CHAPTER I

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1.1 Environment and Development

a) Need of Development

Development is a continuous improvement in the standard of living and the quality of life of the people in the country. From the prehistoric human, the process of development has started from the association of people groups for safety and comfort. They generally lived in small nomadic groups. The beginning of agriculture was started in stone age. Access to food surplus has pioneered to the formation of permanent human settlements. The domestication of animals and the use of metal tools have been started as a process of development. Agriculture development supported the trade and cooperation, and led to a complex society. The concept of hand production methods changed to machines, new chemical manufacturing and iron production processes, improved efficiency of water power, the increasing use of steam power and the development of machine tools. The use of coal replaced the wood and bio-fuels. Agricultural dependency for a livelihood has changed from generations and followed by an unprecedented explosion of new ideas and new technology inventions which created an increasingly industrial and urbanized country.

b) World Scenario

The scenario of the world development has drastically changed from the industrial revolution period from the 18th to the 19th century where major changes in agriculture, manufacturing, mining, transport, and technology had a profound effect on the socioeconomic and cultural environment. It has started in the United Kingdom and then subsequently spread throughout Europe, North America, and eventually the developing world.

The industrial revolution influenced on every aspect of daily life. The transition has begun in parts of world’s previously manual labor and draft-animal–based economy towards machine-based manufacturing. It started with the development in textile industries, the development of iron making techniques and the increased use of refined coal. Introduction of canal improved roads and railways had improved the trade expansion. The production capacity increased due to the introduction of steam power primarily by coal, wider utilization of water wheels. The advancement in metal machine tools facilitated the manufacture of more production machines in the industries. The Industrial Revolution began an era of per-capita
economic growth in capitalist economies. Increased use of natural resources changed
the livelihood of the capitalist economies. Construction of large dams for
hydroelectric projects, developed automobile sector, mining activities for metal
industries, development in the construction industries, infrastructure advancement,
development in transport modes i.e. air, surface and water etc. has changed the
scenario of the world in terms of development.

c) National Scenario

In India technological changes, railways, canals, and the telegraph were
introduced in 18\textsuperscript{th} and 19\textsuperscript{th} century. Economic liberalization, in the 1990s, has created
a large urban middle class, transformed India into one of the world’s fastest growing
economies. Major agricultural products produced in India include rice, wheat, oilseed,
cotton, jute, tea, sugarcane, and potatoes. Major industries include textiles,
telecommunications, chemicals, pharmaceuticals, biotechnology, food processing,
steel, transport equipment, cement, mining, petroleum, machinery, and software. India
is the world's second-most populous country. Its population grew at 1.76% per annum
during 2001–2011, Medical advances made in the last 50 years as well as increased
agricultural productivity brought by the Green Revolution, have caused India's
population to grow rapidly. The number of Indians living in urban areas has grown by
31.2% between 1991 and 2001. The world’s 2\textsuperscript{nd} populous country has a dependency
on natural resources and lack in the advancement of renewable resources.

1.2 Environmental Issues Associated with Development

The rapid advancement of scientific and medical understanding in the 19th
and 20\textsuperscript{th} centuries led to the development of fuel-driven technologies and improved
health, causing the human population to rise exponentially. The industrial revolution
led to dependency on more utilization of natural resources. Humans cannot survive on
the earth without utilizing the natural re-sources. In such circumstances the concept of
sustainable management becomes diluted. The effects of any development cause a
multitude of indirect effects through consumption of goods and services, production
of building materials and machinery, additional land use for the activities of various
manufacturing and industrial services, mining of resources etc. There is need to study
the impacts of human activities on environment which are the ultimate essence of
human development. However the efforts taken by every individual can lead to
resource development and maintenance of pleasant surroundings. The Environmental Policy Act of 1969 and the reports on an environmental assessment that it requires are aimed at insuring such a balanced approach. An effective system is in demand for relating large numbers of actions and environmental factors and for placing value judgments on impacts which are difficult to quantify.

1.3 Concept of EIA

The purpose of EIA is to ensure that the decision makers have considered the environmental impacts of all possible alternatives and decided an economically feasible & environmentally sound to proceed with the project. The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical social, and other relevant effects of development proposals prior to major decisions being taken and commitments made (Jansamood et al., 2009). EIAs do not require adherence to a predetermined environmental outcome, but rather they require decision makers to account for environmental values in their decisions and to justify those decisions in light of detailed environmental studies and public comments on the potential environmental impacts of the proposal. Shepherd and Ortolano, 1996 stated that the large proposals which cause wide ranging national as well as international environmental effects need to consider the possible alternatives during the decision-making process for their execution.

a) Origin of EIA

The assessment of environmental impacts of any activity started in mid of 1970's. The legislation pertaining to EIA was executed in US as a National Environmental Policy Act (NEPA), 1969. Since then the EIA has been used widely in a number of countries of the world. EIA as it is practiced today, is being used as a decision aiding tool rather than a decision making tool. There is a need for stronger foundation of EIA practice through training for practitioners, guidance on EIA practice and continuing research (Jay et al., 2007)

b) EIA in India

On 27 January 1994, the Union Ministry of Environment and Forests (MoEF), Government of India, under the Environment (Protection) Act 1986, promulgated an
EIA notification making Environmental Clearance (EC) mandatory for expansion or modernization of any activity or for setting up new projects listed in Schedule 1 of the Notification.

The Union Ministry of Environment and Forests (MoEF), notified the new EIA notification in September 2006. The projects in schedule-1 are divided in 2 categories. The attempt to decentralize powers to the state government is the only major difference in the new notification of EIA.

c) EIA and Sustainable Development

EIA is a process to predict the environmental consequences of development activities and to plan measures to eliminate or reduce adverse effects and to increase the environmental & economical viability.

EIA functions at three levels; to predict problems, to find ways to avoid them and to enhance positive effects. EIA is used to demonstrate ways through which environment may be improved as a part of the developmental process. It also predicts the constraints between proposed projects and its environment. It gives an opportunity for mitigation measures to minimize problems. It enables monitoring programs to be established to assess future impacts and provide data through which decisions are made to avoid environmental damage.

EIA thus facilitates sustainable development. Environmentally beneficial impacts are enhanced while adverse impacts are avoided as possible. EIA helps to select and design projects with long term viability and improves cost effectiveness.

1.4 Railway Transportation

Rail transport is where a train runs along a set of two parallel steel rails, known as a railway or railroad. The rails and perpendicular beams are placed on a foundation made of concrete or compressed earth and gravel in a bed of ballast. A train consists of one or more connected vehicles that run on the rails. Propulsion is commonly provided by a locomotive that hauls a series of unpowered cars that can carry passengers or freight. The locomotive can be powered by steam, diesel or by electricity supplied by trackside system. The earliest evidence of a railway was a 6-Kilometre (3.7 m) Diolkos wagonway, which transported boats across the Corinth isthmus Greece during the 6th century BC. Trucks pushed by slaves ran in grooves in limestone, which provided the track element. The Diolkos ran for over 600 years
(Lewis, 2009). For nearly a hundred years, the railways remained the dominant mode for land transport and continue to remain the land carrier that can carry anything anywhere the rail tracks go and do it at a cost lower than other types of land or air transportation. It brings together people from the far corners of the country and makes possible the conduct of business, sightseeing, pilgrimage and education. It has bound the economic life of the world and helped in accelerating the development of industry and agriculture.

a) World Scenario

United States of America occupied a first position in the railway network. Indian Railways has 64,600 km’s (40,052 mi) of route length and 7,500 stations. Indian Railway has the world's fourth largest railway network after those of the United States, Russia and China (www.cia.gov).

Figure 1.1: World Scenario of Railway Route & Railway Transportation

b) Indian Railway

From a very modest beginning in 1853, when the first train steamed off from Bombay to Thane, a distance of 34 km, Indian Railways has grown into a vast network of 7,500 stations spread over a route length of 64,600 km with a fleet of 239,281 (freight) wagons, 59,713 coaches and 9,549 locomotives. Indian Railways have one of the largest and busiest rail networks in the world, transporting over 8224 million passengers and more than 975.16 million tones of freight annually (IRFF, 2012).
Figure 1.2: Growth of Indian Railway Route Length in Last 60 Years. (IRFF, 2012)

Figure 1.3: Growth of Passenger Originating in Last 60 Years (IRFF, 2012)

Figure 1.4: Growth of Freight Traffic in Last 60 Years. (IRFF, 2012)
The growth in the network of transport and the demand for transport services in the last 50 years has been quite significant (Figure 2, 3 and 4). Rail route length has increased from 53596 km’s in the year 1950 to 64600 km’s in the year 2012. The passengers have increased from 1284 million in year 1950 to 8214 million in the year of 2012. Freight traffic has increased from 93 million tones in 1950 to 727.75 million tones in the year 2012.

Indian Railway is the world’s largest commercial or utility employer, with more than 1.6 million employees. Indian Railway is a department owned and controlled by the Government of India via the Ministry of Railways. Indian Railways is divided into zones, which are further sub-divided into divisions. The number of zones in Indian Railways increased from six to eight in 1951, nine in 1952, and finally 16 in 2003. Each zonal railway is made up of a certain number of divisions, each having a divisional headquarters. There are a total of sixty-seven divisions (www.indianrail.gov.in).

**Table 1.1: Indian Railway Zones and Divisions**

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<th>Divisions</th>
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<td>Central Railway (Mumbai)</td>
<td>Bhusawal, Nagpur, Mumbai, Solapur, Pune</td>
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<tr>
<td>2</td>
<td>Eastern Railway (Kolkata)</td>
<td>Malda, Howrah, Sealdah, Asansol</td>
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<tr>
<td>3</td>
<td>Northern Railway (New Delhi)</td>
<td>Ambala, Ferozpur, Lucknow, Moradabad, Delhi</td>
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<td>4</td>
<td>North Eastern Railway (Gorakhpur)</td>
<td>Lucknow, Varanasi, Izatnagar</td>
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<tr>
<td>5</td>
<td>Northeast Frontier Railway (Guwahati)</td>
<td>Katiyar, Lumding, Tinsukhia, Alipurduar, Rangia</td>
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<td>6</td>
<td>Southern Railway (Chennai)</td>
<td>Chennai, Madurai, Palghat, Trichy, Trivandrum</td>
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<tr>
<td>7</td>
<td>South Central Railway (Secunderabad)</td>
<td>Secunderabad, Hyderaba, Guntakal, Vijaywada, Guntur, Nanded</td>
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<tr>
<td>8</td>
<td>South Eastern Railway (Kolkata)</td>
<td>Kharagpur, Chakradharpur, Adra, Ranchi</td>
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<tr>
<td>9</td>
<td>Western Railway (Mumbai)</td>
<td>Bhavnagar, Mumbai Central, Ratlam, Rajkot, Vadodara, Ahemdabad</td>
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<tr>
<td>10</td>
<td>East Central Railway (Hajipur)</td>
<td>Danapur, Dhanbad, Sonepur, Mughalsarai, Samastipur</td>
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<td>11</td>
<td>East Coast Railway (Bhubaneswar)</td>
<td>Khurda Road, Waltair, Sambalpur</td>
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<tr>
<td>12</td>
<td>North Central Railway (Allahabad)</td>
<td>Allahabad, Jhansi, Agra</td>
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<td>13</td>
<td>North Western Railway (Jaipur)</td>
<td>Bikaner, Jodhpur, Jaipur, Ajmer</td>
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<tr>
<td>14</td>
<td>South East Central Railway (Bilaspur)</td>
<td>Nagpur, Bilaspur, Raipur</td>
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<td>15</td>
<td>South Western Railway (Hubli)</td>
<td>Bangalore, Mysore, Hubli</td>
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<tr>
<td>16</td>
<td>West Central Railway (Jabalpur)</td>
<td>Jabalpur, Bhopal, Kota</td>
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1.5 Rail Activities

a) Freight Operation

The freight business is the major source of revenue for the Indian Railway. A main activity center of Freight operation includes terminals, yards, control office and stations.

b) Rail Transportation and Other Departments

The commercial department plays an important role in canvassing for traffic, improving marketing, customer relations in general, booking of traffic, expediting loading/unloading of wagons, quick disposal of unconnected wagons and trans-shipment of wagon detached out of course for hot axles etc. The other departments like mechanical, electrical, civil engineering and signaling and tele-communications (S & T) provide and maintain various assets and infrastructure (track, wagons, engines, S & T Network etc.). These departments also ensure sufficient availability, reliability, predictability, safety and a reduction in equipment failures; promptness in restoration in case of breakdowns and accidents should also be ensured. They also endeavor for the achievements in technology up-gradation along with the operational strategies and determine the level of excellence in railway operations to a great extent. In a nutshell, all the functionaries have to work as a dedicated team.

All technical disciplines involved in train movement have a representative in the control office to provide the required support from these departments. These would include -


The entire organization works round the clock, all days of the year without any interruption to monitor actual movement of trains on the entire rail network.

c) Control Office and its Basic Functions

1) Train Control: Supervising & regulating movement of trains from station to station on the section to avoid delay to trains and to maximize utilization of the capacity of the section.
2) Traffic Control: General and over-riding control for supervision of the movement of goods and coaching traffic on the section.

3) Power Control: Responsible for provision of motive power to all trains by maintaining a position of locomotives.

4) Carriage and Wagon control: Assist the train and traffic control and to ensure timely examination and fitness of all trains.

5) Commercial control assists the traffic and train control.

6) Traction power control is provided to assist in traffic and train control.

7) Engineering control monitors imposition & cancellation of Engineering Restrictions, Working of track machines & monitoring integrated maintainable blocks. To co-ordinate works during maintenance blocks running of material trains.

8) Signal control assists traffic and train control and is responsible for-
   a) To keep a watch over the S & T failures and take remedial action.
   b) To ensure efficient working of communication channels.


1.6 Transportation and Environmental Issues

The issue of transportation and the environment is paradoxical in nature. From one side, transportation activities support increasing mobility demands of passengers and freight, and this ranging from urban areas to international trade. On the other side, transport activities have resulted in growing levels of motorization and congestion. Though an efficient public transportation system can provide mobility to all sections of society without the negative fallouts of individual automobilisation, transport planners have not given due consideration to the environment during the process (Ghose, 2003). As a result, the transportation sector is becoming increasingly linked to environmental problems (Mahboob and Makshoof, 2008). With a technology relying heavily on the combustion of hydrocarbons, notably with the internal combustion engine, the impacts of transportation over environmental systems has increased with motorization. This has reached a point where transportation activities are a dominant factor behind the emission of most pollutants and thus their impacts on the environment.
The urban growth rates in Asia, Africa and Latin America are higher than those in Europe and North America and so are the vehicle growth rates. With increasing number of vehicles in these countries, air pollution levels continue to rise and remain high (Mohan, 2002). The relationships between transport and the environment are multi-dimensional. The most important impacts of transport on the environment relate to climate change, air quality, noise, water and soil quality as well as loss of biodiversity. Transport systems become a nuisance to the public when passes through or near the residential areas (Carpenter, 1994). Transport sector encompasses highway vehicles, marine engines, locomotives and aircraft, which are the sources of pollution in the form of gases and particulate matter emissions that effects on air quality causing damage to human health.

Ambient air is most polluted in the cities, with the increase in the number of motor vehicles caused by economic growth and industrialization, the level of pollution is expected to worsen more in the future (Alam et al., 1999). Some aspects are unknown and some new findings may lead to drastic changes in environmental policies as it did in regards of acid rain and chlorofluorocarbons in the 1970s and 1980s. Transportation became an important dimension of the concept of sustainability, which is expected to become the prime focus of transport activities in the coming decades. These impending developments require a deep understanding of the reciprocal influence between the physical environment and transport infrastructures. The main factors considered in the physical environment are geographical location, topography, geological structure, climate, hydrology, soil, natural vegetation and animal life.

1.7 Railway Transportation and Pollution

The most important impacts of transport on the environment relate to air quality, noise, water quality, soil quality, biodiversity and land use pattern.

a) Impact of Railway Transport on Air Quality

Coal generated smoke in steam days was a significant part of atmospheric pollution. Although, steam traction is now only of historical interest due to the introduction of electric traction it still has a part to play in the areas where electrification has not been entirely phased in. Steam locomotives emit smoke particulates in the vicinity and contribute sulfur and nitrogen oxides and CO₂ to the
wider atmosphere. Diesel locomotives and rail motor units produce the same sort of emissions as do road lorries, including carbon monoxide, nitrogen oxides, hydrocarbons and carbon based particulates. The contribution of electric transport to atmospheric pollution occurs where electricity is generated at fossil fuel burning power stations (Carpenter, 1994a). The sources of pollution in railway stations are welding fumes, iron particulate emission from a rail track due to speed of the train. People are exposed to iron oxide, assuming the fine iron abrasion dust is rapidly oxidized, with trace amounts of chromium, copper, zinc, manganese, and quartz. These cases are mostly observed in underground railways (Seaton et al., 2005).

A possible cause of air pollution is dust from open wagons carrying coal, aggregates or excavated soil. Fine particle or noxious commodities such as cement or fertilizers are carried in closed wagons. A more likely pollution is at the godowns where stationary wagons are being loaded or unloaded with various goods. Particulate matter generated by these goods is added into atmosphere during its handling which acts as a source of ambient air pollution on the platform and rail yards. Renovation activities in the railway station or nearby areas which includes breaking of old constructions and construction of new structures are the source of dust pollution in railway stations.

The volume and spatial distribution of the emissions, as well as dispersion conditions affects on levels of pollution. Several other factors also play a part in determining the exposure of a population. Pollution intake is also determined by the number of people and duration of their stay in polluted areas (Krzyzanowski, 2005).

b) Noise Pollution

In developed countries noise annoyance is an important source of environmental concern. Noise does not only generate a reduction of the sense of well-being of affected, but also causes property value depreciation (Brons et al., 2003). Noise generated by railway activity on the station is depends upon a) Cruise speed of the train before entering and after departing a station and b) Train acceleration rate while entering and departing the station (Pamanikabud and Paoprayoon, 2003). Noise has its origin in vibrations also. Particles of a vibrating body, such as an engine or rail track set neighboring particles in the surrounding medium into motion transferring physical vibrations to adjoining buildings or sound waves to distant observers.
Trains Noise: Trains noise can be generated by

i) Motive Power Units: Motive noise includes that of auxiliary equipment, such as air compressor, radiator cooling fans and heating/air conditioning equipment, which is significant for stationary trains or those running at low speeds. Diesel engine noise sounds of reciprocating parts and turbochargers become dominant when full power is being applied, whether for accelerating, maintaining top speed or working up steep gradients.

ii) Wheels, Running on Rails: Actual noise levels depends upon the condition and type of the rails and wheels as well as on the axle loads an design of brakes, suspension and bogies. The contact causes characteristic train noise as each pairs of wheel crosses an open rail joint, but is more uniform on the continuous welded rail which is now common on the fast lines. In either case wear on a rail increases its roughness and hence the noise levels.

iii) Aerodynamic Effects: Aerodynamic noise is insignificant in open situations except at exceptionally high speed.

iv) Vibrating Structures: The noisiest vibrating structures are generally steel bridges. Noise during passage of trains over structure increases where the track is fixed directly to the bridge girders.

v) Accelerating diesel engines as trains leave the stations or after the signal stops or speed restrictions, or high power output climbing gradients.

vi) At points and crossings.

vii) Horns.

viii) Noise emerging from tunnel vents shafts.

ix) ‘Swoosh’ of air pressure as trains leave tunnels or pass under bridges.

c) Water Quality

Transport activities have an impact on hydrological conditions. Fuel, chemical and other hazardous particulates discarded from aircraft, cars, trucks and trains or from port and airport terminal operations, such as de-icing, can contaminate rivers, lakes, wetlands and oceans. Major oil spills from oil cargo vessel accidents are one of the most serious problems of pollution from maritime transport activities.
d) **Soil Quality**

The environmental impact of railway transportation on soil consists of soil erosion and soil contamination. Soil contamination can occur through the use of toxic materials by the transport industry. Fuel and oil spills from motor vehicles are washed on road sides and enter the soil. Chemicals used for the preservation of railroad ties may enter into the soil. Hazardous materials and heavy metals have been found in areas contiguous to railroads, ports and airports.

e) **Biodiversity**

Transportation also influences natural vegetation. The need for construction materials and the development of land-based transportation has led to deforestation. Many transport routes have required draining land, thus reducing wetland areas and driving-out water plant species. The need to maintain road and rail right-of-way or to stabilize slope along transport facilities has resulted in restricting growth of certain plants or has produced changes in plants with the introduction of new species different from those which originally grew in the areas. Many animal species are becoming extinct as a result of changes in their natural habitats and reduction of ranges.

f) **Landscape**

Transportation facilities have an impact on the urban landscape. The development of port and airport infrastructure is significant features of the urban and peri-urban built environment. Arteries or transport terminals can define urban borders and produce segregation. Major transport facilities can affect the quality of urban life by creating physical barriers, increasing noise levels, generating odors, reducing urban aesthetic and affecting the built heritage.

g) **Constructional Impacts**

Railway operations between stations are comparatively isolated from local surroundings. The impact of the railway on its neighborhood can be more directly noticeable during its construction. The emissions of rail activities are directly related to the construction during the completion of the foundation work, superstructure and track laying, signal and telephone lining, and electrical lines before implementation of regular Railway activity.
i. Human and Social Impacts

A large temporary population of single workers with relatively high wages and requiring drink, food and lodging; local inhabitants’ concern and need for protection against the occasional recreational excesses of the workers.

ii. Impacts on Flora and Fauna

Trains can disrupt local ecosystems in irreparable ways. A railway traveling through a rural area can interrupt migration patterns, destroy habitat and even kill animals attempting to cross the tracks. Railways are often affected the local flora and fauna.

h) Impacts on Land and Material Resources

Temporary land-take is often needed for construction depot, haul roads and around the structures of the site. Constructional processes need the material affecting the present scenario of resources.

i) Water Pollution and Solid Waste

Railways can be associated with water or land pollution through other aspects of operation such as activities at depots or in electricity generation or through railway construction. Spillage of fuels and lubricants may occur at stations, locomotive depots and rolling stock servicing sidings.

j) Impacts on Resources

Transport operations require energy to propel vehicles. Physically, railway system comprises:

- Trains, power supply, signals and control apparatus.
- Buildings and facilities used for transfer of passengers and freight to and from trains.
- The permanent way on which trains run.
- The land space which is occupied by the buildings, tracks and its earth work.

The manufacture of trains and equipment requires energy and mined raw materials. The price of these resources is dictated by international demand. Conserving the energy resources used in obtaining raw materials and manufacturing
trains, rails, sleepers, ballast and structures can only be influenced by fiscal or legislative controls such as taxing resources or restricting their use for any purpose. Land resources for new railways are more directly within the control of railway planners.

**k) Visual Impacts**

There are four ways in which railways can give visual pleasure or displeasure -

- Reactions which arise from the sight of trains: stimulation or distraction of line side residents and visitors-relaxing, working, playing and watching games or visiting sites of cultural interest.
- Obstruction of views railway structures.
- The clash or blend of railway infrastructure and trains in the wider landscape.
- The attractiveness or interest of the view from the train.

**l) Socioeconomic Impacts**

Transportations means not only transportation industries, those businesses whose primary activity is to provide transportation services, but also includes the transportation activities of other business establishments and consumers (Han and fang, 2000). Railways were conceived as a means of freight transport, initially from mines, later for longer distance distributions, e.g. in India cotton market was focused in initial days; but it was people’s use of railways which inspired many early schemes. These provided social as well as economic opportunities. Socioeconomic impact affects the livelihood, earnings, welfare and enjoyment of people. The social issues related to railway development includes -

- Job creation- Either directly in the construction or operation of the railway or in commercial activity generated by transport.
- Changes in the housing market.
- Tourism & recreation.
- Health & social services.
- Educational facilities.
- Commercial & agricultural Industries.
m) Impact of Workplace Environment

Time–activity patterns, particularly residence or work near busy stations (or both), and time spent in traffic are critical for population exposure. Population growth and future expansion of urban centers are not considered while planning of rail projects in India. As a result a large number of the population is exposed to Railway Transportation (Khairnar and Ingle, 2009). Occupational activities which involve exposure to dust and particulate matter affects the lung capacity and Cardio-respiratory fitness of workers (Debray et al., 2002). The impairment in lung efficiency increases with duration of exposure in the exposed population (Wagh et al., 2006). Shopkeepers working in the affected area are at high risk of exposure to the air pollution (Ingle et al., 2005). Shop assistants in an air conditioned environment should be less exposed to traffic fumes and their lung should be better preserved compared to ‘unprotected’ vendors exposed directly to vehicle pollution (Jones et al., 2008). Travelers are often exposed to levels that are three times the background levels. Groups with high levels of exposure include people who live near transportation activity and people whose jobs require them to spend a long time on the stations. Urban planning and development also strongly shape exposure; they determine not only patterns of residence and mobility, but also the availability of public transport.

1.9 Profile of the Jalgaon Region

Jalgaon is a city in western India, to the north of the Maharashtra state in Jalgaon district, which itself is located on the northern Deccan plateau. Located within the productive, irrigated agricultural region of Khandesh, Jalgaon is a municipal corporation. As of 2011 India census, Jalgaon had a population of 460,468 in an area of about 11,700 sq km. At the 2001 census, males constitute 52% of the population and females 48%. Jalgaon has an average literacy rate of 76%, higher than the national average of 59.5%: male literacy is 80%, and female literacy is 71 (Census of India, 2001). It is abounded by many religious places and cultural establishments. The major tourist attractions are Pal hill station at Raver, Patnadevi temple at Chalisgaon confluence of Tapi and Purna rivers and hot water springs at Unapdev in Chopda Taluka. The world famous heritage site, Ajanta caves is near to Jalgaon (50 kms) making it as one of major international tourist hub. The district has excellent rail and road connectivity and is a central destination to reach out to major places in India.
Jalgaon market is mainly known for gold, pulses, wholesale tea, agriculture and grains trading. Banana and cotton are main crops of the District. Jalgaon district is known for its advances in horticulture. Its production of bananas and cotton, especially by resorting to drip irrigation, has created a role model for cultivators in other parts of India. Bananas grown in the district are export outside the state and to other countries. Jalgaon is a largest banana growing district in India. Jalgaon is also growing up as a premier educational place with many colleges in the field of engineering and computer science. Modern Jalgaon is now boasting of the vast industrial area, educational institutes and good hospitals. The city is well developed with good roads, shopping centers, residential areas, with good infrastructure in communication and transport.

Map 1.1: Jalgaon Railway Network

Source: [http://ejalgaon.com/tourism/important%20information.htm](http://ejalgaon.com/tourism/important%20information.htm)

Jalgaon is connected with central railway and one of the major railway stations of Bhusawal division. Major trains like Karnataka express, Navjeevan express, Jabalpur Garibrath Express, etc. have a stop in Jalgaon. Bhusawal railway junction, which is approximately 20 minutes away from Jalgaon city, is one of the major railway junctions in Maharashtra. It connects the city with New Delhi, Mumbai, Kolkata, Chennai etc.

Though the impacts of rail transportation on the environment are wide ranging, the most critical aspects of air and noise pollution, their impacts on the employees, passengers and the public are considered in the present study.
1.10 Objectives

The overall objective of the study is to assess the impacts of the railway transportation in and around the Jalgaon area. The specific objectives of the study include

- Air & Noise pollution assessment in the Jalgaon area due to Rail activities.
- Impact of rail transportation noise pollution on the exposed population in the area.
- Impact of air pollution on the exposed population in the area.
- Estimation of risk of exposure to air and noise pollution in the area.
- To study the occupational health hazards among the rail employees.