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APPROACHES TO ECOLOGICAL PLANNING

GIS EVALUATION OF THE EFFECT OF URBANIZATION ON ÇUKUROVA PLAIN WITH THE HELP OF REMOTE SENSING

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Foreword

Turkey, today, faces similar environmental problems like the rest of the world. It is, therefore necessary to prepare sustainable use and protection plans to solve current and future problems. Suitable and applicable plans will be helpful to reduce the possible hazards of rapid industrialization.

Industrialization and its consequent problems are an important issue for Çukurova region which is one of the major agriculture regions of Turkey. As a result of the developments in industry and agriculture and the mild climate, the region faces a migration problem. Lack of sustainable use, protection plans and measures results various environmental and urbanisational problems.

This study was carried out to reveal how Adana Province is affected and under risk from the negative environmental factors stated above.

Introduction

In less than three decades that have passed since the United Nation Conference on Human Environment of 1972 we have witnessed drastic changes worldwide regarding environmental issues. On the other hand, the environmental problems of our planet and the destruction of natural resources have risen to even greater dimensions; and on the other hand, our understanding of these phenomena and the concept of environment have greatly improved.

Environmental problems are becoming increasingly pressing every day and are encountered in one form or another in almost every region of the country. Not only the causes themselves, but also the factors affecting the increase and spread of these problems are various. In general, industrialization, inappropriate urbanization, dramatic population growth and the resultant rapid flow of population to big cities are responsible for environmental pollution. At the same time, these factors, together with human activities, threaten natural resources in the country and hence have made environmental problems one of the most important concern for people in the last quarter of the twentieth century, also because in direct and indirect alteration of the

environment may affect people directly or through supplies of air, water and agricultural and biological products.

A major step in solving environmental problems is to present the problem as a whole. But at the same time, many factors vary from region to region along with their sociological, economical and cultural variations.Therefore these factors will be taken into consideration in this paper.

One of the primary goals of environment planning policy is the protection of natural resources and to provide their sustainability. It is, therefore, essential to begin with the land use planning for all sectors in the implementation of such a policy. Selection of appropriate areas especially for urbanization, industry and agriculture, will no doubt, significantly decrease potential environmental problems.

Industrial sector is a major job oppurtunity for many people in Adana Province. Richness of social, economic and cultural activities together with the attraction of industry results in an increasing demand for our region. The migration from villages to the city is a major source of stress on the environment. In Turkey, from 1927 to 1990, percentage of the villagers out of total population decreased from 76% to 41%. Rapid industrial development affects the stable structure of the city which normally changes in rather a slow process, thus, exposes the city to a sudden change. This brings economic, social, physical and politic problems (Yıldız, 1995).

City planning concept which effects public life, has variously defined by different scientists. According to Lewis (Yıldız, 1995), urbanization is an activity to organize appropriate development of the city and its environs considering better and comfortable health conditions, trade requirements and industrial needs.

Yıldız (1995) defines the city as an area which extends to a certain surface of land and has a considerable population from different sectors.

As a consequence of advancing technology, the industrial development leads to the formation of different sectors. Industrial sectors, mainly textile, fats and oils, plastics cause a continuous increase in the population of Çukurova region. People from rural areas migrate to the city for better living conditions. In Adana Province, migration is another reason for the population growth, because current rural agriculture field production is not sufficient to provide the consumption need of this population. Migrating people from rural areas are also a problem for agriculture, because they decide to settle on cheaper regions of the city, usually with illegal urbanization which is directed towards fertile agriculture areas.

To prevent such adverse effects, urbanisation must be realized according to the development plans. Development plan regulations exist in Turkey, but the implementation of the regulations are not sufficient. Hence, there is deficiency in the applications. Adana province which faces dense migration, must be very strict with the implementation of the development regulations to prevent inappropriate

urbanisation. The aim of this paper is to present the results of rapid and inappropriate urbanisation on agricultural areas and reveal the risks on the natural resources.

Research area

Çukurova plane is a fertile land with extensive agriculture. Adana is situated just in the heart of this plain which is not only a centre of importance in the field of agriculture, but is also an industrial centre of the region (State of the Environment in Adana Report 1998). Consequently urgent problems exist which arise both from agricultural and industrial activities. Sudden growth of population and urbanization followed by the establishment of the industry on this fertile land together with erosion caused a huge problem of environment.

Adana city located between Seyhan and Ceyhan Rivers in the northeast Mediterrenean Coastal Region. Çukurova Delta formed by the sediments carried by these two rivers is the largest delta in Turkey and includes four very important wetland habitats. Adana Province is selected as the research area. It is situated between $37^{00}00'$ N and $35^{00}20'$ E. The area of the city is 14.030 km^2. The Taurus Mountains cover the north of the city.

Material and method

Material

In this study, soil maps of 1/200.000 scale, groundwater maps of 1/50.000 scale, topographic maps of 1/25.000 scale, industry settlement maps of 1/25.000 scale and satellite images were used. Satellite images are dated 3.11.1985 and 24.10.1993, with resolution of 30x30m, 3^{rd}, 4^{th} and 5^{th} bands of Landsat-TM satellite. Digital Chart of the World with various scales is also used. Other data obtained from different governmental and non-governmental organizations were also recorded to Geographic Information System (GIS) databases. Arc/Info, ArcView and Erdas software were used in the studies.

Method

In this study, GIS techniques has been used. GIS is defined as "a technological tool to integrate and process the graphic and non-graphic data obtained from spatial observation and measurements (Yamralioglu et al., 1994).

Today, most of the information about the earth are obtained from satellites at various orbits around the world. By providing a wide observation range because of their high orbital altitudes, high data collection speed of satellite systems and a number of spectral bands used, it is now possible to have a lot of information in an economical way.

One of the major benefits of satellites is making analysis of large areas possible in a short time. The images used in this project are from Landsat-TM (Thematic Mapper) satellite and resolution is 30x30 m, except the 6th band. Landsat-TM which has 7 bands. For this project, following bands were used;

Band 3: 0.63 - 0.69 µm (red); Band 4: 0.76 - 0.90 µm (near infrared); Band 5: 1.55 - 1.75 µm (mid infrared).

Images used in the project are dated November 3rd, 1985 and October 24th 1993. Bands are 3rd, 4th and 5th of Landsat-TM. These bands on the CD medium were converted to a suitable format by using Erdas software for analysis and classification. As these images are not connected to a projection system, control points were taken from 1/25.000 scaled topographic maps and a geometric correction is realized to work within actual world coordinates.

Current situation

Geographic situation

Research area, the Adana Province is located between 35-38 northern lattitudes and 34-36 eastern longitudes. Area is 14.030 km^2 and lies at southeast of Mediterranean region (one of the seven geographic regions of Turkey) surrounded by Kayseri at north, Osmaniye at east, Niğde and İçel at west and Hatay at southeast (State of the Environment in Adana Report 1998).

Geology and topographical structure

The Adana Basin is one of the largest Neogene basin in the Tauride Orogenic Belt, with an area of approximately 10.000 square km. Deformed Paleozoic and Mesozoic rock units from the basement of the basin, most of the Upper Palaeozoic sequence comprises shallow marine limestones and clastic (edge of Afro-Arabian shield). The Mesozoic overlies the paleozoic units with angular unconformity and includes a further thick sequence of platform carbonates, capped by deep marine turbidite sediments. These older units are tectonicaly overlain by a thick allochthonous melange unit and by thrust slices of basic/ultrabasic ophiolitic rocks, emplaced in this region during the Late Maastrichtian.

The main Adana Basin was formed during the Late Tertiary era on an irregular palaeotopograpy of deformed Palaeozic-Mesozoic rock units. The main basin-fill sequence is represented by eight formations with a total thickness of 9000m, most of which displays highly variable facies and was deposited during a Middle Miocene phase of rapid subsidence. These eight formations can be broadly characterised as pre-transgressive, transgressive and regresive sequences. The pre-transgressive group outcrops in the NE and NW parts of the basin and comprises the Late Eocene-

Oligocene Karsanti and Oligocene-Early Miocene Girdirli formations. The Karsantı Formations was probably deposited in a separate intermontane basin, prior to inception of the main Adana Basin.The slightly younger Girdirli Formation, best developed in the NW part of the basin, is dominated by the terrestrial redbeds. The transgressive cycle is associated with early Miocene marine inundation from the south and includes the marine Kaplankaya, Karaisalı, Cingöz and Güvanç formations. The major part of Adana Basin till accumulated durin this period. In accordance with general shallowing of the Adana Basin during the Late Serravalian to Messinian interval, the paralitic Kuzgun and Handere formation represent a major regressive cycle, leading to emergence of the western part of basin by late Tortonian. By the Messinian, the whole Adana Basin had followedextensive evaporite deposition accuted in the west (Unlugenc et al., 1990).

Soil structure

Çukurova soils have been formed by alluvial deposit. Most of the soils on this plain are of fine structure. Organic material, salt and lime contents are variable and have slightly basic character (State of the Environment in Adana Report, 1998).

Adana Province has large soil groups. Large soil groups are: alluvials, hydromorphic alluvials, alluvial coastal swamps, coallivuals, organic soils, brown forest soils, brown forest soils without lime, rendzina, verticol, regosol, bazaltic soils, river beds, dunes on the beach, and bare rocks and molozlar.... (State of the Environment in Adana Report 1998).

Land suitability classes which are important means for agricultural interpretation, have a different distribution in Adana Province. 14.3% of the city area is 1^{st} class soils, 6.5% is 2^{nd} class, 7.9% is 3^{rd} class, 4.9% is 4^{th} class, 0.06% is 5^{th} class, 8.7% is 6^{th} class, 50.9% is 7^{th} class and 6.8% is 8^{th} class soils.

Climate

Mediterranean climate is the dominant climate type in Adana Province; winters are mild and rainy, summers are hot and dry. Annual average mean temperature is 17.8-18 $^{\circ}$C. Monthly maximum temperature is 35 ^{o}C in August and 4 ^{o}C as the minimum. In January humidity level is 66-68% in the area, however, in winter period, humidity rises to 68-70% and in summer to 65-85%. Annual precipitation is about 650-700 mm (Adana State Meteorology Office , 1998).

Natural sources

Adana Province has two important surface waters, namely Seyhan and Ceyhan rivers. Akyayan, Akyatan, Ağyatan and Tuzla lakes are major lakes-wetlands of the city. These wetlands are also in watershed class (State of the Environment in Adana Report 1998).

Since the city has rich groundwater potential, water for drinking purposes, daily consumption and other uses is obtained from wells. Groundwater potential is 793 hm/year (State of the Environment in Adana Report, 1998).

Adana Province is rich in vegetation and wild life. Mild climate produces a natural habitat for many plants and animal species. Plant species which demand higher temperatures are mostly of Mediterranean flora (Tekeli, 1996).

While psomophylles and psomotypes exist in coastal sands, halophytic plants can be found in salty areas. Bushes and shrubs are present on the soils with poor organic content (The Summit Report of Agriculture, 1998).

Artifical factors

Transportation is provided by highways, railways, waterways and airways in Adana Province. In the city, the harbours of Botas and Toros Fertilizer factories are used for international fuel-oil and cargo transportation. A shelter in Karataş district serves for local people (State of the Environment in Adana Report 1998).

Related to the development of industrialization in Adana, population growth is rapid. There is a major difference from the 1st population census realised in 1927 to the last one in 1997. The population increased from 227.735 to 1.185.049 (State Statistical Institute, 1999).

In Table 1, 1985 and 1997 population census results are listed for the towns in Adana province. An increase is observed in some towns while there is a decrease in others. Main reason for this situation is the fast industrial development in some districts which led to migrations from villages to towns.

Sudden increase in population and other related problems resulted inappropriate urbanisation which increased immediate demand for housing .

Tab. 1. 1985-1997 Population through districts

DISTRICTS	TOTAL POPULATION (person)	
	1985	1997
Aladağ	24395	22088
Ceyhan	147497	157050
Feke	23988	20097
İmamoğlu	29778	42973
Karaisalı	36206	35734
Karataş	26317	25719
Kozan	113911	115311
Pozantı	17383	22517
Saimbeyli	20528	15586
Seyhan	560000	781742
Tufanbeyli	25611	19940
Yumurtalık	20345	20419
Yüreğir	321369	403307

(source: State Statistical Office, 1999)

Results and discussion

Current landuse

"Supervised Classification" method was used to identify land use in georeferenced images from the years 1985 and 1993. Defined landuse is grouped into 15 classes according to "Corne Land Cover Nomenclature" system.

As seen in the Figure 1, the majority of the plain was used for irrigated agriculture in the year 1985. Citrus orchards can be seen by Seyhan river, just at the south of the urban areas.

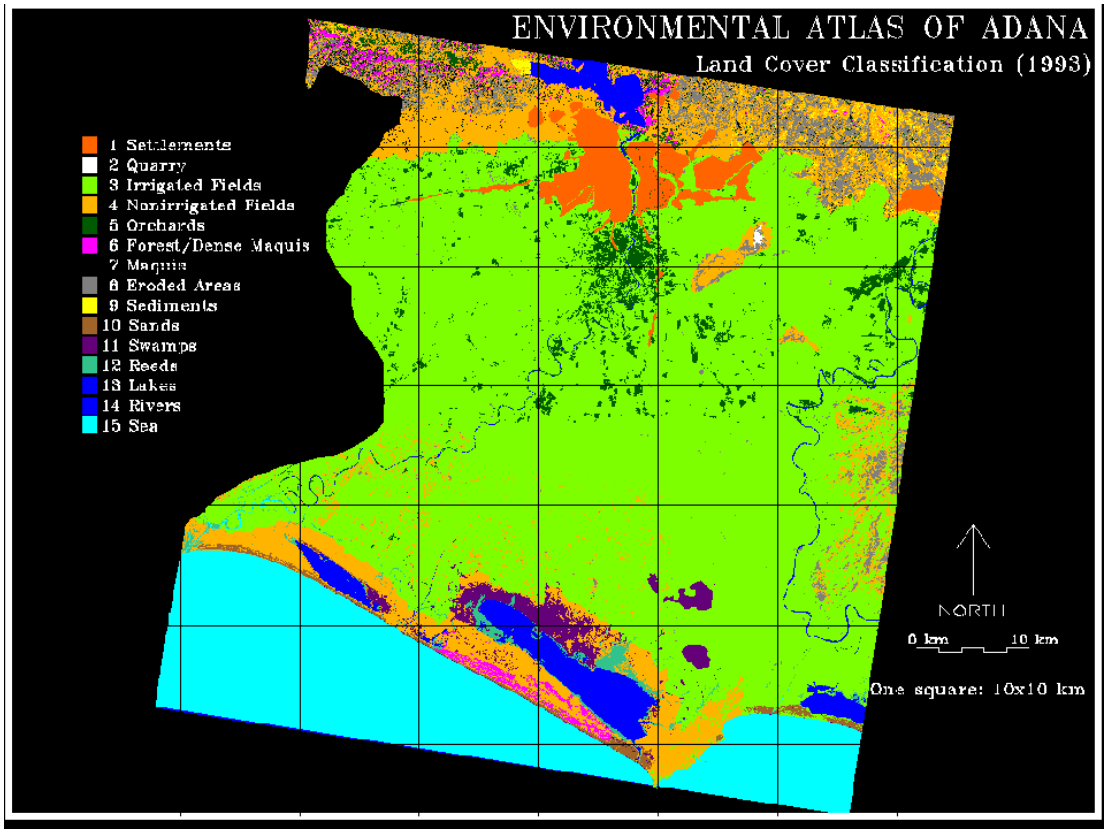

Fig.1. Land cover classification for 1985 from Landsat-TM satellite image

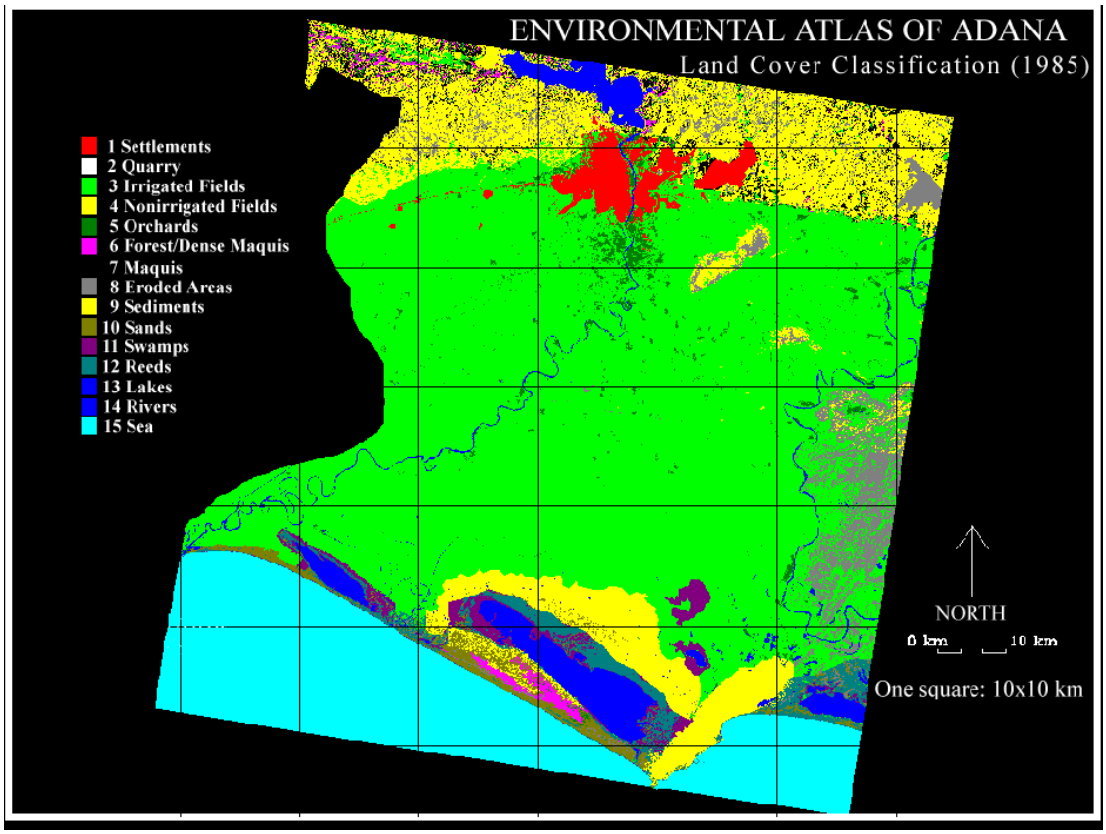

Fig. 2. Land cover classification for 1993 from Landsat-TM satellite image

In Figure 2, landuse of 1993 is shown and it is observed that the increase in the urban areas is putting a pressure over agricultural fields. Irrigated fields reveal a decrease both by urbanisation and the replacement of citrus orchards. Existing orchards by the Seyhan river have increased and new orchards were established next to Ceyhan river.

Increase in eroded areas is clearly visible in the 1993 image. The reason for erosion is inappropriate landuse and lack of necessary protection measures. Swamps exist at the south and show an increasing tendency. Wetlands are not protected as essential and some of their parts is used for agricultural activities which result damages in these areas, consequently the crop yields of the farmers are very poor. Because of afforestation activities at Akyatan sand dunes, a part of the coast is classified as forests. Another afforestation area exists at the east of Seyhan Dam Lake and again classified as forest.

With various analyses, landuse distribution for 1985 and 1993 were calculated (Table 2). Field studies were undertaken on control points to confirm the accuracy. The data of the selected areas are loaded to the computer in order to compare the classified areas. Consequently, the accuracy is 83.7%.

As seen in Table 2, urban areas are 1.89% in 1985 and this rate increases to 3.11% in 1993 as a result of migration as stated previously.

Tab. 2. Distribution of land uses (ha)

LANDUSE	Amount of distribution for 1985		Amount of distribution for 1993	
	Ha	%	Ha	%
Settlements	5,784,300	1.89	9,522,990	3.11
Quarry	-	-	83,610	0.03
Irriagated Fields	159,264,547	52.06	167,991,844	54.91
Nonirrigated Fields	44,108,102	14.42	37,535,043	12.27
Orchards	5,017,410	1.64	10,321,471	3,37
Forest/Dense Maquis	1,948,860	0.64	2,814,750	0.92
Maquis	5,454,450	1.78	1,413,720	0.46
Eroded Areas	12,617,551	4,12	10,518,931	3.44
Sediments	344,340	0.11	1,128,420	0.37
Sands	3,906,180	1.28	1,772,100	0.58
Swamps	4,007,970	1.31	4,354,470	1.42
Reeds	5,816,160	1.90	2,349,000	0.77
Lakes	10,310,851	3.37	9,009,271	2.94
Rivers	1,555,290	0.51	1,452,150	0.47
Sea	45,808,478	14.97	45,676,621	14.93

Changes in land use

Variation of landuse from 1985 to 1993 were investigated by the help of satellite images (Figure 3). There is a significant increase in urban areas. The only positive point here is that urbanisation streches towards the north where suitable land for urbanisation exists.

Another important increase is in Citrus orchards, primarily results from the shift of the cereals production to the Southern Anatolian region. Forest areas at the east of Seyhan Lake are formed by the afforestation activities of the Cukurova University.

Urbanisation areas observed around Town Misis are originally industrial zone. As it has similar features with urban areas, it has been classified as urban. Even if this industrial zone would be excluded from the total urban areas, there is still increase in urbanisation. Excavation activities in the lime kilns resulted additional increase in 8 year period.

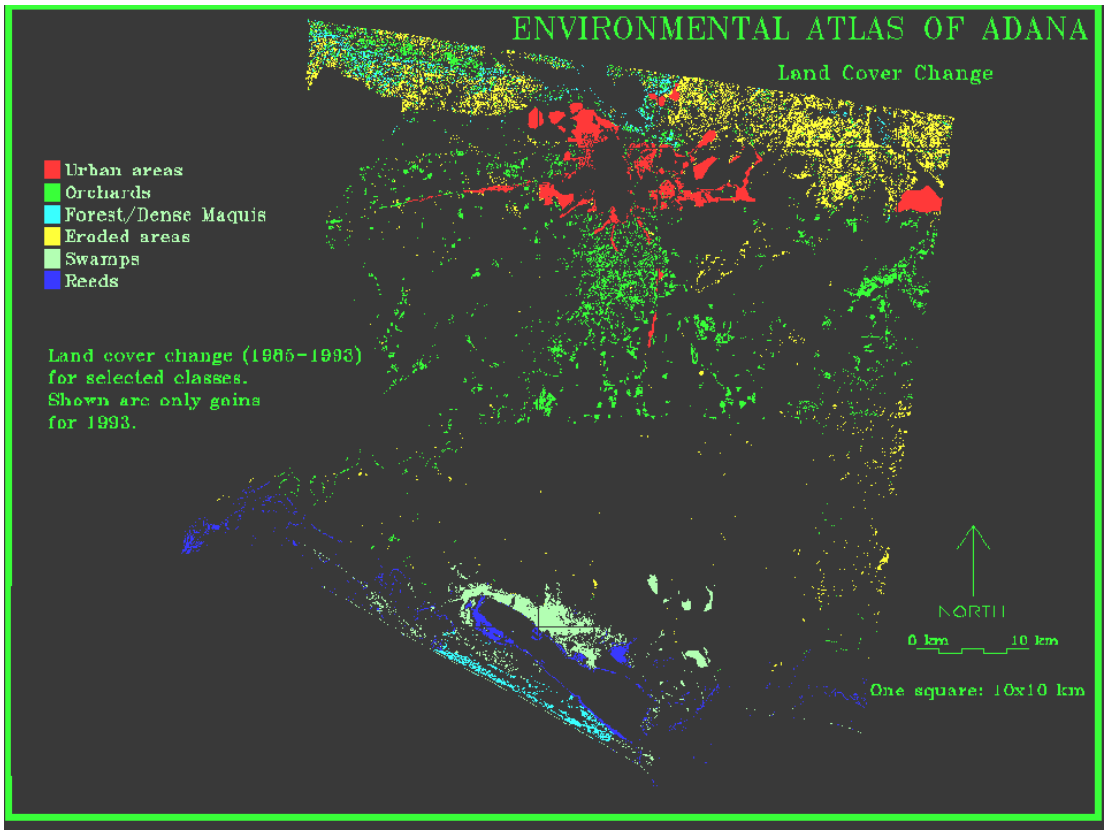

Fig. 3. Landsat-TM images analysis result of differences of land uses, between 1985 and 1993

Risky areas

A hazardous area map was created after analysing maps and information from satellite images (Figure 4). Hazardous zones related to groundwater, landuse, erosion and urbanisation-industry and habitats were shown by evaluating the data observed. Blue areas in Figure 4 shows high sensitivity of groundwater. Land use problems become intense at the south. These pro blematic areas are wetlands and highly cultivated lands for agricultural purposes which puts some endemic species in danger. The dune vegetation at the north and south of Akyatan Lake is annihilating with agricultural uses. There are some erosion zone observed at the north and east of the city. Main reasons for that are inappropriate landuse such as agricultural activities in non-suitable soils, lack of afforestation studies and others.

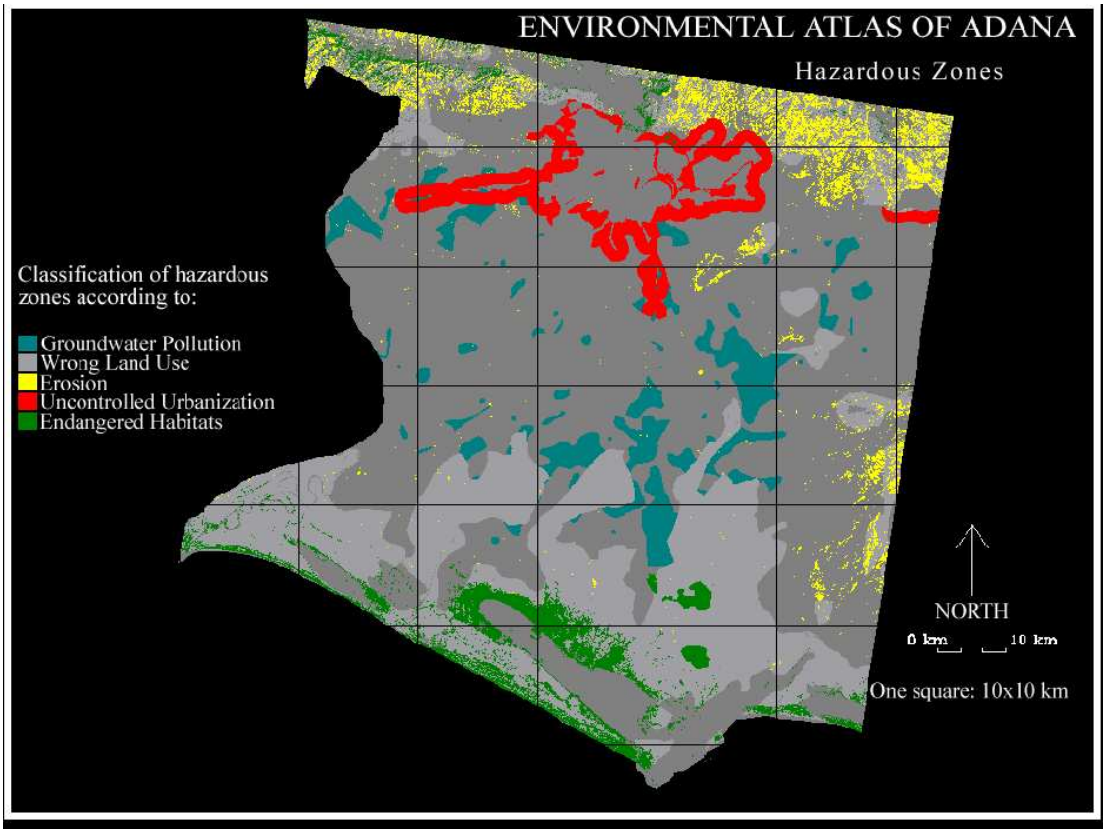

Fig. 4. Present and possible risk zones.

Results

Although the industry developes together with the new available technologies and contributes to the economy of the country, it creates problems and reveals a negative impact on the environment. The most important negative effect is migration from rural areas to the cities. This migration results in crowded cities and puts a pressure over fertile soils which creates immense problems in planning. The supply deficit of agricultural products against population increases and consequently inappropriate soils are used for cultivation such as forests. In order to increase the crop yield, the mis-use of fertilizers and pesticides increase tremendously. According to the data of 1994, the amount of fertiliser used in Adana city is 583.083 tons (State Statistical Office, 1997). Such a high consumption of the fertilizers leads to the contamination of food and groundwater.

When the sources are misused and/or managed inappropriately, agricultural losses (salination, urbanization, erosion) will exist which will be a total loss of agricultural production. Today the whole world is aware of the importance of sustainable agriculture, which defines agricultural activities that uses natural resources in such a way to let them restore themselves in due course.

As a consequence of the sudden demand of housing, valuable and fertile agricultural lands are being used for urbanisation. As well as the agricultural loss of these soils, air and water pollution problems arise as a result of inappropriate urbanisation.

The use of fertile lands and natural resources in a sustainable manner must be realized; additionally, careful city planning for appropriate urbanisation must be followed strictly in order to protect and improve the environment and the future of new generations.

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