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EFFECTS OF URBAN SPRAWL ON DRINKING-WATER BASINS: ALIBEYKOY BASIN (ISTANBUL-TURKEY)

Zehranur ŞERBETCİ*

Abstract

Istanbul firstly tended to develop on the east-west axis and then towards the north of the province in the period of rapid growth that began in the 1950s and continues until the present day. Forest areas and drinking-water basins were largely affected by the province's development towards the north. Drinking-water basins are among the areas of absolute protection that should not allow activities that will have a negative effect on their natural characteristics. This study aimed to determine whether or not the urban sprawl in Istanbul is suitable for the sustainability of Alibeyköy drinking-water basin. In line with the aim of the study, weighted overlay was carried out with the purpose of determining the appropriate areas by eliminating areas that are not suitable for urban development. Lithology, slope (degree), exposure (directions), basin belts (m), distance to rivers (m), land use and land use ability class parameters were used in the analysis. According to the results of the analysis, 78% of area was not suitable for settlement and 15% of area consisted of suitable and very suitable areas. Unsuitable areas in the Alibeyköy Basin generally occupy a place in the north of the basin. The southern areas of the basin are more suitable for settlement.

Keywords: İstanbul, Drinking Water Basins, Alibeyköy, Sieve Analysis.

1. Introduction

The drainage basin is an area that sends the rainfall water to an exit point while passing through the mountain/hill ridges and is bounded by water division line. It is defined in Water Pollution Control Regulation (RG: 26786, 13.2.2008) as "*the whole of a region in lakes and reservoirs where ground and surface water that feed this water source are being collected and, the upstream section of the region in a part of a stream that feeds a particular section.*" Natural and human activities, such as the reduction of forest areas, natural soil erosion, sediments and sudden floods in rivers, reservoirs and coastal shores, less water leakage into the ground and deterioration in water quality, are the factors that cause degradation in basins. Physical (environmental) costs and socio-economic impacts have led to the development of watershed management approaches (Daeghouth et al., 2008: 15). River basin can imply the watershed management of sub-basins or micro-basins. The basin is managed by the joint work of the relevant institutions and the participation of the stakeholders within its boundaries through the use of all natural resources in a holistic manner.

The use of basins towards multi-purpose development planning and management dates back to 1930s. The Tennessee Valley, the first regional development planning experience of the United States, began its work by means of a center founded in 1933 with multi-purpose planning and enforcement powers such as flood control, electricity generation and distribution, stimulation of industrialization and employment, prevention of soil erosion and increasing agricultural productivity. After this first experience, basin development planning and management approaches have been implemented in many countries. In the Water and Sustainable Development Conference held in Dublin in 1992, the need for a holistic approach that attributes social and economic development to the preservation of natural ecosystems as well as the use of land and water in the whole basin was expressed for the effective management of water resources and tributary basins that include surface and underground water were declared to be the most suitable geographic unit for the protection of ecosystems (Friend, 1992; Barrow, 1998). When addressing it across the globe, the management of water resources (Bahri, 2012) has several common characteristics in the watershed management practices of many countries.

* Dr., Istanbul University, Geography Department, zsavran26@gmail.com

These common characteristics include division of water resources into basins, their management by the state, presence of long-term national water policies in the state, establishment of basin committees at local scale, availability of watershed databases, watershed management, and their support by laws, regulations and policies.

The *"Water Management Coordination Committee"* was established in Turkey with the Prime Ministry Circular No. 2012/7. The committee has duties such as taking measures to protect water resources and developing plans and policies within the framework of holistic watershed management. The National Watershed Management Strategy (2014-2023) has been adopted to strengthen the legal and institutional capacities of basins, to ensure their sustainable management and to protect biodiversity and landscape. *ISKI Drinking-Water Basin Regulation* (2011) is quite important for being the most fundamental legal basis used in plans covering drinking-water basins within the borders of Istanbul Metropolitan Municipality. Although the overlap in jurisdiction of ISKI and Metropolitan Municipality is an important step for the prevention of unplanned urbanization in settlements within the basin, drinking-water basins continue to be under pressure. Despite the importance of some expropriation activities carried out by ISKI in order to preserve the basin areas, it is necessary that new settlements should not be allowed in these areas and monitoring and control mechanisms should be used effectively in this regard.

Istanbul, especially in the period of rapid growth that commenced in the 1950s and has continued until the present day, has experienced a process of urban development that was partly planned but, to a large extent, was shaped by unplanned constructions. The urban development process, which manifests itself in the form of urban sprawl and fringe, tended to develop in the east-west axis at first and then towards the north of the province. Forest areas and drinking-water basins have been negatively affected the most in terms of natural resources by the sprawl of the province towards the north. Drinking-water basins are among the areas of absolute protection that should not allow activities that will have a negative effect on their natural characteristics (water surfaces, forest areas, pastures and shrubs, agricultural lands). The drinking-water basins in Istanbul were particularly affected by major infrastructure investments such as TEM Highway and Fatih Sultan Mehmet Bridge (Second Bosporus Bridge). There is unplanned urban sprawl in the drinking-water basins in Istanbul (Küçükmehmetoğlu and Geymen, 2009, 571). This study aimed to determine whether or not the urban sprawl in drinking-water basins is suitable for the sustainability of the basin. The suitability of the land for certain usage types is determined by analysis (suitability) (FAO, 1985; Rossiter, 1996). In addition, the study aimed at making suggestions on the effective use of land and its sustainability. The conservation and development of water, soil, vegetation and other natural resources for the benefit of those living in basin areas as well as contribution to sustainable protection were intended in watershed management (Ministry of Forestry and Water Affairs, 2014).

2. Material and Method

Alibeyköy Basin was chosen for the study area (Figure 1). The total drainage area of the basin, located within the boundaries of Gaziosmanpaşa, Eyüp and Bakırköy districts, is 160 km2. Three square miles of this area covers the area of dam reservoir. There is a total of 10 settlements within Alibeyköy Drinking-Water Basin Area. The study intended to determine whether or not there is land use suitable for the preservation and sustainability of the basin in drinking-water basin and to identity the impact of urbanization on hydrological factors (Leopold, 1968,1). "*Sieve analysis*", one of the methods of suitability analysis, was applied to the study area. Data, used in weighted overlay conducted in order to determine whether or not suitable land-use was applied/ not applied in the basin, was obtained from very different organizations and institutions. The lithology (bedrock) map was created by taking advantage of geological maps of MTA with 1 / 25,000 scale. Data on slope, exposure and distance to rivers were obtained from topographical maps (10 m resolution) with 1/25,000 scale acquired from HGK (General Command of Mapping). Land-use data and land-use capability classes were created by making use of the map with 1/25,000 scale prepared by Survey and Project Department of the Directorate General of Rural Services. "*Buffer*" analysis, one of the tools of GIS, was utilized in determining the distance to rivers and basin belts. The boundaries of the basin protection zones were taken from IBB (Istanbul Metropolitan Municipality. A land-use map was created by using the data on CORINE (Environmental Information Coordination) 2012 land-use. Temperature and precipitation

parameters, which are the parameters of climate, were not used because there were no significant changes in temperature and precipitation within the basin boundaries. The parameters used in the weighted overlay of the basin area are shown in detail in table 1.

Raster maps were produced in 10x10 m resolution by processing the scores of the determined parameters. Then, the maps of potential areas suitable for settlement were obtained by the mapping of the related maps brought together. *"Weighted overlay"* was conducted for urban development and sieve analysis was administered in determining the suitable areas through the elimination of unsuitable areas. The areas to be excluded from urban development in sieve analysis were defined as veto areas. The values given in the analysis were based on expert opinion (city planner, environmental engineer, landscape architect, and geographer). While the criteria for settlement were given values ranging between 1 and 9 as the effect value, percentage values were given as the weight value (Table 1). This study scoring scale: High suitability: 9-6, moderate suitability (6-3) ve unsuitability (3-1)

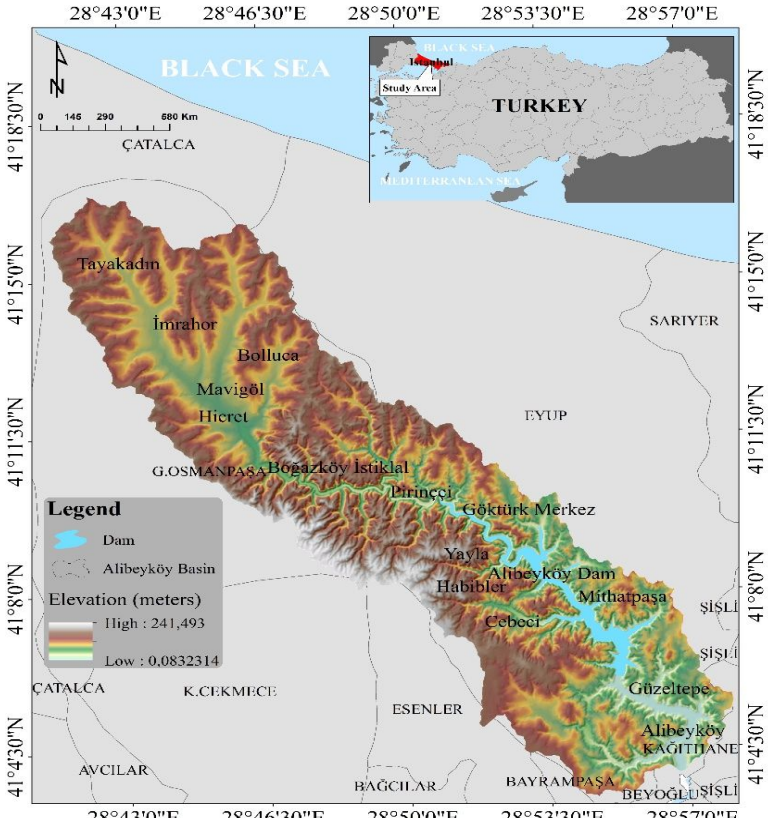

Figure 1: Location map of the research area

Basic Parameter	*Parameter*	*Rank*	*Weight influence*
Lithology (Bedrock)			20
	Alluvial	Veto	
	Andesite-Dacite	8	
	Sandstone-Mudstone	7	
	Sandstone-Mudstone-Limestone	7	
	Volcanite Deposit Rock	3	
	Slope Wash-Alluvial Cone	3	
	Conglomerate-Sandstone-Mudstone	4	
	Shale	5	
Slope (Degree)			12
	0--5	9	
	5--10	8	
	10--15	5	
	15--30	2	
	30-	Veto	
Aspect			6
	East- Southeast- Southwest -South	9	
	West	6	
	Northeast-Northwest-North	1	
	Flat	7	
Basin Zones			25
	Max Shelter Zone	Veto	
	Absolute and Short Shelter Zone	Veto	
	Medium Shelter Zone	1	
	Tall Shelter Zone	2	
Distance to Rivers (m)			10
	0-50	Veto	
	50-100	3	
	100-200	5	
	200-500	7	
	500-1000	9	
	1000-10000	9	
Land Use			**15**
	Paths, Forest, Agriculture, Pasture, Mine Settlement	Veto 9	
Land Use Capability Classes			12
	I ve II	Veto	
	III	1	
	IV	5	
	VI	7	
	VII	9	

Table 1. Parameters and weight values influential in settlement suitability analysis

3. Result

In the study, the weighted overlay was carried out by making use of lithology, slope (degree), exposure (directions), basin belts (m), distance to rivers (m), land-use and land-use capability class parameters (Figure 2).

Lithology (Bedrock); the west and south-west of the basin, 44% of its area, consisted of shale. Its east and northeast was composed of conglomerate, sandstone and mudstone. Alluvial areas, which are not suitable for settlements in terms of soil liquefaction with their rate of 5%, extend to the northwest of the basin in the form of line.

Slope (Degree); slopping areas increase from the east of the basin towards its west. The slope of 5-10˚ covers an area of 30%. The rates of 30˚ and above indicate that the sloppiness in the basin is quite low.

Aspect; 35% of the basin's area is in east, south-east, south-west and south directions. Directions are important in ecological-based designs appropriate for the basin.

Basin Zones (m); long protection belt, absolute and short protection belt, and medium protection belt in the boundaries, determined in accordance with the Regulation on Drinking-Water Basins specified in the

ISKI Law, cover an area of 54%, 19% and 18% respectively. Pirinççi Village, one of these settlements, is located within the absolute protection zone. Housing structures in the absolute-short distance protection belts and stream protection belts negatively affected the area located within the boundaries of Alibeyköy Basin.

Distance to Rivers (m); according to the results of the buffer analysis administered in the basin, the area with the highest ratio was between 500 m and 10000 m with an area of 86%. The fact of building houses at certain distances to rivers is important for protection from floods.

Land Use Capability Classes; while 56% of the basin's area is covered by forest areas, the fact that 24% of its area is covered by urban areas and these areas rapidly spread in the basin indicate that the land-use is not suitable for sustainability. In addition, the land selection by favorable industrial and agricultural areas on the streams is not appropriate for the sustainability and protection of the basin. The sprawl of residential areas towards the north of the basin threatens forest and agricultural areas.

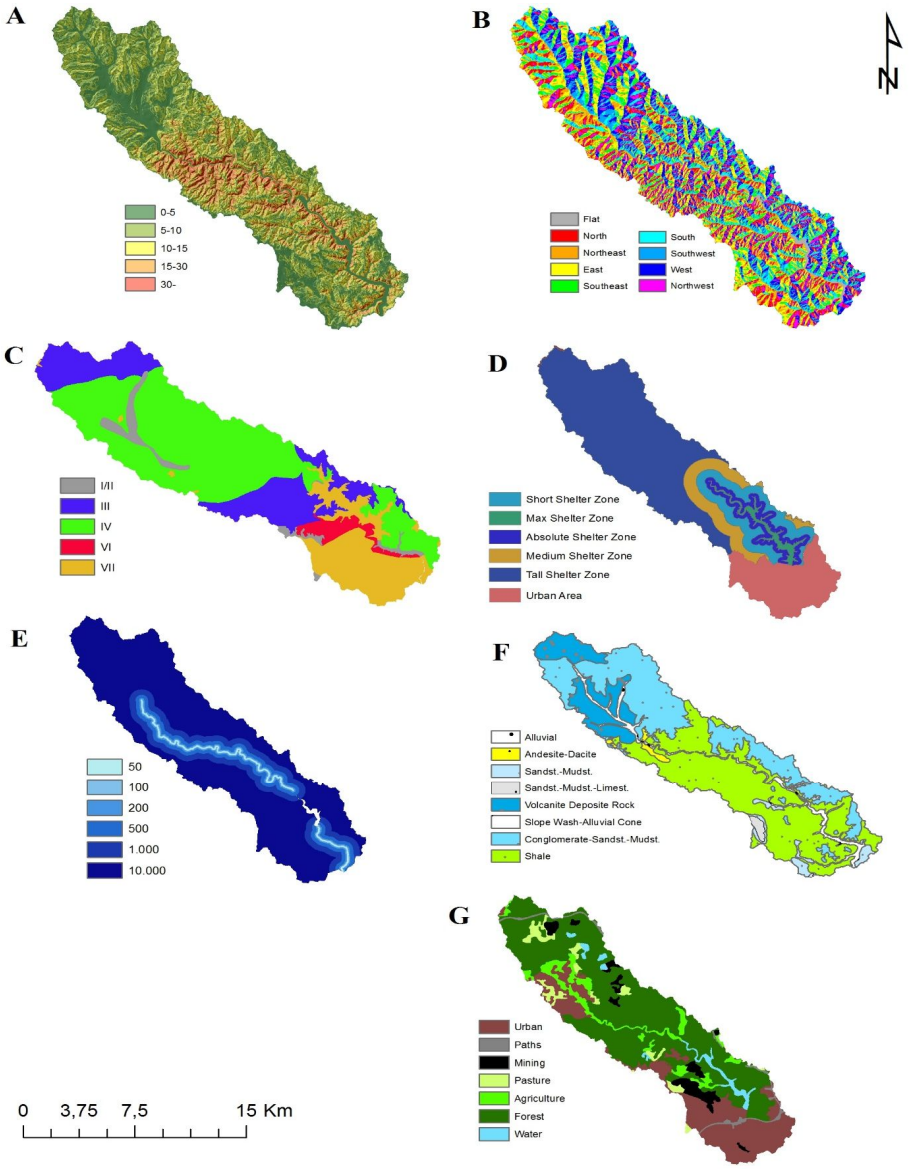

Figure 2: Alibeyköy Havzası'nın uygunluk analizinde etkili olan parametreler A) Slope (degree) B) Aspect C) Land Use Capability Classes D) Basin Zones (m) E) Distance to Rivers (m) F) Lithology (Bedrock) G) Land Usesettlements in Bursa Plain according to size of population F) Transportation in Bursa Plain G) Distance to tourist attractions in Bursa Plain (m).

52% of the area in the basin, located in the east, west and northwest, is Class IV land that is continuously used as pasture grounds as well as growing field crops. Pirinççi, Boğazköy İstiklal, Bolluca and İmrahor neighborhoods in the basin are the settlements located on the Class IV land.

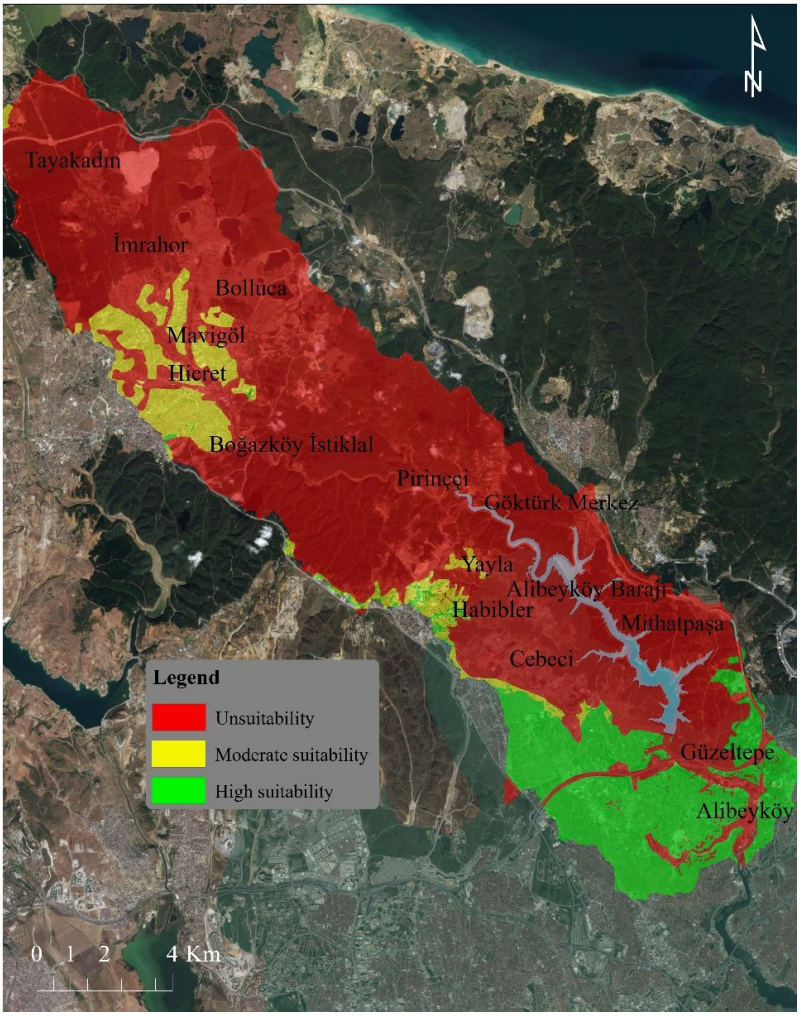

Figure 3: Suitability analysis of Alibeyköy Basin

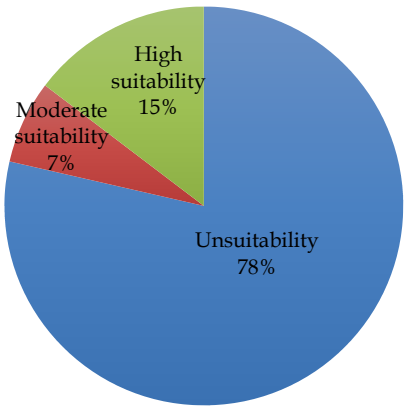

Figure 4: Spatial distribution of Alibeyköy Basin according to the results of suitability analysis.

78% of the area is not suitable for settlement according to the results of the analysis. The area of 15% consisted of suitable and quite suitable areas (Figure 3-4). The unsuitable areas in the Alibeyköy Basin generally occupy a place in the north of the basin. The southern areas of the basin are more suitable for settlement. The fact that the housing areas in the basin are not ecologically-based affected the quantity and quality of drinking-water negatively.

4. Conclusions

In the weighted overlay administered in the basin, it was discovered that 78% of the area was not suitable for settlement, 15% area was quite suitable and 7% area was either suitable or less suitable. While the unsuitable settlements in the Alibeyköy Basin are concentrated in the northern areas, the eastern and western parts of the basin are not suitable for settlement. In particular, the housing structures in the absolute and short-range protection zones and in the creek protection belts affect the basin negatively. Especially the fact that the structures in the Alibeyköy drinking-water basin also clustered in the absolute protection areas shows that the sustainability of the basin is under quite a great risk. In addition, the facilities, like Sultangazi Small Industrial Area and Organic Chemical Industry, which are not supposed to be there, are also located in the basin.

The conservation processes of the basins are greatly affected by unsuitable land-uses and urban sprawl. The significance is given to agriculture and forestry in planning in the basin. Urban planning, located within the boundaries of the basin, is being overlooked. In the watershed management process, it is necessary to plan and to control of land-use, to minimize the pollution in water resources and to direct urban sprawl towards the most suitable areas in the drinking-water basin. A rehabilitation program, which prioritizes the ecological concerns, should be initiated in the Alibeyköy Basin. The basin should be considered as a whole and together with its immediate surroundings. Open spaces should be planned within the basin and ecological corridors should be formed within the basin.

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