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Flood Hazard Mapping for Khadakwasla Waterhsed

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ABSTRACT: There are lager development in the field of real estate are happening in study area. For them it is very important to consider the areas which are flood prone. This has to be considered a vital component before land use planning of any city. Here we have prepared a flood hazard map by considering the various aspects of the environment and demographic factors which are responsible for the floods. Here we have also considered the distances of the flood prone areas from the nearest water resources which are contributing to the flood.

KEYWORDS: Flood, Flood hazard Map, GIS, Arc-Hydro food map.

I. INTRODUCTION

There are larger development in the field of real estate are happening the near areas of the Pune city. For them it is very important to consider the areas which are flood prone. This has to be considered a vital component before land use planning of any city. The paper presents the flood hazard index in the areas in the watershed of Khadakwasla complex in the GIS environment (Forkuo, 2010). During study here we are presenting the maps and the charts which can be easily read and understand (Bapalu and Sinha, 2005) which will eventually help to plan the mitigation measures in the areas which are under high risk of flood. Floods are probably the most recurring, widespread, disastrous and frequent natural hazards of the world. India is one of the worst flood-affected countries, being second in the world after Bangladesh and accounts for one fifth of global death count due to floods. About 40 million hectares or nearly 1/8th of India's geographical area is flood-prone(Bapalu et al).There is lot of attention is given on preparing the flood hazard maps before planning of a new development. There are various papers which describe the different technologies of preparing the flood hazard map (Skelton and Panda, 2009; Singh and Sharma 2009; Leenaers and Okx, 1989; Cova and Church, 1997; Balabanova and Vassilev, 2010; Islam and Sado, 2000a; Islam and Sado, 2000b; Sinha et al. 2008; ; Sanyal and Lu, 2004)In the present paper the flood hazard areas are predicted based on their characteristics related to the Nearness to river or dam, population, agricultural production, elevation, and no of villages in the watershed. Flood hazard study is not only important because of its devastating effect but for the optimal loss of the agricultural and economic growth in the populated country like India. And this is definitely not possible without the preparation of easy to study flood hazard maps. The main objective of this research is the mapping of flood hazard zones in the Khadakwasla Complex basin. The decision factors are the one who are relating to suitability concerning a controlling flood hazard in the study area. The primary decision factors considered in this study are geomorphic features, elevation, vegetation, land cover, distance from active channels, and population density. (Eric KwabenaForkuo, 2010)

II. MATERIAL AND METHODOLOGY

Previously the main purpose of the study to identify the flood hazard areas in the khadakwaslaas stated Complex basin to assist the future policy design makers to prepare the policy for the mitigation plan or planning within the area. The study area consists of three major dam and one minor dam Panshet, Varasgaon, Khadakwasla and Temhar respectively. There are major flood caused which flush the entire Pune city on 12 July 1961 due to bursting of the Panshet dam. This Dam is constructed on River Ambi however the Varasgaon Dam is constructed on River Mose and Khadakwasla dam is constructed on river Mutha. The minor dam Temghar is situated on the River Mutha.All of the three major dams are

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the source of water for drinking, irrigation and industrial Pune city and the following areas like Daund and Indapur.The minor dam Temghar is situated on the River Mutha.

The methodology used to generate the flood hazard map is to assign the various hazard ranks as per the ground truth surveys and the flood history to the various villages with the study area. The Ground truth survey was carried out to identify the villages in the study area and the agricultural productive areas within the villages. The ArcGIS and The ERDAS Imagine are the software are used for the Digitizing the map, GIS study and Georeferencing Respectively. Digital elevation model is prepared from the contours tracing and was then further studied using ArcGIS. The studies like classification of the satellite image using ERDAS for various land use within the area is done. The study area is divided into the different catmints based on the river pattern within the area and DEM is used to identify the highest elevation in the area. Also based on the secondary data collected the ranks were defined for the population density, Agricultural usage of land in the study area. The process carried out is explained in detail in the following study.

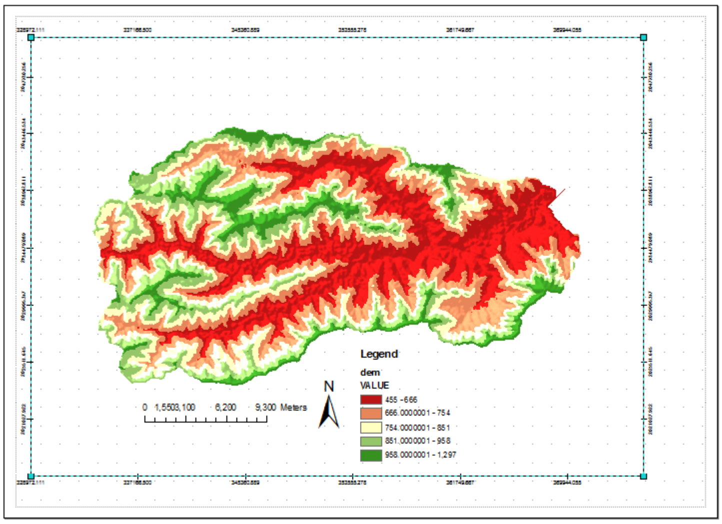
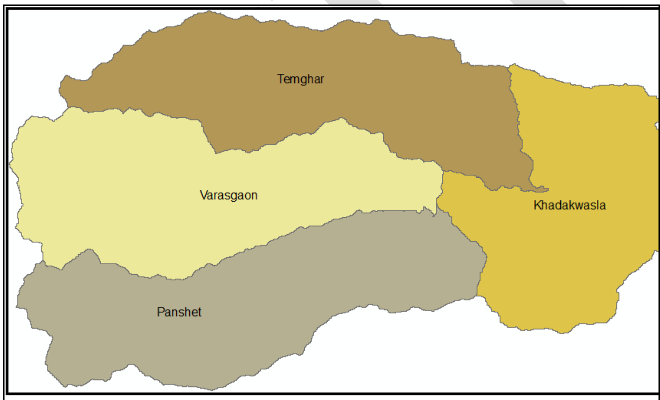


Fig 1 DEM of Study Area



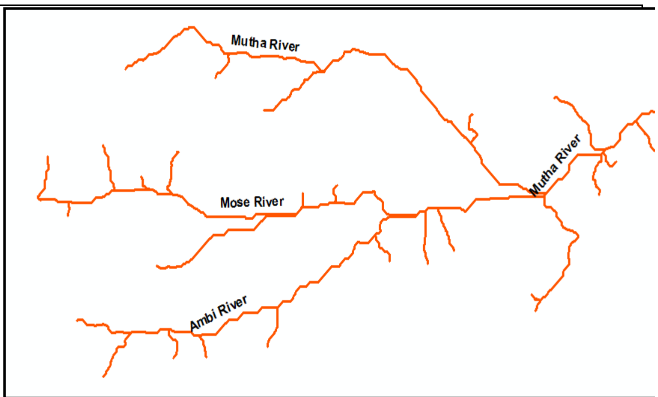


Fig 2 Dams in Study Area	**Fig 3 Rivers in study Area**

The study area consists of three major damsPanshet, Varasgaon, Khadakwasla and one minor dam,Temharwhich is shown Fig 2. Rivers on which dams are constructed are shown in fig 3.

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Methodology to generate the flood hazard map

Extraction of Highest elevation point in each sub catchment

The DEM is further processed in the Arc-hydro tools to delineate the different catmints following the river and dams in study area accordingly the DEM is divided into the fourteen sub catchments each including the varying number of Villages. As shown in the figure there are fourteen no of polygons and using the ArcGIS Zonal Statistics function from Special analyst the maximum elevation point in each polygon is identified.

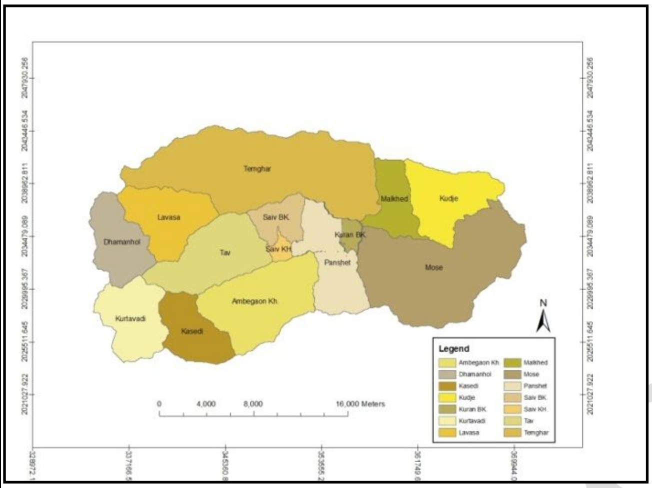

Fig. 4 Polygons of the catchments

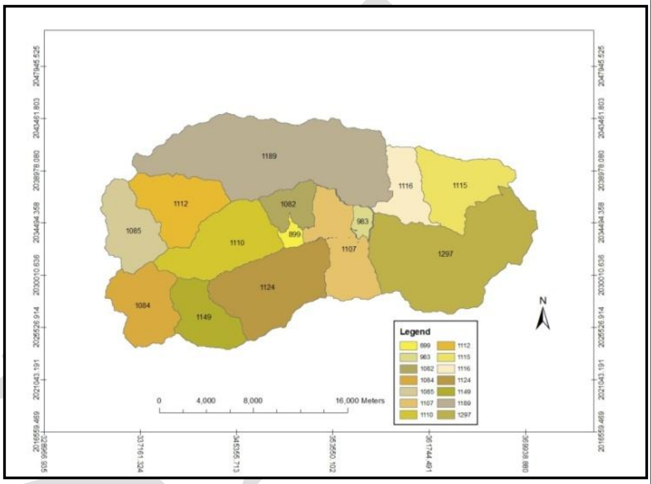

Fig. 5 Highest elevation in each catchment

The Figure 4 shows polygons of the catchments and the Figure 5 shows the highest elevation point in each polygon.

The satellite image of Landsat Thematic Mapper of 13th February 2012 is used to generate the Landuse map of high resolution. This data is geometrically and radiometrically calibrated (Forkuo, 2010). The landuse maps are prepared using the supervise classification. During the classification, we have considered the following six classes of land parcel Barren land, Vegetation, Scrub land, Fallow land, Agriculture, Water. Exiting topological map, ground truth survey data and shape files and Google earth imagery is used to check the accuracy of the data produced.

Area Extraction: The classified map is extracted to the polygon features the polygon. And the polygon land covershapefile is overlaid on the district feature class and with the help of the Union function of Analysis Tools of Arc Toolbox and subsequently clipped it using the ArcGIS (McCoy and Johnston, 2005) clip function the area of each land cover in the every catchment is computed which is provided in the Table 1.

Land Type	**Catchments (Million km^2)**						
	Temghar	**Kudje**	**Malkhed**	**Lavasa**	**Saiv BK.**	**Mose**	**Dhamanhol**
Barren Land	19.16	7230028	2763512	7745072	2987035	23276385	6275033
Vegetation	11122510	97219	118144	6821249	820784	315119	6831179
Scrub Land	63501522	9565140	7426219	12762808	7805116	42855897	10223616
Agriculture	7706218	2525440	1372920	4445929	817098	4625850	3494571
Fallow Land	12218386	11174487	7904529	1374537	451391	19005744	907319
Water	1205356	4483738	495928	450947	1092141	3506122	25471

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Land Type	Catchments(Million km^2)						
	Saiv KH.	Kuran BK.	Tav	Panshet	AmbegaonKh.	Kurtavadi	Kasedi
Barren Land	779104	1111580	10275983	10039474	12602089	5554261	8349759
Vegetation	96312	48618	6558791	412551	3926308	6806623	1683764
Scrub Land	1454700	1480748	18416366	15690508	26094442	15089380	12878388
Agriculture	96642	293210	3217798	967009	2881577	2726510	1653470
Fallow Land	140090	1040370	1370605	4761260	2468863	835614	334368
Water	814682	142203	2914724	2144774	4462456	6535	1303

Table 1: Land cover distribution within the Catchments in the study area

TABLE 1 Land cover distribution within the Catchments in the study area are described with their area within the catchment.

Identification of the proximity to the water resources: Proximity of the all the catchments within the study area to the water networks which includes the dam, rivers and streams are identified firstly so that the nearest catmint can be identified as a highest risk of flood. Catchments are drawn as a polygon features which are first converted to point features considering the midpoint of the each catchment. By using this shape file the distances of the each point from the nearby water source were extracted using the near function of the analysis tool. (Forkuo, 2010).

S.No	NAME_1	NEAR_DIST Km)
1	Temghar	0.61
2	Kudje	1569.38
3	Malkhed	1376.29
4	Lavasa	1626.18
5	Saiv BK.	2165.26
6	Mose	350.35
7	Dhamanhol	139.43
8	Saiv KH.	246.21
9	Kuran BK.	1015.15
10	Tav	439.40
11	Panshet	835.16
12	AmbegaonKh.	235.59
13	Kurtavadi	568.74
14	Kasedi	1351.20

Table 2: Distances of catchment from the river

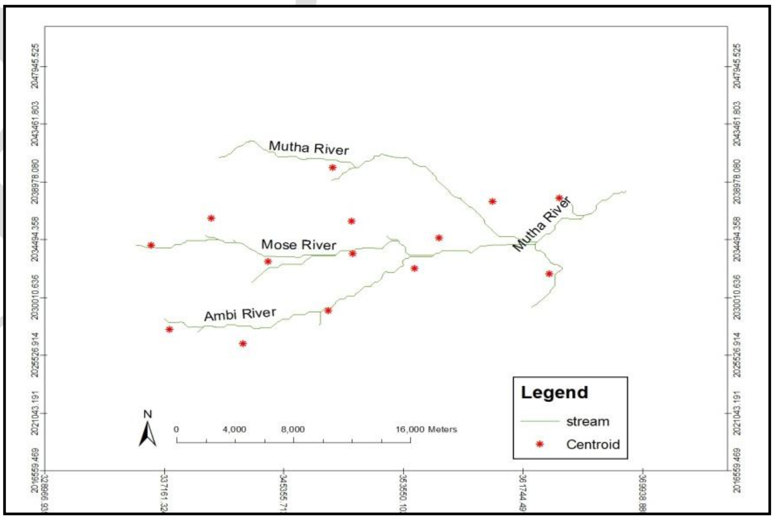

Fig. 6Proximity to water resources

Table 2 and 3 describes the catments and therir proximity to river as shown above.

Flood Hazard Mapping: Flood hazard mapping delineates and identified flood hazard areas along streams and lakes using design flood levels established as part of flood hazard studies. This is majorly important to prepare for the decision makers to take the decision about the planning for the mitigation measures to reduce the impact of the flood op

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the surrounding areas. However it is observed that the flood hazard maps are generally prepared using one or two administrative unit and accordingly the hazard scale is decided. Islam and Sado (2000a) formulated methodology toprepare flood hazard map for Bangladesh. Later, efforts have been made to integrate population density in the flood hazard maps in order to create land development priority maps (Islam and Sado, 2002).Here in this study we are using the different administrative units as investigation units of flood hazard map and deciding the ranking of the flood prone areas within the study region. (Forkuo, 2010). This will help the decision makers to plan and provide the resources. Then flood efforts have been made to integrate population density in the flood hazard maps in order to create land development priority maps (Islam and Sado, 2002). A flood hazard map based on administrative units is particularly handy for the planners and administrators for formulating remedial strategy.. A small scale leads to identification of the higher hazard zone upon which a large scale and a detailed mapping eventually identifies the high hazard areas (Sanyal and Lu, 2005). Managing and analysing flood hazard is one of the most important factors.

Flood Hazard Index:

Distance(km) from catchments Area (Near_Dist)	Hazard Rank (Dist_R)
100-250	3
250-450	2.5
450-600	2
600-1050	1.5
1050-1650	1
1650 and above	0.5

Table 3:Predefined Hazard rank of catchment distance from the river

An additive model has been adopted for generation of flood hazard map. It is recognized that the principle of assigning rank to the variables is very crucial in this entire process of hazard mapping. The variable 'Near_Dist' which is the proximity to the river has been attached high importance because where the risk of inundation is very low other variables do not contribute anything to the element of flood hazard. Districts have been assigned rank for each of the 5 hazard indicators. These ranking scheme clearly displays that very low or 2 ranking have been applied at very high 'Near_Dist' value to prevent the far districts from getting a higher flood hazard index on the basis of other factors. On the other hand, ranking have been increased at rate with higher risk of flood occurrence.

Number of Towns (Property)	Rank (R_prop)
0-1	0.2
2-4	0.4
5-7	0.6

Table 4: Hazard rank of Property density ranks

Highest elevation (shelter)	Hazard Rank (R_shelter)
899-983	2
1082-1149	1.5
1189-1297	1

Table 5: Hazard rank of Highest Elevation ranks

Table 4 5 shows Predefined hazard rank for property density and highest elevation

Population (Pop)	Rank (R_Pop)
<5,000	2
5000-10,000	4

Agriculture %	Rank(R_Agri)
10-20%	0.5
20-40%	1
More Than 40%	1.5

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>10,000	6	
Table 6: Hazard rank of Population ranks		**Table 7: Hazard rank of Agricultural Produce ranks**

Table 6,7 shows Predefined hazard rank for population and agricultural produce rank

III. FLOOD HAZARD INDEX MODEL

For preparing a composite index, a model is normally adopted. The variables and the principle ofassigning ranks to the variables are very crucial in arriving at a flood composite index in process of hazard mapping. Mostly, the process of assigning ranking to flood hazard indicators is knowledge based.

FID	Name	Pop_R	Dist_R	Village_R	Height_R	Cult_R	FHI	Rank
1	Temghar	4.0	1.5	0.4	1	1.5	8.4	High
2	Kudje	2.0	1	0.2	1.5	1.5	6.2	Low
3	Malkhed	4.0	1	0.4	1.5	1.5	8.4	High
4	Lavasa	2.0	0.5	0.4	1.5	1	5.4	Very Low
5	Saiv BK.	4.0	0.5	0.4	1.5	1.5	7.9	Moderate
6	Mose	6.0	2.5	0.4	1	0.5	10.4	Very High
7	Dhamanhol	2.0	3	0.4	1.5	1.5	8.4	High
8	Saiv KH.	2.0	3	0.4	2	1.5	8.9	High
9	Kuran BK.	4.0	1.5	0.4	2	1.5	9.4	Very High
10	Tav	4.0	2.5	0.6	1.5	1.5	10.1	Very High
11	Panshet	6.0	1.5	0.4	1.5	1.5	10.9	Very High
12	Ambegaon Kh.	4.0	3	0.4	1.5	1.5	10.4	Very High
13	Kurtavadi	2.0	2	0.4	1.5	1.5	7.4	Moderate
14	Kasedi	2.0	1	0.4	1.5	1.5	6.4	Very Low

Table 8: Flood Hazard Index (FHI)for the entire catchment

Final flood hazard index (FHI) for district scale is created from an additive model which was adapted for this study (Sanyal and Lu, 2003).

FHI = (Dist_R + R_shelter + R_pop + R_prop +R_crop)

Where Dist_R is rank for the districts' proximity to the river, R_shelter is rank for districts' highest elevation, R_pop is rank for districts population density, R_prop is rank for properties, and R_crop is rank for agricultural produce at risk. The attribute tables bearing the various indicators ranking, were join and field calculations performed to obtain the index for the districts. The table with the flood hazard indices for the various districts is shown in Table 8.

Hazard categories: After the final flood hazard index was devised it has been represented in a graduated colour map using ArcMap. It has been classified into 4 hazard categories by natural breaks (Jenks) scheme since the data ranges are not very familiar. In this process ArcMap identifies break points by identifying inherent clustering pattern of the data. Class boundaries are set where there are relatively big jump in the data values (Minami, 2000). Hazard values have been divided into 5 classes on the basis of 3 quartiles measurements. The classification scheme is summarized in Table 9 and the final flood hazard map produced is shown in Figure 7.

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Index Value Range	Number of Villages	Hazard Category
5-6	2.0	Very Low
6-7	3.0	Low
7-8	6.0	Moderate
8-9	13.0	High
9 Above	21.0	Very High

Table 9: Classification of composite hazard ranks into qualitative hazard intensity classes

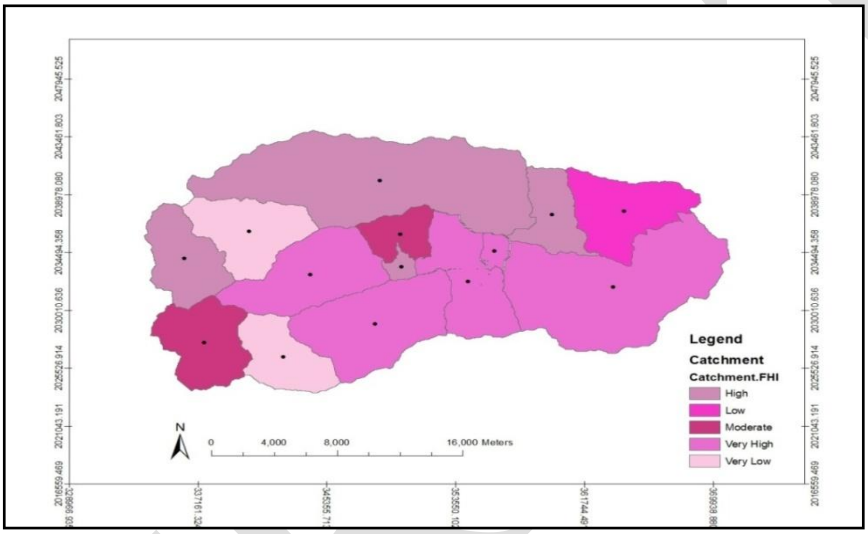

Figure 7: Floodhazard map for Khadakwasla catchment

IV. CONCLUSIONS

The study has described the integration of GIS and secondary data available in combination of DEMs in delineating flood hazard extent of each revenue district of the study area. An additive model was utilized to create a composite flood hazard index based on administrative units. In developing this model five variables (near distance to the River, Dam, population density, number of towns in each district, area of cultivated land, and availability of high ground) were investigated. Each of the factors has been assigned different ranking to quantify the severity of hazard and this can be modified and improved in future research. Also, maximum flood-prone areas were mapped using high resolution DEM and these areas were extracted by applying spatial analysis on GIS.These results obtained in this study provide essential information for planners and administrators to analyze and manage flood hazards, and also to formulate remedial strategy. However, one thematic area that could have been factored into the flood hazard modellingwill help the evacuation of lives and property in the event of a flood.

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