Effect of Melamchi Water Supply Project on Soil and Water Conservation in the Indrawati River Basin, Nepal

Chiranjivi Sharma

RAP-Rural Access Programme
E-mail: csharma@infoclub.com.np

Abstract: The Indrawati River basin, located about 50 km North-East of Kathmandu lies in the central region of Nepal. The river originates from the Himal region of the Mahabharat range (5,863 m asl). From its origin, Indrawati flows southwards to meet Sunkoshi River, one of the major rivers in Nepal at 626 m asl. The basin spans across Sub-tropical to Alpine climatic zones and overlaps three districts, Sindhupalchok, Kavreplanchok and Kathmandu of Nepal. The catchment area of the basin is 124,000 hectares and 40 percent of the basin is covered by forest. The average annual rainfall at higher elevation (Sarmathang) is 3,874 mm, while it is about 1,128 mm at Dolalghat, lower elevation Zone. The average annual potential evapotranspiration for the basin is 953.91 mm and the temperature ranges from 32.5°C to about 5°C. The average relative humidity is about 70% and varies from 60% in the dry season to 90% in the rainy season.

The population density of the basin in 1991 was 165/km^2 and the projected figure for 1998 is about 175/km^2. Ninety-six percent of the population is involved in agriculture. Farm size per household (0.9 ha on an average) is very small. Major crops grown in the basin are rice, wheat, maize, potato, mustard and millet. A major attraction of the basin is its National Park at the head of the basin covering sizeable area and is one of the most favourite trekking routes of the tourists visiting Nepal. Water in the basin is used for irrigation, for drinking by both humans and animals, consumed by forest and vegetation, to extract hydropower and to operate water mills.

In steep terrain the variation of rainfall is high. The effects of high rainfall on soil erosion and landslide are tremendous. At the same time, over grazing by livestock, intensive crop cultivation and encroachment of forest and cultivation of marginal lands have caused soil erosion and severe landslides in the basin. Majority of the soils in the basin are red soils (*Rhodustalfs*) that are highly susceptible to erosion and landslides. Agricultural practices that are adopted in the basin are also supportive to increase the rate of soil erosion.

At the same time, construction activities of development infrastructures have also challenged the dynamic ecosystem of the basin. Recently, the Government of Nepal is implementing Melamchi Water Supply Project (MWSP). Melamchi River basin is one of the sub-basins of the Indrawati River basin. Kathmandu valley, the capital city of the Kingdom of Nepal, has been suffering from the shortage of drinking water for a long time. The population of Kathmandu valley is 1.1 million and the growth rate is about 4.82 percent per annum. The shortage of water supply has affected public health and economic activity in Kathmandu. The government carried out many studies to meet the water demand of Kathmandu valley. These studies formed the basis for the implementation of the MWSP.

An environmental impact assessment (EIA) study of the Project has been carried out and the impacts of MWSP on the environment of Indrawati River basin cannot be overlooked. The present study is also an attempt of documentation of the effects of MWSP on soil and water in Indrawati River basin.

Keywords: river basin, soil erosion, watershed, conservation, mountain

1 Introduction

1.1 Overview of soil and plant nutrient depletion trends in Nepal

Nepal has an area of 147,181km² and an average north-south width of 193 km and east-west length of 850 km. The country is situated between India on three sides-east, west, and south-and China to the

north. The altitude varies from 90 metres above sea level (m asl) in the south to 8,848m in the north. The large part of the country's terrain is mountainous. Both hill and mountain together occupy 77 % of the total physical area. The rest 23 percent is Terai (plain). But in terms of population, the Terai region has nearly 48.5 percent of the country's estimated total population of 23.215 million in and the mountain and hills the rest. The country has diverse natural resources: soil, water, forest, climate and biodiversity and offers suitable habitat for a variety of flora and fauna. However, the country as not yet been able to utilise properly such resources for her sustainable economic development. Many natural and man-made factors are responsible in the development of available natural resources. These factors include:

- population growth
- fragility of the ecosystem
- torrential rainfall
- expansion of agriculture on to steep slopes
- encroachment on forests
- livestock pressure on grazing land
- construction of roads and irrigation schemes over hill slopes

Impacts of the above mentioned factors on natural resources are clearly visible. According to the recent study conducted by UNEP (in collaboration with MoPE/HMGN, SACEP, ICIMOD and NORAD (2001)) the following losses were estimated:

- loss of fine top soil
- depletion of organic matter and plant nutrients
- Landslides

Owing to the complex features of the mountain terrain, the nature of soil degradation varies greatly. However, information on soil degradation is scattered and sketchy. Information on the soil erosion rates for different land-use patterns are presented in Table 1(MPFS 1988).

Table 1 Estimates of soil erosion rates

Land-use categories	Soil erosion rate (tonnes/(ha • yr)
Well-managed forest land	5—10
Well-managed paddy terraces	5—10
Well-managed maize terraces	5—15
Poorly-managed sloping terraces	20—100
Degraded rangelands	40—200
Source: CBS (1998)	

1.2 Efforts on soil and water conservation in Nepal

The responses of government and bilateral agency level include:

- Establishment of the Department of Soil Conservation and Watershed Management in 1974
- Soil and Watershed Conservation Act 1982 and its regulations 1984
- Community Forestry-more than 650,000 ha of public forests converted into community managed forests
- Become a signatory to the United Nations Convention to Combat Desertification

2 Indrawati river basin

2.1 Location

The Indrawati river basin is located in the mid-hills of Nepal (Figure 1). The basin area lies about 50 km northeast of Kathmandu-the capital city of Nepal. It overlaps three districts of the country namely, Sindhupalchok, Kavrepalanchok and Kathmandu. The basin extends from Latitude 27º 37'11" N to 28º 10'12"N and Longitude 85º 45'21"E to 85º 26'36"E. The catchment area of the basin is 1,240 km².

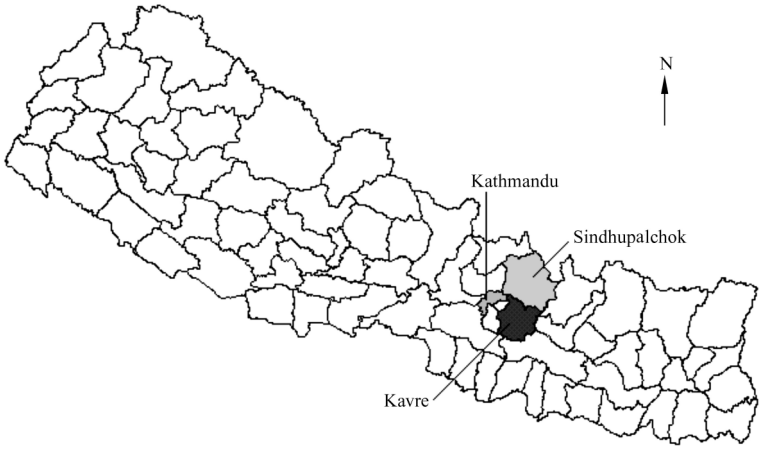

Fig. 1 Location map of indrawati river sin

2.2 Climate

The basin enjoys a range of climate from sub-tropical to alpine. The average annual rainfall varies from 1,128 to 3,874 mm. The temperature ranges from about 5º to 32.5º C. The average relative humidity is about 70 percent and varies from 60 percent in the dry season to 90 percent in the rainy season. Forty percent of the land area of the basin is covered by forest. The population density of the basin in 1991 was 165/km^2 and the projected figure for 1998 is about 175/km^2. Ninety-six percent of the population is involved in agriculture. Farm size per household (0.9 ha average) is small.

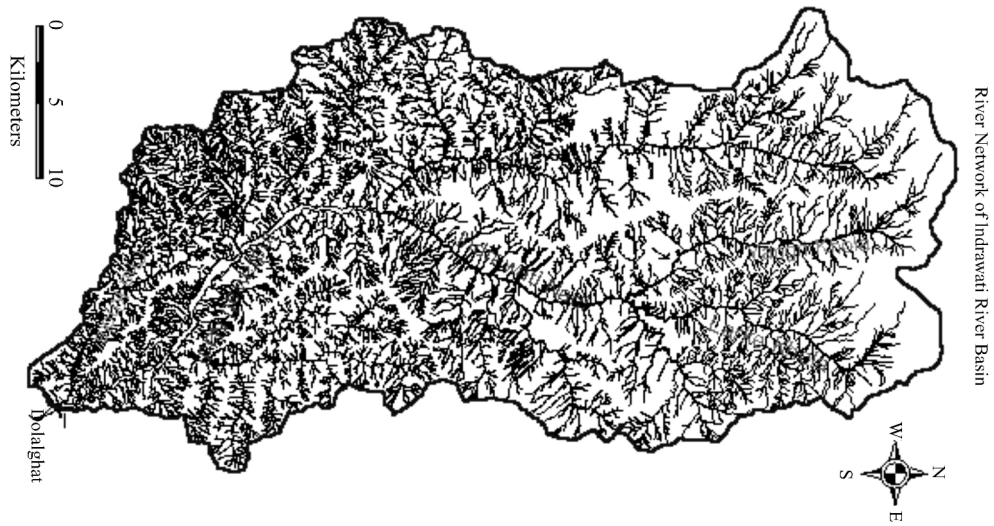

Fig. 2 Map of Indrawati River Basin Showing River Network

2.3 Land resource

The land resource in the basin can be divided into four landforms. They include:

Alluvial plain-The alluvial plain landform covers a large part of the basin. The landscape is moderately sloping. The most important hazard is riverbank cutting and river channel overflow especially during monsoon season.

River Terraces- The river terraces, locally called "*tar*" are located on relatively higher positions than the alluvial plain. The *tars* are prone to rainfall run-off and surface soil erosion. Usually topsoils are rich

in organic matter and other macro-nutrients content. Loss of topsoil reduces level of soil fertility. So these soils require proper erosion control measures for their conservation. The main crops grown in these soils are rice, wheat, maize, and mustard.

Mountain terrain-The variation of slopes in this landform is high (5º—30º). The erosion and landslide problems on unvegetated slopes is severe. Likewise, mass wasting is also serious. Adequate soil conservation measures are taken and soil fertility is maintained through adoption of terracing. The major crops grown are maize, millet, farm grown trees and citrus.

Sloping mountain terrain- Slopes here range from 25º to 45º with irregular surface topography. The erosion hazards by mass wasting are very high on slopes. These areas are used for forest, fodder and grazing.

A major attraction of the Indrawati basin is the Langtang National Park located at the head of the basin. The park covers a sizeable area and is one of the most popular places of tourist attraction for trekking in Nepal. The Langtang National Park is situated just outside the basin and occupies an area of 1,710 $km^{2.}$ The park represents a meeting point between indo-Malayan and Palearctic realms, and holds a rich biodiversity. The Langtang National Park represents some of the best examples of graded climatic conditions in the Central Himalaya.

3 Melamchi water supply project (MWSP)

Melamchi Water Supply Project (MWSP) was identified during the preparation of the water supply master plan in 1973 as the potential water source for the Kathmandu valley. The executing Agency of MWSP is HMG/N, Ministry of Physical Planning and Works (MoPPW), Melamchi Water Supply Development Board (MWSDB). The project duration is 6 years (July, 2001—July 2006). The estimated cost of the project is US$ 464 million.

Melamchi River is the source of water in stages I, and Yangri and Larke- (tributaries of Indrawati) for the stage II and III. Kathmandu valley has been suffering from the shortage of drinking water for a long time. At present, Nepal Water Supply Corporation (NWSC) can supply only 120—140million-litters per day (MLD) in the rainy season and 80—90 MLD in the dry season with the present available sources; where as the daily demand of Kathmandu is 180 MLD.

At present, the water from the proposed sources is being used for irrigation, drinking, and consumption by animals, consumption by forests and vegetation, hydropower generation and water mills operation in the basin.

4 Likely effects of melamchi water supply project on soil and water conservation

Effects of access road upgrading activities. The existing 30 km earth road from Lamidanda (0 km) to Talamarang has been proposed to upgrade and 12 km new road from Talamarang to Timbu for construction. This road passes through the Indrawati river basin areas. More impacts on the physical environment along the roadside areas of the basin will occur with new road construction whereas in the upgraded section less impact is expected. Effects of earth road upgrading and new construction activities will produce various environmental hazards such as loss of cultivated land, forestland, and grazing land by side cutting and disposal of excavated materials. Likewise, effects of movement of large capacity vehicles and heavy traffic will increase vulnerability of mountain landscapes and bio-diversity-flora and fauna. The second element is socio-economic, in terms of the impact of improved access on a previously remote community.

The rate of soil erosion and runoff would be increased during Melamchi Water Supply Project construction period. Soil along the road may be affected in the early stages of construction by excavation works, which affect slope stability and result in removal of soil. The effect will be greatest in the monsoon season when the ground is soft and there is high runoff. In view of the fact that most works are under ground the effect on soil will be localised and very limited. Most of the construction works at the intake will be in proximity to the river where riverbed will be cleared and a bench area will be created for the construction of diversion weir. This will disturb the riverbed characteristics. The sites for soil spoil disposal are located on the riverbanks. Gabion and stonework structures will be constructed to prevent

erosion of spoil tips. However, during floods some materials will be washed away and increase the sediment loads of the river.

Diversion of Yangri and Larke Khola water may deplete the volume of source in the Indrawati River. Its effect on use of irrigation water, fishery and other aquatic and wildlife in Indrawati basin area will obviously be less favourable.

5 Emerging issues

In addition, there are other issues that are emerging in the basin. These issues are: inherently prone to landslides and soil erosion process in the basin due to frequent torrential rain during monsoon season. The basin is prone to different forms of mass wasting, such as landslides, slumps, rock falls, and river cutting problems. A significant portion of soil in the basin is red soil, which is more prone to erosion. The red soils affected by a short period of rainfall. The sediment deposition onto the cultivated terraces is in increased trend. The landholding distribution pattern is highly skewed which has further accelerated cultivation of marginal land by the marginal farmers. Pressure of rapid growth of human and livestock populations in the basin is in increasing trend. The socio-economic condition of the basin is highly inequitable which has increased human induced soil erosion hazards in the basin.

6 Future challenges

The Indrawati river basin is facing a large number of challenges if these challenges are not minimised over the period the soil and water conservation issues in the basin will be aggravated. Presently faced issues include:

- Stream and river floods control
- River bank cutting control
- Reduction of soil loss during pre-monsoon season
- Conservation of bio-diversity
- Rural to rural and rural to urban migration
- Very little information on basin level are available
- Reduction of soil loss during pre-monsoon season

7 Recommendations

A major problem in planning and sustainable development of the soil and water conservation programme on basin is the lack of adequate information/data available. The study suggests the following recommendation for the improvement of soil and water conservation situation of the basin. These activities include:

- Develop common understanding to carry out long-term research studies on different dimensions of soil degradation in the different ecological regions at basin level.
- Formulate and implement a policy on sustainable use of land according to its capacity.
- Promote efficient management of watersheds using integrated soil fertility management systems, agro-forestry, horticulture, and so on.
- Tying up income generation activities with programmes that focus on rehabilitating degraded lands.
- Encourage local people to manage forest resources.
- Promote indigenous techniques to reduce bank erosion and sedimentation problem.
- Aware local people to manage sustainable development of the watersheds.
- Basin development approach should not be isolated only for soil and water conservation it should apply as an integrated manner.

References

CBS 2001. Preliminary Results of Population Census 2001. Central Bureau of Statistics, Kathmandu, Nepal.

CBS. 1998. A Compendium on Environmental Statistics 1998, Nepal. Kathmandu: Central Bureau of Statistics HMG/Nepal.

Mishra V.S., R.L. Shilpakar. 2001. Water Accounting Study in Indrawati River basin, Nepal.

Paper prepared for the one day Workshop on "Integrated Development and Management of Nepal's Water Resources for Productive and Equitable Use" Organized by WECS/HMGN and IWMI/Nepal, 25 April 2001.

Upadhyay S. (2001) Stakeholder's Inclusion and Exclusion Process in the Indrawati River basin: A review. Paper prepared for the one day Workshop on "Integrated Development and Management of Nepal's Water Resources for Productive and Equitable Use" Organized by WECS/HMGN and IWMI/Nepal, 25 April 2001.

UNEP. 2001. State of the Environment, Nepal. UNEP in collaboration with MoPE/HMGN, SACEP, ICIMOD, NORAD. Published by the United Nations Environment Programme, Regional Resource Centre for Asia and the Pacific, Outreach Building, Asian Institute of Technology, Thailand.

UNDP. 1995. Technical Assistance to Melamchi Diversion Scheme, Bank Feasibility Study (Draft Final Report) vol.I. Kathmandu, Nepal.