CLIMATE CHANGES AND SOIL EROSION

Oana Răcușan[1], Marcel Dîrja[2*]
[1]University of Agricultural Sciences and Veterinary Medicine, Faculty of Horticulture and Rural Development Business, Horticulture and Landscape Architecture Department, Mănăştur St.3-5, 400372, Cluj-Napoca, Romania; [2]University of Agricultural Sciences and Veterinary Medicine, Faculty of Forestry and Land Survey, Mănăştur St.3-5, 400372, Cluj-Napoca, Romania
[*]Corresponding author: marcel.dirja@usamvcluj.ro

Abstract. A percentage of 95% of the food consumed by the population is produced, directly or indirectly, on the soil. Along with food, functional soils play an essential role in water supply and resilience to floods and droughts by capturing and storing water, then making it available for uptake by spontaneous vegetation and crops. Certainly, the most important aspect is that soil is a finite resource, which means that its loss and degradation take a very long time to rehabilitate. Balance is very important, especially when the stakes are high, and here we are talking about three elements, namely climate change, human actions and soil erosion phenomena, which condition each other in a negative sense, but which can condition in the opposite sense, even if some phenomena are no longer reversible, they can certainly be slowed down or stopped.

Keywords: soil, soil erosion, climate change, human activities, vegetation

INTRODUCTION

Changes in soil quality are most often sensitive to increasingly frequent anthropogenic disturbances (Freckman et al, 1997). Physical and chemical properties are internal components of soil, and their limits may be imposed by ecosystem and climate factors, but soil quality depends largely on how it is used and the management decisions that have, in the past, led to it to soil degradation, reducing a large part of its quality (Saunders 1992). The intensity of the physical soil alteration processes, as well as the biological processes occurring in the soil, definitely depend on the climatic elements. They are influenced at the same time by its water regime, but also by the variation of the climate, which, in turn, is closely related to the relief. At the same time, a vegetation variation process implicitly intervenes, which has direct and immediate consequences on the soil cover (Paulette, 2008).

The most important aspect of soil is that it is a finite resource, which means that its loss and degradation take a long time to restore. Soil quality is a problem of the present, which may even affect the climate in the future. They are two elements that at first glance are not related, but practically they are in a vicious circle. The perception of the term soil quality can be different depending on the interest or field of activity of the individuals, meaning, for example, fertility for a farmer, and for a landscaper, its ability to integrate or reintegrate as harmoniously, aesthetically and functionally as possible in a geographical landscape. This concept is closely related to the satisfaction of human requirements and includes very important properties of the soil, namely fertility, the degree of pollution and its suitability for various uses, properties that have a certain degree of quantification, all of which are closely related to the climate and implicitly climate change in full swing.

MATERIAL AND METHODS

Soil erosion occurs naturally due to climatic conditions caused by rain or wind, which cause water erosion and wind erosion. along with these forms of erosion, anthropogenic activity comes in addition, through its forms of manifestation, such as waterproofing (specifically through urbanization) or massive deforestation, to amplify the phenomenon of erosion. Climate change, in addition to influencing the phenomenon of erosion, can lead to the loss of biodiversity in the soil, decrease in the amount of organic matter, salinization, floods, desertification, landslides. Regarding biodiversity, there is evidence that biodiversity reacts, through phenological changes, changes in the distribution and abundance of species and ecosystem processes (European Commission).

Heavy rains cause erosion by water droplets hitting the soil surface, breaking down and dispersing the constituent particles.

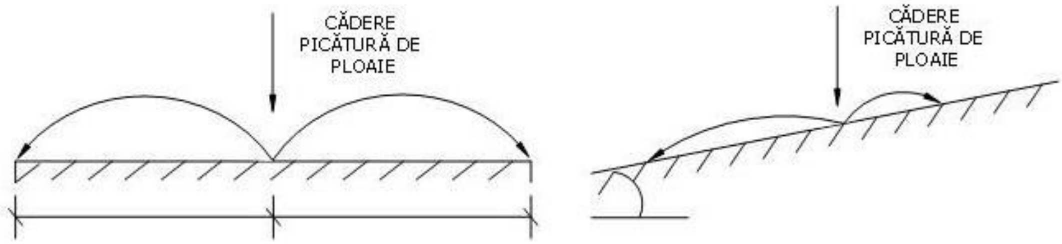

Figure 1. Distribution of soil particles dislodged by raindrops
https://www.creeaza.com/referate/geografie/geologie/Eroziunea-solului-procese-de-e671.php

It is obvious that the type of soil, the relief, the way of using the land also come into play here. The water from precipitation or melting snow will start to flow down the slope, forming small beds, called fagases or trickles, with a depth of up to 20 cm, which will get bigger, depending on the amount of water that flows. Torrential rains are expected to become increasingly intense, causing flooding, the main cause being the high temperatures recorded. The torrentiality represents the most complex action of the waters resulting from the rains and the melting of the snow, being a phenomenon of enormous proportions both in terms of flow and duration and it manifests itself over wide spaces, and as a result it creates a specific form of relief - the torrent (Ielenicz , 2004).

Figure 2. Raven, torrent
https://delovyelyudi.ru/ro/galstuk/eroziya-znachenie-slova-eroziya-eroziya-kamnya/
https://www.fotocommunity.fr/photo/le-torrent-jeanpierre/40757986

In order to prevent or stop water erosion, in the case of cultivated lands, it is possible to intervene, where appropriate, through the correct formation of furrows, exemplifying planting methods, each of them influencing the erodibility of the land: a) – furrows parallel to the isohypses (level curves) gives the land minimal erodibility; b)–diagonal furrows against isohypses, medium erodibility; c)-perpendicular furrows on the isohypse, give maximum erodibility, the rainwater will channel, generating intense washes, gullies and, in a final stage, torrentiality. These measures must be taken in order to stop the destruction of agricultural vegetation, bringing with it as a local impact the loss of organic matter.

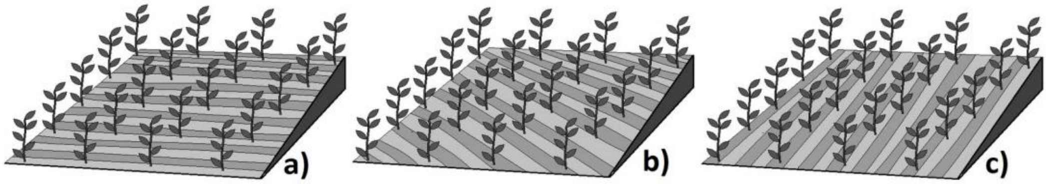

Figure 3. Three types of furrows on sloping ground
https://3.bp.blogspot.com/-q_GZ2wqreSU/Td1NkYlQ7eI/AAAAAAAAAnk/gUSl-g6leDk/s1600/brazde.jpg

Soil erosion under climate change is most directly affected by changes in extreme precipitation (Nearning et al, 2004). Extreme precipitation is projected to increase as a result of changes in the moisture-holding capacity of the warming atmosphere, resulting in a much more vigorous hydrological cycle. The amount of global precipitation will change by the end of this century and regional differences will be observed that will accentuate the contrast between wet and dry regions, these changes themselves seriously affecting degradation phenomena (Bojaru et al, 2015). The increase in the number of torrential rains will be able to influence the quantity and even the quality of fresh water, by the fact that the resulting rainwater will lead to the penetration of waste water into surface waters. On the other hand, frequent droughts can cause a decrease in water quality, thus stimulating the development of toxic bacteria or algae (European Commission).

Wind erosion is also a widespread phenomenon. According to the European Environment Agency, approximately 42 million ha of agricultural land in Europe may be affected by wind erosion. Water erosion and wind erosion are similar both in terms of the processes involved and the effects on the soil. There are three important factors that condition the phenomenon of wind erosion. Aridity - manifests itself in areas where precipitation is less than 600 mm, there are periods longer than six months without precipitation, and the vegetation changes from savanna to steppe vegetation type, with areas of bare soil, and the wind speed must to exceed 6 m/s.

Thus, the effects of the wind erosion phenomenon will increase proportionally in the presence of strong, regular winds or gusts (Satyavrat, 2014). Soil texture - for example a more clayey soil being much stickier, better structured will therefore be more resistant to wind. Soil moisture - increases the cohesion of sand and clay particles, temporarily preventing their erosion by wind.

An assessment of these effects and the extent of damage and costs caused was made in the framework of the European Union research project - Wind Erosion and European Light Soils (Riksen et al, 2001). As concrete examples, Riksen and De Graaff (2001) reported that wind erosion can affect about one million hectares in the western part of Denmark, representing about 38% of the used agricultural area, 170,000 ha in Sweden (about 5%), in around two million ha in Northern Germany (12%), 260,000 ha in Great Britain (approx. 1 - 5%) and 97,000 ha in the Netherlands (approx. 5.2%) (Riksen et al, 2001). Wind force can cause erosion by lifting loose soil particles or by transporting larger particles to the soil surface, which will be affected. Wind erosion also reduces the soil's ability to retain nutrients and moisture and causes severe soil degradation.

Figure 4. The result of wind erosion
https://lataifas.ro/destinatii-turistice-unice/52669/babele-de-la-bozioru-suratele-mai-mici-ale-babelor-din-bucegi/ https://50locuridevizitat.wordpress.com/2014/04/28/rezervatia-gradina-zmeilor/

Following its degradation, the earth will be able to support fewer and fewer plants, these being the ones that absorb carbon dioxide from the atmosphere, responsible for warming the climate. Better land management could help keep soils intact so that vegetation does not suffer. At the same time, it is the vegetation that can slow down the erosion processes by its very presence. It can create curtains of vegetation against the wind and absorbs a large amount of water. An extremely destructive anthropogenic action also intervenes here, namely massive deforestation, which leaves thousands of hectares of land uncovered, directly exposed to erosion. Vegetation, especially forests, absorbs carbon dioxide (CO2) from the atmosphere through photosynthesis and stores the carbon in biomass and soil. This process is known as carbon sequestration and is able to help mitigate climate change by reducing greenhouse gas concentrations. Forests are particularly efficient at sequestering carbon due to their high biomass and long-term carbon storage capacity. Deforestation releases stored carbon into the atmosphere, contributing to higher CO2 levels. In addition to this role, vegetation regulates the water cycle in nature and maintains ecosystem health.

Figure 5. Deforested areas
https://zin.ro/05/02/2022/mediu/paduri-defrisate-romania-raport/ https://www.emaramures.ro/defrisari-ilegale-masive-in-maramures-1100-de-dosare-penale/

RESULTS AND DISCUSSIONS

Climate change can have a direct and indirect impact on soil erosion, and the influencing factors are multiple. Higher rainfall, rainfall intensity, and extreme rainfall events can directly increase soil erosion, while higher air temperature can increase plant biomass, evapotranspiration rates, vegetation density, and the rate of residue decomposition, and even decrease the amount of precipitation that falls. in the form of snow, thus indirectly affecting soil erosion.

On the other hand, the Intergovernmental Commission on Climate Change supports the fact that uncontrolled climate change can worsen erosion phenomena. A report by the Intergovernmental Panel on Climate Change found that if land is farmed without conservation practices, soil erodes up to 100 times faster than it is formed.

Soil erosion leads to an increase in carbon emissions into the atmosphere. This is because soil erosion leads to the displacement of soil and the organic carbon it contains, especially in the absence of vegetation. Erosion allows the release of a greater amount of carbon dioxide into the atmosphere, which implicitly leads to the amplification of the effect of climate change (UK Parliament, 2020). The risk of erosion is high and is likely to be further exacerbated by emissions-driven global temperature change, resulting in reduced agricultural land areas and thus production, reduced land values and deterioration of human health.

It can therefore be stated that the phenomena of erosion and climate change are in a vicious circle, conditioning each other, this fact is due to the lack of balance between them, largely determined by the increasingly obvious anthropogenic actions .

CONCLUSIONS

Soils also serve as carbon sinks by storing organic materials. healthy soils contain high levels of carbon, derived from plant residues and decaying organic matter. Sequestering carbon in the soil helps offset co2 emissions and contributes to mitigating climate change. Deforestation disrupts this process because the removal of vegetation leads to soil degradation, increased erosion and reduced accumulation of organic matter. These factors decrease the carbon storage potential of the soil.

It is possible that climate change will affect erosion in the future, but there are still uncertainties about the actual mechanisms and damage caused and the impact, which is different according to the regions of occurrence. It is clear that more studies and research are needed to explore the impact of land management practices on soil erosion in the future of climate change.The pressure exerted by the anthropic factor can lead to the overexploitation of terrestrial natural resources and the expansion of cultivated agricultural areas beyond the limits between which the human-environment balance can still be maintained. Therefore, the nature and global extent of anthropogenically eroded soils is related to the sociological and geographical aspects of civilization.

Therefore, climate change influences soil erosion mainly through changes in rainfall, vegetation and crop management practices. The impact can be positive or negative. The magnitude of the impact of climate change and the offsetting effect of different factors still remain unclear and difficult to predict accurately. It is important that researchers in the field study the phenomenon of erosion as closely as possible in order to determine the various necessary preventive works or works to improve and enhance the value of already eroded lands.

REFERENCES

1. Bojariu Roxana, Bîrsan M.V., Cică Roxana, Velea Liliana, Burcea S., Dumitrescu A., Dascălu S.I., Gothard Mădălina, Dobrinescu Andreea, Cărbunaru Felicia, Marin Lenuța. (2015). Schimbările climatice – de la bazele fizice la riscuri și adaptare, Administrația Națională de Meteorologie, Editura PRINTECH, București
2. Freckman D.W., Virginia R.A. (1997). Low-diversity Antarctic soil nematode communities: distribution and response to disturbance Ecology, 78, pp. 363-369
3. Ielenicz M. (2004). Geomorfologie generală. Editura Universitară Bucureşti
4. Nearing M.A., Pruski F.F, Oneal M.R. (2004). Expected Climate Change Impacts on Soil Erosion Rates: A Review, Journal of Soil and water conservation 59(1)
5. Paulette Laura. (2008). Pedologie. Editura Todesco Cluj-Napoca
6. Riksen M. J. P. M., De Graaff. (2001). On site and off site effects of wind erosion on European light soils, https://doi.org/10.1002/ldr.423
7. Satyavrat N. (2014). Deflation-geomorphology, Encyclopaedia Britanica
8. Saunders D.W. (1992). International activities in assessing and monitoring soil degradation (Special Issue on Soil Quality), Am. J. Alter. Agric., 7, pp. 17-24
9. UK Parliament. (2020). Soil erosion. A global challenge

https://www.creeaza.com/referate/geografie/geologie/Eroziunea-solului-procese-de-e671.php
https://delovyelyudi.ru/ro/galstuk/eroziya-znachenie-slova-eroziya-eroziya-kamnya/
https://www.fotocommunity.fr/photo/le-torrent-jeanpierre/40757986
https://3.bp.blogspot.com/-q_GZ2wqreSU/Td1NkYlQ7eI/AAAAAAAAAnk/gUSl-g6leDk/s1600/brazde.jpg
https://lataifas.ro/destinatii-turistice-unice/52669/babele-de-la-bozioru-suratele-mai-mici-ale-babelor-din-bucegi/
https://50locuridevizitat.wordpress.com/2014/04/28/rezervatia-gradina-zmeilor/
https://zin.ro/05/02/2022/mediu/paduri-defrisate-romania-raport/
https://www.emaramures.ro/defrisari-ilegale-masive-in-maramures-1100-de-dosare-penale/