

## AN EVALUATION OF STUDIES ON USING GIS BASED ANALYSIS IN TURKEY'S RIPARIAN ECOSYSTEMS

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### Abstract

*Geographical Information Systems (GIS) are used for analysis, processing and mapping of objects and events on the earth. It provides classification of information by using databases for query purposes and statistical analysis. In addition to these applications, GIS; it is used in many areas such as natural resource management, rural and urban planning, natural disaster method and ecosystem planning.*

*In this study, document analysis method, one of the qualitative research methods, was used. The studies which is prepared by using GIS on riparian ecosystems in Turkey for last decade have been analyzed. Totally 10 scientific studies were analyzed. It has been determined that studies have become widespread in the last decade with the widespread using of GIS. The importance of GIS has been emphasized in the protection of riparian ecosystems and studies on landscape management. With this study, the protection of Riparian ecosystems in Turkey and increasing the use of GIS is considered within the scope of landscape management and new research questions will provide a major contribution towards the reveal.*

**Keywords:** *document review, landscape management GIS, riparian ecosystem, Turkey*

### 1. INTRODUCTION

Geographical Information Systems (GIS) emerged as a result of the need to work with more than one map in planning studies. In order to make analyzes and produce decisions in line with the purposes of the studies, the necessary maps are based on the logic of layering and overlapping different layers (Yörüklü, 2009; Uzun et al., 2010). GIS is a system consisting of software, hardware and personnel who will perform operations that enable the collection, storage, updating and querying of all geographically definable spatial data and quality information in the same environment (Aydın, 2015).

According to Phoenix (2000); GIS was first used for military and strategic purposes in Canada in early 1960s. Along with the development of functions that allow the multidimensional understanding and analysis of space, many professional disciplines such as landscape architecture, urban and regional planning and forest engineering, especially geography, began to realize GIS in the 1980s and use this technology in their research. GIS is used by over 100 disciplines today (Demirci and Karaburun, 2010). GIS has an interdisciplinary nature as it is used by all disciplines related to space.

In the field of landscape ecology, GIS and remote sensing are used extensively in planning and management studies related to landscapes. With the software that can be used integrated with GIS, the structure, function and change of the landscape can be analyzed. The use of GIS provides convenience especially in upper scale analyzes such as basin and regional scale (Forman and Godron, 1986; Turner and Gardner, 2015; Bilgili et al., 2018). Prior to the use of GIS, mostly descriptive studies were carried out, and with the use of GIS, studies in many different professions gained more quantity and provided the opportunity to analyze, compare, synthesize and draw conclusions (Demirci and Karaburun, 2010). With all these features, GIS has been a facilitator in understanding and solving current social problems.

Avdan and İnan (2010) evaluated the ecology and water quality of riparian areas, which is a very important natural structure for the environment, by using remote sensing (RS) and GIS technique and made suggestions on this subject. Riparian areas are areas of energy and nutrient transfers between terrestrial and aquatic ecosystems along rivers and streams where many species live (Naiman and Decamps, 1997; Apan et al., 2002; Avdan and İnan, 2010; Gültekin and Gültekin, 2019). Different

studies in the literature emphasize that the riparian zone serves functions such as water quality, erosion prevention function, hydrological balance, protection of biodiversity, and sustainability of the biological chain (Dinç, 2019). As stated by Gültekin (2019a) riparian areas are faced with a variety of negative interference and these areas cannot fulfill their functions adequately in Turkey. Management of these areas and the creation of a healthy riparian zones have a great importance nowadays. Studies on riparian ecosystems in Turkey seem to include ecosystem services, management of riparian areas, landscape analysis at the basin scale, landscape planning, river banks repair, vegetation determination, land cover temporal change, water quality, flood risks, soil characteristics, agriculture, ecotourism and recreation in riparian areas (Şahin et al., 2014; Uzun et al., 2015; Özdeniz, 2016; Gültekin et al., 2017; Gültekin, 2019b; Gültekin, 2019c).

Determination of riparian areas according to topographic features, creation of adequate protection nets and buffer zones, and distance adjustment according to certain geographical features are only possible with information technologies such as GIS (Avdan and İnan, 2010). In parallel with the developments on a global and national scale, the use of information technologies has come to the fore in studies to solve the problems related to the protection and management of riparian ecosystems. The aim of this study is to examine and explain some case studies on Riparian Ecosystems in Turkey by applying GIS and RS methods.

## **2. MATERIALS AND METHODS**

As the material of the study, some academic studies in Turkey, which include the concept of "riparian" and where spatial technologies such as RS are used, are based on the use of GIS. In the method of the study, content and document analysis technique was used, and national projects, graduate theses and articles focusing on the analysis, evaluation and monitoring of the temporal change of riparian areas of GIS and RS, and the structure-function-analysis of the landscape were evaluated in the creation of the method. The number of academic studies prepared by using GIS and RS techniques in the evaluation of agriculture, forest, urban and wetland ecosystems in Turkey is very high.

Within the scope of this study, scientific studies that directly evaluate riparian ecosystems and river coastal areas with GIS and/or RS technologies are emphasized. Within the scope of the research conducted in Google academic, YÖK thesis scanning center, the official website of the Ministry of Agriculture and Forestry, and the TUBITAK database, 41 studies were found that included the concepts of riparian and GIS. The scientific studies reached were classified according to the criteria of method, geographical location, whether the study was theoretical or applied, whether the study scale was national-local, whether it was multidisciplinary or not, and interpreted over 10 sample studies.

Although the use of GIS in Turkey dates back to the 1980s, the widespread use of GIS and the elimination of software, hardware and personnel deficiencies coincide with the early 2000s (Demirci and Karaburun, 2010). Especially after 2010, the number of GIS laboratories in different universities has increased and the facilities have been improved. The use of "riparian ecosystems" as a concept, on the other hand, intensified in the literature in 2010 and later, and it is seen that concepts such as "basin", "wetland", "coasts of stagnant waters", "sea coast" were mostly used before. In this study, the scientific documents that analyze the land cover changes in the coastal bands of fluvial rivers with GIS technology are focused on, and their adequacy and importance of the subject in terms of method and results are examined.

## **3. RESULTS**

The role of GIS and RS technologies in understanding, planning, protecting, managing and monitoring the structure of riparian ecosystems is very important in obtaining faster and more accurate information. In this context, 10 sample scientific studies in which riparian ecosystems in Turkey were evaluated using GIS and/or RS technology are summarized below.

### *3.1. Ecological improvement and landscape management model for Zir Brook (2010)*

In the doctoral thesis prepared by Yenil (2010), it is aimed to reveal how the hydrological landscape structure of the river should be evaluated while creating the management model of Zir Brook and the analysis method that can be an example for ecological improvement criteria in rivers. Another subject that is emphasized in the scope of the thesis is the emergence of the necessity of working together with different disciplines and institutions in river landscape management. With the applied method, it has been tried to establish a management structure in terms of ecological improvement.

In order to reveal the river basin character in the method of the study, first of all, landscape inventory and analysis were made in the study. The maps obtained digitally by inventory studies and the maps obtained and digitized by analogy were transferred to the computer environment with the help of ArcView, ArcGis programs, which is a GIS software, and a database was created. In addition, ArcMap was used in some queries and analysis. The hydrological landscape structure of the basin has been revealed by the landscape analysis carried out using the field data. During the landscape inventory and analysis studies, human-induced pressures were also determined.

The study is especially important in terms of being a doctoral thesis aiming at ecological improvement in river systems based on the use of GIS and opening a horizon for the training of experts on this subject. There is a need for more advanced doctoral theses in this field in Turkey.

### *3.2. A research using landscape metrics on assessment of landscape structure in Bartın city and Arit basin (2012)*

In the study prepared by Gökyer (2012), the landscape structure of the area was evaluated by using GIS and landscape measurements over the land cover data of Bartın Arit Basin. In the method of the study, the data related to the field were transferred to the digital environment using the ArcGIS 8.2 program. Land cover maps of 1984 and 2001 were created from topographic maps produced by the General Command of Mapping (HGK) in 1984 and 2001. In the study, Bartın Arit Stream was emphasized as the most important landscape element in the area and it was revealed that it affected other uses. Bartın Stream is the flow corridor in the research area. With this feature, it provides the connection between the landscape types in the whole area. At the same time, it is stated that it separates the landscapes from each other by forming a narrow, strip-like surface throughout the area.

### *3.3. Landscape restoration and regeneration technical guide in river corridors (2014)*

Sahin et al. (2014) based on extensive literature research on river landscapes, landscape survey of river corridors, habitat survey, river corridor repair, wetland restoration, ecological repair and landscape restoration. In the method of the study, landscape character analysis and evaluation in river corridors should be carried out at two different hierarchical levels. One of the levels is Landscape Character Analysis and Evaluation in Basin/Lower Basin, another level is River Corridor Landscape Survey and Evaluation. The landscape restoration plan and techniques defined in the study include 1/25.000 and 1/5.000 scales that can be defined as local scale, and 1/1.000 and lower scales that will be the basis for implementation.

The maps used in the study were obtained by using GIS technology. It is one of the important studies for Turkey on landscape planning and landscape restoration covering river corridors by utilizing GIS technology.

### *3.4. Yeşilirmak basin landscape atlas project (2012-2015)*

Uzun et al. (2015) landscape character assessment was carried out by determining the landscape character and landscape character areas at the local, regional and national level in the Yeşilirmak Basin with the project of preparing the Yeşilirmak Basin Landscape Atlas. In addition, it is aimed to reveal the landscape diversity and biological diversity on the basis of the basin, to draw the landscape quality map on the basis of the basin, to determine the landscape strategies on the basis of the basin and to prepare sectoral landscape guides.

One of the most important outputs of the project is its contribution to the establishment of the “National Landscape Information System”. In defining the current situation, information obtained from literature

searches, data available or transferred in the GIS environment, data and information received from relevant institutions and organizations, studies conducted in the basin, meetings and observations and visual materials were used.

Within the scope of the project, 47 analyzes and definitions were carried out. Some of these data include landscape analysis as a synthesis of academic studies carried out in Turkey since the 1930s, and some of them include definition and analysis at the micro-watershed level, which is an important geographical unit in determining natural boundaries in the landscape.

### *3.5. Assessment of landscape change in the Manavgat River Basin in the context of landscape protection, planning and management (2016)*

In the study prepared by Yıldırım and Ortaççeşme (2016), the landscape change of the Manavgat River Basin was discussed, and this change was interpreted with landscape metrics and suggestions for the protection, use and management of the area were developed. In the method of the study, images of the areas within the Manavgat Basin belonging to the years 1955, 1971 and 1981/1986 were obtained, and images of four different periods were created with the RapidEye satellite image of 2010. Based on the obtained aerial photographs and satellite images, the existing Land Cover/Land Use types were determined based on the 2nd level of the European Union CORINE Land Classification System, on-site controls were made and digitized with the help of ArcGIS 9.3 software and transferred to the GIS environment. Changes between 4 different temporal periods were determined as amount and percentage. In addition, landscape metrics were measured with the FRAGSTATS software to determine matrix, patch and corridor relationships.

In the study, it was emphasized that landscapes are in change, and suggestions were made for conservation, planning and management. The most important aspect of the study is emphasizing that river basins are a suitable biosystem for large-scale ecosystem management and planning, since river basins have natural boundaries, and the "basin" scale is taken as a basis in the management of natural resources.

### *3.6. Development of landscape restoration and management strategy in Büyük Melen river basin (2016)*

The study prepared by Gülerüz (2016) covers the catchment area between the Düzce Efteni Lake wetland and the Black Sea of the Büyük Melen river basin located in the Western Black Sea basin no 13. In the research, analyzes for the function of the landscape such as water permeability at the basin scale and potential erosion risk were carried out using GIS. In the method of the study, the numerical data obtained from the relevant institutions and obtained in the field were transferred to the computer environment with the help of ArcGIS 10.3 software, which is one of the GIS programs, to create a database related to the area. In addition, Arcview 10.3 program and related subprograms (3D, Spatial) were used in the study.

According to the evaluations made regarding the Büyük Melen Basin and the main river axis; Repair strategies have been developed under three main headings: current land uses, protected areas according to the water pollution control regulation, and visual landscapes based on land use around the main river axis. The study is one of the important studies involving the use of GIS in riparian ecosystems within the framework of landscape restoration.

### *3.7. Ecological sensitivity and risk assessment in Kızılırmak delta (2016)*

The study prepared by Ersayın (2016) is in the geography department. The aim of the study is to develop suggestions for the sustainable use of these areas by revealing the ecosystems with high ecological sensitivity and at risk due to anthropogenic and natural factors in the Kızılırmak Delta. In the study, ecological risk and sensitivity were tried to be revealed by using a GIS-based multi-parameter model. In the study, 1/25.000 scaled topography maps, soil and management maps were used.

According to the results of the study; The east of the Kızılırmak Delta, the surrounding of the lagoon lakes and the low areas around the coastal dunes, were determined to be high in sensitivity and risk. As a result of the study, the areas with high ecological sensitivity and risk and the boundaries of the existing protection areas in the delta area were evaluated. It has been determined that the borders of the Wildlife

Development Area do not cover the sensitivity and risk areas. It has been determined that the borders of the other two protection statuses (Ramsar and Natural Protected Areas) cover areas with high sensitivity and risk.

*3.8. The analyses of the physical effect of land use decisions on stream systems and its reflection on urban life: the risk evaluation of flood and overflow in İstanbul (2019)*

In the study prepared by Dinç (2019), the focus is on 168 streams, which are open basins, and about 3344 km long stream systems in the basin, in an area of approximately 2740 km<sup>2</sup>, which is excluded from the drinking water basin in İstanbul. In the conceptual approach of the study, the concept of "riparian" is mentioned, and definitions of concepts closely related to riparian field studies such as biome, ecotone, natural stream systems, flooding and drainage are given.

The study includes map studies that enable the determination of the main stream basin boundaries and creek systems, the determination of the physical structure of the coastal length section of the stream lines in each basin and the land structure on it, the mutual analysis of the findings, and the evaluation of the findings in terms of flood and flood risk within the framework of conceptual research.

In the study, macro-scale and micro-scale maps were created using GIS. The research findings reveal that the city of İstanbul is not ready for the environmental problems that will increase with the climate change, which the world is on global alarm, and cannot manage the risks. It is recommended to establish interdisciplinary coordination at the planning scale, and to establish a relationship between the plan scales and the river basin scale and other scales in order to deal with the stream systems holistically.

The analyzed study is an up-to-date and valuable study on the stream systems of İstanbul, one of the largest metropolises of Turkey and the world, by using GIS technology.

*3.9. Analysing the potential and change of ecological urban corridors in the Bursa city (2020)*

The study was prepared by Akin (2020), and it is aimed to determine the quality and quantity of natural ecological corridors of Bursa and to evaluate them in terms of sustainability. Within the scope of the study, forests, open-green areas, river branches and road networks were evaluated as ecological corridor elements. In the study, remotely sensed data sets of different time periods, Google Earth image and current maps of Bursa province were used to determine the ecological elements in question.

In the method of the study, a land cover/area use map was created with the object-based classification method for the years 1979 and 2015. Afterwards, stream tributaries and road networks were digitized in the GIS environment with the help of Google Earth image and existing maps. Finally, the maps obtained by classification and digitization were integrated and evaluated considering the current land use/land cover. In the city of Bursa, which has an important place in Turkey with its rich hydrological resources, it is possible to create effective ecological corridors between the river branches, Uludağ and the planned road networks. It is emphasized that a functional, aesthetic, connected, holistic green space system will contribute to the sustainability of the city by evaluating the current potential.

*3.10. Ecological assessment of a riparian zone within the scope of blue green infrastructure: Gaziantep Alleben creek (2021)*

In the study prepared by Kılıç (2021), it was aimed to evaluate the riparian zone of Gaziantep Alleben Stream from an ecological point of view within the scope of blue-green infrastructure. In the study, first of all, data were collected at the scale of the basin and the creek, and the collected data were evaluated separately at the scale of the basin and stream, using field observations. In the method of the study, natural and cultural data were collected at the basin scale by adopting the approach that the data at the basin scale should be evaluated in order to evaluate the Alleben creek holistically. In the study, slope, aspect elevation, large soil groups and land capability classes, current land use maps were prepared in ArcMAP 10.3.1 program in GIS environment.

In the mentioned study, the concept of "riparian zone" is frequently mentioned and it is included in the keywords. The study data was produced in the GIS database, and the riparian zone assessment was carried out at two different scales, at the basin scale and at the local scale.

#### **4. DISCUSSION**

In this study, in which the document review technique is used as a method, graduate theses, articles and national projects in the fields of landscape architecture, forest engineering and geography, where the concept of "riparian" and the concept of "GIS" are used together, were examined. In some years, a large number of scientific studies were carried out, while in some years it was seen that no study was conducted. Riparian ecosystems and GIS expertise are specific topics and the preparation of doctoral theses containing these topics will provide academic diversity. In this respect, it is important to support doctoral studies of the use of GIS in studies of riparian ecosystems. When the keywords of graduate theses, articles and projects are examined, it has been determined that the words coastal ecosystems, wetlands are also used intensively instead of the concept of riparian. Especially, the number of studies in which the words basin and GIS take place together is quite high. This shows that the word "riparian" is not preferred in keywords.

Riparian ecosystems have their own dynamics and the same issue can be approached from many different angles, ecologically, socially and culturally. Scientific studies prepared by utilizing GIS are in the topics such as river networks, flood risk analysis, temporal change of land cover. The research methods used in the studies vary. Some studies were prepared with a multidisciplinary approach, and the data were interpreted by evaluating different perspectives together. Some studies have been dealt with in a specific framework in a single professional discipline. The riparian and GIS studies examined vary between local scale and regional scale. It is seen that the studies involving the use of GIS in the subjects of riparian ecosystems and river corridors are mostly done by the professional discipline of landscape architecture.

Since this compilation study was made by considering only some published studies, it cannot be said to represent all relevant studies conducted in Turkey. However, it can be said that it reflects the general trend in Turkey in terms of seeing GIS usage areas in the evaluation of riparian ecosystems, which are generally examined. It is expected that this study will give an idea to the academicians who will do research in the field.

#### **5. CONCLUSIONS**

The rapid development in technology today has also affected GIS and RS techniques, and with the increase in accessibility to these techniques, the quality and quantity of studies using GIS have increased in Turkey after 2010. It is seen that they are frequently used in the professional disciplines of landscape architecture, geography and forestry engineering, which are professional fields directly related to riparian ecosystems. When the studies are evaluated according to the topics, it is seen that they are used in landscape planning, landscape management, landscape ecology, sustainable ecosystem management, determination of ecosystem services, land cover change analysis, protection and monitoring studies. GIS programs provide convenience in understanding the landscape functions, structure and change of different programs working in conjunction with their data update feature and GIS programs.

The hydrology, ecological function of all riparian areas is not the same. There are many differences such as climate conditions, topographic structure, water collection sources. In the evaluation of Riparian ecosystems, site-specific features should be determined and site-specific solutions should be developed. GIS, which is a program used by all disciplines based on space, is a tool preferred by researchers in terms of mapping data, storing it numerically, monitoring temporal data comparatively, and facilitating scale-sensitive studies.

Researchers working on riparian ecosystems in Turkey need to be more interested in learning, using and teaching GIS and take the necessary steps in this regard. GIS databases owned by Turkey should be used effectively in the planning, protection and management of riparian ecosystems. It is of great importance to carry out GIS-based inventory studies for Turkey's 81 provinces and 25 main river basins. Outputs, maps, reports and models obtained with the use of GIS and RS will enable decision makers to learn about riparian ecosystems and contribute to the solution of planning problems they face. The widespread

use of GIS and the developments in riparian area modeling and mapping will facilitate the understanding of the results of nature and human interaction.

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