

Infrastructure Development And Ecology

The scenario of ecological processes in the Arun Basin from the disintegration of rocks at high elevations to the sedimentation of rivers at valley bottoms is not too far different from those of other mountain regions in the Himalaya. Age-old traditions of trial and error with marginal land resources have been responsible for sustaining people on mountain slopes. Rapid growth of population has become a threat to the balance of mountain ecosystems. Poor economic conditions and the even poorer educational base stand out as the most conspicuous constraints for any development strategy.

Development activities in the basin are aimed at fulfilling the basic needs of the people by improving upon the agricultural system, managing forest resources with particular reference to fuelwood needs, hygiene, and education. The Dharan-Dhankuta-Hile-Basantapur road of 86 km is a major development programme of KHARDEP, run under assistance from the United Kingdom. The programme also includes land use (crops, livestock, community forestry), roads, bridges and trails, drinking water supply schemes, irrigation projects, cottage industries, agricultural education, in-service teacher training, health, and women's development. The implementation period of five years from 1980 to 1985 in a remote mountainous area is too short to expect any appreciable effects, except in the areas of physical construction and public works. The support of the Pakhribas Agricultural Centre (PAC), also run under the co-operation of the U.K., should be regarded as an important factor that supports rural development.



The Arun river as seen from Hedangna looking South. Approximate site of the Arun-III power house lies in this sector. Num village is seen at the top left hand side corner. Sub-tropical hardwood forest (*Schima-Castanopsis*) is seen on slopes bordering the river



The Arun gorge between Num and Hedangna is the approximate site for the intake of Arun-III hydro-electric project

His Majesty's Government of Nepal is implementing a community forestry programme in the hill districts of Nepal but none of the three districts of the Arun Basin are included. The KHARDEP has a component of community forestry in its programme of rural development. In the face of the present situation where Arun III is making headway, the community forestry programme should be implemented in all the districts of the basin.

Of all the projects under consideration, Arun III Hydro-electric Scheme could well be singled out for consideration.

Arun III Hydro-electric Project

His Majesty's Government of Nepal is to undertake the Arun III Hydro-electric project and aims to complete it by the year 1995. An access road of about 170 km will be a major impetus for regional development, because its alignment falls largely along the preconceived growth axis for regional development.

The project site has a river gradient as steep as 1/30 to 1/50 in the upstream area, and the valley slopes also are quite steep with more than 40° angle. Geological, topographical, and meteorological conditions, coupled with deforested slopes, indicate that watershed management should be implemented as early as possible. The section of the valley on the upstream side, especially from the bridge below Num village, to the Chepuwa village may be considered as a "hot spot". Slash-and-burn activities should, therefore, be stopped immediately and the hill slopes should be subjected to stabilization activities, such as massive afforestation. People who are dependant on those lands should be given alternative means of livelihood by providing jobs in various construction works to begin with, and by promoting small scale industries on a long-term basis.

Priority should be given for rapid research to identify appropriate species of plants for afforestation, and to find ways and means for mass propagation of trees and shrubs. Field observations suggest that all the slopes should be barred from grazing animals or ploughing. The invasion of the *Eupatorium* and other weed species should be encouraged. Areas with stabilized soil should be identified for cultivation of *Alnus nepalensis* along wet ravines, and of bamboo on drier sites. In the sub-catchment areas agro-forestry should be encouraged, especially for cultivation of car-

damom and tea. The sub-catchments 1, 2, 3, 4, 6, 7, 9, and 10 should be viewed as special areas for environmental management with a prerequisite master plan for watershed management. Structures for this project include a concrete dam 65 m high, an underground desanding basin, a 7-m diameter tunnel 11.3 km long and an underground power house. The pondage creates about 4 km of backwaters, and a maximum waterlevel rise of 50 m will inundate some of the paddy fields and a stretch of tropical forests along the gorge. An installed capacity of 201 MW is to be completed in the first phase by the year 1994. With the completion of the feasibility study, an agreement with the Federal Republic of Germany has been signed for assistance to carry out the detailed design. Major civil works are said to be on the way.

This project has generated a high degree of aspiration among the people in the Arun Basin. People have started to develop their own economic strategy by investing in lands along the proposed alignment of the road. One of the entrepreneurs has already started a distillery to produce spirits to serve the workers and labourers. Businessmen from Chainpur, Bhojpur, and Khandbari are focusing their interest on purchasing land along the road.

It is, therefore, suggested that an Action Plan for the development of Arun Basin be designed at the earliest opportunity. This would need a rapid study to elucidate and evaluate human systems in addition to physical and biological systems. Aegerter and Messerli (1985) have made a useful contribution by outlining various systems and impact areas for a systematic study. A relevance matrix for an environmental impact study for Arun III Hydro-Electric Power Development Project has been presented in the Interim Report (Nov. 1986), based on the work of the same authors. It is, however, essential that key areas for impact studies be identified. The following few areas may be identified for early consideration.

A. Non-biotic

1. Soil and Rock (Cultivated and Natural)
2. Climate (Meso-and Micro-climate)

B. Biotic

3. Terrestrial ecosystems (Forests/Agriculture)
4. Fauna (Rare and Endangered species)

5 Flora (Rare and Endangered species)

C. Social

6. Population movement
7. Structure for power and decision-making
8. Communication and Transport

D. Cultural

9. Traditions and customs
10. Cultural institutions

E. Economic

11. Infrastructures

F. Political

12. Interests of the indigenous population

Basic data on aquatic ecology is seriously lacking. However, it is obvious that the dam will interrupt the migratory fishes along the river, since no fish ladder construction is envisaged in the project.

The lake formed would provide a habitat for migratory water birds, such as duck and water fowl, and it will be a complementary waterbody to the already existing Kosi Barrage waterbody, further towards the south in Morang.

Arun Access Road

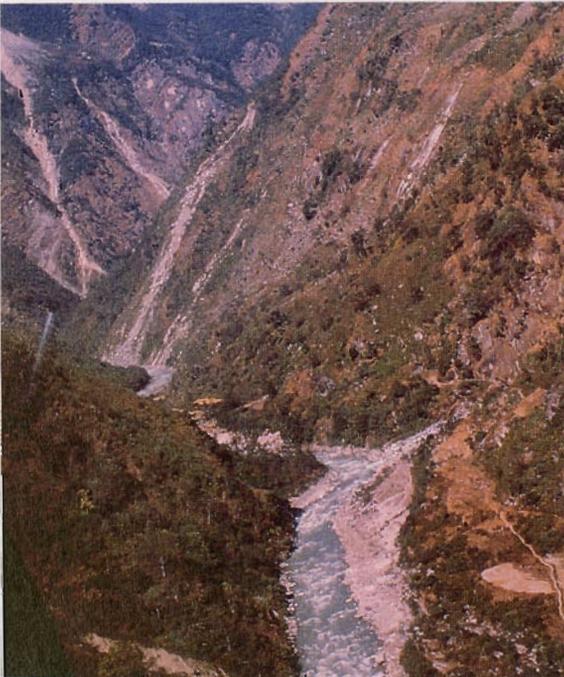
The Arun Access Road (AAR) should be visualized as a "trunk road" for eastern Nepal that links the mountainous regions with the plains of Terai. It fits well with the "growth-axis" proposed for regional development, and its socio-economic impact on the eastern development region would be very great.

The length of the road from its points of origin along Dhankuta-Basantpur Road to the intake site is estimated to fall somewhere between 110 km to 170 km. Several alternative routes have been identified (Scott Wilson Kirkpatrick and

partners 1987). The programming of the Arun III demands the access road to be completed by 1990. The task ahead looks tremendous with the given schedule for road construction. Road construction on a mountain terrain is most challenging and to combat the administrative formalities, such as bidding procedures, contract award, mobilization of resources (men and machineries) within a short period of time will be still more challenging. Thus an unprecedented strategy and procedures for operating the project have to be developed.

Two options emerged for the alignment from several studies: (1) the valley route, and (2) the ridge route. Those routes lie broadly on the counter-dip alignment of the bedrock. No sector falls towards the upstream of the river to effect the watershed of the Hydel project. The "valley" route versus the "ridge" route issue needs to be analyzed on the basis of construction costs, vehicle operating costs, maintenance costs, and also environmental costs.

The valley route : It begins apparently at Hile on the ridge of Milke Danda. This ridge is unique in Nepal in terms of its northward extension to the Chinese border, almost keeping parallel to the Arun river. The valley route quickly



The sector of the Arun Valley lying between Chepuwa loop (Arun-VI site) and the Num loop (Arun-III site) is extremely degraded and needs special treatment for restoration. Slopes are steep, rainfall is high and the people are poor

descends from this ridge to Pakhribas and follows the Mahamaya Khola to reach the bank of Arun. Then it keeps all along the Arun to the intake site. The air strip of Tumlingtar falls along this route, somewhere near the middle. The valley route traverses through sub-tropical and tropical zone, forested with sal trees on red laterite soil. Thus a greater risk of soil erosion and drainage problems is evident.

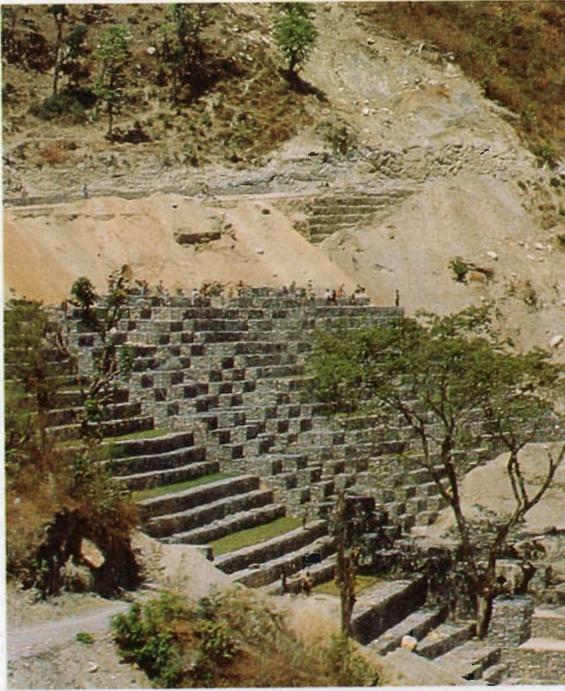
The Ridge route : It would be a kind of continuation of the Dharan-Dhankuta-Hile-Basantapur road, which is being constructed under the KHARDEP project. This route keeps along the Milke ridge further north of Basantapur to Mamling, Chainpur, Kharang and then descends to Tumlingtar. It will then link the district headquarters, Khandbari, and follow another ridge till it descends to the intake site.

The ridge route has finally been accepted, mainly due to its alignment along more stable terrain, and also due to strategic points for magnificent views of mountains and valleys that can be seen on either side of the ridge. Thus there is an added potential for developing tourism along the ridge.

Environmental considerations

Construction of roads in mountain terrain is a massive interference with the environment and, therefore, utmost care should be taken during planning, construction, operation, and maintenance phases. There has been a considerable degree of environmental awareness among planners and the engineers during the last five years, especially in the field of slope maintenance and vegetation conservation. However, studies and subsequent norms and strategies for mountain roads have yet to be developed. The Arun Access Road almost sounds like a crash programme. Thus an integrated team of engineers, environmental scientists, and social scientists should work together on the operation site to minimize adverse effects leading to environmental degradation.

The Milke Danda offers unique habitats for a wide variety of Nepalese rhododendron, magnolia, and the orchids. Faunal wealth is equally rich. A conservation programme should be implemented in order to safeguard these trees, which are presently exploited for cooking meals, providing temporary shelter for over 6,000 workers along the alignment of the road and, for preparing tons of bitumen for surface coating of the road. The forests of Milke danda are heavily subjected to intense

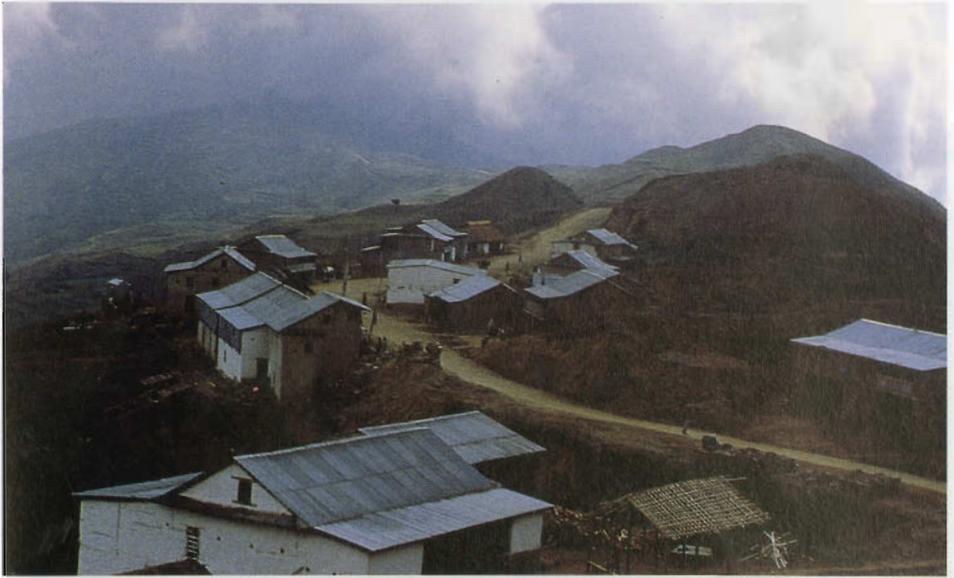


A sector of the Dharan-Dhankuta road showing heavy engineering work in road construction

exploitation during the works on the Hile-Basantapur sector. A hill called 'Guransé Danda', i.e., the Rhododendron Ridge in literal Nepali, has turned into a bare slope without a single tree even before the road reached there. After the road arrived, forested slopes on either side of the ridge have been more extensively deforested. Thus a conservation plan for the management of forests and forest resources has become imperative.

A flow-chart of environmental impacts due to construction of roads has been outlined by Joshi and Dhungel (1986). The lessons of experience from the task of building the Lamosangu-Jiri 110 km road are highlighted by Shaffner (1987).

The flow chart (Fig 11) indicates that the construction of a road begins with forest clearance and acquisition of land. The activity culminates with the generation of employment, which mean drawing more people to the work site and increasing fuel needs and timber demand. Shaffner's experiences confirm that the area served by the Lamosangu-Jiri road is increasingly threatened by deforestation and land degradation, a fact which not only has negative influence on road construction, but also on road maintenance. Thus forest management stands out as one of the key is-



Dharan-Dhankuta road extends to Basantapur along the ridge top. New settlements appear rapidly along new roads

sues in road construction and maintenance. Slope stabilization is fundamental to any road construction. A heavy rainfall area, like the Arun Basin, poses a lot of problems at attempts to improve and maintain the stability of a slope. Mistakes during alignment or construction often lead to perpetual problems of repair and maintenance.

Erosion control through bio-engineering is an option in the Arun Basin due to the regenerating capacity of its vegetation, especially below an altitude of 3,000 m. Identification of plants suitable for the climatic condition of the site and subsequent propagation along the slope will provide added strength to the slope to combat detrimental effects of surface runoff of water during the monsoon. Plants like *Jatropha*, *Eupatorium*, etc., which respond to simple vegetative methods of propagation, should be encouraged to cover the slopes. Plants unpalatable to animals should be preferred to the ones with fodder or food value, in order to avoid encroachments from domestic animals and local people.

The success of bio-engineering work lies in keen observation of natural facts and phenomena. Decisions should be based on findings of actual observation during the surveys of road alignment. Management of slopes through biological means is a continuous process throughout the life span of a road.

Economic Aspects

Road construction has an enormous impact on the socio-economic structures of the region. The Dharan-Dhankuta-Hile-Basantapur road has already indicated what sort of impact is likely to be expected in the region. Hile, for example, was nothing but a tiny village of some Tibetan people who came down from Wol-lanchung Gola after the trade with Tibet (China) was reduced to a small fraction. The decision to make it a road head was soon followed by a rapid growth of the township and, in less than 15 years, it has become an active marketing centre of eastern Nepal. This resulted in the reduction of commercial activities at Dhankuta. In the same fashion, Sidhuwa and Basantapur are growing rapidly, and the resources of mountain people are being used up in investments for fixed assets, like houses and lodges. A general impression from the area suggests that unless tourism is developed as a strong component, those investments are unlikely to bring good returns on a long-term basis. The road construction activities will generate a substantial amount of income for the local people, and their easy access to consumer goods should bring about considerable changes not only in the life style of the people but also in their spending habits. It is still to be seen how much the road would facilitate the increase in productivity of the area through modern inputs like fertilizers, improved seeds, improved livestock, pesticides, and so on.

The Arun Basin, like any other mountainous region in Nepal, has a subsistence farming economy. How this system can be converted into a market economy through production of cash crops and development of forest resources should be a priority area of planning for the development of the Arun Basin.