

**IMPACT OF SOIL EROSION: AN AGRICULTURAL PRODUCTION CHALLENGE IN GLOBAL ENVIRONMENT****Dr. Jaspal Singh\*<sup>1</sup>****<sup>1</sup>Lecturer (Geography), Kisan Adarsh Inter College, Khadgugar, Amroha, India.****Overview**

Global warming is expected to lead to a more vigorous hydrological cycle, including more total rainfall and more frequent high intensity rainfall events. Rainfall amounts and intensities increased on average in the United States during the 20th century, and according to climate change models they are expected to continue to increase during the 21st century. These rainfall changes, along with expected changes in temperature, solar radiation, and atmospheric CO<sub>2</sub> concentrations, will have significant impacts on soil erosion rates. The processes involved in the impact of climate change on soil erosion by water are complex, involving changes in rainfall amounts and intensities, number of days of precipitation, ratio of rain to snow, plant biomass production, plant residue decomposition rates, soil microbial activity, evapo-transpiration rates, and shifts in land use necessary to accommodate a new climatic regime. This paper reviews several recent studies conducted by the authors that address the potential effects of climate change on soil erosion rates. The results show cause for concern. Rainfall erosivity levels may be on the rise across much of the United States. Where rainfall amounts increase, erosion and runoff will increase at an even greater rate: the ratio of erosion increase to annual rainfall increase is on the order of 1.7. Even in cases where annual rainfall would decrease, system feedbacks related to decreased biomass production could lead to greater susceptibility of the soil to erode. Results also show how farmers' response to climate change can potentially exacerbate, or ameliorate, the changes in erosion rates expected.

Soil is the earth's fragile skin that anchors all life on Earth. It is comprised of countless species that create a dynamic and complex ecosystem and is among the most precious resources to humans. Increased demand for agriculture commodities generates incentives to convert forests and grasslands to farm fields and pastures. The transition to agriculture from natural vegetation often cannot hold onto the soil and many of these plants, such as coffee, cotton, palm oil, soybean and wheat, can actually increase soil erosion beyond the soil's ability to maintain itself.

Half of the topsoil on the planet has been lost in the last 150 years. In addition to erosion, soil quality is affected by other aspects of agriculture. These impacts include compaction, loss of soil structure, nutrient degradation, and soil salinity. These are very real and at times severe issues.

The effects of soil erosion go beyond the loss of fertile land. It has led to increased pollution and sedimentation in streams and rivers, clogging these waterways and causing declines in fish and other species. And degraded lands are also often less able to hold onto water, which can worsen

flooding. Sustainable land use can help to reduce the impacts of agriculture and livestock, preventing soil degradation and erosion and the loss of valuable land to desertification.

The health of soil is a primary concern to farmers and the global community whose livelihoods depend on well managed agriculture that starts with the dirt beneath our feet. While there are many challenges to maintaining healthy soil, there are also solutions and a dedicated group of people, including WWF, who work to innovate and maintain the fragile skin from which biodiversity springs.

### **Causes**

As the human population has expanded, more and more land has been cleared for agriculture and other pursuits that degrade the soil and make erosion more likely to occur.

### **Agriculture**

When agriculture fields replace natural vegetation, topsoil is exposed and can dry out. The diversity and quantity of microorganisms that help to keep the soil fertile can decrease, and nutrients may wash out. Soil can be blown away by the winds or washed away by rains.

### **Deforestation**

Without plant cover, erosion can occur and sweep the land into rivers. The agricultural plants that often replace the trees cannot hold onto the soil and many of these plants, such as coffee, cotton, palm oil, soybean and wheat, can actually worsen soil erosion. And as land loses its fertile soil, agricultural producers move on, clear more forest and continue the cycle of soil loss.

### **Overgrazing**

The conversion of natural ecosystems to pasture land doesn't damage the land initially as much as crop production, but this change in usage can lead to high rates of erosion and loss of topsoil and nutrients. Overgrazing can reduce ground cover, enabling erosion and compaction of the land by wind and rain.. This reduces the ability for plants to grow and water to penetrate, which harms soil microbes and results in serious erosion of the land.

### **Use of Agrochemicals**

Pesticides and other chemicals used on crop plants have helped farmers to increase yields. Scientists have found that overuse of some of these chemicals changes soil composition and disrupts the balance of microorganisms in the soil. This stimulates the growth of harmful bacteria at the expense of beneficial kinds.

### **Impacts**

The loss of fertile soil makes land less productive for agriculture, creates new deserts, pollutes waterways and can alter how water flows through the landscape, potentially making flooding more common.

**Desertification**

Desertification can be characterized by the droughts and arid conditions the landscape endures as a result of human exploitation of fragile ecosystems. Effects include land degradation, soil erosion and sterility, and a loss of biodiversity, with huge economic costs for nations where deserts are growing.

**Loss of Arable Land**

Arable land is any land that can be used to grow crops. Many of the practices used in growing those crops can lead to the loss of topsoil and destruction of soil characteristics that make agriculture possible.

**Clogged and Polluted Waterways**

Soil eroded from the land, along with pesticides and fertilizers applied to fields, washes into streams and waterways. This sedimentation and pollution can damage freshwater and marine habitats and the local communities that depend on them.

**Increased Flooding**

Land is often transformed from a forest or other natural landscape, such as floodplains and wetlands, into a crop field or pasture. The converted land is less able to soak up water, making flooding more common. There are methods to improve soil water holding capacity as well as restoration and maintenance of wetlands.

**Promoting Sustainable Agriculture**

Agriculture gives us food, fiber, and even biofuels. Farming is the world's largest industry, employing a billion people who produce more than \$1 trillion of food annually. WWF works with farmers, major companies and their supply chains to promote the use and development of sustainable agriculture that preserves and restores critical habitats, helps protect watersheds and improves the health of soil and water.

**Working to Reduce Deforestation**

Eliminating all deforestation is not possible. Parts of the landscape will need to be reshaped and altered as populations grow and change—but this can be balanced through sustainable forest management, reforestation efforts and maintaining the integrity of protected areas. Given the amount of deforestation around the world, zero net deforestation may seem unattainable. However, it is not only possible, but necessary if we intend to preserve our most precious wildlife, respect and empower local communities, maintain critical ecosystem services and reduce greenhouse gas emissions. Some nations are already finding success. Paraguay reduced the rate of deforestation in their country by 85% in the years just following enactment of its 2004 Zero Deforestation Law. WWF advocates for governments, international bodies and other stakeholders to make zero net deforestation a reality by 2020.

## **Understanding Forestry**

### **Environmental Effects**

Greenplan's forests are planted on land formerly used for farming of sheep and cattle. It is useful to contrast the environmental effects of plantation forests in comparison to agricultural activities. Such a comparison also helps to put the effects of pine forests in context.

### **Water Yield**

Forests reduce water yields relative to pasture by between 25 and 50% in some New Zealand sites.

In some situations forests reduce flooding, except in cases of poor forestry practices, such as poorly designed roading and skid sites, which increase sedimentation. On the other hand good practices can reduce erosion and flood effects.

### **Water Quality**

Water quality in New Zealand's remote areas is very good by international standards. However lowland areas where agriculture is the main activity have poor water quality. This is mainly due to run-off of inorganic fertilisers and faecal contamination.

Sedimentation is often increased by agricultural activities.

Forestry can have a negative effect on water quality mainly at the time of logging and roading if there is not good management. There are clear guidelines for ensuring water quality is not degraded.

The Resource Management Act, under which forestry is strictly regulated, but agricultural activities left alone, places strict controls on forestry activities in relation to water quality.

### **Soil Erosion**

Some degree of erosion is the inevitable result of natural geological forces.

However in many parts of New Zealand erosion has been accelerated by large scale land clearance. An estimated 5.5 million ha currently under pasture is unsustainable in its present use.

If land is susceptible to erosion it is likely to be greater on farm land than within forests.

There is clear evidence that most forms of erosion are significantly reduced if forested with pine trees. Trees dry out the soil, and bind it with their roots to a much greater extent than grass species. Soil erosion at harvest time can be largely eliminated by good management and immediate replanting.

### **Soil Deterioration**

Soil can be said to deteriorate if the growth of any future crop is likely to be inferior to the growth of a similar, current crop.

There is no proof that agricultural or forestry practices cause deterioration of soils, provided appropriate site preparation and fertiliser treatments are used.

Studies have shown that forestry enhances the availability of soil nutrients, especially nitrogen and phosphorus, in the top soil layers.

Studies have also shown that there is a temporary increase in acidity levels under pine trees. This benefits trees as most prefer acidic soils. Acidity is neutralised over time as foliage and branches decompose.

Soil compaction is greater in pastoral sites than in well managed forests.

### **Greenhouse Effect**

There is increasing agreement that global warming is occurring largely because of human activity.

Forestry is one option for offsetting the effects of global warming. Trees absorb carbon dioxide, one of the main Greenhouse gases. They convert it to wood, through photosynthesis.

A hectare of radiata absorbs between 20 and 25 tonne of carbon per hectare annually.

Although some carbon is released during the harvesting and processing of forests there is a positive net absorption of carbon.

Agricultural activities do not result in the storage of large volumes of carbon in the crop. Any uptake of carbon is more than offset by annual carbon losses.

New Zealand's emissions of methane and nitrous oxide from livestock and high nitrogen pastures may contribute more to global warming than its total emissions of carbon dioxide from fossil fuel usage.

### **Aesthetics**

There is wide ranging opinion as to the aesthetic value of plantations, and of pastoral land. Because of this little can be said in regard to the relative merits of the aesthetic values of each.

Indigenous forests are normally preferred to plantation forests, especially by New Zealanders.

Many foreign visitors seem to appreciate the aesthetic qualities of plantation forests to a greater extent, or do not notice a significant difference...

### **Forest Practices**

Radiata pine is the predominant species planted in New Zealand because of its high productivity, relative high rates of return, length of growing cycle and established markets.

If pasture land is converted to forestry there is normally little site preparation required and only minimal clearance of existing woody vegetation.

Use of herbicides although unpopular with some environmental groups is likely to be less destructive than other forms of site preparation such as burning or 'windrowing'.

Radiata forests are clear felled rather than selectively logged because it is not possible to establish a commercially viable mixed age forest of radiata. In some cases it may be preferable to progressively log some forests rather than fell a continuous area.

Riparian strips along waterways are a partial solution to problems of sedimentation, and flow of nutrients into streams.

Good site preparation, and management of road construction prior to harvest is of vital importance to minimise erosion and compaction.

Increased harvest volumes produce increased noise, road traffic, and road maintenance costs.

An offsetting factor is that forest owners contribute to roading and infrastructure costs through local body rates over the life of their forests, but only impact on local infrastructure for part of that time. The agricultural industry however contributes in the same way, but impacts on infrastructure continuously.

### **Biodiversity**

Biodiversity describes the variety and complexity of life.

Plantation forestry in New Zealand has been shown to support a greater number of birds than any other type of mainland forest.

In comparison to pastoral land use forestry increases biodiversity to a great extent, especially in terms of under storey vegetation and birds, as well as aquatic life.

### **Monocultures, Pest and Disease Risk**

Radiata forests are described by some as unnatural monocultures. This is debatable. Many monocultures, such as New Zealand's beech forests, occur naturally. Radiata forests contain greater diversity than many other types of forest, and certainly in comparison to biodiversity of agricultural systems. There is no proof that New Zealand's radiata forest would be more susceptible to outbreaks of disease or other pest than any other form of forest. This would largely depend on the type of pest or disease, the exact genetic composition of trees and local factors such as climate.

It is no more likely that New Zealand radiata forests will be significantly affected by introduced pests and diseases than agriculture would be affected by a significant disease such as Foot and Mouth.

### **Socio Economic Effects**

The major socio economic concern regarding forestry is the loss of farmland, with the assumption that this will create a decline in employment and income in areas dependant on

agriculture. This raises the question of whether a forestation is a cause or a symptom of the long term decline in pastoral farming.

In areas of small scale a forestation there is unlikely to be significant impact on agriculture.

In areas of larger scale a forestation there is likely to a short term lowering of employment levels and household income levels. However this will be offset by demand for forest workers during forest development and harvesting. There is also likely to be significant employment in associated businesses servicing forest operations.

### **Economic and Environmental Effects of Erosion**

Erosion has long-term consequences for soil quality and short-term consequences on individual crops. Off-site environmental effects are increasing and becoming more unacceptable to those affected as well as the public at large.

#### **Repeated erosion reduces the fertility of the soil by:**

- removing top soil which is rich in nutrients and organic matter;
- reducing the depth of soil available for rooting and for storing water available for crop growth; and
- reducing infiltration of water into soil and increasing run off.

#### **Short-term damage and increased costs can result from:**

- loss of seeds, seedlings, fertilisers and pesticides, and the need to repeat field operations;
- soil being washed from the roots;
- young plants being blasted with sand during wind erosion; and
- the need to level out eroded surfaces by extra cultivations.

#### **Damage to the off-farm environment takes the form of:**

- deposition of sediment onto roads, neighbouring properties and in roadside drains;
- damage to the quality of watercourses, lakes and coastal waters through excess inputs of nitrogen, phosphorus and pesticides;
- sediment in rivers damaging the spawning grounds of fish; and
- increased run off and deposition of sediment causing a greater flood hazard downstream.

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