Rashtriya Krishi | Volume 7 | Issue 2 | December, 2012 | 50-51

EFFECT OF CLIMATE CHANGE ON SOIL QUALITY

T.V. Jyothi and M.B. Roodagi
Department of Soil Science, College of Agriculture, DHARWAD (KARNATAKA) INDIA
Email : veeranna.jyothi@gmail.com; mbroodagi@gmail.com

Exponential growth of $CO_2$and other greenhouse gases in the atmosphere is causing climatechange. It affects agriculture, forestry, human health, biodiversity, snow coverand aquaticto mountain ecosystems. Changes in climatic factors like temperature, solar radiation andprecipitation have potentials to influence crop production. Climate change presents unique challenges to soil science. Soils are essential for the balance of all three major greenhouse gases. More carbon is stored in soil than in the combined pools of atmospheric carbon dioxide, plants and animals. Soils are an important methane source, and by far the largest nitrous oxide source. Global change affects climate conditions and results in profound land use changes (e.g. increased biofuel production). This might lead to soil degradation due to a decline in biotic and abiotic soil parameters. Our second challenge is therefore to secure soil quality under changing and increasing claims on global soil resources.

Soil quality:

It is the capacity of a specific kind of soil to function within natural or ecosystem boundaries, to sustain plant and animal productivity, to maintain or enhance water and air quality, and to support human health and habitation.

Ecosystem functions:

– Retain and release nutrients and other chemical constituents

– Partition rainfall at the soil surface into runoff and infiltration

– Hold and release soil water to plants, streams, and groundwater

– Resist wind and water erosion

– Buffer against the concentration of potentially toxic materials

Climate change

Climate change is a phenomenon due to emissions of greenhouse gases from fuel combustion, deforestation, urbanization and industrialization resulting variations in solar energy, temperature and precipitation. It is a real threat to the lives in the world that largely affects water resources, agriculture, coastal regions, freshwater habitats, vegetation and forests, snow cover and melting and geological processes such as landslide, desertification and floods, and has long-term affects on food security as well as in human health.

Climate change is an overarching driver affecting numerous soil quality issues such as:

– A loss of organic matter because of higher decomposition rates (e.g. increased temperature, drying of wetlands);

– Erosion as a result of more frequent extreme rainfall events;

– Reduced trafficability as a result of periods of increased soil wetness;

– A reduction in soil fertility;

– Increased and changing pest loads;

– achange of vegetation type and an increase in plant growth (both crops and natural vegetation).

Factors influencing on climate change:

Effects of rainfall and temperature changes in different climates:

In the humid tropics and monsoon climates, increased intensities of rainfall events and increased rainfall totals would increase leaching rates in well-drained soils with high infiltration rates, and would cause temporary flooding or water-saturation, hence reduced organic matter decomposition, in many soils in level or depressional sites.

They would also give rise to greater amounts and frequency of runoff on soils in sloping terrain, with sedimentation down slope and, worse, downstream.

Soils most resilient against such changes would have adequate cation exchange capacity and anion sorption to minimize nutrient loss during leaching flows, and have a high structural stability and a strongly heterogeneous system of continuous macropores to maximize infiltration and rapid bypass flow through the soil during high-intensity rainfall.

Atmospheric deposition:

The burning of fossil fuels by industry, households and vehicles releases gaseous emissions of sulphur dioxide and oxides of nitrogen that can travel hundreds of miles in the atmosphere. These gases can be dissolved in rainwater to form sulphuric and nitric acids. These will subsequently be deposited on soil and result in soil acidification which can cause:

– Reduced drainage water quality due to increased leakage of acidic compounds and toxic elements;

– A loss of above and below ground biodiversity, as certain species are unable to survive in acidic soils;

– structural damage to soil minerals.

CO_2 concentration:

– Enhanced atmospheric CO_2 concentrations have generally been found to increase crop production.

– This is because higher CO_2 levels tend to improve plant water-use efficiency and rates of photosynthesis. However, the relationship is not simple.

– For instance, certain types of plants, such as legumes, are expected to benefit more in the future than others, and the nutritional quality of some crops will likely decline.

– In addition, there are several factors, including moisture conditions and the availability of soil nutrients, that could limit or negate the benefits of CO_2 fertilization on plant growth.

Effects of climate change on soil properties:

Soil reaction (pH):

In conditions where leaching is accelerated by climate change, it would be possible to find relatively rapid soil acidification after a long period with little apparent change. The soil might in fact be steadily depleted of basic cations, but a pH change may start, or may become more rapid, once certain buffering pools are nearly exhausted.

Soil degradation:

Soil erosion threatens agricultural productivity and sustainability, and adversely affects air and water quality.There are several ways that soil erosion could increase in the future due to climate change. Wind and water erosion of agricultural soils are strongly tied to extreme climatic events, such as drought and flooding, which are commonly projected to increase as a result of climate change. Land use change could exacerbate these impacts, as conversion of natural vegetation cover cropland greatly increases the sensitivity of the landscape to erosion from drought and other climatic fluctuations. Warmer winters may result in a decrease in protective snow cover, which would increase the exposure of soils to wind erosion, whereas an increase in the frequency of freeze-thaw cycles would enhance the breakdown of soil particles.The risk of soil erosion would also increase if producers respond to drought conditions through increased use of tillage summerfallow.

Poor soil fertility:

Due to low accumulation of organic matter and loss of fertile top soil by soil erosion the dry land soils are poor in fertility status. Most of the dry land soils are deficient in nitrogen and zinc. A higher mineralization rate as a consequence of climate change also adds to the potential soil fertility loss. Climate change also results in increase in the organic matter decomposition rate with temperature and soil moisture.

Soil crust problem:

Crust formation is a serious problem due to climate change. The topsoil becomes denser as a result of the additionof fine material from the subsurface layer caused by plowing. In case of red soils, the formation of hard surface soil layers hinders the emergence of seedlings which ultimately affect the plant population.Crusting of soil surface after rainfall reduces infiltration and storage of rainfall, due to high run off. Presence of hard layers (pans) in soil and deep cracks affect the crop production especially in case of black soils.

Change in soil biodiversity:

The over-exploitation of land and soils, land use changes and climate change all have an effect on soil biodiversity, reducing the number and variety of soil species. The impacts that this can have are:

– The potential for a reduction of soil functions;

– Disruption of food supplies and webs;

– loss of potential resources for future applications (e.g. biotechnology, drugs).

Measures to mitigate the climate change impact:

Carbon sequestration in soil and terrestrial ecosystems can contribute to climate change mitigation and also promote food security by enhancing agronomic production and input efficiency.

The adoption of recommended management practices (e.g. no-till in conjunction with mulching and cover cropping, integrated nutrient management to create a positive nutrient budget, use of biochar, complex crop rotations, and water harvesting and recycling with drip/ furrow irrigation) can sequester carbon in soil at a rate of 200 to 1000 kg/ha/y with a total potential of 1 billion tonnes of carbon per year in agricultural soils (between 70 and 190 million tonnes for western Europe).

Removal of crop residues for biofuel can adversely impact soil quality and create a large soil carbon debt. Rather than using crop residues, the conversion of degraded and agriculturally marginal soils to energy plantation (e.g. switch grass, miscanthus, poplar, willow), and growing algae and cyanobacteria in bioreactors are possible strategies to produce biomass for biofuel production.

* * * * *