INDIAN STREAMS RESEARCH JOURNAL
ISSN NO : 2230-7850
IMPACT FACTOR : 5.1651 (UIF)
VOLUME - 12 | ISSUE - 6 | JULY - 2022

IMPACT OF CHAR DHAM HIGHWAY EXPANSION ON HIMALAYA ECOSYSTEM: POLICY SUGGESTIONS AND RECOMMENDATIONS

Madhuri Meena
Department of Geography,
Delhi school of Economics, University of Delhi, India.

ABSTRACT

Road expansion refers to the increasing rate at which roads are constructed across the globe. Increase in population size and GDP, particularly in developing nations, are drivers of road expansion but mainly because of transportation planning decisions. Road expansion has some positive but many potential negative impacts. Roads will facilitate access to markets, health services and education but may allow greater exploitation of the natural environment, and can negatively impact communities, biodiversity and economies of the Himalaya. Many studies have pointed towards the negative impacts of the road construction such as landslides, air and water pollution, waste which is overshadowed by the greed of human development. Long term impacts of road building will be definitely seen on the residents of the area. Along with the problems many policy suggestions and solutions are also discussed which can help to mitigate the negative impact of road expansion such as strategic approach to road management, local capacity building, greening of the roads, formulation and implementation of various mitigation techniques along with its effective monitoring over the time and lastly awareness programs need to be conducted for the local population and construction authorities.

KEYWORDS : *Road expansion, landslide, waste, green roads, local capacity building, awareness.*

1. INTRODUCTION

The article focusses on the potential negative environmental impact of Char Dham Highway expansion in the Himalaya region. The paper caters to various research findings and literature review already done in this area which supports the impact which are being felt on various physical, biological and social parameters of the region and suggestions which are likely to reduce these impacts over the period of time. The study will be important for various land use planners, government authorities, tribal population living in the hilly areas, people dependent on the forests, construction authorities as well as for the local population. This project of Chardham Mahamarg Vikas Pariyojna, whose foundation stone was laid in December 2016, seeks to improve connectivity between four pilgrimage sites – Kedarnath, Badrinath, Yamunothri, and Gangothri – in Uttarakhand. The project, which costs around Rs 12,000 crore, seeks to develop approximately 889 km of road in the Himalayan region. The Char Dham project will focus on the widening of the existing roads in the region, along with ensuring adequate and sufficient slope protection. The entire length of the highways will be two-laned with paved shoulder and with a minimum width of 10 metres (Saadhya Mohan, 2021) . Though the project is made to facilitate and solve various problems of the hilly region such as strategic connectivity, tourism, transportation,

connection of the four Dhams of the region but alongside many negative impacts are being witnessed which cannot be overlooked in the guise of development.

As we all know that this Himalayan region is mostly disaster prone. The Ganga-Himalaya basin is one of the most fragile, vulnerable valleys in the entire Himalyan range. In the recent past many disasters have struck this area like kedarnath floods (2013) which led to catastrophic loss to both the life and property. Authorities should plan the minimal construction in such a way that this risk of disaster can be minimized. It is a great responsibility that the decision such large scale infrastructure projects, which have proven to cause so much environmental impact, should not have been taken like this. Pandemic had also added to the woes of the people in the region with these impacts which is leading to many difficulties for the population. Owing to this high growth and requirement of roads for rural connectivity, tourism potential and security needs, the road sector lacks effective framework to address the environmental impacts from road construction. Large scale development of linear projects (roads, railways, highpower transmission lines) in fragile Himalayan Ecosystem have intensified forestfelling/deforestation, accelerated soil erosion manifold, destroyed surface and underground drainage system leading to drier conditions, and initiated mass-movement at places neighbouring the infrastructural development pointing to destabilization overcast stretches (environicsindia, 2018)

Climate change is another ensuing problem of the recent time. Though climate is changing due to both natural like volcanic eruptions, ocean currents, the Earth's orbital changes, solar variations, internal variability and anthropogenic reasons such as transportation, livestock farming, industries, burning of fossil fuels, deforestation and like, the real culprit for all these changes are human activities in the recent times. All these changes can be connected to the tragedies taking place in the Himalayan ecosystem. Development of rural road network in Himalaya is constrained by its topography, geological condition of Himalayan region, scarce financial resources and lack of sufficient and experienced technical manpower in the districts. Conventional road building techniques without addressing properly the environmental issues have made the road building a costly endeavor and unsustainable. Another vivid aspect of Himalayan Road construction is the resource depletion. There is situation of acute unemployed manpower at one hand and there is big resource depletion taking place through the conventional road building by means of fuel, machinery, materials used in construction.

Considering all these problems; low-cost, resource conservation-oriented roads constructed with local resources and people's participation seems to be the viable alternative for the expansion of road network in mountains to its rural corners (Hare Ram Shrestha, 2009). Many problems effecting the physical factors of the Himalaya area are being witnessed like air where (Ingle et.al, 2005) reported that shopkeepers working at the highway sides are at high risk of exposure to the air pollution caused by heavy highway traffic, water where (Abewickremal et. Al, 2013) projected that there was increase in BOD and E. Coli were attributed mainly due to uncontrolled runoff and discharge from the site as well as the reason for increase in DO, soil pollution where (Ndiokwere, 1984) found decrease in concentrations of the metals with distance and high accumulations of the metals on soil samples near to the highway than from sites at a greater distance, contamination of the groundwater, disposal of the waste and debris in the river which further leads to blockage of the stream flow, incidences of the landslides are increasing where studies such as (Sajwan KS et. Al, 2016) projected that Habitation and infrastructure development initiatives in close proximity of streams and rivers as also unplanned disposal of excavated rock and debris are observed to aggravate the fury of both the landslides and flash floods.

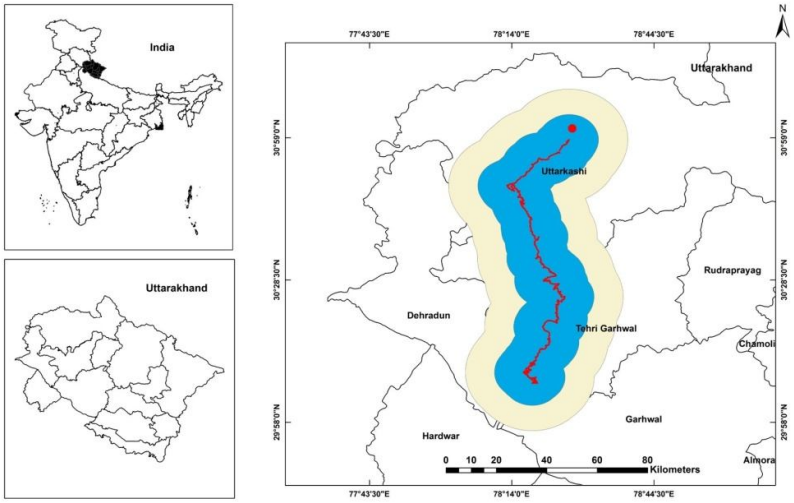
Even biological factors are not being spared. Habitat destruction due to construction is leading to man-animal conflict as the pace of the animals is decreasing. Deforestation is taking place at a very rapid pace without paying any heed to compensating the cutting of the trees. The difference in species richness between the two zones could be due to the edge effects, which often results higher species richness and greater numbers of exotic species at the edges (KC and Gautam, 2012). Further aquatic species are also getting disturbed due to water contamination and stream disturbance. We know that humans are the creators of this infrastructure which is being developed to fulfil their needs and comforts but this in turn is also affecting them also. We can say that to a certain extent yes, the tourism

and connectivity will be benefitted due to this expansion but only at the human's cost. Labour sector is also getting employment due to this project but pandemic have played havoc with their lives again. In comparison humans are at a more loss. As pollution is increasing in air, water, soil this is affecting the human health only. Soil is affecting the agriculture which in turn is affecting the humans. Noise pollution due to hill blasting and construction is disturbing the humans as well as the biodiversity. Construction also leads to the vibrations which leads to earthquake like situation. This tells us that the cost of the project in both terms i.e., financial and human is very high. In addition to direct loss of habitat and ecosystems caused by the footprint of resource roads, another spatial aspect is the "road-effect zone"3 that can radiate out from the sides of the road and/or extend downstream where effects on aquatic conditions may be located a distance from the source (Daigle Patrick, 2010).

Environmental effects of roads include spatial and temporal dimensions and biotic and abiotic components. Effects can be local (along a road segment) or extensive (related to a large road network) (Fred Kihara, The Nature Conservancy). Spatial effects of roads vary because species habitat requirements and ecosystem characteristics are diverse. Many studies have already been done on the negative impact of road construction such as (Nergiz and Durmus, 2016) studied that some birds failed to find alternative nest area affected by habitat destruction caused by road construction activity. Even in situations where people are not required to physically move, the project may still impact on their livelihoods or income-generating activities, either temporarily or permanently (i.e. economic displacement) (IFC 2002).

With respect to temporal dimensions, road-related negative effects may occur during road construction or from the subsequent presence, use, and maintenance of the road and its verges. Some species have seasonal life-cycle necessities and require both aquatic and terrestrial habitats to meet their needs. Roads may negatively affect species, habitats, and physical and chemical characteristics at the site and landscape levels. Uttarakhand shares borders with Nepal and China, many roads are managed by Borders Road Organisation (BRO) – a Government of India undertaking. The state of Uttarakhand like many other states has already undergone several road improvement programmes, several are underway and several under implementation with the support of multilateral agencies like the Asian Development Bank (ADB) and the World Bank (WB) (environicsindia, 2018). Owing to this high growth and requirement of roads for rural connectivity, tourism potential and security needs, the road sector lacks effective framework to address the environmental impacts from road construction.

2. STUDY AREA



Uttarakhand , also known as Uttaranchal is a state in the northern part of India. It is often referred to as the "Devbhumi" (literally "Land of the Gods") due to its religious significance and

numerous Hindu temples and pilgrimage centres found throughout the state. Uttarakhand is known for the natural environment of the Himalayas, the Bhabar and the Terai regions. It borders the Tibet Autonomous Region of China to the north; the Sudurpashchim Province of Nepal to the east; the Indian states of Uttar Pradesh to the south and Himachal Pradesh to the west and north-west. The state is divided into two divisions, Garhwal and Kumaon, with a total of 13 districts.

Uttarakhand has a total area of 53,566 km² (20,682 sq mi), of which 86% is mountainous and 65% is covered by forest. Most of the northern part of the state is covered by high Himalayan peaks and glaciers. In the first half of the nineteenth century, the expanding development of Indian roads, railways and other physical infrastructure was giving rise to concerns over indiscriminate logging, particularly in the Himalaya. Two of the most important rivers in Hinduism originate in the glaciers of Uttarakhand, the Ganges at Gangotri and the Yamuna at Yamunotri. They are fed by myriad lakes, glacial melts and streams. The state hosts the Bengal tiger in Jim Corbett National Park, the oldest national park of the Indian subcontinent. The Nanda Devi and Valley of Flowers National Parks, a UNESCO World Heritage Site located in the upper expanses of Bhyundar Ganga near Joshimath in Gharwal region, is known for the variety and rarity of its flowers and plants.

The highest elevations are covered by ice and bare rock. Below them, between 3,000 and 5,000 metres (9,800 and 16,400 ft) are the western Himalayan alpine shrub and meadows. The temperate western Himalayan subalpine conifer forests grow just below the tree line. At 3,000 to 2,600 metres (9,800 to 8,500 ft) elevation they transition to the temperate western Himalayan broadleaf forests, which lie in a belt from 2,600 to 1,500 metres (8,500 to 4,900 ft) elevation. Below 1,500 metres (4,900 ft) elevation lie the Himalayan subtropical pine forests. The Upper Gangetic Plains moist deciduous forests and the drier Terai-Duar savanna and grasslands cover the lowlands along the Uttar Pradesh border in a belt locally known as Bhabar. These lowland forests have mostly been cleared for agriculture, but a few pockets remain.

According to the 2011 Census of India, Uttarakhand has a population of 10,086,292 comprising 5,137,773 males and 4,948,519 females, with 69.77% of the population living in rural areas. Like most of India, agriculture is one of the most significant sectors of the economy of Uttarakhand. National parks in Uttarakhand include the Jim Corbett National Park (the oldest national park of India) in Nainital and Pauri Garhwal District, and Valley of Flowers National Park & Nanda Devi National Park in Chamoli District, which together are a UNESCO World Heritage Site. Uttarakhand has a multi ethnic population spread across two geocultural regions: the Garhwal, and the Kumaon.

3. METHODOLOGY

Various methods like multi criteria decision analysis, SWOT analysis and case studies was used in this study. Case studies involve the documented history and comprehensive analysis of a situation concerning subjects such as industries, organizations, and markets. The distinguishing factor of the case-study methodology is that it aims to bring out unique characteristics and interesting differences in the situation under observation. The case-study approach is typically used for idiographic research, which means it focuses on atypical circumstances and distinctive outcomes as a subjective phenomenon. Another application of case studies is for nomothetic research aimed at building new theory, typically through the analysis of multiple cases and large sets of data within each case. The strong point of case studies is the depth of analysis that they offer. The narratives in case studies offer detailed, rich descriptions of situation and their context. More experienced researchers have shown that multiple-case methodologies can be used to build theory via replications logic. Each case serves as a separate experiment that stands on its own as a discrete unit of analysis. Multiple cases can be viewed as distinct experiments, very much like a series of laboratory experiments, which meet the criteria of reliability and generalizability of emerging theory.

4. FACTOR WISE RECOMMENDATION AND SUGGESTIONS TO REDUCE THE NEGATIVE IMPACT OF ROAD CONSTRUCTION

a. Recommendation and suggestions for impact on soil

The likelihood of serious enviromnental impacts on soil as a result of road projects can be reduced by minimizing the area of ground clearance; avoiding sensitive alignments, such as those which include steep hillsides; avoiding previously contaminated sites; replanting disturbed areas immediately after disturbance has stopped. Replanting cleared areas and slopes is the most effective action to be taken in reducing erosion and stability problems. It should be undertaken as early as possible in the construction process, before erosion becomes too advanced; to be most effective, it should be done immediately after the disturbance takes place (Tsunokaw Koji, 1997). Well-established engineering measures for slope protection include intercepting ditches at the tops and bottoms of slopes, terraced or stepped slopes to reduce the steepness of a slope, retaining structures, retaining walls and shotcreting and geotextiles. Drainage improvement and compensatory measures needs to be adopted wherever necessary.

b. Recommendation and suggestions for impact on water

Remedial measures include various mitigative and preventive measures which helps in reducing the impact of road construction on water. Laws like The Water (Prevention and Control of Pollution) Cess Act, 1974 should be timely implemented. Measures used to avoid severe impacts on local hydrological environment may include avoiding alignments which are susceptible to erosion, minimizing the number of water crossings, leaving buffer zones of undisturbed vegetation, etc and mitigation measures include Flow speed control, Settling basins, Paving, Infiltration ditches, Water collection, control, and treatment wherever possible; Undertake careful planning and design at water crossings, Water resources-sensitive mitigation plans, Invoke laws, regulations and guidelines onwater quantity and quality which helps in arresting the negative impacts of road construction(Tsunokaw Koji, 1997).

c. Recommendation and suggestions for impact on air

Impacts of motor vehicle air pollution can be prevented by routing traffic away from populated areas and reducing traffic congestion (Tsunokaw Koji, 1997). Dust incidences can be treated by either watering, alternative material choices or using dust binders near houses. If dust binders are used they should be used with care especially when they could affect the local groundwater (Roadex Network, 2021). Project-specific design improvements to limit motor vehicle air pollution impacts include selecting road alignments, providing sufficient capacity to avoid traffic congestion, taking account of prevailing wind direction, avoiding steep grades and sharp curves, sealing high-use dirt roads, planting tall, leafy, and dense vegetation between roads and human settlements to filter pollutants National and regional strategic and regulatory measures related to air pollution may form part of an environmental action plan or an air quality strategy for a major city. Measures could include policies, regulations, charges, and enforcement programs. Where impacts are inevitable, compensation measures are called for. Proper implementation of **National Clean Air Programme (NCAP) under the Central Sector "Control of Pollution" Scheme** is the need of the hour.

d. Recommendation and suggestions to reduce the impact of landslides

Techniques in biotechnical slope stabilization are becoming popular for reducing the environmental impact of slope-protection measures. These so-called "soft" remedial measures not only are environmentally more "friendly" than steel and concrete retaining structures, but they often are more economical and provide better long-term stability (Robert L. Schuster et. Al, 2021). Biotechnical slope protection consists of two elements: biotechnical stabilization and soil bioengineering stabilization, both of which entail the use of live materials – specifically vegetation (Gray and Sotir, 1996). Biotechnical slope-protection systems blend into the landscape. They emphasize the use of natural, locally available materials, such as soil, rock, timber, and vegetation, in contrast to man-made

materials, such as steel and concrete. The structural or mechanical components do not visually intrude upon the environment as much as conventional earth retaining structures (Gray and Leiser, 1982).

e. Recommendation and suggestions for impact on flora and fauna

Elevated highways over wetlands or lowland forest, wider bridges and wildlife-safe tunnels and other nature engineering options are important and should be encouraged as a part of the development of new highways. Signages that provide a means to alert about the locations of wildlife-crossings are also important in controlling the speed of the vehicles especially on roads passing through forest and wildlife habitats (DAVID MAGINTAN, 2012). Acts such as Wildlife (Protection) Act in 1972 and Environment Protection Act, 1986 should be followed properly.Wherever possible, road develop ments should be located more than one kilometer away from sensitive areas to avoid severe impacts on flora and fauna (Tsunokaw Koji, 1997). Re-engineering road cross-section designs, Planting, Animal crossings, Fencing, Water crossings, Traffic control measures are the additional measures needed to be taken to tackle the problem. Constructions authorities and governments should Collect relevant data, Make informed alignment choices, Select preferred design, Prepare mitigation plan and prepare Legislation and regulations in regard with this problem.

f. Recommendation and suggestions for communities and their economic activities

The splitting of a community can be minimized by taking account of local movements at the road design stage and by making provision for improved crossings or alternative access routes (Tsunokaw Koji, 1997). The effects of bypassing local businesses The effects of bypassing local businesses can sometimes be mitigated by providing service areas adjacent to the new routes and by encouraging local communities to make use of the new opportunities provided. Resettlement and compensation may need to be considered for those whose housing, land, welfare or livelihood is directly affected by a project. Minimizing impacts on communities and their economic activities can be done by undertaking various effective methods like collecting Baseline data and potential environmental impacts, Analysis of alternatives, Mitigation plan, Environmental specifications for contractors and proper formulation of laws and legislation.

g. Recommendation and suggestions to reduce the impact of land acquisition and resettlement

To safeguard against the possibility of negative outcomes, it is imperative that sufficient attention is given to ensuring that people have participated throughout the process and have been able to properly establish themselves in their new location with ongoing viable livelihoods. In the case of land-based livelihoods, for example, if there are agronomic differences between the old farmland and the new environment, assistance may be needed to adapt farming strategies (Frank, 2017). Impacts on roadside land users can be avoided by choosing route locations away from built-up areas and by restricting the extent of road works to avoid interference with existing activities. The adoption of a reduced-speed design, reduced right-of-way land requirements, or design changes can avoid impacts on properties and activities (Olken Benjamin (2007). THE RIGHT TO FAIR COMPENSATION AND TRANSPARENCY IN LAND ACQUISITION, REHABILITATION AND RESETTLEMENT ACT, 2013 should be properly implemented in the effected areas. The Act has provisions to provide fair compensation to those whose land is taken away, brings transparency to the process of acquisition of land to set up factories or buildings, infrastructural projects and assures rehabilitation of those affected.

h. Recommendation and suggestions for impact on Indigenous population

The use of more rigorous approaches to project assessment and planning, such as cost-benefit analyses, proactive land-use planning, and strategic environmental-impact assessments are processes important for the improvement of road developments. One way to accomplish this is through the formulation of an indigenous peoples development plan (IPDP) for any project that affects them (Tsunokaw Koji, 1997). Local consultation and participation also provide an opportunity to determine whether traditional groups wish to remain in the area , or to relocate to some other area. Thorough

consultation, participation, and social analysis can assist in the design, implementation, and monitoring of such measures. Studying Baseline data and potential environmental impacts, Analysis of alternatives, Mitigation plan and proper formulation of the laws is the necessity of the hour.

i. Recommendation and suggestions for impact on noise pollution

Various measures to reduce the noise are quieter vehicles; quieter tyres; quieter road surfaces; traffic measures (e.g. speed reduction); noise barriers; home insulation. Engineering controls isolate people from the noise hazard. Certain pieces of equipment help reduce the noise by enclosing or re-routing the path of noise from the source. Administrative controls are changes in the way people work. These controls are less about the equipment within a construction site and more about optimizing the work schedule to lessen noise effects on workers (Bigrentz, 2021). A simple but fairly effective measure to manage the effects of noise is to notify the persons likely to be affected that work is about to start. A general piece of advice that applies to noise is to use modern equipment wherever possible. Such equipment normally has better noise and vibration attenuation than older machines. Modern machinery also offers other benefits, such as reduced emissions, etc. (Roadex network)

j. Recommendation and suggestions to reduce the impact of waste

Good handling of materials can enable most residual materials to be put to use in one way or another. If the quality of material is too poor to use in the road structure, it can usually be employed as landscaping material, e.g. to level out steep slopes. Some waste will of course always occur, e.g. packaging material, oil residues and the like, but these should be minimized (Roadex network). It is particularly important that environmentally harmful waste should be transported to landfill or incineration plants intended for this purpose. During road construction and maintenance all vehicles on the site need to be serviced appropriately to ensure that there are no leaks. Waste management fees, under the 'polluter pays principle', can help mitigate levels of construction waste. Taxing landfill has been most effective have all decreased their landfill disposal by over 30% since introducing the tax.

5. Recommendation and suggestions to reduce the impact of road construction worldwide

a. THE KECAMATAN DEVELOPMENT PROGRAM (KDP)

KDP is an Indonesian Government program established in 1998, supported by a loan from the World Bank. As of 2004, KDP funded projects in approximately 15,000 villages each year. Each village received an average of Rp. 80 million (US$8,800), which they usually used to surface existing dirt roads. KDP funded projects are large relative to ordinary local government activities. In 2001, the average annual village budget was Rp. 71 million (US$7,800), so implementation of a KDP project more than doubled average local government expenditures. The influx of such a large amount of money through KDP creates opportunities for a high level of leakages (Luke Whistler et. al (2013).

5.2 CASE STUDY ABOUT ENVIRONMENTAL IMPACT OF HIGHWAY PROJECTS AND ITS CONTROL (Texas, USA)

This research digest presents Research Scheme R-57 of the Indian Ministry of Surface Transport (MOST). The basic objectives of the scheme's project proposal are to assess the environmental impacts of road widening and the resulting construction, and of a new road such as a bypass. Locations on National Highway NH-2 and State Highway SH 45 were selected for study. At each location, there was: (1) a study of traffic including its composition; (2) measurement and analysis of noise; (3) measurement and evaluation of air pollutants; (4) monitoring of water pollution; and (5) monitoring of soil erosion. These field studies were followed by laboratory studies. A Doppler radar speedometer was used to observe the speeds of different types of traffic. A table shows the concentrations of various pollutants observed: particulates, sulphur dioxide, nitrogen oxides, carbon monoxide, hydrocarbons, and lead. Air and noise pollution were increased significantly by the widening and construction work on the NH-2. However, no changes in water quality and no soil erosion were observed at either site during

the study period. Three specific measures for reducing noise and air pollution are outlined, and four recommendations are made for further research (Olken Benjamin (2007).

5.3 Case Study – Chile 2000kms of Salt Roads – Caminos Básicos

The "Caminos Básicos 5 000" programme has improved 5 000 km of low traffic roads using lowcost construction techniques. In particular 2 000 km of roads have been made with readily available salt (magnesium and calcium chlorides) in the northern regions of the country. This salt construction method has delivered inexpensive roads at the same time as generating local skills and providing employment. The techniques carried out on the "Caminos Básicos 5 000" are now being repeated in similar circumstances across Mexico, Bolivia, Peru and Argentina. There is also a history of salt road construction techniques in Botswana and Namibia (Luke Whistler et. al (2013).

5.4 Case Study – Western Australia

95 per cent of Road Construction Waste Recycled – Main Roads WA

The Great Eastern Highway is a major connection between the metropolis of Perth and the nearby city of Kalgoorlie. It is also a key freight connection to the wheatbelt and goldfields. Recent upgrades to the highway necessitated the demolition and removal of a number of buildings in Midvale. Previously, this waste would have been sent to landfill, but Main Roads WA were able to seize the opportunity to reuse much of the construction waste in other projects. Main Roads engaged local business All Earth Group for this work, and 95 per cent of the waste was recycled in various ways – in a new carpark for the Perth Airport, in steel recycling plants and for garden and farming mulch. This project is a significant step in the process of encouraging recycling of construction and demolition waste in Western Australia, which has traditionally fallen behind other Australian states in its recycling programs. Indeed, most recycling companies in WA now find that the demand for recycled products far outstrips the supply of material sent to them rather than dumped in landfill. Hopefully, with Main Roads WA leading the recycling way, other companies will soon follow, and thus help to reduce the huge amount of waste sent to landfill every year in Western Australia (Luke Whistler et. al (2013).

5.5 Case Study – Queensland

Foamed Bitumen – Department of Transport and Main Roads

In 1997 a 1.6 km section of the Cunningham Highway was the site of the first foamed bitumen trial, and it also included the replacement of cement in the bitumen blend. Smaller tests had been conducted in Australia but none were conducted on this magnitude. This trial concluded that the use of foamed bitumen in the construction of roads allowed traffic to use the road earlier than in conventional methods, and the long term use of foamed bitumen was deemed feasible. The foamed bitumen process uses a mixture of air, water and bitumen. Cold water is added to and the mixture is then combined with the bitumen and cement particles to form a usable base for road construction as shown below in Figure 3. Figure 3 Foamed Bitumen on the Cunningham Source: Evans, P (2011)63 The Cunningham Highway trial showed no signs of distress from road use. The road was later lightly sealed and continued to operate. After two years of service it showed minor signs of distress but was considered acceptable for continued operation. The results of this trial support further use of foamed bitumen throughout Queensland. Given the success of the 1997 Cunningham project it was decided to implement this technique on a larger scale project, and so in 1999 a 17 kilometre section of the New England Highway between Warwick and Toowoomba was replaced using foamed bitumen stabilisation. The blend used was adjusted from the Cunningham project to take into account differences of scale, weather and climate. This blend was 3.5 per cent bitumen and 1.5 per cent quicklime. After 3 years of service 1 per cent of the road was showing signs of distress, which was considered normal, and the road is still in service today after 12 years (Luke Whistler et. al (2013).

6. CONCLUSION

Problems persist in every development project but if done with proper care and precautions they can be minimized and in some cases can be completely avoided. Minimizing the mass wasting and to reduce the post construction landslides along the hill roads are very important to harmonize the road development with fragile hills. Thus mass balanced method of hill road construction, selection of optimal alignment, labor-based implementation of construction, phased construction approach, optimization of width of the roads, re-use of excavated material as construction materials, optimizing the drainage requirement, minimization of blasting for rock excavation and bioengineering works for road slope stabilization are the major consideration to harmonize the road development in the mountains. It is also very importance that governments at all the levels, NGOs, civil societies and local population should be included in the policies meant to solve the negative environmental issues.

Policy of planned undertaking of road construction with labour-based construction method, participatory management of road construction, social mobilization support and technical support is required. Training to local people for transfer of know-how and their capacity building at local level is very important. After the completion of construction appropriate operation and maintenance management mechanism is to be established and adherence is required for its sustained use. Lastly proper formulation and implementation of various government rules, laws, policies and programs is the need of the hour. After implementation it is also important that proper monitoring of such programs should be done to ascertain whether all the objectives and aims are properly fulfilled. Green roads approach should be followed by every country taking into loop the concerns of the environment and the people of the region. Lastly in India National Mission for sustaining the Himalayan ecosystem under NAPCC will play a major role in improving the conditions of the mountain region.

7. REFERENCES

Abewickremal AWN, Amanthika RWM, Abeysinghe ALTM, Tennakoon RK, Tennakoon AH, Caldera HMM (2013) Assessment of water quality impacts of Highway and road construction projects. South Asian Institute of Technology and Medicine Research Symposium on Engineering Advancements, 2013, 136-143.

BigRentz, Inc. (2021). How to Prevent Noise Pollution in Construction.

Daigle Patrick. (2010). A summary of the environmental impacts of roads, management responses, and research gaps: A literature review, BC Journal of Ecosystems and management,

Environmental Concerns: Linear Projects in Himalayas,

ENVIRONMENTAL ISSUES RELATED TO ROAD MANAGEMENT, Roadex network.

Gray, D. H. and Leiser, A. T. (1982). Biotechnical slope protection and erosion control. pp.271

Gray, D.H. and Sotir, R.B. (1996) Biotechnical Soil Bioengineering Slope Stabilization: A Practical Guide for Erosion Control. John Wiley & Sons, New York

Ingle ST, Wagh ND, Pachpande BG, Patel VS, Attarde SB (2005) The influence of workplace environment on lung function of shopkeepers working near National Highway in Jalgaon: A note. Transportation Research Part D: Transport and Environment. 2005; 6(10):476-482.

KC JK, Gautam AP. (2012) Impact of roads on biodiversity: a case study from Karekhola rural road in Surkhet district of Nepal, 2012.

Kihara Fred. The Nature Conservancy.

Luke Whistler et. Al, (2013). Reducing the environmental impact of road construction. Curtin University and the Queensland University of Technology

Magintan David. (2015). Mitigation of road related impacts on wildlife. Wildlife Institute of India.

Ndiokwere CL. (1984) A study of heavy metal pollution from motor vehicle emissions and its effect on roadside soil, vegetation and crops in Nigeria. Environmental Pollution Series B, Chemical and Physical. 1984; 7(1):35-42.

Nergiz H, Durmus A. (2016) Effects of road construction works on some bird communities in Van (Turkey). Journal of Science and Technology. 2016; 6(2):73.

Olken Benjamin (2007). REDUCING INEFFICIENCIES IN ROAD CONSTRUCTION Journal of Political Economy, 2007, vol. 115, no. 2.

SAADHYA MOHAN. (2021). Explained: The Char Dham Project, Its Ecological Impact & the SC Judgment.

Sajwan KS and Sushil K (2016) A Geological Appraisal of Slope Instability in Upper Alaknanda Valley, Uttarakhand Himalaya, India; Journal of Geology & Geophysics

Schuster Robert L. and Highland Lynn M. (2021). Impact of Landslides and Innovative Landslide-Mitigation Measures on the Natural Environment, Geologic Hazards Team, U.S. Geological Survey, Denver, Colorado, U.S.A.

Shrestha, Hare Ram. (2009). Harmonizing Rural Road Development with Mountain Environment: Green Roads in Nepal.

Tsunokaw Koji et. al (1997). Roads and the Environment.

Vanclay Frank. (2016). Project-induced displacement and resettlement: from impoverishment risks to an opportunity for development? Impact Assessment and Project Appraisal Volume 35, 2017 - Issue 1: Displacement, resettlement and livelihoods.