Trans. Inst. Indian Geographers
Vol. 26, No. 2, 2004

The Riparian Vegetation of Upper Nira and Kanand Basins

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Abstract

The vegetation is an important factor of drainage basin, especially the river channel, its form and processes leading to the development of fluvial systems. Since 1967, although considerable interest has been created in fluvial geomorphological aspects of drainage basin, the significance of vegetation has not been considered in an integrated way. It appears from recently published accounts of channel forms and processes that there is now a general agreement over the significance of vegetation in management of river channel. But the precise way in which this factor affects the river behaviour is still not very clear.

The aim of the present paper is to assess the significance of vegetation as a factor of fluvial geomorphology, in the upper stretch of Nira, a gravel bed river of Maharashtra. The findings were compared with another gravel bed stream from the same orographic, lithologic and geomorphic province-River Kanand with which the findings were collated. These differ from Upper Nira only in terms of its catchment area and length.

In its geographic expression the study implies the influence of a variety of channel variables on the bank vegetation in downstream direction. The associations and the correlations between these factors and the vegetation do reveal the complexity of environmental interactions.

Introduction

The channel form and the lateral stability of river depends on the strength of bank material, which is influenced significantly by the binding properties of vegetation on and near the river bank. Such vegetation is known as riparian vegetation. Riparian vegetation is stream-side vegetation and is controlled by geomorphological, hydrological and ecological processes together (Malanson G.P.1993). It is normally considered as a topical issue in flood plain geomorphology. An under-standing of the riparian pattern depends upon appreciation of environmental processes and river ecosystem.

The riparian systems worlds over have been affected by growing industrialization and change in land use pattern (Malanson G.P. 1993). There is always a linkage between the river sediment budget, woody debris, channel stability and erosion with the riparian vegetation. Primary hydrological process affecting the riparian vegetation pattern is the over bank flooding.

The importance of riparian vegetation lies in its ability to retain the floodwater by

acting as a filter. It can absorb nutrients and even improve the water quality. Riparian zones are identified as the corridors or pathways for the dispersal and migration of species.

Change in the landuse also causes the fragmentation of riparian habitats. The study of vegetation in the riparian zone is very significant from the point of view of river and flood plain management and planning.

It has been recognised that well vegetated banks are associated with lower form ratios than the, poorly vegetated banks. Although this relation is commonly given in many geomorphic writings it has not been a subject of any systematic study (Hickin 1984). Most of the evidences sited to prove this relation are of historical and qualitative nature except that by Baker (1995) and Bendix (1994).

The encroachment of vegetation into fluvial environment results in the contraction of the channel width. Some workers have stated that the bank vegetation reduces the tendency of the rivers to braid rather than meander. Whatever the situation, the controlling factor is not convincingly supported by the evidences. Hickin (1984) has identified that the riverbanks that are particularly bound by roots offer more resistance lateral erosion than the Simple unvegetated banks. The bank erodibility is very sensitive to the type of vegetation and root density. There is little doubt that vegetative effect is particularly important on low slope channels.

The influence of riparian vegetation is supposed to decrease after the width of channel equals or exceeds the height of trees on the bank (Gregory K.S. & Gurnell A.M. 1988).

It appears from the reported incidences of bank collapse and bank erosion that erodability is also a function of root density. According to one estimate bank erodability changes inversely and exponentially with root density (Thorne C.R. 1990). The influence of riparian vegetation is also assessed by studying the tendency of migration of channel. The tree or grass lined channels normally do not migrate but are widened or deepened.

The Study Area

The study area includes the upper part of main stream Nira and one of its major tributaries river Kanand. Nira is one of the major rivers draining a part of Bhor Taluka in Pune district whereas river Kanand is one of the major tributaries of river Gunjavani draining a part of Velhe Taluka in Pune district.

The Upper Nira drains the area between 73^0 36' and 73^0 51' east longitudes and 18^0 15' N and 18^0 11' N latitudes whereas river Kanand drains the area between $73^0$32' East to 73^0 45' E longitudes and $18^0$15' N and 18^0 20' north latitudes. Both the rivers originate in the high rainfall zones of Western Ghats of Maharashtra and flow over trappean landscape represented by basalt. The drainage of both the rivers is dictated by regional slope of upland Maharashtra

These adjacent watersheds are representative of upper reaches of most of the rivers originating in western ghat region of Maharashtra (Fig. 1).

The impact of human activities on the watershed is not completely ruled out but the interference is relatively minimum as compared to that in other rivers. Moreover

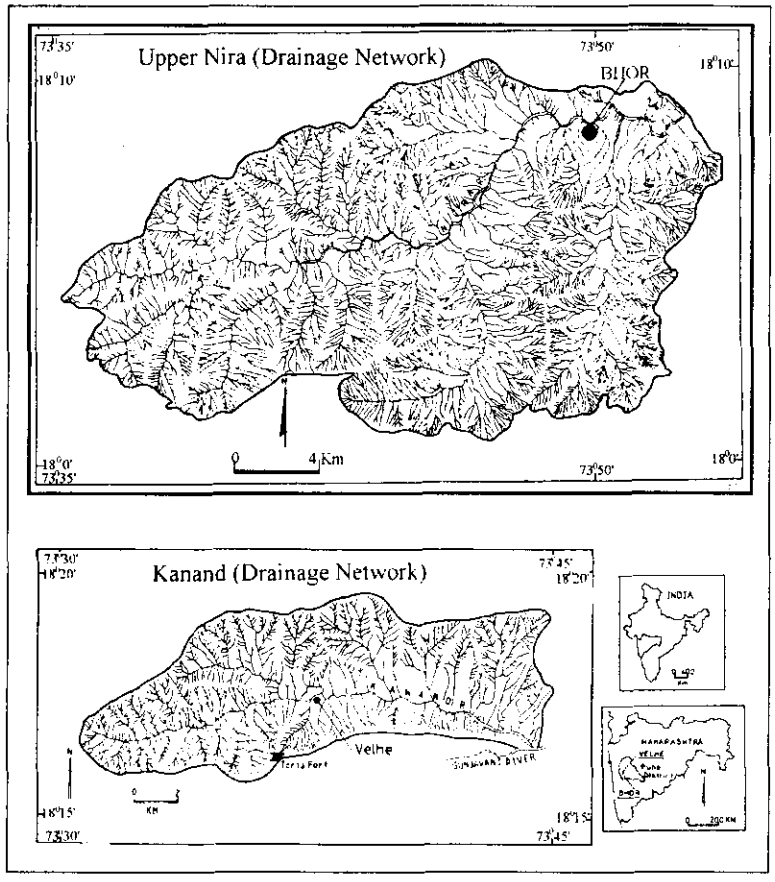

Fig. 1 Upper Nira and Kanand Drainage Network

study area of both the rivers lies considerably away from sediment control structures like dams and bunds in the river courses. This has ensured the fact that the stream flows are unregulated. Thus the lack of major modifications due to human interference and absence of sediment arrest in the stream flow have facilitated the assessment and collation of bank vegetation in their most natural setting.

The source region of Nira receives a rainfall of about 2400 mm end that of Kanand 2200 mm. The climate of both the basins can be described as having tropical type of climate. These river basin are characterized by plentiful and monsoonal rainfall during the period of June to September. The drainage basin of Upper Nira and Kanand receives a annual average rainfall of about 1500 mm and 1400 mm respectively. The annual variability of rainfall is about 25% in both the river basins. The Maximum temperature recorded in Kanand basin is 30°c and average temperature is 23°c. Whereas maximum temperature recorded in upper Nira basin is 35°c and average temperature is around 25°c.

The area selected for the study is a part of Deccan trap of Maharashtra. It was observed that basalt is well exposed in upper reaches of both the rivers. In the middle and lower reaches it is overlain by alluvial deposits mainly by gravels. The source regions of Kanand as well as Nira are also characterized by exposed basaltic lava flows., The banks of Nira and Kanand are characterized by clayey deposits in lower reaches. The depth of clay deposit varies from 2 to 6 meters in Kanand and 3 to 6 meters in upper Nira. The column of weathered basalt exposed at many places in both the basins does not exceed 10 m in height.

Geomorphic Environment

The river Nira rises at an altitude of 817.8 m. and meets the major tributary river Valvand at 567.0 m. above sea level. The basin in general and valley flanks in particular are characterized by coarse shallow soils. The basin is bounded by Raireshwar Plateau to south attaining a height of 1408.2 m. above sea level. River Kanand rises at an altitude of 1205 m. and meets Gunjavani at 670.5 m. above sea level. The basin is bounded by Rajgad and Torna to the south attaining a height of 1402 m. and 1411.2 m. above sea level respectively.

The terraces and flood plains are narrow and pediments are covered by thin cover of colluvium and debris displaced from the hill top. The drainage network and hydrogeomorphic environment of both the streams is a result of specific hydrogeomorphic conditions. These conditions in turn affect vegetation in channel. The flow characteristics and channel development are consequently affected by vegetation. Due to change in hydrogeomorphic parameters distinct variation occurs in the vegetation pattern in one and the same drainage basin (Richard K.S. 1973). The variation in the channel and bank vegetation of Upper Nira and Kanand can be easily recognized, which is probably a result of different hydrogeomorphic conditions. A study of these parameters clearly indicates that the basin of upper Nira is morphologically more mature than the basin of Kanand river. The Kanand river has maintained a steep gradient as compared to the gradient of the upper Nira. The valley floor slope and the channel slope ratio which is considered as a variable of stability (Kale V.S. and Rajguru S.N. 1988). In case of upper Nira it is 0.87 and in Kanand 0.99. One can say that the channel slope of upper reaches of Kanand ace less stable leading to observed non - existence of bed plants to distance of 11 Km. from the source. On the contrary the bed and bank plants exist throughout the length of upper Nira up to Bhor 34 Km. downstream from the sources. The channel stability due to hydrogeomorphic character is supposed to be an important aspect of river vegetation (Gregory et al. 1988).

Both the basins are less circular in shape, the elongation being pronounced especially in Kanand river basin (Fig. 2 & 3). In this respect these drainage basin are comparable to rivers of Konkan (Dikshit 1981, Karlekar 1981). The striking aspect of upper Nira is its meandering course from source region itself especially from 9 Km. from source. In Kanand meandering is ill-defined. From other geomorphic parameters like the relief and width and the depth of the channel it appears that both the rivers are in the incision phase. This is confirmed by presence of knicks and inflection points at few places in

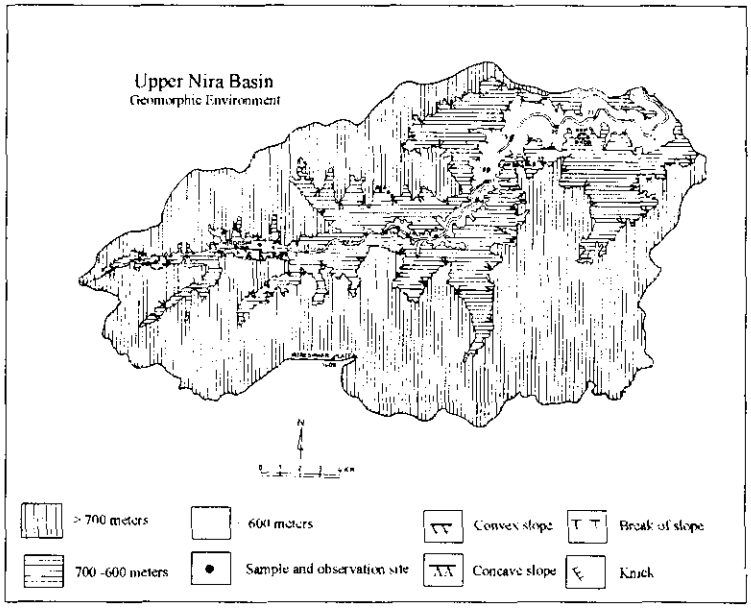

Fig. 2 Upper Nira Basin

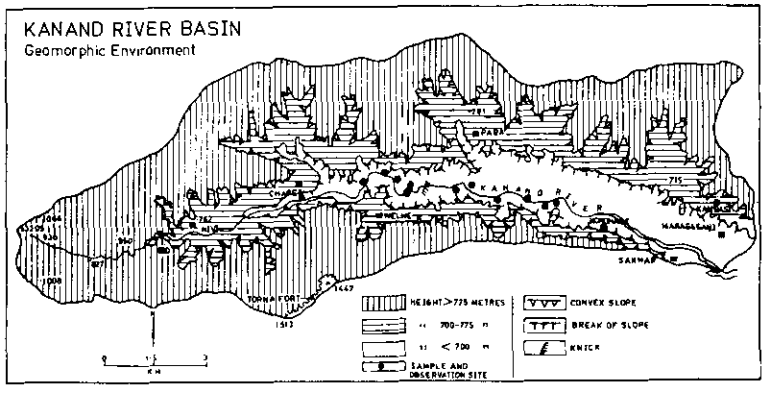

Fig. 3 Kanand River Basin

the rivers, such points occur at elevation from 550 to 700 m. above sea level (Fig. 2 & Fig. 3). The gorges and potholes are however characteristics of Kanand river only. The valley floor of Upper Nira is comparatively wider and shallower than that of Kanand. This dissimilarity is probably due to the faster erosion and undercutting of the valley sides. The active flow through the rivers is however quite inconspicuous end valleys appear to be misfit valleys. The flood plain of upper Nira is relatively wider downstream of Hirdoshi. The flood plains and terraces are of less consequence along the Kanand river. Both the streams exhibit valley asymmetry a well as channel asymmetry. The southern slopes of the, river channels are steeper than the northern slopes. For most of their courses, the channel beds are covered with gravels and pebbles.

The high level erosional surfaces can be identified near the interfluves at an altitude of 700m. above sea level in the basins. Northern valley flanks are the pediment and terraces covered with colluvial deposits. Yellow brown silt and gravels and cobbles are the main sedimentary deposits found on exposed northern banks of both the rivers. The southern banks of the channel show near absence of sand or silt. The southern banks are characterized by cobbles, pebbles and thin cover of alluvium. Fresh rock exposures can be seen on both the banks near source region, particularly west of the Chapet in Kanand.

Biotic Environment

Stretch of river Nira up to Bhor and that of Kanand up to Sakhar also exhibit considerable diversity in floral composition. The vegetation in the river bed and on the river banks shows longitudinal as well as transverse variation in species composition, height and density, which is due to are specific hydrogeomorphic conditions.

The basins under investigation have a large scope for the evaluation and assessment of the role of vegetation in channel morphometry and development.

Methodology

The channel and riparian vegetation along upper Nira and Kanand river was studied in pre-monsoon and post-monsoon seasons for at least seven years from 1988 to 1994. This was done basically to find out the variation that occurs in pattern and density of vegetation and to study the change in foci of sedimentation associated with plant

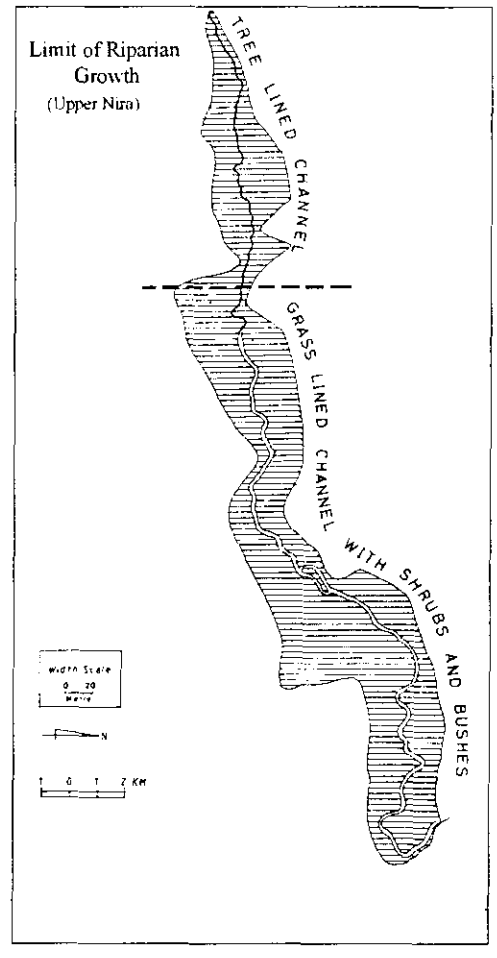

Fig. 4 Limit of Riparian Growth in Upper Nira Basin

growth in every season. This study of channel and riparian vegetation of the rivers is exclusively based on field observations and field measurements in the catchment and the channel of said rivers.

The detailed studies were carried regarding the bank vegetation and sediment, channel cross sections, indicator and dominant plant species, debris and organic dams, concave bank benches, channel bars and velocity distribution in the channel. The variables used to study riparian environment

included frequency of bank trees, height of bank trees, bank resistance, channel width and channel depth.

Limit of Riparian Vegetation

A more vexing problem in such studies is to identify the limit of riparian growth (Bendix 1994 and Baker 1995). The map showing riparian vegetation was prepared in the field for both the rivers (Fig. 4 and 5). It appears that on the whole, the riparian zone widens in the downstream direction. Riparian zone is narrow in the upper reaches and meandering loops. This however is not the rule and local variations do occur due to streams joining the main stream. It appears that the width is also governed by the extent of the flood terrace on both the banks of both the rivers. Flood severity and variation in substrate is apparent in the width of riparian zone along both the rivers. Segregation of vegetation types like trees, shrubs and bushes and grass in the riparian zone is due to the differing rooting depth, availability of capillary moisture and clearing by floodwater.

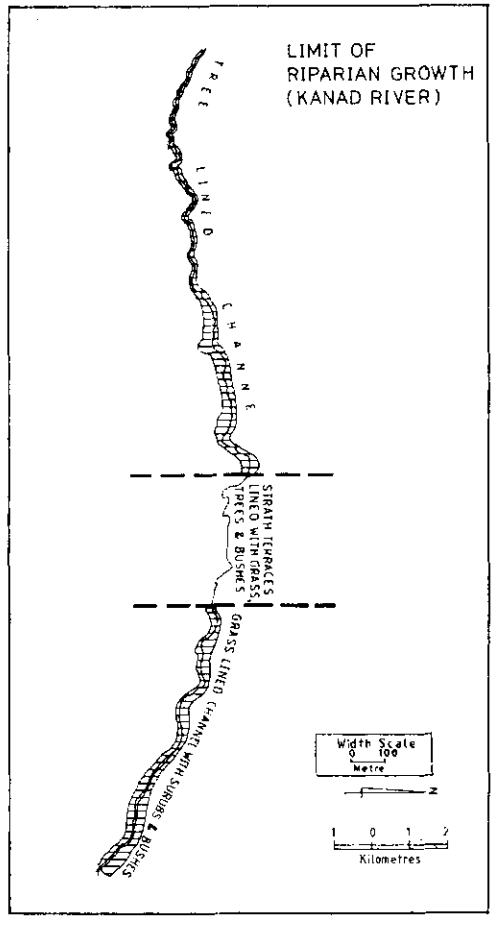

Fig. 5 Limit of Riparian Growth in Kanand River

Riparian Region of Upper Nira

The field study shows that there is a slight transverse scale variation or species diversity in riparian vegetation along the study stretch. However the stretch is characterized by a distinct longitudinal scale variation in vegetation type. The upper stretch of river upto a distance of 11 km. is tree lined channel, and remaining part of the course is grass lined channel with shrubs and bushes. The irregular boundary of riparian zone is due to irregularity of terraces formed in overbank flood conditions and occurrence of hillslope rock exposures. One can easily note the overall widening of the riparian region in downstream direction and on the left bank of the channel.

Riparian Region of Kanand

Like Nira, this channel also shows longitudinal scale variation and slight variation in transverse direction. The extent of riparian region along this river has a distinct structural control. The middle reach of stream nearly 4 km. downstream of Velhe

is an entrenched stream course. The terraces in this section only favour the growth of grasses and scanty bushes. The trees in this section are very few in number and grow only along the channel in narrow zone. The upper reaches of about 13 km. is treelined channel especially between Velhe and Nivi. Upto Nivi from source riparian region is very narrow. Downstream of entrenched stream course upto confluence the channel is grassined with occasional shrubs and bushes. The width of riparian zone is variable all along the channel and is controlled by the foothills and pediments in the region. Like Nira the roughness in the stream flow does not have any connection with the extent of riparian region along the river. The narrow riparian region of Kanand is a result of steep thalweg with gradient of 2.18 %.

Dominant Riparian Plants of River Upper Nira and Kanand

Along both the river channels different types of bank plants were seen. These were classified into trees, bushes and grasses. The group of bushes includes shrubs of all kinds. The grass was also found to occupy some areas along both the channel banks. The plants observed in these groups in both the rivers are,

Trees: *Accacia arabica, Ficus glomurata, Mangifera indica, Ecalyptus sp, Casia fistula, Bridelia retusa, Zizipus zuzuba* and *Bamboo* etc.

Bushes and Shrubs: *Vitex negundo, arissa carandus, Memecylon umbellatum, Woodfordia floribunda, Lantana camara, Xanthium strumarium* and *Ipomoea carnea* etc.

Grasses: *Poa ciliata* and *Cynodon dactylon* etc. These differences in the habitat are due to textural properties of the bed substrate.

The River Channel and The Riparian Region

The riparian region along the river channels is influenced by channel morphology, bank resistance and river discharge. The effect of river discharge is reflected in the extent of the flood terraces on the bank. It was seen that the width of both the channels increases progressively in the downstream direction with minor local fluctuations. This trend was correlated with the trees in the riparian zone. It was observed that there is no significant correlation in the average number of bank trees and the channel width as well as the height of left bank trees and channel width in case of Upper Nira. The height of right bank trees is however correlated positively with channel width, thereby meaning that the wider channel sections are lined by tall trees in Nira . In case of Kanand the average height of riparian trees is correlated with width positively and with a r of 0.40 The number of trees however decrease as the channel widens

The vegetation is a significant influence upon the water and sediment inputs to the river channel system (Gregory et al. 1988). It contributes much of the resistance to the flow of water on land surface. it is therefore necessary to study the pattern of bank resistance due to riparian vegetation in the study area.

The riparian zone of river Kanand has different structural and lithological set of

controls. It is interesting to see that bank resistance increases in the downward direction which is not an effect of increase in the riparian vegetation. This is a result of stability of bank in downstream direction. The upper reaches are characterized by the phenomenon of bank collapse as seen at Chapet.

Acknowledgements

I am indebted to Dr. S.N. Karlekar for his valuable help during all the field visits.

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