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CASE STUDY OF CHEMICAL LEAK IN 1984 IN THE CITY OF BHOPALTOXIC METHLYISCOCYANATE GAS TRAGEDY

Miss. Vaishnavi B. Tapre[1],Miss. Roshani H. Shende[2], Prof. Manish S. Deshmukh[3]

[1]P. R. Pote(Patil)College of Engineering& Management,Amravati. Civil Engineering Department
[2]P. R. Pote(Patil) College of Engineering & Management, Amravati. Civil Engineering Department
[3]P. R. Pote (Patil)College of Engineering&Management, Amravati. Civi Engineering Department

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Abstract -In the MadhyaPradesh state, the city of Bhopal on 3rd December 1984 about 45 tons of the toxic Methly Isocyanate escaped form an insecticide plant. The Plant owned by the Indian subsidiary of the American firm an Carbide Corporation. The unforgettable gas tragedy of 1984 Bhopal must be considered, and it should be continuously considered as a warning sign that with the globalization and industrialization in the nation the security of people and environment must be considered along with the development. As ignoring the protocols and environment has resulted in such a big tragedy that is still affecting so many lives and claiming lives too. The protocols must be followed by everyone the owner, manger, people, and government which were ignored and heeded once. The consequences of the Bhopal case and its aftermath should be considered as a warning as the path towards industrialization and globalization, for the developing countries like India.

***Key Words*:**Toxic, MethlyIsocyanate, Globalization, Protocols,NTG,GPCG,MP,India

1.INTRODUCTION

In Bhopal on the night of 2nd to 3rd December 1984 more than half million people were directly exposed in the toxic methyl Iisocyanate (MIC) pesticide gas and other leaked chemicals that was leaking because of the leniency and carelessness of a pesticide plant UCIL established in the Bhopal. Considering the estimation, around ten thousand people died under the two weeks after the leakage started, thousand suffered permanent ailments and severe health conditions and hence numbers of victims continued to die thereafter. The influence of the gas was so severe that even after years the newborn infants were suffering from health conditions and permanent disabilities. It becomes important to learn about the case and understand the situation and conditions that made it so critical for the state. The mishandling errors made, the protocols, on spot decisions, precautions, and legal actions everything must be studied so that the people and the nation must stay cautious and prepared for any possible tragedy like this. Since chemical plants are common in states so proper knowledge and rules regulations must be followed by every shareholder to avoid any such situation in the future. Refer the figure 1 and to two to understand by the pictorial depiction how severe was the Bhopal gas accident and sever were the effects on people and on the city.

The morning of Bhopal on third December 1984 was not normal as a heavy gray cloud was covering the whole sky and was rolling around with the slow winds. It was a very poisonous cloud formed of methyl Isocyanate (MIC) from the pesticides UCIL Plant established in the capital state of Madhya Pradesh, India. The cloud emerged because of the uncontrollable release of around forty tons of hazardous gas which spreader gradually throughout the surroundings of the city. The accident was so severe that its effects on the city became a nightmare for everyone and unfortunately it still affects people with no end. The residents of the city start panicking as soon as the heavy clouds of suffocating gas approached towards them thousands of people start running on the dark roads and streets, hundreds of victims start arriving at the hospitals with problems like breathlessness and blindness. The most affected human organ was eyes, the lungs, muscles, and the brain. It even affected the gastrointestinal functionality, severe neurological influence, reproductive organs and the immunity system of people were severely damaged in victims who survived. The devastated night ends up in a scene where human and animal dead bodies were blocking the streets of the city, heavy smog around the streets, smelly and black burning atmosphere. As estimated ten thousand people immediately died and half a million population were severely affected with serious symptoms.

2.BACKGROUND

2.1. Union Carbide in Bhopal

Bhopal, the state capital of Madya Pradesh, is geographically at the Centre of India. About a third of its one million inhabitants live in tightly packed, shanty ('kucha') housing in its northern and central districts (see Figure 2). In 1969, Union Carbide (India), a subsidiary of the large American corporation, set up a pesticide formulation plant (Figure 3) on the north edge of the city, originally to import, mix and package pesticides manufactured in the United States. Ten years later, a 5000-ton methyl isocyanate (MIC) production unit was installed, primarily to manufacture an effective and inexpensive carbaryl pesticide marketed as 'Sevin'.

Figure-1 Kucha housing adjacent to the site of the Union Carbide factory

Figure-2 The (defunct) Union Carbide factory, Bhopal 1994.

MIC is produced by the reaction of (mono) methylamine with phosgene, both of which were manufactured elsewhere in India and transported in bulk to Bhopal. There it was mixed with 1-naphthol to produce Sevin for sale throughout the country. MIC is colorless, with a low boiling point (39°C) and high vapor pressure; because of its chemical instability it is stored under refrigeration in dry, stainless steel vessels. At the Bhopal plant, there were several such storage tanks, one (#610) having an unusually large capacity of 60 tons.

2.2. The Gas Disaster

For reasons that remain unclear, the cooling system of tank 610 was not functioning in last months of 1984. Late in the evening of December 2nd, it is hypothesized that water (either through mechanical malfunction or operator error) entered the tank, mixing with the store MIC.The result was a violent, exothermic reaction, possibly catalyzed by ferrous corrosion of the tanks lining. By 1.00 a.m. the next morning,mtank ruptured and over the next few hours approximately 27 tons of vapor was discharged. Although most of this was probably pure MIC, products of hydrolysis (monomethylamine, carbon dioxide and various ureas) and pyrolysis (carbon monoxide,nitrous oxides and hydrogen cyanide) may also have beenreleased in smaller quantities; the exact constitution of discharged gases remains a matter for conjecture.

There is very little available information on meteorological conditions that night, but data from the city's airport suggest an air temperature of about 10°C and a slow, northerly wind. At this temperature, the discharged MIC would have rapidly condensed and fallen groundward, the plume passing over the northern edge of the city and towards its Centre. An estimated 350000 people were exposed. Immediate effects, & those over the following month, included the deaths of approximately 5000 people, most attributable to the direct respiratory effects of inhalation.

Over the next three years, health studies of survivors confirmed residual, obstructive airways disease, though its nature was poorly characterized. Ophthalmic sequelae, prominent in the weeks after the disaster, were believed to be more transient; the presence of disease in other organ systems was not convincingly established. Since 1986, only small case studies of persistent (respiratory) disease have been published and the question of causation has been poorly addressed. No further epidemiological studies have been completed.

2.3. The International Medical Commission

The Permanent Peoples' Tribunal is an international organization of health care, legal and environmental professionals which aims to provide an objective examination of situations with important health, environmental or human-rights implications. In 1992, the Tribunal met in Bhopal to examine the question of the disaster and its aftermath; and subsequently recommended an assessment of any persistent effects of gas exposure in combination with an examination of current health provision for survivors resident in the city. Applications were sought from interested physicians in 60 European, Asian and American universities. Of those responding, thirteen were selected and formed an International Medical Commission (Appendix). One, from Pakistan, was subsequently refused a visa. The Commission visited Bhopal, and carried out most of its fieldwork, in December 1994.

3. LITERATURE REVIEW

Bhopal tragedy was such a big industrial disaster that its influences can still be seen in that respective area where this pesticide plan company was located and hence this became a greater interest of research for the international as well as Indian researchers. There are numerous research papers available discussing the tragedy from different aspects of the environment, social, government and industry also. One of them is "The Bhopal gas tragedy—A perspective" written by R.K. Binary and Swaraj Puri the Ex-Mayor of Bhopal, Madhya Pradesh, India and Director General of Bhopal Police respectively. The paper narrates the whole situation, happenings and the other handling aspects related to the on spots decisions and there later consequences. That had to be made with the hope that no such accident happens anywhere .

Another paper with the title "The Bhopal disaster and its aftermath: a review" written by Edward Broughton. This review paper highlights the facts that weak protocols and policies towards the chemical plants

lead to this tragedy. Since the tragedy happened India has been in the experienced rapid industrialization. While some positive changes in government policy and behavior of a few industries have taken place, major threats to the environment from rapid and poorly regulated industrial growth remain. Widespread environmental degradation with significant adverse human health consequences continues to occur throughout India.
Paper entitled "The unfolding of Bhopal disaster" written by Ex-MIC Plant Operator of UCIT Mr. T.R. Chauhan. The paper presents the concerns related to the facts that the authors has knowledge about as an ex- employee. The merciless cost-cutting severely affecting materials of construction, maintenance, training, manpower and morale resulted in the disaster that was waiting to happen. Significant differences between the West Virginia, USA plant and the Bhopal, India plant show the callous disregard of the corporation for the people of the developing countries . The narrative below, if given a proper thought by the management and governments, should help in significantly reducing industrial accidents.

4.0 - METHODOLOGY

4.1. Design:

4.1.1. What factors lead to this huge leak and why was it uncontrollable?

The initial investigations by the official authorities' community conducted by the Indian government and the teams of UCC noticed that a significantly high volume of liquid water had been presented in the MIC tanks. Which caused a kind of chemical reaction that increased the pressure and enforced the release of valves to get open and it ultimately allowed the leakage of gas in open. The conclusion was released by Indian government after more than two years of investigation of the tragedy, the final documentation was 70,000 pages long. The lengthy documents findings include the scientific and the legal investigations details. The declared cause of gas leakage concluded was the 'sabotage'. The UCC's investigation proceeded and proved the situation with the evident virtual certainty according to that the cause of disaster was direct introduction of the water content into the gas Tank 610 possibly through a passage hose that was directly connected with the gas tank.

4.1.2. The Theories:

1.The execution of cause of tragedy is only possible due to negligence of some insider workers. This arises the theory of the 'disgruntled employee' in that plant. It could be an employee who is not happy or has grudges for the UCC which makes that employee permit the storage of water into the Tanks. So, someone on purpose intentions or a serious grudges of the person triggered this tragic disaster in the city.
2. other popular version is from the point of view of the 'Corporate Negligence' that argues that the cause of this disaster is a vigorous combination of negligence, under-maintained plant and also a decaying facilities leads to vulnerable situations, safety negligence as safety concerns were not examined and estimated properly, and of course the under trained and weak workforce in the plant lead enhancementof situations, as the concluding actions of workers when leakage starts-compelled the adverse effect and the decision to introduce the water penetration inside the MIC tanks and also in the absence of properly working safeguards.

Figure 4 shows a collage some tragic pictures

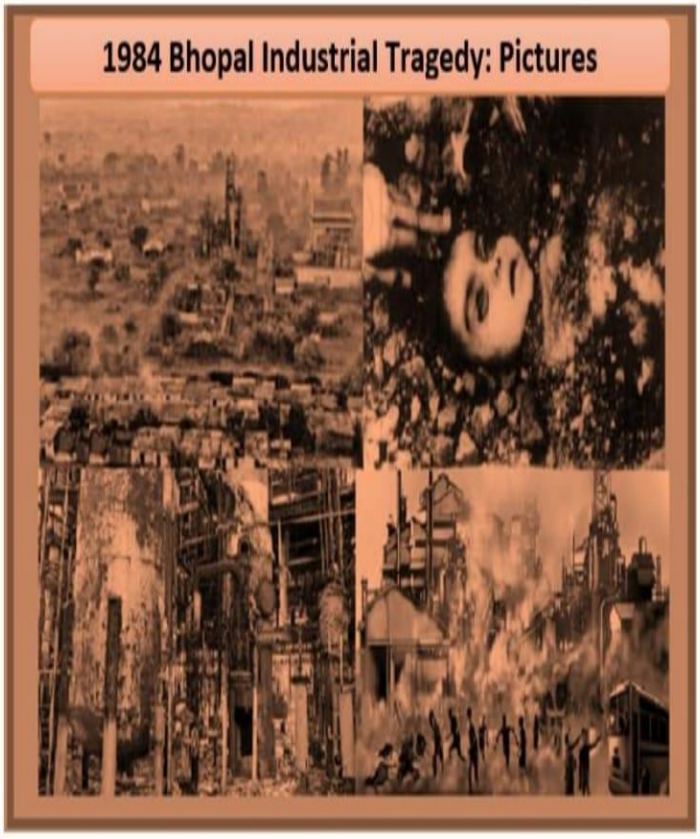

Figure 4. A collage of some tragic pictures of the Bhopal gas accident and the famous picture Bhopal hazardous gas victim that died tragically. The heavy smog rolling around the sky and screams and dead bodies around the streets of the city.

4.1.3. Whyis it not yet sensed as a closure?

Even after 32 years of the world's most tragic industrial disaster, the victims and the affected resident people are yet waiting to see any appropriate and comprehensive step or efforts to clean and minimize the groundwater contamination which happened around the areas near the disaster site. This is so unfortunate that for the victims this prolonged disaster is not yet ended but is still ongoing in various offerings. The NGOs and Organizations which are still fighting for the comprehensive justice of the victims of Bhopal gas tragedy victims. They are consistently and repeatedly presenting the aftermath and severe effects of the disaster which is still making the victims suffer and the ongoing and future generations that were born after the Bhopal tragic incident. The children are still born with severe symptoms of health conditions and health risks that occur because of the poisons and hazardous gases that were leaked in air from the tanks of the pesticide factory. To understand

more about it refer to figure 4 which depicts the immediate severe effects by this toxic gas on people.

The claims by these organizations are pointing to the fact that abandoning the factory by the corresponding corporation causes severe effects and is still making people sick and killing them. The maiming problem in people is common due to the poisonous groundwater in the city which becomes even more severe because of the irresponsible and careless dumplings of the polluted and toxic waste chemicals and products during the 14 years long operational activities of the plant in prior times of the disaster. The ignorance of official authorities and government is also responsible for these worst conditions. Hence these organizations also criticized the government authorities for not focusing the working and operational activities and environments but for only considering the toxicity of about a thousand forty-five tons of toxic waste product that was kept stored inside the plant premises of the UCIL. The authorities completely ignored this releasing waste by the factory in open without proper reuse or rectification. Even the locals boldly claim that there are three main local ponds where this industrial waste was dumped and released by the factory between the long time of 1977 and 1984 of globalization. Moreover, there were 21 more identified locations present inside the plant factory which was used to bury the industrial waste.

4.2. Sample:

4.2.1. Similar accidents in India post the tragic incident of Bhopal?

After Bhopal case there was a realization among people that with the globalization and industrial development if the industrial development remains unregulated, careless and sensor less then it surely will lead to dangerous effects on the environment. And in case if this development is ongoing without the adequate and proper safeguards and equipment the consequences to it could be dangerous and far reaching from the control of the governments. But alongside these concerns, the increased demands of globalization and industrialization grew the accountability of the industries as well as these are engaged in the potentially very hazardous and toxic activities.

Though Bhopal started a massive influence and change in the government's actions and legislative framework related to the industrial disaster management authorities. Hence numerous laws were amended and passed as the action in aftermaths of the tragedy. The committed judiciary started taking a very active start and role towards environmental protection. So, working on these concerns and exactly a year later the Bhopal gas tragic accident on the fourth and sixth December of 1985 the Indian judiciary declared the Doctrine of Absolute Responsibility decision in a serious court case involving the oleum gas leakage from the Cloths Mill factories of Delhi owned by brand called Shriram Foods. This was also implemented for the industries dealing in production of Fertilizer in Delhi. Considering the information provided by the India's National Disaster Management Authorities (NDMA), around one hundred and thirty chemical emission accidents had been registered around the whole country and being reported in thatdecade to the year October 2013, which caused two fifty-nine premature deaths and around five sixtythree serious injuries and serious health impacted victims. Unfortunately even after the 1984, many industrial accidents have been registered and the concerning this is not even getting dimmer as even last year and this year gas leakage in factory of Visakhapatnam, Andhra Pradesh and in Assam these severities have been reported, The list includes previous case of leakage of chlorine gas at a factory of Jamshedpur in 2008, a hazardous fire outbreak at the petrol pump of Oils and Natural Gas Corporations (ONGC) located at Bombay High in 2005, and a severe leakage of chlorine gas in a factory of Vadodara in 2002 that somehow affected more than two hundred and fifty people in that area .

These cases are not limited to some accidents; sometimes these were so severe that the impact was more like some disaster and even natural disasters can cause such tragedies. A chemical accident happened because of a natural disaster at oswal chemical and three fertilizers ltd. in Pradeep of Odisha in year 1999 large volume of ammonia gas was start leaking during the crossing of a super-cyclone in the state. Another reported tragedy because of an earthquake in Bhuj of Gujarat occurred in 2001 that damaged the complete sludge of phosphoric acid. The National Green Tribunals (NGT) convicted the members of Pollution Control Boards (GPCB) and the popular cement manufacturing company called as Ambuja Cements Limited for a case that involved and claimed illegals release of toxic gases in atmosphere that damaged the agricultural fields of Gujarat. While the GPCG punished with a fine of one lakh rupees, and the company made to give a fine of five lakh rupees.

4.3. Data Analysis:

4.3.1. The legal proceeding of the Bhopal gas in the aftermaths of the tragedy?

After the accident a very long unending justice journey for the suffered victims of the tragedy is carried along with the years. The question was majorly oriented around two questions first was the quantification and responsibility of the liability and employers of the corresponding corporation that handled the hazardous waste and dumping of the substances with carelessness, violating the protocols and in absence or not following any well-established security principle. The other concerning question was the impacts of these hazardous elements and waste on the biodiversity and environment. The issues related to the prevention of these effects and such damages to the people or environment which could be possible in the future accidents as for the proper installation of safety equipment and security devices and adoption of right mechanisms.

When the tragic gas accident took place in Bhopal, it was well watched by the clustered American lawyers as the pesticide company belongs to the USA. Also, the Government of India tried to ensure and tackle each claim about the accident and the facts arising out., regarding thegas disaster were dealt with full proper investigation and as well speedily results which were enacted in the processing claims of Bhopal Gas Leak Disaster Act, passed in 1985. This Act provides an exclusive right to the Indian Government for acting as a prior leader, to represent the case and all the claimants. In both courtrooms of within India and outside India as well. The

legal battle of Indian government with the corporate giants proceeded further here in India after the USA. The District Court of Bhopal, MP granted an amount of three hundred fifty crores as an interim payment. But later in a filed appeal against this judgment, the amount was reduced by 30%, but against this decision the Union of India again appealed in the Supreme Court of India. Then a five-judge bench of Supreme Court proceeded to the hearings of the case and on 14th of February in 1989 the Supreme bench of judges ordered a final settlement of all the claims made and that arose because of the accident. In the judgment UCC was fined and made to pay an amount of four hundred and seventy million dollars to the Indian Government.

4.3.2. What major changes India saw as a learning after the tragic accident of Bhopal?

After Bhopal a big change has been seen in the case of gas leakage in the oleum case that occurred in the1987, that time the Indian Factories Act, of 1948 has been amended so that to minimize victims of accidental risk from such chemical industries and to extend the scope of people in the safe side of the law protection. This scope previously was very narrowly defined that only covers the industry workers and the starting premises of industry was increased to the extent of the public as well in the vicinity sector of the industry. These modifications also amended for the appraisals when the chemical or hazardous elements industries were being established or being expanded.

5. HISTORY

In the 1970s, the Indian government-initiated policies to encourage foreign companies to invest in local industry. Union Carbide Corporation (UCC) was asked to build a plant for the manufacture of Sevin, a pesticide commonly used throughout Asia. As part of the deal, India's government insisted that a significant percentage of the investment come from local shareholders. The government itself had a 22% stake in the company's subsidiary, Union Carbide India Limited (UCIL). The company built the plant in Bhopal because of its central location and access to transport infrastructure. The specific site within the city was zoned for light industrial and commercial use, not for hazardous industry. The plant was initially approved only for formulation of pesticides from component chemicals, such as MIC imported from the parent company, in relatively small quantities. However, pressure from competition in the chemical industry led UCIL to implement "backward integration" – the manufacture of raw materials and intermediate products for formulation of the final product within one facility. This was inherently a more sophisticated and hazardous process.

In 1984, the plant was manufacturing Sevin at one quarter of its production capacity due to decreased demand for pesticides. Widespread crop failures and famine on the subcontinent in the 1980s led to increased indebtedness and decreased capital for farmers to invest in pesticides. Local managers were directed to close the plant and prepare it for sale in July 1984 due to decreased profitability. When no ready buyer was found, UCIL made plans to dismantle key production units of the facility for shipment to another developing country. In the meantime, the facility continued to operate with safety equipment and procedures far below the standards found in its sister plant in Institute, West Virginia. The local government was aware of safety problems but was reticent to place heavy industrial safety and pollution control burdens on the struggling industry because it feared the economic effects of the loss of such a large employer.

At 11.00 PM on 2 December 1984, while most of the one million residents of Bhopal slept, an operator at the plant noticed a small leak of methyl isocyanate (MIC) gas and increasing pressure inside a storage tank. The vent-gas scrubber, a safety device designer to neutralize toxic discharge from the MIC system, had been turned off three weeks prior. Apparently, a faulty valve had allowed one ton of water for cleaning internal pipes to mix with forty tons of MIC. A 30 ton refrigeration unit that normally served as a safety component to cool the MIC storage tank had been drained of its coolant for use in another part of the plant. Pressure and heat from the vigorous exothermic reaction in the tank continued to build. The gas flare safety system was out of action and had been for three months. At around 1.00 AM, December 3, loud rumbling reverberated around the plant as a safety valve gave way sending a plume of MIC gas into the early morning air.Within hours, the streets of Bhopal were littered with human corpses and the carcasses of buffaloes, cows, dogs and birds. An estimated 3,800 people died immediately, mostly in the poor slum colony adjacent to the UCC plant. Local hospitals were soon overwhelmed with the injured, a crisis further compounded by a lack of knowledge of exactly what gas was involved and what its effects were. It became one of the worst chemical disasters in history and the name Bhopal became synonymous with industrial catastrophe.

Estimates of the number of people killed in the first few days by the plume from the UCC plant run as high as 10,000, with 15,000 to 20,000 premature deaths reportedly occurring in the subsequent two decades.The Indian government reported that more than half a million people were exposed to the gas. Several epidemiological studies conducted soon after the accident showed significant morbidity and increased mortality in the exposed population.

6. AFTERMATH

Immediately after the disaster, UCC began attempts to dissociate itself from responsibility for the gas leak. Its principal tactic was to shift culpability to UCIL, stating the plant was wholly built and operated by the Indian subsidiary. It also fabricated scenarios involving sabotage by previously unknown Sikh extremist groups and disgruntled employees, but this theory was impugned by numerous independent sources.

The toxic plume had barely cleared when, on December 7, the first multi-billion-dollar lawsuit was filed by an American attorney in a U.S. court. This was the beginning of years of legal machinations in which the ethical implications of the tragedy and its effect on Bhopal's people were largely ignored. In March 1985, the Indian government enacted the Bhopal Gas Leak Disaster Act as a way of ensuring that claims arising from the accident would be dealt with speedily and equitably. The Act made the government the sole representative of the victims in legal proceedings both within and outside India. Eventually all cases were taken out

of the U.S. legal system under the ruling of the presiding American judge and placedentirely under Indian jurisdiction much to the detriment of the injured parties.

In a settlement mediated by the Indian Supreme Court, UCC accepted moral responsibility and agreed to pay $470 million to the Indian government to be distributed to claimants as a full and final settlement. The figure was partly based on the disputed claim that only 3000 people died and 102,000 suffered permanent disabilities. Upon announcing this settlement, shares of UCC rose $2 per share or 7% in value. Had compensation in Bhopal been paid at the same rate that asbestosis victims were being awarded in US courts by defendant including UCC – which mined asbestos from 1963 to 1985 – the liability would have been greater than the $10 billion the company was worth and insured for in 1984. By the end of October 2003, according to the Bhopal Gas Tragedy Relief and Rehabilitation Department, compensation had been awarded to 554,895 people for injuries received and 15,310 survivors of those killed. The average amount to families of the dead was $2,200.

At every turn, UCC has attempted to manipulate, obfuscate, and withhold scientific data to the detriment of victims. Even to this date, the company has not stated exactly what was in the toxic cloud that enveloped the city on that December night. When MIC is exposed to 200° heat, it forms degraded MIC that contains the more deadly hydrogen cyanide (HCN). There was clear evidence that the storage tank temperature did reach this level in the disaster. The cherry-red color of blood and viscera of some victims were characteristic of acute cyanide poisoning. Moreover, many responded well to administration of sodium thiosulfate, an effective therapy for cyanide poisoning but not MIC exposure. UCC initially recommended use of sodium thiosulfate but withdrew the statement later prompting suggestions that it attempted to cover up evidence of HCN in the gas leak. The presence of HCN was vigorously denied by UCC and was a point of conjecture among researchers.

As further insult, UCC discontinued operation at its Bhopal plant following the disaster but failed to clean up the industrial site completely. The plant continues to leak several toxic chemicals and heavy metals that have found their way into local aquifers. Dangerously contaminated water has now been added to the legacy left by the company for the people of Bhopal.

7. LESSONS LEARNED

The events in Bhopal revealed that expanding industrialization in developing countries without concurrent evolution in safety regulations could have catastrophic consequences. The disaster demonstrated that seemingly local problems of industrial hazards and toxic contamination are often tied to global market dynamics. UCC's Sevin production plant was built in Madhya Pradesh not to avoid environmental regulations in the U.S. but to exploit the large and growing India pesticide market. However, the way the project was executed suggests the existence of a double standard for multinational corporations operating in developing countries. Enforceable uniform international operating regulations for hazardous industries would have provided a mechanism for significantly improved in safety in Bhopal. Even without enforcement, international standards could provide norms for measuring performance of individual companies engaged in hazardous activities such as the manufacture of pesticides and other toxic chemicals in India. National governments and international agencies should focus on widely applicable techniques for corporate responsibility and accident prevention as much in the developing world context as in advanced industrial nations. Specifically, prevention should include risk reduction in plant location and design and safety legislation.

Local governments clearly cannot allow industrial facilities to be situated within urban areas, regardless of the evolution of land use over time. Industry and government need to bring proper financial support to local communities so they can provide medical and other necessary services to reduce morbidity, mortality, and material loss in the case of industrial accidents.

Public health infrastructure was very weak in Bhopal in 1984. Tap water was available for only a few hours a day and was of very poor quality. With no functioning sewage system, untreated human waste was dumped into two nearby lakes, one a source of drinking water. The city had four major hospitals but there was a shortage of physicians and hospital beds. There was also no mass casualty emergency response system in place in the city. Existing public health infrastructure needs to be considered when hazardous industries choose.sites for manufacturing plants. Future management of industrial development requires that appropriate resources be devoted to advance planning before any disaster occurs. Communities that do not possess infrastructure and technical expertise to respond adequately to such industrial accidents should not be chosen as sites for hazardous industry.

8. SINCE 1984

Following the events of 3rd December1984 environmental awareness and activism in India increased significantly. The Environment Protection Act was passed in 1986, creating the Ministry of Environment and Forests (MoEF) and strengthening India's commitment to the environment. Under the new act, the MoEF was given overall responsibility for administering and enforcing environmental laws and policies. It established the importance of integrating environmental strategies into all industrial development plans for the country. However, despite greater government commitment to protect public health, forests, and wildlife, policies geared to developing the country's economy have taken precedence in the last 20 years.

India has undergone tremendous economic growth in the two decades since the Bhopal disaster. Gross domestic product (GDP) per capita has increased from $1,000 in 1984 to $2,900 in 2004 and it continues to grow at a rate of over 8% per year. Rapid industrial development has contributed greatly to economic growth but there has been significant cost in environmental degradation and increased public health risks. Since abatement efforts consume a large portion of India's GDP, MoEF faces an uphill battle as it tries to fulfill its mandate of reducing industrial pollution. Heavy reliance on

coal-fired power plants and poor enforcement of vehicle emission laws have result from economic concerns taking precedence over environmental protection.

With the industrial growth since 1984, there has been an increase in small scale industries (SSIs) that are clustered about major urban areas in India. There are generally less stringent rules for the treatment of waste produced by SSIs due to less waste generation within each individual industry. This has allowed SSIs to dispose of untreated wastewater into drainage systems that flow directly into rivers. New Delhi's Yamuna River is illustrative. Dangerously high levels of heavy metals such as lead, cobalt, cadmium, chrome, nickel, and zinc have been detected in this river which is a major supply of potable water to India's capital thus posing a potential health risk to the people living there and areas downstream.

Land pollution due to uncontrolled disposal of industrial solid and hazardous waste is also a problem throughout India. With rapid industrialization, the generation of industrial solid and hazardous waste has increased appreciably, and the environmental impact is significant.

India relaxed its controls on foreign investment in orderto accede to WTO rules and thereby attract an increasing flow of capital. In the process, several environmental regulations are being rolled back as growing foreign investments continue to roll in. The Indian experience is comparable to that of several developing countries that are experiencing the environmental impacts of structural adjustment. Exploitation and export of natural resources has accelerated on the subcontinent. Prohibitions against locating industrial facilities in ecologically sensitive zones have been eliminated while conservation zones are being stripped of their status so that pesticide, cement, and bauxite mines can be built. Heavy reliance on coal-fired power plants and poor enforcement of vehicle emission laws are other consequences of economic concerns taking precedence over environmental protection.

In March 2001, residents of Kodaikanal in southern India caught the Anglo-Dutch company, Unilever, red-handed when they discovered a dumpsite with toxic mercury laced waste from a thermometer factory run by the company's Indian subsidiary, Hindustan Lever. The 7.4-ton stockpile of mercury-laden glass was found in torn stacks spilling onto the ground in a scrap metal yard located near a school. In the fall of 2001, steel from the ruins of the World Trade Center was exported to India apparently without first being tested for contamination from asbestos and heavy metals present in the twin tower debris. Other examples of poor environmental stewardship and economic considerations taking precedence over public health concerns abound.

The Bhopal disaster could have changed the nature of the chemical industry and caused a reexamination of the necessity to produce such potentially harmful products in the first place. However, the lessons of acute and chronic effects of exposure to pesticides and their precursors in Bhopal has not changed agricultural practice patterns. An estimated 3 million people per year suffer the consequences of pesticide poisoning with most exposure occur-ring in the agricultural developing world. It is reported tobe the cause of at least 22,000 deaths in India each year. In the state of Kerala, significant mortality and morbidity have been reported following exposure to Endosulfan, a toxic pesticide whose use continued for 15 years after the events of Bhopal.

Aggressive marketing of asbestos continues in developing countriesbecause of restrictions being placed on its use in developed nations due to the well-established link between asbestos products and respiratory diseases. India has become a major consumer, using around 100,000tons of asbestos per year, 80% of which is imported with Canada being the largest overseas supplier. Mining, production, and use of asbestos in India is very loosely regulated despite the health hazards. Reports have shown morbidity and mortality from asbestos related disease will continue in India without enforcement of a ban or significantly tighter controls.

UCC has shrunk to one sixth of its size since the Bhopal disasterto restructure and divest itself. By doing so, the company avoided a hostile takeover, placed a significant portion of UCC's assets out of legal reach of the victims and gave its shareholder and top executives bountiful profits. The company still operates under ownership of Dow Chemicals and still states on its website that the Bhopal disaster was "cause by deliberate sabotage".

Some positive changes were seen following the Bhopal disaster. The British chemical company, ICI, whose Indian-subsidiary manufactured pesticides, increased attention to health, safety and environmental issues following the events of December 1984. The subsidiary now spends 30–40% of their capital expenditures on environmental-related projects. However, they still do not adhere to standards as strict as their parent company in the UK.

The US chemical giant DuPont learned its lesson of Bhopal in a different way. The company attempted for a decade to export a nylon plant from Richmond, VA to Goa, India. In its early negotiations with the Indian government, DuPont had sought and won a remarkable clause inits investment agreement that absolved it from all liabilities in case of an accident. But the people of Goa were notwilling to acquiesce while an important ecological site was cleared for a heavy polluting industry. After nearly a decade of protesting by Goa's residents, DuPont was forced to scuttle plans there. Chennai was the next pro-posed site for the plastics plant. The state government there made significantly greater demand on DuPont for concessions on public health and environmental protection. Eventually, these plans were also aborted due towhat the company called "financial concerns".

9. CONCLUSION

The unforgettable gas tragedy of 1984 Bhopal must be considered, and it should be continuously considered as a warning sign that with the globalization and industrialization in the nation the security of people and environment must be considered along with the development. As ignoring the protocols and environment has resulted in such a big tragedy that is still affecting so many lives and claiming lives too. The protocols must be followed by everyone the owner, manger, peopleand government which were ignored and heeded once.

The consequences of the Bhopal case and its aftermath should be considered as a warning as the path towards industrialization and globalization, for the developing countries like India.

In particular is distraught with the people, the environment and the economic threats. Sustainable development should be considered on the priority it is applied to developing or developing both the countries. As the Indian economy and development is growing with a tremendous rate but along with it the industrialization, deforestation, and urbanization collaboratively polluting the nation and because of these reasons the subcontinent continues to get polluted. Far more steps in the context of chemicals and environment remain to be carried out for the public health and the environment in the main context of development, industrialization and globalization taking the case of Bhopal 1984 tragedy as an experience.

This paper can help and refer to the people who want to learn more about the tragedy and want to research the water contamination in Bhopal.

10. REFERENCES

1. Fortun K: Advocacy after Bhopal. Chicago , University of Chicago Press; 2001:259.
2. Shrivastava P: Managing Industrial Crisis. New Delhi , Vision Books; 1987:196.

3. Shrivastava P: Bhopal: Anatomy of a Crisis. Cambridge, MA , Ballinger Publishing; 1987:184.
4.Accident Summary, Union Carbide India Ltd., Bhopal, India: December 3, 1984. In Hazardous Installations Directorate Health and Safety Executive; 2004.
5. MacKenzie D: Fresh evidence on Bhopal disaster. New Scientist2002, 19(1):.
6. Sharma DC: Bhopal: 20 Years On.Lancet 2005,365(9454):111-112.
7. Cassells J: Sovereign immunity: Law in an unequal world. Social and legal studies 1996, 5(3):431-436.
8. Dhara VR, Dhara R: The Union Carbide disaster in Bhopal: a review of health effects. Arch Environ Health 2002, 57(5):391-404.
9. Kumar S: Victims of gas leak in Bhopal seek redress on compensation. Bmj 2004, 329(7462):366.
10. Castleman B PP: Appendix: the Bhopal disaster as a case study in double standards. In The export of hazards: trans-national corporations and environmental control issues Edited by: Ives J. London ,Routledge and Kegan Paul; 1985:213-222.
11. Mangla B: Long-term effects of methyl isocyanate. Lancet 1989,2(8654):103.

12. Varma DR: Hydrogen cyanide and Bhopal. Lancet 1989,2(8662):567-568.
13. Anderson N: Long-term effects of mthyl isocyanate. Lancet 1989, 2(8662):1259.
14. Chander J: Water contamination: a legacy of the union carbide disaster in Bhopal, India. Int J Occup Environ Health 2001,
15. Tyagi YK, Rosencranz A: Some international law aspects of the Bhopal disaster. Soc Sci Med 1988, 27(10):1105-1112.
16. Carlsten C: The Bhopal disaster: prevention should have priority now. Int J Occup Environ Health 2003,