Appraisal of Geoenvironmental threats posed by Indo-Myanmar Kaladan Multi Modal Transit Transport Project (KMTTP) in southern Mizoram, India

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Abstract

Mizoram, the southernmost of the seven sister States in Northeastern India, shares borders with Tripura, Assam, Manipur, Bangladesh and Myanmar. Despite its challenging connectivity to mainland India, the region holds strategic geographic advantages. The Kaladan Multi Modal Transit Transport Project (KMTTP) was initiated in 2008 to enhance trade and connectivity between India's northeastern States and the rest of the world via the Sittwe port in Myanmar. This project includes the development of a 100 km highway from Lawngtlai, Mizoram to the Myanmar border and navigable waterways linking the Kaladan River to inland transport networks. Geologically, the Kaladan river traverses Oligocene-Miocene sandstones and shales with its course passing through semi-evergreen and bamboo forests.

The project, however poses significant environmental challenges including large-scale dredging (2 million cubic meters of sediment), deforestation and altered river nutrient cycles. Increased soil erosion due to high rainfall (254–350 cm annually) threatens aquatic biodiversity and navigation. Sustainable mitigation strategies such as silt traps, riparian vegetation restoration and erosion control using dirt glue polymer are essential to balance development with ecological preservation. Achieving socio-economic growth while maintaining environmental equilibrium remains a critical challenge for the region.

Keywords: KMTTP, Geoenvironmental, threats, Mizoram, Myanmar.

Introduction

The Kaladan Multimodal Transit Transport Project (KMTTP) is an ambitious strategic plan initiated by the Indian Government and fully funded as well. It will be a game changer in the development of the Indo-Myanmar and hitherto most unapproachable Mizoram regions. This project targets to boost trade and connectivity between Manipur, Mizoram and Tripura with Myanmar for regional economic growth. Kaladan river flows through Myanmar and India and forms part of the Kaladan corridor. The river flows in Myanmar and Mizoram and finally drains into the Bay of Bengal. The river systems of Mizoram bear huge potential and avenue in the multi modal transport system in the region[10]. The KMMTTP will provide an alternative and much shorter transport route for goods and passengers between Northeast India and Myanmar, bypassing the very long and tedious journey of more than 1500 km through rough mountainous terrain with poor railway and road infrastructure.

The Kaladan project includes three main phases:
1. Port development (Sittwe Port, Myanmar) at the mouth of Kaladan River.
2. River Navigation on Kaladan River.
3. Road Transport from Sittwe Port to Mizoram and Tripura states.

Indian Government came up with this visionary idea with an ambition to boost India's trade and cultural ties with its Asian neighbors on one hand and with the other to transform the socio-economic scenario of the land-locked northeast region of the country. Further, to reach the southern tip of Mizoram (Lawngtlai and Saiha districts), another 24 hr road travel is needed.

In contrast, the distance between Sittwe port (Myanmar) and Haldia port is only 600 km and the distance between Visakhapatnam port and Sittwe port is 1,030 km. Traveling through the Bay of Bengal from Kolkata (India) to Sittwe port (Myanmar) takes only 12 hr. This sea route has drastically reduced the total travel time from 48 hr to 12 hr.

Since 9th May, 2023 the Sittwe port has been operational and ships have already been reaching there from Haldia port and Visakhapatnam port. After the completion of interlinking of road and waterways from Sittwe port to north Mizoram, the distant barriers will collapse greatly and the northeastern region of the country will no longer remain land locked.

The significance of the KMMTTP port has been highlighted, with ongoing dredging activities at Sittwe port and along the 158 km Sittwe - Paletwa river stretch along with the delivery of six IWT vessels[2]. These observations are well explained in fig. 1. In the light of this fact, India has developed the Sittwe port at the mouth of Kaladan river, at a cost of Rs.5.4 billion. This port can be seen as the gateway for the northeastern States to the rest of the world. The new 100 km highway, from Lawngtlai in eastern Mizoram to Myanmar border at an estimated cost of Rs.650 crore, is coming up on

NH-54, to provide linkage with the Sittwe port in Myanmar. 98% of the road construction has been completed.

Rs. 1,132 crore road connecting Mizoram with Myanmar under Kaladan project is expected to be completed by July, 2025. In addition, India and Myanmar have agreed to open a border trade center at "*Zokhawthar*" in Mizoram and "*Avakhung*" in Nagaland. A border trade center "*Moreh*" in Manipur already exists.

Material and Methods

Location and Accessibility: Mizoram is located in the Northeastern India bordered by Myanmar to the east and by Bangladesh to the southwest. It has an area of about 21,087 km^2 having population of 12, 52,000 (2011 Census). It spreads between latitudes 21º56´N and 24º31´N attitudes and longitudes 92º16´E and 93º26´E as in fig. 2. Aizawl is the capital of Mizoram 92º60' E longitude and 23º58' N latitude. Lunglei, Lawngtlai and Saiha are connected to mainland India through NH 54 to Silchar, Shillong and Guwahati. In addition, Aizawl is also connected by air service to New Delhi, Kolkata, Guwahati and Imphal. Aizawl is very likely to come on the railway map of India by December, 2025 after the completion of Bairabi- Sairang (Aizawl) railway line.

Climate: Mizoram has a moderate climate. The winter temperature ranges between 7^0C to 20^0C and the summer temperature between 17^0C to 30^0C. Mizoram comes under the heavy rainfall zone under the influence of SW monsoon. Maximum rainfall is received between May and September. Mizoram's annual rainfall is 254 cm, the maximum rainfall being over 350 cm. Mizoram is known for its pleasant cool weather and abundant rainfalls.

Relief: The relief map of Mizoram as in fig. 3 shows that most of the western margin is a low elevation zone (less than 300 – 600 m.). Most of the eastern part is having higher elevation (900-1800 m.). Many higher peaks of more than 1800 m are located mostly in the central and eastern regions of the State[9].

Flora: In the study area around KMMTP, a wide range of flora have their natural habitat. *Cleome speciosa, Mahonia pycnophylla, Mesua ferrea, Saurauia nepaulensis, Abelmoschus manihot, Bombax ceiba, Semecarpus anacardium, Cordia dichotoma, Crotalaria anagyroides, Derris robusta, Aganope thyrsiflora, Butea monosperma, Erythrina arborescens, Bauhinia glauca, Saraca asoca, Acacia pennata, Acacia eburnea, Mimosa pudica* etc. are found plentiful.

Geological Setting: Mizoram is a part of Tripura - Mizoram mio-geosyncline which is a component of the Assam - Arakan basin. The Mizoram hills (Lushai Hills) form an integral part of the mobile belt constituted of N-S trending anticlines alternating with broad saucer shaped slightly arcuate westward trending synclines[8,11].

Figure 1: India-Myanmar Trade Through Kaladan Multimodal Transit Transport Project

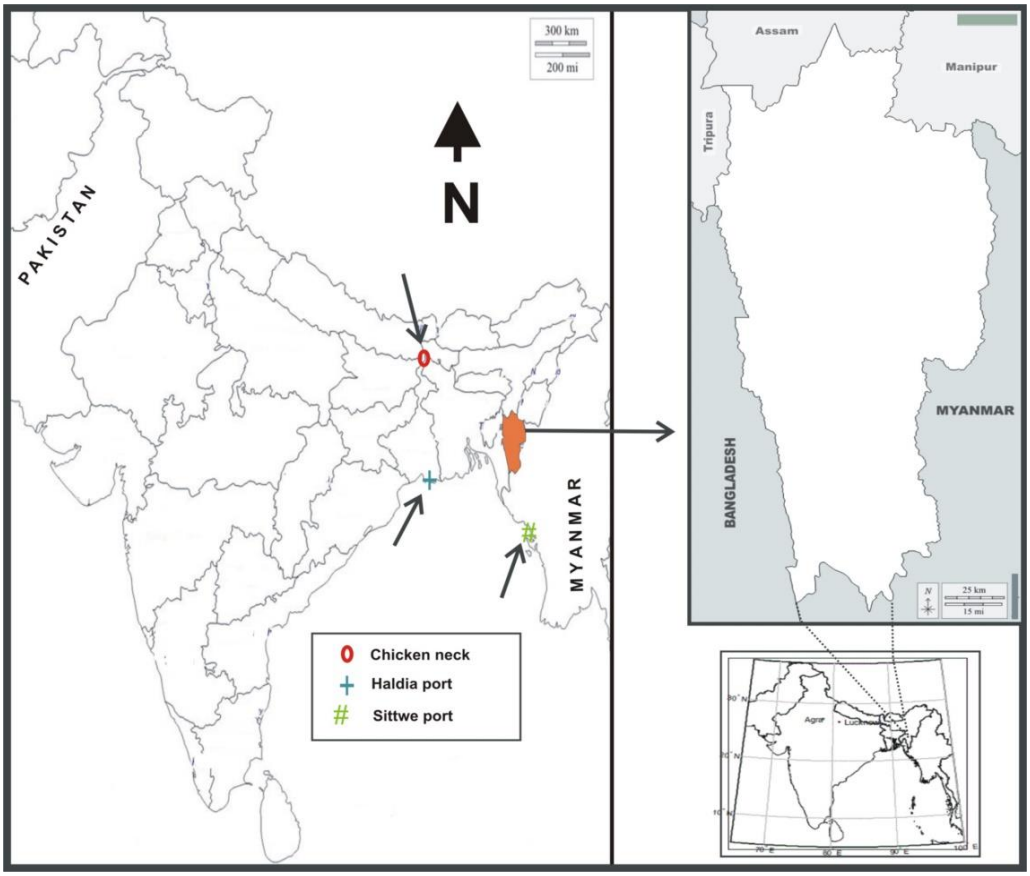

Figure 2: Location Map of Mizoram

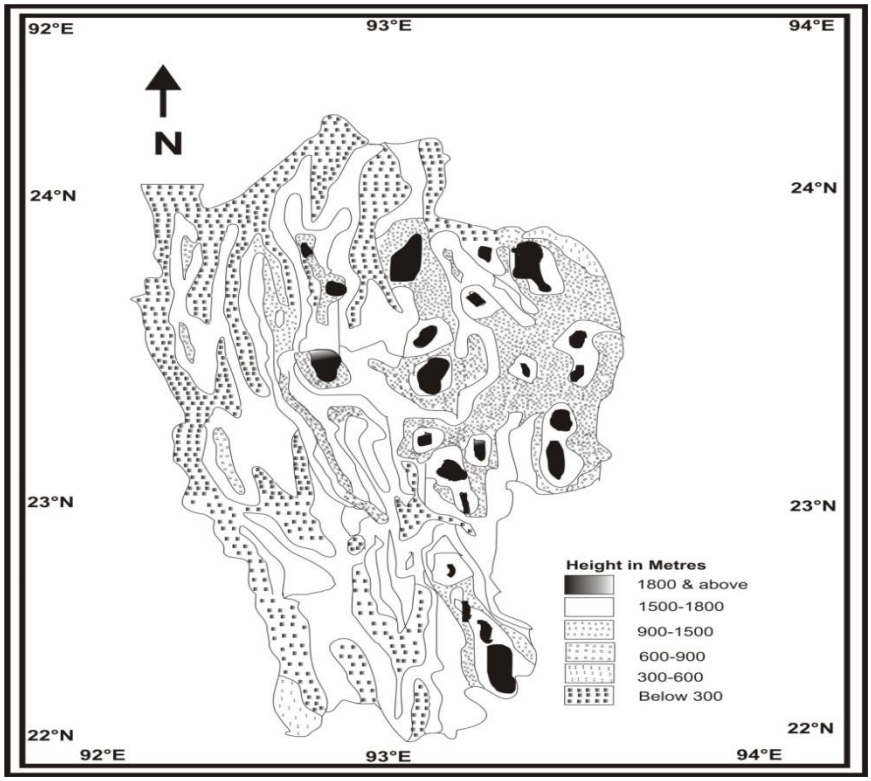

Figure 3: Relief Map of Mizoram

Geomorphology and Physiography: Physiographically, Mizoram is characterized by N-S trending steep, mostly anticlinal hill ranges and synclinal narrow valleys. The other geomorphic elements are the high dissected ridges deep gorges, spurs, keels and cols. The elevation between valley floor and hill tops greatly varies from east to west. The hill

ranges towards the east are steeper than towards west. All the rivers in Mizoram attain maximum volume during monsoon and post monsoon periods.

Tlawng (Dhaleswari), the Tuirial (Sonai) and the Tuivawl start from central Mizoram and flow northward and meet Barak River at the northern border of Mizoram. Karnaphuli flows north from the southwestern tip of the State and halfway along the boundary it enters into Bangladesh where it is tapped for a huge hydel project. The Kaladan river flowing south from Myanmar enters into Mizoram and flows north up to Mat Fault and from there it takes a hairpin bend and again flows south where it re-enters Myanmar again.

Results and Discussion

Geo-climatic Factors: Geologically the entire river course is dominated by sandstones and shales of Oligocene-Miocene period of Surma group. These sedimentary rocks are highly prone to erosion. Previous geological investigations in the region reveal that the rocks of Aizawl have a mixed provenance of sedimentary rocks[6]. The geochemical analyses of the rocks of Aizawl show higher concentration of Ni, Cr, U, Th, Pb and Ga. These heavy metals are finally adding to the ground water through intense soil erosion[4]. The top layer of the soils is loose clayey and loamy, young and immature.

Kaladan river flows through Udalf-Ochrepts-Aqueptus soil terrains during most of its course.These soils have moderate to high acidity with pH value ranging from 4.5-6.5 and contain low K and P. They have loamy texture too. The lower layer is rich in accumulated organic matters. The average rainfall in Mizoram is 254 cm and that exceeds even 350 cm in the southern part of Mizoram including the Kaladan basin. Such a heavy average rainfall of more than 300 cm with a high average discharge rate of Kaladan river (40 cusec/seconds) is capable enough for active lateral erosion.

The Kaladan river, throughout its course flows in the hilly terrain (600-1500 m) amidst the dense sub Himalayan semi Evergreen forests and mixed forests. Only the right bank in the southern part in the lower course is dominated by bamboo forests as in fig. 4.

Geoenvironmental Factors: As per the Inland Waterways Authority of India report, 5,61,954 cm^3 of dredged material was excavated from the approach channel and the port areas of the Sittwe port. The dredged material from the approach channel was dumped in the sea for the reclamation of 48,000 m^2 land. Further, Kaladan will be dredged on at least 35 locations excavating a total of about 20,00,000 m^3 of sand, pebbles, boulders and rocks. This exercise will lead to massive land degradation in the region.

Erosion Index factor: Intense dredging from the downshore area will surely induce slope erosion. To maintain strict vigilance on the impact of the erosion, the universal soil loss equation, devised by Wischmeier and Smith[12] is as follows:

$$A = RKLSCP$$

where A = computed soil loss in tons/ acre/ year, R = rainfall factor (Intensity and frequency of rainfall), K = soil-erodibility factor (including Thaw and snowmelt), L = slope-length factor, S = slope-steepness factor, C = cropping-management factor (Values for Pasture, Construction Areas and Idle Land etc.) and P = erosion-control practice factor (the ratio of soil loss with a specific support practice).

On the basis of above calculations, the erosion index (EI) of soil loss potential and erosion risk in a river valley is calculated. The value of the erosion index depends on various factors such as soil type, land use, vegetation cover, relief, lithology and local annual rainfall. In summary:

- **EI < 10**: Considered safe (within natural regeneration capacity).
- **EI 10-20**: Moderate risk (requiring soil conservation).
- **EI > 20**: High erosion risk (requiring, urgent intervention)

An erosion index <10 is typically recommended in river valleys to prevent excessive sedimentation, habitat degradation and loss of agricultural productivity. Sustainable land-use practices, vegetation buffers and erosion control structures can help to keep erosion at safe levels. More than 70% of Tuirial river basin falls under the "slight" erosion risk category, with soil loss ranging from 0 to 5 Mg ha^{-1} yr^{-1}. These regions have a lower EI <10 by virtue of dense forest covers and gentle slopes[3].

The Tlawng river basin has a variable value of EI between 10-20. Nearly 45.19% of the area is classified under "very low" erosion intensity. These areas are often in the lower reaches of the basin where the landscape has evolved to an old or monadnock stage, indicating minimal erosion activity. Rest of the Tlawng water shed comes under moderate to high risk of erosion. Most of the Kaladan river watershed mainly the Upper Course (Mizoram, India) and Middle Course (Chin and Rakhine States, Myanmar) falls under EI > 20. The practice of shifting cultivation 'jhum', that involves burning and clearing forested areas for agriculture, exposes soil surfaces and aggravates erosion. The erosion becomes more intense during the monsoon season.

Rainfall above 300 cm leads to immense soil erosion, contributing to excess sedimentation in the riverbed. This heavy erosion causes multiple damage such as destabilizing of riverbanks, collapse of homes, uprooting of trees with complete degradation of hill slopes.

The Middle course is susceptible to both mechanical and biological erosion. Apart from mechanical erosion of the sedimentary rocks, there is reported bioerosion through the

borings of organisms. The lower course of Kaladan is having a relatively lower erosion index (EI) than those of upper and middle course. In the proximity of the Bay of Bengal, the Kaladan river traverses gently sloping deltaic plains characterized by extensive mangrove forests, which help in reducing the impact of tidal forces and stabilizing the coastline and riverbanks.

The erosion intensity along the Kaladan river varies significantly across its course, influenced by a combination of natural factors and human interventions. In the upper reaches, steep terrains and agricultural practices like jhum contribute to higher erosion rates, while the middle course experiences both geological and biological erosion processes. The lower course benefits from natural protective features like mangroves, but ongoing development projects pose challenges to erosion control. Comprehensive management strategies are essential to address these varied erosion dynamics and to ensure the river's ecological and economic sustainability.

According to the executive summary of the Mizoram Pollution Control Board, the Kaladan river watershed is under considerable erosion threat, primarily driven by natural monsoonal patterns and potentially intensified by human activities[7]. The pros and cons of development and control in the Borderlands of Myanmar have also been discussed[1]. A comprehensive erosion management strategy to protect both the environment and local communities in the Kaladan river basin is needed.

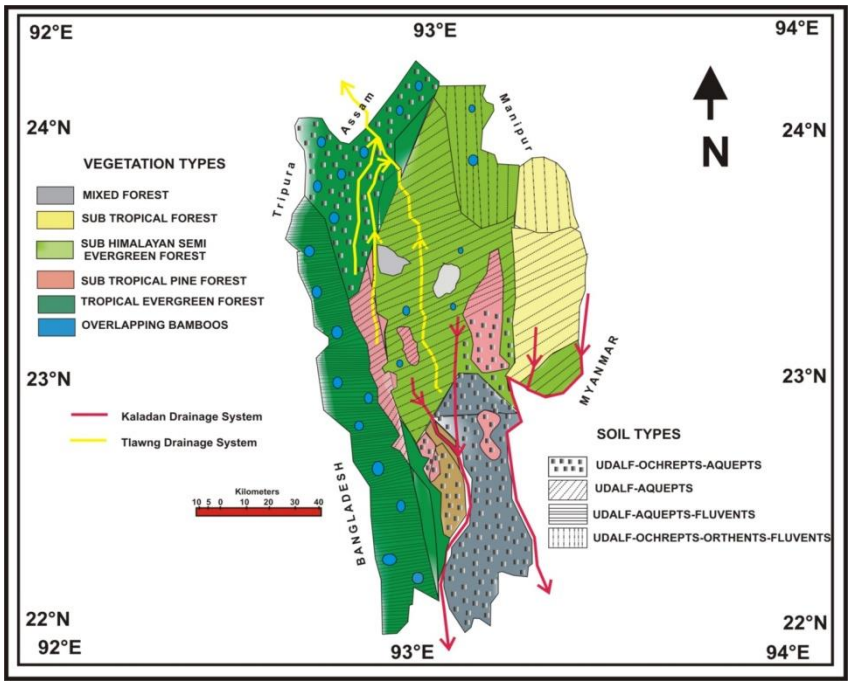

Figure 4: Soil Vegetation Drainage Composite

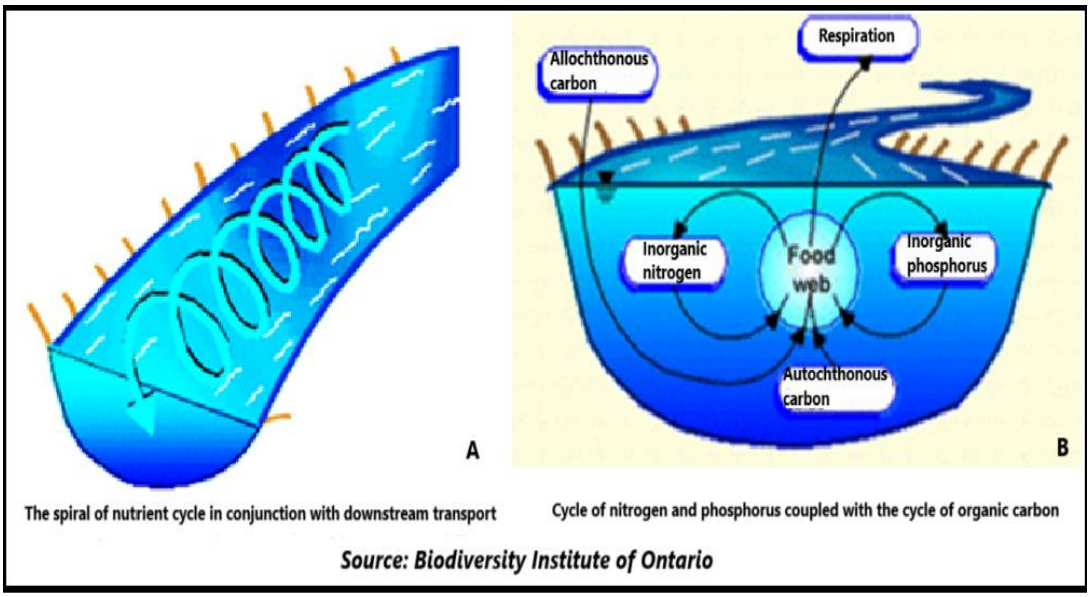

Figure 5: (A) River with Tight Spiral (High SMI); (B) Cycle of Nitrogen, Phosphorus and Carbon in the Food Web

Stream Mobilization Factor: Large scale deforestation and widening of the river channel are must for this KMMTTP project. Widening and deepening of river channel surely lead to the reduction of dissolved organic matter (DOM, CPOM and FPOM) and also weaken the nutrient cycle of the river. The universal fact is that a stream with a tighter spiral or shorter spiraling length is more efficient in recycling its nutrient resources and they are considered to have a higher stream metabolism index fig. 5. A stream with lower SMI will be weaker in the river recycling capacity. The reduction in the SMI will lead to the deficiency in a number of major ions in river water such as nitrogen (N), phosphorus (P), calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), chlorine (Cl), the macronutrients and dissolved organic carbon (C)[5].

The metabolic activity of a river is controlled by two major sources of organic matter: Primary production from living organisms occurs within the river (autochthonous) and organic matter is derived from the land surrounding the river (allochthonous). It is noteworthy that the soil erosion is at its peak during monsoon and post monsoon season. The eroded material will be deposited as the excess silts in the riverbed and smother riverbed reduces the aquatic populations on one hand and will hamper the navigation on the other hand.

Conclusion

The solution lies in maintaining the equilibrium between development and environment. The main task is to maintain the "river continuum". The suggested effective control measures as in fig. 6 A-I are as follows:

A. Install coarse woody debris to create living and dead soft revetments in areas of actively eroding riverbanks.
B. Fence out the livestock to remove the overgrazing pressure.
C. Construction of Spurs to check excess run off.
D. Intensify "bamboo plantation all along the slopes in the Kaladan basin, as bamboo is a great source of oxygen and also a great measure to prevent soil erosion and landslides.
E. Intensify grass cover in the lower slope as erosion control mat.
F. Plantation in the upstream area to check runoff in the upper slope.
G. A large high strength geo textile tube filled hydraulically with slurry of sand and water used in coastal and riverine erosion control applications.
H. Apply "Dirt Glue Polymer" as a "green erosion control" measure. It is a non-hazardous, non-toxic bonding material with incredible strength.
I. Application of non - woven jute to check erosion.

The Kaladan Multimodal Transit Transport Project (KMTTP) is Indian Government's visionary idea with an ambition to boost India's trade and cultural ties with its Asian neighbors on one hand and to transform the socio-economic scenario of the land locked northeast region of the country.

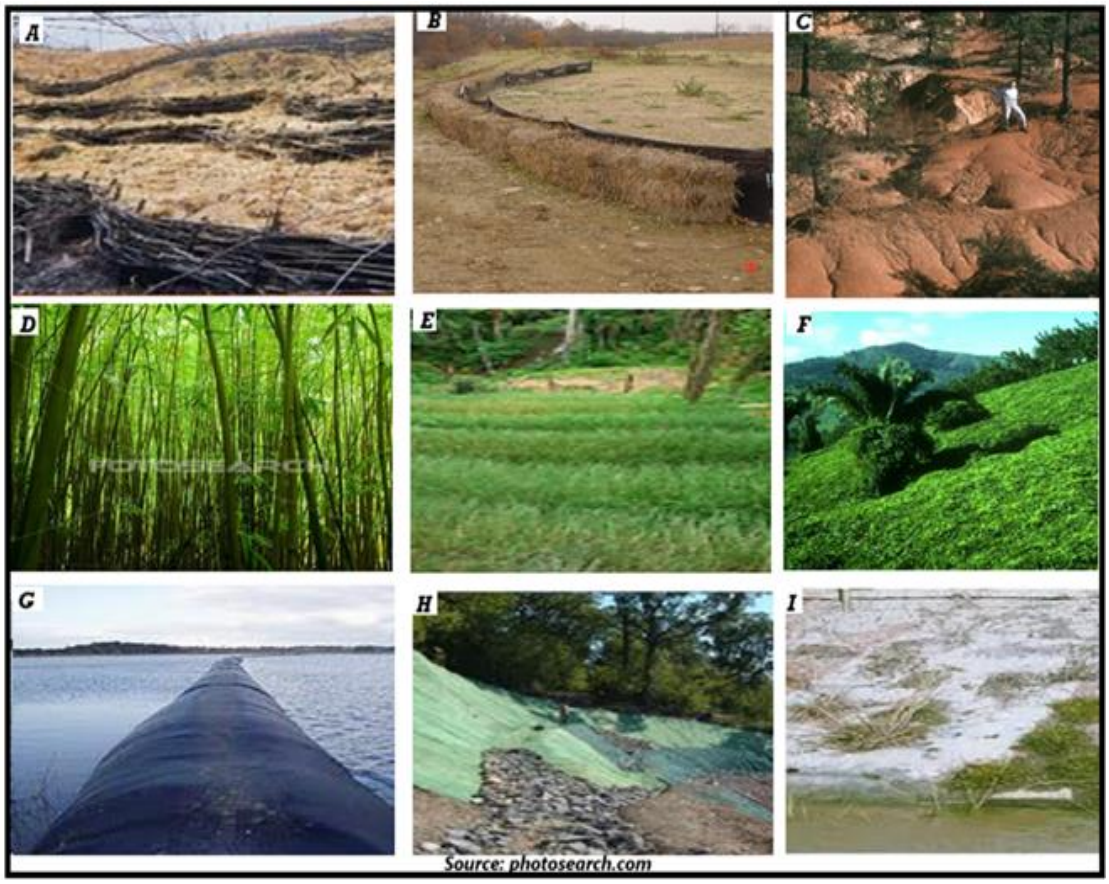

Figure 6 (A-I): Effective Control Measures

This distance is more than 1,600 km and this 36-40 hr of challenging road journey amidst hilly terrain is full of landslides problems during monsoon and post monsoon. In addition, the security threats from several insurgent groups are also a big challenge. Further, to reach the southern tip of Mizoram (Lawngtlai and Saiha), another 24 hr road travel is needed. On the other hand, the distance between Sittwe port (Myanmar) and Haldia port is only 600 km. Traveling through the Bay of Bengal from Haldia Port, Kolkata (India) to Sittwe port (Myanmar) takes only 12 hr. This sea route has drastically reduced the total travel time from 48 hr to 12 hr.

Sittwe port has been operational and ships are reaching there from Haldia port and Visakhapatnam port. It is high time to complete the interlinking of road and waterways from Sittwe port to north Mizoram, the distance barriers will collapse greatly and the northeastern region of the country will no longer remain land locked. In addition, the friendship road between India and Thailand will be a game changer for the overall reform of the new trade route and hub in the SE Asia.

The bigger challenge is the protection of geoenvironment in the Kaladan and Tlawng river basins. Most of the Mizoram rivers have moderate (EI between 10-20) and high (EI>20). Dredging operations to enable the river for navigation of bigger ships, will surely impact adversely on the ecosystem of the region. Development activities will affect the floral and faunal life of the region. Fortunately, the region is blessed with rich natural growth of Bamboo. Bamboo plantation aided with other suggested measures can effectively control the land degradation.

In nutshell, estimation and control of soil erosion rates require multiple measures. These measures are listed as- install coarse woody debris, fencing out the livestock, construction of spurs, intense bamboo plantation all along the slopes, intensify grass cover in the lower slope, plantation in the upstream area, installation of a large high strength geo textile tube filled hydraulically, application of dirt glue polymer as a green erosion control and application of non - woven jute to check erosion.

Socio-economic growth of any region and any nation is the need of the hour. When the wheel of progress moves forward, it should not leave a negative footprint on the nature. By all means, developmental activities in any region must be an eco-friendly drive.

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