Biopore Technology: A Sustainable Mitigation Strategy for Managing Water and Reducing Flood Risks in Tropical Climates

By

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"India's vulnerable people will suffer even more due to climate change if sustainable long-term strategies are not adopted with urgency"
- Jameel *et al.* -

Introduction

Global warming has dramatically changed weather patterns worldwide especially in tropical regions. The total number of natural disasters linked to climate change has increased markedly in the first two decades of the twenty-first century. For instance, extreme rainfall caused by typhoons has become more intense, leading to widespread flooding in many parts of the world. The percentage rainfall impacted during the El Niño and La Niña years with respect to normal years during the Indian summer monsoon. El Niño or La Niña indicates the drought/flood situation through the weakening or strengthening of the monsoon rainfall occurring during the Indian summer monsoon over the study period (1998-2014). During the La Niña years, leads to a high water vapor content available in the air and high relative humidity resulting in hygroscopic growth of water-soluble aerosols leading to the formation of large cloud cover in the lower atmospheric layers, where condensation of moisture produces high rainfall. Many studies have been exploring precipitation changes at both global and regional scales. The distribution daily rainfall clearly indicates as high as 900 mm/day in few locations mostly in Indian Himalay regions the maximum value of the in the recent year of analysis i.e., 2022 indicating a signature of regional climate change driven high impact rainfall event [4]. **Fig. 1** shows almost continental India received rainfall more than 100 mm/day during the 72-year period.

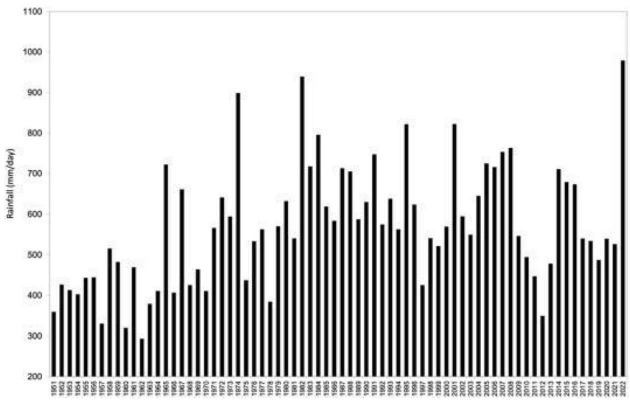

Figure 1. Variability of daily rainfall observed at any location in continental India (Samantray *et. al.*, 2023)

Heavy rainfall flooding can seriously affect humans and property such as economic and social development, destructive agriculture, and ecological environment [1]. Heavy rain is an important factor leading to high flood risk. Flooding is caused by poor drainage systems, especially in densely populated areas, which happens because the ground doesn't have water infiltration. Excess water in the soil environment due to periodic heavy rains is very threatening to decrease the biomass of microorganisms. Microorganisms have an important role in phosphorus formation. Organic phosphorus compounds are converted and mineralized by microorganisms into organic compounds, if their number decreases will affect soil quality [2]. Environmentally friendly drainage is needed as a control of runoff which directly absorbs into the ground which is using biopore.

What is Biopore?

The concept of biopore is being replicated through an infiltration hole. Biopore tubes are solid structures designed and manufactured in a cylindrical hole (usually coated with plastic pipe) that are buried vertically underground with the aim to absorb surface water due to heavy rain. Biopores consisting of pralon tubes and concrete tubes provided with infiltration holes are also frequently utilized. It is hoped that the addition of biopore infiltration pores may function in minimizing the impact of flooding. The illustration of biopore shows in **Fig. 2.**

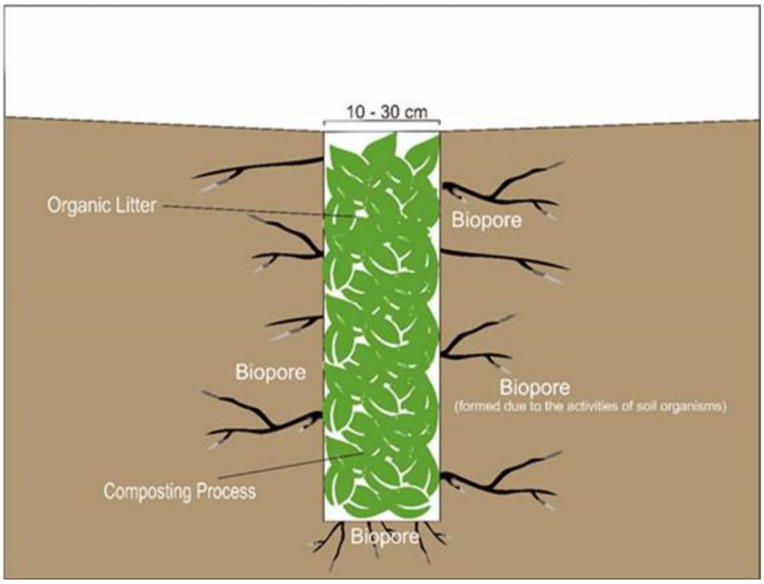

Figure 2. Biopore infiltration (Nug et al., 2018 in Nugraha et al., 2024)

Biopores utilize various organic materials, including leaf litter, vegetable scraps, fruit peels, and kitchen waste, as natural compost within the soil. These materials serve as a food source for decomposer organisms like earthworm, Coleoptera, and other macrofauna, which play a crucial role in improving water absorption into the ground more quickly. These organisms actively burrow the soil, creating an extensive network of small tunnels that enhance water distribution. They contribute to the formation of larger macropores, which play a crucial role in improving soil structure. Macropores allows rainwater to seep deep into the ground rather than accumulating on the surface [3].

Increased aeration also promotes root growth and microbial activity that can help maintain soil moisture and reduce the risk of drought stress in plants. By preventing excessive surface runoff, this process minimizes soil erosion and protects the topsoil layer [3]. The presence of macrofauna contributes to both agricultural productivity and environmental sustainability.

What is the Important Role of Macrofauna with Soil Fertility?

The improved soil macroporosity caused by earthworm activity allows plant roots to go deeper into the soil and favors tree crops that prefer an aerated soil for their development, also reducing the incidence of soil-borne disease. Integrating tree crops with either spontaneous or cultivated cover crops can enhance soil biodiversity. This system tends to support a larger earthworm community and higher densities of ants, termites, and epigeic detritivores that live and feed on the soil surface. The presence of these organisms plays a crucial role in accelerating organic matter decomposition, improving soil fertility, and naturally enhancing soil structure. Moreover, soils amended with compost or with other endogenous or exogenous carbon sources are more favorable for earthworm development, as there is an improvement in leaf litter quantity and quality, and a reduced physical soil perturbation.

Fertile soil plays a fundamental role in maintaining agricultural productivity and ecosystem balance. It provides essential nutrients, ensures the continuous cycling of nutrients, stores water, and reduces soil erosion. One of the important roles in soil management is the process of mineralization, in which organic matter decomposes and releases nutrients into the soil. If soil degradation is not properly planned and carried out, it can lead to a decrease in soil fertility. Organic matter in biopores also supports an underground ecosystem. The diversity of soil fauna and organic materials are key indicators for the rate of soil degradation in an agrosystem. Moreover, biopores formed by soil organisms help prevent soil compaction. With more biopores, rainwater can penetrate deeper into the soil, reducing surface runoff and flood risks especially in urban areas.

Conclusion

Biopore technology has a crucial role in flood mitigation by effectively managing rainwater overflow, reducing the risk of waterlogging and soil erosion. This innovative approach involves creating vertical infiltration holes that increase groundwater absorption, preventing excessive surface runoff. Additionally, biopores serve as microhabitats for organism underground like decomposers, which contribute to improved soil structure, drainage, and aeration. By integrating biopore technology into urban and agricultural landscapes, local communities are able to improve the quality of their soil.

References

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