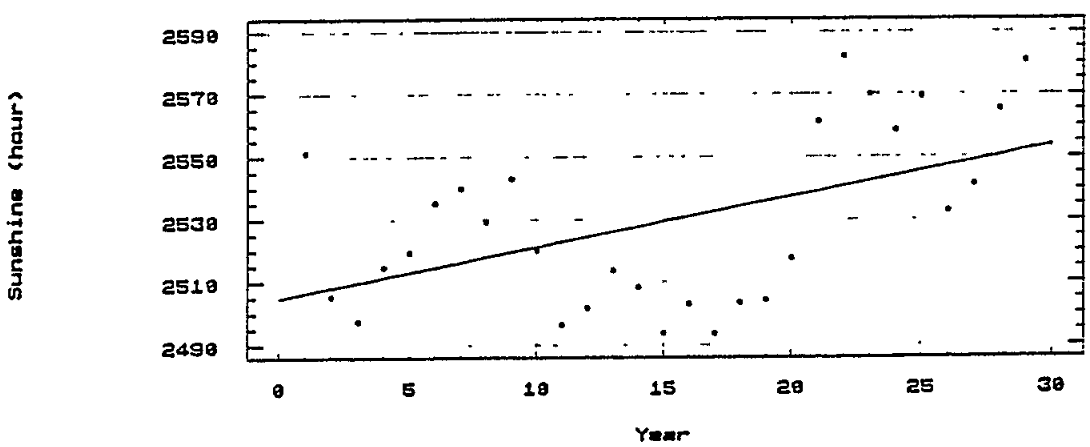


Figure 16 - The trend in daily hours of sunshine at the Tirana station (1953-1990)

The analysis of atmospheric pressure indicates an increasing trend (Fig. 12), which is linked with the increase in anticyclonic conditions over Albania and consequently with the increase in the incidence of low-level temperature inversions. This meteorological situation causes an increase in relative humidity (as can be seen from Figure 14). It also obstructs the dispersion of suspended particles, including pollutants, vertically and horizontally, because of the absence of winds.

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

Smog is present in the study area, especially over the big cities. Smog over Tirana may be seen every morning if the city is viewed from Mount Dajti. However, there is no routine observation of smog.

Fog is a rare phenomenon in the study area. The number of foggy days varies between 2 and 9 days per year on the eastern side. Usually, fog lasts no longer than 2 - 3 hours. In some cases, longer durations are observed, as in Shkodra on 9 February 1954 (15.5 hours), in Tirana on 29 January 1968 (11.7 hours), etc. (HMI, 1985).

Measurements in Tirana (for 1974 - 1984) show that the annual quantity of dust precipitated from the atmosphere is 90 $ton.km^{-2}$ (Dautaj and Xhelili, 1987). Owing to the drastic increase in the number of vehicles in recent years, the dust content of the atmosphere has increased considerably, but official measurements are not made.

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
Durrës	71.9	40.9
Lac	-	190.4
Fier	55.9	36.7
Vlora	54.3	16.4
Albanian health norms	50	150

Source: MHEP, 1990

2.2. Lithosphere

2.2.1. Geology

Being a constituent part of the Dinaric-Albanic-Hellenic arc, the following stages in the geologic-tectonic evolution of the Albanides can be observed: the late stage of the Varisic tectonics; the alpine rifting during the Lower and Middle Triassic; the oceanic opening during the Jurassic; the tectonic stages related to period limits, such as those between the Jurassic and the Cretaceous at the end of the Cretaceous, at the end of the Eocene, Oligocene, Pretortonian and Pliocene-Quaternary eras.

The magmatic activity of the 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 by the overthrusting, over-burdening and near-vertical block-like disjunctive faults. The Albanides are intersected by two main transverse faults: Shkodra-Peje and Fier-Elbasan-Diber (Aubovisi and Ndoaj, 1964).

The Albanides may be separated into inner and external parts. The inner Albanides are characterised by the extensive development of magmatism, but in the external part the magmatism is limited. The inner Albanides comprise the following tectonic zones: Korabi, Gashi and Mirdita. The external Albanides (Fig. 17) comprise the Albanian alps, Krasta-Cukali, Kruja, Ionian and Sazani zones (Shehu *et al.*, 1981).

The northern part of the study area, up to Durrës, consists of three types of lithological deposits (Aliaj, 1966):

(a) quaternary deposits, occupying extensively all coastal plains up to the foothills, up to 10m above sealevel;

(b) neogene deposits, mostly found in the chain of hills between Lac and Milot and at Rodoni Peninsula;

(c) Cretaceous and Jurasic deposits, occupying the Renci mountain range at the mountain border of the coastal region.

The general geomorphology of the northern coastal region is mainly characterised 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 three main shore types in this region: rocky shores (Shengjin up to Ishull Lezha), which consist of limestone with a few terrigenous materials and which are subject to erosion; river deltas; and sandy beaches with dunes (Velipoja, Shengjin, Kune Tale and Patoku areas). The sandy shore from Velipoja to Shengjin extends over 20km, while the Kune, Tale and Patoku beaches extend over 12, 3 and 5km, respectively.

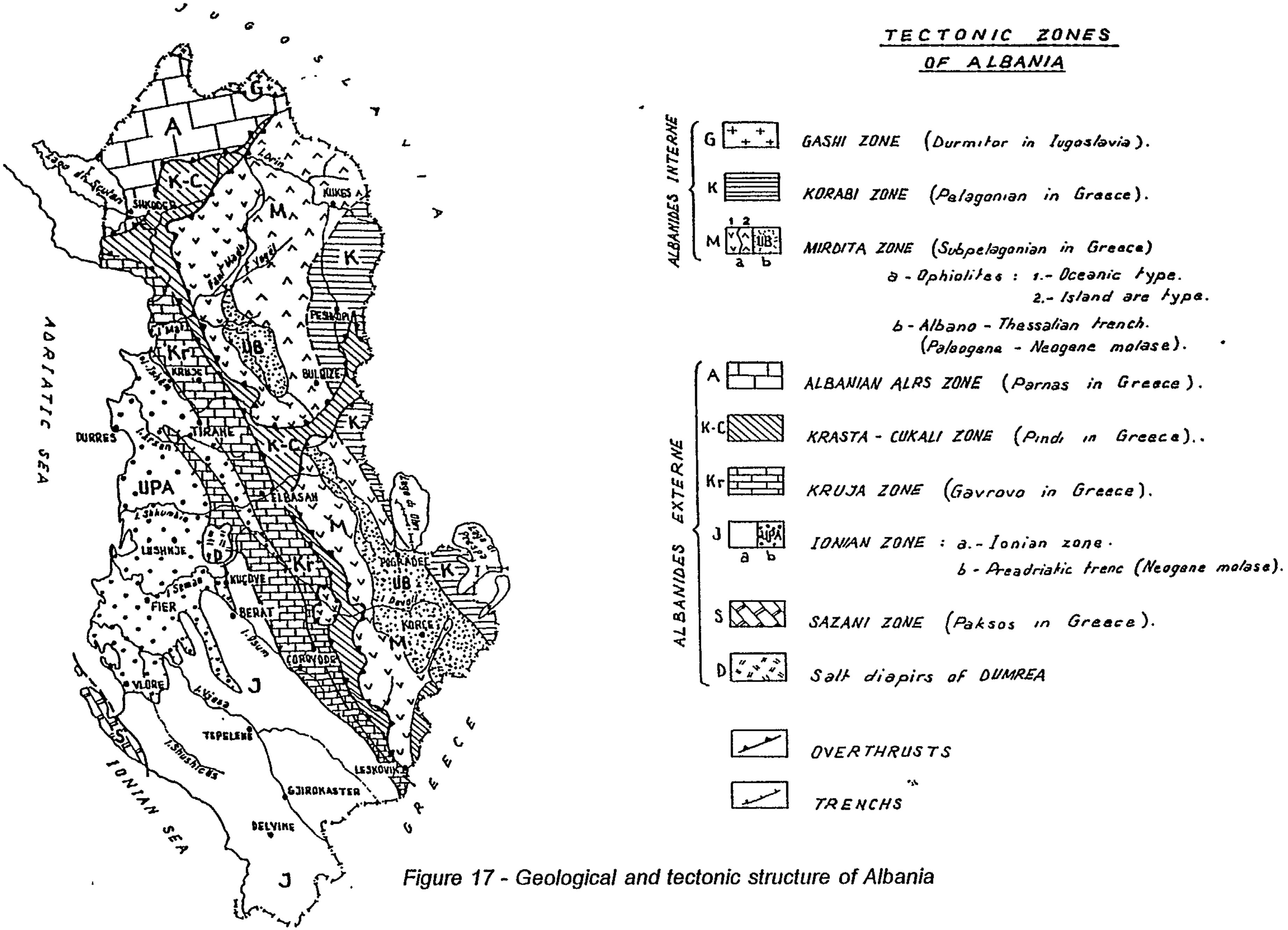


Figure 17 - Geological and tectonic structure of Albania

The central part of the coastline, from Durrës to Vlora, consists of beaches and cliffs. There are three types of beaches (Yzeiri and Bakia, 1980):

(a) permanent beaches created by solid deposits from rivers;

(b) beaches poorly fed from rivers (small in size, located inside bays or coves, always with a rocky backset); and

(c) residual beaches (originally formed by rivers at their mouths).

The cliffs are active (sea in direct contact with the rocks) or inactive (particularly protected from the sea by small beaches).

There are four physiographic units present in this coastal area:

(a) Ishëm river mouth-Cape Rodoni, consisting of mildly recessing cliffs (active cliffs). The low and medium-high cliffs are intersected by small lateral valleys. Their slopes are composed of soft terrigenous materials and therefore liable to erosion. To the right of the Erzeni river mouth is the remaining erosion zone in the Lalzi bay. The erosion tends to move southwards as a consequence of the shifting of the river mouth rather than the decreasing sediment transport;

(b) Bishti i Pallës - Durrës Cape is an unstable unit, since the beaches are attacked by erosion and the earth tends to slide down the cliff face. Progressive erosion has been observed at the beach between Karpen and Golem. The only stable section of the coastline is the one between Durrës harbour and Golem beach;

(c) Durrës Cape - Vlora Bay is the most dynamic part of the Albanian coast. The evolution of the coastline is linked to the fluvial dynamics of solid sediments, which cause the spreading of the river mouths, the beach advancement towards the sea, development of the sand dunes, etc; and

(d) Orikum plain is created by alluvial and marine deposits. Erosion has endangered the coastal road.

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

This area includes the following geological complexes:

(a) Quaternary deposits (Mursi plain and Butrinti lake);

(b) Neogene complex (between Piqerasi, Lukova and Nivica); and

(c) Cretaceous and Jurassic (carbonate rocks) and Neogene calcareous (limestone) rocks, including caves, wells and karstic formations.

The dynamics of the coastline are presented in Figure 18; almost 70% of the coastline is undergoing erosion (Konomi, 1994).

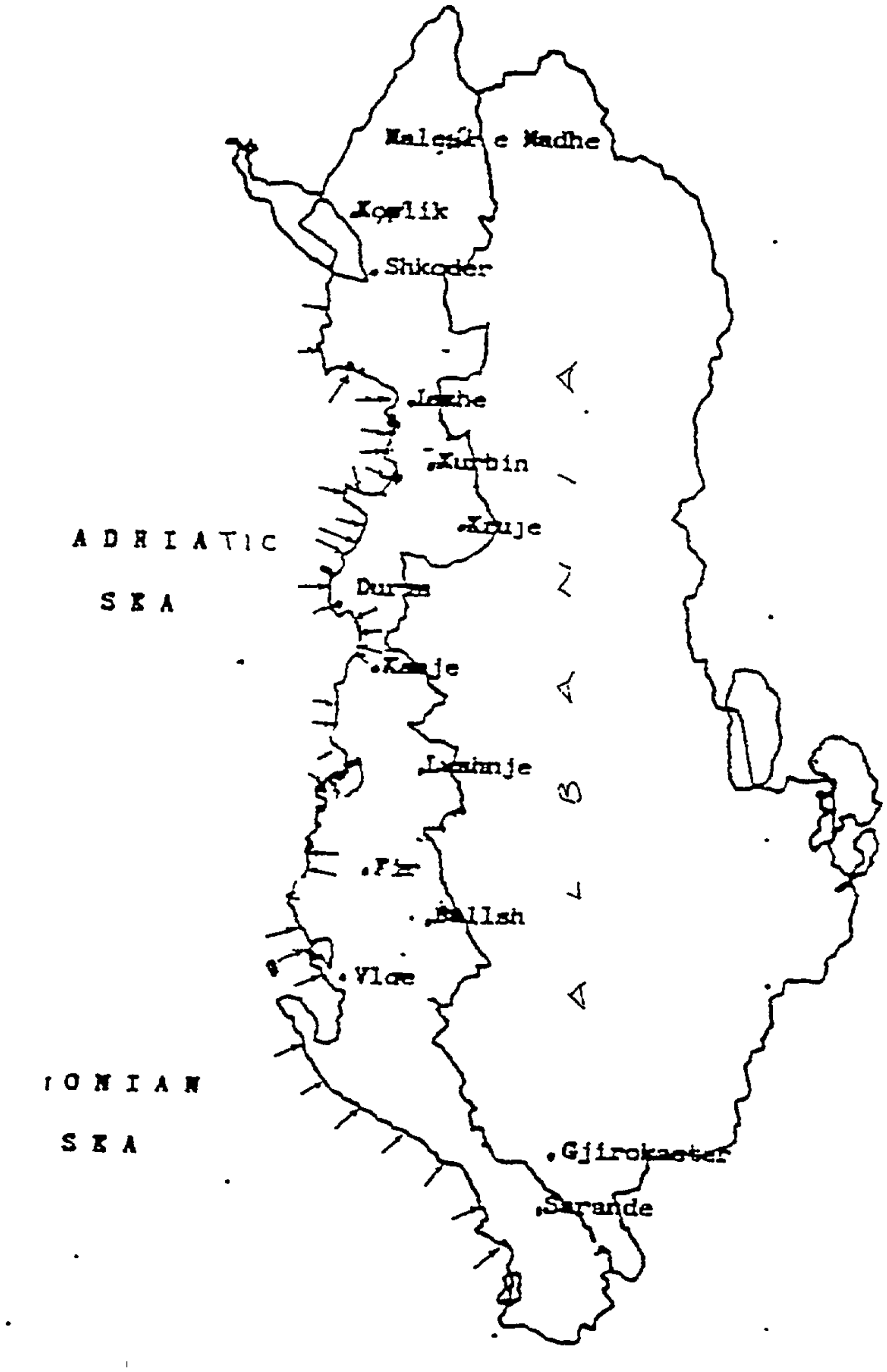


Figure 18 - Dynamics of the coastline

2.2.2 Soils

The loose sediments or soils are deposits of Quaternary age, which are widespread over the older rocks and consist of various genetic types (Fig. 19).

The alluvial deposits are spread along the river valleys passing through this area and lie generally in an east-west direction similar to the river flow. These deposits are clearly seen when drilling exploratory water wells. Their content is mainly gravel and sands which, in the terminal 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 180m.

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

Swampy and swampy-lagoon deposits are widespread in the western part of the depression and are of mixed character. They are encountered behind the dunes, in the Narta and Karavasta valleys and in the area of Durrës. These formations present an interleafing of clay and sub-clay layers with silt and sub-sand.

The prolluvion and delluvium deposits are less extensive than other kinds of deposits. They are more widespread in the inner part of the depression and over the slopes of hills surrounding the marine deposits. They originate from the weathering of the host rocks and the subsequent transportation of the resulting loose material over the bottom of the hill slopes. The thickness of such deposits varies over a wide range and can reach 10 or 20m.

Salinization

The saline soils in Albania lie in the western part of the coastal strip, especially in the Durrës, Hoxhare, Narte, Karavasta and Velipoje areas. They occupy about 35,000ha; about 20% of them have a high salt content (12 - 16%), the others having a medium or low salt content.

Physical analysis shows that saline soils have a different mechanical content if derived from sub-clays, compared to heavy clays. Heavy soils occupy about 35% of these areas, especially in Durrës, where clay accounts for 70 - 90%; the porosity is 50 - 55% and the volumetric mass is 1.3 - 1.5g.cm^{-3}. The salt content of these soils, as in the Durrës, Hoxhara Narte, Bregu i Mates areas, changes from 1% at the surface to 3.5% at 2.5m depth (Garo, 1985).

The soils of low or medium salinity, such as those at Lushnje, Berat, or Fier, have a 0.3 - 1.5% salt content. The soil near the coastline consists of chloride salts (ratio $Cl:SO_4$ is 6:1), whereas the soils far from the coastline have a higher sulphate content, the ratio $Cl:SO_4$ being about 3:1.

It should be stressed that salinization is a natural phenomenon in this region.

A map of the distribution of saline soils is given in Figure 20.

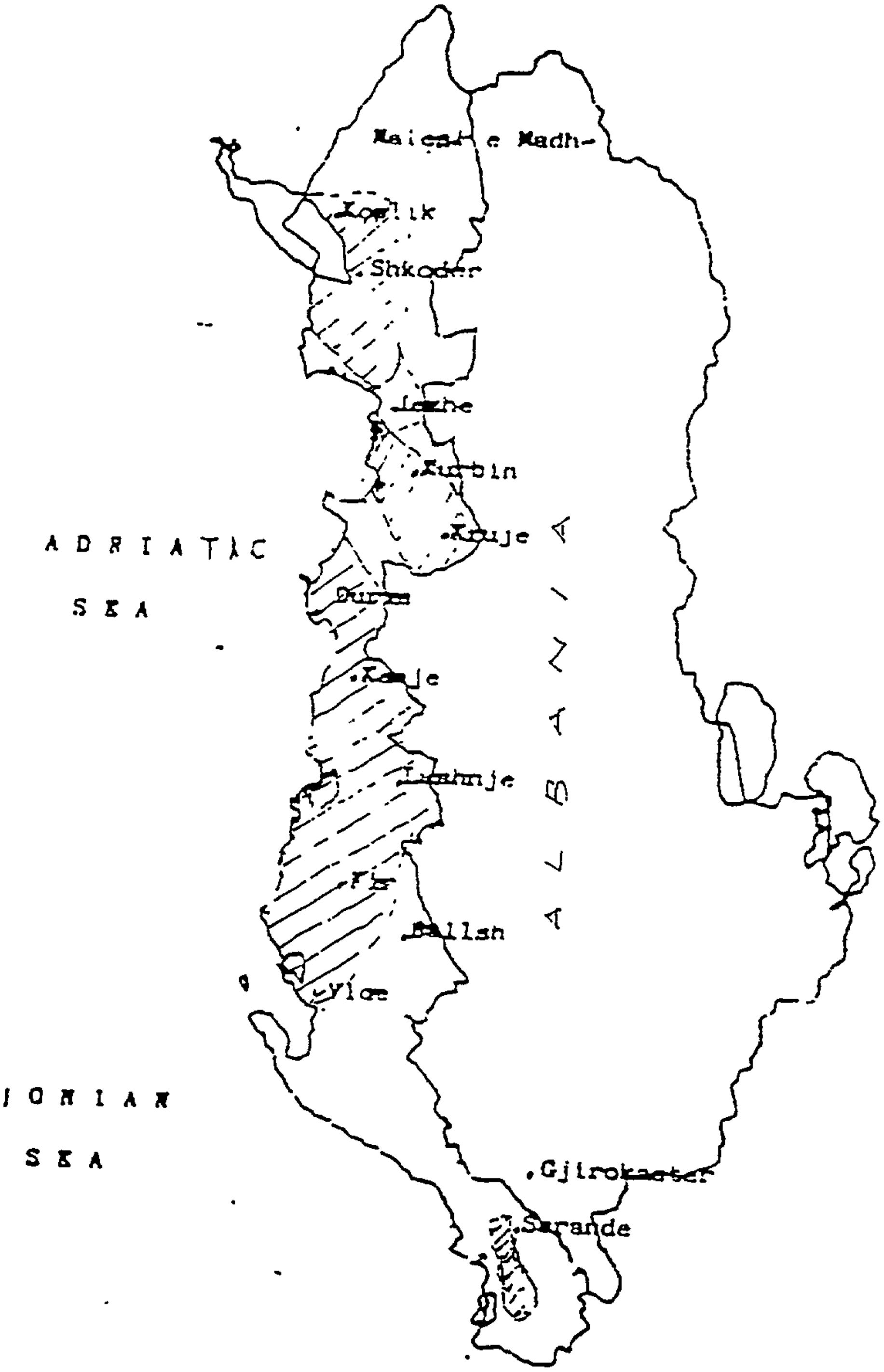


Figure 19 - The distribution of loose deposits

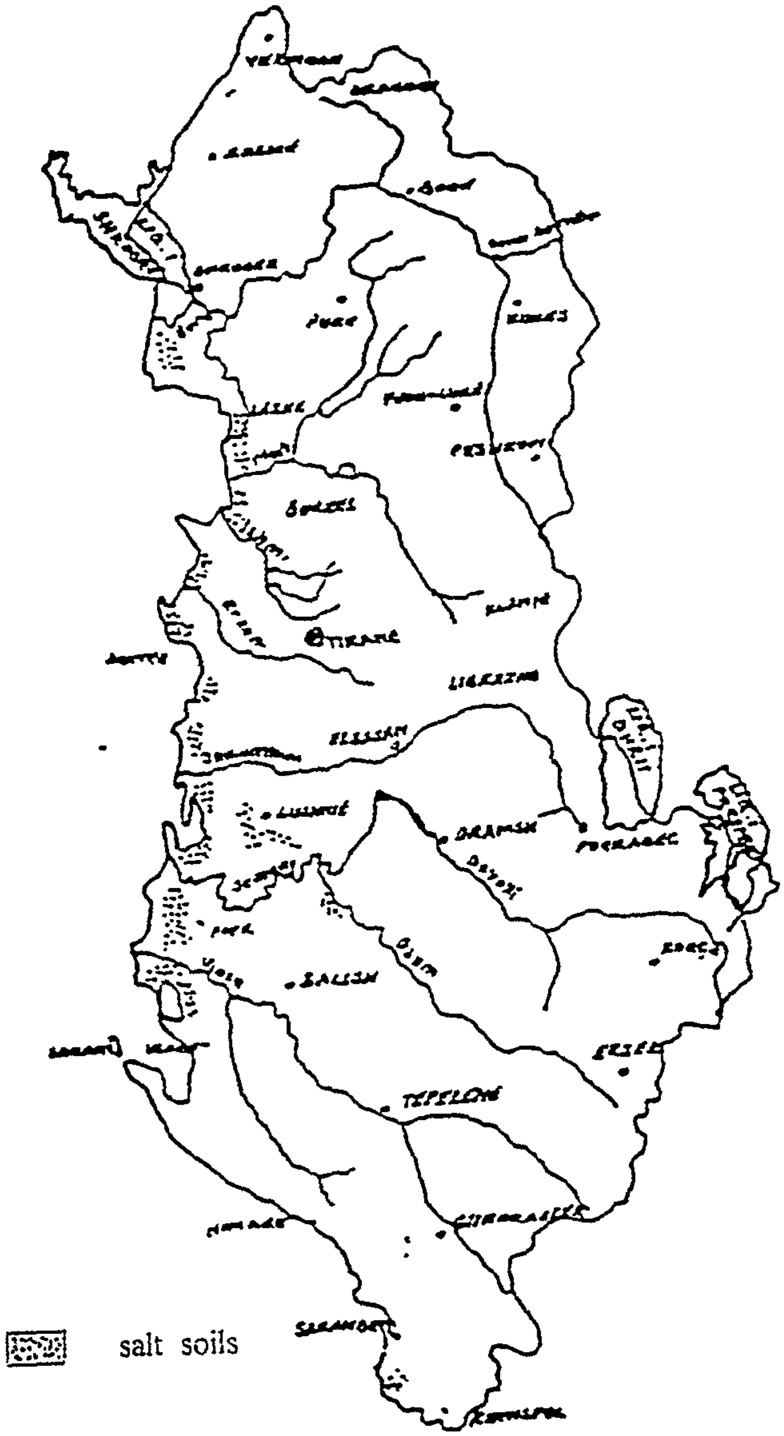


Figure 20 - The distribution of saline soils

2.3. Hydrosphere

2.3.1. Surface water

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

All the main rivers of Albania have the same direction: from east to west. In the coastal zone, the rivers run slowly downhill following a winding course until they reach the sea.

There are 32 hydrological stations in this zone. Some general characteristics of the hydrological stations at river mouths discharging into the sea are given in Table 12.

TABLE 12

General characteristics of the water flow into the sea

River basin	Area (km^2)	Station and period of measurements	Mean annual discharge ($m^3.s^{-1}$)	Mean annual volume ($m^3.10^6$)
Buna	19,582	Dajc (1958-1985)	675	21,263
Mati	2,441	Fani Rubik (1951-1986) Mati Shoshaj (1949-1987)	87.4	2,753
Ishmi	673	Sukth Vendas (1968-1992)	19.8	624
Erzeni	760	Sallmonaj (1949-1992)	16.9	532
Shkumbini	2,440	Rrogozhine (1948-1991)	58.7	1,849
Vjosa	6,710	Mifol (1948-1987)	189	5,954
Semani	5,649	Mbrostar (1948-1987)	86	2,709
Bistrica	447	Krane (1949-1987) Kalasa Blerim. (1949-1987)	32.1	1,011
Pavla	374	Bogaz (1951-1991)	6.7	210
Other rivers	4,028		72.1	2,271
Total	43,104		1,244	39,186

Source: HMI, 1995

During the wet period of the year, the total annual precipitation in the coastal area is lower than in the middle and upper parts of the catchment area. There is therefore a small contribution from this area to the water flow. The contribution of the rivers discharging into 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 rivers discharging into the sea (Fig. 22).

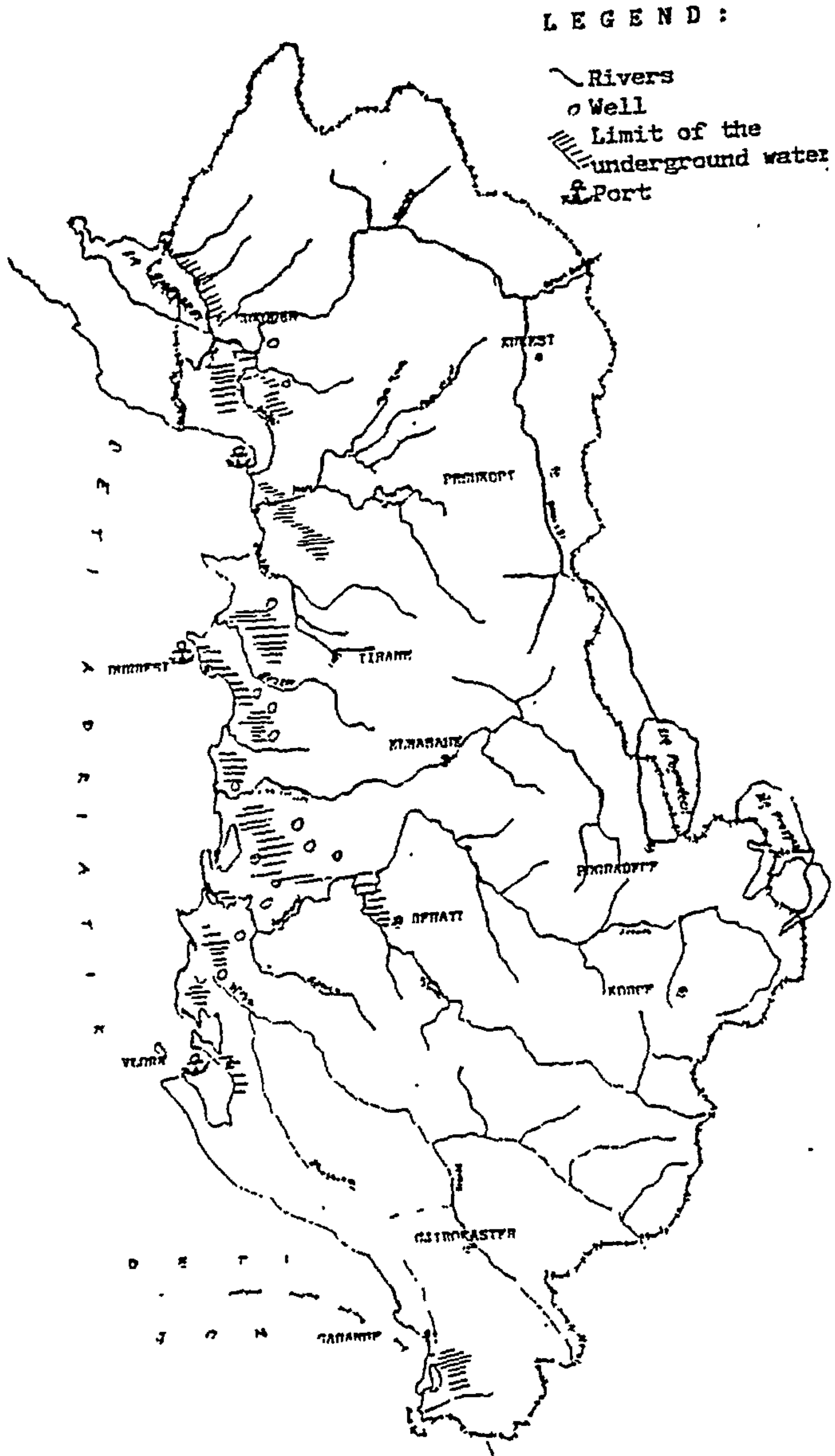


Figure 21 - Water resources of the Albanian coast

TABLE 13

Long-term mean water discharge and the distribution throughout the year

River basin	Disch. $m^3 s^{-1}$	Month												wet	dry
		X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X-V	VII-IX
Buna	675	420	723	1,053	1,037	859	851	899	899	575	334	214	238	6,741	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
Shkumbini	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	2,021	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
other rivers	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	1,244	704	1,396	1,981	1,973	1,834	1,696	1,685	1,499	885	493	341	407	12,768	1,241

Source: HMI, 1995

TABLE 14

Long-term water discharge (%) and the distribution throughout the year

River basin	Discharge %	Month												wet	dry
		X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X-V	VII-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
Shkumbini	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
other rivers	100	4.58	9.86	13.4	13.9	13.9	12.0	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

Source: HMI, 1995

TABLE 15

Long-term water-flow volume and the distribution throughout the year

River basin	Discharge m^3	Month												wet	dry
		X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X-V	VII-IX
Buna	21,263	1,103	1,898	2,764	2,722	2,255	2,234	2,360	2,360	1,509	877	562	625	17,696	2,064
Mati	2,753	126	305	402	360	360	328	326	245	127	57.5	43.3	75.6	2,452	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
Shkumbin	1,849	73	169	216	229	246	235	250	224	105	39.4	24.4	38.6	1,642	102
Vjosa	5,954	226	583	874	924	882	704	648	465	242	145	129	132	5,306	406
Semani	2,709	102	252	328	368	386	383	360	279	124	46.2	30.2	52.5	2,458	129
Bistrica	1,011	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
other rivers	2,271	104	224	305	315	315	273	251	199	112	61.7	47.8	64.6	1,986	174
Total	39,186	1,848	3,664	5,200	5,266	4,815	4,453	4,424	3,938	2,322	1,295	895	1,069	33,609	3,259

Source: HMI, 1995

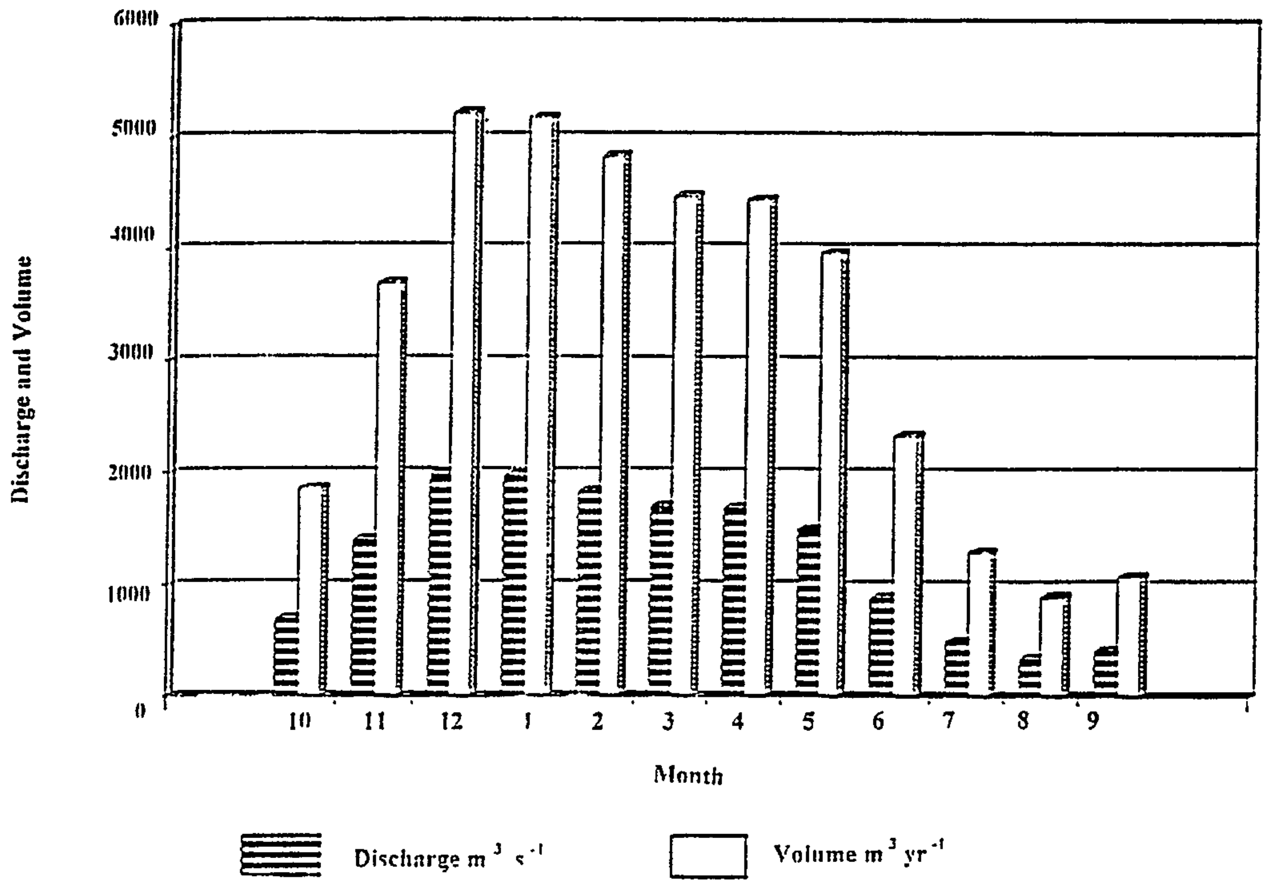


Figure 22 - Long-term monthly distribution of the total water flow

The long-term average discharge into the Mediterranean is $Q_o = 1{,}244\ m^3s^{-1}$. The total volume of water flow is $W_o = 39{,}186\ 10^6\ m^3$ per year.

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

There are two characteristic periods in the year in terms of the water flow: the wet period (October-May) and the dry period (June-September). Eighty-six percent of the annual water flow is discharged during the wet period and 8%, during the dry period. June is a transition period accounting for 6% of the annual water flow; 39% occurs in the winter, 33% in the spring, 17% in the autumn and 11% in the summer. The month with the highest value of water flow is December (13.3% of annual water flow), followed by January (13.2%) and February (12.3%). The month with the lowest water flow is August, with 2.29%. Water flow represents the water potential that the Albanian catchment area discharges into the Mediterranean Sea. It varies within wide limits, from $19.5\ 10^9\ m^3$ in a dry year (P = 99%) to $73\ 10^9\ m^3$ in a wet year (P = 1%). The coefficient of variation is 0.30 (Tables 16 and 17).

TABLE 16

The parameters of the probability distribution for annual water flow (discharge)

River basin	Disch. $m^3.s^{-1}$	Probability (%)											
		1	2	5	10	20	50	75	90	95	98	99	CV
Buna	675	1,212	1,120	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
Shkumbini	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
Bistrica	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
other rivers	72.1	126	117	106	97.6	88.0	69.9	58.2	49	42.9	38.1	35.8	0.270
Total	1,244	2,317	2,130	1,890	1,714	1,509	1,200	972	839	757	667	620	0.297

Source: HMI, 1995

TABLE 17

The parameters of the probability distribution of the annual water flow (volume)

River basin	Volume $m^3.10^6$	Probability (%)											CV
		1	2	5	10	20	50	75	90	95	98	99	
Buna	21,263	38,178	35,280	31,437	28,760	25,641	20,633	16,601	14,774	13,325	11,876	11,088	0.244
Mati	2,753	4,253	4,064	3,780	3,528	3,213	2,700	2,340	2,038	1,871	1,704	1,597	0.210
Ishmi	624	1,329	1,181	1,040	917	784	592	469	378	334	294	268	0.343
Erzeni	532	1,203	1,077	920	803	680	498	391	309	269	231	206	0.364
Shkumbini	1,849	3,906	3,528	3,093	2,741	2,262	1,745	1,355	1,112	967	838	756	0.324
Vjosa	5,954	12,159	11,025	9,608	8,505	7,308	5,701	4,599	3,780	3,402	2,961	2,731	0.297
Semani	2,709	5,796	5,229	4,505	4,032	3,434	2,558	2,000	1,619	1,547	1,200	1,090	0.329
Bistrica	1,011	1,651	1,528	1,405	1,285	1,172	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
Others	2,271	3,969	3,686	3339	3,074	2,772	2,202	1,833	1,544	1,351	1,200	1,128	0.270
Total	39,186	72,986	67,095	59,535	53,991	47,534	37,800	30,618	26,429	23,846	21,011	19,530	0.297

Source: HMI, 1995

Figure 23 shows clearly the annual variations of the total water flow discharged into the Mediterranean Sea. 1963 was the wettest year ($Q = 2{,}023 m^3 s^{-1}$) and 1954 was the driest ($Q = 704 m^3 s^{-1}$).

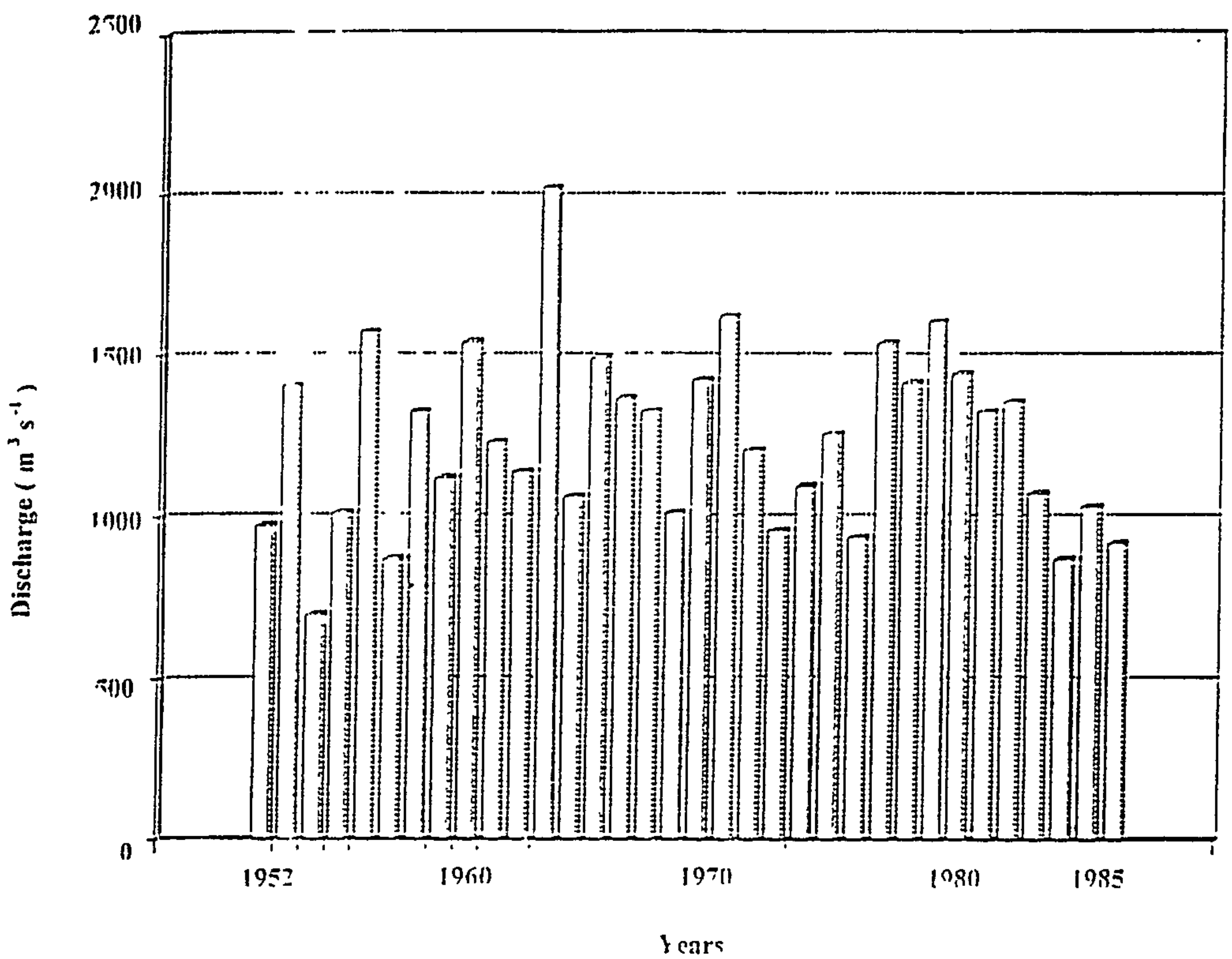


Figure 23 - Long-term average annual discharge of all rivers

There is a decreasing trend in the total water flow for 1952 - 1985. The slope of this trend is too small ($8.15 m^3 s^{-1}$ over 34 years) relative to the mean long-term water flow, which is $Q = 1{,}244 m^3 s^{-1}$. Precipitation has a significant effect on the water flow. The precipitation trend (see Figures 8 - 11) shows similar characteristics to the water-flow trend (Fig. 24), the lower the precipitation, the lower the water flow. The effect of the precipitation on the water balance is explicit.

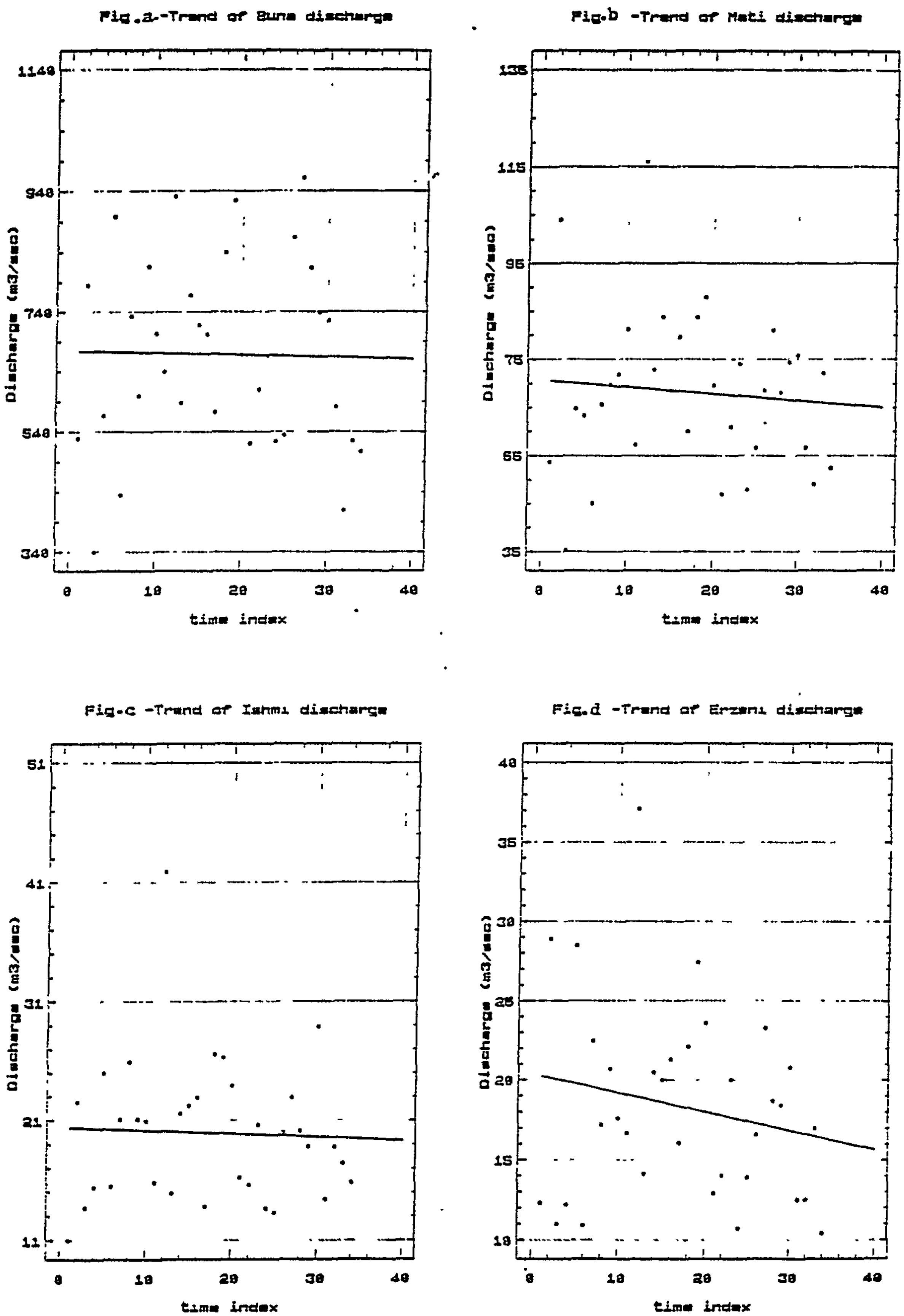


Figure 24 - Trend in the discharge of Albanian rivers (1951-1985)
a - Buna; b - Mati; c - Ishmi; d - Erzeni

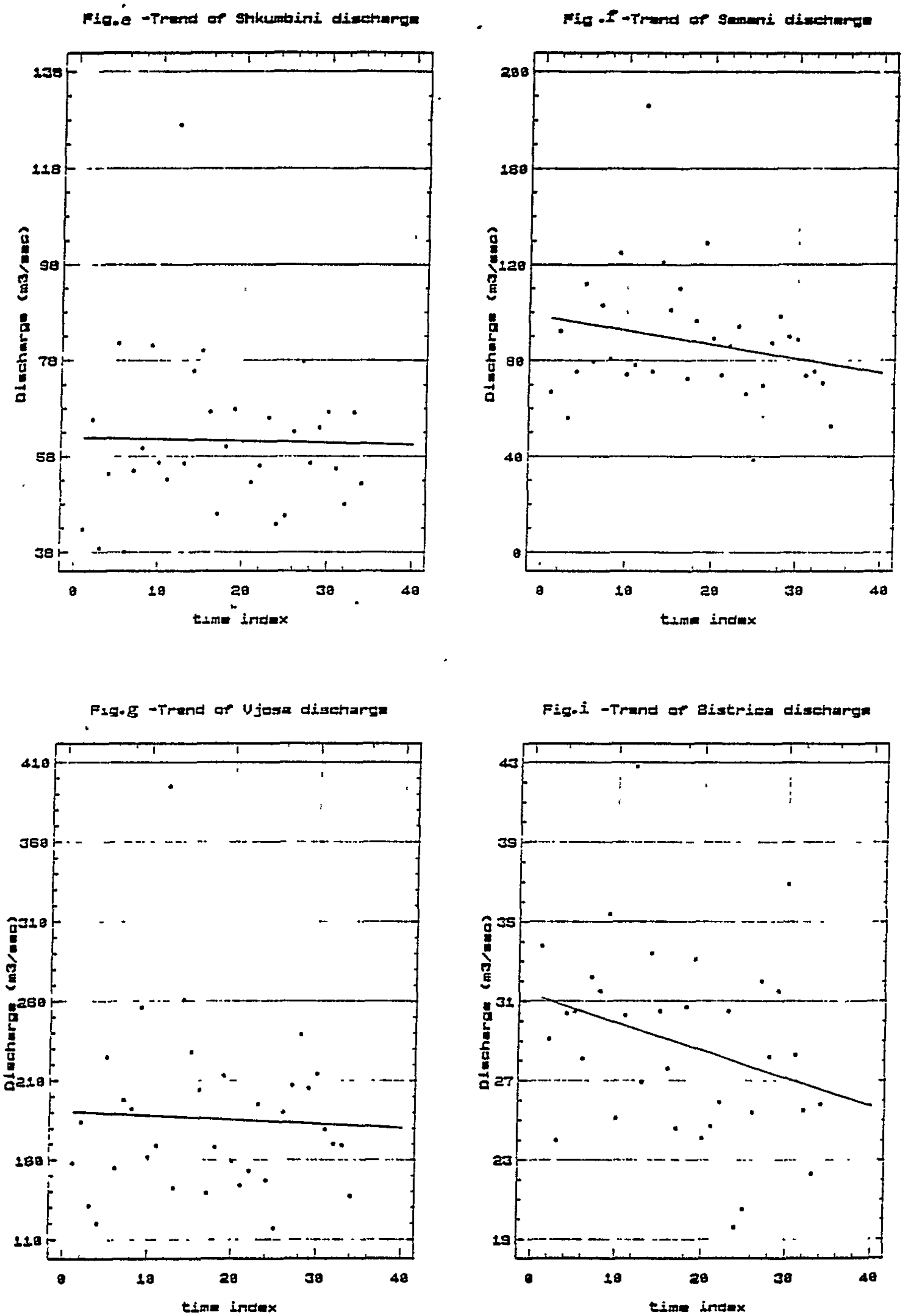


Figure 24 (continued) -
e - Shkumbini; f - Semani; g - Vjosa; i - Bistrica

Fig.k -Trend of Pavla discharge

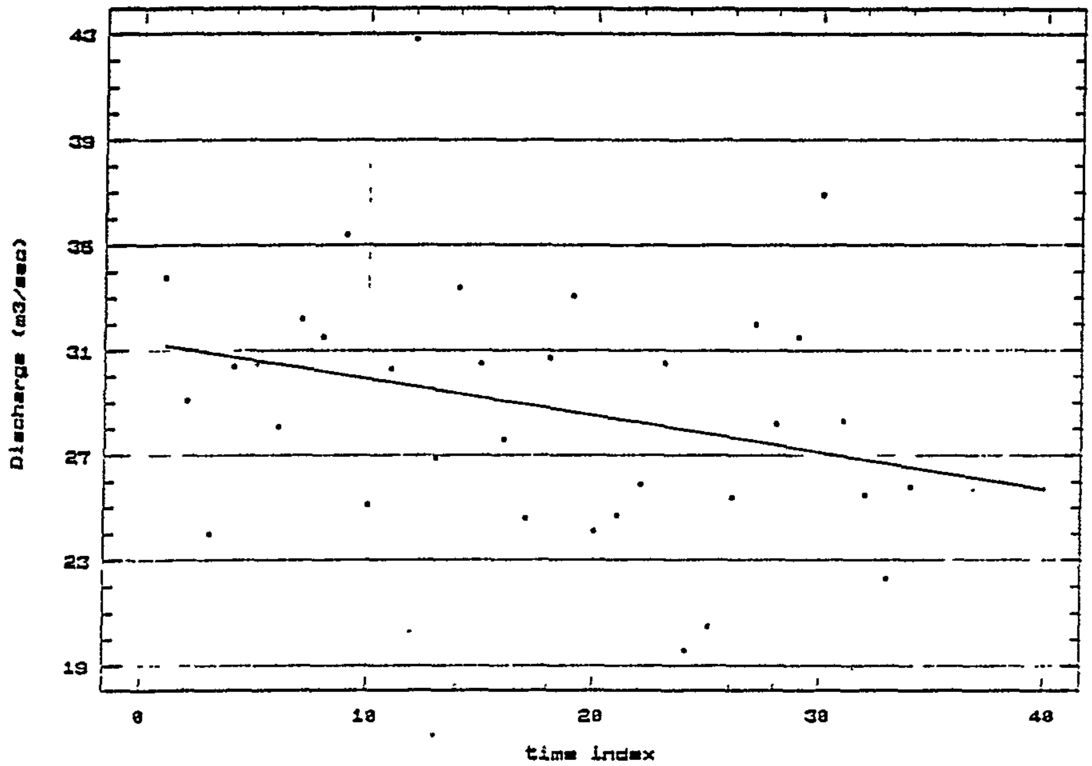


Fig.t Trend of Total discharge

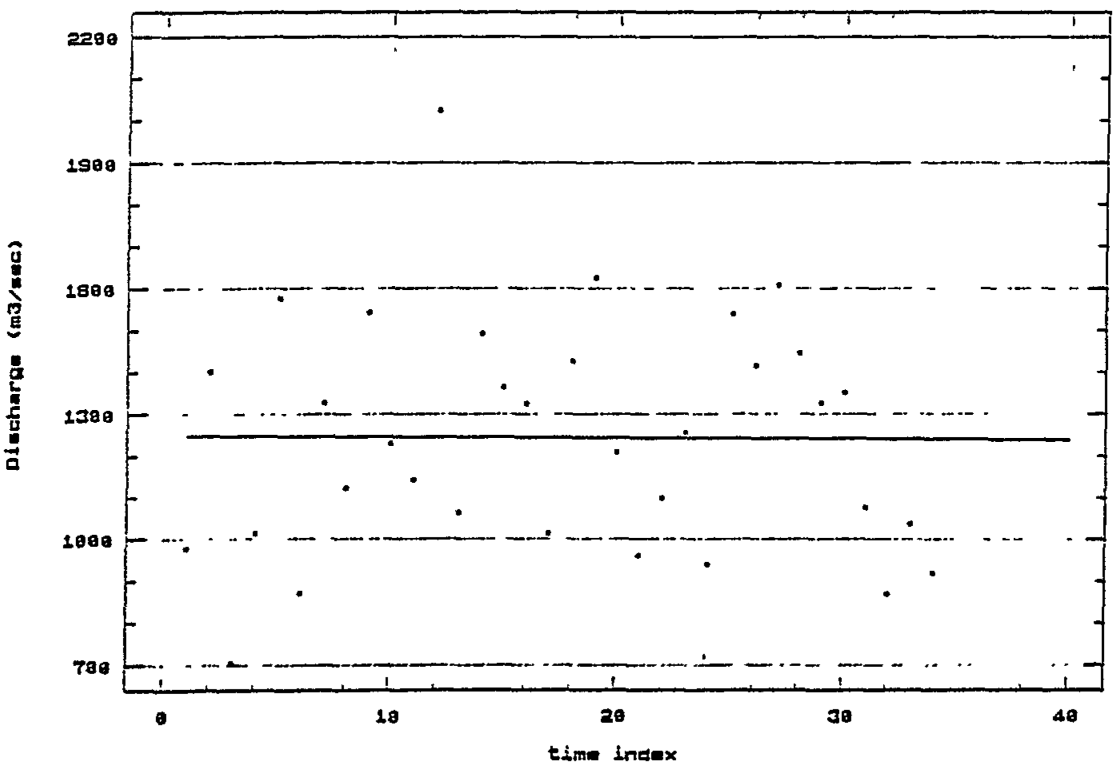


Figure 24 (continued) -
k - Pavla; t - total discharge

Temperature has an effect on the water flow as well, but this 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 evapotranspiration is low.

Although the precipitation and temperature are the main factors affecting water flow, Man's influence cannot be ignored. The building of artificial lakes has increased the evaporation surface as well as the evaporation value.

We do not have any method for distinguishing human influence from climatic effects on water flow. It is also important to keep in mind that the time series is about 40 years long, which is rather short to allow definite conclusions.

Consequently, there is no significant trend in the water flow (for 1952 - 1985), since the trend is lower than the standard deviation.

Suspended matter

The volume of suspended matter transported by river is $W_p = 3.2\ 10^6$ tons per year; 18% of it is discharged from the Drini river, 16% from the Semani and 13% from the Vjosa.

The average amount of suspended matter per square kilometre discharged per year into the Mediterranean Sea through the Albanian coastal zone is 480 tons. This fact indicates a high level of erosion in the catchment basin. The total volume of the suspended matter discharging annually into the Mediterranean Sea varies from $W_p = 2.57\ 10^6$ tons in dry years to $W_p = 16.64\ 10^6$ tons in wet years (Pano, 1984; Selenica, 1984).

Water quality

River water that is discharged into the Adriatic Sea belongs to the biocarbonated class and the calcium group. Biological Oxygen Demand (BOD) values are 0.5 - 2mg.l^{-1}. The waters of these rivers have a pH value from 7.2 to 8.4. The dissolved-oxygen value is 12mg.l^{-1} and the dissolved-CO_2 value is 15mg.l^{-1}. River waters are not aggressive (HMI, 1985).

To assess the impact of river pollution by industry on sea-water quality, monitoring is being carried out at the river mouths. The results show considerable quantities of nutrients and organic matter.

All domestic and industrial waste water is discharged into the rivers, the drainage system and the sea without any treatment, because there are no sewage-treatment facilities.

The results of pollution monitoring confirm that:

(a) the Buna river is contaminated by the Kiri river (Shkodra District), which contains carbonates, chlorides, alkaline hydroxides, sulphates, suspended matter and other organic matter;

(b) the Mati river is contaminated by copper production;

(c) the Tirana river, a part of the Ishmi river is very contaminated by industrial and domestic waste; the maximum observed BOD value is 100mg.l^{-1} oxygen, while the respective value for the Ishmi river is 5.0mg.l^{-1};

(d) the Erzeni river is less polluted than the above-mentioned rivers;

(e) the waste from the Metallurgical Combine in the Elbasani area and the disposal of city sewage into the Shkumbini river have brought about the heavy pollution of this river;

(f) the Semani river is heavily contaminated by industrial and municipal liquid waste from Ballsh, Patos and Fier cities as well as by leakage from the oil fields. Urban and industrial liquid wastes from the chemical fertiliser and power plants are discharged into the Gjanica river, a tributary of the Seman (UNEP, 1994e); and

(g) the Vjosa is the only major Albanian river that seems unpolluted by industrial or urban waste, but it is polluted by agricultural runoff (UNEP, 1994e).

Concerning the rivers discharging into the Ionian Sea, the state of pollution is not a problem. There are no big cities nor big industrial enterprises in this area. The climatic and geographical conditions are very different from those of the other part of the coastal area. There are two small rivers: Pavla and Bistrica. The mineralisation of these rivers decreases from the source to the mouth. The water has a high level of dissolved oxygen and, more important, the water of these rivers does not contain nitrogen or phosphorus. The only riverine influence on the Ionian Sea is the decrease in the salinity in this area. It was observed that, over a long period, the salinity of Saranda bay was about 20.

Consequently, pollution of the rivers affects the coastal area, particularly the shallow waters in the vicinity of the river mouths. The three rivers that largely contribute to the problem are the Ishmi, Shkumbini and Semani. Samples of water analysed in 1989 from the Buna, Mati, Erzeni and Vjosa rivers indicated that the level of pollution of these rivers was low and that they have not influenced the quality of the sea water (UNEP, 1994e).

2.3.2. Marine waters

Monthly variations in sealevel are caused by non-uniform influences on the hydrometeorological factors. There are five tide gauges located along the Albanian coast, at Shëngjin, Durrës, Vlora, Himara and Saranda.

The highest levels are observed during November-December because strong southern winds present at this time cause elevation of the sealevel. Lowest levels are observed during July-August which is the quietest period of the year (Fig. 25). The stability of the sealevel is of interest for practical statistical purposes (Fig. 26).

Of great importance to sealevel are extremes caused by strong winds blowing 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 minimum value of -60cm to the maximum one of +175cm (HMI, 1984).

Waves along the Albanian coast are generated by the deep area of the sea. Changes in wave patterns along the coast are mainly dependent on interaction between the wind and the sea surface where morphological characteristics play an important role as well.

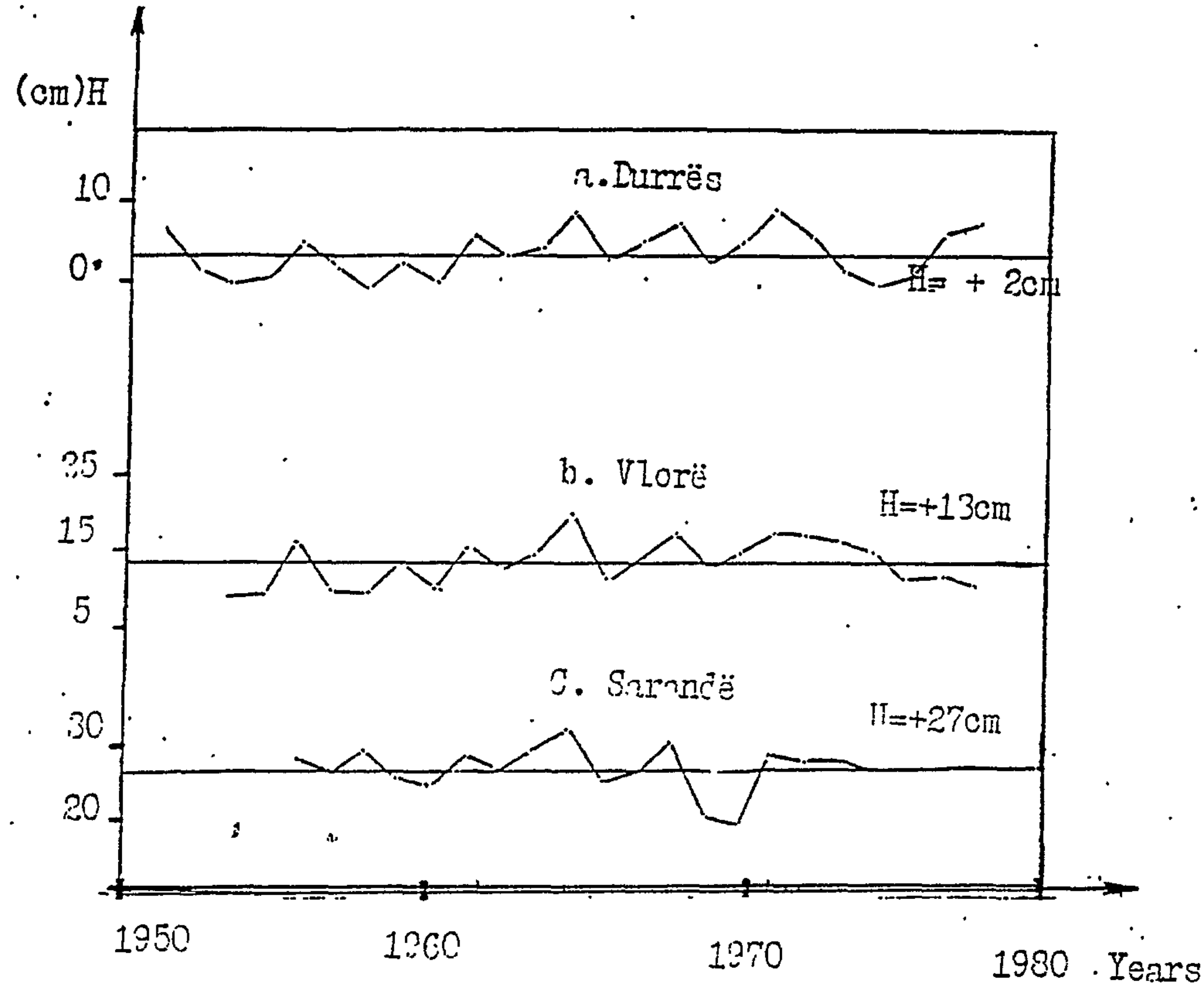


Figure 25 - Long-term variation of annual mean sealevel (1951-1985)

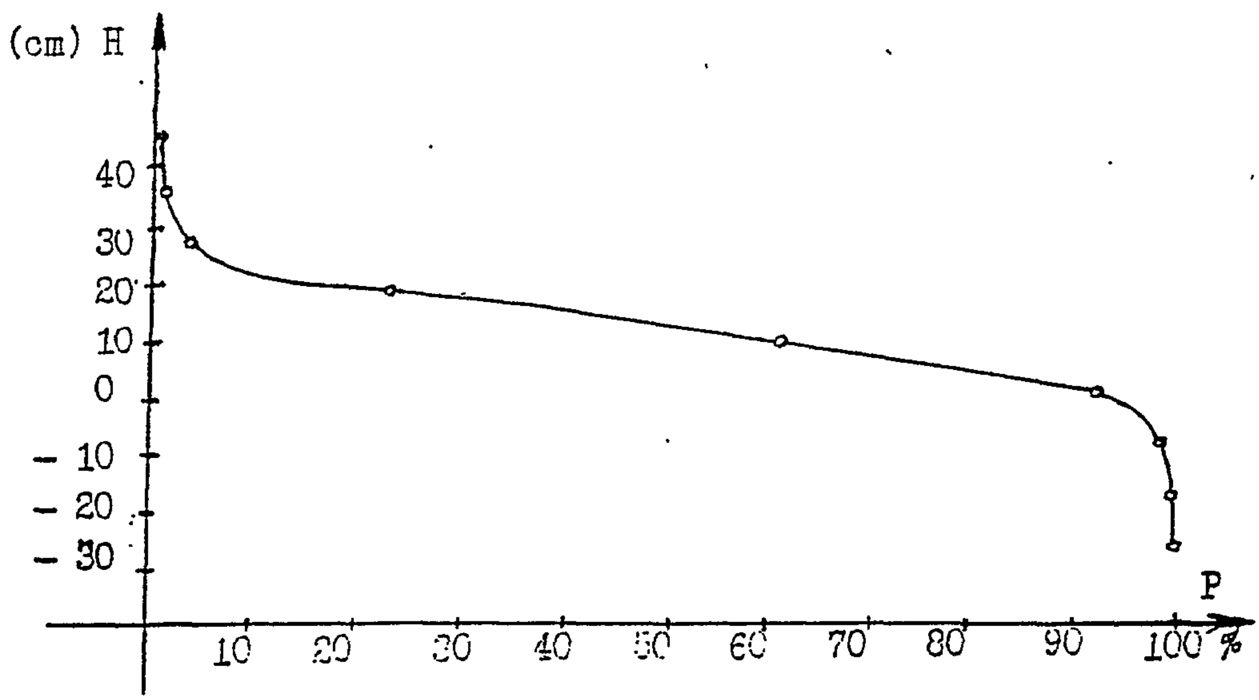


Figure 26 - The probability curve of daily mean sealevel

The SW and W directions appear to be dominated by waves with a height of over 0.5m, the highest waves coming from the SW. Wave height varies from 3.5m in the bays up to 4.5m in the open sea; wave length reaches 80m. The principal swell direction varies seasonally: WNW-NW (autumn-winter) and SW (summer-spring) (HMI, 1985). It creates littoral currents and sediment drift either to the north or to the south, in some places.

The tidal oscillations are irregular and their return period is 12 hours. The tides along the Albanian coast are weak. The mean daily tidal amplitude varies between 20cm and 30cm (HMI, 1985).

The tidal range is low (max. 30 - 50cm) and storm surges are infrequent. Seiche is calculated by means of an advanced explicit method of finite elements; the highest value reaches 35 - 55 minutes.

The temperature of the sea water is mainly determined by the solar radiation, but it is also subjected to the influence of fresh water, winds, marine currents, waves, etc. The highest temperatures are observed during July-August (Fig. 27) when the solar radiation is at its maximum, and minimal temperatures are observed in February (HMI, 1985; HMI, 1995).

The salinity of the sea water is 30 in winter and 39 in summer. The pH value varies between 8.05 and 8.40. The value of dissolved oxygen is 9.6mg.l^{-1} in summer and 12.0mg.l^{-1} in winter. This fact indicates the low level of biotic materials.

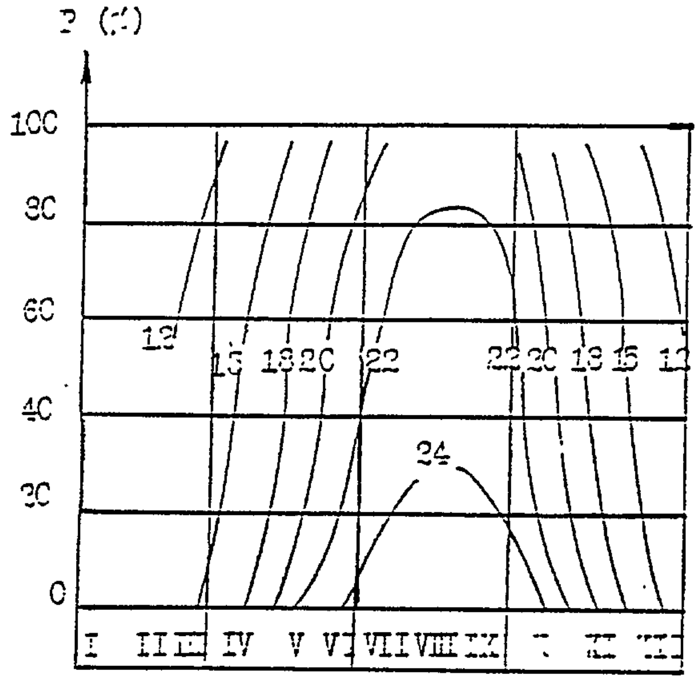


Figure 27 - Annual sea-water temperature variation

Dynamic processes

Dynamic processes operating in marine waters include the thermohaline circulation, water-mass formation and transformation, dispersion and mixing. The low-salinity water of Atlantic origin enters the Ionian and Adriatic Seas through the Strait of Sicily. As it circulates, driven by the wind and other forces, it disperses down to a depth of a few hundred metres. Deep-water formation occurs in the Adriatic Sea. The southern Adriatic, which is several hundred metres deep, serves as a site for this deep-water formation in winter. Very cold and dry air winds apparently cause deep convection throughout the water column. The details of this process are not yet known (Robinson, 1987). The newly formed deep water leaves the Adriatic through the strait of Otranto, plunges to the bottom and moves along the deep western boundary of the Ionian basin. The water formed in the Adriatic is a mixture of surface and intermediate water (Pinardi, 1988). The main current entering the Adriatic through the Otranto strait along the Albanian coast is deflected westwards towards the Italian coast. 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 annual harmonics in the curl of the wind stress.

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

The main Albanian coastal lagoons are the Karavasta, the Narta and the Butrinti lagoons.

The Karavasta lagoon has an area of 4180ha and is separated from the sea by a slimy narrow strip of sandy dunes. Its average depth is 0.8m and the maximum depth is 1.15m. Water passages connect the lagoon to the sea, but water exchange due to the tides may occur. This means that the lagoon water is saline. The water transport during one lagoon-seawater exchange cycle is about 20 - 30m^{3}s^{-1}. Time-series of Karavasta water temperature have the same pattern as that of the air temperature. Thermal advection also has a small influence. Owing to non-uniform dispersion of the waves, the salinity is 48 - 49 on the western side and about 60 on the northern and eastern sides (Fig. 28). The lowest value of dissolved oxygen (5.9 - 9.85mg.l^{-1}) in Karavasta lagoon corresponds to the dry period and the highest value (11.30 - 12.75mg.l^{-1}), to the wet and cold period of the year.

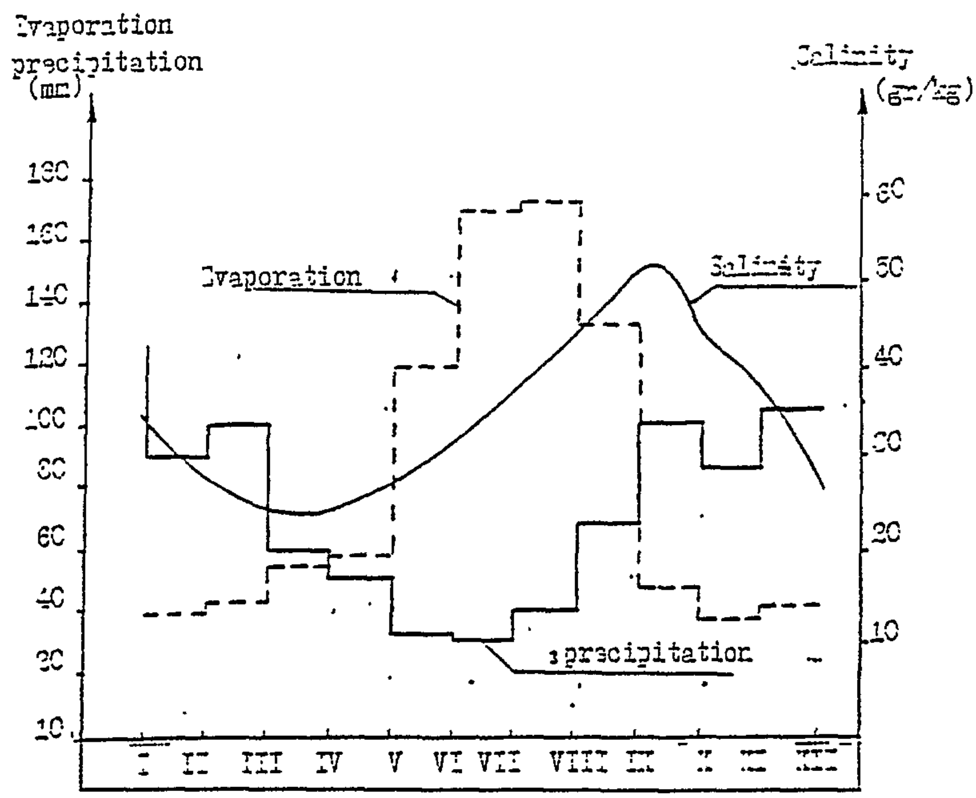


Figure 28 - Water level, precipitation, evaporation and salinity in Karavasta lagoon

The Narta lagoon has an area of 4500 ha. Owing to the high evaporation and the sea-lagoon water exchange, salinity varies from 36 (wet period) to 78.5 (dry period). Water-temperature variation follows that of air temperature (Fig. 29). The lagoon level is mainly determined by precipitation and evaporation but, during the wet period, only tides ensure the lagoon's existence.

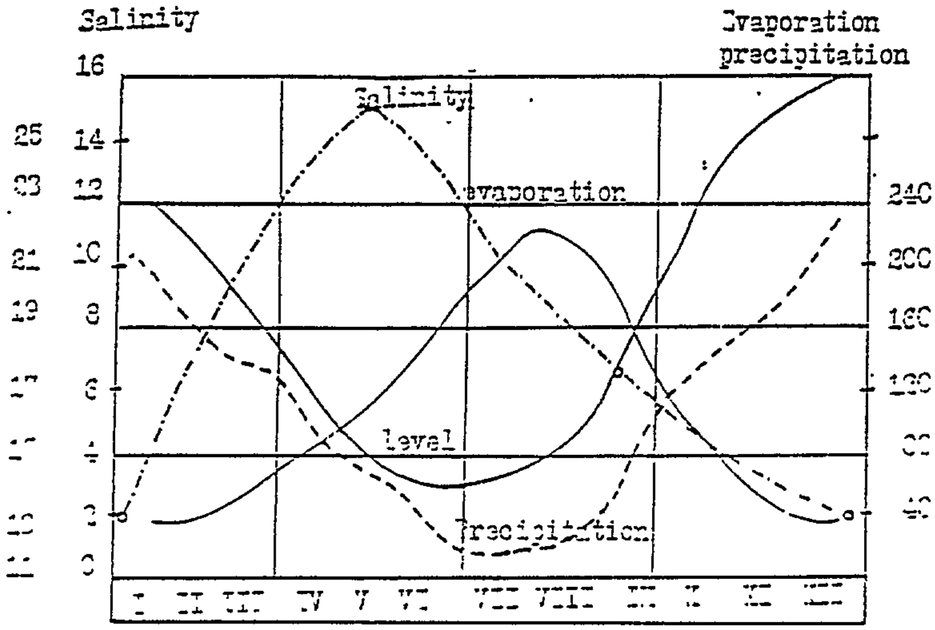


Figure 29 - Water level, precipitation, evaporation and salinity in Narta lagoon

Butrinti lagoon has an area of 1600ha 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 14m and a maximum depth of 21.4m. The Butrinti canal has a width of 80 - 160m and a depth of 6m. The water level undergoes fluctuations of up to 20cm due to the tide and meteorological factors. Salinity varies from 22 during the wet period to 26 in summer. Water temperature depends on the regional climate and on water mixing (Fig. 30). pH values vary from 8.7 (summer) to 10.2 (winter) and dissolved-oxygen is up to 7.2mg.l^{-1} in summer and 10.2mg.l^{-1} in winter (HMI,1985; HMI, 1995).

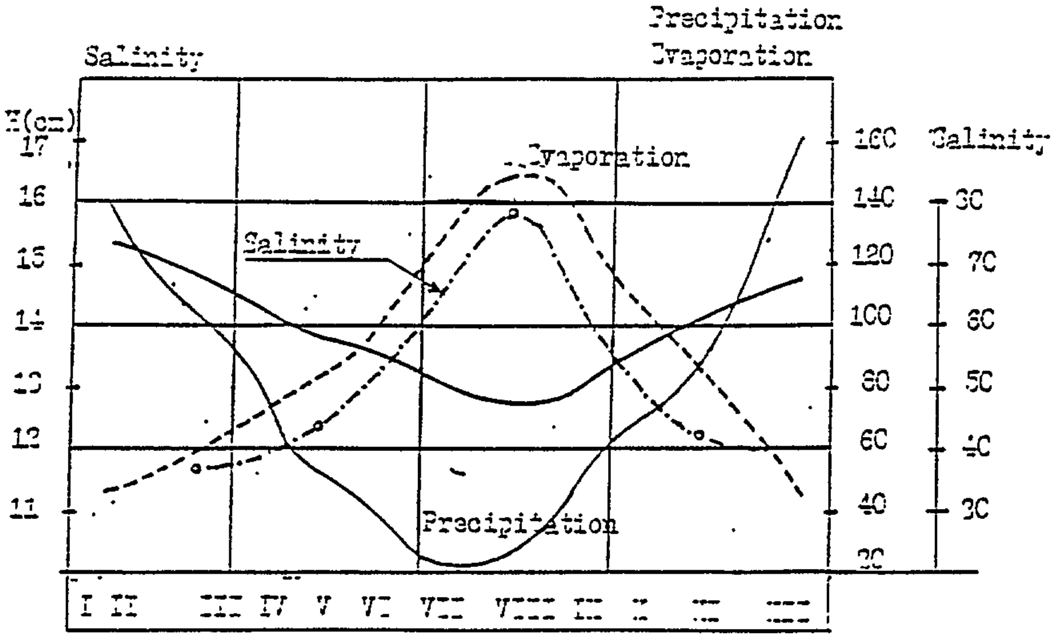


Figure 30 - Water level, precipitation, evaporation and salinity in Butrinti lagoon

2.3.3. Ground water

Ground water (here meaning unconfined water) is subjected to climatic, morphological, hydrological and geographical factors.

The most important factor on which ground-water levels depend is precipitation. The ground-water levels vary according to precipitation (Fig. 31). There are also good hydraulic relationships between rivers and ground waters.

Ground-water level variation depends not only on natural factors but also on the influence of human activities. In the study area, the ground-water level (i.e., depth below the surface) varies, as follows:

(a) the Zadrima plain is situated to the south of Shkodra city between the Gjadri and Buna rivers. In this plain, the highest ground-water level is about 50cm, during the wet period, and the lowest level is about 450cm, during the dry period. The level varies between 50 and 150cm, during the wet period, and between 150 and 450cm, during the dry period;

(b) long time-series data from Mabe, Gramsh and Gjader villages (Zadrima plain) in the Lezha district show that the highest level is 30 - 50cm during January, February and March. The lowest level is about 240 - 280cm during August and September. The level varies between 200 and 250cm. The highest level is near ground level and the lowest level is between 300 and 340cm depth in extreme cases;

(c) in the Thumana plain, the highest level reaches about 30cm during February and March and the lowest level about 90 - 100cm during September and October. The annual depth range is about 80cm. The highest level is near ground level and the lowest is at 170 - 230cm in extreme years;

(d) the Durrës plain is formed by marine and continental sedimentary deposits. During July - September, the lowest level is about 70 - 100cm, whereas, in the case of extreme events, it reaches 150cm. During November-April, the highest level is 20cm; the level is near the earth surface during January and February in extreme cases. The level varies between 80 and 150cm, and, in certain places, up to 200cm;

(e) one of the most important agricultural areas in Albania is the Lushnja plain. It is situated between the Shkumbini and Semani rivers. The ground-water level depends on the precipitation during the wet period. The highest level, varying from 60cm up to very close to the surface, is observed during January, February and March. In April the level begins to go down, till September, reaching 300cm, and, in particular cases, even 445cm;

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

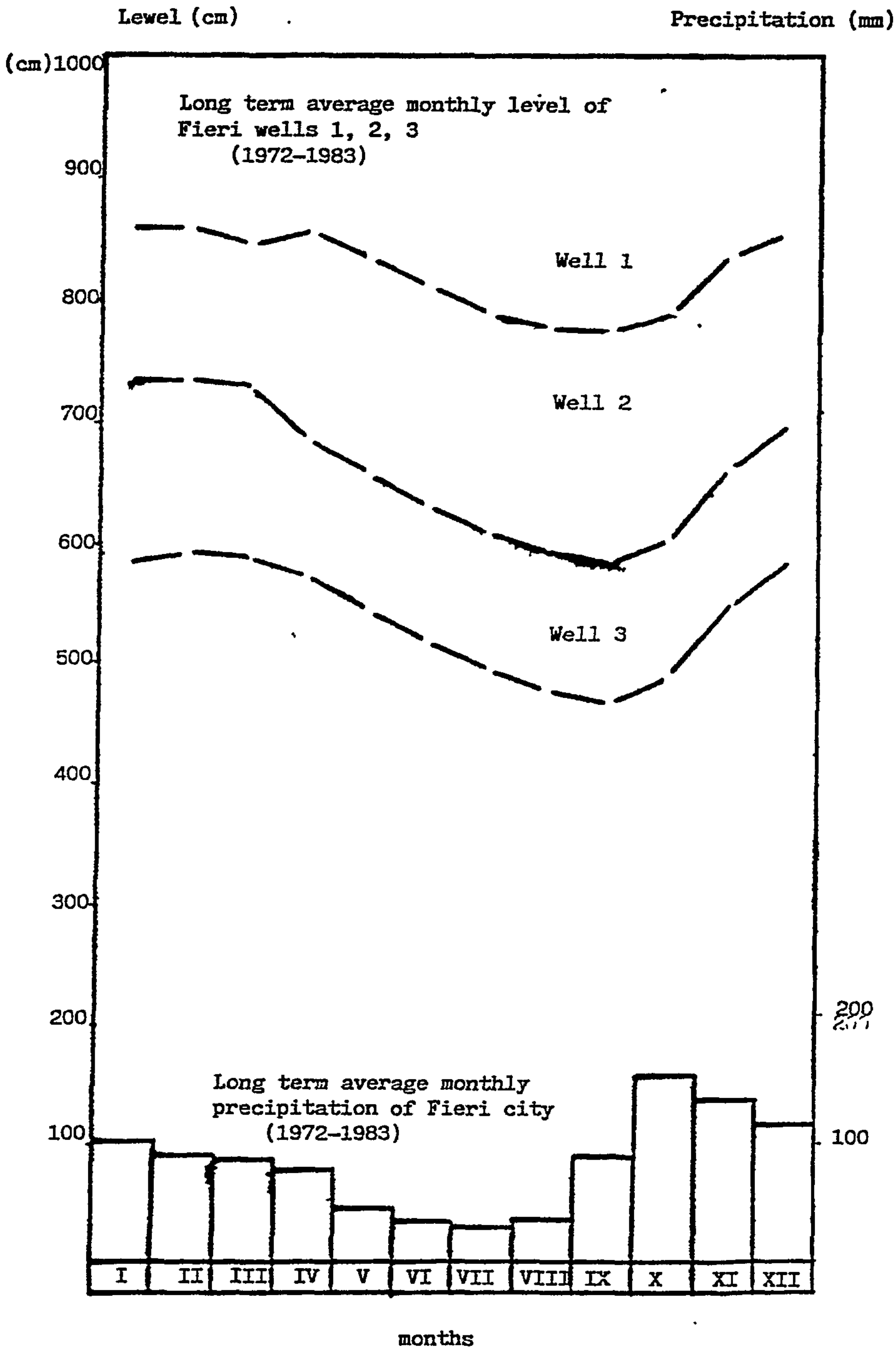


Figure 31 - Long-term mean monthly level of the Fieri wells 1, 2 and 3 (1972-1983) in Butrinti lagoon

The problem of drinking-water supply is resolved by using underground resources (extracted according to two principles, gravity and attractive flow). The drinking water is of good quality (according to the national standard and the directives of the World Health Organization (WHO)). The demand for drinking water in urban areas accounts for 150 litres per person per day. The water demand for societal and economic needs is 400 - 500 litres per person per day (Blue Plan, 1995). Only in cities (see Table 18) the drinking-water supply is through a centralised water supply and distribution network to the consumer. This water- supply network poses problems in terms of meeting technical requirements at the sources, especially with respect to well drillings, but problems generally lie within the distribution network. The old age of the pipelines of the distribution network has been the cause of a big loss of drinking water; in Tirana the losses amount to 40% of the total.

TABLE 18

The supply of drinking water

	Districts	Water resources	Quantity ($l.s^{-1}$)
1.	Shkodra	Water supply network Rjoll, Dobrac, Bahcallek Water supply network for the population	152.5 75
2.	Durrës	Drilling well Fushe Kuqe, water supply Pjesez	625
3.	Kavaja	Drilling well	65
4.	Lushnja	Drilling well Drilling well for the population	180 140
5.	Fieri	Drilling well Drilling well for the population	970 250
6.	Vlora	Water supply network	700
7.	Gjirokastra	Drilling well	110
8.	Saranda	Water supply network	70

Source: MHEP, 1994

Environmental damage may be caused by over-use of fertilisers, herbicides and pesticides in agriculture; agricultural run-off has a high concentration of herbicides and pesticides which affect the quality of the ground water and surface water. This has been identified as a major environmental problem. The ground-water reservoirs in the Zadrima plain are close to the surface (4m). Contamination of ground water must be high, given the water quality of the Kiri river and the nature of the industries in the region.

The gravelly, alluvial, karstic aquifers and the sandstone-conglomerate aquifers of the Rrogozhina formation have reached the salinity limit for potable water expressed in terms of total dissolved solids (TDS); the limit is lower than $1.0g.l^{-1}$ and the limit for hardness, expressed as iron content, is lower than $0.3mg.l^{-1}$ (in German degrees). The pollution risk is greater in the Rrogozhina area, owing to the pollution of the Shkumbini river by discharges from the iron works in the area of Elbasan (Puka, 1990).

Generally, the quality of water of gravelly aquifers near a recharge source is good, as in the Vjosa and Shushica plains, the Cerma sector of the Lushnja plain and in the Shkumbini valley (HMI, 1984).

2.4. Natural ecosystems

There are several types of ecosystem along the Albanian coast: terrestrial; fresh-water; lagoon; marine.

The natural ecosystems of the Albanian coast are of economic, recreational, biological and, in some cases, international value.

The economic value comes from the development of agriculture and tourism, the development of marine and lagoon fisheries, hunting, the use of other natural resources as fuel, as pharmaceuticals, and industrial plants, etc.

The beaches constitute one of the recreational values. The specially protected areas and lagoons, which help to conserve rare endemic and migratory animals and plants (Annex V), are among the biological values.

The human influence on the natural ecosystems, especially in recent years, has been significant. The demographic movement from the north-eastern and central areas of Albania towards the coast and the development of various industrial, agricultural, construction and communication activities have not had a positive influence on these ecosystems. There has been a decrease in the area of wetlands through the reclamation of land to create new arable areas, the cutting down of trees for construction and heating, the removal of sand and gravel for construction and the creation of beaches, uncontrolled and unplanned building, uncontrolled hunting and fishing, sometimes using explosives, etc.

The lack of legislation and regulations, as well as non-compliance with those in force, have led to damage to the ecosystems.

2.4.1. Terrestrial ecosystems

Terrestrial ecosystems comprise: sandy dunes; Mediterranean pine forests; machia and phryganas.

2.4.1.1. Sandy dunes

Sandy dunes lie mainly along the Adriatic coast, but there are a few along the Ionian coast. Along the Adriatic coast, some dunes are intersected by river mouths; otherwise, they extend all along it. Their height varies from 1 - 2m to 4 - 5m. Numerous dunes and very high ones are found in Zhuk-Poro, Velipoje, Divjake etc. (Anon., 1990).

The sandy belt along the coastline is completely bare of vegetation over a width sometimes extending up to 30m. The lack of vegetation in this belt contrasts with the active terrestrial and aquatic life of such taxa as *Coleoptera, Amphipoda* (*Talitrus* sp.) etc.

The phanerogamic vegetation lies inland of this denuded belt, in a sandy belt already leached of considerable amounts of salts as a result of rain. Pioneer species, as *Cakile maritima, Salsola kali, Xanthium strumarium* subsp.*italicum*, initially sparse, become more frequent with distance from the coast (Mullaj, 1989).

Gradually, farther from the coastline, and as the height of the sandy dunes increases, the appearance of the vegetation is imparted by the species *Elymus farctus, Cyperus capitatus, Sporobolus pungens*, which pertain to a more evolved phase of psammophytic vegetation which has a potential for stabilizing the sandy banks from Velipoja to Vlora (Mullaj, 1989).

The increase in dune height is also accompanied by a gradual change in the appearance of this vegetation. *Elymus farctus* succeeds *Ammophila arenaria*, which is predominant in the dune vegetation. The presence of this species is an important factor in impeding the movement of sand blown by the sea winds towards the continent.

From this type of vegetation along the Adriatic coast there are two noticeable lines of development:

(a) the stabilisation of sandy masses, their compression and decreased permeability create conditions for an association better adapted to this environment, in which *Ephedra distachya* is dominant. This association extends fragmentarily along the coastline from Kavaja rock in the north to the discharge of the Dracit stream to the south of Golemi beach. This association is the most evolved phase of the sandy-dune vegetation on the borderline between the typical dune vegetation and the Mediterranean pine forests; and

(b) the line starts with the degradation of sandy dunes and the formation of depressions. The bottom of the depressions lies closer to the level of saline ground waters. The ground becomes wetter and a vegetation different from that of the dunes emerges, dominated by coniferous species. Uncontrolled sand quarrying is threatening the natural balance of the beaches, particularly along those sections that are affected by natural erosion. 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 protective belt of pine trees.

2.4.1.2. Mediterranean pine forests

Mediterranean pine forests occupy a considerable part of the Adriatic coast, concentrated mainly in areas of movable substrata (sandy dunes). Of the area covered by these forests, less than half is of geobotanic interest. Of the above-mentioned formations, the most interesting are the Divjaka and Pishe-Poro forests that form the delta of the Shkumbini river to the south of the Vjosa delta. The rest of this coniferous formation, as in Velipoje, Shengjin, Rrushkull, Kavaja rock, Golem, Spille and Vlora Old Beach, is relatively young, having been cultivated recently to stabilise the sandy dunes and protect the agricultural lands (Anon., 1990).

Divjaka forest

This forest is situated between the Shkumbini and Seman deltas. It has a length of about 10km and a width from a few hundred metres up to 1 - 1.5km and an area of around 1100ha. To the east it is bordered by agricultural lands and the Karavasta lagoon, whereas to the west it is bordered by the sandy beach.

This forest represents an important and interesting ecosystem in respect of the diversity of its structure and the beauty of the created recreational environments. Being considered a national park since 1966, it has been comparatively well preserved, so the growth of a rich natural flora and fauna has been facilitated. The "heart" of the park is the reserve located in the northern part. The reserve has an area of about 700ha including the water areas and the non-productive lands (Gjiknuri and Hoda, 1994).

The physiognomy of this forest is imparted by the species *Pinus halepensis* and *Pinus pinea* which here and there are mixed with deciduous species such as *Ulmus minor, Quercus robur, Populus alba, Alnus glutinosa* etc. The sub-forest is represented by typical Mediterranean species which are occasionally very dense. The most widespread bushes in this formation are: *Myrtus communis, Erica manipuliflora, Pistacia lentiscus, Juniperus oxycedrus* subsp. *macrocarpa* (Mullaj, 1989)

This floor (stratum) in many cases is interwoven with the numerous elianas, such as *Smilax aspera, Hedera helix, Clematis flammula* etc. The high density of trees and bushes has considerably limited the grassy stratum. The most common species are *Vulpia fasciculata, Asparagus acutifolius, Asphodelus æstivus.*

There are ligatine microhabitats, known as *struga*, in the forest, where a typical hydro-hygrophilic vegetation is developed. The endemic species, such as *Aster albanicus* subsp. *paparistoi, Orchis albanica* and a hybrid form *Orchis xpaparisti (O. albanica x O. coriophora*) are of special interest (Mullaj, 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. Having lived for several generations in free range, they have acquired distinctive morphological and ecological features.

The forest has a rich ornithofauna. Besides aquatic fowl, other species may be observed: *Columbia oenus, C. palumbus, Picus viridis, Galerida cristata, Oriolus oriolus, Silvia* spp., *Phyloscopus* spp., *Passer* spp., *Carduelus, Emberiza, Athena noctua, Tito alba, Cricus earuginosus*, among others. The presence of a free-range pheasant (*Phasianus colchiccus*), acclimatized after 1955, may be mentioned. There are many reptiles and amphibians, as *Emys orbicularies, Testudo hermani, Ophisaurus apodus, Triturus vulgaris, Bufo bufo, B. viridis* etc. (Gjiknuri and Peja, 1992; Lamani, 1985).

The forest also has a rich entomological fauna. The mosquitos *Culex* and *Anopheles* are so abundant during the summer that they are a great nuisance to the human beings in these surroundings of rare beauty.

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

Because of its manifold values, together with the Karavasta lagoon, which lies on the other side, it has recently (22 August 1994) been declared a Strictly Protected Natural Ecosystem and therefore covered by the Ramsar Convention. Actually, some projects for its better management and for the development of an appropriate eco-tourism have been approved.

Pishe-Poro forest

This forest lies on both sides of the Vjosa river mouth; it is situated on sandy dunes and is dominated by *Pinus halepensis, P. pinea* and *P. pinaster*. It is younger than the forest of Divjaka but has a similar physiognomy thereto.

The fauna is poorer than that of Divjaka. The inhabitants of the surrounding area use the pine wood for heating and building, giving rise to appreciable damage.

2.4.1.3. Machia and phryganas

Machia is the most characteristic formation of Mediterranean flora and the one with the widest distribution (about 6000ha) in the coastal area of Albania. There are many bushes with green leaves that resist the dry weather, as *Arbutus unedo, A. andrachne, Erica arborea, Quercus coccifera, Pistacia lentiscus, Asparagus acutifolius, Cistus incanus, C. salvifolius,* etc. The plants that need warmth for growth are more widespread in south and central Albania than in its northern part. The most widespread shrub in the machia is *Quercus coccifera*, which grows on almost uninhabitable rocky ground, with a typical degraded structure. It represents the degradation phase of ilex (*Quercus ilex*) assemblages, from the evaluative point of view. The ilex assemblages are rare in Ksamil and on islands, although they should cover, more or less without interruption, the upper altitudinal belt to an altitude of 400 - 500m above sealevel.

Quercus coccifera has a great altitudinal range, between the coast and an altitude of 800 - 1000m, forming floral assemblages mostly found in Jonufer, Sazan and Dukat, on the Karaburun peninsula. Quite often they occur as bushes 3 - 4m high and occupy great areas on compact limestones. It may be found on flysh rocks, but is readily substituted by deciduous oaks. In Dukat (Vlora area) this vegetation assemblage has been much damaged and is reaching the point of substitution by *Phlomis fruticosa* and *Salvia triloba*.

Another variant of the machia on the Albanian coast is dominated by *Arbutus unedo* and *Erica arborea*, which are found in the previous bioclimatic area but always on siliceous substrata, as in Vlora, Turra Castle, Kavaja, Ishem, etc.

Besides *Arbutus unedo* and *Erica arborea*, there are bushes and woods with evergreen and deciduous trees in this assemblage. Those principally encountered are *Juniperus oxycedrus, Cistus incanus, Phillyrea latifolia, Pyracantha coccinea, Pistacia lentiscus*; less common are *Carpinus orientalis, Fraxinus ornus, Cotinus coggygria, Pistacia terebinthus.*

Laurus nobilis (laurel) is one of the most interesting and earliest variants of the machia in Albania; it is widespread over the hills of the Turra Castle in Kavaja. This ancient formation, pertaining to the Tertiary period, represents one of the numerous miracles of Albanian nature, and is of considerable historical, biological and ecological value. Its preservation is indispensable for Albania.

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

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

The principal plant families in these associations are *Leguminosæ, Rosaceæ, Euphorbiaceæ* and *Compositæ.*

Phryganas found in Albania are:

(a) *Phlomis fruticosa* association. This is the most widespread phrygana in Albania especially along the Ionian coast, up to an altitude of 500 - 600m. *Phlomis fruticosa,* in most cases, forms simple associations, but is accompanied by Mediterranean xerophilic bushes and shrubs, as, for example: *Salvia officinalis, S. triloba, Cistus incanus, Thymus capitatus;*

(b) *Salvia officinalis* association. This is widespread, mainly along the Ionian coast of Albania and in the mountains of Kakarriq and Rrenci;

(c) *Cistus* association (*C. incanus, C. salvifolius, C. monspeliensis*). In association with bushes, it covers a considerable and often dry area, as on the slopes of Durrës mountain; and

(d) *Erica manipuliflora* association. In contrast to *E. arborea, E. manipuliflora* is met frequently on limestone soils such as the mountains along the Ionian Sea coast.

2.4.2. Fresh-water and delta ecosystems

River-delta ecosystems are important components of the Albanian coast. Almost all the deltas are of a simple kind, having only one main river discharge channel. The only exception is the Buna delta which has two discharge channels and surrounds two small sandy islands: Ada and Franc-Joseph.

The most complicated and biggest delta is that of the Drini; it has many sand belts and narrows, gulfs, godullas, lagoons and islands (Kune). Since 1963, following the construction of the hydropower stations on the Drini river and its deviation to the Buna river, discharge has decreased.

For all these rivers, there exist not only new but also old river mouths, many kilometres away from the present ones. The most typical are those of the Shkumbini, Durrës, Seman and Vjosa rivers. Big sediment discharges are characteristic of all the rivers that discharge into the Adriatic, especially during the rainy period. This is a consequence of the high erosion that is found in Albania, due to deforestation and to the opening of terraces and new lands in mountainous and hilly areas.

The Ishëm, Shkumbin and Seman rivers are polluted because there are industrial plants which discharge their wastes into these rivers. The Bistrica and Pavla rivers are notable because they receive fewer solid discharges and unpolluted waters (Anon., 1990).

The river mouths and their surroundings are places preferred by water-fowl, which seek suitable conditions for food, shelter and reproduction. The fowl that frequent the river mouths are of the following families: *Ardeidæ* (*Eggreta garzeta, E. alba, Ardea cinerea* etc.), *Sternidæ* (*Sterna albifrons*), *Phalacrocorax carbo* (*P. pygmæus,* etc.), *Laridæ* (*Larus argentatus, L. melanocephalus, L. ridibundus*). Flocks of curly pelican (*Pelecanus crispus*) have been observed at the mouths of the Shkumbini, Seman and Vjosa rivers (Lamani, 1985).

The ichthyofauna of the river mouths is represented by euryhaline fishes such as those of the *Mugilidæ* family. The aquatic fauna of these areas has not been very much studied. Fishing by primitive methods is conducted in the mouths of the main rivers.

The river mouths are characterised by a very rich and interesting flora. There are many factors that have favoured its development, including in particular the fresh- and salt-water interface. The most important floral assemblage is hygrophilic forest dominated by *Alnus glutinosa, Fraxinus angustifolia, Ulmus minor, Quercus robur and Populus alba* at the mouths of the Buna, Drini, Mati, Erzeni and Bistrica rivers. There are also floral associations dominated by marina (*Tamarix dalmatica, T. hampeana*) which are found at all the river mouths, and by *Phragmites communis, Scirpus maritimus* and *Typha angustifolia*, which follow the river flow.

2.4.3. Lagoon ecosystems

These are the most characteristic components of the Adriatic coast. Apart from the lagoons mentioned in section 2.3.2, other lagoons, such as those of Viluni, Lezha (Ceka and Merxhani), Patoku and Dukati are found along the Adriatic coast. Their total surface area exceeds 15,000ha (Anon., 1990).

On the Ionian coast there is only one such ecosystem, the lake of Butrinti. It acquired the characteristics of a lagoon only after 1959, with the deviation of the Bistrica river for the reclamation of the Vurgu fields. The formation and evolution of the lagoons are related to the very big sediment discharges of the rivers and the dynamic processes in the coastal sea; this is still an active process.

Besides these ecosystems, there are forestry formations that have been proclaimed shooting reserves and national parks: the Velipoja reserve, near Vilun; the Kune-Vaini reserve, near Ceka of Merxhan; Fushe Kuqe, near Patok; the Divjaka National Park, near Karavasta; and the Butrinti forest. The existence of these ecosystems adds to the bio-ecological value of the lagoons themselves.

While most of the lagoons have one or two communicating channels to the sea, normally with a considerable flood to ensure the biological life in those ecosystems, the lagoon of Narta, where the flooding is very limited, presents a problem. There is a water stratification that is reflected in the temperature, dissolved-oxygen and salinity data. This stratification explains why, at a depth of 7m, there is hydrogen sulphide. According to the data, this lake seems to have entered into a phase of eutrophication.

The aquatic flora of the lagoons is mainly represented by *Zostera noltii* and *Ruppia cirrhosa* which form homogeneous monospecific populations. They have the character of an underwater meadow covering large areas in the alluvial bottoms of the lagoons.

The algal vegetation differs according to the salinity and depth. Macrophyte algæ have the largest distribution: *Chætomorpha linum, Cladostephus verticillatus, Laurencia* sp., *Cladophora* sp., etc. Even the phytoplankton is relatively rich, being dominated by diatoms.

There have been sudden blooms of *Chætoceros wighamii* and of peridines, such as *Prorocentrum minimum, P.micans, Scrippsiella* sp. etc, which show that this ecosystem has entered a state of eutrophication.

This kind of floral colonies, together with accompanying species, mainly algæ, represents one of the richest of the benthic biocenoses, having a threefold importance: biological, ecological and economic. They represent the main source of dissolved oxygen for the waters of the lagoons, as well as food for the fish.

Another aspect of the sandy soils around the coastal lagoons during the hot season is the fact that the land hereabouts 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 salinity and ground-water level, the predominant floral species are: *Arthrocnemum fruticosum, A. glaucum, Salicornia europæa* and *Limonium vulgare*. Characteristic of these associations is the great floral scarcity and the tendency to develop into monophytic colonies. Further development depends on two basic factors: the degree of salinity and the hydrological conditions.

Moving away from the coast, the decrease in the ground-water level causes the afore-mentioned species gradually to leave space for another association, comprising *Juncus maritimus, J. acutus, Salsola soda, Tamarix dalmatica, Vitex agnuscastus,* etc. Between these assemblages are associations of a cosmopolitan hygrophilic nature with a very wide ecological range, like those dominated by *Phragmites australe, Scirpus maritimus,* etc. Such associations can survive even in an environment in which the salinity is somewhat high.

All the lagoons are characterised by a euryhaline ichthyofauna. Fish of the *Mugilidæ* family (*M. cephalus, Liza ramada, L. saliens*), *Anguilla anguilla, Dicentrarchus labrax, Sparus aurata, Pagellus erythrinus, Solea* sp., *Aphanius fasciatus, Gobius bucchichi*, etc.

The crab *Carcinus æstuarii* is present in all the lagoons, and the bivalve *Mytilus galloprovincialis* is present in the lake of Butrinti. This shellfish is a very important industrial raw material for this lake (Gjiknuri and Peja, 1992; Gjiknuri and Hoda, 1994).

The Albanian lagoons represent a very important place for aquatic fowl, some of which nest on their shores. The most important fowl are those of the following families: the *Phalacrocoracidæ* (*Phalacrocorax carbo* and *P. pygmæus*); the *Sternidæ* (*Sterna albifrons*); the *Ardeidæ* (*Egretta garzeta, E. alba, Ardea cinerea, Fulica astra, Rallus aquaticus*); the *Laridæ* (*Larus argentatus, L. melanocephalus, L. ridibundus*), the *Anatidæ* (*Anser anser, Anas platyrinchus, A. crecca*), etc.

The lagoon of Karavasta is of special importance because the curly pelican (*Pelicanus crispus*) and the *Sterna albifrons* nest there. Karavasta is the westernmost limit of the pelican's distribution. There is a colony of 60 couples, but 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 fishermen, who consider the pelicans to be their competitors.

2.4.4. Marine ecosystems

Ecosystems on smooth and on solid sea bottoms are present along the coast of Albania. The composition of the biocenoses changes according to the nature of the beds. Biocenoses on smooth beds (sand, sand-mould) are found mostly in the Adriatic Sea, whereas those of solid bottoms are found in the Ionian Sea.

The soft bottoms of the infralittoral zones are populated by the marine phanerogams

Posidonia oceanica and *Cymodocea nodosa*, which form many underwater meadows which are very widespread in the Ionian Sea too, down to depths of 30 - 40m. At this depth, the algas *Caulerpa prolifera* and, more rarely, *Padina pavonica* are found.

The fauna of smooth bottoms is dominated by: bivalve mollusc genera such as *Venus, Donax, Cardium, Mactra, Tapes, Solen, Scorbicularia, Tellina, Solencurtus,* etc; cnidarians (*Alcyonum palmatum*); sea cucumber (*Sticopus regalis*); ascidians (*Pallusia mamillata*); fish of the families *Soleidæ, Sygnathidæ, Triglidæ, Mullidæ, Sirenidæ, Rajidæ, Torpedinidæ* etc. Many other pelagic animals are found, such as fishes of the families *Sparidæ, Mugilidæ, Clupeidæ,* etc., medusa (*Rhizostoma pulmo*); cephalopod (*Sepia officinalis*), etc.

Industrial pollution in the bays of Vlora and Drini, in recent years, and urban pollution in coastal towns have had an effect. In the past, prawns were found in the bay of Drini, mostly at the mouths of the Drini river. Now, they are only a very rare component of the fauna. The scarcity of the prawn is due to the discharges of the paper mill in this bay. The ichthyofauna has undergone an obvious reduction. There are also many obvious changes in the benthic biocenoses of the bay of Vlora because the wastes from the soda and PVC factories are discharged into Vlora bay.

The solid-bottom biocenoses are of special interest. The mediolittoral zone of these beds is characterised by the growth of the algæ *Tenarea undoluza, Lithophyllum trochanter, L. lichenoides (tortuosum)*, etc., whereas the infralittoral zone is characterised by the algal genera *Cystoseira, Padina pavonica, Acetabularia acetabulum, Laurenzia obtusa, Corallina elongata, Halimeda tuna, Cladophora prolifera*. In the ports and their surroundings a nitrophilic vegetation is dominated by *Ulva rigida* and by species of the genera *Enteromorpha, Pterocladia,* etc.

The benthic fauna comprises: sponges of various genera (e.g., *Condrosia* etc.); cnidarians of the genera *Actinia, Paramuricea, Eunicella, Cladocora,* etc.; polichæte annelids of the genera *Protula, Sabellia, Spirographis* etc.; gasteropods of the genera *Conus, Columbella, Cerithium, Vermetus, Monodantha, Gibbula, Patella, Haliotis,* etc.; polyplacophores of the genus *Chiton*; crustaceans of the genera *Eriphia, Xantho, Pachigrapsus, Porcellana, Dromia, Eupagurus, Cibanarius, Scyllarus, Palinurus, Homarus,* etc.; echinoderms of the genera *Ophiothrix, Ophioderma, Holothuria, Coscinasteria, Echinaster, Marthasteria, Asterina, Sphærechinus,* etc. and especially such sea-urchins as *Paracentrotus lividus* and *Arbacia lixula*. Rock holes are populated by the echiurid annelid *Bonellia viridis*, fishes of the *Blenidæ* and *Gobidæ* families, the Mediterranean moray eel, *Murena helena*, and the groupers of the genus *Epinephelus*, the cephalopod *Octopus vulgaris* etc. There are fishes of the *Sparidæ* family and the multicoloured fishes, *Serranus scriba* etc., which swim in the rock holes.

According to some reports, the monk seal, *Monachus monachus*, has been observed on the coasts of Karaburn and Saranda.

Certain thermophilic species which cannot be found in the Adriatic Sea are characteristic of the rocky coasts of the Ionian Sea, such as *Ophidiaster ophidianus, Hacellia attenuata*). The rocky western coast of Karaburun and the bay of Porto Palermo, having been for a long time a military zone free of industrial pollution, have kept their flora and fauna intact. At the same time, there are many underwater caves and various other cultural-historical sites. It is suggested that all these zones should be given the status of protected zones and of sea parks.

2.5. Managed Ecosystems

2.5.1. Agriculture

Agriculture is the most important sector of the Albanian economy in terms of value added and employment. In recent years, this sector has accounted for about 25.1% of the gross national product, and 35.9% of national income. In Albania, over 60% of the population lives in rural areas, engaged in agriculture.

The study area, with 287,200ha of arable land, comprises 41% of the total arable land of Albania and accounts for about half of the total agricultural production. Field crops occupy about 83% of the total arable land, the rest consisting mainly of orchards, olive groves and vineyards (Table 19). The favourable natural conditions, such as soil content, climate and abundance of water resources, which offer suitable conditions for cultivating various kinds of crops, together with other human activities, have influenced land use in favour of agricultural production.

By the desiccation of some marshes in the coastal area and investment in drainage systems, about 60% of the soil has been rehabilitated. The level of the saline phreatic water has dropped. There are presently 13 pumping stations working in the coastal districts to drain the soil. Not only are the coastal lowland and arable land being drained, but the forested hilly slopes are also being converted into cultivated areas. Also, about 2933ha are undergoing desalinization in the Lezha, Kavaja, Lushnja, Vlora and Saranda districts.

The Adriatic coast of Albania consists of about 30% cinerary brown, 33% meadow cinerary brown and 22% alluvial soils. The rest is divided among turf-marshy and salty soils. There are alluvial or brown mountainous soils, meadow cinerary soils and cinerary forest soils in the Ionian coastal area. From the agricultural point of view, cinerary brown soils, meadow 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 are of good quality, which favours the development of agriculture.

TABLE 19

Composition of arable land in Albania (x1000 hectares)

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

Source: DS, 1991

TABLE 20

The surface (hectares) of arable lands and irrigation capacity

Districts	Arable land	Field crops	Irrigation total	Capacity %	Arable land 1000m² per inhabitant
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

Source: Jaehne and Schinke, 1993

Table 20 shows the distribution of arable land by coastal district (following the new district division), the irrigation capacity and the arable land per inhabitant.

The production (%) and the yield (kv/ha) of the main agricultural crops in the study area during 1960 - 1990 are summarized in Table 21. (NB: 1kv = 100kg)

TABLE 21

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

Crops	Production (%)	Yield (kv/ha)
Wheat	30	28
Maize	10	40
Dried beans	10	11
Vegetables	10	160
Fodder	35	170
Industrial plants	5	9-15

Source: Jaehne and Schinke, 1993

During 1990 - 1995, following political and economic changes, the agricultural crops grown in this area changed to meet the supply and demand in the newly established market economy and the development of tourism in this area. The sown surfaces and the crop yields by district for 1993 are given in Tables 22 and 23.

TABLE 22

The sowing surfaces (hectares) by district and crop for 1993

Districts	Cereals	Wheat	Maize	Rye
Shkodra	9348	5382	3966	-
Lezha	7215	4429	2786	-
Lac	3688	2066	1622	-
Kruja	5509	3769	1740	-
Durrës	9991	7308	2683	-
Kavaja	7706	5783	1919	-
Lushnja	22550	17118	5432	-
Fier	21124	15218	5906	-
Vlora	10427	8201	2226	-
Saranda	2488	2115	370	3

Source: Jaehne and Schinke, 1993

TABLE 22 (continued)

Districts	Vegetabl e 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)

	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	-
Durrës	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

Source: Jaehne and Schinke, 1993

TABLE 23 (continued)

Districts	Vegetable 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 mainly situated in Saranda, Vlora, Fier and Lushnja, with about 6% in Kavaja, Durrës and Kruja. Over 99% of the citrus plantations are 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 of olives and citrus fruits

		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

Source: Jaehne and Schinke, 1993

Another agricultural activity in the study area is livestock production. Their number, by district, is presented in Table 25.

TABLE 25

Distribution of livestock numbers (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

Source: Jaehne and Schinke, 1993

2.5.2. Fishery

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

2.5.2.1. Marine resources

The shelf of the Albanian coast is wider (up to 40km across) in the northern part (Adriatic Sea) than in the south (Ionian Sea; 3 - 4.8km across). The sea bottom varies from north to south. In the northern part the shelf is not only wider, but slopes less steeply down to the 200m isobath, so it is easier to trawl. The Ionian coast, where the depth rapidly reaches 200m, is uneven and covered with rocks, and is therefore difficult for trawling.

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

Sardine (*Sardina pilchardus*) 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 - 80m depth.

Different species of sharks populate the coastal sea from north to south at depths from 5 to 300m. The main species are *Squalus* spp., *Carcharhinus* spp., *Mustelus* spp., etc. Angelsharks, such as *Squatina* spp., *Torpedo* spp., *Raja* spp., etc. are also found at these depths.

Anchovy (*Engraulis encrasicholus*) is a small pelagic fish of particular importance, which is found at 100 - 300m depth.

European hake (*Merluccius merluccius*) is one of the industrial fishes and is of particular importance to trawling; the hake lives at depths of 50 - 300m.

Surmullets (*Mullus barbatus* and *Mullus surmuletus*) are found along the coast; the former species along the Adriatic coast at depths of 20 - 150m, and the latter along the rocky Ionian coast at depths of 5 - 6m.

Sea bass (*Dicentrarchus labrax*), sea breams (*Sparus auratus*, *Diplodus* spp. and *Pagellus* spp.) and dentex (*Dentex* spp.) are found at depths of 2 - 30m.

Various molluscs, such as carpet shells (*Tapes* spp.), clams (*Donax*), mussel (*Mytilus galloprovincialis*) etc., cuttlefishes (*Sepia* spp.), squids (*Loligo* spp.) and octopus (*Octopus* spp.), etc. are found all along the Albanian coast.

2.5.2.2. Lagoon resources

The main features of the lagoons along the Adriatic coast, particularly the depth, the salinity, water temperature and dissolved-oxygen content (see section 2.3), influence the trophic status and fish production. The main species are mullets (*Mugil* spp., *Liza* spp., *Chelon* spp.), sea bass (*Dicentrarchus labrax*), eel (*Anguilla anguilla*), sea bream (*Sparus aurata*), sand smelt (*Atherina hepsetus*) etc. The average yield in recent years has varied from 40 to 80 kg/ha.

In Butrinti lagoon, with its specific characteristics and the above-mentioned fish species, the improved trophic status has created optimal conditions for mussel culture.

2.5.2.3. Inland water resources

Fishing is practised mainly in the three big lakes: Shkodra, Ohri and Prespa, the Albanian part of which has a surface of 25,000ha. Only Shkodra lake lies in the study area. The main fish species in Shkodra lake are carps (*Cyprinus carpio, Hypophthalmichthys molitrix, Ctenopharyngodon idella, Alburnus albidus*), eel, mullets etc.

2.5.2.4. Fishery organization

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

The Albanian fishery sector has three main parts: marine fishing; artisanal fishing; and inland-water fishing. The fishing fleet consisted originally of 110 vessels. During the upheavals in 1991, a number of them disappeared, were sunk or damaged beyond repair. During 1992 - 1994, private associations, persons and entities have bought fishing boats, and there are now 168 of them. The fleet, by home port, is as follows: Shëngjin - 20 vessels; Durrës - 64 vessels; Vlora - 62 vessels; and Saranda - 22 vessels. The main types of vessel are shown in Table 26.

TABLE 26

The fishing fleet (1994)

Category	Number	Engine horsepower	Fishing method
Inshore	53	80-140	Lines, gillnetting etc.
Purse seiners	15	150-300	Purse seining, trawling, seining
Trawlers	100	200-600	Trawling

Source: FRI, 1994

About 300 small boats belonging 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 made up of plastic pipes in the main channels of the lagoons. Some of the boats are to be found in the lagoons, harbours and other places along the Shkodra-Vlora coast. There are also about 100 boats equipped with outboard engines.

2.5.2.5. Fish catch

During the 1980s, the Albanian fishery sector normally caught 10,000 - 15,000 tons per year of fish and shellfish from three main subsectors: marine fisheries - 7000 tons; fresh-water fisheries - 3000 tons (500 tons from aquaculture); molluscs - 3000 tons.

The socio-economic changes, which Albania has been faced with, brought about changes in fish production as well. Establishment of 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 fishing, prevail. The statistics for the last few years are approximately as shown in Table 27.

TABLE 27

Annual fish catch for 1990-1994

Years	1990	1991	1992	1993	1994
Catch (tons)	10400	3200	3000	2000	1200

Source: FRI, 1995

In recent years, particular fishermen or groups have exported a great amount of fish, to a total value of US$13 - 14 million.

2.5.3. Aquaculture

Aquaculture began at the end of the 1960s with the establishment of state fish farms in different parts of the country. The main fish species zere common carp (*C. carpio*), silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*), and grass carp (*Ctenopharyngodon idella*). There were 16 fish-farming centres with a total water surface of 4km^2. Ten of them were situated in the coastal area and covered a water surface of 3km^2. The yield was 200 tons/km^2 for consumption and about 10 million fingerlings/km^2.

There are actually four types of aquaculture practised in Albania: fresh-water cypriniculture (carp family) - 16 fish farms; one trout farm, with raceways (5.2ha), near Saranda; a shrimp-culture farm in the fish farm of Kavala (20ha); and mussel culture in Butrinti lagoon with 80 frames installed in different parts of the lagoon, with a yearly production of 3000-4000 tons.

Judging by the country's water resources, climate and biological potential, there are real possibilities for developing this important sector towards mariculture in floating cages.

2.5.4. Forestry

Forest exploitation in Albania began in ancient times (by the Greeks, Illyrians and Romans) and has continued to this day. Because of over-exploitation and deforestation, many forests have 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. Logging was conducted in the first half of this century mainly by Italian companies. Deforestation and the planting of a considerable area with oranges, olives, agricultural crops, etc. (at Lukova, Jonufri, the hills of Divjaka, Kavaja, Durrës, Ishmi, etc.) was carried out during the second half of this century.

The coastal forests perform a protective function, preventing the salty sea winds from penetrating inland. The forests provide the raw materials for construction and the wood industry and meet the population's needs for fire wood.

Along the Albanian coast, new forests are planted with the aim of protecting the agricultural areas from sea winds and to green the territory (Saranda mountain). Some experiments have been performed by planting fast-growing, exotic species, such as the Monterey pine, red pine, eucalyptus species, etc. (Karadumi, 1992).

The forests in the study area occupy only 33,700ha or 3.2% of the total forested surface of the country. They cover 12,700ha or 37.6% of the coastal forested surface along the Ionian coast and 21,000ha or 62.4%, along the Adriatic coast. These forests have a standing wood stock of 2,756,000m^3 or 3.4% of the standing wood stock of all the national forests.

The main forests are: the mixed conifer and broadleaf forest in the Llogara region and the single-species broadleaf forest in the Karaburun-Vlora region; the oak forests in Gradishta, Gjeneruk-Lushnje, Ishmi-Durrës, Renci-Lezhe and Shkodra; the *Quercus ægilops* forests in Mile, Kakome, Himare, Karaburun and Tragjas; the Mediterranean pine forests (Aleppo pine and stone pine) in Poro-Vlora and Fier and in Divjaka-Lushnja; and all the man-made forests, principally based on Mediterranean conifers, along the coastal strip (Kume of Vlora, the Seman coast of Fier, Spille and Golem-Kavaje, Bisht Kamez and Rrushkull-Durrës, Fushe Kuqe-Lac, Tale, Kune, Vain, Shengjin-Lezhe and Velipoje-Shkodra); and the shrubs which are mainly found along the Ionian coast (Karadumi, 1992).

The trees of the coastal forests, up to the age of 141 years, have diameters of 0.3 - 72.0cm and heights of 0.15 - 28.0m. They belong to the first to fifth production classes, with a crown density of 0.2 - 1.0, and provide a cover of 40 - 100% (Karadumi, 1992).

The composition of the forests in the study area, by tree types, is given in Table 28. From this Table, one may generally conclude that:

! about three-quarters of the surface of coastal forests consists of broadleaf species, whereas conifers occupy a quarter. Of 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 cypress conifers) extend over a small area along the Vlora and Kavaja district coasts;

! broadleaf oak forests (*Quercus ægilops*, Turkey oak, Macedonian oak, Chestnut oak, pubescent oak, Hungarian oak and holly oak) extend all along the coast with the exception of the Fier and Kavaja districts, although *Quercus ægilops* principally extends along the Ionian coast (Saranda and Vlora districts). The other broadleaf forests (ash, alder, plane, etc.) also extend along the coast, with the exception of the Kavaja district. Poplar forests and plantations occur only along the Adriatic coast;

! plantations of black locust cover a small surface, principally along the Adriatic coast, in the districts of Vlora, Lushnja, Kavaja, Shkodra and, over a smaller surface, along the Ionian coast of the Vlora district. The maple forests are limited and extend only along the Vlora coast;

! walnut plantations are located only along the coast of the Saranda district; eucalyptus, only along the Kavaja coast; and *Acacia saligna*, only along the Vlora coast. The forest and plantation of sweetbay cover a small surface, located along the Vlora, Lushnja and Saranda district coasts. The willow plantations have a limited extent along the Adriatic coast of the Lushnja, Vlora, Fier and Kavaja districts;

TABLE 28

The forested areas and stocks, by tree type and/or species

Species	Surface		Standing wood stock	
	ha	%	m^3	%
Conifers	8,351.54	24.80	668,885	24.30
- Mediterranean pine (i)	6,817.54	20.20	397,485	14.40
- Silver fir (iii, iv)	598.00	1.00	158,700	5.80
- Black pine (iii, iv)	847.00	2.50	103,100	3.70
- Other conifers (i) (cypress etc.)	89.00	0.26	9,600	0.35
Broadleaf	25,381.66	75.20	2,087,067	75.70
- Oak Turkey (ii, iii) Macedonian (ii, iii) Chestnut (iii) Pubescent (ii, iii) Hungarian (iii) Holly (i)	9,765.39	28.90	840,197	30.50
- *Quercus ægilops* (ii, iii)	2,249.15	12.60	359,627	13.00
- Poplar (i, ii)	1,039.28	3.10	89,246	3.20
- Black locust (iii)	50.00	-	5,200	0.19
- Other broadleaf sp. Ash (i, ii, iii) Alder (i, ii) Plane (ii), etc.	3,593.55	10.70	301,765	10.90
- Maple (ii, iii)	225.20	0.78	39,038	1.40
- Walnut (i)	30.00	-	-	-
- Eucalyptus (ii)	3.50	-	269	-
- *Acacia saligna* (i)	10.00	-	100	-
- Sweetbay (i, ii)	75.00	-	280	-
- Willow (i, ii, iii)	115.50	-	-	-
- Strawberry (i)	1,878.00	5.60	121,400	4.40
- Oriental hornbeam (i,ii,iii)	319.78	-	21,452	0.78
- Erica (i)	391.00	-	15,900	0.58
- Myrtle (i)	82.25	-	-	-
- Box (iii, iv)	59.00	-	17,100	0.62
- Other shrubs	3,465.06	10.30	275,393	10.00
TOTAL	33,700.00	100.00	2,756,000	100.00

Source: FPRI (Forest and Pasture Research Institute), 1992

NB: i,..iv correspond to the classification in Annex VI

! strawberry shrubs extend only along the Ionian coast (Saranda and Vlora districts) and part of the Adriatic coast (Vlora and Durrës districts); and

! heaths (*Erica* spp.) extend mainly along the Durrës, Saranda and Vlora district coasts; oriental hornbeam, along the Durrës, Saranda, Shkodra and Lezha coasts; myrtle, along the Adriatic coast (Durrës and Lushnja districts); and box, only along the Adriatic coast (Vlora district); mack privet and tamarisk, along the Ionian coast (Saranda and Vlora districts) and the Adriatic coast (Lezha, Fier, Shkrodra and Kruja districts).

Over this territory one can see all the main vegetation assemblages, beginning with oranges, olives and evergreen forests, continuing with deciduous forests, black pine, silver fir and *Pinus leucodermicus* forests, with Mediterranean alpine pastures at the highest altitude above sealevel (Karadumi, 1992).

The vegetation types are distributed as follows (see also Annex VII):

(a) Eu-Mediterranean evergreen forests

This vegetation type extends from sealevel up to 350m above sealevel (Saranda 350m, Vlora 250m, Fier 100m, Lushnja 50m), in areas free of frosts throughout the year.

(b) Deciduous forests with kermes oak

This vegetation type extends from sealevel to 550m altitude (Saranda 350 - 550m, Vlora 250 - 450m, Fier 100 - 500m, Lushnja 50 - 190m, Kavaja 0 - 190m, Durrës 0 - 227m, Kruja-Laci 0 - 50m, Lezha 0 - 200m and Shkodra 0 - 150m). This is a vegetation type that contains some components of the Eu-Mediterranean forests together with a few deciduous species.

(c) Deciduous forests

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

(d) Silver fir (*Abies alba*, Mill) and black pine (*Pinus nigra*, Arn.) forests.

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

(e) The Mediterranean alpine vegetation

This vegetation type extends between 1850 and 2045m above sealevel (Vlora 1850 - 2045m).

Fire is, among other things, a serious threat to forests. Numerous cases of natural and man-made forest fires are recorded yearly (Table 29). Fires and overhunting have diminished the forest biodiversity and have stimulated degradation and desertification.

TABLE 29

Forest fires in the Albanian coastal districts (1989-1993)

District	1989	1990	1991	1992	1993	Total number of fires	Burned area (ha)
Saranda, Vlora, Fier, Lushnja, Durrës, Kruja, Lezha, Shkodra	17	88	48	108	105	366	624

Source: FAO, 1995

2.6. Energy and Industry

2.6.1. Energy

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

The three largest power plants are located on the Drini river, with a total generating capacity of 1350MW.

The potential energy-generating capacity based on hydroelectric power is estimated to be about 15.10^9 kiloWatt-hours (kwh).

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

The energy consumed for domestic use in 1990 was 6.5% of the total energy generation. 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. Owing to these changes, the share of domestic-energy use increased to 61.5% in 1994. A decrease in this ratio is expected for the next year, owing to the reactivation of industry and the use of liquified gas for domestic purposes.

2.6.2. Industry

Until 1990, industry generated 58% of the gross domestic product (GDP). Since the beginning of 1990, the economic situation aggravated rapidly and activity decreased by about 50%. After that, the main sectors, as the chemical, metallurgical and mechanical industries and other related branches, almost stopped operating and only by the beginning of the second half of 1992 were there signs of reactivation. The industrial sector is currently one of the weakest points of the Albanian economy.

Industry is distributed all over Albania, with a higher density in the western part, especially in respect of the chemical, metallurgical and paper industries.

In 1990, the coastal districts' share of total industrial production was about 37%.

The soda and PVC plants, with a capacity of 30,000 tons of sodium carbonate per year and 6000 tons of PVC per year, are located at Vlora, near the Adriatic Sea; they are out of work because of the obsolete technology and poor maintenance. It is expected that only small and second-hand units will operate in the future.

The nitrogen-fertiliser plant, with a capacity of about 300,000 tons per year, is located at Fier. Today, this plant is running at about 15% of capacity, owing to the lack of methane gas and the low demand of agriculture for fertilisers. An increase in production is expected in the coming years.

Until some years ago, the chemical plant at Durrës produced a lot of chemicals, such as inorganic salts and pesticides. Today, some units are destroyed and some others run at low capacity because of the low demand. An increase in production is expected in the coming years.

A superphosphate plant, with a capacity of 330,000 tons per year, is located at Lac near the sea. This plant is working at a low capacity, because of the low demand. A gradual increase in production is expected in the coming years.

A copper plant, with a capacity for processing 60,000 tons of ore per year, is located at Laci. Today this plant works at low capacity, owing to the lack of raw material and to out-of-date technology. Reconstruction of the copper industry is planned, which will lead to greater production.

The paper industry is located at Lushnja, Kavaja and Lezha, with a total capacity of 20,000 tons per year. Because the waste waters of paper factories cause contamination, it is anticipated that, in the future, this industry will work with imported cellulose.

The largest oil fields are located in the south-western part of the country, in the watersheds of the Osum and Vjosa rivers, but most of the wells are closed. The largest oil-processing plant, with a capacity of 1.2 million tons per year, is located at Ballshi and is working at low capacity, owing to the lack of oil.

A considerable number of small factories engaged in 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 then, mainly for political reasons, tourism was undeveloped. Tourism was run by the ALBTURIST enterprise. Before the creation of the Ministry of Tourism, the greatest number of tourists in Albania in one year was 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 the European Union and the European Bank for Reconstruction and Development, the Ministry of Tourism has prepared a Strategy for Tourism Development from 1993 to 2010, and other studies, including environmental concerns. According to this strategy, tourism will be mainly concentrated in the coastal zone. Four priority regions have been designated for tourism development in the study area: Lalzi and Durrës Bays (Adriatic coast), the northern and southern parts of the Albanian riviera (Ionian coast).

The Ministry of Tourism has attached considerable importance to the development of high-quality, small-scale tourist villages, which are to be harmoniously integrated with existing villages, and to the development of eco-tourism, in parallel with the building of new hotels in Tirana and the renovation of the existing ones in the southern part of the country. It is planned to promote rural tourism (bed and breakfast) in southern Albania (Saranda and Gjirokastra regions), with the financial support of the PHARE programme. This is considered to be a suitable approach from the environmental standpoint.

Some statistical data on tourism in Albania in 1956-1994 are given in Figure 32. The number of tourists increased after 1987, especially in recent years, compared to the previous years, but the average time of stay is not the same. The reason lies in the fact that the visits of businessmen are included in the tourism statistics; also, there are many private tourist agencies now operating in Albania. The intensity of visits is higher in summer than during the rest of the year. There are 14 hotels with 687 rooms and 1288 beds, and a few small private motels and hotels in the study area.

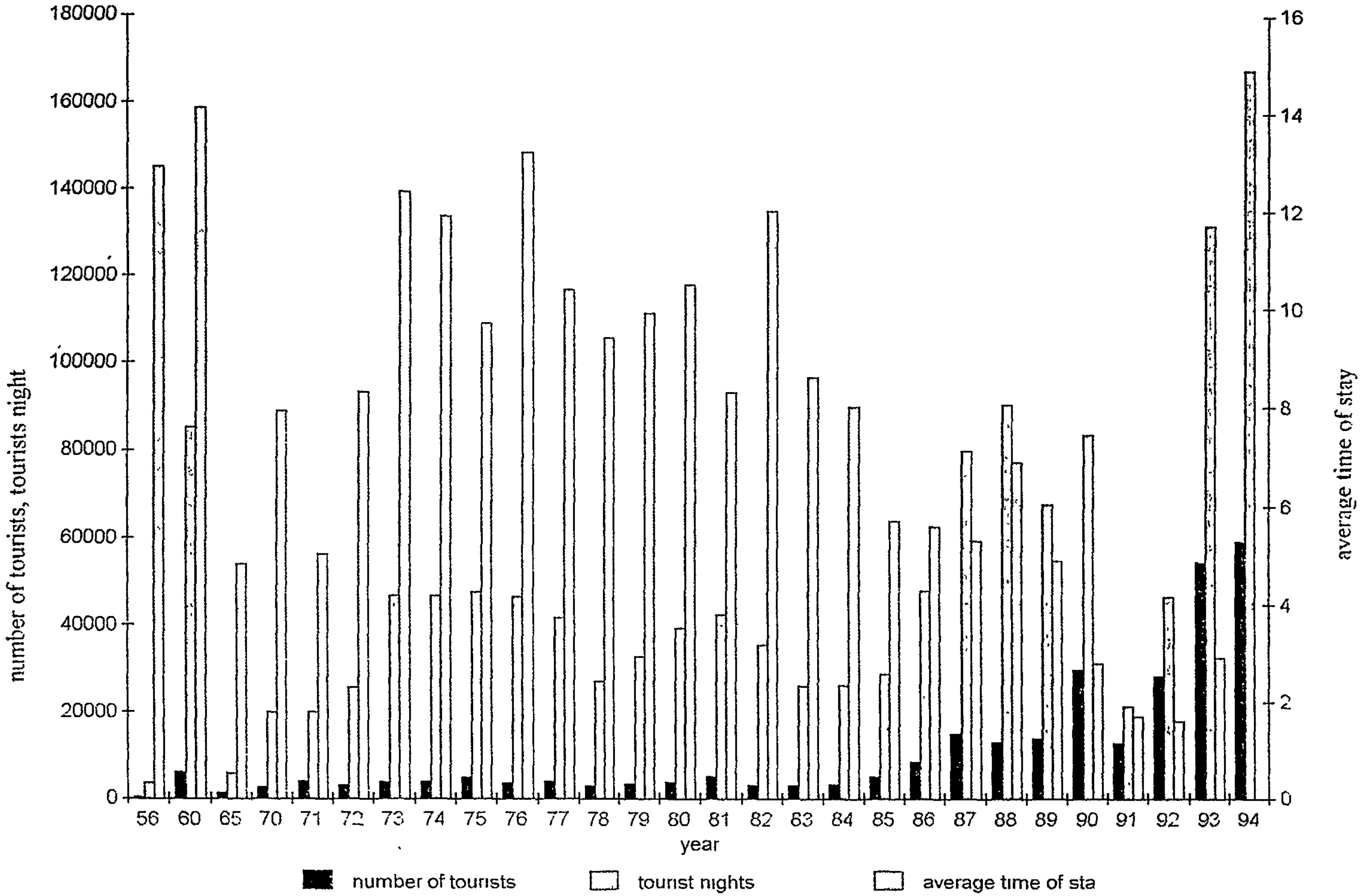


Figure 32 - The number of international tourists in Albania

2.8. Transport

The development of road, railway and air transport started at the beginning of the twentieth century. The main components in any analysis of this development are: infrastructure, traffic, vehicle inventory and geographical distribution.

2.8.1. Road transport

In 1938, the total length of public roads in Albania was 2,540km, mostly unasphalted and situated in the western part of the country. That year, the volume of goods transported, by a small number of vehicles of low capacity (5 - 7 tons), reached 12,000 tons over an average distance of 63km. About 4,400 passengers were transported over an average distance of 80km.

After 1945, higher development rates in road infrastructure, relative to the other components, were observed; at the end of 1990, road infrastructure was greatly on the increase. Nowadays, about 35% of the total road network is asphalted (roads in the study area are completely asphalted). During 1990, about 90,000 tons of goods were transported, 40% of which corresponded to the coastal area. Passenger traffic underwent a greater annual increase, accounting for about 200 million passengers, 60% of which corresponded to the study area. The 1990 inventory consisted of 12,000 vehicles, mainly imported from eastern countries and mostly very old ones (15 - 18 years on the road), with a negative influence as far as environmental pollution is concerned.

Private ownership after 1990 greatly influenced the rate of transport development. About 80,000 vehicles are registered in the coastal area (7 times more than in 1990). They are relatively new and imported from western Europe; even so, the pollution problems are becoming more acute.

Improvement of the road network, conditioned by the increase in vehicle numbers, tourism and the prospective development of the country, became a great priority. The first programme for the rehabilitation of a 100km stretch of road within two years is being undertaken. It will be followed by other medium-term programmes for the rehabilitation of the main road network (of 500km) and of the trans-European roads, and the construction of the first Tirana-Durrës highway, etc.

2.8.2. Rail transport

The first railway (44 km long, with a standard gauge) was built in 1947. Later, the railway network was gradually strengthened and enlarged towards the main economic and agricultural areas. The present railway network has a total length of 450km, 75% of which covers the coastal area.

The development of industry and agriculture, accompanied by the continuous growth of the railways, has brought about a significant increase in the volume of goods and the number of passengers transported. Thus, in 1990, about 6.5 million tons of goods and 10 million passengers (respectively, 27 and 12 times higher than in 1950) were carried.

The general decrease in production during the transition period (1990 - 1995), the increase in the number of private buses and cars, compared to the last decade, are reflected in the rail transport as well. In 1994, rail transport accounted for only 0.5 million tons of goods and 4 million passengers. In studies on the development of rail transport, in parallel with the economic development, it is foreseen that the transport of goods is likely to increase approximately two times relative to 1994, but passenger transport is likely to remain at the same level in the coming years, until 2005. In any case, this kind of transport is not likely to reach the 1990 level.

2.8.3. Maritime transport and harbours

Maritime transport was not well developed until 1950. At that time, about 100,000 tons of goods were transported annually. Gradually, transport capacity has been increased, accounting for 67,500 tons in 1990 and 900,000 tons in 1994, thus transporting 30% of the total export/import volume.

There are four ports along the Albanian coast: Durrës, Vlora, Saranda and Shëngjin. The difference between the sea surface and quay surface is 1.8 - 2m. Durrës is the biggest port. The total annual amount of goods passing through these ports is about 3.3 million tons, 2.8 million of which are loaded/unloaded in Durrës. Total quay length is 2,028m, with 9,500m of associated railway. There are depot areas (about 2,800m^2), with a capacity of 500,000 tons and 31 cranes of different capacities.

During 1990 - 1994, the volume of loading/unloading decreased considerably to 700,000 tons, whereas the number of ferries increased. The number of passengers travelling by ferry boat reached 188,000 in 1994.

Durrës port will remain the main one and the most important link in the Albania-Macedonia-Bulgaria transport line. It is expected that the volume of loading/unloading will increase, 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 undergo such reconstruction in the near future. They will be mainly engaged in ferry services, tourism and trade.

2.8.4. Air transport

Inland air transport was established for the first time in 1930 - 1940, connecting Tirana with 4 - 5 other cities. There were only a couple of small aeroplanes, and only the Tirana runway was of concrete.

In 1957, an international airport was constructed at Rinas, near Tirana. Its runway is 2,700m long by 67m wide, but it is too small to handle the great flux of passengers, which increased considerably in 1990 - 1994.

Albania does not yet have its own national airline. Nine European and one American airlines operate here.

To meet the increase in air transport, the reconstruction of Rinas airport will begin this year.

The prospect for transport will be its harmonic development. The development of road transport is of first priority to meet the increasing demands of tourism, private agriculture and travel etc. The rate of transport development is planned to be high, especially after 2000; an annual mean increase of 15% is foreseen. Two programmes for the rehabilitation of the existing road network and the construction of new roads, mainly in the coastal area, are being prepared.

The development of the other kinds of infrastructure is planned, depending on the increasing demands for transport and related services.

2.9. Sanitation and health aspects

2.9.1. Sanitation

Only a brief description of water supply, waste-water and solid-waste systems can be given here.

The problem of drinking-water supply is solved through the use of ground-water resources (according to two principles, gravity flow and siphoning). The drinking water is of good quality (according to the national standards and the relevant WHO directives).

As was mentioned before (see section 2.3.3), only in cities is the supply of drinking water to the consumer effected through centralised water-supply and distribution networks. These water-supply networks pose problems in terms of meeting the technical requirements at the sources, especially with respect to well drilling, but some general problems arise within the distribution network. Great deficiencies are ascribable to the crossing of the drinking-water supply pipelines with the waste-water and sewerage systems. The network is obsolete and the crossings, especially in Tirana, Durrës, Fier and Elbasan, have been the cause of water contamination which is expressed in health effects (gastro-intestinal disturbances, dysentery). The old age of the pipelines of the distribution network has been the cause of loss of large quantities of drinking water; e.g., in Tirana, the losses amount to 40% of the total. Bearing in mind the possibility of the penetration of organic pollutants, disinfection is practised at the source, but the drinking water retains disinfectants up to the point of consumption.

The drinking-water supply in rural areas constitutes another problem; in some areas, the supply networks do not meet the technical and sanitary requirements. In many rural areas in which a water supply network is lacking, shallow, open wells are being used (often close to cesspits, animal stables, etc.). In the event of outbreaks of illness in rural areas, the health authorities intervene to disinfect the sources of drinking water, whereas normally the sources should be disinfected by the farmers.

During 1994 (September) in Albania, there was an outbreak of cholera which extended over several districts. In the town of Librazhd (outside the study area) and in rural areas of Peqini and Fier, the cholera outbreak was due to infected drinking water, whereas in other areas, the main cause was judged to be the non-application of sanitary measures.

Urban waste is another environmental issue. From the collection points in specific places, its transport and treatment is carried out using primitive methods, in urban areas, whereas, in rural areas, this issue is not even taken into consideration, since the treatment of waste from agricultural activities is done individually, completely neglecting any technical requirement. The usual method of waste disposal until now has been composting, but it is not carried out according to the technical and 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 plagues. In some rural areas, waste waters are discharged into streams.

The assessment of air quality has been carried out in the main cities in different years, using indicators such as soot and sulphur anhydride; it shows that, in several areas and appropriate periods, the levels exceed the sanitary standards (Table 11). Tirana, Elbasan, Fier and Vlora have had such a problem. Albanian industry uses old technology, has no facilities for cleaning gases or industrial waste water, and emits these directly into the outdoor environment. Unfortunately, knowledge and possibilities have not been sufficient to allow the effects of pollution on the health of urban populations to be recorded. At present, industrial activities are almost paralysed, thus how much they affect the environment cannot be assessed.

2.9.2. Health aspects

The country's health system is state-dependent, divided into health care at the primary, secondary and tertiary levels. Primary health care is available in rural areas and towns, but secondary and tertiary health care are only available in urban areas.

Recently, after the country opened up to democratic change, the privatisation of some health sectors started, including total privatisation of the pharmaceutical network, partial privatisation of the dental-care network (keeping dental care for the 0 - 18 year age groups under state ownership), private labs and small private health clinics. Health insurance will be established for the first time in 1995, besides the state social security system.

Health care services cover the means for combatting and preventing infectious diseases, and hygiene requirements through the relevant laboratories. With a view to increasing immunity in the population, several obligatory vaccine treatments were applied, such as those for DTP (diphtheria-tetanus-pertussis), measles, BCG-antituberculosis and, in 1994, a vaccine against viral hepatitis.

In 1991 - 1994, there was only one case of poliomyelitis in Albania, outside the study area; diphtheria has generally low frequency values (Table 30). Generally, tuberculosis constitutes about 50% of all the diseases in the study area. Taking into consideration that this area has 35% of the total Albanian population, and that it has a high population density, infectious and airborne diseases are very frequent in this area (Table 30).

The contagious diseases constitute an important health problem which is given special consideration, through statistical surveys and the evaluation of each case. The frequency data are given in Table 31.

The data show that the diseases of the gastro-intestinal tract are expressed mainly as gastro-enteritis and as acute dyspepsia, with a few cases of toxic dyspepsia. From 1988 to 1993, gastro-enteritis underwent a drastic decrease, from 43 to 31% (of the national total), while, for dysentery, this decrease was from 37 to 27%. These nosologies (from typhoid to salmonellosis) have been and are expressed always for the summer season, a period that lasts more than seven months in the study area. The reason for the increase during this period is related to the environmental conditions, especially to the habitat location, the lack of running drinking water and maybe an insufficient regard to hygiene by the people themselves in everyday life.

A very frequent phenomenon of the study area is scab infection; the percentage of the national frequency declined slightly from 40% in 1988 to 38% in 1993 (Table 31), while abdominal typhoid infection decreased by half between 1988 and 1993.

TABLE 30

Frequencies of infectious diseases in the study area; the percentages are of study area/national total

Diseases	1991		1992		1993		1994	
	Cases	%	Cases	%	Cases	%	Cases	%
Diphtheria	10	43	12	28	4	67	4	28.5
Tetanus	3	37.5	3	43	7	39	10	71
Pertussis	65	24	6	12	32	26	72	29.5
TBC	114	33	85	36	143	48	81	35

Source: MHEP (Ministry of Health and Environmental Protection), 1995

TABLE 31

Frequencies of contagious diseases in the study area; percentages are of the study area/national total

Diseases	1988		1989		1990		1991		1992		1993	
	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%
Abdominal typhoid	80	44	49	39	47	50	70	69	18	13	13	22
Dysentery	1730	37	1684	38	1152	35	655	36	366	31	388	27
Gastroenteritis	46064	43	38867	35	34643	30	20109	30	11720	28	12972	31
Acute dyspepsia	47052	44	41482	39	39440	38	27759	44	16269	37	14475	39
Toxic dyspepsia	1387	50	1128	51	864	55	721	62	775	67	686	58
Salmonellosis	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
Viral hepatitis	3770	32	3540	37	5957	53	2572	41	1489	32	1869	33

Source: MHEP, 1995

Even viral hepatitis has been a serious problem. At the national level, the infection of the A and B forms have generally had the same value. The A form of viral hepatitis appears more in the age-groups of 4 - 15 years, whereas the B form is spread more over the infant and old age groups. In Albania generally, disposable syringes are not used, so this form of hepatitis is easily spread. Also, sterilisation is not always effective. The effort in this field has been to make the hepatitis vaccine obligatory for new-born babies, starting May 1991. In 1991, the mortality of children up to 1 year of age in the study area was 28.17%, while at the national level this was 34.6%. The mortality of new-born babies remains stable at 30%, but it has undergone a considerable decrease compared with 1980.

The infant-mortality data show that pulmonary diseases are the most frequent, with gastro-intestinal cases being less frequent. The morbidity level for the whole country has not been studied yet, so it is difficult to collect data for the study area. At the national level, respiratory diseases are the principal concern, followed by central-nervous-system diseases. These two types of disease have been decreasing every year; although the tumoral and blood diseases vary during the year, they have had the same stable level. The statistical analytical results show that, in 1989, the incidence of cardiopathic diseases was 16,700 per 100,000 inhabitants (50.5% of all cases in Albania), while the mortality due to malign tumours was 2,238 per 100,000 inhabitants (69.9% of all cases in Albania).

2.10. Population and Settlements

2.10.1. Population

According to the 1990 statistics, the coastal area of Albania had 1,099,088 inhabitants, of which 44.1% lived in urban areas and 55.9% in rural areas.

The most marked characteristic of Albanian demography is the high natural growth rate and the young population. During 1945 -1990. emigration was forbidden; hence, the Albanian population grew only by natural processes The State has carefully controlled the movement of population inside the country in accordance with the national development strategy, and the natural increase in the population was favoured. The natural increase (%) of the population by districts (year 1990) is shown in Figure 33

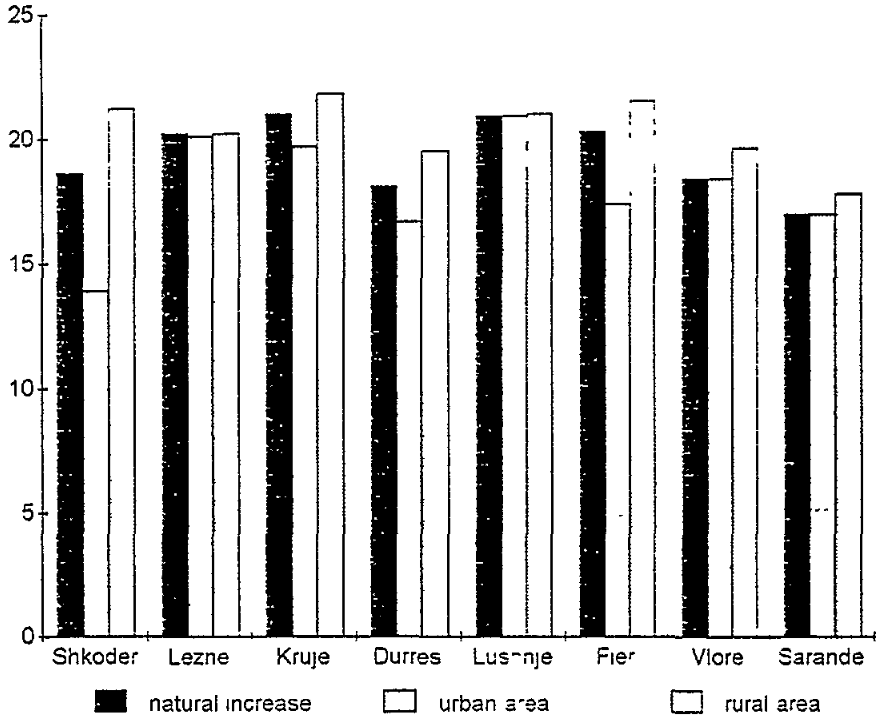


Figure 33 - Natural increase in the Albanian population

The coastal region is not very different from the others. The coastal plain and the surrounding hills have become the most densely populated and urbanized part of the country. Geomorphology and hydrology are the main factors influencing the settlement of the region. The population density varies from 81.5 inhabitants per square kilometre (Saranda district) to 296 inhabitants per square kilometre (Durrës) (DS, 1991)

In recent years, the situation has changed, because the population growth and distribution depend highly upon social and economic conditions. Two main tendencies have been observed: emigration and the movement from the northern part towards the lowlands, the coastal area and the big cities. This population movement tends to follow the opportunities for employment, environmental circumstances and cultural development. There are better conditions for human activity in the coastal area than in other areas of the country, such as better quality of land, better climate, good opportunities for agricultural activity, and more chance of employment in activities such as tourism, oil exploration in the Adriatic Sea, highway construction, fishing, services and other infrastructures.

So, there was a considerable movement from inland to the Adriatic coastal area after 1991. Generally, people from the north-eastern part of the country relocated to the Durrës and Lezha districts, and people from the south-eastern part, to the Vlora district. On the other hand, emigration appeared; young people from all over the country, sometimes whole families, particularly from the Albanian coastal areas, emigrated to find a job in Greece, Italy or other countries. Because of the economic situation, the number of births decreased, as well. As a consequence of the combination of these factors, the population in Shkodra, Durrës (including Kavaja), Fier, Lushnja, Vlora and Saranda districts decreased by 0.9%, 1.2%, 16.9%, 0.7%, 5.3% and 4.0%, respectively, whereas in Lezha and Kruja (including Laçi) it increased by 2.5% and 0.7%, respectively. However, in general, an increase in the population of the coastal area occurred. It had 1,233,470 inhabitants in 1993.

2.10.2. Settlements

Albania is part of the ancient Mediterranean civilisation and reflects the traces of relationships with other civilisations, as the Roman, Greek, Byzantine and Ottoman.

The Albanian coastal area is recognised as the most ancient civilised region; it includes such ancient settlements as Shkodra (Scutari), Lezha (Lisi), Laci, Kruja, Durrës (Dyrachium), Fier (Apolonia), Xarra, Saranda (Onhezmi), Butrinti (Buthrot), etc.

Dyrachium was one of the most important ports, where the Egnatia road started. Lisi, Apolonia and Scutari were important stations on the ancient Balkan routes too.

In most of those settlements, the life had continuity and many of them have not lost their importance with the passing years. Of course, they have grown in population as in their everyday activities.

The Albanian lowland is mostly fields resulting from the draining of marsh land over the last 30 - 40 years. This was the basis of the new settlements created at this time. The new settlements were combined with the traditional ones, but the difference is often remarkable. The new villages were usually built by the State before the people immigrated and, in some cases, they have an apartment style, planned, concentrated and in large number.

Moving towards the north, the villages become more scattered over the agricultural land, whereas, in the south, the villages are denser but also more in harmony with the landscape.

Because of the mountainous territory and the low rate of industrialisation, people were forced to make their living mainly from agriculture. Since the agricultural land had always been very scarce and scattered, people were interested in protecting it. So it became traditional for the settlements to be built in the foothills.

Settlements are usually situated alongside the main transport corridors. In many cases, towns and villages are crossed by national roads.

Using the statistics available, the study area may be divided into three parts: northern, central and southern.

On the northern Albanian coast, Shkodra is the main city, including the tourist site at Velipoja and the nature reserve. Shengjini, Lezha and Laçi are the other towns in the northern part.

In 1926, the region had 202 settlement centres, with 80,741 inhabitants; in 1945, 219 settlement centres, with 123,951 inhabitants; and in 1994, 267 settlement centres, with 40,334 inhabitants.

Compared to 1945, the overall population increased 3,3 times. There are 36 new villages, 5 new towns (some of the new towns are villages that were transformed into towns because of their importance in the region). The population growth rate was high, especially until 1969, mostly as a result of a high birth rate and inter-regional migration.

There are many hectares of drained marshes in the northern region around Velipoja and Lezha, etc., that have sheltered people that moved from the Albanian highland and inland. Also, the towns have been characterised by a high population growth rate.

The Durrës-Vlora region, in the central part of the study area, is the most dense and urbanised area of the country. The towns of Durrës, Kavaja, Lushnja, Fier and Vlora belong to it. Land reclamation in the coastal plain led to the creation of a dispersed settlement system.

Most of the settlements (about 85%) have from 400 to 1,000 or 2,000 inhabitants, and accommodate 43% of the region's population, but there are 11 settlements with about 4,000 inhabitants each. The settlements of more than 4000 inhabitants are either some traditional villages, composed of small units scattered usually in the foothills, or newly constructed settlements composed of multi-storey houses, which are not very suitable for farm workers. There are also 5 towns with more than 20,000 inhabitants (Durrës, Kavaja, Fier, Lushnja, Vlora). Durrës is the most important industrial and transport centre, situated in the middle of the region. Vlora is very important too. Durrës and Vlora port are also the main ports.

The settlements in this region are new, most having been created in 1955 - 1969, to exploit the reclaimed land. The population of these villages is mixed.

The southern coast, from Vlora to Stillo Cape, has a different morphology. It is rocky and has very little agricultural land. The special southern coast and landscape have a very high tourist potential that has not been well used in the past.

In 1960 - 1980, the coastal hills of the Albanian riviera were terraced and planted with citrus fruits and olives. The excavation and creation of those terraces was done by Albanian Youth. After the plantation, some of them preferred to live in this part of the country, so some new villages, such as Ksamili, were integrated here with such traditional villages as Vuno and Qeparo. In some other places, the endemic peoples were mixed with the immigrant peoples.

The southern coast has had a continuity of life from ancient times and a dense population too. There were oscillations in population number, but it was always a considerable one.

Emigration to other countries and regions has been typical of the area for the last two centuries. In 1926, there were 58 settlement centres, with 25,581 inhabitants; in 1945, 59 centres, with 28,689 inhabitants, and in 1994, 63 centres, with 59,027 inhabitants.

During 1950 - 1990, the population had generally grown. After 1990, the region had a general decrease, especially because of the emigration to Greece. Some special settlements, as Himara, lost about 40% of their population, including even the seasonal movements. At the same time, Saranda city grew in size and population.

In the coastal areas, the tendency of people owning bigger houses to use them to accommodate tourists must be taken into consideration. It is traditional for the coastal settlements to let one or two rooms, even of apartments, in the summer. It happens very often north of Durrës, but mostly in the villages of the south, such as Himara, Qeparo, Borsh and in the town of Saranda. Given this tradition, people are going to invest in improving and enlarging their houses. People from other parts of the country want to have second houses at the seaside too.

The movement of people towards the coast is one of the latest and most prominent strategies of the Albanian Government. The ex-owners who no longer have the possibility to use their ex-properties (sites) in the cities, are compensated or will be compensated with sites on the coast, in support of the idea to build up the Albanian coastal area and to orient the economy towards tourism.

House types

The most traditional Albanian house types date from the 15th - 16th centuries. Moving from the north towards the south, there are some different house types.

In the north, including the northern part of the study area, the traditional houses are built of stone and have some small holes that serve as windows. This type is called "kulla e veriut", which means "the northern tower".

The typical town house in Shkodra is a big one, usually with two floors, and is called "banesa me hajat".

The central lowland type is the "open" house, called "banesa me cardak". The main part of it is an open space that serves as a living room in summer and as an economic space for the rest of the year.

The southern type is a big house with two floors, oriented towards the sea; it has evolved as a second house, often serving partly as a pension or for bed-and-breakfast accommodation, in season.

3. POTENTIAL IMPACTS OF EXPECTED CLIMATE CHANGE ON NATURAL SYSTEMS AND SOCIO-ECONOMIC ACTIVITIES

3.1. Climate

The results of the application of global circulation models (GCM) models to the Albanian coastal area for two time horizons (Table 1) suggest the following scenarios:

(a) Annual scenario

For this scenario, a change of temperature from 0.7 to 2.5EC might be expected, depending on the time horizons. It is probable that the upper limit of the mean annual temperature will be between 17.2 and 20EC. While such an increase must be taken into consideration, a significant precipitation change is not to be expected. The mean annual precipitation for the study area ranges from 890 to 1880mm, so a range from 1000 to 2000mm from south to north may be expected.

(b) Winter scenario

The expected temperature increase in winter follows the annual one, while the expected precipitation ranges between -28 and +5%, indicating a decreasing trend. This decrease may not be of great importance because winter precipitation in Albania is higher than in the other seasons, and ranges between 105 and 215mm. Since evaporation is small during the winter, such a decrease in precipitation will have little influence.

(c) Spring scenario

According to this scenario, the expected spring temperature will change almost within the same limits as the annual one. The spring temperature in this area varies between 13.8 and 15.7EC, so a variation between 15.2 and 18.5EC may be expected. A small increase in precipitation (up to 18%) might be expected, which could influence agricultural production.

(d) Summer scenario

This scenario proposes an expected temperature range between 23.2 and 24.7EC in this area. Such a change may be given high consideration. Summer precipitation ranges between 19 and 63mm. A decrease of 22 to 60% could seriously influence the hydrology of this area.

(e) Autumn scenario

The temperature range under this scenario is rather wider than the annual one and the precipitation change could reach +53%.

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

The UEA scenario for Albania agrees relatively well with the actual trend (for 1931 - 1991) not only in respect of winter temperature but also of spring and annual precipitation, but it remains the same for the other parameters analysed. Their change is expected to be similar or somewhat the reverse of the present trend.

The annual temperature change is likely to increase 0.9 - 1.0EC per degree of global warming, being more marked in the northern part of the study area, although the present trend in the mean annual temperature (for 1931 - 1990) is the reverse: a temperature decrease of 1EC in the extreme northern and southern parts and of 0.2EC in the central part of the study area.

An increasing trend of 0.7 - 1.0EC per degree of global warming, more marked in the central part of the study area, may be expected in the spring, although the observed temperature trend for this season (for 1931 - 1990) is decreasing (0.3EC over the sixty years in the central part and 0.8EC over the same sixty years in the extreme north and south).

The summer pattern is broadly the same as the spring pattern.

According to the scenarios, an increase of 0 - 7% per degree of global warming may be expected in spring precipitation, as was observed over the period 1931 - 1990, whereas, in the summer, the expected decrease in precipitation, which is more marked in the northern part of this area (up to 24%), does not correspond to the observed increase.

The autumn scenario shows an increasing trend in temperature, of 0.7 - 1.2EC per degree global warming, and in the precipitation in the study area, being more marked in the northern part (21%). For the period 1931 - 1990, a decreasing trend in temperature (0.01 - 0.02EC per year) and in precipitation are proposed.

These scenarios should be considered as indicators of changes that might occur. However, they do not take into account the behaviour of other climatic elements. It is very difficult to predict either the expected change in other climatic elements or extreme events. Nevertheless, it is worth speculating on the possible change, using physical arguments. The expected impacts are as follows:

(a) increase in drought intensity and frequency, due to temperature increase and precipitation decrease, particularly in summer;

(b) pressure change, although it is not possible to quantify the behaviour of the pressure field under the expected new climatic conditions;

(c) increase in wind speed, particularly in summer; as was mentioned in section 2.1, the study area is affected by sea breezes during summer and the temperature rise will cause an increase in the land-sea temperature difference, thus intensifying the sea breezes;

(d) increase in global radiation and daily number of hours of sunshine, a process also known as cyclogenesis, is often promoted by the land-sea temperature difference; a large-scale warming could affect this contrast, probably reducing it during winter, thus decreasing cloudiness; since the effect of cloudiness on the daily number of hours of sunshine and on incoming solar radiation is more significant than the effect of possible air pollution, the values of these two parameters may be expected to increase as cloudiness decreases;

(e) decrease in the number of days on which snow falls, due to the expected rise in winter temperature;

(f) decrease in the number of days on which hailstorms occur, which are related to fronts passing over this area; a decrease in cyclogenesis frequency will cause a decrease in the number of hailstorm days, although an increase in such days during summer may be expected, owing to the temperature rise;

(g) a slight increase in relative humidity due to two opposite effects of a temperature increase on relative humidity; such an increase first increases the quantity of water vapour in the atmosphere (by increasing evaporation), but then it decreases the relative humidity of the atmosphere itself, by dispersing the water vapour;

(h) the number of foggy days may decrease because a temperature rise will oppose any increase in the number of condensation nuclei in the air due to pollution; the trend is not clear, however;

(i) a slight increase in the frequency of storms and strong winds may be expected.

3.2. Lithosphere

Given the problems presented, the expected climate change might influence more the western lowland than the Ionian coast. In the light of the predicted change in temperature, precipitation and sealevel, described in the UEA scenarios, certain processes may be expected to become more intense than at present, particularly by 2100; they are:

(a) erosion of the coastal area will be mainly of the physical type and more likely to affect rocks of weak stability vis-à-vis atmospheric agents; in general, such rocks are of the argillite, silt and, to a lesser degree, sandstone, which are mainly in the western part of Albania, particularly in the Kepi i Rodonit-Durrës-Kavaja and the Lushnja-Fier regions, etc;

(b) coastline changes due to sealevel rise and the expected decrease in sediment flow;

(c) soil alteration will be of the physical and chemical types, because of the expected increase in soil salinity;

(d) landslides in different rock formations or the depression of rock blocks, which may affect the natural equilibrium of the massifs or rock slopes, will probably occur in argillite-silt rocks; such slides now occur mainly on the western side of the country and in the coastal area, in Currila (Durrës), Kavaja, Vlora, Bishti i Pallës, for example;

(e) karst formation is expected to occur rather more intensively than at present; it is known to be connected with high temperatures and humidity and is more developed in carbonate rocks (limestone and loess dolomites along the Ionian coast), as well as in salt rocks and gypsum (Kavaja, Lushnja and Vlora areas);

(f) change in the geotechnical properties of soils and rocks, which may be caused by sealevel rise, since this process is related to increase in pore pressure.

3.3. Hydrosphere

3.3.1. Surface waters

It is very difficult to predict accurately the effects of climate change on the water balance. Nevertheless, three elements of climate change (increase in temperature, in precipitation and in sealevel) will influence local water resources. The following impacts are expected:

(a) decrease in the flow of surface waters; the scenario for Albania shows a reduction in annual precipitation of less than 2% in the south and an increase in the north, in the study area. Consequently, the water flow in the southern part will decrease more than 2% by 2030 and 5% by 2100, but there will not be significant changes in the northern part for the same time horizons. Also, the southern part of the country possesses less than 20% of the free water resources, so no considerable increase in water flow may be expected;

(b) worsening of the water-availability problem, since there is a seasonal variation in precipitation with an expected decrease in precipitation during summer; the expected increase in precipitation in autumn will increase water turbidity, thus having a negative effect on the near-shore vegetation and ecosystems;

(c) evapotranspiration (ET) is expected to increase over the land throughout the year. 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 cause an increase in the sea-surface temperature and hence enhance surface evaporation. An increase in temperature of about 3EC may cause an increase in evapotranspiration to such a degree that it may result in decreasing the total amount of free water and accelerate the reduction and degradation of aquatic habitats. It may also cause problems, especially in summer, because the precipitation is expected to decrease significantly (-60 to +13% by 2100), although perhaps less in autumn because of the expected increase in precipitation;

(d) changes in sediment inputs and the sea-bed profile near shore as a consequence of the increase in intensity and frequency of floods;

(e) sealevel rise (expected to be +48cm by 2100) will increase the intrusion of sea water and raise the water level in the lower parts of river basins and thus change the Albanian coastline; the effect is expected to be marked by 2100 and may be especially felt at the Mifol hydrometric station on the Vjosa river.

3.3.2. Marine waters

The expected changes in marine waters are:

(a) increased water exchange between lagoons and the sea, thus changing the elevation of the lagoons and increasing their salinity but with no very significant extension of protected coastal lakes and lagoons, even by 2100, because of the natural and artificial barriers, and as long as a buffer zone of beaches and dunes exists; a more active water exchange between the lagoons and the sea may be expected, together with other consequences in lagoons such as periodically high temperatures and salinity and less dissolved oxygen, which might cause considerable changes in the vegetation and the lagoon or lake ecosystem;

(b) increased mixing of surface and deep marine waters, with concomitant changes in dissolved-oxygen distribution and, consequently, in the composition of marine fauna and flora;

(c) increase in flooded coastal areas (ligatines) due to sealevel rise may be expected by 2100. In non-protected lagoons, accretion is expected to occur, following destruction of the low strands separating them from the sea. Where sandy dunes do exist, some of them, especially those below a height of 0.5m at the time, their destruction will have a similar effect. Such situations are expected to occur to the north and south (Patok) of the Mati delta, to the north of the Erzeni delta, in the old Seman delta, in the area between Seman and Vjosa and to the south of Vjosa. An increase in sealevel may also be expected in the Ceka lagoon and the formation of new ligatines is expected in the Mati delta. Patoku lagoon may suffer the destruction of the existing barriers and the modification of the lagoon by the sea. Rrushkull, to the north of the Ishmi river, once a hunting reserve, is expected to be flooded, since it is situated below sealevel and is separated from the sea by a low dune barrier. Karavasta and Narta lagoons are expected to have better communications with the sea in the future. An increase in the ligatine surfaces in the area between the rivers Vjosa and Seman is also expected;

(d) increased temperature and salinity of marine surface waters. In the Adriatic basin, summer temperature - salinity stratification may be followed by winter mixing under the influence of the cold, strong northern winds. The downwelling of the surface water renews and oxygenates the deep layers. At the same time, the surface waters are replaced by less dense, deep water. A possible increase in river discharge (see the changes in the upper limits of precipitation in Table 1) could reduce surface salinity and density, although the scenarios suggest more a decrease than an increase, so an increase in salinity may be expected;

(e) increased formation of sapropel mud. According to Schlosser (1989), an increase of 0.7EC in sea-surface temperature and a decrease in sea-surface salinity of 0.2 would be sufficient to cause bottom stagnation and the formation of sapropel muds.

3.3.3. Ground water

The predicted sealevel rise of +16cm by 2030 is not expected to have any significant impact on ground waters, whereas the sealevel rise of +48cm and reduced precipitation expected by 2100 will cause:

(a) increase in the salinity of aquifers and fresh-water resources of the coastal area; this effect will be more marked in the Fushë Kuqe aquifer (which supplies drinking water to the northern coastal cities as well as Durrës and Kavaja), in the Durrës plain (the altitude is 0.11m above sealevel), because it was a swamp many years ago and even after its reclamation, the soil still has a relatively high salt content. The other areas that will be influenced, though less than the Durrës plain, are Velipoja (Zadrima plain in Shkodra) and the Vlora plain, which are near the sea (their altitudes are 1.67m and 1.83m above sealevel, respectively); the same conclusion may be drawn for all areas in which there are saline soils;

(b) shortage of drinking water of adequate quality due to weak precipitation and an increased salt content; moreover, the demand for drinking water and water for social and economic purposes may be expected to increase. Depending on the population growth rate, it is calculated that, in Albania, the demand for drinking water by 2025 will be 280 million cubic metres per year and the social and the economic demand will vary between 655 and 820 million cubic metres per year (Blue Plan, 1995). It is probable that these demands will have increased significantly by 2100;

(c) decreased rate of recharge of aquifers by 2100, owing to a reduction in precipitation, especially during summer.

3.4. Natural Ecosystems

The expected increase of 0.9EC temperature and of 16cm in sealevel by 2030 is thought likely to have only a slight impact on the natural coastal ecosystems, whereas the expected increase of 2.5EC in temperature and the decrease in precipitation, particularly in summer, as well as the 48cm increase in sealevel, by 2100, will bring about considerable changes in these ecosystems.

Increase in drought frequency may contribute to other related impacts:

(a) plants would have to adapt to the new climatic conditions and some dominant species, such as *Quercus ilex*, would disappear;

(b) changes in the vegetation pattern might occur; the plants of the plain would probably extend their altitudinal range into the hilly areas and hill plants would extend to even higher altitudes, so there would be an extension of the area which is presently classified as evergreen Mediterranean vegetation, at the expense of sub-Mediterranean communities; evergreen species of the sub-Mediterranean zone can endure warmer weather, which is beneficial to them, whereas the species of the sub-Mediterranean deciduous communities do not like soil desiccation and intensified evapotranspiration;

(c) it may also be assumed that the fauna of the coastal area will expand at the expense of mesophyllic one, although, given the animals' ability to adapt, significant changes in faunal composition are not expected.

Increase in sea-surface temperature and salinity may have other effects:

(a) they will undoubtedly change some kinds of marine life forms, with a general shift towards more thermophilic species or their extension northwards;

(b) small changes may be expected in the existing Rhodophyta/Phæophyta ratio;

(c) changes may be expected in the composition of the plankton, and especially in its seasonal dynamics, and in the arrival and departure times of migratory species.

The impacts of sealevel rise are expected to be:

(a) an increase in salinity in the external parts of lagoons, possibly with a negative impact on such plants as *Phragmites, Typha, Scirpus*, etc;

(b) an increase in flooded coastal areas and the formation of new ligatines, accompanied by a partial change in favour of halophilic-hygrophilic or salt-marsh vegetation;

(c) the damage to dunes would negatively affect their characteristic vegetation and would bring about its migration inland.

Some beneficial impacts of sealevel rise may be expected:

(a) increased exchange of water between lagoons and the sea, bringing about an increase in salinity which will have a positive effect on the living organisms in these environments;

(b) creation of new ligatines in Hamallaj and Rrushkull, which will give rise to suitable environments for sheltering, feeding and, in some cases, even for reproduction of aquatic birds.

3.5. Managed Ecosystems

3.5.1. Agriculture

There are a lot of inhabitants in the coastal area of Albania engaged in agriculture, so climate change may have a considerable impact on socio-economic status, although, according to the proposed scenarios, no considerable impact may be expected by 2030.

The negative impacts by 2100 might be:

(a) reduction in the extent of arable land due to soil erosion and alteration;

(b) changes in the growth cycles, harvest time, and the quality of agricultural production, owing to an increase in salinity due to the sealevel rise and intrusion of salt water into the soil;

(c) the leaching of nutrient substances from the superficial arable soil, owing to increased precipitation in autumn;

(d) increased demand for irrigation of arable land;

(e) a temperature rise of up to 2.5EC and an insignificant change in precipitation on an annual scale may affect water availability and other factors, by 2100; so an increase in water shortage in parallel with increased salinity and erosion may be expected;

(f) summers with an expected temperature increase (up to 2.8EC) and an expected decrease in precipitation (from -60 to +13%) might be detrimental to agriculture if the irrigation problems cannot be solved properly; also, crops that have a high water demand (such as vegetables, olive groves, etc.) will suffer the consequences of decreased precipitation; hence, the use of more xerophilic crops might be required;

(g) the distribution of new harmful parasites and their associated diseases may be brought about by a temperature rise of 2 - 2.5EC; the reproductive cycles of these parasites may also be shortened or become more frequent.

Climate change is expected to have some positive influences as well, possibly bringing about:

(a) changes in the type of crops, to adapt to new climatic conditions;

(b) the cultivation of early agricultural products in the open air or in greenhouses, owing to an increase in winter temperature;

(c) changes in the exchange of soil moisture during the vegetation period, in the evapotranspiration, and possibly in the prolongation of the summer season, owing to the expected temperature change and concentration of the precipitation towards the spring, by 2100.

3.5.2. Fisheries

It is very likely that the expected climate change and its direct consequences will cause changes within the ecosystems of fishery interest. Existing ecological balances and chains will be broken, and new ones formed at significantly different levels. The Mediterranean region is a typical example of this problem because it contain species that are heterogeneous in each sub-area, the result of the vastly different biotopes (Jeftic *et al.*,1992). The expected changes are likely to bring about better living conditions for existing fish species or for the migration of others.

The expected increase in temperature and decrease in precipitation in summer (by 2100) would increase the evaporation, hence, the salinity and sea-water temperature. These changes could affect the inflow of nutrients from rivers or from the upwelling of deep water. The changes in the physical characteristics also could affect the level of dissolved oxygen in the sea water (Jeftic *et al.*, 1992).

3.5.3. Aquaculture

As long as aquaculture is concentrated in the coastal area it will be influenced by the expected climate change, but this influence will probably not be significant. One of the negative impacts is likely to be due to the increased demand for fresh water needed for aquaculture.

The increases in sea salinity and temperature may be expected to result in a decrease in the concentration of dissolved oxygen and an increase in the decomposition of organic matter, which may increase the oxygen depletion and may even create anoxic conditions (Jeftic *et al.*, 1992); this process may especially affect fish bred in tanks.

There is, however, a likely positive impact: an increased potential for aquaculture.

The increase in sea-water temperature in winter as a consequence of expected climate change might create favourable conditions for growth of marine organisms during this season. So, rearing time could be shorter and aquacultural production more efficient.

3.5.4. Forestry

The distribution of the vegetation by zones, which are identified by thermal limits calculated by regression analysis (Treska, 1963; Ciancio, 1971; Rameau, 1993) for each coastal district, allows the possibility of applying the climate change scenarios for the time horizons 2030 and 2100 and to specify approximately their implications for Albanian coastal forests.

The vegetation zones, by altitude above sealevel and for the time horizons 1975, 2030 and 2100 are given in Table 32.

Taking the values for the 1975 time horizon as a reference, the following impacts may be expected:

(a) Eu-Mediterranean evergreen forests would adapt to the expected climate change (temperature, rainfall) and would spread over the coastal area from Kavaja to Shkodra district (up to 200m above sealevel) in which they do not presently exist; they would spread above 150m above sealevel by 2030 and up to 700m by 2100;

(b) deciduous trees mixed with kermes oak (*Quercus coccifera*, L.) would adapt and spread to altitudes of 200 - 700m by 2030, and 400 - 900m by 2100 (150 - 400m higher than at present);

(c) deciduous forest would adapt and spread up to altitudes of 350 - 1400m by 2030, and 550 - 1650m by 2100 (100 - 250m higher than at present);

(d) silver fir (*Abies alba*, Mill.) and black pine (*Pinus nigra*, Arn.) forests would adapt to the new conditions and spread to altitudes of 1400 - 2000m by 2030, and 1650 - 2045m by 2100 (150 - 250m higher than at present);

(e) Mediterranean alpine pastures might extend up to 2000 - 2045m above sealevel only by 2030;

(f) the species that resist high temperatures and severe, long, dry seasons would be able to survive; for the species that need moisture (silver fir, etc.) the danger of being limited in distribution or disappearing does exist; the species that produce many small seeds and have a high distribution potential (*Pinus* etc.) would be able to survive and to spread at sealevel, whereas oak species, which produce big seeds, would occupy new areas only very slowly;

(g) the precipitation changes from -5% over the southern part to +13% over the northern part of the coastal area, will favour the growth of species resistant to drought in the south and of some species of the higher zones that have a high moisture/heat demand at sealevel.

TABLE 32

Vegetation types by altitude for time horizons 1975, 2030, 2100

Vegetation types	Altitude (m) by time horizon		
	1975	2030	2100
Eu-Mediterranean evergreen forests	up to 350	up to 500	up to 700
Deciduous forests with kermes oak (*Quercus 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	-

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

In forests and pastures, fires would be more frequent and more dangerous; also, many pests that might appear and prosper in the warmer conditions would be much too dangerous for some forest tree species (*Cnethocampa pityocampa, Evetria buoliana, Limantria dispar,* etc.).

If the predicted climate change occurs, a new vegetation distribution would arise. The implications of other factors, such as fires and wild animals, would change this distribution; the migratory species, particularly birds, would change their resting places, so the species composition could be expected to change, too.

The expected higher temperatures might favour the breakdown of stone and compacted soil; this, together with the increased precipitation in the northern part, would cause more intensive soil erosion.

A summary of the expected extent of the forests and the vegetation assemblages on the Albanian coast, by district, forest unit and assemblage and altitude, by 2030 and 2100, relative to 1975, is given in Annex VIII.

Sealevel rise would, according to the scenarios, have the following impacts:

(a) sealevel rises of +16cm and +48cm would not have any implications for the 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, Argjinatura e Shkumbinit), Kavaja (Kryevidh), Durrës (Kodër Laç-Rrotull), and Shkodra (Maja e zezë) districts;

(b) sealevel rise, by directly influencing the increase in the ground-water levels and composition, would limit the growing of some species that do not need the moisture and salt, such as the forests of Vlora (Kumel-Shoshicë, Pishë Poro, Ana e L. Vjosa), Fier (Pishë, Bregdet-Pishë Poro, Bregdet-Ndernenas), Lushnja (Pisha e Divjakës), Kavaja (Malësi e Kavajës), Durrës (Shijak-Maminas-Bisht Kamëz, Rrushkull), Kruja and Laçi (Fushë Kuqe), Lezha (Shëngjin-Tale) and Shkodra (Dajc-Velipojë) districts;

(c) in the National Park of Llogara, the silver fir forest could be replaced by deciduous forests, and the silver fir seed stand too; the black pine seed stand could be replaced by deciduous forests mixed with kermes oak (*Quercus coccifera*, L.);

(d) the National Park of Pisha e Divjakës-Lushnjë, the seed stand of Pishë Poro-Fier, the natural monuments of the Butrinti and the Zvërneci Island forests would continue to remain eu-Mediterranean evergreen forests, but the area of the first two would be limited by sealevel rise;

(e) the seed stands of the Golem, Kaladrekajve and Matkeqi forests would acquire the eu-Mediterranean evergreen forest type conditions; in the seed stands of the Golem and Matkeqi forests, the level and the salinity of the ground water would decide their existence; the same conclusion would also be valid for the Kaladrekajve forest (composed of beech), because of the expected higher temperature, the risk of disappearing does exist;

(f) in the hunting reserve of Karaburun, the silver fir forest would be replaced by a deciduous forest; in the hunting reserve of Pishë Poro (Vlora and Fier) and Pisha e Divjakës-Lushnje, the Mediterranean conifer forests would continue to exist but be limited to the eu-Mediterranean evergreen forest zone;

(g) in the hunting reserves of Rrushkull-Durrës, Fushë Kuqe-Krujë-Laç, Kune-Vain Lezhë and Velipoja-Shkodra, conditions for the eu-Mediterranean evergreen forest type would remain good, but the increase in the level and salinity of the ground water would decide their existence;

(h) the sealevel rise in these hunting reserves would enlarge the water surfaces and therefore increase the capacity for hosting migratory birds.

3.6. Energy and Industry

The climate change expected for Albania by 2030 is not likely to have a great influence on the energy and industry sectors. By 2100, an impact on both these sectors may be expected, as follows:

(a) an increased demand for industrial fresh water (especially for cooling) and for the treatment of used water. The expected decrease in precipitation and the possible increase in the salinity of coastal aquifers could lead to greater difficulties for the industries using mainly fresh water, such as the food industry. An increased demand for energy for water treatment before use must therefore be assumed. The sealevel rise may threaten the factories that are located near the sea, such as the salt and soda plants in the Vlora district;

(b) increase in energy demand in summer for ventilation and air conditioning; this would be influenced by the increase in outside temperatures during the "prolonged summer". It may cause some other problems for other activities in the open air. The higher energy demand in summer is likely to be compensated by a lower energy consumption in winter;

The expected climate change might also have some positive effects, such as:

(a) decrease in energy demand for heating; the expected increase in winter temperature (2 - 2.5EC per degree of global warming) should reduce the need for heating, insofar as the inside temperature would increase, thus creating more comfortable conditions for working and living;

(b) increased potential for the use of solar energy for water heating.

3.7. Tourism

Tourism is apparently becoming a very important sector of the Albanian economy. According to the Strategy for Tourism Development, mentioned in section 2.7, tourism will be concentrated along the seaside. It will be primarily oriented to activities using the sea shore directly, for such activities as swimming, sun bathing and recreation etc. Therefore the climate, the quality of sea and the land are of great importance. The expected climate change could affect tourism as well.

Some positive impacts to be expected are:

Extension of tourist season into the periods of the year that are presently cold. It may be inferred from the UEA scenarios, that a "prolonged summer" would lengthen the tourist season and increase the number of tourists visiting the Albanian coast; it would also make for less crowded sunbathing and swimming in summer.

The likely negative impacts to be taken into consideration are:

(a) the sealevel rise of +48cm by 2100 may threaten the existing tourist facilities, particularly in the Shëngjin-Durrës area;

(b) tourism makes a great demand on water resources and is a producer of liquid and solid wastes, so it would suffer from a water shortage and the impairment of sewerage systems;

(c) tourism will also suffer from the negative impact of expected climate change on agricultural production (see section 3.5.1), which is needed by tourists as well;

(d) the expected temperature rise in summer and the possible increase in wind and storms (see section 3.1) might cause uncomfortable and unpleasant conditions at the seaside;

(e) a higher level of pollution and turbidity of sea water may occur as a result of soil erosion along the rivers; this may lower the interest in tourism based on swimming and sun-bathing.

3.8. Transport

The impact of climate change will be more significant on the harbours than on the roads, railways or airports. The impacts on transport are likely to be:

(a) the flooding of coastal roads (especially the Durrës-Golem road), as result of the expected sealevel rise of +48cm, by 2100;

(b) this same sealevel rise will not have any negative impact on existing harbours, because the level difference between the sea surface and the quay surface is greater than 1.5m;

(c) maritime transport might be influenced by the expected increase in the frequency of strong winds and storms; many cases of strong winds or storms causing problems in harbours have been recorded;

(d) the expected temperature increase would require the upgrading (especially air-conditioning) of public transport, which is not at present equipped with air conditioning.

3.9. Sanitation and Health Aspects

It is very difficult to estimate the impact of climate change on public health, because the impact of other, non-climatic factors is greater. Nevertheless, by 2100, some negative impacts on sanitation and health may occur:

(a) shortage of drinking water of adequate quality;

(b) impairment of coastal sewerage systems based on gravitational flow, owing to sealevel rise. The drinking-water problem would become especially keen during summer, but so would that of liquid and solid wastes; if discharged directly into the sea, they would destroy or strongly modify the sea flora and fauna. Without solving the two last problems, the impact of climate change would lead to a deterioration in the health of the Albanian population as a whole and not only the part living in the coastal zone;

(c) increase in illnesses transmitted by biological vectors. Insect-borne diseases may well become widespread under conditions of higher temperature, either because the vector would be able to survive better at higher latitudes or because parasites would be able to complete their life-cycle more easily. Temperature increases would lengthen the breeding season and survival rates of a number of insect vectors, including mosquitoes of the genus *Anopheles*; as a consequence, malaria might reappear in Europe (UNEP, 1994d);

(d) increase in illness and mortality associated with extreme climatic events. A temperature rise of up to 2.8EC and an increased frequency of extreme temperatures, as well as the increased humidity (as a result of increased evaporation) may adversely influence the health of people who suffer from heat stress or are hypertonic or cardiopaths.

3.10. Population and Settlements

The climate change by 2030 is not expected to have any considerable effect on the dynamics of the population nor on settlement patterns, especially along the Adriatic coast. The population growth in the coastal area may be expected to follow present trends. The Ionian coast is rocky and abrasive and settlements are located at higher altitudes; therefore, the sealevel rise would affect neither the population nor the settlement. The beaches there are narrow, so that construction of new buildings must be undertaken with care.

Population seems unlikely to be affected by the expected climate change until 2100. Since human beings are very adaptable, they can be expected to react and to try to create an improved microclimate, especially in closed and/or covered environments. People may be expected to situate their habitations nearer the sea and/or water surfaces; drought would stimulate people to live near the water basins, to facilitate adaptation to the drought. The expected increase in drought frequency and the shortage of drinking water of adequate quality will mean more expensive ways of ensuring the availability of running water.

The expected climate change by 2100 may cause changes in settlement patterns and sites. Some settlements situated very near the coastline, especially in the low-lying northern part and those in areas at low altitude, such as Durrës, some villages near the mouth of the Mati river, near Ceka and Merxhani lagoons and Narta lagoon would be forced to move inland, because of expected soil erosion. The traditional settlements situated in the foothills would not be endangered by the sealevel rise. Some dense settlements along the coast and particularly along the principal drainage channels and protective dikes would be affected to some extent.

Although the demand for urban space along the coast would become more acute as the population and tourism grew, it will not be much affected by the loss of a small proportion of the total coastal land area. The dependence of some settlements on agriculture would change towards tourism and the provision of services.

The typology of the houses may be expected to change, with living space more open towards the natural surroundings. Since new construction would be situated nearer the coastline, it would have more open space and more glassed-wall area.

4. RECOMMENDATIONS FOR ACTIONS

4.1. Suggested Action to Avoid, Mitigate or Adapt to the Predicted Effects

4.1.1. Climate conditions

As has already been pointed out, air pollution is one of the most acute problems today, because of its direct negative influence on other environmental media.

In parallel with the impacts of atmospheric pollutants on the biota, there is the serious problem of their possible influence on the climate system, through warming and contamination of the atmosphere by greenhouse gases.

The following actions are recommended:

(a) development of new technology to decrease the emission of carbon dioxide and other greenhouse gases into the atmosphere;

(b) use of alternative forms of energy, such as solar and wind energy;

(c) establishment of an air-quality monitoring system is very urgent, but the existing meteorological service must also be improved, so that the possible increase in air contamination may be assessed and adequate warning of danger may be given;

(d) international scientific cooperation to develop general circulation models, taking into consideration other meteorological elements, to allow more accurate prediction.

To adapt to the expected new climate conditions, the following actions are recommended:

(a) afforestation to help mitigate the impact of drought and strong winds;

(b) establishment of an artificial precipitation system to avoid the negative effects of drought on agriculture;

(c) establishment of a hail-suppression system to decrease the harmful effects of hail, especially in summer.

4.1.2. Lithosphere

To evaluate and control the negative effects of the predicted climate change, the following actions are recommended:

(a) study of the erosion and the dynamics of the coastal area, especially on the Adriatic coast;

(b) preparation of a landslide map and a detailed geological map of vulnerable areas.

The following engineering actions against these phenomena are also recommended:

(a) afforestation of the Currila (Durrës), Vlora and Kryevidh (Kavaja) areas;

(b) construction of protective step walls or pipes in the areas prone to landslides, such as Kryevidh, Kepi i Rodonit, Bishti i Pallës, Shëngjin, etc.;

(c) setting up of artificial barriers in areas threatened by erosion, so as to prevent the negative effects due to sealevel rise (it is of great importance to preserve the Patoku lagoon);

(d) improvements in the drainage of surface and ground waters;

(e) improved planning of the civil engineering works, including complete technical, economic and architectonic studies;

(f) the application of remote sensing to the study of coastline dynamics.

4.1.3. Hydrosphere

The following administrative and construction measures must be taken, by the national authorities concerned, to mitigate the possible impact of the climate change:

(a) investigations of the coastal dynamics to determine changes in the sediment budget as a result of sealevel rise and in the output of sediment by rivers;

(b) mapping of areas vulnerable to flooding;

(c) rehabilitation of the flood-warning system which does not function at present;

(d) control of land reclamation, to reduce the coastal area susceptible to inundation;

(e) monitoring of surface-water and ground-water quality, and of water-table depth;

(f) control of ground-water exploitation, to reduce subsidence.

4.1.4. Natural ecosystems

To protect the natural ecosystems from the impact of climate change, the following actions are recommended:

(a) implementation of some protective measures to prevent the negative influence of sealevel rise (as recommended in section 4.1.2), especially near Natural Protected Areas;

(b) preparation of a strategy to protect biodiversity of the coastal area, including, *inter alia*:

- ! protection and rehabilitation of biologically important areas, ecosystems and species;

- ! prevention of large-scale tourism development disregarding the sensitivity of ecosystems;

- ! prevention of the discharge of waste water into coastal wetlands.

4.1.5. Managed ecosystems

To avoid and mitigate the negative impact of climate change on agriculture, which is planned to be developed rapidly in the coming years, the following actions are recommended:

(a) development of a modern irrigation system, based, if possible, on drip irrigation, so as to make rational use of available water under the future climate conditions;

(b) installation of pumping stations with higher specific discharge to protect the arable land threatened by the expected increase in salinity;

(c) afforestation and the setting up of barriers to protect the arable land threatened by soil erosion and alteration;

(d) planning of agricultural production to allow adaptation to the higher winter and summer temperatures and to the scarcity of water in summer, etc.; agricultural development should therefore be adjusted towards enhanced winter production and towards species that would adapt best to the expected soil and atmospheric conditions (increased temperature and evaporation, scarcity of precipitation, increased salinity, pests, etc.);

(e) control of the use of fertilisers and pesticides, to avoid over-application.

On the basis of present knowledge, it is rather difficult to recommend actions in the fishery and aquaculture sectors; the following actions are suggested:

(a) rational use of the fish stock, so as to prevent over-exploitation and impoverishment of fish stocks;

(b) prevention and control of overfishing, monitoring of fish stocks and inspection if fishing activities;

(c) cultivation, in priority, of fish in floating-cage systems;

(d) prevention of the construction or extension of fish farms in fresh waters, because of the expected water shortage;

(e) development of the inland market to sell high quality fish to support future development of tourism.

Regarding forests, the following actions are recommended to avoid, mitigate, or adapt to, the predicted impact of climate change:

(a) identification of the appropriate approaches to support the increase and development of mixed forests resistant to the expected new climate conditions;

(b) cultivation of big-seed forest species, which will be likely to occupy new areas, as well as other forest species more resistant to drought, fires, pests, shortage of ground water, increased salinity etc.;

(c) preparation of management plans for the sustainable development of forests in harmony with the development of other sectors of the economy;

(d) establishment of mixed forests in abandoned agricultural lands or in forests of low density (up to 40%) as well as on slopes of 22 degrees;

(e) conduct of studies on the dynamics of forest fires, on the rehabilitation of the existing forests, and on the damage that pests might cause under the expected future climatic conditions.

4.1.6. Energy and industry

To prevent the impact of sealevel change by 2100, the following actions are recommended:

(a) protection or relocation of factories located on the sea shore;

(b) take into account the expected sealevel rise during the selection of locations for new future industries;

(c) inclusion of the use of solar energy and other forms of renewable energy, as a clean energy resource, in the National Energy Programme;

(d) reduction of industrial water consumption (by better recycling) and improved methods of treating fresh and used water under a condition of water shortage (as a result of intrusion of saline water into aquifers, decrease in the flow of surface water, etc.);

(e) development of the food industry, so as to respond to the increased demands of tourism (since a prolonged tourist season is expected).

4.1.7. Tourism

Since tourism will be one of main activities in Albania, a more detailed study of the possible impact of climate change on tourism is called for. The following actions are recommended:

(a) development of environmentally sound tourism that is not only sensitive to coastal and marine habitats, but which also enhances their quality;

(b) application of preventive measures to protect the existing tourist structures against sealevel rise by 2100 and the design of new structures, including marinas, taking into account the expected climatic conditions;

(c) undertake a study of (for example, an appraisal of the negative impacts of mass tourism), and plan, the integration of tourism with other socio-economic activities, given that the problems created by coastal tourism involve employment, communications, water and food supplies, etc.;

(d) prevention of the discharge of untreated urban and industrial wastes (liquid or solid) into the sea;

(e) development of educational programmes on the protection of coastal and other environments, so as to make the population and decision-makers more aware of the possible impact of expected climate change.

4.1.8. Transport

Keeping in mind that transport is of great importance to all sectors of the economy, preliminary measures to eliminate the negative impact of climate change need to be taken. The following actions are recommended:

(a) reconstruction of the Durrës-Golem road, which might be threatened by sealevel rise by 2100;

(b) development of road-transport and harbour-construction programmes in the coastal area;

(c) give high priority to the control of pollutant emissions;

(d) establishment of storm- and flood-warning systems, to warn of hazardous events in good time; such systems should be installed at the main ports and airports and the telecommunication links with forecasters should be rehabilitated countrywide.

4.1.9. Health and sanitation

It is very important to take the necessary measures to:

(a) control the drinking-water quality;

(b) monitor the water quality;

(c) exercise permanent control over water supply and sewerage systems affected by salt-water corrosion and intrusion;

(d) establish treatment systems for urban and industrial wastes;

(e) raise the awareness of the resident population, as well as of tourists, with respect to possible environmental influence (as, for example, excessive sunbathing) especially on individuals with premorbid conditions or already with diseases.

4.1.10. Population

The following actions are recommended:

(a) monitoring and mapping of coastline changes, to identify accurately the high-risk areas, so that planners could prevent major mistakes, to ensure improved distribution of land (sites) to the ex-owner (this redistribution will be in the coastal area);

(b) development of new building and planning standards for the protection of existing and new constructions;

(c) orientation of population movement away from areas threatened by sealevel rise or that are vulnerable to flooding;

(d) improvement of the sewerage systems of existing and new settlements;

(e) preparation of another scenario to evaluate what might be expected to occur as a result of human activities carried out by the population (maybe to orientate their activities towards fishery, tourism, aquaculture, etc.);

(f) preparation of improved zoning proposals and land-use plans, based on this new scenario, to be used as a guideline for future developments.

4.2. Suggestions for Follow-up of the Present Study

To evaluate and control the major negative effects, a number of activities should be part of national plans and strategies:

(a) a strategy is required to prevent or avoid in good time the impact of climate change, keeping in mind the continuity of this change; therefore:

- it is important to establish a monitoring system to observe the impact of climate change and human activity;

- it is urgent to prepare local inventories of impacts on water resources, ecosystems and socio-economic activities due to changes in temperature, precipitation and sealevel; the precise identification of the areas that are likely to be affected by climate change is also recommended;

- the impact of climate change must be taken into consideration by developing integrated planning;

(b) information on the possible consequences of climate change and the need to take the necessary steps for their avoidance must be distributed to economic and political decision-makers at all levels. Therefore:

- the use of renewable energy, as a resource that does not cause pollution, should be given priority;

- a cost-benefit analysis should be made to evaluate the costs of mitigating the effects of climate change.

ANNEX I

LIST OF TASK TEAM MEMBERS

NATIONAL MEMBERS

Ms Eglantina Demiraj
Coordinator of the Task Team
Hydrometeorological Institute
Durrës Street, 219
Tirana
Albania

Ms Mirela Bicja
Hydrometeorological Institute
Durrës Street, 219
Tirana
Albania

Mr Emil Gjika
Institute of Chemical Technology
Tirana
Albania

Mr Lekë Gjiknuri
Natural Sciences Faculty
University of Tirana
Tirana
Albania

Ms Liri Gjoka Muçaj
Hydrometeorological Institute
Durrës Street, 219
Tirana
Albania

Mr Fatos Hoxha
Hydrometeorological Institute
Durrës Street, 219
Tirana
Albania

Mr Përparim Hoxha
Faculty of Geology and Mining
Polytechnical University
Tirana
Albania

Mr Spiro Karadumi
Institute of Forestry Research
Tirana
Albania

Mr Sokol Kongoli
Ministry of Tourism
Tirana
Albania

Mr Alfred Mullaj
Institute of Biological Research
Tirana
Albania

Mr Vangjel Mustaqi
Hydrometeorological Institute
Durrës Street, 219
Tirana
Albania

Mr Arjan Palluqi
Ministry of Agriculture and Food
Directorate of Fisheries
Tirana
Albania

Ms Elvana Ruli *
Physical Planning Institute
M. Gjollesha Street, ISTN
Tirana
Albania

Mr Mustafa Selfo
Ministry of Agriculture and Food
Directorate of Fisheries
Tirana
Albania

Mr Agim Shehi
Ministry of Health and Environmental Protection
Tirana
Albania

Mr Qemal Sino**
Ministry of Industry, Transport and Trade
Tirana
Albania

<u>EXTERNAL MEMBERS</u>

Mr Ljubomir Jeftic
Deputy Coordinator
Coordinating Unit for the Mediterranean Action Plan
48 Vassileos Konstantinou
11635 Athens
Greece

Mr Stjepan Keckes
21 Ludovico Brunetti
Borik
52210 Rovinj
Croatia

* joined the Task Team in September 1995
** joined the Task Team in June 1995

ANNEX II

LIST OF ACRONYMS

BCG	Bilié Calmette-Guérin
BOD	Biological Oxygen Demand
CAMP	Coastal Area Management Programme
CFC	Chlorofluorocarbon
CRU	Climate Research Unit (of UEA)
DTP	Diphtheria-Tetanus-Pertussis
EIA	Environmental Impact Assessment
ET	Evapotranspiration
FAO	Food and Agriculture Organization of the United Nations
FPRI	Forest and Pasture Research Institute
FRI	Fishery Research Institute
GCM	Global Circulation Model
GDP	Gross Domestic Product
GFDL	Geophysical Fluid Dynamics Laboratory
GIS	Geographical Information system
GISS	Goddard Institute of Space Studies
HMI	Hydrometeorological Institute
ICAM	Integrated Coastal Area Management Programme
IPCC	Intergovernmental Panel on Climate Change
IUCN	World Conservation Organization
LBS	Land-based source
MHEP	Ministry of Health and Environmental Protection
MEDS	Ministry of Economics Directory of Satistics
OSU	Oregon State University
PVC	Polyvinylchloride
SPA	Specially Protected Areas
TDS	Total Dissolved Solids
UEA	University of East Anglia
UNEP	United Nations Environment Programme
UKMO	United Kingdom Meteorological Office
WHO	World Health Organization

ANNEX III

TEMPERATURE AND PRECIPITATION SCENARIOS

FOR ALBANIA

TEMPERATURE AND PRECIPITATION SCENARIOS FOR ALBANIA

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

February 1994

CLIMATIC RESEARCH UNIT
School of Environmental Sciences
University of East Anglia
Norwich, NR4 7TJ
England

TEMPERATURE AND PRECIPITATION SCENARIOS FOR ALBANIA

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

(in alphabetical order)
X. Guo, J.P. Palutikof and T.M.L. Wigley

Climatic Research Unit
School of Environmental Sciences
University of East Anglia
Norwich NR4 7TJ
U.K.

February 1994

TABLE OF CONTENTS

Figures

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)

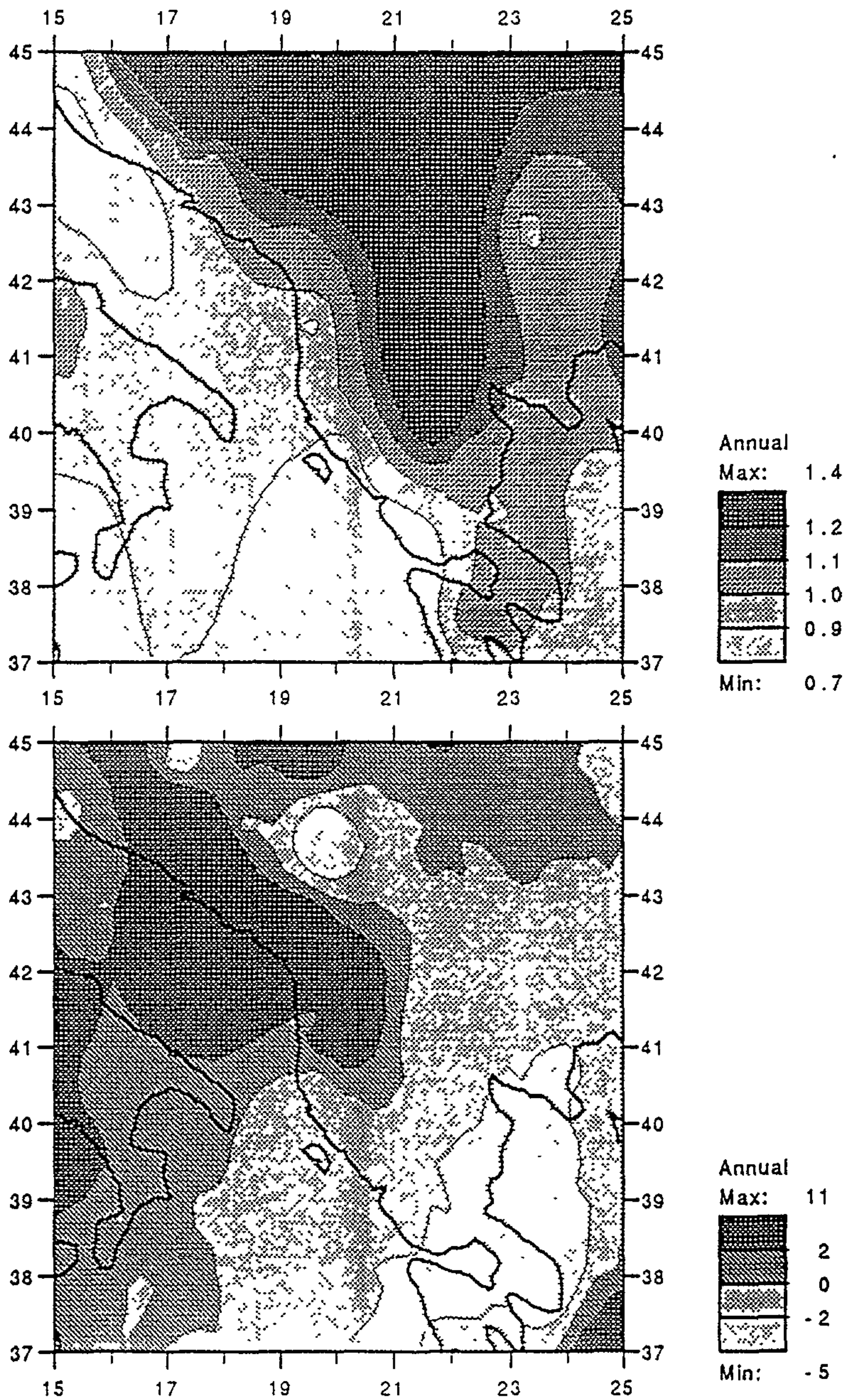


Fig. 2 Regional climate scenarios for Albania winter Upper map shows change in temperature (°C per °C global change) and the lower map shows change in precipitation (% per °C global change)

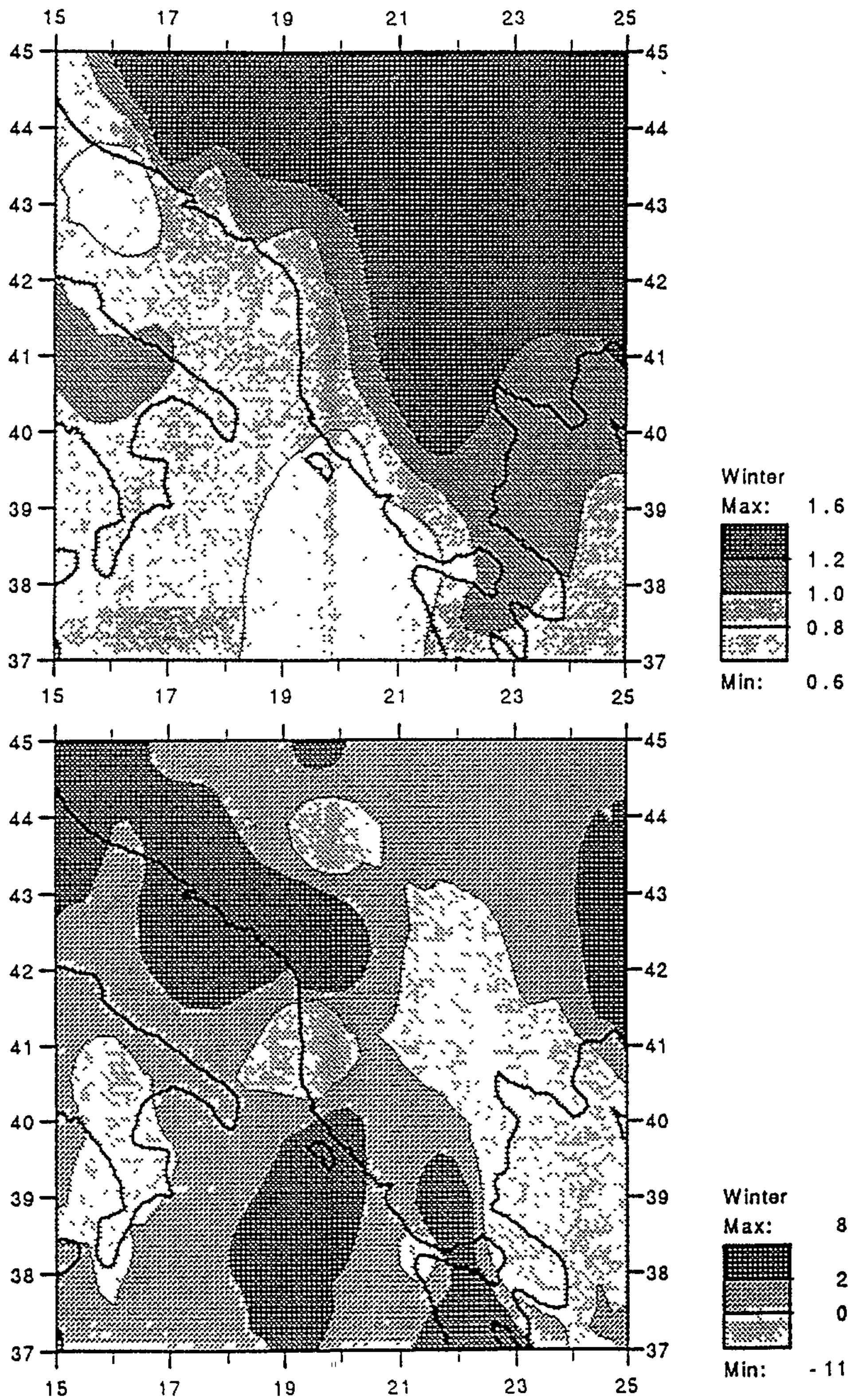


Fig. 3 Regional climate scenarios for Albania spring Upper map shows change in temperature (°C per °C global change) and the lower map shows change in precipitation (% per °C global change)

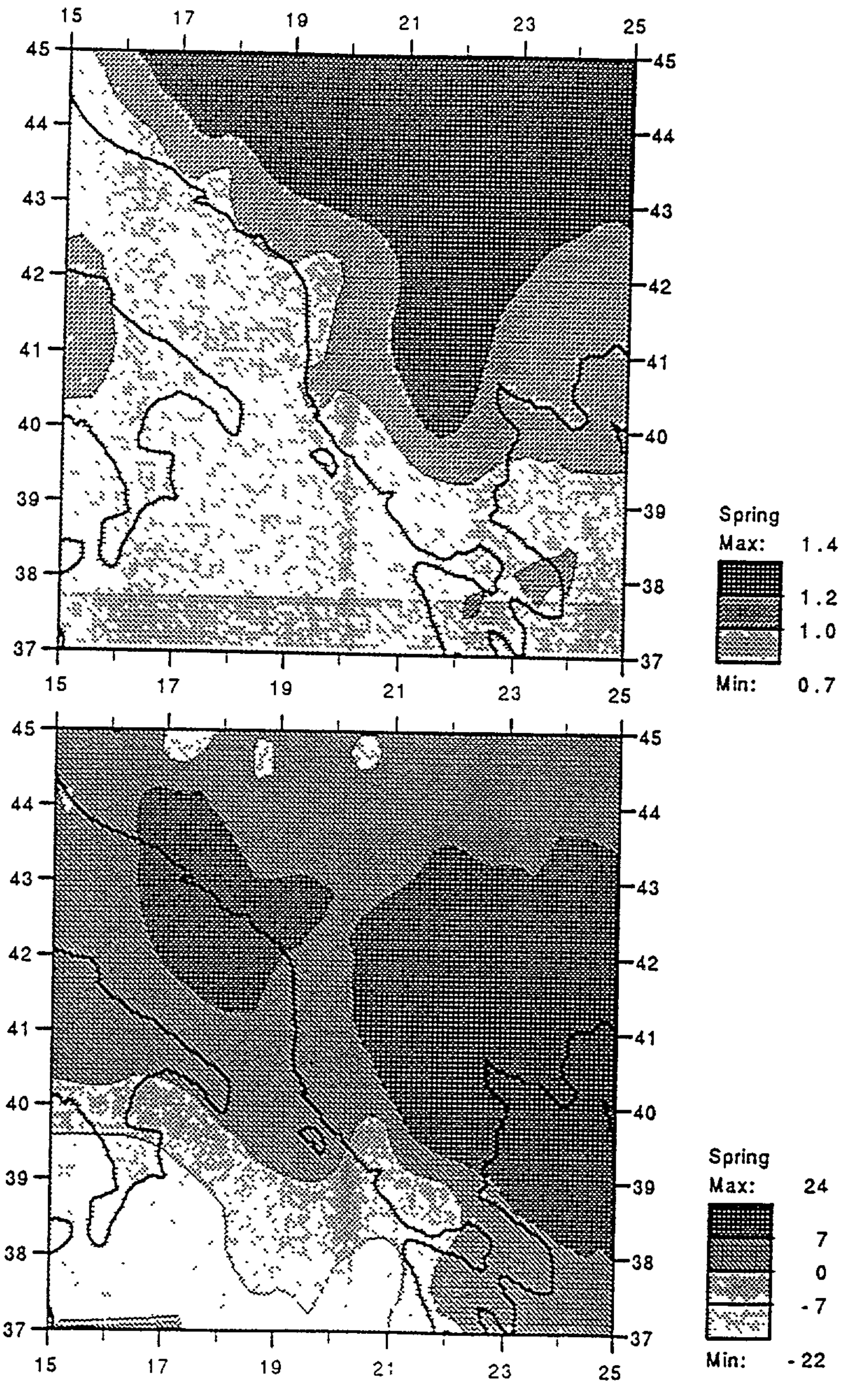


Fig. 4 Regional climate scenarios for Albania summer. Upper map shows change in temperature (°C per °C global change) and the lower map shows change in precipitation (% per °C global change)

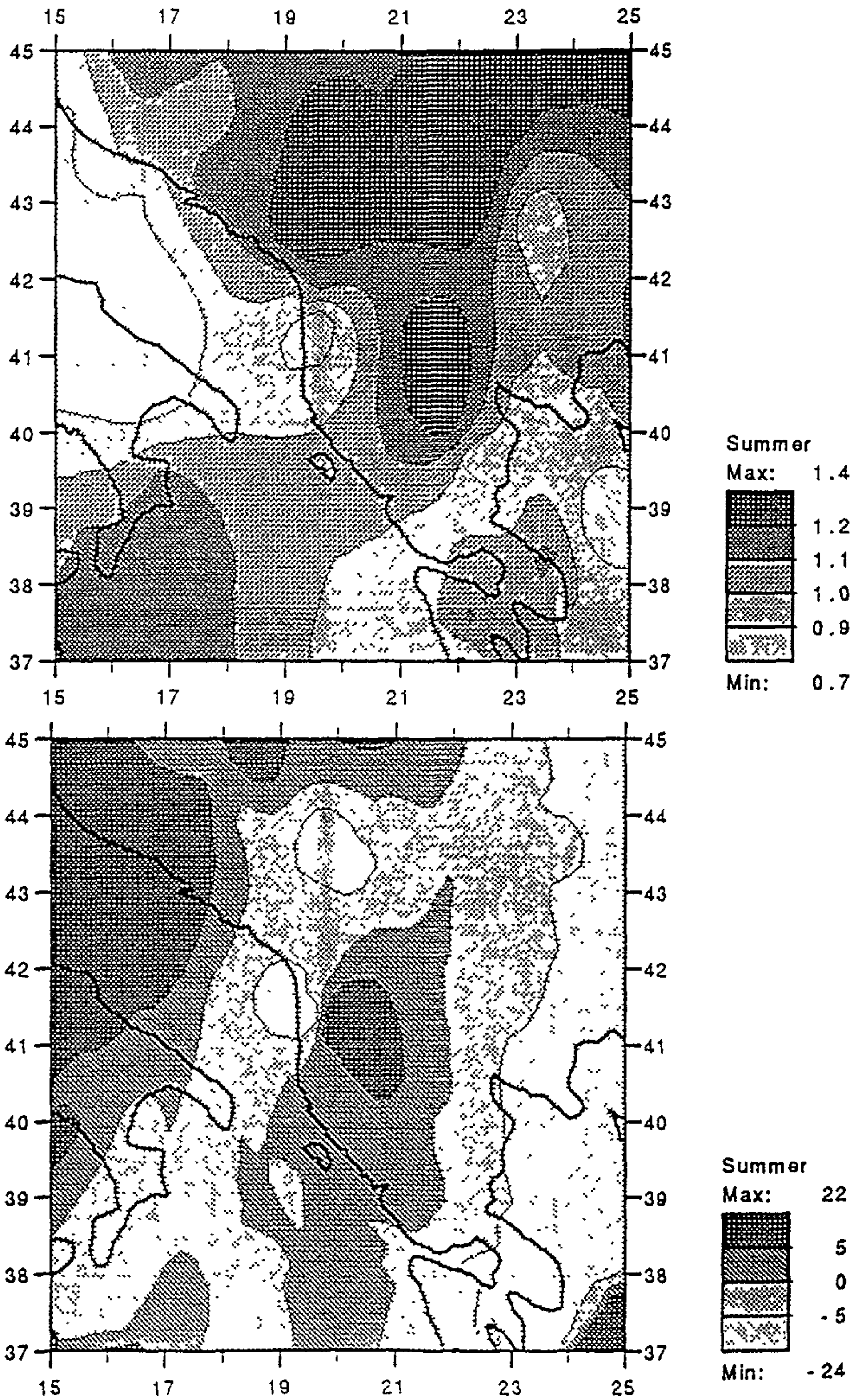
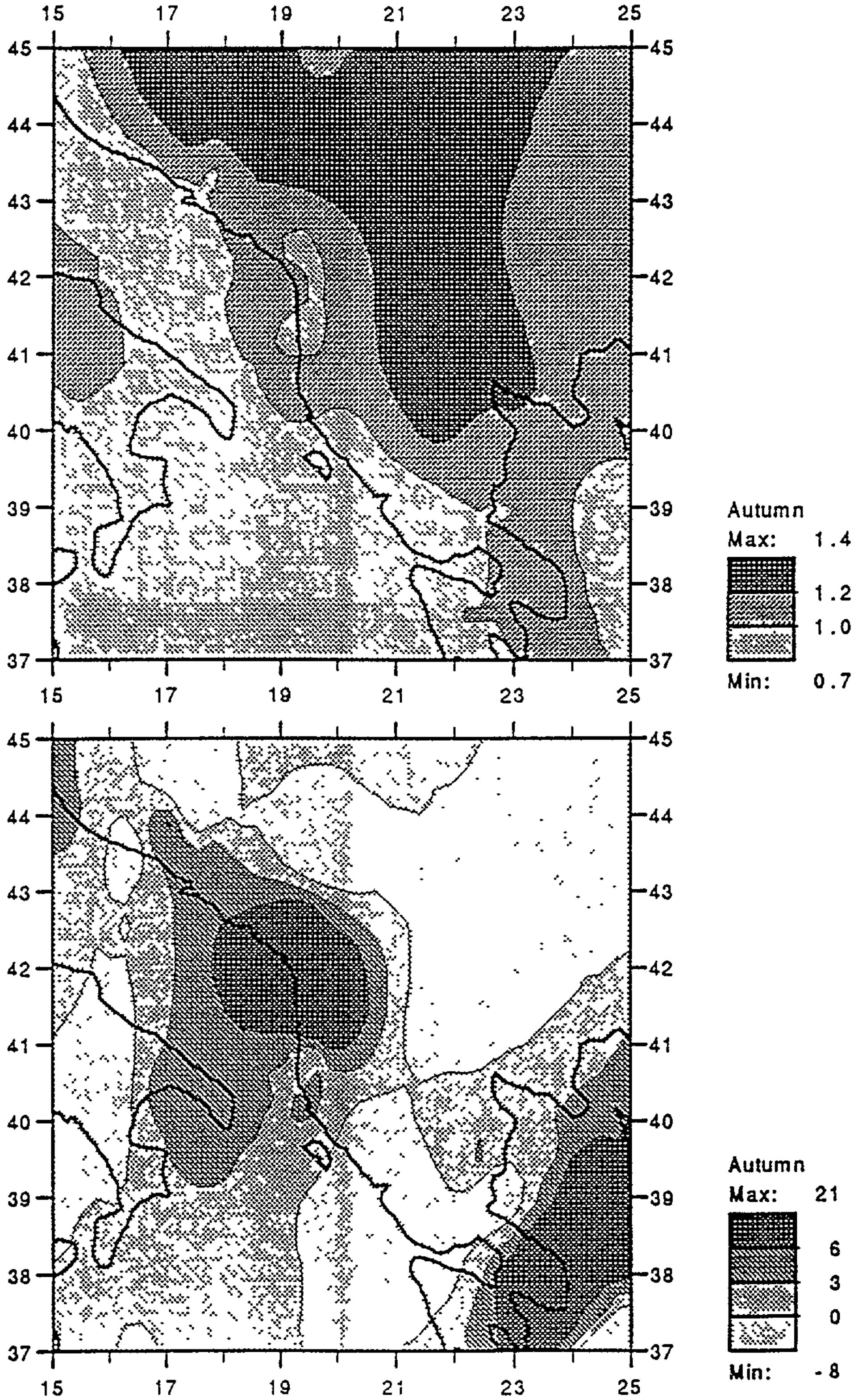


Fig. 5 Regional climate scenarios for Albania autumn Upper map shows change in temperature (°C per °C global change) and the lower map shows change in precipitation (% per °C global change)



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 IV

LIKELY MAJOR IMPACTS ASSOCIATED WITH EXPECTED CLIMATE CHANGE

(this list was prepared by the Task Team members on the basis of Delphi exercise.
The list is presented in decreasing order of impacts
and numbers indicate the total number of points given by the Task Team)

(a) Harmful impacts

Drought, particularly in summer	98
Intrusion of saline waters in coastal aquifers	50
Shortage of adequate quality drinking water	48
Soil erosion (physical)	43
Reduction in the extent of arable land due to soil erosion and alteration caused by climate change	37
Coastal erosion	37
Increased exchange of water between lagoons and the sea due to sea level rise; i.e., elevation of lagoon salinity	32
Increased mixing of surface and deep marine waters with concomitant changes in dissolved-oxygen distribution and in the composition of marine fauna and flora	31
Increase in flooded coastal areas (ligatines) due to sealevel rise	30
Impairment of coastal sewerage systems operated by gravitational flow, due to sealevel rise	26
Increased need for irrigation of arable land	25
Increase in illness transmitted by biological vectors	25
Increased temperature and salinity of marine surface waters	20
Decrease in the flow of surface waters	20
Structural changes (species composition and abundance) in natural ecosystems	19
Soil alteration (chemical) due to salinization, loss of nutrients, etc.	13
Decrease in the recharge of aquifers	13
Increased intensity and frequency of storms, rain, floods	11
Intensified karst formation	10
Increased demand for industrial fresh water (especially for cooling) and treatment of used water	10
Increase in illness and mortality associated with extreme climatic events (e.g. heat strokes)	10
Extension of tourist season into periods of the year presently too cold	9
Altitudinal and north/south shifts in the location of natural ecosystems	8
Harbour installations and operations affected by sealevel rise	7
Land slides	6
Increased demand for fresh water for aquaculture	5
Increased potential for altitudinal and north/south shifts in lands under forests, particularly in replacing deciduous with evergreen forests in the northern part of the study area	4
Change in the type of crops so as to adapt to new climate conditions	3
Increased potential for aquaculture (introduction of new species, prolonged periods of intensive growth, etc.)	3
Changes in lagoon-cultivated species due to changing salinity of lagoons	3
Increased potential for use of solar energy	3
Increased intensity and frequency of fog	1

(b) Beneficial impacts

Extension of tourist season into periods of the year presently too cold	9
Increased potential for use of solar energy	9
Decreased energy demand for heating	8
Increased potential for aquaculture (introduction of new species, prolonged periods of intensive growth, etc.)	7
Increased exchange of water between lagoons and the sea due to sealevel rise; i.e. elevation of lagoon salinity	3
Increased potential for altitudinal and north/south shifts in lands under forests, particularly in replacing deciduous with evergreen forests in the northern part of the study area	1
Increased mixing of surface and deep marine waters with concomitant changes in dissolved-oxygen distribution and in the composition of marine fauna and flora	1
Decrease in the flow of surface waters	1
Altitudinal and north/south shifts in the location of natural ecosystems	1
Change in the type of crops so as to adapt to new climate conditions	1

ANNEX V

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 site	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 VI

LIST OF ENDEMIC, RARE AND ENDANGERED SPECIES IN THE COASTAL AREA OF ALBANIA

Plant species

Quercus robur
Capparis marina
Ephedra distachya
Juniperus communis
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. *vloranse*; endemic
Limonium anfractum
Micromeria myrtifolia
Orchis albanica; endemic
Petteria ramentacea
Sinapis pubescens
Stachys decumbens
Teucrium fruticans

Animals/vertebrates

<u>Mammals</u>

Capreolus capreolus
Bos primigenius (living in the wild, Divjaka)
Lutra lutra
Martes foina
Meles meles
Canis aureus
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
Haliæetus albicilla
Aquila clanga
Aquila pomarina
Buteo lagopus
Falco peregrinus
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

<u>Reptiles</u>

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

<u>Amphibians</u>

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

ANNEX VII

SPECIES COMPOSITION OF THE PRINCIPAL VEGETATION ASSEMBLAGES

i Eu-Mediterranean evergreen forest

(up to 350m above sealevel)

The principal species in this assemblage are: holly oak (*Quercus ilex*, L.), kermes oak (*Quercus coccifera*, L.), strawberry (*Arbutus unedo*, L.), mastic (*Distacia lentiscus*, L.), mack privet (*Pillyrea media*, L.), olive (*Olea europæa*, L.), orange (*Citrus aurantium*, L.), heath (*Erica* sp., L), *Cistus* sp., L, sweetbay (*Laurus nobilis*, L.), large-fruited juniper (*Juniperus macrocarpa*, S.), Aleppo pine (*Pinus halepensis*, Mill), stone pine (*Pinus pinea*, L.), seaside pine (*Pinus pinaster*, Sol.), roman cypress (*Cupressus sempervirens*, L.), myrtle (*Myrtus communis*, L.), privet (*Ligustrum vulgare*, L.), smilax (*Smilax aspera*, L.), ivy (*Hedera helix*, L.), traveller's joy (*Clematis vitalba*, L.), sumac (*Cotinus coggygria*, Scop), Spanish broom (*Spartium junceum*, L.), oriental hornbeam (*Carpinus orientalis*, L.), thorn (*Cratægus* sp., L.), common Judas (*Cersis siliquastrum*, L.), blackthorn (*Prunus spinosa*, L.), common oak (*Quercus robur*, L.), ash (*Fraxinus* sp., L.), white poplar (*Populus alba*, L.), common dogwood (*Cornus sanguinea*, L.), bladder senna (*Colutea arborescens*, L.), common elm (*Ulmus foliacea*, Gilib.), walnut (*Juglans regia*, L.), common alder (*Alnus glutinosa*, L.), tamarisk (*Tamarix* sp., L.), acacia (*Acacia saligna*), willow (*Salix viminalis*) (Ciancio, 1971; Sabato and Valenciano, 1975; Muharremi, 1990; Karadumi, 1992; Mitrushi, 1993; Rameau, 1993).

ii Deciduous forest with kermes oak

(up to 550m above sealevel)

The following species might be found in this assemblage: kermes oak (*Quercus coccifera*, L.), olive (*Olea europæa*, L.), sweetbay (*Laurus nobilis*, L.), *Quercus ægilops*, L., Macedonian oak (*Q. trojana*, Webb), pubescent oak (Q. pubescens, Willd), Turkey oak (*Q. cerris*, L.), common oak (*Q. robur*, L.), oriental hornbeam (*Carpinus orientalis*, L.), hop hornbeam (*Ostrya carpinifolia*, Scop.), maple (*Acer* sp., L.), flowering ash (*Fraxinus ornus*, L.), common elm (*Ulmus foliacea*, Gilib.), terebinth (*Pistacia terebinthus*, L.), *Christ's thorn* (*Paliurus spina Christi*, Mill), almond (*Amygdalus* sp., L.), pear (*Pyrus* sp., L.) cornel (*Cornus* sp., L.), rose (*Rosa*, sp., L.), berry (*Robus* sp., L.), common Judas (*Cersis siliquastrum*, L.), white poplar (*Populus alba*, L.), common alder (*Alnus glutinosa*, L.), oriental plane (*Platanus orientalis*, L.), eucalyptus (*Eucalyptus camaldulensis*, Desf.), willow (*Salix viminalis*) (Ciancio, 1971; Sabato and Valenciano, 1975; Muharremi, 1990; Karadumi, 1992; Mitrushi, 1993; Rameau, 1993).

iii Deciduous forests

(from 150 to 1250m above sealevel)

The following species might be found in this assemblage: *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. trojana*, L.), oriental hornbean (*Carpinus orientalis*, Mill), hop hornbeam (*Ostrya carpinifolia*, Scop.), ash (*Fraxinus* sp., L.), spring maple (*Acer obtusatum*, Waldst et Kit.), Norway maple (*A. platanoides*, L.), Tartarian maple (*A. tataricum*, L.), elm (*Ulmus* sp., L.), privet (*Ligustrum vulgare*, L.), box (*Buxus sempervirens*, L.), black pine (*Pinus nigra*, Arn.), silver fir (*Abies alba*, Mill), berry (*Rubus* sp., L.), traveller's joy (*Clematis vitalba*, L.), kermes oak (*Q. coccifera*, L. which, in the lowest places, forms underforest), holly (*Ilex aquifolium L.*), dogrose (*Rosa canina*, L.), common yew (*Taxus baccate*, L.), European forsythia (*Forsythia europæa*, Deg. and Bould), black locust (*Robinia pseudoacacia*, L.), willow (*Salix incana*, Schrank), plum (*Prunus domestica*, L.), holly oak (*Quercus ilex*, L.), prickly cedar (*Juniperus oxycedrus*, L.), bladder senna (*Colutea arborescena*, L.), shop-sage (*Salvia officinalis*, L.), sage (*Phlomis fruticosa*, L.), garland flower (*Daphne cneorum*, L.), goatsleaf (*Lonicera caprifolium*, L.), *Siderites ræseri*, Boiss and Held, etc. (Ciancio, 1971; Sabato and Valenciano, 1975; Muharremi, 1990; Karadumi, 1992; Mitrushi, 1993; Rameau, 1993).

iv Silver fir

(1250 - 1850m above sealevel)

This assemblage comprises the following species: silver fir (*Abies alba*, Mill), black pine (*Pinus nigra*, Arn.), box (*Buxus sempervirens*, L.), holly (*Ilex æquifolium*, L.), dogrose (*Rosa canina*, L.), common yew (*Taxus baccata*, L.), hop hornbeam (*Ostrya cartpinifolia*, Scop.), European forsythia (*Forsythia europea*, Deg. and Bould), shop sage (*Salvia officinalis*, L.), maple (*Acer* sp., L.), garland flow (*Daphne cneorum*, L.), goatsleaf (*Lonicera caprifolium*, L.), etc. (Ciancio, 1971; Sabato and Valenciano, 1975; Muharremi, 1990; Karadumi, 1992; Mitrushi, 1993; Rameau, 1993).

v Mediterranean alpine vegetation

(1850 - 2045m above sealevel)

This assemblage consists principally of species of the families *Graminaceæ, Leguminoseæ* and *Compositeae*, marjoram (*Origanum vulgare*, L.), cinchona (*Cinchona officinalis*, L.), tutsan (*Lavandula angustifolia*, Mill), meadow saffran (*Colchicum autumnale*, L.), *Siderites ræseri*, Boiss and Helder, sesleria (*Sesleria* sp., Scop), *Andropogon* sp., L. etc. (Ciancio, 1971).

ANNEX VIII

EXPECTED DISTRIBUTION OF ALBANIAN FORESTS

Table I

forests and vegetation assemblages, by altitude, for three time horizons: 1975, 2030, 2100

Districts Forest unit		Vegetation assemblage	Altitude (m)		
			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 kermes 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 kermes 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	Forest of Gjomollë	Eu-Mediterranean evergreen forests	up to 250	up to 400	up to 650
		Deciduous forests with kermes 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 kermes 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 kermes 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 kermes oak	250-450	400-600	650-850
		Deciduous forests	450-1250	600-1350	850-1350
		Silver fir and black pine forests	1250-1350	-	-

Districts Forest unit		Vegetation assemblage	Altitude (m)		
			1975	2030	2100
2.1.2	Forest of llogara	Deciduous forests with kermes oak	-	-	655-850
		Deciduous forests	655-1250	655-1400	850-1464
		Silver fir and black pine forests	1250-1464	1400-1464	-
2.1.3	Forest Tragjas-Shengjergj	Eu-Mediterranean evergreen forests	90-250	up to 400	up to 650
		Deciduous forests with kermes oak	250-450	400-600	650-850
		Deciduous 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 kermes 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 kermes 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 kermes 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 kermes oak	up to 10	-	-
2.5	**Durrës**		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 kermes oak	up to 150	-	-
2.5.2	Forest of Rrushkull	Eu-Mediterranean evergreen forests	-	5 to 3	5 to 3
		Deciduous forests with kermes 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 kermes oak	up to 227	-	-

Districts Forest unit		Vegetation assemblage	Altitude (m)		
			1975	2030	2100
2.6	**Kruja, Laci**		up to 50	up to 50	up to 50
2.6.1	Forest of Fushë-Kuqe	Eu-Mediterranean evergreen forests	-	up to 50	up to 50
		Deciduous forests with kermes oak	up to 50	-	-
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 kermes oak	1--15	-	-
2.7.2	Forests of Mali I Rencit	Eu-Mediterranean evergreen forests	-	up to 200	up to 400
		Deciduous forests with kermes 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 zezë	Eu-Mediterranean evergreen forests	-	up to 200	up to 400
		Deciduous forests with kermes 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 kermes oak	up to 100	-	-

Table II

The national parks, nature monuments, seed-stand forests and vegetation assemblages, by altitude, for three time horizons: 1975, 2030, 2100

National parks Nature monuments Seed stands		Vegetation assemblages	Altitude (m)		
			1975	2030	2100
1.1	Llogara, Vlorë	Eu-Mediterranean evergreen forests	-	-	475-650
		Deciduous forests with kermes 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 zvërnecit-Vlorë	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 kermes oak	50-150	-	-
2.4	Pylli I Matkeqit-Lezhë	Eu-Mediterranean evergreen forests	-	up to 1	up to 1
		Deciduous forests with kermes 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 farorë I PIshe Zezë Llogara-Vlorë	Eu-Mediterranean evergreen forests	-	-	610-650
		Deciduous forests with kermes 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 kermes oak	up to 2	-	-

Table III

Hunting reserves and the vegetation assemblages, by altitude, for three time horizons: 1975, 2030, 2100

Hunting reserve		Vegetation assemblages	Altitude (m)		
			1975	2030	2100
1.	Karaburun-Vlorë	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-Vlorë	Eu-Mediterranean evergreen forests	up to 7	up to 7	up to 7
3.	Pishë Poro-Fier	Eu-Mediterranean evergreen forests	3 to 7	3 to 7	3 to 7
4.	Pisha e Divjakës-Lushnjës	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.	Fushë 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-Lezhë	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	-	-

REFERENCES

Aliaj, S., 1966. La zone de transition entre les zones externes ionienne et de Karaburun. Bul. USHT. seria shk. nat. No. 3.

Anon., 1990. Gjeografia Fizike e Shqipërisë. Vol. I, II.

Anon., 1995. Janar, Inflacioni rritet 1.8%. Gazeta Shqiptare, 8 Shkurt 1995.

Aubovisi, J. and Ndoaj, I., 1964. Regard sur la géologie de l'Albanie et sa place dans la géologie des Dinarides. Bull. Soc. Géol. Fr. (7) Vol. 6.

Blue Plan, 1995. Reports Prepared for Systemic and Prospective Analysis, Development/Environment Scenarios for Albania (in the framework of CAMP).

Boriçi, M. and Demiraj, E., 1993. The air temperature and precipitation trends in Albania over the periods 1988 - 1990 and 1931 - 1990. In: Precipitation Variability and Climate Change. Proceedings of Symposium on Precipitation and Evaporation. Vol. 2. Bratislava, Slovakia.

Ciancio, O., 1971. Sul clima e sull distribuzione altimetrica della vegetazione forestale in Calabria. Annali dell'Istituto Sperimentale per la Silvicultura Arezzo Estatto, dal vol. II.

Dautaj H. and Zhelili L., 1987. Disa veçori të rënies në tokë të pluhrave të atmosferës së Tiranës. Studime Hidrometeorologjike, Nr. 12.

DS, 1991. Statistical Yearbook of Albania. Department of Statistics, Tirana.

FAO, 1995. International Forest Fire News, No.12, January 1995.

FPRI, 1992. Cadastra of forests. Forest and Pasture Research Institute.

FRI, 1994. Fishery Research Institute.

FRI, 1995. Fishery Research Institute.

Garo, R., 1985. Tokat e kripura dhe përmirësimi i tyre. Tiranë.

Gjiknuri, L. and Hoda, P., 1994. Vlerësimi ekologjik i kompleksit Divjakë-Karavasta dhe mundësitë potenciale për zhvillimin e ekoturizmit. Studim i fazës së parë.

Gjiknuri, L. and Peja, N., 1992. Le lagune albanesi e l'effetto del sviluppo economico ed agricolo su di esse.

HMI, 1975. Klima e Shqipërisë. Hidmet. Tiranë.

HMI, 1984. Hidrologjia e Shqipërisë. Hidmet. Tiranë.

HMI, 1985. Veçoritë klimatike e hidrologjike të Ultësirës Perëndimore. Hidmet. Tiranë.

HMI, 1995. Archives of HMI.

Houghton, I.T., Jenkins, G.I. and Ephraum, I.I. (eds.), 1990. Climate Change: the IPCC Scientific Assessment. Cambrige University Press, Cambrige, UK.

IPCC, 1994. Radiative Forcing of Climate Change. Summary for Policymakers.

Jaehne G. and Schinke E., 1993. Agriculture and Food Statistics of Albania. Duncker and Humboldt. Berlin.

Jeftic, L., Milliman, J.D. and Sestini G. (eds.), 1992. Climatic Change and the Mediterranean. Edward Arnold, London.

Karadumi, S., 1992. Pyjet, shpendët e kafshët e egra të bregdetit shqiptar dhe vlerat peisazhistike e turistike. Tiranë. Pa publikuar.

Konomi, N., 1994. Gjeologjia Inxhinjerike (Vetitë fiziko-kimike të shkëmbinjve). Tiranë

Lamani, F., 1985. Shpendët e Shqipërisë (në fondin e Katedrës së Zoologjisë).

MHEP, 1990. Archives of Statistics Sector, Ministry of Health and Environmental Protection.

MHEP, 1994. Archives of MHEP. Studim mbi cilësinë e ujit të pijshëm në vendin tonë. Instituti i Higjenës e Epidemiologjisë.

MHEP, 1995. Archives of Statistics Sector, Ministry of Health and Environmental Protection.

Mitrushi, I., 1993. Drurët dhe shkurret e Shqipërisë. Tiranë.

Muharremi, V., 1990. Parqet, pyjet kombëtare (PPK). Materiali i përgatitur për krijimin e tyre. Tiranë (not published).

Mullaj, A., 1989. Vegjetacioni bregdetar i Shqipërisë (Disertation).

Mustaqi, V., 1986. Ecuria vjetore e reshjeve nëpërmjet analizes harmonike. Studime Hidmet, No. 11.

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 Gas Warming. MAP Technical Reports Series, No. 66. UNEP, Athens.

Pano, N., 1984. Veçoritë kryesore të rrjedhjes ujore dhe të rrjedhjes së ngurtë të pellgut ujëmbledhës të rrjetit hidrografik të Shqipërisë. Studime Hidrometeorologjike, No. 10.

Pinardi, N., 1988. Dynamics of deep jets in the Polymode region. J. Phys. Oceanogr. 17(8):1163-1188.

Puka, V., 1990. Monitorimi i cilësisë dhe shkallës së ndotjes së ujrave të lumënjve të Shqipërisë.

Rameau, I.C., 1993. Flore Forestière Française. Tome 3: Monsion. J. Montagnes Institut pour le Développement. Dume, G. Forestier.

Robinson, A., 1987. The Harvard open ocean model. App. Numer. Math., 3(1-2):89-131.

Sabato, S. and Valenziano, S., 1975. Flora e vegetazione di una zona dell Appenino. Centro Setentrionale (Rincine) 1 - Flora. Pubblicazioni del Centro di Sperimentazione Agricola e Forestale, Vol. XIII, Fasc. 3. Roma.

Schlosser, A., 1989. Future climatic change. J. Phys. Oceanogr. 13(7).

Selenica, A., 1984. Aspekte të studimit të rregullimit të rrjedhjes ujore në lumenjtë Drin i Zi dhe Vjosë. Studime Hidrometeorologjike, No. 10.

Shehu, R., Xhaska, P., Lleshi B. *et al*., 1981. La structure géologique des Albanides. International Symposium on the Hellenic Arc and Trench (HEAT), Athens.

Treska, L., 1963. Silvikultura. Instituti i Lartë Shtetëror i Bujqësisë, Tiranë.

UNEP, 1992. Implications of Expected Climate Change on Cres/Losinj Islands. Document UNEP(OCA)/MED WG.55/5 (revised).

UNEP, 1994a. Implications of Expected Climate Change on Kastela Bay. Document UNEP(OCA)/MED WG.55/4 (revised).

UNEP, 1994b. Implications of Expected Climate Change on the Syrian Coast. Document UNEP(OCA)/MED WG.55/6 (revised).

UNEP, 1994c. Implications of Expected Climate Change on the Island of Rhodes. Document UNEP(OCA)/MED WG.55/2 (revised).

UNEP, 1994d. Implications of Expected Climate Change on Malta. Document UNEP(OCA)/MED WG.55/3 (revised).

UNEP, 1994e. The Region of Durrës - Vlore Coastal Profile. Document CAMP/1993/AL/ICAM-CP.

Yzeiri, D., Bakia, H., *et al*., 1980. La carte géologique à 1:100.000 de la zone ionienne. Le fonds géodésique de l'OGNG.

PUBLICATIONS OF THE MAP TECHNICAL REPORTS SERIES

1. UNEP/IOC/WMO: Baseline studies and monitoring of oil and petroleum hydrocarbons in marine waters (MED POL I). MAP Technical Reports Series No. 1. UNEP, Athens, 1986 (96 pages) (parts in English, French or Spanish only).

2. UNEP/FAO: Baseline studies and monitoring of metals, particularly mercury and cadmium, in marine organisms (MED POL II). MAP Technical Reports Series No. 2. UNEP, Athens, 1986 (220 pages) (parts in English, French or Spanish only).

3. UNEP/FAO: Baseline studies and monitoring of DDT, PCBs and other chlorinated hydrocarbons in marine organisms (MED POL III). MAP Technical Reports Series No. 3. UNEP, Athens, 1986 (128 pages) (parts in English, French or Spanish only).

4. UNEP/FAO: Research on the effects of pollutants on marine organisms and their populations (MED POL IV). MAP Technical Reports Series No. 4. UNEP, Athens, 1986 (118 pages) (parts in English, French or Spanish only).

5. UNEP/FAO: Research on the effects of pollutants on marine communities and ecosystems (MED POL V). MAP Technical Reports Series No. 5. UNEP, Athens, 1986 (146 pages) (parts in English or French only).

6. UNEP/IOC: Problems of coastal transport of pollutants (MED POL VI). MAP Technical Reports Series No. 6. UNEP, Athens, 1986 (100 pages) (English only).

7. UNEP/WHO: Coastal water quality control (MED POL VII). MAP Technical Reports Series No. 7. UNEP, Athens, 1986 (426 pages) (parts in English or French only).

8. UNEP/IAEA/IOC: Biogeochemical studies of selected pollutants in the open waters of the Mediterranean (MED POL VIII). MAP Technical Reports Series No. 8. UNEP, Athens, 1986 (42 pages) (parts in English or French only).

8. Add. UNEP: Biogeochemical studies of selected pollutants in the open waters of the Mediterranean MED POL VIII). Addendum, Greek Oceanographic Cruise 1980. MAP Technical Reports Series No. 8, Addendum. UNEP, Athens, 1986 (66 pages) (English only).

9. UNEP: Co-ordinated Mediterranean pollution monitoring and research programme (MED POL - PHASE I). Final report, 1975-1980. MAP Technical Reports Series No. 9. UNEP, Athens, 1986 (276 pages) (English only).

10. UNEP: Research on the toxicity, persistence, bioaccumulation, carcinogenicity and mutagenicity of selected substances (Activity G). Final reports on projects dealing with toxicity (1983-85). MAP Technical Reports Series No. 10. UNEP, Athens, 1987 (118 pages) (English only).

11. UNEP: Rehabilitation and reconstruction of Mediterranean historic settlements. Documents produced in the first stage of the Priority Action (1984-1985). MAP Technical Reports Series No. 11. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1986 (158 pages) (parts in English or French only).

12. UNEP: Water resources development of small Mediterranean islands and isolated coastal areas. Documents produced in the first stage of the Priority Action (1984-1985). MAP Technical Reports Series No. 12. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1987 (162 pages) (parts in English or French only).

13. UNEP: Specific topics related to water resources development of large Mediterranean islands. Documents produced in the second phase of the Priority Action (1985-1986). MAP Technical Reports Series No. 13. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1987 (162 pages) (parts in English or French only).

14. UNEP: Experience of Mediterranean historic towns in the integrated process of rehabilitation of urban and architectural heritage. Documents produced in the second phase of the Priority Action (1986). MAP Technical Reports Series No. 14. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1987 (500 pages) (parts in English or French only).

15. UNEP: Environmental aspects of aquaculture development in the Mediterranean region. Documents produced in the period 1985-1987. MAP Technical Reports Series No. 15. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1987 (101 pages) (English only).

16. UNEP: Promotion of soil protection as an essential component of environmental protection in Mediterranean coastal zones. Selected documents (1985-1987). MAP Technical Reports Series No. 16. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1987 (424 pages) (parts in English or French only).

17. UNEP: Seismic risk reduction in the Mediterranean region. Selected studies and documents (1985-1987). MAP Technical Reports Series No. 17. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1987 (247 pages) (parts in English or French only).

18. UNEP/FAO/WHO: Assessment of the state of pollution of the Mediterranean Sea by mercury and mercury compounds. MAP Technical Reports Series No. 18. UNEP, Athens, 1987 (354 pages) (English and French).

19. UNEP/IOC: Assessment of the state of pollution of the Mediterranean Sea by petroleum hydrocarbons. MAP Technical Reports Series No. 19. UNEP, Athens, 1988 (130 pages) (English and French).

20. UNEP/WHO: Epidemiological studies related to environmental quality criteria for bathing waters, shellfish-growing waters and edible marine organisms (Activity D). Final report on project on relationship between microbial quality of coastal seawater and health effects (1983-86). MAP Technical Reports Series No. 20. UNEP, Athens, 1988 (156 pages) (English only).

21. UNEP/UNESCO/FAO: Eutrophication in the Mediterranean Sea: Receiving capacity and monitoring of long-term effects. MAP Technical Reports Series No. 21. UNEP, Athens, 1988 (200 pages) (parts in English or French only).

22. UNEP/FAO: Study of ecosystem modifications in areas influenced by pollutants (Activity I). MAP Technical Reports Series No. 22. UNEP, Athens, 1988 (146 pages) (parts in English or French only).

23. UNEP: National monitoring programme of Yugoslavia, Report for 1983-1986. MAP Technical Reports Series No. 23. UNEP, Athens, 1988 (223 pages) (English only).

24. UNEP/FAO: Toxicity, persistence and bioaccumulation of selected substances to marine organisms (Activity G). MAP Technical Reports Series No. 24. UNEP, Athens, 1988 (122 pages) (parts in English or French only).

25. UNEP: The Mediterranean Action Plan in a functional perspective: A quest for law and policy. MAP Technical Reports Series No. 25. UNEP, Athens, 1988 (105 pages) (English only).

26. UNEP/IUCN: Directory of marine and coastal protected areas in the Mediterranean Region. Part I - Sites of biological and ecological value. MAP Technical Reports Series No. 26. UNEP, Athens, 1989 (196 pages) (English only).

27. UNEP: Implications of expected climate changes in the Mediterranean Region: An overview. MAP Technical Reports Series No. 27. UNEP, Athens, 1989 (52 pages) (English only).

28. UNEP: State of the Mediterranean marine environment. MAP Technical Reports Series No. 28. UNEP, Athens, 1989 (225 pages) (English only).

29. UNEP: Bibliography on effects of climatic change and related topics. MAP Technical Reports Series No. 29. UNEP, Athens, 1989 (143 pages) (English only).

30. UNEP: Meteorological and climatological data from surface and upper measurements for the assessment of atmospheric transport and deposition of pollutants in the Mediterranean Basin: A review. MAP Technical Reports Series No. 30. UNEP, Athens, 1989 (137 pages) (English only).

31. UNEP/WMO: Airborne pollution of the Mediterranean Sea. Report and proceedings of a WMO/UNEP Workshop. MAP Technical Reports Series No. 31. UNEP, Athens, 1989 (247 pages) (parts in English or French only).

32. UNEP/FAO: Biogeochemical cycles of specific pollutants (Activity K). MAP Technical Reports Series No. 32. UNEP, Athens, 1989 (139 pages) (parts in English or French only).

33. UNEP/FAO/WHO/IAEA: Assessment of organotin compounds as marine pollutants in the Mediterranean. MAP Technical Reports Series No. 33. UNEP, Athens, 1989 (185 pages) (English and French).

34. UNEP/FAO/WHO: Assessment of the state of pollution of the Mediterranean Sea by cadmium and cadmium compounds. MAP Technical Reports Series No. 34. UNEP, Athens, 1989 (175 pages) (English and French).

35. UNEP: Bibliography on marine pollution by organotin compounds. MAP Technical Reports Series No. 35. UNEP, Athens, 1989 (92 pages) (English only).

36. UNEP/IUCN: Directory of marine and coastal protected areas in the Mediterranean region. Part I - Sites of biological and ecological value. MAP Technical Reports Series No. 36. UNEP, Athens, 1990 (198 pages) (French only).

37. UNEP/FAO: Final reports on research projects dealing with eutrophication and plankton blooms (Activity H). MAP Technical Reports Series No. 37. UNEP, Athens, 1990 (74 pages) (parts in English or French only).

38. UNEP: Common measures adopted by the Contracting Parties to the Convention for the Protection of the Mediterranean Sea against pollution. MAP Technical Reports Series No. 38. UNEP, Athens, 1990 (100 pages) (English, French, Spanish and Arabic).

39. UNEP/FAO/WHO/IAEA: Assessment of the state of pollution of the Mediterranean Sea by organohalogen compounds. MAP Technical Reports Series No. 39. UNEP, Athens, 1990 (224 pages) (English and French).

40. UNEP/FAO: Final reports on research projects (Activities H,I and J). MAP Technical Reports Series No. 40. UNEP, Athens, 1990 (125 pages) (English and French).

41. UNEP: Wastewater reuse for irrigation in the Mediterranean region. MAP Technical Reports Series No. 41. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1990 (330 pages) (English and French).

42. UNEP/IUCN: Report on the status of Mediterranean marine turtles. MAP Technical Reports Series No. 42. UNEP, Athens, 1990 (204 pages) (English and French).

43. UNEP/IUCN/GIS Posidonia: Red Book "Gérard Vuignier", marine plants, populations and landscapes threatened in the Mediterranean. MAP Technical Reports Series No. 43. UNEP, Athens, 1990 (250 pages) (French only).

44. UNEP: Bibliography on aquatic pollution by organophosphorus compounds. MAP Technical Reports Series No. 44. UNEP, Athens, 1990 (98 pages) (English only).

45. UNEP/IAEA: Transport of pollutants by sedimentation: Collected papers from the first Mediterranean Workshop (Villefranche-sur-Mer, France, 10-12 December 1987). MAP Technical Reports Series No. 45. UNEP, Athens, 1990 (302 pages) (English only).

46. UNEP/WHO: Epidemiological studies related to environmental quality criteria for bathing waters, shellfish-growing waters and edible marine organisms (Activity D). Final report on project on relationship between microbial quality of coastal seawater and rotarus-induced gastroenterities among bathers (1986-88). MAP Technical Reports Series No.46, UNEP, Athens, 1991 (64 pages) (English only).

47. UNEP: Jellyfish blooms in the Mediterranean. Proceedings of the II workshop on jellyfish in the Mediterranean Sea. MAP Technical Reports Series No.47. UNEP, Athens, 1991 (320 pages) (parts in English or French only).

48. UNEP/FAO: Final reports on research projects (Activity G). MAP Technical Reports Series No. 48. UNEP, Athens, 1991 (126 pages) (parts in English or French only).

49. UNEP/WHO: Biogeochemical cycles of specific pollutants. Survival of pathogens. Final reports on research projects (Activity K). MAP Technical Reports Series No. 49. UNEP, Athens, 1991 (71 pages) (parts in English or French only).

50. UNEP: Bibliography on marine litter. MAP Technical Reports Series No. 50. UNEP, Athens, 1991 (62 pages) (English only).

51. UNEP/FAO: Final reports on research projects dealing with mercury, toxicity and analytical techniques. MAP Technical Reports Series No. 51. UNEP, Athens, 1991 (166 pages) (parts in English or French only).

52. UNEP/FAO: Final reports on research projects dealing with bioaccumulation and toxicity of chemical pollutants. MAP Technical Reports Series No. 52. UNEP, Athens, 1991 (86 pages) (parts in English or French only).

53. UNEP/WHO: Epidemiological studies related to environmental quality criteria for bathing waters, shellfish-growing waters and edible marine organisms (Activity D). Final report on epidemiological study on bathers from selected beaches in Malaga, Spain (1988-1989). MAP Technical Reports Series No. 53. UNEP, Athens, 1991 (127 pages) (English only).

54. UNEP/WHO: Development and testing of sampling and analytical techniques for monitoring of marine pollutants (Activity A): Final reports on selected microbiological projects. MAP Technical Reports Series No. 54. UNEP, Athens, 1991 (83 pages) (English only).

55. UNEP/WHO: Biogeochemical cycles of specific pollutants (Activity K): Final report on project on survival of pathogenic organisms in seawater. MAP Technical Reports Series No. 55. UNEP, Athens, 1991 (95 pages) (English only).

56. UNEP/IOC/FAO: Assessment of the state of pollution of the Mediterranean Sea by persistent synthetic materials which may float, sink or remain in suspension. MAP Technical Reports Series No. 56. UNEP, Athens, 1991 (113 pages) (English and French).

57. UNEP/WHO: Research on the toxicity, persistence, bioaccumulation, carcinogenicity and mutagenicity of selected substances (Activity G): Final reports on projects dealing with carcinogenicity and mutagenicity. MAP Technical Reports Series No. 57. UNEP, Athens, 1991 (59 pages) (English only).

58. UNEP/FAO/WHO/IAEA: Assessment of the state of pollution of the Mediterranean Sea by organophosphorus compounds. MAP Technical Reports Series No. 58. UNEP, Athens, 1991 (122 pages) (English and French).

59. UNEP/FAO/IAEA: Proceedings of the FAO/UNEP/IAEA Consultation Meeting on the Accumulation and Transformation of Chemical contaminants by Biotic and Abiotic Processes in the Marine Environment (La Spezia, Italy, 24-28 September 1990), edited by G.P. Gabrielides. MAP Technical Reports Series No. 59. UNEP, Athens, 1991 (392 pages) (English only).

60. UNEP/WHO: Development and testing of sampling and analytical techniques for monitoring of marine pollutants (Activity A): Final reports on selected microbiological projects (1987-1990). MAP Technical Reports Series No. 60. UNEP, Athens, 1991 (76 pages) (parts in English or French only).

61. UNEP: Integrated Planning and Management of the Mediterranean Coastal Zones. Documents produced in the first and second stage of the Priority Action (1985-1986). MAP Technical Reports Series No. 61. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1991 (437 pages) (parts in English or French only).

62. UNEP/IAEA: Assessment of the State of Pollution of the Mediterranean Sea by Radioactive Substances. MAP Technical Reports Series No. 62, UNEP, Athens, 1992 (133 pages) (English and French).

63. UNEP/WHO: Biogeochemical cycles of specific pollutants (Activity K) - Survival of Pathogens - Final reports on Research Projects (1989-1991). MAP Technical Reports Series No. 63, UNEP, Athens, 1992 (86 pages) (French only).

64. UNEP/WMO: Airborne Pollution of the Mediterranean Sea. Report and Proceedings of the Second WMO/UNEP Workshop. MAP Technical Reports Series No. 64, UNEP, Athens, 1992 (246 pages) (English only).

65. UNEP: Directory of Mediterranean Marine Environmental Centres. MAP Technical Reports Series No. 65, UNEP, Athens, 1992 (351 pages) (English and French).

66. UNEP/CRU: Regional Changes in Climate in the Mediterranean Basin Due to Global Greenhouse Gas Warming. MAP Technical Reports Series No. 66, UNEP, Athens, 1992 (172 pages) (English only).

67. UNEP/IOC: Applicability of Remote Sensing for Survey of Water Quality Parameters in the Mediterranean. Final Report of the Research Project. MAP Technical Reports Series No. 67, UNEP, Athens, 1992 (142 pages) (English only).

68. UNEP/FAO/IOC: Evaluation of the Training Workshops on the Statistical Treatment and Interpretation of Marine Community Data. MAP Technical Reports Series No. 68. UNEP, Athens, 1992 (221 pages) (English only).

69. UNEP/FAO/IOC: Proceedings of the FAO/UNEP/IOC Workshop on the Biological Effects of Pollutants on Marine Organisms (Malta, 10-14 September 1991), edited by G.P. Gabrielides. MAP Technical Reports Series No. 69. UNEP, Athens, 1992 (287 pages) (English only).

70. UNEP/IAEA/IOC/FAO: Organohalogen Compounds in the Marine Environment: A Review. MAP Technical Reports Series No. 70. UNEP, Athens, 1992 (49 pages) (English only).

71. UNEP/FAO/IOC: Selected techniques for monitoring biological effects of pollutants in marine organisms. MAP Technical Reports Series No. 71. UNEP, Athens, 1993 (189 pages) (English only).

72. UNEP: Costs and Benefits of Measures for the Reduction of Degradation of the Environment from Land-based Sources of Pollution in Coastal Areas. A - Case Study of the Bay of Izmir. B - Case Study of the Island of Rhodes. MAP Technical Reports Series No. 72. UNEP, Athens, 1993 (64 pages) (English only).

73. UNEP/FAO: Final Reports on Research Projects Dealing with the Effects of Pollutants on Marine Communities and Organisms. MAP Technical Reports Series No. 73. UNEP, Athens, 1993 (186 pages) (English and French).

74. UNEP/FIS: Report of the Training Workshop on Aspects of Marine Documentation in the Mediterranean. MAP Technical Reports Series No. 74. UNEP, Athens, 1993 (38 pages) (English only).

75. UNEP/WHO: Development and Testing of Sampling and Analytical Techniques for Monitoring of Marine Pollutants (Activity A). MAP Technical Reports Series No. 75. UNEP, Athens, 1993 (90 pages) (English only).

76. UNEP/WHO: Biogeochemical Cycles of Specific Pollutants (Activity K): Survival of Pathogens. MAP Technical Reports Series No. 76. UNEP, Athens, 1993 (68 pages) (English and French).

77. UNEP/FAO/IAEA: Designing of monitoring programmes and management of data concerning chemical contaminants in marine organisms. MAP Technical Reports Series No. 77. UNEP, Athens, 1993 (236 pages) (English only).

78. UNEP/FAO: Final reports on research projects dealing with eutrophication problems. MAP Technical Reports Series No. 78. UNEP, Athens, 1994 (139 pages) (English only).

79. UNEP/FAO: Final reports on research projects dealing with toxicity of pollutants on marine organisms. MAP Technical Reports Series No. 79. UNEP, Athens, 1994 (135 pages) (parts in English or French only).

80. UNEP/FAO: Final reports on research projects dealing with the effects of pollutants on marine organisms and communities. MAP Technical Reports Series No. 80. UNEP, Athens, 1994 (123 pages) (English only).

81. UNEP/IAEA: Data quality review for MED POL: Nineteen years of progress. MAP Technical Reports Series No. 81. UNEP, Athens, 1994 (79 pages) (English only).

82. UNEP/IUCN: Technical report on the State of Cetaceans in the Mediterranean. MAP Technical Reports Series No. 82. UNEP, Regional Activity Centre for Specially Protected Areas, Tunis, 1994 (37 pages) (English only).

83. UNEP/IUCN: Specially protected Areas in Mediterranean. Sketch of an Analytical Study of Relevant Legislation. MAP Technical Reports Series No. 83. UNEP, Regional Activity Centre for Specially Protected Areas, Tunis, 1994 (55 pages) (French only).

84. UNEP: Integrated Management Study for the Area of Izmir. MAP Technical Reports Series No. 84, UNEP, Regional Activity Centre for Priority Actions Programme, Split, 1994 (130 pages) (English only).

85. UNEP/WMO: Assessment of Airborne Pollution of the Mediterranean Sea by Sulphur and Nitrogen Compounds and Heavy Metals in 1991. MAP Technical Report Series No. 85, Athens, 1994 (304 pages) (English only).

86. UNEP: Monitoring Programme of the Eastern Adriatic Coastal Area - Report for 1983-1991. MAP Technical Report Series No. 86, Athens, 1994 (311 pages) (English only).

87. UNEP/WHO: Identification of microbiological components and measurement development and testing of methodologies of specified contaminants (Area I) - Final reports on selected microbiological projects. MAP Technical Reports Series No. 87, UNEP, Athens, 1994 (136 pages) (English only).

88. UNEP: Proceedings of the Seminar on Mediterranean Prospective. MAP Technical Reports Series No. 88, UNEP, Blue Plan Regional Activity Centre, Sophia Antipolis, 1994 (176 pages) (parts in English or French only).

89. UNEP: Iskenderun Bay Project. Volume I. Environmental Management within the Context of Environment-Development. MAP Technical Reports Series No. 89, UNEP, Blue Plan Regional Activity Centre, Sophia Antipolis, 1994 (144 pages) (English only).

90. UNEP: Iskenderun Bay Project. Volume II. Systemic and Prospective Analysis. MAP Technical Report Series No. 90, Sophia Antipolis, 1994 (142 pages) (parts in English or French only).

91. UNEP: A Contribution from Ecology to Prospective Studies. Assets and Issues. MAP Technical Reports Series No. 91, Sophia Antipolis, 1994 (162 pages) (French only).

92. UNEP/WHO: Assessment of the State of Pollution in the Mediterranean Sea by Carcinogenic, Mutagenic and Teratogenic Substances. MAP Technical Reports Series No. 92, UNEP, Athens, 1995 (238 pages) (English only).

93. UNEP/WHO: Epidemiological studies related to the environmental quality criteria for bathing waters, shellfish-growing waters and edible marine organisms. MAP Technical Reports Series No. 93, UNEP, Athens, 1995 (118 pages) (English only).

94. UNEP: Proceedings of the Workshop on Application of Integrated Approach to Development, Management and Use of Water Resources. MAP Technical Reports Series No. 94, UNEP, Athens, 1995 (214 pages) (parts in English or French only).

95. UNEP: Common measures for the control of pollution adopted by the Contracting Parties to the Convention for the Protection of the Mediterranean Sea against Pollution. MAP Technical Reports Series No 95, UNEP, Athens, 1995 (69 pages) (English and French).

96. UNEP/FAO: Final reports of research projects on effects (Research Area III) - Pollution effects on plankton composition and spatial distribution, near the sewage outfall of Athens (Saronikos Gulf, Greece). MAP Technical Reports Series No. 96, UNEP, Athens, 1996 (121 pages) (English only).

97. UNEP/FAO: Final reports of research projects on effects (Research Area III) - Pollution effects on marine communities. MAP Technical Reports Series No. 97, UNEP, Athens, 1996 (141 pages) (English and French).

PUBLICATIONS "MAP TECHNICAL REPORTS SERIES"

1. PNUE/COI/OMM: Etudes de base et surveillance continue du pétrole et des hydrocarbures contenus dans les eaux de la mer (MED POL I). MAP Technical Reports Series No. 1. UNEP, Athens, 1986 (96 pages) (parties en anglais, français ou espagnol seulement).

2. PNUE/FAO: Etudes de base et surveillance continue des métaux, notamment du mercure et du cadmium, dans les organismes marins (MED POL II). MAP Technical Reports Series No. 2. UNEP, Athens, 1986 (220 pages) (parties en anglais, français ou espagnol seulement).

3. PNUE/FAO: Etudes de base et surveillance continue du DDT, des PCB et des autres hydrocarbures chlorés contenus dans les organismes marins (MED POL III). MAP Technical Reports Series No. 3. UNEP, Athens, 1986 (128 pages) (parties en anglais, français ou espagnol seulement).

4. PNUE/FAO: Recherche sur les effets des polluants sur les organismes marins et leurs peuplements (MED POL IV). MAP Technical Reports Series No. 4. UNEP, Athens, 1986 (118 pages) (parties en anglais, français ou espagnol seulement).

5. PNUE/FAO: Recherche sur les effets des polluants sur les communautés et écosystèmes marins (MED POL V). MAP Technical Reports Series No. 5. UNEP, Athens, 1986 (146 pages) (parties en anglais ou français seulement).

6. PNUE/COI: Problèmes du transfert des polluants le long des côtes (MED POL VI). MAP Technical Reports Series No. 6. UNEP, Athens, 1986 (100 pages) (anglais seulement).

7. PNUE/OMS: Contrôle de la qualité des eaux côtières (MED POL VII). MAP Technical Reports Series No. 7. UNEP, Athens, 1986 (426 pages) (parties en anglais ou français seulement).

8. PNUE/AIEA/COI: Etudes biogéochimiques de certains polluants au large de la Méditerranée (MED POL VIII). MAP Technical Reports Series No. 8. UNEP, Athens, 1986 (42 pages) (parties en anglais ou français seulement).

8. PNUE: Etudes biogéochimiques de certains polluants au large de la Méditerranée (MED POL VIII).
Add. Addendum, Croisière Océanographique de la Grèce 1980. MAP Technical Reports Series No. 8, Addendum. UNEP, Athens, 1986 (66 pages) (anglais seulement).

9. PNUE: Programme coordonné de surveillance continue et de recherche en matière de pollution dans la Méditerranée (MED POL -PHASE I). Rapport final, 1975-1980. MAP Technical Reports Series No. 9. UNEP, Athens, 1986 (276 pages) (anglais seulement).

10. PNUE: Recherches sur la toxicité, la persistance, la bioaccumulation, la cancérogénicité et la mutagénicité de certaines substances (Activité G). Rapports finaux sur les projets ayant trait à la toxicité (1983-85). MAP Technical Reports Series No. 10. UNEP, Athens, 1987 (118 pages) (anglais seulement).

11. PNUE: Réhabilitation et reconstruction des établissements historiques méditerranéens. Textes rédigés au cours de la première phase de l'action prioritaire (1984-1985). MAP Technical Reports Series No. 11. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1986 (158 pages) (parties en anglais ou français seulement).

12. PNUE: Développement des ressources en eau des petites îles et des zones côtières isolées méditerranéennes. Textes rédigés au cours de la première phase de l'action prioritaire (1984-1985). MAP Technical Reports Series No. 12. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1987 (162 pages) (parties en anglais ou français seulement).

13. PNUE: Thèmes spécifiques concernant le développement des ressources en eau des grandes îles méditerranéennes. Textes rédigés au cours de la deuxième phase de l'action prioritaire (1985-1986). MAP Technical Reports Series No. 13. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1987 (162 pages) (parties en anglais ou français seulement).

14. PNUE: L'expérience des villes historiques de la Méditerranée dans le processus intégré de réhabilitation du patrimoine urbain et architectural. Documents établis lors de la seconde phase de l'Action prioritaire (1986). MAP Technical Reports Series No. 14. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1987 (500 pages) (parties en anglais ou français seulement).

15. PNUE: Aspects environnementaux du développement de l'aquaculture dans la région méditerranéenne. Documents établis pendant la période 1985-1987. MAP Technical Reports Series No. 15. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1987 (101 pages) (anglais seulement).

16. PNUE: Promotion de la protection des sols comme élément essentiel de la protection de l'environnement dans les zones côtières méditerranéennes. Documents sélectionnés (1985-1987). MAP Technical Reports Series No. 16. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1987 (424 pages) (parties en anglais ou français seulement).

17. PNUE: Réduction des risques sismiques dans la région méditerranéenne. Documents et études sélectionnés (1985-1987). MAP Technical Reports Series No. 17. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1987 (247 pages) (parties en anglais ou français seulement).

18. PNUE/FAO/OMS: Evaluation de l'état de la pollution de la mer Méditerranée par le mercure et les composés mercuriels. MAP Technical Reports Series No. 18. UNEP, Athens, 1987 (354 pages) (anglais et français).

19. PNUE/COI: Evaluation de l'état de la pollution de la mer Méditerranée par les hydrocarbures de pétrole. MAP Technical Reports Series No. 19. UNEP, Athens, 1988 (130 pages) (anglais et français).

20. PNUE/OMS: Etudes épidémiologiques relatives aux critères de la qualité de l'environnement pour les eaux servant à la baignade, à la culture de coquillages et à l'élevage d'autres organismes marins comestibles (Activité D). Rapport final sur le projet sur la relation entre la qualité microbienne des eaux marines côtières et les effets sur la santé (1983-86). MAP Technical Reports Series No. 20. UNEP, Athens, 1988 (156 pages) (anglais seulement).

21. PNUE/UNESCO/FAO: Eutrophisation dans la mer Méditerranée: capacité réceptrice et surveillance continue des effets à long terme. MAP Technical Reports Series No. 21. UNEP, Athens, 1988 (200 pages) (parties en anglais ou français seulement).

22. PNUE/FAO: Etude des modifications de l'écosystème dans les zones soumises à l'influence des polluants (Activité I). MAP Technical Reports Series No. 22. UNEP, Athens, 1988 (146 pages) (parties en anglais ou français seulement).

23. PNUE: Programme national de surveillance continue pour la Yougoslavie, Rapport pour 1983-1986. MAP Technical Reports Series No. 23. UNEP, Athens, 1988 (223 pages) (anglais seulement).

24. PNUE/FAO: Toxicité, persistance et bioaccumulation de certaines substances vis-à-vis des organismes marins (Activité G). MAP Technical Reports Series No. 24. UNEP, Athens, 1988 (122 pages) (parties en anglais ou français seulement).

25. PNUE: Le Plan d'action pour la Méditerranée, perspective fonctionnelle; une recherche juridique et politique. MAP Technical Reports Series No. 25. UNEP, Athens, 1988 (105 pages) (anglais seulement).

26. PNUE/UICN: Répertoire des aires marines et côtières protégées de la Méditerranée. Première partie - Sites d'importance biologique et écologique. MAP Technical Reports Series No. 26. UNEP, Athens, 1989 (196 pages) (anglais seulement).

27. PNUE: Implications des modifications climatiques prévues dans la région méditerranéenne: une vue d'ensemble. MAP Technical Reports Series No. 27. UNEP, Athens, 1989 (52 pages) (anglais seulement).

28. PNUE: Etat du milieu marin en Méditerranée. MAP Technical Reports Series No. 28. UNEP, Athens, 1989 (225 pages) (anglais seulement).

29. PNUE: Bibliographie sur les effets des modifications climatiques et sujets connexes. MAP Technical Reports Series No. 29. UNEP, Athens, 1989 (143 pages) (anglais seulement).

30. PNUE: Données météorologiques et climatologiques provenant de mesures effectuées dans l'air en surface et en altitude en vue de l'évaluation du transfert et du dépôt atmosphériques des polluants dans le bassin méditerranéen: un compte rendu. MAP Technical Reports Series No. 30. UNEP, Athens, 1989 (137 pages) (anglais seulement).

31. PNUE/OMM: Pollution par voie atmosphérique de la mer Méditerranée. Rapport et actes des Journées d'étude OMM/PNUE. MAP Technical Reports Series No. 31. UNEP, Athens, 1989 (247 pages) (parties en anglais ou français seulement).

32. PNUE/FAO: Cycles biogéochimiques de polluants spécifiques (Activité K). MAP Technical Reports Series No. 32. UNEP, Athens, 1989 (139 pages) (parties en anglais ou français seulement).

33. PNUE/FAO/OMS/AIEA: Evaluation des composés organostanniques en tant que polluants du milieu marin en Méditerranée. MAP Technical Reports Series No. 33. UNEP, Athens, 1989 (185 pages) (anglais et français).

34. PNUE/FAO/OMS: Evaluation de l'état de la pollution de la mer Méditerranée par le cadmium et les composés de cadmium. MAP Technical Reports Seri es No. 34. UNEP, Athens, 1989 (175 pages) (anglais et français).

35. PNUE: Bibliographie sur la pollution marine par les composés organostanniques. MAP Technical Reports Series No. 35. UNEP, Athens, 1989 (92 pages) (anglais seulement).

36. PNUE/UICN: Répertoire des aires marines et côtières protégées de la Méditerranée. Première partie - Sites d'importance biologique et écologique. MAP Technical Reports Series No. 36. UNEP, Athens, 1990 (198 pages) (français seulement).

37. PNUE/FAO: Rapports finaux sur les projets de recherche consacrés à l'eutrophisation et aux efflorescences de plancton (Activité H). MAP Technical Reports Series No. 37. UNEP, Athens, 1990 (74 pages) (parties en anglais ou français seulement).

38. PNUE: Mesures communes adoptées par les Parties Contractantes à la Convention pour la protection de la mer Méditerranée contre la pollution. MAP Technical Reports Series No. 38. UNEP, Athens, 1990 (100 pages) (anglains, français, espagnol et arabe).

39. PNUE/FAO/OMS/AIEA: Evaluation de l'état de la pollution par les composés organohalogénés. MAP Technical Reports Series No. 39. UNEP, Athens, 1990 (224 pages) (anglais et français).

40. PNUE/FAO: Rapports finaux sur les projets de recherche (Activités H, I et J). MAP Technical Reports Series No. 40. UNEP, Athens, 1990 (125 pages) (anglais et français).

41. PNUE: Réutilisation agricole des eaux usées dans la région méditerranéenne. MAP Technical Reports Series No. 41. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1990 (330 pages) (anglais et français).

42. PNUE/UICN: Rapport sur le statut des tortues marines de Méditerranée. MAP Technical Reports Series No. 42. UNEP, Athens, 1990 (204 pages) (anglais et français).

43. PNUE/UICN/GIS Posidonie: Livre rouge "Gérard Vuignier" des végétaux, peuplements et paysages marins menacés de Méditerranée. MAP Technical Reports Series No. 43. UNEP, Athens, 1990 (250 pages) (français seulement).

44. PNUE: Bibliographie sur la pollution aquatique par les composés organophosphorés. MAP Technical Reports Series No. 44. UNEP, Athens, 1990 (98 pages) (anglais seulement).

45. PNUE/AIEA: Transfert des polluants par sédimentation: Recueil des communications présentées aux premières journées d'études méditerranéennes (Villefranche-sur- Mer, France, 10-12 décembre 1987). MAP Technical Reports Series No. 45. UNEP, Athens, 1990 (302 pages) (anglais seulement).

46. PNUE/OMS: Etudes épidémiologiques relatives aux critères de la qualité de l'environnement pour les eaux servant à la baignade, à la culture de coquillages et à l'élevage d'autres organismes marins comestibles (Activité D). Rapport final sur le projet sur la relation entre la qualité microbienne des eaux marines côtières et la gastroentérite provoquée par le rotavirus entre les baigneurs (1986-88). MAP Technical Reports Series No.46. UNEP, Athens, 1991 (64 pages) (anglais seulement).

47. PNUE: Les proliférations de méduses en Méditerannée. Actes des IIèmes journées d'étude sur les méduses en mer Méditerranée. MAP Technical Reports Series No.47. UNEP, Athens, 1991 (320 pages) (parties en anglais ou français seulement).

48. PNUE/FAO: Rapports finaux sur les projets de recherche (Activité G). MAP Technical Reports Series No. 48. UNEP, Athens, 1991 (126 pages) (parties en anglais ou français seulement).

49. PNUE/OMS: Cycles biogéochimiques de polluants spécifiques. Survie des Pathogènes. Rapports finaux sur les projets de recherche (activité K). MAP Technical Reports Series No. 49. UNEP, Athens, 1991 (71 pages) (parties en anglais ou français seulement).

50. PNUE: Bibliographie sur les déchets marins. MAP Technical Reports Series No. 50. UNEP, Athens, 1991 (62 pages) (anglais seulement).

51. PNUE/FAO: Rapports finaux sur les projets de recherche traitant du mercure, de la toxicité et des techniques analytiques. MAP Technical Reports Series No. 51. UNEP, Athens, 1991 (166 pages) (parties en anglais ou français seulement).

52. PNUE/FAO: Rapports finaux sur les projets de recherche traitant de la bioaccumulation et de la toxicité des polluants chimiques. MAP Technical Reports Series No. 52. UNEP, Athens, 1991 (86 pages) (parties en anglais ou français seulement).

53. PNUE/OMS: Etudes épidémiologiques relatives aux critères de la qualité de l'environnement pour les eaux servant à la baignade, à la culture de coquillages et à l'élevage d'autres organismes marins comestibles (Activité D). Rapport final sur l'étude épidémiologique menée parmi les baigneurs de certaines plages à Malaga, Espagne (1988-1989). MAP Technical Reports Series No. 53. UNEP, Athens, 1991 (127 pages) (anglais seulement).

54. PNUE/OMS: Mise au point et essai des techniques d'échantillonnage et d'analyse pour la surveillance continue des polluants marins (Activité A): Rapports finaux sur certains projets de nature microbiologique. MAP Technical Reports Series No. 54. UNEP, Athens, 1991 (83 pages) (anglais seulement).

55. PNUE/OMS: Cycles biogéochimiques de polluants spécifiques (Activité K): Rapport final sur le projet sur la survie des microorganismes pathogènes dans l'eau de mer. MAP Technical Reports Series No. 55. UNEP, Athens, 1991 (95 pages) (anglais seulement).

56. PNUE/COI/FAO: Evaluation de l'état de la pollution de la mer Méditerranée par les matières synthétiques persistantes qui peuvent flotter, couler ou rester en suspension. MAP Technical Reports Series No. 56. UNEP, Athens, 1991 (113 pages) (anglais et français).

57. PNUE/OMS: Recherches sur la toxicité, la persistance, la bioaccumulation, la cancérogénicité et la mutagénicité de certaines substances (Activité G). Rapports finaux sur les projets ayant trait à la cancérogénicité et la mutagénicité. MAP Technical Reports Series No. 57. UNEP, Athens, 1991 (59 pages) (anglais seulement).

58. PNUE/FAO/OMS/AIEA: Evaluation de l'état de la pollution de la mer Méditerranée par les composés organophosphorés. MAP Technical Reports Series No. 58. UNEP, Athens, 1991 (122 pages) (anglais et français).

59. PNUE/FAO/AIEA: Actes de la réunion consultative FAO/PNUE/AIEA sur l'accumulation et la transformation des contaminants chimiques par les processus biotiques et abiotiques dans le milieu marin (La Spezia, Italie, 24-28 septembre 1990), publié sous la direction de G.P. Gabrielides. MAP Technical Reports Series No. 59. UNEP, Athens, 1991 (392 pages) (anglais seulement).

60. PNUE/OMS: Mise au point et essai des techniques d'échantillonnage et d'analyse pour la surveillance continue des polluants marins (Activité A): Rapports finaux sur certains projets de nature microbiologique (1987-1990). MAP Technical Reports Series No. 60. UNEP, Athens, 1991 (76 pages) (parties en anglais ou français seulement).

61. PNUE: Planification intégrée et gestion des zones côtières méditerranéennes. Textes rédigés au cours de la première et de la deuxième phase de l'action prioritaire (1985-1986). MAP Technical Reports Series No. 61. UNEP, Priority Actions Programme, Regional Activity Centre, Split, 1991 (437 pages) (parties en anglais ou français seulement).

62. PNUE/AIEA: Evaluation de l'état de la pollution de la mer Méditerranée par les substances radioactives. MAP Technical Reports Series No. 62, UNEP, Athens, 1992 (133 pages) (anglais et français).

63. PNUE/OMS: Cycles biogéochimiques de polluants spécifiques (Activité K) - Survie des pathogènes - Rapports finaux sur les projets de recherche (1989-1991). MAP Technical Reports Series No. 63, UNEP, Athens, 1992 (86 pages) (français seulement).

64. PNUE/OMM: Pollution par voie atmosphérique de la mer Méditerranée. Rapport et actes des deuxièmes journées d'études OMM/PNUE. MAP Technical Reports Series No. 64, UNEP, Athens, 1992 (246 pages) (anglais seulement).

65. PNUE: Répertoire des centres relatifs au milieu marin en Méditerranée. MAP Technical Reports Series No. 65, UNEP, Athens, 1992 (351 pages) (anglais et français).

66. PNUE/CRU: Modifications régionales du climat dans le bassin méditerranéen résultant du réchauffement global dû aux gaz à effet de serre. MAP Technical Reports Series No. 66, UNEP, Athens, 1992 (172 pages) (anglais seulement).

67. PNUE/COI: Applicabilité de la télédétection à l'étude des paramètres de la qualité de l'eau en Méditerranée. Rapport final du projet de recherche. MAP Technical Reports Series No. 67, UNEP, Athens, 1992 (142 pages) (anglais seulement).

68. PNUE/FAO/COI: Evaluation des ateliers de formation sur le traitement statistique et l'interprétation des données relatives aux communautés marines. MAP Technical Reports Series No. 68. UNEP, Athens, 1992 (221 pages) (anglais seulement).

69. PNUE/FAO/COI: Actes de l'Atelier FAO/PNUE/COI sur les effets biologiques des polluants sur les organismes marins (Malte, 10-14 septembre 1991), publié sous la direction de G.P. Gabrielides. MAP Technical Reports Series No. 69. UNEP, Athens, 1992 (287 pages) (anglais seulement).

70. PNUE/AIEA/COI/FAO: Composés organohalogénés dans le milieu marin: Une synthèse. MAP Technical Reports Series No. 70. UNEP, Athens, 1992 (49 pages) (anglais seulement).

71. PNUE/FAO/COI: Techniques sélectionnées de surveillance continue des effets biologiques des polluants sur les organismes marins. MAP Technical Reports Series No. 71. UNEP, Athens, 1993 (189 pages) (anglais seulement).

72. PNUE: Coûts et bénefices des mesures pour la réduction de la dégradation de l'environnement des sources de pollution d'origine tellurique dans les zones côtières. A - Etude de cas de la baie d'Izmir. B - Etude de cas de l'île de Rhodes. MAP Technical Reports Series No. 72. UNEP, Athens, 1993 (64 pages) (anglais seulement).

73. PNUE/FAO: Rapports finaux sur les projets de recherche traitant des effets de polluants sur les communautés et les organismes marins. MAP Technical Reports Series No. 73. UNEP, Athens, 1993 (186 pages) (anglais et français).

74. PNUE/FIS: Rapport de l'Atelier de formation sur les aspects de la documentation marine en Méditerranée. MAP Technical Reports Series No. 74. UNEP, Athens, 1993 (38 pages) (anglais seulement).

75. PNUE/OMS: Mise au point et essai des techniques d'echantillonnage et d'analyse pour la surveillance continué des polluants marins (Activité A). MAP Technical Reports Series No. 75. UNEP, Athens, 1993 (90 pages) (anglais seulement).

76. PNUE/OMS: Cycles biogeochimiques de polluants spécifiques (Activité K): Survie des pathogènes. MAP Technical Reports Series No. 76. UNEP, Athens, 1993 (68 pages) (anglais et français).

77. PNUE/FAO/AIEA: Conception des programmes de surveillance continue et de gestion des données concernant les contaminants chimiques dans les organismes marins. MAP Technical Reports Series No. 77. UNEP, Athens, 1993 (236 pages) (anglais seulement).

78. PNUE/FAO: Rapports finaux sur les projets de recherche traitant des problèmes de l'eutrophisation. MAP Technical Reports Series No. 78. UNEP, Athens, 1994 (139 pages) (anglais seulement).

79. PNUE/FAO: Rapports finaux sur les projets de recherche traitant de la toxicité des polluants sur les organismes marins. MAP Technical Reports Series No. 79. UNEP, Athens, 1994 (135 pages) (parties en anglais ou français seulement).

80. PNUE/FAO: Rapports finaux sur les projets de recherche traitant des effets des polluants sur les organismes et communautés marins. MAP Technical Reports Series No. 80. UNEP, Athens, 1994 (123 pages) (anglais seulement).

81. PNUE/AIEA: Examen de la qualité des données pour le MED POL: Dix-neuf années de progrès. MAP Technical Reports Series No. 81. UNEP, Athens, 1994 (79 pages) (anglais seulement).

82. PNUE/UICN: Rapport technique sur l'état des cétacés en Méditerranée. MAP Technical Reports Series No. 82. PNUE, Centre d'activités régionales pour les aires spécialement protégées, Tunis, 1994 (37 pages) (anglais seulement).

83. PNUE/UICN: Les aires protégées en Méditerranée. Essai d'étude analytique de la législation pertinente. MAP Technical Reports Series No. 83. PNUE, Centre d'activités régionales pour les aires spécialement protégées, Tunis, 1994 (55 pages) (français seulement).

84. PNUE: Etude de gestion intégrée pour la zone d'Izmir. MAP Technical Reports Series No. 84, PNUE, Centre d'activités régionales pour le programme d'actions prioritaires, Split, 1994 (130 pages) (anglais seulement).

85. PNUE/OMM: Evaluation de la pollution transférée par voie atmosphérique en mer Méditerranée pour les composés soufrés, azotés et pour les métaux lourds en 1991. MAP Technical Reports Series No. 85, UNEP, Athens, 1994 (304 pages) (anglais seulement).

86. PNUE: Programme de surveillance continue de la zone côtière de l'Adriatique Est - Rapport pour 1983-1991. MAP Technical Reports Series No. 86, UNEP, Athens, 1994 (311 pages) (anglais seulement).

87. PNUE/OMS: Identification de constituants microbiologiques et de dosage (mise au point et essai de méthodes) de contaminants donnés (Domaine de recherche I) - Rapports finaux sur certains projets de nature microbiologique. MAP Technical Reports Series No. 87, UNEP, Athens, 1994 (136 pages) (anglais seulement).

88. PNUE: Actes du Séminaire débat sur la prospective méditerranéenne. MAP Technical Reports Series No. 88, UNEP, Blue Plan Regional Activity Centre, Sophia Antipolis, 1994 (176 pages) (parties en anglais ou français seulement).

89. PNUE: Projet de la Baie d'Iskenderun. Volume I. Gestion de l'environnement dans le cadre de l'environnement-développement. MAP Technical Reports Series No. 89, PNUE, Centre d'activités régionales pour le Plan Bleu, Sophia Antipolis, 1994 (144 pages) (anglais seulement).

90. PNUE: Projet de la Baie d'Iskenderun. Volume II. Analyse systémique et prospective. MAP Technical Reports Series No. 90, UNEP, Sophia Antipolis, 1994 (142 pages) (parties en anglais ou français seulement).

91. PNUE: Une contribution de l'écologie à la prospective. Problèmes et acquis. MAP Technical Reports Series No. 91, Sophia Antipolis, 1994 (162 pages) (français seulement).

92. PNUE/OMS: Evaluation de l'état de la pollution de la mer Méditerranée par les substances cancérigènes, tératogènes et mutagènes. MAP Technical Reports Series No. 92, UNEP, Athens, 1995 (238 pages) (anglais seulement).

93. PNUE/OMS: Etudes épidémiologiques relatives à la qualité de l'environnement pour les eaux servant à la baignade, à la culture des coquillages et à l'élevage d'autres organismes marins comestibles. MAP Technical Reports Series No. 93, UNEP, Athens, 1995 (118 pages) (anglais seulement).

94. PNUE: Actes de l'Atelier sur l'application d'une approche intégrée au développement, à la gestion et à l'utilisation des ressources en eau. MAP Technical Reports Series No. 94, UNEP, Athens, 1995 (214 pages) (parties en anglais ou français seulement).

95. PNUE: Mesures communes de lutte contre la pollution adoptées par les Parties contractantes à la Convention pour la protection de la mer Méditerranée contre la pollution. MAP Technical Reports Series No. 95, UNEP, Athens, 1995 (69 pages) (anglais et français).

96. PNUE/FAO: Rapports finaux des projets de recherche sur les effets (Domaine de recherche III) -Effets de la pollution sur la composition et la répartition spatiale à proximité de l'émissaire d'eaux usées d'Athènes (Golfe Saronique, Grèce). MAP Technical Reports Series No. 96, UNEP, Athens, 1996 (121 pages) (anglais seulement).

97. PNUE/FAO: Rapports finaux des projets de recherche sur les effets (Domaine de recherche III) -Effets de la pollution sur les communautés marines. MAP Technical Reports Series No. 97, UNEP, Athens, 1996 (141 pages) (anglais et français).

Issued and printed by:

Mediterranean Action Plan
United Nations Environment Programme

Additional copies of this and other publications issued by
the Mediterranean Action Plan of UNEP can be obtained from:

Coordinating Unit for the Mediterranean Action Plan
United Nations Environment Programme
Leoforos Vassileos Konstantinou, 48
P.O.Box 18019
11610 Athens
GREECE

Publié et imprimé par:

Plan d'action pour la Méditerranée
Programme des Nations Unies pour l'Environnement

Des exemplaires de ce document ainsi que d'autres
publications du Plan d'action pour la Méditerranée
du PNUE peuvent être obtenus de:

Unité de coordination du Plan d'action pour la Méditerranée
Programme des Nations Unies pour l'Environnement
Leoforos Vassileos Konstantinou, 48
B.P. 18019
11610 Athènes
GRECE