

## Soil and water conservation measures for sustainable agro ecosystem development of Uttarakhand

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Uttarakhand is a mountainous State in Northern India known for its diverse ecosystem, rich faunal & floral biodiversity, rivers & valleys and a rich cultural heritage. The total population of the state is 1.01crores (census 2011) out of which most of the people are poor accounting for 11percent of the population is below the poverty line as compared to 30.23 percent of those living on the plains. Human population is growing at a rate of 60.1 percent increases in the last decade, combined with an increasing livestock population has resulted in the increased demand for food, fuel-wood for humans, and fodder for livestock. As human population and livestock densities increase, the rate of degradation and the dependence on common property resources has also increased which required the collective management approaches. Many parts of the state are experiencing drought-like conditions with acute shortages of drinking water with the depletion nearly 30 percentwater source has lead to non-functionality of drinking water schemes.

A large part of the state (86 percent) is hilly with fragile soils and steep slopes that make them highly prone to soil erosion during the monsoon season. Each year

state is losing fertile soil at a rate of 10 times more than the national average. This problem is further compounded by declining soil fertility due to high erosion and nutrient leaching through run-off water. Land degradation is therefore a serious problem in Uttarakhand with estimates suggested that upto1.6 million hectares land is facing varying degrees of degradation.

The country is facing heavy monsoon rain fury in different regions every year. The Himalayan region is ecosensitive zone with mountains, glaciers, lakes with gigantic river systems. 'Cloud burst' is a common phenomenon in most parts of Himalaya which poses great threat to environment & human settlements. Such frequent incidents can be managed by proper disaster management system, timely meteorological warning and quick and efficient governance. Irregular construction of commercial buildings, clearance given to hydel power projects and other industries without proper assessment of environmental impact leads to the obstacle in the natural flowing path of various river systems and consequently to the unexpected disaster.

Uttarakhand and Himachal Pradesh are two hill states in the Himalayan range that

are worst hit by the extreme rains that struck Northern India every year during monsoon leading to landslides, flash floods and heavy rains. Heavy rainfall every year creates havoc on the region because of the fragile slopes and poor soil stability of the Himalayan range. The assessment reveals that the mud slides and debris brought by the flood waters completely destroy the houses & farmlands standing crops & trees in several villages. Many households have losses all household goods and their domestic animals, which were significant contributors to household income. Hence, a family member frequently requires monetary assistance for rebuilding houses, rehabilitating farmlands and replacing household goods that they lose during the calamity. Further, during these periods injures to peoples, spread of disease, epidemics are also common occurrence. The overall losses due to flash flood and high erosion affects roads, bridges and jhulas including National Highway, water supply system, irrigation channels, sewerage, Power projects, transmission lines, Forest infrastructure, cultivated area, human & cattle lives, private houses, standing crops and fruit trees.

But man induced factors that have compounded the scale of the disaster such as unabated expansion of hydro-power projects, deforestation and construction of roads, ever-increasing tourism, especially religious tourism are also major causes for the unprecedented scale of devastation. A new (mountain) range like the Himalaya will remain steady if not tampered much, but the huge expansion of roads and transport is bringing the mountains in Uttarakhand to the down. Data with the Uttarakhand State Transport Department confirm that in 2005-06, 83,000-odd

vehicles were registered within the state and the figure increases to nearly 180,000 in 2012-13. Out of this proportion, cars, jeeps and taxis, which are the most preferred means of transport for tourists' visiting the state? Rampant construction of roads or dams has led to land use change and the cumulative effect is getting reflected in the extent of damage by the rains. Himalayan mountains were never so fragile, but the construction of roads with heavy machines and unplanned development activities has weakens the slopes which suffer from severe landslides during the rainy season. The landslide debris raises the river water level which leads to flash floods and damages in areas vicinity to the river system during heavy rainfall. Also due to unscientific mining, quarrying and cutting trees for development projects, hills slopes loses their stability and continuous disturbances resulting in the massive landslides and rapid erosion.

Water conservation is its use and management for the well beings of all the consumers. Water is abundant throughout earth, yet only three percent of all water is fresh water and less than seventeen percent of freshwater is usable. There are multiple domestic, industrial and agricultural uses, while most of the usable water is utilized for the irrigation. It is predicted that after fifteen years, nearly two-thirds of the world's population will be living in some sort of acute water shortage. Although water scarcity will rise day by day, but there are many ways to start better conserving the existing water sources. Water conservation is rapidly become a hot topic, yet many people do not realize the concerns involved with soil conservation as well. Soil conservation is defined as the control of soil erosion in

order to maintain landscape and agriculture productivity. Soil erosion is often the effect of many anthropogenic such as construction, cultivation and other activities and natural causes such as effect of water and wind.

There are various scientific methods for soil and water conservation for arable and non-arable lands to prevent soil erosion and retention of soil moisture. Several mechanical measures like terracing, bunding, bench terracing, till farming, contour cropping, strip cropping, etc. are practised to minimize run-off and soil erosion, particularly on the slopes in arable lands. Apart from this, tree based farming system like agro forestry, farm forestry and agri-horticulture systems have demonstrated strong and long term potential in protecting the soils from erosion. In non-arable lands measures like, trenching, waling, retaining walls, crib structure, geotextiles, check dams, gully plugging, gabion structure, spillways and afforestation are highly effective in reducing the soil erosion. For water harvesting, structures like ponds, check dams, contour trenches/bunds, small dams and tanks etc. can be constructed for storing the excess water which can be used during dry seasons and in low rainfall areas. These measures in agriculture and non-agriculture land can help in avoiding and preventing disaster due to heavy rainfall and soil erosion.

Rainfall management and resultant run-off through watershed management helps greatly to the sustainability of the Himalayan Mountains. A watershed is a drainage basin area bounded by the divide line of water. Himalayas are one of the most vital watersheds in the world, but are threatened by deforestation & other ecological malpractices that have resulted

in the depletion of soil and water resources. For watershed management programmes works such as soil and land use survey, soil conservation measures, afforestation, social forestry programs and drought prone development programs and water harvesting measures are adopted and implemented. In watershed development, mechanical measure helps in reducing the water velocity and conserves rain water, while afforestation, agroforestry and tree plantation programmes prevents soil erosion in the watershed and similar lands. Soil and water conservation measures have great advantages in different lands. Along the roadside construction of the toe wall and toe drain prevents the occurrence of landslips. Similarly, check dams in non-arable areas improve the condition of water springs and streams. A terrace on hill slopes prevents the soil erosion and enhances the agricultural productivity. Gabian structure along the stream banks prevents soil erosion and flooding along the adjoining areas and stabilizes agriculture fields from excess runoff generated from the heavy rainfall event. Presence of forests in the upper portion and agriculture in the lower portion in a watershed protect later from heavy rainfall events as forest reduces the runoff quantity. Sometime landslips are also occurred in the forest area that may be due to fragile geology, high soil moisture or tree weight, but still there is need to find out the exact cause of landslide in forest area. Grasslands are equally effective for soil and water conservation. A tree and shrubs combination also helps in protecting lands from the effect of erosion. During time of heavy rainfall, agro forestry system could reduce damage to the crops as former are least affected by heavy rainfall events. Therefore, soil and

water conservation measures on watershed basis are important for protecting and enhancing landscape productivity. Further, study needed to be carried out to assess the

carrying capacity of the Himalaya and development activities should be planned accordingly.