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REVIEW ARTICLE

Mitigating the impact of intensive farming on the climate change

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Abstract

Unfortunately, the problem of climate change is extremely urgent. Today, it is very difficult to find a place on the planet that has not undergone any changes from these processes. This paper examines the problem of climate change in Germany, namely in Bavaria. This is the southeastern part of the country. It is famous for its rich history, cuisine and, of course, beer. One of the problems faced by residents of this area of Germany because of climate change is the high risk of flooding. So far, many scientists have modeled possible scenarios of climate change in the area and concluded that the most likely scenario is that due to the increase in air temperature, the amount of precipitation will also increase. This will lead to changes in agriculture as well. Therefore, this work examines ways to solve the problem for farmers and the impact on human health due to climate change.

Keywords: Soil, Moisture, Temperature, Green gas emission, Food security

Introduction

Climate change is an extremely urgent issue today. Scientists constantly discuss changes in the weather and the possible impact of these changes on crop yields (Xiao et al., 2020) or on the availability of drinking water for people (Hssaisoune et al., 2020). These issues are quite important, as they ensure the food security of society.

The topic of this study is the study of the impact of climate change on the terrain in Bavaria (Germany). Bavaria, or rather the Free State of Bavaria, is a land in Germany that is extremely rich in history and is located in the southeast of the country (The Free State of Bavaria – Bayerisches Landesportal, 2023).

Literature Review

The weather in this region of Germany can be traced back to ancient times (since 1400 AD to be more precise) thanks to the works of many scientists who described their research in the field of agriculture, technical sciences or

medicine (Winkler, 2023). In this work, it is said that the climate in this area was usually more arid. However, in recent years, due to global warming, the number of floods has increased. Yes, the largest in recent years happened in 2021. Due to heavy rains, the drainage systems could not cope with the amount of water, which is why large areas of Germany, Switzerland, Austria, etc. were flooded. Due to this, a large number of buildings were destroyed and unfortunately people lost their lives (Gaedi & Niranjan, 2021).

The main question is: why exactly did this happen and how can the next possible catastrophes be prevented? Scientists (Rojo et al., 2021) have proven, thanks to the study of pollen, that the temperature in this part of Germany has increased slightly over the last decade, except for the winter period. At the same time, the amount of precipitation increased significantly. This was proven in a paper (Emeis, 2021; Karpenko et al., 2021), where four weather stations were considered and changes in precipitation were analyzed. An increase in the amount and intensity of average daily precipitation over 90 years was confirmed. Other scientists have investigated the temperature of groundwater in Bavaria. It was found that their temperature also increased significantly and correlated with their depth. The good news is that the increase in groundwater temperature in this region of Germany is not as rapid as the increase in air temperature. However, it is important to understand that this factor also affects the increase in air temperature (Hemmerle & Bayer, 2020). However, the worst thing is that scientists predict a worsening of the condition in the future. Thus, due to the increase in temperature, an increase in the amount of precipitation and its shift in time is expected, i.e. the "rainy season" will occur earlier in the spring than usual (Poschlod et al., 2020). Such simulations of weather changes were carried out by other scientists. In particular, (Hertig, 2020) writes that the average daily air temperature will increase in Bavaria by the end of the century. This will lead to the fact that the maximum daily concentration of ozone will also increase. (Ziegler et al., 2020) draws similar conclusions based on modeling. And also on the basis of climate change simulations, believe that under conditions of moderate emissions of greenhouse gases, the spring period will begin 8 days later, while under conditions of high emissions by 15 days. Also, in the conclusions to the modeling, it is said that it is possible to reduce the snow cover in the mountainous regions of Bavaria (Pollinger et al., 2017).

With such indisputable evidence, it is worth thinking about the consequences of climate change in Bavaria on agriculture. After all, climate change will primarily affect the vegetation of the region. In general, this studied part of Germany has the highest number of agricultural enterprises, but they are small, with an average area of 36.9 hectares (Betriebsstrukturen–Bayerisches Staatsministerium für Ernährung, Landwirtschaft und Foresten, 2022). Although not always, as a rule, such small farms grow vegetables. The most popular are root crops (potatoes, carrots, beets) and greens (lettuce, lettuce, spinach), etc. If we talk about other crops, usually 70% of arable land in Germany is generally occupied by wheat, corn, rapeseed, sugar beets, etc. (What grows on Germany's fields?, 2024).

Since climate change, in most cases, leads to an increase in air temperature or an increase in humidity, this directly affects any agricultural crops. In particular, such conditions are perfect for the development of pathogens, which can significantly reduce yields. Secondly, an increase in temperature leads to changes in the phenological phases of the culture, that is, they can come earlier or, conversely, later. Thirdly, precipitation plays an important role. In particular, they may be lacking in critical phases of the culture, which will ultimately affect the productivity of the plant. Alternatively, a disruption in the usual rainfall pattern may affect crop pollination (Mwangi, 2023). And of course, the floods that have already occurred and are predicted by many scientists in Bavaria will not contribute to the cultivation of agricultural crops.

Maize cultivation in Bavaria under climate change has already been written (Estrella & Menzel, 2013; Karpenko et al., 2023), in this work it was predicted that there will be droughts in Bavaria in the summer, therefore a recommendation was made to use hybrids that will be resistant to climate change. At the same time, a more recent study (Cetin & Mauser, 2023) and simulation of corn productivity in the conditions of Bavaria suggests that climate change, on the contrary, can help to obtain higher crop yields. Such conflicting opinions are normal for scientists, because only in controversy can one find the truth. However, what should ordinary farmers do and prepare for? Based on research and weather modulation for the next century, in my opinion, it is still best to prepare for possible field flooding. Therefore, if farmers have "free" funds, they should improve the drainage system.

If we talk about the use of certain agricultural techniques that will help preserve crops in Bavaria. Among all the possible methods of using hybrids resistant to flooding is the best idea. In particular, there is a hybrid of winter wheat that

is resistant to waterlogging of fields, it is called Hyvento (Hussain et al., 2022). It is important to emphasize that this is not the only hybrid that can be used in conditions of possible flooding. In particular, (Mustroph, 2018) in his article considers the possibility of creating plants in which the *aerenchyma* and the growth of accessory roots will be extremely developed. This is available not only for wheat, but also for corn, soybeans and barley.

Another method of combating climate change is more global reducing greenhouse gas emissions. In this way, sudden changes in temperature or precipitation can be slowed down. However, this cannot be done just by a few farmers in Bavaria getting together and trying to reduce the emissions of such gases. In my opinion, this should be a political decision of the authorities. That is, the introduction of measures that will reduce emissions. In particular, the influence of carbon dioxide is most often talked about. But it is difficult to prevent its emissions when carbon is included in the composition of the soil and makes up almost 60%. Therefore, in order to reduce carbon emissions, it is necessary to introduce certain rules for the use of mineral and organic fertilizers, as well as measures for handling soil and animal waste.

In order for these regulations to be implemented, it is also necessary to introduce support for farmers, which will encourage them to comply with certain regulations and use regenerative and/or organic farming methods that allow to reduce greenhouse gas emissions (Tan & Kuebbing, 2023).

However, these are not the only steps taken by the state that can help in the fight against climate change. In particular, it is necessary not only to regulate and motivate, but also to help residents to deal with the consequences that have already led to certain changes. In particular, not only farmers can build drainage systems, but also the state can implement a program to reduce the consequences of possible floods. In case of droughts, the development of an irrigation program can be started. This will make it possible to obtain stable crops in case of long droughts. Yes, of course, this will affect the cost of products, but, nevertheless, the food security of the country will be ensured.

Speaking about food security, we should not forget about access to clean water. It is worth noting that the majority of water resources for the population of Bavaria is underground water, the next place in the supply of water to the population is spring water and river water (BGR Report. Public Water Supply of Germany 2019, 2020). During floods, this is an extremely big problem. It does not matter how the water is collected, the river overflows, or there is an unusually large amount of precipitation, but the problem remains the same drinking water pollution. This happens due to soil washing, which contains various substances that appeared in it as a result of anthropogenic influence. These can be pesticides, fertilizers or industrial waste stored in the open area. Of course, getting such substances into drinking water is not permissible, as it can cause poisoning or diseases of the gastrointestinal tract, the possibility of infection in such water should also be remembered (Kaźmierczak & Cavan, 2011).

In addition, floods can damage the water supply infrastructure. That is, sources of water supply, water purification systems and water supply systems. Such damage can lead not only to interruptions in water supply, where the territory is flooded, but also to the provision of other basic needs of people.

Therefore, it is necessary not only to regulate the actions of farmers in order to reduce greenhouse gas emissions, but also other branches of industry. In a complex, such actions will be more effective. The state should also invest in water purification technologies and protection of water sources from pollution.

Do not forget that Bavaria has the Alps (Bavarian Alps, 2024). The Bavarian Alps is a collective concept that includes several mountains. The highest of them, Zugspitze, has a height of 2.962 m. Of course, climate change has a significant impact on the mountainous terrain of Bavaria. It should be understood that the unique nature of the mountains in Bavaria attracts tourists in summer and winter, which affects the economic situation in the region. Agriculture is equally important in this mountainous area. In particular, alpine milk is famous worldwide for its unique taste and quality (Mendel & Ketterle, 2018; Parkhomenko et al., 2021). This milk is later used to make cheeses that have an extraordinary taste and a rather high price. For example, farmers living near the mountains usually send some cows to the mountains in early spring and take them back in late autumn. According to a certain agreement with a shepherd who can take care of the cows of several farmers, the owners of the cows receive cheese produced directly in the mountains at the end of the

season. After all, selling milk in the mountains is an extremely difficult task, so it is immediately processed into a product that can be stored for a long time.

So, the first and most obvious problem caused by climate change is the melting of snow or glaciers in the mountains (Hagg et al., 2012). This causes a change in the regime of rivers or other reservoirs into which meltwater flows. This is an additional reason that can cause flooding of the territory.

Also, climate change leads to changes in flora and fauna in the Alps. In the work (Vitasse et al., 2021) it is proved that as a result of warming over the last 40 years, the vegetation has changed significantly. Also, the life cycles of insects and reptiles have changed, this leads to changes in trophic relationships and disruption of the ecosystem balance.

The next consequence is an increase in the risk of avalanches. The fact that there is an increase in temperature leads to the melting of snow, which in turn frees the mountain slopes from it earlier, which can lead to avalanches.

As you can see, everything in nature is interconnected. People produce certain useful things for themselves, which leads to greenhouse gas emissions. Those, in turn, contribute to an increase in temperature and greater accumulation of moisture. Accumulation of large amounts of moisture leads to increased rainfall, which can lead to flooding. However, it is not only rain that can lead to flooding, but also melting glaciers and snow in the mountainous area of the Alps in Bavaria.

Such changes are quite significant and will have consequences not only for the people living in this area now, but also for future generations, who will probably see more large scale consequences if we do not start fighting global warming now.

This article has already considered measures that can help reduce human impact on the environment. And in my opinion, they should be used not only in Bavaria, but also all over the planet. In particular, it is not only necessary to restrict and blame farmers for climate change. And to mention the large factories and plants all over the planet that emit a much larger amount of greenhouse gases into the atmosphere.

If we talk about the Bavarian Alps, then in order to combat climate change in this area, it is worth applying afforestation of the mountain slopes. The article (Gálos et al., 2011) discusses the advantages of such protection. In particular, this is a decrease in air temperature due to the evaporation of moisture through the leaves. Also, a decrease in air temperature in the mountains due to soil shading and moisture retention in the plants themselves, which will help reduce the risk of floods.

Conclusions

Thus, Bavaria is a unique region of Germany with an extremely beautiful nature and landscape. However, it faces risks due to climate change that could lead to the disappearance of this uniqueness. Scientists predict an increased amount of moisture in this region, which in turn can lead to floods. This will primarily affect the flora and fauna, as well as the inhabitants of the region. Also, floods do not contribute to successful farming. Therefore, it is necessary to take certain measures that will help reduce their impact. In particular, the best, in my opinion, is the choice of varieties or hybrids of plants that are resistant to flooding. Agriculture in mountainous areas is also at risk, as it may suffer from avalanches due to melting snow and glaciers. The authorities of Bavaria and Germany in general should develop effective methods that will help protect this unique territory from the effects of climate change.

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