CHAPTER VIII
ASSESSMENT OF UTILITY OF RESOURCE

8.0 River basin resources

Human beings are residing beside river channels for a long time, which confer a supply of water and power, fertile floodplain soils, fisheries and a potential means of navigation. Seeing that the mountain basin serve up as the source of resources for the inhabitants residing in the hills in addition to in the plains. Rayeng Basin has great potentiality in terms of forest resources, water resources and fish resources. If the resources of this basin can be used in proper scientific way, the people residing in this basin area may get benefits. During the use of resources of this basin, the sustainability must be kept in consideration. Indeed as the form of environmental degradation is quite extensive other particularly is applied to the extraction of timber and other forest produces, mining and agriculture are taken into account. As human population expands in the hills, forests are being depleted for the extension of agricultural lands, introduction of new settlements, roadways etc.

8.1 Land capability classification of Rayeng Basin

According to David Dent and Anthony Young (1980), Capability is the potential of the land for use in specified ways, or with specified management practice. There is an assumed sequence of uses built into the system, a kind use pecking order. They mentioned the sequence of assumed desirability in descending order as follows:

A) Arable use for any crops and without soil conservation practices.

B) Arable land use with restriction on choice of crops and or with soil conservation practices.

C) Grazing of improved pastures.

D) Grazing of natural pastures or, at the same level, woodland.

E) At the lowest level recreation, wildlife conservation, water catchments and aesthetic purpose.

A, Klingebiel and P. Montgomery, (Land Capability Classification, Agriculture Handbook, No. 210, 1966), have mentioned following land capability classes:

Land capability class I

Included in land capability class I are all lands suitable for cultivation and irrigation with flat topography and no major limiting factors. With good management, these lands are highly productive and do not present special conservation problems.

Land capability class II

These lands are also suitable for irrigation and cultivation. They have flat to gently undulating topography. Limiting factors are not severe and can be compensated for with good management practices. High productivity can be attained with good management and by implementing moderate conservation measures, generally drainage or contour planting in undulating areas.

Land capability class III

Class III contains lands suitable for cultivation and irrigation with flat to undulating topography but with limiting factors (generally medium fertility soils, or moderate stoniness or shallowness). Medium to high productivity can be attained under intensive management and conservation, particularly from sheet erosion.

Land capability class IV

This group of lands has limited cultivation or irrigation possibilities. Flat to very undulating topography may make these lands prone to erosion. When used for permanent tree crops, limited soil conservation measures are required; with other crops requiring clean cultivation, the danger of erosion increases, demanding soil conservation as part of the technological management package. Medium productivity can be attained with good management.

Land capability class V

These are lands which are unsuitable for cultivation but suitable for intensive pasture. Severe limiting factors exist, particularly drainage considerations. When intensive management is applied, high productivity is possible with pasture and crops adapted to water-logged conditions. Soil conservation is necessary for long-term preservation of these lands.

Land capability class VI

These lands are unsuitable for cultivation but appropriate for permanent crops (tree crops, fruit trees) and natural pasture. Under certain conditions of soil and climate, some intercropping is possible with annuals which require no tilling. Topography, shallow soils and stoniness are very severe limiting conditions. Use of these lands requires strict observance of soil conservation measures.

Land capability class VII

In Class VII is normally natural forest unsuitable for cultivation. In selected areas, timber production is possible; in areas where soils, topography and climatic conditions are better, coffee and coco can be grown. Extremely severe limitations are associated with this class of lands and strict conservation measures should be observed in their use.

Land capability class VIII

Land totally unsuited to cultivation, suitable only for national parks and wildlife zones. These lands should be left in their natural state and protected.

Methodology for land capability classes of Rayeng basin

For land capability classification of the study area, Topographical maps bearing the number 78 A/8 (1972) & 78 B/5 (1987), published by the Survey of India, Satellite imageries- IRS 1C LISS III – 19th January, 2002, IRS P6 LISS III – 26th January, 2006 National Remote Sensing Agency, Hyderabad, soil map, land use map, geological map, landslide susceptibility map have been studied. Soil of study area has been studied taking soil sample.

Parameter used for land capability classification of Rayeng basin

Topography

This river basin has mostly steep mountainous topography at the confluence height of the basin is <200m whereas at the source region it is >2400m. Topography is very rugged and characterized by deer river valleys, ridges, spurs, rocky slope. Elevation of the basin increases from southeast to northwest. Average slope varies from moderate to very steep. Slope is one of the most significant limiting factors for cultivable use of land (Table 8.0).

Table 8.0 Slope condition of the study area.

Slope category	Amount of area (sq. km)	Percentage of the area to total area	Remarks	Name of the village under this slope category
< 16°	42.50	29.21	Moderate slope	Northern part of Pubong khasmahal of Birik forest, Rambi bazaar of Kalimpong-I
16° - 23°	49.50	34.02	Moderately steep slope	Toryak khasmahal, Rolak, Lonku, Sittong Khasmahal of Kurseong Blok
23° - 30°	51.25	35.22	Steep slope	Mongpu, Reshop bazaar, Labda khasmahal of Rangliranglіot Block
> 30°	2.25	1.55	Very steeper slope	Mongpu of Ranglirangliot Block
Total	145.50	100		

Based on Topographical map (slope analysis by Wentworth's method)

Soil of the basin

Depending on parent material different textural category of soils are formed in this basin having different fertility rate. Due to steep slope, soil of this basin has not been developed properly. Thus skeletal soil is found in the basin.

Climate of the basin

This basin experiences heavy rainfall high humidity in the monsoon season. But the yearly rain is variable. Rainfall and temperature is favorable for cultivation. Altitude dominates the climatic condition of different altitudinal zones of the basin.

Landslide prone areas of Rayeng Basin

The basin occupies the villages namely Pubong Khasmahal, Rangli-Rangliot Tea garden, Pubong Teagarden, Reshop Bazer, Labda Khasmahal, Rongchong Khasmahal of C.D Block Rangli Ragliot, Chattakpur Forest, Upper Mamring Khasmaha, Lower Mamring Khasmahal, Toryak Khasmahal, Sittong Khasmahal, Barasitong Khasmahal, Selpu Khasmahal, Rolak Khasmahal, Lonku Khasmahal of C.D Block Kurseong, Turzam Forest, Rambi Bazar D.I.F., Riayang Railway Station, Birik Forest of C.D Blok Kalimpong-I. These villages are suffered from the critical problem of landslides. Many individuals and institutes have studied the landslide phenomena of the Darjeeling hill area.According to final report published by Prof. Mamta Desai, Project Coordinator, Department of Ecology & Environment, Netaji Institute for Asian Studies, the Block wise landslide affected areas explain itself the comparative intensity of landslides in the Blocks. It appears that the Kalimpong I, Kalimpong II and Rangli Rangliot Blocks are comparatively vulnerable or severely vulnerable regarding landslides. The rate of vulnerability is also high in Kurseong and some parts of Bijanbari and Gorubathan blocks. But as a whole the condition is critical in Kalimpong Sub-division, where the land under agriculture exceeds that of the area under plantation or forests. Moreover, these areas are cultivated with root crops like potato, ginger, cardamom and onions. These root crops are harvested just after monsoon in the months of September to October. This particular practice changes the cohesiveness of the soil and makes it vulnerable The Critical Area zonation map has been prepared by the aforesaid institute based on the geology, soil, and climatic factors along with land use pattern.

Land use and land cover

A large portion of the basin is covered by dense vegetation. Tea plantations and cinchona plantations are also found in many part of the basin. Due to encroachment of human settlements and constructional works, notable portion of the vegetal covers have been removed. At the lower reaches of the basin, agricultural land use is found (Figure 8.0). Due to excessive soil erosion some land becomes barren. Pastures are also practiced in portion of the basin.

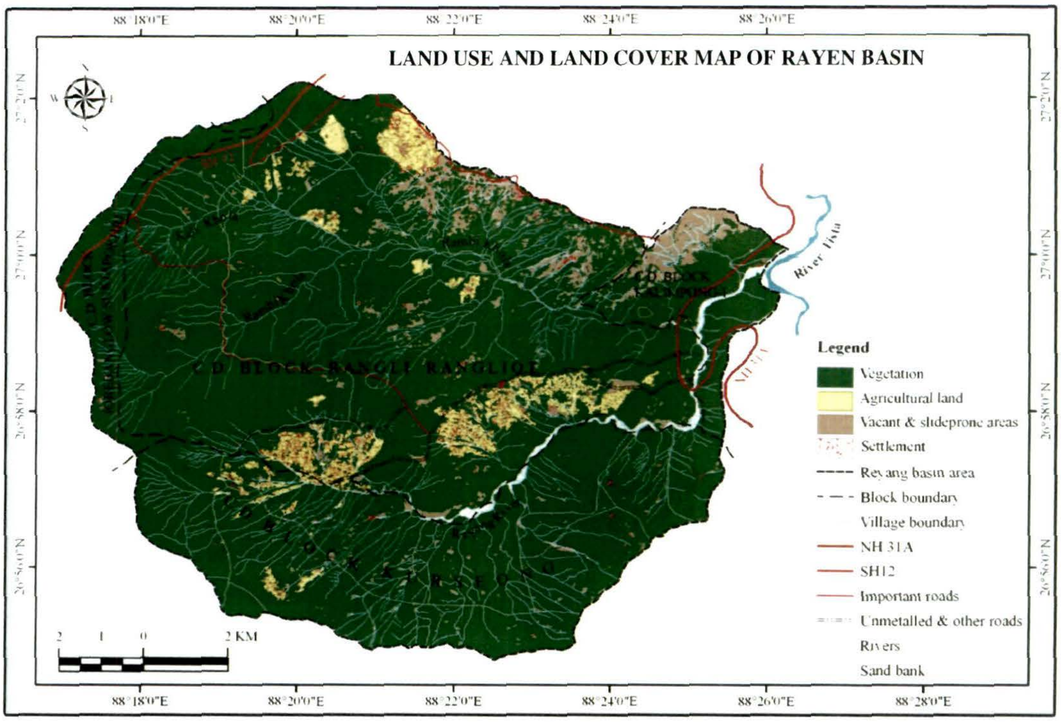

Figure 8.0 Land use and land cover of the basin.

Depending on the aforesaid parameter following land capability classes have been identified in the Rayeng Basin (Table 8.1 & Figure 8.1):

Table 8.1 Land capability classes of Rayeng Basin.

Class	**Land area (sq. km)**	**Percentage to total area**	**Cultivation possibility**	**Name of the area**
I	Nil	Nil	Nil	Nil
II	Nil	Nil	Nil	Nil
III	29.69	20.40	Cultivable	Mangpu of Rangli Rangliot Block
IV	25.58	17.58	Limited cultivation	Pubong tea garden area and other tea garden
V	11.23	7.71	Pasture	Rolak and Sittong Khasmahal of Kurseong
VI	8.13	5.58	Permanent crops	Lower part of Rongchong khasmahal, Rambi bazar
VII	33.97	23.35	Timber, natural forest	Upper Mamring & Lower Mamring khasmahal etc
VIII	36.88	25.35	Reserved forest	Senchal forest area
TOTAL	145.50	100		Rurik forest, Bhalukhop forest

Compiled by the Researcher.

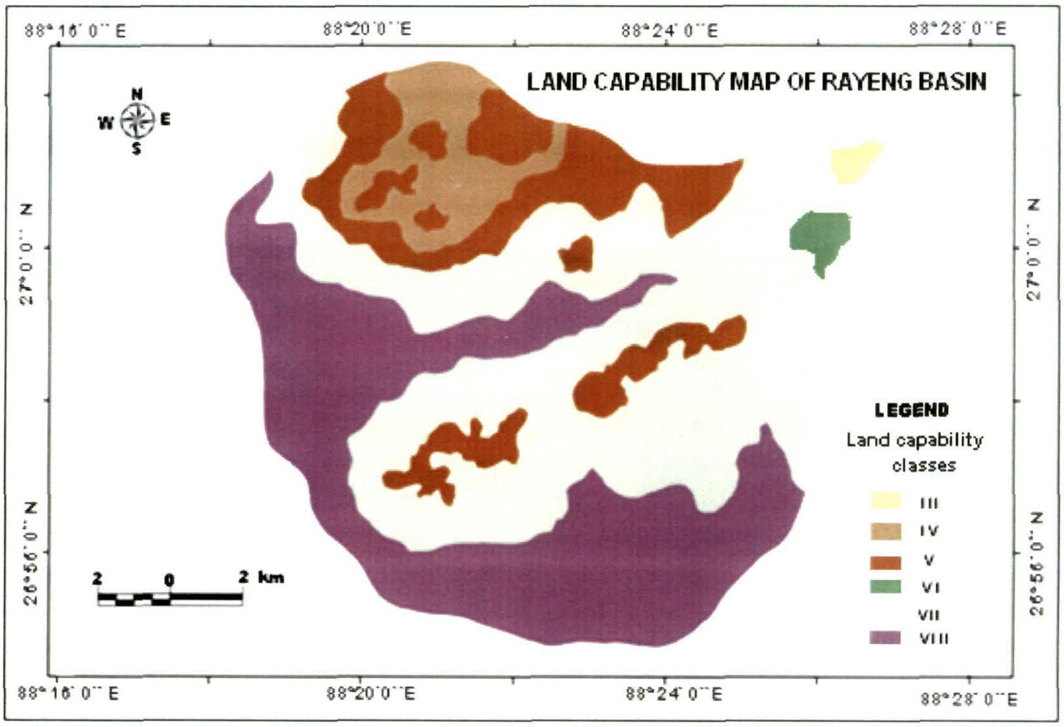

Figure 8.1 Land capability classes of the basin.

Management of land resource

The areas having Steep slopes, shallow soil, stoniness and low fertility are the factors hindered cultivation. Landslide is one of the limiting factors for the use of this basin. Human interference is also responsible for decoration of cultivable land. Tea garden and cinchona plantation accelerate the rate of soil erosion of the basin. To manage the land resource following steps should be taken:

1) Forest areas should be extended to steeply sloping lands to prevent cultivation, which could reduce soil erosion.
2) Soils which are highly erodible should not be cultivated.
3) Forests should be for protective cover of the soil and wildlife habitat. Forest products should be carefully managed in respective areas.
4) Intensity and magnitude of landslide must be recognized.
5) Grazing must be restricted on the slopes which are vulnerable to soil erosion.
6) Tea and cinchona plantations should not be permitted on the landslide prone land.

8.2 Measurement of field capacity of Rayeng Basin

Field capacity is defined as the quantity of water in soil after excess water has drained away and the rate of downward movement has significantly decreased, which takes place within 2-3 days after a rain in the soils of uniform structure and texture. The physical definition of field capacity is the bulk water content retains in soil at 33J/Kg (-0.33 bar) of hydraulic head or suction pressure. Field capacity is characterized by measuring water content after wetting a soil profile covering and monitoring in the change in the profile. Following calculations are used for the measurement of field capacity of Rayeng Basin:

$$1.\ \text{Water at field capacity} = \frac{\text{Soil mass at field capacity- oven dry mass}}{\text{Oven dry mass}} \times 100$$

$$2.\ \text{Water at wilting point} = \frac{\text{Soil mass at wilting point – oven dry mass}}{\text{Oven dry mass}} \times 100$$

3 .Available water (%) = Field capacity (%) – wilting point (%)

4. Hygroscopic water (%) = Air dry water (%) – oven dry water (%)

5. Capillary water (%) = Field capacity (%) – hygroscopic water

Method of measurement of water at field capacity

To determine the field capacity water content of the different soil of Rayeng Basin dry pulverized soils samples are placed on ceramic plate. The samples are then saturated in with water and left equilibrate over night. In the next day the porous ceramic plate is placed in to a container that is pressurized with 1/3 atmosphere of pressure (about 5 psi). The slight pressure in the container pushes excess water out of the soil sample and through the ceramic plate. After 24 hours in this chamber the moisture content in the soil sample is said to be at field capacity. The soil samples are then weighted and placed in an oven at 105° C and then weight again.

Method of measurement of wilting point water content

First day pulverized soil samples are placed on the ceramic plate and saturated with over night. The next day the ceramic plate is placed into a container that is pressurized with 15 atmospheres (about 222 psi). This pressure pushes most of water out of the soil samples through the ceramic plate. The samples are then left in the pressurized container for 48 hours. The samples are then weighted before they placed in an oven at 105° C for two hours to remove the remaining water. The amount of water that is left in the soil in held too tightly for to extract hygroscopic water and then weight. Field capacity of the Rayeng Basin is variable for different category of soil (Table 8.3).

Table 8.2 Field capacity of Rayeng basin

Textural category of soil	Wilting point (%)	Field capacity (%)	Available water for plant growth (%)
(A) Coarse Sand and Gravel	5	11	6
(B) Sand	5	12	7
(C) Sandy loam	8	18	10
(D) Radish Sandy Loam	12	19	7
(E) Loam and Silt Loam	13	20	7
(F) Clay Loam and Silty Clay Loam	22	34	12
(G) Silty Clay and Clay	30	36	6

Source: Sample soil test of Rayeng Basin in the laboratory (27/12/2009).

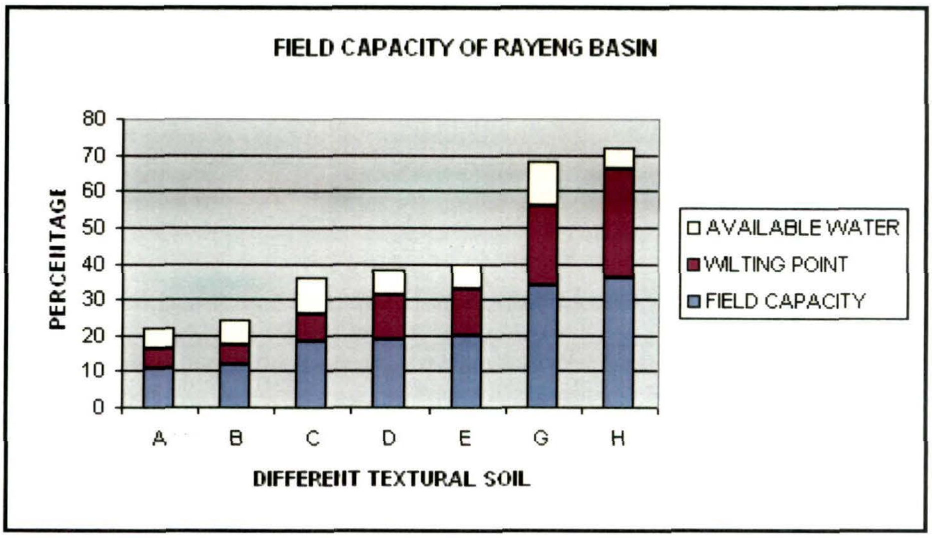

Figure 8.2 Field capacity of the basin.

Due to variation in rainfall soil moisture is also varied temporarily. Soil moisture of Rayeng Basin has been measured during rainy and dry season separately. From the investigation it is revealed that there is a notable variation in moisture content in rainy period and non rainy period. After heavy shower moisture content of soil is increased and vice–versa in dry period (Table 8.4).

Table 8.3 Soil moisture of Rayeng Basin.

Year	Months	Average rainfall in mm	Soil moisture in mm / m						
			Coarse Sand and Gravel	Sands	Sandy Loams	Radish Sandy Loams	Loams and Silt Loams	Clay Loams and Silty Clay Loams	Silty Clays and Clays
2008	December	00.00	40.00	65.00	129.90	160.00	200.00	175.00	152.00
	July	738.50	105.00	138.00	350.00	325.25	410.50	375.50	305.50
2009	December	1.800	43.55	71.00	131.85	165.50	205.15	185.00	161.50
	July	765.20	112.00	145.50	358.50	327.50	418.50	395.00	311.50
2010	November	00.00	38.55	63.00	128.30	155.50	200.10	180.50	155.50
	July	981.40	121.00	155.60	391.50	335.15	425.50	401.50	318.50

Source: Hydrometric division, Indian Meteorological Department & laboratory analysis by the researcher.

Topographic condition influences the rate of runoff, infiltration, as well as moisture content of soils. Mainly the slope influences the rate of the mentioned hydrologic processes. On the steep slope rate of runoff is high but the rate of infiltration reduces. Except the confluence area entire Raying Basin has steep to very steep slope. Such condition decreases the rate of infiltration consequently soils get comparatively less as opportunity to received water.

Soil moisture and plants of the Rayeng Basin

The total available water for plants in the root zone is termed as TAW. The range of moisture of the soil at field capacity and permanent wilting point is defined as TAW. It is varied from 250 mm/m to 600 mm/m. Soil moisture of the Basin is variable (Table 8.5).

AVAILABLE WATER IN THE SOIL FOR PLANT GROWTH

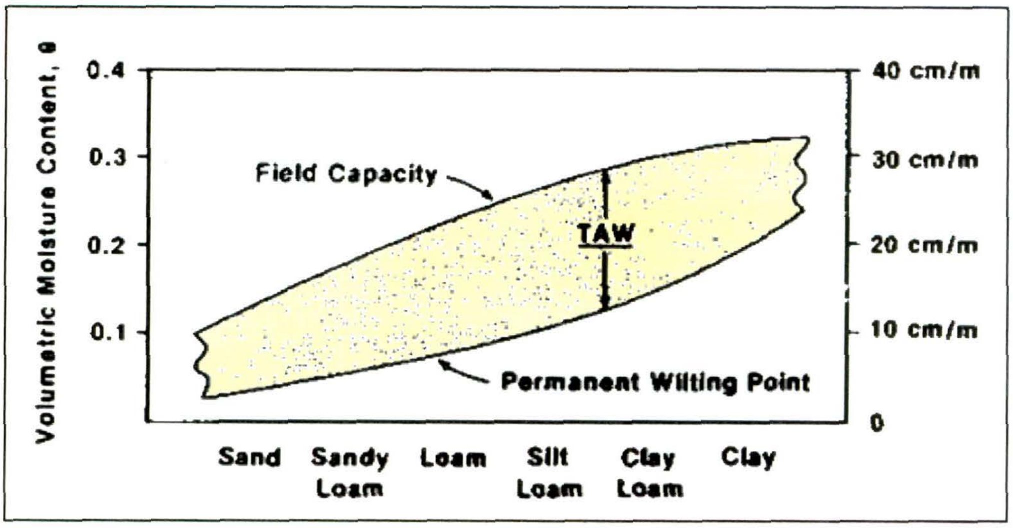

Figure 8.3 Relationships between soil types and total available soil moisture holding capacity, field capacity and wilting point (courtesy to Walker and Skogerboe, 1987).

Table 8.4 Growing plants in relation to TAW of Rayeng Basin.

Soil types	TAW (%)	Name of plants
(A) Coarse Sand and Gravel	6	Callicarpa arborea, Srboreaahima wallichii, Gmelia
(B) Sands	7	Callicarpa arborea, Srboreaahima wallichii, Gmelia
(C) Sandy loam	10	Semul, Mundane, Hopea
(D) Radish Sandy Loams	7	Benteak, Bomsum
(E) Loams and Silt Loams	7	Aini, Laurel
(F) Clay Loams and Silty Clay Loams	12	Cinchona, Shisham
(G) Silty Clays and Clays	6	Magnolina, Rhododendron

Compiled by the Researcher.

Findings of the study

From the overall study of the field capacity of the Rayeng Basin following conclusion can be drawn:

1. Different textural types are found through the field method in the Rayeng Basin. Thus field capacity of soils is variable. Sandy soil has comparatively low water holding capacity than the other types of the soils of the basin.
2. Soil texture is one of the striking determinants of field capacity. Soil porosity as well as permeability is also determined by the soil texture.
3. Rate of infiltration influences the field capacity. There is a positive relation between field capacity and soil porosity.

4. Soil moisture is varied seasonally. In the basin moisture content of soils declines in dry season and increases in wet seasons on account of variation in amount of rainfall.
5. Slope of the terrain highly in fluencies the rate of runoff and infiltration. Thus moisture content of the soils is also determined by the slope.
6. Depending on the total available water (TAW) various plants are grown in basin although there other factors like altitude and climate influences the growth and distribution of vegetation.

8.3 Resource potentiality of the basin

Water potentiality of Rayeng Basin

For the existence and survival of the plants and animals water is essential. It is compulsory for all various purpose of life such as drinking water, food production, and health, to produce energy and so on. It has also spiritual and esthetic values. Raying Basin has various water potentialities such as follows:

Role of this basin as water tower

This mountainous river basin performs the role of water tower. Large amount of fresh water receive by this basin area from huge rainfall which debouches in the river Tista through Rayeng and Rambi. People of the basin area get huge water from this river for households and agricultural use. This water is crucial for the welfare of mankind of the basin. Thus, careful management of this water resource must get priority.

Storage and distribution of water to the lowlands

If waters of this basin is stored would be supplied in low land areas for agricultural and industrial usage. For the smooth operation Tista Lower Dam Project near Rambi Bazar avail supply of water provided by the streams of this basin.

The life-sustaining role of water

Supply of clean and unfailing water for the dwellers of the basin may be confirmed by this basin if the basin can be managed scientifically without hampering it natural characters. Freshwater of this basin may also be sustained many natural habitats consequently contributing to the conservation of biodiversity.

Fragile ecosystems

Human habited portion of this basin has the high fragile ecosystem. Heavy seasonal rainfall, steep slopes can induce severe surface runoff, soil erosion and landslides. Eroded sediments are major pollutants of surface water. Land use, development of infrastructure, and tourist activities in mountain areas may significantly affect the quantity and quality of river water and groundwater of this basin. To restore ecosystem this must be conserved.

Contributes to fresh water storage

If the water of the basin is stored in any way within the sustainability of the basin, thereby it would be supplied for drinking and irrigation. This fresh water storage may protect aquifers from depletion and devastation floods may be minimized.

Plate 8.0 Local people collecting pebble from the bed of the Rayeng River for building materials.

Conclusion

This basin is important for the supply of water for drinking and for food, energy etc. Freshwater from this basin also supports unique ecosystems and biodiversity of this basin area. This is under pressure from deforestation, agriculture and tourism, construction of roads and other heavy construction. For the security of the local people water resource of this basin must be restored. Improvement in science and technology in conjunction with reorganization of means of achievement of developmental activities is desired for enhancing the element of sustainability in Rayeng basin scenario. Manifold facets of problems and potentials of the basin demand integrated approaches. However, integrated approaches have however to advance from just bringing different development sectors under a widespread programme as at present to a framework where interference improving the state of one sector go together to the development objectives of the other sector.

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