

## URBAN ENVIRONMENTAL CRISIS : A STUDY OF BHOPAL GAS TRAGEDY

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**ABSTRACT:** To gear up the development like many countries of the world, India, too, had invited several multinational companies to install their plants without having any premonition of future date risks. The Union Carbide Plant was one of them which was located in a densely populated area of Bhopal. Although this plant was set up in 1969 as a part of the effort to bring 'Green Revolution' prosperity but the leakage of tonnes of lethal Methyl-Iso-Cyanite (MIC) gas from the pesticide plant on the night of December 2/3, 1984, suddenly shook the whole world the following morning. Thousands of people died instantly and 369,409 others were exposed and have continued to die and suffer from blindness, lung and respiratory diseases, foetus damage, psychological traumacity etc.

Looking into the long-term continuing environmental crisis in the city of Bhopal, authors have attempted to study the issues related to their perception towards the disaster, varied forms of damages caused to human health and potential risk involved in long-run etc. It would also evaluate their satisfaction with regard to relief measures provided by the government and non-governmental organisations. To study the same, informations have been collected with the help of a questionnaire administered on 394 persons interviewed randomly from the affected area. However, care has been taken to draw the sample from different cross-sections of the society. The study concludes that poorer sections of the society were highly affected as compared to others. It also confirms that its effect will be discernible in urban environment in the long-run.

Planned economic development has accelerated the process of urbanisation and industrial

growth as well as the modernization of agriculture. Technological development, sometimes out of context, has been considered the *sine qua non* for improving the lot of the impoverished masses in the developing countries. In third-world urban areas, potentially hazardous plants are usually located adjacent to the densely populated neighbourhoods, and hence vast number of persons are at risk in case an accident occurs (Karan *et al*, 1986). As economic benefits run supreme in a backward economy, very few people bother about the deleterious effect of the technological dominance and majority of them just ignore it. A slight negligence may endanger the whole ecological system be it land, water, air or living organisms—human, animal and plants. As a result, technological hazards are increasing at an alarming pace, particularly in the developing countries. Natural gas explosion in November 1984 at Pomex plant, Mexico city; deadly gas leakage in Union Carbide

Plant at Bhopal in December 1984; leakage of dioxin gas in Milan city of Italy in 1970; leakage of gas in Sri Ram Foods and Fertilizers, Delhi in December 1985; nuclear mishap in Chernobyl, U. S. S. R. in 1986; Coal dust explosion at Honkeiko Colliery, China in 1942; mine explosion at Chasnala Colliery, India in 1975 are some of the striking examples of industrial disasters. Very recently (26 August 1992), the ammonia gas leak at the Panipat plant of the National Fertilizers Limited had killed 11 persons.

In the developing countries, there is a greater likelihood of introducing hazardous technol-

ogy because of inadequate perception and assessment with respect to suitability and safety at the time industrial plants are established (Kayastha and Nag, 1991). With an objective to gear up the development process and to secure the state of art technology, India, like many other developing countries invited several multinational companies to establish their plants without having any premonition of future risks. The Union Carbide plant was one of these which was located in a densely populated area of Bhopal (Fig. 1). Although this plant was set-up in 1969 as a part of the effort to bring in 'Green Revolution' prosperity, the

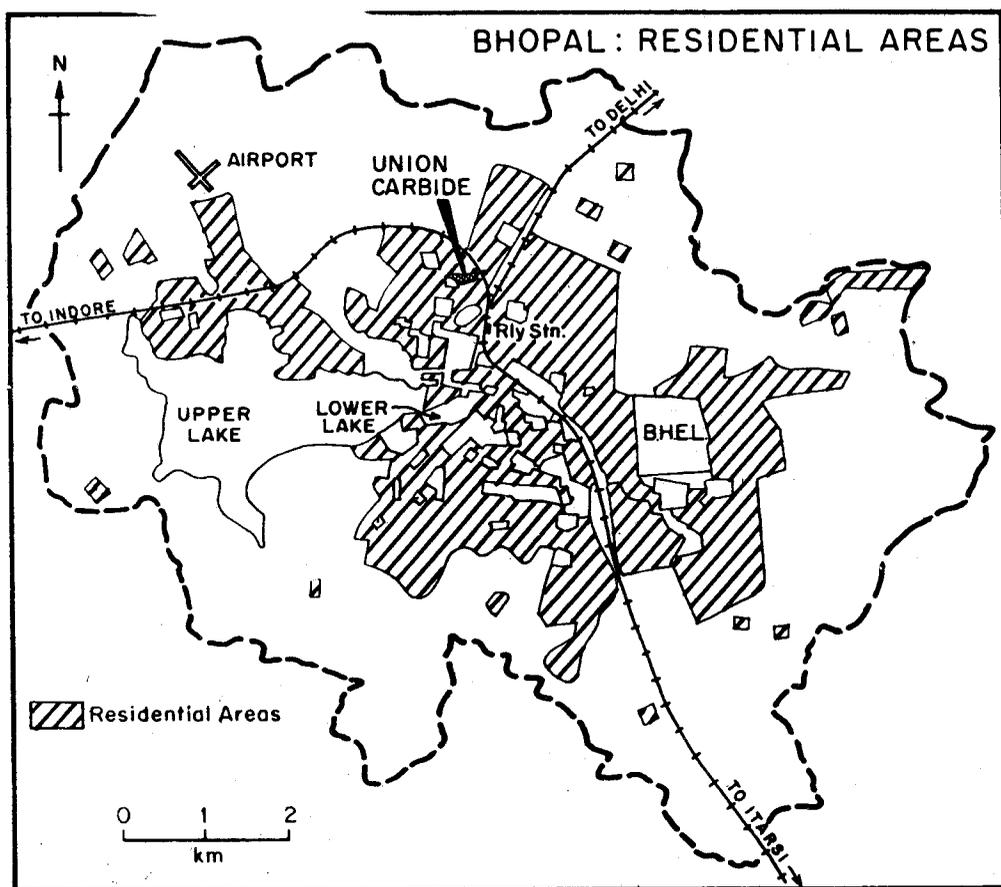


FIG. 1

Based on Karan et al., 1986

leakage of tonnes of lethal Methyl-Iso-Cyanite (MIC) from the pesticide plant during the fateful night of December 2/3, 1984 suddenly shook the whole world the following morning. It is still fresh in the memory of our

countrymen. The deadly gas spread on the wind and affected mostly the area adjacent to plant and the south-eastern part of the city (Fig. 2). Thousands of people died instantly and 369,409 others comprising 54.94% of the

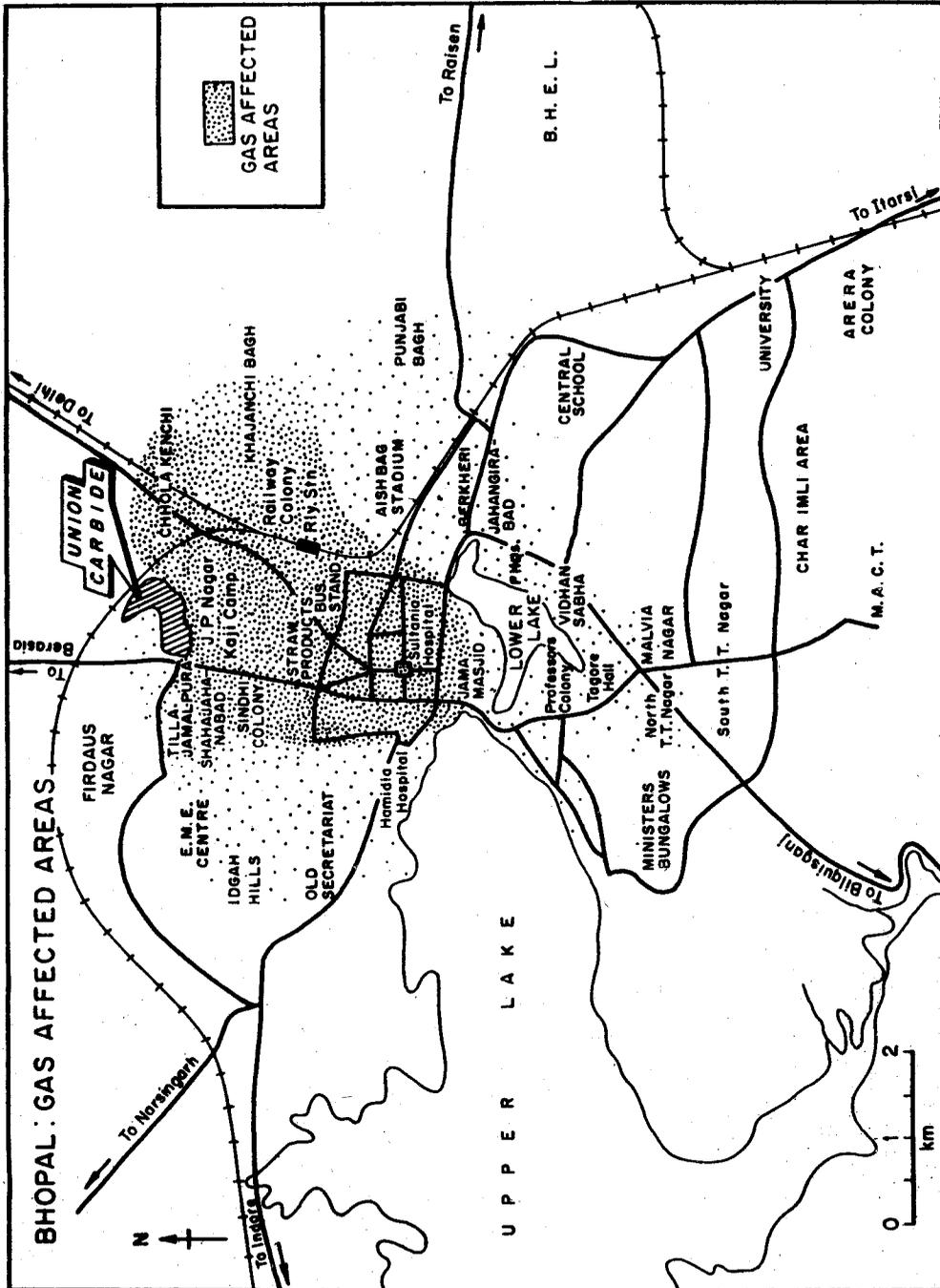


FIG. 2

then total population were exposed to the poisonous gas and have continued to die from blindness, lung and respiratory diseases, foetus damage, psychological traumacity etc. According to a report, on an average, five gas victims continue to die every week in the affected areas of the city (The Hindustan Times, 2 December 1990). So, Banerjee (1986) is right in his statement that the lessons of Bhopal should not be forgotten, the memory of Bhopal tragedy victims appeals to all people.

Looking into the long-term continuing urban environmental crisis in Bhopal, an attempt has been made by the authors to study the issues related to people's perception of the disaster, varied forms of damages caused to human health and potential risks involved in the long-run. It would also evaluate their satisfaction with regard to relief measures provided by the government and non-governmental organisations (NGOs). Finally, their views to cope with industrial disasters have been ascertained. Such a study would provide a base to our urban planners, policy makers and environmentalists to ponder over the issues like safety, siting of hazardous plants, risks to human population etc. so that these havocs may not recur to despoil our urban environment. Authors feel that the present study will certainly help in raising the level of general awareness on an issue of immediate concern for human survival.

#### **STUDY AREA :**

Bhopal is the capital city of Madhya Pradesh with a population of 10,63,662 (1991) and sprawling over an area of 284.90 km<sup>2</sup>. The 1951 census recorded a total area of 71.20 km<sup>2</sup> inhabited by 1,02,333 persons. The geographical nodality and political importance have been the most powerful factors for the rapid expansion of the town. The favourable situation of the town increased the commer-

cial, industrial and administrative importance of the place. The growth rate of population was 58.51 per cent during 1981-91. During the last 40 years the urban area has expanded westward along the highway to Indore and south-eastward along the rail-road to Bombay. Slums are located in low lying areas between the old and new residential zones along the rail-road track near the railway station.

The Union Carbide plant full of deadly chemicals was established over a 70 acre plot on Chhola Road in the north-western part of the city with a capital investment of Rs. 20 crores. The plant employed 750 persons—all Indians—and produced 2500 tonnes of Sevin insectide annually. The plant which was based on American Technology had three 40 to 60 tonnes storage tanks for MIC and, as the authorities claim, it used the most sophisticated safety devices. The plant in its three units manufactured carbon monoxide (CO), MIC and Sevin. The MIC plant producing Methyl-Iso-Cyanate gas (Tolerance Limit Value i.e. TLV 0.05 ppm) used CO (TLV 50 ppm), phosgene (TLV 0.02 ppm) and chloroform (TLV 100 ppm). The end product, namely Sevin, was a poisonous insecticide (The Civic Affairs, December 1984). When the plant was established, some squatter settlements grew up in the neighbourhood in addition to the existing ones. It attracted thousands of workers and migrants to the area. Majority of the dwellers were Hindus and Muslims and belonged to economically poor segments of the population. The problem, therefore, was not that some people decided to live near the plant after it was built but rather that the plant was located very close to large pre-existing concentrations of people (Morehouse and Subramaniam, 1986).

#### **OBJECTIVES OF THE INVESTIGATION**

This study aims at analysing the awareness

among the local population about the toxic/hazardous effects of the emission from the UC plant before the plant was established. Secondly, the instant and long-term effects of MIC leakage on winter night of 2/3 December 1984 on human body and other living and non-living organisms have also been examined. Thirdly, an attempt has been made to evaluate the level of people's satisfaction towards various relief measures provided by the government and non-governmental organizations. Finally, the views of the respondents towards mitigating such technological disasters in future has also been ascertained.

#### METHODOLOGY AND DATA BASE :

The study is primarily based on field data collected with the help of a questionnaire administered on 394 persons selected randomly from the affected areas. However, care has been taken to draw the samples from different cross-sections of the society. The primary data has been supplemented by secondary data and wherever necessary, the same has been cross-checked. The findings of the discussions with local officials, social workers, politicians, intellectuals etc. and personal observations made during the course of field study have also been utilized in the present study. Since the plant was established in the

**TABLE I**

#### SOCIO-ECONOMIC CHARACTERISTICS OF THE RESPONDENTS, 1991

S. No.	Age-Group (years)	Percentage of total respondents	Level of Education	Percentage of total respondents	Occupation	Percentage of total respondents	Income	Percentage of total respondents
1.	10-19	4.06	Primary school	18.02	Household industry	7.11	<1000	30.20
2.	20-29	20.05	Junior High school	19.54	Other than Household industry	0.51	1000-2000	30.46
3.	30-49	51.01	High School	19.29			2000-3000	9.64
4.	50-59	14.97	Intermediate	11.67	Trade and Commerce	13.20	3000-4000	2.54
5.	60+	9.90	Graduate and above	11.42	Services Daily wage earners	44.67 7.87	>4000	0.51
6.	Illiterates	20.05			Non-workers	26.65	No-personal income	26.65
Total		100.00	100.00	100.00		100.00		

Source: Compiled from field interviews, 1991.

late 1960s and the mishap occurred in 1984, an attempt has been made to select respondents from 20+ age-groups who seem to be aware of both the events.

### GENERAL SOCIO-ECONOMIC PROFILE OF THE RESPONDENTS :

Table 1 provides the general socio-economic and cultural profile of the respondents. Males constitute 74.11 per cent of the total. About 96 per cent of the respondents are of more than 20 years. However, 86.06 per cent of the respondents belong to the economically active age-group (20 - 59 years). Education has direct bearing on knowledge of the respondents about the positive and negative aspects of an event. It is apparent from the Table I that 79.95 per cent of the respondents are literate. Among the literates, 11.42 per cent have their education upto graduation and above. Of the total males, 86.64 per cent are literates where among females about 61 per cent are literate. The occupational structure of the respondents reveals that 44.67 per cent are engaged in services while

trade and commerce accounts for 13.20 per cent. Since the level of satisfaction is linked with income of the respondents, it was felt essential to assess their income levels. Most of the respondents (60.66%) are poor as their monthly income is below Rs. 2000/-. Only 12 respondents have their monthly income above Rs. 3000. Hindus outnumber (70.56%) Muslims (28.93 per cent) among respondents. It is worthwhile mentioning that the average family size of Hindus is 5.63 and of muslims is 6.97.

### RESULTS AND DISCUSSION :

*Awareness* : The awareness about the potential dangers of the UC plant has been examined with reference to only those respondents who were living over there prior to the installation of the plant. It may be noted here that 41.37 per cent of the total respondents were living in this area before the establishment of the plant. Only about one-fifth (30.86 per cent) respondents (34 in number) were aware of the lethal effects of its products. Since education in-

TABLE II

#### AWARENESS OF MIC'S DANGEROUS EFFECTS

S. No.	Level of Education	Percentage of total respondents aware of the dangers
1.	Primary	20.59
2.	Junior Highschool	8.82
3.	Highschool	17.65
4.	Intermediate	20.59
5.	Graduate and above	29.41
6.	Illiterate	2.94
Total		100.00

Source: Compiled from field interviews, 1991.

creases the level of awareness, the relationship between the awareness level and the educational status has been examined. As expected awareness increases with the level of education (Table 2). Of the total respondents who were aware of its ill effects, 29.41 per cent had received education upto graduation and above. Further, it was noted that 32.35 per cent of the respondents who were aware of it had made agitation against the installation of the plant at its present site. It reveals that the people in general were least aware of the potential danger and hence their agitation could not pressurise the management of the multinationals. Similar observation has been made by Buch (1985). In his view the Bhopal tragedy clearly highlights the almost total lack of citizens awareness of and reaction to issues of public importance. People do not care that their lives are at danger. Management did not disclose the dangers associated with the products. Not only this, even available reports show that workers or the scientific personnel at the plant were not properly enlightened on the harmful consequences of the chemical experiments being conducted in the plant (Das, 1985). Hence, the question of general awareness among other citizens does not arise.

2. *The Time of Disaster : a crucial point.* The severity of any disaster depends upon the working position of the inhabitants living in the concerned area. On the mid-night of 2/3 December 1984 when leakage of 30 tonnes of MIC for about 40-50 minutes occurred, 86.29 per cent of respondents were at home wherein 78.93 per cent were sleeping while 7.36 per cent were awakened. Further 12.81 per cent were at work and 1.52 per cent of respondents were out of the town on that fatal night. It highlights that more people were caught in the clutch of the accident as they were in bed in their houses with closed doors and windows. By the time inhabitants could know of

the gas leakage, they had already inhaled the gas which resulted in high casualties and damage.

3. *Experience of Gas Exposure :* MIC is known to produce severe effects on eyes and respiratory tracts though effects on kidney, abdomen, liver and nervous system have also been noticed. Over exposure will cause lung oedema and suffocation and survivors may develop varying degree of fibrosis and respiratory insufficiency (Bhandari, 1978, p. 55). The survey revealed that 97.20 per cent of the total respondents had experienced respiratory problems and suffocation at the time of gas leakage whereas 86.04 per cent felt vomiting and abdomen pain. It may be noted here that a good proportion of the respondents experienced more than one symptoms and ailments.

4. *Effect of MIC Exposure on Human Body Responses* to the question 'which parts of the body were affected by MIC exposure' show that the maximum percentage (98.73) of the respondents reported eye-ailments followed by chest and respiratory (71.06%) and ENT problems (65.48%). However, 25.38 per cent had suffered from stomach impairments and 5.58 per cent reported skin trouble, heart ailments and memory loss.

Inhalation of the toxic fumes by the pregnant women caused foetus damage. Another study of the severely affected area has revealed that among 2,566 expectant mothers, there were 355 spontaneous abortions i.e. 13.84% whereas the normal rate is only 2 per cent. The present investigation included 64 expectant mothers on that night among the 394 surveyed families. Among them, there were 20 spontaneous abortions (31.25 per cent of pregnancies). In addition, 17.19 per cent expectant mothers delivered child who died instantly (Table 3). The people have reported that the babies born alive were underweight and experienced below average physical and mental growth. A

clinical examination of 625 children belonging to three affected areas enabled Bhandari (1987, p. 56) to conclude that 46.8 per cent of these children were deficient in Vitamin A and 31.80 per cent were anaemic.

Leakage resulted in the death of a large number of people due to acute pulmonary oedema and respiratory problem (Vijayan *et al.*, 1989). An exposure to MIC has caused 89 instant deaths in the surveyed families. Table 4 shows ward-wise distribution of the respondents and the number of casualties that occurred in their families on that fatal night. Maximum casualties have been reported from ward 13 which was severely affected by the leakage of gas.

It may be mentioned here that 2,372 survivors of the surveyed families have been affected by the toxic effects of the gas in one way or the other. Among the survivors, over 50 per cent belong to the lower age-group (below 20 years). Majority of them have suffered mainly from respiratory problems of varying dimension.

*5. Effects on Living and Non-living Organisms:* An attempt has also been made in the present study to ascertain the effects of MIC on other living and non-living organisms. The investigation reveals that about 52 per cent of the respondents witnessed damage to plants whereas 41.87 per cent have reported its lethal effects on domestic birds and animals. The study conducted by a team of botanists from the laboratory of Cytogenetics, Banaras Hindu University, has reported the damage on plants in the form of defoliation, burnt patches and drying up of most aerial parts. Maximum damage was observed in succulent and xerophytic plants (Kumar, Tripathi and Roy, 1989; Kumar and Roy, 1990). Another study revealed that MIC retards growth and induces chlorophyll deficiency and mosaicism in plants (Kumar, Sahi and Roy, 1990). Fruits with-

ered and they were unusual and too light with shrunken seeds (Kumar and Roy, 1990). Tripathi and Roy (1988) had also reported that MIC worked as retardant or inhibitor in growth of roots. It was due to contamination of soil. Moreover, 86 respondents reported that their domestic animals particularly goats and dogs and birds (parrots) died instantly. Further, about 85 per cent of respondents feared that their food-stuffs were contaminated and hence, disposed them off. Only 3 respondents reported the contamination of water.

*6. Delayed After Effects:* So far as the delayed after effects are concerned, technological disasters tend to pose long-term threats particularly to public health, pregnancy and working efficiency of the individuals. As a result thousands of people became incapable of carrying on their occupation to earn their livelihood. Keeping these facts in view, information on 'Do you still feel the ill effects of MIC? If yes, mention the nature of illness' has been gathered. The investigation reveals that majority of the respondents have reported more than one ailments. Table 5 shows that 69 per cent of respondents are still suffering from respiratory problem and chest pain. Of the total respondents 13 are suffering from tuberculosis. Further, 63.19 per cent have reported weakness and fatigue while 34.77 per cent have suffered from vision problem. Besides, mental illness (8.12%), joint pain (15.74%), and hypertension (5.32%) have also been observed. Three respondents have reported impotency. Thus, the agony of those who have survived has been long and lingering (Singh, Kumara and Singh, 1988).

*7. Relief Measures:* Apart from instant medical care and an ex-gratia payment of Rs. 10,000 to the next of kin of the dead and Rs. 2,000 to those seriously injured and Rs. 1,000 to minor injuries, relief measures in the form of cash, food-stuff, medicines were provided

**TABLE - III****IMPACT ON PREGNANT WOMEN**

Impact	Percentage of total cases reported
Abortion	31.25
Abnormality in infants	17.19
Instant death	15.62
Normal delivery	31.25
Others	4.68
Total reported cases	64

*Source:* Compiled from field interviews, 1991.

**TABLE IV****WARD-WISE NUMBER OF RESPONDENTS AND DEAD PERSONS.**

Ward No.	Number of Persons interviewed	Total number of dead persons in their families
5	27	-
9	02	-
10	04	-
11	36	02
13	72	47
14	02	-
17	02	-
19	02	-
20	89	18
40	33	04
45	34	04
46	91	14
Total	394	89

*Source:* Compiled from field interviews, 1991.

TABLE V

## DELAYED AFTER EFFECTS OF GAS LEAKAGE.

S. No.	Delayed effect	Percentage of total respondents
1.	Weakness and fatigue	63.19
2.	Respiratory and chest pain	69.03
3.	Vision problem	34.77
4.	Stomach pain	14.46
5.	Joint pain	15.74
6.	Mental illness	8.12
7.	Skin irritation	1.78

Source: Compiled from field interviews, 1991.

to those families who had no resources to meet their immediate needs. Since the agony of the survivors has been long and lingering, it requires long-term relief measures. The survey reveals that 93.65 per cent of respondents have received various kinds of relief measures by the government as well as from NGOs. NGOs were in no way lagging behind in providing relief and rehabilitation. Among NGOs, the services rendered by Tata group, the Redcross, and Christian missionaries have been praiseworthy. There were 2.53 per cent of respondents who received assistance only from NGOs, while 2.28 per cent got relief measures from the government. However, four respondents were found to be indifferent towards relief measures. Besides, there were two respondents who reported that they have not received assistance from any source. It is encouraging to note that of the total respondents (366) receiving medical aid, 11.20 per cent of them have discontinued their medical treatment. They now feel that they do not require treatment any more.

8. *Satisfaction from the Relief Measures :* Instant as well as long-term relief measures have been offered to the affected population. Therefore, it was relevant to know their attitude on 'Are you satisfied with relief measures?' Of the total respondents, only 9.39 per cent expressed satisfaction with the relief measures whereas 24.62 per cent were partially satisfied. It may be noted here that about 64 per cent of respondents have not been satisfied at all owing to delay in compensation, anomalies in disbursement of cash and medical aid and above all the ad-hoc approach. People complained of general apathy and inadequate relief measures. Moreover, the level of satisfaction has been examined in relation to the income level of the respondents as it affects the need and demand. It is evident from Table 6 that with the increase in income, the percentage of satisfied respondents also increases. Majority of the respondents belonging to lower income groups (< Rs. 2000) are not satisfied with the relief rendered by various organisations so far. The present analysis reveals that the poor have been the worst

TABLE VI

## SATISFACTION FROM THE RELIEF MEASURES.

Monthly family	Percentage of respondents in				Total
	Satisfied	Partially satisfied	Not satisfied	Indifferent	
<1000	4.85	8.28	83.44	3.55	169
1000-2000	8.59	28.83	61.96	1.23	163
2000-3000	22.44	57.14	20.41	-	49
>3000	30.76	61.54	-	-	13
Total	37 (9.39%)	97 (24.62%)	252 (63.96%)	08 (2.03%)	394 (100%)

Source: Compiled from field interviews, 1991.

sufferers. Eight respondents expressed their indifference towards this question.

Majority of the respondents pertaining to partially satisfied and unsatisfied groups demanded enhancement in the quantum of financial assistance and improvement in medical aid irrespective of their income levels. Further, it has been observed that a considerable proportion of the respondents (28.05%) from lower income groups have expressed their option for job opportunities to eligible members of their bereaved families.

**9. Coping Strategies :** The magnitude of the Bhopal gas tragedy was so great that citizens themselves have expressed grave concern to this untoward incident. They have come forward with their own views in solving the issues pertaining to industrial safety, siting of hazardous plants, environmental damage, provision of compensation to genuine persons etc. The views expressed by 302 respondents in this regard have been tabulated into five

categories according to their educational level (Table 7). It is evident from the Table that 72.85 per cent of respondents are of the view that such plants need to be located away from the city area in order to avoid heavy loss of life, property and occupational work. A higher percentage in each strata reflects the seriousness of the tragedy. Another 12 per cent respondents laid emphasis on ensuring proper maintenance and adopting adequate safety measures in such plants. A small proportion of the respondents (5.96%) are of the view that compensation from Union Carbide management should have been made available earlier so that the same could have been utilized in arranging better means of livelihood. It is feared that a few persons from non-affected areas have also moved into the affected areas and have put forth their claims for compensation. In addition, about 4 per cent of respondents were of the opinion that such a plant should have been established in this area after making environmental impact

TABLE - VII

## PEOPLE RESPONSES TOWARDS COPING STRATEGIES.

S. No.	Suggestive measures	Percentage of the respondents who mentioned specific information						Total
		Primary School	Junior High School	High School	Inter-mediate	Graduate and above	Illiterates	
1.	Shifting of the plant	15.89	16.22	15.23	6.29	5.63	13.58	220 (72.85%)
2.	Quick disbursement	1.65	0.99	-	-	1.32	1.98	18 (5.96%)
3.	Environmental Impact assessment	-	0.33	0.99	0.99	1.65	-	12 (3.97%)
4.	Proper maintenance and safety measures	1.65	1.32	2.32	3.64	1.65	1.32	36 (11.92%)
5.	Compensation to right persons	1.32	0.33	0.66	0.33	1.65	0.99	16 (5.30%)
Total		62	58	58	34	36	54	302 (100.00%)

Source: Compiled from field interviews, 1991.

assessment. This view largely came from educated respondents having better awareness.

### CONCLUSION :

The study has revealed that most of the residents living in that area belonged to poorer section of the society and many of them have been living there even prior to the establishment of the plant. Majority of the population was not aware of the hazardous effects of the products manufactured in the plant. As a result it suffered heavy losses, the work efficiency has been impaired due to inhalation of toxic

gases. This, in turn, has damaged the respiratory system and the eyes—the two most important organs of the body. Apart from instant casualties and damage, people are suffering from prolonged illness and shattered household economy. The establishment of the plant within the city area has not only jeopardised the present urban environment but has also endangered the foreseeable future. It has caused irreparable damage to the progeny. Undoubtedly, this industrial disaster has left many issues to be pondered over by our urban planners, industrial entrepreneurs, policy and decision makers and environmentalists. People are compelled to live in the same environment

even after seven years of the incident. Affected people are, in general, not satisfied with the relief measures and their demand for quick disbursement of adequate compensation is not altogether unjustified. The present investigation reveals that despite heavy losses, people are still living in the same area perhaps due to delay in settlement of the compensation from the U. S. based Union Carbide Company.

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