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ORIGINAL ARTICLE

How can the agricultural soil support in the climate change mitigation and adaptation?

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ABSTRACT

The rise in temperature over the earth due to the increase in the greenhouse gas concentration in the Earth's atmosphere is defined as "Global Warming". The precipitation and temperature regimes do not continue in the usual order and the meteorological disasters experienced cause people to worry about the future. It also reveals more than just its claims on biodiversity, orientation, and food security. Agricultural production is one of the important sectors that will be directly affected by global warming and climate change, in the light of current information. Food production, which enables people to survive, takes place directly through agriculture. In today's conditions, it is unthinkable to feed large masses without soil. The soil provides all the necessary nutrients to humanity, but only if it is sufficient. Soil health is at the forefront to produce ordinary food. Although what can be done is limited, practical measures should be taken by making projections on climate change. In addition, mitigation and adaptation studies should be carried out for the continuity of agricultural production activities. Due to the slow progress of these mitigation and adaptation strategies, green pursuits for faster action are on the top of the agenda. The pursuit of green has become a powerful weapon in the transformation of rural areas. As an extension of the Paris Agreement, the Green Deal has come to the fore as a strong effort and discourse that the European Union (EU) aims to spread environmental concerns to all policy areas. The agriculture part of this discourse includes "From Farm to Table Strategy" and "Common Agricultural Policy". In this study, the place and position of the European Green Deal in the harmonization process of the effects of global warming and climate change on agricultural soils are also examined.

Keywords: Global warming, climate change, agricultural land, adaptation, mitigation

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1. INTRODUCTION

Increasing productivity is the main goal in the agricultural sector. In the changing environment with climate change, productivity decreases. The negative effects of agriculture on the environment can be reduced through sustainable approaches. along with this, an increase in product efficiency is achieved (Rosenzweig and Hillel, 2008). Instability observed in the climate regime may cause a change in the current production order (Lin et al., 2015). Thanks to the growth of agricultural production, food security can be increased, and poverty can be reduced. Variability in environmental factors can adversely affect soil fertility and the diversity of microflora and microfauna communities. It is now well known that high concentrations of Greenhouse Gases (GHGs) accumulating in the Atmosphere, which cause climate change, can affect agricultural production (IPCC, 2007a). From the Industrial Revolution to the present, human activities have led to an increase of more than 40% in the CO_2 concentration in the atmosphere (Blasing, 2014). The impact of agriculture and farming practices covers more than 14% of total greenhouse gas emissions (Varanasi et al., 2016). Traditional farming practices cause more than 70% of nitrogen oxide emissions. (Burney et al., 2010). These negative effects can be reduced with modern technologies such as precision farming practices and supplementation of bio-based products. The focus of these applications is the use of technologies that promote processes that increase the sequestration of greenhouse gases through soils and plants (Mueller et al., 2012; Johnson et al., 2014). According to the Intergovernmental Panel on Climate Change (IPCC), climate change is defined as any change in climate over time due to natural or human activity (IPCC, 2007a). The IPCC has accepted the increase in the concentration of greenhouse gases (CO_2, CH^4 and N_2O) in the atmosphere as the main factor of global climate change (IPCC, 2007a). The melting of glaciers, rising sea level, increasing air temperature, long-term drought, and frequent observation of tropical storms since 1950 are among the events experienced because of global climate change. The surface temperature will increase by 1.8 - 3.6 °C by 2100; As a result, it is predicted that situations such as intermittent floods, drought and extreme temperatures will occur (World Bank, 2008). Such abiotic and biotic stress factors in climatic conditions can cause significant losses in agricultural product productivity (Ramegowda and Senthil-Kumar, 2015; Pandey et al., 2017; Waqas et al., 2019). This situation can cause delay in seed germination, growth retardation, inhibition of photosynthesis, nutrient deficiency, insufficiency in fertilization, etc. (De Storme and Geelen, 2014; Dresselhaus and Hückelhoven, 2018)

The ecological crisis, which has become more visible with the global climate change, has brought and will bring many green discourses and policy tools from ecology to economy, from economy to politics. Environmentalism and the green movement, which stands out as activism, have turned into a very serious sanction tool by the European Union (EU). This tool is the search for an alternative way of life of economic growth, which cannot be waived, and the search for a new normal in which the new social order can exist. For new pursuits, the idea of green is always promising. The idea of green is the manifestation of green thinking, and the starting point of green thinking is the respect for nature. Europe, which pioneered the Green Consensus, is the continent that also constitutes the primary source of green thinking (İmga and Olgun 2017). In addition, the environmental crisis of global climate change cannot be solved by economic or ecological struggle alone. Therefore, with a holistic perspective, it is possible to state that the common point of the search for green solutions from economy to space is carbon management.

2. THE IMPACT OF CLIMATE CHANGE ON AGRICULTURE

It is stated that the most probable main cause of global warming is the increase of greenhouse gas concentration in the atmosphere, which is the result of economic activities, above the required level. As a result of the gradual warming of the planet with climate changes; It is stated that the melting of glaciers, the rise of sea level, the change of regional and local precipitation movements, the occurrence of extreme weather events, the disappearance of some plant and animal species due to the change of ecosystems, the increase in undesirable natural events such as floods, storms, hurricanes, tornadoes and droughts. Agriculture, food, livestock, fisheries, forestry, trade, tourism and health are among the sectors that are mainly affected by climate change. Among these sectors, agriculture has an impressive role economically, as it is the sector that produces essential foodstuffs for the continuation of activities depending on nature and for the survival of humanity. Processes such as tillage, fertilization, chemical control to obtain a product, conversion of agricultural lands, energy use, animal fertilizers are stated as conditions that affect carbon emissions (Bayraç and Doğan, 2016). It is emphasized that increasing temperature and precipitation rate, changes in the amount of CO_2, the formation and severity of climatic movements that we are not accustomed to for our world and humanity, and increases in sea water level negatively affect the agricultural sector. In addition, it has been reported that this situation changes the existence of living organisms in the soil, the amount of humus in the soil, soil erosion, the flow of nutrients that are beneficial for the development of plants, the living things adapted to the region where they live, the development of plants and the amount of product (Durak and Ece, 2007). It is also reported that global climate change may cause changes in the distribution and diversity of plant and animal species, cause extinction of species and loss of biodiversity (Schaller and Weigel, 2007; Dellal, 2008). In a study conducted in China between 1980 and 2010, by using agricultural data, factors other than temperature and precipitation, especially humidity and wind speed, have negative critical effects on the development and yield of rice and wheat plants, and also ignoring these variables can affect the yield of climate change. It has been stated that it may cause more harm than expected (Zhang et al., 2017). In identifying the impacts of climate change and variability on agriculture and food security in Kenya, the country's heavy reliance on rain-fed agriculture, with seasonal changes in precipitation and varying temperatures and durations, negatively affect crop production and food security for already vulnerable communities in arid and semi-arid regions. reveals the opinion that it will continue to affect it (Kogo et al., 2020). Wheat, barley, sugar beet, poppy, chickpea, tomato, watermelon and various fruit and vegetables are among the most grown agricultural products in Uşak in our country, and yields are 10-20% higher than the average of Turkey. However, in a study conducted between 2000 and 2008, it was reported that there was a decrease in the yield of wheat, barley, oat, corn, tobacco, poppy and chickpea plants. When the morphology and physiology of the plants were evaluated in general, it was stated that there was a decrease in germination rates, short plant heights, early yellowing of leaves, shortening of vegetation period, decrease in seed yield, number and weight, and it was stated that climate change had negative effects on the yield of agricultural products throughout the province (Kara et al. et al., 2010). Another issue that we have faced as a country recently is the decrease in groundwater levels due to the decrease in snow and rain precipitation, and thus the drying up of our rivers and lakes. In this case, it will harm the agricultural sector, which is of great importance for the economic development and development of our country, and Turkey will face the danger of a food crisis and drought. In such a situation, it has been reported that there will be yield losses due to drought in Çukurova and other similar regions where irrigated agriculture is applied (Şahin, 2007). Since climate change is a factor that negatively affects the survival time, reproductive activities and habitats of living things, it is stated that, for example, the body temperature of insects changes according to the temperature of the air and the environment, and the changes that will occur in climatic conditions together with global warming will cause some important differences in the physiology and geographical distribution of insects. It has been reported that changes in temperature and humidity factors affect the functions of insect metabolism, reproductive capacity, feeding activities and also their distribution (Akbulut, 2000). In a study conducted in Kayseri and its surroundings, it was stated that the nectar and pollen resources that bees can benefit from to raise young are scarce, especially in the early spring months, and in recent years, the local beekeepers have reported that the blooming and nectar secretion periods have changed with the changing weather events, and consequently the honey yield has decreased and there have been problems. have reported. For this reason, it has been reported that it becomes inevitable to feed the bee colonies with additional feed in spring in order to produce more offspring and enter the nectar flow more strongly (Bekret et al., 2015).

3. EUROPEAN GREEN CONSENSUS

Reconciliation is literally defined as the harmony, agreement, or compromise between the parties on a certain issue (TDK. 2021). Its main starting point is absolutely to reduce the impact of global climate change. According to EU strategies, the biggest statement of the agreement is the goal of being the first climate-neutral continent in the world. In some studies, although the climate-neutral target is passed as a carbon-neutral target, it represents the transition to the decarbonization process at an individual, institutional and national level, which causes greenhouse gas emissions. The increase in environmental degradation due to climate change causes ecosystem losses. In this direction, the EU has created the "A European Green Deal" framework with the approach of turning an emergency crisis into an opportunity for its countries and citizens. The European Green Deal is a new growth strategy that aims to transform the European Union countries into a fair society with a resource-efficient and competitive economy without net greenhouse gas emissions by 2050 (European Commission, 2019). The Consensus is a new initiative born on the green economic order as a supporter of the Kyoto Protocol in the past and the Paris Agreement in the current conjuncture. In the current situation, accelerating the transformation that has taken place at a very slow pace, with a widespread and slow-to-defective progress, is one of the most important elements in establishing the consensus. This initiative is not just an environmental strategy, as it includes 'green', Yeldan et al. as (2020) stated, it is a sanction argument for the revision of the new international trade system and the sectors that affect the global climate change. European Green Consensus is referred to as the "EU New Green Deal" in some sources. Therefore, it is based on the goal of holistic and reorganizing the systems. This change in order comes to the fore as an effective power in the fields of industry and trade. Consensus is accepted as a rewriting of the next generation trading system rules and a new generation growth strategy and is characterized as a kind of next generation industrial revolution. Since mitigation efforts will create significant stress in Europe, it is of great importance that they agree and be consistent in other countries. For this reason, effective transformation of Turkey in this process is also on the agenda of the Turkish economy as a transition that must be implemented in terms of both not experiencing loss in the import market and contributing to global climate change. The European Green Deal has two main objectives: short-term and long-term. While the short-term goal is to reduce greenhouse gas reductions by 55% by 2030 compared to 1990, the long-term goal is to reduce net greenhouse gas emissions to zero by 2050. The biggest and most striking statement of the consensus is the goal of becoming a climate neutral continent by 2050. The EU supports the agreement with four key components in the transition process: (i) providing financial support, (ii) setting new targets, (iii) leaving no country behind, and (iv) increasing adaptability. 2030 targets have been established for eight reconciliation action areas (Figure 1).

After the publication of the Green Reconciliation strategy, the published and updated policies related to the agricultural sector were "From Farm to Fork Strategy" and "Common Agricultural Policy".

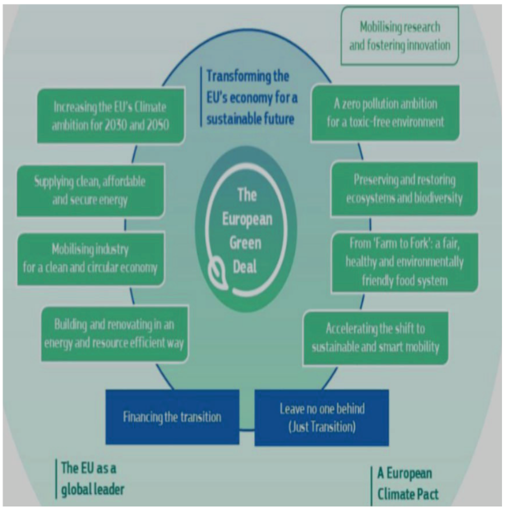

Figure 1. The various elements of the European Green Deal

3.1. Farm to Fork Strategy

From Farm to Fork Strategy; It aims to reduce the environmental impact of the food processing and retail sectors by taking action on transportation, storage, packaging and food waste. The Farm to Fork Strategy includes actions to combat corruption in the food sector, including strengthening implementation and research capacity at EU level, and identifying/developing new innovative food and feed products, such as algae-based seafood (European Commission, 2019b).

3.2. From Farm to Fork Strategy;

1. Reducing the use and risk of chemical pesticides by 50% by 2030,

2. Reducing nutrient losses by at least 50% without any reduction in soil fertility and reducing the use of chemical fertilizers by at least 20% by 2030,

3. Reduction of antimicrobial sales by 50% in livestock and aquaculture by 2030,

4. Organic farming on at least 25% of agricultural lands by 2030,

5. It includes targets for all rural areas to have fast broadband access by 2025 to enable digital innovation.

3.3. Common Agricultural Policy

The European Commission aims to make the system more responsive to current and future challenges such as climate change, while continuing to support European farmers with its Common Agricultural Policy (CAP). CAP provides financial support to farmers (European Commission, 2019). The total EU budget is €161.7 billion and plans to spend €58.4 billion (36.1%) on CAP. Major Common Agricultural Policy objectives are (i) providing a fair income to farmers, (ii) increasing competitiveness, (iii) rebalancing power in the food chain, (iv) climate change mitigation, (v) environmental care, (vi) landscapes and biological preserving diversity, (vii) promoting generational renewal, (viii) preserving vibrant rural areas, (ix) preserving the quality of food and health. Farmers, agri-food businesses, foresters and rural communities;

1. Build a sustainable food system through the Farm to Fork strategy;

2. Contribute to the new biodiversity strategy by preserving and enhancing the diversity of plants and animals in the rural ecosystem;

3. To reach the net zero emission target in the EU by 2050, the Green Deal has an important role in many key policies such as contributing to climate action (Maçin, 2021).

4. APPROACH TO REDUCING THE GLOBAL WARMING POTENTIAL: CARBON SEQUESTRATION IN AGRICULTURAL SOILS

The most disturbing event for the scientists today is Global Climate Change and its impact on various ecosystems and humans after all. With the meetings that have been arranged by internationally and the activities of environmentalist organizations since 1996, the issue remains its importance and never lost its actuality when considered its effects. There are 3 gases (GHGs) that can be associated with agricultural activities: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Seven percent of total GHGs emissions (401.0 Tg-CO_2 equivalent value) which was estimated by Turkish Statistical Institute (TÜİK, 2012) by using International Clime Change Panel guide, occurred by agricultural activities. When considered on the basis of GHGs, 4% of 2010 total CO_2 emission, 30% of CH_4 and 74% of N_2O

occurred by agricultural facilities. While CO_2 constitutes the most important GHGs problem on the basis of sector, when considered in view of animal production the most important GHG for the agriculture is CH_4, and when considered in view of plant production, it is N_2O. According to the IPCC Fourth Assessment Report, emission of greenhouse gasses generating from agricultural activities constitutes the 10-12 percent of total GHGs emissions across the globe (IPCC, 2007a). Greenhouse gas emission by forestry was reported as 17.4% (IPCC, 2007b). GHG emissions generating from forestry sector can be seen because of deforestation rather than forestry activities.

In view of carbon dioxide emission, agricultural activities and soil have a great importance. Because agriculture sector performs the function of sequester (store) as well as performing CO_2 emission (source, pool). Recent research have been performed towards the purpose of decreasing CO_2 emission and increasing C-sequestration potentials of agricultural soils. Increasing the C-sequestration rate has a great importance for storing CO_2 in agricultural soils, wetlands, and forests.

When CH_4 and N_2O is compared, high amount CO_2 is subjected to a loop by means of agricultural activities. While plants consume high amounts of CO_2 with photosynthesis, all plants which are used as food, feed and fuel start to decay and turn back to CO_2 with consuming. While the C-loop in agriculture is considered, amount of CO_2 emission occurred due to agricultural activities is low and the resource of this emission is the energy use during the process of agricultural products and transportation.

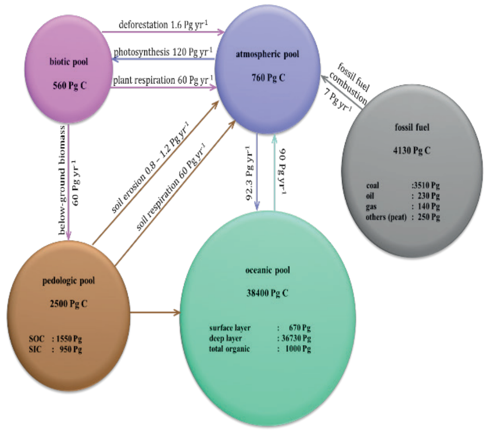

Figure 2. Principal global C pools and fluxes between them (Adopted from Lal, 2008)

Five main carbon pool can be stated all around the world. (Figure 2). The biggest C reserves oceans are followed by fossil fuels, pedologic (soils), biotic and atmospheric pools. All these pools are related with each other, and C changes occur among them. When 560 Pg level biotic pool and 760 Pg level atmospheric pool are compared, global C-pool is quite high with 2500 Pg (1500-1550 Pg organic C [SOC], 950-1000 Pg inorganic-C [SIC], to 1 m depth). (Lal et al. 1998a; Lal, 2008). Main compound of organic carbon pools of soils is mostly active humus-C and slightly inactive coal-C. When the sub compounds of this mixture are analysed, (a) plant and animal residues at various stages of decomposition; (b) substances synthesized microbiologically and/or chemically from the breakdown products; and (c) the bodies of live micro-organisms and small animals and their decomposing products (Schnitzer, 1991). Inorganic C-Pool (SIC) includes elemental-C and carbonate minerals (calcite, dolomite, and compound products of primary and secondary carbonates). Primary carbonates occur with the weathering of main material. Conversely, secondary carbonates occur with the transformation of CO_2 (H_2CO_3) to carbonic acid in soil air with water in soil solution and with its interaction with calcium (Ca+2) and magnesium (Mg+2). Inorganic C-pool is an important compound of the soils in especially arid and semiarid climate areas.

4.1. C-sequestration mechanism in soil

This process of transfer and secure storage of atmospheric CO_2 into other long-lived C pools that would otherwise be emitted or remain in the atmosphere is called "carbon sequestration" (Lal, 2008). Non-sequestrated CO_2 will stay in atmosphere and will continue to be oscillated through atmosphere. C sequestration realizes naturally and human-oriented (anthropogenic). The purpose of anthropogenic C sequestration process is to balance global C supply. This balance is based on "C neutral" strategy in which no net gain is acquired for the C atmospheric C pool. Main purpose in this strategy is to sequestrate anthropogenic CO_2 as almost safe, acceptable in view of environmental aspect and stable techniques with low risks of leakage. There are different technological options which aims at sequestrating atmospheric CO_2 in different global pool like injection to the oceans, geologic injection, mineral carbonation (abiotic) and sequestration by oceans, terrestrial sequestration, and secondary carbonate formation (biotic) (Lal, 2008). The choice of one or a combination of several technologies is important for formulating energy policies for future economic growth and development at national and global scales.

To the process in which atmospheric CO_2 is added to biotic and pedologic C pools is called "C sequestration in terrestrial ecosystems". In these systems, "biotic C sequestration" which is different from management systems that decrease or balance CO_2 emission, is based on the organization basis of removing of CO_2 in atmosphere by high plants and microorganisms.

4.2. Impact of field usage state on CO_2 emission

As a result of changes made in the event of field use, some changes in the organic substance number of soils can be observed. As the result of transformations made towards to arable field usage, a rapid decrease in the organic substance content of soils, in other words, an increase in the CO_2 emission of soils C pool to atmosphere. (Jenkinson, 1991; Paustian et al., 1997). In the arable lands around the world, it is stated that loss in the soils' organic substance is 0.6 C per year. (Dalal and Carter, 1999). In the Amazon area in South America, it can be stated that 5% of soil organic-C in the surface is lost every year because of the grass-pasture rotations of the forestlands. (Neill and Davidson 1999). In research made in the west parts of Nigeria, it was determined that organic substance content in 0-10 cm surface decreased from 2% to 1.4% because of the rotation in arable lands in 10 years period (Lal, 1996). When similar research is summarized, a decrease at the rate of 50-70% in the organic substance content due to the cultivation.

4.3. Global soil erosion and C dynamics

It is quite difficult to predict the total amount of C which change place from topsoils with erosion. Total sediment transportation to oceans by means of rivers is nearly 19 pg yr-1 (Lal, 1995). Erosion rate in arable lands is 3-4 times more than the rate in grasslands. When eroded soils are considered, water erosion is 1.3 Pg, and wind erosion is 0.3 Pg (Oldeman, 1994). If transportation parameter is assumed as 10% (Walling and Webb, 1996), total sediment change from eroded fields can be predicted as 16 Pg yr-1. It can be assumed that transported soil organic carbon is 3% which is equivalent to 0.5 Pg C (Lal, 1995). As a result of the application of soil protection measures, a loss with the amount of 0.1 Pg C yr-1 in the wake of accelerated erosion can be prevented (Lal and Bruce, 1999).

4.4. Renewing of disturbed soils and C sequestration

Renewing of disturbed soils because of the economic and environmental causes is very important. With the improvement of these soils, organic-C content of soils will increase, and soil quality will be better. In nearly 2 billion ha wide total disturbed fields, those which are exposed to heavy erosion is 250 Mha (Oldeman, 1994). Nearly 100 Mha field is exposed to heavy erosion in the view of agricultural fields. These fields are not appropriate for the agricultural activities. But with the right planning, appropriate bushes and tree varieties can be cultivated in these areas with organic and inorganic manure use. Besides the intensification of agricultural activities and implementation of best management practices to these areas primarily, with the afforestation and other renewing measures, improvement of heavily disturbed fields can be achieved (Cole et al., 1995). With the recycling of heavily disturbed topsoils, C- sequestration potentials can be increased to 0.025 Pg-yr-1. Another important strategy about disturbed topsoil is cultivating specific plant kinds which are used in biofuel production in these fields. Biofuels which are directly burned for energy production, can be used in the place of fossil fuels. As a result of the production of appropriate kinds in different ecologic areas, 5 Mg ha-1 yr-1 C assimilation can be achieved (Lal et al., 1998b).

Disturbing of topsoils can occur with another way. Saline soils include the 1/10 of mainland in the world (Szabolcs, 1998), 1/3 of the arid and half arid climate areas, (Rengasamy, 1998) and 930 Mha area all over the world (Sumner et al., 1998). These soils which have many structural defects and imbalance between water and salt, restricts the herbal production. It was reported that with the help of adopting appropriate improvement techniques, there can be achieved a significant betterment in the carbon content of soils (Gupta and Abrol, 1990; Singh et al., 1997; Garg, 1998). Even a smaller increase in 0.2 – 0.3 Mg C ha-1 yr-1 level which will occur in organic-C content because of the evaluation of the saline soils' improvement is important.

4.5. Conservation tillage and agricultural waste management

Many application ways of conservation tillage (CT) can be found like zero-tillage, reduced tillage, mulch tillage, chisel plowing. Among many benefits of CT, soil organic carbon increase when passing on CT from traditional soil cultivation system can be counted (Carter, 1994). In Lal's (1997) research predicted that the size of globally arable lands under CT could be reached to 120 Mha from 1995 to 537 Mha in 2020, that's to say, total increase in 25-year period would be 417 Mha. When the C increase that will be emerge in 25-year period is supposed to be 0.2 Mg ha-1 yr-1, soils C sequestration potentials of the soils will be nearly as 0.08 Pg yr-1 as adopting and applying CT systems. Adoption of conservation tillage may also save fossil fuel at the rate of about 8 Kg C ha-1 yr-1 (Paustian et al., 1997; Lal et al., 1998b).

Crop residue management is a complementary compound of CT systems. Crop residue produced amount all around the world is nearly 3.5 Pg yr-1 (Lal, 1997). Additionally, number of weeds and other biomass in agricultural fields nearly 0.5 Pg. As a result of transforming 2 Pg crop residue which contains 40% C to (0.8 Pg C) soils and 10% of its' transformation to constant humus, additional 0.08 Pg increase to C sequestration potential with the help of herbal residual management will occur.

4.6. Improved farming/cropping systems

The importance of adoption best management practices for the purpose of increasing agricultural efficiency and plant production is vital (Cole et al., 1995). Some best management practices can be summarized as headlines as below:

1. Soil fertility management,

2. Organic manures and byproducts,

3. Water management,

4. Improving product efficiency,

5. C sequestration potential of agricultural areas.

5. CONCLUSIONS

The European Green Deal is very important for the struggle in the climate-environment relationship within the scope of the strategies planned to be implemented. It plays a central role in the Sustainable Development Goals by 2030 (Bouma et al., 2019). By 2050, soils in particular play a key role in achieving the goal of a climate neutral EU. As a carbon sink, soils play an important role in reducing greenhouse gas emissions and are therefore an important element of the new EU Climate Law. In addition, soils have a large biodiversity pool and have been included in the Biodiversity Strategy 2030 (Jeffrey et al., 2010). The Biodiversity Strategy fully addresses sustainable soil management as it has ambitious goals such as increasing organic farming, planting trees, reducing pesticides, and minimizing land tillage. Our soils are the foundation of agriculture and therefore play an important role in the EU Farm-to-Fork Strategy. Sustainable land management strategies that have continuity will be difficult to stick to, given some conflicting goals and objectives. We need to be able to create a coherent framework and make improvements for our future. A coherent framework would be a revised EU Soil Thematic Strategy, which considers the aims and ambitions of the European Green Deal.

REFERENCES

AKBULUT, S. (2000). Kuresel Isınmanın Bocek Populasyonları Uzerine Muhtemel Etkileri. *Ekoloji*, 9(36), 25-27.

BAYRAÇ, H.N., DOĞAN, E. (2016). Turkiye'de İklim Değişikliğinin Tarım Sektoru Uzerine Etkileri. *Eskişehir Osmangazi Üniversitesi İİBF Dergisi*, 11(1), 23- 48.

BEKRET, A., CANKAYA, S., SILICI, S. (2015). The Effects of Mixture of Plant Extracts and Oils are Added to Syrup on HoneyBee Colony Development and Honey Yield. *Turkish Journal of Agriculture-Food Science and Technology*, 3(6), 365-370.

BLASING T.J. (2014). Recent greenhouse gas concentrations.http://dx.doi.org/10.3334/CDIAC/atg.032 (verified on Feb 14, 2021)

BOUMA, J., MONTANARELLA, L., EVANYLO, G. (2019). The challenge for the soil science community to contribute to the implementation of the UN Sustainable Development Goals. *Soil Use Manage* 1–9. https://doi.org/10.1111/sum.12518.

BURNEY J.A., DAVIS S.J., LOBELL D.B. (2010). Greenhouse gas mitigation by agricultural intensification. *Proc Natl Acad Sci USA* 107: 12052-12057.

CARTER, M.R. (Ed.), (1994). Conservation Tillage in Temperate Agroecosystems. *Lewis Publishers, Boca Raton*, FL, 390 pp.

COLE, V., CERRI, C., MINAMI, K., MOSIER, A., ROSENBERG, N., SAUERBECK, D. (1995). Agricultural Options for Mitigation of Greenhouse Gas Emissions. IPCC, Working Group 2, Cambridge Univ. Press, UK, pp. 748-771.

DALAL, R.C., CARTER, O.R. (1999). Soil organic matter dynamics and C sequestration in Australian tropical soils. In: Lal, R. et al. (Eds.), Carbon Dynamics in Tropical Ecosystems. Ann Arbor Press, Chelsea, MI.

DE STORME N., GEELEN D. (2014). The impact of environmental stress on male reproductive development in plants: biological processes and molecular mechanisms. *Plant Cell Environ.* 37: 1–18.

DELLAL, Đ. (2008). Kuresel İklim Değişikliği ve Enerji Kıskacında Tarım ve Gıda Sektoru. *İgeme'den Bakış*, 36:103-11.

DRESSELHAUS T., HÜCKELHOVEN R. (2018). Biotic and abiotic stress responses in crop plants. *Agronomy* 8: 267.

DURAK, A., ECE, A. (2007) İklim Değişikliğinin Toprak Ozelliklerine ve Sebze Tarımına Etkisi. *Türkiye İklim Değişikliği Kongresi.* 11-13 April 2007, İTU, İstanbul, 186-193.

European Commission (2019). Communication from the Commission to the European Parliment, the Eupean Council, the Council, the Eupean Economic and Social Committe of the Regions, The European Green Deal, Brussels COM (2019) 640 final. [Access: 11 December 2021].

European Commission, (2019b), The European Green Deal, https://ec.europa.eu/commission/ presscorner/detail/en/ip_19_669, [Access: 16 August 2021].

European Commission, Joint Research Centre (2020). RONZON, T., SANCHEZ LOPEZ, J., FOLLADOR, M., et al., Building a monitoring system for the EU bioeconomy: progress report 2019: description of framework, Publications Office.

GARG, V.K. (1998). Interaction of tree crops with a sodic soil environment: potential for rehabilitation of degraded environments. Land Degrad. Develop. 9, 81-93.

Gupta, R.K., Abnol, I.P. (1990). Salt-affected soils: their reclamation and management for crop production. In: Lal, R., Stewart, B.A. (Eds.). Soil Degradation. Adv. Soil Sci. 11, 223-287.

IPCC (2007a). "Climate Change 2007: Mitigation of Climate Change", Chapter 8: Agriculture, IPCC Working Group III Fourth Assessment Report, *Cambridge University Press.* pp 498-540.

IPCC, (2007b). Summary for Policymakers. In: Climate Change 2007: Synthesis Report. Contribution ofWorking Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, [CoreWriting Team, Pachauri, R.K. and Reisinger, A. (Eds.)], Geneva, Switzerland.

İMGA, O., OLGUN, H. (2017), Yeşil ve Siyaset Siyasal Ekoloji Üzerine Yazılar, Liberte Yayınları, Maltepe, Ankara, 472ss.

JEFFREY, S., GARDI, C. JONES, A. (2010). European Atlas of soil Biodiversity. European Commission Publications Office of the European Union

Luxembourg. EUR 24375 EN,128pp.

JENKINSON, D.S. (1991). The Rothamsted long-term experiments: are they still of use. Agron. J. 83, 2-12.

JOHNSON J.A., RUNGE C.F., SENAUER B., FOLEY J., POLASKY S. (2014). Global agriculture and carbon trade-offs. Proc Natl Acad Sci USA 111: 12342-12347.

KARA, H., DONMEZ, ŞAHIN, M., AY, Ş. (2010). İklim Değişikliğinin Uşak'ta Tarım Urunlerine Etkisi. *Biyoloji Bilimleri Araştırma Dergisi*, 3(1), 39-46.

KEANE J., PAGE S., KERGNA A., KENNAN J. (2009). Climate change and developing country agriculture: An overview of expected impacts, adaptation and mitigation challenges, and funding requirements. International Centre for Trade and Sustainable Development (ICTSD), International Envrionment House, Geneva, Switzerland.

KOGO, B.K., KUMAR, L., KOECH, R. (2020). Climate change and variability in Kenya: a review of impacts on agriculture and food security. Environ Dev Sustain, 23–43.

LAL, R. (1995). Global soil erosion by water and carbon dynamics. In: Lal, R., Kimble, J.M., Levine, E., Stewart, B.A. (Eds.), Soils and Global Change. CRC/ Lewis Publishers, Boca Raton, FL, pp. 131- 142. 87-98.

LAL, R. (1996). Deforestation and land use eects on soil degradation and rehabilitation in western Nigeria. II. Soil chemical properties. Land Degrad. Dev., 7: 87-98.

LAL, R. (1997). Degradation and resilience of soils. Phil. Trans. R. Soc. London. B 352, 869-889.

LAL, R., KIMBLE, J.M., FOLLETT, R.F., STEWART, B.A. (Eds.), 1998a. Soil Processes and Carbon Cycle. CRC Press, Boca Raton, FL, 457 pp.

LAL, R., KIMBLE, J.M., FOLLETT, R.F., COLE, C.V., (1998b). The Potential of US Cropland to Sequester C and Mitigate the Greenhouse Effect. Ann Arbor Press, Chelsea, MI, 108 pp.

LAL, R., BRUCE, J.P. (1999). The potential of world cropland soils to sequester C and mitigate the greenhouse effect. Environmental Science & Policy, 2: 177–185.

LAL., R., 2008. Carbon sequestration. Phil. Trans. R. Soc. B, 363: 815–830. doi:10.1098/rstb.2007.2185.

LIN, H., WANG, W., MORTIMER, P., LI, R., LI, D., HYDE, K., XU, J., SOLTIS, D., CHEN, Z., (2015). Large scale phylogenetic analyses reveal multiple gains of actinorhizal nitrogen-fixing symbioses in angiosperms associated with climate change. Sci. Rep. 5, 14023–14028.

MAÇIN, K. E. (2021). Yeşil Mutabakat, Biyoekonomi Stratejisi ve Sıfır Atık Perspektifinden Türkiye'de Gıda Atıkları Yönetimi ve Paydaşların Görevleri.

MUELLER N.D., GERBER J.S., JOHNSTON M., RAY D.K., RAMANKUTTY N., FOLEY J.A. (2012). Closing yield gaps through nutrient and water management. Nature 490: 254-257.

PANDEY P., IRULAPPAN V., BAGAVATHIANNAN M.V., SENTHIL-KUMAR M. (2017) Impact of Combined Abiotic and Biotic Stresses on Plant Growth and Avenues for Crop Improvement by Exploiting Physio-morphological Traits. Front. Plant Sci. 8:537. doi: 10.3389/fpls.2017.00537

RAMEGOWDA, V., SENTHIL-KUMAR, M. (2015). The interactive effects of simultaneous biotic and abiotic stresses on plants: mechanistic understanding from drought and pathogen combination. J. Plant Physiol. 176, 47–54. doi: 10.1016/j.jplph.2014.11.008

ROSENZWEIG, C., HILLEL, D. (2008). Climate Change and the Global Harvest: Impacts of El Nino and Other Oscillations on Agroecosystems. Oxford University Press, New York, USA.

SCHALLER, M., WEIGEL, H.J. (2007). Analyse des Sachstands zu Auswirkungen von Klimaveranderungen auf die deutsche Landwirtschaft und Masnahmen zur Anpassung Landbauforschung Volkenrode - FAL Agricultural Research, Bundesforschungsanstalt für Landwirtschaft (FAL), ISSN 0376-0723, ISBN 978- 3-86576-041-8, Sonderheft 316, Braunschweig, Germany, 246 p.

ŞAHIN, U., (2007). Turkiye İcin Geliştirilen Bir Ornek Acil Eylem Planı. Yeşiller İklim Değişikliği Acil Eylem Planı. www.yesiller.org.(03.02.2011).

TDK, (2021), Mutabakat, https://sozluk.gov.tr [Erişim 04 Nisan 2021].

VARANASI A., VARAPRASAD P.V., JUGULAM M. (2016). Impact of climate change factors on weeds and herbicide efficacy. Adv Agron 135: 107-146.

WAQAS M.A., KAYA C., RIAZ A., FAROOQ M., NAWAZ I., WILKES A., LI Y. (2019) Potential Mechanisms of Abiotic Stress Tolerance in Crop Plants Induced by Thiourea. Front. Plant Sci. 10:1336. doi: 10.3389/fpls.2019.01336

World Bank (2008). World Bank data on agricultural value added as a share of GDP in 2008.

YELDAN E., ACAR S., AŞICI A. (2020). Ekonomik Göstergeler Merceğinden Yeni İklim Rejimi, TÜSİAD, 114ss.

ZHANG, P., ZHANG, J., CHEN, M. (2017). Economic impacts of climate change on agriculture: The importance of additional climatic variables other than temperature and precipitation. Journal of Environmental Economics and Management, 83, 8-31.

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ORIGINAL ARTICLE

Effect of vermicompost and biochar application on microbial activity of soil under deficit irrigation

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ABSTRACT

Climate change is a growing global threat to biodiversity and ecosystems. In this study, we aim to find a solution to sustain soil microbial life under water shortage that occurs as a result of climate change. In this study, tomato plants were grown under full and two-stage limited irrigation conditions in soil treated with vermicompost and biochar. An insignificant effect of irrigation regime and planting application on soil respiration (BSR) value could be determined. Compared to the control, no difference could be detected with ECOF applications in unplanted soils under full irrigation conditions. While the dehydrogenase (DHG) activity of the unplanted plots was determined as 14.35 µg TPF g-1, the determination of the planted plots as 12.52 µg TPF g-1 can be considered as an expression of the fact that the microorganisms in the soil are less exposed to cultural processes in tomato cultivation and support to increase their populations. In Full irrigation and Deficit 1 application in unplanted soils, DHG activity at the level of 14.08 and 17.58 µg TPF g-1 was obtained, respectively, with the addition of biochar, followed by control plot in Full irrigation application and vermicompost application in Deficit 1 application. In Deficit 2 application, biochar application made a significant difference compared to the other two applications and caused activity of 34.91 µg TPF g-1 ($P<0.05$). With these results, it has been revealed that even at limited moisture levels, biochar applications with high porosity content can provide a lifetime opportunity to microorganisms. In conclusion, it can be stated that vermicompost and biochar applied at the level of 10 t ha-1 can support the microbial activity in the soil under limited irrigation conditions, and biochar application contributes more when the soil moisture is reduced to 15%.

Keywords: deficit irrigation, soil microbial activity, biochar, vermicompost, tomato

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1.INTRODUCTION

Tomato is the most species in the world and in our country, and Turkey ranks 3rd in world tomato production in 2020 (FAOSTAT, 2022). Therefore, is one of the most researched horticultural crops and considerable progress has been achieved in all the areas. Likewise, we preferred tomato for our research about different fertilizers and soil water keeping capacity comparison consequently.

Composting is a common practice that recycles biosolids, as well as agroindustrial organic wastes; It is considered as a simple and effective way to turn it into a non-toxic, pathogen-free and plant-nutrient-rich crop suitable for use as soil improver and fertilizer (Ros et al., 2006). There are many benefits of applying easily degradable organic wastes to agricultural soils by composting instead of dumping them into landfills or incineration. However, incorporation of organic wastes into the soil without completing their decomposition may cause phytotoxicity by immobilizing plant nutrients (Butler et al., 2001; Ros et al., 2006; Basheer, 2013). On the other hand, as a result of mixing matured compost into agricultural soils as a natural fertilizer or soil conditioner, aggregation of soil particles is encouraged and structural improvement is observed. Although composting is generally considered environmentally friendly, the most important negative aspect is the potential for oxygen (O_2) consumption and the release of carbon dioxide (CO_2), methane (CH_4), nitrogen oxide (N_2O), ammonia (NH_3) and other biogenic volatile compounds into the atmosphere in the process. For this reason, the pre-composted vermicompost product was used in the experiment, not the traditional compost product that was humified as a result of aerobic composting. In this way, it has a high potential in terms of high plant nutrition and increasing the biological activity of the soils, since it does not cause disease, weed or pathogen toxicity to the environment in which it is used, but because it has experienced the composting process very little (Bonde et al., 1988; Keeney, 1982).

There are many studies in the international literature on vermicompost. However, most of these studies generally focused on the effects of vermicompost on plant growth and yield, its ability to suppress pathogens and vermicompost production mechanisms. Although relatively few, there are also studies investigating the effects of vermicompost on soil microorganisms (Pilli, 2019). However, there are no studies showing the adaptation abilities of soil microorganisms to arid conditions where the soil surface is covered with and without plants. In our country, studies on vermicompost in terms of soil and plant nutrition are at the initial stage. Although, there are some studies on vermicompost production (Kızılkaya and Türkay 2012) examining the effects of different applications on earthworms, earthworm excrement and its environment (Ekberli and Kızılkaya 2006; Kızılkaya and Hepsen 2007; Kızılkaya 2008). There are very few studies on the effects of vermicompost on soil as an organic fertilizer. Most of the existing studies are related to the effects of seedling and plant growth, yield, quality and nutrient status in the soil (Çıtak et al., 2011; Tavalı et al., 2013; Atik 2013; Kızılkaya et al., 2012; Atmaca et al., 2014; Küçükyumuk et al., 2014).

Biochar has attracted increasing attention in recent years, with the increasing need for soil conditioners at the global level, as well as the idea of using soils as a carbon sink (Lehmann et al., 2006; Saifullah et al., 2018). Biochar has a much more stable structure than any fresh or composted organic soil conditioner or additive; demonstrating that it can remain in soils for a long time without decomposition (Lehmann et al., 2011). Researches showed that biochar applications increased the organic material and the availability of macro contents including nitrogen (N), phosphor (P) and potassium (K) (Yilmaz and Ergun, 2019). The data showing that it increases the availability of plant nutrients constitute the basis of interest (Lehmann, 2009). These characteristic features of biochar are due to its high charge density (Liang et al., 2006), as well as specific physical and chemical properties that can provide more effective plant nutrient retention, low solubility and unique chemical structure (Skjemstad et al., 1996; Baldock and Smernick, 2002). is supported by the fact that it is more resistant to microbial decomposition than other organic substances in the soil (Shindo, 1991; Cheng et al., 2008). While trying to increase the amount of organic matter in the soil by applying fresh organic fertilizer to the soil, a significant amount of CO_2 is released into the atmosphere due to the rapid organic carbon movement. The important sources of carbon released into the atmosphere are the decomposition of hydrocarbon compounds and organic compounds of agricultural-soil origin. As one of the causes of global warming, the increase in the amount of CO_2 in the atmosphere is of great importance. For this reason, the use of biochar has gained importance in recent years, especially in Europe, as one of the applications that will increase the amount of organic matter in the soil as a sustainable physical and chemical regulator and cause a minimum amount of CO_2 release into the atmosphere (Kimetu et al. 2008; Steiner et al., 2007). As a result, the application of biochar to soils is seen as one of the ways of atmospheric CO_2 sequestration. In this process, carbon leaves its fast ecological cycle and joins the slower and more stable biochar cycle (Lehmann, 2007). In the light of similar studies and publications, the idea that biochar can be an important tool in environmental management has gained its current persuasiveness.

It is generally known that, the soil ecosystem of Mediterranean Basin where arid and semi-arid climatic conditions are dominate, adversely affected not only by drought but also by biodegradable conditions due to the high temperatures, as is known, the untimely and extreme precipitation regimes which are called global climate change. In terrestrial ecosystems, natural processes of C transformation occur mainly in the soil, where biogeochemical activities and abiotic factors, such as climate, regulate the internal cycles and flows of the organic and inorganic forms of these elements (Monreal et al., 1997). A series of strategies to increase long term pools of agricultural and degraded soils, such as the dissemination of zero-soil treatment, the use of cover plants, and the adoption of low-density grazing systems, are proposed (Lal, 2004). Land use (LU), land use change (LUC) and management practices alter the long-term steady-state level of soil organic C and N in soils. These activities, along with climatic variables, can potentially increase or decrease soil biological activity associated with heterotrophic decomposition of soil organic matter (SOM). Additionally, the most stable C in the soil are organic materials that are complex with clay minerals or biochemically protected such as biochar. Some studies were suggested that application of the mixture of vermicopost and the biochar can improve the C/N concentration in the treated soil (Yilmaz and Kurt, 2020).

The application of organic residues has been presented as an adequate strategy against soil degradation in semi-arid environments. However, the interactions between organic amendments and drought which is a major deficit on agricultural production are not fully known. We evaluate the proposed study whether biochar and vermicompost amendment in Mediterranean soils influences the stability of the soil microbial community and microbially-mediated processes against drought. We hypothesize that a multi-level characterization of the soil microbial community provided a better understanding of the responses of amended soils to drought. We also hypothesize that vermicompost and biochar provide different services. We would also like to understand the persistence of the soil communities and associated ecosystem services after application organic amendments to the soils in the different type of drought conditions.

2. MATERIAL AND METHOD

This research was conducted in the agricultural greenhouse of Horticulture Department of Ege University, (38◦27′17.03′′N. 27◦14′17.71′′E; Bornova- İzmir) in the spring of 2021. The greenhouse, whose side and roof ventilations are covered with insect net, is 16.5x50 m in size, and is covered with a polyethylene (PE) cover. Prior to the experiment, the 0-30 cm soil layer had a mean carbonate content of 13.2 g kg^{-1}, pH (saturation paste) of 8.24, soil electrical conductivity (EC) of 0.93 dS m^{-1}, total nitrogen ($N_{KJELDAHL}$) of 0.62 g kg^{-1}, total organic carbon (C_{org}) of 10.30 g kg^{-1}, available P_{OLSEN} of 21.80 mg kg^{-1} and available K_{NH4OAc} of 217 mg kg^{-1}.

2.1. Plant material and organic soil amendments

Among the tomato genotypes sent from different countries within the framework of the PRIMA-VEGADAPT project, VC-T24 GRC-451/04 AUA (Agricultural University of Athens-Greece) genotype was used as a planted medium in the study. Vermicompost (pH, 6.92; EC, 5.56 dS m^{-1}; organic-C, 32.52%; total N, 2.61%; total P, 1.62%; total K, 1.28%) was obtained by processing by *Eisenia foetida* type worms in a 1-year period from dairy manure using the box method. The manure obtained after the harvest was rested in a cool and dry environment for 1-year. Biochar (pH, 6.71; EC, 2.16 dS m^{-1}; organic-C, 31.09%; total N, 3.78%; total P, 2.12%; total K, 0.15%) was obtained by slow pyrolysis at 550°C, using olive pomace, a waste of 3-phase olive oil plant.

2.1.1. Seed planting medium

The seeds used in the experiments were sown with imported peats (Klasmann TS1, Germany). The peat clods in the package were crushed, moistened and filled into the seed sowing container (viol). 128 foam trays (66.5 x 33.5 x 4.9 cm) were used to grow tomato seedlings.

2.1.2. Growing site (pots)

Cultivation was carried out in brown plastic horizontal pots (Model: S334, Ceren Plastic, Yenisehir-Izmir) measuring 75x23x16 cm. In the research, super coarse "Perlite" (İzper Perlite Enterprises, cigli, Izmir) for agricultural purposes was used as the growing medium.

21.3. Seed planting

After the peat used in seed sowing was blended and moistened, it was filled into 128 foam viols. The seeds of the selected genotypes used in the experiment were sown on February 19, 2021, with 1 seed in each cell compartment, then the medium was moistened again and the viols were placed in the germination chamber after they were covered with cling film. The viols were kept under dark conditions for 3 days at 22-24 °C day and night temperatures and 80% humidity, then continued to be grown in the same cabin under light for 16 hours at 20-22 °C day and 16-18 °C night temperatures. During seedling cultivation, 300 g/da Agroleaf Power 20-20-20+TE foliar fertilizer was given along with irrigation and irrigation when necessary. Irrigation and foliar fertilization were done with a back pump in the form of micro particles.

2.1.4. Cultivation System and Planting

In the research, open system media culture was used in soilless cultivation. Before planting, the greenhouse was prepared for production, the pots left over from the previous production were disinfected, filled with perlite (18 liters/pot), and the perlites in the pots in the greenhouse were washed with plenty of water. After the water drained from the media, on March 29, 2021, 2

Figure 1. General view of the greenhouse after planting seedlings

plants (100 x 37.5 cm) were planted in each pot (Figure 1). The plant density was 2.66 plants/m2. For each genotype used in the experiment, a total of 24 seedlings were planted with 3 replications and 8 plants in each replication under the relevant irrigation topic. Only for VC-T14 (Seccagno PSC1-1) genotype 12 seedlings were planted at 4 plants per replication because there were not enough seeds.

2.1.4. Nutrient Solution Recipe and Used fertilizers

Day's (1991) recipe was used for plant nutrition. According to the recipe, a nutrient solution was prepared by using fertilizers that are easily available in the market and easily dissolved in water. The nutrient solution recipe and the fertilizers used are given in Table 1. Nutrient applied to the seedlings the day after planting.

2.1.5. Irrigation System and Trial Topics

In the study, drip irrigation system was used in the application of nutrient solution and water to the root zone. The fertilizers in Table 1 were prepared as a stock solution (stock A, B and C) and a 10 liter volume micro element solution (stock MESS) in 3 separate tanks with a volume of 150 liters, according to their miscibility, then added to the water in the main tank and added nutrients to made the solution. The solution, taken from the main tank with the help of centrifugal pump, was conveyed into the greenhouse through a PVC main pipeline with 50 mm outer diameter after passing through a disc filter, and was used to fill the feeding tanks. The solution, which comes out of the feeding tanks with 20 mm main pipes, was delivered to the plants by black coloured PE lateral pipes with 16 mm outer diameter. In the study, the amount of nutrient solution applied for each subject was measured with the help of the calibrated counters. Pipes with a length of 5 cm and a diameter of 16 mm were attached to the ends of the pot drainage outlets to collect the drained nutrient solutions. Drainage outlets were combined with pipes with a diameter of 25 mm and conveyed in the drainage tank. In the greenhouse experiment, irrigation issues were included in the main plots and plant situations as planted and unplanted were included in the subplot. Irrigation topics consisted of S0: full irrigation (control) and S1: Deficit and S2: Deficit 2. The experiment was carried out in randomized blocks according to the split plot design with 3 replications. In the programming of irrigation, the value of the accumulated solar radiation value in the greenhouse was taken as a basis, and approximately 25-30% drainage was allowed for full irrigation (S0). The amount of irrigation water applied in S1 and S2 subjects was reduced by 35% and 50%, respectively. Irrigation issues were started 3 weeks after planting. The amount of irrigation water applied during the trial was automatically measured and recorded with digital meters.

2.1.6. Experiment, Soil Sampling and Analysis

In the greenhouse experiment, on March 24, 2021, organic soil conditioners, vermicompost and biochar, were applied at 10 t ha^{-1}. Tomato seedlings were planted on March 29, 2021 and the first soil sample for microbiological purposes (dehydrogenase-DHG and basal soil respiration-

Table 1. Nutrient solution recipe used in plant nutrition

Element	mg/L	Chemical source used	
N	210 (240) *	Ammonium nitrate	NH_4NO_3 (%33)
P	40	Phosphoric acid	H_3PO_4 (%85)
K	250 (300) *	Potassium nitrate	KNO_3 (%13 N, %46 K)
Ca	150 **	Calcium nitrate	$5Ca(NO_3)_2.NH_4NO_3.10H_2O$ (%15.5 N, %19 Ca)
Mg	50	Magnesium sulfate	$MgSO_4.7H_2O$ (%10Mg)
Fe	2	Iron chelate	Na_2.Fe-EDTA (%1.5 Fe)
Zn	0.50	Zinc sulfate	$ZnSO_4.7H_2O$
Mn	0.75	Manganese sulfate	$MnSO_4.H_2O$
B	0.4	Boric acid	H_3BO_3
Cu	0.10	Copper sulfate	$CuSO_4.5H_2O$
Mo	0.05	Ammonium molybdate	$(NH_4)6Mo_7O_{24}.4H_2O$

*Doses in parentheses were applied after the 3rd cluster.

** Calculated considering the amount in the irrigation water.

BSR) was taken from a depth of 0-15 cm on April 8, 2021, 15 days after the applications. With the last harvest, the second soil sample for microbiological purposes was taken on July 16, 2021, 114 days after the applications. To evaluate whether biochar and vermicompost amendment in Mediterranean soils influences the stability of the soil microbial community and microbially-mediated processes against drought, two organic amendments (biochar and vermicompost) and 3 irrigations treatments namely (1) Full irrigation (water is applied when 20% of soil water depletion), (2) Deficit 1 (70% of water applied at Full irrigation), (3) Deficit 2 (40% of water applied at Full irrigation) were tested. Agricultural chemical applications were carried out with pesticides and chemical fertilizers and application doses specified in the project. However, hoeing, taking a seat and etc. cultural processes, such as these, were applied only to planted areas. Thus, to declare the possible different between planted and unplanted areas, sampling carried out through planted either unplanted soil in this study. Basal soil respiration was detected using a 0.1 N NaOH solution after an incubation period of 24 h at 25° C (Isermeyer, 1952; Jäggy, 1976). Dehydrogenase activity (DHG, EC 1.1) was determined by photometric measuring at 546 nm of TPF (triphenyl formazan) formed by adding a solution of TTC (2,3,5 triphenyl tetrazolium chloride) at a concentration determined according to soil texture and the amount of organic matter, and incubating for 16 h at 25°C (Thalmann, 1968).

2.1.7. Statistical evaluation

Independent variables in the study known as; soil sampling period (PERIOD; 1-08.04.2021, 2-16.07.2021), vegetation status (PLANT; 1-Unplanted, 2-Plant), irrigation (IRRIGATION; 1-Full Irrigation, 2-Deficit1, 3-Deficit2) and organic soil amendments (TREATMENT; 1-Vermicompost, 2-Biochar, 3-Control). There were also three replications (REPLICATION; 1-2-3) in the study. Basal soil respiration (BSR) and dehydrogenase activity (DHG) were the dependent variables. The data obtained in the study; factorial multivariate ANOVA (MANOVA) was evaluated according to the variance analysis technique using the "SPSS 25.0" statistical package program, and Duncan's test, one of the multiple comparison methods, was used to detect different groups as a result of the variance analysis.

Table 2. Microbial parameters determined in soil samples

Dependent variables				BSR[f] (*µg CO_2-C g^{-1} h^{-1}*)	DHG[g] (*µg TPF g^{-1}*)	Dependent variables				BSR (*µg CO_2-C g^{-1} h^{-1}*)	DHG (*µg TPF g^{-1}*)
1st Period (8 April 2021)	Unplanted	Full irrigation	V[a]	4.96[d] (±2.70)[e]	9.52 (±2.62)	2nd Period (16 TJuly 2021)	Unplanted	Full irrigation	V	4.62 (±1.26)	7.57 (±0.57)
			B[b]	6.64 (±1.53)	17.83 (±2.01)				B	3.66 (±1.22)	10.32 (±0.44)
			C[c]	7.18 (±2.03)	11.51 (±3.64)				C	4.21 (±1.16)	10.75 (±1.30)
		Deficit 1	V	4.34 (±91)	11.82 (±6.63)			Deficit 1	V	5.45 (±0.52)	13.03 (±2.16)
			B	7.48 (±1.47)	14.56 (±6.39)				B	5.38 (±0.51)	20.61 (±4.57)
			C	8.63 (±0.11)	5.52 (±0.54)				C	5.79(±0.45)	11.14 (±5.02)
		Deficit 2	V	7.33 (±1.25)	17.17 (±1.99)			Deficit 2	V	3.80 (±0.35)	10.62 (±0.75)
			B	8.51 (±0.57)	38.90 (±4.68)				B	5.30 (±0.22)	30.93 (±1.90)
			C	10.76 (±2.53)	12.52 (±1.29)				C	7.83 (±1.91)	3.89 (±2.33)
	Planted	Full irrigation	V	7.02 (±0.88)	11.66 (±2.40)		Planted	Full irrigation	V	5.68 (±0.82)	16.78 (±0.65)
			B	6.65 (±3.26)	12.74 (±3.21)				B	7.30 (±0.95)	10.44 (±0.63)
			C	8.19 (±1.07)	19.30 (±7.06)				C	6.44 (±1.28)	5.98 (±1.23)
		Deficit 1	V	7.32 (±1.40)	13.73 (±2.29)			Deficit 1	V	5.73 (±0.96)	6.89 (±2.46)
			B	7.80 (±0.82)	16.63 (±0.80)				B	5.92 (±0.70)	10.92 (±3.34)
			C	7.93 (±0.76)	11.60 (±2.80)				C	5.37 (±1.37)	2.75 (±1.18)
		Deficit 2	V	6.47 (±2.14)	15.98 (±2.06)			Deficit 2	V	6.01 (±0.31)	9.95 (±2.21)
			B	7.00 (±2.24)	40.74 (±20.4)				B	4.62 (±1.26)	7.57 (±0.57)
			C	5.44 (±1.65)	4.93 (±1.67)				C	3.66 (±1.22)	10.32 (±0.44)

[a]: V, Vermicompost; [b]: B, Biochar; [c]: Control; [d]: All values are given on a dry matter basis as the average of six values; [e] : Standard deviation; [f] : Basal soil respiration; [g]: Dehydrogenase activity.

* Averages shown with the same letter are not statistically different from each other according to the Duncan test. (P<0.05). Lower case letters following averages show comparisons of organic soil conditioners in the same irrigation application, uppercase letters in the same planting status, and bold capital letters in the period average.

3. RESULTS

According to the statistical analysis of the data obtained from the greenhouse experiment results; the differences that the independent variables created on the biological properties of the soils individually and interactively were found to be significant in terms of the dependent variables. The fact that the replications established in the trial plan were found to be statistically insignificant indicates that the data obtained from the study can be evaluated more healthily.

3.1. Effects on soil respiration (BSR)

As can be seen from Table 2, the BSR value of the research soils varied between 3.66 and 10.76 µg CO_2-C g^{-1} h^{-1}. The amount of CO_2, which is the end product as a result of the use of organic C in the soil as a C and energy source by heterotrophic microorganisms, gives healthy and important information about the mineralization of soil organic C. CO_2-formation is also known as soil respiration (BSR). Soil microbial activity is easily affected by cultural treatments applied to soils. The fact that the unplanted area shows lower BSR activity than the planted area is the biggest evidence for this. In addition to the negative effects of cultural processes on the structure of the soil in the planted area, it is an expected result that the planted area will show higher BSR activity as a result of the increase in the amount of oxygen entering the soil through plant roots and hoeing.

Table 3. Changes in mean microbial parameters

Dependent variables				BSR[f] (µg CO_2-C g^{-1} h^{-1})				DHG[g] (µg TPF g^{-1})			
Mean Results of the Periods	Unplanted	Full irrigartion	V[a]	4.79	*a*	*B*	***D***	8.55	*b*	*C*	***DE***
			B[b]	5.15	*a*	*B*	***B-D***	14.08	*a*	*BC*	***CD***
			C[c]	5.69	*a*	*B*	***B-D***	11.13	*ab*	*C*	***C-E***
		Deficit 1	V	4.90	*b*	*B*	***CD***	12.42	*ab*	*BC*	***CD***
			B	6.43	*ab*	*B*	***B-D***	17.58	*a*	*B*	***C***
			C	7.21	*a*	*AB*	***BC***	8.33	*b*	*C*	***DE***
		Deficit 2	V	5.56	*b*	*B*	***B-D***	13.90	*b*	*BC*	***CD***
			B	6.90	*ab*	*B*	***B-D***	34.91	*a*	*A*	***A***
			C	9.29	*a*	*A*	***A***	8.20	*b*	*C*	***DE***
	Planted	Full irrigation	V	6.35	*a*	*AB*	***B-D***	14.22	*a*	*B*	***CD***
			B	6.98	*a*	*AB*	***B-D***	11.59	*a*	*B*	***C-E***
			C	7.32	*a*	*A*	***B***	12.64	*a*	*B*	***CD***
		Deficit 1	V	6.53	*a*	*AB*	***B-D***	10.31	*ab*	*B*	***C-E***
			B	6.86	*a*	*AB*	***B-D***	13.77	*a*	*B*	***CD***
			C	6.65	*a*	*AB*	***B-D***	7.17	*b*	*B*	***DE***
		Deficit 2	V	6.24	*a*	*AB*	***B-D***	12.96	*ab*	*B*	***CD***
			B	6.24	*a*	*AB*	***B-D***	26.73	*a*	*A*	***B***
			C	5.14	*a*	*B*	***B-D***	3.25	*b*	*B*	***E***

Full irrigation	**6.05 A**	**12.04 B**
Deficit 1	**6.43 A**	**11.60 B**
Deficit 2	**6.56 A**	**16.66 A**

Vermicompost	**5.73 B**	**12.06 B**
Biochar	**6.43 A**	**19.78 A**
Control	**6.88 A**	**8.46 C**

[a]: V, Vermicompost; [b]: B, Biochar; [c]: Control; [d]: All values are given on a dry matter basis as the average of six values; [e] : Standart deviation; [f] : Basal soil respiration; [g]: Dehydrogenase activity.

* Averages shown with the same letter are not statistically different from each other according to the Duncan test. (P<0.05). Lower case letters following averages show comparisons of organic soil conditioners in the same irrigation application, uppercase letters in the same planting status, and bold capital letters in the period average.

No difference could be detected with organic soil conditioner applications in unplanted soils, under full irrigation conditions, compared to the control. However, due to the decrease in the amount of water, the amount of CO_2 released from the soils could be reduced with vermicompost and biochar applications with high stable carbon content. When evaluated from this point of view, the effect of vermicompost material, which was rested for 2 years after it became stable and mature, was statistically significantly different from the control group. Although a decrease was detected in the BSR value with the application of biochar compared to the control soils, it was not found to be statistically significant (Table 3). The effectiveness of the independent variables in terms of BSR value in tomato plant cultivation was not found significant.

If the effectiveness of irrigation practices on BSR is examined, the effectiveness of all three irrigation water amounts on BSR was not found significant. In addition, providing BSR activity close to or lower than the control group with organic soil conditioners can be considered as an important indicator of preventing the release of CO_2 greenhouse gas formed in the soil into the atmosphere. Increasing the stable carbon content of soils with porous organic materials ensures that the CO_2 formed in the soil is kept in the soil. It is thought that carbon dioxide, which is released as a greenhouse gas as a result of the reaction of CO_2 with the water held in the pores of organic soil conditioners, has the potential to alleviate the positive contribution of agricultural production on global climate change, especially even under limited irrigation conditions.

3.2. Effects on DHG Enzyme activity

Soil enzyme analyses have been used as a possible holistic evaluation of soil quality to investigate biochemical processes in soils and to reflect the biological status of soils (Bandick and Dick, 1999; Ndiaye et al., 2000; Vepsäläinen et al., 2001). Enzyme assays measure the total activity of a soil sample bound to active microorganisms and stabilized enzymes in the soil. Considering that it is difficult to extract the intact enzymes in the soil from the environment, activity is measured instead of mass (Knight and Dick, 2004). Small amounts of extracellular enzymes are stabilized on soil colloids and can maintain their activity for a long time (Burns, 1982; Nannipieri et al., 1996). This may provide an ecological advantage to some soil organisms that may benefit without having to decompose and/or synthesize these enzymes or substrates that are too large to be taken up by a microbial cell. these stabilized enzymes appear to be protected against denaturation by both proteolytic enzymes and heat (Nannipieri et al. 1996; Rao et al., 2000). According to the results of the research, we determined that the DHG enzyme activity analysed within the scope of the project can be significantly manipulated by 11 different independent variables and their interactions at 1% and 5%. Soil enzymes give a very fast and clear response to cultural processes in the soil. The activity of DHG, an intracellular enzyme, is thought to reflect the total oxidative activity range of the soil microflora and may be a good indicator of microbial activity (Nannipieri et al., 1990). Considering the average values, the DHG activity of the unplanted plots was determined as 14.35 μg TPF g^{-1}, while the determination of the planted plots as 12.52 μg TPF g^{-1} can be accepted as an expression of the support of the microorganisms in the soil to increase their populations due to less exposure to cultural processes in tomato cultivation. In Full irrigation and Deficit 1 applications in unplanted soils, DHG activity at the level of 14.08 and 17.58 μg TPF g^{-1} was obtained, respectively, with the addition of biochar, followed by control plot in Full irrigation application and vermicompost application in Deficit 1 application. In Deficit 2 application, biochar application made a significant difference compared to the other two applications and caused an activity of 34.91 μg TPF g^{-1} ($P<0.05$) (Table 3). With these results, it has been demonstrated that even at limited moisture levels, biochar applications with high porosity content can provide a life opportunity to microorganisms. Changes in soil moisture levels can have a significant effect on the size of the microbial population in the soil. However, in the study, the lowest soil moisture level of 15% did not affect the DHG activity as it was not limiting for the microbial population in the soil. In particular, the soil moisture value of 5%

in the soil samples taken with the harvest was stated in previous studies as the reason for the low microbial population size of the soils (Kayikcioglu et al., 2020). It is seen that there is a similar trend in the plots where tomato plants are grown. While no statistical difference can be determined between organic soil conditioners and control in full irrigation application, it is seen that biochar application comes to the fore due to the decrease in water. Interestingly, Deficit 2 application comes to the fore when the irrigation regime is discussed ($P<0.05$). It is thought that the most important effect in this is the high DHG activity provided by biochar. This result is also seen in the average values where organic soil conditioners are taken into account. Biochar application provided the greatest difference in DHG activity ($P<0.05$), followed by vermicompost application. Both treatments made a significant difference from the control group ($P<0.05$).

4. CONCLUSION

The water deficit caused by the global climate change and which we will feel in every sector, not only in the agriculture sector in the coming period, stands before us as one of the important problems that we need to fight. In this study, the potential of mitigating the negative effects of water, which is of vital importance for living things, on soil health of the scarcity of plant production on soil health was investigated. In the study carried out under controlled conditions in greenhouse conditions, it can be said that the amount of irrigation water applied at Deficit 1 level by using soil conditioners with stable carbon content such as vermicompost and biochar is suitable for the microbial parameters examined. Moreover, Deficit 2 irrigation water amount can also support microbial activity with appropriate soil conditioners. Vermicompost and biochar applications can support soil microbial activity at different levels due to their different properties in different irrigation water conditions. While higher microbial activity could be obtained from vermicompost and biochar applications at Deficit 1 level, microbial activity could be supported only by biochar application at Deficit 2 level. The higher microbial activity of unplanted soils without cultural processes such as hoeing, spraying etc. can be considered as an indicator of the deformation of the soil structure and the negative effects of chemical pesticides on soil microorganisms. When all the results are evaluated, it can be stated that vermicompost and biochar applied at the level of 10 t ha^{-1} can support the microbial activity in the soil under limited irrigation conditions, and biochar application contributes more when the soil moisture is reduced to 15%.

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REFERENCES

ATIK, A. (2013). Effects of planting density and treatment with vermicompost on the morphological characteristics of oriental beech (Fagus orientalis Lipsky.). Compost Science and Utilization, 21, 87-98.

ATMACA, L., TUZEL, Y. AND OZTEKIN, G.B. (2014). Influences of vermicompost as a seedling growth medium on organic greenhouse cucumber production. Ii International Symposium on Organic Greenhouse Horticulture. 1041, 37-45.

BALDOCK, J. A. AND SMERNIK, R. J. (2002). Chemical composition and bioavailability of thermally altered Pinus resinosa (Red pine) wood. Organic Geochemistry, vol 33, pp1093–1109

BANDICK, A.K. AND DICK, R.P. (1999). Field Management Effects on Soil Enzyme Activities. Soil Biol. Biochem. 31, 1471-1479.

BASHEER, M. (2013). Effect of vermicompost on the growth and productivity of tomato plant (*Solanum lycopersicum*) under field conditions. Bonde, T.A., Schnürer, J., Rosswall, T. (1988). Microbial biomass as a fraction of potentially mineralizable nitrogen in soils from long-term field experiments. Soil Biology & Biochemistry, 20: 447–452.

BURNS, R.G. (1982). Enzyme activity in soil: location and a possible role in microbial ecology. Soil Biology and Biochemistry 14, 423–427.

BUTLER, T.A., SIKORA, LJ., TEEINHILBER, P.M., DOUGLASS, L.W. (2001). Compost age and sample storage effects on maturity indicators of biosolids compost. J. Environ. Qual. 30, 2141-2148.

CHANDA, G., K., BHUNIA, G., CHAKRABORTY, S., K. (2010). The effect of vermicompost and other fertilizers on cultivation of tomato plants. Journal of Horticulture and Forestry. Vol. 3(2). pp. 42-45.

CHENG, C. H., LEHMANN, J. AND ENGELHARD, M., (2008). Natural oxidation of black carbon in soils: Changes in molecular form and surface charge along a climosequence. Geochimica et Cosmochimica Acta, vol 72, pp1598–1610

ÇITAK, S., SÖNMEZ, S., KOÇAK, F. VE YAŞIN, S. (2011). Vermikompost ve ahır gübresi uygulamalarının ıspanak (Spinacia oleracea var L.) bitkisinin gelişimi ve toprak verimliliği üzerine etkileri. Derim, 28(1), 56-69.

DUXBURY, J.M., LAUREN, J.G. AND FRUCI, J.R. (1991). Measurement of the biologically active soil nitrogen fraction by a N15 technique. Agriculture. Ecosystems and Environmental. 34(1-4): 121-129.

EKBERLİ, I. AND KİZİLKAYA, R. (2006). Catalase enzyme and its kinetic parameters in earthworm L-terrestris casts and surrounding soil. Asian Journal of Chemistry, 18, 2321-2328.

FAOSTAT, (2022).

GIL-SOTRES, F., TRASAR-CEPEDA, C., LEIRÓS, M.C., SEOANE, S. (2005). Different approaches to evaluate soil quality using biochemical properties. Soil Biol. Biochem. 37, 877–887.

GLODOWSKA, M., WOŹNIAK, M. (2016). Biochar characteristics and application in the agriculture. Badania i Rozwój Młodych Naukowców w Polsce – Agronomia i ochrona roślin.

IRMAK YILMAZ, F., ERGUN, Y. A. (2019). Impact of biochar and animal manure on some biological and chemical properties of soil. Applied Ecology and Environmental Research, 17(4): 8865-8876.

IRMAK YILMAZ, F., KURT, S. (2020). The effects of biochar and vermicompost applications on some enzyme activities in rhizosphere root zone of corn (Zea mays L.) plant. CR Acad Bulg Sci 73(8): 1177-1186.

ISERMEYER H, 1952. Eine einfache methode zur bestimmung der bodenatmung und der karbonate im boden. Z Pflanzenernaehr Dueng Bodenk 56: 26-38.

JÄGGI W, 1976. Die bestimmung der CO_2-bildung als maß der bodenbiologischen aktivität. Schw Landw Forschung 15: 371-380.

KAYIKCIOGLU, H.H., DUMAN, İ., KAYGISIZ ASCIOGUL, T., BOZOKALFA, M.K, ELMACI, Ö.L. (2020). Effects of tomato-based rotations with diversified pre-planting on soil health in the mediterranean soils of western Turkey. Agriculture, Ecosystems and Environment, 299: 106986.

KEENEY, D.R. (1982). Nitrogen availability indices. In: Page AL, Miller R, Kenny DR, editors. Part 2: Chemical and Microbiological Properties. Methods of Soil Analysis. 2nd ed. Madison, WI: American Society of Agronomy. p. 711–733.

KİMETU, J.M., LEHMANN, J., NGOZE, S.O., MUGENDİ, D.N., KİNYANGİ, J.M., RİHA, S., VERCHOT, L., RECHA, J.W. AND PELL, A.N. (2008). Reversibility of soil productivity decline with organic matter of differing quality along a degradation gradient. Ecosystems, 11(5), pp.726-739.

KİZİLKAYA, R. (2008). Dehydrogenase activity in Lumbricus terrestris casts and surrounding soil affected by addition of different organic wastes and Zn. Bioresource Technology, 99, 946-953.

KİZİLKAYA, R. AND HEPSEN, S. (2007). Microbiological properties in earthworm cast and surrounding soil amended with various organic wastes. Communications in Soil Science and Plant Analysis, 38, 2861-2876.

KİZİLKAYA, R., TURKAY, F.S.H., TURKMEN, C. AND DURMUS, M. (2012). Vermicompost effects on wheat yield and nutrient contents in soil and plant, Archives of Agronomy and Soil Science, 58, S175-S179.

KNIGHT, T.R., DICK, R.P. (2004). Differentiating microbial and stabilized β-glucosidase activity relative to soil quality. Soil Biology and Biochemistry, 36: 2089–2096.

KÜÇÜKYUMUK, Z., GÜLTEKİN, M. VE ERDAL, İ. (2014). Vermikompost ve mikorizanın biber bitkisinin gelişimi ile mineral beslenmesi üzerine etkisi. Süleyman Demirel Üniversitesi Ziraat Fakültesi Dergisi, 9(1), 51-58.

LAL, R. (2004). Soil carbon sequestration impacts on global climate change and food security. Science, 304: 1623–1627.

LEHMANN, J. (2007), Bio-energy in the black. Frontiers in Ecology and the Environment, vol 5, pp381–387

LEHMANN, J., 2009, 'Terra preta Nova – where to from here?', in W. I.Woods,W.G.Teixeira, J. Lehmann, C. Steiner and A.WinklerPrins (eds)

LEHMANN, J., GAUNT, J. AND RONDON, M.

(2006). Bio-char sequestration in terrestrial ecosystems – a review. Mitigation and Adaptation Strategies for Global Change, vol 11, pp403–427

LEHMANN, J., RILLIG, M., C., THIES, J., MASIELLO, C., A., HOCKADAY, W., C., CROWLEY, D. (2011). Biochar effects on soil biota. Soil Biology & Biochemistry. 43 1812e1836 Contents.

LİANG,B.,LEHMANN,J.,SOLOMON,D.,KİNYANGİ, J., GROSSMAN, J., O'NEİLL, B., SKJEMSTAD, J.O., THİES, J., LUİZÃO, F. J., PETERSEN, J. AND NEVES, E. G., (2006).Black carbon increases cation exchange capacity in soils', Soil Science Society of America Journal, vol 70, pp1719–1730

MONREAL, C.M., R.P. ZENTNER, AND J.A. ROBERTSON. (1997). An analysis of soil organic matter dynamics in relation to management, erosion and yield of wheat in long-term crop rotation plots. Canadian Journal of Soil Science 77:553-563.

NANNIPIERI, P., GRECO, S., CECCANTI, B. (1990). Ecological significance of the biological activity in soil. In: Bollag, J.M., Stotzky, G. (Eds.), Soil Biochemistry, vol. 6. Marcel Dekker Inc., New York, Basel, pp. 293–355.

NANNIPIERI, P., SEQUI, P., FUSI, P. (1996). Humus and enzyme activity, in: Piccolo, A. (Ed.), Humic Substances in Terrestrial Ecosystems. Elsevier, New York, pp. 293–328.

NDIAYE, E.L., SANDENO, J.M., MCGRATH, D., DICK, R.P. (2000). Integrative biological indicators for detecting change in soil quality. American Journal of Alternative Agriculture 15, 26–36.

PILLI, K., SRIDHAR, D. (2019). Vermicomposting and its uses in Sustainable Agriculture.

RAO, M.A., VIOLANTE, A., GIANFREDA, L. (2000). Interaction of acid phosphatase with clays, organic molecules and organo-mineral complexes: kinetics and stability. Soil Biology and Biochemistry 32, 1007–1014.

ROS M, KLAMMER S, KNAPP B, AICHBERGER K, INSAM H. (2006). Long-term effects of compost amendment of soil on functional and structural diversity and microbial activity. Soil Use Manage. 22:209–218.

SAIFULLAH, S.D.; NAEEM, A.; RENGEL, Z.; NAIDU, R. (2018). Biochar application for the remediation of salt-affected soils: Challenges and opportunities. Sci. Total Environ., 625, 320–335.

SHİNDO, H. (1991). Elementary composition, humus composition, and decomposition in soil of charred grassland plants. Soil Science and Plant Nutrition 37.4 (1991): 651-657.

SKJEMSTAD, J.O., CLARKE, P.,TAYLOR, J. A., OADES, J. M. & MCCLURE, S.G. (1996). The chemistry and nature of protected carbon in soil. Australian Journal of Soil Research, vol 34, pp251–271

STEİNER, C., TEİXEİRA, W.G., LEHMANN, J., NEHLS, T., DE MACÊDO, J.L.V., BLUM, W.E. & ZECH, W., 2007. Long term effects of manure, charcoal and mineral fertilization on crop production and fertility on a highly weathered Central Amazonian upland soil. Plant and soil, 291(1-2), pp.275-290.

TAVALI, İ.E., MALTAŞ, A.Ş., UZ, İ. & KAPLAN, M. (2013). Karnabaharın (Brassica oleracea var. botrytis) verim, kalite ve mineral beslenme durumu üzerine vermikompostun etkisi. Akdeniz Üniversitesi Ziraat Fakültesi Dergisi, 26(2), 115-120.

THALMANN A, 1968. Zur methodik der bestimmung der dehydrogenaseaktivität im boden mittels triphenyltetrazoliumchlorid (TTC). Landwirtsch Forsch 21: 249-258.

VEPSÄLÄINEN, M., KUKKONEN, S., VESTBERG, M., SIRVIÖ, H., NIEMI, R.M. (2001). Application of soil enzyme activity test kit in a field experiment. Soil Biology and Biochemistry 33, 1665–1672.

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ORIGINAL ARTICLE

Determination of drought distribution using palmer drought severity ındex: Case study of Susurluk basin*

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ABSTRACT

The results such as decrease in agricultural production, product quality and change in diversity because of drought create important socio-economic problems. Due to these reasons, it is becoming an increasingly strategic study topic in academic circles. The fact is that it is not observed instantly like natural disasters makes it possible to take necessary measures on a basin basis in case of drought. Accordingly, obtained data, from meteorological stations in the Susurluk Basin, were used in this study. Within the scope of the study, the starting and ending dates, and intensities of dominant dry periods were determined by using the PDSI (Palmer Drought Severity Index). Using data such as precipitation, evaporation, transpiration, and the water holding capacity of soil as inputs, a tool was developed in the R environment for PDSI, and annual values were calculated for each meteorology station by running all inputs in this tool. For calculated PDSI values, spatial and temporal analyze were made using the digital elevation model of the Susurluk Basin using the ordinary cokriging interpolation method in ArcGIS 10.8 program.

Keywords: drought, geographic information system, PDSI, statistical computing, Susurluk Basin

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1. INTRODUCTION

It is estimated that the world population, which is 7.6 billion today, expected to reach 9.8 billion in 2050 and 11.2 billion in 2100. (United Nations Anon 2017). If this population estimation is realized, developing countries should increase their food production by 100%. Despite the increasing population, the perceived climate change and drought change the efficiency of agricultural land use and reduce the rate of food production. It can be possible with appropriate irrigation, fertilization, and precision agriculture practices for efficient production of agricultural lands (FAO Anon 2009). Water demand is expected to increase by 55% due to increasing urbanization, thermal electrical energy production and domestic waste in developing countries (WWAP Anon 2015). This situation will directly affect agriculture, which is the sector that uses water the most. To optimize agricultural production and to provide irrigation water in the agricultural field in line with the needs of the plant, the amount of water in the growing medium must be constantly monitored and given as needed, because drought is a meteorological disaster that occurs very slowly, does not show itself and causes significant social-economic damage. Therefore, drought climate directly affects water resources and agricultural activities negatively (Anon 1999). For this reason, the analysis of the relationship between precipitation and runoff, and the analysis of dry and rainy seasons is very important. Monitoring drought is an important process in tackling some climate problems because if it is predicted and warned early, its damage can be reduced (Hao et al. 2017). Since drought indices are related to climate and environment, it is stated as an effective way of determining drought.

According to Vanders et al. 2017, 10 out of 20 drought monitoring indices are frequently used for drought detection in all parts of the hydrological cycle. In addition, if we want to specify the two most used indices in drought determination so far, one of them is Palmer (1965) and the other is MCkee et al. (1993) The SPI (standardized precipitation index) developed (Tirivarambo et al., 2018). SPI is a drought index calculated from precipitation data only, while PDSI is calculated based on precipitation and evapotranspiration. It is stated that PDSI is more appropriate than that of the SPI in assessing the potential impact of climate change on the future perspective of drought, since drought is dependent on temperature and precipitation. In addition, in the calculation of PDSI, how two parameters such as precipitation and evapotranspiration change over time, flow moisture determination and water holding capacity of the soil at the desired location are used as input variables (Wells et al. 2004). However, PDSI does not consider the spatial variation of the soil structure, vegetation, topography, and hydrological processes of the basin in drought calculations. Although Palmer has some disadvantages as stated above, considering its advantages over SPI, palmer drought index was chosen for drought estimation in this study.

2. MATERIALS AND METHODS

The Susurluk basin is situated in the Northwest of Anatolia, between 39^{o}-40^{o} North latitudes and 27o-30o East longitudes. As can be seen in Figure 1, the total area surrounded the Susurluk Basin is 24,299 km2, and the most important river it has is the Simav Stream. Within the scope of the Ramsar contract, there are two main freshwater lakes namely, Kuş lake with an area of 24,400 ha and the Uluabat lake with an area of 19,900 ha (Anon 2022). When the agricultural activities in the Susurluk Basin are examined, the plant production pattern can be said to be 65% cereals and other plant products, 28% vegetables and 7% fruits.

Figure 1. Streams and lakes in the Susurluk basin (Anon 2018)

When the climate of the Susurluk Basin is examined, it is generally semi-humid in winters and hot in summers. The annual average precipitation map of the basin is given in Figure 2. The average annual precipitation of the basin is recorded as 662 mm/year (Anon 2018). As seen in Figure 2, the average annual precipitation in the regions of Bursa, Bandırma, Keles and Simav meteorological stations is observed as 750-800 mm and 570-630 mm in Balıkesir and Dursunbey, and 510-570 mm in Tavşanlı meteorological stations.

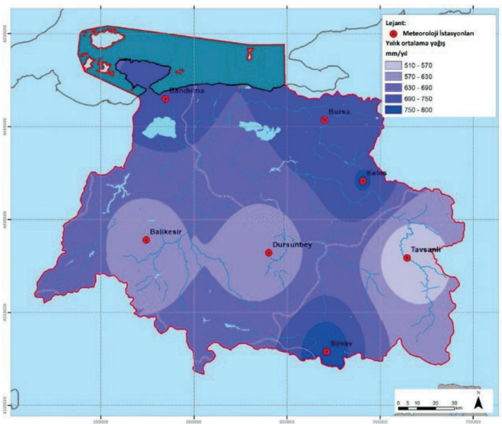

Figure 2. Average annual precipitation compared to 1995-2011 (Anon 2018)

The drought in the basin was examined by using the palmer drought index method by using the average monthly precipitation and monthly average temperature values of the meteorological stations in the Susurluk Basin and the latitude of that station for many years. Data regarding precipitation and temperature of 11 meteorological stations located the Susurluk Basin between 1970 and 2020 were obtained from the General Directorate of State Meteorology Affairs. By calculating the palmer drought severity with the data obtained, it was tried to provide a complete drought analysis of the basin with the Ordinary Co-Kriging interpolation method within the basin.

The palmer drought index was developed by Wayne Palmer in 1960s for hydrological drought determination using monthly average precipitation and temperature data. These class ranges are given in Table 1.

Table1. Palmer drought index classes

CLASSIFICATION	
4 or more	Extremely wet
3.00 - 3.99	Very wet
2.00 - 2.99	Moderately wet
1.00 - 1.99	Lightly wet
0.50 - 0.99	Incipient Wet Spell
0.49 - -0.49	Near Normal
-0.50 - -0.99	Incipient Dry Spell
-1. 00 - -1.99	Mild Drought
-2.00 - -2.99	Moderate Drought
-3.00 - -3.99	Severe Drought
4 or less	Extreme Drought

Palmer divides the soil layer into two parts while calculating the drought index. Palmer (1965) uses monthly total precipitation and monthly total temperature data when calculating the water balance. It empirically assumes that the usable water in the field capacity in the upper layer of the soil is approximately 25 mm. This layer is also the layer where the rain falls, and evaporation movements occur. It assumes that the evaporation loss in the top layer of the soil occurs at a potential level. Since the moisture on the surface of the soil is constantly saturated or completely evaporates, the amount of usable water in the lower layer of the soil depends on the effective root depth of the plant roots and the soil properties.

This study use of palmer drought index using potential evapotranspiration and Thornthwaite method. Thornthwaite (1948) With this method, we derive the coefficients of the ratio of the monthly average of the evaporation and evapotranspiration losses in the soil to the potential value, find the CAFEC: (Climatologically Appropriate for Existing Conditions.) precipitation from these coefficients, use a series of empirical equations according to the difference of this precipitation value from the actual precipitation value, and calculate the drought value and determines the intensity.

The results obtained from these empirical formulas were calculated by the software created in the R program.

3. RESULTS AND DISCUSSION

Long-term precipitation and temperature data of 11 selected meteorological stations used in drought analysis in the Susurluk Basin were used. The importance of the relationship between the data of meteorological stations in the basin and the palmer drought index has been observed. The more precipitation and temperature deviate from the average value in the basin, the drier or rainy it is. This feature of the palmer drought index shows that it is statistically significant.

Drought classes of all months were determined by palmer drought index. However, the drought classes of February and July 2020 were considered. Because it was thought that the drought or rainy situation in February felt in July. Considering the forecast maps created by interpolation on the basin in Figure 3, the similarity between February and July is clearly seen. In Figure 3, it is clearly seen that the onset of drought and mild dryness in the southern regions, which started in February, increased intensity, and became mild and moderately dry in July. The drought that started in Keles and Dursunbey meteorological stations in February increased its severity in July. In addition, it is seen that it is rainier in the Balıkesir meteorological station region in July than that in February.

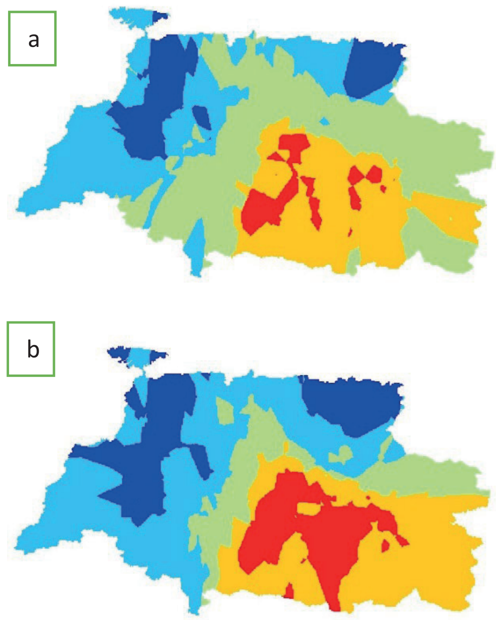

Figure 3. Palmer drought index average drought map between 1990-2020 a: drought averages for February b: averages for July

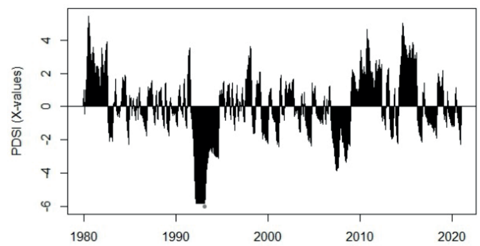

Figure 4. Palmer drought index to Balıkesir meteorological station between 1980-2020

As can be seen from Figure 4, Balıkesir meteorology station was extremely dry between 1993-1995 and humid in 2015.

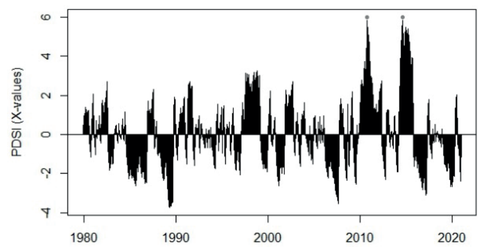

Figure 5. Palmer drought index to Bursa meteorological station between 1980-2020

When Figure 5 is examined, it has been determined that Bursa meteorological station has excessive wet in 2009 and 2014 and light drought in 2020.

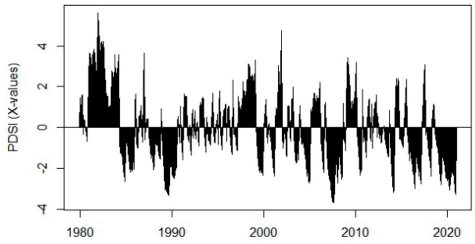

Figure 6. Palmer drought index to Simav meteorological station between 1980-2020

As seen in Figure 6. it has been determined that mild drought is more intense towards 2020 at Simav meteorological station.

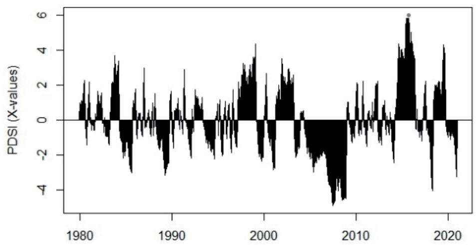

Figure 7. Palmer drought index to Dursunbey meteorological station between 1980-2020

The palmer drought index values of the Dursunbey meteorological station in Figure 7. show that an extremely dry period was detected starting from 2007 and continuing increasingly towards the middle of 2009. Considering the year 2017, an excessive humidity is observed.

4. CONCLUSION

This study was carried out for drought determination by using Palmer Drought Index Severity on the Susurluk Basin, which has an important socio-economic value for Turkiye. When some meteorological stations namely Bursa, Balıkesir, Simav and Dursunbey in the Susurluk Basin were examined, it was determined that 2020 was a dry year. Drought was estimated by using the ordinary kriging method on a basin basis by interpolation.

The possible drought situation in February was determined and interpreted with the climate data of the region, where it was more severe in July. However, the prediction that the drought analysis to be made in February for each region will be drought or wet felt in July may not be valid.

The Palmer drought index uses a set of complex empirical formulas for drought determination. Since these formulas are complex and difficult and there are too many meteorological stations in the drought analyzes to be made on the basin basis, it has been concluded that the evaluation of the palmer drought index on the basin basis is very laborious and difficult. A calculation approach with some artificial intelligence models is suggested for the determination of the palmer drought index on a basin basis.

REFERENCES

Anon (1999). Meteorological Characteristic Natural Disasters and Meteorological Measures, Chamber of Meteorological Engineers, Meteorological Characteristic Natural Disasters Report, Ankara.

Anon (2022). Sakarya ve Susurluk Havzaları kuraklık yönetim hazırlanması projesi: Tarım Ve Orman Bakanliği Su Yönetimi Genel Müdürlüğü Taşkın Ve Kuraklık Yönetimi Dairesi Başkanlığı

Anon (2018). Susurluk Nehir Havzası Yönetim Planı: Tarım Ve Orman Bakanliği Su Yönetimi Genel Müdürlüğü Taşkın Ve Kuraklık Yönetimi Dairesi Başkanlığı

FAO Anon (2009). Global agriculture towards 2050, How to feed the World in 2050, 4

HAO, ZC, HAO, FH, SINGH, VP, OUYANG, W., & CHENG, HG (2017). An integrated package for drought monitoring, prediction, and analysis to aid drought modeling and assessment. Environmental Modeling and Software, 91, 199–209.

MCKEE TB, DOESKEN NJ, & KLEIST J (1993). The relationship of drought frequency and duration to time scales. In: Proceedings of the 8th Conference on Applied climatology. Vol. 22. American meteorological Society Boston, MA, pp 179–183

PALMER W. (1965) Meteorological drought, Research Paper No. 45, US Weather Bureau, Washington, DC :1-59

TAGEM Anon (2018)

THORNTHWAITE, CW (1948). An approach toward a rational classification of climate. Geographical Review, 38, 55–94.

TIRIVARAMBO, S., OSUPILE, D., & ELIASSON, P. (2018). Drought monitoring and analysis: Standardized Precipitation Evapotranspiration Index (SPEI) and Standardized Precipitation Index (SPI). Physics and Chemistry of the Earth, 106, 1–10.

United Nations Anon (2017). World Population Prospects: The 2017 Revision, Key Findings and Advance Tables, United Nations, Department of Economic and Social Affairs Population Division, 46,

WELLS, N., GODDARD, S., & HAYES, MJ. (2004). A self- calibrating Palmer Drought Severity Index. Journal of Climate, 17, 2335–2351. https://doi.org/10.1175/1520-0442(2004)017 2.0. Co;2.

WWAP (United Nations World Water Assessment Programmed) Anon. (2015). The United Nations World Water Development Report 2015, Water for a sustainable World, 13

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ORIGINAL ARTICLE

An example of environmental risk assessment with L-type method: Cold storage in food industry

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ABSTRACT

In this study, the environmental risk assessment for a cold storagefor food industry in the Mediterranean region was determined by the L matrix method. Waste amounts of the cold storage area and offices, possible environmental hazards have been identified. Environmental risks in wastewater, hazardous wastes, other solid wastes, and air pollution were analyzed for risk values. As a result, the activities with the highest environmental risk valueshave been identified as wastewater generation from fruit washing, mercury pollution that may occur due to fluorescent lamps from office and cold storage, contaminated packaging due to detergents to be used for cleaning in cold storage.

Keywords: Cold storage, environmental risk assessment, food industry, Lmatrix.

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1. INTRODUCTION

Cold storages play a very important role in terms of consumption of the products outside the harvest period and preserving their freshness. High energy consumption is required for cold weather facilities that allow the consumption of food throughout the year (Zheng et al., 2022). For this reason, energy saving, and environmental protection are of great importance for cold storage as well as for other sectors. There is a need to establish environmental management and quality management systems to ensure the sustainability of food use and to protect the environment (Marmiroli et al., 2022). However, businesses should evaluate the environmental risks and potentials at the project stage and implement management practices to minimize these risks (Jones,2001).

Hazard identification, risk assessment and management are of great importance for the safe and efficient production of the industrial system (Hao and Nie, 2022). Risk assessment is the science-based component of risk analysis, which consists of four basic steps (hazard identification, hazard characterization, exposure assessment and risk characterization) (Mahoney, 2022). Among the quantitative methods of risk analysis is the L-type matrix method. Since the L type matrix can be applied in all small and large enterprises and because it is an easy method, this method has made it the most applied risk analysis method in the occupational health and safety sector. L type matrix method can be applied even with a single analyst (Soykan, 2018). After the risk has occurred, together with the probability of its occurrence it is an evaluation tool used to analyze the effect it will create as a binary variable (Selcuk and Selim, 2018).

Environmental risk assessment is the process of identifying, evaluating, selecting, and implementing actions to reduce risks to human health and the ecosystem (Celik, 2000). In developed countries, studies such as emergency plans and data banks are carried out to assess environmental risks (Sunar, 1998).

As a result of developing quality management systems, the importance of environmental risk analysis studies has increased. Although there aren't many articles in the literature, a few case studies have been identified. Kuleyin and Asyali (2007), calculated the environmental risk analysis for Aliaga port using the L-type matrix method. A risk checklist of 5 items has been created and measures have been specified for 8 identified hazards (Kuleyin and Asyali, 2007). These hazards include storage and handling operations of cargoes (dry-liquid bulk cargo, general cargo, chemical), port cargo equipment, refueling operations, hazardous and non- hazardous wastes, maintenance operations in the building and port area, air pollution, noise, light, odor. and is formed during garbage. According to the research, legal obligations must be complied with and implemented in order to prevent hazards. Ciftci and Beyhan (2021), The environmental risk assessment of ready-mixed concrete plants in Denizli and Adana was carried out and compared with the L-type matrix method. The environmental risk of the ready-mixed concrete plant in Denizli is less, and it has been determined that all environmental risks in the plant can be reduced to a minimum with the implementation of the recommended measures. It has been observed that the unacceptable risks are higher in the ready mixed concrete plant in Adana (Ciftci and Beyhan, 2021). Falco et al. (2017), the environmental impact determined by the application of storage technology was evaluated using the LCA method. Input and output data are translated into environmental effects such as climate change, acidification, eutrophication and photochemical oxidation. It is expected to have positive effects on the environment, as it improves the energy efficiency of the air conditioning system and reduces electricity consumption (Falco et al., 2017).

Within the scope of this study, the environmental risk assessment of the selected food cold storage was made with the L-type matrix method and solutions were determined about the identified risks. Increasing environmental risk assessment studies will contribute to raising awareness of preventing environmental pollution while creating environmental protection policies and establishing quality management systems.

2. MATERIALS AND METHODS

Since the L matrix method can be applied in small and large enterprises, it is both an easy method and the most applied risk analysis method in the occupational health and safety sector (Selcuk and Selim, 2018).

The L matrix method, which is a two-dimensional matrix graph, has different meanings for horizontal and vertical coordinates.The horizontal coordinate shows the risk consequences (C), and the vertical coordinate shows the likelihood (L) of the risk (Wang and Wang, 2020).

In this method, the risk score is calculated for each environmental element. According to the result of the risk score, suggestions were made to the facility according to whether the risk is acceptable risk, significant risk, high risk and very serious risk (Gul et al., 2014). The risk score was calculated with the following formula and analyzed according to likelihood classification (MSANZ, 2004).

Risk (R) = Likelihood (L) x Consequences (C)

In this place;

L = Likelihood (1-5)

C = Consequences (1-5)

R = data and the result is the degree of risk (Table 1), for risk results are given in Table 2.

Where;

Likelihood:

1: Classification is named "So Light"; insignificant environmental impact, 2: Classification is named "Light"; minor operational rash, 3: Classification is named "Middle"; significant environmental damage, 4: Classification is named "Serious"; environmental life suffers serious losses, 5: Classification is named "So serious"; Disaster (MSANZ, 2004).

Consequences:

1: Classification is named "Very small"; hardly ever, 2: Classification is named "Small"; very little (once a year), only in abnormal situations, 3: Classification is named "Middle"; few (several times a year), 4: Classification is named "High"; often (monthly), 5: Classification is named "Very high"; Very often (once a week, every day) (MSANZ, 2004).

Table 1. Risk score (MSANZ, 2004)

Likelihood		5	4	3	2	1
		So serious	Serious	Middle	Light	So light
5	Very high	25	20	15	10	5
4	High	20	16	12	8	4
3	Middle	15	12	9	6	3
2	Small	10	8	6	4	2
1	Very small	5	4	3	2	1

Table 2. Risk results (MSANZ, 2004)

Risk score	**Action (activity)**	
15,16,20,25	Unacceptable	Action should be taken immediately to reduce risks.
8,9,10,12	Considerable risk	Risks should be addressed as quickly as possible.
1,2,3,4,5,6	Acceptable risk	Immediate action may not be required.

2.1. Facility Data

A food cold storage located in the Mediterranean Region was selected for the study. It operates in cold storage operations in the selected facility. There are 2 packing houses and 2 cold storages with a capacity of 20 thousand tons. 250 people work at the facility.

Wastes in the company are defined in 7 categories. These wastes; 16 06 04 waste code alkaline batteries, 20 01 21 waste code waste fluorescent lamps and mercury lamps, 15 01 01 waste code paper and cardboard packaging, 15 01 02 plastic packaging, 15 01 10 packaging containing residues of dangerous substances or contaminated with dangerous substances , absorbents, filter materials (oil filters, if not otherwise specified), cleaning cloths, protective clothing contaminated with hazardous materials with waste code 15 02 02, non-hazardous mixed municipal waste with waste code 20 03 01. Table 3 gives the waste amounts in 2021. These categories are determined in the Waste Management regulation published by the Ministry of Environment and Urbanization in Turkey (Anonymous, 2015).

3. RESULTS AND DISCUSSIONS

The environmental risk assessment of the selected company was made using the L-type matrix method. The cold storage environmental risk assessment is given in Table 3. There are 8 hazards in Table 4. The risk values of these hazards have been found and precautionary methods have been determined.

There is no environmental risk related to air emission and noise at the facility. Because there is no point and area emission source for air emission, there is no combustion boiler and chimney, it is not subject to the industrial air pollution control regulation. For noise, it is not within the scope of the environmental noise assessment and management regulation and is outside the scope of the environmental permit.

In Table 4, there are 8 environmental hazards identified for cold storage. No activity in the notable risk (R= 8, 9, 10, 12) class has been detected in the cold storage. Many activities inthe study area were evaluated in the unacceptable risk group (R= 15, 16, 20, 25). These hazards can be listed as battery operated devices, lamps and lamps used in lighting, contaminated packaging, cleaning cloths and protective clothing. Paper waste, non-hazardous mixed municipal waste and wastewater generation from the use of printers are included in the acceptable risk group (R= 1, 2, 3, 4, 5, 6). The risk scores on environmental risk analysis of rose oil production in some industrial plants and environmental risk assessment in ready-mixed concrete plants gave similar results with this research (Coskun et al., 2022; Ciftci and Beyhan, 2021). Cleaning detergents and lamps and bulbs used in lighting are evaluated in the unacceptable risk group (Coskun et al., 2022). Activities at the facility are divided into office work and cold storage. The danger is the use of printers and correspondence, and the risk is the damage to environmental resources due to heavy use of paper. Battery-operated devices are shown as a danger, as the risk of alkaline batteries getting into the soil and harming living things. Lamps and bulbs used in lighting are dangerous, and it is a risk that the mercury content of waste fluorescent lamps and mercury bulbs will mix with nature and harm living things.

Lamps and bulbs used in lighting are dangerous, and there is a risk that the mercury content of waste fluorescent lamps and mercury bulbs will mix with nature and harm living things. In order

Table 3. Waste codes of the selected company and waste amounts in 2021

Waste code	Definition	Amount of waste(kg/year)	Disposal / recycling method
16 06 04	Alkaline Batteries	0,5	**D5**
20 01 21	Waste Fluorescent Lamps and Mercury Bulbs	1	**R13**
15 01 01	Paper and Cardboard Packaging	5000	**R12**
15 01 02	Plastic Packaging	500	**R12**
15 01 10	Packages Containing Residues of Hazardous Substances or Contaminated with Hazardous Substances	50	**R12**
15 02 02	Absorbers Contaminated by Hazardous Substances, Filter Materials (oil filters unless otherwise specified), Cleaning Cloths, Protective Clothing	5	**R1**
20 03 01	Non-hazardous Mixed Municipal Waste	1000	**-**

Table 4. Cold storage environmental risk assessment

ACTIVITY	DANGER	RISK	LIKELIHOOD	CONSEQUENCES	RISK SCORE	PREVENTION
Office work	Printer usage and correspondence	Damage to environmental resources dueto heavy paperuse	5	1	5	Waste should be sent to licensed companies.
Office work	Battery powered devices	Mixing of alkaline batteries with thesoil and harmingliving things	1	15	15	Waste should be sent to licensed companies.
Office work	Lamps and bulbs used in lighting	The mercury content of waste fluorescent lamps and mercury lamps mixes with nature and harms living things.	1	20	20	Lighting should be turned off when not in use. Automatic lighting can be used. Waste should be sent to licensed companies.
Cold storage	Crates in which fruits are collected	The harm of plastic crates to nature	5	1	5	Plastic waste should be collected and sent to licensed companies.
Cold storage and office work	Cleaning detergents	Contaminated packaging harming nature	1	20	20	Contaminated packages should be collected and sent to licensed companies on a regular basis.
Cold storage and office work	Cleaning detergents	Cleaning cloths, protective clothing harming nature	1	20	20	Cleaning cloths and protective clothing should be collected and sent to licensed companies on a regular basis.
Cold storage and office work	Organic waste and other office Waste	The unused parts of fruits and other wastes harm nature	5	1	5	Waste should be sent to licensed companies.
Cold storage and office work	Washing fruits and using water in the office	Wastewater generation	5	5	25	It should be stored in a sealed septic tank and cleaned regularly.

to reduce the risk, the lamps must be collected safely and delivered to licensed hazardous waste collection companies. The number of scientific studies containing applicable results on the recycling of lamp parts following mercury removal from waste fluorescent lamps is increasing day by day (Coskun and Civelekoglu, 2014; Coskun and Civelekoglu, 2015; Gedik et al., 2020). For example, the use of fluorescent lamp glasses as a suitable filler in the asphalt binder layer instead of traditional crushed stone dust can provide advantages such as reducing the solid waste load, protecting the ecosystem, and reducing the costs of pavement construction (Gedik, 2021; Viana et al., 2022). Due to the increasing demand for natural and man-made resources, pressures are increasing for effective recovery and reuse of waste materials (waste wood, metal, plastic, glass) in many areas, benefiting from technological developments and engineering improvements (Sahin et al., 2021). Applications related to zero waste management have also developed following this process. The number of scientific studies on important practices such as the Zero Waste Park (Sahin et al., 2022) and increasing people's awareness of waste management is increasing (Coskun 2021; Coskun 2022).The source of danger is the crates in which the fruits are collected, and the risk that the plastic crates will damage the nature. Cleaning detergents, contaminated packaging harming nature, and cleaning cloths and protective clothing harming nature are shown as hazards. Organic wastes and other wastes in the office are hazards, and unused parts of the fruit and other wastes pose a risk to nature. Washing fruits and using water in the office are dangerous, and the formation of wastewater is determined as arisk.

4. CONCLUSIONS

In the research, the risks were evaluated by using the L-type matrix method of the cold storage operating in the food sector in order to reduce the damages to the environment. As a result of this evaluation, a total of 8 risks, 5 of which are unacceptable risks, were identified and control and precautionary activities were determined separately for theserisks.

Wastes because of heavy use of paper resulting from the use of printers and correspondence should be sent to licensed companies once a year. Waste alkaline batteries resulting from battery-operated devices should be sent to licensed companies every 6 months. For lamps and bulbs used in lighting, lighting should be turned off except for use, there may also be automatic lighting, and it should be sent to licensed companies every 6 months for wastes. The plastic wastes of the boxes where the fruits are collected should be sent to licensed companies once a year in order not to harm the environment. Packages, cleaning cloths and protective clothing contaminated by cleaning detergents should be collected regularly and sent to licensed companies every 6 months. Organic and other office waste should be stored regularly and sent to licensed companies. Finally, the water caused by washing the fruits and using water in the office should be collected in an impermeable septic tank and cleaned regularly or sent to a wastewater treatmentplant.

REFERENCES

ANONYMOUS (2015). Date of Access: 06.09.2022.https://www.resmigazete.gov.tr/eskiler/2015/04/20150402-2.htm

CELIK, G. (2000). Ecological risk assessment in environmental management and problem formulation for Uluabat Ramsar Area. Uludag University, *Institute of Science and Technology*, 134s, Bursa.

CIFTCI, B., BEYHAN, M. (2021). Environmental risk assessment in ready-mixed concrete plants. *Bilge International Journal of Science and Technology Research*, 5(1), 13-21.

COSKUN, S. (2021). Effect of the Covid-19 pandemic period on zero waste awareness: A scale development survey in Turkey. *Global Nest Journal*, 23 (4), 581-589.

COSKUN, S., DOGAN, S. Y., BEYHAN, M. (2022). Environmental risk assessment of rose oil production. *In Recent Researches and Practices in Engineering Sciences*, 107-119.

COSKUN, S. (2022). Zero waste management behavior: Conceptualization, scale development and validation – A case study in Turkey. *Sustainability*, 14 (19), 12654.

COSKUN, S., CIVELEKOGLU, G. (2014). Characterization of waste fluorescent lamps to investigate their potential recovery in Turkey. *International Journal of Global Warming*, 6(2/3), 140-148.

COSKUN, S., CIVELEKOGLU, G. (2015). Recovery of mercury from spent fluorescent lamps via oxidative leaching and cementation. *Water, Air and Soil Pollution*, 226 (6), 1-13.

FALCO, D. M., CAPOCELLI, M., LOSITO, G., PIEMONTE, V. (2017). LCA perspective to assess the environmental impact of a novel PCM based cold storage unit for the civil air conditioning. *Journal of Cleaner Production*, 165 (1), 697-704.

GEDIK, A., SELCUK, S., LAV, A. H. (2020). Investigation of recycled fluorescent lamps waste as mineral filler in highway construction: a case of asphaltic pavement layers. *Resources Conservation and Recycling*,168,105290.

GEDIK, A. (2021). An exploration into the utilization of recycled waste glass as a surrogate powder to crushed stone dust in asphalt pavement construction. *Construction and Building Materials*, 300, 123980.

GUL, M., GUNERI, A. F., SELVI, A. E. (2014). Matrix (L-Matrix) method-based risk assessment using fuzzy decision making approaches. *VII. International Conference on Occupational Health and Safety*, 7p.

HAO, M., NIE, Y. (2022).Hazard identification, risk assessmentand management of industrial system: process safety in mining industry. *Safety Science*, 154, 105863.

JONES, R. N. (2001).An environmental risk assessment/ management framework for climate change impact assessments.*Natural Hazards*, 23, 197-230.

KASPERSON, J. X., KASPERSON, R. E. (2001). Global environmental risk. 592s, London.

KULEYIN, B., ASYALI, E. (2007). Ship based environmental risk assessment and management in ports: Aliagaport application. Dokuz Eylul University, *Journal of Social Sciences Institute*, 9(1), 243-261.

MAHONEY, D. (2022). Safety and risk mitigation risk assessment in dairy processing -importance of food safety in the dairy processing sector. *Encyclopedia of Dairy Sciences*, 776-784.

MARMIROLI, M., CALDARA, M., PANTALONE, S., MALCEVSCHI, A., MAESTRI, E., KELLER, A. A., MARMIROLI, N. (2022). Building a risk matrix for the safety assessment of wood derived biochars. *Science of the Total Environment*, 839, 156265.

MSANZ (Maritime Safety Authority of New Zealand) (2004). Guidelines for port &harbour risk assessment and safety management systems, 68s, New Zealand.

OZTEKIN, A. (2010). Environmental risk assessment in lng road transport. Istanbul Technical University, Institute of Science and Technology. Master Thesis, 185s, Istanbul.

SAHIN, C., ONAY, B., MIRZA, E. A. (2021). A natural sustainable material for urban design: wood, In: Theories, Techniques, Strategies For Spatial Planners & Designers, Murat Ozyavuz (ed.), Peter Lang-Belirn, 221-233.

SAHIN C. K., SOLAK, E. B., SAVA, B., ONAY, B. (2022). A Case Study of Egirdir Zero Waste Park for Living and Learning. *European Journal of Applied Sciences*, 10(4), 591-603.

SELCUK, S., SELIM, H. H. (2018). L-Type Matrix method, one of the occupational health and safety risk analysis methods used in the jewelery industry. Istanbul Commerce University, *Journal of Technology and Applied Sciences*, 1(1), 21-27.

SOYKAN, O. (2018). Risk assessment in industry fishing vessels by L type matrix method and its usability. *Ege Journal of Fisheries and Aquatic Sciences*, 35(2), 207-217.

SUNAR, T. (1998). Environmental risk assessment of hazardous substances. Istanbul Technical University, Institute of Science and Technology. Master Thesis, 213s, Istanbul.

ZHENG, H., TIAN, G., ZHAO, Y., JIN, C., JU, F., WANG, C. (2022). Experimental study of R290 replacement R134a in cold storage airconditioning system. *Case Studies in Thermal Engineering*, 36, 102203.

WIANA, L. N., SARES, A. P. S., GUIMARAES, D. L., ROJANO, W. J. S., SAINT'PIERRE, T. D. (2022). Fluorescent lamps: A review on environmental concerns and current recycling perspectives highlighting Hg and rare earth elements. *Journal of Environmental Chemical Engineering*. 108915.

WANG, R., WANG, J. (2020). Risk analysis of out-drum mixing cement solidification by HAZOP and risk matrix. *Annals of Nuclear Energy*, 147, 107679.

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ORIGINAL ARTICLE

Our responsibility in climate change

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ABSTRACT

Almost half of the world's carbon dioxide emissions come from heat and electricity production. The rise of renewables' share can barely keep up with the growing energy demand. The environmental impact and material consumption of renewable energy production and electromobility cannot be neglected either, as confirmed by the ecological footprint, Life Cycle Analysis (LCA), or Material Input per Service Unit (MIPS) methodologies.

In addition, the individual's energy consumption (electricity, fuel, material consumption) is very significant. The latter is also shown by the significant production of waste. But does the individual have any influence at all on these processes, because a single person is very small compared to the 8 billion inhabitants of the earth? How could one take personal responsibility for the world's problems?

The first step forward the solution is for the individual to be aware of the source, amount, and environmental impact of the energy and materials they consume. He/she must understand the sustainability of the current system. This can be followed by energy awareness, which strives to be frugal in all its actions. The best energy is energy that is not consumed (not produced) or consumed (but not stored) during renewable production.

Education for moderation begins in kindergarten and should not only cover energy. It is our responsibility to be aware, to do a little for the greater good - but the physics in the world works independently of us. The solution is the triple E, as the Energy consciousness – Environment consciousness – Earth consciousness.

Keywords: Energy industry, sustainability, personal responsibility, towards sustainability

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1. INTRODUCTION

There are many phenomena and happenings in the world that are partly caused by humans, and which we consider bad and absolutely to be avoided. These include wars, famine, all-encompassing waste, environmental pollution, depletion of natural and energy resources, and epidemics...

There is truth in the fact that we are personally causing problems, but on the other hand, we are the only ones among the 8 billion inhabitants of the earth who have a small impact on the environment. According to them, our responsibility is also very small. Community solutions are obviously needed to remedy the problems. These can only be created in a functioning community, as a result of actions taken in one direction by the individuals of the community. In the following, we will explore the problem area of energy production.

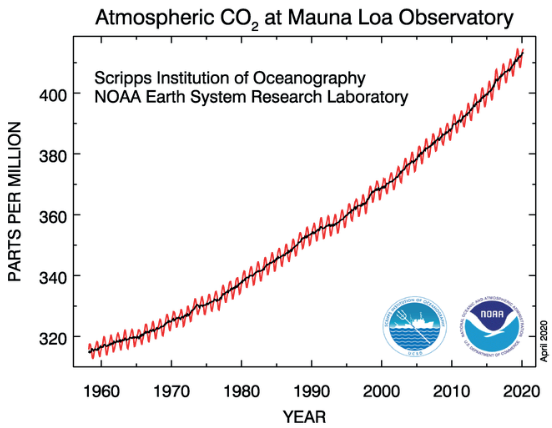
2. ENERGY AND CARBON DIOXIDE

Energy, in a narrower sense, means the thermal energy necessary for human existence and activity and the nowadays indispensable electricity. Of course, as energy consumers, this includes industry, transport, mining, services, etc. Energy has long been in the crosshairs of those concerned about the environment. Not only the depletion of traditional resources but also the high level of carbon dioxide ($CO_{2)}$ emissions is a matter of fact, the electricity industry alone is responsible for more than 40% of the world's carbon dioxide emissions. In the last millennia the carbon dioxide ratio of 275 ppm has risen to 415 ppm since 1700, i.e. it has doubled since the beginning of the industrial revolution as discussed by QUBIT (2018). There is no doubt that at the current rate we will achieve doubling soon. We only have indirect information about the effect of carbon dioxide, but based on compelling reasons, we suspect that it contributes to climate change. By KOVACS, R. (2019) the issue of climate is much more complex.

In the 1960s, they envisioned global cooling. Currently, the climate has changed from a cold period to a warmer one, a fact of no one denies. In the last 400,000 years, there were 5 shorter warm periods. Meanwhile, the peaks of carbon dioxide concentration almost coincided with the temperature peaks. Still, it is not clear whether it increased the temperature as a cause or as a result of the temperature increase. The scientific facts are well presented in different sites, but the conclusions are not clear (e.g. in GLOBAL Warming). In addition, the greenhouse effect water vapor absorbs three times as much energy as carbon dioxide, which is thus only a 20% factor in the energy balance in addition to the other greenhouse gases. In addition, the influence of sunspots and possibly volcanic eruptions on the climate is also very significant. It was indeed the industrial revolution that started the intense anthropogenic carbon dioxide emissions, but at the same time, it was what made humanity's existence independent of the climate and weather conditions, enabled intensive food production and healthier well-being – writes BEHRINGER, W. (2017).

Based on all this, carbon dioxide has become the *indicator and symbol* of man's use of nature and excessive consumption. Although we cannot see carbon dioxide, it can still be easily measured and calculated, both worldwide emissions and individual loads. Just think of the fact that registered coal, oil, and gas are all burned after a few months of transport and storage. So, e.g. it was mined in the year 2000, and all of it has now gone into the atmosphere.

1. Figure: An increase in the carbon dioxide content of the atmosphere



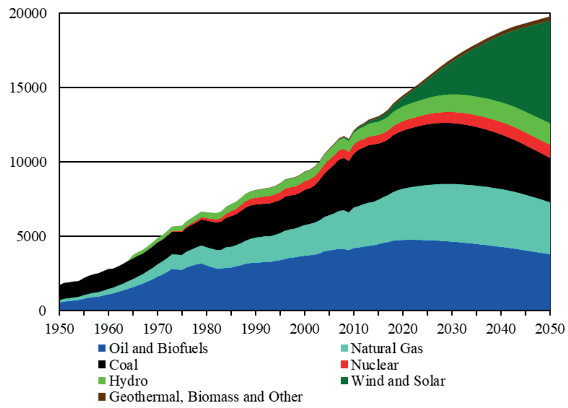
Source: Trends in Atmospheric Carbon Dioxide; Global Monitoring Laboratory - Earth System Research Laboratories

3. ENERGY MIX

If we accept that it is not a good idea to further increase the amount of carbon dioxide, then we have to look for other ways of producing heat and electricity. One form of this is nuclear energy, while the other group consists of renewable energy sources. It is interesting that all of these are renewed by the Sun, just as the water cycle is driven by evaporation caused by the Sun's heat, the wind is nothing but the equalization of atmospheric warming anomalies, biomass is created by photosynthesis, and solar thermal and solar power plants they directly convert solar radiation into electricity. We can look at geothermal energy as energy that will not run out in our little short life,, and even as the planet Earth was formed from a mass of hot matter similar to the Sun.

Among other things, primary energy carriers occurring in nature are used for transportation, industry, and household, and more than 40% of them are used for electricity generation. Compared to 1950, the amount of primary energy used annually has increased 7-fold, while the renewable share is still only around 20%. Despite the massive expansion of renewable energy sources, total demand is still rising. Growth at this rate will soon hit limits, but the fossil energy reserves will not be exhausted, but the climate will change significantly first. According to optimistic estimates for the next decades, the expansion of all uses may turn into a decline by the third of this century, while the growth of fossil use may stop in a decade.

2. Figure: World primary energy consumption, 1950-2050, (Mtoe)



Source: World Energy 2018-2050: World Energy Annual Report (Part 1) By Dr. Minqi Li, Professor, Department of Economics, University of Utah

In every country, electricity production goes back about a century, so many power plants have been built, some power plants have already been demolished, others are still being planned, but there is always a group of power plants that are still operating. They produce on the same electricity network, and we cannot distinguish on the network which power plant produced the electricity we consume. The power plants produced by all the operating power plants produce a so-called energy mix. Half of the Hungarian domestic energy mix is nuclear, twelve percent is renewable, and the rest is based on fossil energy carriers. This power plant has a common CO_2 emission of approx. 400 g/kWh. If the proportion of fossil fuels in the energy mix can be reduced, the specific CO_2 emissions will also decrease. In 2018, the share of electricity produced on a renewable basis in the 27 EU member states was 18.88%, while in Hungary this figure was 12.49% by EUROSTAT (2022).

4. GOOD POWER PLANTS

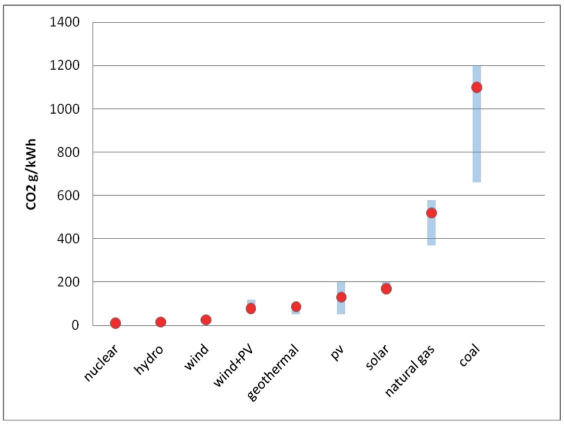
Engineers have developed countless power plant solutions, and their operation, efficiency, and environmental impact are known, and can be planned and calculated. Of course, solutions unimagined today will be developed in the future as well, but the current problems are caused by the currently known technologies, there are no surprises, and the many bad effects are foreseeable.

If there were no financial and resource constraints, and if we didn't have the power plants that have been operating for decades, we wouldn't be able to show a power plant that would provide the clean and cheap energy that everyone wants with a minimum amount of materials and emissions. In addition, there are mathematical methods that help to choose which of the available technologies, how to expand and develop the system so that carbon dioxide emissions, the impact on the environment, the use of materials or even the costs are minimal. Here, however, two problems arise: Among the many aspects, we cannot decide on which one to optimize as is in KADAR, P. (2010) and KADAR, P. (2013). And who even says this? Should it be the fastest-building, cheapest, lowest-emitting power plant? Should all of this fit into the landscape, but not take up land, water, or air? Moreover, the question does not arise as to exactly how big a power plant should be built, but whether one or two blocks (units) or none, so decision alternatives are formulated.

At the level of energy strategy, there is a better and a worse solution, or what we think is the solution based on the currently available knowledge. Unfortunately, previous bad decisions are also revealed in some cases.

Of course, we should not think that power plants declared to be renewable – similar to electric vehicles – do not burden the environment. It is true that no carbon dioxide is emitted at the point of use, or during operation, but a lot of materials and energy must be invested (consumed) during the creation (and subsequent dismantling), and undoubtedly the carbon dioxide emission is also significant.

3. Figure: CO_2 emissions of power plant technologies in Hungary



Source: Own collection/calculation

A clear methodology is available for calculating the environmental effects (LCA – Life Cycle Assessment), which is now increasingly used. With its application, not only carbon dioxide but also other greenhouses, acidifying and toxic emissions can be easily calculated. The MIPS methodology investigates the Material Input per Service Units in RITTHOF, M. et al. (2002), and the Ecological Footprint measures sustainability. In addition to all this, this methodology can examine not only the impact of the transport or energy industry but also every single human activity and product. It is called a life cycle, when something is not yet there (e.g. a chair or an event or even a trip), then everything is finished, happens, and then passes away - and it has consumed material and energy from the environment and emitted something and left it behind, e.g. carbon dioxide, waste, natural damage.

In general, we can say that power plants producing electricity from renewable forms of energy (wind, solar, water) have a lower environmental impact than their fossil counterparts, but overall, even here, emissions are significant. The combined emissions of the best electric cars are approx. 70% of its vehicles use conventional fuel.

5. INDIVIDUAL ENVIRONMENTAL IMPACT

The environmental load of the individual (each person) can also be precisely known. A family car, driven 15,000 km per year and using 1,000 liters of gasoline, emits 3,170 kg of carbon dioxide. The average production of 3,300 kWh of electricity per person per year results in 1,500 kg of carbon dioxide emissions.

What is left behind from our activities yesterday, from last year, from our childhood, from the people who were here 100 years ago, from the history of humanity so far? As time goes on, there are fewer and fewer, but the resources are running out irreversibly.

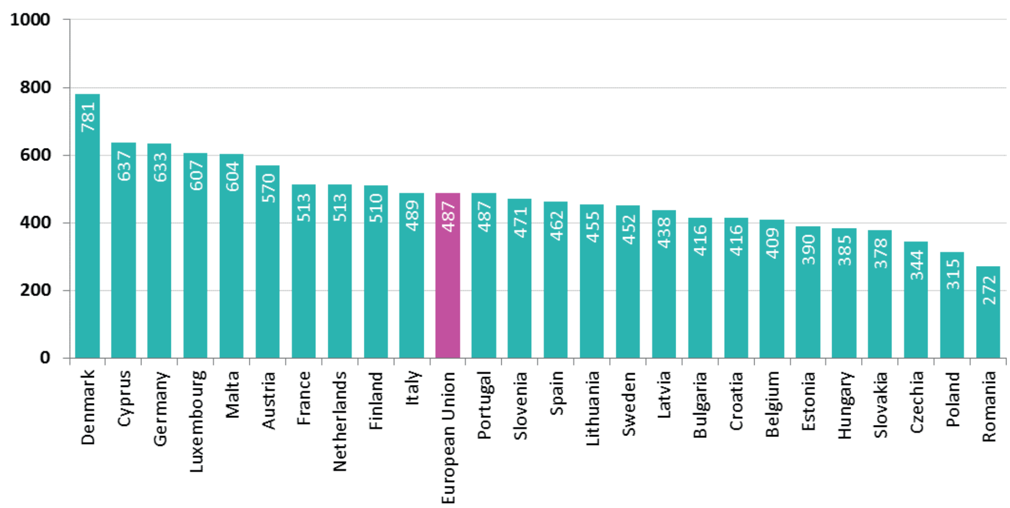
The conscious customer buys domestic yogurt from a plastic cup, receives the meat, bread, and vegetables in a plastic bag, and throws away the plastic bottle. He can't choose, there's no other choice. A paper bag – if you have one – causes a similar burden on the environment. If he can no longer walk for kilometers, he takes the bus, goes by car, or takes the tram. Your bicycle also uses asphalt road, which is made from crude oil. We have no choice, no chance, we are unwittingly part of the environmental destruction. All of this was already true for the ancient man, who sharpened axes from larger stones, snapped stone blades, cleared forests, and exterminated animal species. Our existence on earth involves using the resources of planet Earth and transforming the environment. We feel that we were once given the authority to "Subjugate the earth!" as it is written in the BIBLE, yet seeing the current trends, it will be difficult to stand before the Creator at the final reckoning. The individual has no choice, when we are born our ecological and economic environment determines many things. Or maybe not?

6. AWARE OF SUSTAINABILITY

Humanity, individual countries, and even individual persons can be counted on to have an ecological footprint, which expresses how much land, water, raw materials, and energy carriers they need to sustain themselves (for the way of life they lead) - in a sustainable, renewable way. All of this includes ensuring that your wastewater is purified, that the necessary food can be produced, etc. Consider that the few ancient people did not change their environment much, and today the changes are almost irreversible. The size of the converted biologically productive area per person (biocapacity) was 2.18 hectares in 1996, but this is decreasing with the desertification of the areas and the increase of the population. Most countries use more than their own available biocapacity would allow.

But how could we remedy the problems of the world at home, provide hundreds of millions with enough food, stop wars, reduce mountains of waste, and moderate carbon dioxide emissions?

4. Figure: Annual waste production per capita in EU countries (kg), 2017

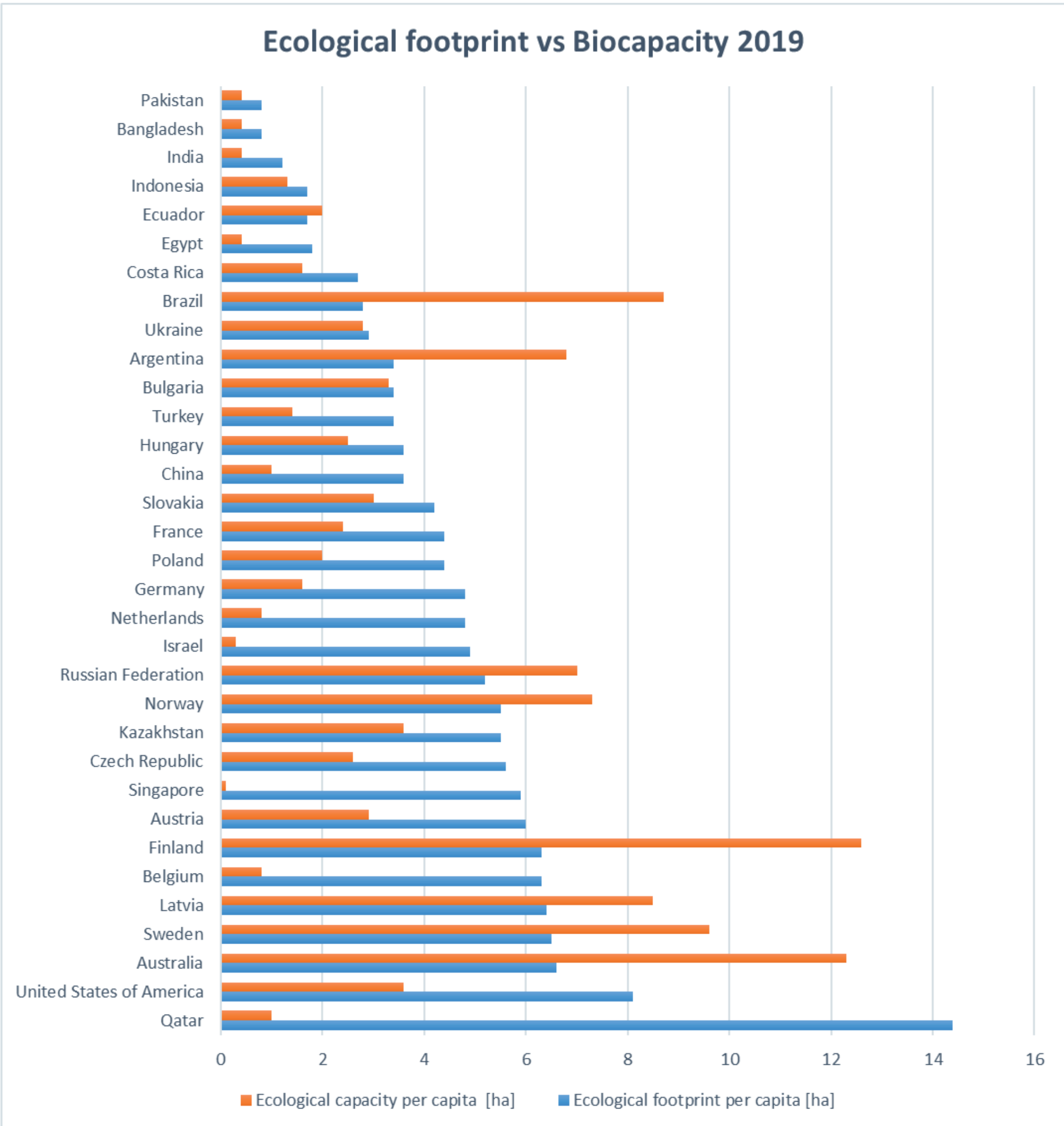


Source: EUROSTAT Database - Waste - Eurostat (europa.eu) https://ec.europa.eu/eurostat/web/waste/data/database

Foremost, we need to become aware, to find out and understand to some extent how and what we live, what we do, and cause. Of course, if we see the whole picture, it is not certain that we should feel guilty about everything. If we look at the consumption of the world's goods, Hungary is in the richest half of the world. There are countries that are greedier and more selfish than us, while the rapidly developing China and India have a huge prospect of expanding consumption. Yes, we march into the abyss together. We need to recognize whether we are speeding up or slowing down this process. Despite the fact that we are not unconditional environmental protection specialists, we must have our own energy awareness, environmental awareness - universal awareness.

Let's see our place and role in the world to some extent, and don't believe everything right away! Not only in the energy industry, but their products are also praised by those interested in the given project. We can hear many true and honest recommendations as to why a nuclear power plant is needed and why a nuclear power plant should not be built. Why should we still use coal, and why is coal harmful? Why renewable energy is good and bad, and more…

5. Figure: The ecological footprint vs biocapacity of consumption



Own graphics based on Global Footprint Network – ttps://www.footprintnetwork.org; 2020 [Date Accessed: 1/09/2022]

Even in the world of faith and morality, similar to good deeds: let's add our small positive part to the world!

Professionals can smile that with the amount of plastic bags we save each year, we do not even touch 1% of our own petroleum consumption. If we turn off the unnecessary light in the pantry, we might not even notice it on our wallet. However, if this becomes ingrained in our culture, sooner or later others will do the same, and eventually, hopefully, those who make more far-reaching decisions will also decide in this way, which will actually have an effect. And in the end, we use nature's resources responsibly, expediently, and only to the extent necessary. The most effective way to teach energy awareness is somewhere in the preschool years. Love, respect, and thrift for nature can still be taught there.

It is unlikely that decision-makers would be able to free themselves from the captivity of self-interest, money, or lobbies in one fell swoop. Despite everything, great individuals appear in history who are able to convey their correct insights to large masses of people, who are able to influence the processes of the entire world. By BOTOS, C. (2019) such persons were, for example, the Indian Joseph Kumarappa, who developed a sustainable economic policy for Gandhi; Ernst Friedrich Schumacher, who fought for sustainable European industry and agriculture; or the American Rachel Carson, who fought successfully against the environmentally damaging pesticide DDT - and the list could be continued for a long time.

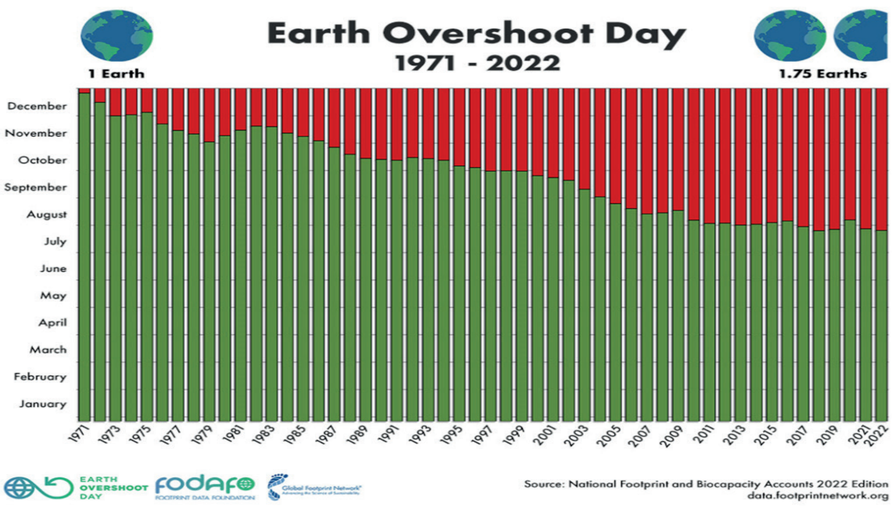
There is currently a worldwide game in which people have been weaned from the traditional way of life, they are fed international food, they are made to travel as global citizens, and they consume the shortest-lived products of overworked industry. Of course, the focus is on money, so don't get your hopes up that the goals of the providers will change. In addition, it is likely that the present social system will not be swallowed up by the Sun growing into a red giant in 7 billion years. Not only SZABO, I. (2020) but the above-mentioned facts show also that the current direction is unsustainable in every respect.

The overshoot day arrived far earlier close to the middle of July. It means we consume instead of the available on Earth (capacity) 1,75 Earth (benefits) per year.

7. CONCLUSION

One thing can be said for sure: The cleanest energy is energy that is not consumed, that is, the energy that is not produced. Likewise for non-manufactured packaging or non-wasted food. If we have saved something here compared to our

6. Figure: Earth overshoot day 1971-2022



National Footprint and Biocapacity Accounts 2022 Edition data.footprintnetwork.org; https://www.overshootday.org/, [Date Accessed: 1/09/2022] previous habits, then we must have made a small contribution to the unchanging nature of the universe. Of course, the question immediately arises: Is it really our job to make it as small as possible? Do we really not need to build the tallest skyscraper in the world? Probably not, as long as we don't have a strong argument for this. We'd rather rely on ourselves to build a sky-high skyscraper, we'll go as far as we can. Until then, we can live in more modest conditions, use more durable tools, and consume products close to home that have traveled a shorter transportation route. For the concept of a simpler way of life, it is excellent to get to know a little more complicated ones or even those who live in much more modest conditions than ours. A new car is always more attractive than an old one, but if we can, we don't have to change it every year. This applies to the bicycle, to the two-year-old skis that have gone out of fashion, and to all our utility devices. Of course, exaggerated "planned obsolescence" in the interests of manufacturers works against this. We don't have to immediately throw out our energy-consuming consumer equipment, either, only if we can thereby save the energy invested in the production of the new equipment. (The reverse of this is that a well-built power plant – e.g. German nuclear power plants – should not be shut down at the dawn of its planned lifetime because this will make its specific environmental impact even greater since it barely produced according to our previous plans.) The solution is the triple E:

Energy consciousness – Environment consciousness – Earth consciousness

One needs to save Energy – Row materials – Water and all other natural resources. The really renewable is the good solution -taking into continuously the Life Cycle Assessment approach.

It is our responsibility to be aware, to do a little for the greater good - but in the world, physics works independently of us.

FOOTNOTE:

1- ppm – pars pro million – pieces of among 1 million air molecules, recently approx. 0,4 % of the total number of molecules and volume; approx. 0,6% of the mass %.

2- Amount of the emitted CO2 during the production of 1 kilowatt-hour

3- Planned obsolescence – a policy of planning or designing a product with an artificially limited useful life or a purposely frail design / Wiki

8. REFERENCES

BEHRINGER, W. (2017) : *Kulturgeschichte des Klimas: Von der Eiszeit bis zur globalen Erwärmung / A klíma kultúrtörténete;* Corvina 2017, ISBN: 978 963 136 430 9

BIBLE – *Book of Moses* 1.28.

BOTOS, C. (2019): *A közjó apostolai – Történelemformáló személyiségek a XX-XXI. században / Apostles of the common good - History-shaping personalities of the XX-XXI. century,* Edition Kairosz, Budapest, Hungary, 2019 SBN: 978 963 514 021 3

EUROSTAT (2022) Data - Energy - Eurostat (europa.eu) https://ec.europa.eu/eurostat/web/energy/data [Date Accessed: 1/09/2022]

GLOBAL Warming - So What? http://www.globalwarming-sowhat.com/ [Date Accessed: 1/09/2022]

KADAR, P. (2010) Power generation portfolio optimisation by externality minimization, *Acta electrotechnica et informatica*; Faculty of Electrical Engineering and Informatics, Technical University of Kosice, SK; April-June 2010, vol.10. No.2, 2010, ISSN 1335-8243, pp5-9

KADAR, P. (2013) Application of Optimization Techniques in the Power System Control, *Acta Polytechnica Hungarica* Vol. 10, No. 5, 2013

KOVACS, R. (2019): *Klímaváltozás / Climate change*; Typotex, Budapest, Hungary 2019 ISBN 978 963 493 043 3

QUBIT (2018) Never ever measured so much carbon dioxide in the earth's atmosphere https://qubit.hu/2018/05/07/soha-ennyi-szen-dioxidot-nem-mertek-meg-a-fold-legkoreben [Date Accessed: 1/09/2022]

RITTHOF, M. et al. (2002) Michael Ritthof - Holger Rohn - Christa Liedtke: *Calculating MIPS Resource productivity of products and services* © Wuppertal Institut for Climate, Environment and Energy at the Science Centre North Rhine-Westphalia, 2002

SZABO, I. (2020): *Civilizácioff - Teremtés vészhelyzet (Creation is an emergency)* – 2020 ISBN: 239 999 028 440 7

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