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THE INFLUENCE OF CLIMATE CHANGE IN EUROPE ON THE SITUATION OF THE FUTURE AGRICULTURE

WPŁYW ZMIAN KLIMATYCZNYCH W EUROPIE NA PRZYSZŁOŚĆ ROLNICTWA

Summary: *Climate change has a significant impact on soils, and changes in land use can either accelerate or slow down these changes. Without proper soil and sustainable land management, we will not be able to face the climate crisis, produce enough food or adapt to climate change. The answer to these questions may be to protect and restore key ecosystems and allow nature to absorb carbon from the atmosphere. After the oceans, soil is the second largest natural carbon sink and surpasses forests and other vegetation in its ability to trap carbon dioxide from the air. These facts remind us of the importance of healthy soils - not only for food production, but also for our efforts to prevent the worst possible effects of climate change. The continual decline in soil moisture can contribute to increasing the need for irrigation in agriculture and can lead to reduced yields and even desertification with potentially dramatic effects on food production. Land surface desertification is also affected by solar activity, which changes as cycles - currently there is a cycle with a fairly moderate impact on agricultural land.*

Keywords: *climate change, soil water resources, desertification of agricultural areas, sun activity*

Streszczenie: *Zmiana klimatu ma znaczący wpływ na gleby, a zmiany w użytkowaniu gruntów mogą przyspieszyć lub spowolnić te zmiany. Bez odpowiedniej gleby i zrównoważonego gospodarowania gruntami nie będziemy w stanie stawić czoła kryzysowi klimatycznemu, produkować wystarczającej ilości żywności ani dostosowywać się do zmian klimatu. Odpowiedzią na te pytania może być ochrona i odbudowa kluczowych ekosystemów oraz umożliwienie naturze pochłaniania węgla z atmosfery. Po oceanach, gleba jest drugim co do wielkości naturalnym pochłaniaczem dwutlenku węgla i przewyższa lasy i inną roślinność pod względem zdolności do wychwytywania dwutlenku węgla z powietrza. Te fakty przypominają nam o znaczeniu zdrowych gleb – nie tylko dla produkcji żywności, ale także dla naszych wysiłków na rzecz zapobiegania najgorszym możliwym skutkom zmian klimatycznych. Ciągły spadek wilgotności gleby może przyczynić się do zwiększenia zapotrzebowania na nawadnianie w rolnictwie i może prowadzić do zmniejszenia plonów, a nawet pustynnienia, co może mieć dramatyczny wpływ na produkcję żywności. Na pustynnienie powierzchni ziemi ma również wpływ aktywność słoneczna, która zmienia się cyklicznie – obecnie występuje cykl o dość umiarkowanym wpływie na grunty rolne.*

Słowa kluczowe: *zmiany klimatyczne, zasoby wodne gleby, pustynnienie terenów rolniczych, aktywność słoneczna*

Introduction

Scientists are already seeing the effects of climate change around the world, including in European soils. Hence, although it would seem that the lack of water affects Poland to a limited extent, nothing could be more wrong. Climate changes, human interference in the natural course of rivers and over-exploitation of water resources make droughts our new reality and the country's steppe – a real problem. We found out about it in April 2021, when the low water level in the Vistula River, revealing a surprising landscape, brought to light the problem of drought in Poland. For example, according to the latest EU report on climate change, its effects and vulnerability in Europe, soil moisture has decreased significantly in the Mediterranean region and increased in parts of northern Europe since the 1950s.

Climate researchers predict similar effects in the coming decades as the rise in average temperatures continues and rainfall patterns fluctuate. A total of 13 EU Member States said they were affected by desertification and in a further 3 the problem is starting to become apparent. In the years 1951-1981, only 6 droughts were recorded in Poland - one on average every 5 years, while in the years 1982–2011 there were as many as 18 droughts - on average every 2 years. Starting from 2013 – drought affects us every year. In 2020, we experienced drought for the first time in spring. The Food and Agriculture Organization of the United Nations (FAO) recently released a map that shows that 30 cm of the top soil in the world contains about twice as much carbon as the entire atmosphere.

Despite these observations, a recent report by the European Court of Auditors recognizes that Europe does not have a clear picture of the situation regarding the challenges of desertification and land degradation, and that the measures taken to combat desertification are not consistent. Figure 1 shows in light color the top view of the soil moisture content in individual European countries. It is clearly visible that the greatest problems with water in the soil are experienced by the Iberian Peninsula,

Fig. 1. The structure of the land surface of European countries in terms of water abundance (light color, tendency to desertification — low water supply in the ground)
Source: https://www.dreamstime.com

southern Italy, Bulgaria, Romania, Central European countries, including Poland and northern European countries. The UN General Assembly in 1995 established June 17 as the World Day to Combat Desertification and Drought.

The influence of the sun also has impact on the condition of agricultural land on earth. Solar activity is a series of cycles in which we observe changes in the behavior of our life-giving star. Cycles lasting about 11 years are characterized by decreases and increases, among others sunspots, flares, and spectacular mass ejections from the sun. Scientists already agree that we have been in the 25th Cycle of Solar Activity for at least a few months, and it is starting to increase. The sun in its cycles sometimes "calms down" and sometimes it behaves more "restless". In the transition periods between cycles, there is no observation of, inter alia, sunspots or large flares in the sun. Such a time occurred in 2017 and 2018. Scientists around the world, including US scientists from NASA and NOAA (National Oceanic and Atmospheric Administration), have been waiting for more symptoms of the new cycle and agree that the transitional moment occurred in December 2019, and today we are certainly experiencing another, 25th solar cycle. First of all, the number of sunspots will continue to increase.

The current observations of astronomers show that in recent months the activity of the Sun has been increasing at a similar pace as it was in the case of the last cycle. On this basis, it is estimated that the peak of solar activity will fall in July 2025, when about 115 sunspots will be visible on the disk of our star. Solar activity has an impact on the Earth, and above all on the temperature of the atmosphere and the temperature of the surface of arable land. Scientists also agree that once in several million years, the Sun can produce such a powerful flare that is capable of destroying the entire ozone layer, leading to the annihilation of life on Earth. Smaller, but still large, flares that can have a noticeable devastating effect on agricultural infrastructure are "slightly" more frequent.

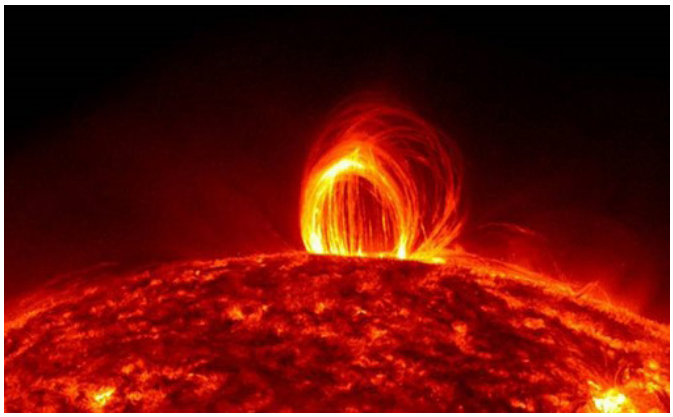

Fig. 2. Local outbreaks in the sun have a big impact on climate change around the globe
Source: [NASA - 2021] https://www.komputerswiat.pl/aktualnosci/nauka-i-technika

Changes in the seasonal temperature pattern may also shift the life cycles of plants and animals throughout the year, which may result in lower yields. For example, spring may come earlier and the trees may bloom before the pollinating insects have hatched. Given the expected population growth, what is needed is an increase, not a decrease, in world food production. This is largely dependent on the maintenance of healthy soil and the sustainable management of agricultural land. At the same time, there is a growing demand for biofuels and other plant-based

Fig. 3. Dried grass during dry season
Source: https://pixabay.com

products due to the urgent need to replace fossil fuels and prevent greenhouse gas emissions.

The EU report also highlights other effects of climate change on soil quality, including erosion, which can be accelerated by extreme weather events such as heavy rainfall, droughts, heat waves and storms. In addition to the loss of land surface, rising sea levels can contribute to changing the condition of the soil in coastal areas or to introducing marine pollutants, including salt, into them. Regarding land use, climate change may render some agricultural areas – mainly in the south – unusable or less productive, while more in the north, climate change is likely to open up new opportunities.

Prevention of the climate crisis through actions for the benefit of the soil

In April 2019, an EU group of scientists called for "the protection and restoration of forests, peatlands, swamps, natural seabed and other key ecosystems" to enable nature to absorb and store carbon dioxide from the atmosphere. Restoring ecosystems will also support biodiversity conservation and contribute to the enhancement of a wide range of ecosystem services including air and water purification, providing people with pleasant spaces for recreation. Information on the relationship between soils and climate change shows that around 75 billion tonnes of organic carbon is stored in soil across the EU. About half of these soil resources are found in Sweden, Finland and the United Kingdom, as they have more forest soils than other countries, in particular moist organic soils such as peat. For comparison, according to the latest EU estimates, in 2017 total CO_2 emissions in the EU amounted to around 4.5 billion tonnes.

Organic carbon content in EU soils may increase slowly, but estimates of the pace of this change are highly uncertain. The situation becomes even more complicated as organic carbon stocks are also constantly changing, as plants capture carbon dioxide from the air before it decomposes and releases gases back into the atmosphere. An EU report confirms that greenhouse gas emissions from all sectors, including land and food, need to be reduced in order to meet the goal of keeping global warming well below 2 degrees Celsius. Despite the uncertainties, restoring ecosystems and improving soil quality can be a very cost-effective action in terms of climate action, with a triple effect.

First of all growing plants helps to absorb carbon dioxide from the atmosphere. According to the FAO, restoring currently degraded soils could remove as much as 63 million tonnes of carbon, which would offset a small but significant percentage of global greenhouse gas emissions. Second, healthy soils trap carbon underground. Third, many natural and semi-natural areas offer powerful protection against the effects of climate change. There are many examples of the benefits. For example, areas adjacent to rivers (riverside zones) and green spaces in cities can provide cost-effective protection against floods and heat waves.

Desertification in the EU – an increasing threat posed by climate change and human activities

Europe is increasingly affected by desertification. The greatest risk of desertification is in southern Portugal, parts of Spain and southern Italy, south-eastern Greece, Malta and Cyprus, and the Black Sea areas in Bulgaria and Romania. Research has shown that these regions are often affected by soil erosion, salinity, soil organic carbon loss, biodiversity loss and landslides. The long period of high temperatures and little rainfall in Europe in summer 2018 reminded us of the growing importance of this problem.

Desertification is a form of land degradation in drylands. The term is used to describe the processes related to human activity and the climate that result in specific problems in arid lands, such as less food production, decreased soil fertility, reduced natural soil resilience and poor water quality.

Desertification means "the degradation of the land in arid and semi-arid regions due to a variety of factors, including climate variability and human activity". This phenomenon can lead to poverty, serious health problems due to wind-blown dust, and

Fig. 4. Typical small Polish farms in Świętokrzyskie region
Source: https://pixabay.com

a reduction in biodiversity. It also has demographic and economic effects as it forces people to flee the affected areas. Desertification does not describe the conditions in areas traditionally described as "deserts". Rather, it relates to dry areas.

Soil degradation means a reduction or loss in biological or economic productivity. As a result, fertile land becomes less productive. Overall, human activity is the cause of soil degradation.

Dry, semi-arid or intermittently dry areas are areas where the ratio of annual rainfall to potential evaporation and transpiration – that is, the dryness index – is in the range of 0.05 to 0.655. Dry areas are prone to frequent occurrence of droughts.

Drought is a situation where rainfall levels remain well below normally recorded levels, causing severe disturbance of the hydrological balance that adversely affects the land resource production system. Drought and desertification are closely related phenomena, but drought is short to medium term in nature, in contrast to desertification which is a long term phenomenon.

If droughts last for months or years, they can affect huge areas and have serious economic, social and environmental impacts. While droughts have always occurred, their frequency and impact have increased as a result of climate change and human activities that are not adapted to local climatic conditions.

Fig. 5. Inhibition of the growth and development of maize seedlings in conditions of water scarcity
Source: https://pixabay.com

Dryness means a climatic situation characterized by a scarcity of water resources. This long-term phenomenon is measured by comparing the long-term average water supply (rainfall) to the long-term average water demand (evaporation and transpiration of plants).

Deserts mean extremely dry, barren areas with very little rainfall and where the consequent conditions are unfavorable for plant and animal life.

Soil degradation leads to emissions of greenhouse gases into the atmosphere, which risk exacerbating climate change and further loss of biodiversity. There is a risk that biomass and organic carbon stored in the soil will be released into the atmosphere as a result of the projected increase in storm intensity, as well as due to fires, soil degradation and the presence of pests.

Soil remediation allows greenhouse gases to be gradually absorbed from the atmosphere, allowing trees and vegetation to grow. These plants, in turn, can absorb greater amounts of carbon dioxide. In areas where soil has been degraded, these processes do not take place and carbon dioxide is not absorbed from the atmosphere.

Fig. 6. Grain just before harvest in central Poland, in an area affected by drought
Source: https://Shutterstock.com

Various climate change scenarios confirm the EU's increasing exposure to desertification. As climate change progresses, water resources in parts of Europe are dwindling and droughts have been found to become more frequent in parts of Europe, increasing exposure to desertification. Based on climate change models used by the European Commission, temperatures are projected to increase by more than 2°C in some regions (e.g. Spain) by the end of the century. Over the same period, summer rainfall is expected to decrease by 50% or more in southern Europe.

The 2018 report of the Intergovernmental Panel on Climate Change stated with great certainty that temperatures on particularly hot days in mid-latitudes will increase by around 3°C with global warming of 1.5 °C and around 4°C with a global warming of 2°C, and that the number of hot days will increase in most land regions.

Forecasts of climate change in Europe confirm that the threat of desertification in Europe is increasing. Hot semi-deserts already exist in southern Europe, where – as the research shows – the climate changes from temperate to dry. Already, this phenomenon is progressing further north. Scientific evidence shows that anthropogenic emissions have significantly increased the likelihood of dry years in the Mediterranean basin.

Discussion and conclusions

— Desertification and land degradation are complex phenomena influenced by many interdependent factors. To date, no scientific consenses has been reached on how to evaluate these factors. However, indirect indicators can be used to detect soil deterioration. While many such indirect indicators exist, the EU recommends the use of three sub-indicators

for assessing soil degradation: land productivity, soil organic carbon, and land cover and land cover change.

- The 2013 EU Strategy on Adaptation to Climate Change recognizes the importance of combating desertification as one of the climate adaptation actions to be supported. Member States are encouraged to develop their own national strategies.
- Data related to desertification monitored by the European Commission report that 22% of Europe's land area is affected by soil erosion.
- Soil degradation has a transboundary impact: soil is not a static formation and the causes of soil degradation are often global. Soil degradation is often considered a local phenomenon, but soil particles move around. Research shows that erosion processes by water and wind, dust storms or human-related phenomena such as pesticide contamination are important in terms of the transboundary impacts of soil degradation and have economic, social and environmental impacts such as climate change, health problems and food shortages. Despite the cross-border dimension of the phenomenon, Member States and the Commission are not coordinating efforts to achieve the EU's land degradation neutrality objective.
- In order to develop a fully consistent assessment of desertification and land degradation across the EU, the European Commission needs the agreement of the Member States on a common methodology for compiling the available indicators.
- The European Commission collects relevant data for monitoring desertification, on land cover/land use, soil moisture content and vegetation/biomass indicators from satellite data (Copernicus program), and soil data from LUCAS and national programs. These data are already included in indicators at EU level (agri-environment indicators, SDG indicators, etc.). In 2018, the Commission published the Global Desertification Atlas, based on data collected at EU and global level.
- It should be recalled that, in the case of afforestation and forestry projects, Member States are required to ensure that the selection of species, varieties and origin of trees takes into account the need for resilience to climate change as well as the hydrological conditions. Forestry projects have a beneficial effect in preventing desertification and soil degradation. The forest cover protects the soil against erosion, and at the same time increases the ability to absorb carbon. Restoring the forest landscape can help to conserve biodiversity and reduce soil degradation. Also, agroforestry measures can help tackle soil degradation through the efforts of local communities in peripheral areas.
- In the absence of EU soil protection legislation and measures to prevent and restore soil degradation, Member States are responsible for implementing appropriate measures at national level.
- We found that the EU is not taking effective and efficient action to reduce the risk of desertification. While desertification and land degradation represent current and growing threats in the EU, the Commission does not have a clear view of the situation in this regard, and efforts to combat desertification are not consistent.

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