

FLOOD HAZARD IN ROTHAK CITY : A GEOGRAPHICAL PERSPECTIVE

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ABSTRACT : The paper dwells at length the 1995 flood situation at Rohtak. Besides giving causes of the sever flood, mitigation measures are also suggested.

INTRODUCTION

Natural disasters, which damage national economy and produce hardships for large sections of the population, are one of the single largest concerns for most nations. Human settlements are frequently affected by natural disasters - floods, earthquakes, hurricanes, cyclones, land slides, volcanic eruptions which take a heavy toll on human lives, destroy buildings and infrastructure and have far reaching economic and social consequences for communities. About 85 per cent of the total geographical area of India is prone to natural disaster of one kind or the other. The number of people affected by disasters has been growing at the rate of 6 per cent each year since 1960.

Ninety per cent of these victims were hit by natural disasters like floods, cyclones, earthquakes, etc. The extent and frequency of damage that is being caused by these extreme events, has raised concerns all over the world resulting into declaration of present decade (1990's) as *International Decade for Natural Disaster Reduction (IDNDR)* to inform people about what they can do and how they can prepare to make themselves safe from natural disasters. The second Wednesday of October every year is observed all over the world as

International Day for Natural Disaster Reduction in a manner befitting the goals and objectives of the Decade.

The present paper is an endeavour to analyse and assess the impact of flood hazard on various anthropogenic activities in the city of Rohtak in 1995. The floods of 1995 have been considered as the unprecedented flood hazard of 20th century in the history of the state of Haryana and also of Rohtak city. This natural hazard created a havoc among people of the city and the infrastructure, property and socio-economic conditions of the city-dwellers were badly affected.

STUDY AREA

The city of Rohtak with an area of 28.38 km² has a sub-tropical location lying about 600 km north of the tropic of cancer. It is located at 28° 54'N latitude and 76° 35'E longitude, 77km to the north-west of Delhi, National Capital and 235 km south of Chandigarh, the common capital of the States of Punjab and Haryana and the Union Territory of Chandigarh (Fig.1). Rohtak is the administrative headquarters of the division, district and tahsil of the same name.

When the present old town of Rohtak came into existence, its initial site of occupancy was

3. To map and identify the spatial patterns of flood-affected areas within the city limits.
4. To study the mitigation measures adopted to deal with the flood hazard.
5. To suggest the disaster-reduction strategies.

DATA SOURCES

The study relies, to a considerable extent, on primary data generated through discussion and interviews in the months of September-October, 1998 and supplemented by data collected from secondary sources like office-records, municipal year books, etc.

RESEARCH METHODOLOGY

The city of Rohtak consists of 35 wards as per 1991 Census. A *key plan* for the city of Rohtak was obtained from the Department of Town and Country Planning and ward boundaries were marked on it. This was adopted as the base map.

The sample size in the present paper consists of 700 households out of the total universe of 36,475 households. A *household* has been taken as the unit of sampling. The *two-stage random sampling design* was adopted to make the same a true representative of the population. In the first stage, *localities suffered with flood havoc* were selected randomly in each of the 35 wards of the city, and in the second stage, random sampling of households was done within the selected localities. However, the localities/areas which were not prone to flooding, were identified separately by making rounds of the whole city personally by the investigator. In selecting clusters for a multistage sample, the best procedure is *probability proportionate-to-size* (PPS) sampling, which has been adopted while selecting *sampling fraction* (the percentage of the population to be interviewed) by wards. The *interview schedule* has been adopted as

the mode for collecting survey data and it was conducted by the investigator himself.

The collected data have been analysed through proper statistical and cartographic techniques like tables, percentages and choropleth to bring out better results and conclusions. Moreover, to ensure accuracy and to save time, the use of computer has been made.

HISTORICAL BACKGROUND

Floods are an annual feature in one or the other part of India and are considered the most devastating hazards which occur frequently all over the northern India. The legendary city of Rohtak, due to its saucer-shaped topography, is considered often more vulnerable to floods. That's why, in twentieth century, the city has experienced devastating floods in the years of 1933, 1960, 1983 and 1995.

In 1993, the city was flooded not only because of heavy downpour but also due to a breach in the J. L. N. Canal passing east of Rohtak. During the period of 50 years from 1901 to 1950, the year 1933 has been observed to be the year of highest annual rainfall. During this span of 50 years, the heaviest rainfall recorded in 24 hours at any station in the district of Rohtak was 484.1mm at Rohtak on September 19, 1933 when streets were traversable only by boats (Haryana District Gazetteers, Rohtak, 1970). This flooding of the eastern parts prompted a rather rapid southward expansion of the city along the Jhajjar Road and Railway Road.

In 1960, the flood in the city was due to overflow in Drain No. 8 passing in the west of Rohtak. During this flooding, 610 houses were partially damaged while 641 houses collapsed. An estimated 40,000 persons left the city for the time being and normal life remained suspended for about two months. The 1960 flooding of the city forced a change in the

expansion of the city from the south to an eastward direction. This has resulted in the emergence of new residential areas in the eastern parts and a virtual cessation of development of western and southern parts of the city (Sharma, 1985).

In 1983, Rohtak city was flooded mainly due to easy inflow of excessive rainwater because of its saucer-shaped topography. In this year, the city received 882.4mm annual rainfall i.e. 44.47 per cent more than the average rainfall of 610.8mm (1975-1999). In the months of July and August, the city received 127.9 mm and 134.9mm of excess rainfall than the average respectively. (Table 1).

After this flood, the then Deputy Commissioner of Rohtak made several arrangements to drain out the water in future from the city. For instance, i) permanent installation of 6 pumps of 60 cusec capacity near Jhajjar Road Railway Crossing to drain out water of Jhajjar Road and its adjoining areas, ii) a parallel nallah of 33 cusec capacity was got prepared from Main Disposal System to Drain No. 8 along an already existing nallah of 32 cusec capacity since 1960 and iii) permanent installation of 4 pumps of 35 cusec capacity on J. L. N. Canal

Table 1

Rohtak City : Monthly Rainfall in Rainy Season, 1983

Month	Rainfall (mm)		
	Average (1975-99)	Actual (1983)	Difference between Average and Actual
July	184.0	311.9	127.9
August	187.5	322.4	134.9
September	81.8	55.5	-26.3
Total	453.3	689.8	236.5

Source : Computed from, D. C. Office, Rohtak.

along Rohtak-Delhi Road to drain out water of outer colonies.

In 1995, Haryana experienced unprecedented floods in its history which are considered to be the largest and worst of the present century in the state. Out of the total 17 districts, 10 districts like Rohtak, Bhiwani, Hisar, Jind, Sirsa, Kaithal, Sonapat, Faridabad, Rewari and Gurgaon were affected by the flood. However, Rohtak district was worst affected where 325 out of 405 villages of the district were badly affected and about 24 villages were completely cut off from the state as well as its various approachable centres. For miles together, there was not a square inch of dry land in the countryside. In Mokhra, one of the worst affected villages, an old man breathed his last and his body had to be cremated on the roof of his house using kerosene as fuel.

Ninety per cent of Rohtak city was worst affected by this devastating flood hazard and was submerged with 2-12 feet of water. On the night of September 3, 1995, when the fury of flood struck, the infrastructure such as rail and road transport, power and water supply, telecommunication, etc. collapsed. The drainage system failed and pumps set up to drain out flood waters stopped operating. There was a deluge and one was reminded of the famous line of Coleridge - "water, water everywhere, nor a drop to drink". The hapless citizens looked like the Ancient Mariner with the dead Albatross of the man-made social structure hanging around his neck (Chaudhary, 1995).

When the residents of many localities of Rohtak woke up in the morning of September 4, 1995, they saw water gushing into their houses and they fled with just the cloths on their back. After September 5, 1995 there was no rain at all, but the flooded water was seen everywhere.

CAUSES OF FLOOD

We generally experience two types of floods. Their origins are different but their impact in respect of devastation is of same magnitude. The first type of flood is related to the cyclonic storms in coastal areas. The other type of flood is caused by heavy and intense rainfall in catchment areas of rivers which overflow their banks. The riverine flood has become more frequent in recent times (De and Sarkar, 1993).

In 1995, the devastating flood experienced by the populous city of Rohtak was also of riverine type and causal factors responsible for such an unprecedented flood were as follows :

1. Occurrence of incessant and excessive rainfall over a short span of time.

The rainfall is generally received from the south-west monsoon which usually reaches Rohtak after 29th of June which is the expected date of arrival of monsoon at New Delhi. On an average, Rohtak city receives 610.8mm annual rainfall (1975-1999). But in the year 1995, the city received 1142.4mm annual rainfall i.e. 87.03 per cent more than the

average rainfall. Although the city received 157.5 mm rainfall in the month of July which was 26.5 mm less than the average rainfall (184.0mm). But in the months of August and September, the city received 338.5mm and 254.2mm more rainfall than the average. On the whole, Rohtak city received 566.2mm more than the average rainfall (453.3mm) received during July to September (Table 2).

More than 89 per cent of the total annual rainfall of the city was received during the monsoon months of July, August and September, 1995 (Table 3).

Table 3

Rohtak City : Monthly Rainfall during the Monsoon Months, 1995

Month	Rainfall (mm)		
	Average (1975-99)	Actual (1995)	Percent to Total Annual
July	184.0	157.5	13.79
August	187.5	526.0	46.04
September	81.8	336.0	29.41
Total	453.3	1019.5	89.24

Source : Computed from, D. C. Office, Rohtak.

Table 2

Rohtak City : Monthly Rainfall in Rainy Season, 1995.

Month	Rainfall (mm)			
	Average (1975-99)	Actual (1995)	Difference between Average and Actual	Percent Variation
July	184.0	157.5	-26.5	-14.4
August	187.5	526.0	338.5	180.5
September	81.8	336.0	254.2	310.8
Total	453.3	1019.5	566.2	124.9

Source : Computed from D. C. Office, Rohtak.

Out of 89.24 per cent, 75.46 per cent of the total annual rainfall was concentrated only in the months of August (46.04 per cent) and September (29.41 per cent). In the month of August, the rainfall started on 2nd of August and continued upto 11th August with a break of one day on 6.8.1995. During this period of 9 days, the city received 312.5 mm rainfall which was 27.4 per cent of the total annual rainfall (1142.4mm).

At the end of August, the city again came in the grip of heavy downpour and the amount of rainfall received during 72 hours (28.8.95 to 30.8.95) was 201.5mm i.e. 17.6 per cent of the total annual rainfall. The month of September was characterised with the incessant and heavy downpour during a short span of 72 hours between 3rd of September to 5th September, 1995. During this period the city received 33.6.0mm rainfall which was 29.41 per cent of the total annual rainfall resulting into devastating flood hazard of 1995.

2. Overflow in Drain No. 8 due to growth of weeds and siltation of its bed reducing water carrying capacity and also due to discharge of excess water of its catchment area.
3. Accumulation of water in the outskirts of the city from the surrounding areas.
4. Saucer-shaped topography of the city, where inflow of rain water is more easy but its outflow is very difficult.
5. Lack of proper drainage system as well as defective and poor drainage system including inadequate sewerage system.
6. Fissures, breaches and cuts made by local people in the drains, highways, and railway tracks in affected areas.
7. Interference with the natural drainage by construction of roads, railways and other structures.
8. Negligence by State Government as well as district officials in the desiltation of drains and sewerages in the pre-monsoon season.
9. Improper functioning and inadequacy of pump-sets installed to drain out the flooded water.
10. Constricting or choking of Bohar drain due to growth of weeds and deposition of silt as well as encroachments made over it.
11. Heavy siltation in two nallahs which drain out sewerage water of the city in Drain No. 8. Because, as against the 60 cusecs capacity of both these nallahs, hardly 25-30 cusecs of water was estimated to have flowed through them.

IMPACT OF FLOOD

In India, every year damages and loss of property caused by floods run into thousands of crores of rupees. But worst of all, precious lives are lost in hundreds. What is more surprising is that despite crores of rupees spent on flood control measures every year, the losses keep mounting although the figures may fluctuate from year to year.

According to figures currently available, the total value of losses due to damage to crops, houses and public utilities which was around Rs. 57.24 crores in 1954 went upto Rs. 1438.8-crores during 1991 but reduced to 571.86 crores in 1995 (Ministry of Agriculture, 1999).

The National Commission on Floods had estimated that 40 million hectares out of 329 million hectares of the country's geographical area were prone to floods and

the average area affected by floods annually is about 7.5 million hectares (Ahuja, 1999).

Out of the total flood prone area, 32 million hectares have been considered as the *protectable area*, while as per the latest information collected by Central Water Commission (CWC), a total area of 14.37 million hectares has been reported protected through structural measures like embankments and dams, etc in various states. But despite all these measures the average annual total value of damage to crops, houses and public utilities during the period 1953-97 was about Rs. 972 crores (Ministry of Agriculture, 1999).

The national policy on flood control was launched in 1954, but floods still, on an average, claim over 1500 human lives and 10,000 heads of cattle every year. As many as 2209 human lives and 70371 heads of cattle were lost in the floods of 1995 (Ministry of Agriculture, 1999).

In Haryana, flood hazard, caused due to sudden, incessant, excessive and untimely downpour, had great impact on the human and livestock population of the state. The flood hazard posed a severe threat to the existing fragile ecosystem, socio-economic development and ecological sustainability of the affected region. As per the estimate, the century's worst floods had badly damaged infrastructure and property worth Rs. 2000 crore, besides claiming several precious lives. More than thousand acres of fertile agricultural land was either washed away or converted into wastelands. Nearly ten districts of the state were fully in the grip of these fierce floods. But Rohtak district with its headquarters of the same name was the worst affected followed by Bhiwani. Almost all parts of villages of these districts were under 8-10 feet deep water. Therefore, such a fierce flood hazard created a havoc in the whole state

and proved very disastrous and destructive to the state economy as a consequence of heavy damage to infrastructure, property, public utilities, houses and crops.

Rahtak city was the worst affected among all the urban centres of Haryana due to this flash flood of 1995. Almost the entire city was under 2 to 12 feet of water. Its impact on various types of activities in the city may be assessed as under :

Loss of Human Lives

The impact of flood hazard on human life is multi-dimensional affecting it in all aspects - domestic, social, economic and the like.

Among all the flood affected districts of Haryana, Rohtak district was at the helm of affairs where the death toll due to flood and rain-related incidents had mounted to 34 as against the 158 in the state as a whole (The Tribune, 1995). However, the life in the city had been crippled due to floods caused by incessant rain but the flood hazard took a toll of less than 10 human lives which were recovered by rescue personnel from various parts of the city like Mansarover Park, Mahavir Park, Guru Nanakpura, Palace Theatre, etc.

Loss of animals

The floods had taken a heavy toll of stray dogs and milch cattle in the city as well as in the district. As reported by the district officials about 500 carcasses were floating in the flood water giving rise to fears of outbreak of an epidemic as against 1000 heads of milch cattle and other animals in the district. The buffaloes in Dairy Mohalla of the city were the worst affected.

Loss of property

Total loss of property of shopkeepers, businessmen, traders and the other residents

Table 4**Rohtak City : Estimated Loss of Property during Flood Hazard, 1995**

Loss in Rupees	No. of Households
10,000 & below	234
10,001 – 20,000	195
20,001 – 30,000	127
30,001 – 40,000	74
40,001 – 50,000	46
50,001 & above	24
Total	700

Source : Field Survey.

of city was estimated about one thousand crore rupees (Table 4).

Disruption of Power Supply

The Haryana State Electricity Board (HSEB) had suffered a loss of more than Rs. 18 crore in the floods in the State. According to an estimate, about 100 substations had been submerged in the flood waters. The maximum loss suffered by the HSEB was in Rohtak, Sonipat and Bhiwani districts. Thousands of electricity poles were uprooted by the high velocity winds accompanied by torrential rain, disrupting power supply in a number of areas including urban centres like Rohtak where normal electricity supply was restored after a gap of about 25 days in most of the flood affected localities of the city. The pumps installed in the city to drain out flood water had been rendered useless in the absence of power. The 330KV power substation on the Northern Bypass along with other power houses was also waterlogged.

Damage to Water Supply Pipe Lines

There was a damage to water supply pipe line. There was intermixing of drinking water and sewerage water due to leakage in respective pipe lines at various places. As a result, pure

drinking water could not be supplied for about a month.

Damage to Houses

Hundreds of houses in various parts of the city had collapsed due to heavy rain as against thousands of damaged houses. As a result, a large number of families had been rendered homeless not only due to the collapse of houses but also because the floodwaters had submerged their houses to a considerable level. Subsequently, they had sought shelter in dharamsalas, schools as well as college buildings.

An estimated 3000 houses had collapsed in the district. However, the number of damaged houses had been estimated at about 51281 (Dainik Tribune, September 20, 1995).

Damage to Roads

The heavy rain had damaged almost all the main roads in the city. Most roads controlled by the PWD (B & R) and Rohtak civic body were in a deplorable condition and roads in the interiors were the worst hit. The repair work undertaken by the PWD was mere an eye-wash.

Notwithstanding the usual charge of poor quality of work by the department or contractors in connivance with supervisory engineering staff, lack of civic sense was equally responsible for the poor condition of the roads.

The condition of state roads was already quite bad even before the rains and the State Government was heavily grilled for this in Haryana Vidhan Sabha Session.

Heavy rains had not only further worsened the condition of roads in Haryana but had also brought to a halt traffic on nearly three dozen roads, including national and state highways.

As a consequence of it, Rohtak city had been delinked from other urban centres like New Delhi, Hisar, Jind, Panipat, Sonapat, Bhiwani, etc. because all the highways joining the city with these urban centres had been submerged with 2 to 3 feet deep water at various places. Moreover, the villagers had also made cuts in the Jind Road, the Gohana Road and N. H. 10 to drain out water.

Damage to Railway Tracks

The rail traffic had also been affected. The flooding of the railway tracks at various places resulted in suspension of traffic. The Chandigarh-Bhiwani Ekta Express stranded near Makrauli village, a few kilometres to the north of Rohtak mainly because of breach made in the railway track near Sheela Bypass, Rohtak. The passengers had to spend the night in the train without food and water.

Telephone Services

The heavy rains had also affected telephone services, with the service becoming faulty and sets going dead in several parts of the city including Medical College & Hospital and Civil Hospital. The faults were mainly due to water seepage into the underground cable ducts as well as uprooting of telephone poles by violent storm accompanied by torrential rain.

Commercial Activities

Rohtak has the distinction of having one of the biggest markets of clothes in North India. Shouri Market is famous for this which was submerged under 5 to 7 feet deep water on the night of September 3, 1995. Similarly, most of the markets notably Railway Road, Quilla Road, Krishna Bazar, Palika Bazar, etc. were submerged in water, rendering many prosperous merchants paupers overnight. Many were marooned and they perched on

rooftops with no food or water. So, nearly all the commercial activity in the city had come to a stand still for about a month.

Businessmen in the city were also facing another peculiar problem. Since many of the banks are located in the flooded areas, these had been closed for several days in the wake of flood in the city. Bank clearance had, therefore, come to a halt, affecting business dealings adversely.

Dewatering Operations

Dewatering Operations had been severely affected by the heavy rain. At many places, pumps deployed for draining away water could not be operated because these were submerged. The flood-hit areas of the city continued to be under 6 to 10 feet of water even after a month. However, with a change in the direction of the flood waters entering the city from the Markauli side, the water level in colonies near Sonipat road had fallen. Then the water was flowing towards the Sukhpura area of the city.

It came to the notice that the discharge from Drain No. 8 was estimated at 28 cusecs against its maximum capacity of 16 cusecs. That explains why the breaches in the drain near Sunderpur and Titoli villages could not be plugged. Officials said unless there is a substantial reduction in the flow, the situation in the city will remain the same despite Herculeon efforts by the Army and the civil authorities.

Mobility of People

Thousands of families had left the city in the wake of floods. After a fortnight, the stagnant floodwater started emitting a very foul smell adding to the misery of the city's residents. It was for this reason that thousands of families had temporarily migrated to Delhi and other nearby towns.

The threat of an outbreak of epidemics because of insanitary conditions in the city had forced people to send their children away to their relatives.

Boosting of Anti Social Elements

The anti-social elements had become active in the city exploiting the failure of power supply and lack of policing in the flood hit colonies. It came to the notice that several houses vacated by their owners because of floods had been broken into.

Shifting of People on Rooftops

Thousands of people in the flood-hit colonies of Nehru Nagar, Sainipura, Chunnipura, Garhi Mohalla, Chamanpura, Hari Nagar and Jagdish Colony were living on the rooftops in the scorching heat. Many of them had refused to be evacuated for fear of their thefts by antisocial elements.

Shifting of Radio Station

The local Radio Station was shifted to the Madina Relay Centre, about 16 km from Rohtak, after flood waters entered the AIR complex.

Outbreak of Diseases

The incidence of viral fever, diarrhoea and jaundice had increased in the wake of floods. Two children were reported to have died due to vomiting and diarrhoea in the flood hit Hanuman colony. Whereas thousands of men, women and children were suffering from such diseases in the whole city.

Shortage of Fodder

There was an acute shortage of fodder in the city. Dry fodder was selling at Rs. 350 to 450 a quintal. Stray animals were the worst affected. These animals had sought shelter in the Bhiwani Stand area. Meanwhile, the Municipal Council had set up three task forces to remove animal carcasses from the floodwaters.

SPATIAL PATTERNS OF FLOOD

Nearly ninety per cent of Rohtak city was affected by the fury of flood and submerged in 2 to 12 feet of water depending on the location of the area. Because, as already explained, the city is characterised with a saucer-shaped topography. The other factors associated with the intra-city variations in the level of flood water are : i) choking of Boar Drain with silt and weeds and encroachments made over it, ii) a breach made in Gohana railway line, iii) reduced carrying capacity of both the ganda nullahs, iv) non-functioning of pump house located at Jhajjar Road in the absence of power supply, v) resistance made by the villagers of Sunarian Kalan to drop water in Kanhelo Drain. In general, the level of water decreased in all directions from Chhotu Ram Chowk with highest water level except with localities having comparatively lower ground. Keeping in view these variations in the level of floodwater in the city, five types of areas have been indentified (Fig.2). These are :

1. Worst Affected Areas (with water level above 7 feet)
2. Badly Affected Areas (with water level between 5-7 feet)
3. Moderately Affected Areas (with water level between 3-5 feet)
4. Less Affected Areas (with water level below 3 feet)
5. Unaffected Areas

1. Worst Affected Areas (with water level above 7 feet) : The worst affected areas by this devastating flood were bounded by Subhash Road in the north, outer Quilla Road and Jhajjar Roa in the west, Gohana railway line in the South and Church Road & the road between Canal Rest House and canal offices in the east. This area was

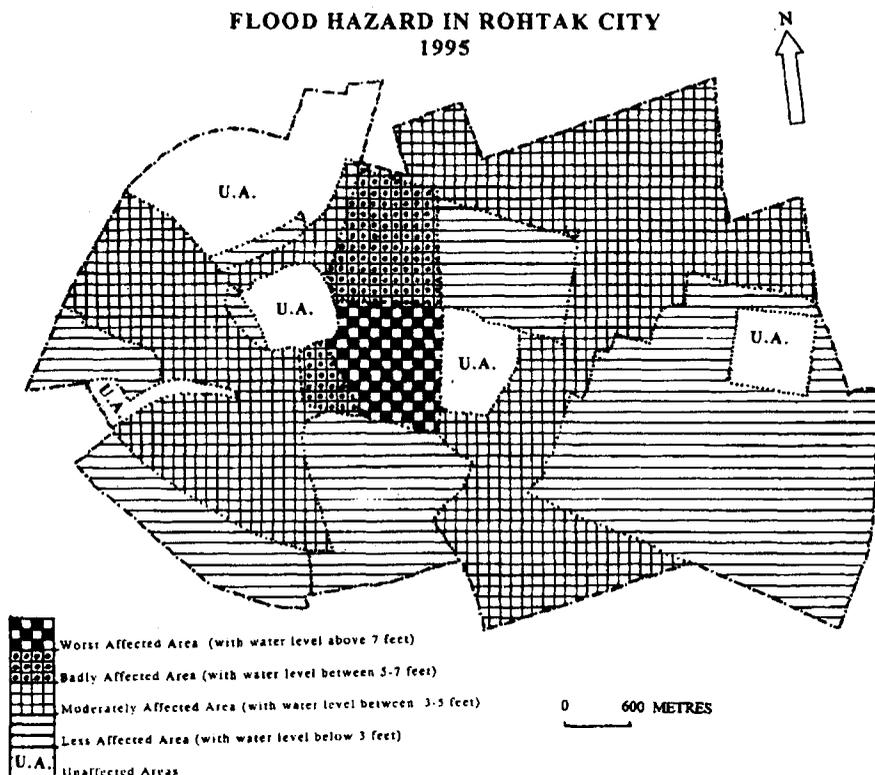


Fig. 2 : Flood Hazard in Rohtak city - 1995

spread over the whole of 19 and 18 wards and a part of ward 17 in the west of Jhajjar Road and that of Ward 20 between Civil Road and Subhash Road.

The worst-hit commercial areas were Chhotu Ram Chowk, Govt. Co-operative Store, Narain Complex, Civil Road, Vijay Path, Civil Hospital Road, Outer Quilla Road, Palika Bazar, HUDA Complex and Jhajjar Road.

On the other hand, the notable residential colonies were Hari Nagar, Sant Nagar, Arya Nagar, Ravi Das Nagar and Shakti Nagar of Ward 19, Shora Kothi, Banistpura, Gyani Pura and Gandhi Ashram of Ward 18, Udampura of Ward 17 and Bhagwan Colony of ward 20.

The other government offices and places of public importance were the Tahsil, Civil Hospital, Sainik Board, Model School, Mahavir Park (Company Bagh) and Canal Rest House. The whole area was submerged under 7-12 feet of water depth Chhotu Ram Chowk, Hari nagar and Sant Nagar were the notable localities where maximum water level of 12 feet was the point of discussion among urban dwellers as well as district officials.

The factors responsible for such a fury of flood in these areas were mainly i) because of their location at the lowest mark of the saucer shaped topography of the city, ii) non-functioning of the pump house located at Jhajjar Road and iii) the breach made by people in the Gohana Railway Line near

Railway Crossing on the Northern Bye Pass at the instance of the then local MLA and Minister of State Home Department in Haryana Government.

2. Badly Affected Areas (with water level between 5-7 feet) : The badly affected areas constitute the localities situated in eight wards i.e. 5, 14, 15, 17, 20, 21, 22 and 24 out of the total number of 35 wards of the city.

The area comprising wards 5 and 17 is bounded by Jhajjar Road in the east, Bhiwani Stand in the north, Mal Godan Road in the west and Railway Line in the south. This is the area which comprises major commercial areas of the city. Notable among them are Bhiwani Stand, Railway Road, Gali Jat Gazette, Gali Dakhana, Gali photowali, Tailors' Gali, Pratap Talkies Road, Shouri Cloth Market, Mal Godam Road, Anaj Mandi (old Grain Market) and Approach Road, Shouri Cloth Market is considered as one of the biggest cloth markets of North India. It was so badly devastated that many of the prosperous cloth merchants were rendered paupers overnight.

On the other hand, this area consists of residential colonies like Peerji Mohalla, Rama Colony and Railway Quarters of ward no. 5 and Mahajan Mohalla, Railway Quarters and other localities between Railway Road and Jhajjar Road of ward 17. The non-functioning of pump sets installed at Jhajjar Road of drain out the water was the main cause for the submergence of these areas under water between 5-7 feet.

Another area spread over wards 14, 15, 20, 21, 22 and 24 is bounded by Gohana Road in the west, Subhash Road and Sonipat Road in the south and Northern Bye Pass in the north. This is mainly a residential zone except Subhash Road and Gohana Road which are occupied by commercial

activities. The notable among the badly affected residential colonies were like Ashok Nagar, Hans Colony and Sanjay Colony of ward 15, Bhagat Singh Colony, Guru Nanakpura, Krishna Colony, Mahabir Colony, PWD Colony, Kripal Nagar and Chaman Pura of ward 14, Saini Pura ward 20, Chunni Pura, western Prem Nagar and Sukhpura of ward 21. The inflow of excessive water from the surrounding countryside in the north was the reason behind the submergence of these residential colonies under water between 5-7 feet.

3. Moderately Affected Areas (with water level between 3-5 Feet) : Out of a total of 35 wards of the city, the moderately affected areas constituted about half of the wards i.e. 15 in number.

The western part comprising wards 1, 2, 3 and 4 is flanked by the boundary between wards 1 and 10 and Gaur Brahamin college road in the north, northern Bye Pass in the west, Old Circular Road and Mal Godam Road in the east and Railway Line in the south.

There are 11 pumps of 65 cusec capacity installed in the Main Disposal System located at Ram Leela Ground. They are used to pump out the surplus rainy waters into Drain No. 8 through two ganda nullahs following parallel to each other. But the reality was that hardly 20-25 cusec water was being drained out through both the *ganda nullahs* as against their capacity of 65 cusecs mainly because of deposition of silt in them. In addition, pumps were also not functioning regularly because of mechanical defects in them. Frequent power failures compounded the problem. Consequently the western parts of the city were affected. The notable residential localities submerged with flood water between 3-5 feet were Kartarpura and Saini Anand Pura of ward 1; Gopal Colony, Krishna Colony and

Garhi Mohalla of ward 2; Kachi Garhi, Ambedkar Nagar, Balmiki Basti, Pili Kothi, Ram Leela Ground and Harizan Colony of ward 3; Gur Charanpura, Krishna Colony, Dairy Mohalla, Islampura and New Grain market of ward 4; and Railway Quarters of ward 5.

On the other hand the main commercial areas and the public places of these wards were like the Main Bus Stand, Old Beri Road, Ram Leela Ground, Market Committee Offices, Govt. Senior Secondary Schools for Boys and for Girls and the New Grain Market.

The north-western and northern area comprising wards 10, 11, 12 and 13 was spread over mainly along the old circular (from Gaur Brahmin College Road to Gohana Road) consisting the colonies of Rup Nagar, Sainiwas, Baba Lachhmanpura Colony and Gopal Colony of Ward 10, Nehru Colony, Shora Kothi and Sainiwas of Ward 11, Harijan Basti of wards 12 and 13 and Tej Colony of ward 13.

The irregular functioning of pumps installed in the main disposal system, besides the low-lying location of Roop Nagar, Nehru Colony and Gopal Colony and Gopal Colony and the heavy inflow of water from the north along Gohana Road were the main causes of flood in north-western and northern area.

The northern and north-eastern area in both sides along the Northern Bye Pass comprised of the residential colonies like Azadgarh of Ward 21, Jasbir Colony, Chanakayapuri and Ram Gopal Colony of Ward 29, Bharat Colony, Model Town and Subhash Nagar of Ward 28.

The Bohar Drain connecting the city to the JLN Canal from Gohana railway line along the Northern Bye Pass is meant to drain out flood waters from the outer colonies of the city. Jasbir Colony, Chanakayapuri, Panchvati,

Vasant Vihar, Ram Gopal Colony and Bharat Colony were submerged with water because the drain was choked with silt and weeds and there was a string of encroachments on it made by house-owners on its bank which reduced the water carrying capacity of the drain. The non-functioning of 4 pumps of 35 cusec capacity fixed at JLN Canal was responsible for the submergence of these colonies with flood water.

However, the Model Town, Subhash Nagar, Bharat Colony and Chanakayapuri were bounded by man-made barriers such as Gohana Railway Line, Northern Bye Pass and N. H. 10 and there was also no provision to pump out the surplus water resulting into the submergence of these residential localities.

The area spread over Wards 25 and 26 was bounded by Rohtak-Delhi Road in the north, circular road in the west and Gohana Railway Line in the east and south. It comprised of the Jawahar Nagar and Gandhi Nagar of ward 26, and Gandhi Nagar, Patel Nagar, Canal Colony, and Chinyot Colony of ward 25 and medical campus boundary wall. Sri Nagar Colony of Ward 30 was bounded by Gohana railway line and Delhi Railway Line. All these colonies submerged with floodwater because no provision had been made to drain out the water mainly due to man-made barriers like railway lines.

Azad Nagar, Housing Board Colony, Ambedkar Nagar, Kamla Nagar, Shashtri Nagar of Ward 31 were flooded with water because they were bounded by barriers like Delhi-Railway Line in the north, Circular Road in the West and Jhajjar Road in the South. To drain out the floodwater of these residential localities in JLN Canal, a deep *nullah* along Jhajjar Road was got constructed by the district administration.

Less Affected Areas (with water level below 3 feet)

The areas flooded with water below 3 feet of depth were mainly spread over the outer wards along the municipal limits of the city. This area is constituted by about one-third of the total wards.

The western area on both sides of Jind Railway Line comprised of the residential colonies like Shyam Colony and J. P. Colony in the west of Jind Railway Line and Indira Colony in the east of Jind Railway Line of Ward 1 and Mohalla Babra bounded by Old Circular Road and Subji Mandi Road in ward 3. All these colonies are located comparatively on higher ground, hence less affected.

The north-western area constituted the residential colonies of Sainiwas, Shora Kothi and Dehri Mohalla of ward 11 and Harijan Basti of ward 12 mainly in the outside of Old Circular Road along the Khokhrakot mound.

The northern part consisting of colonies like Durga Colony of Ward 20, Eastern Prem Nagar of ward 21, Kailash Colony, Chand Nagar, Vikas Nagar, Laxmi Nagar and Krishnpura of ward 22 was bounded by northern bye-pass in the north. HAFED road and Government College for Women in the west, Sonipat road in the south and Gohana railway line in the east. Jhang Colony and Mansarover Colony of ward 22 bounded by Sonipat Road, Rohtak-Delhi Road and Gohana Railway Line was also included in the northern part of the affected areas.

Although, at one stage, all these colonies were affected to a considerable extent when a breach in Gohana railway track had been made on the behest of the then local MLA and the State Home Minister of State Home in the Government of Haryana to protect his own

house located in Model Town from the fury of flood, but the water flowed through Sonipat road and Jail road and ultimately accumulated around Chhotu Ram Chowk located at the lowest ebb of the saucer shaped topography. Hence, these residential localities were comparatively less affected because water did not stagnate for a long time.

The eastern part of the city which was bounded by northern Bye Pass, D-Park to Double Park Road and Rohtak-Delhi Road comprised of colonies like eastern Model Town, Kamal Colony and Tilak Nagar of ward 29. About 2 feet of water was flowing in all these residential localities because there was no drainage and pump house to drain out the water into Bohar Drain. Keeping in view the devastation made by the flood of 1995, a drain from D-Park Chowk to Kamal Colony alongwith Double Park of Model Town was got constructed and a pump house was established permanently near Kamal Colony to pump out the water of these localities in Bohar Drain near Maruti Service Station.

Another eastern part of the city which was bounded by Rohtak-Delhi Road, Gohana railway line, Delhi Railway Line and JLN Canal was consisting of colonies like Arjun Nagar and Gandhi Nagar of Ward 27, Adarsh Nagar, Daryao Nagar, Medical Campus, University Campus and Dev Colony of Ward 30. There was no channel to drain out the surplus water. The only provision to drain out the water was Kanheli Drain which carries waters of these colonies especially University Campus and Medical Campus to Drain No. 8. Pumps were there on the Kanheli Drain to flush out the flood waters but there was no motor. Consequently, the drain overflowed and inundated the colonies like Medical Campus and University Campus.

The southern part which was submerged with less than 3 feet of water comprised of the colonies like Chawla Colony and Shivaji Colony of ward 32, Ram Nagar of ward 33 and 35, Hakikat Nagar and Vijay Nagar of ward 34 and Janata Colony of ward 35. Here slope of land is towards west and the surplus water flowed to west and accumulated along old Beri road resulting into the submergence of Vaish Educational Institutions and the surrounding residential colonies.

Unaffected Areas

The areas, which were not affected by the fury of flood were those residential localities which were located either on the mound or on the comparatively higher grounds. Sarai Mohalla of ward 5, Kalalan Mohalla of ward 6, Pratap Mohalla spread over wards 6 and 7, Julaha Mohalla, Para Mohalla, Pithwara Mohalla and Tibri Mohalla of ward 7, Kayastan Mohalla and Kewal Ganj of wards 7 and 9, Pradhana Mohalla of Ward 8, Dehri Mohalla, Dhobi Mohalla and Gujran Mohalla of ward 9, and Para Mohalla, Mudhalian Mohalla and Quilla Mohalla of ward 16 are the residential areas which are located on the mound.

The commercial areas which could not come in the grip of flood hazard because of their location on the mound were mainly Bara Bazar, Chameli Market, Kewal Ganj and many other markets adjoining Quilla Road.

Sainik Colony of ward 1 in the extreme west, Khokhrokot consisting of Renak Pura of ward 11 and Hanuman Colony of ward 13 in the extreme north, HUDA Sector 14 of ward 29 in the extreme east and Bank Colony of ward 23 in the middle of the city are the other residential localities which were not affected by the fury of flood. This was mainly either because of their location on the comparatively raised ground as in case of Sainik Colony, Renak

Pura, Bank colony and DLF Colony or due to outflow of water in low-lying areas as is the case with HUDA sector 14 where surplus water flowed in the University Campus.

MITIGATION MEASURES

Flood hazard has become a serious problem because it causes enormous destruction of life and property. Steps must be taken to moderate the intensity of flooding and devastating effect of uncontrolled fury of nature to a tolerable level. It must always be remembered that neither it is possible to eliminate fully the devastating nature of flood nor it is desirable to shut out the beneficial effects of floods or our environment. The most important consideration is that the floods do not bring in misery only, they bring in blessings as well (De and Sarkar, 1993).

It should be borne in mind that final selection of flood control methods does not depend in its technical merit alone but on its economic justifications and other conditions such as the availability of capital, labour and materials. These economic considerations are, therefore, of vital importance in flood control methods. Besides these, the social conditions of the people in and around flood prone areas are required to be analysed scientifically in the sphere of flood, its occurrences, remedies and control (De and Sarkar, 1993).

As flood control to the desired extent is not possible, there is marked emphasis and inclination in all levels in mitigating the flood hazards with a combination of structural as well as non-structural measures of flood management (Jana, 1994).

However, compared to the structural measures, like i) construction of dams and storage reservoirs, ii) construction of drainage channels, iii) measures to remove drainage congestion from low areas, and iv) raising of protective embankments, which rarely provide

total protection against floods, non-structural measures like i) flood-plain zones (FPZs), ii) flood proofing, and iii) flood forecasting 7 early warning offer a more effective way of preventing losses due to floods (Basu, 1993).

During the devastating flood of 1995 in Rohtak city, non-structural measures could not be adopted at all, whereas the following structural measures had been adopted to control floods in different parts of the city :

DURING HAZARD MITIGATION MEASURES

- About one kilometre long deep nallah along the Jhajjar Road was constructed by the district administration to drain out the flooded water in JLN canal against the natural flow of water.
- A new pump house of 40 cusec capacity was established temporarily by Public Health Department in Khakhrakot to drain out the flooded water of colonies like Guru Nanak Pura, Krishna Colony, PWD Colony, Sai Das Colony Old Arya Nagar, Bhagat Singh Colony, Radwala Johar, Chunnipura, Chamanpura, Kripal Nagar, Sakhpura Chowk, etc.
- With the two days constant efforts of district administration, two new pumps of 10 cusec capacity had been installed to drain out the water in JLN canal at Jhajjar Road on September 19, 1995.
- Before draining out the flooded water of the city, it was must to reduce the level of water spread over the adjoining area of 13 km. which was entering the city through Sukhpura Chowk. Therefore, first of all, to reduce the level of adjoining water, diversion of water was made at Sukhpura Chowk by the installation of pumps of 40 cusec capacity of drop the water in the sand dunes of Khokhrakot.

POST HAZARD MITIGATION MEASURES

- Raising of roads from 1 to 2 feet in the low-lying inner parts of the city. For instance, Vijay Path, Civil Road, Green Road, Quilla Road, Gohana Road, etc.
- Construction of new drains notably a drain connecting National Highway No. 10 to Jhajjar Road along JLN canal through University Campus.
- Installation of new pumps and increasing the capacity of the existing pumps.
- Protective measures including the repair of breached embankments, desilting and removal of encroachments over the drains.
- Raising and strengthening of bundhs or lining of drains.
- Raising of plinth level and installation of electric motors by the individuals in their houses to pump out the surplus water.

PERCEPTION OF THE PEOPLE

- The situation might not have deteriorated to this extent had there not been a breach in the drain which carried storm water out of the city. It is learnt that the drain had been neither desilted nor its lining strengthened. As a result, the heavy rain caused a breach in the drain blocking the only outlet for draining out the rain water.
- People were generally dissatisfied with the arrangements made by district administration. As a result, a large number of people (traders, politicians, social workers etc.) staged a demonstration and demanded action against those responsible for the upkeep of the drain which was breached.

- The public feared that having suffered untold misery due to administration's lapses, its attempts to cover these up and underplay the losses will result in a low quantum of payment of compensation by the government as well as the insurance companies.
- There was also a difference of opinion on the quantum of rainfall in the city. The authorities said that floods were caused by unusually heavy rains, but the common man thought otherwise.
- For instance, if it is pointed out that villages like Mokhra were inundated several days after the rains, indicating that the authorities failed to monitor the flow of water and to drain it out in time. The authorities also failed to check groups of miscreants from making cuts in roads, canals and railway tracks just to save their crops and houses. For a week, it was a free for all in the district including the city.
- To drain out the water from the city, the total capacity of existing pumps and ganda nallahs is 160 cusecs. The situation in the city might not have deteriorated to such an extent had the pumps and nallahs been in an order of proper functioning. Therefore, all the officers of district administration especially of Public Health Department who were engaged in flood protection measures before the rainy season were held responsible for such a decastation of the city. Because in the pre-monsoon season, neither the overhauling of pumps nor the desilting of nallahs and drains was made.
- Such a vast devastation of the city might have been averted had a breach not been made in Gohana Railway Line at the instance of the then local MLA and State Home Minister in Haryana Government to save his own house located in Model Town from the fury of flood.
- People also blamed the administration of making intentional delay in draining out the flooded water due to political reasons i.e. to get the central grant for the unprecedented flood.
- It was disclosed by senior citizens that the devastation made in the city by the unprecedented flood of 1995 a natural calamity or a man-made disaster? It was a debatable question. The bland argument of the administration that it was a natural calamity and nothing much could be done to avert it was only a part of the truth. Contrary to this, in view of people, it was a man-made disaster despite the fact that it was not possible to contain the heavy rains but, it necessary anti-flood measures had been put into practice in time, the harshness of the calamity could have been averted to a great extent.

HAZARD-REDUCTION STRATEGIES

To achieve the goals and objectives of the International Devade for Natural Disaster Reduction (IDNDR), in addition to the on-going plan programmes for reducing the occurrence and minimising the adverse impact of natural calamities like floods, the following disasterreduction strategies should be adopted:

- The emphasis on non-structural mitigation measures like i) flood plain zones (FPZs) and ii) flood forecasting and early warning. Because flood plain zoning is one of the most scientifically sound and reliable methods of flood protection and the flood forecasting 7 warning is recongnised as one of the most reliable and cost-effective methods.
- Applications of remote sensing technology for monitoring and forecasting and early warning of natural disasters like floods.
- Comprehensive rehabilitation programmes with World Bank assistance for social and economic rehabilitation of disaster victims.

- Involving community leaders, activists, social workers and NGOs with potential for mobilising community efforts and resources in disaster-reduction programmes.
 - Complete ban on encroachments made over the drains.
 - Making the drainage system more effective to deal with the eventuality.
 - Revival of natural flow of the drainage with the help of expertise in Engineering.
 - Construction of the proposed by-pass in the north instead of south of the city, because major inflow of flooded water is generally from the northern side.
 - Construction of ring-bandh along Drain No.8.
 - Strict vigil of district authorities on the personnel of concerned department engaged in flood protection measure especially in pre-monsoon season.
 - Creation of an emergency flood-fighting organisation.
- life and property, indirect losses resulting from the breakdown of communication, disruption of rail and road traffic and other essential services were equally important because their restoration cost crores of rupees. The total loss of property during this devastating flood hazard was estimated about the thousand crore rupees.
- The normal life remained suspended for months together. There was a damage to water supply as well as power supply which could be restored after a gap of about a month in most of the flood affected localities of the city. Hundreds of houses had collapsed, while thousands of houses were partially damaged. As a result, a large number of families had been rendered homeless, while several others were living on the rooftops in the scorching heat of day and spent sleepless nights due to breeding of mosquitoes in abundance for about a month.
 - The floods had taken a heavy toll of stray dogs and milch cattle. About 500 car cases were floating in the flood water giving rise to fears of outbreak of an epidemic. Such a threat of outbreak of an epidemic because of insanitary conditions in the city had forced people to send their children away to their relatives.
 - Thousands of families had left the city and temporarily migrated to Delhi and other nearby towns in the wake of floods. Because, after a fortnight, the stagnant floodwater started emitting a very foul-smell adding to the misery of the city's residents and the incidence of viral fever, diarrhoea, vomiting and jaundice had increased.
 - Spatially, the worst affected areas were spread over the whole of 19 and 18 wards and a part of ward 17 in the west of Hajjar

SUMMING UP

- Almost the entire city was worst affected by the devastating flood hazard of 1995 which occurred mainly due to i) incessant and excessive rainfall, ii) saucer-shaped topography of the city, iii) defective and poor drainage system, iv) non-functioning of inadequate pump-sets, v) growth of weeds, deposition of silt and encroachments made over drains and *johars* and vi) the negligence on the part of district administration in updating the contingency plan.
- The century's worst flood hazard and a great impact on various types of activities. Besides the direct losses in terms of loss of

Road and that of ward 20 between civil road and Subhash road. The whole area was submerged under 7-12 feet of water depth. Chhotu Ram Chowk, Narain Complex, Civil Road, Palika Bazar, HUDA Complex and Hari Nagar, Sant Nagar, Bhagwan Colony were the notable commercial and residential localities respectively where maximum water level of 12 feet was the point of discussion among urban dwellers as well as district officials. The major factors responsible for such a fury of flood in these areas was because of their location at the lowest mark of the *saucer-shaped* topography of the city.

- As flood control to the desired extent is not possible, there is marked emphasis and inclination in all levels in mitigating the flood hazard with a combination of

structural as well as non-structural measures of flood management. During the devastating flood of 1995 in Rohtak city, non-structural measures like i) flood-plain zoning (FPZs), and ii) flood forecasting & early warning could not be adopted at all, whereas the *structural* measures like i) construction of one kilometre long deep nallah along the Jhajjar Road, and ii) establishment of a temporary pump house of 40 cuses capacity in Khokhrakot for the diversion of water at Sukhpura Chowk to reduce the level of water spread over the adjoining area of 13km during the flood hazard and i) raising of roads, ii) construction of drain iii) installation of new pumps and iv) desilting & removal of encroachments over the drains after the floods had been adopted to control floods in different parts of the city.

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