

ROAD TRANSPORT AND ITS IMPACT ON ECOLOGICAL ENVIRONMENT

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ABSTRACT

Today's world is affected by the man-made developmental projects. Transportation is one such a project that aims to accelerate the development of a society, but ends up also being one of the major factors of environmental pollution. The chief among them is Land/Road Transport. There are environmental Problems that arise due to transportation namely natural resource depletion, noise pollution, impact on bio-diversity, human health and safety, migration, and etc. This paper examines the effect of the road transportation in particular and its short term and long term impact on the general ecological environment. Solution to the problem arising are not highlighted, rather the impacts are examined and classified.

KEYWORDS: Transport, Environment, Pollution

INTRODUCTION

Environment

The word "environment" is used often to describe the totality of all living and non-living things that encompasses an organism, or a group of organisms. It denotes the "natural" settings of an organism which includes all elements, factors and conditions that contribute to its natural growth and development. It is also defined as "the combination of all of physical and organic factors that act on a living being, residents, or ecological society and powers its endurance and growth".

There are two factors that impact an organism namely Biotic and Abiotic. The abiotic factor refers to man-made structures and physical components like light, temperature, water and atmospheric gases. The former is known as built environment and the latter as natural environment. The biotic factor refers to all the living species that surrounds organism. These factors are dynamic in nature, and therefore change the environment over time. With the changing environment, most organisms also adapt itself for survival. But when environment becomes hostile, not all organisms survive.

The environment is further classified based on people. When people surround an item or thing, it is known as human environment. This is also known as the social environment which includes elements like the relational, residential, emotional, and religious environment.

Environmental Pollution

The word pollution originates from the classical Latin word "pollute onem" which means to defile or make dirty. The word Pollutant refers to a substance and its presence causes pollution. The pollutant contaminates the air, water, sound and food and in turn affecting our breathing, drinking, hearing and eating respectively. Exposing the evils of man-made pollutants, Uddal (2010) rightly said "the more we exploit, the more our options are reduced, until we have only one to fight for survival. We are destroying the environment and the biosphere, where we live." Describing the environmental pollution, Odum (1971) describes "as an undesirable change in the physical, chemical, or biological characteristics of our

air, land and water that will harmfully affect human life or that of desirable species, living conditions etc". He summarizes the types of pollution into seven (i) Sewage Pollution, (ii) Industrial Pollution, (iii) Air Pollution, (iv) Noise Pollution, (v) Radiation Pollution, (vi) Water Pollution and (vii) Land Pollution

Transportation

Transportation is the fulcrum of development and it is an inseparable part of any society. It has a great influence in the development of civilizations. It has enhanced the style of life, the range and location of human activities and the supply of goods and services for consumption. In fact, advances in transportation advances the way of living and the way in which societies organize it.

Rapid movement of people and goods are made possible by transportation. Such movement has changed the way people live and travel. As in the past, the societies today continue to grow in civilization with the exchange of people and resources made feasible by transportation. People in the developing countries as well as in the developed countries travel a lot for work, to visit places, to shop and to gather in public places. For their travel they rely on transport. Thus the transport has become indispensable to the society. Nevertheless, it also consumes a lot of resources like time and space, and fuel and materials. (NPTEL, May 7, 2007).

History of transportation

The era of Transportation is as old as the history of mankind. Human beings used only their feet to carry, to shift material things in the early periods of human history of Paleolithic and Neolithic period. Transportation was not done other than what one or few could carry. In the later part of Neolithic age, he domesticated animals which helped him to carry goods. However, not until the invention of wheel in about 3500 BC, the capacity of humans to transport goods was restricted to what could be carried by the domesticated animals.

With invention of the wheels, the man-made transportation came into being. The wheels were placed first on carts and then chariots. Next came travel by riverboats believed to have first been used by the Egyptians. Horses were added as a means of transportation. It is believed that the Asians were the first to place some kind of protector on the horse's hooves. The wheelbarrow was instrumental in transporting heavy goods from one site to another. The submarine used to travel underwater was invented in 1620 by Cornelis Drebbel. The first paddle wheel steamboat began rolling down the river during the late 1760s and the beginning of the Industrial Revolution. About 100 years later we saw the first cable car. The Wright Brothers took off in the first airplane which they called a "flying machine" in 1903. Henry Ford created the system to mass produce cars in 1908. Successful helicopter flights took off in the 1940's. After thirty years, Jumbo jets began adorning the runways. And finally, in 1981 the Space Shuttle blasted off the launching pads. (www.typesofthings.com).

Let us first classify the transportation means and then attempt to understand how history unfolded for each one.

Broadly speaking, transportation means can be classified as under:-

- Land transport
- Water transport
- Air transport
- Space transport

ENVIRONMENTAL PROBLEMS DUE TO TRANSPORTATION

Urbanization is the result of modern civilization. Majority of people prefer urban areas for their work and livelihood. It is estimated that the urban population as a whole has been expanding at the rate of nearly 3 percent per year, considerably even faster than the known world population growth rate. It is a categorical fact that a half of the global population lives in cities. And the demographics is no different in India. At present an average of 30 percent population of India lives in urban areas. Coupled with the explosion of population in urban areas, the demand to provide basic goods and facilities also increases. Transport is one of them, which provides mobility, flexibility and accessibility to people.

An efficient transport system is a prerequisite for sustained economic development. It is not only the key infrastructural investment for the growth process but also plays a significant role in promoting national integration. The transport system also plays an important role in promoting the development of the backward regions and integrating them with the mainstream economy by opening them to trade and investment. Unless, it is done in a secure and eco-friendly way, the transportation adds to an unhealthy environment which is so much the result of rapid urbanization.

Rapid urbanization is the mark of any metropolitan cities. Alongside the urbanization, the road traffic also increases. It is noteworthy that cities in India especially New Delhi, Mumbai, Kolkata and Chennai keep breaking their own records of traffic congestion. If the rate of growth of private automobiles on roads is not controlled, the damage caused by the pollutants of the vehicles will become irrevocable. There are neither resources nor technology that allows commuters to think that the damage caused to environment now can be cleaned up later. It is better to prevent pollution now than to cure it later.

The complexity of the situation draws a parallel between, linkages between environmental issues, public transport, non-motorized transport and safety and it must be given proper and adequate care and planning. People could be encouraged to use public transport system instead of taking private vehicles so as to reduce number of vehicles on road. For those who is eco-friendly and who decide to take either walk or use bicycles must be provided with safe and green corridor distinct from other road space dedicated for the motorized vehicles. Reduction of speeds of moving vehicles is yet another sensitive issue that ensures the safe environment for commentators in the transportation system.

Natural Resource Depletion

Fossil fuels are the primary energy source for transport. In OECD countries, above the use of fossil fuels for transport increased by more than 45% from 1980 to 1997 and is expected to continue growing. To be constructed, transport infrastructure requires a substantial amount of concrete and steel. In order to produce vehicles, metals and plastics are required. The extraction and production of all these materials are depleting of natural resources. Apart from depletion of natural resources, transportation also affects life and structures.

Air Pollution

The transport sector, especially road and air transport, contributes to air pollution, acidification and climate change through emissions of carbon monoxide (CO), nitrogen oxides (NO_x), carbon dioxide (CO₂), hydrocarbons (HC) particulate matter (PM), lead (Pb), heavy metals, and volatile organic compounds (VOC). These pollutants are released during the combustion of fossil fuels, the primary energy source for transport. (State of the environment report - 2003).

Noise Pollution

Noise is perhaps the most annoying pollution for living beings. Most of which comes from the transport domain. The noise pollution that comes from roads is directly proportion to the number and the type of motorized vehicles that produce noise. The acceleration, the work of engine pistons, the brake, and other mechanical operations of the vehicle, and the use of horn, loud music, and sudden start and stop of engine contributes to the noise. The construction work of heavy machinery and their maintenance by the roadside increases the level of noise pollution drastically. (Tsunokawa and Hoban, 1997).

The medical science records that noise at all levels when it is continuous affect the stress level in a human person. The noise disrupts communication between persons, causes annoyance and leads to psychological trauma with disorders in sleep and auditory system. It affects wildlife as well. Because, animals are afraid of noise and consequently fail to cross noisy roads. It affects their natural cycle of migration, breeding and feeding.

Vibration is yet another bad effect of road and air transportation. It affects health and properties of people. Like noise, vibration also causes sleeping problems and disrupts normal living patterns. Vibration due to aviation and road transportation affects the buildings and heavy constructions to alarming levels. They do not only cause cracks in the structures but also breakdown monument and heritage buildings on resonance. (State of the environment report - 2003).

Land Use

According to Pastowski (2001) the land used for transportation and for its infrastructure in OECD countries occupies about 30% of urban land area. While major share of about 93% is used by the road transportation, the rail and air transportation shares the rest with minimum 1% by aviation. These lands used by the transportation sector affect the biodiversity and causes habitat fragmentation. And Eutrophication and acidification which are the side effects of transportation activities damage biodiversity in the land.

The transport sector affects the land use in two ways. Directly it affects by their buildings and infrastructure, and indirectly by the urban sprawl. The later facilitates people to move away from cities to less populated areas, nearby. This causes fragmentation of land use, spreads out commercial centers and increases use of private vehicles on road. (Pastowski, 2001).

Soil Pollution and Land Degradation

The road transportation often prefers agricultural soil for its stability and flat surface. Unfortunately this reduces the cultivation and affects the income for the farmers. It degrades the fertile soil and damages the socio-economic balance of that area. Besides, it pollutes the vicinity of fertile soil with its construction works and clearance of vegetation for site accessibility. The major pollutants found in these sites are lead, zinc and chromium. These metals pollute the vegetation soil for centuries and damages the micro organisms in it. Fortunately, these bad effects are concentrated only on the narrow area of vegetation besides the road. (State of the environment report - 2003).

Endangered Biodiversity

Biodiversity is the variety and diversity of life on earth. Some Researchers estimate about 30 million species on Earth, and a few others estimate over 100 million. It is this biodiversity that keeps our earth's species interconnected, alive and healthy. While some species go extinct naturally over a long period of time due to shift in environment, their

accelerated extinction caused by human activities calls for immediate rectification. One such activity that endangers biodiversity is by the transport sector.

Construction of roads, the road service infrastructure and their related activities endanger biodiversity in and around the road. The construction works destroy the biodiversity in the locale directly. Concrete and steel replaces the fertile land for biodiversity of insects and microorganisms. The noise and bright lights of vehicle constantly disturb the animals and even frighten them. These affect their peaceful life and happy cohabitation. They affect the rate of reproduction of animals in these areas. Breeding and feeding are also affected.

The roads that cut across the habitation and especially their corridors cause fragmentation and even deaths. The road pollutants are too strong for them especially for the sensitive plant and animals to adapt themselves to the toxic changing environment. Moreover, the migrating animals along the highways and those crossing roads in search of food end up in the hands of poachers. The roads that cut through the large bodies of water disrupts the spawning cycle of fish. The growth and distribution of plankton are also highly affected by polluted state of the water column in these areas. (State of the environment report - 2003).

Impact on Drinking Water Resources

The groundwater and springs are the natural sources of drinking water for human life. The portable water present below the Earth's surface are affected when the soil cavities and rock fractures are destroyed by the building and road constructions. The lowering of concrete pillars for overhead bridges and underground tunnels block the undercurrent water streams that recharge the groundwater level. They shift the earth configuration that store and divert supply of water to natural and man-made open wells. As a result hundreds of dry bored wells and natural wells are abandoned in the cities. This paves way to portable water merchandising, and a need to control usage of plastics in transportation. (State of the environment report - 2003).

Impacts on Landscape

Natural landscapes are nature's gift to humanity. Its visual appeal is a source to human aesthetics. If not properly considered, this natural beauty can be tampered by the buildings and man-made structures that stand in disharmony with the land topology and contour of plantation. It can block the scenic beauty of sunrise and sunset. It can prevent the natural light and wind that are vital for the well being of humanity. In major cities, the construction of road transportation has damaged the cultural, historical and archaeological value of the place. This negative visual impact is because the aesthetic consideration of building is often compromised to meet the low-budget of transportation sector. However, a careful study of materials used, shape, size, texture and color of building sites in harmony with the physical elements of landscape can ensure the structures to coexist with beauty of the creation.

(Button and Rothengatter, 1993). (CEU SUN 2002).

Negative Impacts of Transport on Social Life

Impacts on Local Communities and Economic Stability

One of the main aims of the rapid transportation is to connect places and thereby connect people for business activities that affect the economic growth of the area. Bypass roads well designed away from occupied areas not only speed up the travel and but creates also new business opportunities along the road. However, the road that connects areas also

divides the land it cuts across. The benefit is more when it connects places but becomes very significant when it divides the land used by agriculturists and commercial units. The fragmentation of the agricultural soil and commercial site causes delay in accessing the disjoint land and multiplies resources for commutation and business processes. The age-old routes used by local communities to access shops, schools and to reach the worship places become redundant by the highways crossings that require extra effort and time to cross over. Widening of roads also scrape off active local small business and cultural activities located along the road. It directly affects the local community and economy of business like cafes, shops and restaurants, when dislocated. (CEU SUN 2002).

Impacts on Human Health and Safety

Road and railways form a major transportation facility in a country. These highways not only transport goods and people, but diseases as well. They become highways for transforming localized diseases to a widespread catastrophe. This happens when infected people travel places spreading contagious diseases between people. Often, it is construction workers and transport labors who come in contact with high risk of pollution and diseases. They are prone to endemic diseases in the construction sites and transmit to other unrestricted areas. Poor sanitation facilities in the building sites often cause waterborne diseases. HIV and other sexual diseases are found among lorry drivers with wavered sexual habits.

Roadways cause injuries and fatal accidents. The rate of road accidents is in the increase in the developing countries truncating the life and growth of the population. (Tsunokawa and Hoban, 1997). The CEU SUN (2002) reports that “the most vulnerable groups of road accidents are pedestrians and users of non-motorized vehicles.” (CEU SUN 2002).

ROAD TRANSPORT EFFECTS ON ENVIRONMENT

Roads have local and wider environmental effects. Local effect includes noise, water and air pollution, and disturbance and destruction of habitat. The wider effect includes climate change and deformation of earth configuration. A proper design and construction of roads and the type of vehicle designed for low emissions, the eco-friendly parking, amenities and other related facilities can reduce effects on environment. (www.wikipedia.com).

Effects on Air Quality

The negative and positive effects on air quality are discussed below.

Negative Effects

Air quality is affected by the pollutants from motor vehicle emissions. The more the vehicles are used, more the air pollution. The vehicles emit more emission when accelerated under low speed conditions. This phenomina is common in traffic congestion in cities roads. Emissions consist of volatile organic compounds, NO_x, carbon monoxide, benzene. And other harmful air pollutants. The polluted air is concentrated in traffic junctions where vehicles emit more emissions. The polluted air spread causing adverse respiratory health problems not only at traffic junctions but at some distance away from the road. The tyres kicked up dust triggering allergic reaction for persons. Though substance like Carbon dioxide in vehicle emission is non-toxic it contributes to the growth of CO₂ concentration causing global warming.

Positive Effects

The bypass roads and outer ring rounds can reduce the concentration of traffic within city limits. They lessen the concentration of the traffic on roads and minimize the concentration of pollution and its menace.

Noise Pollution

Negative Effects

People as well as birds and animals are the direct attack of noise pollution. It becomes a nuisance to the entire living population when the level of noise exceeds the safe limits. Often times it is noise from the heavy loaded vehicles and poorly maintained motor vehicles that cause noise pollution on roads, especially when they operate at high speeds near living areas and on uphill sections. Intensity of this noise pollution grows with the increase of motor vehicles on the road in the cities. Added to that, the speed bumps which are deployed in built-up areas increase noise pollution especially when the traffic is congested.

Positive Effects

From 1973, there is a considerable noise mitigation strategies been drawn by the acoustical engineers to reduce the sound levels of sensitive receiving modules. New roads constructed away from populated centers can relieve the noise pollution. For instance, a newly drawn road scheme planned in Shropshire County, UK projects to mitigate traffic noise in Shrewsbury town centre in the near future.

Water Pollution

Major pollutant of water is from land, especially from roads and industrial waste lands. Urban garbage from roads and other polluted land surfaces is a major source of water pollution. When rainwater runs off the roads, they tend to pick up petrol, diesel, motor oil, heavy metals, waste materials and other pollutants. Thus, road runoff is a major sources of nickel, zinc, copper, Chromium, aluminum, lead and polycyclic aromatic hydrocarbons (PAHS). Rain and sand that run off into roadsides contaminate the underground water and pollute surface waters. Road salts, primarily chlorides of sodium, calcium or magnesium, are toxic to sensitive plants and animals that live in polluted environment.. They do not pollute the sand only but alter the stream bed environments, causing stress for fish and plants that live in water.

Habitat Fragmentation

Habitat fragmentation is caused by roads that act as barriers or filters to animal movement. It is observed that many species do not cross the open space created by roads due to the threat of predators. The roads also contribute to increased animal mortality from traffic. When a road prevents the species from migration and colonization of areas, the species goes locally extinct. Moreover, when roads become a barrier to access seasonal or widely scattered resources, the animals are marooned and perish easily. Finally, habitat fragmentation may also divide large continuous populations into smaller isolated stray populations. And these smaller populations are more prone to drift in genetic shift, inbreeding depression and a lowering of populations leading to a gradual decline and extinction.

Environmental effects that arise from the projects of road development projects fall into three groups:-

- Direct effects
- Indirect effects
- Cumulative effects

These three groups are further classified according to their nature. They are (i) Positive and Negative effects, (ii) Random and Predictable Effects, (iii) Local and Widespread effects, (iv) Temporary and Permanent effects and (v) Short –

and long – term effects.

Direct Effects

Effects that are caused by the road itself, or the road construction work are known as direct effects. For example the damage can be easily and directly accessed and evaluated when the cultivable land is occupied for laying or road, vegetation destroyed and when gravel fills the fertile soil preventing farmers from cultivation. The effects are caused directly by the projects of road transportation.,

Indirect Effects

Some effects are difficult to monitor access and control because in the mega construction projects the indirect cause and effects are subtle to observe. New road promotes the influx of new settlements around the wildlife areas promoting poaching, cutting of trees and clearing of vegetation for domestic purposes. Gradual accumulation of non-degradable materials used by people and the waste water stagnation pollute the soil and water in the long run. The fertilizers and pesticides used for farming permanently weaken the productivity of the soil and affects biodiversity. These effects are difficult to predict and assess at the start of the project.

INDIRECT IMPACTS: THE EXAMPLE OF LAND CLEARING

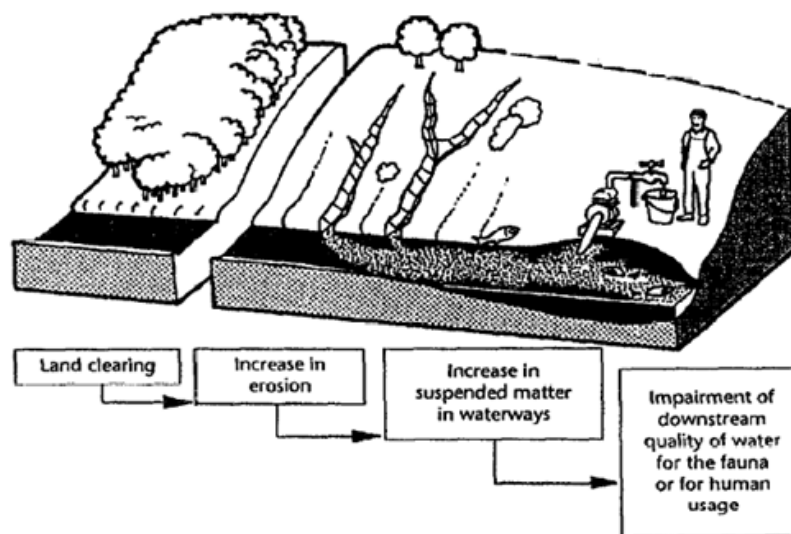


Figure 1: Indirect Impacts of Land Clearing

Therefore, as much as feasible, the assessment of the indirect effects on environment of mega road projects should not be limited to roads only, but cover also to the sites associated with the road project, such as the deposit and borrowing sites, processing areas, quarries, temporary service roads, and make-shift accommodation and relate facilities provided for the contract laborers.

Cumulative Effects

Cumulative effects can be classified under four types of events namely, (i) independent huge events or projects, (ii) Interrelated complex events, (iii) Catastrophic unpredicted natural events and (iv) Incremental but slow and widespread effects caused by bad engineering of road transportation. The results of each individual events and collective events cause cumulative bad effects on ecosystem even destroying species in and around the construction sites. The most affected are

forest, agriculture and watershed areas. Lack of road-side facilities for the drivers and motorists result in massacre of forest and vegetation. The virgin lands are left unprotected when motorist stop sporadically and engage in human activities that pollute air, water and soil. Plastics, glass and metal containers they leave behind degrade the green area. The oil spilled and cutting of trees and removing of rocks loosen the earth. And subsequent rainfall causes further damage by causing erosion. Never thereafter, the vegetation has enough time to recover. And the problem only exacerbates over time due to increase in traffic and human activities.

CUMULATIVE IMPACTS: THE EXAMPLE OF A STREAM

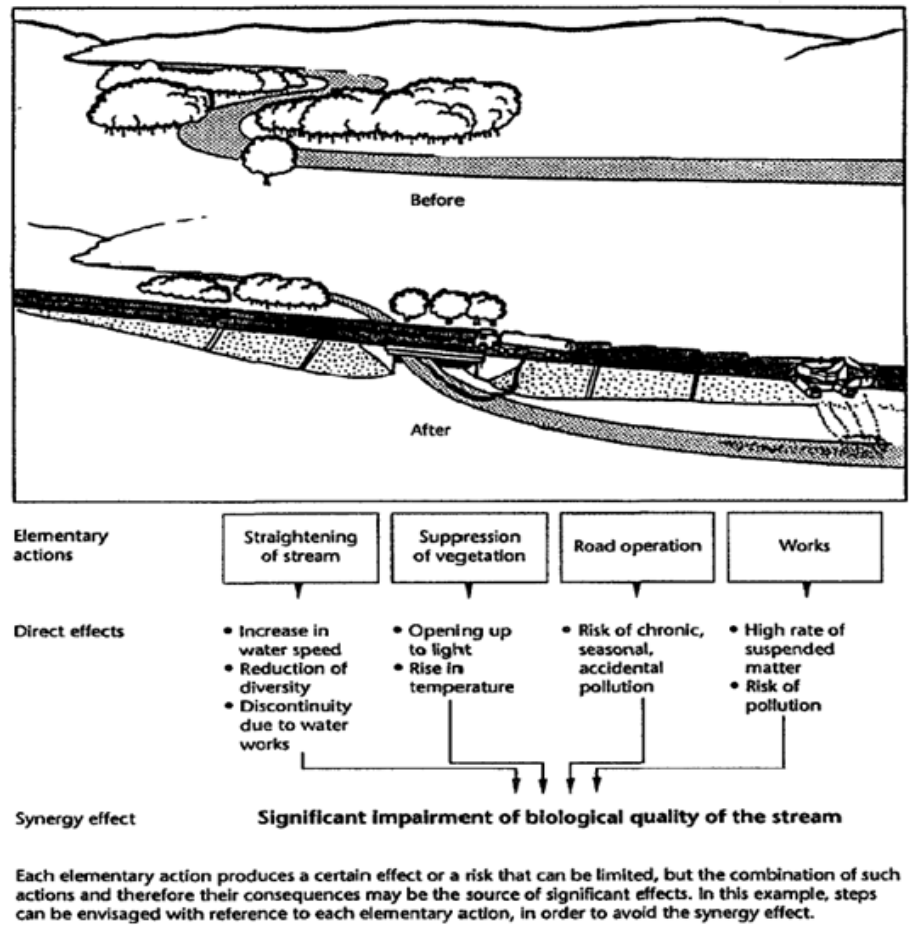


Figure 2: Cumulative Impact of the Stream

Positive and Negative Effects

Land transport projects have both positive and negative effects. Same project can have a positive effect on some people and a negative effect on others in a given environment. For an illustration, redirecting streams and springs as part of road construction improve drainage and water supply for roadside agriculturists but can cause disturbance to fish cultivators who depend on the aquatic species.

Other positive effects that can be considered are safe separate lane for bicyclists and pedestrians built into the project. Rain water harvest, retention of water for local use, and flood control systems are still other benefits that the road transport projects incorporate into their projects.

As it happened along the Caribbean coast, the disastrous negative effects are visible only after a few years. The

highway constructed across a mangrove forest traversed the watersheds in which surface and subsurface water movement is complex suffered bad effects. At the time of planning, much was not known about the complex water balance system between sea and forest for the survival of the healthy on both sides of the road. The road constructed destroyed the natural water complex systems in the forest and left the forest dry within three years. This forest required saline water on one side and a good mixture of sea water with fresh water on the other side. The lesson learnt from this ecosystem devastation is very dear to the country and to people who depended on the Mother Nature.

Further, the forest are encroached by the farmers whose traditional grazing fields are fenced by high new raised highways. The cattle farmers are forced to move their herds onto forest or park lands which results in a swift depletion of grass and plants. This affects the basic forest ecosystem along the forest edges and threatens the inhabitants therein.

Random and Predictable Effects

Random effects are those with a low probability and the predictable effects are those that can be envisaged at the initial stage of the project. Negative effects that are predictable are prevented in the road projects. And what is random and unpredictable should be given adequate consideration in the zero-damage strategy planning and implementation of mega road projects. Population migration to new settlement near the new constructed roads come under predictable effects while the accidental pollution, wildfire, or spillage of toxic elements are random and unpredictable effects of the road transportation activities.

Local and Widespread Effects

Local effects affect the immediate neighborhood of road and the widespread many miles from the project. The destruction of a building, and restriction caused to farmers are local effects of road construction. Widespread effects are often indirect that arise over a longer period of the project. The deforestation, influx of the settlers, and the construction of new commercial areas are some of the widespread effects of the road projects.

Temporary and Permanent Effects

Temporary impacts are those whose periodic occurrence is not permanent, and which will eventually reverse themselves, the affected system having returned to its previous state. An example of this type of impact might be the trampling of roadside vegetation during resurfacing; it recovers after a few weeks, to the point where no change from the original state is observable. Permanent impacts are those which are irreversible and the affected system will not reverse back to its previous state on a human timescale and measure.

Short and Long-term Effects

Short-term impacts are those which appear during or shortly after construction; long-term impacts may arise during construction, but many of their consequences appear during the operational phase, and may last for decades.

CONCLUSIONS

The modern advances in transportation have drastically changed the way of living of the futuristic society of human beings. The location of activities and goods and services for human consumption has been altered due to land transportation in particular.

- The Ecosystem along the roadways is destabilized negatively leading to erosion, ground water depletion, habitat

fragmentation and chemical pollution.

- Motor vehicle emissions will have adverse impact on the human beings, animals, birds and fauna.
- Loss of habitats by the transport infrastructure is an inevitable result of land use.
- An efficient non – polluting transport system is a necessary condition for a gradual economic development.
- A sustainable transport system should offer mobility and accesses to all urban and rural residence in secure and eco-friendly mode of transport.

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