Understanding the significance of fire-intensity concerning soil nutrients and soil-microflorae

[1]Ms. Geetashri Borah, [2]Mr. Arghya Chakrabarty, [3]Mr. Debaaditya Mukhopadhyay

Research Scholars
Rain Forest Research Institute, Jorhat- 785 001, Assam, India

***Corresponding author:** Debaaditya Mukhopadhyay

***Abstract*: Fire-intensity plays a crucial role in determining the extent of the impact on essential soil nutrients and soil microflorae. As the number and intensity of forest fire keep increasing across the globe, we need to understand the different scientific aspects of a forest fire. Some organisms are benefited while some get detrimentally affected after single or repeated burns. Thus, we need to create a clear understanding of fire-intensities and associated conditions that might impact the proportions of different soil nutrients and soil microflorae.**

***Keywords*: Forest fire, soil nutrients, micro-florae**

Forest fire is a major disturbance that brings about detrimental shifts in the ecosystem altering both the physiochemical as well as the biological surroundings through processes of heating and oxidation[1]. Fire-intensity plays a critical role in monitoring the dynamics of the available and total organic compound present in the soil[2]. Fires also bring about notable shifts in the composition of the soil-microflora by changing the abundance and composition of many fungal and bacterial communities in the soil.

Previous studies indicate that fires can alter the carbon, nitrogen, potassium quality, and quantity in the soil besides soil pH. In conditions of low fire-intensity i.e., temperature not exceeding 300°C, it is observed that there is no significant change in the organic carbon content in the soil, however, change is observed when the temperature exceeds 500°C[3]. The nitrogen content of soil falls abruptly immediately after a fire but increases with time mainly due to the process of nitrogen fixation by soil-microbial communities (Figure 1). The humus layer also gets significantly affected by forest fire since higher degrees of temperature break down organic matter leading to immense loss of potassium through leaching within the first year after fire[4]. Shifts in soil-pH are also observed after a fire which makes it more alkaline by 14.29%[4].

Fire-intensity tends to control the severity to which the soil-microflora is likely to get affected[5]. The fungal communities tend to exhibit a higher degree of sensitivity as compared to heterotrophic bacteria with increasing soil-temperature[6]. However, it has been also observed that many fungal species like *Trichoderma sp.*, *Penicillium sp.*, *Actinomycetes sp.*, and *Zygomycetes sp.* die rapidly as the temperature exceeds above 50°C[7]. The ratio of fungal to the bacterial biomass was observed to be the lowest in immediately burnt soil[8]. The leaching of the humus layer leads to lower concentrations of fungal hyphae. Entire fungal populations are wiped away in dry soil at 80°C and moist soil at 60°C temperature whereas bacteria threshold of heat tolerance is found to be 120°C & 100°C respectively[6]. Forest fire also impacts the bacterial population significantly as evidenced by the observation that the gram-positive bacteria count is much higher than the gram-negative bacteria immediately after a fire[9]. Forest fire also impacts the balance of biotic and abiotic soil factors indirectly affecting the microbial communities. These indirect effects include increment in solar penetration and associated shifts in mineral concentrations in soil, humus layer, and ultimately results in the deposition of ash and charcoal thereby chemically altering the constituents of the forest floor.

The demarcations available in categorizing forest fire today are of three types. Dealing with the source, either it can be a natural fire or an anthropogenic fire. Based on the regions of burn, it can be a crown fire, ground fire, or surface fire. However, none of it clearly states the effects the different types shall possess on the soil nutrients and soil microflorae. With the increased rate of forest-fire incidences across the world in the last 10 years, it is extremely important to understand the significance of fire-intensity concerning soil nutrients and soil-microflorae. Accordingly, we need to develop a clear understanding of the forest matrices that is likely to occur at each level of fire intensity. Each such matrix is likely to possess both kinds of organisms and nutrients. Some are likely to escape the unfavorable conditions and benefit from the post-fire matrix while someone shall be unable to cope up with the unfavorable conditions and ultimately perish. In accordance, certain macro and micronutrients shall increase with prevailing fire conditions while some shall show a sharp fall. Different scientific studies also indicate that the rise or fall is not uni-directional in all cases. Certain micro-florae are initially at risk of getting detrimentally affected by the fire. Thus, their population shows a fall after a single burn. But after repeated burn, their densities develop indicating developed adaptability to fire conditions. Hence, it is important to study different fire-intensities under different conditions with associated detailed ranges of temperature and other meteorological factors whose fluctuations may bring about diverse detrimental or incremental impacts on soil nutrients and soil biodiversity.

References:

1. Hart, S. C., DeLuca, T. H., Newman, G. S., MacKenzie, M. D., and Boyle, S. I., Post-fire vegetative dynamics as drivers of microbial community structure and function in forest soils. *For. Ecol. Manage.*, 2005, **220**, 166–184.
2. Certini, G., Effects of fire on properties of forest soils: A review. *Oecologia*, 2005, **143**, 1–10.
3. Bárcenas-Moreno, G. and Bååth, E., Bacterial and fungal growth in soil heated at different temperatures to simulate a

range of fire intensities. *Soil Biol. Biochem.*, 2009, **41**, 2517–2526.
4. Pietikainen, J. and Fritze, H., Microbial biomass and activity in the humus layer following burning: short-term effects of two different fires. *Can. J. For. Res.*, 1992, **23**, 1275–1284.
5. Ahlgren, I. F., The effect of fire on soil organisms. *Fire Ecosyst. Press.*, 1974, pp. 47–72.
6. Dunn, P. H., Barro, S. C., and Poth, M., Soil moisture affects the survival of microorganisms in heated chaparral soil. *Soil Biol. Biochem.*, 1985, **17**, 143–148.
7. Bollen, G. J., The selective effect of heat treatment on the microflora of a greenhouse soil. *Netherlands J. Plant Pathol.*, 1969, **75**, 157–163.
8. Bissett, J. and Parkinson, D., Long-term effects of fire on the composition and activity of the soil microflora of a subalpine, coniferous forest. *Can. J. Bot.*, 1980, **58**, 1704–1721.
9. Mabuhay, J. A., Nakagoshi, N., and Horikoshi, T., Microbial biomass and abundance after forest fire in pine forests in Japan. *Ecol. Res.*, 2003, **18**, 431–441.

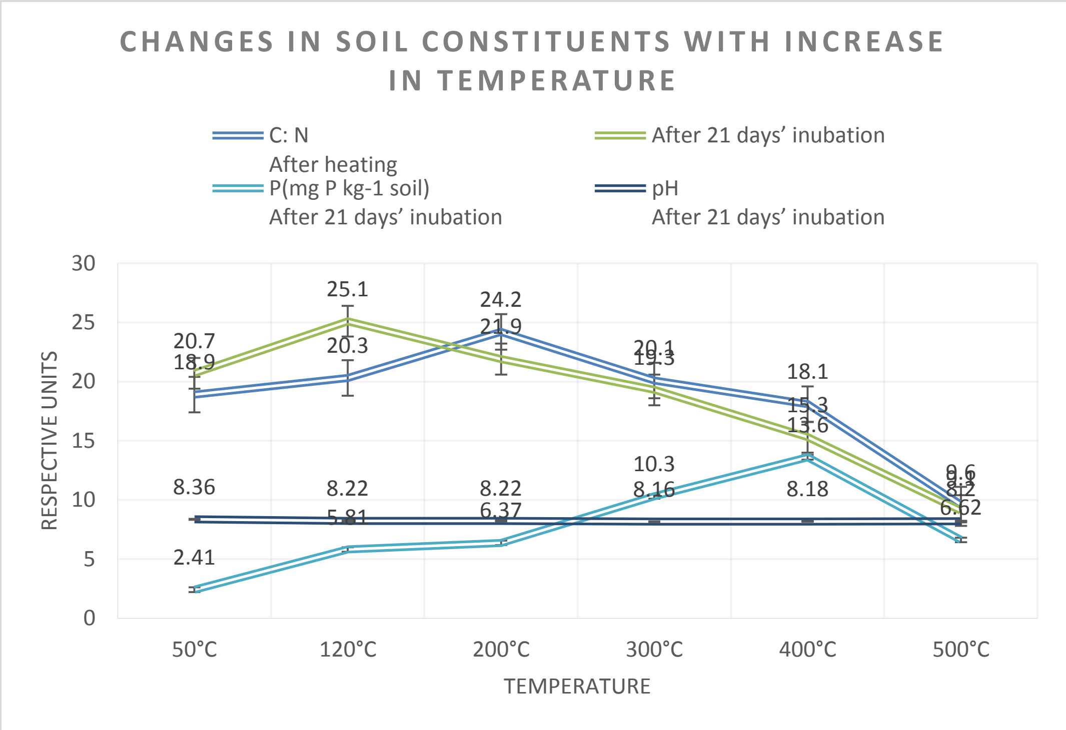

Figure 1: Changes in soil constituents with the increase in temperature based on secondary data obtained from [3].