

IDENTIFICATION OF TECHNOLOGICAL DISASTER PRONE AREAS IN PROVINCE PUNJAB, PAKISTAN

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ABSTRACT: Punjab the most populous and industrialized province of Pakistan consumes greater fraction of imported and domestic chemicals. Punjab's share in production of various industrial chemicals including caustic soda, soda ash, sulfuric acid, fertilizers and papers during year 2006-07 was 95.2%, 100 %, 46%, 70% and 96.3% respectively. Condition of chemical disaster management both in industrial establishments and government sector, vis-à-vis to trained staff, emergency response equipments is not satisfactory. A top to bottom commitment to address the threats posed by chemical disaster in form of administrative infrastructure, disaster management plan, agreed roles and responsibilities under legal cover is necessary. Amongst 35 districts of Punjab, 14 districts are prone to chemical disaster. Out of these, 10 districts are densely populated and about 90 human settlements in radius of about 1.5-2 Km in close vicinity of major industrial units engaged in dealing with hazardous chemicals. Whereas remaining 4 districts have increased trend of industrialization and will require short term administrative measures for their sustainable urban and industrial development.

Key words: Technological disaster, Pakistan, Industrial chemical, Prone areas, Environmental Protection Agency (EPA), Punjab

INTRODUCTION

Disaster is a disruption of the human ecology that exceeds the capacity of the community to function normally (Bertazzi, 1998). Technological disasters are non-natural, technological, purposeful events perpetuated by people (e.g. air pollutions, industrial disasters, fires and nuclear reactor incidents). These encompass famines, transportation, war, terrorism, fire/explosion, chemical and radioactive release (Baxter, 1986). In Seveso, Italy, an uncontrollable surge in temperature and pressure caused the rupture of a safety valve, resulting in release into the air a fluid mixture 2,3,7,8 Tetrachlorodibenzo-pdioxin (TCDD). More than 700 people were evacuated, and restrictions were applied to another 30,000 (Mike 2003, Melhem, *et al.*, 2006). In Bhopal, India, the release of extremely toxic gas, containing Methyl Isocyanate (MIC), claimed lives of 15,000 to 20,000 people as emergency response system was virtually nonexistent. The resulting physical, social, and psychological disruptions continue to be experienced by the population to this day (Dhara, 2002). The Chernobyl Nuclear Power Plant, due to disabling of safety systems and decrease of flow of coolant for checking of generators, generated 100 times more power and blew the 2,000 ton lid off the top of the reactor. Approximately 95 million curies of radioactivity in the form of fission products rained radioactive particles over thousands of square miles and evacuated over 135,000 people. Two engineers were killed by the explosion and 31 other personnel died of radiation poisoning in a few months. People exposed to

dangerous levels of short lived isotope iodine-131 reported to develop thyroid cancer in both Ukraine and Belarus was reported. The long term effects were estimated to range from 140,000 to 475,000 cancer (Ahearne, 1987).

Out of 6400 total industrial units of all types in Punjab, about 6435 units have been identified as using hazardous chemicals and rendered as major polluting units (EPA, 1995). In the Province Punjab, Pakistan, emergence of residential and industrial areas, lack of zoning, and non-utilization of modern industrial location techniques have led to failure of industrial location policy and render it ineffective to track industrial sector for sustainable development. Keeping in view the situation of industrialization and increased trend of shifting of industries, due to political and ethnic violence, from other parts of countries to Punjab province, Pakistan, study carried out by Piracha in 2008, suggested the need of having information to locate the future industries in Punjab so as to leave minimum negative biophysical impacts. The study recommended the use of scientific methods and computer based Geographic Information System (GIS) tools for zoning of the province Punjab to locate different industries based on their compatibility with biophysical conditions (Piracha, 2008). Baja Line, Garhi Shahoo, Lahore incidence caused by leakage of Chlorine killed 18 persons and injured many more. The relief agencies were unable to identify the nature of the gas for day long. Many people left their house without planning and preparedness (EPA, 1995). Improperly maintained and weakened 24 years old oil tanker Tasman

Spirit grounded and spilled about 31,000 tons of the oil into coastal waters of the Karachi Coast. It was estimated that about 11,000 tons of Volatile Organic Compounds (VOCs) were released in the air which effected residential areas, navy installation, ecologically sensitive creek areas with mangrove forests, turtle nesting sites, salt ponds, and harbor (EPA, 2003). There exist no guidelines for transportation, handling and storage of chemical including Liquefied Petroleum Gas (LPG) cylinder. The fact claimed 29 lives in fruit market of Lahore. A similar incidence due to illegal trade of LPG cylinder in industrialized city of Faisalabad caused death of 8 persons (EPA, 2006). The rescue staff was unable to identify the gas leaked in fruit market of Lahore (Jeved, 2006). Even Province of Punjab, like many other industrial developing countries of the world as well as Pakistan, does not have comprehensive laws and regulation to report on chemical accidents and its causes. The regulatory agencies do not have an effective enforcement policy nor strict requirements for reporting injuries and illness at workplaces (Awan, 2001). Although, several occupational diseases, are covered under the Social Security Ordinance and Workmen's Compensation Act but the reporting mechanism is so poor that very few get the benefits (Awan, 2001). The industrial chemical accidents may results massive fires, explosions, releases of toxic gases, spillages and run off of toxic chemicals etc. and endanger life, damages total ecosystem and properties. If the hazard assessment system for sources of chemical disaster is prepared and strictly enforced and revised, the disaster management agencies would be in a position, to a large extent, to prevent chemical disasters. (Pesatori, 1995). A flexible disaster management plan specifying set of instruction for stakeholders must address on-site, off-site and public health features and provide emergency medical and essential public services needs to be prepared at each organizational level. All such plans should be subject to periodic exercises and should be revised to take account of any deficiencies revealed (Philippe and Green 1989). Present study was carried out keeping in view the situation of extensive chemical use, haphazard industrial development, non-existent of chemical disaster management infrastructure, plans and environmental and safety laws to identify the chemical disaster prone areas of the province Punjab, Pakistan.

MATERIALS AND METHODS

Identification of the installations susceptible to a 'major hazard' and environmental disaster involving toxic chemicals and gases was the first step of the systematic approach involved in the study. This was based on the toxic, flammable and explosive properties of the chemicals. Criterion used for identification of major

hazardous installation was based on Article 3 of the Seveso II Directive (EC, 1996). Moreover, in addition to hazardous nature of the chemicals, population density around units in various districts, existence of sensitive installations, and current trend of industrialization was also considered for large and medium size hazardous installation. Based on the Punjab Development Statistics Report, 2009 administrative setup, industrial profiles, geographical and demographical settings of the province Punjab were analyzed. A comparative review of roles and responsibilities of various line Departments as outlined in Government of Punjab, Rules of Business 1974 and Guiding Principles, for management of technological disasters involving releases and spillages of toxic chemicals both for developed and developing countries was also carried out (ILO, 1991 and OECD, 2003). A detailed analysis of capacities and capabilities of all the available disaster response agencies, both in Government and Non-Governmental Organizations(NGOs), to response potential chemical disaster, was made for each district of the Punjab. Petrochemical works and refineries, Safety, health and environmental conditions in chemical works and chemical production plants, Stores and distribution centers for chemicals large fertilizer manufacturing unit, works in which chlorine is used in bulk quantities was evaluated through physical survey, and by checklists. Environmental Protection Act 1997, rules and regulations made under Act, to mange the hazardous chemical and establish new industrial establishments, were reviewed vis-à-vis to technological disaster in Punjab (GOP, 1997).

RESULTS AND DISCUSSION

Faisalabad, Gujranwala, Lahore, Kasur, Multan, Sialkot, Sheikhpura, Rawalpindi, Sargodha, Gujrat, Muzafargarh, Rahim Yar Khan, Minawali and D.G.Khan having 49.54% of the total population of Punjab are densely populated districts of Punjab. Industrial population in these districts comprises of 44635 units out of which 2205 units are engaged in dealing with toxic chemicals and gases. **Table -1** indicates the types, total industrial units and chemical in 14 districts of Punjab.

Fig-1 indicates population density and number of chemical units in 14 major districts of Punjab. Punjab's share in production of major chemicals and chemicals based products by using local as well as imported chemicals namely caustic soda, soda ash, sulfuric acid, fertilizers and papers during year 2006-07 was 95.2%, 100 %, 46%, 70% and 96.3% respectively. **Fig-2** describes the increase of 117.8% in use of various imported chemicals in Pakistan with their major use in Punjab. Fire brigade service, health care facilities, District managements and EPAs have been found lacking

in fire engines, ambulances, capacity to accommodate indoor patients, debris removal machinery and fully equipped and trained staff respectively. Except a small poison centre comprising of 8 beds in District Faisalabad, no specialized poison centre and burn centre were present in Punjab. **Table-2** indicates the number of fire engines and capacity of health care services and ambulances in densely populated and industrialized districts of Punjab. Administrative as well as legal infrastructure, to provide chemical safety and impart chemical disaster response is non-existent and various legislative control measures including Hazardous Waste Management Rules are none existent.

Table-1 Types of Industrial Units in 14 major Districts of Punjab

District	Types of units	Total Units	Chemical Units
Faisalabad	108	10,185	301
Gujranwala	120	7,299	361
Lahore	149	5,768	207
Kasur	74	3,779	97
Multan	82	3,444	264
Sialkot	92	3,391	154
Sheikhupura	121	2,469	148
Rawalpindi	56	2,144	64
Sargodha	61	1,617	149
Gujrat	61	1,102	56
Muzafargarh	26	1,271	108
RY. Khan	49	1,126	174
Mianwali	20	359	19
D. G. Khan	32	681	103
Total		44635	2205

Source: (GOP, Punjab Statistics Report, 2009, GOP, Industries Department, Lahore, Pakistan)

Table-2. Status of Fire Service, number of Beds and Ambulances in Health care facilities in 14 densely populated Districts of Punjab

District	Total Vehicles	Total fire Stations	Staff	Major Hosp.	Total Beds	Ambulances
D. G. Khan	4	1	17	6	382	12
Faisalabad	19	9	125	23	2730	36
Gujranwala	12	4	89	14	1168	12
Gujrat	4	3	33	12	646	18
Kusur	3	2	25	6	317	27
Lahore	17	13	398	42	12690	36
Mianwali	3	1	16	5	338	15
Multan	10	6	148	15	1903	26
Muzaffargarh	2	1	11	9	345	13
R. Y. Khan	7	5	47	8	871	12
Rawalpindi	15	5	120	15	2683	24
Sargodha	7	4	77	16	875	16

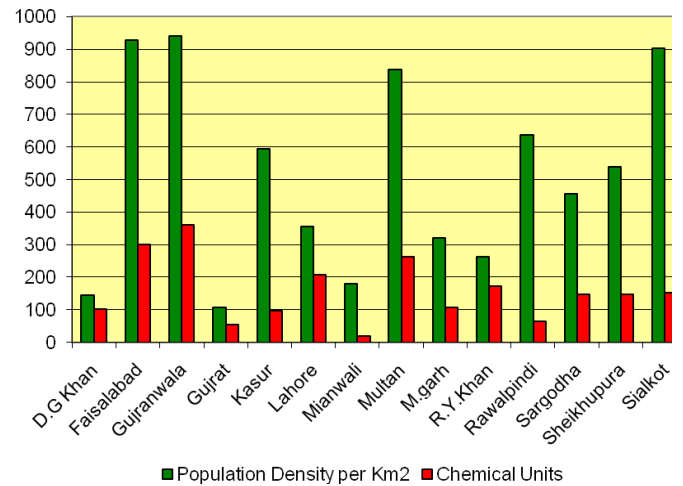


Fig: 1: Population density and total chemical units in 14 district of Punjab

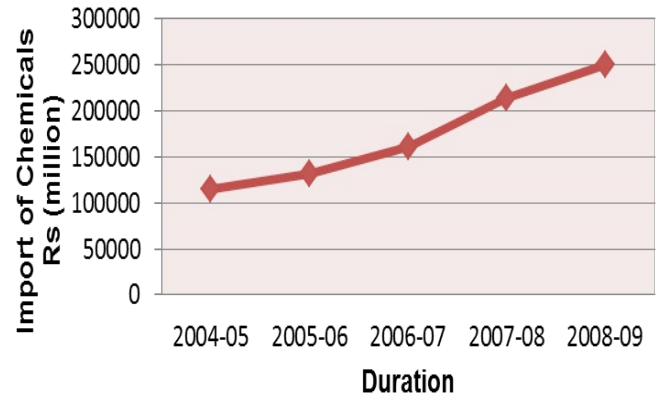


Fig-2: Increase in import of Industrial chemicals in Pakistan

Sheikhupura	7	3	46	13	692	14
Sialkot	10	4	43			

Source: (All Punjab Fire Brigade Services Employees Association, 2008 and Government of Punjab Health Department, 2008)

Faisalabad, Gujranwala, Lahore, Kasur, Multan, Sialkot, Sheikhupura, Rawalpindi, Sargodha, Gujrat, Muzafargarh, Rahim Yar Khan, Minawali and D.G.Khan are 14 major districts which possess, major chemical processing units and have potential of industrial development can likely be affected by technological disasters. There are about 91 human settlements and commercial areas in 14 major districts of Punjab having

potential to be effected by Technological Disaster and road accidents involving releases of toxic chemicals and gases. **Figure-3** illustrates districts having potential of industrial development and can likely be affected by technological disasters whereas **Table-3** describes district wise detail of human settlements having potential to be effected by technological disasters.

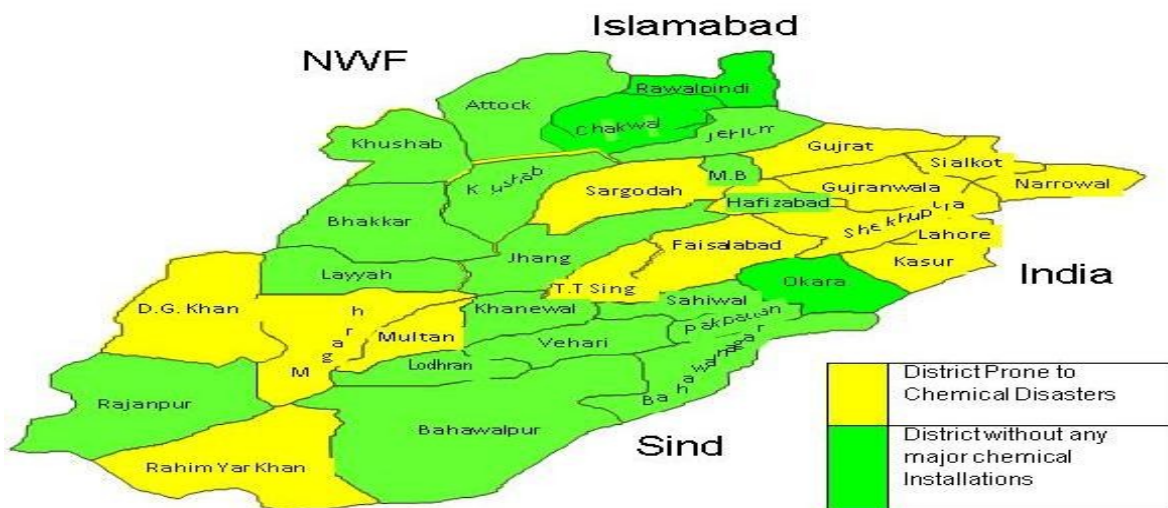


Figure-3 Identification of Chemical Disaster Prone Districts in Punjab

Table-3. Residential and commercial areas having potential to be effected by Releases caused by Road accidents and Industrial fires and Technological Disaster

Districts	Areas / Localities with Probable Environmental Toxicant Chemicals
Faisalabad	Maqbool Road, Nishatabad, Summundri Road, Khurianwala Road, Sheikhupura Road, are likely to be effected by toxic chemicals releases, Hydrocarbon, SO ₂ , smoke and un-burnt Hydrocarbons
Gujranwala	Gondlawala, Sheikhupura road, can likely be effected by NH ₃ , releases of Hydrocarbon, SO ₂ , smoke, un-burnt Hydrocarbons and Sadhuke Muhalla Pir Kandu Darogha Colony, Zahid Colony, Maraliwala Sarfraz Colony and Nizamabad with Industrial Fire, releases of Hydrocarbon, SO ₂ , smoke, un-burnt Hydrocarbons, Sabzi Mandi, Noshehra Snasani Wanianwala Ghakkar, Bajwa Road, Kot Qazi Stop with NH ₃ ,

Lahore 11-Km, Multan Road with Fire and highly inflammable gas cyclo-pentane, Sharif Park Multan Road & Bhattian Chowk Raiwind with Fire hazard, Toxic Fumes of Pesticides, Fruit Market, Ferozepur road with NH₃, Ferozepur road, near Model Town Lahore, Circular Road and adjacent commercial areas industrial fire, Smoke, Toxic fumes as a result of burning of Paints, Varnishes and additives and other chemicals, G.T Road near Engineering university with Acetylene gas, fire, release of calcium carbide, Industrial Area Kot Lakhpath & Gulberg with chemical releases due to road accidents and technological disaster, industrial fire, Hydrocarbon, SO₂, smoke, un-burnt Hydrocarbons

Kasur Niaz Nagar Din Garh, Younas Nagar, Molvi Abdul Qadir Qattal Guri Multan Road Phoolnagar with releases of toxic chemicals (Used in Tanning industry), and Industrial fire, Hydrocarbon, SO₂,

Multan	smoke, un-burnt Hydrocarbons. Alla abad Road Chunian, Kot Radha Kishan Road, Khudian with NH ₃ Jehangirabad, Sameejabad, New Multan, Mouza Gulzar Pur Mouza Raja Pur, Farukh Town, Matitan Road Hassan Abad with NH ₃ , NO ₂ and Multan Industrial Estate Toxic Fumes of Pesticides	Rahim Yar Khan	can likely be effected by releases of toxic chemicals, Hydrocarbon, SO ₂ , smoke, un-burnt Hydrocarbons in urban areas in case of Technological Disaster, Industrial fire, terrorist attack and war fare etc. Potential of industrialization is increasing gradually. Need proper land use planning to avoid chemical accidents.
Sialkot	Muhallah Water Works, Fatehgarh, Agency Nasir Road Bonkan Gohar pura with Releases of toxic chemicals in urban areas in case of Road Accidents and Kotli Behram, Humza Ghous Chitti Shaikhan, Malkay Kalan, Nikan pura, Zafar wali, Mundair Koth, New Miana Pura, Hajipura Rodas road, Shahabbpura with Technological Disaster, Industrial fire, acidic fumes, Hydrocarbon, SO ₂ , smoke, un-burnt Hydrocarbons	Mianwali D.G.Khan	Sparsely populated areas in Sikandarabad can be effected by NH ₃ , NO ₂ . Potential of industrialization is increasing gradually. Need proper land use planning to avoid chemical accidents
Sheikhpura	Zia Abad, Bismillah Colony Dara Shahwan, Hakeem Pura with Chlorine Gas and Proposed Housing Scheme of WAPDA and Village Chicho-ki- Mallian with NH ₃ , NO ₂		
Rawalpindi	New Lalazar Colony, Defense Housing Authority, Fauji Foundation College, Nai Abadi, Army Housing Welfare Scheme, Office of National Cleaner Production Center, Office of Pakistan Oil Ltd, PSO Oil Terminal, UN Peace Keeping Office, Office of Attock Petroleum Limited, Attock Hospital Ltd. With Fire, Hydrocarbon, SO ₂ , smoke, un-burnt hydrocarbons		
Sargodha	No major chemical plant, however District has potential for having major chemical installations in future. Proper EIA study for individual plants and land use planning will be required to control emergence of urban and industrial areas in Sargodha		
Gujrat	No major chemical plant, however District has potential for having major chemical installations in future. Proper EIA study for individual plants and land use planning will be required to control emergence of urban and industrial areas. Commercial area along G.T.road Gujrat can likely be effected by Fire, Hydrocarbon, SO ₂ , smoke, un-burnt hydrocarbons		
Muzafargarh	Qusba Gujrat Mehmood Kot Khuga, Basti, Utrawala, Bayrein wala, Shahwala, Kular wala, Basti Aayrar Supra, Dhrokari, Supray wala-I, Supray wala-II, Lohar wala, Basti Arayin wala		

There exists no administrative infrastructure to cater the technological disaster involving releases of toxic chemical and gases. Hence establishment of Provincial Chemical Disaster Management Council in Punjab, with political acceptance and a proper legal cover, to achieve the effective administrative control at the time of chemical disaster is mandatory. The Punjab must develop a Chemical Disaster Management Plan with previously agreed roles and responsibilities of all the stakeholders assigned under the rules of business. The working guidelines for the stakeholders for all stages of chemicals disaster i.e. prevention, preparedness, response, and follow up are necessary to be prepared, given legal cover and promulgated. However, preparedness and quick response of various agencies to minimize the effects of chemical disaster will require skill to utilize the computer and communication equipment, continuous training and orientation and rehearsal. Various Government Departments of the Punjab, including Health, Relief and Crisis Management, fire brigade, EPAs, particularly in chemical disaster prone areas, need their capacity building to identify the releases of environmental toxicants, types of fires as a result of chemical spillages and guide community, rescuers, medical and paramedical staff, fire brigade and District Managements to impart right response to chemical disaster. Increased population coupled with migration from rural to urban areas and liberal industrial location policy has resulted in emergence of residential and industrial areas. In addition, non-compliance of section (12) of the Pakistan Environmental Protection Act (PEPA), 1997, under which proponents of development projects are required to file an Environmental Impact Assessment or Initial Environmental Examination (EIA/IEE) report to EPAs also needs to be addressed for sustainable development (GOP, 2000). Inhabitants in densely populated and industrialized districts are prone not only to pollution caused by these units but are likely to be adversely effected by releases of toxic chemicals, gases and smoke etc. as result of technological disaster. The problem of such growing habitation will aggravate with the passage of time if environmental assessment and mitigation by

involving all the stakeholders especially public is not undertaken (GOP, 1997). There is a big network of wholesale dealers and stockiest in chemical business within urban areas. The chemicals, both toxic and inflammable, are stored by the dealers in the godowns in congested downtown business area / market area. Self auditing system for safety storage / handling / transport is non-existent, in the absence of which such storehouses are potential hazard for disaster, which we had been witnessed in leakage of chlorine gas in Baja Line, Lahore (EPA, Punjab, 1995). Hazardous Substances Rules for safe handling of chemicals and reporting of accidents involving toxic chemicals and even near misses are necessary to be approved and promulgated to avoid chemical accidents (GOP, 2003). All these activities for disaster management, when fully completed will provide a new paradigm in connectivity and database availability in the province and enhance capability of all state agencies to deal with information flow and decision-making.

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