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Ecological Impact Assessment in Urban Development Areas: The Case of Niğde Orhan Batı and Tevfik Streets

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A B S T R A C T

While the cities formed with their natural and cultural values were shaped to the extent allowed by the natural climate conditions in the historical process, the pressures on the traditional character of the cities and natural landscapes have increased as a result of the technological developments and changes that have arisen with the increasing human activities along with the population increase. Urban development areas have emerged around the traditional settlements, resulting in the destruction of natural water resources, pasture, agriculture and forest areas. As a result, this negative impact on the local economy, as well as the ecological balance in the natural landscape surrounding the cities, negatively affects the regional and national economy at the upper scale. Within the scope of the research, NDVI analysis was carried out to determine the effect of urban development areas in the Orhan Batı and Tevfik Çalın Streets connecting the Niğde Central and Bor districts to the green areas and the change in the land cover was created by spatial maps. In addition to NDVI analysis, water permeability of soil and rock structure was determined in order to determine the effect of urban development areas on Groundwater recharging and the effect of Groundwater recharging status and urban development areas on Groundwater recharging with the weighted method of registration were determined and suggestions have been developed in order not to adversely affect natural landscape areas.

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Introduction

With natural resources, technological development and change in the world, it is very important for catching this change especially for developing countries to make use of the resources more effectively and to ensure its continuity. The need for food, water, fuel and other natural resources continues to increase as long as the population increases globally and economic and commercial activities continue to develop. In recent years, due to the increase in the need for natural resource use, the issue of efficient use of resources, ensuring continuity and transferring to future generations is frequently on the agenda in national and international platforms.

The cities, which are formed with natural and cultural values, are experiencing a rapid change and transformation process with today's changing needs and technological interventions resulting from human activities. Urbanization, together with social and cultural benefits for people on the one hand, while providing an obligation to live in an artificial and unhealthy environment. Especially in Turkey, urbanization rate reaches high values in recent years. It is very difficult to talk about healthy ecological balances in a rapidly urbanized system. The social and economic problems that arise with insufficient and inaccurate environmental policies cause the loss of green areas due to the non-sustainable building, the occupation of the land and the disruption of the cultural environmental protection Works (Melchert, 2005). In addition, the increasing population increases the destruction of the green area.

In recent years, urban development activities have accelerated in Niğde, which is one of the developing cities and the population has increased recently and the urban migration rate is high. In Niğde City, there is 0.07% increase in 2014 (343.898 ha), 0.64% increase in 2015 and 1.55% increase in 2016, whereas in 2017 (352.727 ha) there is 0.36% increase. If the population of the city continues to increase at this rate, it is estimated that this ratio will rise to about 3.09% in the 2050s (Anonymous, 2018). The need for space with population growth increases the use of areas with high fertile and groundwater recharging. This causes the destruction of natural flora and fauna habitats. In order to continue the cultural and economic activities without interruption, the ecological balance must be maintained and maintained (Luck et al., 2009), Byron et al., 1999, Millennium Ecosystem Assessment, 2005). However, the unconscious natural resource use of societies causes many environmental problems and natural disasters in today's conditions. The use of renewable energy sources, landscape ecology and ecosystem balance have been neglected in the use of natural landscaping elements (air, water, soil, vegetation and animal presence etc.) especially in urban development areas (İlke et all., 2011).

The Importance of Research Area

The study area is a bridge connecting the Niğde Merkez and Bor districts. In accordance with the article "Endemic Bird Species and Population Hosting", which corresponds to the 2nd Criteria of the Ramsar Convention by the Ministry of Environment and Forestry within the boundaries of the study area, Akkaya Dam is declared as the "Wetland of International Importance" in 2005. In addition, it is an important natural landscape area in which biological species of species and varieties (405 taxa belonging to 74 families and 262 genera) (Başköse et al., 2012) and migratory birds are accommodated. However, despite the biodiversity and productivity, Akkaya Dam and its close vicinity are close to the organized industrial zone and as a result of the contaminated waste, natural ecosystems as well as the fruit and vegetable gardens and pasture areas in the region; Therefore, it is known that human health is affected negatively. The study area, in addition to the natural landscape values, is the livelihood of agricultural areas and other vineyard-garden areas, which are the livelihood of a large part of the local population living in Niğde, and the boundaries of the Niğde Urban Forest, which is the most preferred recreation area for individuals. It is chosen because it is located on a very important highway route which connects Kayseri-Niğde-Ankara-İstanbul provinces.

The study area has rich biodiversity and significant habitats in terms of flora and fauna. For this reason, the protection of the area without damaging the natural structure, to create high-quality green areas for people living in the city and to provide access to services by local people; to improve and expand the infrastructure of the city, to provide transportation with ecological solutions and repair works that do not break the green areas, to develop the habitat areas in the city and in the urban wall, to prevent the deterioration of the landscape functions, to protect the cultural structure of the city and to ensure the sustainability. Within the scope of the research, the geological and hydrological structure of the study area has been determined in order to determine the effect of urban development areas on the natural landscape; The change in the amount of green space has been determined and suggestions have been developed in order to ensure the preservation and continuity of the natural landscape.

Material and Method

The main material of the study is the urban development area in Orhan Batı and Tevfik Çalın Streets which connects the Niğde Central and Bor districts. In the scope of the research, numerical, verbal and visual data provided for collecting, analysing and evaluating the data constitute the other materials of the study. These:

- Google Earth 2018 satellite images of Orhan Batı and Tevfik Çalın Streets and its immediate surroundings,
- Landsat 8 OLI / TIRS satellite images for August 2018 with the Landsat 4-5 TM satellite image in June 2000,
- General Directorate of Mineral Research and Exploration, Earth Sciences 1/25.000 scale geological formation map,
- Republic of Turkey, The Ministry of Agriculture and Forestry, Department of Geographical Information Systems 1/25.000 scale soil map,
- The Ministry of Environment and Urbanization, Kırşehir-Nevşehir-Niğde-Aksaray Planning Region 1/100.000 Scale Environmental Plan,
- National literature data on theoretical foundations, methods and research findings.

In order to evaluate the ecological effect in the field of urban development, the method of landscape planning approaches based on national and international geographic information systems were examined and a study consisting of 6 stages was carried out (Table 1).

Table 1. Stages of the research

Stage	Scope	Explanation
1. Stage	Determination of the scope, purpose and scope of the research area	Niğde "Tevfik Çalın Streets
2. Stage	Literature review and ınventory collection	Compilation of data on theoretical foundations, methods and research findings
3. Stage	Determination of method	Determination of land cover change Determination of groundwater change
4. Stage	Production of geographic database	Determine the location of the Research Area (Google Earth 2018 satellite image) Height Model (DEM) Landsat 4-5 TM and Landsat 8 OLI / TIRS Satellite Images 1/25.000 Scale soil map 1/25.000 Scale geological formation map 1/100.000 Scale environmental plan
5. Stage	Analysis	Normalized Difference Vegetation Index (NDVI) Analysis, CORINE land cover controlled classification of 2000 and 2012, Groundwater recharging analysis
6. Stage	Evaluation & Conclusion	Ecological impact assessment in urban development areas

Orhan Batı and Tevfik Çalın Avenue; it is the most intensively used way connecting the Central and Bor districts of Niğde. In the study on theoretical foundations and the study area; for the purpose of literature review and collecting of inventories, national and international literature data and visual data such as maps were used. In order to provide a base for the study, numerical elevation model (DEM) and relief map were created in geographic information system environment. Within the scope of the study, spatial and written data were used with the use of Landsat 8 OLI / TIRS satellite images with ArcGIS 10.2 and Landsat 4-5 TM from the geographic information systems software for the purpose of evaluating the ecological impact in urban development areas, and the change in land cover was formed by spatial maps. In addition to NDVI analysis, water permeability of soil and rock structure was determined in order to determine the effect of urban development areas on groundwater recharging, and the effect of groundwater recharging status and urban development areas on groundwater recharging was determined by weighted registration method.

Research Findings

In the research findings section, the effect of urban development areas on green areas and groundwater recharging was determined.

Determination of the Effects of Urban Development Areas on Green Areas

In geographic information systems and remote sensing technologies, the use of indexes which are aimed to determine green areas are frequently mentioned in national and international platforms. The most important and practical method developed for this purpose is the Normalized Difference Vegetation Index (NDVI) (Doğan at al., 2014). NDVI is a standardized index allowing you to generate an image displaying greenness (relative biomass). This index takes advantage of the contrast of the characteristics of two bands from a multispectral raster dataset the chlorophyll pigment absorptions in the red band and the high reflectivity of plant materials in the near-infrared (NIR) band (ESRI, 2016).

The documented and default NDVI equation is as follows:

$$NDVI = ((IR - R)/(IR + R))$$

IR = Pixel values from the infrared band
R = Pixel values from the red band

This index outputs values between -1.0 and 1.0, mostly representing greenness, where any negative values are mainly generated from clouds, water, and snow, and values near zero are mainly generated from rock and bare soil. Very low values (0.1 and below) of NDVI correspond to barren areas of rock, sand, or snow. Moderate values (0.2 to 0.3) represent shrub and grassland, while high values (0.6 to 0.8) indicate temperate and tropical rainforests (ESRI, 2016). In the scope of the research, in order to determine the effect of urban development areas in Orhan Batı and Tevfik Çalın Avenue and its surrounding areas on the green areas, the Landsat 4-5 TM image of June 2000; NDVI analysis was performed using close infrared (band 4) and red (band 3) combinations; In the Landsat 8 OLI / TIRS satellite image of August 2018, NDVI values of the study area were determined using close infrared (band 5) and red (band 4) combinations (Figures 1 and 2).

As a result of the analysis of June 2000; NDVI was found to be between 0.9 and -0.9. NDVI map was divided into two categories as rock, sand or barren areas (-0.9 - 0.2) and green areas (0.3 - 0.9) and the area (ha) was calculated. As a result of the analysis of August 2018; The NDVI value was found to be between 0.6 and -0.3. NDVI maps were divided into two categories as rock, sand or barren areas (-0.9 - 0.2) and green areas (0.3 - 0.9) and their area (ha) was calculated (Table 2). While the amount of green areas in the study area was 10696 hectares; In 2018, due to urban development, the amount of green areas decreased by 45% and decreased to 5875 hectares.

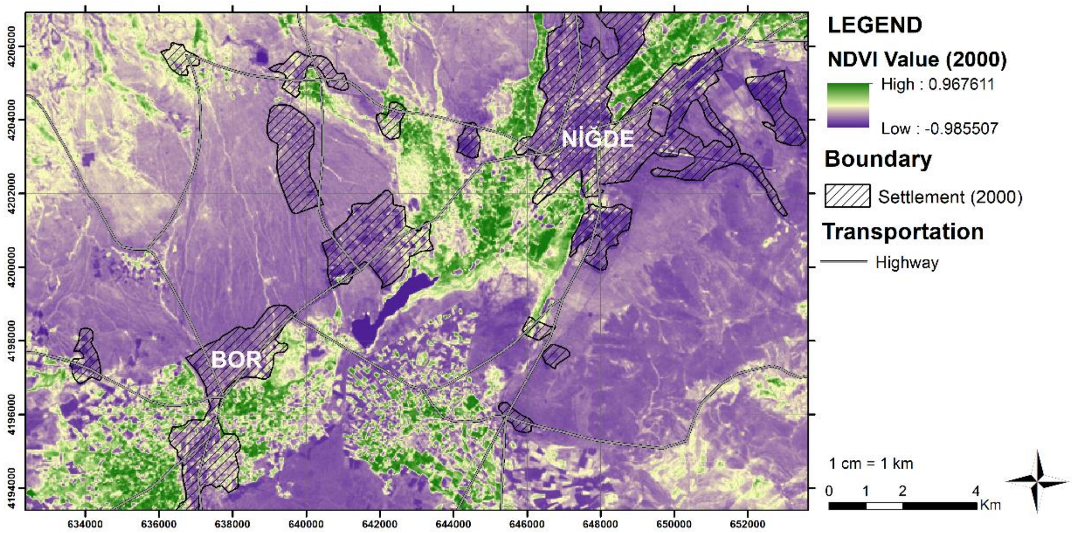

Figure 1. Niğde Orhan Batı and Tevfik Çalın streets ecological impact assessment in urban development areas NDVI analysis in 2000 (Original, 2019)

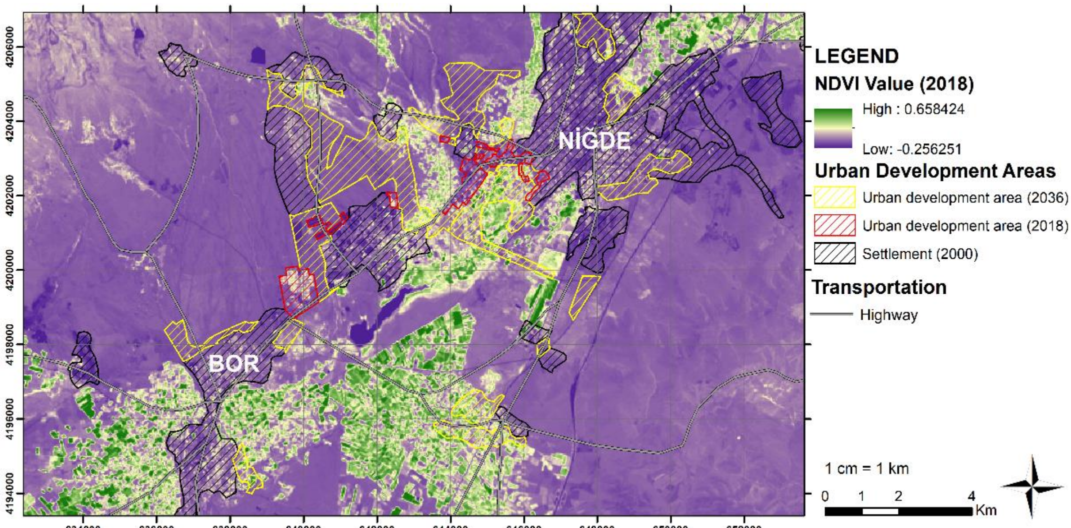

Figure 2. Niğde Orhan Batı and Tevfik Çalın streets ecological impact assessment in urban development areas NDVI analysis in 2018 (Original, 2019)

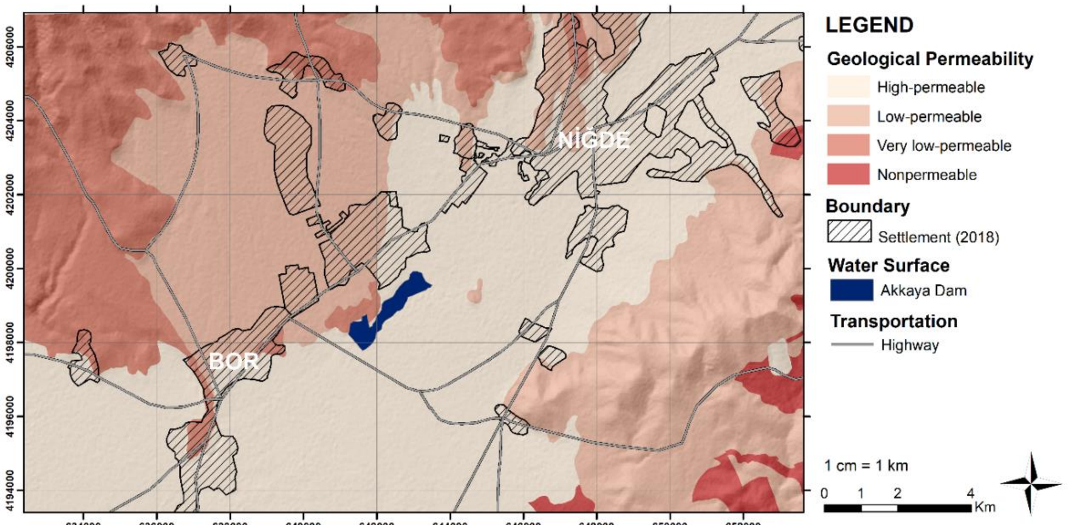

Figure 3. Niğde Orhan Batı and Tevfik Çalın streets ecological impact assessment in urban development areas Geological Permeability Map (Original, 2019)

Table 2. Change in the amount of green space

Satellite Image / Year / Month	Size (ha)	
	Rock, sand or wasteland areas (-(0.9 - 0.2)	Green areas (0.3 – 0.9)
Landsat 4-5 TM / 2000 / June	19669 ha	10696 ha
Landsat 8 OLI/TIRS / 2018 / August	24490 ha	5875 ha
Change	4821 ha increased	4821 ha reduced

Determination of the Effect of Urban Development Areas on Groundwater Recharging

In order to determine the ecological effect of the urban development areas on the natural landscaping areas in the Orhan Batı and Tevfik Çalın Avenue and its vicinity, the method of groundwater analysis was carried out in three stages as "Rock Structure Permeability, Soil Permeability and Water Permeability" (Buuren, 1994; Sahin, 1996; Sahin, 2007; Uzun et al., 2010).

Rock Structure Permeability

The rock structure permeability map of the study area was obtained by reinterpretation of the geological structure map obtained by the digitization of 1/25.0000 scale geological formations in the Earth Science Map Viewer website of the General Directorate of Mineral Research and Exploration. Descriptions of rock structure permeability coding are given in Table 3 and the map is shown in Figure 3. When the prepared geological permeability map is examined; 44% (13,523 ha) of the study area (30,452 ha) were found to be high permeable, 36% (10911 ha) of the study area were medium permeable, and 20% (6018 ha) of the study area were low or very low permeable.

Soil Permeability

In order to determine soil permeability, the Soil Conservation Service (SCS) in the USA was used in 1972 to utilize the Hydrological Soil Groups (Marsumi et al., 2017) and 1/25.000 scaled official land data developed for the efficient use of water and soil resources. The soil properties of the land according to the SCS CN method are expressed by the hydrological soil groups in Table 4 and Table 5. Table 4. Hydrological soil groups (SCS 1986).

The hydrological soil groups map of the study area was obtained by interpreting the data base data of the 1/25.000 official scale of soil maps according to Table 4 and Table 5 (Figure 4). When the soil permeability map is examined; 30452 ha of the total study area; It was found that 4% (1096 ha) was very high transmission, 27% (8176 ha) was high and 69% (21180 ha) was very low permeable or impermeable.

Water permeability

The study area water permeability map was obtained by combining rock permeability and hydrological soil groups according to Table 6 (Figure 5). Water permeability degrees, codes and areas covered are given in Table 7.

Table 3. Re-classification of the rock structure of the study area in terms of permeability (Şahin et al., 2014)

Geological Structure	ICONA Rock Classes	Code
Undifferentiated continental clastic rocks	High-permeable	2
Continental clastic rocks	High-permeable	2
Q(b): Alluvial fan, slope debris, moraine etc	High-permeable	2
Marble, schist	Low-permeable	4
Andesite	Very low-permeable	5
Diorite	No permeable	6
Quartzite, quartz, schist	No permeable	6

Table 4. Hydrological soil groups and permeability (Öztürk et al., 2011)

Hydrological Soil Groups	Explanation	Code
D Class	Nonpermeable	4
C Class	Low-permeable	3
B Class	High-permeable	2
A Class	Very High-permeable	1

Table 5. According to the combination of large soil groups and soil characteristics of hydrological soil groups (Öztürk et al., 2011)

HSG	Major Soil Groups	Land Type	Combination of Soil Properties
A Minimum Infiltration: 7.5-10 mm/h.	L		1-11, 13-15, 17-19, 21, 22
	A		3, 6, 9, 10
	E,T		1-16
	O		m, p, r or together with one or more of the symbols h, s, a, k, v
		KK, SK,IY	
B Minimum Infiltration: 3-7,5 mm/h.	P, G		1, 2, 5, 6, 9, 10
	C,D,M,N		1-10
	E, T		17-24
	B, F, R, Y		1-8
	U		1, 2, 3
	L		12, 16, 20, 24
	X		1-4
	K		4-6, 13-15, 22-24
	A		With 3, 6, 9, 10 and one or more symbols h, s, a, k, v
C Minimum Infiltration: 0,8-3 mm/h.	P, G		3, 4, 7, 8, 11-22
	C, D, M, N		11-18
	B, F		9-23
	U		4-21
	R		9-21
	L, E, T		25
	Y		9-25
	X		5-20
	K		1-3, 10-12, 19-32
	Ç		3, 6, 9
	A		2, 5, 8 with one or more symbols h, s, a, k, v
D Minimum Infiltration: 0-08 mm/h.	P, G		23, 24, 25
	C, D, M, N		19-25
	B, F		24, 25
	R, U		22-25
	V		1-25
	Z		1-4
	A		With one or more symbols 1, 4, 7 or h, s, a, k, v
	H		With one or more symbols H or h, s, a, k, v
	S		S or h, s, a, k, v with one or more of the symbols
	X		21-25

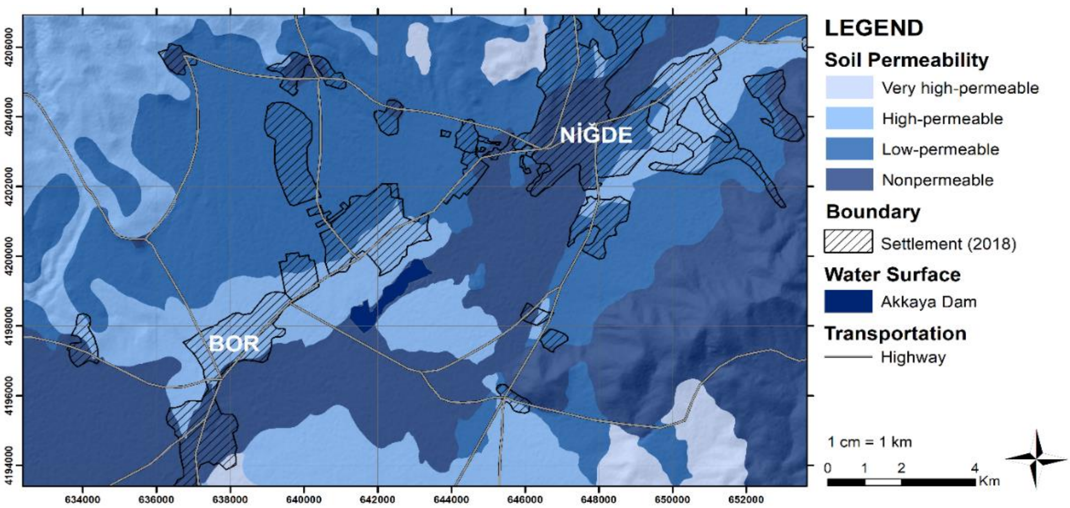

Figure 4. Niğde Orhan Batı and Tevfik Çalın streets ecological impact assessment in urban development areas Soil Permeability Map (Original, 2019)

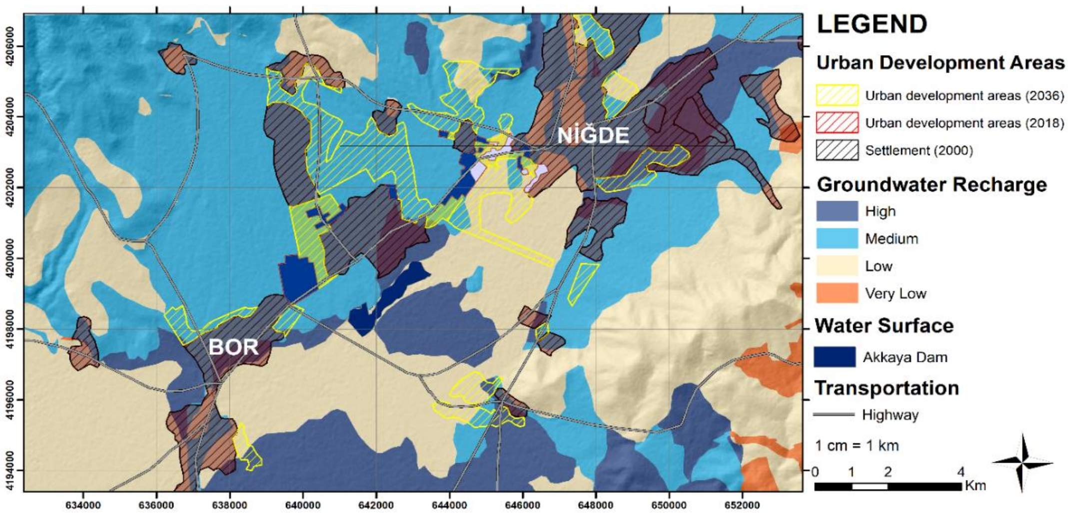

Figure 5. Niğde Orhan Batı and Tevfik Çalın streets ecological impact assessment in urban development areas Water Permeability Map (Original, 2019)

Table 6. Rock and soil permeability values (Sahin et al., 2014)

Geological Permeability	Hydrological Soil Groups			
	A	B	C	D
Very High-permeable	1	2	3	4
High-permeable	1	2	3	4
Permeable	2	3	3	4
Low-permeable	3	3	4	4
Very low permeable	3	3	4	5
No permeable	4	4	4	5

Table 7. Water permeability degrees, codes and areas covered

Explanation	Code	Area (ha)
High	2	4615
Medium	3	13696
Low	4	11702
Very Low	5	439

When the water permeability map is examined; 30452 ha of the total study area was found to be 15% (4615 ha) of high permeability, 45% (13696 ha) of medium permeability, 40% (12141 ha) was low or very low permeable. Prior to urban development, the groundwater recharging of the 30452 ha area, which covers the settlement area and the surrounding area of the year 2000, the groundwater of 2036, covering the 20-year period of the area today (2018) and the future of urban development after urban development has started in Table 8; Table 9 shows the total change in groundwater recharging together with urban development.

Table 8. Groundwater recharging before and after urban development

Urban Development (2000-2036)	Groundwater Feeding	Area (ha)
Before Urban Development (Year 2000)	High	4.615 ha
	Medium	13.697 ha
	Low	11.703 ha
	Very Low	439 ha
After Urban Development (Year 2018)	High	4.615 ha
	Medium	13.488 ha
	Low	11.653 ha
	Very Low	439 ha
After Urban Development (Year 2036)	High	4425 ha
	Medium	12.388 ha
	Low	11.165 ha
	Very Low	439 ha

Table 9. Change in Groundwater recharging before urban development and after urban development

Change in Groundwater Recharging	Area (ha)
High	190 ha decreased
Medium	1518 ha decreased
Low	588 ha decreased
Very Low	0 ha
Total	2296 ha decreased

The urban development area boundary for the future status of the study area was taken from the 1/100.000 Scale Environmental Plan prepared by the Ministry of Environment and Urbanization for the Spatial Planning General Directorate of Kırşehir-Nevşehir-Niğde-Aksaray Planning Region. As a result of the evaluation, on 30,452 hectares of study area, high groundwater recharge areas decreased by 4% (190 hectares), while average groundwater recharge areas decreased by 33% (1,518 hectares) and poor groundwater recharge areas decreased by 13% (588 ha) as a result of urbanization.

Discussion

Without monitoring we cannot learn from any impacts that do occur or determine the accuracy of significance assessment (Dipper et al., 1998); especially since the response of an ecosystem is often unpredictable (Doak et al., 2008). There has been widespread recognition for a number of years that monitoring and feedback would improve practice of EIA, but it has received little uptake (Gilpin, 1995; ODA, 1996; Tinker et al., 2005; Wood, 1999, Briggs et al., 2013).

As a result of the literature review, it has been determined that the studies on Akkaya Dam have been carried out with the title of "The flora of Nigde University campus area and Akkaya dam lake (environment) (Başköse et al., 2012)", "Evaluation of spatial and temporal water quality in the Akkaya dam watershed (Nigde, Turkey) and management implications (Korkanç et al., 2017)", "Effects of the land use/cover on the surface runoff and soil loss in the Niğde Akkaya Dam Watershed, Turkey (Korkanç, 2018)", "The effect of Akkaya Dam on the Niğde Province Climate (Aslan, 2017)".

However, due to its natural landscapes and strategic location, it was seen that there was no study in the field of Landscape Architecture related to Orhan Batı and Tevfik Çalın Streets which was an important place and it was chosen as the research area. The fact that the current situation of the research area is not known and the future studies in this area has not been made necessitated researches on the preservation of the natural character of the study area. This study will shed light on the future planning and design studies to determine the impact of urban development areas on green areas, determination of soil and water permeability, especially in urban development and transformation areas.

While the cities formed with their natural and cultural values were shaped to the extent allowed by the natural climate conditions in the historical process, the pressures on the traditional character of the cities and natural landscapes have increased as a result of the technological developments and changes that have arisen with the increasing human activities along with the population increase. However, natural landscape areas are important for the continuity of the ecological balance. In the planning and design phase of rural and urban areas natural areas need to be protected. Urban landscape must be created in urban environments as good imitations of natural landscape areas (Polat et al., 2017). As a result of the evaluations made in the field of urban development in Orhan Batı and Tevfik Çalın Streets which connects the Niğde Merkez and Bor districts; While the amount of green areas in 2000 is 10,696 hectares; the amount of green areas decreased by 45% and decreased to 5,875 hectares in 2018. High permeable surfaces, which are important for groundwater recharging, did not change between the years 2000-2018.

Considering the 2036 year urban development area boundary for the future status of the study area; It is foreseen that in 2018, 4,615 ha wide surfaces with a high groundwater recharging will fall to 4,425 hectares with a decrease of 190 hectares by 4% in 2036 with urban development. Considering these values, anthropogenic activities should prevent the reduction of the existing vegetation and decrease the areas with high permeability. With the studies to be carried out in the city centre, the amount of water passing to the surface flow is calculated and the ecological balance of the water such as rainwater harvesting is maintained and sustained by means of green infrastructure systems. In areas where deterioration of the vegetation is detected and in the areas facing the danger of degradation and extinction in the process, carbon sinks that will be formed as a result of repair works with natural plant species will help to reduce the effect of urban heat island and contribute to reducing the effects of climate change.

In addition, Akkaya Dam, which has been declared as Candidate to International Wetland and Ramsar in 2005, and to prevent the access of the wastes of the industrial and industrial facilities to the dam for protection and sustainability of the flora and fauna species in its vicinity, technological methods should be provided for treatment. In addition to water pollution in Akkaya Dam, soil pollution caused by chemical wastes of industrial and industrial facilities in the region and phytoremediation technique (use of soil-cleaning plant species) can be biologically challenged.

Conclusion

Ecological Impact Assessment is significant for protecting and promoting ecosystem stability. According to the results obtained in this article, protection of ecologically important areas and ensuring continuity provides natural, social, economic benefits.

When the 2000-2018 NDVI data's are evaluated, the green area will be reduced by 45%, decreasing the green area per person, decreasing the amount of oxygen needed by the person and causing the people to be affected psychologically. Green space filter air, help reduce air pollution, reduce noise pollution, help diminishing urban heat island (UHI) effect, infiltrate storm water, and refill groundwater (Nowak et al., 2006; Escobedo et al., 2011, Gerçek et al., 2017). This change in the 18-year period shows that with the increase in population, the amount of green space will decrease further in the following years.

The fact that the areas with high ground water supply are rare and impermeable to the development of these areas have a negative impact on the ground water level. On the protection and management of water functions; Water quality management, social and environmentally reliable groundwater management practices, management of water and soil resources management and applications with sustainable use and environmental protection approach, small and medium water resources management should be utilized and water-efficient landscape design practices should be increased (Akduman Vural, 2017). In the research area, the continuity of existence should be ensured by taking into consideration the planning stage within the scope of the studies with high permeability areas which are important in terms of groundwater recharging.

In conclusion, it should be emphasized that the efforts made in the physical planning process for the protection of agricultural areas are of great importance, but they are not sufficient (Akseki et al., 2013). If the city of Niğde is planned and the plans are implemented without considering the soil and geological features in the area, the results cannot be recycled. With the increase of the relatively inefficient soils in the city, the development of agricultural soils with high efficiency and permeability will not be prevented. The main problem here is the fact that the major gains / rents in certain regions of the city will lead to a decrease in urban ecology and urban quality of life. The basic condition for resisting the pressure created by the city, as concretized by the experiences of the city of Niğde, is the production of policies aimed at sharing the economic inputs and positive values that will support these decisions as well as the planning decisions taken.

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