

Analysis of soil erosion and conservation approaches and models in India

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Abstract: Soil and water are the two principal natural endowments responsible to regulate the entire living world. It is the contribution of nature that gifted for the sustainability of the whole biological kingdom. It is impossible to produce a handful of soil through the application of science. Soil is the principal medium of the plant growth which has both features of a renewable as well as an exhaustible resource. Its nutrients and organic matters can be replenished. But when the top soil depth is reduced by erosion the soil eventually be lost irreversibly. Soil resources are an essential input of production and no output could be thought up without the use of soil.

Soil loss and degradation are at alarming rates. Gullies and ravines are steadily encroaching into productive table land of many of our major command areas and considerable number of flora and fauna are being endangered. Soil conservation is the only known way to protect the productive land. The aim is to keep the surface soil intact and minimize the impact of the factors of erosion. By applying different methods the surface soil is protected and conserved. The process of conservation practices include biological measures, mechanical measures, technical measures, contour farming, contour bonding, graded bonding, beach terracing on steep slopes, runoff harvesting, storage and recycling. In this study an attempt is being made to analyse the economics of soil erosion and conservation with various methods and measures of it..

Keywords: Land Degradation, Soil Erosion, Soil Conservation, Contour Farming, Contour Bonding, Graded Bonding, Beach Terracing, Runoff Harvesting, Water Storage and Recycling.

I. INTRODUCTION

Soil erosion is a major cause of environmental degradation and a threat to the sustainability and productivity in the factors of production. The principal meaning of soil conservation is sustenance of soil mass, structure and fertility intact which needs control of soil erosion. In addition maintenance of physical, chemical and biological composition of the soil is also important. Its supply is fixed and cannot be enhanced by any scientific, physical and mechanical interference. The main aim of soil conservation is to eliminate or reducing the harmful effect of land degradation. By applying different method, either to slower the speed of the running water or to check the soil and other organic content from its flow is known as conservation. It has three phases of damage i.e. detachment, transportation and deposition. According to Morgon, soil erosion is a two phase process consisting of detachment of individual particles from the soil mass and their transport by erosive agents such as water and wind. When sufficient energy is no longer available to transport the particles the third phase deposition occur (Morgon,1986). So soil conservation is a complex issue which needs scientific and technological sincerity. It is complex specifically for the infectors/ stakeholders, solution providers, decision makers and service implementers. Management option for conservation restraining and maintaining in three ways may be defined as:

- Primary protection based on with the identification of the area and estimation of loss.
- Secondary protection is the application of available scientific knowledge appropriate policies and operational procedure with rapid solution.
- Final protection is the timely implementation periodical monitoring and proper supervision for conservation of soil.

Conservation is a well known comprehensive treatment to this alarming issue. Soil is non renewable resources over the human time scale. It is dynamic and prone to repaid degradation with land misuse. Productive lands are less than 11% of earth area. It provides food to more than six billion people with an increasing rate of 1.3 % per year (Eswaram et.al, 2001).

2. Objectives of the Study

The present study intends to pursue the following objectives:

- i.To Know the history of soil erosion and conservation in India and abroad.
- ii.To analyses various soil erosion and conservation approaches and methods.
- iv.To know soil conservation practices in different plan periods of India.
- v.To know the scientific way of assessment of soil erosion.

3.History of soil erosion and conservation

Accelerated erosion is dated back to the old civilization in Greece, Mesopotamia, Rome and other civilization of mankind that developed in the valleys of Indus, Nile,Eupretes rivers of Chine have evolved with the boon of soil erosion. These civilizations arose of irrigated alluvial plain were dependent upon flied deposits of silt for continued fertility that provided plant nutrients

(Hudson, 1986 and Wild,1993). The loss of soil and dissolved nutrients from Ethiopia as far millennia enriched the soil of Egypt (Blauce and Brookfield, 1987).

The collapse of ancient civilizations in Mesopotamia with Tigris and Eupreties rivers are due to irreversibly degradation of land. Rivers changed their direction due to massive land sliding. Continual soil erosion from agricultural lands has forced the people to migrate other place.

Hugh Hammod Bennett recognized as the father of soil conservation in the US described in his well known publications in details the historical episode and consequences of severe erosion. Dr. Hugh Bennett became aware of the threat caused by the erosion of soil. He observed that by water and wind reduced the ability of the land to sustain agricultural productivity. He launched a public crusade of writing and speaking about the soil erosion crises. His highly influential publication "Soil erosion: A National Menace" in 1928 influenced Congress to create the first soil erosion experiment station in USA. Bennett urging for creation of a permanent soil conservation agency. President Rosevelt realized the fact, by which conservation of soil and water resources became the National priority.

3.1 History of soil erosion and conservation in India

Soil erosion has recognized as a serious natural disaster from the ancient time in India. Land degradation has a serious problem. It covers more than half and 329 million he. of geographical area in country. The British Government initiated soil conservation research work and passed the Soil Conservation act in Punjab State in 1900.

In early 1920 severe soil erosion and frequent draught in the rain fed farming regions draw attention the government for research programme to control and provide a viable technology for soil erosion. Government carried out pioneering work for controlling and stabilizing erosion. Legislation had also been enacted to enforce preventive measures.

Large scale conservation measures begin in 1951. Research, Demonstration and Training Centres with Multi disciplinary expertise were established in representative areas under the control of the Ministry of Agriculture. Deheradun, Otacomd, Chandigad, Bellary, Kora, Vasad, Agra, Ibrahimpatna and Hyderabad were the centres for soil erosion and Management Research Centres.

At state level initial steps were taken up by the old Bombay province adopting intensive programme of contour bonding to combat erosion and moisture stress condition. Soil Conservation Society of India was came from the National symposium of soil conservation at Hazaribag, Bihar in December 1951. This registered under Regd. No. 14, 1952-53 at Patna under Society Registration Act, 1860. It was the first Multi Disciplinary Integrated Department of soil conservation in India at the Damodar Valley Corporation, Hazaribag, Bihar. The Society is devoted to conserve the soil water and associated resources of plant and animals since its inception. It is an association of scientists and professionals. The society is shifted to Hazaribag to New Delhi at the Annual General Body Meeting on January 19, 1990 at IARI, Pusa, New Delhi.

All India Soil and Land Use Survey (AISLUS) with its four regional centers was established in 1956 to meet the requirements in the catchment of River Valley Projects where 43 drying demonstration centres were launched in 11 States and Union Territory of Delhi and Damodar Vallay of Bihar. In 1959 a model soil conservation bill was circulated to the states for enaction suitable legislation for effective implementation of soil and water conservation programme.

4.Types of soil erosion

Soil erosion can be broadly classified into 5 categories which are discussed below:

4.1.Type-1 Erosion

Water is the most powerful agents to disturb the surface soil. Since degradation of land is a very complex and analytical issues which relates with other factors and events. Erosion due to water mainly depends upon the volume and speed of the runoff which again depends on the slope and terrain of the earth surface. Surface erosion of sheet erosion I vital form of water induced erosion which damages the top soil and sub soil drastically. Splash, Interril, Gully, Ravines, Tunnels, Stream Banks are the various type and forms by which surface soil losses its quality, safe and structure. Coastal erosion is the other forms which lead to severe land dis-shape of environment physiology. Universal Soil Loss Equation (USLE) is used to predict the level of soil erosion. (De Graaff,1996)

Wind also destroys the top soil leading to massive degradation of arable land. The Dust Bowl Stone in 1930 depicts the consequences of soil erosion. Formation of Sand dunes in desserts, hollows in terrains and beaches is a sing og excessive wind erosion.

4.2.Type-2 Erosion

The next component is the rain, flood, river and natural drainage system which affect the soil and slit into the downstream. The top soil affected by volume of rain, water logging and drainage.

4.3.Type-3 Erosion

The other type of land degradation is due to geological agents. Volcano,Earthquake, and Ice Burgs are the main events to induce the soil damage. Acidification, Stalinisation, Alkanisation,Global warming and Depletion of Ozone layer are the interrelated consequences which ultimately destroy the surface soil. Type three erosion creates long run devastation to economy and environment.

4.4.Type-4 Erosion

Soil composition has been analysed that leads to deterioration of nutrients of the soil. These may happen due to biological, physical and chemical events. Germ culture disturbance, decomposition fail and soil nutrient depletion degrades the top soil. Soil compaction, surface sealing and causing, subsidence of organic soil occurs under physical deformation of land. Solid type like rock, sandy, dry, alluvial loam and clay are its own variety of corrupting agents. Chemical interference at form destroys the soil nutrients, its composition and biodiversity.

4.5.Type-5 Erosion

Topographical imbalances are also major events for soil erosion and degradation of land. Landscape, terrains, Hills, Agro economic practice, Habitat, Land use patterns are determined the extent of soil erosion and degradation of surface land.

Use of land for agricultural purpose, applying various methods and practices for erosion control has a many limited calculation. But when considered in a broader sense erosion is in a massive blow of natural resource of a country. Conservation practices as may be considered as an important tool to retain the economics of soil conservation.

1. Treatment options for different types of land

Generally, treatment of soil and its control is taking by adopting by various ways. A list of treatment options for different types of lands are indicated Table-1 below:

Table- 1: Major activities practices for different categories of land

SI. No.	Category of land	Condition of land	problems	Major activities
1	2	3	4	5
1	Aat Land(Up land)	-Situating above berna land having 8%-25% slope,unleveled. - Soil depth is up to 0.30 m and rain fed cereals, pulses and oilseeds along with rainy vegetables. - Soil erosion and nutrient loss possessions problems.	-Safe disposal of run-off water -Breaking the length of slope. -Retain a part of run-off. -Make the land suitable for free plantation -Gully stabilisation	-Plantation -Stone Wall -Staggered trench -Contour bund -Percolation Tank -Brush wood check dam -Gully control structure.
2	Berna (Medium land)	-Situating above the with mild slope of 2 % - 8 % -Under leveled and irrigation situation two crops are assured -Paddy with short and medium duration are usually cultivated -Erosion takes place due to over flow of run-off water from near by areas.	-To break the slope length -Conserve max.water for crop production. - Drainage development -Silt detention	-Water hole -WHS -Wells -Agroforestry -Pasture -Fruit plantation -Backyard Orchard -dry land horticulture
3	Behal (Low land)	-Developed from stream bed where water flows regularly. Jholla land comes under this category. -Due to retention nature of soil moisture and continuous flow, two crops of paddy are usually taken.	- Cut-off wall at lower side to check subsurface flow.	- Division weir - Farm pond -Drop spill way –Open well -Stream bank erosion control

Source: OWDM,2017 & NRM activities,2017

5. Measures of soil conservation

Soil conservation is widely considered as a serious threat to the long term viability of environment ecology and biodiversity in many parts of the world. Human history contains many examples of previous civilization whose downfall was caused by excessive soil erosion (Lal et. al, 1996).

Since land erosion is a major threat for the most developing country like India. Sustainable development in the sense referred not only the losses of game undisturbed in practice erosion control measures one not only aimed at preserving soil and nutrient losses but also at controlling and conserving water resources (FOA,1995),

Before the discussion on soil conservation measures it is pertinent to clear that approaches should be very appropriate and vision based. Soil conservation measurement on 'Public land' that can be directly planned executed implemented and managed by government or any authorized agencies.

Soil conservation measures on private land intervenes the stakeholder's activist and government. They will go either for physical structures line intervenes or any technical mechanical measures suitable.

In country like India, several methods have been implemented. More than 40 million he. of land have been reclaimed from soil erosion as per the statistical report.

More over the following methods one often discussed for conservation of soil.

1. By afforestation, erosion may be checked un-planning cutting of trees to be restricted.
2. Reservation of specific piece of land exclusively used for grazing viz Gochar.
3. Scientific method of cultivation have been introduced and encouraged by restricting unscientific, Jhum cultivation, (Podu)(Slash & Burn, 1998) cultivation.
4. For development of roads and railways unscientific and un-judicious removal of soil has been checked.
5. Any measures for conservation of soil are taken into account by considering a number of factors like topography geographical location soil type soil depth type of erosion usually occurs in the area etc, are taken into account.

6. Approaches on soil conservation

Conservation of soil is a complex issue. Erosion is a global phenomenon but its magnitude is different from region to region. Application of developed technology and proper conservation method to be adopted where the erosion is a threat. Unless farming system is based on economically feasible and environmental sound practices of soil conservation is meaningless. Soil conservation practices are also age old as the soil erosion. The affected group adopts traditional and local methods depending upon their climate, topography, terrain and agro-economic practices. In addition to the local practice there are certain other standard practices in the conservation.

6.1 Biological Approach

By afforestation, improvement of vegetation gross cover and farm cultivation top soil movement is restricted are summed caused by running water. Crop rotation and changing pattern of cultivation are encouraged to farmers copy demonstration. Afforestation benefits are popularized among the farmer's inhabitants and public.

6.2 Cultural approach

Agro economical measures are taken to check the erosion. Farmer and stakeholders are learnt about the value of soil, danger of dryness benefits of vegetation and damage of erosion. The economic impact consequent upon the social devaluation due to soil erosion is circulated among the public.

6.3 Demonstration approach

Different methods of soil conservation measures are carried out by demonstration. Farm cultivation, afforestation contour bonding fencing rock packing and other methods are adopted. People getting aware of all the demonstration carried out by government department lime soil conservation department. Forest department and agriculture department.

6.4 Mechanical or technical measures approach

High technical scientific measures are adopted to control the erosivity of soil. To maintain the topography and geographical terrain intact undisturbed technical measures are adopted.

6.5 Economic Measures

Whatever the measures carried out by government private and NGOs, economic evaluation has been done in terms of soil depletion and retention. Flood management, water shed management, water harvesting system are some of the important tools for erosion control.

7. Economics of soil conservation

Soil is a very important input for all production function. Its supply is fixed and non-substitute. One inch of productive soil is formed in 400 years. Its function is including food production, carbon storage, climate regulation, water storage and above all support for biodiversity and living kingdom. But practically, we mean soil means the productive lane.

It is a natural capital with the potential to produce a flow of benefits and utilities in the futures. Conservation and production proceed side by side. On the contrary degradation of land and erosion does not confined to productive field only. It may occur in any geographical area. Farmers land is protected by any means, but the problem involves in non-agricultural Common Property Resources (CPR) very difficult to manage. So, huge property is endangered. Problem can be viewed in two aspects i.e. production point of view and environment point of view. From government side soil conservation activities are undertaken various agro-economical and socio-economic circumstances. The central government has launched many policies, Programmes to protect the soil erosion and to increase the productivity in the through rehabilitation. Various approaches like watershed management, promoting farm crops (cashew, mango, sisal, etc.) have been an effective tool for rural transformation and natural resource management.

During the 1970s the agricultural output expansion caused a substantial increase in soil erosion. The resulting concern stimulated two kinds, one showing the economic impact of reduced erosion and another about how current erosion reduces future agricultural productivity. Both have the intensity to curtail soil loss. The soil conservation department has provided technical and financial assistance to curtail erosion for almost fifty years in India but there is a little evidence about that erosion has been curtailed.

In developing country like India large area of cultivable forest land and other areas become ecologically damaged and economically weakened because of serious land degradation. Out of the total area of the earth approximate (13000 Million He.) 12% is used as arable land against 24% as pasture land, 31% as forest and wood land and 33% as other Waste and Desert Land((WDI,1990).

De Graff in 1993 showed that the annual soil loss from crop land in selected developing countries ranges from 1—800 t/ha./yr, depending on the slope of land under cultivation, type of crop grown and other ecological factors. For a clear cut understanding of the various agents and institutions of land degradation, it can be discussed in two broad categories.

8. Soil Erosion Region of India

Soil Erosion is a natural geographical and perennial occurrence in the rainfed area. The rate of erosion defers with the volume of rain, slope of the terrain and many other causes. Conservation practices also go side by side with erosion.

Indian sub-continent with its diversified landscape and terrain experiences different type of soil erosion. All the coastal zone of Odisha, Andhra Pradesh, Karnataka, Kerala having coastal erosion, Rajasthan and Gujarat suffers with sand dunes. Madhya Pradesh and Jharkhand having gully and sheet erosion. Himanchal Pradesh and Uttarakhand area also suffers with gully, rill, and tunnel and sheet erosion. Himalayan range and Kashmir suffers with glacier erosion and severe land sliding. Arunachal Pradesh, Nagaland, Manipur, Mizoram, Koraput of Odisha suffer from erosion for shifting cultivation. Bihar and Karnataka with sand erosion and entire middle zone affected with sheet erosion. South West and North East monsoon is also a factor for land degradation. Koraput of Odisha suffers with tunnel, gully, rill, and sheet type erosion corresponding to the diversified landscape.

1. Five Years Plan and Soil Conservation

During 1920 severe soil erosion in hilly regions and frequent drought in rainfed region drew attention of the Central Government. So, Government carried out pioneering work in controlling and stabilizing torrents which was a serious problem in disrupting communication system. The wide spread problem of soil erosion and land degradation and its impact in total economic life had received attention of the government. A group of serial administration officers and engineers from related discipline deputed to United State making on field study of Soil and Water Conservation Programmes.

1.1 First Five Year Plan (1951-56) and Second Five Year Plan Policies (1956-61)

Large scale soil conservation measures began in 1951. During first five plan period, Central Soil Conservation Board was established and chain of nine Research Demonstrations, seven Training Centres with multidisciplinary expertise were established under Ministry of Agriculture.

During second plan, All India Soil and Land Use Survey (AISLUS) organisation with its four regional centers were established to meet the soil survey requirement in the catchment of river valley projects under central sponsored schemes. About 43 dry farming demonstrations were launched in 11 States, Union Territory (UT) of Delhi and Damodar Valley. In 1959 a Model Soil Conservation Bill was circulated to the States for enacting suitable legislation for effective implementation of the soil and water conservation programmes. (Table-2)

Table-2: Programmes in First Five Year Plan (1951-56) and Second Five Year Plan Policies (1956-61)

SI. NO.	Abbreviation	Programme	Plan Period
1	2	3	4
1	ERRP	Rural Labour employment Generation Programme – Plantation),	1 st
2	IGE	1. (River Valley Project – Watershed),	1 st
3	RLEGP	.(Revised Long Term Action Plan – Plantation),	1 st
4	ACA	(Mahatma Gandhi National Rural Generating Activities – Plantation),	2 nd

Source: Various study materials

9.2 Third Five Year Plan Policies (1961-66)

In the third plane a working group reviewed the problems and facilities. A national scheme for treating the catchment of selected Multipurpose River Projects was launched in 13 catchments. Another programme for survey and categorization of waste lands was taken up in 17 states in order to ascertain areas which could be reclaimed a third scheme landless agricultural labourers were resettled. Similarly, a centrally sponsored scheme was launched for identification and categorization of ravenous areas in four states. The programme content both for agricultural and non-agricultural lands. State Soil Conservation Boards were also established in a number of states.

9.3 Annual plan Periods (1966-69)

During 1966-69 centrally sponsored scheme of soil conservation was launched in five intensive. Agricultural Development Programmes and District Agricultural Research unit has been transferred to Indian Council of Agricultural Research (ICAR). An attached office namely Inventory Centre was set up in the Ministry of Agriculture.

9.4 Fourth Five Year Plan Policies (1969-74)

During 4th Five year plan period integrated planning of watershed with a multi-disciplinary approach was strongly advocated in 1974 the model Bill was re-circulated among the 14 states and 2 union territories enacted suitable legislation to facilitate implementation of soil and water conservation programme with greater involvement of the people.

9.5. 5th Five year plan (1974-79)

Watershed Programme got wide momentum. In this period three Central Plans were launched.

1. Pilot project of Amendment of Alkali and Acid soil in compact areas.
2. Creation and strengthening of state soil and land use survey organisation.
3. Control of shifting cultivation.

9.6 6th Five Year Plan (1980-85)

National Land Resources Conservation and Development Commission on National and State Land Use Board were set up. Integrated watershed management in the catchment of flood prone river launched. Soil conservation in the catchment of river valley projects were started.

9.7 7th Five Year Plan (1985-90)

Seventh Plan aims at intensifying the water and soil conservation programme to checking the lead degradation and enhancing the productivity available land. To ensure people participation for effective maintenance of soil conservation utilization of assets created.

9.8 8th, 9th, 10th and 11th Five Year plan Policies (1992-97, 1997-2002, 2002-2007 & 2007-2012)

Following works were under taken in 8th, 9th, 10th, 11th, five year plan.

Ground Water development and utilization on construction of water harvesting structure, National Watershed Development Programme in rainfed areas are launched and Revised river valley projects were enacted. (Table-3)

Table-3: Programmes in 8th, 9th, 10th and 11th plan (1992-97, 1997-2002, 2002-2007 & 2007-2012) periods

SI. NO.	Abbreviation	Programme	Plan Period
1	2	3	4
1	R.L.E.G.	Rural Labour employment Generation Programme – Plantation),	8 th
2	RVP	1. (River Valley Project – Watershed),	9 th
3	R.L.T.A.P.(.(Revised Long Term Action Plan – Plantation),	10 th
4	MGNRGA	(Mahatma Gandhi National Rural Generating Activities – Plantation),	11 th

Source: Various study materials

10. Views of Bennett of soil Conservation

H.H. Bennett, the father of soil conservation in his famous inscription “Soil erosion, A National Menace” clearly described to give a special approach to the problem. His postulates are as follows:

1. Enormous wastage must be stopped,
2. Overgrazing should stopped at once,
3. Arrow cutting must be checked by engineering work,
5. Efforts for establish and conserve the optimum vegetation cover.

Vegetation improves soil structure, allowing greater moisture penetration. It increases the water holding capacity of the soil by increasing organic matter. It breaks the effect of wind. It binds the soil and lessens sheet erosion. It absorbs runoff and reduces the velocity of flow and the carrying power of the water and by catching soil particles it leads to form miniature terraces of slopes and dams and fills in small gullies. The more complete the plant cover the more adequate is the protection against erosion (Bennett, H., 1984).In this connection Various methods and approaches used for soil erosion and conservation are given below:

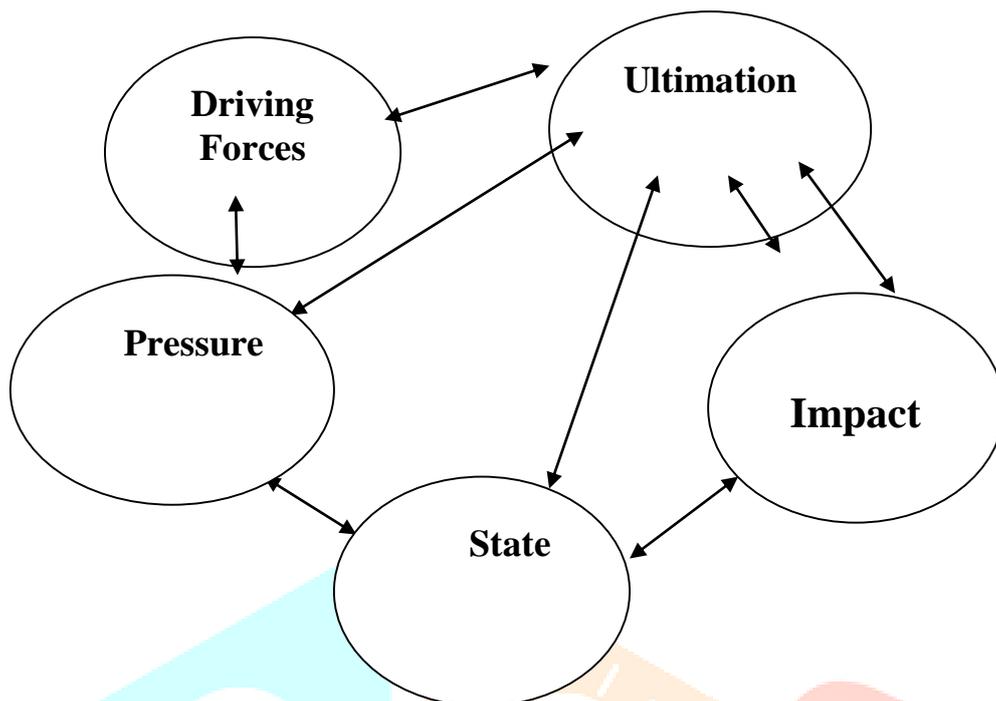
10.1 DPSIR Approach

European Environment Agency has developed a comprehensive approach to soil conservation issues by picking up certain indicators. The approach was designed on the basis of DSR framework approach (Blum, 1998)

The DPSIR approach distinguished between Driving forces, Pressures, State, impacts and Responses is the framework (Blum, EHW, 2004)

The approach is based on the indicators causing soil damage and bio-diversity. The damage indicators are human induced or natural. It also points out the issues related to land deterioration. The DPSIR approach distinguished between driving forces, pressures, state impact and responses in a framework (Fig-1).

Fig-1 :DPSIR Model



Spource: Blum EHW, 2004

State of soil: The force that keeps the soil profile and texture intact. The causes may be cultural, social, economical or ecological that drives the soil to degrade.

Resistance : It is the tolerance capacity of the soil. The torture like storms, forest fire, mining, deforestation, urban expansion to which it cannot tolerate. Abide get reacted.

The fatal soil : Contamination, nutrient depletion, compaction, enthronization, leading to bio-diversity.

The ultimation : Due to the loss of soil fertility it losses all vitality and productivity. Food scarcity, pressure on land, global warming are the issues. The resulting change in soil function and decrease in soil fertility causes the direct impact of reduced biomass and subsequent food production,

Hence, in this approach social instrument and economic tools to be applied in controlling the driving forces to keep the soil profile undamaged.

11. Assessment of soil erosion through USLE Method

Soil erosion has been recognised as a hazard of significant concern. The number of studies on this ground is limited. A proper assessment of the erosion problem is greatly dependent of its spatial, economic, environmental and agricultural context. A good soil lose management is therefore needed to reduce land degradation and low water quality due to siltation and sedimentation etc. . Soil erosion modellings are able to know many of the complex issues that influence rate of erosion. Various parametric models such as empirical i.e. statistical, conceptual (semi empirical), physical process based models are available to compute soil lose. Most of these models need information related with soil type, land use, landform, climate and topography to estimate soil loss. They are designed for specific set of conditions in particular area.

Universal Soil Loss Equation (USLE) is most widely used model. The universal soil loss equation is an empirical model developed by Wischmeir and Smith in 1975 to soil erosion from field. Mathematically, the equation is denoted as:

$$A \text{ (tons/ha/year)} = (R+K+L+S+C+P)$$

Where,

A= Annual Soil loss

R= Rainfall and runoff erosive index

K= Soil erosion factors

L= Length of slope factor

S= Degree of slope factor

C= Cropping management factor

P= Conservation practice factor

Singh et.al. (2002) carried out study on prioritisation of annual soil loss of Bata river basin using RS and GIS techniques. Assessment of soil erosion and analysis of soil loss based on sub watershed within a watershed has been done by using Morgan Model (1984). The model result shows the average annual soil loss in the watershed is 17.22 ton/hect. Mohan et.al. (2002) carried out a study to

analysis using II, WIS, GIS for computation of soil loss estimation. He indicated that the area has a high soil erosion and sedimentation rate. Jerotia and Singh (2006) computed runoff and soil erosion by GIS model of the catchment area along Uhampur and Kud. Different thematic layers, for example, lithology, land use and landcover map, geomorphology, a slope map and a soil texture map, were generated from these input data. USLE and Revised USLE (RUSLE) are often used to estimate soil erosion at regional landscape.

12. Conclusion

Conservation of soil is a complex issue. Erosion is a global phenomenon but its magnitude is different from region to region. Unless farming system is based on economically feasible and environmental sound soil conservation is meaningless. Soil conservation practices are also age old as the soil erosion. The affected group adopts traditional and local methods depending upon their climate, topography, terrain and agro-economic practices. In addition to the local practice there are certain other standard practices in the conservation. Use of developed technology and proper conservation method to be adopted.

Contour Farming is also old technology to protect the crop land free from erosion. Water run-off is controlled and checked wherever necessary. Detachment and displacement of soil by erosive agent are restricted. Runoff force of water will be checked of embankment.

Steep slopes, contour bonds, graded bonds are constructed to curtail erosion and water runoff speed in rainfall hilly area. Mechanical methods of conservation technology are adopted where the erosion is high. Contour ditches and bench terracing applied to protect erosion hazards. The contour ditches trapezoidal in shape are laid on contour at the same interval as the contour on graded bonds.

Water runoff is the prime cause of soil erosion. Rain water moves down stream with detached soil particles. Runoff first checked with field bonding. The runoff water move with soil and accumulated rain water dumped in a place for further use is the main motto. Rain drop hits the ground and do not allow to move into the soil. In modern technology applied in urban and non-agricultural land by collecting and storing to inject into the ground. So that the ground water recharge can be made.

Agricultural land is protected by the farmers but the non agricultural land is un-protective. Afforestation is a process to grow with different plants and trees. Once the land is covered with natural plant means bio-diversity cycle will automatically grow. Flora and fauna on the land will restrict the water to run and to lift the soil. These lands have many limitations such as steep slopes excessive erosion, stoniness, rockiness, shallow soils, wetlands, flooding etc. These lands can be put to productive use as pastures and forest.

Under social forestry schemes the adjacent beneficiaries are allowed to use upper branches of the tree for fire wood. The roots of the trees protect the soil and absorb the rain water to keep soil intact. Bana Surakhya Samiti has formed to look after the plantation under Joint Forest Management Scheme (JFMC). Erosion prone areas uplands and non-cultivated lands are selected for plantation. The main intention of fuel fodder plantation is to keep the traditional natural forest undisturbed and non interference to forest dependent. National vegetation will remain intact and soil erosion can be checked and flora and fauna can be preserved.

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