International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

Flood Study of Wainganga River in Maharashtra Using GIS & Remote Sensing Techniques

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Abstract: ***In the past, there have been several climatic parameters occurring in most part of the earth due to climate changesuch as intensity of rainfall, cloudburst, heavy rainfall etc. Flood is a one of the natural calamities occurring from time to time and space to space in all rivers, which not only damages natural resources and the lives but also causes the loss of economy and human being. So I have attempt to made in the Mapping of flood impact of Wainganga river basin in Maharashtra based on using remote sensing and GIS techniques. So the prepare from such calamity, vulnerable areas for flood affection area a need to find out. Therefore, in this research paper try to made find out the flood prone areas by using remote sensing and GIS techniques. To get the demarcation of flood line with the help of Grid rainfall data. With the help of such information identifies flood prone areas and will help in river management.***

Keywords: Wainganga river basin, Grid rainfall, Flood impact map, GIS, remote sensing.

1. Introduction

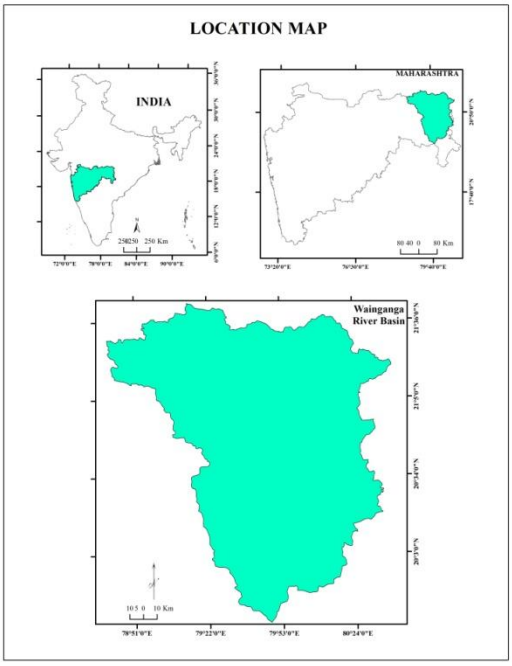
When rivers overflow their banks they cause damage to lives, property, infrastructure and crops. Rivers can also flood its surroundings when the when ice or a landslide temporarily block the course of the river channel, dams fail etc. The rivers bring heavy sediment load from the catchments. Inadequate carrying capacity of the rivers is responsible for causing floods, drainage congestion and erosion and deposition of river-banks. The Impact of flood map for the study area identifies flood prone areas that will help in river management and appropriate planning of development works. Eighty per cent of the precipitation takes place in the monsoon months from June to September. The Wainganga sub-basin is naturally prone to flooding, with floods being recorded every 5-7 years. Recently the Wainganga basin has experienced floods in 2001, 2004, 2007 and 2013.

2. Study Area

The Wainganga River rises atEl 640.0 m in the Seoni District of Madhya Pradesh from the Western slopes of Maikala Ranges which is continuation of the Satpura Ranges in Central**,** India. The Wainganga River receives numerous tributaries on either bank and drains the western, central and eastern regions of the Chandrapur, Gadchiroli, Bhandara, Gondia and Nagpur districts of Maharashtra.

(Latitude extension- 19^{0}30'N to 22^{0}30 N'& Longitude extension- 79^{0}00'E to 80^{0}30 E')

It is joined by the Wardha River at a place called Gundapet flowing from the west, draining the major portion of the Maharashtra Plateau. Thereafter the river is known as Pranhita River. The climate of the sub-basin is characterized by hot summer from March to May with rainy season from June to September although the area has some rains in post monsoon season also. The Prahnita River joins the Godavari River on the left bank which drains the Eastern Coast in Andhra Pradesh and flows out to the Bay of Bengal. The Wainganga River receives numerous tributaries on either bank and drains the western, central and eastern regions of the Chandrapur, Gadchiroli, Bhandara, Gondia and Nagpur districts of Maharashtra.



Map 1: Location Map of Study Area

3. Material and Methods

For the present studies of flood analysis data have obtained from one inch topographic map of Survey of India (1:63,360 or 1:2, 50,000). They are toposheet No. 55K, 55O, 55P, 56M, 64C, 64D, 65A.Includes sorting of data, digitization of various layers, preparation of maps, statistical analysis and other GIS/RS techniques, like Georeferencing, Data attachment, area calculation. The various maps were formed using ArcGIS and ERDAS imagine software. The rainfall distribution map was prepared from Indian Metrological

Department (IMD) 0.25^0 to 0.25^0 grid data. The thematic maps of rainfall distribution, slope, and micro watershed size, drainage density, soil type and land use/land cover per micro watershed were prepared using ArcGIS software and assigned weightage for each class. And then finally, integrated Flood Impact map was prepared.

4. Literature Review

Several studies related with different aspects of Flood analysis of river have been carried out from different parts of the country and abroad.

Kale V.S.(1999): He emphasized on causes and consequences of flood in major Indian river systems of North and eastern India

Rana Narendra Kumarand Tyagi Nutan(2008): Hedemarcate flood prone are a identified three different risk zones based on physical exposure of the area to flood and nature and extent of human vulnerability.

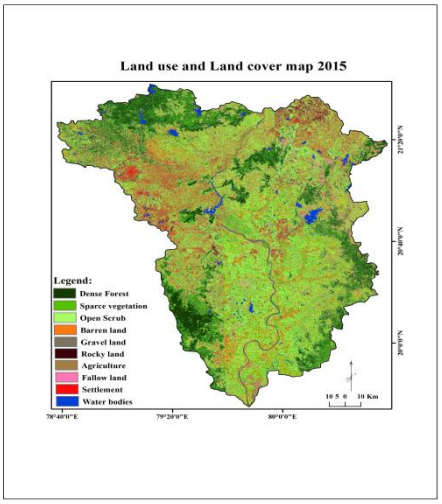
Paranjpye Vijay (2013): The report "Master Plan for Integrated Development and Management of Water Resources of Wainganga Sub- Basin". Gives guidelines on important issues regarding river system and its work process.

Ajin, et al., (2011) has carried out a study to prepare Flood hazard risk zone maps of Vamanapuram River basin based on using GIS & RS tools. The factors such as rainfall distribution, drainage density, land use, soil type, slope etc. are studied to prepare Flood hazard risk zone map.

5. Results and Discussions

5.1 Land use Land Cover

Land use land cover is most important factor that causes the flood hazard. The Wainganga distribution of land use land cover classes of image include rocky land /open space, dense Forest, water bodies, agriculture, sparse vegetation, fallow land, open Scrub, barren land, settlement, gravel land. The major land use categories in the Wainganga River's basin includes build up land (1.89%) and agricultural land (14.17%) that comprises of generally kharif, rabi and double crop system in the region.For Agricultural land the presence of thick vegetation cover slows the journey of water from sky to soil and reduces amount of runoff. Forest cover (65.75%) comprises of dense forest (15.03%), sparse vegetation (23.01%), open Scrub (27.71%) and recent plantations. Deciduous or dense forest largely spreads out in the region in the east of the all Wainganga river basin area. Forest cover comprises of deciduous forests, degraded forests, forest blanks and recent plantations. Barren land consists of soil in which plants cannot grow results in increasing runoff on the other side fallow land causes destruction to free flow of runoff. Water Bodies (2.11%), barren Land (9.48%), fallow Land (4.19%), gravel Land (0.52%), rocky Land or open Space (1.88%) can also be found in the region. Waste land with or without scrub and barren rocky/stony waste can also be found in the region. A supervised classification method was adopted using ERDAS Imagine software and later analyzed using ArcGIS spatial analyst tools.



Map 2: Land Use map of Wainganga sub-basin

5.2 Soil type

For flood hazard zonation soil type is a most important factor as the amount of water flow through soil is depends on infiltration capacity and the remaining results in to the surface runoff. Different types of soil can be found in the Wainganga river basin, which directly influence the kind of agricultural practices followed. Similarly the information on soil types was obtained from Survey of India toposheet and National Bureau of Soil Survey and Land use Planning. It is shown from Map 3, that the majority of the study area is consists of the soils of the Wainganga sub-basin is sub type of soil 45 dominate as the principal soil types of the study area. The chances of flood increase with decrease in infiltration capacity.

5.3 Morphometry control on flood

According to Strahler's scheme of Stream Ordering in Wainganga basin is 7^{th} order drainage basin and total stream 4870 that included 1^{st} 3318, 2^{nd} order 1117, 3^{rd} order 331, 4^{th} order 88, 5^{th} order 11, 6^{th} order 4 stream. The Wainganga River basin total means Bifurcation Ratio is 3.55 that is a natural river system where uniformity is seen with respect to climate, rock type and stage of development. The number of streams of a given order in a drainage basin systematically with increasing stream order and to reach up number of segments is 2786.1. In the Wainganga River having sinuosity index more than 1.41 is defined as meandering. Drainage basin geometry shape mainly in sub basin of Wainganga is dendritic to dendritic type. The Wainganga River sub-basin drainage density is Coarse (drainage density 0.70). Stream frequency is the measure of number of stream per unit area so it's having 0.18 km^2. This value is low which indicates the basin is highly thick vegetative cover and permeable sub soil.

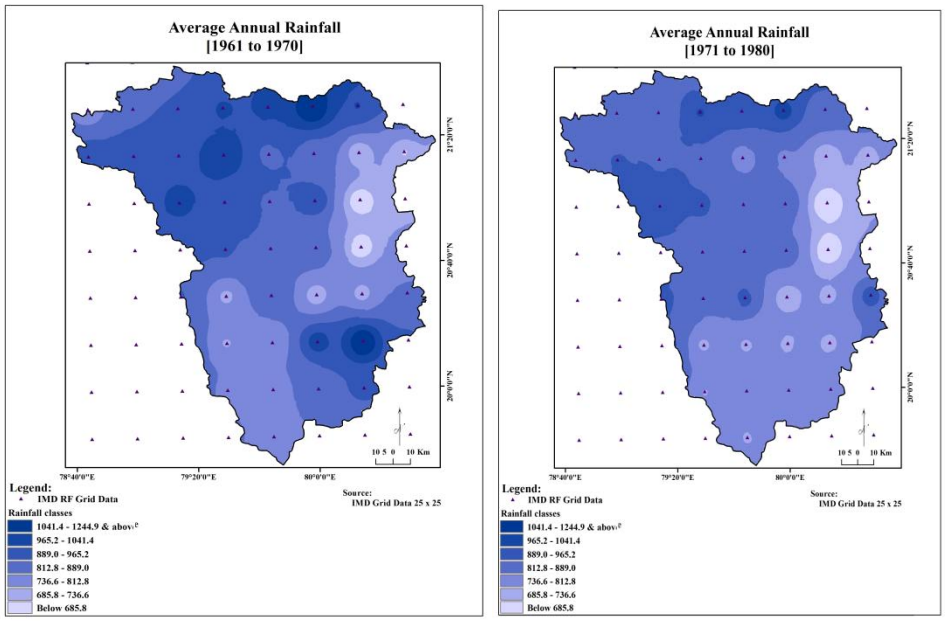
5.4 Rainfall distribution

The rainfall data of these stations were collected from IMD and the rainfall maps was prepared using 49 Grid stations and prepare spatial and temporal rainfall map form collected

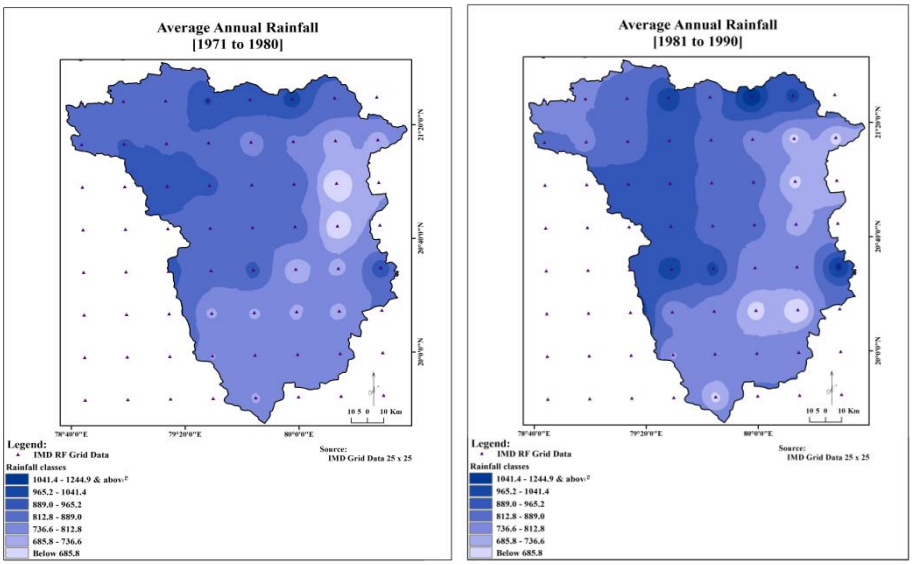
IMD .Rainfall distribution is important factor for flood hazard zonation. High intensity rainfall is results into heavy floods. Floods occur when the volume of water exceeds the ability of a stream and river to hold the water within its normal banks. Gridded rainfall data of 0.25°×0.25° resolution was analyzed to annual and seasonal scales in Wainganga river basin located in Maharashtra during 1961 to 2014. Only 1972,1974,1984,1987,1991,1996,2004 years has a significant decreasing trend during 1961–2014. During the study period, overall a 1972 decrease in annual rainfall is found. The most probable year of highly rainfall change was found to be 1992 in annual and monsoonal rainfall. There is an increasing rainfall trend in the basin during the period 1961, 1975, 1978,1990,1992,1994,2001,2005,2007 and 2013.

Spatial Distribution

This space variation is accounted in fact by working out to use Isohyet method. This variation found in Grid 20.25^0 to 80.25^0 have highest rainfall 1059.38 mm and in the 20.00^0 to 80.25^0 lowest rainfall is 640.57 mm in the year of 1961 to 1970. In the 1971 to 1980 decade found of the highest rainfall 1001.31 mm in 21.75^0 to 80.00^0 grids and also 640.57 mm lowest rainfall occurs reference to grid 20.75^0 to 80.25^0. In the decade of 1981 to 1990 highest rainfall is 1097.10 mm and lowest rainfall 672.44 mm in 21.50^0 to 80.00^0 and 21.25^0 to 80.50^0 respectively. The recent 24 years the maximum rainfall 1248.46 mm and minimum rainfall 616.56 mm found that area 21.50^0 to 80.00^0 and 21.75^0 to 78.50^0.



Map 3: Average Auuaal Rainfall in the Wainganga Sub-basin (1961 – 1970 & 1971 - 1980)

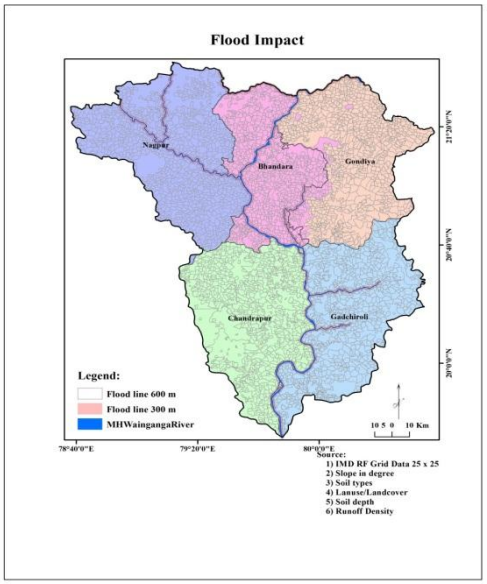


Map 4: Average Auuaal Rainfall in the Wainganga Sub-basin (1961 – 1990 & 1991 - 2014)

5.5 Impact of Flood Line on Wainganga River

The GIS technique has been used to obtain the flood impact map of Bhandara, Nagpur, Gondia, Chandrapur and Gadchiroli district. The flood impact map has been classified into two classes from the study of rainfall data i.e above rainfall of 1200mm and 600mm.The high risk zone area covers part along the whole Wainganga River. Flood line

demarcation plays important role in the villages and cityIn the flood year of the during 1961 to 2014 in Gondia district 188 villages have been affected by the floods and its cover the area of 336.35km^2. In the same year 102 villages impact of flood in the Chandrapur district. 147 villages have been affected by the floods in Gadchiroli district and its cover the area of 254.11km^2 . In Nagpur district and around the Wainganga River 322.13km^{2}areasaffected by the flood and near about 148 villages are continuously under the flood. Flood Impact map give us an idea of highest flood level in the flood prone area, which helps to understand channel changes in the study region.



Map 5: Flood Impact of Wainganga River

6. Conclusion

This study envisioned to demarcate the flood line and impact of risk zone areas Wainganga river basin by using Survey of India toposheet, Cartosat DEM and satellite data. GIS technology is being used to identify the danger zones for flood vulnerability. The result from the study can be useful to the people residing in the villages which are prone. The study concluded that the extreme water accumulation in the basin in association with abrupt occurrence of surplus rainfall is the key cause for flash flood existence. Therefore, the potential flood risk area need to take into consideration for any type of disaster and preparedness plan and pre-warning notice. This will empower individuals and officials to take suitable preliminary and response measures, which will help them for taking decision.

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