

Paper Title: Environment Risk Reporting and Information System – A GIS Based Framework for Managing Industrial Risks in India

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Thematic Area :

1. Corporate Social Responsibility
2. Disaster Information System
3. Emergency Response System

Abstract :

Every year, industrial accidents like the Bhopal disaster take their toll on business and communities - in terms of lives, injury to workers and financial resources. India has been witnessing fast paced industrialization since the liberalization of the economy in the early 1990's. Resultantly, medium sized industrial towns and development zones have been witnessing a steady induced growth of population because of a "honey pot" effect. This has in turn led to increase in vulnerability of people to technological risks posed by potentially hazardous industries. It is well accepted now that the accessibility of up-to-date information on industrial hazards, exposed neighborhoods, population vulnerability, resources available for response, etc. in an easily accessible information management system can enable decision makers and responders to better prepare for and respond to an industrial disaster. Moreover, since technological risk management is principally a spatial problem, an integrated GIS based system that can be accessed by administrators, relevant stakeholders and social actors can play an important role in industrial disaster risk management. With this in mind, the Environmental Risk Reporting and Information System (ERRIS) Project was launched by the Indian Chamber of Commerce as a Corporate Social Responsibility initiative for industrial corporates in the industrial towns of Haldia and Durgapur in eastern India in consonance with the precautionary approach for environment protection mandated by the Rio Declaration and the UN Global Compact. At the first level, the project aims to promote a structured mechanism for voluntary reporting of risk related information by potentially hazardous industries in these two towns. At the second level, the project is in the process of establishing a computerized and collective GIS based system for management of technological risks arising out of the industries. The information system would contain spatial and non-spatial data comprising of digitized maps of the industrial areas, location-specific data on hazardous industries, vulnerable population, and first responders such as police, fire, medical agencies. The data is stored in a relational database designed to meet the requirements for risk management and would be made available through a customized user interface to responders and stakeholders of concern.

Key Words:

Technological Hazards, Risk, Geographical Information System, Vulnerability, Risk & Hazard Map, Loss Estimation, Web-GIS, Geo-database.

Abbreviations:

MAH – Major Accident Hazard, GIS – Geographical Information System, HDA – Haldia Development Authority, ADDA – Asansol Durgapur Development Authority, GPS – Global Positioning System, MSDS – Material Safety Data Sheet, MSIHC – Manufacture Storage and Import of Hazardous Chemicals, EPPRCA - Emergency Planning Preparedness and Response to Chemical Accidents, TRI – Toxics Release Inventory, IT – Information Technology, CSR – Corporate Social Responsibility, MARS - Major Accident Reporting System, SPIRS - Seveso Plant Information Retrieval System, RDBMS – Relational Database Management System.

1. Introduction

South Asia, comprising of India, Pakistan, Bangladesh and Nepal, has been the second fastest growing region in the world in the past decade with a GDP growth averaging around 5% per year. However, despite considerable progress, the region continues to face fundamental constraints on sustainable development including unchecked population growth; rapid and unplanned urbanization; weaknesses of local governments; exclusion of most of the people from decision making; lack of access to information and failure of institutions to sufficiently integrate environmental and social developmental considerations into economic policy objectives.

The region also stands out as most vulnerable to natural disasters such as floods, cyclones, earthquakes and landslides which occur regularly. Statistics show that in the period 1990 to 1998, the region accounted for over 60% of disaster related deaths worldwide (1). In many cases, the effects of such disasters are borne by the weaker segments of the society who are already disadvantaged in many other ways. As an example, the Tsunami in December 2004 that caused more than 500 deaths in Chennai alone, affected mostly the poor people living in hutments on the shoreline.

On the other hand, risks arising out of human activities are also on the increase as a result of the fast paced industrialization that India has been witnessing since the liberalization of the economy in the early 1990's. Resultantly, medium-sized industrial towns and development zones, where most of such industrial growth is taking place, have been witnessing a steady induced growth of

population because of a “honey pot” effect, attracting population from the surrounding rural areas to these potential sources of employment. This has in turn led to increasing population densities in the vicinity of potentially hazardous industrial facilities and to an increase in the vulnerability of the local population. Therefore, there is an urgent need to adopt *integrated risk management strategies* that will effectively address the issues of risk reduction, emergency preparedness and response planning in order to mitigate the adverse consequences of any technological accident that might occur (2 & 3).

2. Regulatory Framework

As compared to natural hazards, where very little can be done to avoid the occurrence of the phenomena, a certain degree of human control can be exerted on preventing the occurrence of technological accidents. Among the important tools for this are regulatory and institutional frameworks that exist in most countries that try to address disaster preparedness and response for a technological risk scenario.

After the Bhopal Disaster in 1984 policy and decision makers in India realized the true nature and severity of the environmental problems inherently linked with the process of economic development. As a result, the need was felt to further broaden the regulatory framework to encompass areas like environmental hazards caused by chemicals and wastes, as also other areas which were earlier not considered to be a priority. Since then, there has been a gradual evolution of a fairly comprehensive legislative framework and the Central government through the Ministry of Environment and Forest has promulgated a wide array of legislation that covers almost all aspects of environmental protection and related issues.

Legislation specific to prevention and management of accidents arising out of hazardous installations was formulated in the form of the Manufacture, Storage, Import of Hazardous Chemicals Rules (MSIHC) in 1989 (recently amended in 2000) and the Emergency Planning, Preparedness and Response to Chemical Accidents (EPPRCA) Rules in 1996. According to MSIHC Rules, industries storing and handling hazardous chemicals are required to submit a safety report and an Onsite Emergency Plan to the regulatory agencies containing vital industry specific information that would enable the regulators to attain swift control of an industrial accident. The EPPRCA Rules which complement the MSIHC Rules envisage a four-tier crisis management system in the country – involving the Central Crisis Group, the State Crisis Group, the District Crisis Group and the Local Crisis Group - to manage emergencies arising out of

industrial operations. Effectively, the EPPRCA thus provides statutory backup for setting up of Crisis Groups at various levels to ensure the management of risk arising out of Major Accident Hazard (MAH) installations.

However, with an inadequate institutional framework, government agencies and regulatory bodies have been severely constrained in implementing most of the regulations under a “Command and Control” regime. Consequentially, many industries default on providing right and timely information on risks present within a MAH installation while on the other hand, the government is yet to set up and make operational functional Crisis Groups who can coordinate effective response in a contingency situation. The local emergency control centres are also handicapped with lack of proper information resources. As a result, the triggering of an industrial incident / accident may result in a situation that may be as severe in proportion as the Bhopal disaster of 1984.

3. GIS and Management of Technological Risks

With the rapid advances made in the field of information technology (IT) and the development of the understanding that having access to time-critical information is the key to achieving control of an emergency arising out of an industrial accident, efforts were initiated to implement IT tools and technology with the science of risk management in the last few decades. In the United States several software databases and electronic information systems have been put in place, such as the “Vulnerable Zone Indicator System” and the “Toxic Release Inventory (TRI) of Chemicals”¹ which provide communities with vital information to manage risks arising out of hazardous industries operating in the neighborhood. In Europe also, recent initiatives under the EU Joint Research Commission (JRC) has led to the setting up of the Major Accident Reporting System (MARS), Seveso Plant Information Retrieval System (SPIRS) and the Area Risk Analysis (ARIPAR) software fulfilling the information exchange obligations towards the EU Member States under the Seveso II Directive (4 & 5).

The evolution of Geographical Information Systems (GIS) as a tool for doing risk based planning and emergency management has provided further impetus to technological risk management initiatives. This is because, the science of risk management is an information intensive process

¹ The Vulnerable Zone Indicator System and the Toxic Release Inventory databases in the US are the outcome of the Emergency Planning and Community Right-to-Know Act (EPCRA) that was enacted in 1986 with the intent of informing communities and citizens of chemical hazards in their neighbourhood.

needing large volumes of technical information from different sources which have to be collected, shared, managed, combined and displayed, preferably, in a spatial context to enable decision making and analysis. GIS technologies provide an adequate framework for converting geo-referenced raw data into useful information, for the integration of spatial data from several sources, for building linkages with related databases as most importantly for the modeling of hazard and risk scenarios and making these available to decision makers. Furthermore, with advancement in IT, such operational systems can now be implemented and deployed on distributed client–server architectures that support real time remote access over the Internet, through mobile clients, thereby allowing the system to be used by a host of responders and decision makers.

4. ERRIS and Corporate Social Responsibility

The ERRIS project has been conceived as a Corporate Social Responsibility (CSR) initiative with the foundation being based on the voluntary disclosure of risk related information by hazardous industries. Hazardous industries in India, as a regulatory obligation, are required to submit information on hazardous substances they store and process in their premises to regulatory bodies. Besides complying with the law, some industries with hazard potential have developed codes of practices and management systems that address accident prevention and community involvement. For example, many Indian corporates subscribe to the Responsible Care® (6), a set of voluntary management codes that address safety practices, product stewardship, and community involvement in environment and risk related issues. Voluntary disclosure of environmental and risk related information to stakeholders and interested sections of the community also form the mainstay of the Global Reporting Initiative (GRI) (7) and the UN Global Compact² initiatives.

After sensitization to the overall project objective of setting up a collective industrial risk information database and the potential benefits that may be accrued from the system to effectively manage a technological risk scenario, the hazardous industries in Haldia and Durgapur now understand the necessity of sharing such information through a voluntary framework thereby helping to involve the local authorities and communities as partners in managing chemical risks and planning for chemical emergency response.

² The Global Compact is a direct initiative of the UN Secretary-General and through the power of collective action, seeks to promote responsible corporate citizenship so that business can be part of the solution to the challenges of globalization. Refer website <http://www.unglobalcompact.org>.

5. Case Study Area

The industrial town of Haldia lies in the eastern region of India at the southern tip of the state of West Bengal, approximately within the geographical coordinates 22° 04" 53.00 – 22° 03" 43.89 N latitude and 88° 07" 53.15 – 88° 09" 03.61 E longitude. The Haldia Municipality covers an area of 104 sq kms and the Haldia Planning Area which is managed by the Haldia Development Authority (HDA) occupies a larger area of 326 sq kms including the Haldia Municipal area. The town is located on a peninsula bounded by the rivers Rupnarayan to the North, Hooghly to the East and Haldi to the South and falls within the coastal plains of East Medinipur District. It is connected by road to other cities, including the metropolis of Kolkata by the National Highway 41 and State Highway 4. There is also a railway line that links Haldia with the main railway link between Kolkata and Kharagpur. In addition, it is connected by waterways to towns on the other bank of the rivers.

The total population of the Haldia Municipality is 169996 persons as per the 2001 Census. The area recorded a decadal growth rate of 32.7 % in its population over the last ten years as a result of increased urbanization and potential employment opportunities. At present, the Haldia industrial region is fast growing into the single biggest manufacturing centre of eastern India with a major concentration of industries like oil refineries, petrochemicals, and chemicals that is supported by a large port complex and other infrastructural facilities. With its key location advantage and existing industrial base the port city is becoming a good choice for prospective investors.

However, like most other industrial towns in India, urbanization of Haldia has happened without proper land-use planning and resultantly the town has evolved in a haphazard manner. From the industrial risk standpoint, no zoning approaches have been applied that separate hazardous or polluting industries from residential areas (8 & 9). This has resulted in a mixed land-use with no clear demarcation of zones for industries, residential areas and agricultural lands. In the early 1970s, before the first industries like the Indian Oil Refinery, Hindustan Fertilizer Corporation and the Haldia Port were set up, the region was scattered with villages, agricultural lands and low lying wetlands. At present, more than 20 medium and large-scale industries have come up in the town thereby comprising the predominant land-use, with pockets of vulnerable population sandwiched in between. Many of these industries are hazardous in nature and include petrochemicals, chemicals, tank farms, gas storages, etc.

It is only of late that some efforts are being undertaken by the local development authority to evolve a systematic land-use plan for optimal use of available land for future industrial and infrastructural development of the area while also keeping in mind the overall needs of the community. It is also expected that with the operationalisation of ERRIS, consideration for setting up future hazardous units will be integrated with land-use planning controls at the local level.

6. Main Characteristics of ERRIS

Industry Information

Technological risk arises out of the hazardous substances stored and processed in industrial facilities, storage depots and also when such substances are transported from one location to another. The availability of information about hazardous facilities and the hazardous substances they store in the form of raw materials, intermediates or products is the key to the development and functioning of any information system for technological risk management. As a part of the voluntary reporting scheme, approximately 20 Major Accident Hazard (MAH) industries in Haldia have already disclosed information in a structured reporting format containing the following information:

- Facility / Industry identification;
- Emergency contact information;
- Hazardous substances inventory;
- Properties of the storage containers, primary and secondary control, containment systems;
- On-site emergency response resources.

The above information has been stored in a structured industry database called the Risk Reporting System (RRS). The data thus gathered can be used by the ERRIS software application to process and analyze risk related information and may be selectively presented to the stakeholders in a spatial context through the Risk Information System (RIS). Through the RRS the industries will have the flexibility of adding information on new storages as and when they come up in the future or modify existing information, if the need arises. Authenticated and filtered access to the above information will be provided to each industry through a secured login to the system, so that data can be added and updated by the respective industry only.

Chemical Database (MSDS)

In addition, a fully searchable database on Materials Safety Data Sheet, commonly known as the MSDS, has been developed for each of the hazardous chemicals that have been reported by the industries (Figure 1). The MSDS has been integrated with the ERRIS system with an aim to provide the decision makers and the first responders with real-time information on the type of chemicals involved in a risk scenario, properties, and mitigation action to be taken to prevent injuries and damage to vulnerable receptors thereby assisting them in emergency preparedness planning, response and mitigation, in the event of an industrial emergency.

NFPA 704 (Section 16)

MATERIAL SAFETY DATA SHEET
NATURAL GAS (odorized) **MSDS No. 8010**

1. CHEMICAL PRODUCT and COMPANY INFORMATION (rev. Aug-98)

Amerada Hess Corporation
 1 Hess Plaza
 Woodbridge, NJ 07095-0961

EMERGENCY TELEPHONE NUMBER (24 hrs): CHEMTREC (800) 424-9300
COMPANY CONTACT (business hours): Corporate Safety (732) 750-6000

SYNONYMS: Compressed Natural Gas (CNG); Dry Natural Gas; Methane; Pipeline Spec Gas;
 Processed Gas; Residue Gas; Sweet Natural Gas; Treated Gas

See Section 16 for abbreviations and acronyms.

2. COMPOSITION and INFORMATION ON INGREDIENTS (rev. Aug-98)

INGREDIENT NAME (CAS Number)	EXPOSURE LIMITS	CONCENTRATION PERCENT BY VOLUME
Natural Gas, dry (68410-83-9)	None established by OSHA or ACGIH Simple asphyxiant; exposure limited by oxygen and flammability	100
Methane (115-07-1)	None established by OSHA or ACGIH Simple asphyxiant	< 90
Ethane (74-84-0)	None established by OSHA or ACGIH Simple asphyxiant	< balance >

A complex mixture of light gases separated from raw natural gas consisting of aliphatic hydrocarbons having carbon numbers in the range of C1 through C4, predominantly methane (C1) and ethane (C2); may contain carbon dioxide (CO₂). Odorized with trace amounts of odorant (see Section 9). This is for natural gas that has been processed and is in commerce.

3. HAZARDS IDENTIFICATION (rev. Aug-98; Tox-98)

EMERGENCY OVERVIEW
DANGER!
EXTREMELY FLAMMABLE GAS - MAY CAUSE FLASH FIRE OR EXPLOSION!

High concentrations may exclude oxygen and cause dizziness and suffocation. Contact with pressurized vapor may cause frostbite or freeze burn.

EYES

Figure 1 : Sample MSDS

Use of high resolution satellite images for making GIS maps

The effective management of technological risk is an information intensive process and has a strong spatial dimension. The overall goal with regard to obtaining spatial data for Haldia and using it for risk management was towards delivering accurate, appropriate information on spatial

features that may pose a technological risk or can be considered to be a vulnerable element at risk or may be an important resource for the purposes of emergency response and mitigation (critical facilities). With the objective of building digitized GIS maps of the Haldia region, Panchromatic and Colour composite IKONOS imagery of 1m and 4m spatial resolution respectively have been used to identify land-use of the study area using the ArcGIS 9x software package. The images were geo-referenced based on ground-truthing done using handheld GPS. The land-use cover classification of the area carried out includes agricultural lands; residential areas, villages and slum clusters, industrial and commercial areas; forests and greenbelts; ponds, wetlands and rivers; and transportation corridors and has been stored in the land-use geo-database layer as polygon parcels. Figure 2 below illustrates the various land-uses that have been mapped.



Figure 2 : Land use mapping for Haldia

The MAH installations have been stored as a separate layer to facilitate better viewing and efficient querying from the RDBMS. The exact location of storage sites for hazardous substance was matched with site maps made available by the industries and were digitized as a point feature geo-database layer. In a similar manner, the exact location of critical facilities like educational institutions, hospitals, commercial complexes and response agencies like police, fire stations and administrative buildings have been identified and digitized on the map as separate point feature geo-database layers. In total four individual layers were prepared : land use, hazardous storages, critical facilities and elements at risk.

In addition, detailed attribute information on elements at risk have been stored in the RDBMS and linked to the spatial features to enable querying during various stages of disaster risk management, such as. emergency planning, preparedness, response and mitigation. Such information includes the demarcation of high population risk areas related to the impact by a toxic release, fire or explosion at a nearby hazardous facility, areas which are environmentally sensitive or have fragile ecosystems and critical facilities like educational institutes, hospitals and market places. Varying patterns of population occupancy during different times of the day in each of these receptors has been taken into account to provide accurate temporal information to decision makers and responders when they plan for evacuation or location of shelters.

7. ERRIS Software and Web-GIS Components

The most crucial component of ERRIS is a customised Risk Information System (RIS) application that provides spatial information on various facets of risk management. This application software is capable of performing real time data access, retrieval, analysis and presentation through a customized web browser based interface and is linked with spatial maps and back-end databases so that various queries can be handled when required.

The following are the key components of the application:

- A spatial geo-database storing geometry and attribute data in a Relational Database Management System (RDBMS).
- A set of web server, spatial data server and application servers that can pre-process and extract data from the RDBMS, handle queries in real time and forward them to a customized user interface.
- A customized browser-based user interface that enables access to the maps and risk related data for users connected to the internet or the local intranet.

Using the components described above, the RIS would enable the stakeholders with a relatively simple, low-cost, yet powerful way of sharing and accessing critical industry and risk related information for emergency response planning or in real-time at the time of an emergency (Figure-3)

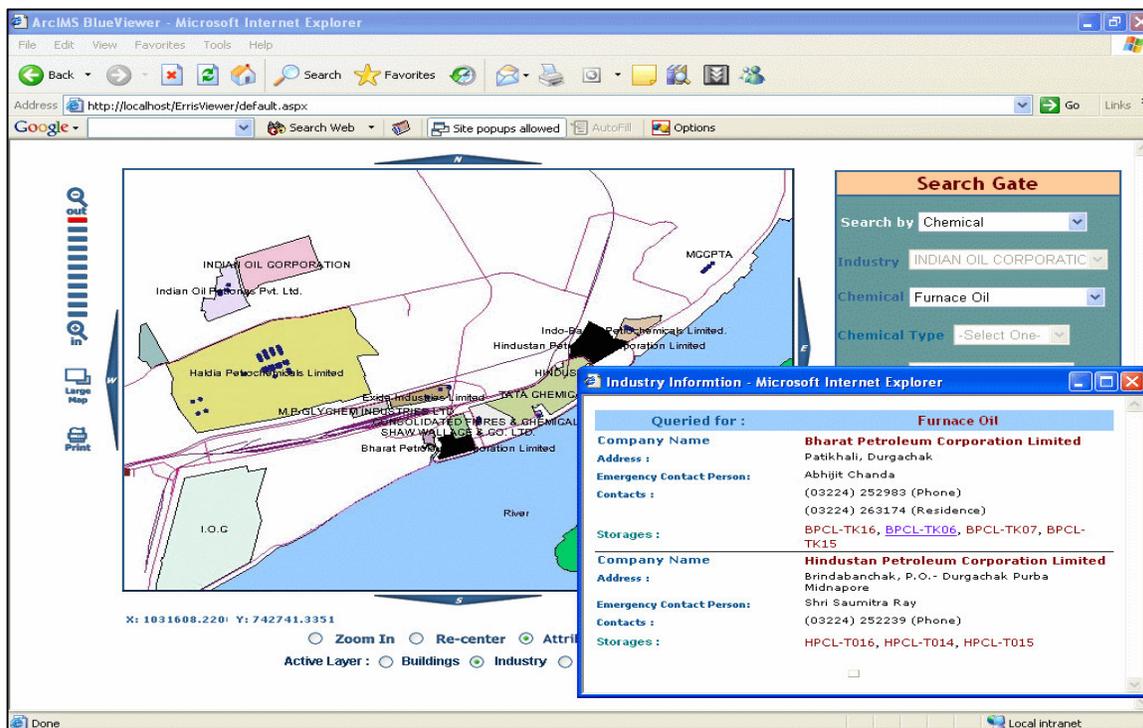


Figure - 3 : ERRIS Software Application Interface showing map browser and the information windows that pop-up on querying

As mentioned earlier, the ERRIS software application is based on a thin-client Web-GIS architecture that ensures easy maintainability of the application while at the same time providing scalability to accommodate future changes. Since communication of the various software components is based on the standard HTTP protocol, a high degree of hardware independence has also been achieved. At present local outreach centres at the industrial towns of Haldia and Durgapur are being set up and linked to the Risk Management Resource Centre (RMRC) at the ICC. The RMRC would host the central data and map servers that would coordinate the various information resources and provide regular updates to the outreach centre local servers, across the internet.

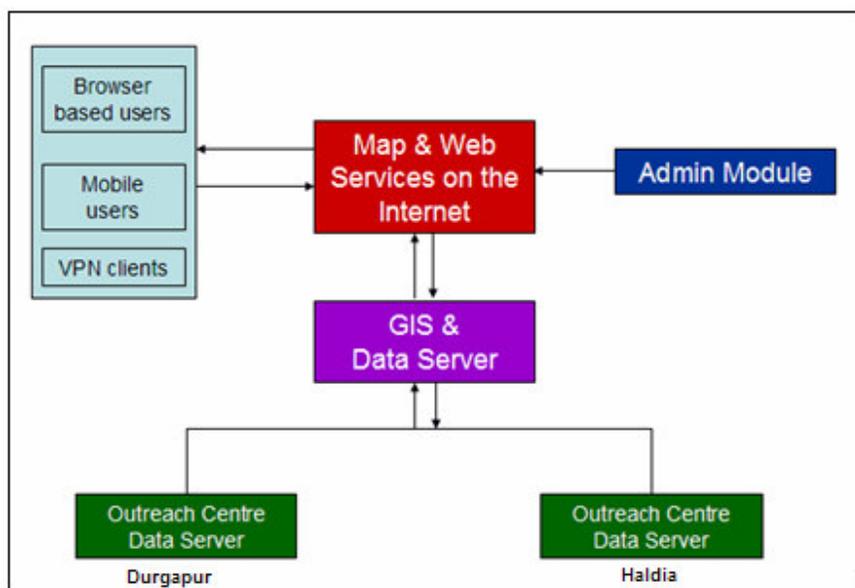


Figure 4 : ERRIS Deployment Architecture

8. Development of a Decision Support System

It is important that users of ERRIS are able to make a judicious decision under constraints of time and resources during an emergency scenario. Consequently, the ERRIS system is presently being upgraded to assist in basic decision-making. This is being done by integrating a modeling sub-system to the software application, which will help to predict the consequences of accidental chemical releases and resulting fire or explosions and display the same on the GIS map as a 'hazard footprint'. The models being used are based on standard equations formulated by the US Environmental Protection Agency (10) and will be able to predict an endpoint distance in terms of concentration of toxic chemicals, exposure to heat radiation or explosion overpressure due to a particular accident scenario at a hazardous facility. The endpoints would then be rendered dynamically on the GIS map as a hazard footprint and would assist the decision maker and the administration to issue an early warning to residents of the affected area or direct responders to initiate preventive evacuation or rescue operations. It would also help extract information on the probable number of people at risk or elements at risk which may potentially be affected by the simulated accident. The prediction of potential off-site consequences would be based upon a minimum set of data requirements so that it is easy to use during an emergency scenario and the aim is to conservatively delineate areas that may get affected by the accident. To enable this, the model would directly input chemical specific and storage related data from the RDBMS and also provide options to the user to make a rational choice between different probable scenarios. Also, when the

exact nature of the accident is confirmed by the responders, a fairly accurate estimate of the potential loss suffered as a result of a risk scenario can be assessed and evaluated by the system.

9. Conclusions

The ERRIS project, when operational, is envisaged to have a significant beneficial impact on all the stakeholder groups involved. It would help in building capacity at the local level to manage local environmental risk related issues, which is in accordance with the goals of UNEP's Local Agenda 21. The project would also boost the efforts of the Indian and State Government machinery to enable local authorities to plan and operate an environmental infrastructure as has been mandated by the Indian Constitution through the 73rd and 74th amendment of 1994. Additionally, the ERRIS would play a central role by helping the various government bodies at the state and local level, industries and communities to work in unison with increased levels of cooperation and coordination with the goal of enhancing the exchange of information and knowledge amongst each other. In the process, following a bottom up approach, it would seek to shape local level strategy and policies that would assist in the implementation of national and regional policies and regulation in the area of risk management.

At the same time it would significantly improve the capability of the local decision makers, other social actors (including response personnel, police, fire brigade and hospitals) and the community to respond to a risk situation. With the availability of GIS maps of the regions where risk management planning is being carried out, these data can be easily accessed by the industries, and administrative bodies thereby providing the responders and other stakeholders appropriate and sometimes time-critical information on industrial risks. Additionally, given the existing status of institutional framework and the supporting infrastructure, ERRIS would go a long way establishing an effective and efficient system for risk management that can be emulated and implemented in all industrial towns of the country.

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Curriculum Vitae of Authors(s):

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Dr. Cees van Westen graduated in 1988 for his MSc (doctoral) in Physical Geography from the University of Amsterdam. He obtained his PhD in Engineering Geology from the Technical University of Delft in 1993, with a research on "Geographic Information Systems for Landslide Hazard Zonation". He joined the Division of Applied Geomorphology of ITC in 1988, and was appointed as associated professor in 2000. He has worked on research projects, training courses and consulting projects related to hazard and risk assessment in many different countries, such as Austria, Switzerland, Italy, Guatemala, Honduras, El Salvador, Costa Rica, Colombia, Peru, Bolivia, Argentina, Cuba, India, Nepal, Thailand, Philippines, and Uganda. He is currently Project Supervisor of institutional strengthening projects in India (with the Indian Institute of Remote Sensing) and SE Asia (the EU funded CASITA project) and East Africa. He is also principal investigator in a research project "Strengthening local authorities in risk management (SLARIM)", which deals with the development of a methodology for the application of Geoinformation for urban risk assessment and management. He is also coordinator of the United Nations University –ITC Programme on Capacity Building for Disaster Geo-Information Management.

Nazeeb Arif

A post graduate in Business Economics from the University of Delhi, Mr Arif began his career in the Chambers of Commerce at the apex national Chamber, Federation of Indian Chambers of Commerce and Industry (FICCI) in New Delhi. He joined the ICC in 1992 and took over as Secretary General in 1996.

As Secretary General and CEO of the Indian Chamber of Commerce, he has handled international linkages with various countries on a wide range of issues. He has also been responsible for the planning and execution of innovative projects and initiatives that prepare business and industry for the challenges of the future. Mr Arif has been invited abroad on a number of occasions including an Invitation from the US Government for an International Visitors Program as well as an Exchange Program on Environment. He was also an advisor to the Asian Development Bank.

Debanjan Bandyopadhyay

Debanjan is currently working as Environment Management and System Integration Specialist with the Environmental Risk Reporting and Information System (ERRIS) Project of the Indian Chamber of Commerce, Kolkata. He played a key role in conceptualizing the project and is now jointly responsible for its overall management and coordination. He has a MBA degree in Systems from the University of Calcutta and also a Post-Graduate Diploma in Environment Management from the Indian Institute of Social Welfare and Business Management. He also received specialised training on use of GIS technologies for risk assessment at the International Institute of Earth Observation and Geo-Information Sciences (ITC), Netherlands. He has close to 10 years of experience in varied fields related to environmental management and management information systems. Previously working with Environmental Resources Management (ERM), one of the largest providers of environmental management services worldwide, he has managed and participated in projects on areas like Environmental and Social Impact Assessments, ISO 14000 - Environment Management Systems, Cleaner Production, Environmental Legislation and Policy Studies related to environment management. He has undertaken these projects in a cross-

section of infrastructural, developmental and industrial sectors. This includes a number of projects for multilaterally funded agencies like the UNIDO, World Bank, JBIC, European Commission, USAID and USAEP.

Nilanjan Paul

Nilanjan is working as Database Development and System Administration Specialist with the Environmental Risk Reporting and Information System (ERRIS) Project of the Indian Chamber of Commerce, Kolkata. He has played a key role in conceptualizing the ERRIS project and is now responsible for deployment of the project at the nodal centre in Kolkata and at the industrial towns of Haldia and Durgapur. He is also the technical coordinator of ICC Informatics, a division of the Indian Chamber of Commerce that develops customized business software solutions with intensive database back ending using relational databases like MS-SQL Server and Oracle. He has a MBA degree in Systems from the University of Calcutta from the Indian Institute of Social Welfare and Business Management. He also received specialized training on use of GIS technologies in Decision Support Systems at the International Institute of Earth Observation and Geo-Information Sciences (ITC), Netherlands. He has close to 8 years of experience in areas related to design, integration, configuration and maintenance of distributed networks and business application systems in Client/Server environment. He has been instrumental in conceptualizing and developing the user interface and the search tool of the EnviroSafe™, a comprehensive database of Indian environment and safety legislation. He has been the technical coordinator of the eastern chapter of the Environmental Information Centre, a joint project under the Trade in Environmental Services and Technologies (TEST) program of the United States Agency for International Development (USAID), the Indian Chamber of Commerce (ICC) and the Federation of the Indian Chambers of Commerce and industry (FICCI).