

AN OVERVIEW OF STUDIES ON “RIPARIAN ECOSYSTEMS” IN TURKEY (2010–2021)

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Abstract

Riparian ecosystems are important areas of energy and nutrient passages along rivers and streams, between terrestrial and aquatic ecosystems, where a large number of species live. However, there are contradictions in the literature regarding the concept of riparian area and its awareness, scientific studies focus only on ecological effects, anthropogenic effects and socio-economic dimensions are not at sufficient level and the concept of "riparian" is often not included among key words.

In this study, document analysis method is used as the qualitative research methods. The scientific studies which are directly or indirectly associated with Riparian ecosystems were analyzed in Turkey. A general evaluation has been made about the findings obtained within the scope of the study. For riparian ecosystems, the studies' sufficiency level interpreted held in Turkey, recommendations on how to correct the deficiencies have been developed. It is thought that it will make great contributions to the emergence of new research questions and the development of scientific project topics to increase the level of knowledge on the issue of recognition Riparian ecosystems in Turkey with this study.

Keywords: *document review, inventory, riparian ecosystems, Turkey*

1. INTRODUCTION

The word "riparian" comes from the Latin word "ripa", meaning "river bank" (Yılmaz and Çiçek, 2003). Riparian term; it is also closely related to terms such as riparian corridor, riparian habitat, riparian vegetation and riparian zone (Özdeniz, 2016). According to Stewens et al. (1995), the areas with sufficient humidity to form a natural vegetation cover different from the vegetation on the free-drained neighboring slopes at the edges of streams, lake shores and wetlands, and the floodplains of these areas are called "Riparian" (Kuşak, 2006).

Riparian areas are considered as wetland ecosystems. Wetlands are dynamic areas rich in biodiversity, open to natural factors and anthropogenic influences. These riparian ecosystems, located on the banks of streams and rivers passing through agricultural lands, have many important functions both aesthetically and functionally (Özdeniz, 2016). Riparian regions are areas of energy and nutrient transitions between terrestrial and aquatic ecosystems along rivers and streams where many species live (Apan et al., 2002; Naiman and Decamps, 1997; Avdan and İnan, 2011). These areas, which are accepted as the world's natural wealth museums due to their biological diversity; it is one of the most important ecosystems of the earth with its natural functions and economic values. At the same time, these areas have an extremely important ecological balance as they form ecotones with special conditions (Özdeniz, 2016).

Riparian zones or areas are transition zones between terrestrial and aquatic ecosystems. Riparian zones are important ecotone zones for streams (rivers) and the terrestrial habitats around them (Molina et al., 2004). Odum (1953) describes an ecotone as “a transition between two or more communities; a junction or region of tension that may have significant linear length but is narrower than adjacent assemblies (Kark and Rensburg, 2006). Dynamic transition zones have many functional tasks in the system they are in (Farina, 2006).

Since riverine coastal ecosystems are a natural regulation mechanism for aquatic environments, it is necessary to focus on these ecosystems in planning. For this, Stream Coast Ecosystems Management Plans (SCEMP) should also be prepared. In these plans, the functionality and health status of the existing

river corridors should be revealed, development methods and practices should be determined, and their developments (better or worsening) should be monitored in time (Özdemir et al., 2020).

Riparian fields have always been beneficial to humans. Easy use of water, natural use of fertile soil for agriculture are just a few of these benefits. At the same time, they are corridors of cultural importance with high recreational values (Özdeniz, 2016). Throughout history, coastal ecosystems have been the most preferred areas in terms of human activities, especially settlement, due to their richness. These ecosystems have always been an important natural resource for humans and other living things (Kaypak, 2012).

The management structure of diverse areas such as coastal ecosystems and riparian ecosystems is very complex. The jurisdictions of various administrative units are intertwined. Since the holistic management approach aims to cover all management levels from the central government to the smallest local unit, it can be seen as an effective tool to be used in overcoming this problem (Clark, 1996; Kaypak, 2012). When the literature is examined, there are different studies in Turkey that focus on participatory management approach, making evaluations for local, regional and national scales, and the importance of a holistic approach on a basin basis while determining the boundaries of the study area (Uzun et al., 2011; Uzun et al., 2012a; Uzun et al., 2012b; Uzun et al., 2015; Gültekin et al., 2017; Gültekin et al., 2018).

This study focuses on current riparian ecosystems in Turkey and aims to examine studies that include definition, purpose and scope, method, scale of study, related professional disciplines, and sub-topics related to riparian ecosystems. At the same time, with this study, it is aimed to evaluate the studies on riparian ecosystems in terms of quality and quantity.

2. MATERIAL AND METHODS

Within the scope of the study, literature review and document analysis were made. Some scientific studies conducted in the literature in Turkey, directly or indirectly related to riparian ecosystems from national and regional scale to local scale, have been examined. The studies discussed are limited to the databases accessible to the researcher.

Projects at different scales, master's and doctoral theses, scientific publications, intelligibility of riparian ecosystems studies in Turkey, information production and access to information, common language use in the literature, new methods developed, ecological and anthropological effects, legal and administrative situation, socioeconomic approaches analyzed and suggestions for future work were made. The documents examined within the scope of the study were evaluated in terms of purpose, scope, method, scale of study area and keywords.

3. RESULTS

3.1. Some studies related to riparian ecosystems in Turkey (2010-2021)

In this section, national level projects, masters and doctoral theses and scientific researches related to riparian ecosystems in Turkey are explained in detail.

3.1.1. Yeşilirmak basin landscape atlas project (2012-2015)

“Yeşilirmak Basin Landscape Atlas Project” published in 2015 was prepared by the Ministry of Agriculture and Forestry. The project, which was prepared as a multidisciplinary study, aims to make landscape character analyzes on the basis of natural and cultural landscape inventory in the Yeşilirmak Basin, Turkey's 6th largest main river basin, to determine the regulating and supporting functions, as well as cultural landscape functions, which provide resources within the scope of ecosystem services. It aims to define landscape indicators, determine landscape diversity and biodiversity by making impact, change and pressure analyzes, produce landscape quality maps, prepare “Yeşilirmak Basin Landscape Atlas” and determine landscape protection/development strategies and create sectoral landscape guides.

This project consists of 3 basic stages: Creating a Project, Survey-Inventory-Evaluation and Landscape Database; Landscape Character Evaluation with Landscape Function Analysis, Indicators; Preparation of Landscape Atlas and Sectoral Landscape Guides. The duration of the project is 900 days. The project was finished in 2015. Opening and working meetings were held in Amasya, Samsun, Tokat and Çorum provinces, and training meetings were held in Ankara. The 1st Progress Report, consisting of the Survey-Inventory-Evaluation sections of the Project, was submitted to the Ministry in August 2013, and the 2nd Progress Report, including the Landscape Analysis, in August 2014. Final Report and Landscape Atlas studies were completed in 2015 (Uzun et al., 2015; Uzun et al., 2018).

By drawing attention to the necessity of landscape restoration plan and approaches at the basin scale in the project, guides have been created for problematic themes and areas such as diffuse pollutants, solid wastes and cities that come to the fore in the project area.

3.1.2. Büyük Menderes basin landscape atlas project (2018-)

The “Buyuk Menderes Basin Landscape Atlas” project, which was included in the 2018-2021 program and carried out by the Ministry of Agriculture and Forestry, General Directorate of Nature Conservation and National Parks within the scope of the European Landscape Convention, was prepared to cover the provinces of Aydın, Denizli, Afyon, Uşak and Muğla. The project is based on the natural and cultural landscape inventory in the Büyük Menderes Basin, where an assessment of the conservation of landscape character is made, landscape character types and landscape character areas, landscape diversity and biodiversity are determined, landscape quality map is drawn, landscape protection and development strategies are determined and sectoral landscape guides are created, it aims to establish a landscape information system with the "Landscape Atlas of the Büyük Menderes Basin".

The project for the creation of the Büyük Menderes Basin Landscape Atlas and the Yeşilirmak Basin Landscape Atlas Projects are important examples of ecological, socio-cultural and managerial approaches, covering riparian ecosystems at the regional scale.

3.1.3. Analyzing riparian forest cover changes along the Firniz River in the Mediterranean City of Kahramanmaraş in Turkey (2014)

The study aims to analyze riparian forest cover changes along the Firniz River located in Mediterranean city of Kahramanmaraş in Turkey. Changes in riparian forest cover from 1989 to 2010 have been determined by implementing supervised classification method on a series of Landsat TM imagery of the study area. Riparian buffer zone was determined by using GIS tool (ArcGIS 10) and supervised classification method was applied by using ERDAS Imagine software. The accuracy of the classification process was evaluated based on the forest stand type maps of the study area. It was found that the agricultural lands decreased by 5.37 %, while forest opening increased by 6.15 (Akay et al., 2014).

The study is one of the important examples of land cover change in riparian ecosystems in Turkey using remote sensing and GIS.

3.1.4. Syntaxonomical analysis of the riparian vegetation of the Porsuk River (Eskişehir-Kütahya/Turkey) (2016)

The study was carried out to make the syntaxonomic analysis of the riparian vegetation of the Porsuk Stream and to determine the plant associations in the study area and to reveal the relations of these associations with the environment. Riparian areas are considered as wetland ecosystems. As one of the important results of the study, the phytogeographic regions of the taxa in the units defined in the Porsuk Stream riparian vegetation were discussed and as a result, their chorology was deduced. Accordingly, the high rates of taxa with Euro-Siberian elements prove that the study area is located in wetlands (Özdeniz, 2016).

The study is one of the examples examining vegetation analysis in riparian ecosystems in Turkey.

3.1.5. Assessment of relationship between land use/cover and surface water quality trends within the riparian zone: a case study from Sivas, Turkey (2020)

The main purpose of the study is; to reveal trends in surface water quality in Kızılırmak river basin, to determine the effects of land use/land cover (LULC) change, soil type and slope characteristics on surface water quality and to reveal the main factors affecting the variation in quality of surface water. The basis of the study method is to reveal the effect of LULC changes belonging to vicinity of Sivas city center and watershed characteristics on water quality trends of Kızılırmak river. In this context, the method applied consists of the stages of: watershed and riparian area formation, determination of LULC changes for different years, identification of soil type and slope characteristics, and determination of trends in water quality. RS methods were used for LULC change analysis and the method of trend analysis was used to determine trends in water quality. Statistical methods were also used to determine the effects of LULC changes and watershed characteristics on water quality. Results obtained from the study; LULC, soil types and slope variables have shown that have a very high impact on the deterioration of water quality. Considering the LULC changes; the increase of settlements and agricultural areas in the study area has affected the water quality negatively. Sewage and industrial discharges originating from residential and industrial areas have deteriorated water quality within the boundaries of riparian area (Karakuş, 2020).

3.1.6. Bird diversity along a riparian corridor in a moderate urban landscape (2020)

The main objective of the study is to spatially compare bird species richness, abundance, and community structure along the Asar River, an urban riparian corridor in Düzce, Turkey. In the study 63 Bird species were identified, comprising 6722 individuals, and classified into one of three groups: generalist species (11 species), woodland species (40 species), and waterbird species (12 species). Bird species richness is positively related to vegetative cover and negatively to urbanization. Richness is low in the winter and was higher during spring and summer. Riparian Quality Index (RQI) scores (mean = 54.8 ± 33.7 ; max. = 97 and min. = 5) were relatively low for all sampling plots and was reduced by human activities (e.g., roads, farmland, settlement). The number of woodland bird species changed positively ($r = 0.71$) with RQI. The generalist bird species, adapted to urbanization, is more common around settlements and open areas. Human population and settlement around Asar River increased one-third and farmland and natural habitat decreased one fifth during the last decade. The area has high potential for growth and increased urbanization, thus increasing the pressure on the natural areas. Activities that diminish the amount of tree cover in the riparian corridor should be avoided. Habitat restoration and rehabilitation will increase RQI values, which can be used as indicators for bird richness in urban landscapes and benefit avian diversity along the riparian corridor. In the study it is recommended that existing riparian corridor and any enhancements to the corridor will help conserve Düzce's biodiversity in the future (Keten et al., 2020).

The study is an important example that focuses on the fauna of riparian ecosystems and addresses the pressure of urbanization.

3.1.7. The evaluation of landscape survey in river management (2016)

In the study prepared by Yenil and Şahin (2016), how the river corridor survey, which is frequently encountered in international river management practices, is carried out, which data can be obtained, and its place and importance in determining landscape management strategies are discussed. Within the scope of the study, it is recommended to carry out studies based on the ecological process and natural order based on existing elements in the development of river landscape management strategies.

The study is one of the important works in the field of riparian ecosystems management, especially in Turkey. In stream management; it is suggested to develop a model in which factors such as ecology, hydrology, land data, landscape character, socio-cultural structure, land use status are evaluated holistically.

3.1.8. Landscape restoration and regeneration technical guide in river corridors

Restoration to Nature, Landscape Repair and Recreation Project" prepared by Sahin et al. (2014) and supported by the Landscape Protection Branch of the Sensitive Areas Department of the Ministry of

Forestry and Water Affairs, Nature Conservation and National Parks Directorate. In the study, a method has been developed for the purposes of defining, protecting, repairing and using river landscapes. The method includes both project design and implementation phases. The specified method is presented in this technical guide in detail and with the help of studies carried out in the pilot area. The guide provides leading for the definition of river landscapes, preparation of river landscape restoration plans, sectoral development planning in river landscapes, river landscape management and waterfront recreational development plans. Although the technical guide has been prepared within the scope of river landscapes, the method put forward can be used as a basis for the preparation of environmental management plans of other sectoral developments and in this context, especially for the production of impact assessment studies and landscape restoration plans.

The study is one of the most important examples made in Turkey within the scope of landscape restoration works on river banks.

3.1.9. Yeşilirmak Havzası Peyzaj Atlasının Hazırlanması Projesi exchange of soil carbon storage in riparian zone ecosystems (case study of Bolu Aladağ catchments) (2017)

In the doctoral thesis prepared by Yılmaz (2017), the variation of organic carbon and some soil properties according to the distance from the stream was investigated in different Land Use Type / Land Cover (AKT / AO) soils in the waterside ecosystems of the Aladağ Stream basin (Bolu). The main objectives of the research are to 1- determine the optimum zone width to be protected for carbon storage 2- determine the effects of different land use types on carbon storage capacity, 3- contribute to the creation of the most appropriate land management plans. Within the scope of the study, the optimum zone width in terms of carbon storage capacity is 125 m in DM and OIA soils, taking into account the other soil characteristics, topographic and morphological characteristics, average groundwater depths and vegetation characteristics on the right and left shores of the main stream in Bolu Aladağ Stream Basin waterfront ecosystems. It is determined as 100 m in DO soils.

Study riparian ecosystems is one of the examples where soil properties are examined.

3.1.10. Ecosystems, restoration and stream rehabilitation (2016)

In the study prepared by Yıldız (2016), a general analysis is made of how riparian ecosystems affect the structures and functions of riparian ecosystems by specifying the structural and functional characteristics and services of riparian zones. Study aims to examine ecologically the arrangement of the inner parts of the riparian zones under stream rehabilitation. Structural and functional features and services of the riparian zones in general were specified and the condition of the extensions of these ecosystems passing through the settlements according to the natural systems was evaluated. The research area is Düzce province. According to the results of the study; it is recommended to review the studies carried out under the name of stream rehabilitation and transform them into ecosystem-based restoration, and to examine the historical reasons for the formation and functioning of local landscape and riparian ecosystems. Considering the demands of all stakeholders regarding these systems, the importance of defining the problem in order to achieve the targeted purpose and determining how the system will fulfill the desired function is emphasized.

4. DISCUSSION

In relation to the concepts of riparian ecosystems, coastal ecosystems, wetland ecosystems, and riparian management, it is seen that the word "riparian" has been used in postgraduate theses since 2010, in the document review conducted in the thesis scanning center of the Turkish Higher Education Institution (YÖK) (Table 1).

Number	Year	Phd/Master	Title
1	2017	Master	Effect of land use on erosion risk and chemical properties of soil of riparian zone of Andirin river, Kahramanmaraş
2	2017	PhD	Exchange of soil carbon storage in riparian zone ecosystems(case study of Bolu Aladağ Catchments)
3	2016	PhD	Syntaxonomical analysis of riparian vegetation of Porsuk Stream (Eskisehir-Kütahya)
4	2013	Master	Rapid riparian buffer width and quality analysis using LiDAR in South Carolina
5	2012	Master	Development of monitoring strategies to inform management actions in support of riparian ecosystem restorations: As applied to clover groff stream restoration
6	2010	Master	The Nile River water's sharing after 1990 three riparian country Egypt, Sudan, Ethiopia

Table 1. Postgraduate theses containing the concept of "riparian" in the thesis screening center of the Higher Education Institution (YÖK), Source: Anonymous (2021a).

Before 2010, studies on “riparian ecosystems” were used as the concepts of river banks, wetlands and coastal ecosystems. Through Google scholar, 17 studies including the concept of riparian ecosystems in Turkey could be accessed. Some of the available studies are explained in detail in the “Results” section.

Studies directly or indirectly related to riparian ecosystems prepared by the Ministry of Agriculture and Forestry, General Directorate of Nature Conservation and National Parks based on the European Landscape Convention (2003), were searched in the database of the ministry. The resulting projects are listed in Table 2.

Number	Year	Project Title
1	2008-2010	Konya province, Bozkır-Ahırlı-Yalılıhüyük Districts, Suğla Lake location, Landscape Protection, Management and Planning
2	2010-2012	Landscape Character Analysis and Evaluation in terms of Tourism and Recreation at Provincial Scale
3	2012-2015	Yeşilirmak Basin Landscape Atlas Project
4	2012-2013	Regaining to Nature, Landscape Restoration and Recreation Project
5	2018-2021	Büyük Menderes Basin Landscape Atlas Project

Table 2. Projects Related to the "Riparian" Concept in the Database of the Ministry of Agriculture and Forestry, Source: Anonymous (2021b).

When Table 2 is examined, it is seen that the most successful studies related to riparian ecosystems, which include a holistic assessment at the basin scale, and which develop concrete method proposals on Turkey's most river ecosystems and riparian areas, are of national importance, created with an interdisciplinary understanding, and supported by the Ministry of Agriculture and Forestry.

Giving more place to riparian ecosystems in the Ministry of Agriculture and Forestry, TUBITAK, Scientific Research Projects of Universities, Postgraduate theses and publications scanned in

international indexes is important in ensuring the sustainability and understanding the value of sensitive and richly diverse transition ecosystems such as riparian areas.

5. CONCLUSIONS

Within the scope of the study, the definition of riparian ecosystems, transition ecosystems, the importance and management of ecotone and riparian zone are mentioned. It is aimed to increase riparian ecosystem research with ecological, socio-cultural and managerial approaches at different scales by examining current projects, postgraduate theses and publications made in the last 10 years, directly or indirectly about the concept of riparian ecosystems made in Turkey at the national, regional and local level necessity is emphasized.

When the literature is examined and the occupational groups that deal with riparian ecosystems as a study subject are evaluated; forest engineering, landscape architecture, geography, biology and agricultural engineering professions seem to be one of the priority study subjects. When considered as sub-study fields; Remote sensing and GIS are distributed as land cover change, land use, forest botany, vegetation survey, silviculture, hydrobiology, coastal geography, biogeography, watershed management, landscape ecology, landscape restoration and landscape planning. There is a very limited number of studies in the fields of forest economics, forest policy and management.

It is one of the results of the study that the importance of studies on riparian ecosystems in Turkey began to be understood especially in the 2000s, and the researches intensified between the years 2010-2021. As of 2018, there are few studies emphasizing the understanding of the socio-economic importance of riparian areas and the participatory governance approach in these ecosystems. The number and quality of studies on the management of riparian ecosystems in Turkey should be increased. Participatory practices and participation levels should be increased and expanded in the management of Riparian ecosystems. In the riparian area planning studies to be carried out by public institutions and local governments, it should be implemented by using all the stages of informing the public, making joint decisions and giving authority.

When the studies on riparian ecosystems are evaluated in terms of scale, it has been observed that there are mostly studies on a single river or its branch at the provincial level, and the number of studies with a holistic approach is insufficient. On the other hand, there are also national projects prepared by the Ministry of Agriculture and Forestry, in which analyzes are carried out at the regional scale, at the basin level. It is seen that studies on riparian ecosystems, which are of national importance, are prepared as multidisciplinary and produced in collaboration with landscape architects, forest engineers, geological engineers, hydrologists, biologists, fauna and flora experts, geography experts, GIS and remote sensing experts, agricultural science experts and sociologists. Increasing the number of riparian ecosystems studies that include a multidisciplinary, interdisciplinary and transdisciplinary approach with a similar approach is important in ensuring the sustainability of riparian ecosystems, producing and transferring knowledge on the subject.

When Riparian ecosystems studies are evaluated in terms of method, purpose and scope, remote sensing and the use of GIS and temporal evaluation of land cover changes, determination of flora, fauna and vegetation, agricultural pattern analysis, ecological and structural solutions in river landscape restoration, determination of ecosystem services, indicators, it is seen that there are studies on field survey, modeling tools, phytoecological approaches, recreational opportunities, flood risk analysis, urbanization pressures, evaluation of the negative effects of human activities, socio-cultural issues, global climate change adaptation and water quality.

There is an urgent need in Turkey for studies that preserve the natural structure of rivers and riparian ecosystems, address the river systems holistically at the basin scale, prepared in interdisciplinary coordination, care about adaptation to global climate change, include up-to-date methods and approaches, and develop river-specific restoration proposals. It adopts the participatory approach as a principle, embracing all the river systems and 25 main river basins of Turkey from urban pressure, wrong land use decisions, legal, administrative measures, protection-utilization strategies, emphasizing raising

social awareness, addressing socio-cultural and ecological approaches together. It is seen that riparian field studies are insufficient in the national literature.

It is recommended to benefit from international experience on riparian field studies in Turkey. In this context, it is thought that the publications, working group meetings and project documents produced from the COST ACTION CA16208-Knowledge Conversion for Enhancing Management of European Riparian Ecosystems and Services (CONVERGES) project will guide researchers working on this subject. In order for riparian ecosystems and riparian management studies to become widespread in Turkey and for the protection of ecosystems, first of all laws, regulations and plan decisions against the protection of these areas should be cancelled. There is a need to create an inclusive policy in the form of a chain extending from the local to the national level, which handles river ecosystems with a holistic approach throughout the basin.

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