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Challenges for introducing risk assessment into land use planning decisions in an Indian context

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A B S T R A C T

The 1984 Bhopal accident in India resulted in severe consequences with more than a thousand people dying in the immediate vicinity of the Union Carbide facility. After this tragedy, the implementation of landuse and zoning restrictions around hazardous installations got accepted worldwide as an important strategy reducing consequences from potential industrial accidents. Many European countries have already formulated specific landuse planning policies taking industrial risks into account. However, till date India is yet to effectively employ risk assessment techniques for landuse planning decisions around industrial clusters, as well as the relevant acceptability or tolerability criteria are yet to be formulated.

In this paper, we have applied the classical quantitative risk assessment method to map cumulative risk levels arising from a number of hazardous installations located in Haldia, a densely populated area where several industrial plants storing and processing dangerous substances are located. The risk maps were prepared using common GIS tools and functions, and their sensitivity to various factors ascertained using uncertainty analysis techniques. Through the analysis of some reference plants, the aim of the paper is to underline the current difficulties an analyst has to face to determine confident risk maps as a basis for planning the uses of land due to deficiencies in the Indian legislation and the lack of guidelines.

1. Introduction

Over the last few decades, a number of large-scale industrial accidents have occurred in hazardous industries worldwide, resulting in damage and loss of life in the surroundings. Among these events, the accident occurred at the Union Carbide pesticide production plant in Bhopal (India) in 1984, is ranked as the world's worst industrial catastrophe. A leak of 41 metric tons of acutely toxic Methyl Isocyanate (MIC) resulted in the exposure of hundreds of thousands of people living in the neighbouring area of about 50 km^2 (Singh and Ghosh, 1987; Lees, 1996). It was reported that in the neighbourhood colonies of the plant, by the end of the day over 3000 people were killed and in the aftermath several thousands more died as a result of the exposure (Shrivastava, 1995; Eckerman, 2005; Mannan et al., 2005). Among many other reasons including lack of adequate information about the storage and handling of hazardous materials, lack of co-ordination between the factory management and the emergency service providers, inadequate warning systems and plant maintenance practices, limited capacity to cope with the crisis and mitigate the damages, etc., lack of landuse restrictions resulting in the co-existence of densely populated residential areas in close proximity of the plant make the incident worse (Shrivastava, 1995; Bisarya and Puri, 2005). However, even after 30 years of the tragic accident, there has been no significant improvement in this regard in India (NDMA, 2007).

Today the country is one of the emerging economies of the world, and a considerable part of this fast paced GDP can be attributed to the good performance of key industrial sectors mainly the chemical industries. Currently the Indian chemical industry stands as the 3rd largest producer in Asia (after China and Japan) and 8th largest in the world (CeFIC, 2011). Based on its rapid GDP growth, the country is also identified as one of the highly industrialized countries in the world. According to data available with

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central agencies, as of 2008, there were 1666 Major Accident Hazard (MAH) industries located in 260 districts in India.[1] And many of these MAH units are often found in clusters to take advantage of common infrastructural facilities and the availability of skilled manpower. An inventory undertaken by the Central Pollution Control Board (CPCB) identified 170 of such industrial clusters housing more than five MAH units across the nation. Furthermore, number of such clusters is anticipated to go up significantly in the form of Petroleum Chemicals and Petrochemicals Investment Regions (PCPIRs) as conceptualized by the Ministry of Chemicals & Fertilizers, Govt. of India and Special Economic Zones (SEZs) thus to provide further impetus to growth of chemical industries.

However, there is a flip side of this growth. In absence of an appropriate regulatory requirement for landuse restrictions, some of these industrial clusters are often located in the vicinity of densely populated areas. Moreover, acting as engines of industrial and economic growth, these areas often witness a steady influx of population resulting from the migration of people from other part of the country to take advantage of jobs and other livelihood opportunities generated by these industries, thus resulting in increasing levels of risk. And in most cases, the concentration of population growth driven by these urban-biased industrial developments evolved without adequate infrastructure, basic civic amenities like housing, transportation, water, sanitation and electricity supply, etc., hence create hazardous living conditions (Shrivastava, 1995). This in-turn led to large number of low-income group people whosoever migrated to this area for job opportunity, do not have any alternative but to settle in adjacent areas to these potentially dangerous chemical plants, thus becoming highly vulnerable to any industrial accidents, of which the Bhopal disaster (1984) is an example (de Souza Porto and de Freitas, 1996).

Nonetheless such a situation is not typical of India alone. Many industrialized western European countries have encountered similar challenges in the past and have evolved objective methods for assessing risk from hazardous industries which then led to the adoption of suitable risk-based landuse planning decision strategies. In order to assess cumulative risk arising from a cluster of hazardous industrial units and evaluate options for area level risk mitigation measures, several studies were carried out in countries like the Netherlands, UK and Italy during the 1970's. Some examples of these risk studies include those undertaken in Rijnmond, the Netherlands (Roodbol, 1984), Canvey Island in the UK and the Ravenna area in Italy (Amendola et al., 1995) during 1970's. But then, it is only after the accidents in Bhopal and Mexico both occurred in 1984, resulting in widespread fatalities to population in the neighbourhood, the importance of restricting the use of land around hazardous installations became widely accepted as a measure for limiting the adverse effects of such accidents (Christou et al., 1999; Christou and Porter, 1999; Christou and Mattarelli, 2000; Christou et al., 2006).

Accordingly, to formalize the adoption of specific landuse planning restrictions for areas surrounding hazardous facilities, European governments amended the first EU Directive 82/501/EEC – so called Seveso Directive of 1982 that focused on the prevention of major accidents and limiting of potential consequences on man and environment. The Article 12, as incorporated in the amended Seveso Directive II (96/82/EC) of 1996, stipulates that appropriate safeguard distances should be implemented through landuse planning decisions (Porter and Wettig, 1999; Wettig et al., 1999). Guided by the Directive II, EU Member States have laid down different approaches for risk assessment and acceptability or tolerability thresholds in accordance with their political, cultural, technical, legal and societal backgrounds (Christou et al., 2006). These methods range from a generic safety distance-based approach as in Germany to a risk-based approach based on results of quantitative risk assessment (QRA) as practiced in the Netherlands and the UK (Papazoglou et al., 1998; Hauptmanns, 2005; Cozzani et al., 2006; Basta et al., 2007). Countries like France and Italy have formulated a hybrid approach as a combination of the consequence and risk-based approaches (Kontic and Kontic, 2009; Sebos et al., 2010; Taveau, 2010).

In India, issues related to the safe siting of hazardous industries although put forward through certain regulatory provisions, but none of the legal provisions provide any specific criteria which can guide landuse planning decisions for an industrial cluster. Section 41A of the Factories (Amendment) Act of 1987 (Ministry of Labour, Govt. of India)[2] requires that the location of hazardous industries has to be evaluated from the safety point of view by a site appraisal committee; but fails to provide a mechanism through which such siting decisions can be linked to landuse planning considerations for an industrial area. The EIA Notification of 2006 (Ministry of Environment & Forest, Govt. of India)[3] does provide scope for the assessment of risk originating from new hazardous industries, but in practice EIA studies seldom evaluate alternative siting based on risk contribution to the neighbourhood communities or provide recommendations for mitigating offsite consequences of the potential accident scenarios. In addition, the CPCB of India has prepared the ‘Zoning Atlas for Siting of Industries’ taking environmental considerations into account, but risk is yet to be factored into criteria for zoning of an industrial area (Punihani et al., 2002). More importantly, the Zoning Atlas also fails to provide a linkage to the existing landuse zoning regulations as proposed in the UDPFI Guidelines[4] prepared by the Ministry of Urban Affairs & Employment, Govt. of India. Consequently, during discussions at the Second India Disaster Management Congress (2009) organized by the National Institute of Disaster Management (NIDM), a consensus was reached on the need for adoption of landuse planning principles based on scientific rationale as a strategy for risk reduction and mitigation.[5]

However, for the adoption of any systematic approach for risk informed landuse planning in industrial towns, the availability of information on the hazards present in industries and the vulnerability in the surrounding residential areas are vital. In India, an effort to consolidate such information was made through the ‘Environmental Risk Reporting and Information System’ (ERRIS) which was implemented in selected industrial towns in 2006. The system has subsequently been upgraded to a more versatile platform called the Risk Management Information System (RMIS) and is capable of storing spatial and related attribute data of industries, including their hazardous chemical storage facilities, the nature of the chemicals stored/handled, the nature of the process details, site maps, and detailed information about vulnerabilities in terms of exposed buildings and populations at different time periods (Sengupta, 2007; Bandyopadhyay et al., 2011).

The key objective of this research is to apply a methodology based on Quantitative Risk Assessment (QRA) with necessary adaptation, for estimating and spatially representing cumulative risk originating from a cluster of hazardous industries, based on

[1] http://cpcb.nic.in/upload/NewItems/NewItem_112_nationalchemicalmgmtprofileforindia.pdf.

[2] http://labour.gov.in/upload/uploadfiles/files/ActsandRules/Service_and_Employment/The%20Factories%20Act%2C%201948.pdf.

[3] http://www.envfor.nic.in/legis/env_clr.htm.

[4] http://mhupa.gov.in/w_new/summaryudpfi.pdf.

[5] http://nidm.gov.in/idmc2/PDF/Outcome/Manmade.pdf.