MANAGEMENT AND PLANNING OF GANDAK BASIN A GEOGRAPHICAL ANALYSIS

Dr. SANJITA KUMARI
Department of Geography,
B.R.A.Bihar University, Muzaffarpur.

Abstract:
Burhi Gandak is a left bank tributary of the Ganga River. It is meandering in nature and flows in the southeast direction. The Burhi Gandak river basin is bounded by Himalaya in the north, by Ganga River in south, by Kosi River in the east, and by Great Gandak River on the west and makes the eastern boundary of the Gandak Megafan . It originates in the terai area of Chautarwa Chaur near Bishambharpur, West Champaran district in Bihar state . It is known as Sikrana in its upper reaches. Harha, originating near Someshwar Hill, receives water from many small mountainous rivers and is known as Masan when it comes to plain and is the main source of water to Sikrana. Singha, another mountainous river, originating near Someshwar Hill, splits into two, one joins Harha/Masan near Churharwa and the other known as Ramrekha joins Sikrana. Masan and Ramrekha rivers join to form Sikrana at Lauria Nandangarh, and contribute significantly to its discharge. Dhanauti, a highly sinuous almost abandoned river (field observation), meets with Sikrana near Pakridayal village, Motihari, and after this confluence, the Sikrana is known as Burhi Gandak.

Keywords: Meandering, River, Gandak Basin, Channel, Muzaffarpur.

Methodology

The present research work based on the observational description and observational rational methods in order to decipher the theme of the research. Various statistical and cartographic methods has applied where ever needed. The present research study based on both primary and secondary data. The primary data collected through personal observation, interview, questionnaires schedule etc. while the secondary data collected from concerned district or block headquarters. Map and diagrams, graphs etc. have been
widely used in this research papers.

Objectives

1. To ensure regulated exploitation and optimum & judicious use of ground resources.
2. To implement ground water recharge programme on a large scale in an integrated manner and to bring over-exploited/critical blocks into safe category in a time bound manner.
3. To effectively implement conjunctive use of surface water and ground water.
4. To promote efficient methods of water use in the stressed areas.
5. To give priority to the river basin/watershed approach in ground water management planning and conservation.
6. To identify ground water polluted areas in order to ensure safe drinking water supplies.

7. To implement ground water conservation and recharging programmes by the concerned departments through participatory management approach in a co-ordinated and integrated manner.

Introduction

The right main channel of Bagmati meets Burhi Gandak near Rosera and affects its discharge during monsoon season. Traversing a distance of about 400 km in the alluvial plain, Burhi Gandak joins Ganga near Gogri Jamalpur, Khagaria district of Bihar . The Burhi Gandak basin is spread over the West Champaran, East Champaran, Muzaffarpur, Samastipur, Begusarai, and Khagaria district of Bihar. There are about thirty-two streams which contribute to the Burhi Gandak. Some foothill rivers also join it in the Champaran district.

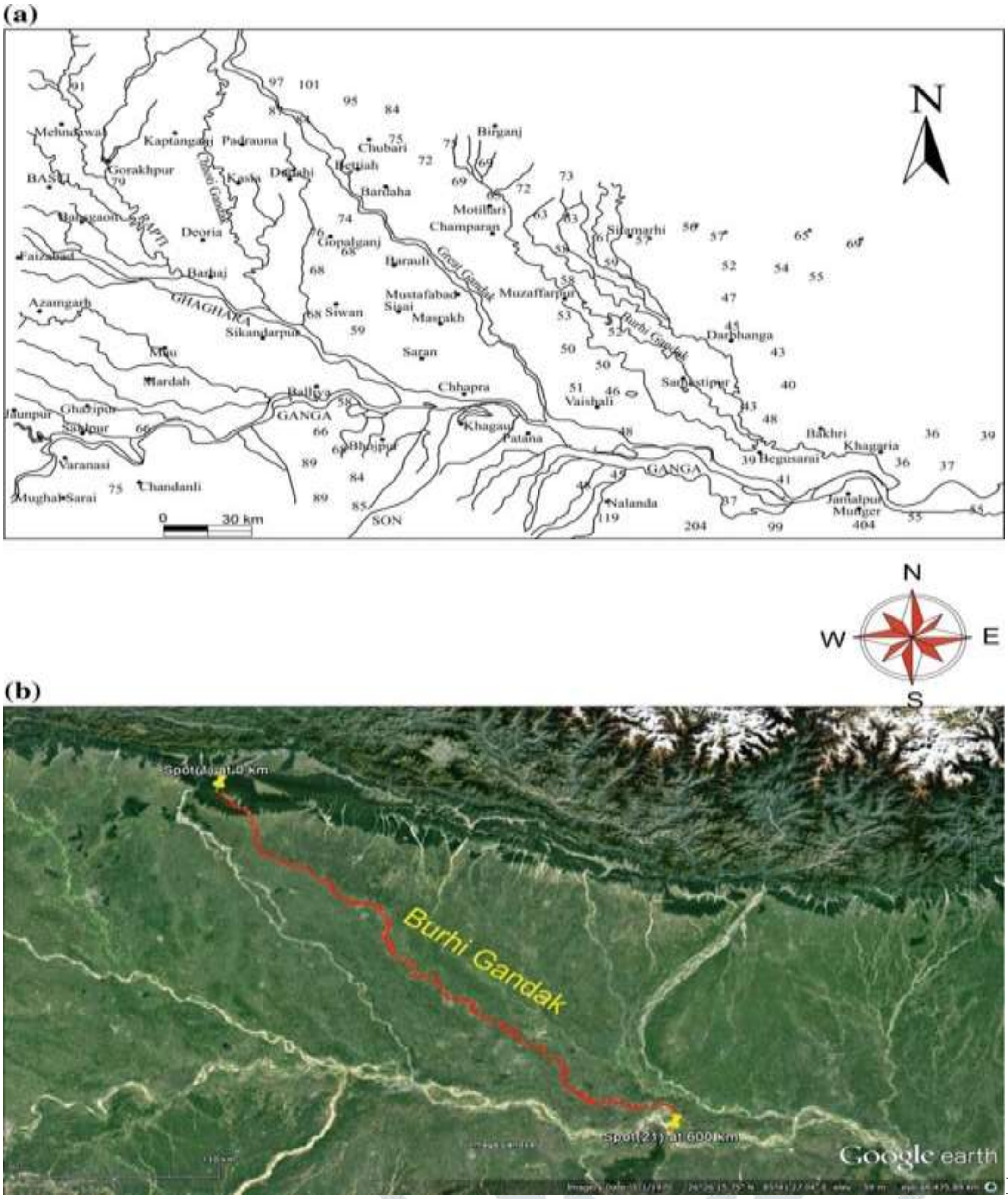
8.60 cm/km, respectively. And the mean size of the sediment is 2.03, 2.44, and. The valley width varies from 20 to 800 m, minimum in the proximal part and maximum in the distal part. The channel varies from 10 to 350 m, minimum in the proximal part and maximum in the distal part. The elevation is maximum 230, 124, and 90 m in the proximal part and minimum 43, 38, 31 m in the digital part. The calculation of channel width, valley width, and sinuosity of Burhi Gandak River is shown in , and graph between these three is mentioned in.The sinuosity varies from 1.1 to 5.9 except with one spot where it is 13.9 The sinuosity is low in proximal part and high in the middle part and again low in distal part .

The analysis provides informationthat recharging of the groundwater is a natural process in this basin therefore planning for water resource management and recharging ponds should be made to retain it and caution should be taken during prolonged heavy precipitation for flood mitigation.

Granulometric parameters of old and new point bars indicate that the transporting capacity of the river which is controlled by discharge is continuously decreasing. The decrease in discharge is attributed to the loss of upstream catchment areas by river piracy or by low precipitation due to climate change.

Chhoti Gandak is a fifth order river with dominance of lower order streams and the basin is elongated in SE direction. The dominance of first order streams indicates uniform lithology and gentle slope gradient where the major fraction of precipitation flows as surface run-off. Variation in the size and order of streams are in direct response to the physiography and climate. However, lithology is alluvium and infiltration rate is high which is against the dominance of first-order streams.

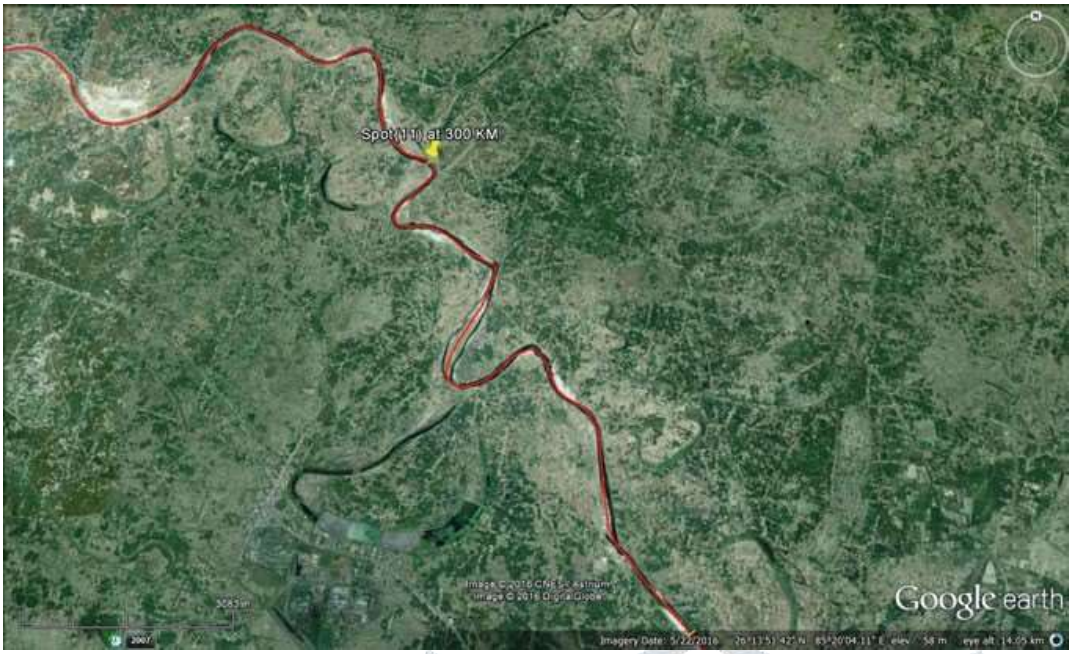
Hence, prolonged precipitation during monsoon in the catchment area reduces the rate of infiltration and increases the surface runoff and number of first-order streams. Gentle slope gradient and low basin relief indicate low surface run-off, low sediment transport and high infiltration rate. Low drainage density and gentle slope characteristics evaluate low run-off and high percolation potential. Gentle slopes are favorable for building up the hydraulic gradient and are most suitable for groundwater recharge (Shankar and Mohan, 2005).



Natural Hazards

Bihar is India’s most flood affected state. Maximum area of the catchments of snow-fed rivers draining Bihar lies in Nepal/Tibet. The high water discharge and huge sediment load carried by rivers are dropped in the Bihar Plain, thus reducing the water holding capacity of the river. Burhi Gandak is a river which is well known for frequent flooding. In the flood of 1998, 2001, and 2004, the embankment of Burhi Gandak was damaged at many places which caused loss of life and property. In 2007 and 2012, breaches of embankment due to heavy rainfall cause catastrophic flooding in the basin. At West Champaran, the flood water reaches up to the railway track. An embankment has been built along the river to protect Khagaria city from the flood.

The accommodation space of a river should be calculated to understand its water storage capacity. So that a relationship between precipitation and water holding capacity of the river can be established. A flood inundation and flood frequency



It is the lifeline for the people of about five districts in Bihar. The important cities and towns located at its left bank are Madhubani, Siwaipatti, Kishanpur, Rosera, Majhaul, Khagaria, Gogri, and Jamalpur, and right bank cities are Lauria Nandangarh, Motihari, Pipra, Mehsi, Motipur, Kanti, Muzaffarpur, Samastipur, and Narhan.

The local people consider it as Ganga. It also causes loss of life and property during floods due to poor planning and management. It provides the sand as the raw material for the construction and building industry. It also provides the lime ($CaCo_3$) through the bivalve and gastropod shells to the rural people for local consumption and to prepare the lime at local scale for tobacco. Many rituals are performed at its bank.

The initial filling of Indo-Gangetic foreland basin was carried out by numerous alluvial fans (Parker, 2000). Fluvial processes operated under different tectonic and climatic regime carve the present landscape. Deformation of the order of few mm (2–3 mm)/year can produce anomalous features in a river basin, hence the landforms and subsurface characteristics. Dynamics of a fluvial system subjects to geometry and nature of channel pattern, and river deposits. These essential elements provide important information about the dynamics of the fluvial system. The channel adjusts to significant changes in the water discharge, and nature of sediment supplied to the channel. When the quantity of water and sediment over a period of years remains relatively constant, the channel geometry and pattern vary about a mean of quasi-equilibrium conditions. Understanding the processes of river channel adjustment in response to a change in the water discharge, sediment size, and sediment load supplied to the channel is vital for the successful river basin management. The adjustment within a river basin that significantly influence the sediment size distribution, occurrence of bars, and channel width describe the hydraulic processes controlling these characteristics as well as the rate at which they function. Therefore the physical characteristics of the channel, describe the dynamics of the river at the time of their evolution. The discharge of Chhoti Gandak is mainly controlled by rain which is very high during monsoon and low during summer. It has been observed that whenever precipitation is high in the catchments area, there is flood in the downstream part of Chhoti Gandak River Basin. The nature of drainage pattern and drainage density reflects the hydrogeological condition of the area. The wide valley occupied by narrow channel indicates that river was carrying high discharge in the past when this wide valley was carved. High discharge is attributed to large drainage area and enhanced precipitation. Narrow channel is the result of decrease in discharge due to change in climate. Most of the rivers in the Ganga Plain (Ganga, Yamuna, Ghaghara, Great Gandak, Kosi etc.) are characterized by narrow channel confined within wide valley (Singh, 2007, Singh et al., 2010). The reduced discharge in the peninsular river such as Narmada River Basin is also attributed to the change in climate (Kale and Rajaguru, 1988). The basin has gentle slope, low surface relief, low surface run-off, high infiltration rate, and low water storage capacity which indicates mature stage of topographic evolution and erosion and so reworks the preexisting sediments of the Ganga Plain. This groundwater fed alluvial river originating in the terai region has natural drainage system. The water spreads within the basin and concentration of peak discharge takes place in the distal part. The morphometric parameters have hydrological significance.

It is controlled by climate processes in the area underlying uniform lithology (Sreedevi, et al., 2004). All streams originate in the alluvium and their drainage network shows a linear relationship with a small deviation when logarithmic stream number is plotted against the stream order. The mean Bifurcation ratio indicates that the streams are natural and not influenced by geological structures (Strahler, 1964). The study of climate and tectonics control also indicates that the river valley is not tectonic in origin (Singh et al., 2009). However, it is believed that in the Ganga Plain, rivers are flowing through tectonic lineaments (Mohindra and Parkash, 1994; Singh and Singh, 2005). Hence, it is concluded that the groundwater-fed rivers originating in the terai region have natural drainage system (Singh et al., 2009; Awasthi and Singh, 2011). The stream-length ratio and number of first-order streams reflect mature stage of topographic development and erosion. Hypsometric integral (value = 0.52) for this basin also indicate mature stage of landscape evolution (Singh et al., 2009, Awasthi, 2012). The RHO coefficient and gentle slope gradient indicate spreading of water within the basin due to its low water storage capacity, which causes flooding.

The basin has low water storage capacity due to which water spreads within the basin. The channels are far away from each other, as a result, during prolonged precipitation water accumulates in the basin which creates flood due to water logging. The length of overland flow (Lg) indicate longer path for the concentration of flow and so the peak discharge takes place in the downstream part of the river. The rainfall data indicate that whenever rain is high in the catchment area there is flood (1974, 1978, 1980, 1984, 1998, 2000, 2008) in the downstream part of the basin (based on the rain fall data and information of local people) (Singh and Awasthi, 2011a, Awasthi, 2012). Therefore, caution should be taken and planning should be made during prolonged precipitation for water resource management and flood mitigation. The shape parameter indicates that basin is elongated and skewed in SE direction and has smaller flood peaks but longer periods of flooding. Dendritic drainage network is the definite response of basin to complex physical processes such as climate and hydrology (Garde, 2006; Rao et al., 2010). The drainage network of the basin is effective to provide a sufficient superficial drainage with dominance of low order streams that flow directly in the principal collector or in upper order streams. The Hypsometric Integral (HI) indicates the mature stage of landscape evolution for Chhoti Gandak River Basin which is also confirmed by valley widening and meandering pattern of the channel. Stream length-gradient index (SL) describe that soft material is available for erosion and transportation in upper reaches whereas higher value indicate relatively resistant material in lower reaches. It is also confirmed by granulometric analysis, the presence of sand in upper reaches and clay in the lower reaches. Drainage basin asymmetry factor (AF) and transverse topographic symmetry factor (T) indicate tilting of the basin due to which the river has a tendency to migrate within the valley. The similarity of cliff, coalescing point bars, fluctuation in discharge, anatomy of channel and valley width, and river terraces indicate various energy levels of the river under direct control of climate by the river in the past during humid climate. Due to climate change and reduced discharge the channel has become very narrow. The reducing size of point bars indicates the changes in sediment load and water discharge of this river in direct response to the change in climate from humid to arid. The palaeodischarge and point bar complex are controlled by climate and indicate that monsoon was stronger in the past. The migration of stream and tilting of the basin are controlled by tectonics. The river terraces are evolved under the control of both climate and tectonics. Climate change produces fundamental changes in channel geometry and depositional style. Cold and arid stages are characterized by the presence of channel facies whereas warm and humid stages contain channel as well as interchannel facies.

References

Awasthi, A., 2012. Fluvial Dynamics and Subsurface Stratigraphy of Chhoti Gandak River Basin, Ganga Plain. Ph. D. Thesis, Department of Geology, University of Lucknow, Lucknow, India. 127 pp.

Awasthi, A. and Singh, D.S., 2011. Shallow Subsurface Facies of the Chhoti Gandak River Basin, In: Singh, D. S. and Chhabra, N.L. (Eds.), Geological Processes and Climate Change, Macmillan Publishers India Ltd., pp. 223-234, ISBN: 978-0230-3212922-32

Awasthi, A.K., 1970. Skewness as an environmental indication in the Solani river system, Roorkee (India). Sedimentary Geology, 4: 177-183.

Bhardwaj, V., Singh, D. S., and Singh, A.K., 2010. Environmental repercussions of canesugar industries on Chhoti Gandak River basin, Ganga Plain, India.

Environmental Monitoring and Assesment, 171:321-344. (DOI 10.1007/s10661-009-1281-2) Bridge, J.S., 1981.

Hydraulic interpretation of grain size distribution using a physical model for bed load transport. Sedimentary Petrology, 51: 1109-1124.

Bridges, E.M., 1990. World Geomorphology, Cambridge University Press, Cambridge, 260 pp. Dwivedi, G.N., Sharma, S.K., Prasad, S., and Rai, R.P., 1997.

Quaternary Geology and Geomorphology of a Part of Ghaghara-Rapti-Gandak Sub-basins of Indogangetic Plain, Uttar Pradesh, Journal Geological Society of India. Vol.49, pp. 193-202. Evans, I., 1972.

General geomorphometry, derivates of altitude, and descriptive statistics. In: R. Chorley (ed.), Spatial Analysis in Geomorphology (pp. 17-90). Methuen. London. Fisher, N.I. and Powell, C.McA., 1989.

Statistical analysis of two-dimensional palaeocurrent data: methods and examples. Australian Journal of Earth Science, 36: 91-107.