Environmental planning in Magnesia prefecture, Greece

K. Michailidou[1], P. Samaras[2], O. Christopoulou[3], E. Beriatos[3] & A. Kungolos[3]

[1]*Department of Management of Rural Environment and Natural Resources, University of Thessaly, Greece*

[2]*Department of Civil Engineering, University of Thessaly, Greece*

[3]*Department of Planning and Regional Development, University of Thessaly, Greece*

Abstract

The environmental planning of Magnesia Prefecture is studied in this work, aiming at the assessment of the environmental quality and the determination of the most appropriate objectives and priorities, for the achievement of the highest environmental protection level in the target area. Examination of air pollution sources showed that atmospheric pollution is mainly attributed to point sources, while the contribution of diffusion sources is negligible. In Pagasitikos Gulf, seawater pollution is increased, especially in the bay of Volos, in places where treated domestic and industrial wastewaters are discharged, and intense marine activities are developed (harbor of Volos). Moreover, significant pollution results from human activities such as drainage from rural areas, discharge of raw industrial wastewaters from olive processing units, and wastes from ships navigating in the area. Other important pollution problems include fresh water salination in coastal areas, and high concentration of nitrates, related to the over-fertilization of farming lands. Sources of soil pollution include domestic and stockbreeding waste landfills, and uncontrolled landfills in Pelion area and in streams of Almyros. From the current study it is evident that significant environmental problems are detected in the Prefecture, and an integrated environmental planning program has to be developed, that will promote the preservation of the biodiversity and protect the natural resources, according to the principles of sustainable development.

1 Introduction

During the last decades, the principles of sustainable development became a new focus for the development and operation of cities together with the minimum effects on the immediate, surrounding and global environment, mainly embraced by urban planners [1]. Today sustainable development is viewed as a framework for comprehensive long-term plans, integrating new tools (such as economic instruments or environmental thresholds), raising new issues and affecting underlying attitudes.

The main achievement of an environmental study regarding sustainable development in an area is that it may provide an important role model to citizens and other community institutions, of environmentally responsible behavior [2]. In large prefecture corporations, the "greening" of the workplace can be effectively promoted by establishing environmental management systems and guidelines for each department. This fact addresses the specific mandates and procedures of those departments. The establishment of such a project includes several parameters like policy integration and inter-sectional approach, self-commitment of the prefecture to the principle of sustainable development, attainment of several environmental economic and social goals, consideration of the relationship between the size of the project and its goals, minimization of produced waste and procurement and use of environmentally friendly goods and services [3].

In last years, environmental issues enjoy political prominence in Magnesia. Political supports of decision makers and widespread public concern have often been cited as crucial variables in undertaking national environmental programs. There have been extensive ecosystem studies concerning the environmental aspects in the area since 1985 [4, 5]. In addition in the recent years (1998-1999) several monitoring programs were set up [6, 7]. However, an integrated management framework has not been established in order to promote urban activities in environmental areas [8].

In most papers dealing with environmental planning and management, specific issues such as air/water quality in local areas, waste management etc are discussed [4, 6, 7]. It is the purpose of this paper to examine the integrated prefecture environmental management in Magnesia area, aiming at indicating the most important environmental problems in the area and at suggesting potential corrective actions.

2 Environmental conditions in the target area

Prefecture of Magnesia is situated in the central eastern part of Greece, in the region ("Periferia") of Thessaly. The population of the prefecture on 2001, reached up to 206.995 within an area of 2.636 km² (78,5 p/km^2). This is an area with significant percentage of cultivable land (26,77%) and industrial activities. Volos, the greatest city and capital of prefecture, lies on the north side of Pagasitikos Gulf, covering an area of 26,6 km², with a population of 82.439 inhabitants (Figure 1). Traffic and the associated environmental problems

characterize the majority of Volos urban area, and especially the city center. The primary environmental problems in the area include air, water and soil pollution and are further analyzed in the following paragraphs. Information and data for the present study were gathered from official documents written by state and provincial government, internal notations, scientific literature and personal interviews with persons, who are active in sustainable development plans and are involved in the implementation of such projects.

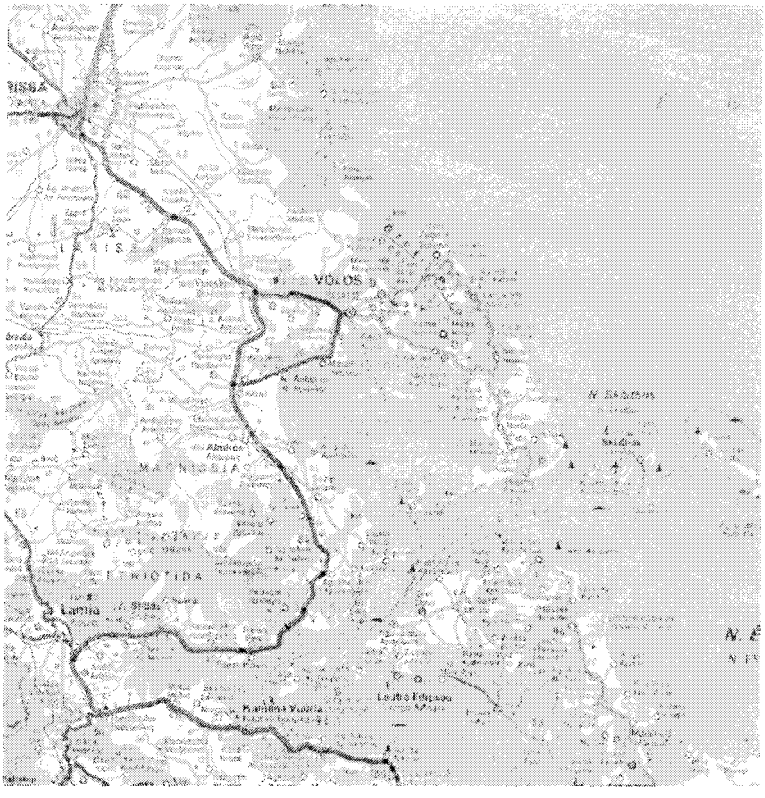

Figure 1. The area of Magnesia Prefecture

2.1 Air pollution

The atmospheric environment is influenced by human activities especially around the industrial city of Volos. Significant industrial activities involve metal-processing plants, strawboard manufacturing, and a cement production industry, resulting in increased air pollution. Particulate emissions are considered as the most significant problem in the nearby district (i.e. N. Dimitriada), as measured concentrations of TSP and NO_2 are very high, exceeding national standards [9]. On the other hand, the increasing use of vehicles in Volos urban areas considerably influences the atmospheric environment and mainly the

concentration of photochemical pollutants. The traffic problems are aggravated by the increasing demand for parking services, which become one of the main sources of traffic condition worsening, especially in the city center. Traffic of cars and diesel heavy goods vehicles (HGVs), is increased in the center and the west side of Volos, due to the one-track access to Pillion and the transport of merchandises and raw material from and towards the industries and the harbor. Other pollution sources in the area include district heating and dust of roads restitution and navigation.

There are no systematic controls of air quality in the city by local authorities. However, the air quality management is an important task for the reduction of environmental burden, and recently a mobile air pollution measuring system was installed in the City of Volos. The installation of this instrument in certain areas and the continuous measurement of several pollutants such as SO_2, NO_2, O_3, T.S.P. and carbon levels revealed that the emissions of these compounds are low compared to European standards. The on-line system was placed in a populated area far away from downtown, near to SE exit of town, and close to a cement company. This site is referred as N. Dimitriada. The equipment was also placed in another populated area far away from downtown, near the NE entrance, and close to the Greater Industrial Area. This site is referred as S. Anargiroi. The air pollution in Volos urban areas is in general satisfactory. In most cases, the concentration of gaseous pollutants does not exceed the limits that have been placed by legislation. However increased temporal values of the primary pollutants were observed for T.S.P. reaching up to 514 $\mu g/m^3/h$ and for NO_2 reaching up to 425 $\mu g/m^3/h$ in the region of N. Dimitriada. Nevertheless, lower values were measured in the centre and the entry of city i.e. T.S.P. ranging from 18 to 76 $\mu g/m^3/h$ and for NO_2 varying between 23 and 56 $\mu g/m^3/h$. The high pollutants values in the eastern side were correlated to increased dust emissions from the cement plant. Low secondary pollutants emissions were observed during the period 1996-1998. i.e. O_3 from 12 to 79 $\mu g/m^3/h$, CO 0,1-4,6 $mg/m^3/h$ and SO_2 0-62 $\mu g/m^3/h$ presenting a continuous decreasing trend [10].

2.2 Water pollution

Certain places have been located in the wider region of Magnesia, facing serious problems of water quality, as a result of marine water intrusion into underground aquifers and of pollutant releases to water bodies such as nitrate, ammonia etc. The water quality deterioration observed in the area may be attributed to a number of reasons such as: (a) the change of land culturing from extensional to intensive agriculture resulting to a significant increase of irrigation water demand, in the last decade, (b) the development of tourist activities constituting the primary economic activity for the coastal regions of Prefecture and most important for the islands of N..Sporades, (c) the particular geological characteristics of the prefecture area including locations where easily corroded carbonic rocks are prevailing (Agria), (d) the lack of high mountains in the islands of N. Sporades, (e) the low level of underground water-bearing stratum

and (f) finally the older depositions of salts existing in the rocks (region Sourpi and Karla).

In addition to salination, nitrate pollution problems have been observed as high concentrations of nitrate ions were detected in samples of water, reaching to values greater than 50 mg/L. Nitrate pollution is correlated to over-fertilization and they are observed in regions with intensive cultures. The intensity and seasonal variation of nitrate pollution is directly related to the geological background of each region. The presence of limestone rocks enhances the direct infiltration (Agria), while in the compact rocks (Sourpi) is observed indirect infiltration of ions. Due to these phenomena, the target area has been characterized as "vulnerable zone" already from 1994, and an action plan including a monitoring program was set up, in an attempt to study the extent as well as the effects of the nutrient enrichment from agriculture [11].

Drinking water supplies of the Greater Area of Volos, presents low quality due to salinity problems, especially during the summer months. Daily drinking water demands in the Greater Area of Volos varies between 30.000 to 40.000 m^3. During the winter period water hardness ranges between 8 to 12 French degrees while chloride concentration varies from 10-17 mg/L depending on snowfall and rainfall frequency. In the remaining period, water hardness ranges from 15-35 French degrees while the chloride content varies from 100-300 mg/L [12, 13].

In addition to water supplies, Magnesia Prefecture faces several seawater pollution problems. Pagasitikos Gulf is a semi-enclosed bay at the southern part of Volos. The mean depth is 69m and the total surface area is 520 km^2. At the south it is connected to the Aegean Sea, through the narrow channel of Trikeri (3-10km). The ecosystem of the gulf is significantly influenced by the industrial, urban and agricultural activities concentrated mainly at the North part, where the city of Volos is situated. The system of Pagasitikos is greatly influenced by human activities especially around the industrial town of Volos and the entire the peninsula of Magnesia. Although in the surrounding area there are no major rivers with the exception of small torrents, significant quantities of polluted waters enter the system of the Gulf on a permanent or occasional basis. There are several major pollution sources: the scattered farmlands along the coastline, some rather distant sources, the domestic/industrial effluents, and pollutants deduced from human activities by the sea such as anti-fouling toxic substances that are used in the boats and residues of petroleum products that emanate from ships [14]. Nevertheless, the ecological quality of coastal water, examined by bioassays using *Artemia franciscana* as a test organism, was found satisfactory [15].

In the greater area of Pagasitikos intensive agriculture of cereals and cotton is applied by using significant quantities of fertilizers containing high percentages of nitrogen, phosphate and sulphur. An important distant source of pollution is Lake Karla, where during a drainage program, large quantities of water enriched in nutrients were discharged via channels into the north part of the bay. Additional problems may arise from rainwater from the wider area of Karla during the winter period ending into Pagasitikos. This water may wash the soil becoming enriched in fertilizers, pesticides and particulate material. Other

discharges to the gulf include domestic and industrial sewage fed into the drainage channels throughout the year. Finally the sewage treatment plant of the city of Volos as well as the industrial park of the area located 5 km west from the city are important sources of pollution. The water nutrient enrichment at the north part of the bay in conjunction with the increased temperatures of the summer period results in the frequent appearance of harmful algal blooms, causing problems both to tourism and fisheries [16]. Due to compensatory and buffering mechanisms within the food web natural systems, the gulf ecosystem is able to withstand nutrient inputs below a certain limit or critical load without any undesirable effects. However for a given food web structure there should be a certain critical level of nutrient supply where the likelihood of uncontrolled blooms should increase abruptly and non-linearly [17].

The results of a recent research program in Pagasitikos [18, 19] show that the water mass of Pagasitikos is fairly mixed in the winter months, forming a two-layer thermocline for the rest of the year at approximately 20 m. depth, with the exception of August when three layers are observed. Water renewal mainly takes place by entering at the deep-water layer across the eastern part of the communication channel and out flowing across the west part. The direction of water movements is reversed at the surface layer. Inflows of fresh waters in the areas of Volos and Almiros are also observed occasionally. Water currents are generally small to moderate due to weak winds and renewal occurs mainly through the deep-water layer of the communication channel with Aegean Sea, inflowing across the east part and out flowing across the west part. This water movement is reversed at the surface layer. As a result, the internal part of the gulf is characterized by eutrophic conditions, which under favorable conditions result in the development of the observed harmful algal blooms. The central part of Pagasitikos is an organic matter deposition zone since it includes the deep areas of the bay, which due to long stratification periods and the dominant anticyclonic circulation, traps all nutrients released from the sediment, developing a microbial food web. It is only when the thermocline erodes that nutrients find their way up in the upper layers of the eutrophic zone shifting the system into a classic food web with increased primary production. The outer bay is highly influenced by the Aegean Sea creating a dilution zone with mesotrophic conditions.

The planning and the construction of sewage pipelines and the construction and the operation of wastewater treatment plants are not well developed up to today, in the target area. In most regions wastewaters are disposed in the soil by absorbent cesspools or septic reservoirs, and pollutants are transferred in underground waters, rivers or in the torrents and finally to the sea. Municipal wastewaters from Volos area are currently treated in a municipal wastewater treatment plant, which is under operation since 1998. The plant receives wastewaters produced by 80.000 residents reaching up to 31.000 m^3/day (Volos, Nea Ionia, Dimini). Furthermore, additional 1000m^3/day of industrial wastewaters are fed to the plant. However, the treatment of wastewater from other urban areas is limited. The treatment plant serving the Skiathos Island was completed in 1997 but the sewage network covers about 80% of the urban area.

The Almiros sewage collection and treatment system is under construction. Several studies have been performed in the regions of Pillion (from Agria until Afissos), Skopelos and Allonisos, focusing on the integrated management of water and wastewater sources, but the materialization of the results from the studies is delayed mainly due to financial deficiencies [20].

An important pollution source in the area is the presence of 46 olive processing plants for production of oil from olives. Mainly the side of Pagasitikos of gulf locates all these units and wastewaters are characterized by a high organic content including some toxic substances like phenols. Partially or untreated wastewaters from these plants are discharged in Pagasitikos Gulf, through torrents or by surface disposal on evaporation ponds. The total annual wastewater quantity from the olive processing units is estimated to 125.000 m^3 while the corresponding organic loading is about 1700 ton BOD_5 [21]. In the coastal area several locations are currently used for the establishment of a number of industrial and semi-industrial activities like ship yards, veterinary surgeon units, disposal of fuels, and food processing companies, which are potential sources of environmental pollution through the uncontrolled discharge of their wastewaters.

2.3 Soil pollution - landscapes

In the area of Magnesia prefecture, there is not a developed plan for the management (collection, treatment and disposal) of solid wastes [22]. As a result solid waste disposal is mainly taken place in uncontrolled landfills especially in small settlements [23]. Municipal solid wastes from the city of Volos are currently disposed in a sanitary landfill located at Dimini, about 8km from Volos. In this landfill about 77.890 ton of domestic solid wastes are disposed each year coming from about 86% of the population of Volos. In addition, the landfill accepts about 10.700 ton of industrial solid wastes, while in the area there are not any considerable sources of toxic solid wastes. In addition, a sanitary landfill is currently under construction about 50 km northeastern from Volos, which is going to serve the region the southern and eastern Pillion.

The disposal of solid wastes from the southwestern regions of Magnesia is under investigation. Two alternative methods are considered as very promising: the construction of a sanitary landfill at Almiros, and the construction of an intermediate compaction plant where solid wastes will be compacted before transportation to the existing landfill of Volos. For the three islands of Prefecture, Skiathos, Skopelos and Alonnisos, the construction of a sanitary landfill is examined in each island, but currently disposal is taken place at uncontrolled areas. The main problem in these areas is the touristic development and the associated variation in the quantity and the characteristics of produced solid wastes.

Another source of soil pollution is originating from the presence of about of 48 quarries of aggregate, marbles and industrial mines constituting the surface exploitations in the prefecture Magnesia. The primary environmental results from quarrying exploitations are the aesthetic deterioration, the environmental

harmful effects, and the alterations of landscapes. Several quarries are visible from settlements or roads while other are visible from the Aegean Sea. From the total number of quarries, which are established in the region around the city of Volos, which cause aesthetic deterioration, two of them have prepared and submit to the responsible authorities, studies of re-establishment. The remaining queries have been shut off before the establishment of law 998/1979, which put the principles for the obligatory re-establishment of disturbed environment [24].

3 Protected regions

In the area of Magnesia several regions have been characterized as environmentally sensitive areas, including: The National Marine Park of Alonnisos-Northern Sporades, Eastern Skopelos, the Aesthetic forests of Skiathos – Koukounaries and Kouri of Almiros and landscapes of particular natural beauties. According to directive 92/43/EEC the regions that have been proposed for integration in the network Natura 2000 include the mountain Pillion and the National Marine Park of Alonnisos in Northern Sporades, Eastern Skopelos and Kouri area of Almiros. In addition, in the area several monuments have been excavated originating from the ancient and Byzantine times, which are protected by national laws.

4 Conclusions and suggestions

In this study the environmental quality of Magnesia Prefecture was examined resulting in the following comments:

Regarding the air quality, the presence of a number of industrial activities results in the deterioration of the atmospheric environment. The environmental quality is further burdened due to the increasing number of vehicles and the emissions from central heating. The establishment of an on-line gas emissions measurement system is required for the continuous monitoring of pollutants in the gaseous phase. Furthermore, this system should be accomplished with a system of mobile instruments for the measurement of specific pollutants in certain locations such as the exit of flue gas devices at industrial plants. This integrated system may be used for the identification of potential pollution sources and the taking of decision of specific corrective actions in the case of harmful events. Furthermore, a management plan has to be developed aiming at the spreading of the use of environmentally friendly energy sources like biomass, natural gas etc.

Water pollution problems in the target area are mainly associated to saline water intrusion and to increased nutrient content of water receivers. A water quality monitoring program is considered as necessary through the establishment of an extended network of on line instruments for the continuous measurement of water parameters in certain locations: points of wastewater discharge, location receiving draining from farming areas etc. The integrated plan should also include the performance of bioassays for the evaluation of the real condition of an ecosystem, which will be coupled with the chemical analysis results. In

addition to the monitoring program, a water and wastewater management plan should be applied in the greater area aiming at the sustainable use of all the available water sources. Several factors should be taken into account in such a plan like the water demand for irrigation, the salt water intrusion into the groundwater aquifers, the available surface and underground water deposits and the application of certain wastewater reclamation and reuse projects. Furthermore, this plan should also include specific actions for the planning of wastewater treatment plants serving the large number of small isolated settlements in the area with specific problems: the high variation of inhabitants during the winter and the summer period. Emphasis should be given to the development of natural wastewater treatment plants and to the arrangement of wastewaters from olive oil processing units.

The reduction in soil pollution due to the uncontrolled disposal of municipal and industrial solid wastes is of great importance in the area, since it is an area of touristic development. Special emphasis should be given on methods of solid wastes management, including the collection of municipal solid wastes, the extended application of recycling projects, the construction of controlled sanitary landfills and the anticipation for the disposal of industrial solid wastes. A great part of soil pollution is attributed to the presence of quarries; their re-establishment should be enforced and supported by local authorities.

In addition to environmental quality, a number of environmentally sensitive areas are included in the area and their protection may be achieved through the constitution of institutions of management.

In general, the integrated environmental planning in the area has to be achieved through the commitment of responsibility both by the local society and the industrial sector. Such an action could involve the establishment of an Environmental Agency where municipalities, civilians, industries etc., may have their representatives.

References

[1] Selman, P., Local sustainability: Can the planning system help get us from here to there? *Town Planning Review 66*, p.p.287-301, 1995.

[2] Diamantini, C., Zanon, B., Planning the Urban Sustainable Development. The case of the plan for the province of Trento, Italy. *Environmental Impact Assessment Review*. Vol.20, Issue 3, p.p.299-310, June 2000.

[3] *European Academy of the Urban Environment*. The Hague: Integrated Municipal Environment Management, 2001.

[4] Theocharis, A. and Friligos, N., Physical and chemical characteristics of Pagasitikos Gulf. *Symposium on the Pollution of Enclosed Bays*. The Pagasitikos case, pp. 85 –86. Volos, Greece, 1985.

[5] Friligos, N., et al., Oceanographic Study of Pagasitikos Gulf, *National Center of Marine Research*, Athens, 1990.

[6] Theodorou, A., Ecological monitoring studies for Volos Sea outfall (Pagasitikos Gulf, western Aegean Sea), in *El. Proc. of 2nd Int. Symp. on Marine Disposal Systems*, Istanbul – Turkey, 1995.

[7] Koliou-Mitsou, A., *Development of integrated policy for the sustainable management of Pagasitikos Gulf,* Municipal Water Authority, Volos 1999.
[8] Beriatos, E., *Land planning III – Environmental Planning and Policy*, University of Thessaly, Volos, 2002 (in Greek).
[9] Municipal Enterprise of Water supply of Sewerage of More major region Volos, "*General estimate for the situation of quality of air in the region of Volos",* Volos, 1996 (in Greek).
[10] Municipal Enterprise of Water supply of Sewerage of More major region Volos, "*General estimate for the situation of quality of air in the region of Volos",* Volos, 1998 (in Greek).
[11] National Institution of Rural Research. *Plan of Action of sensitive regions of Thessaly*, Athens, 1999 (in Greek).
[12] Vavizos, G., Zannaki, K., Zafeiropoulos, D., *Land planning and Environmental Characteristics of Peninsula Magnesia*, Athens, 1997 (in Greek).
[13] Mylopoulos, N., *Preliminary investigation and management of water resources of more major hydrologic basin Volos,* University of Thessaly, Volos, 2000 (in Greek).
[14] Theodorou, A., *Oceanographic study of Pagasitikos Gulf*, Final Report, University of Thessaly, Volos, 1998.
[15] Kungolos, A., Samaras, P., Koutseris, E., Using bioassays for testing seawater quality in Greece, *J. Env. Sci. Health-Part A* A38 (3), 533-544, 2003.
[16] Friligos, G., Eutrophication assessment in Greek coastal waters, *Toxical and Environmental Chemistry* 15, p.p. 185–196, 1987.
[17] Ingrid, G., Andersen, T., Vadstein, O., Pelagic food webs and Eutrophication of Coastal Waters: impact of grazers on algal communities. *Marine Pollution Bulletin* 33 (1–6), 22–35, 1996.
[18] Petihakis, G., Triantafyllou, G. Theodorou, A., Enrichment of Pagasitikos Gulf by run-off fertilizers. A modeling study. *Fifth International Conference on the Environmental Pollution*, Thessalonica, Greece, 2000.
[19] Petihakis, G., Triantafyllou, G. Theodorou, A., A numerical approach to simulate nutrient dynamics and primary production of a semi-enclosed coastal ecosystem (Pagasitikos Gulf, Western Aegean, Greece). *Periodicum Biologorum* 102, 339–348, 2000.
[20] Roikos, E.E., Municipality Volos, *Study of management of urban sewages in Magnesia,* Athens, 2002 (in Greek).
[21] Prefectoral Self-government Magnesia, Developmental Company Magnesia *File: Olive presses*, Volos, November 1999 (in Greek).
[22] Frantzis, I., and Collaborators, Region Thessaly, *Administrative Drawing of Solid Waste for the prefecture Magnesia,* Athens, 2000 (in Greek).
[23] Kungolos, A., Beriatos, I., Perakis, K., Hannay, D., "Environmental problems associated with uncontrolled solid wastes landfill sites in Magnesia prefecture", *5th International Conf. on Environmental Pollution*,

701-705, ed. A. Anagnostopoulos, Thessaloniki, Greece, August 28-September 1, 2000.

[24] Christopoulou, O., Sfouggaris, A., *GEE, Pan-Hellenic Scientific Congress*, Protection of Environment and Agricultural Production, Aesthetic Pollution by exploitation of Quarries in the region Volos, March 1989 (in Greek).