Chapter 21
River Corridors as a Refuge for Freshwater Biodiversity: Basic Information and Recommendations to the Policymakers for Possible Implications in Iraq

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Abstract Rivers provide a special group of benefits and services highly appreciated by the public that are intimately linked to their flow and its interaction with the landscape. Protection of a greater number of rivers and corridors is vital. This will need partnerships among multiple cohorts in the respective river basins and wise land-use planning to minimize additional development in watersheds with valued rivers. Ensuring environmental flows by purchasing or leasing water rights and/or altering reservoir release patterns will be needed for many rivers. Implementing restoration projects can be used to protect existing resources so that expensive reactive restoration to repair damage associated with any changing is minimized. Special attention should be given to diversifying and replicating habitats of special importance and to monitoring populations at high risk or of special value so that management interventions can occur if the risks to habitats or species increase significantly over time. The set of recommendations given will be considered the first step into the river management in Iraq, and policymakers should follow in order to conserve the freshwater biodiversity in Iraq.

21.1 Introduction

It has been known for a long time that rivers are characterized with high ecological value, but in contrary, they are highly endangered ecosystems (Palmer et al. 2010). Waterways that created for the sake of human transportation have the same characteristics (Wolter and Vilcinskas 1997).

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L. A. Jawad (ed.), *Tigris and Euphrates Rivers: Their Environment from Headwaters to Mouth*, Aquatic Ecology Series 11,
https://doi.org/10.1007/978-3-030-57570-0_21

Without any modifications to the rivers, flood control will become a serious matter as the case at the end of the last century, where 77% of the rivers in Europe, the Commonwealth of Independent States (CIS) and North America were seriously modified (Cowx and Welcomme 1998). The floodplains are considered as ecological corridors for species spreading and they provide home space, which results in remarkably high levels of biodiversity (Naiman and Decamps 1997). Vice versa, biodiversity is an important teamster of ecosystem functionality (MEA 2005; Naeem et al. 1994), and therefore, the functional biodiversity method has received increasing thoughtfulness during the last few years (Petchey and Gaston 2006). Ecosystem functioning is rather determined by the traits and characteristics of species than by mere species numbers (Díaz and Cabido 2001). In functional diversity research, the range and value of those traits (e.g. ability to fix nitrogen, growth form, and dispersal mode) are studied and used as a measure of biodiversity.

Biodiversity and functionality of riparian systems are intensely affected by human activities, which change the river body itself, such as hydromorphological changes, river impoundment, and water management (Naiman and Decamps 1997). In addition, change and intensification of human land use influence riparian systems (Méndez-Toribio et al. 2014). Together, these events caused the above-mentioned loss in floodplain space and functionality. Such changes have drawn the attention of the policymakers, starting with the Ramsar Convention on Wetlands (United Nations 1971), the European Habitats Directive (92/43/EEC, The Council of the European Communities 1992), the Convention on Biodiversity (CBD), and the Millennium Ecosystem Assessment (MEA 2005).

The similarity between artificial water bodies and rivers is simply trivial (Hatcher et al. 1999). Canals have a regular structure, a negligible flow velocity, and regulated water levels, with lack of the dynamics of the rivers (Willby et al. 2001). With such differences, they cannot deliver the same functions like riparian systems with respect to nutrient cycling or flood retention. Still they provide habitat space, increase the connectivity within a landscape, and thus might serve as migration corridors (Jesus Casas et al. 2011). Fish species might use canals as secondary habitats (Waltham and Connolly 2007; Wolter 2001) also invertebrate (Grumiaux and Dhainaut-Courtois 1996) for survival when their natural habitat is spoilt or vanished, as described (Gómez and Araujo 2008).

The aim of this chapter is to give basic information about the river corridors, their benefit, and their protection. At the end of the chapter, a set of recommendations have been given in order to be taken by the policymakers in Iraq to create river corridors and initiate river management for the conservation of the freshwater biodiversity.

21.2 The Contribution of Streams and Springs to Biodiversity in River Networks

The diversity of life in the streams and springs subsidizes to the biodiversity of a river system and its riparian network. Small streams differ widely in physical, chemical, and biotic attributes, thus providing habitats for a range of unique species. Springs species include permanent residents as well as migrants that travel to headwaters at particular seasons or life stages. Movement by migrant's links springs with downstream and terrestrial ecosystems, as do spreads such as emerging and drifting insects.

Even intermittent streams may support rich and distinctive biological communities, in part because of the expectedness of dry periods. The effect of springs on downstream systems emerges from their subsidizes that meet unique habitat requirements of residents and migrants by offering a refuge from temperature and flow extremes, competitors, predators, and introduced species; serving as a source of colonists; providing spawning sites and rearing areas; being a rich source of food; and creating migration corridors throughout the landscape. Degradation and loss of headwaters and their connectivity to ecosystems downstream endanger the biological integrity of entire river networks.

The biota living in streams and springs can be divided into five main groups: (1) species that are exclusive to these small ecosystems; (2) species that are found in these and larger streams, although their abundance may vary with stream size; (3) species that move into streams seasonally as the spring network expands and contracts or as downstream conditions grow less favourable; (4) species that spend most of their lives in downstream ecosystems, but require headwaters at particular life-history stages (e.g. for spawning or nursery areas); and (5) species that live around but not in headwater streams, requiring the moist habitat they provide or feeding on the products of headwaters (e.g. benthic, emerging, or drifting insects) (Meyer et al. 2007).

Streams and springs should always be connected to water bodies downstream. Such connectivity is important for the maintenance of species diversity in downstream ecosystems (Labbe and Fausch 2000). Among the ways that small streams maintain diversity in the river network is by providing a source of colonists for recovery of downstream systems following disturbance (Progar and Moldenke 2002). Small streams also provide movement corridors for plants and animals across the landscape. Their riparian zones provide cooler conditions than those found in the uplands (e.g. Richardson et al. 2005). The flight paths of adult aquatic insects are intense along streams and riparian zones, which serve as dispersal corridors (Petersen et al. 2004).

In spite of their sole assistances to and significance in preserving the diversity and functional integrity of entire river systems, small streams are continually under danger by human activity (Meyer and Wallace 2001). Threats may originate from groundwater extraction, which threatening species associated with small springs (Hubbs 1995), has caused tributaries of Kansas streams for example to go dry, resulting in the extirpation of 16 species from the river system (Cross and Moss 1987). Other land activities such as agriculture, urbanization degrade, and eliminate headwater habitats can also have an impact on small streams (Meyer and Wallace 2001). The increasing impact of damaged headwaters subsidizes to the loss of ecological integrity in ecosystems downstream. Small streams are thus a vital part of the biological integrity of our nation's waterways. Deprivation of headwater habitats and loss of their connections to larger streams have negative consequences not only for inhabitants of small streams but also for the diversity of downstream and riparian ecosystems.

21.3 River Corridors

A river corridor can be generally defined as the river and river channel together with their associated wildlife and the adjacent riparian ecosystem. The linear character of a river corridor is a vital aspect of its value for conservation, since river corridors link the uplands with the lowlands and may also link otherwise isolated habitats and populations (Gardiner 1991). The corridor, or linear subdivisions of the corridor (known as stretches), may thus be regarded as management parts. Since riparian vegetation frequently grades into adjacent habitats, the river corridor is a theoretical rather than a physical feature. The apparent width of the corridor is generally random because of this gradation and also varies along its length according to the form of the landscape and the nature of the adjacent vegetation (Budd et al. 1987).

Due to the complexity of biophysical interactions within river corridors, suitable classification systems that identify corridor units according to their character and sensitivity to management should be created. However, any classification system should take into consideration that the river corridors can be subdivided into units by clearly defined boundaries. The gradually varying nature of river environments both along and across their corridors tends to prevent the identification of clear boundaries, so a clash exists between describing the river corridor environment in a clear and actual way and introducing boundaries which are to some extent arbitrary.

The classification of river corridors may simply aim to describe what is there in a brief and actual form. Here, classification suggests the allocation of river units to a series of classes, whereas indexation can infer the estimation of the value of either a continuous or discrete index for each unit. Such classifications depend the collection of data on some aspect or aspects of the river corridor environment at an appropriate spatial scale or scales. Among the classifications, there are criteria about judgements of the value of particular river corridor units or in assessing their sensitivity to management.

The following are characteristics of any classification of the river's corridors need to be in order to support conservation and management decision-making: (1) include as many features of river channel and corridor form, process, and ecology as possible, so linking to the range of disciplines concerned with rivers; (2) include information on the dynamics of the fluvial system, so integrating a temporal viewpoint; (3) be capable of application at a range of spatial scales; (4) give reliable and reproducible results.

21.3.1 Planning to Build River's Corridor

The main aim of building river's corridors is for the persistence of biodiversity (Rouget et al. 2003). Also within the aim in designing corridors is to represent the biological gradients within each biogeographically distinct water catchment. Corridor design, therefore, focused primarily on ensuring biodiversity persistence (i.e. the long-term maintenance of ecological and evolutionary processes), on which the conservation assessment is founded.

The design of the corridor must contain the following four key functions in order to (1) maintain ecological processes (gradients) to enable movement of biota over ecological and evolutionary time scales; (2) ensure habitat retention and connectivity; (3) maximize wildlife habitat suitability; and (4) represent biodiversity pattern (to integrate biodiversity persistence and representation).

Corridors were developed in three phases: phase 1, primarily forced by biological process considerations, identified the core area of the corridor (referred to as "conservation paths"); phase 2 expanded the core area to develop representation of habitats and the persistence of processes; and phase 3 further expanded corridors into areas of high irreplaceability value for biodiversity pattern.

Phase 1: Recognition of the Area to Be Ecologically Assessed

The area that needs to be conserved should include upland-lowland and climatic gradients operating at a macroscale, which should show the following importance: (1) run through thicket vegetation types; (2) are not in transformed habitats (urban areas excluded from the analysis); (3) run through habitats highly suitable for wildlife; (4) include other process components (i.e. riverine corridors, biome interfaces, sand movement corridors); (5) tie protected areas; and (6) are not in areas likely to be transformed in future.

On the other hand, some criteria need to set in the process of designing the corridors that ensure the functionality of the selected areas. These relate to (1) the presence of thicket vegetation and its condition; (2) the occurrence of process components; (3) the degree of suitability of wildlife habitat; (4) the location of protected areas; and (5) future land-use pressures.

The cost of each criterion to develop is depended on the nature of the criterion itself, where criteria of higher rank override lower rank criteria (i.e. intact habitat was always more suitable than transformed or degraded habitat irrespective of wildlife habitat suitability).

An area of about 1 km wide needs to be reserved within single primary water catchments by attaching them to major river mouths and ending them at the northern margin. River mouths were selected because of key ecological processes associated with their estuaries and wetlands (Heydorn and Tinley 1980). Based on the landscape suitability surface, least-cost surface analysis identified the best option to link start and end points. Urban areas, including rural settlements, were excluded (i.e. the paths could not traverse urban areas).

Phase 2: Enlarging Conservation Path Along the Corridors
The area besides the corridors is known as "conservation paths." This area is recommended to be increased toward the corridor 1 km wide. It denotes a nearly optimal location and the bare minimum extent for conserving processes along upland-lowland and macroclimatic gradients. The reason of expanding such an area is to (1) buffer the conservation path; (2) include fixed process substitutes; (3) achieve targets for vegetation types; (4) select areas highly suitable for wildlife; and (5) include existing protected areas. The expansion was attuned to evade areas threatened by future land-use pressures

Phase 3: Enlarging the Corridors
The final step in designing the river's corridor is to explore the extent to which corridors could be expanded to capture areas of high irreplaceability for biodiversity. Irreplaceability values need to be recalculated starting from the current configuration of corridors (from stage 2). Considered the contribution of corridors to targets for biodiversity features should be accounted for assuming that each of the corridors was afforded conservation management relatively consistent with that of protected areas. The identified planning units were important for achieving remaining biodiversity targets.

21.3.2 How to Evaluate the Effectiveness of Corridor

In order to check the competence of the design of the corridor, it is always a good idea to compare the design with those of established and well-known corridors worldwide and in environment similar to that the corridor needs to be built in and compare the criteria: extent of natural area, thicket representation, achievement of pattern targets (vegetation types), achievement of process targets, and avoidance of land-use pressures (i.e. implementation constraints), and linkages to protected areas (implementation opportunities) (Rouget et al. 2006).

21.4 Public Awareness of River Corridors

It is an essential practice to make the people who live or own in the area where the river corridors will be built. Such move is different from the previous steps that used to be. The public input has regularly depended upon discussions involving formal meetings with interest groups and local politicians, but the means of public consultation are changing. With direct consultation with the public who are concerned with river corridors, the organization building these corridors now relies less on public meetings and increasingly more on a direct approach and involvement of the public.

The project of building river corridors will face huge problems if the owners of the areas or living in the areas where the corridors designed to be built in not have been consulted before starting the project. In Iraq, most of the areas where corridors need to be built in are either owned by tribes of people belonging to certain tribes living in the area. Dealing with tribe is major dilemma and settling such problem will need time and money. In the urban areas of Iraq, specialized research companies can do such survey and obtain the response of the public about the river corridor project.

House and Fordham (1997) have shown that there are an enlarged amount of research programmes in the area of public approaches to rivers and to river management. In order to get a direct response of the public, House and Fordham (1997) have suggested to use questionnaire surveys and semi-structured interviews with local residents living within a proposed project area or river catchment, which have also been mentioned by others (Tapsell and Tunstall 1994; Sawyer and Fordham 1994).

Among the issues that the public usually raise are the environmental factors in the management of rivers in general (Witherspoon 1994) and flood hazard management in particular. The public may not support the project of the river management if no sign of environmental sensitivity has been included in the project (Tunstall et al. 1994).

In order to reach a compromise in the public awareness about the river corridor, social surveys can form part of a public education programme, as participation in such interviews invariably leaves the participants both better informed, as information is often provided during the questionnaire survey, and more reflective than before, as few people will previously have spent an hour or more deliberating on the issues raised by the survey.

21.5 Protection of River Corridors

The lands contiguous to river channels are important to aquatic and terrestrial ecosystems (Smith et al. 2008), offer vital ecosystem amenities (Postel and Carpenter 1997), and are socially important (Millennium Ecosystem Assessment 2005). The worth of river corridors to both aquatic ecosystems and public safety has led the governments and organizations looking after the river corridors in the world to invest substantial time and capitals to establish a river corridor protection programme over the past decade. This approach goes beyond the customary view of buffers as land use setbacks to maintain water quality. For such a protection programme, geomorphic-based river corridors are being established to maintain natural channel form and functions, as well as serious ecosystem services such as flood and erosion hazard mitigation.

According to several research performed in the field of river management and in particular in protecting river corridors (Kline and Cahoon 2010), there are two chief mechanisms for such protection process: (1) state and municipal land-use restrictions on development within defined fluvial erosion hazard areas; and (2) a programme to support the purchase of development and channel management rights in river corridor conservation easements. The purpose of establishing this easement is to give the river the space to re-establish a natural slope, meander pattern, and floodplain connection.

21.6 Recommendations to the Policymakers in Iraq About Creating River Corridors in Their Country

In this chapter, the author has aimed to deliver to the reader a programme for protecting river corridors. The following recommendations were composed from researches such as Fischer and Fischenich (2000) and Wenger and Fowler (2000) on the issue of river management and modified to fit the environment of Iraq.

1. Initiate a public information campaign to explain the benefits of river corridors.
2. Identify critical river corridor areas in which existing land uses may pose a threat to water quality. Such areas include cattle watering spots, areas where chicken waste is applied to fields, older homes with septic drain fields, etc.
3. Identify high-priority wildlife habitat areas, historic or prehistoric sites, and other.
4. Create limits on waterproof surfaces to control run-off.
5. Properly impose erosion and sedimentation control statutes.
6. Adjust the jurisdiction's existing flood damage prevention ordinance to include importance of the importance of limiting floodplain development for purposes of flood storage, water quality protection, and wildlife habitat preservation. Prohibit activities in the floodplain that could directly threaten water quality, including application of fertilizers and pesticides, siting of animal waste lagoons, and disposal of hazardous materials, including motor oil.
7. Establish a turbidity standard to monitor erosion and sedimentation control and river corridor effectiveness in the area selected.
8. Think at a watershed scale when planning for or managing corridors. Many species that primarily use upland habitats may, at some stage of their life cycle, need to use corridors for habitat, movements, or dispersal.
9. Continuous corridors are better than fragmented corridors.
10. Wider corridors are better than narrow corridors.
11. Riparian corridors are more valuable than other types of corridors because of habitat heterogeneity, and availability of food and water.
12. Several corridor connections are better than a single connection.
13. Structurally diverse corridors are better than structurally simple corridors.

14. Native vegetation in corridors is better than non-native vegetation.
15. Practice ecological management of corridors; burn, flood, open canopy, etc., if it mimics naturally occurring historical disturbance processes.

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