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Evaluation of anthropogenic stress on ecological quality of riparian habitat of Kolar River

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Abstract
Riparian zones are among the major ecologically valuable ecosystems due to their abundant richness in biological diversity and services. The present study was conductedon Kolar River, in a stretch of about 80 kms to assess the ecological quality of riparian habitat using *qualitat del bosc de ribera* (QBR) index. In this study, QBR index has been used to determine the riparian habitat quality of Kolar River. The selected stretch (60 km) has been divided into eight different sampling sites. The on-site assessment has been carried out on the left and right banks of Kolar River on these sites using different parameters for assessment of riparian habitat quality like total riparian cover, cover structure, cover quality and channel alteration. These parameters have been analyzed and it was evaluated that some sites along the banks of river *viz*; (S1, QBR score = 75), (S3, QBR score = 85) (S3, QBR score = 80) and shows QBR score in between 75-90 (Green) which reveals good quality and some disturbance of riparian habitat whereas the sites S4, S5, S6, and S8 reflects QBR score of 70, 65, 60 and 55 respectively which lies in between 55-70 (Yellow) that determines fair quality and important disturbance of riparian habitat. Moreover, site seven (S7) shows (QBR score=50) in the range of 30-50 (Orange) which reflects strong alteration and poor quality of riparian zone. The current conditions of riparian zone were due to increase in anthropogenic activities like built-up, overgrazing, deforestation and expansion in agricultural activities. Human dependence as livelihood is being the major cause of the change in riparian zone of study area. Therefore, it is compulsory to save riparian habitat quality of Kolar River from further disturbances and degradation by anthropogenic pressures.

Keywords: Riparian habitat, ecosystem, Kolar River, QBR index, anthropogenic

1. Introduction
Riparian habitats are important ecological areas having rich biodiversity and provides important ecosystem services (Gurnell *et al.* 2012; DeVore *et al.* 2016, Pandey *et al.* 2022) [25, 26]. The ecologically functional riparian zone (ERZ) supports main ecological functions (Lind *et al.* 2019; Martin and Chambers, 2002; Naiman *et al.* 1993) [27, 28, 12]. The word 'riparian' is derived from Latin word '*riparius'* which means on the bank of a river (Naiman and Decamps, 1997) [29] "A riparian area can be defined as the transitional area between a river or stream and the adjoining upland vegetation, including both the stream channel itself and its surrounding land which influences due to fluctuating water levels" (Corbacho *et al.* 2003; Goebel *et al.* 2003; Seibert and McGlynn, 2005) [14, 16, 30] but they vary from upland in term of their hydrologic and soil characteristics. Riparian zone provides ecosystem services for riverine ecosystem and it also acting an important role for maintaining abiotic and biotic components. It provides shelter and food for fauna living nearby the river and helps in water filtration (Bunn and Arthington, 2002) [31] and aquifer recharge. Riparian zone helps in maintaining water quality, control sediment erosion (Noe & Hupp, 2009, flooding (Cadotte *et al.* 2011) [32, 53] & temperature control, decreasing hydrological risk and construct stable river banks (Fu *et al.* 2017) [15]. Two features that distinguish riparian ecosystems are the hydrologic interaction that occurs between the stream channel and adjacent areas through the periodic exchange of surface and ground water, and the unique geomorphic characteristics and vegetation communities living in response to this hydrologic interaction (Richards 1982; Kovalchik and Chitwood 1990; Gregory *et al.* 1991; Goodwin *et al.* 1997; Malanson 1993) [2, 4, 5, 6, 7].

Riparian areas are considered as one of the most productive ecosystems (Jansson *et al.* 2000) in the world, but are also among the most threatened (Brunotte *et al.* 2009; Dixon *et al.* 2016; Strokal *et al.* 2016; Ltifi *et al.* 2017; Wright *et al.* 2017; Knouft and Ficklin, 2017; Capon *et al.* 2013; Mohit and Samant 2012) [34, 36, 38, 37, 35, 8, 13].

Pressures on rivers and riparian zones are expected to increase in the coming decades due to human population growth, land use change, and climate change (Seager *et al.* 2013) [40] heightening the importance of strategic riparian management (Capon *et al.* 2013, Mello *et al.* 2017) [8, 10]. The reduction and alteration of riparian forests have resulted in habitat fragmentation and destruction of habitat of diversity in the river system (Ding *et al.* 2013; Ou *et al.* 2016; Yang *et al.* 2016; Zhang *et al.* 2013; Kuglerover *et al.* 2014) [43, 39, 41, 42, 44].

Assessment of riparian quality has been globally evaluated from decades by applying different protocols and indices. In this study, QBR index was suitable for the present study area. The QBR index ("*qualitat del bosc de ribera*" or riparian forest quality) is convenient to use field method for evaluation of the habitat quality of riparian forests. This index has been first developed for use in Mediterranean streams in Spain (Munne *et al.* 2003) [17]. This index is based on score and has been divided into four main aspects of the riparian zone *viz*; total riparian cover, cover structure, cover quality, and channel alteration. Its main focus is to contrast sites, to compare sites, to ideal conditions and to assess the success of restoration of riparian zone/riparian forests (Lakhera *et al.* 2020) [54].

1.1 Study Area

The present study has been carried out on Kolar River of Madhya Pradesh (M.P) of India. Kolar River rises in the Vindhya Range of district Sehore and then flows in a south-westerly direction to meet the Narmada River near Nasrullahganj which lies in the Raisen district of M.P. Its total drainage area of Kolar River is of 1,347 km^2 and has spread across the two districts in M.P. The upper part of the river basin lies at an elevation of 350-600 meters from MSL and much of it is under tropical deciduous forest area. The river debouches into the plains near Jholiapur. The map showing study area is given (Fig. 1).

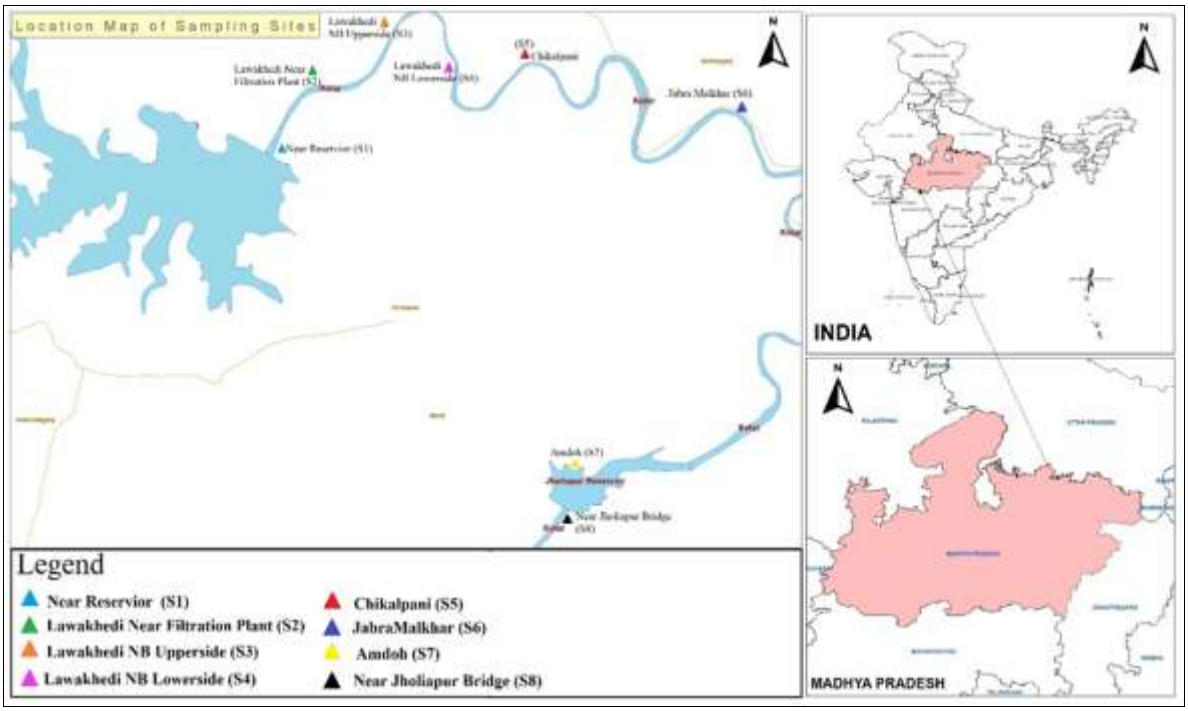

Fig 1: Showing location of sampling sites

2. Material and Methods

The qualitative assessment has been adopted for the analysis of study area. In this context, the study area has been divided into 8 different sampling sites *viz*; Near Reservoir = S1, Near Filtration Plant = S2, new bridge upper side = S3, new bridge lower side =S4, Chilkapani = S5, Jabra Malkhar = S6, Amdoh = S7 and Near Jholiapur Bridge = S8 (Fig. 1).

In the present investigation, the riparian habitat quality of Kolar River was assessed by using QBR Index Munne *et al.* 2003 [17] (Table 1). The QBR (*"qualitat del bosc de ribera"* or riparian forest quality) is convenient to apply in field method for assessing ecological quality of riparian habitat. This protocol was developed by F.E.M. (Freshwater Ecology and Management) research group of *Universitatde Barcelona* (Munne *et al.* 2003) [17]. The QBR index is based on four classes of a riparian habitat *viz.*, total riparian cover, cover structure, cover quality and channel alterations. Each category includes several attributes. The scores for each category range from 0 to 25, being 100 the maximum total score assigned to the highest quality and, representing five classes (Table 1).

Table 1: Quality ranges of riparian habitat as per the QBR Protocol (Munne *et al.* 2003) [17]

Riparian Habitat Quality Class	QBR Score	Colour
Riparian habitat in natural condition	>=95	Blue
Some disturbance, good quality	75-90	Green
Disturbance important, fair quality	55-70	Yellow
Strong alteration, poor quality	30-50	Orange
Extreme degradation, bad quality	<=25	Red

3. Result and Discussion

In the present study, riparian habitat quality of Kolar River was assessed by using QBR index, the parameters like total riparian cover, cover structure, cover quality and channel alteration were observed at all the mentioned sites of Kolar River. The study found well differences in the results from one location to another as shown in the table 2 and figure 2.

Table 2: Score of Riparian Habitat Quality of Kolar River by Using QBR Index

Categories	Score							
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**
Total riparian cover	25	20	25	25	20	15	15	15
Cover structure	15	20	20	20	15	15	10	15
Cover quality	15	15	15	15	15	10	10	10
Channel alteration	20	15	25	20	15	20	15	15
Final score	75	70	85	80	65	60	50	55
Riparian Zone Condition and Quality	Some disturbance, good quality	Disturbance important, fair quality	Some disturbance, good quality	Some disturbance, good quality	Disturbance important, fair quality	Disturbance important, fair quality	Strong alteration, poor quality	Disturbance important, fair quality

The analysis of riparian zone of Kolar River has been carried out on eight sampling sites using QBR protocol.

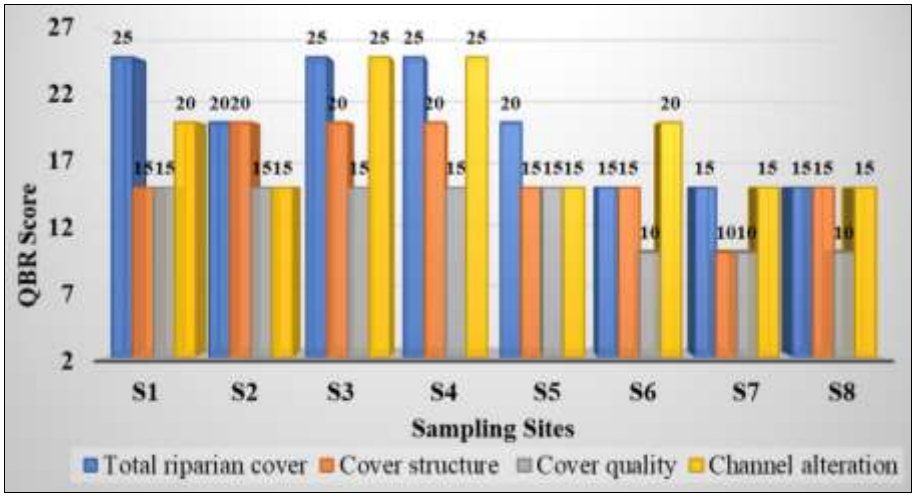

Fig 2: QBR score of riparian habitat quality of selected sites

According to the protocol (QBR index), strong alteration and poor quality of riparian zone was observed on one site (S7), little disturbance and fair quality of riparian zone was found in four sites (S2, S5, S6 & S8) with important disturbances and three sites (S1, S3, & S4) were found in good quality and some disturbances were observed in these areas (Figure 3).

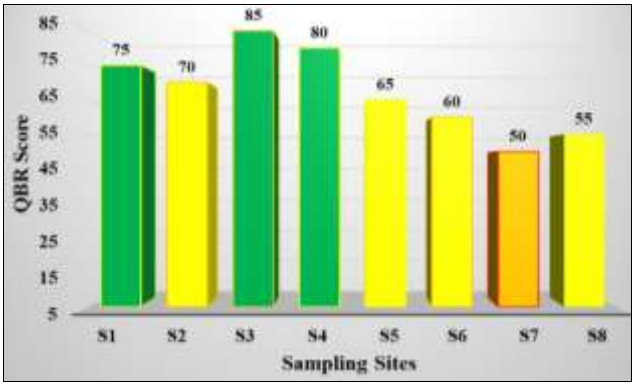

Fig 3: Final QBR score of riparian habitats at different sampling sites of Kolar River

On inclusive observation of the riparian zone, it has been found that 44% area of riparian zone was of good quality and possess some disturbance whereas, 46% area of riparian zone fall under little disturbance and of fair quality and remaining 10% shows poor quality and strongly altered riparian areas (Fig. 4). According to the study, disturbances on the riparian vegetation occur due to the changes in the land use pattern. Agricultural activities, overgrazing and deforestation are the main activities observed in the riparian area. The cultivation of crops on the banks of river is responsible for degradation of riparian area. Identical observations were reported in river Narmada using QBR index for assessing riparian zone quality on 25 stations in which, 13 stations fall under bad quality, 7 stations were found in fair quality, 4 stations showed very bad quality while only one station was in good quality of riparian zone (Kumar *et al.* 2019) [46]. Tembhare *et al.* (2018) [21] assessed the ecological quality of riparian habitat of streams of Narmada River basin using QBR index to evaluate the riparian habitat quality of Barna and Jamner streams during the carried-out study on the left and right banks of the streams. They observed that Barna stream showed fair riparian quality due to the presence of a large number of trees whilst, Jamner stream fall under bad riparian quality due to anthropogenic pressure.

The fifth longest river of China, Songhua River, which showed 60% of the riparian zone, was disturbed by human activities like build-up and farm land contraction (Bolin *et al.* 2017) [47]. Degradation of riparian zone in Kaliyadeh stream the tributary of River Narmada in the central zone was reported by Pandey *et al.* (2015) [48], the same was observed at Bhahner River by Bahsir *et al.*, (2015) [49] and Chandni Nalla by Chaurasia, *et al.*, (2015) [50]. Expansion of agriculture practices on the banks of Chandni Nalla was also reported by War *et al.*, (2014) [51] which are more responsible for soil erosion and ecological degradation of a stream/River. Poor qualities of riparian zone of River Narmada through the dominance of agricultural activities were also stated by Vyas *et al.*, (2012) [52].

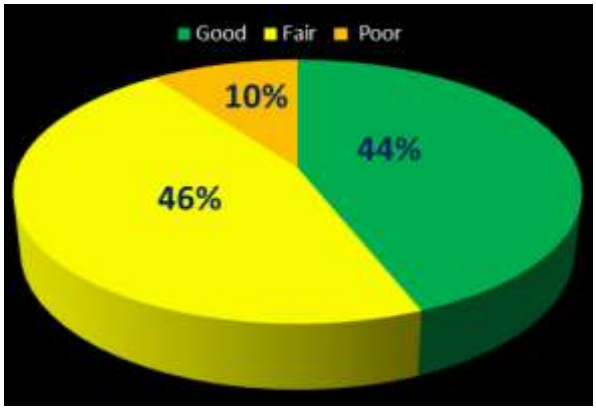

Fig 4: Graphical representation of status of riparian quality

4. Conclusion

In this study the riparian habitat quality assessment has been evaluated using QBR index for assessing the different parameters such as total riparian cover, cover structure, cover quality and channel alteration. It was observed that some of the selected locations represent good quality, some locations reflect fair and some signifies poor riparian habitat quality. It has been suggested that the riparian vegetation cover of Kolar River needs improvement and rejuvenation besides plantation. Moreover, this study clearly predicts that the land use pattern and riparian conditions have profound effect in determining riparian habitat quality. So, it becomes compulsory to protect the riparian habitat quality of Kolar River from further disturbances and degradation by anthropogenic pressures. Therefore, government should categorise this area as protected area and give necessary attention for restoration of aesthetic value and well planning for maintain overall quality of Kolar River. Moreover, proper management and policies should be framed for the settlement of human habitation along the buffer zones of the river network which will help in saving the ecology as well as aesthetic value of Kolar River.

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