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RIVER CHANNEL ADJUSTMENT TO MEANDER CUTOFFS IN PART OF RIVER GODAVARI

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ABSTRACT:

River menders are highly dynamic to being stable under some situation. They are major component of fluvial landscape. Mender cutoff is a specific type of avulsion where channel length and sinuosity are reduced through lateral erosion of the neck on the inside of a mender bend. Channel migration and mender cutoff are natural processes. The present paper is tried to focus on how the cutoffs makes a river to adjust into downstream and upstream direction. It will also study the fluvial processes and fluvial forms within the evolving cutoff. Area has been selected for the present study is a part of river Godavari in Nasik and Ahmednagar district in Maharashtra. Specific objectives of this work are: 1) Morphological evolution of cutoff channel, 2) Flow structures of channel at upstream and downstream, 3) Pattern of erosion and deposition.

These objectives are achieved by mapping, the exact morphology of the cutoff channel, the bed morphology and mapping patterns of erosional and depositional zone. The length of River Godavari is 215 kms. upto the back water of Jayakwadi Dam. Order of the stream is 8th. Numbers of major tributary joins are -11th. Numbers of major bends are 13th. Total 5 major cutoffs have observed in this region.

While studying the area it is observed that most of the cutoffs have made main stream to adjust with the changing nature of cutoffs. The Godavari channel shows highly meandering nature in downstream of each major confluence. The river has developed meandering just after its first major tributary Alandi, which join's the Godavari close to Nasik.

On the basis of observation in the field and mapping of the area it can be said that increase in discharge and sediment are major variables in the formation of cutoffs. At these locations sediment supply exceeds the competence of the stream.

Keywords: River meanders, Gravel bed, Cutoffs, Sediment deposition, Confluences, bed Morphology.

INTRODUCTION:

The creation of cutoffs and of oxbow lakes is a well-known feature of meandering rivers, but views on the extent to which they are inherent in meander behaviour have varied. These features have been studied for both their geomorphological and engineering importance, using a range of empirical and theoretical approaches. Various techniques have been employed to investigate their morphology, stratigraphy and distribution including historical mapping, remote sensing, and sedimentological analysis. Long term development has been traced and various phases have been identified and modeled. The rates and patterns of sedimentation have received particular attention because of their importance in interpretation of the alluvial record. Very few observations of cutoffs actually taking place and of subsequent adjustments of the channel have been made, with notable exceptions, e.g. Johnson and Paynter, 1967; Mosley, 1975a. Information on the nature of channel changes within cutoff reaches and, on the times, -scale of adjustment are needed to help predict and understand impacts of cutoffs and to interpret past evidence of cutoffs. Opportunity to measure and document these aspects of meander cutoffs has occurred from monitoring channel change in river Godavari in Maharashtra.

Formation of cutoffs is infrequent, but it is important variable to understand meandering rivers. It gives the bypass to main channel and also at as a parallel channel in flood situation. The study of the role of cutoff occurrence in long term river dynamics has been carried out according to different, but interconnected, approaches: the descriptive and the numerical approach. The former one is typical in classical geomorphological studies, where the cutoff is implicitly taken into account when the plan form characteristics of real rivers are analyzed with the aim of deriving some empirical laws that relate the hydraulics to some geomorphological parameters (e.g., Leopold and Wolman, 1960; Carlston, 1965, Hansen, 1967). Although these valuable hydromorphological relationships are irreplaceable predictive tools which are still widely adopted, these approaches have seldom investigated how cutoff events are able to influence river dynamics. In fact, only a few observations really concerning cutoff events, oxbow lake formation and channel adjustment following the cutoff have been carried out (e.g., Johnson and Paynter, 1967; Hooke, 1995, Gay et al., 1998).

Assumptions of meander behavior have shifted from those of stability and equilibrium to recognition of gradual evolution and increased complexity of form. Cutoffs are frequent and the abandoned channels often spectacular and common components of the floodplain, (e.g. Fisk, 1952; Coleman, 1969; Kulemina, 1973; Schattner, 1962).

Lewis and Lewin (1983) identify five types of cutoffs, with four positions for chute cutoffs and examine the morphological and sedimentological characteristics of each. They find cutoffs are most common in the middle reaches of drainage basins where stream power is also at a maximum but the relationship of lateral migration rate or cutoff type to stream power is not simple.

Mosley (1975a) wrote: "Meander cutoffs, as important processes of geomorphic change, clearly warrant greater future attention."

OBJECTIVES:

1. Morphological evolution of cutoff channel,
2. Pattern of erosion and deposition.
3. To analyses the morphological adjustment to cutoff.
4. To identify bends of migrations.
5. To study the morphological change in the channel.

STUDY AREA:

The Godavari, with its tributaries, drains the largest percentage of the area of the State. The river origin from the Sahyadris at Trimbak, 25 km west of Nashik. Upto Nahik there is no perceptible slope and its broad and flat valley appears a trickle. A few kilometers upstream from Nashik a dam locally called Gangapur dam is built across the river. From Nashik, the river follows a east-south-easterly course.

The Godavari basin occupying roughly half the area of the state has a number of subsidiary basins belonging to its tributaries. The Pravara and Mula, both originating from Western Ghats in the upper Godavari basin, the Manjara River draining the Balaghat plateau, a terrain higher than the adjacent Godavari plain, and finally the wardha-Wainganga and Pranhita basins in the eastern part of the state. A characteristic feature of Godavari is its deep channel enclosed between its banks, which are more like embankments and the narrow alluvial flood plain. Prolonged rain in the source region and the upper part of the valley associated with depressions leads to a higher stage of flow exceeding the bankfull discharge and the consequent floods.

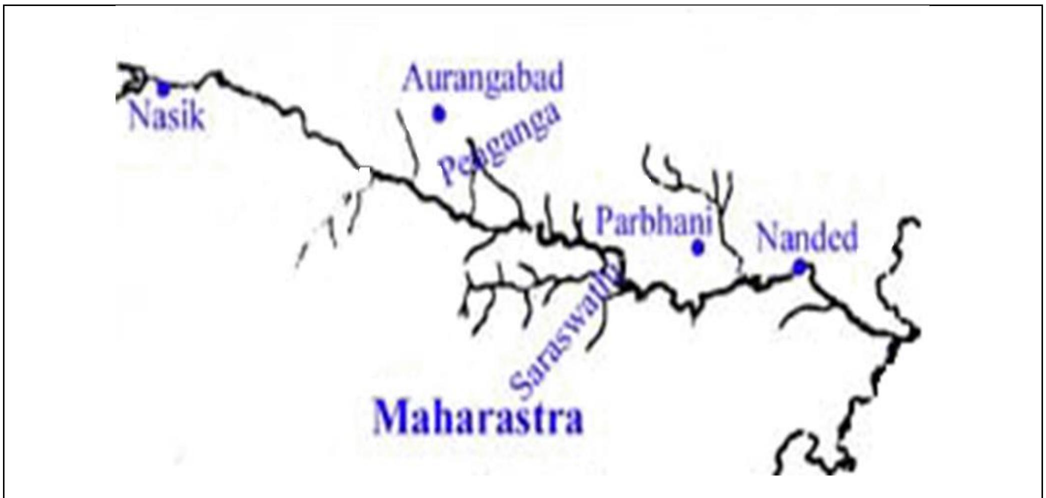


Fig: Map of Study Area

(Nashik to Nanded in River Godavari Basin Part of Maharashtra)

METHODOLOGY:

River Godavari shows highly meandering nature just from 50 km from its source. Channel is active meandering gravel bed. Five cutoffs have occurred in the study reach, and all the cutoffs were natural in their mechanism and breaching is not affected by human activity. Three cutoffs are surveyed and two have observed. Mapping of cutoff is done. Morphological analysis is also done. It is found that the shape of the meander plays important role in changing form at two ends of the cutoffs.

PREVIOUS WORK:

Johnson and Paynter (1967), Mosley (1975), Schumm (1969), inferred that information on the nature of channel changes within cutoff reaches are important aspect to predict and understand the paleo evidences of the cutoffs. Much of the evenly work on river cut off is done on areas where frequent and abandoned channels are common in their flood plain reaches. Friedkin (1945) Matthes (1947) said that this practical problem of river management and it was complemented by physical simulation of meander migration and cutoff formation. Mosley (1975) opined that formation of cutoff is a consequence effect of bank erosion. Sinuosity and later Hooke (1991) Jannet Hooke and Redmond (1992) have found that there is increase the sinuosity decreases. Lewin (1983) have studied the types of cutoffs and examined its morphology Schattner (1962) have done the distribution of cutoffs in individual river system and geomorphological controls over it. Mosley (1975a) wrote, Meander cutoffs, as important processes of geomorphic change, clearly warrant greater future attention.

MID-CHANNEL BARS IN RIVER GODAVARI:

Table: Mid-channel bars in River Godavari

Sr. No.	Name of the Mid-Channel Bar	Length in km. (from Source)	Contour Height	Tributaries
1	Chakora	20	620	Downstream of Kikvi Nala confluence
2	Lakhalgaon	65.5	540	Upstream of Darnanadi confluence
3	Chapadgaon	97.5	539	Upstream of Kadva Nadi confluence
4	Madmeswar	103.75	520	At the Kadva Nadi confluence
5	Tamaswadi	108.75	520	Downstream of Kadva Nadi confluence
6	Kolgaon	117.25	520	At the Dev Nadi confluence
7	Chas	123.5	516	Upstream of Dev Nadi confluence
8	Chand govhan	147.75	500	At the Umri Nala confluence
9	Kopargaon	152.25	500	Downstream of Umri Nala confluence

10	Vari	170.25	494	Upstream of Lendi Nala confluence
11	Sarala bet	195.5	479	Downstream of Narangi Nala confluence

Above table shows the details about mid-channel bars 1. Name of the Mid-Channel bars, 2. Length from source region, 3. Contour height of the bars and 4. Upstream Downstream location of the bars.

River Meanders:

Once a river reaches relatively flat ground, it tends to form a relatively broad channel that slowly wanders back and forth like a snake. The sinuosity of a river is a measure of how 'bendy' it is. We call a bend in river meander. Meanders tend to occur at regular intervals along the river channel, depending on the flow rate. The higher the flow rate, the greater the distance between meanders tends to be. This average distance between meanders, for a given river, is known as the meander wavelength and is typically about ten times the channel width. Straight river channels are rare and straight channels eventually erode into meandering channels.

The river network as a whole is an open system tending toward a steady state and within which several hydraulically related factors are mutually interacting and adjusting-specifically, velocity, depth, width, hydraulic resistance, and slope. These adjust to accommodate the discharge and load contributed by the drainage basin. The adjustment takes place not only by erosion and deposition but also by variation in bed forms which affect hydraulic resistance and thus local competence to carry debris.

Image shows river meanders at Imampur in river Godavari basin at Gangapur Tahsil. Meandering channel and straight channel show main flow of the river is in meandering path of the river. In the flooding water pass through the straight channel. Meanders migrate sideways due to lateral erosion, broadening the floodplain and eroding the interlocking spurs.

River meander at Imampur in River Godavari basin

Bed Morphology:

The study of river bed morphology requires detailed study of the various parameters affecting the bed width depth ratio, sinuosity, sediment load, aggrading or degrading behavior of the bed etc. This study for the River Godavari is of particular importance, in view of the exceptionality of its problem and its disreputable shifting tendency.

Sediment Deposition:

Sedimentation rates vary in space and time (Schumm and Lichty, 1965). The downstream variation in mean sedimentation rate within each channel infill. A linear decrease in sedimentation in relation to the mean distance to the bank is observed. The relationship between sedimentation rate and distance to the bank differs between meandering channel infills and wandering channel infills. A slightly higher sedimentation rate occurs in wandering and braided channel infills with increasing distance from the bank, compared to meandering channel infills.

River Cutoff at Kopargaon:

Height of Kopargaon is 500 m. from MSL. Distance from Trimbakeswar to Kopargaon is 152.5 Kms. Kopargaon is situated at left bank of the Godavari Basin after Umri nala confluence. Kopargaon is one of the flood affect town. In the monsoon season flooding water enter in the town. Flooding water spread surrounding area mainly because of sand saturated in bed of the river Godavari. Mid-channel bar is form due to this bar main channel is divided into two parts.

Best example of shift of meander in river channel is identified from toposheet and ground truth. In the toposheet 47 I/9 meander bend of the river shows district of Aurangabad and Ahmednagar which is shifted to southward and old abondanded meander channel can be located on google image. That old channel can be path for flood water. It is also shows that the tributaries join the old channel prove the fact.

Toposheet and Google Image of Kopargaon in River Godavari Basin

Geomorphic Map of River Godavari Basin at Kopargaon

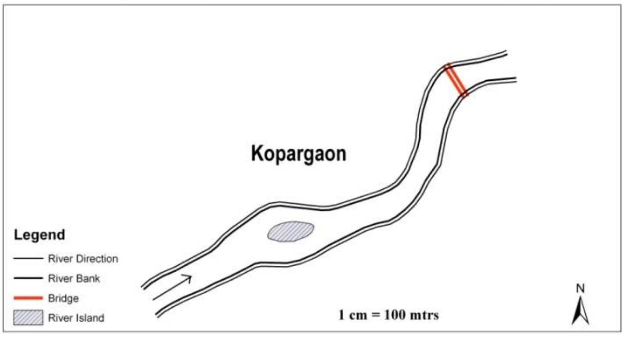


Fig. Geomorphic Map of Kopargaon in River Godavari Basin

River Cutoff at Sarala Bet:

River island and mid channel bars which is prominent feature of gravel bed channel. Sarala Bet is largest island observed in River Godavari. It is very interesting note right bank stream is rock bed channel whereas left bank shows the huge alluvium. Distance from Trembakeswar to Sarala bet is 195.5 kms in Godavari basin. Sarala bet area is 65 acers. Height of Sarala bet is 479 m from Mean Sea Level. This bar is form after Narangi nala confluence. Narangi nala is the left bank tributary of river Godavari. Distance between Narangi nala and Sarala bet is 10 kms.

Favorable Factors of Sarala Bet Stabilisation:

- Preferential sedimentation in one of the cause for Island development.
- Erosion during a flood.
- Gradual incision or bed-level lowering of one flow path in preference over the other
- Gradual corrosion of the island through lateral migration during peak discharge.
- Erosion of bed and bank along the island perimeter, causing an decrease in size.

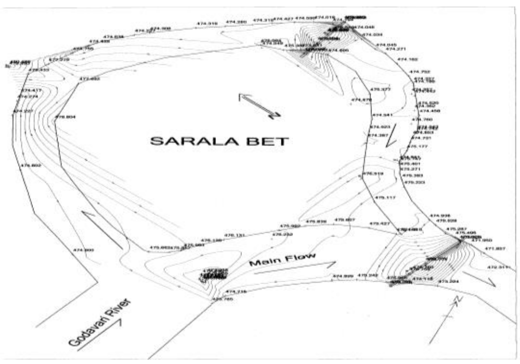


Fig. Surveyed map of Sarala bet in River Godavari Basin

Geomorphic Map of River Godavari Basin at Sarala Bet

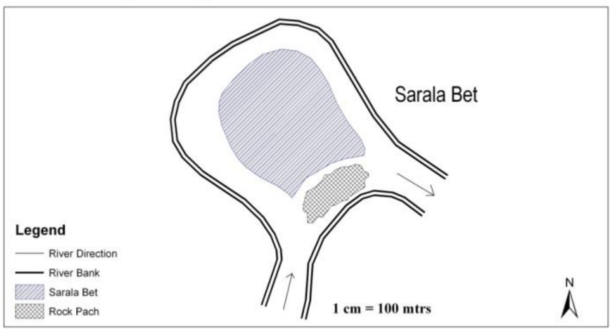
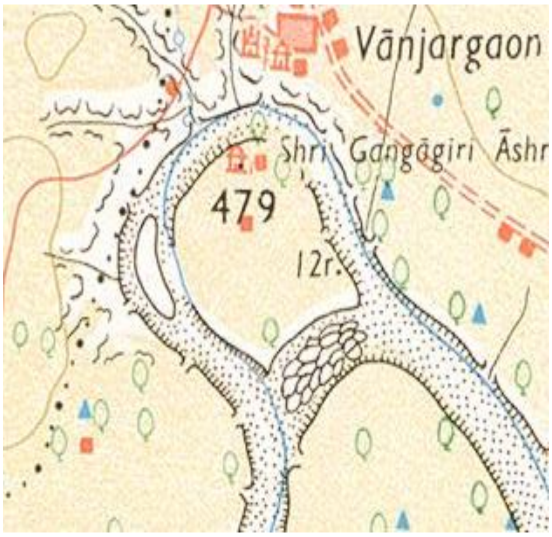


Fig. Geomorphic map of Sarala Bet in River Godavari Basin



Toposheet and Google Image of Sarala Bet in River Godavari Basin

Photographs of River Godavari Channel at Sarala Bet

Land use Land Cover of Sarala Bet

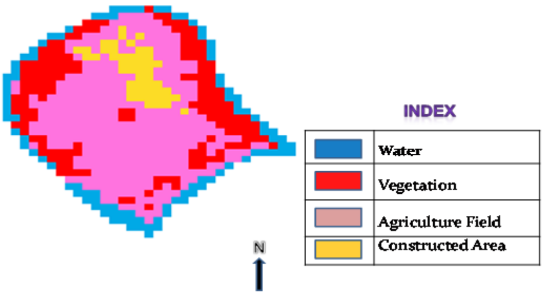


Fig. Land use Land Cover Map of Sarala Bet in River Godavari Basin

TIN Map of Sarala Bet

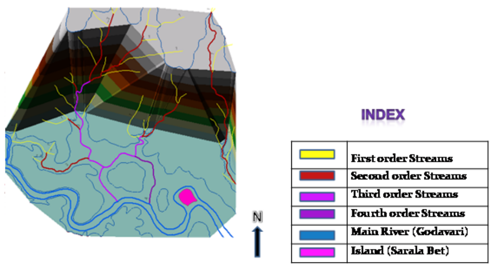
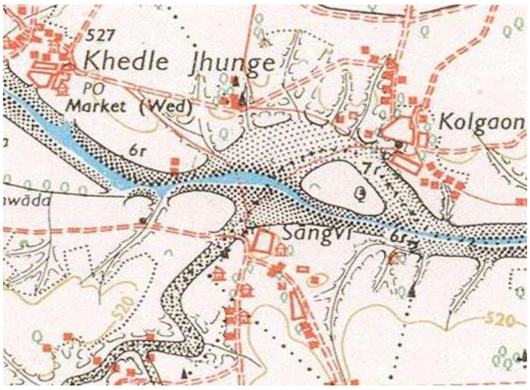


Fig. TIN Map of Sarala Bet in River Godavari Basin

River Cutoff at Kolgaon:

In the Toposheet (47 I / 1) suveryed in 1974 shows river island of quite large in size but now it is under agriculture and no sign of island is left. Height of Kolgaon is 520 m. from MSL. Distance from Trimbakeswar to Kolgaon is 117.5 kms.



Toposheet and Google Image of Kolgaon in River Godavari Basin

Geomorphic Map of River Godavari Basin at Kolgaon

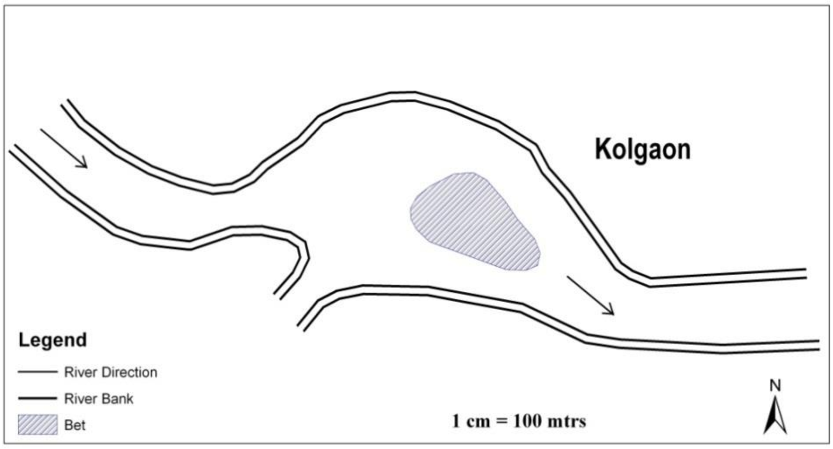


Fig. Geomorphic map of Kolgaon in River Godavari Basin

Characteristics of Meander Bends in River Godavari:

- Constantly erode material - Cut bank
- Constantly deposit material - Point bar
- Change their channel course gradually
- Create floodplains wider than the channel
- Very Fertile soil
- Subjected to seasonal flooding

Some work has been done in the subsequent years but still not all that much, especially on the contemporary processes. Good data are lacking, particularly on rates and timescales of adjustment. Care must be taken in generalising from so few case studies and comparability of processes can only be assumed for similar environments. Nevertheless, the mode of adjustment of a channel has rarely been followed over this timescale of 5 to 10 years. The cases discussed here indicate that final breaching can occur in a low magnitude event, that changes in morphology within the new channel tend to be rapid in the first 2-3 years with adjustments of width, bar and riffle morphology being particularly important. Effects may be propagated upstream in high gradient and erodible sections but the new straight channel created by neck cutoffs may itself stablise after a few years.

FINDINGS:

1) Cutoff is an inevitable consequence of bank erosion.
2) Autogenic behavior of river increases its sinuosity and decreases its sinuosity.
3) Cutoffs are most common in the middle reaches of drainage basin.
4) Palaeohydrological inferences on a range of time scales can be made from morphological and sedimentological evidence of abandoned channels.

LIMITATIONS:

- Frequency of occurrence has mainly been derived from dating of relict channel which I could not do this time.
- More meander bends should study to find out average rate of migration or alteration of bends.

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