

Disaster Risk Reduction Plan for Industrial Area

Case Study of Ankleshwar

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Abstract - Natural disasters are one of those the most known threats enduring development. As, estimated over the last 20 years, it is observed that natural disasters have affected around 4.4 billion people, taken 1.3 million lives, and even caused economic losses of 2 trillion USD (UNISDR 2012). Also, in coming years, gauge, frequency, and acuteness of natural disasters are likely to grow at an accelerated rate. Research indicates that global environmental change and demographic change are two important drivers of future disaster risk (Foresight 2012).

Disaster risk management is an organized application of management policies, procedures, and practices for identifying, analysing, evaluating, treating, and monitoring disasters and risks. Disaster risk reduction requires some practical techniques to control and limit the risk of catastrophe caused and losses by addressing hazards and people and area's vulnerability to the risk. Typically, disaster risk management is the well-planned application of disaster risk reduction policies and strategies to minimize risks due to new disasters, trim down risks of existing disasters and manage enduring risk by strengthening the elasticity and reduction of disaster losses.

Key Words: Disaster, management, environmental, demographic, catastrophe, reduction

1. INTRODUCTION

Disaster is the obstruction or impediment that occurs for a short or long-time period. It causes widespread economic, and environmental troubles and exceeds a maximum limit that people cannot cope with using their resources and might lead to loss of lives. When some disasters hit any developing country, its long-term development plan mainly gets affected by natural disasters such as floods, landslides, etc., or industrial disasters like poisons, gas leaks, industrial fire, and many more to count. Directly or indirectly, any sort of disasters affects the lives of many people.

Developing nations go through most of the loss when disasters hit any of its areas. Precisely, approx. 95% of loss of human life caused due to disasters and natural hazards in developing countries are almost twenty times more than in developed countries as compared in GDP percentage. It does not matter in what community disasters occur, life of people affected by disasters gets changed either in minor or major ways.

2. Disaster Risk

Disaster risk is the potential loss of life, health injuries, damage caused to assets of a system or society, in a particular time period that determined as a function of hazard, exposure, vulnerability, and capacity. Technically, disaster risk can be defined by combining three words: a threat, direction, and vulnerability.

2.1 Disaster and risk Management

Disaster risk management is an organized application of management policies, procedures, and practices for identifying, analysing, evaluating, treating, and monitoring disasters and risks. Disaster risk reduction requires some practical techniques to control and limit the risk of disasters happened and losses by addressing hazards and people and area's vulnerability to the risk. Typically, Disaster risk management is the well organised application of disaster risk reduction strategies and approaches to minimize risks due to new disasters, slender down risks of existing disasters and manage enduring risk by strengthening the elasticity and reduction of disaster losses.

2.2 Disaster Risk Reduction (DRR)

Disaster Risk Reduction or DRR is aimed to prevent new disaster risks, diminish existing disaster risk and manage enduring left-over risk. All these factors of DRR contribute to strengthening resilience and, therefore, achieving sustainable development. The "UNDR" definition further annotates that disaster risk reduction is a disaster risk management policy objective. Disaster

risk reduction strategies and plans define their goals, objectives, and aims. Disaster Risk Reduction strategies and policies explain goals and objectives throughout different timescales, with concrete targets, indicators, and time frames.

Causes of industrial disasters:

Industrial disasters occur due to some recklessness or negligence of the employer, some carelessness and irresponsibility of employees, and some innate accidents. The following list can be some conceivable causes of industrial disasters.

- Improperly guarded equipment.
- Defect in any equipment or machines
- Unsafe storage of harmful chemicals such as congestion overloading
- Improper illumination in the workshops
- Fall on stairs, ladders, walkways
- Congested workplace
- Dangerous work looks such as throwing materials.
- Use Unsafe procedures in loading, placing or mixing, or lifting things improperly.
- People or employees working with impaired vision under the influence of drugs or alcohol are not checked and exhibit negative behaviour.

Vulnerabilities to Industrial disasters:

Inappropriate location of residential areas that are located too close to the industrial estates are more prone to damage and risks of industrial disasters. Suppose there is an explosion, chemical release, or severe industrial fire, these closely located people will be severely affected with many deaths and structural damage as well. Likewise, there are some vital factors that serves as vulnerabilities to industrial disasters.

- **Poor development planning of industrial areas.**

Industrial plants or industrial areas established without a proper plan of action and infrastructure increase vulnerability to disasters. As consequences of poor planning or absence of plan for the industrial regions, the risks of industrial disasters increase drastically. If industrial estates are established without a plan and they are problematic to one failure or accident and lead to a domino effect and multiplies the risk of any disaster, it would be the worst vulnerability for a disaster. For instance, there is a methanol plant situated near a power generation plant, and we know that a power plant can produce a straightforward ignition source. Any possible leak may occur from the methanol plant; how disastrous it could be beyond our imagination.

- **Lack of knowledge**

Most of the people living close to any industrial area are astonishingly unaware of the actual dangers and the risks of disasters they face daily. Even if it has been said many times, many people continue to pay no attention to this before any disaster of tragic scale has not occurred or before at the zone, and companies or the industries themselves claim the probability of such an incident or disaster.

- **Lack of mitigation measures**

From studies about industrial disasters, it has been proven that the relief measures put in place in industrial areas must be sufficient to face any industrial disaster or industrial accident. If there would not be any specialized medical facility to deal with industrial disaster cases or to control the situation during the disaster, how it would be possible to mitigate the damage due to industrial disaster. Even though there are facilities near the industrial area, it must also have some proficient mitigation measures to reduce the vulnerability towards fatal industrial disasters.

- **Lack of evacuation expertise**

When industries do not have a proper emergency exit systems or proper support of evacuation expertise on time, they become vulnerable to damage and disaster risks.

- **Transportation risks**

It is expected that industrial chemicals, including flammable hydrocarbons, are transported on the roadway alongside other vehicles and pedestrians, and industries easily allow this with high-grade safety. But still, there is a risk of explosion, fire, blast fragments, and another injury to bystanders or maybe the death of some people if any incident happens with these transporters.

Losses Due to Industrial disasters:

Industrial disasters are enormously costly because they lead to many losses directly or indirectly, and the losses are both visible and invisible. The invisible losses due to disaster are immeasurable and cannot be valued in monetary terms.

The various monetary losses which an industrial organization suffers because of disaster are as follows.

Direct Costs

Direct cost loss involves the wages of employees, compensation and the cost of medical aids for the injured workers, the cost incurred on training a new worker, loss due to damage to raw materials, and many more to count on.

Indirect costs

Indirect cost loss includes the following casualties to the industrial organization:

- The cost that government incur on industrial organization because it has to maintain a more significant number of factory inspectors to check the disaster, it has to spend more on the employee's health insurance needs and other social security benefits, and because the cost of all this mis happening is recovered by imposing higher taxes on the industrial owners or management.
- The cost of salary is given to the employees when they have been without work because the industrial disaster impairs them.
- The cost incurred on the machine and tools that have been damaged in case disaster is not severe, or the cost of the entire industrial plant that is destroyed due to the disaster and or the cost of the spoilage of raw material and other things when the tragedy occurred.
- The loss of profit on the production which the injured employees would have been earned for the industry.
- Including the loss incurred due to the machine on which he was working was idly and generating profit for the industry.
- The cost is sustained on the amount of the wages paid to an employee when they were vainly aiding their injury and even after they return to work. Also, production profit made because of their work would be worth much less than before they sustained the injuries in disaster.
- Some overhead costs such as the expense incurred on light, heat, rent, and other similar services and items that continue to be used while the injured employees are non-producer and not generating profit for the industry are also included.

It is quite comprehensible that a disaster causes a lot of suffering and loss to the employees, the employer, the government, and even to the people living nearby. It is particularly hard on the employee's family, especially when they are the sole earner in the family. Also, the disaster lowers the morale of fellow workers and decreases the willingness to do work as it is not easy to forget such tragic incidents.

The employees and the workers become pessimistic and increasingly aware of the hazardous nature of their work to earn money. Therefore, disaster increases the overall cost of production and adversely affects employees' productivity, profit, and morale.

Some devastating industrial disaster around the world.

Sr. No.	Name of the incident	Details
1.	Rana Plaza, collapse of building running several factories.	In Savar, Bangladesh on 24 April 2013 where more than 1,100 suffered
2.	Gas leak in Union Carbide India Limited (UCIL) pesticide plant. Also called Bhopal Gas Tregady.	Between 2-3 December, 1984, in Bhopal, Madhya Pradesh, India. 3,787 were killed, 558,125 were severly injured, 38,478 temporary partials injured and 3,900 suffered permanently disabling injuries.
3.	Coal dust and gas explosion in a coal mine	On 26 April, 1942, at Benxihu Colliery, Benxi Liaoning, China, around 1,549 deaths were recorded
4.	Nuclear Explosion at the Chernobyl nuclear power plant during an unauthorized test	26 April, 1986, Prypiat, Ukraine, 50 killed due to radiation, 3,940 suffered serious injuries due to radiation induced cancer and leukaemia
5.	Fire near 2,300 tons of ammonium nitrate on S.S. Grandcamp causes explosion	16 April, 1947, Port of Texas City, Texas, USA, 581dead
6.	Explosions at a Liquid Petroleum Gas tank farm	19 November, 1984, San Juanico, Mexico, 500 killed
7.	Coal dust explosion	10 March, 1906, Courrieres, France, 1,099 died

8.	ICMESA, a chemical manufacturing plant, releases dioxins (TCDD)	10 July, 1976, Seveso, Italy, 3,300 farm animals, 80,000 animals are later slaughtered
9.	Exxon Valdez, an oil tanker, spills 260,000 to 750,000 barrels of crude oil into the sea	24 March, 1989, Prince William Sound, Alaska, USA, 100,000 to 250,000 seabirds were affected
10	Explosion at a fireworks storage depot	13 May, 2000, Enschede, Netherlands, Fatalities were 23

Industrial Disaster

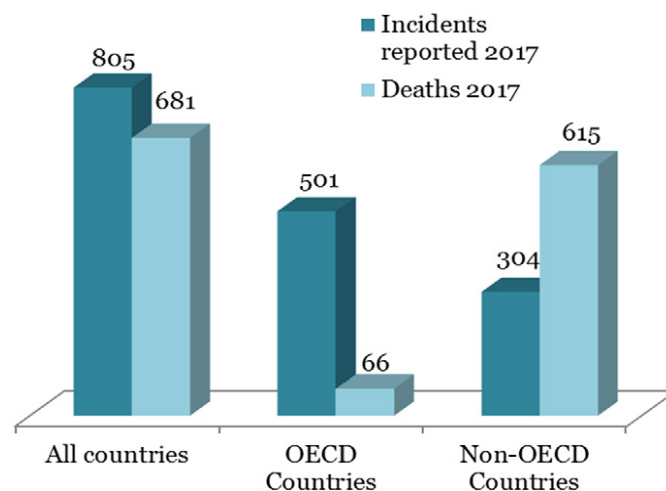
Industrial disaster is the cause of significant damage, injuries, and loss in terms of the life of people, business assets, and the environment as well. Disasters such as nuclear explosions, chemical explosions, industrial fire, toxic chemical or gas leakages, and pollution due to industrial chemicals are all examples of industrial disasters.

The International Labour Organization estimates that around 2.3 million people around the globe capitulate to industrial accidents and diseases per year. Also, this leads to over 6000 deaths every day around the globe. On an annual record there are around 340 million industrial accidents and 160 million victims of illnesses caused by industrial work. The ILO updates these figures at regular time intervals and the updates indicate an increase of accidents and ill health.

The unplanned and ad-hoc expansion of cities to accommodate prompt population growth, combined with inappropriate land-use and the failure of urban authorities to regulate building standards, contribute in vulnerability of urban populations in terms of industrial disasters. Additionally, poor health, inadequate nutrition, poverty, illiteracy, and deficient or non-existent sanitation establish a permanent threat to their physical and psychological security and create "everyday risks" that cause minor accidents or may be disasters on regular basis. Urbanization often increases the exposure of people and economic assets to industrial disasters and creates new patterns of risk, making the management of disasters in urban areas even more complex (UNDP).

The European Commission's Joint Research Centre (EC-JRC) has brushed up a wide range of chemical accident data from different sources in recent years. According to this research, industrial chemical accidents still a very

frequently occur in all industrial countries that puts questions on their adequacy of disaster risk reduction plans and efforts.



Chemical incidents occurring in 2017 reported in the global media

This figure represents information of global media reports on chemical incidents in industries collected by the EC-JRC. This data shows release of unsafe substances on fixed sites, offshore platforms, etc. along with transporting dangerous substances, and pipelines disasters during the year 2017. These figures or the graph indicate that chemical incidents due to industries are relatively common in all parts of the world. It also shows that such industrial chemical accidents tend to kill hundreds of people every year and in some areas of the world this rate is far more than hundreds.

In the past mankind has witnessed horrific after effects of industrial disasters. Locals near the boundary of industrial areas encounter various problems on daily bases. Industries that do not follow the guidelines provided by government to control the pollutant effluents causes damage to environment in the form of air pollution, water pollution, and soil pollution. This affects not only to residents nearby but also the flora and fauna. In addition to this various hazardous accident that occurs leaves life damaged for the generations. Industrial hazards can occur due to mismanagement or environmental effects. Either way absence of proper medical team and unawareness on how to handle these situations causes damage to multiply.

Industrial disasters involve four fundamental disasters. It's because industries use many distinct processes and a wide range of poles apart raw materials, intermediate products that produce waste products, and final products. The industrial disasters that such as environmental damage, fire, explosion, toxic release, and are mostly seen.

Fire This is frequent industrial disasters, yet the consequences of industrial fire are usually more minor. The effect of fire on nearby people usually dependent on the exposure time and the intensity of the heat. Also, industrial fires produce toxic fumes like Acrolein, Carbon monoxide, Cyanides, and many more. The severe intensity of fire or heat produced can damage the physical structures or infrastructure. Sometimes industrial fire may also impact essential services like power and instrumentation, which can cause an intensification of the fire and cause more damage.

Explosion Industrial explosions are generally heard from far away as a 'bang' sound resulting from a shock wave originating in an industrial building. The overpressure due to the explosion can be even severe to kill people working in the plant. Still, the indirect effects such as collapsing buildings, flying glass, and debris cause far more loss of life and severe injuries to the people. Different types of explosions result in industrial disasters, which include gas explosions and dust explosions. Gas explosions occur when flammable gases used in any production unit or reactors mix with air and contact ignition. At the same time, dust explosions occur because of volatile solids, particularly metals in fine powder, mixed with air in large amounts and ignited.

Toxic Chemical release Sudden releases of poisonous chemical vapours have the potential to cause death and severe health injuries to people sitting several miles from the release point or industrial area. The number of sufferers typically depends on the weather and environmental conditions of explosion, population density in the area of the cloud and shock waves, and the efficiency and usability of the emergency arrangements to tackle with such disasters.

Environmental Damage Disaster caused due to industries have the potential of causing injury, loss of life, and property damage. The disaster due to fire, explosion, or toxic releases can also lead to severe environmental threats. The release of industrial substances might not be directly harmful to humans but can cause significant pollution problems. It is not less than a disaster.

Disaster Risk Reduction Plan

What is the foundation of risk reduction?

According to UNISDR, identifying and understanding risks and measuring disaster support risk management. In comparison, disaster risk reduction revolves around the choices, decisions, and lack of information.

Hence, risk reduction depends on the following factors.

Risk identification

Risk identification is the most significant factor that can be a foundation to a risk reduction plan. Observing the damages and losses caused by past disasters, risks are not often identified. The possible harms and losses that could arise from some future disasters may not be understood by people at all, that is why risk identification is essential; exact information about the risk and effective communication at the correct point of time can help raise awareness and trigger the course of actions by the people or society.

Risk reduction

Information about disaster risk can be used to collect statistics for a wide range of activities involved in risk reduction. From improving building codes and designing risk reduction measures such as flood and storm course protection to minimize damage and carrying out macro-level assessments of the risks to different types of infrastructures to prioritize investment in reconstruction and retrofitting.

Preparedness

For reducing risk, people must be prepared to face it first. Preparedness for risk is about understanding the geographic area affected by the disaster and the intensity and frequency of different hazard events. This understanding is crucial for planning evacuation routes, creating shelters, and running preparedness drills to manage and reduce disaster risk factors.

Financial protection

Analysis of disaster risk is born out of the requirement to calculate the risk of somewhat rare but adversely impactful natural disasters. Governments of different countries look for managing their sovereign financial risk or support programs that address individual financial troubles, such as micro-insurance or household earthquake insurance and many more.

Resilient reconstruction

Risk assessment plays a critical and role in the impact modelling of plans before a disaster strike. Moreover, it can provide initial and rapid estimates of human, physical, and economic loss in a disaster's immediate after-effects. Since we rarely have time to collect the information required to form resilient design and land-use plans after any disaster occurs.

Understanding hazards, exposure, and vulnerability

Hazard: It is defined as a natural phenomenon, or human activity that may bring about loss of life, cause injury, health degradation, damage to property, social and economic interruption, or any environmental dilapidation. Hazards can occur from single, successive, or combined source or can have effects in single, successive, and combined form. Every hazard has its own specifications and is embodied by its intensity or magnitude, frequency of occurrence, location of occur and probability of happening.

Exposure It is referred as the situation of people, infrastructure capacities, and many other tangible human assets located in a disaster-prone area. As mentioned in the UNDRR thesaurus, measures of the degree of "exposure" incorporate the number of people and types of assets exposed or are at risk of exposure during the disaster.

Vulnerability It is defined as the conditions that are determined by physical, social, economic, or environmental factors and processes that intensify the risks of an individual, any community, assets, or a system to the effects bear upon some disasters. Vulnerability is multi-dimensional and mainly the four dimensions above. Some studies include poor design and construction of buildings in the area of disaster, inadequate protection to the assets, lack of public awareness such as awareness about threats, high levels of poverty, lower education rates, limited recognition of risks and readiness measures, and many more factors that makes an area more vulnerable to risks and effects of disasters.

Results of successful Disaster Risk Reduction

- Successful DRR is the combined result of the top-down approach, such as institutional changes and strategies - and the bottom-up approach of local and community-based systems.
- DRM programs should not be like a standalone program. Rather, it must be unified into sustainable development planning and practice because disasters indicate failed or distorted development approaches for unmanageable economic and social processes and ill-adapted societies.
- Disaster management approaches need to address the different layers of risks from intensive to extensive risk, underlying risk drivers, and be tailored to local and regional contexts. There are no 'one-size fits all' tactics that can be used to implement Disaster Risk Management, but a few tackles and frameworks have been effectively implemented to reduce disaster risk many times.

Disaster Risk Reduction Programme

A disaster risk reduction program aids designers and developers in developing and delivering services in an affordable, systematic, and sustainable manner that are intended for protecting lives, property, and resources. It would eventually aid to robust and balanced development under the climate changes.

Scope

The scope of the Disaster Risk Reduction Programme embraces the strengthening of National Meteorological and Hydrological Services capacities. Furthermore, it focuses on:

- Supporting preparedness via early warning systems.
- We are providing related disaster information for risk assessments, response, presentation, and recovery from risk. And risk transfer across different sectors.
- They are diminishing existing risks and preventing the development of new threats.
- Responding to user requirements as a priority.
- Cooperating and getting engaged in disaster risk governance structures at all levels.

Objective

The long-term objective of the DRR Programme is to reinforce the capacities (technical and functional) of people. To provide meteorological, hydrological, and climate services, Disaster Risk Reduction Programme also strengthen National Meteorological and Hydrological Services, operational and research networks that will facilitate in reducing the risks of disasters. It will become a support for planning and making vital decisions in disaster risk and emergency management. DRR programme demands the cooperation and involvement of WMO and NMHSs with various stakeholders amid partnerships and engagement in multiple forums to deal with disaster risks effectively.

Its Structure

Congress and the Executive Council provide an ultimate insight into the disaster risk reduction Programme. Executive Council Working Group has stated Some specific guidance on Disaster Risk Reduction. Furthermore, disaster risk reduction has its principal focus on the Regional Associations, Technical Commissions, and another relevant program (DRR FP RA-TC-TP) to ensure coordination with these bodies in disaster risk reduction. To support the effective implementation of the DRR program is WMO's priority, as laid out in its DRR Roadmap. This Programme is also channeled by User-Interface Working Groups (UI-WGs)

on topics such as hazard and risk assessment multi-hazard early warning systems (MHEWS) and disaster risk financing. At the Secretariat, the DRR Services Division is under the Weather and Disaster Risk Reduction Services (WDS) Department.

Components

The primary and fundamental aim of the Disaster Risk Reduction (DRR) program is to avoid new risks of disasters and reduce the effects of existing disaster risks and impactfully contribute to strengthening the elasticity of resources. Disaster risk management (DRM) includes processes and actions to achieve the objective to manage and transfer enduring risks and disperse losses and damages during disaster events that occur in any area. Disaster risk reduction is a program of topmost priority for WMO. Besides, the National Meteorological and Hydrological Services (NMHSs) play a vital role in disaster risk management and participate extensively for disaster risk reduction. This DRR Programme focuses on reinforcement of the NMHSs to support risk assessments, prevention, alertness, and mitigation through early warning, response, human assistance, recovery, and disaster risk financing and transfer.

• Supporting Hazards and Risk Management

Risk assessment helps determine the nature, intensity, and extent of disasters' existing and potential future risks and their components. It includes identifying, evaluating, and analysing hazards or disasters in terms of their location, intensity, frequency, duration, and probability of their happening in a particular area. Also, it involves the vulnerability towards disaster in terms of its physical, economic, social and environmental aspects. Moreover, the exposure of people, assets, and effectiveness of prevailing or alternative coping and adaptive capacities is also counted in risk assessment.

Hydrometeorological observations and forecasts by NMHSs are fundamental inputs for sound and practical risk assessments. On the other side of this, post-disaster data of losses and damage that occurred serves as input for estimating future impacts of that particular disaster. In this case, this data must be quality-assured, geographically and temporally referenced with the disaster event, consistently categorized, and properly filed away.

• Supporting Prevention and Mitigation

Disaster prevention **is the hypothesis and objective to avoid the adverse** effects by taking necessary actions in advance of or before a potentially disastrous event hits that area. It is often impossible to completely prevent losses due to disaster. In this case, complete avoidance of casualties is not feasible, and efforts turn to relief. **For determining effective risk relief measures,**

accurate meteorological, hydrological, and climate information is essential. For example, the proper and impactful designing of the levels of embankments that protect high-risk flood zones and where settlement and economic or industrial activities are vulnerable. Also, authorities can take organizational and non-structural actions during or after a disaster to prevent secondary hazards and consequences. For example, the after-effects of any disaster can be air, soil, or water contamination.

• Supporting Response and Recovery

In the past decade, the Inter-Agency Standing Committee (IASC), the primary mechanism for inter-agency coordination of humanitarian assistance since 1992 involves the critical United Nations (U.N.) and non-UN human partners, initiated several reforms programs to improve emergency planning for disasters management, using the cluster approach to enhance coordination among human agencies on national and international levels. As a result, agencies like IASC have used essential meteorological, hydrological, and climatological information in their planning. An inter-commission task team on "Meteorological Services for Improved Humanitarian Planning and Response" was established by The Commission for Basic Systems (CBS). This team incorporated experts from a wide range of NMHSs to realize these opportunities to support and recover from disaster risks. The DRR Programme coordinates this work within the U.N. and other humanitarian agencies to demonstrate the benefits of weather and climate services when targeted to needs and requirements.

• Supporting disaster risk financing and money transfer

Disasters affect human life and significantly put impact local and national economies. Over the past decades, there has been a constant increase in the number of disasters happening in different world areas. Also, hydrometeorological hazards account for the lion's share of them. Therefore, the disaster risk reduction program effectively contributes and facilitates the development of services like weather, water, and climate for risk in the financing, insurance, and other financial risk transfer mechanisms to cope with remaining risks of already happened disasters.

Sometimes, it results in setting back development gains by many years in countries with limited resources or developing countries.

How to reduce risks involved in industrial disasters

• Design and Pre-modification review

Designing and pre-modifying proper analysis of layout, facilities, and material selection. In-depth research must

be done and put some effort to replace highly toxic chemicals with safer ones. Along with this, a lesser amount of chemicals should be stored, especially when the chemical is flammable. If there is an inventory reduction, it would automatically reduce the degree of damage if any fatal industrial disaster might occur at any time.

• Chemical Risk Assessment

Chemicals used in industries must be assessed based on compatibility, flammability, toxicity, explosion risk and should be stored with some specific protection to reduce the risk of industrial disaster.

• Process Safety Management

Management should take responsibility and develop a culture of safety in industrial organizations to reduce the risk of industrial disasters. A proper checking and study of reliability of process equipment that incorporates safety trips and interlocks, scrubbing system, etc., must be done before it affects some significant process changes and leads to some disastrous accidents.

Safety Audits

In every industrial organization, routine audits and assessments of safety procedures, practices, and performance of safety systems and gadgets must be performed. Along with this, some follow-up measures should be carried out periodically.

Emergency Planning

A practical, specific written down and practised emergency procedures must be planned for inclusive risk examination that indicates the influence of after-effects along with suitable facilities should be made. It can be done by the industrial organization, communities, and national or regional corporation authorities for disaster management.

Training

Proper training of employees, workers, and protection services should be done to handle the situation and consequences properly.

Special times and escorts for dangerous vehicles

There should be some specific transportation time given to vehicles carrying hazardous substances of chemical and some safety escort to reduce the risk of industrial disasters.

Public cooperation on the road

It is for the common public; people must oblige with the police and injurious chemical tankers and heavy-duty vehicles to avoid bumps one road with these industrial

chemical tankers and vehicles. Also, people allow dangerous vehicles to be on the road for the shortest possible time and let them pass quickly.

Public awareness

Common people must be aware of potential disasters and have information on protective and safety measures taken during these industrial disasters. MSDS sheets should be accessible and voluntarily available for the common public. The manufacturer must stand out on dangerous household and car care products.

Proper storage of hazardous Materials

All chemicals used in industries are hazardous materials and should be kept at proper storage temperature and in locked rooms away from reach of children and animals. Also, if highly reactive substances are stored, they should be stored in watertight or airtight containers with all safety measures.

Safety measures that must be taken during Industrial Disasters

Securing the area to prevent further damage or accident

The first thing one should do in an industrial disaster is to secure the area. The reason for doing this is so important as it can help prevent more injuries and further damage to the other part of the industrial area. By limiting the number of people who can get close to the situation, one can help keep them from getting injured, or even worse, killed by the effects of the disaster. In an industrial disaster, it is crucial to remain prepared ahead of time as possible. Companies from that industrial area and the communities or society living near the industrial area must know about the risks of industrial disasters. It should have an executable plan to respond and manage any industrial disaster.

People in the industry or around the industry should also have the proper equipment, tools, services, and training to deal with any disaster scenario and save people's lives at least. Taking action quickly and securing the area can help reduce the effects of the disaster on individuals, society, and the environment in any worst-case scenario. It is also crucial that the proper authorities are contacted and given responsibility immediately. It will ensure that only highly trained people in taking required actions in these types of industrial disasters are handling the situation.

Following all safety and emergency protocols

Many times, when an industrial disaster strikes, ordinary people go to great lengths to help others who are in need. Although this is very selfless to help people in such disastrous situations simultaneously, it is also essential to take into account that if you are not careful

while helping people struck by disaster, you might end up causing more harm while doing good. If you think that or you can safely help prevent further damage to the lives of people or more injuries to them, you can proceed but with utmost awareness about the intensity of the disaster.

On the other hand, it is imperative to remember that you do not have any extraordinary power, and you don't need to be or act as a hero. You ought to make sure that you follow every safety and emergency protocol stated for each particular type of disaster before moving ahead to help. Please wait for the professionally trained emergency handling team and fighters to arrive at the place of tragedy and then offer your assistance to them and work under their guidance. They can let you know in a better way than what help you can do to them and the best possibilities to avoid further problems.

Remember that different situations may ask for different responses and ways of dealing.

It is essential to remember that not all industrial disasters are the same. As already mentioned, there are many different disasters such as fire, explosion, toxic chemical release spills, hazardous waste release, and many others depending on the industry type and material and process used. These disasters have to be treated quite differently, especially considering the size and scope of the place and the industry where the incident happened. It is also essential to know how to take any action in these disastrous situations. However, no matter what type of disaster has occurred, getting hyper and reacting to the problem will not help anyone. Always remember to remain calm and think intelligently instead of reacting in panic. Knowing that panicking will almost always make things and the situation worse. Hence you might lead to more damage or people getting injured instead of helping and protecting them.

Study of Ankleshwar Industrial Area

The industrial area of Ankleshwar GIDC has grown significantly over the year. It has helped to manage the supply and demand chain and employment to thousands. As per the data given by Disaster Training, Mitigation & Response at DPMC, Ankleshwar, Gujarat at a conference on Industrial Safety and Emergency Preparedness at New Delhi in July 2019, Ankleshwar has 1200 industries approximately which include 750 Chemical, Pharma, and Bulk Drug and 400 Packaging, Rubber, and Service units. Large scale industries require tones of electricity and water storage. Along with these, they store tons of raw material that can be toxic and hazardous if not handled appropriately. Disaster Prevention and Management Center, Ankleshwar, is an established body which is responsible for promoting

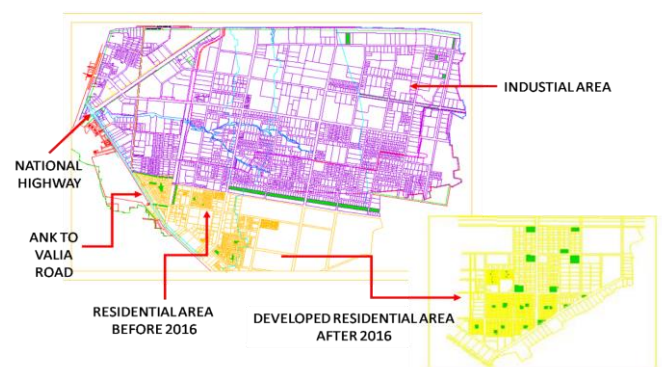
safely awareness, carry out regular inspection of the industrial unit and carry out safety drills from time to time, and provide assistance at the time of hazardous incidence.

Ankleshwar is a city located in the Bharuch district of Gujarat, India. This city is not only famous for its picturesque temples and natural beauty but is also mentioned as the oil city of Gujarat. Ankleshwar is one of the fastest growing industrial areas. Ankleshwar Industrial Association is one of the largest in Gujarat and is controlled by MCM. the city is also known for its township name Gujarat Industrial Development Corporation (GIDC).

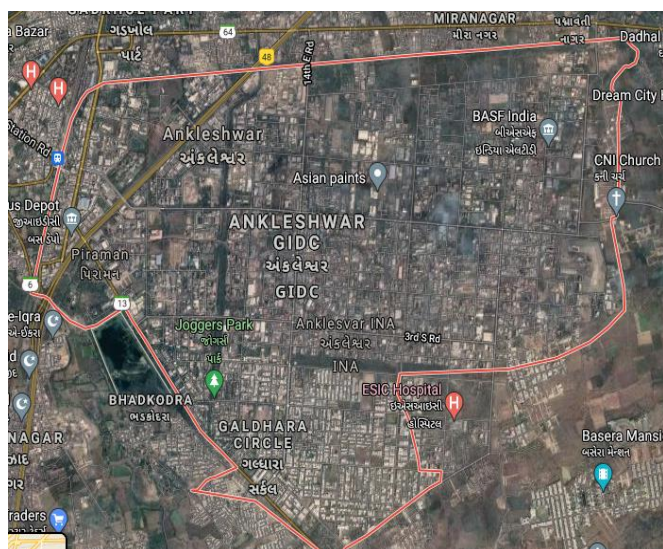
Ankleshwar Industries Association was established by the industries located in the year in 1978 in city of Ankleshwar GIDC estate. It is spread over 1600 hectares area of near National Highway No.8 and the Delhi-Mumbai Railway Line. Apparently, there are over 1200 industries in city of Ankleshwar that consist of chemicals, pesticides, pharmaceuticals, bulk drugs, petroleum products, engineering, textiles, plastics, rubber, and packaging industries as well.

With this industrial development came various environmental problems. As the number of units grew the air quality index went from normal to harmful. This has been one of the concern areas and ironically a price we human paid for development. To tackle these situations local authorities have taken various steps and establish working systems.

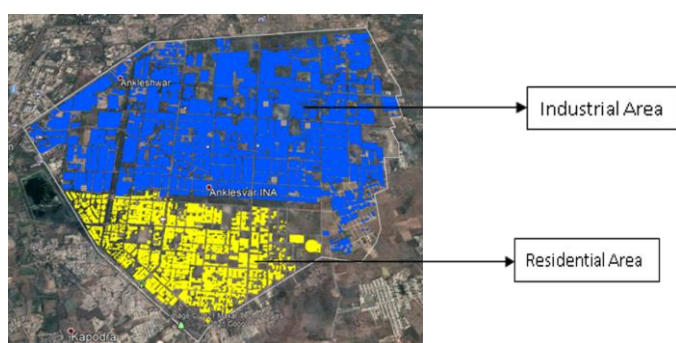
Ankleshwar Environment Preservation Society was established as a Society under the Indian Societies Act in 1989. In a way it is a public charitable trust that focuses on the environment, safety, and community welfare for the areas associated with Ankleshwar Industrial Association. It inspires industries in Ankleshwar to engage in safe work, environment friendly practices and motivates them to fulfil social responsibility. (<http://www.aepsindia.co.in/>).



Ankleshwar with green patch after 2016



Satellite map of Ankleshwar



Satellite image of Ankleshwar showing the industrial area in blue and residential area in yellow

Ankleshwar is a Municipality city located in the district of Bharuch, Gujarat. The city of Ankleshwar is divided into total 16 wards. As per a report released by Census India 2011, the Ankleshwar Municipality or main city has a population of 89,457 of which 46,733 are males while 42,724 are females.

The population of Children with ages of 0-6 is 9843 which is 11.00 % of the total population of Ankleshwar (M + OG). In Ankleshwar Municipality, the Female Sex Ratio is 914 against the state average of 919. Moreover, the Child Sex Ratio in Ankleshwar is around 861 compared to Gujarat state average of 890. The literacy rate of Ankleshwar City is 89.02 % higher than the state average of 78.03 %. In Ankleshwar, Male literacy is around 92.27 % while the female literacy rate is 85.49 %.

Ankleshwar Municipality has total administration of over 19,822 houses to which it supplies basic amenities like water and sewerage. It is also authorized to build roads within Municipality limits and impose taxes on properties coming under its jurisdiction. In terms of caste and religion Scheduled Tribe (ST) constitutes 16.65 % while Schedule Caste (SC) was 4.27 % of the total population in Ankleshwar (M + OG). Looking at

the work profile at Ankleshwar, out of total population, 30,552 are engaged in work or business activity. Out of this 25,754 are males while 4,798 are females. In the census survey, the worker is defined as a person who carries out business, job, service, cultivator, and labour activity. Of the total 30552 working population, 93.02 % are engaged in Main Work while 6.98 % of total workers were engaged in Marginal Work.

Industrial Growth in Ankleshwar:

If we compare the satellite image take year apart, we can observe significant growth in the town area, especially the industrial sector. As per the data given by Disaster Training, Mitigation & Response at DPMC, Ankleshwar, Gujarat at a conference on Industrial Safety and Emergency Preparedness at New Delhi in July 2019, Ankleshwar has 1200 industries approximately which includes 750 Chemical, Pharma, and Bulk Drug and 400 Packaging, Rubber, and Service units. Ankleshwar GIDC has Rs. 10,000 crore of investment, Rs. 15,000 crores of products, Rs. 6000 crores/annual state and national revenue contribution and have employees more than 1,00,000.

To manage and maintain discipline government has established various governing bodies which look after the needs and issues of the industries. These associations keep an eye on the industries whether they are following all the general as well as environmental norms, assist at times of emergency, and establishing new units.

Ankleshwar Industries Association (AIA)

Ankleshwar Industries Association has been one of the important pieces in assisting the growth of the Ankleshwar GIDC estate. there is a total of 1,200 members in AIA. AIA carries out activities such as compensations and protests faced by the member industries, overseeing Infrastructural development of city through industrial member's participation, updating and explaining guidelines to MSME members for fulfilling distinct legal requirements and green belt development, activities related to environmental preservation and pollution control Disaster prevention, and management, and creating awareness among surrounding population about various issues.

Gujarat Industrial Development Corporation (GIDC)

The government of Gujarat established Gujarat Industrial Development Association (GIDC), to set up the industrial estates of Ankleshwar and Panoli. It has offered tax holidays and capital subsidies of up to 25% to the entrepreneurs who are willing to set up units in Ankleshwar and Panoli.

Gujarat Pollution Control Board (GPCB)

Gujarat Pollution Control Board is responsible for overseeing and solving issues related to the environment. Their task is to make sure industrial planning in accordance with the environmental layout, including the green patches and proper waste management process. This organization ensures strict compliance of the chemical units to pollution control and effluent discharge norms. Every unit in Ankleshwar has to get its expansion plans approved by GPCB. In case of an increase in any kind of pollution, GPCB needs to take solid steps to manage the pollution and make way for a greener lifestyle.

Disaster Prevention and Management Centre Ankleshwar

The industrial estate in Ankleshwar was setup by Gujarat Industrial Development Corporation in early 70s. This estate is spread over an area of 1600 hectare in close proximity to Delhi Mumbai Industrial Corridor (DMIC). Ankleshwar is the largest chemical industrial estate in the country and in Asia. The Industrial estate is prone to emergencies due to human mistakes, natural calamities and technical failures all the time.

Ankleshwar Industrial Association (AIA) set up Disaster Prevention and Management Centre (DPMC) in 1995 through Ankleshwar Environmental Preservation Society with the help of Gujarat Industrial Development Corporation, Notified Area Authority, Ankleshwar and Industrial Safety and Health Department. DPMC was established on 4th April, 1995 and on December 2003, full-fledged new building of DPMC was made operational.

DPMC looks after all the activities of Fire and Emergency Services at Notified Area, GIDC, Ankleshwar. It was fully capable of attending emergencies like fire, explosions and gas leaks in the industrial estates of Ankleshwar, Panoli, Jhagadia and Valia of Bharuch District. DPMC is fully equipped to tackle any kind of disaster. It also offers its helps to surrounding areas when needed. DPMC has taken care of the emergencies on National Highway during various accidents.

Due to improper knowledge and insufficient experience about chemical and industrial hazard, the fire fighters were facing difficulties in doing their jobs. DPMC was setup with combination of qualified and experienced safety personnel and firefighting personnel. The main reason behind the establishment of DPMC was to reduce the fatalities due to industrial accidents and disasters.

The society has managed various projects.

1. SAJJAN Plant Ecology Study Centre

Here tree plantation activities are carried out. Environmental monitoring Laboratory where GPCB authorized packing material inspection is carried out in various industries.

2. Disaster Prevention Management Centre

Here various industry specific training and various equipment's to tackle the disasters are made and stored.

3. EHS Technical Education Centre

They run various courses of Post diploma in Industrial Safety and Post Diploma in Industrial Environmental Technology and Management, affiliated with Technical Education Board, Gandhinagar.

4. AEPS Institute of Science

Here they run PG course like M.Sc. Organic Chemistry affiliated with Veer Narmada South Gujarat University.

Ankleshwar Industrial State

Ankleshwar Industrial Estate was established up by Gujarat Industrial Development Corporation, it spread over an area of 1600 hectare nearby Delhi Mumbai Industrial Corridor (DMIC) and National Highway No.48, and Delhi-Mumbai Railway (WR) Line. Ankleshwar has been well known for industrialization added to its excellent demographic location. As of now, more than 1200 industrial units, including chemicals, pesticides, pharmaceuticals, bulk drugs, petroleum products, engineering, textiles, plastics, rubber, and packaging are located in this industrial estate. Being one of the largest chemical industrial estates and having units operating in small and medium sectors. The industrial estate is always prone to emergencies due to human mistakes, natural calamities, and technical failures. To tackle these types of emergencies Disaster Prevention & Management Centre (DPMC) was established in 1995, with the help of Ankleshwar Environmental Preservation Society (AEPS), Gujarat Industrial Development Corporation (GIDC), Notified Area Authority (NAA), Ankleshwar, and Industrial Safety and Health Department. DPMC is responsible for looking after all the activities of Fire & Emergency Services at Notified Area, like Operation, Maintenance, and Administration.

DPMC has attended to emergencies like fire, explosions, and gas leaks in Ankleshwar, Panoli, Jhagadia, and Valia industrial estates of Bharuch District. The organization is equipped with all necessary equipment

for all types of emergencies and trained personnel. Services of DPMC are also extended to other surrounding areas as and when needed, they have tackled emergencies on the National Highway when there were major road accidents of fire, toxic release, gas leakages. DPMC has successfully managed rescue operations during the time of the flood, cyclone, and other natural calamities.

Sendai Framework on Disaster Risk Reduction (2015-2030)

The Sendai Framework on Disaster Risk Reduction (2015-2030) was taken up at the Third United Nations World Conference for Disaster Risk Reduction, organised from 14 to 18 March 2015 in Sendai, Miyagi, Japan, which represented a unique opportunity for countries is an agreement whose objective is to extensively minimise the disaster risk and losses of lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

It pursues the following goal: "Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience."

The focused action within and across sectors by States at local, national, regional and global levels includes:

- Understanding the disaster risk.
- Reinforcement of disaster risk governance to manage disaster risk.
- Investing for resilience in disaster risk reduction.
- Enhancing disaster preparedness or alertness for effective in recovery, rehabilitation, and reconstruction.

3. CONCLUSIONS

After carefully reviewing the findings, it can be concluded that the problem at hand is disaster management and pollution. The major area under risk includes the employees as well as the residential. To address the issues several small but effective changes are required. Even though incidents are not in an individual's hand, pre-preparation can help to minimize the damage and loss of lives. Following strategies can be implemented to understand the issues and make changes.

Planning Industrial Growth

While permitting land for new industrial settlement, the appointed authority should take their sweet time. They should consider which location can serve best and will not hinder the residential area should be taken into consideration. Organizations should also keep in mind whether the industrial waste will come in direct contact with the residents of flora and fauna. Also, there should be a considerable distance between the unit and the general population, so in case of any disaster, damage can be minimized.

Environmental and Safety Policies

After the industrial unit has run for time being, frequent inspection should be carried out to make sure the pepper guidelines are being followed. The pollution control board should make sure all the guidelines in regards to the environment is being in place. Also, regular checks on the safety equipment should be done to make sure they are not faulty and are in good condition.

All the safety regulations should be followed thoroughly and all the new or old employees be given proper training. Appropriate training will help people to coordinate and work in an organized manner in the time of any accidents. New or updated policies are needed to be drafted in accordance with changing world or priorities.

Availability of Help

The government has established a set of organizations and departments such as AIA, DPMC, PCB which are always on standby for any kind of emergencies. These organizations should be given thorough details of what types of industries are under them, what possible disaster can occur, and how to tackle them. Staff should be properly trained with the help of regular drills and should be equipped with updated tools and devices. Medical facilities should be established, along with enough medical supply, and staff.

Wastage Treatment

In order to control pollution caused by the industrial units, several methods can be implemented. To control air pollution, the usage of raw materials should be evaluated. The alternative option should be looked for which can give out less pollutant. Also, filters can be developed and attached to the chimneys which can absorb some toxic pollutants. Similarly, while dispatching wastewater and waste by-products, there should be a protocol to dissolve or eliminate toxins before releasing them. By-products that can be recycled should be stored and recycled later instead of adding them to the pile.

Updating Technologies

With time and evolving world technologies are advancing. Technologies are developed per the emerging problem, aiding to solve those issues and improve the quality. Owners should be informed and educated about these developing technologies and their benefits. Updates should be carried out from time to time, also machinery should be checked periodically to avoid any accidents due to insufficiency of them. Adopting new technology, efficient training to the employees for safe use will help in avoiding severe issues or incidents.

Development of Green Patch

Hectors of land have been cleared to make space for industrial settlement. This leads to the rapid increase in pollution. While planning industrial unit government should make sure that there are enough spaces for the green patch. With the help of certified biologists and planners, those trees and plants should be planted in the area around the industries as well as residences. This green patch will help in managing air pollution and will add to the scenic background.

Displacements of Industrial Units

Removing the industrial plants will cause chaos and will affect the livelihood of the major population residing in Ankleshwar. To tackle pollution and other issues, we can suggest that the plant owner operate smaller production plants in this area and move bigger plants to the area away from the town such as Dahej. We can also request the government to provide industries with inexpensive deals on land and subsidies, which will help them, start their larger production units in outside areas. This will provide a secluded area for industrial settlement away from the residential area.

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BIOGRAPHIES



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