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Effect of Flow on Vegetation

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Abstract

Plant species and its parameters along the Left Hand Bank and Right Hand Bank of Mula River for the selected locations were collected for the study the effect of flow on vegetation using PCA (Principal Component Analysis). The order of importance of each parameter was calculated, and it is observed that the most significant location is RahuriBudruk, followed by Manori, Baragaon Nandur and Valan.

Keywords: The order of importance of each parameter was calculated

Introduction

Vegetation is a dominant part of most riverine ecosystems. Riparian vegetation stabilize river channels, banks and floodplains; contribute towards the attenuation of floods; influence water temperature and quality; and provide habitat, refuge and migration corridors for terrestrial and aquatic fauna. The structure, composition and overall condition of the vegetation determine the degree to which it is involved in ecosystem functioning. The ecosystem also provides many resources used by man, including food. Plant roots bind the surface of the soil to varying extents, providing resistance to erosion by water. Shrubs and trees are deeper rooted and can utilize subsurface moisture. They tend to survive for longer periods and their permanent cover lends longer term and greater stability to the land. Plants by their presence offer resistance to the passage of water. Dense and overhanging vegetation creates shade that results in cooler water and reduced fluctuations in temperature. Most trees and shrubs that line waterways are restricted in distribution to the riparian zone and a typical of the larger environment. ***Kent and Coker (1992)*** stated that the vegetation is important in ecology for three reasons: Vegetation usually is the most obvious physical representation of an ecosystem. Vegetation is the result of primary production where solar energy is transformed through the process of photosynthesis. The vegetation is important in the food web as it is usually the primary food source; Vegetation forms the habitat in which organisms of other types than plants live, grow, reproduce and die.

Effect of Flow on Different Vegetation

Information on the effect of flow on vegetation species along riverine environment is scanty. Therefore, the present experiment was designed to study the effect of flow on vegetation species along the river reach of selected locations had been carried out.

Davies and Day (1998) stated that the rivers are isolated geographical entities and are therefore the focus point in the environment where biological diversity occur and can therefore be seen as genetic resources. The vegetation that occur in the riparian areas influence theamount and nature of the organic matter input into the streams and rivers, which is an important source of food and therefore play an important role in the food webs. Furthermore, the riparian vegetation has the ability to influence the chemistry of the water in the river by either intercepting chemical ions or by retaining nutrients from the catchment before they reach the river. The vegetation also has an influence on the net water yield from the catchment and therefore influences the river's discharge levels. Lastly, the vegetation also play a role in the physical channel morphology as the bank stabilization by roots and the formation of partial or complete woody debri dams are important in shaping the rivers.

Although the diversity of flowering plants, in the aquatic environment, are quite low, the riparian zones have abundant species of plants that are dependent on the seasonal water of the rivers which inundate the riparian zone. One also has to take into account that riparian zones are nutrient rich due to the high water levels of the system. The river is then influenced by the plants as dense stands of vegetation reduce the velocity of the water current which in turn leads to an increase in sedimentation ***(Giller and Malmqvist 1998).***

Riparian corridors have high numbers of plant species and may support a significant portion of the flora present in the area ***(Keddy 2000)***.

Material and Methods

Experimental Site and Data Acquisition

Mula Basin is situated at 19º 21′30″ N latitude, and 740 34′30″ E longitudes at 555.650 m above mean sea level, as shown in Figure 1. The Mula rises on the eastern slopes of the Sahyadri between Ratangad and Harishchandragad. It flows parallel to the Pravara; for the first 25 km, draining the southernmost Kotul valley of Akola taluka. The river is incised in a deep valley almost from its source and its steep valley-sides are highly dissected by deep gullies formed by mountain torrents which rush into the main stream. Skirting the large market village of Kotul it takes a bend to the south, winding past the rocky precipitous slopes at the foot of Baleshwar hills. It then flows through the south-west parts of Sangamnertaluka and follows an easterly course between Shevgaon and Parnertalukas flowing in a deep bed between rugged hills on the north and the tableland of Vasunda on the south. It then takes a sudden turn to the north-east and enters the plains in the same direction for another 30 km. It joins the Pravara at the village of Tilapur. The total length of the Mula River from its source to its confluence with the Pravara is 145 km; except in lower parts of its course on account of an entrenched course, its water is used for agriculture only in alluvial flats on the foot of the rugged ledges jutting into the river-bed. Fourteen stations were selected along the Mula River.

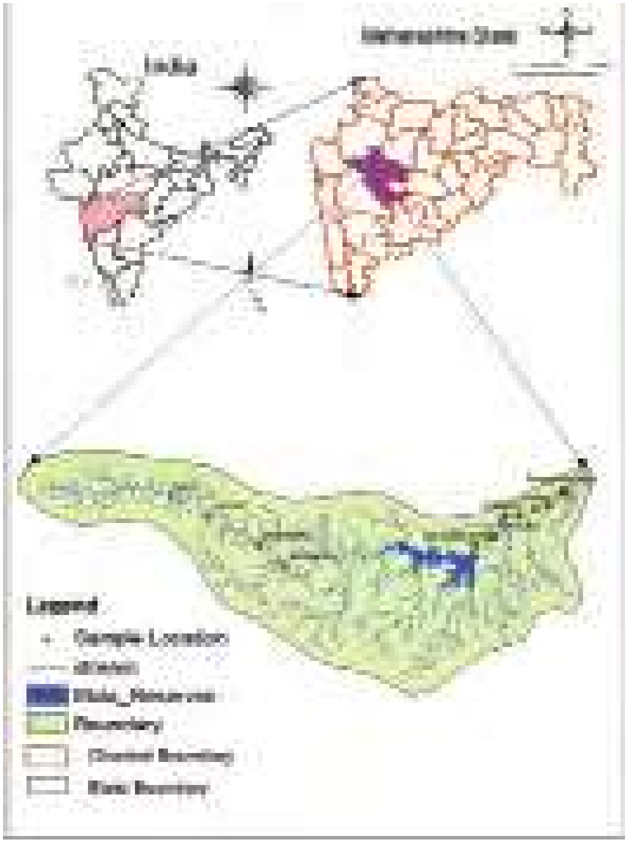
Climate and Rainfall

The climate of the Ahmednagar district is hot and dry in general. The maximum temperature recorded in the month of May rises to 40°C, while the lowest temperature recorded in the month of January goes down to 5 - 8°C. The district is one of the drought prone districts of the state due to uncertain and uneven distribution of rainfall. It receives an annual average rainfall of about 556 mm. The rainfall varies between 360 mm in Pathardi tehsil to 1034 mm in Akole tehsil. However, rainfall in Akoletaluka receives higher rainfall as compared to other tehsil of the Ahmednagar district. The cold season in the district commences from December and ends in the month of February. The period from March to the 1st week of June is the hot season which is followed by southwest monsoon season which lasts till the end of September; October and November constitute the post monsoon season.

Statistical Analysis

Effect of flow on Vegetation

Riparian vegetation is one of the three biotic components commonly applied in Building Block Method (BBM) for the overall assessment of EFRs, the other two being aquatic invertebrates and fish. Unlike these other biotic components, which are primarily good indicators of low flow requirements, the vegetation is a good indicator of both low flow and high flow requirements. Depending on the characteristics of a river reach, riparian vegetation commonly occupies a range of positions relative to the river channel. Marginal vegetation in the form of mesic grasses and sedges is often found on the edges of the wetted area, while other herbaceous and woody species may occupy this area as well as others further away from the river, on the macro-



Mula Basin Map with selected fourteen locations

channel floor or macro-channel bank. Under this vegetation species with its parameter from the Left Hand Bank (LHB) and Right Hand Bank (RHB) of river reach were collected for the selected fourteen locations along the Mula River.

Principal Component Analysis

The main objectives of the principal component analysis are to refer the dimension of a complex multiplicative problem. The Principle Component Analysis (PCA) approach is used for developing composite index. The component analysis takes the correlation matrix into account and produces components. Principal components are the linear combinations of random of statistical variable which have special properties in terms of variances. The component analysis produces components in descending order of their importance from obtained composite index.

Inter-correlation among Parameters

The inter-relationships among selected fourteen locations with its parameters are obtained by using SAS 9.3 software. The inter-correlation indicates that some of the information contained in one variable is also contained in some of the other remaining variables. Interrelationships among the selected thirteen dimensionless parameters are used later in the analysis. The inter-correlation matrix of the geomorphic parameters is obtained by using the following procedure:

1. The parameters are standardized

$$x = \frac{(x_{ij} - x_j)}{S_j}$$

where,

x, denotes the matrix of standardized parameters,

x_{ij} = i^{th} observation on j^{th} parameter

i = 1, ……………, N (no. of observations)

j = 1, ……………, P (no. of parameters)

x_j = mean of the j^{th} parameters

S_j = standard deviation of the j^{th} parameters

2. The correlation matrix of parameters is the minor product moment of the standardized predictor measures divided by total number of observation as

$$R = (X' \times x) / N$$

where,

x′ denotes the transpose of the standardized matrix of predictor parameters

The analysis of the correlation structure and the results are presented in the Results and Discussion chapter.

Principle Component Loading Matrix

The next step after evaluating inter-correlation matrix is obtaining principle component loading matrix from correlation matrix using SAS 9.3 software. The principal component loading matrix reflects how much a particular parameter is correlated with different factors. The first principal component is that linear combination of the original variables which contributes a maximum to their total variance; the second principal component, uncorrelated with the first, contributes a maximum to the residual variance, and so on until the total variance is analyzed. Since the method is so dependent on the total variance of the original variables. Principal component loading is applied in order to get better correlation and clearly group the parameters in physically significant components.

Development of Composite Index of Technology

The components of technology can be utilized for developing composite index of technology. A composite index is a single numerical value representing the net adoption of all components of technologies whose values lies in between 0 and 1.

PCA based on correlated was on matrix between k^{th} components of technology computed. A set of k^{th} components explaining 100% of total variation of all components of recommended technologies was considered correlation matrix where row represents variables and columns represents eigen vectors from which weight (wi) coefficients of components of technology say Σ was determined,

$$wi=\frac{Mi}{\sum Mi}$$

where,

Wi = weight or coefficient of component of technology.

Mi = maximum element in i^{th} row.

ΣMi = sum of maximum element in i^{th} row.

Order of Importance of Parameters

The order or rank of parameters according to their importance is given according to value of composite index. The composite index of technology is obtained in previous step are arranged in descending order and gives rank of importance of first to the parameter that having highest composite index of technology.

Results and Discussion

Effect of Flow on Different Vegetation

Riparian vegetation is one of the three biotic components commonly applied for overall assessment of Environmental flow requirement, the other two being aquatic invertebrates and fish. Therefore, the vegetation component is a good indicator of both low flow and high flow requirements

Plant Species

Depending on the characteristics of a river reach, riparian vegetation commonly occupies a range of positions relative to the river channel. Numbers of village wise plant species along the Mula River were recorded as per the format of procedure given in the BBM. Common plant species with its height, bank position on, surface subsurface stratum, vertical position and lateral position were collected in fourteen villages along the river.

Principal Component Analysis

The main objectives of the principal component analysis are to refer the dimension of a complex multiplicative problem. The method is described in the previous chapter as Principal Component Analysis. The principal component analysis was used to obtain the development of composite index. The results are discussed in the following sections.

Intercorrelation among vegetation species with its parameters

The vegetation species with its parameters are usually many times correlated. The correlation indicates that some of the information contained in one variable is also contained in some of the other remaining variables. For obtaining the intercorrelationship among parameters, which are used later as independent variables, correlation matrixes were obtained using SAS 9.3 software. The correlation matrix of the fourteen selected location along with its parameters reveals the strong correlations (correlation coefficient more than 0.9). Also, a good correlation (correlation coefficient more than 0.75) exist between, some more moderately correlated parameters (correlation coefficient more than 0.6). In the next step, the principal component analysis has been applied. The correlation matrix is subjected to the principal component analysis.

Principal Component Matrix

Principal components are the linear combinations of random statistical variable which have special properties in terms of variances. Component analysis produces components which are uncorrelated with one another, to bypass the problem of multi-co linearity. Eigen values of the Correlation Matrix are obtained from the Correlation Matrix using SAS 9.3 software. It can be seen from this table that all the components have eigen value less than 1. The eigen vector matrix was obtained from correlation matrix.In eigen vector matrix, row represents variables (dimensionless) and columns represent eigen vectors. From eigen vector matrix, weight coefficient of components of technology was obtained.

Order of Importance of Parameters

The order of importance of parameters was calculated by composite Index which is obtained in the process of obtaining weight coefficient of components of technology. The order of importance of each parameter is calculated and presented in Table 1. It is observed from Table 1 that most important selected location is RahuriBudruk, followed by Manori, BaragaonNandur and Valan. These four Locations observed to be the most important amongst all as per vegetation species

Table 1 Composite index and rank from the standardized data of fourteen villages along the Mula River

Village Name	Site Code	Maximum Eigen vector	Composite index	Rank
Kotul	RM-1	0.4398	6.66	8
LahitKhurd	RM-2	0.4316	6.53	10
Borbanwadi	RM-3	0.3398	5.14	12
MandaveKhurd	RM-4	0.5158	7.81	5
Mula Dam	MD-5	0.4503	6.82	7
BaragaonNandur	RM-6	0.5984	9.06	3
RahuriBudruk	RM-7	0.7028	10.64	1
RahuriKhurd	RM-8	0.2849	4.31	14
Deswandi	RM-9	0.4288	6.49	11
Aradgaon	RM-10	0.3065	4.6	13
Valan	RM-11	0.5340	8.08	4
Manori	RM-12	0.6501	9.84	2
Manjari	RM-13	0.4855	7.35	6
Panegaon	RM-14	0.4348	6.58	9
Total		6.6038		

along with its parameters.

Decline in Vegetation Population and Species

The systematic collection of vegetation species as per the format of BBM along the selected locations on left and right bank of Mula River observed maximum 40 species in Kotul location and minimum 29 species in RahuriBudruk location. On the basis of PCA, the composite index of Kotul and Rahuri Budruk was formulated to be 6.66 and 10.64 respectively.

Summary

Effects of flow on vegetation were worked out using Principal Component Analysis (PCA). Correlation matrices were obtained using SAS 9.3 softwarefor obtaining the intercorrelationship among parameters, which was used as independent variables. The order of importance of each parameter was calculated, and it was observed that the most favourable location is Rahuri Budruk, followed by Manori, Baragaon Nandur and Valan in terms of the vegetation. These four locations showed good vegetation along the banks of Mula River. However the stations Kotul, Lahit Khurd, Borbanwadi, Mandave Khurd, Mula Dam, Rahuri Khurd, Deswandi, Aradgaon, Manjari and Panegaon showed worst condition of vegetation, hence needs the attention to maintain river flow.

Conclusions

The vegetation species along the Mula River indicates that, Rahuri Budruk was most favourable followed by Manori, BaragaonNandur and Valan, as per the Principal Component Analysis. Decline of vegetation was observed at Lahit Khurd, Borbanwadi, Mandave Khurd, Rahuri Khurd, Deswandi, Aradgaon, Manjari and Panegaon stations. This is not because of nil flow, but the nil flow promotes the local communities for doing the unauthorized agricultural activities.

References

1. Ambasht, R.S. 1971.Ecosystem study of a tropical pond in relation to primary production of different vegetation zones. Hydrobiologia 12: 57-61.
2. Babu, K. L. and Harish Kumara, B. K. 2009. Environmental flows in river basins: a case study of River Bhadra. Current Science, 96(4).
3. Davies, B. and Day, J. 1998. Vanishing Waters. University of Cape Town Press. Cape Town, South Africa.
4. Giller, P.S. and Malmqvist, B. 1998.The biology of streams and rivers. Oxford University Press, New York.
5. Keddy, P.A. 2000. Wetland Ecology: Principles and Conservation. Cambridge University Press. United Kingdom.
6. Kent, M. and Coker, P. 1992. Vegetation description

and analysis. A Practical Approach. John Wiley and Sons Ltd. New York.

7. King, J. and Brown, C. 2006. Environmental flows: striking the balance between development and resource protection. Ecology and Society11(2): 26.

8. King, J. Brown, C and Sabet, H. 2003. A Scenario based holistic approached to Environmental Flow Assessments for Rivers. River Research Application.19: 619–639.

9. Kothari, S. K. and Mishra 2015.Environmental Flows Assessment by Drought Analysis. International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, 4 (4).