Direct Research Journal of Agriculture and Food Science
Vol. 12(2), Pp. 180-183, May 2024
ISSN: 2354-4147
DOI: https://doi.org/10.26765/DRJAFS19866747
Article Number: DRJAFS19866747

https://journals.directresearchpublisher.org/index.php/drjafs

Soil and Water Support Life on Earth, given Proper Management Practices

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Received 9 April 2024; Accepted 17 May 2024; Published 30 May 2024

ABSTRACT: Soil and water are essential resources for sustaining life on earth. Soil and water are interconnected resources that need integrated management. Improper soil and water management practices affect soil erosion, soil biodiversity, soil fertility and water quality and quantity. Soil and water are essential resources for sustaining life on earth, and are undeniably vital resources that contribute to the sustenance of life on earth. The interplay between these elements is crucial in various aspects, and understanding their key aspects is essential for comprehending their significance and ensuring their conservation; recognizing and preserving the integrity of these essential resources is crucial for ensuring the long-term sustainability and well-being of our planet.

Keywords: Soil, water, support, life, earth, proper, management practices

Citation: Akinmutimi, A.L. (2024). Soil and Water Support Life on Earth, given Proper Management Practices. Direct Res. J. Agric. Food Sci. Vol. 12(2), Pp. 180-183. https://doi.org/10.26765/DRJAFS19866747.

INTRODUCTION

Soil, also commonly referred to as earth or dirt, is a mixture of organic matter, minerals, gases, liquids, and organisms that together support the life of plants and soil organisms. Soil consists of a solid phase of minerals and organic matter as well as a porous phase that holds gases (the soil atmosphere) and water (the soil solution) (Voroney and Heck, 2007) Soil is our life support system. Soils anchor roots, hold water and store nutrients. Soils are home to earthworms, termites and a myriad of micro-organisms that fix nitrogen and decompose organic matter (Balestrini *et al*., 2015). 95% of our food comes from water, but not without water (Jayeoba, 2023).

Accordingly, soil is a three-state system of solids, liquids, and gases (McCarthy, 2014). Soil is a product of several factors: the influence of climate, relief (elevation, orientation, and slope of terrain), organisms, and the soil's parent materials (original minerals) interacting over time (Balasubramanian, 2017). Soil continually undergoes development by way of numerous physical, chemical and biological processes, which include weathering with associated erosion (Guo *et al*., 2019). Given its complexity and strong internal connectedness, soil ecologists regard soil as an ecosystem (Ponge, 2015).

One of the primary aspects of soil and water is their role in supporting the growth and nourishment of plants. Soil acts as a reservoir of vital nutrients that plants require for their development. It serves as a medium for anchoring roots, facilitating water absorption, and providing a stable environment for microbial activity (Huntley, 2023). Without fertile soil, the natural processes of plant growth and food production would be severely hindered, leading to devastating consequences for ecosystems and human societies alike. Water, on the other hand, serves as a lifeline for all forms of life. It plays a fundamental role in the survival of organisms by enabling metabolic processes, maintaining cellular integrity, and regulating body temperature. Beyond its biological significance, water is also crucial for various human activities, including agriculture, industry, transportation, and recreation. The availability and quality of water resources directly impact the overall well-being and socioeconomic development of communities worldwide (Jayeoba, 2023).

Soil has four important functions: As a medium for plant growth, as a means of water storage, supply and purification, as a modifier of Earth's atmosphere, And as a habitat for organisms (De Deyn and Kooistra, 2021). All of these functions, in their turn, modify the soil and its properties. Soil science has two basic branches of study: edaphology and pedology. Edaphology studies the influence of soils on living things (Glossary of terms in soil science, 2013). Soil water on the other hand, can be defined as the amount of water held in soil pores (spaces within soil particles). Improper soil and water management affect not only soil erosion, but also soil biodiversity, soil fertility, and water quality and quantity (Maximillian *et al*., 2019).

- Water scarcity leads to the loss of soil biodiversity, while leaching and eutrophication from agriculture practices lead to the loss of biodiversity in water bodies.
- The mismanagement of pesticides and fertilizers not only threatens soil and water quality but also poses significant risks to human health and ecosystems.

1. Poor irrigation and drainage practices are some of the main drivers of soil salinization.
1. Rising sea levels contribute to land loss, increasing the risk of soil salinization and sodification, which can negatively impact agricultural productivity.

Available water capacity is the amount of water held in a soil profile available to plants. As water content drops, plants have to work against increasing forces of adhesion and sorptivity to withdraw water. Irrigation scheduling avoids moisture stress by replenishing depleted water before stress is induced (Oregon State University, 2016).

Soil as a home of biodiversity

Biodiversity is the structural and functional variability of the diverse forms of life that inhabit the biosphere, at increasing levels of organization and complexity: at the genetic, population, species, community and ecosystem levels (Bardgett, 2010). Large numbers of microbes, animals, plants and fungi are living in soil. However, biodiversity in soil is much harder to study as most of this life is invisible, hence estimates about soil biodiversity have been unsatisfactory. A recent study suggested that soil is likely home to 59 ± 15% of the species on Earth. Enchytraeidae (worms) have the greatest percentage of species in soil (98.6%), followed by fungi (90%), plants (85.5%), and termites (Isoptera) (84.2%). Many other groups of animals have substantial fractions of species living in soil, e.g. about 30% of insects, and close to 50% of arachnids (Anthony *et al*., 2023).

Several groups and a great diversity of organisms live in the soil: insects, mollusks, protozoa, algae, bacteria, fungi, etc. Soils have a very high level of heterogeneity, and an extremely large number of habitats, which also contribute to a high level of biodiversity, if the soil is in “good health”. Indeed, the level of biological abundance and diversity can vary widely from one soil to another, depending on a variety of factors, including organic matter content, soil mineral composition (especially texture), pH and soil management practices (Bardgett, 2010). This biodiversity is not only very high in number, it can also be functional. Indeed, soil organisms maintain complex relationships with each other, but also influence the entire ecosystem by controlling the circulation of materials essential to plant life (carbon, nitrogen, phosphorus, potassium, etc) (Maximillian *et al*., 2019).

Soil organisms are generally classified into four groups according to the size of the individuals: microorganisms (or microflora), microfauna, mesofauna and macrofauna. This classification reflects, among other things, the ability of different organisms to move through the soil pores (Lal, 2004). In addition, the upper flora (trees, shrubs, herbaceous plants) is involved through its root system, which represents a significant biomass and performs important functions in the soil.

Soil micro-organisms are extremely abundant and of great taxonomic and functional diversity. They include bacteria, fungi, microalgae, archaea and protists (Bertrand *et al*., 2011). The biological functioning of soils is strongly linked to microbial activity, which gives these microorganisms a major role in many soil functions.

The role of soil and water as a source of life

Soils are the primary provider of nutrients and water for much of the plant life on earth. There are 18 elements considered essential for plant growth, most of which are made available to plants through root uptake from soils (Brady and Weil, 2008). Soils retain nutrients by several mechanisms. Most nutrients are dissolved in soil water as either positively or negatively charged ions; soil particles are also charged and thereby are able to electrically hold these ions. Soils also hold nutrients by retaining the soil water itself.

Among the most important functions performed by soils is to provide the ideal conditions for clay synthesis. Clays are important because they are often active, which is a general term soil scientists use to describe how chemically reactive a particle is with ions, water, and other particles. These reactions are critical for the provision of many ecosystem services. Clays are often the most active mineral particles because they have unique chemical characteristics and also because they have so much surface area — clays can have 10,000 times the surface area of sand of the same weight

(Brady and Weil, 2008). Soil moisture is the water content of the soil. It can be expressed in terms of volume or weight. Soil moisture measurement can be based on in-situ probes (e.g. capacitance probes, neutron probes) or remote sensing methods (Zhang *et al*., 2021).

Water that enters a field is removed from a field by runoff, drainage, evaporation or transpiration. Runoff is the water that flows on the surface to the edge of the field (Guo *et al*., 2019); soil drainage is a natural process by which water moves across, through and out of the soil as a result of the force of gravity (Fausey, 2005); evaporative water loss from a field is that part of the water that evaporates into the atmosphere directly from the field's surface; transpiration is the loss of water from the field by its evaporation from the plant itself.

Water affects soil formation, structure, stability and erosion but is of primary concern with respect to plant growth. Water is essential to plants for four reasons:

- It constitutes 80%-95% of the plant's protoplasm.
- It is essential for photosynthesis.
- It is the solvent in which nutrients are carried to, into and throughout the plant.
- It provides the turgidity by which the plant keeps itself in proper position.

Water is essential for life on earth

Water is critical for all life on Earth and its availability in terrestrial systems is highly variable and dynamic. The water cycle upon which terrestrial life relies for replenishment has been scrutinized in the context of climate change due to recurrent extreme events such as droughts and floods (Samaniego *et al*., 2018). In addition, not all of the water stored in soil is usable for biological processes. For instance, water films and water in very fine pores are largely inaccessible to plant roots and microorganisms. In contrast, mid-size and large pores provide water usable for organisms, but can also be prone to rapid infiltration and water flux through the soil matrix (Vereecken *et al*., 2022).

Impact of soil in carbon sequestration

The soil carbon (C) stock, comprising soil organic C (SOC) and soil inorganic C (SIC) and soil being the largest reservoir of the terrestrial biosphere, is a critical part of the global C cycle. Soil has been a source of greenhouse gases (GHGs) since the dawn of settled agriculture about 10 millenia ago. Soils of agricultural ecosystems are depleted of their SOC stocks and the magnitude of depletion is greater in those prone to accelerated erosion by water and wind and other degradation processes (Lal *et al*., 2021). Adoption of judicious land use and science-based management practices can lead to re-carbonization of depleted soils and make them a sink for atmospheric C. Soils are massive carbon sinks, acting as key players in the global carbon cycle. They capture and store more carbon than the atmosphere and all plant life combined (Lal, 2004).

Natural hazards mitigation

Soils have an integral role in our global ecosystems and the policies that guide their sustainable management. Natural hazards such as desertification, land degradation leading to soil infertility, draught, deforestation and inappropriate agricultural practices could be overcome when the policies are judiciously implemented. Soil and water contribute to the regulation of hydrological, erosional and biogeochemical cycles, including the carbon cycle (Keesstra *et al*., 2012), and soils are known to store massive amounts of carbon (C) (second only to oceans) where management strategies can be used to increase current levels of soil organic carbon even further. The interaction between soils and plants is particularly important for ecosystem functionality (including hydrological and biogeochemical functions) and to prevent degradation processes (Cerdà *et al*., 2017).

Conclusion

Soil and water are undeniably vital resources that contribute to the sustenance of life on earth. The interplay between these elements is crucial in various aspects, and understanding their key aspects is essential for comprehending their significance and ensuring their conservation. The key aspects of soil and water as sources of life encompass their roles in supporting plant growth, their significance for all forms of life, their involvement in the hydrological cycle, their contribution to biodiversity, and their interrelationships. Recognizing and preserving the integrity of these essential resources is crucial for ensuring the long-term sustainability and well-being of our planet.

REFERENCES

Anthony, M. A.; Bender, S. F; van der Heijden, M. G. A. (2023)."Enumerating soil biodiversity".*Proceedings of the National Academy of Sciences*. 120 (33): e2304663120.

Balasubramanian, A. (2017). Soil Forming Processes.Technical Report. February, 2017. DOI:10.13140/RG.2.2.34636.00644.

Balestrini, R., Lumini, E., Boriello, R. and Bianciotto, V. (2015). Plant Soil Biota Interractions. *Soil Microbiology, Ecology and Biochemistry* (fourth edition). Chapter 11; pages 311-338.

Bardgett, R.D. (2010). " The diversity of life in soil: A community and ecosystem approach". *Biology of Habits*. Oxford Academic, 1 Apr.

2010.
Bertrand, R., Lenoir, J., Piedallu, C., Riofrio-Dillion, G., Rufray, P., Vidal, C., Pierrat, J. and Gegout, J. (2011).Changes in plant community composition lag behind climate warming in lowland forests. *Nature*, 479, 517-520.
Brady, N. C. and Weil, R. R (2008). The Nature and Properties of Soils, 14th ed. Upper Saddle River, NJ: Prentice Hall, 2008.
Cerdà A, Lucas Borja ME, Úbeda X, Martínez-Murillo JF, Keesstra S. (2017). Pinushalepensis M. versus Quercus ilex subsp. Rotundifolia L. runoff and soil erosion at pedon scale under natural rainfall in eastern Spain three decades after a forest fire.*Forest Ecol. Manage*. 400, 447-456.
De Deyn, G.B. and Kooistra, L. (2021).The role of soils in habitat creation, maintenance and restoration. *Philos Trans R SocLond B BiolSci* ; 376 (1834): 20200170.
Fausey, N.R. (2005). Drainage, surface and subsurface.*Encyclopedia of Soils in the Environment*.Reference Module in Earth Systems and Environmental Sciences.USDA Agricultural Research Service, Columbus, OH, USA.Pages 409-413.
Glossary of terms in soil science"(2013). Agriculture and Agri-Food Canada. . Archived from the original on 27 October 2018.Retrieved 3 April 2022.
Guo, Y., Zhang, Y., Zhang, T., Wang, K., Ding, J. and Gao, H. (2019). Surface runoff.*Observation and Measurement of Ecohydrological Processes*.Pp 241-306.
Huntley, B.J. (2023). Soil, water and nutrients. In: Ecology of Angola. *Springer, Cham*. https://doi.org/10.1007/978-3-031-18923-4_6
Jayeoba, O.J. (2023). Soil and Water: A Source of Life. Paper presented at the World Soil Day Expert Dialogue Workshop held at the National Merit House, Abuja on 5th December, 2023.
Keesstra S.D., Geissen, V., Mosse, K., Piiranen, S., Scudiero, E., Leistra, M. and van Schaik, L. (2012).Soil as a filter for groundwater quality.*Curr.Opin. Environ. Sustain*. 4, 507-516.
Lal, R. (2004). Carbon sequestration impacts on global climate change and food security. *Science*, 304, 1623-1627.
Lal, R., Monger, C., Nave, L. and Smith, P.(2021). The role of soil in regulation of climate.*Phil. Trans. R. Soc. B* 376: 20210084. https://doi.org/10.1098/rstb.2021.0084
Maximillian, J., Brusseau, M.L., Glenn, E.P. and Mathias, A.D. (2019). Pollution and environmental perturbations in the global system.*Environmental and Pollution Science* (third edition). Chapter 25; pages 457-476S
McCarthy, D. F. (2014). Essentials of soil mechanics and foundations: *Basic Geotechnics* (7th ed.). London, United Kingdom: Pearson. ISBN 9781292039398.
Oregon State University (2016).“Water holding capacity". 24 June 2016. Retrieved 9 October 2022.
Ponge, J. (2015). "The soil as an ecosystem".Biology and Fertility of Soils. 51 (6): 645–648.
Samaniego, L., Thober, S., Kumar, R., Wanders, N., Rakovec, O., Pan, M., Zink, M., Sheffield, J., Wood, E. F. and Marx, A. (2018). Anthropogenic warming exacerbates European soil moisture droughts. *Nature Climate Change*, 8(5), 421–426.
Vereecken, H., Amelung, W., Bauke, S. L., Bechtold, M., Blöschl, G., Bogena, H., Brüggemann, N., Carminati, A., Javaux, M., Konings, A. G., Kusche, J., Montzka, C., Neuweiler, I., Or, D., Steele-Dunn, S., Verhoef, A., Young, M., Vanderborght, J., & Zhang, Y. (2022). Soil hydrology in the Earth system.*Nature Reviews Earth & Environment,* 3(9), 573–587.
Vincent, Q.(2018). Study of abiotic, biotic and functional parameters and their interactions in neglected soils.PhD thesis.University of Lorraine.
Voroney, R. P. and Heck, R. J. (2007)."The soil habitat". In Paul, Eldor A. (ed.). *Soil Microbiology, Ecology and Biochemistry* (3rd ed.). Amsterdam, the Netherlands: Elsevier. pp. 25–49.
Zhang, Lijie; Zeng, Yijian; Zhuang, Ruodan; Szabó, Brigitta; Manfreda, Salvatore; Han, Qianqian; Su, Zhongbo (2021). "In Situ Observation-Constrained Global Surface Soil Moisture Using Random Forest Model".*Remote Sensing*. 13 (23): 4893.