



Analysis of Meander Cut-off Mechanism for the formation of Abandoned Channels of Sankosh River, India

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Abstract

The Sankosh river in its lower course is found to have a tendency to meander over floodplains in order to balance the transport of its water and sediment load. As a result, both the neck and chute cut-offs develop and are considered to be the main mechanism of abandoned channel formation. The neck cut-off occurs due to the continuous deposition of sediments on the convex bank and sediments curved out of the concave bend. As a result, the sinuosity of the meander increases, thereby forming a narrow neck. The convoluted meander bend at the neck remains in the threshold level of instability unless naturally, the neck disappears due to the crossing of the limit of threshold. Eventually, a straight channel is formed, creating a cut-off. When the cut off is sealed from the main channel by sediment deposition, an ox-bow lake is normally formed and left as an abandoned channel. On the other hand, chute cut-off occurs when successive high flows develop a chute across the inner part of a point bar which starts to flow as straight channel decreasing the sinuosity of the main river course on that part. Thus, the former sinuous course becomes detached as an abandoned channel. Thus, channel sinuosity is reduced with increase in velocity and gradient in flow and discharge through chute and neck leaving cut-offs that lead to the development of abandoned channels.

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Introduction

Meander cut-off is a general process for the development of an alluvial channel or meandering stream. In general, a meandering channel is characterized by some deeps (pool) at the concave slope of bends and shallow fills (riffle) at the convex slope of bends along its course. A pool is characterized by a water surface profile less than the mean (stream) gradient and by finer bed material, whereas a riffle has a water surface slope steeper than the mean stream gradient and is composed of coarser bed material (Morisawa, 1985). Consequently, the most meandering channels having sinuosity index value >1.5 is defined as bends facing down valley and traverse downstream from a geometric viewpoint.

Objectives

The aim of this research is to study the meander cut-off mechanism for the formation of abandoned channels in the course of the Sankosh river, India

Methodology

Empirical and quantitative techniques of geomorphology have

been applied according to the requirement. Relevant maps have been prepared by using geo-spatial techniques on the Remote Sensing and GIS platform. Inferences have been derived from systematic compilation, processing and classification of information (generated by sample survey) and data.

The Study Area

The Sankosh river is one of the major rivers of North Bengal and Assam in India. It traverses through the mountains of Bhutan and then flows through the undulating plains of North Bengal and Assam and finally enter into Bangladesh to meet the Brahmaputra river. The Khalisamari Beel, located in the Chagalia village of Dhubri district of Assam, is an abandoned channel of Sankosh river. It was disconnected by the process of chute cutoff for a long time. It occupies about 212 bighas of land with a mean ground elevation of about 32m a.s.l. The length of this abandoned channel is around 8 km from the Chotto Guma to Kaimari village. The depth of water in this abandoned channel is about 5 - 6m during the rainy season and 3 - 4m in the dry season and is affected by flood in the rainy season (fig. 1).



Findings and Discussion

Formation of Meander Cut-off and Channel Abandonment

In the lower course of river Sankosh (lower course), there are several meandering cut-offs in the form of abandoned channels, also called oxbow lakes. Its formation process through meandering chute cut-off is illustrated in fig.2 in a schematic manner. The three stages of abandonment that can be distinguished are:

Cut-off Initiation: According to Lewis and Lewin (1993) and Hooke (1995), the triggering of the cut-off occurs when the majority of the river discharge is diverted from the meander and starts to flow along the newly activated channel which has developed diagonally as chute over the plug bar by the process of sediment deposition. It must be mentioned here that the entrance of the two meander bends to the chute of the Sankosh river has shrunk due to channel infilling to initiate the process of plug bar formation which is responsible for separation of the chute from the meander ends, the active channel earlier (fig. 3).

Plug-Bar Formation: The plug bar is defined as a bed sediment bar formed at the entrance of a bifurcation channel, hindering flow into a channel (Fisk,1947; Gagliano and Howard,1984; Hooke,1995). In the downstream section of the Sankosh channel near the inner bends of Khalisamari Beel, the plug bar has been perpetuated by bedload supply. With the steady supply of bed load, it appeared to stop the channel flow because of the channel fill and cut-off occurred from the crest of the bends. Thus, channel deposition not only caused shallowing but also narrowing as well as shrinkage of the meander bend in the study area.

Disconnection: The disconnection of the channel begins with no continuous flow of discharge carrying sediment load (Willem Toonen et. al. 2012). In study area, the discharge was no longer being carried regularly through the chute. Depending on the maturity of the plug bar and the proximity to the active channel, a flood may temporarily cause a diversion of discharge through the chute delivering a pulse of suspended sediment. As a result, the chute is disconnected from the network of the active main channel of the Sankosh River and finally, the chute cut-off occurred which now remains as an abandoned channel. Thus, the disconnection of the meander bend with the main channel

occurred only after the completion of plug bar formation. This disconnected stretch of meander bend is recognized as chute cut-off that eventually became an abandoned channel in the study area.

Conclusion

Thus, a highly meandering course of the Sankosh river developed on the right bank near the village of Falimari, Cooch Behar district, West Bengal and Koimari and Khalishamari villages, Dhubri district, Assam. It is evident that a meander chute cut-off was initiated with the deposition of sediments at the inner part of the bend and it was gradually increased with the occurrences of successive extreme bankfull discharge. As a result, meander channel entrances near the inner bends are responsible for more and more bedload supply. This initiated the formation of plug bar in the downstream section of the Sankosh river channel near the inner bends of Khalisamari Beel and finally, the plug bar formation has been completed by bedload supply and with more bed load appeared to stop the inner channel flow and resulted in cut-off from the crest of bends.

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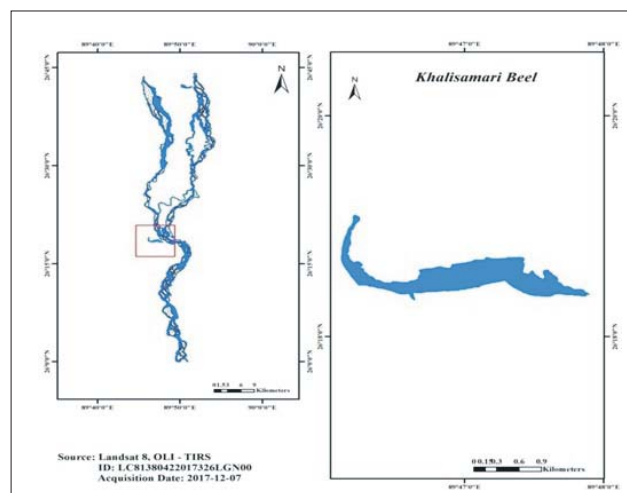


Fig.1: Location of the Study Area

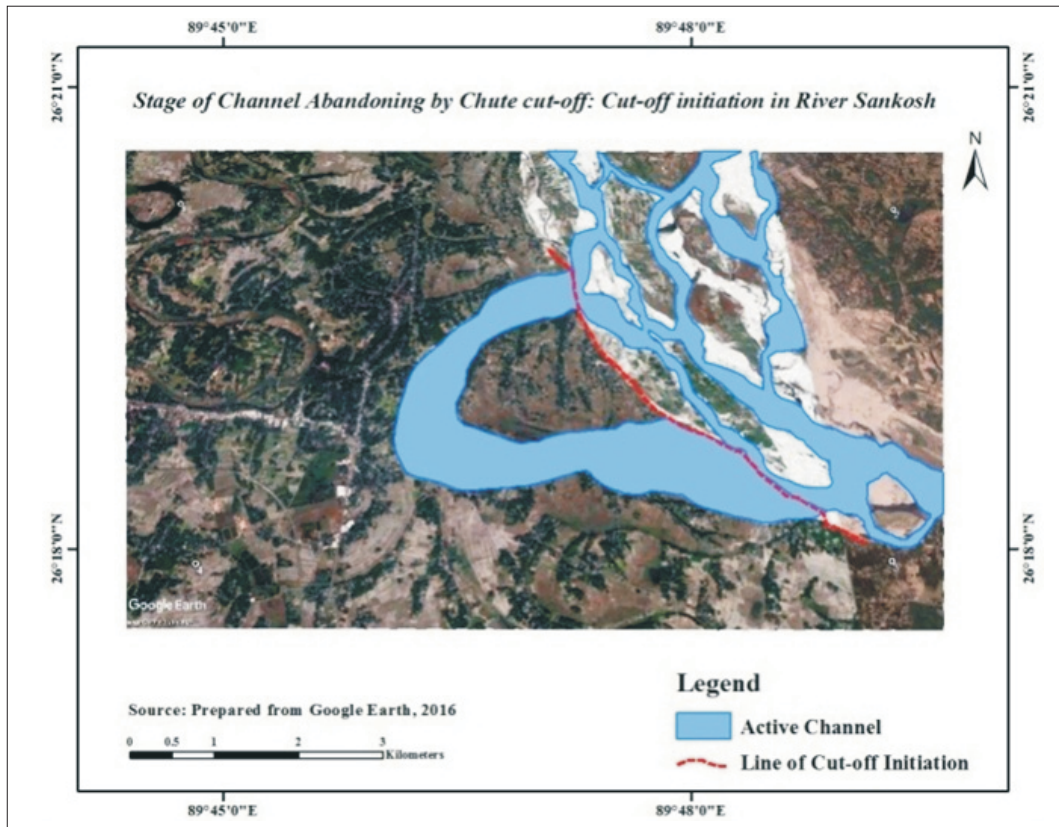


Fig.2: Cut-off Initiation in 1970

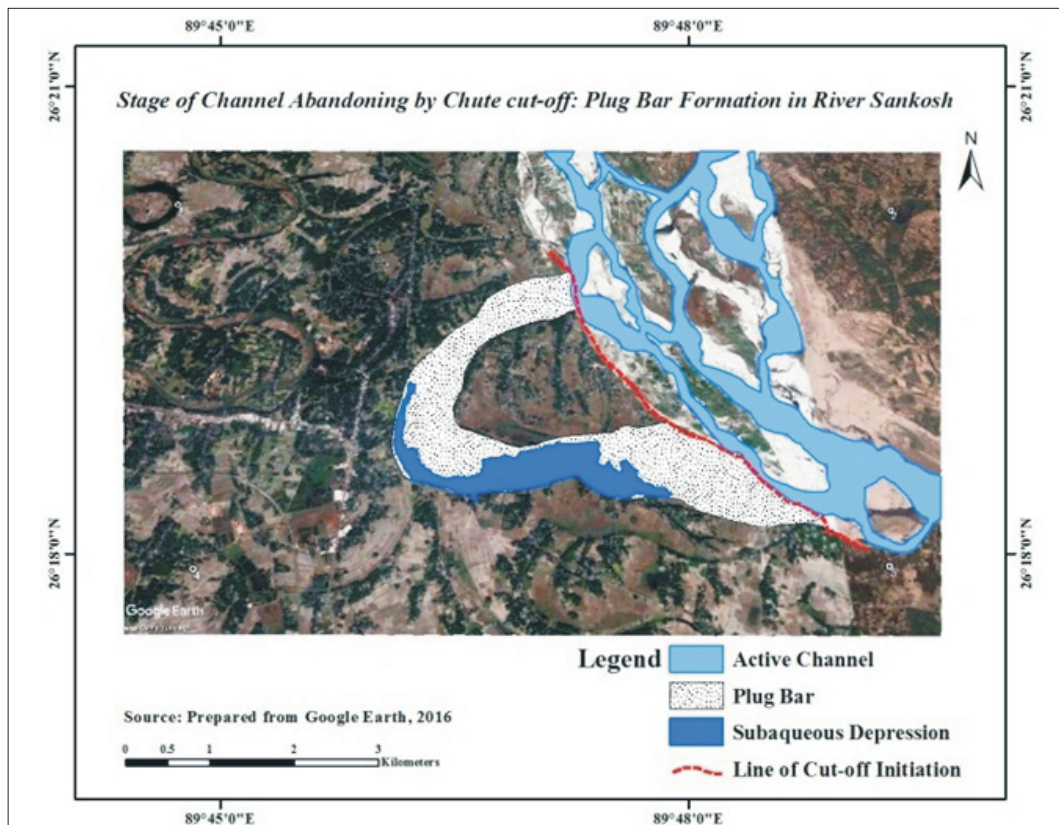


Fig.3: Formation of Plug Bar in 2000

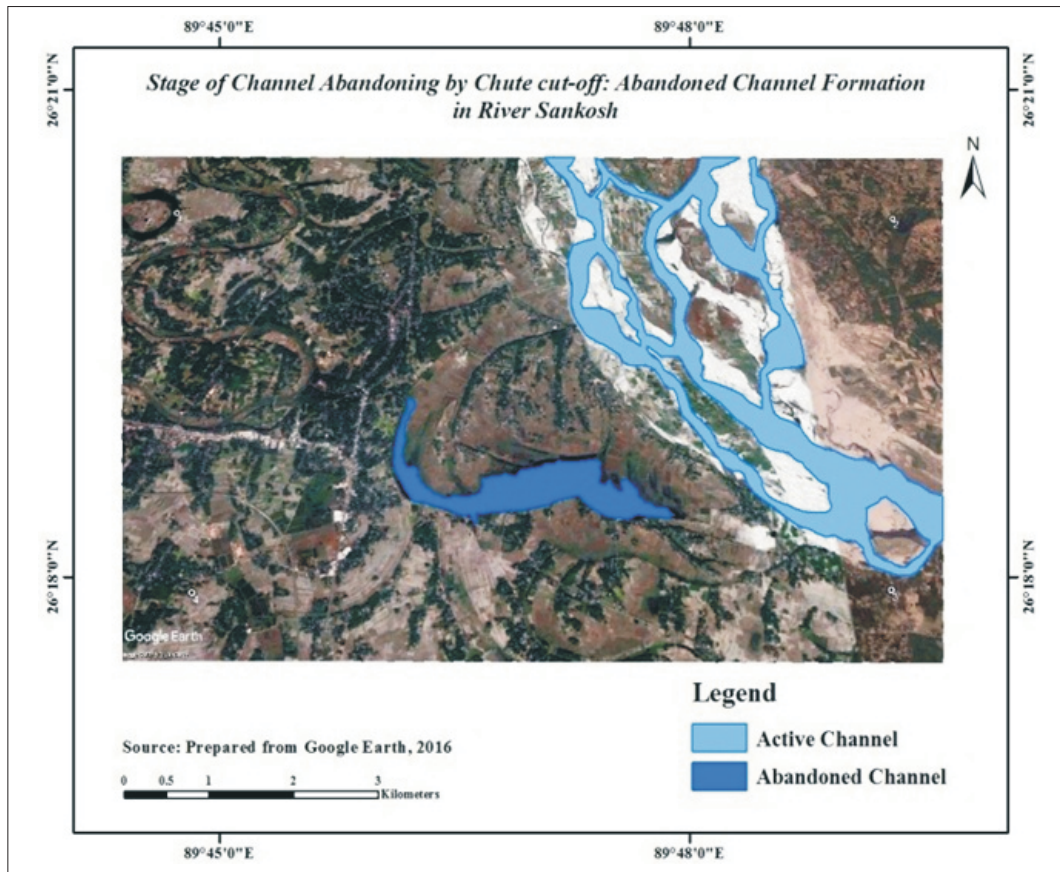


Fig.4: Disconnection of Chute cut-off in 2018



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