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Causes of Floods in Upper Krishna Basin of Maharashtra

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Key Words:
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Causes of floods
Anthropogenic factors
Natural factors

ABSTRACT

The present paper attempts to analyse probable causes of flood situation in upper Krishna basin of southern Maharashtra. Flood situation has become disastrous during the years 2005 and 2006 in later part of July and early August in upper Krishna basin. It is also important to note that floods are aggravated phenomena by human and natural activities. About 27.72% of the geographical area of the upper Krishna basin of southern Maharashtra is affected by floods of which about 2.12% of total population of Upper Krishna basin has suffered in 2006. Since, the floods of rivers are responses of both natural and anthropogenic factors, the relative effects and causes vary from place to place. To analyse the causes of flood situation in the region under study, the statistical data and concerned information have been collected through personal visits and records available at Tehsil headquarters of Sangli, Kolhapur and Satara districts.

INTRODUCTION

Flood is a natural phenomenon, which occurs due to prolonged high intensity of rain. This situation becomes hazardous when it causes colossal loss to human lives and property (Singh 1995). Floods are usual phenomena in north and eastern India, but during the years 2005 and 2006 in July and August, the flood situation has been experienced in upper Krishna Basin. It is also important to note that floods are aggravated by human activities. About 3.5 % of the total geographical area of the world is affected by floods with its 16.5 % of the total population (Singh 1995).

The floods of rivers are the responses of both natural and anthropogenic factors. The causes of floods of alluvial rivers are highly complex and their relative importance changes from place to place (Singh 1995). The present paper aims to find on the probable causes of flood situation in upper Krishna Basin of Maharashtra.

METHODOLOGY

Sources of Data and Information: Required data and information have been collected from various sources. The vast statistical data and concerned information have been collected through personal visits to tehsil headquarters of Sangli, Kolhapur and Satara districts. Number of affected villages have been visited to have discussion with the affected people and Government officers.

The secondary data have been taken from socio-economic reviews and district statistical abstracts, census handbook and district gazetteer of Satara, Sangli and Kolhapur districts. Various articles published on flood situation in daily news papers, journals, magazines, S.O.I. toposheets and reference books were also referred.

To find out causes of floods in upper Krishna Basin, the relative information regarding the rainfall, area under irrigation, bridges on Krishna and other rivers, statistical information about flood affected area, population and other aspects were collected through primary and secondary sources of data. Analysis of data and information has been done with the help of cartographic methods, dia-

Table 1: Flood affected villages.

1.	Helwak (Tal.- Patan)	55.	Dudhari (Tal.- Walwa)
2.	Koyananagar (Tal.- Patan)	56.	Takari (Tal.- Walwa)
3.	Rasati (Tal.- Patan)	57.	Borgaon (Tal.- Walwa)
4.	Banpetwadi (Tal.- Patan)	58.	Kharatwadi (Tal.- Walwa)
5.	Patan (Tal.- Patan)	59.	Bahe (Tal.- Walwa)
6.	Yerphale (Tal.- Patan)	60.	Hubalwadi (Tal.- Walwa)
7.	Mandrul Haveli (Tal.- Patan)	61.	Junekhed (Tal.- Walwa)
8.	Navadi (Tal.- Patan)	62.	Aitavade Kh. (Tal.- Walwa)
9.	Jamadwadi (Tal.- Patan)	63.	Chikurde (Tal.- Walwa)
10.	Girewadi (Tal.- Patan)	64.	Devarde (Tal.- Walwa)
11.	Kalgaon (Karad Tahsil)	65.	Kundalwadi (Tal.- Walwa)
12	.Chachegaon (Tal.- Karad)	66.	Tandulwadi (Tal.- Walwa)
13.	Potale (Tal.- Karad)	67.	Yelur (Tal.- Walwa)
14.	Yerawale (Tal.- Karad)	68.	Bahadurwadi (Tal.- Walwa)
15.	Karve (Tal.- Karad)	69.	Kanegaon (Tal.- Walwa)
16.	Rethre Budruk (Bk.) (Tal.- Karad)	70.	Koregaon (Tal.- Walwa)
17.	Shere (Tal.- Karad)	71.	Bagani (Tal.- Walwa)
18.	Khubi (Tal.- Karad)	72.	Mirajwadi (Tal.- Walwa)
19.	Ghondi (Tal.- Karad)	73.	Gaundwadi (Tal.- Walwa)
20.	Kapil (Tal.- Karad)	74.	Farnewadi (Tal.- Walwa)
21.	Goleshwar (Tal.- Karad)	75.	Tupari (Palus Taluka)
22.	Kodoli (Tal.- Karad)	76.	Dahyari (Palus Taluka)
23.	Dushere (Tal.- Karad)	77.	Ghogaon (Palus Taluka)
24.	Belvade Haveli (Tal.- Karad)	78.	Dudhondi (Palus Taluka)
25.	Tasavade (Tal.- Karad)	79.	PundiTarf Walwa (Palus Taluka)
26.	Kavathe (Tal.- Karad)	80.	Pundiwadi (Palus Taluka)
27.	Umbraj (Tal.- Karad)	81.	Nagrale (Palus Taluka)
28.	Korti (Tal.- Karad)	82.	Burli (Palus Taluka)
29.	Bhuyachi Wadi (Tal.- Karad)	83.	Sawantpur Kr. (Palus Taluka)
30.	Koparde Haveli (Tal.- Karad)	84.	Godilwadi (Palus Taluka)
31.	Sayapur (Tal.- Karad)	85.	Anugdewadi (Palus Taluka)
32.	Koregaon (Tal.- Karad)	86.	Amanapur (Palus Taluka)
33.	Nadshi (Tal.- Karad)	87.	Vithalwadi (Palus Taluka)
34.	Karad Urban (Tal.- Karad)	88.	Nagthane (Palus Taluka)
35.	Karad Rural (Tal.- Karad)	89.	Kholewadi (Palus Taluka)
36.	Varunji (Tal.- Karad)	90.	Radewadi (Palus Taluka)
37.	Gote (Tal.- Karad)	91.	Ankalkhop (Palus Taluka)
38.	Khodashi (Tal.- Karad)	92.	Tavdarwadi (Palus Taluka)
39.	Tambhave (Tal.- Karad)	93.	Burungwadi (Walva Taluka)
40.	Mhopre (Tal.- Karad)	94.	Khandobachiwadi (Palus Taluka)
41.	Sajur (Tal.- Karad)	95.	Malwadi (Palus Taluka)
42.	Padalikese (Tal.- Karad)	96.	Bhilwadi (Palus Taluka)
43.	Paschim Supane (Tal.- Karad)	97.	Chopdewadi (Palus Taluka)
44.	Aatke (Tal.- Karad)	98.	Sukhwadi (Palus Taluka)
45.	Rethre Kr. (Tal.- Karad)	99.	Bramhanal (Palus Taluka)
46.	Vathar (Tal.- Karad)	100.	Khatav (Palus Taluka)
47.	Malkhed (Tal.- Karad)	101.	Wasgade (Palus Taluka)
48.	Kasegaon Walwa Tahsil	102.	Tung (Miraj Taluka)
49.	Dhotrewadi (Tal.- Walwa)	103.	Mauje Digraj (Miraj Taluka)
50.	Tambhave (Tal.- Walwa)	104.	Kasabe Digraj (Miraj Taluka)
51.	Kole (Tal.- Walwa)	105.	Dudhgaon (Miraj Taluka)
52.	Narsihapur (Tal.- Walwa)	106.	Savalwadi (Miraj Taluka)
53.	Shiate (Tal.- Walwa)	107.	Malwadi (Miraj Taluka)
54.	Rethre Harnaksha (Tal.- Walwa)	108.	KavathePiran (Miraj Taluka)

Table 1 cont....

...Cont. Table 1

109.	Samdoli (Miraj Taluka)	141.	Chinchvad (Shirol Taluka)
110.	Haripur (Miraj Taluka)	142.	Arjunwad (Shirol Taluka)
111.	Bichud (Walwa Tahsil)	143.	Shirol (Shirol Taluka)
112.	Inamdhamani (Miraj Tahsil)	144.	Ghalwad (Shirol Taluka)
113.	Sangali (Miraj Taluka)	145.	Kutwad (Shirol Taluka)
114.	Bhartawadi (Walwa Tahsil)	146.	Hasur (Shirol Taluka)
115.	Nandre (Miraj Taluka)	147.	Kanwad (Shirol Taluka)
116.	Padmale (Miraj Taluka)	148.	Nandani (Shirol Taluka)
117.	Karnal (Miraj Taluka)	149.	Takavade (Shirol Taluka)
118.	Ankali (Miraj Taluka)	150.	Shirdhon (Shirol Taluka)
119.	Bamani (Miraj Taluka)	151.	Herwad (Shirol Taluka)
120.	Nilaji (Miraj Taluka)	152.	Terwad (Shirol Taluka)
121.	Vadai (Miraj Taluka)	153.	Majarewadi (Shirol Taluka)
122.	Davali (Miraj Taluka)	154.	Bastawad (Shirol Taluka)
123.	Mhaisal (Miraj Taluka)	155.	Akiwat (Shirol Taluka)
124.	Kavathesar (Shirol Tahsil)	156.	Nursihawadi (Shirol Taluka)
125.	NilewadI (Hatkangle Taluka)	157.	Aurwad (Shirol Taluka)
126.	Khochi (Hatkangle Taluka)	158.	Gaurwad (Shirol Taluka)
127.	Shiroli (Hatkangle Taluka)	159.	Kavtheguland (Shirol Taluka)
128.	Rukadi (Hatkangle Taluka)	160.	Shedshal (Shirol Taluka)
129.	Mangaon (Hatkangle Taluka)	161.	Ganeshwadi (Shirol Taluka)
130.	Rui (Hatkangle Taluka)	162.	Bubnal (Shirol Taluka)
131.	Ingali (Hatkangle Taluka)	163.	Alas (Shirol Taluka)
132.	Chandur (Hatkangle Taluka)	164.	Takliwadi (Shirol Taluka)
133.	Ichalkarhgi (Hatkangle Taluka)	165.	Takli (Shirol Taluka)
134.	Rangoli (Hatkangle Taluka)	166.	Rajapur (Shirol Taluka)
135.	Rendal (Hatkangle Taluka)	167.	Khidrapur (Shirol Taluka)
136.	Danoli (Shirol Taluka)	168.	Rajapurwadi (Shirol Taluka)
137.	Kothali (Shirol Taluka)	169.	Danwad (Shirol Taluka)
138.	Umalwad (Shirol Taluka)	170.	Dattwad (Shirol Taluka)
139.	Jaysingpur (Shirol Taluka)	171.	Karundwad (Shirol Taluka)
140.	Udagaon (Shirol Taluka)	172.	Shirati (Shirol Taluka)

grams, photos, tables and maps

The Region: The region under study is located in southern Maharashtra (15°43' N to 18°30' N; 73°33' E to 75°10'E) (Fig. 1). The region is drained by Krishna river and its tributaries Venna, Koyna, Urmodi, Tarali, Morna, South Mand, Warna, Panchganga, Vasota and Yerala and is called upper Krishana basin (Fig. 2).

The area affected by floods comprises of 47 villages of Patan and Karad Tehsils in Satara district, about 76 villages of Palus, Wakwa and Miraj Tehsils in Sangli district, and about 49 villages of Hatkangale and Shirol Tehsils in Kolhapur district (Fig. 3, Table 1). The flood affected area is low lying flood plain of Krishna river and its tributaries. The region has generally west east slope. All the right tributaries of the river Krishna rise in Sahyadri Ghat where the intensity of rainfall usually high. Region records height (above msl) of 519 meters at Rajapur in Shirol Tehsil in Kolhapur district, 527 meters at Sangli city, 552 meters at Audumbhar, 555 meters at Narsingpur in Sangli district, and 576.5 meters at Khodashi in Karad in Satara district. The gradient is 1/120 from Karad to Sangli.

CAUSES OF FLOOD SITUATION

Underground water level: After severe drought in 1972 Krishna Basin has brought vast area under irrigation. Before 1972 age-old Krishna Canal was only available source for irrigation to the left side of Krishna River. It starts from Karad to Tasgaon in Sangli district. The Canal was drawn from Khodsi weir and constructed during the British regime. After 1972 Maharashtra government has introduced several major lift irrigation schemes in Satara, Sangli and Kolhapur districts. Similarly thousands of co-operative lift irrigation societies have also made available irrigation facilities at every village on both the sides of these rivers. These lift irrigation schemes have provided water to the area some 10 to 50 km away from the concerned river.

At present more than 70% agricultural area on both sides of the river is permanently irrigated, and sugarcane is the major perennial crop taken in the area to which water is supplied year-round. Due to continuous water supply the underground water table in Krishna valley has increased considerably, which is at ground level during the rainy season and about one-two meter during dry season.

During the floods, due to increased water table, water is not absorbed and percolated in the soil, but the volume of run off is increased which creates severe flood (Shinde 2006).

Cropping pattern: Due to vast expansion of canal and lift irrigation schemes in Krishna and its tributaries, about 70 % sown area is under irrigation. The region has number of co-operative sugar mills in the radius of 5-10 km from each other. Therefore, most of the irrigated area is under sugarcane. The crop requires year-round water supply. Sugarcane is planted in two different seasons. "Adsali" during July-August, and "Suru" October-November months. During the rainy season, Adsali crop is about two to three meters high, which resists flow of flood water and makes the flood situation more serious and worse (Shinde 2006).

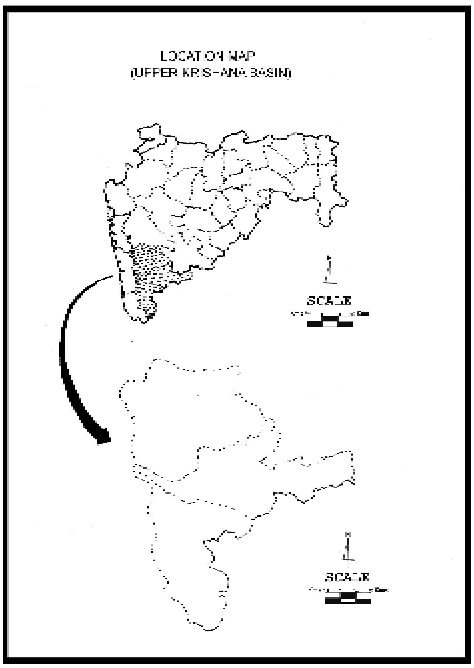

Fig. 1: Location map of the study area.

River bridges and K. T. weir: Bridges on river provide transportation facility and link both sides of the rivers. There are about 22 bridges on Krishna and its tributaries within Maharashtra state. The height of these bridges is usually low, below the height of both sides of the river. During floods most of these bridges are drowned. Due to this situation the flood level beyond the bridge is increased with the breadth of the bridge. While considering the total number of bridges and the flood of water they impeded, it has been observed that they increased the level of flood by some meters more than the actual flood level of 2005 and 2006.

There are 16 Kolhapur type weirs (K. T. weir), which have been constructed in the bed of number of rivers to preserve water during dry season for the purpose of irrigation and drinking. Due to these weirs, there is deposition of sand and silt which make the river bed shallow. It is also one of the important

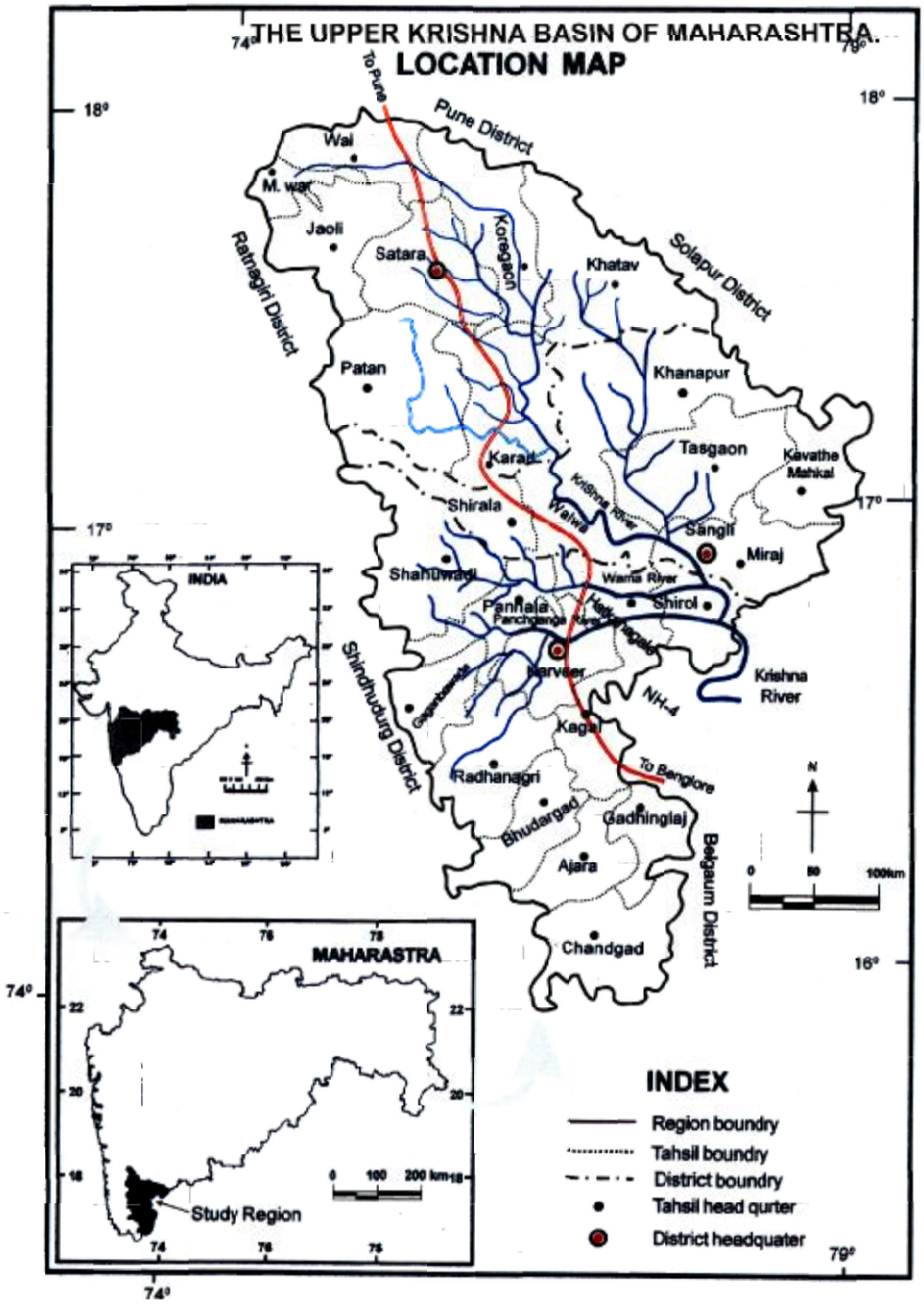

Fig. 2: The upper Krishna basin of Maharashtra.

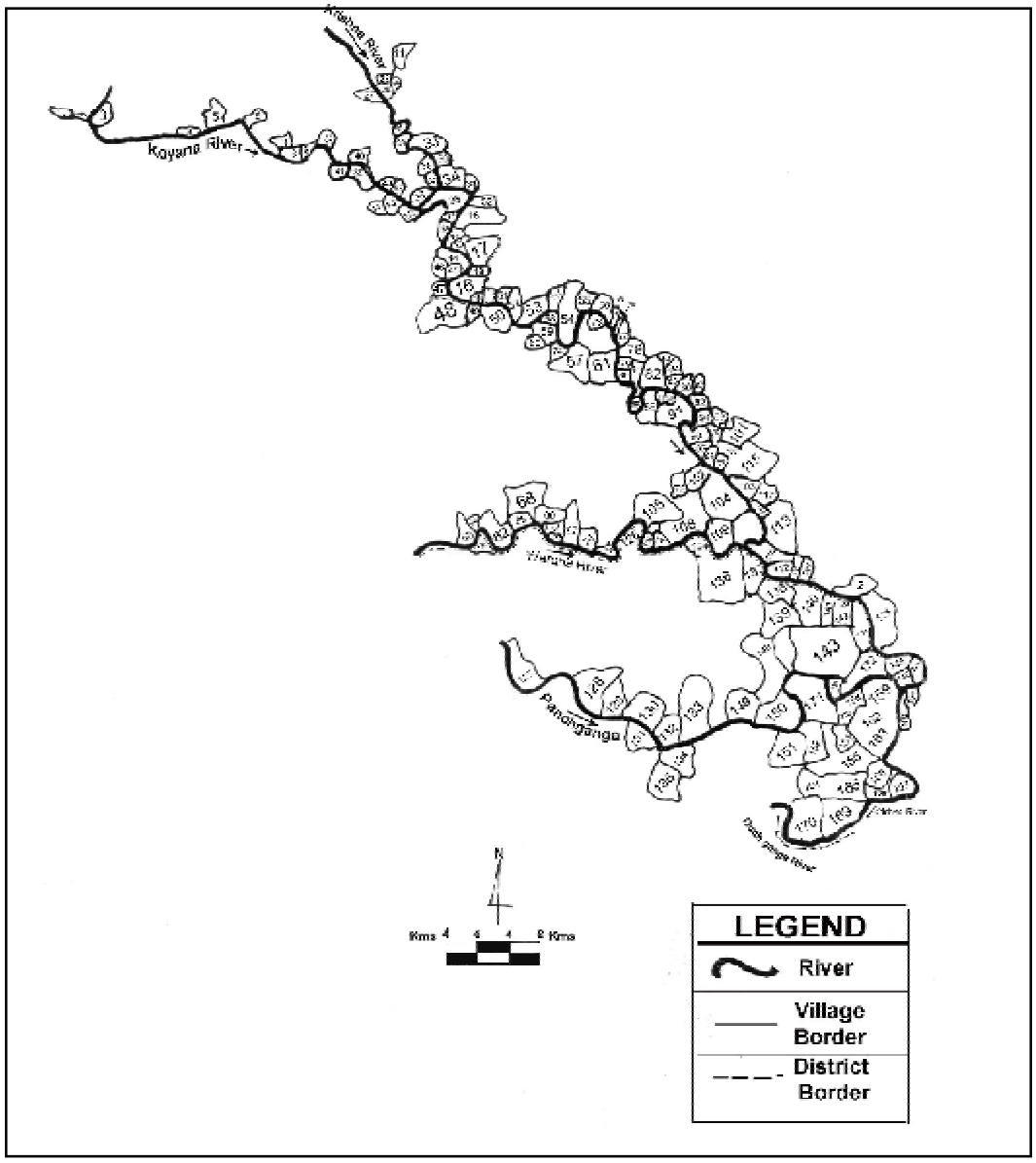

Fig. 3: Flood affected villages in upper Krishna basin.

causes responsible for the recent severe flood situation in upper Krishna basin (Khemlapur 2006).

Unauthorized construction within flood lines: The District Collector of the concerned district has demarcated the floodline of every river in 1976, 1989 and 1997. It is assumed that any type of construction is not allowed in between, but the unauthorized construction in the form of houses and huts has taken place recently and, therefore, responsible for the floods of 2005 and 2006. Due to increased level of flood, thousands of houses and huts have completely and partially drowned particularly in

Sangli district. Settlements along Koyana river in Karad, Kera river in Patan, and Krishna river in Sangli are worst damaged during the flood of 2006. Government has also paid huge amount to the collapsed and partially damaged buildings. However, after the flood of 2006 the Government has announced that there will be no compensations for the constructions within revised flood line in 2007. Every village and town in the upper Krishna basin is marked with revised flood line (Shinde 2006).

Shallowness of upper Krishna basin: Due to construction of dams and K. T. weirs large amount of slit and sand have accumulated in the river courses. It made the river course more shallow. This shallowness increased the level of water during the flood (Shinde 2006).

Almatti dam: Though, it is not officially established, the severe flood condition in Sangli district and near Shirol tehsils of Kolhapur district is due to Almatti dam, constructed on the Krishna river in Bijapur district in Karnataka State. It is about 260 km from Sangli town. The height of Almatti dam is about 519 metres from sea level and almost the same height is also recorded at Shirol tehsil and Sangli (527 m). It reveals that all the discharge and run-off from Krishna basin is collected in Almatti dam. Therefore, the completed plain area of Sangli, Shirol to Almatti has drowned under floods (Bavle 2006).

Large catchments area: The Krishna basin comprises of vast area between Mahadev ranges to Gadhinglaj ranges in south. The catchments are located immediately east of Western Ghat where there is maximum rainfall during south-west monsoon period. The average rainfall on the crest of Western Ghat is more than 4500 mm with the highest of more than 6500 mm recorded at Mahabaleshwar. Due to hilly and rugged terrain, there is large volume of runoff, which is collected through various tributaries of Krishna at Sangli and Shirol Tehsils of Kolhapur. This was worst affected area in the basin (Shiddhartha 2001). In both the years under study, the region received excessive rainfall as shown in Table 2 in Satara district.

Location of low pressure area: Usually during south-west monsoon the low pressure area is definite located on north India; Gandhinagar in Gujarat in the West to mouths of the Ganga is east. Low pressure area is usually associated with small and large disturbances.

However, in 2005 and 2006, last week of July and first part of August the low pressure area along with minor disturbances was located on Andhra Pradesh, Chattisgarth, and Vidharbha regions of Maharashtra. Due to meteorological situation there was constant heavy rainfall during the period. This was also one of the causes of heavy flood in upper Krishna basin (Ghorphade 2006).

Discharge of excess water from dams: In upper Krishna basin number of major dams have constructed such as Dhom and Khodsi on Krishna, Koyana on Koyana, Kanher on Venna, Chandoli on Warana, and Radhanagari on Panchganga. In spite of these dams, there are number of minor and major weirs constructed on these rivers.

During the floods of 2005 and 2006, due to heavy rainfall in the catchments area of these dams, huge volume of excess water has been discharged in river courses, which increased flood level considerably. For example, on 28 July 2006, through these dams the excess water discharged in the Krishna and its tributaries has been estimated to be 73000 cusecs, on July 30, 2006, 148179 cusecs, on 5 August 2006, 59000 cusecs, on 6 August 45590 cusecs, on 8 August 2006, 79737 cusecs, on August 11, 2006, 116421 cusecs, and on August 21, 2006, 12980 cusecs. This excess amount of discharged water from dams is one of the important causes of the floods in Krishna basin (Singh 1995).

Meandering courses of the river: The meanders are the uneven line of streams of the river affecting the normal discharge of water. The velocity of water is restricted near the meanders which delays

Table 2: Rainfall distribution in Satara district 2006 (in mm).

Sr.No.	Talukas	Average rainfall up to Oct.	Rainfall recorded up to Oct. 2006	Percentage of rainfall with average
1	Satara	908.0	1530.4	168.55
2	Javli	1603.0	2676.2	166.95
3	Koregaon	642.6	1258	195.77
4	Karad	632.1	997.3	157.78
5	Patan	1733.0	2902.6	167.49
6	Phaltan	382.0	558.6	154.08
7	Man	442.8	472.6	106.73
8	Khatav	415.9	632.1	152.31
9	Wai	710.3	1334.7	187.91
10	Mahabaleshwar	2223.0	8403.1	378.1
11	Khandala	416.0	664.1	159.64
	Total	10107.8	21460	212.31
	District average total	918.9	1950.0	212.31

Source: District Head Office, Satara

passage of water resulting in the stagnation of water in the river. There are more meanders in the course of Krishna and its tributaries (Siddhartha 2001). These meanders have also caused flood condition in the upper Krishna basin.

Impact of global warming: For this flood situation there are references of global warming with other causes also. This year the western region of the Pacific ocean, i.e., Philippines, Indonesia, China, Taiwan, Japan and Korea suffered by several disastrous cyclones. The increase in the number of cyclones caused by the water hit affects Bay of Bengal also, which made favourable condition of the rain in India. But at the same time the blowing wind from Pacific ocean to China turned towards south in monsoon period. Because of this, there was heavy rainfall in the south region of India which was responsible of the flood situation in the upper Krishna basin (Ghorphade 2006).

High intensity of rainfall: During last week of July and early period of August 2005 and 2006, the region has received high intensity and prolonged rainfall, which is more than its average during the same period particularly in the catchment area of Krishna and its tributaries. On eastern side of Western Ghat, amount of rainfall during period is much more than the plain area of the upper Krishna basin, which has recorded low rainfall during the flood period. It was observed that the intensity of rainfall is one of the basic causes of the floods in the region in both the years under study. The region received excessive rainfall as shown in Tables 3 and 4 in Satara district during 2005-06 (Siddhartha 2001).

CONCLUSION

During 2005-06, Krishna basin region of Maharashtra has experienced unprecedented flood situation, which affected social, economic and environmental conditions of the region. There was huge loss of man and animal, damage to the property and evacuation of thousands of people from their native. State government has compensated more than 1000 crore rupees. Such type of flood situation was not occurring in the region under study previously. Therefore, number of experts from different disciplines have studied the probable causes of this situation. So for geography is concern, we consider the above causes as responsible factors for this flood situation.

Table3: Rainfall distribution in Satara district, year 2005 (in mm).

Sr.No.	Tehsil	Average	June	July	August	September	October	Total
1.	Satara	908.0	430.4	557.6	438.0	315.1	84.4	1821.5
2.	Javali	1603.0	614.6	882.7	646.6	461.4	114.8	2720.1
3.	Koregaon	642.6	409.4	393.5	293.9	152.5	146.3	1395.6
4.	Karad	632.1	301.4	290.1	256.3	213.8	122.9	1184.5
5.	Patan	1733.0	639.2	1117.1	883.2	543.4	106.8	3289.7
6.	Phaltan	382.0	19.4	126.1	151.2	99.8	63.0	459.5
7.	Man	442.8	97.0	130.3	79.0	134.5	102.0	542.8
8.	Khatav	415.0	130.0	211.2	102.6	90.0	72.0	605.8
9.	Wai	710.3	319.5	527.6	259.9	300.3	129.8	1537.1
10.	M.shwar	2223.0	1353.0	3032.5	2620.5	1431.0	202.5	8639.5
11.	Khandala	416.0	134.1	162.4	94.8	296.1	91.0	778.4
	Total	10107.8	4448.0	7425.1	5826.0	4037.9	1237.5	22974.5

(Source: District Head Office, Satara)

Table 4 Rainfall distribution in Satara district, year 2006 (in mm).

Sr.No.	Tehsil	Average	June	July	Aug.	Sept.	October	Total
1.	Satara	908.0	345.8	554.8	409.2	182.6	38	1347.8
2.	Javali	1603.0	412.7	649.5	805.3	155.1	23.2	2045.8
3.	Koregaon	642.6	265.8	477.6	302.7	185.5	26.4	1258
4.	Karad	632.1	284.9	302.7	324.7	72.7	12.3	997.9
5.	Patan	1733.0	540.6	1224	873	188	77	2902.6
6.	Phaltan	382.0	192.0	83.5	81	192.1	41	589.6
7.	Man	442.8	146.4	82	27.1	124	47	426.5
8.	Khatav	415.0	183.1	158	86.8	104.7	99.5	532.6
9.	Wai	710.3	321.1	413.8	263.8	292	44	1334.7
10.	M.shwar	2223.0	1108.8	3618.2	3018	501.6	163.5	8910.1
11.	Khandala	416.0	127.2	187.3	94.4	212.6	46.8	668.3
	Total	10107.8	3921.4	7749.8	6285.5	2210.9	618.7	20786.3

(Source: District Head Office, Satara)

REFERENCES

Singh, Savindra 1995. Environmental Geography, Prayag Pustak Bhawan, Allahabad, pp.391.
Shinde, S. B. 2006. Krishna basin floods potential causes. Daily Pudhari, 20 August, 2006.
Khemlapur, B.B. 2006. Krishna basins floods potential causes and solutions. Daily Lokmat, 04 September, 2006.
Bavle Rajiv 2006. A threat to southern Maharashtra. Aikaya, 13 January.
Siddhartha K. 2001. India, India, The Physical Aspects, Kisalia Pub. Pvt. Ltd., New Delhi, pp. 203.
Ghorphade Abhijeet 2006. Flood Itihas and Vartaman. Loksatta, 20 August.