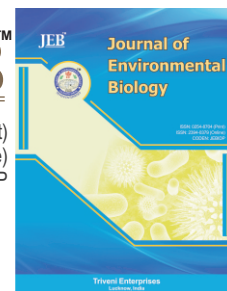




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Temporal change of land use in the Protection Basin of Tahtalı Dam (1990-2015), (Izmir, Turkey)

Authors Info

A.E. Gülersoy^{1*} and M.A. Çelik²

¹Department of Social Studies, Buca Faculty of Education, Dokuz Eylül University, Izmir, 35150, Turkey

²Department of Geography, Faculty of Arts and Sciences, Kilis 7 Aralık University, Kilis 79000, Turkey

*Corresponding Author Email : gulersoy74@gmail.com

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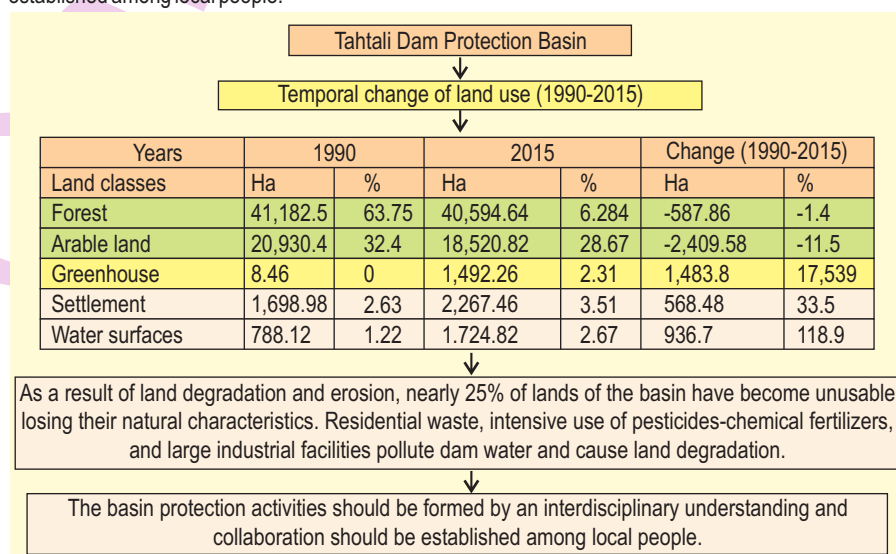
Abstract

Aim: The present study was carried out evaluate the temporal changes of land use in the Protection Basin of Tahtalı Dam in terms of sustainable use of natural resources through 1990 and 2015.

Methodology: In the study, Lands at TM satellite image dated 06.08.1990 with spatial resolution of 15 km and Lands at OLI satellite image dated 06.08.2015 were used in order to determine conditions of land use through the year 1990 and 2015.

Results: Despite a 12% decrease in cropland areas and 1.4% in forests-maquis-garrigues, a 119% increase in water surfaces, 34% in residential areas and 17539% in greenhouse areas occurred through 1990-2015 in the Protection Basin of Tahtalı Dam. There was a mismatch between the land capability classes and their use. The said situation had resulted in some disadvantages. As a matter of fact, severe erosion which was seen at the part of 54% of the basin has the impact on lands which are inclined and devoid of natural vegetation cover. There was an increase stemming from domestic and industrial wastes in parameters for chemical oxygen demand and biological oxygen demand in the basin. As a result of land degradation and erosion, nearly 25% of lands of the basin have become unusable losing their natural characteristics.

Interpretation: In order to prevent degradation, erosion and pollution, soils should be used according to the land capability classes. Cooperativation should be encouraged for a continuous and planned marketing in the basin, and alternative sustainable economic activities should be promoted. Furthermore, basin protection activities should be formed by an interdisciplinary understanding and collaboration should be established among local people.



Introduction

Improvement attempts of developing countries such as Turkey in particular as well as increasing population and needs within natural environment-human activities are ever increasing pressure on sources of natural environment (Öztürk *et al.*, 2002; Goudie, 2006; Atalay and Efe, 2010; Efe *et al.*, 2012; Efe *et al.* 2013; Gülersoy *et al.*, 2015; Gülersoy and Çelik, 2015). Plain and middle inclined areas suitable for agriculture make up 21% of the farm land in Turkey. Within this scope, it is understood that areas such as the Protection Basin of Tahtalı Dam (the percentage of plain and middle-inclined lands suitable for agriculture, 36%) have an important role for the country's economy in terms of agricultural and water demand. Tahtalı Dam Protection Basin meets 34% of Izmir's water demand.

Although dams are largely regarded as environment-friendly and renewable resources, they lead to shrinkage of agricultural lands, siltation, ecosystem problems, and migration (Strahler and Strahler, 2006; Sönmez, 2012). Despite the downsides, dams are built to meet the demand for drinking-potable water by the growing number of people living especially in cities. It is a fact that the economic lives of dams are likely to come to an end in less than 100 years (Strahler and Strahler, 2006). Preventing siltation and pollution of dams is only possible through the engagement of local population in basin protection efforts and the employment of a suitable land use method (Ghimire and Pimbert 1997; Ay, 2001; Manyari and Carvalho, 2007).

Materials and Methods

Purpose of this study is to evaluate temporal changes of land use in the Protection Basin of Tahtalı Dam in terms of sustainable use of natural resources through 1990 and 2015. In the study, we used Landsat TM satellite image dated 06.08.1990 with spatial resolution of 15 m and Landsat OLI satellite image dated 06.08.2015 in order to determine conditions of land use through the years of 1990 and 2015. Controlled classification was applied to satellite images in Erdas Imagine software. The images which were classified by applying "Maximum Similarity Method" were composed of 150 classes at first. Later, the recorded images were reduced to 4th class on satellite image of the year 1990 and to 5th class on satellite image of the year 2015, and then land use maps of the Protection Basin of Tahtalı Dam for the years 1990 and 2015 were created. These classes were determined as forest, cropland (field), greenhouse (only for 2015), residential areas and water surfaces. In the study, accuracy analyses were performed on the data produced by "maximum similarity method" from Landsat TM satellite images of the years 1990 and 2015. Accordingly, while accuracy rate of the image belonging to 1990 is 0.85 by kappa coefficient, that of 2015 is also 0.85 (Fig. 2). These obtained data are an indication of the fact that classification is at a level which may be deemed valid (Gülersoy, 2013).

Study area: Located at the central part of the Coastal Aegean Subdivision in the Aegean Region of the Western Turkey, the Protection Basin of Tahtalı Dam is in between highlands where western and southern slopes of Mount Nif (1510 m.) on the

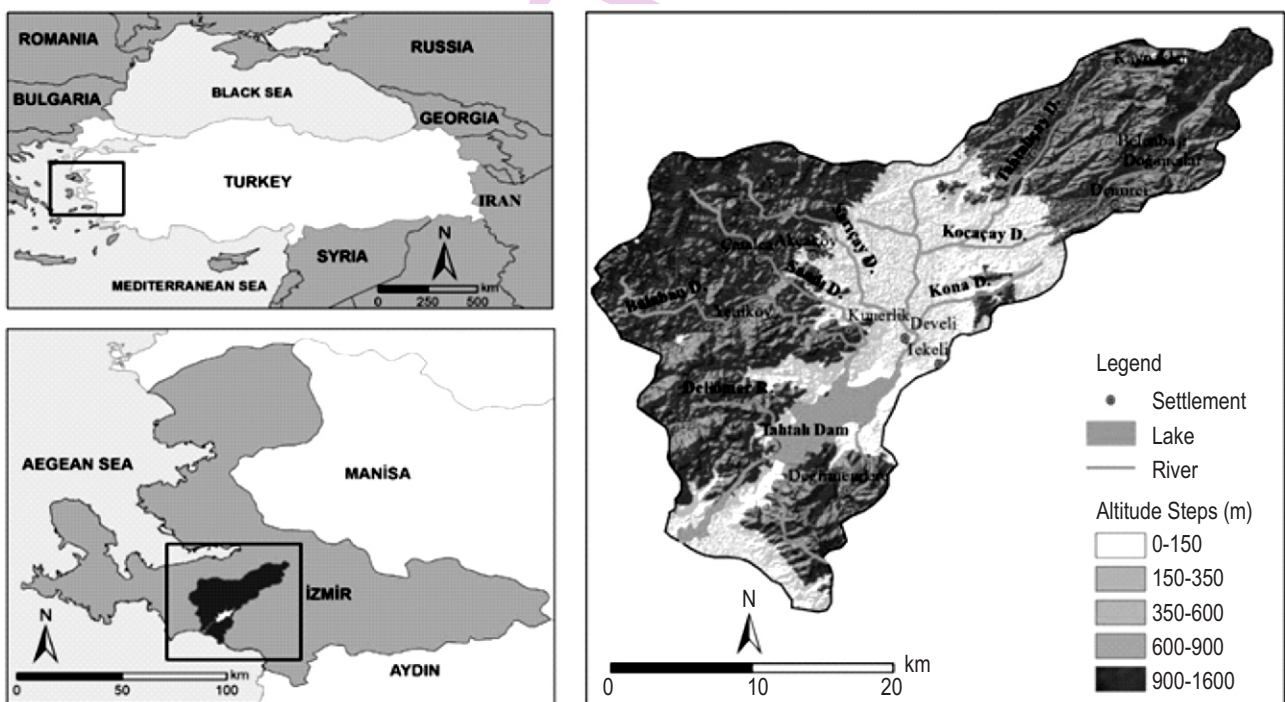


Fig. 1 : Location map for the Protection Basin of Tahtalı Dam

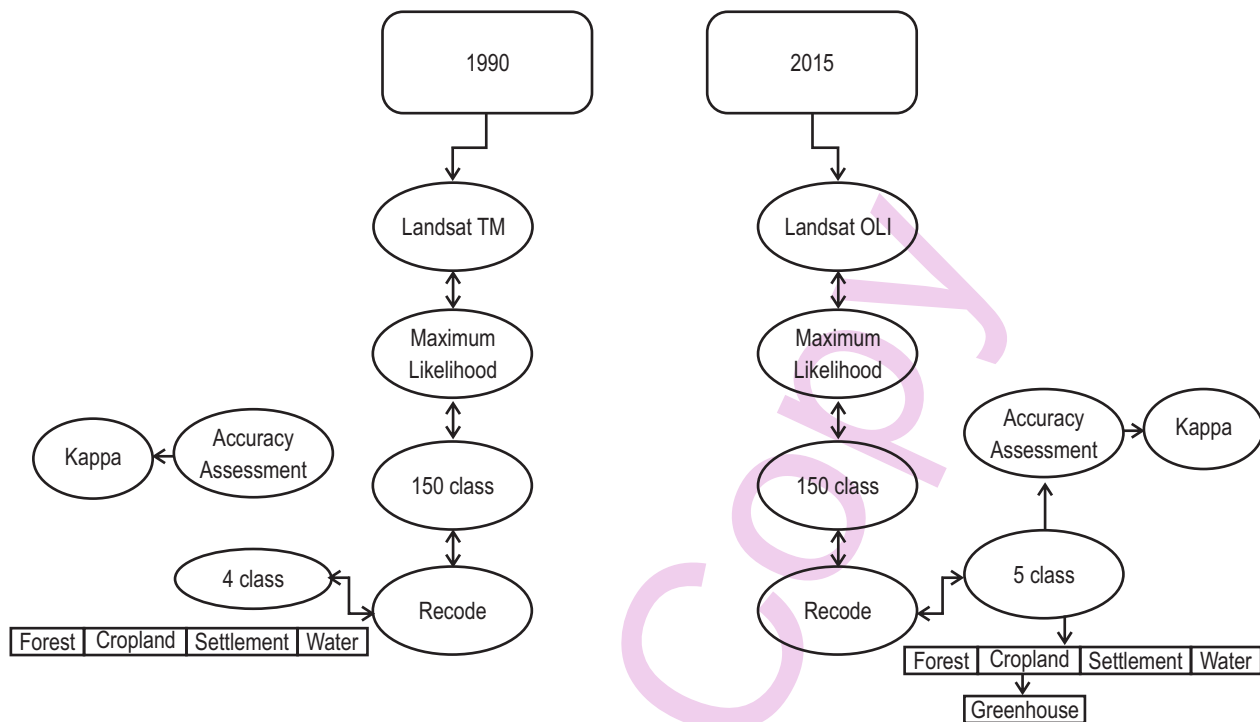


Fig. 2 : Producing stages of land use maps (1990, 2015) for The Protection Basin of Tahtalı Dam

northeast connects with Buca ridges, and Çatalkaya slopes on the west, Gümüldür-Tahtalı strait on the south and Little Meander (Küçük Menderes) plains on the east. While 69% of the basin remains within the borders of Izmir province, this big part is located within the administrative areas of Menderes district; 19% within Buca; 4.4% within Gaziemir; 3% within Kemalpaşa; 2.4% within Torbalı; 2% within Karabağlar; and 0.2% within Seferihisar. The basin covers an area of 646 km², and is drained by Tahtalı Streamlet and its tributaries (Fig. 1).

Results and Discussion

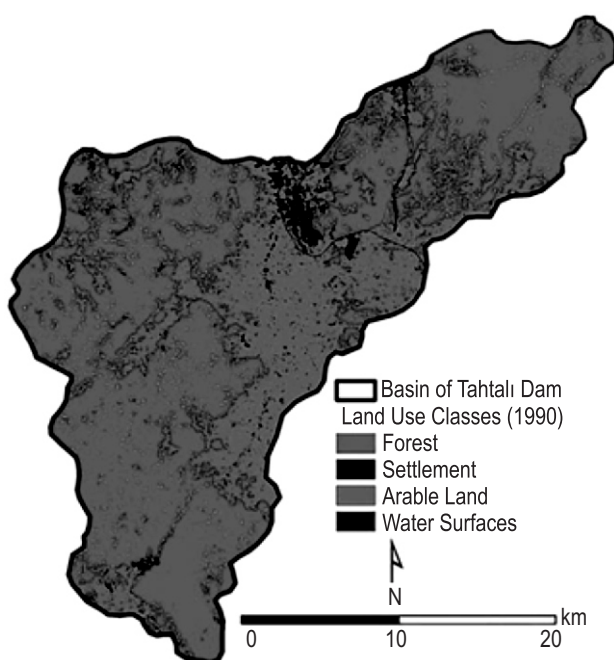
Land use (1990): In 1990, 64% of lands in the Protection Basin of Tahtalı Dam constituted the forest areas, 32% agricultural areas, 3% residential areas, and 1% of water surfaces (Table 1; Fig. 3). Maquis and garrigue plant formations constitute 30% of the forest areas. Seventy six per cent and 24% of agricultural areas were used as dry farming area and irrigated farming area, respectively. In the research field, the meadow-pasture areas occupying a small space (2%) increased the pressure on forest-maquis. In the 3% area of the basin, residential, tourism, industry and mining activities were carried out. Together with Tahtalı Streamlet and its tributaries as well as ponds on them, the lower part by which the dam had begun to retain the water (construction started in 1986) constituted water surfaces which form 1% of the area.

Forest areas (62.8%) in the Protection Basin of Tahtalı Dam showed distribution on mountainous-hilly areas surrounding the base of the basin over 6th and 7th class lands in general on the

inclined areas (incline rate is 10-15%) where metamorphic rocks (marble, schist), flysch, limestone, marl, and vulcanite had a wide coverage. In the basin, maquis-garrigues in residues, which was the result of the destruction, had an extensive coverage over 6th and 7th class lands. Seventy six per cent of agricultural lands were used as dry farming area (grain, olive, vineyards, and etc.). Dry farming areas showed distribution in almost every part of the basin over 1st, 2nd, 3rd, and 7th class lands. In 1990, irrigated farming activities were carried out in the 24% of agricultural areas. Irrigated farming activities being intense over 1st, 2nd, 3rd, and 4th class lands were performed on the base of the basin and along-valley where incline value was less than normal (the incline was 0-5%). Irrigated farming areas showed distribution around Tahtalı Streamlet and its tributaries, and around Cumaovası. Irrigated farming activities were based largely on underground watering. In the study area in 1990, production of grain (36%) and grape (26%) were frequent. Olive (14%) has been a preferred agricultural crop in the basin from past to present. Olive grove areas had a wide coverage on the Neogene sediments, colluvial deposits, and the flysch. Production of tobacco (10%), vegetables (6%) and cotton (5%) relatively maintained former importance in the basin (Buca, Gaziemir, Menderes, Torbalı district Agriculture directorates, 1990; Ay, 2001). Greenhouse areas appeared in a quite limited area (1%) and agricultural production in these greenhouses was performed to meet the needs of Izmir metropolis. While pasture areas did not have a wide coverage (2%) in the basin, deficiency of pasture areas caused forest, maquis areas, and olive groves to be used as the grazing land,

Table 1: Land use situation in the Protection Basin of Tahtalı Dam (1990)

Forms of land use	1990	
	ha	%
Forest	41.182,5	63.75
Arable land	20.930,4	3.4
Greenhouse	8,46	0
Settlement	1.698,98	2.63
Water surfaces	788,12	1.22

**Fig. 3 :** Map for land use of the Protection Basin of Tahtalı Dam (1990)

and this accelerated land degradation. Pasture areas showed distribution on the sloped areas surrounding the base of the basin, on 7th and 6th class lands which were devoid of trees and underbrush, and on 1st, 2nd, 3rd class lands which should be used as agricultural areas. Residential, tourism, industry and mining activities were carried out in the 3% of the basin. Residential areas appeared over 2nd, 3rd, 6th and 7th class lands, in general. In the Protection Basin of Tahtalı Dam where 41.270 people used to live by the year 1990, Menderes (6799 people), Sarnıç (4184 people), Tekeli (2382 people), Bulgurca (2237 people), Değirmendere (2227 people), Görece (2080 people), Kaynaklar (1946 people) and Oğlananası (1935 people) were among the important settlement centers (TÜİK, 1990).

Land use (2015) : In the present day, an important part of lands constitutes the forest-maquis-garrigues(62.8%) and agricultural areas (31%) in terms of usage in the basin. In the basin which is located in the hinterland of Izmir, metropolitan residential areas cover a space (3.5%) larger than the average of Turkey (1%). However, water surfaces constitute 2.7% of the basin depending on the presence of Tahtalı Dam (Table 2; Fig. 4).

According to the regulation prepared by İZSU (Izmir Water and Sewerage Administration General Directorate) for Tahtalı Dam Basin, in horizontal distance beginning from maximum water level, 0-300m was determined as absolute protection area (15km²), 300-1000m as short-distance protection area (28km²), 1000-2000m as middle-distance protection area (34km²), over 2000m as long-distance protection area (453km²), and 0-100 m (28km²) as absolute protection area of rivulet (Barış, 2008; İZSU, 2016).

In the research area, dry farming has been performed in the 56 % of agricultural lands. Protection status of the research area has brought dry farming activities (grain, particularly olive) and green housing (organic agriculture/farming) into the forefront. Dry farming areas show distribution in almost every part of the basin over lands of 1st, 2nd, 3rd, and 4th classes. In the basin, irrigated farming and greenhouse areas (44%) are getting larger day by day. Irrigated farming activities which are intensively performed over 1st, 2nd, 3rd, and 4th class lands are being conducted on the base of the basin and along-valley where the incline value is low. In this protection basin, irrigated farming activities are generally based on the underground watering (irrigation). Olive-grove areas (22% of agricultural areas) appear on the base of the basin and over colluvial and Plio-Quaternary deposits on the sides of the basin, in general. Also in the destroyed forestry area, olive groves, together with the Maquis, could be encountered.

According to the agricultural land use in the Protection Basin of Tahtalı Dam, the first place is taken by cropland (field) areas (56%) followed by olive-grove areas (22%), planted areas (10%), vegetable areas (7%), and greenhouse areas (5%). Among croplands, wheat, barley (36%), corn (11%), tobacco (2%), cotton (1%), and forage plants such as *Vicia sativa*, clover, etc. are at the forefront (Buca, Gaziemir, Menderes, Torbalı district Agriculture directorates, 2015). Olive-grove areas (6% of the basin and 22% of agricultural areas) have a wide coverage over Neogene sediments, colluvial deposits and flysch. Among planted areas, agriculture for fruit, vineyard, citrus etc. are at the forefront. Plantation of grapevine and fruit has accelerated in the upper parts of the basin through promoting organic farming during the recent years. As for vegetable fields, production of watermelon, pepper, tomato, artichoke, and melon is important.

Table 2 : Land use situation in the Protection Basin of Tahtalı Dam (2015)

Forms of land use	2015	
	ha	%
Forest	405.94,64	62.84
Arable land	18.520,82	28.67
Greenhouse	1.492,26	2.31
Settlement	2.267,46	3.51
Water surfaces	1.724,82	2.67

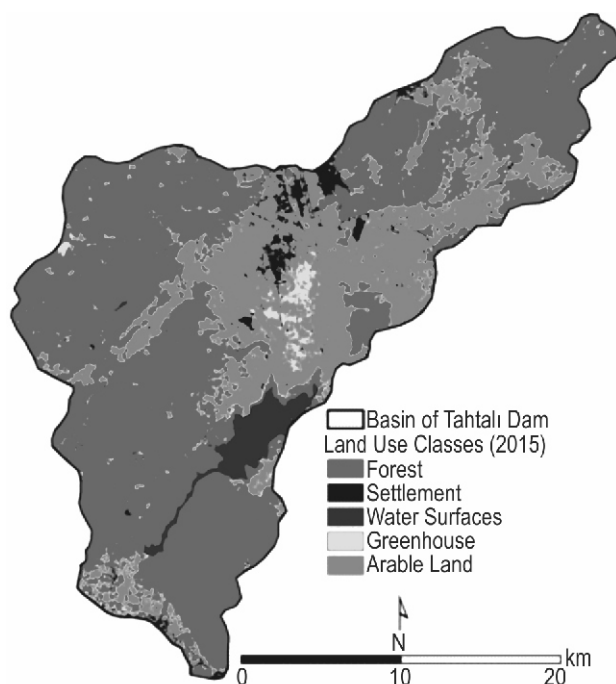


Fig. 4 : Map for land use of the Protection Basin of Tahtalı Dam (2015)

Within the scope of protection activities in the basin, permission for dry farming and ecological agriculture has led to increase green housing activities as well as dry farming in short-, middle-, and long-distance protection areas. In general, cucumber, lettuce, rocket, parsley, tomato, bean, purslane, and cress are grown in the greenhouses which constitute 5% of agricultural areas in the basin (8.2km²). As for the cut-flower production, clove and rose are at the forefront.

Forests (62.8%) in the Protection Basin of Tahtalı Dam show distribution on mountainous-hilly areas surrounding the base of the basin over lands of 6th and 7th classes in general on the inclined areas (incline rate is 10-15%) where metamorphic rocks (marble, schist), flysch, limestone, marl, and vulcanite have a wide coverage. In the study area, intensive calabrian pine (*PinusBrutia*Ten.) communities are seen particularly on north- and west-facing slopes of mountainous areas, depending on suitable humidity conditions. Generally starting from 250-300m altitude in the basin and being able to rise up to 800-900m in mountainous-hilly areas, calabrian pines are present in mixed with the Maquis, oak species, and hygrophilous species in inner parts of the valley. Over this altitude, black pines (*PinusNigra*) start to be seen. Calabrian pines were heavily destructed around residential areas. In these areas where forest areas were turned into maquis-garrigue areas or agricultural lands, bare surfaces devoid of vegetation cover can be encountered (Çukur, 1998). As a matter of fact, calabrian pines are densely seen on high plains at 1000-110m, on the east slopes of Mount Tekke (1017m) which is

in the northwestern of the basin out of human impact, and on the west slopes of Mount Nif (1446m) which is in the northeastern of the basin. Around Künerköy Village, stone pines (*Pinuspineae*) show distribution over volcanic sands (Çukur, 1998). Black pines (*Pinusnigra*) communities grow and develop at the altitude of 850-900m (on the west slopes of Mount Nif and east slope of Mount Tekke) and can be seen up to the altitudes at which mountain steppes are present. Forestry areas in the Protection Basin of Tahtalı Dam, in general, appear over lands of 7th (55%) class and 6th (25%) class. In the basin, it is possible to encounter maquis-garrigue areas (30%), which is the result of the destruction in pieces. The maquis-garrigue can begin from 150-250m in general and go up to 650-700m. Ryegrass, sandalwood, terebinth, kermes oak, phillyrea, prickly juniper, arbutus, cistus creticus, leaved cistus are encountered up to 500m, on a relatively less high hilly areas in the northeastern of Menderes and in the other parts of the basin (Koçman, 1989). To come across maquis-garrigue in lands of 7th class which should be the forest area in the basin is striking with regards to dimension of land degradation (Özturk, 1995, 1999; Feoliet *al.*, 2003) in the basin (Fig. 4, 5 and 6).

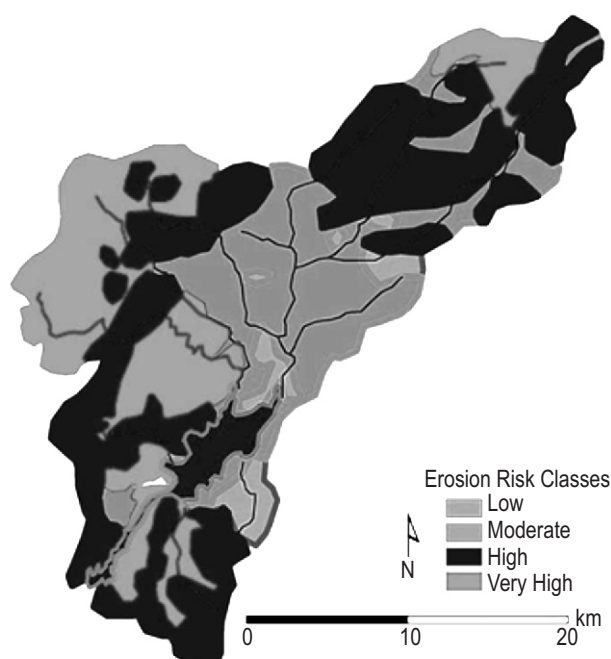
Pasture areas constitute only 2% of the basin. They show distribution on the sloped areas surrounding the base of the basin, on 6th and 7th class lands which are devoid of tree and underbrush, and on 1st, 2nd, 3rd class lands which should be used as agricultural area. In the areas which should be covered with absolute vegetation and the incline has exceeded 10%, excessive and early grazing has caused erosion to aggravate. There is no compatibility between pasture areas and existing animal presence in the basin. Deficiency of pasture areas has caused forest, maquis areas and olive groves to be used as the grazing land, and this has accelerated land degradation (Fig. 5).

In 3.5% of the basin, residential, tourism, industry and mining activities are realized. Residential areas appear over 2nd, 6th, 3rd, 7th, 4th, and 1st class lands. Having witnessed to settlement for nearly 4000-5000 years, the Protection Basin of Tahtalı Dam has hosted 94.649 people by the year 2015. The Menderes county town (35.540 people), Sarnıç (25 427 people), Görece (7590 people), Tekeli (2823 people), Küner (2227 people), Develi (1994 people), Bulgurca (1821 people), Çileme (1790 people), Oğlananası (1782 people), Çamönü (1695 people), Değirmendere (1589 people), Kırklar (1520 people) and Kaynaklar (1248 people) neighborhoods are important settlements in the basin (TÜİK, 2015). Settlement in the basin begins from the base of the basin and can be able to go up to 440m (Doğancılar Neighborhood). In the study area, it is seen that half of the settlements (52%, 14 settlements) appear on the base of the basin, 33% (9 settlements) on the skirt plains, and 15% (4 settlements) on the mountain slopes.

Temporal change of land use (1990-2015) : Despite a 12% decrease (2410ha) in cropland areas and 1.4% (588ha) in forest-

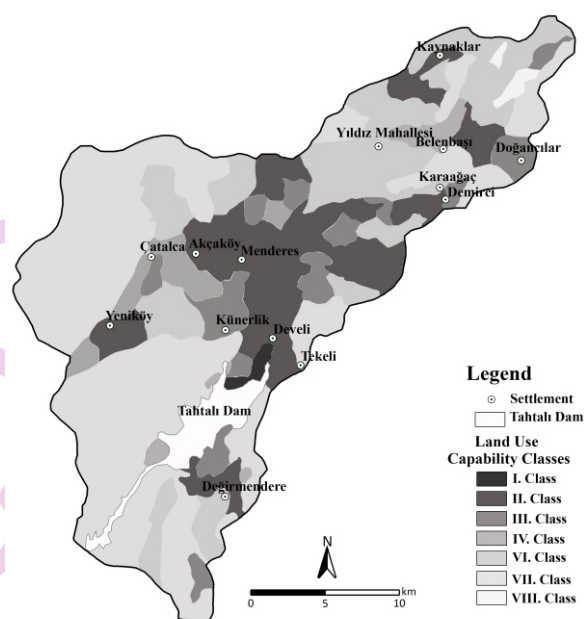
Table 3 : Temporal change of land use in the Protection Basin of Tahtalı Dam(1990-2015)

Years	1990		2015		Change (1990-2015)	
	ha	%	Ha	%	Ha	%
Forest	41.182,5	63.75	40.594,64	6.284	-587,86	-1.4
Arable land	20.930,4	32.4	18.520,82	28.67	-2.409,58	-11.5
Greenhouse	8,46	0	1.492,26	2.31	1.483,8	17.539
Settlement	1.698,98	2.63	2.267,46	3.51	568,48	33.5
Water surfaces	788,12	1.22	1.724,82	2.67	936,7	118.9

**Fig. 5 :** Erosion map in the Protection Basin of Tahtalı Dam

maquis areas, a 119% increase (938 ha) in water surfaces and 34% (569ha) in residential areas occurred through 1990-2015 in the Protection Basin of Tahtalı Dam (Table 3, Fig. 3 and 4). A 17539% increase (1484 ha) happened in greenhouse areas (in 1990, only 8.46 ha, 0.01%). Decrease in cropland areas is associated with the beginning of Tahtalı Dam to retain water (the year 1996) and expanding residential areas.

Decrease in forest-maquis areas is associated with intensive destruction by the people in the vicinity as well as the beginning of Tahtalı Dam to retain water (the year 1996) and expanding residential areas. Increase in greenhouse areas is due to promoting dry farming and green housing within the scope of protection activities. The increase in water surfaces is associated with occupying cropland, forest, and partly residential areas by dam's water along with beginning of Tahtalı Dam to retain water (1986-1996). Expansion in residential areas is related to the unearned income-purpose housing (number of illegal dwelling-house is over 5000) and the construction of new industrial-commercial facilities, as well as increasing population through

**Fig. 6 :** Map of land capability classes in the Protection Basin of Tahtalı Dam

birth and domestic migration. As a matter of fact, through 1990-2015, population of the basin increased 129% (53.379 people).

This paper was aimed to evaluate temporal change of land use in the Protection Basin of Tahtalı Dam in terms of sustainable use of natural resources through 1990 and 2015. Despite a 12% decrease in cropland areas and 1.4% in forest-maquis areas, a 119% increase in water surfaces, 34% in residential areas and 17539% in greenhouse areas occurred through 1990-2015 in the Protection Basin of Tahtalı Dam.

There is a mismatch between the land capability classes and their use (Fig. 4 and 6). Indeed, in the basin, agriculture (18%) has been carried out in non-arable 6th, 7th, and 7th class lands and there have been settlement areas (2%). Some part of arable lands of 1st, 2nd, and 3rd, and 6th has been used as settlement areas. Four per cent of 1st, 2nd, and 3rd, and 6th class lands submerged under the dam's water. The said situation has resulted in some disadvantages. As a matter of fact, severe erosion which is seen at the part of 54% of the basin has the impact on lands which are

inclined and devoid of natural vegetation cover (Fig. 5). There is an increase stemming from domestic and industrial wastes in Parameters for Chemical Oxygen Demand and Biological Oxygen Demand in the basin (Selçuk and Elçi, 2008). As a result of land degradation and erosion, nearly 25% of lands of the basin have become unusable losing their natural characteristics.

In order to prevent degradation, erosion, and pollution, soils should be used according to the land capability classes (Atalay and Gündüzoğlu, 2015). In the basin, agriculture of xeromorphic species which consume less water instead of those which need plenty of water should be carried out (Fig. 6). Chemical fertilizer/insecticide use in agricultural areas, industrial facilities and development of canals&sewages to the dam through rivulets, including the Menderes county town, which all are essential pollutant elements of the dam's water, should be prevented. Cooperativation should be encouraged for a continuous and the planned marketing in the basin (Gülersoy, Gümüş and İlhan, 2014), and alternative sustainable economic activities should be promoted. Furthermore, basin protection activities should be formed by an interdisciplinary understanding and collaboration should be established among local people.

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