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Effects of Land Use Development on Urban Open Spaces

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Abstract: City of Aydin has grown extremely due to immigration from the eastern part of Turkey, immigration from rural areas to urban areas of the city and alterations in economic and social structure of the nation. The rapid expansion of the urban area results in dramatic change in the open space system of the town. Understanding this transformation is important to generate sustainable planning in the area. The purpose of this study is to elaborate the different open space opportunities in Aydin and to detect the change in these areas. Black and white aerial photographs from 1977 and 1993 and Ikonos 2002 images are utilized for the analysis in GIS environment. First, 14 different open space types are defined and the open spaces are delineated from the aeriels and satellite images. Second, the change in the area of these patches is analyzed. The results indicate that urban open spaces are negatively affected by historic land use development. The natural and agricultural patches diminished while semi-natural or man made open space patches increased. Opportunities to increase the variability in the open space types should be embraced to promote sustainability in the urban matrix. Ecological design of the man made open spaces is necessary to increase their contribution in this endeavor.

Key words: Open spaces, change, urbanization, sustainability, urban planning, GIS

INTRODUCTION

Urban open spaces are vital part of urban landscapes with their own set of structure and function. Natural or man-made, they contribute to the quality of life in many ways (Burke and Ewan, 1999) by providing psychological (Chiesura, 2004) and recreational (Antrop, 2000) services. Thompson (2002) sees open spaces in cities as places to celebrate cultural diversity, to engage with natural processes and to conserve memories. They not only serve the social needs of the urbanites, but also contribute to urban ecosystems (Soule, 1991) at different rates. In spite of their benefits, these areas are affected by rapid urbanization (Wasilewski and Krukowski, 2004). Understanding the characteristics of different types of open spaces in an urban matrix may guide local authorities in the long term planning and design process. The assessment of change in open space system is equally important to take measures in maintaining livable cities.

The present study aims to investigate the effects of land use development on different open spaces in one of Turkey's rapidly growing city, Aydin. Specifically, the objectives are to define the types of open spaces and to detect the change in the open space system in the urban matrix. A set of recommendations pertaining to the long-term ecosystem planning of the area is presented. The city of Aydin has grown extremely since 1970s due to

immigration from the eastern part of Turkey, immigration from rural areas to urban areas of the City and alterations in economic and social structure of the nation. Rapid urbanization caused significant conversion of the open space patches in and around the city (Deniz, 2005). The uncontrolled development and lack of sustainable planning signal the continuation of this trend in the future.

The concept of open space in complex urban matrix is not limited only to the urban parks, but man made-semi natural-places to suit the varying outdoor needs of human beings and needs of plant and animal species. Public spaces such as streets, school yards, outdoor sport complexes, cemeteries and public squares are important open spaces (Hall, 1998). Baines (1999) recognizes the value in waste lots, the derelict, gap sites awaiting redevelopment but not currently managed. Also, railways, highway right of ways and canals have functional values (Thompson, 2002). Sound planning and design of such spaces aids in establishing ecological networks (Cook, 2000, Cook 2002) in the urban matrix. Also, agricultural areas become an important part of the open space system by penetrating into the urban matrix (FAO, 1996). Chiesura (2004) suggests taking into account the variability in the open space types to fulfill the needs and expectation of all segments of the population. This work builds on Chiesura's approach and sees open spaces as

opportunities to improve urban environments. Findings of this research are important to generate more realistic planning goals for the City of Aydin as well as for other urban areas facing the similar problem.

MATERIALS AND METHODS

This case study focuses on different open space types in the City of Aydin, Turkey (Fig. 1). The study area is limited to the extension of the urban area (2195 ha) in the 2002 city plans. The history of Aydin goes back to 7000 years. During the history, the town was always an important commerce and agriculture city, due to its location on the major transportation routes. A railroad system was constructed in 1853 to deliver the agricultural products to major harbors. Today, the railroad still operates; also a major highway traverses the town connecting neighboring two highly industrialized cities of Izmir and Denizli. The rights of ways of these transportation structures are examples of linear open spaces (Noss, 1993).

Almost a 183% population increase occurred between 1970 and 2000 in the city. Starting around 1980's,

Aydin has experienced a considerable population increase (Fig. 2). Industrialization and the establishment of a state university contributed to this increase by generating jobs in the city. Because of the rich history, the town of Aydin possesses historic remnants of the ancient city of Tralleis. The completion of the excavations and restorations would generate opportunity for tourism development, which may trigger urbanization in the future. Tralleis' archeological site is also an example of an open space that is preserved by law.

The municipalities aim to promote quality of life in Aydin's high density matrix through urban parks and outdoor recreation areas. However, their effort is undermined by excessive amount of impervious surfaces and great numbers of exotic species in these parks (Esbah, 2006).

More open space alternatives exist in the town. For instance, the urban area borders with the natural system on the north and an agricultural landscape surrounds the City on the east, south and west. These areas hold a great potential for improving the ecosystem qualities of the City; nevertheless, the urban development occurs at their expense. Increasing density also threatens the ecological



Fig. 1: Study area-the City of Aydin, Turkey

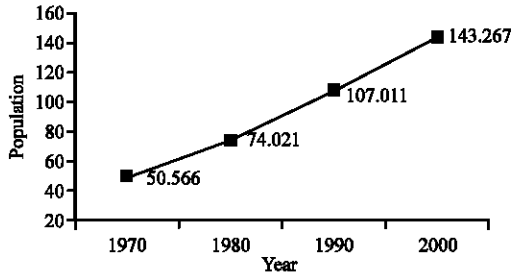


Fig. 2: Population increase in the City of Aydin, 1970-2000

values of the natural drainage corridors. Tabakhane Stream running through the city is one example of the negative example of the historic land use development (Tuncay and Esbah, 2006). The areas around the canalized section of this stream have recreational values. Restoration of the habitat qualities in this section may contribute to the canal's open space attributes as well as urban environment. A previous study suggests that all types of opportunities should be embraced to tie Tabakhane stream with the rest of the urban open spaces (Tuncay and Esbah, 2006). Also, public open spaces, school yards and the campuses of public offices contribute substantially to the green network of the City of Aydin (Deniz, 2005).

A set of aerial photographs from 1977, 1993 and Ikonos images from 2002 were utilized. The aerial photographs were on 1:25000 scale. The resolution of pan sharpened Ikonos was 1 m. Some ancillary data such as city plans, pictures and historic documents also assisted the analyses. Aerials were, first, georeferenced by using already rectified Ikonos image. RMS error was 0.47 and 0.32 for 1977 and 1993, respectively. Second, they were registered to UTM (Zone 35). An image enhancement technique (contrast adjustment) is applied to improve the visual qualities of the aerial photographs. Analysis was done in ArcGIS 8.3 environment (Esri, Redlands, CA.).

Types of open spaces were defined through field studies, scrutinizing the materials and creating GIS coverages. Also, the magnitude of change in the open spaces was investigated by using GIS technology.

Fourteen different open space categories were defined: Natural, natural drainage, agricultural, open lands, vacant, military, transportation, industry, archeological, park, canal, public, school and sport. The polygons for each type were created by on screen digitization and their related features were entered manually to the attribute table. This procedure is pursued for each study period. In the attribute table of each year exists columns pertaining to type, the area and perimeter of each polygon. Also a set of attributes-percentage of

permeable surfaces, ownership, access rights and management-are inserted to the attribute table of 2002. Ownership, access rights and management attributes are important to understand the institutional structure and the type of use. Percentage of permeable surfaces is used as an indicator of ecological integrity (Forman, 1997; Schueler, 1994). The numbers for natural, natural drainage, agricultural, open lands, vacant, military, transportation, industry and archeological areas are adopted from Deniz (2005) and the numbers for parks and natural drainage are from Esbah (2006) and Tuncay and Esbah (2006) respectively. For the categories of public, school, sport and canal, area of impervious surfaces such as pavements, buildings and compressed soil due to foot traffic are extracted from the total area of the each open space polygon. The ratio of remaining pervious soil surfaces over the whole area yielded the permeability value of a polygon. Average of the numbers yielded the overall percentage of the permeable surfaces for each open space type.

RESULTS AND DISCUSSION

Open space pattern of Aydin changed due to historic land use development. Open spaces shrank continuously from 73.5% in 1977 to 55.1% in 1993 and to 42.6% in 2002 (Table 1). Agricultural areas are mostly affected by this transformation (Fig. 3-5), because the urban area is originally located on an agricultural landscape. Amount of agricultural land decreased 45.3% between 1977 and 1993; the decline continued with an accelerated rate of 54.3% in the 1993-2002 period. Loss of agricultural areas due to urbanization is a worldwide phenomenon. Even though, urbanization is stated as one of the greatest threats to sustainable agriculture by FAO (1996), the loss of these ecologically and economically important patches continues.

Table 1: Amount of open spaces in 1977, 1993 and 2002

Open space type	1977 (ha)	1993 (ha)	2002 (ha)
Natural	37.1	27.8	18.0
Natural Drainage	13.0	5.7	4.1
Canal	2.4	6.7	7.9
Agricultural	1,241.1	679.1	310.2
Open land	149.5	158.0	79.8
Vacant	35.4	109.6	131.4
Public	39.0	88.3	159.5
School	18.6	35.7	50.3
Park	5.9	10.8	23.0
Sport	4.7	6.1	12.0
Military	34.3	35.0	34.7
Transportation	13.2	23.8	72.6
Industry	17.3	18.9	27.2
Archeological	2.8	2.8	30.0
Open space (Total)	1614.3	1208.5	960.7

Open spaces in Aydin-1977

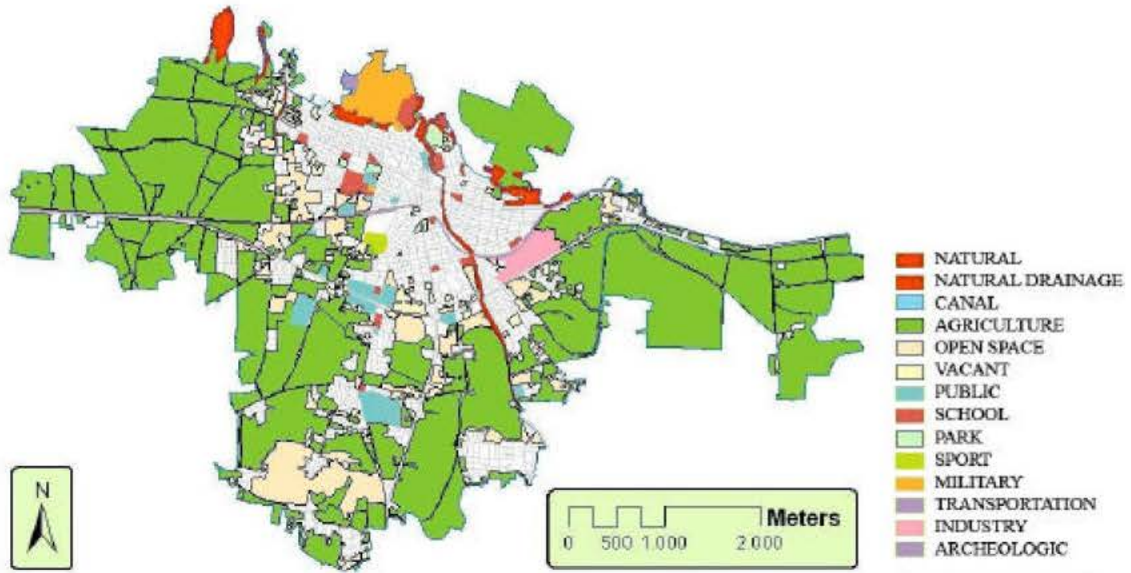


Fig. 3: Distribution of urban open spaces, Aydin, 1977

Open spaces in Aydin-1993

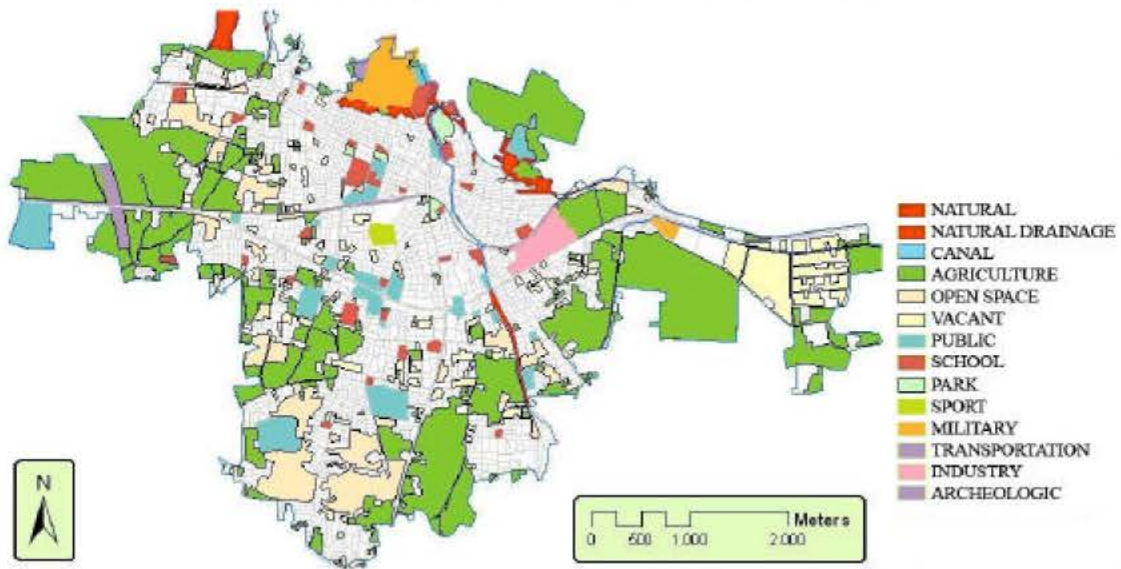


Fig. 4: Distribution of urban open spaces, Aydin, 1993

Open spaces in Aydin-2002

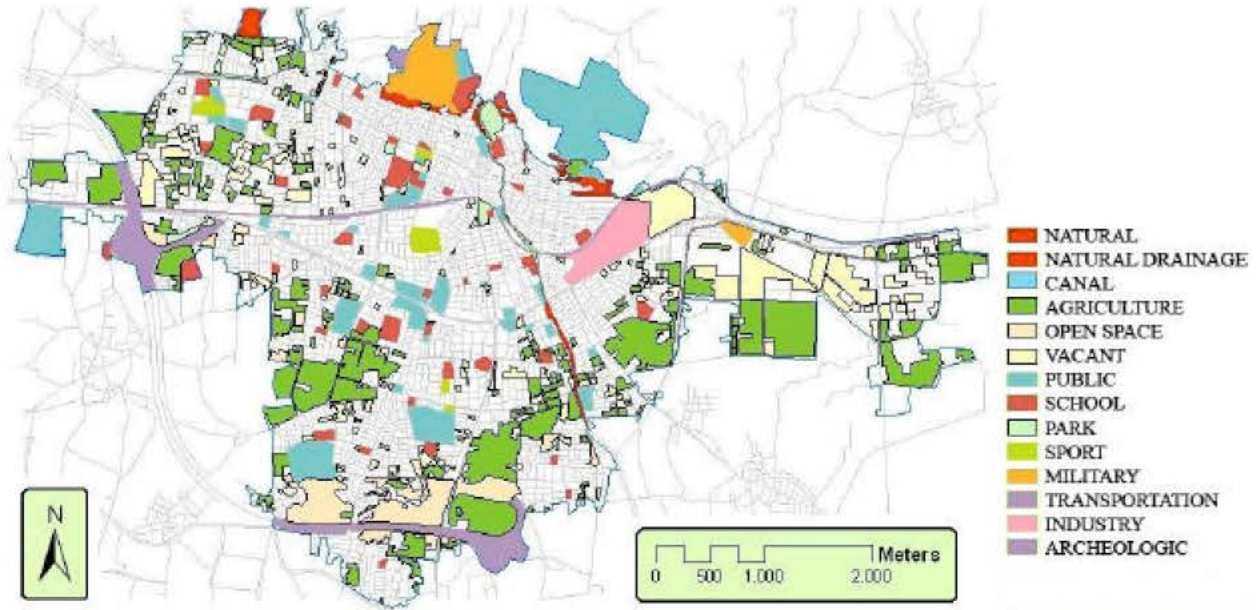


Fig. 5: Distribution of urban open spaces, Aydin, 2002

Table 2: Permeability, ownership, access rights and management characteristics of open spaces

Type	Permeable Surfaces (%)	Ownership	Access Rights	Management
Natural	96.00	Public,	Open access	Municipality, local offices of related ministries
Natural Drainage	77.30	Public	Limited access	Municipality
Canal	13.80	Public	Limited access	Municipality, state water affairs (DSI)
Agricultural	97.00	Private	Limited access	Private, local offices of related ministries
Open land	62.40	Public, private	Open access	Municipality
Vacant	95.90	Private	Limited access	Municipality
Public	47.90	Public	Open access	Municipality, local offices of related ministries, governorship
School	40.16	Public, private	Limited access	private, school board, local offices of related ministries
Park	37.98	Public	Open access	Municipality
Sport	21.31	Public, private	Open access	Municipality, governorship
Military	59.00	Public	Limited access	Army
Transportation	51.55	Public	Open access	State highway and railway departments
Industry	19.70	Private	Limited access	private
Archeological	36.00	Public	Limited access	Municipality, local offices of related ministries

The preservation of the agricultural landscape is imperative for Aydin as the area is one of Turkey's most prominent agricultural regions. In addition to its economic benefits, these areas present opportunities for outdoor recreation such as hobby gardens. Agricultural land has a private ownership (Table 2) status in that the farmers have the right to sell their land for construction. Some measurement such as taxation could be taken to prevent their purchase for development. Effective management of agricultural landscape is non-existent, even though the local office of the Ministry of Agriculture conducts different programs. Ecological and social benefits of this type of open spaces rely on the type of agriculture; therefore the sustainable agriculture that respects the ecological qualities of the ecosystem should be pursued.

Open lands of derelict and gap sites diminished in a 25 year period. The percentage of such patches was constituted the 6.8% of the study site in 1977 and 3.6% in 2002 (Table 1). The historic land use pattern is very compact and not sprawling in the town. Because traditional land use development practice tended to utilize available open lots before further expansion, the magnitude of these openings in the landscape dropped. However, lately, the urban expansion style is being influenced by the examples from developed countries and suburbanization (causing sprawled development) is entering the local planning agenda. Understanding of the positive and negative aspects of suburbanization and its implementation in the Turkish context is necessary. Open lands have a relatively higher permeable surfaces and are

rich in native species (Deniz, 2005). In this respect, they could shelter different wildlife, even though their visual qualities rather low in the highly manicured urban landscape. Whether to convert these lots to building blocks is in the hands of the owners (private citizens or the municipality). Currently, everyone can access to the open lands. Management of these areas is on the municipality; however, due to budget constraints these areas look abandoned.

Because it was already a cultural landscape of heavy agricultural practices, the study site did not contain ample natural patches. Therefore, from the beginning, the natural patches' share in the overall open system was very low (almost 2.30% in 1977 and 1993 and 1.87% in 2002) (Table 1). The existing natural patches are the extension of mountainous natural landscape on the north of the town. The city was not able to extend that direction due to the rugged characteristics of the landscape and the cost of bringing infrastructure. The potential of this natural landscape on the north should be recognized as a source area and the dispersal opportunities of them into urban matrix should be searched.

Natural drainage corridors including Tabakhane stream decreased between 1977 and 2002. These corridors were taken over by residential and commercial land uses. The sections of Tabakhane stream in the municipal boundaries are canalized during time hence contributing to the loss of natural drainage areas. A detailed analysis of the stream environment is presented in Tuncay and Esbah (2006). Their research showed that not only the area of the stream is decreased, but also its corridor is filled with less ecologically compatible land uses. Subsequently, the area of canal increased. Canals are example to the synthetic corridors (Cook, 2002). If they comprise substantial green areas along them, they may still contribute to the open space system of a city. In Aydin's case, however, opportunities for green areas along the canal are very limited and the existing green spaces are invaded by concrete surfaces (Table 2). The access to surrounding green areas of the canal is not limited, although the entrance into the canal construction is prohibited (partial access). Municipality and the State Water Affairs department are responsible from the management of the canal area. Their effort includes only maintaining the canal structure. Restoration and the redesign of the canal corridor for visual and ecological improvements are necessary.

Results, so far, has elaborated that the drop occurred in the natural drainage corridors, natural, agricultural and open lands of Aydin, due to historic land use development. Some of these areas has been shifted to

residential and commercial uses, while others are converted to different man made open space types such as parks and public open spaces.

The city of Aydin puts a great deal of effort in bringing nature to the urban landscape through parks. Thus, the number of parks increased gradually. However, their contribution in the open space system was and is, very low: these areas constituted only the 0.37% in 1977 and 2.30% of the system in 2002 (Table 1). Analysis in GIS, site visits and the park statistics (Esbah, 2006) yielded the fact that these parks were very small in area and dominated by impervious surfaces (Table 2). Sustainable and ecologically sound design of urban parks is very crucial in Aydin to improve their various open space qualities. Parks are open to all segments of society; however NGOs do not involve in the management of these areas. NGOs and citizen's participation in the planning and management of the parks could be more beneficial. These parks are mostly on a neighborhood park scale. A large urban park and even a preserve in the northern section may be the first steps of improving ecological networks in the city.

The man made patches of public open spaces such as cemeteries, gardens of hospitals and campuses of government offices etc. hold a great potential in environmental and social enrichment of the city. The investigations of aerial photographs showed that, public open spaces make up 2.4% of open space system in 1977 and 16.6% in 2002. With the addition of school yards and outdoor sport complexes the contribution of these anthropocentric open spaces increases from being 3.85% in 1977 to 23.08% in 2002. Access is not limited in these areas during the operation hours, however, only the staff and the customers of the facilities utilizes the area. From this point of view, these areas may not seem to serve large numbers of the society, but from wildlife point of view their existence is significant.

In Aydin, transportation routes, industrial and archeological land uses increased especially after 1993. The realization of the open space potential of these areas is necessary, as they possess vast amount of open areas in their property boundaries and right of ways. Likewise, the potential of the vacant lots waiting for the imminent urban development is unarguable in terms of seizing all type of opportunity to support the larger open space system in Aydin. The changing face of the open spaces from natural and agricultural to man made open spaces is an indicator of the changing social, economic and cultural face of the city. As more anthropocentric land use types dominate the landscape, open space types change to fit the anthropocentric needs of urban life.

CONCLUSION

Urban open spaces are key ingredients in the cities' sustainability. If the aim is to create livable cities, the recognition of different types of open spaces and their contribution in the overall system should be assessed and evaluated. Opportunities to increase the variability in the open space types should be embraced to enhance the ecological functioning of the highly complex urban matrix.

Urban open spaces are the direct expression of what is on the local and national agenda. Their design and perception is affected by socio-economic policies, mostly, leaving no space for ecological thinking. They are also affected by governmental and municipal planning shaping the urbanization process.

Turkey encourages industrialization and sees cities as sources to trigger economy. This approach changed Aydin's overall physical, social and economic face. Subsequently, urbanization boomed in the town, this brought many government offices and services as well as trade. From a comprehensive open space point of view, this caused very unsustainable structures of ecological barriers in the urban landscape such as addition of highways and roads, new public buildings and canalization of old riverbed. The ecological design and coordination of these artificial corridors and patches in the ecological network of urban matrix should be considered in timely manner. Otherwise the significant increase in the area of these anthropocentric elements generates nothing but a lack of livability in Aydin's urban environment.

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