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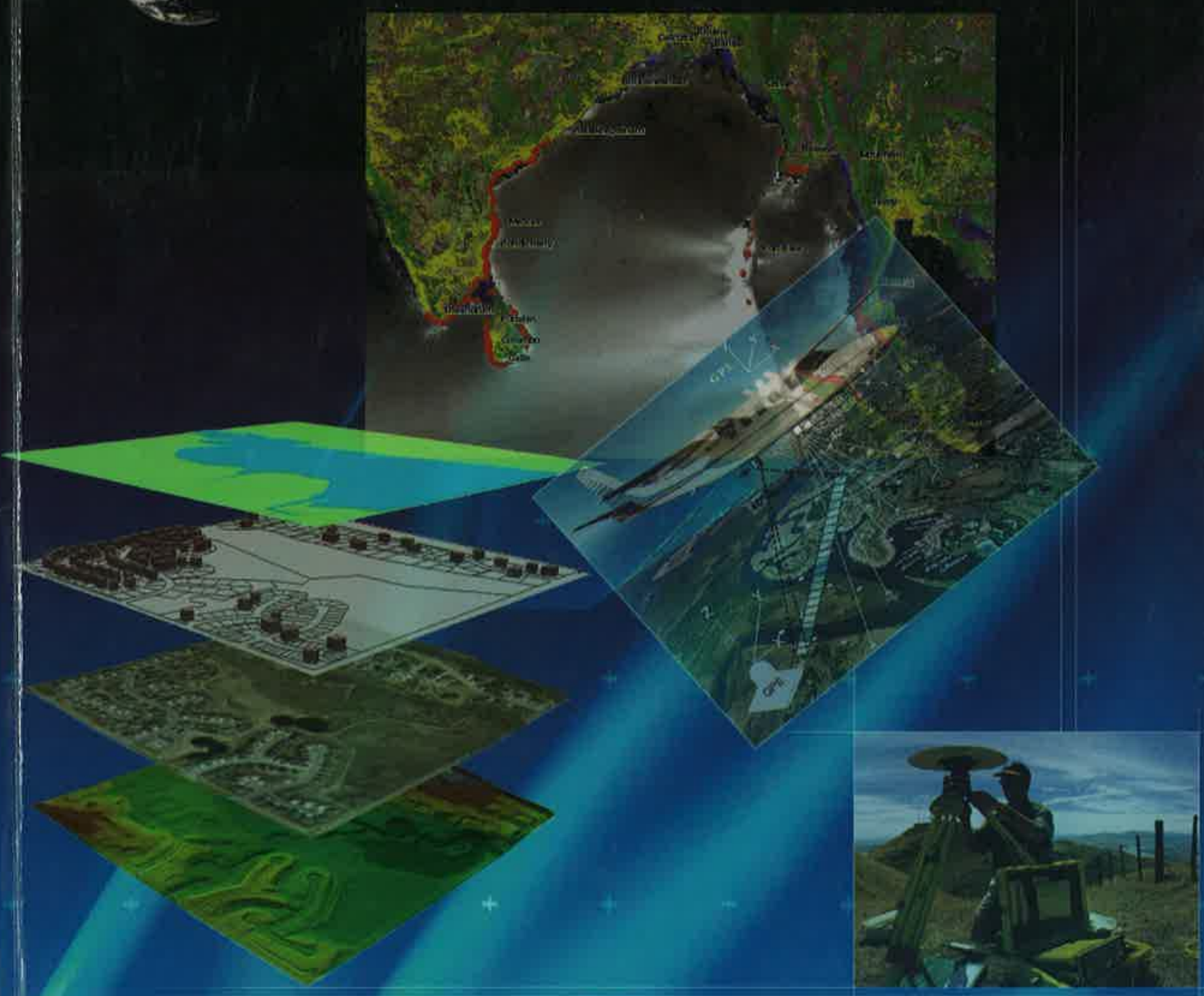

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A GEOGRAPHICAL ANALYSIS OF CAUSES OF FLOOD DISASTER IN UPPER KRISHNA BASIN: A CASE STUDY OF SANGLI DISTRICT

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ABSTRACT

Floods are usual phenomenon in north India but in the year 2005 and 2006, in last fortnight of the July and first fortnight of the August the disastrous flood situation had experienced in upper Krishna basin in general and Sangli district in particular. Thus, the present research paper focuses on the causes of devastating flood situation occurred in the year 2005 and 2006, in the study region. For the present research paper, primary as well as secondary data has been used. Sinuosity Index has calculated by using S. A. Schunm's method. For the analysis of water discharge, from selected dams' unit hydrograph technique is applied.

The study reveals that the floods of the year 2005 and 2006 had occurred due to the combination of various natural as well as manmade factors.

KEY WORDS: *Flood, Floodplain, Hazard, Disaster, Hydro-meteorological, Multiple Cross Section and Unit Hydrograph, etc.*

INTRODUCTION:

"A flood may be defined as a discharge which exceeds the channel capacity of a river and then proceeds to spill onto the adjacent floodplain". River floods are one of the most widespread short termed hydro-meteorological hazards, which arise from the concentration of population in well-defined danger areas, and they produce a highly distinctive human response in the construction of storage dams and river modification work *(Smith, K., 1975, p. 7)*. Flooding occur along major rivers, small streams as well as along the margins of some lakes. Flooding due to surface runoff and locally inadequate drainage can be a major problem, particularly in rapidly urbanizing areas *(Talwar, A. K. and Juneja, S., 2009)*. Flooding causes by the inadequate capacity within the banks of rivers to contain the high flows brought down from the upper catchments due to heavy rainfall *(Goel, S.L., 2007)*.

It is aptly remarked, "Floods are act of God, but acts of man cause flood damages". Floods depend on many things such as climate, nature of the collecting basin, nature of streams, soil and vegetative cover, amount of snowmelt and over all rainfall. Flood is a natural phenomenon and it occurs due to prolonged high intensity of rainfall *(Sharma, R.K. and Sharma, Gangadeep (Ed), 2009).*

Floods are usual phenomenon in north India *(Singh, Savindra, 2003)* but in the year 2005 and 2006, in last fortnight of the July and first fortnight of the August the disastrous flood situation had experienced in upper Krishna basin in general and Sangli district in particular. Thus, the present research paper focuses on the causes of devastating flood situation occurred in the year 2005 and 2006, in the study region.

Location:

For the present research paper, the Sangli district is selected as a study region. It is located in the southern part of Maharashtra and covers an area about 8572 sq. km. Its' latitudinal extent is 16o 45' N to 17o 33' N and longitudinal extent is 73o42' E to 74o40'E. It includes ten tahsils out of that four tahsils are flood prone whereas six tahsils are drought prone. These are Shirala, Walwa, Miraj, Palus, Tasgaon, Atpadi, Khanapur, Kadegaon, Kavate Mahankal, and Jat. Solapur district in northeast; Bijapur district of the Karnataka in the east and south; Kolhapur district in the south-west; and the Satara district in the north-west (Government of Maharashtra, 1972) delimit the study region (Fig.1).

The Sangli District
Location Map

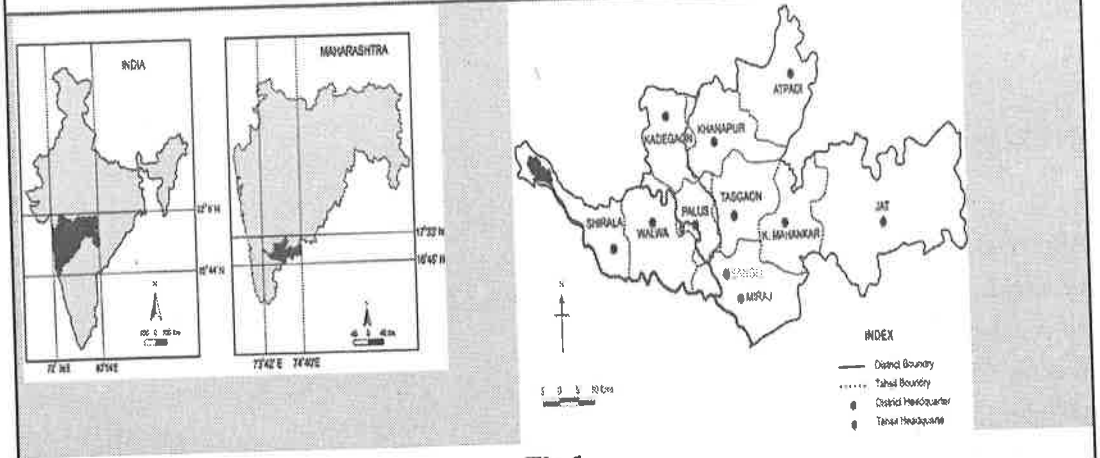


Fig.1

Objectives:

The present study has addressed to the floods of the year 2005 and 2006 faced by the Upper Krishna Basin especially experienced by the Miraj, Palus, Walwa, and Shirala tahsils of Sangli district. The main objective of the present study is...

- To find out causes of the severe floods occurred in the year 2005 and 2006 in the Sangli District.

Methods Of Data Collection:

The present research work has based on both primary and secondary data. However, primary data is the main source to meet the objectives of the study. Therefore, the correlated data has collected by conducting intensive fieldwork.

The primary data regarding natural and anthropogenic causes of flood disaster has collected through post flood fieldwork. During the field investigation, observation method as well as informal personal communications with some persons has made for the purpose of verification of data. The Google Earth Satellite Imageries have used for the understanding topography, collection of data and analysis of the data. Secondary data has collected from the various government offices, SOI topographical maps, books, journals, newspapers and several websites etc., which have explained under references.

Methods Of Data Analysis:

After the collection of primary and secondary data, it has processed. The processed data tabulated and presented in the form of charts and diagrams. The Auto CAD Map software has used for the preparation of maps and drawing of drawing of diagrams Coral DRAW Software is used.

For the calculation of the Sinuosity Index, the following equation given by S. A. Schunm *(Singh, Savindra, 2001)* is applied. The equation is

$$\text{Channel Sinousty} = \frac{O_L}{E_L}$$

Where,

O_L= Observed (actual) path of a stream

E_L= Expected straight path of a stream

The Unit Hydrograph (Gupta, B.L. and Gupta, Amit, 2008) is the basic quantitative tool used for the analysis of the water discharge from selected dams during flood period.

Causes Of Flood Disaster In The Sangli District:

India has the monsoon type of climate. Thus, in India, four months viz. June to September are rainy months and others are dry *(Tiwari, R.C., 2005)*. A monsoon rainfall, which is in the forms of heavy downpour, often causes devastating floods in the country. Deforestation, silting of the riverbeds, faulty land use practices, unplanned settlement activities in the flood plains, obstruction of the natural drainage by development activities, and rise of water table due to excessive irrigation are some of the other factors that directly or indirectly helped in aggravating menace of floods in the country (Basu, Swapana and Santra, S., 1988).

Since the flood of the rivers are response of both natural and anthropogenic factors, the causes of floods of alluvial rivers become highly complex and their relative importance varies from place to place (Sigh, S.R., 2008). During 2005 and 2006, devastating flood situation had occurred in the study region. These two floods are most devastating in the history of floods in the region (Daily Pudhari, 15th August, 2006). The reasons of these two floods are not only limited to the study region but also they extends to the catchments area and watershed of the upper Krishna basin. In the following paragraphs, key causes of the flood disaster of the year 2005 and 2006 have analyzed.

Deforestation:

Forest vegetation, in general, increases rainfall and evaporation while it absorbs moisture and lessens runoff (Naik, S. J., 2007). Large-scale deforestation in the upper catchments is perhaps the most important anthropogenic factor of the causes of river floods. Large-scale deforestation affected by man for various purposes decreases infiltration capacity of the cutover land and consequently increases surface runoff. It helps tremendously in increasing magnitude of flood (Singh, Savindra, 2003 and Lingaraj, W. and Tripathy, S.H., (Ed), 2007). It is based on the field observation in the upper Krishna basin by the researcher for last twenty years that the area under forests and intensity of forests is declining from last few decades in the watershed of the river Krishna and its tributaries. It is also proved by the informal communications, through interview, with the people living in the watershed of the river Krishna and its' tributaries. Declining proportion of area under forests and proportion of vegetation cover helps to increasing runoff and increasing proportion of soil erosion in the watershed of the river Krishna and its' tributaries. Increased runoff may also helps to siltation of dams and the channels of the rivers and it affected on the water storage capacity of the upstream dams and accumulating capacity of the rivers. By this way, directly or indirectly deforestation caused devastating flood situation in the study region.

Excessive Rainfall:

A heavy rainfall for long period in continuation is the root cause of river floods because immense volume of water either through high-intensity rainfall or through large-scale snowmelt is the prerequisite condition for river floods. Heavy rainfall in the upper catchments areas of the concerned river causes sudden increase in the volume of water downstream. Sudden torrential rainfall causes sudden increase in the volume of water, which has not be disposed off by the rivers immediately and thus the swelling water overtops the riverbanks and instantaneous floods are caused *(Singh, Savindra, 2003).*

During the last week of July and first fortnight of August 2005 and 2006 the watershed of the river Krishna and its' tributaries has recorded high intensity heavy rainfall for long period in continuation, from 26^{th} July to 8^{th} August, in both the years. It is the root cause of floods because immense volume of water is created through high-intensity rainfall.[18] During 2005 between 21^{st} July and 13^{th} August highest amount and variability of rainfall is recorded at certain places. About 90 percent of the rainfall is received in the month of June to August and most of it concentrated in the month of July and August. 26^{th} July is the date, which recorded highest amount of rainfall and 27^{th} July recorded peak floodwater. Table I and II show the rainfall received at some selected stations located in Upper Krishna basin.

Table- I

Rainfall at Some Selected Stations from Upper Krishna Basin (Between 20th July 2005 and 13th August 2005) (In mm)

Date	Mahabaleshwar	Koyna	Navja	Dhom	Kanher	Warna	Sangli	Miraj	Shirala	Islampur	Karad	Khodshi
20th July	11 (2643)	9 (1653)	41 (2198)	2 (417.40)	Nil (678)	Nil (1496)	0.20 (265.60)	Nil (228.20)	Nil (432)	2 (291)	Nil (363.80)	Nil (351)
21st	31 (2674)	67 (1720)	133 (2331)	2 (419.40)	4 (682)	24 (1520)	22 (287.60)	3.30 (231.50)	26 (457)	16 (307)	17 (380.80)	22 (373)
22nd	48 (2722)	22 (1742)	42 (2373)	5.20 (424.60)	8 (690)	37 (1557)	9.40 (297)	9.40 (240.90)	7 (464)	4 (311)	2 (382.80)	2 (375)
23rd	67 (2789)	88 (1830)	59 (2432)	11 (435.60)	3.50 (693.50)	70 (1627)	0.50 (297.50)	Nil (240.90)	10 (474)	2 (313)	0.80 (383.60)	Nil (375)
24th	90 (2879)	74 (1904)	133 (2565)	1 (436.60)	1.50 (695)	33 (1660)	0.10 (297.60)	Nil (240.90)	6 (480)	Nil (313)	1.20 (384.80)	1 (376)
25th	186 (3065)	157 (2061)	205 (2770)	28.80 (465.40)	32 (727)	185 (1845)	2.20 (299.80)	Nil (240.90)	34 (514)	5 (318)	9.20 (394)	3 (379)
26th	380 (3445)	558 (2619)	552 (3322)	150.40 (615.80)	109 (836)	336 (2181)	41 (340.80)	30.20 (271.10)	189 (703)	105 (423)	88.30 (482.30)	75 (454)
27th	255 (3700)	92 (2711)	170 (3492)	35.60 (651.40)	54 (890)	63 (2244)	26.10 (366.90)	21.50 (292.60)	36 (739)	28 (451)	37.20 (519.50)	45 (499)
28th	132 (3832)	57 (2768)	100 (3592)	22.40 (673.80)	19 (909)	67 (2311)	11.60 (378.50)	14.00 (306.60)	46 (785)	29 (480)	37 (556.50)	22.0 (521)
29th	189 (3832)	74 (2842)	85 (3677)	41.50 (715.30)	52 (961)	76 (2387)	9.10 (387.60)	4 (310.60)	17 (802)	11 (493)	7.60 (564.10)	11.0 (532)
30th	139 (4160)	114 (2956)	184 (3861)	10.70 (726)	23 (984)	58 (2445)	9.30 (396.90)	16.40 (327)	30.00 (832)	8 (499)	11.60 (575.70)	12 (544)
31st	262 (4422)	92 (3048)	141 (4002)	38.20 (764.20)	32 (1016)	126 (2571)	4.40 (401.30)	8 (335)	16 (848)	21 (520)	18.20 (593.90)	19 (563)
1st August	315 (4737)	292 (3340)	476 (4478)	53 (817.20)	35 (1051)	126 (2697)	14.80 (415.10)	14 (349)	129 (977)	40 (560)	42 (635.90)	52 (615)
2nd	424 (5161)	176 (3516)	254 (4732)	58.20 (875.20)	40 (1091)	202 (2899)	14.20 (429.30)	33.30 (382.30)	37 (1014)	35 (595)	22 (657.90)	52 (667)
3rd	217 (5378)	104 (3620)	154 (4886)	45 (921.20)	49 (1136)	242 (3141)	20.10 (449.40)	20 (402.30)	55 (1069)	79 (674)	12.20 (670.10)	10 (677)
4th	128 (5506)	86 (3706)	111 (4997)	10 (931.20)	28 (1167)	106 (3247)	31.80 (481.20)	31.30 (433.60)	63 (1132)	38 (712)	14.20 (684.30)	16 (693)
5th	130 (5636)	67 (3773)	97 (5094)	14.70 (945.90)	27 (1194)	63 (3310)	3.10 (484.30)	4 (437.60)	18 (1150)	12 (724)	17 (701.30)	13 (706)
6th	244 (5880)	158 (3931)	135 (5229)	25 (970.90)	35.50 (1229.50)	59 (3369)	6.60 (490.90)	7 (444.60)	13 (1163)	9 (733)	23 (724.30)	19 (725)
7th	132 (6012)	55 (3986)	22 (5251)	20.10 (991)	22.50 (1252)	68 (3437)	2.60 (494.50)	5 (449.60)	3 (1166)	2 (735)	6.80 (731.10)	6 (731)
8th	71 (6083)	62 (4048)	60 (5311)	3.50 (994.50)	11 (1263)	32 (3469)	6 (500.50)	4 (453.60)	14 (1180)	4 (739)	4 (735.10)	4 (735)
9th	69 (6152)	57 (4105)	70 (5381)	2 (997)	8 (1271)	38 (3507)	7.50 (508)	15 (568.60)	19 (1199)	5 (744)	5 (740.10)	4 (739)
10th	41 (6193)	30 (4135)	45 (5426)	1.10 (998.10)	15 (1286)	8 (3515)	0.10 (508.10)	Nil (568.60)	1 (1200)	Nil (744)	1 (741.10)	1 (740)
11th	25 (6218)	5 (4140)	20 (5446)	3 (1001.10)	Nil (1286)	9 (3524)	6.20 (514.30)	1.30 (469.90)	4 (1204)	1 (745)	1 (742.10)	1 (741)
12th	75 (6293)	24 (4164)	35 (5481)	4.70 (1005.80)	1 (1287)	17 (3541)	2.30 (516.30)	10 (479.90)	1 (1205)	4 (749)	0.80 (742.90)	Nil (741)
13th	39 (6332)	7 (4171)	10 (5491)	2 (1007.80)	3.50 (1290.50)	24 (3565)	6 (522.60)	5.40 (485.30)	3 (1208)	7 (756)	4 (746.10)	3 (744)

Source: Irrigation Department, Sangli Subdivision (2005): Daily Rainfall Record Report.

Note: Figures in the bracket shows cumulative rainfall of the respective date in the year 2005.

Table- II

Rainfall at some selected stations from Upper Krishna Basin (Between 20th July 2006 and 13th August 2006) (In mm)

Date	Mahabaleshwar	Koyna	Navja	Dhom	Kanher	Warna	Sangli	Miraj	Shirala	Islampur	Karad	Khodshi
20th July	75 (3045)	64 (3050)	70 (3285)	7 (520)	9 (498)	40 (1739)	1.60 (294)	4.20 (249.70)	4 (582)	1 (292)	3 (452)	4 (470.20)
21st	80 (3125)	104 (3154)	127 (3412)	11 (531)	10 (508)	27 (1766)	4.80 (298.80)	1 (250.70)	10 (592)	6 (298)	4.10 (456.10)	2 (472.20)
22nd	112 (3237)	122 (3276)	127 (3539)	21 (552)	22 (530)	66 (1832)	2.20 (301)	4 (254.70)	13 (605)	7 (305)	2.40 (458.50)	4 (436.20)
23rd	216 (3453)	197 (3473)	150 (3689)	35 (587)	43 (573)	101 (1933)	3.50 (304.50)	5 (259.70)	23 (628)	16 (321)	16.10 (474.60)	18 (454.20)
24th	107 (3560)	130 (3603)	105 (3794)	14 (601)	25 (598)	67 (2000)	4.30 (308.80)	6.40 (266.10)	11 (639)	8 (329)	15 (489.60)	15 (469.20)
25th	42 (3602)	38 (3641)	60 (3854)	6 (607)	12 (610)	43 (2043)	5.20 (314)	2.20 (268.30)	8 (647)	6 (335)	8.20 (497.80)	6 (475.20)
26th	40 (3642)	29 (3670)	42 (3896)	3 (610)	4 (614)	10 (2053)	4.80 (318.80)	5.40 (273.70)	6 (653)	3 (338)	4 (501.80)	3 (478.20)
27th	110 (3752)	65 (3735)	122 (4018)	4 (614)	12 (626)	34 (2087)	0.20 (319)	Nil (273.70)	5 (658)	2 (340)	5.20 (507)	3 (481)
28th	230 (3982)	168 (3903)	165 (4183)	37 (651)	62 (688)	144 (2231)	18.10 (337.10)	18.30 (292.00)	51 (709)	60 (400)	19 (526)	18 (499)
29th	326 (4318)	210 (4113)	240 (4423)	69 (720)	90 (778)	128 (2359)	15.60 (352.70)	4.40 (296.40)	15 (724)	7 (407)	27 (553)	27 (526)
30th	340 (4658)	218 (4331)	177 (4600)	50 (770)	77 (855)	173 (2532)	21.80 (374.5)	29.20 (325.60)	61 (785)	38 (445)	31.60 (584.60)	38 (564)
31st	167 (4825)	158 (4484)	136 (4736)	22 (792)	24 (879)	149 (2681)	5.60 (380.10)	2.30 (327.90)	15 (800)	16 (461)	4.20 (588.80)	6 (570)
1st August	196 (5021)	98 (4582)	108 (4844)	27 (819)	30 (909)	76 (2757)	1.70 (381.80)	4.10 (332)	10 (810)	2 (463)	1.20 (590)	3 (573)
2nd	163 (5184)	154 (4736)	160 (5004)	20 (839)	19 (928)	95 (2852)	1.90 (382)	1 (333)	5 (815)	5 (468)	5 (594)	4 (577)
3rd	64 (5248)	79 (4815)	91 (5095)	15 (854)	16 (944)	32 (2884)	5.60 (387.60)	4.90 (337.90)	8 (823)	2 (470)	4 (599)	7 (584)
4th	41 (5289)	28 (4843)	33 (5128)	7 (861)	7 (951)	14 (2898)	1.60 (389.20)	1.20 (339.10)	8 (831)	Nil (470)	6.0 (605.30)	3 (587)
5th	22 (5311)	16 (4851)	30 (5158)	2 (863)	4 (955)	24 (2922)	7 (396.20)	3.10 (342.20)	8 (839)	11 (481)	2.30 (607.60)	2 (589)
6th	110 (5421)	121 (4980)	110 (5268)	22 (885)	33 (988)	67 (2989)	19.60 (415.8)	33.30 (375.50)	60 (898)	32 (513)	29.40 (637)	28 (617)
7th	109 (5530)	144 (5124)	185 (5474)	22 (907)	30 (1018)	147 (3136)	28 (443.8)	28.10 (403.60)	45 (943)	41 (554)	37.40 (674.40)	38 (655)
8th	97 (5727)	304 (5428)	410 (5884)	29 (939)	75 (1093)	192 (3328)	107 (450.8)	14.10 (417.70)	61 (1004)	78 (632)	80 (740)	85 (740)
9th	273 (6000)	108 (5536)	118 (6002)	49 (985)	81 (12711751)	96 (3424)	15.40 (466.20)	15.60 (448.90)	28 (1032)	34 (668)	41.20 (795.60)	27 (767)
10th	101 (6101)	121 (5739)	131 (6133)	15 (1000)	30 (1205)	66 (3490)	1.30 (467.50)	1 (449.90)	21 (1053)	10 (678)	13.20 (868.80)	12 (779)
11th	253 (6354)	230 (5989)	238 (6371)	22 (1022)	18 (1223)	120 (3610)	22.40 (490.90)	14 (463.90)	45 (1078)	37 (715)	44.2 (853)	52 (831)
12th	200 (6554)	99 (6068)	102 (6473)	26 (1048)	42 (1265)	61 (3671)	4.90 (495.80)	2.10 (466)	48 (1146)	7 (722)	11 (864)	6 (837)
13th	54 (6608)	88 (6156)	105 (6578)	2 (1050)	7 (1272)	41 (3712)	4.10 (499.90)	2 (468)	7 (1153)	2 (724)	5 (869)	5 (842)

Source: - Sangli Irrigation Department (2006): Daily Rainfall Record Report.

Note: - Figures into bracket shows cumulative rainfall of the respective date.

Underground Water Level:

The level of underground water table is also important in the disastrous effect of flood because it affects upon rate of water percolation in the ground. During the flood period due to increased water table, water is not absorbed and percolated in the soil, therefore the volume of runoff has increased, (www.maharashtra.gov.in) which created severe floods in the region in the year 2005 as well as 2006. In recent years due to high amount of rainfall in Pune division in 41 tahsils underground water level has increased. In the Sangli district, excluding Atpadi tahsil all the tahsils have reported increasing water table *(Daily Sakal, July 20, 2007 and Daily Sakal, July 12, 2007).* Thus this is one of the reasons of the devastating flood situation occurred in the study region in the year 2005 and 2006.

River Bridges And Kolhapur Type Weirs:

There are 22 bridges for the transportation and 24 Kolhapur Type (K. T.) weirs have in the Sangli district on the rivers like Warna, Krishna and Yerla. These K. T. weirs have constructed for the purpose of preservation of water during dry season for irrigation and drinking purpose. The K. T. weirs assisted to deposition of sand and silt in the river basin of the river Krishna and its' tributaries *(Khemlapur, B.B., (2006).* Figure 2 depicts the siltation in the river Krishna at Mhaisal River Gauging Station. This is clear from the multiple cross section of Mhaisal R. G. Station that around one metre siltation took place during 2005-2006. The bridges obstruct the natural flow of floods and it aid to raise the floodwater level. This has investigated at the time of post flood fieldwork that "the flood water level come down slowly than it rises and it is due to the filling up of road near Manjari Bridge". This issue has also supported by the Daily Sakal's news network *(Daily Sakal, July 5, 2007).*

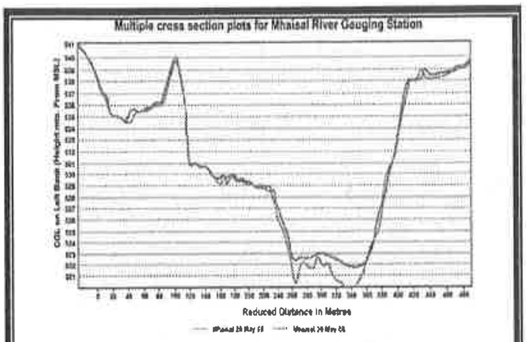


Fig.2

Construction Within Flood Lines And Filling Up Of Drainages:

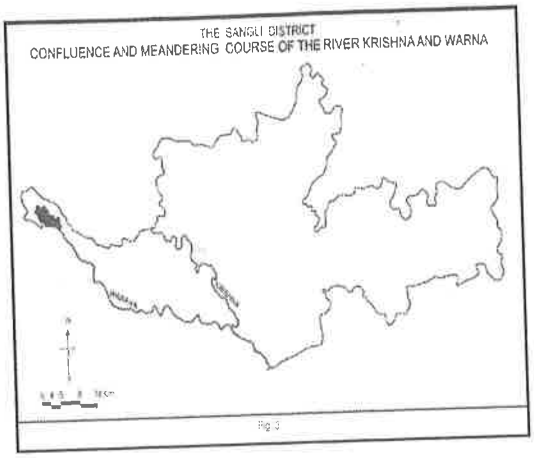
Constructions within flood lines and filling up of the drainages are the most important man made causes. The man made causes may be immediate or long term (Singh, Mahendra, 2008). In the Sangli district especially in the Sangli-Miraj municipal area, constructions have made below flood line. The areas like Karnal Road, Magar Machh Colony and some part of Jamvadi has observed below flood line *(Daily Sakal, July 11, 2007).* In spite of these, in some villages recently few constructions have made below the flood line. For instance, Mouje Digraj, Shigaon, Amnapur etc. In some places filling up of the drainages and poorly developed drainages, *(Daily Sakal, July 6, 2007)* helped to flash floods of the year 2005 and 2006. In the border area of the Miraj city

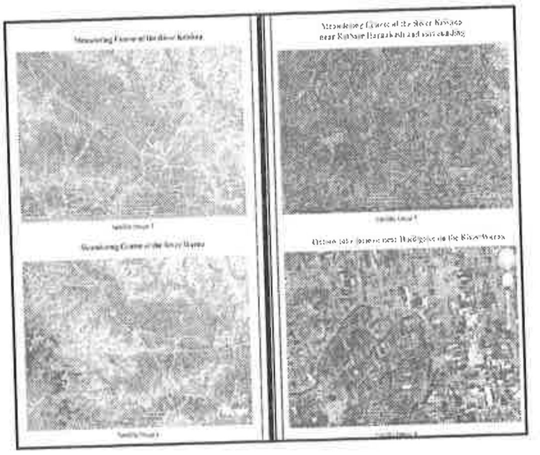
Source: - Sangli Irrigation Department (2006): Daily Rainfall Record Report.
Note:- Figures into bracket shows cumulative rainfall of the respective date.

drainage of dirty water management has filled up. The land is used for the purpose of construction of 'apartments', 'school buildings', 'temple' towards Miraj side of the drainage while opposite side i.e. towards Mhaisal agricultural encroachment has took place in the drainage. Before twenty-five years, the drainage was like a big river but today it becomes a small drainage only *(Daily Sakal, July 17, 2007).*

Meandering Course Of The River :

Highly sinuous and meandering courses of the rivers obstruct the normal discharge of water and thus the velocity is reduced which delays the passage of water resulting into stagnation of water. Consequently, the meandering valleys have immediately over flown and belts and loops of meanders have flooded *(Singh, Savindra, 2003).* In the study region, the river Krishna and Warna have meandering courses and Sinuosity index for them is 1.73 and 1.49 respectively. The river Krishna formed acute meanders at Haripur, Shirgaon, Shirte, Rethare-Harnaksh, Banewadi and near Bhilwadi. In the other sense river Warna formed meanders near Samdoli, Kumbhoj, Shigaon, Tandulwadi, Devarde, Kade, Sagar, Panvat, Kothrud etc. The ox-bow lake has formed near Dudhagaon by the river Warna. The villages located on the meanders of both the rivers have more affected than any other villages (Fig. 3 Satellite Image 1, 2, 3 and 4).





Retardation Of Flow Due To Backwater Effects:

Retardation of flow due to backwater effects *(Gupta, B.L. and Gupta, Amit, 2008, p. 141)* is also one of the important causes of flood disaster occurred in the study region. It has based on the field investigation that the river Panchganga Joins to the river Krishna from right side near Nrusinghwadi created back push to the water of river Krishna. Like river Panchganga, River Warna, a right bank tributary, also helped to the creation of back push of floodwater. This is the reason behind intensive flood situation in the Sangli City and

Sangli District especially in Krishna river valley. It has observed at the time of post flood fieldwork that the Village Haripur has most affected because it is located on the junction of river Krishna and Warna. Same way Brahmnal has affected due to conflunce of the river Yerla with the river Krishna.

Almatti Dam:

In the Bijapur district of Karnataka state, Almatti dam has constructed on the river Krishna, *(Kale, C.N., 2007, p. 69)* that is one of the major cause behind flood situation in Sangli district *(Daily Sakal, 28th July, 2007, p.1, 9th July, 2007, p.1, 3rd May, 2007, p.7 and 3rd July, 2007, p.1)*. Dr. Patangrao Kadam, Ex. Relief and Rehabilitation Minister, reported that the devastating flood situation occurred in the Sangli District is due to the Almatti dam *(Daily Sakal, 6th July, 2007, p.2)*. A retired Irrigation Engineer, S. B. Kulkarni had done study about the causes of the devastating flood situation appeared in the Krishna river basin during 2005 and 2006. He reported that devastating flood situation in the Krishna river basin is due to the five reasons and among them Almatti dam is most important one. During 2005, the water level at Almatti dam had 519.60 meters from MSL and it had created back push of 537 meters to 543 meters in the River Krishna at Sangli city. Whereas during 2006, the water level at Almatti had kept on 517 to 518 meters from MSL at that time back push created by the dam was 537 meters to 542 meters at Sangli city *(Daily Sakal, 6th July, 2007, p.2)*. It has also supported by the great Social worker Smt. Megha Patkar. She appointed a study group to study the causes of devastating floods of the year 2005 and 2006 occurred in the upper Krishna basin, under the presidency of Dr. Mukund Ghare *(Daily Pudhari, 26th December 2007, p.1)* and by this way, she supported to the contribution of Almatti dam in devastating flood situation occurred in the Kolhapur and Sangli district of Maharashtra. If one takes reference of the flood of the year 2007 and water level at Almatti dam, then he may believe in the role of Almatti dam in devastating flood situation. In the year 2007, Authority of Almatti dam had kept water level less than 509 metres from MSL at Almatti dam and because of this flood condition in Sangli is less as compared to the year 2005 and 2006.

Excessive Water Discharge From Upstream Dams:

Excessive water discharge from upstream dams (Singh, Savindra, 2003, p. 393) is also one of the most important causes causing devastating flood situation and disaster. In the Sangli district, too excessive water discharge from upstream dams is the major cause behind devastating flood situation of the year 2005 and 2006. The upstream dams, such as, Warna, Koyna, Dhom, Kanher, Radhanagari had excessive water discharge during flood period. On July 27, 2005 more than one lakh cusecs water had discharged from the Koyna dam. This higher amount of discharge continued until August 4, 2005. Same situation was applicable to other dams also.

Table III
Highest Water Discharge from Some Selected Dams Located on River Krishna and Its Tributaries (2005)

Sr.No.	Date	Water Discharge in Cusecs			
		Koyna	Dhom	Kanher	Warna
1	01-08-2005	92737	11209	8717	25958
2	02-08-2005	99358	22400	14087	35517
3	03-08-2005	96976	3240	2781	36772
4	04-08-2005	62236	5599	5014	15136
5	05-08-2005	20740	6046	6150	15590

Source: Information Booklet (2009) Surface Water Hydrology Project, Sangli Sub division

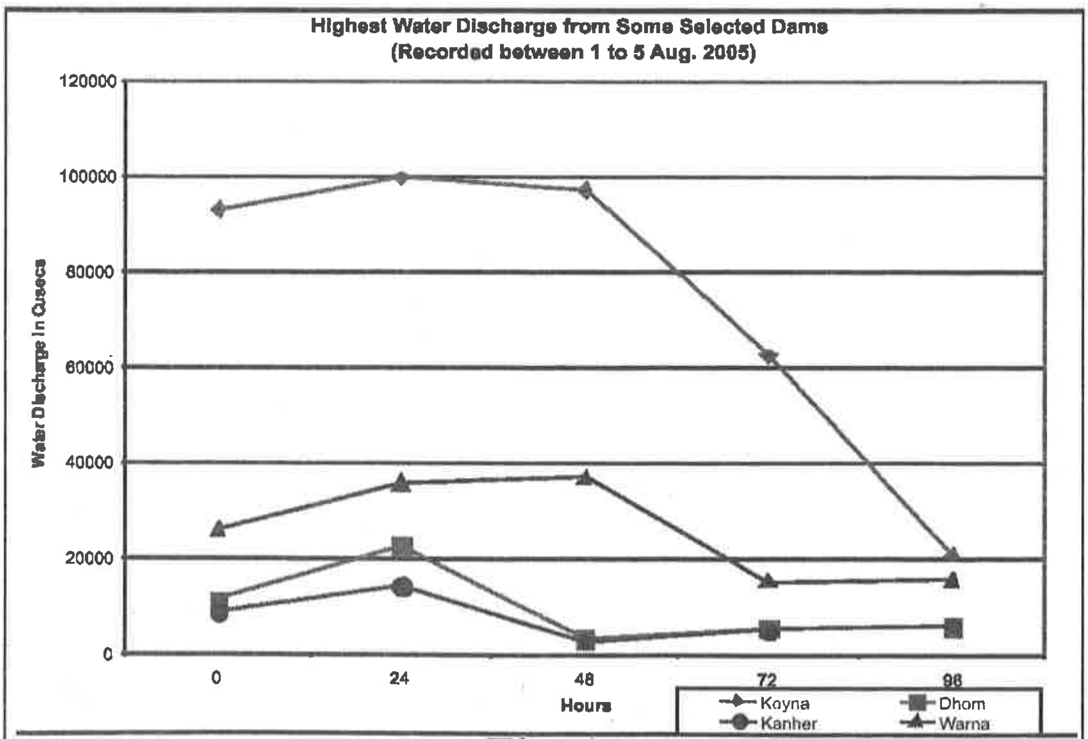


Fig. 4

Table IV

Highest Water Discharge from Some Selected Dams Located on River Krishna and Its Tributaries (2006)

Sr. No.	Date	Water Discharge			
		Koyna	Dhom	Kanher	Warna
1	30-07-2006	1,00,000	12252	8999	22125
2	31-07-2006	73758	9125	8964	22688
3	01-08-2006	62765	10459	6966	13021
4	02-08-2006	61347	9089	4999	13658
5	03-08-2006	58808	2925	8710	13374
6	04-08-2006	46317	2986	620	12581

Source: Information Booklet (2009) Surface Water Hydrology Project, Sangli Sub division

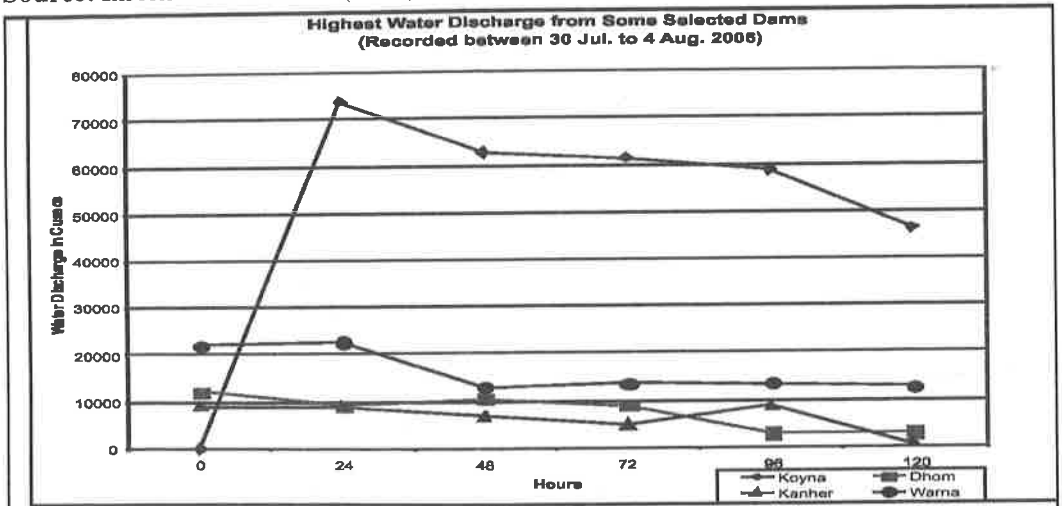


Fig. 5

The discharge from the Koyna dam was one-lakh cusecs on July 30, 2006 and this trend continued for long time. Except major dams, minor dams had also higher discharge during flood period in both years. The Figure 4 and 5 shows the trend of water discharge from the Koyna, Warna, Dhom and Kanher dams (Table III and IV).

Land Use Pattern In The Study Region:

The land use or land management has a great effect on the resulting surface runoff *(http://www.bgsu.edu/departments/acs/1890s/johnstown/page3.html)*. In the Western Sangli district, Krishna and Warna are the major rivers. This western part of the district has irrigated land and the crops like Sugarcane, Soyabean and Jawar have grown in this region. Forests are also cleared and land is utilized for the agricultural purposes it helps to increased rate of soil erosion and finally it helped to the devastating flood situation occurred in the study region in the year 2005 as well as 2006.

Discussion & Conclusion:

During 2005 and 2006, floods in the Sangli district are not a result of any single factor but it caused due to the combination of various factors. Among the major causes of the flood disaster excessive rainfall, excessive water discharge from upstream dams, back push created by the Almatti dam, meandering course of the river Krishna and Warna etc. are the important ones. In spite, other minor factors like, deforestation, land use pattern, construction within flood lines and filling up of drainages, river bridges and Kolhapur Type (KT) weirs had intensified the disastrousness of the floods occurred during 2005 and 2006. In short, the flood disaster of the study region caused due to the natural factors and its intensity had increased by the manmade factors.

Suggestions:

Totally, elimination or control of floods is neither practically possible nor economically viable because floods are a natural phenomenon. Hence, flood control aims at providing reasonable degree of protection against flood damage at economic costs. Hence, for the Flood Disaster Management of the Upper Krishna basin preventive measures should have given more importance than the flood control measures. The preventive measures include Flood Plain Management, Flood Forecasting and Flood Warning, Disaster Preparedness, effecting structural changes, flood proofing of area and Adoption of Suitable Development Policies.

References

Basu, Swapana and Santra, S. (1988): Flood Problems of Howrah District, Geographical Review of India, vol.50, No.4, P.69

Critchfield, H.J.(1987): General Climatology, 4th Edition, Prentice - Hall Inc. Englewood Cliffs, N.J., U.S.A. P.258.

Daily Pudhari, dated 15th August 2006.

Daily Pudhari, dated 26th December 2007, Supplement, p.1 and 4.

Daily Sakal, Kolhapur Edition, dated 3rd May, 2007, p.7.

Daily Sakal, Kolhapur Edition, dated 9th July, 2007, p.1.

Daily Sakal, News Network, dated 20th July 2007.

Daily Sakal, Today Supplement, Kolhapur Edition, P.2, dated 12th July, 2007.

Daily Sakal, Today Supplement, Sangli Edition, dated 11th July, 2007.

Daily Sakal, Today Supplement, Sangli Edition, dated 28th July, 2007, p.1.

Daily Sakal, Today Supplement, Sangli Edition, dated 3rd July, 2007, p.1.

Daily Sakal, Today Supplement, Sangli Edition, Dated 5th July, 2007 P.1.

Daily Sakal, Today Supplement, Sangli edition, dated 6th July 2007 P.1.

Daily Sakal, Today Supplement, Sangli Edition, dated 6th July, 2007, p.2.

Daily Sakal, Today Supplement, Sangli, Edition, dated 17th July, 2007 P.1.

Goel, S.L. (2007): Disaster Administration and Management: Text and case studies, Deep and Deep Publications, New Delhi, P.226.

Government of Maharashtra, Department of Relief and Rehabilitation, Report of Maharashtra Floods, 2005, www.maharashtra.gov.in

Government of Maharashtra, Water Resources Department (2009): Surface Water Hydrology Project, Sangli Sub division, Information Booklet.

Gupta, B.L. and Gupta, Amit (2008): Water Resources System and Management, Standard Publishers, Delhi, p.141.

http://www.bgsu.edu/departments/acs/1890s/johnstown/page3.html

Kale, C.N.(2007): Causes and Effects of Flood Situation in Upper Krishna Basin of Maharashtra: A Geographical Analysis, A unpublished M. Phil. thesis submitted to Tilak Maharashtra Vidyapeeth, Pune p. 69.

Khemlapur, B.B. (2006): Krishna Basin Flood Potential Causes and Solutions" Daily Lokmat, dated 4th September.

Lingaraj and Tripathy S.H. (Ed) (2007): Environmental Hazards, Sonali Publications, New Delhi, P.1.

Naik, Sambhaji J (2007): Post Inundation Scenario of Panchganga River in Year 2005: A Geographical Analysis, A M. Phil thesis submitted to Shivaji University Kolhapur, P58.

Sharma V.K. and Kaushik A.D. (2005): Floods in India, http://dhemaji.nic.in/flood/flood history.htm

Sharma, R.K. and Sharma, Gangadeep (Ed) (2009): Natural Disasters: Institutional Building for Mitigating the Impact on Vulnerable Sections, A.P.H. Publishing House, New Delhi, P.17.

Sharma, V.K. (1976): Some hydrologic Characteristics of the Damodar River. Geographical Review of India, Vol. XV II, No.1, pp. 1-5.

Shinde, S.B. (2006): "Krishna Basin Floods Potential Courses", Daily Pudhari, dated 20th August.

Sigh, S.R. (2008): Disaster Management, A.P.H. Publishing Corporation, Delhi, p.83.

Singh, Mahendra (2008): Natural Calamities in India, Satyam Publishing Houses New Delhi, P.45.

Singh, Savindra (2003): Environmental Geography, Prayag Pustak Bhavan, Allahabad, pp.391-393.

Singh, Savindra (2001): Geomorphology, Prayag Pustak Bhavan, Allahabad.

Smith, K. (1975): Principles of Applied Climatology. McGraw Hill Book Company (U.K.) Limited, p. 7 and 124.

Talwar, Arun Kumar and Juneja, Satish (2009): Flood Disaster Management, Common Wealth Publishers, New Delhi. p.1.

Tiwari, R.C.(2005) : Geography of India, Prayag Pustak Bhavan, Allahabad, P.391.