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# Ecological Health Assessment of River Sip, a Tributary of Central Indian River Narmada by Using Habitat Assessment

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**Abstract**

Habitat study is one of the most important tool for assessment of fish survival as it defines their health and abundance. The objective of this study is to assess the impairment of river ecosystem by the anthropogenic activities. For evaluating the aquatic health, physical habitat condition was taken as a tool. Sip River is a Tributary of River Narmada which is a Central Indian River, joining Narmada at right bank just upstream of Indira Sagar Reservoir. Seven sites were selected from the sip river. In the present study, the physical habitat condition was assessed by using Rapid Bioassessment Protocol (RBP's) in terms of visual assessment. It is found in the study that the two sites are Optimal, two sites are suboptimal and three sites are Marginal. The change in land use pattern and increasing developmental activities near the banks is affecting the habitat of the organisms residing in the aquatic ecosystem.

Water is the primary need of all living organisms. It provides the habitat for the aquatic communities. The habitat includes the biological, chemical and physical properties of an ecosystem which directly and indirectly affects the existence of the resident species. The habitat assessment includes complex and dynamic properties of the physical structure of the aquatic ecosystem. The physical habitat is majorly affects the instream organisms of the aquatic ecosystem.

The Rapid Bioassessment Protocols (RBP)[3] has been used as a tool to assess the integral health of the aquatic ecosystem[9]. The study of physical habitat is one of the important factor in the bioassessment protocol. Physical habitat is a potential technique to evaluate the perturbation in the aquatic ecosystem. For the study of physical habitat, a visual- based habitat assessment approach has been used to measure the degree of disturbance in the stream and river[3]. This approach is minutely observes the condition of the site by taking into consideration several attributes. The assessment scoring includes the observation of channel morphology, riparian cover, substrate structure, bank stability etc.

In the present study river sip, a

Table-1: Sampling site details with their geographical information

| S. No. | Sites | Longitude | Latitude | Elevation |
|---|---|---|---|---|
| 1 | Devpura | 76°59'83.4" E | 22°54'42.9" N | 517 |
| 2 | Kaliyadev | 77°05'58.7" E | 22°54'27.0" N | 442 |
| 3 | Kosmi | 77°08'74.4" E | 22°51'76.9" N | 362 |
| 4 | Ambha kadim | 77°11'28.5" E | 22°47'68.8" N | 319 |
| 5 | Chhapri | 77°11'51.7" E | 22°47'69.8" N | 298 |
| 6 | Pandagoan | 77°11'33.7" E | 22°38'63.1" N | 278 |
| 7 | Satdev | 77°15'06.5" E | 22°34'78.4" N | 270 |

tributary of River Narmada has been selected for the habitat evaluation. The Sip River joins in the Narmada at right bank just upstream of the Indira Sagar reservoir. In this, habitat assessment parameters were scored according to the available condition for each section and were categorized under four conditions *i.e.* optimal, suboptimal, marginal and poor. According to the protocol, each parameter has a given score *i.e.* for poor condition category 0-5, marginal 6-10, suboptimal 11-15 and optimal 16-20. All seven parameters were scored according to their condition category and after giving proper scores to each parameter of a reach these scores were summed up to get a total score which in turn gave an integrated picture of the reach.

Sip is a long perennial tributary of Central Indian River Narmada which is the fifth longest river of the country. The river sip has the origin from the Ramdasi village at Ichchawar block of Sehore district of Madhya Pradesh and confluences with Narmada River at Satdev village of Nasrullaganj Block of Sehore District (Shown in Map-1). The details of the sampling sites (Shown in Map-2) selected during the research work are given in Table-1 along with the geographical details.

*Habitat Assessment:*

The habitat quality was assessed by using Visual - Based Rapid Bioassessment Protocol for streams. Seven parameters have been selected for the study and each parameter has given four condition categories on the basis of the suitability of health. The most suitable and pristine site has given the optimal category and the most polluted and impaired site has given the poor category. The integrated scores for habitat suitability conditions are given in table-2.

Table 2: Integrated scores for habitat suitability conditions

| S. No. | Condition categories | Total scoring |
|---|---|---|
| 1. | Optimal | 106-140 |
| 2. | Suboptimal | 71-105 |
| 3. | Marginal | 36-70 |
| 4. | Poor | 0-35 |

The habitat assessment scoring of each sampling station for the entire reach was evaluated. The scoring of each section (sampling reach) is given in table-3. In the present study it has been found that the sites 1

and 3 are optimal, 2, 6 and 7 are sub-optimal and 4 and 5 are marginal.

*1. Epifaunal substrate/Available cover :*

It is the variety of substrates including different sizes of rocks, parts of fallen trees which serve as a habitat for various organisms as well as food for feeding and spawning ground[7]. In the present study, the sites 1,2 and 3 are optimal as they are the most pristine and falls under the less disturbed area, while sites 5 and 6 are sub-optimal and sites 4 and 7 are at the marginal category.

*2. Pool substrate characterization :*

This parameter helps in evaluating the condition of the substrate type within the reach. The vegetation and root mat with the firmer sediment such as gravel and sand supports several invertebrates and fishes. The availability of different size and type of substrate and their mixture in the pool supports more biodiversity rather than the similar or less substrate type[4, 13]. In the present study, site 2 and 3 are optimal, 1, 4, 6 and 7 are sub-optimal and 5 is marginal.

*3. Pool variability :*

Pool variability is the presence of varied pool type within the reach. As per the protocol there are four types of pool types; large-shallow, large-deep, small-shallow and small-deep. Classified on the basis of size and depth, these pools exhibit different type of habitat for the survival of different types of species. In the present study, sites 1 and 3 are optimal, sites 2,4,6 and 7 are sub-optimal and site 5 is marginal.

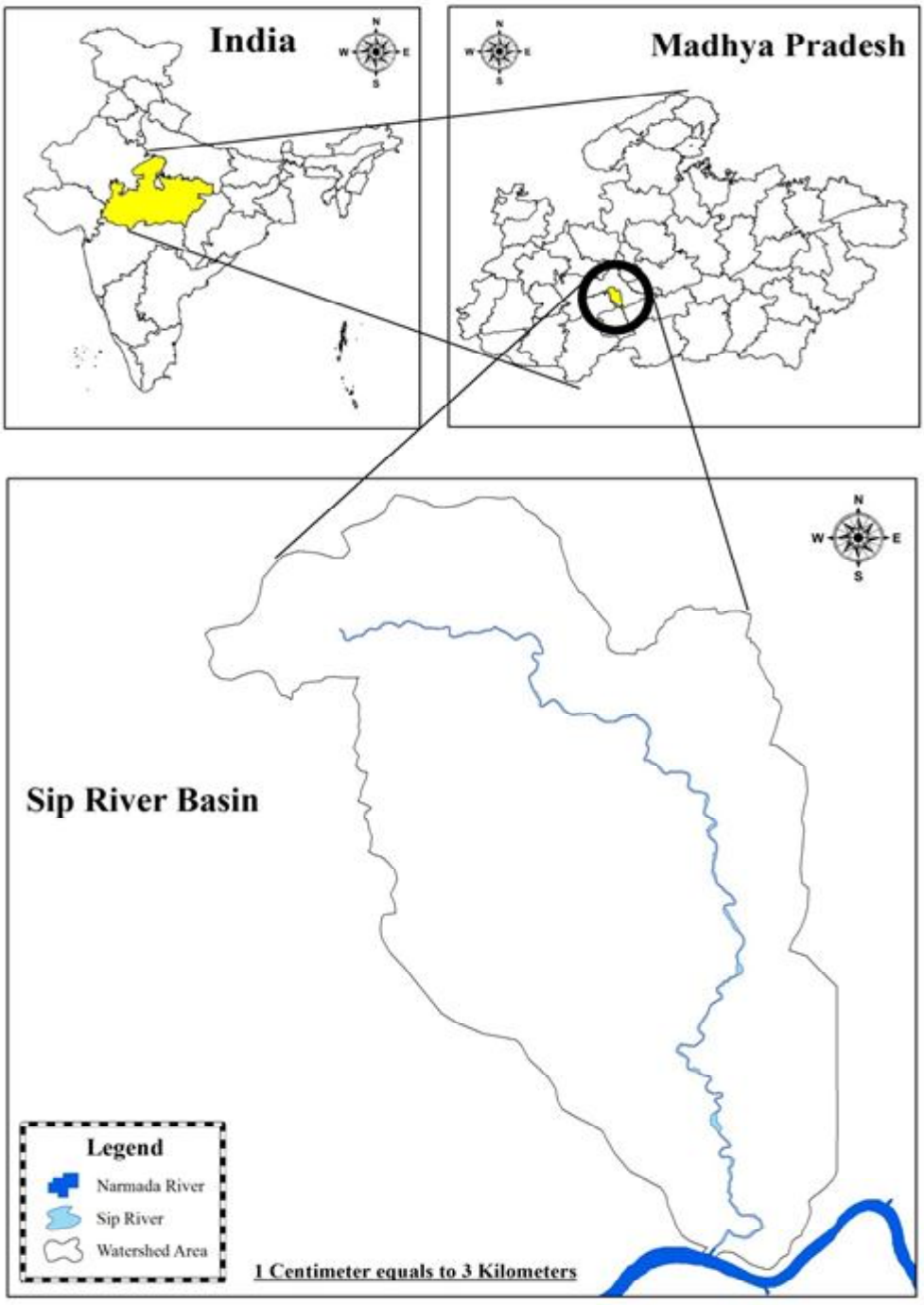
*4. Sediment deposition :*

The sediment deposits in the stream gets accumulated in the bottom of the pools which leads to the formation of enlargement of islands and point bars. Such type of accumulation of sediment creates difficulties for the survival of many organisms as it abrupt the flow and disturbs the natural process of stream flow[2,11]. During this investigation, sites 1, 2, 3 and 6 were optimal; sites 4, 5 and 7 are sub-optimal.

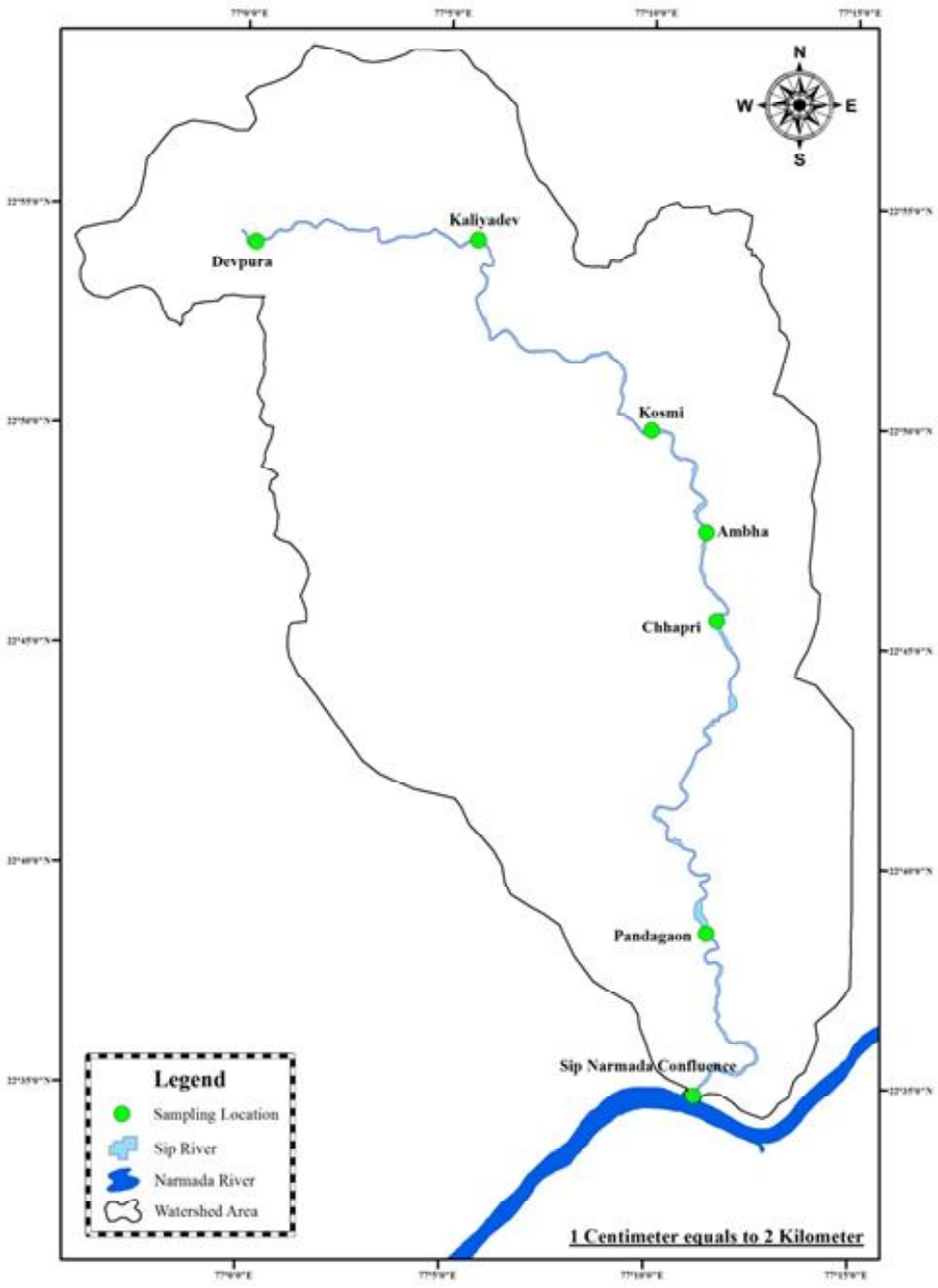
Table-3: Scoring of Habitat Assessment Parameters of Sip River

| S. No. | Habitat Assessment Parameters | Section -1 | Section -2 | Section -3 | Section -4 | Section -5 | Section-6 | Section-7 |
|---|---|---|---|---|---|---|---|---|
| 1 | Epifaunal Substrate/ Available Cover | 17 | 18 | 19 | 10 | 11 | 15 | 10 |
| 2 | Pool Substrate Characterization | 14 | 16 | 18 | 13 | 9 | 14 | 13 |
| 3 | Pool Variability | 18 | 12 | 17 | 12 | 7 | 15 | 14 |
| 4 | Sediment Deposition | 20 | 17 | 16 | 11 | 13 | 19 | 15 |
| 5 | Channel Flow Status | 17 | 16 | 14 | 11 | 12 | 19 | 17 |
| 6 | Channel Alteration | 19 | 14 | 17 | 9 | 11 | 18 | 15 |
| 7 | Channel Sinuosity | 16 | 10 | 17 | 6 | 4 | 4 | 4 |
| Total Score | | 121 | 103 | 118 | 61 | 70 | 104 | 88 |
| Habitat Suitability Condition | | Optimal | Sub-optimal | Optimal | Marginal | Marginal | Sub-optimal | Sub-optimal |

Map- 1 Showing the location of the River Sip



Map- 2 Showing the sampling stations of the River Sip



*Channel flow status :*

It is a measure of degree of water available in the channel. When the channel is filled with water reaching both the banks (left and right) of the stream, creates good quality habitat for the organisms to survive. On the other hand, the channel with low water availability creates limited habitat and space for the aquatic organisms for their living[12]. In the present study, sites 1,2,6 and 7 are optimal and sites 3,4 and 5 are sub-optimal.

*Channel alteration :*

An aquatic ecosystem witnesses several geological and physical changes. For the agricultural practices and anthropogenic activities, the streams are diverted, deepened, or straightened. Such unnatural changes made in the stream results in lesser diversity and fewer habitats for the suitability of organisms. Dam and bridge construction, artificial embankments and riparian zones destruction are the causes for the channel alteration[8]. The present investigation shows sites 1, 3 and 6 under optimal, while sites 2, 5 and 7 as suboptimal and site 4 as marginal.

*Channel sinuosity :*

Channel Sinuosity is simply the meandering of a stream observed in the whole reach. The meander pattern of the stream exhibits its potential to provide better and stable condition for the flora and fauna. Each meander increases the stream length and makes it longer than the straight channel. A non-shifting, highly stable channel that does not characterize any modification apart from the few temporary changes[5,6]. In the present study, sites 1 and 3 are optimal, sites 2 and 4 are marginal and sites 5,6 and 7 exhibited poor category condition.

All the condition categories have interrelation with each other and support the sustenance of whole ecosystem and its Functioning[13] . Vyas *et al.,*[14] worked on river Denwa, a tributary of River Narmada recommended that while assessing the ecological conditions, bioassessment protocols are the major determinant of the habitat and its biological potential. [1]Anomodin *et. al.*, worked on the similar approach and showed that the river bank erosion and sediment accumulation on the banks is majorly caused by urbanization. Kim and An[9] observed that poor epifaunal substrate and pool substrate conditions in the upstream and found that channel alterations and sediment depositions are the causes of impaired habitats. The current research work also suggests that urbanization, agricultural activities and anthropogenic disturbance are the major causes behind the stream impairment.

The habitat estimation and assessment by using its physical conditions were studied in the river Sip and observed the quality of the each sampling reach. Sampling sites were observed by using Visual Based Rapid Biomonitoring Protocol and ranked in the order of health accuracy as Optimal, Suboptimal, Marginal and Poor. It is recommended in the present study that for the evaluation of health assessment of river ecosystem, bioassessment protocols are beneficiary due to their potential relation with the aquatic communities.

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