The natural carbon sinks in the fight against climate change

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Abstract: *Experts' climate models predict a continued trend in global warming over the coming decades. They present climate change as a major challenge to modern society with a clear and complex nature in various aspects – ecological, social, technological, economic and political. The EU's response to the challenges of climate change and the environment is contained in the Union's strategic goals and objectives for 2030 with a horizon of 2050, agreed in the Green Deal and the Digital Compass of the European Union.*
The purpose of this report *is to present the state of environmental indicators for Bulgaria and the region and the role of natural carbon sinks for their improvement.*
Keywords*: ECO-INDICATORS, CARBON SINKS, CLIMATE CHANGE, WARMING TRENDS*

1. Introduction

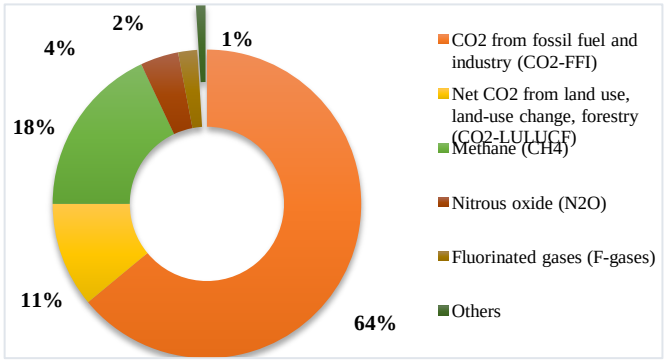
Climate change is among the main problems of our society. To a large extent, they are the result of human activity. Scientific studies show that the state of the environment has deteriorated over the past few decades. [1]

The main factor influencing climate change is the greenhouse effect. Certain gases in the Earth's atmosphere act somewhat like glass in a greenhouse, trapping the sun's heat and stopping it from returning to space, causing global warming. [2]

Greenhouse gases are the result of natural processes or human activity. Naturally occurring gases are changes in solar radiation or volcanic activity, but research shows that they contribute only about 0.1°C to overall global warming.

Human activity causes an increase in the concentration of gases such as carbon dioxide, methane, nitrous oxide and fluorine-containing gases in the atmosphere. Among the reasons causing an increase in greenhouse gas emissions are the burning of coal, oil and gas, deforestation by cutting down forests, the use of nitrogen fertilizers, etc.

According to the scientific community, human activity is the main source of climate change and carbon dioxide (CO2) is the greenhouse gas that mankind emits in the largest quantities. [3] The latest data from the IPCC Climate Change report from 2022 [4] shows that CO2 (CO2 from fossil fuel and industry (CO2-FFI) and Net CO2 from land use, land-use change, forestry (CO2-LULUCF) accounts for 75% of the total amount of greenhouse gases. In second place is methane (CH4) with 18%, followed by nitrogen oxide (N2O) with 4%, fluorinated gases (HFC, PFC, SF6) – 2% and



others – 1% [5] (Fig.1).

Fig. 1. Distribution of types of greenhouse gases emitted by human activity

Source: IPCC Climate Change 2022 Report: Mitigation of Climate Change, https://www.ipcc.ch/report/ar6/wg3/IPCC_AR6_WGIII_FullReport.pdf

According to the latest report of the Joint Research Center [6], the distribution of global greenhouse gas emissions (Fig. 2) shows that carbon dioxide is the largest.

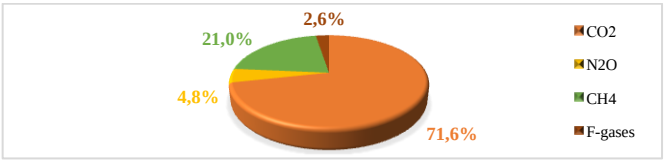


Fig. 2. Types of greenhouse gases in %, 2022. [6]

The increase in CO2 has been significant over the last 5 decades (Fig.3) [7]

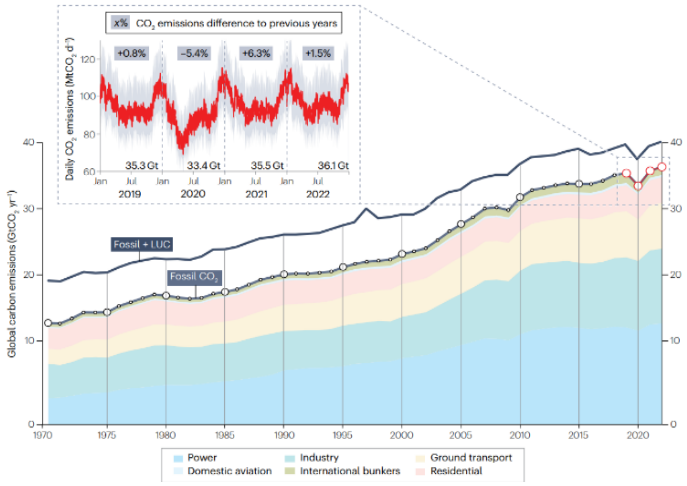


Fig.3. Global CO2 emissions 1970–2022

Source: Liu, Z., Deng, Z., Davis, S. *et al.* Monitoring global carbon emissions in 2022. *Nat Rev Earth Environ* **4**, 205–206 (2023). https://doi.org/10.1038/s43017-023-00406-z

The percentage distribution of the sectors causing CO2 pollution are presented in fig. 4 [8]

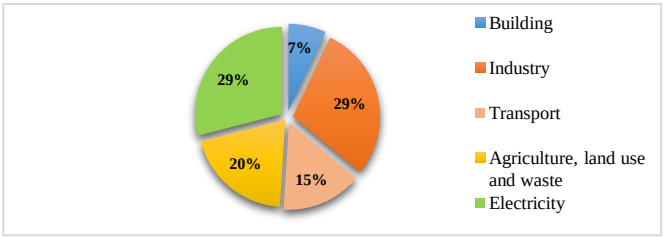


Fig. 3. Global emissions of CO2 by sector
Source: GHG_emissions_of_all_world_countries_booklet_2023report.pdf

The data show that the sectors with the largest share in CO2 pollution are industry with 29% and energy – 29%. In third place is the agricultural sector – 20%, followed by transport (15%) and building – 7%.

2. Literature review

The global warming trend is an important indicator of the scale of climate change and its possible consequences. [9] We witness natural disasters such as devastating floods, prolonged droughts,

forest fires, strong storms and hurricanes, unbearable heat. [10] The data shows that the global average temperature has risen more than 1^0 C from pre-industrial times, and the last 8 years (2015–2022) have been the warmest in human history. [11] (Fig. 4)

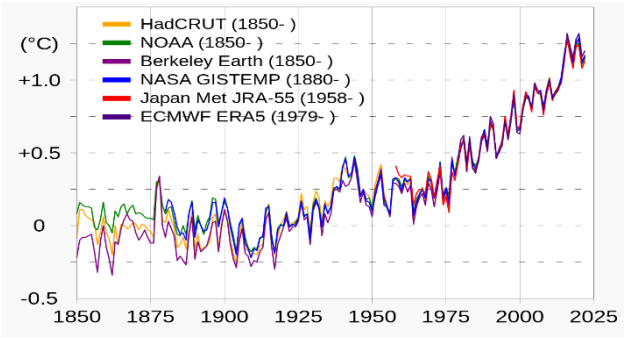


Fig. 4. Global average temperature change
Source: https://en.wikipedia.org/wiki/Instrumental_temperature_record

The data from various scientific organizations about the global average temperature of the planet are completely converging. In the figure, the value "0" is the average temperature of the period 1850–1900. It is considered pre-industrial temperature.

In the latest report of The European Union's Copernicus Climate Change Office, the past year 2023 was the hottest in the history of the planet. [12] The average temperature of the planet was 1.48 °C warmer than the pre-industrial period 1850-1900. At this rate of growth, the probability of the worst predictions coming true is very likely. The forecast of global warming trends is shown in Fig. 5.

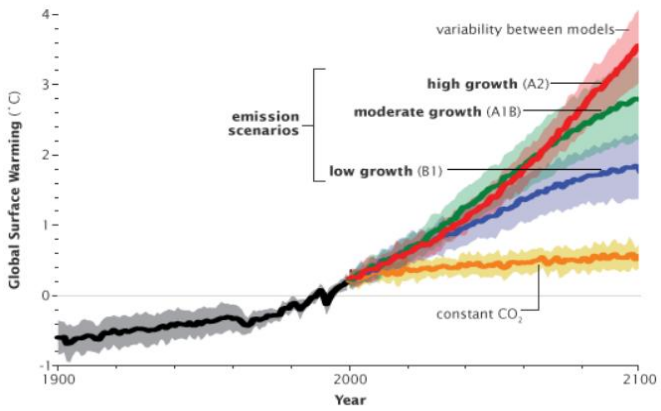


Fig.5. Global warming forecast
Source: https://earthobservatory.nasa.gov/features/GlobalWarming

According to the model of Earth observatory NASA, increasing fossil fuel consumption will affect greenhouse gas concentrations and they will continue to rise. As a result, the average surface temperature of the Earth will rise. The model, reflecting a range of likely emissions scenarios, shows that the average surface temperature could rise between 2°C and 6°C by the end of the 21st century. [13]

According to the report by the Joint Research Center (JRC), the European Commission's science and knowledge service in 2022, the country that generated the largest volume of CO2 emissions is China with 29.2% of global emissions. In second place is the USA with 11.2% followed by India (7.3%), EU 27 (6.7%) and Brazil with 2.4%. [13]

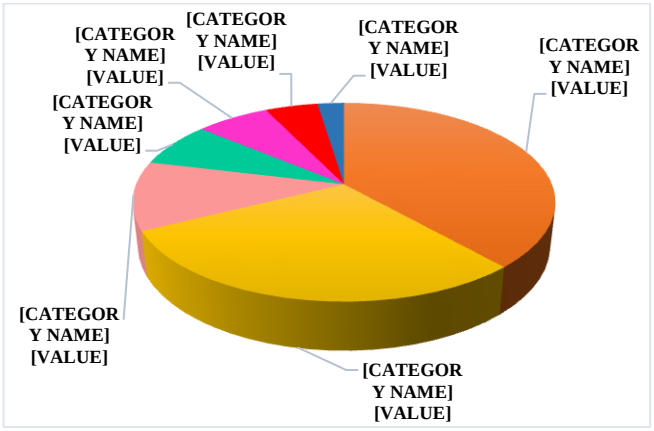


Fig. 6. GHG emissions (%) and contribution of the major emitting economies and the rest of the world in 2022

On 28 June 2021, the EU adopted the European Climate Law as a key element of the European Green Deal aimed at achieving the Union's ambitions to reduce greenhouse gas emissions by 55% by 2030 compared to 1990 levels and to achieve climate carbon neutrality by 2050 to build a zero-emissions society and economy.

Carbon neutrality refers to a state in which greenhouse gas emissions caused by human activity equal the amounts that are captured and released into the atmosphere. [14] In this regard, on 14.03.2023, the EC adopted a law on carbon sinks from the land use and forestry sector. The aim is to increase carbon sinks in the EU by 15% by 2030. All member states set binding national targets, with penalties for non-compliance. For Bulgaria, the value of net greenhouse gas emissions must be reduced by 9.718 million tons of CO2 equivalent by 2030.

A greenhouse gas sink is any process, activity, or mechanism that results in the removal of a greenhouse gas, precursor, or aerosol from the atmosphere. [19]

Under the current regulation (from 2018), each member state must ensure that emissions from the sector are offset by at least an equivalent amount of removals in the period 2021-2030. The new rules envisage a two-step approach to achieving the new target, containing two phases (2023)

Under Phase 1 - until 2025, the current system remains in force, with each member country obliged to balance emissions and removals.

According to Phase 2 - in the period 2026 - 2030, the new target (at EU level) of net removals of 310 Mt should be reached.

In fig. 7 presents the status of the level of carbon sequestration in the EU in 2019 (at 249 Mt CO2, the current target (-225 Mt CO2) and the new target (-310 Mt CO2)

***Mt** = million tons of CO2 equivalent

Fig. 7. Status, current target and updated target for CO2 sinks from the land use and forestry sector

Given that plants and especially trees are natural sinks that absorb CO2 from the atmosphere and capture it as part of the photosynthesis process, the removal of CO2 through carbon 'sinks' has become an EU policy priority.

3. Research and discussion

Plant species and especially trees are natural sinks that absorb CO2 from the atmosphere and capture it as part of the photosynthesis process. Removing CO2 through 'carbon sinks' has become a priority of EU policy. A greenhouse gas sink is any process, activity, or mechanism that results in the removal of a greenhouse gas, a precursor, or an aerosol from the atmosphere.

The land use and forestry sector absorbs more carbon than it emits into the atmosphere. This defines it as a net carbon sink. Forests in the EU absorb the equivalent of almost 10% of all greenhouse gas emissions generated by the Union. [15] The EU has an area of 4.104 million km², and the total area of forest massifs by 2021 is 159 million hectares, occupying 39% of the territory of the countries in the Community. In five of the countries, more than 50% of the territory is occupied by forests (Fig. 8).

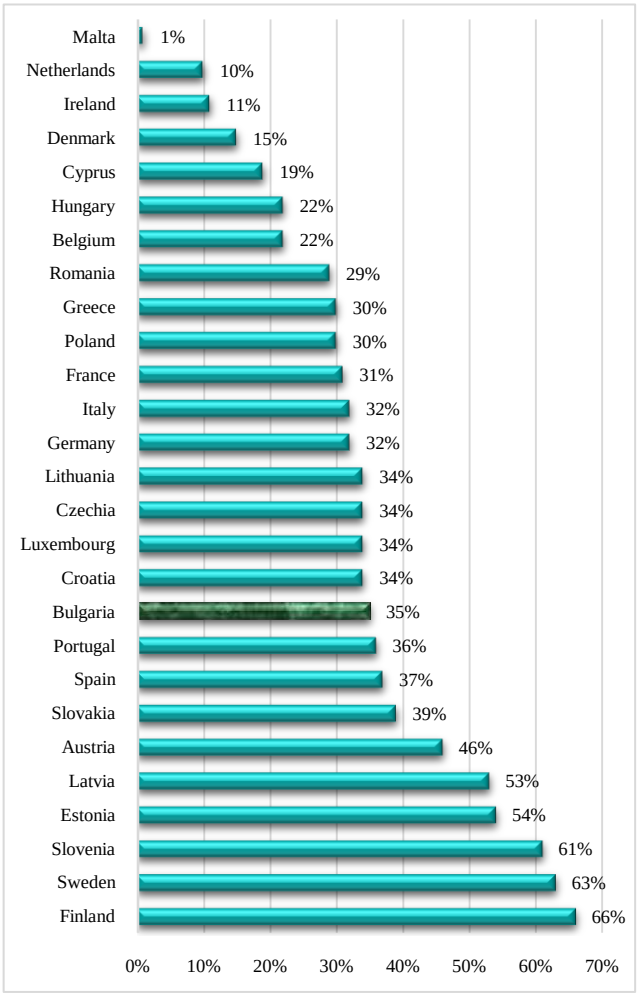


Fig. 8. Areas covered by forests in EU countries, 2020
Source: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/edn-20210321-1

Among them are Finland (66%), Sweden (63%), Slovenia (61%), Estonia (54%) and Latvia (53%). There are 14 countries with forested areas in the EU between 30% and 50% of their territory. Bulgaria is among them. Bulgaria is in 10th place with a 35% share of forest massifs compared to the total area of the country. Eight European countries have less than 30% forested areas. Last in the ranking is Malta with 1%. [16]

Forests and the forestry sector are an essential part of Europe's transition to a modern, climate-neutral, resource-efficient and competitive economy. According to statistics, fallow land in the EU-27 in 2019 was approximately 6.1 million hectares, which is equivalent to 6% of the Union's cultivated agricultural land. The share of fallow land varies considerably between Member States. The data from Fig.9 show that Spain owns the most of them. [17]

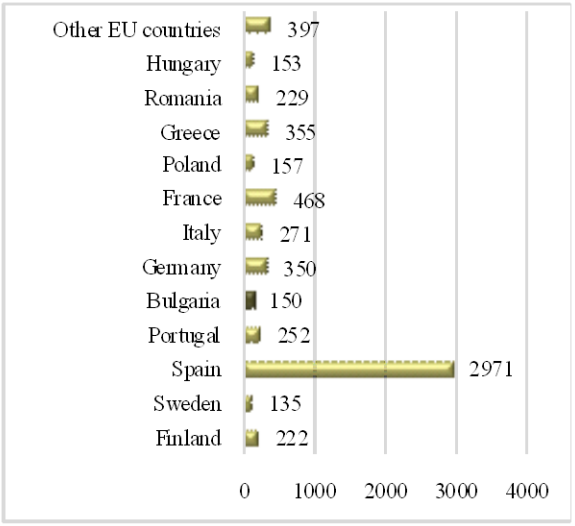


Fig. 9. Wasteland in EU countries, 1000 hectares in 2019
Source: https://eu.boell.org/sites/default/files/2022-04/E- land.pdf

Data from the inventory of greenhouse gas (GHG) emissions as of 2020 in Bulgaria show that the total CO2 emissions in the country are 55,25 gigagrams (Gg) without taking into account the absorption by the "Land use, land use change and forestry" sector (PGMS). Taking into account the absorption by the LULUCF sector, the net emissions are 43.75 Gg. (Fig.10) Compared to 2005 data, the 7.85% decrease from 2005 levels. [18]

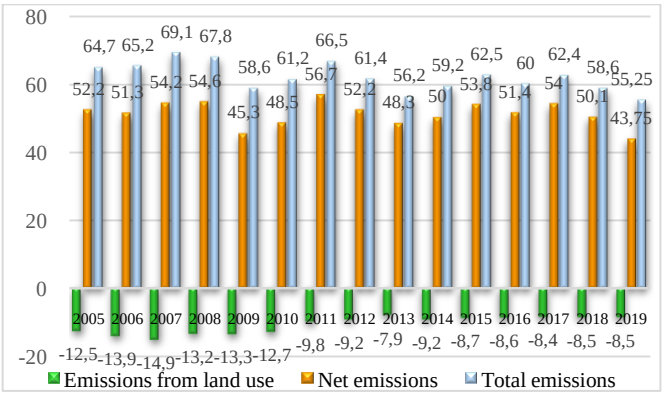


Fig. 10. Total emissions of greenhouse gases in Bulgaria, 2005-2019, million tons
Source: https://eea.government.bg/bg/soer/2019/climate/climate1

Sectoral distribution of pollutants with greenhouse gases in Bulgaria is presented in fig. 11. The energy sector (22.66 million tons) accounts for the largest share, followed by the transport sector (9.77 million tons) and agriculture (5.22 million tons), manufacturing (4.6 million tons) tons) and waste (3.89 million tons)

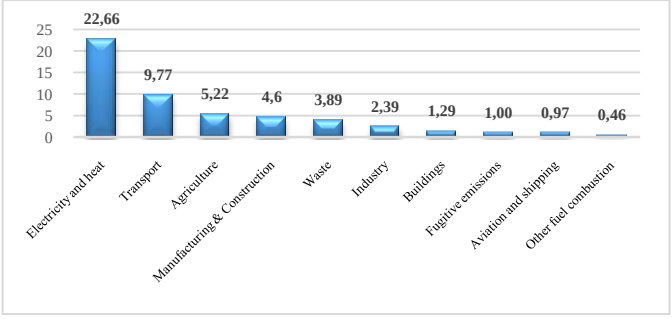


Fig. 11. Distribution of greenhouse gas emissions by sector in Bulgaria, 2022, million t.
Source: https://ourworldindata.org/ghg-emissions-by-sector/BGR

By the end of 2023, the Bulgarian forest and timber sector has the opportunity to offset about 20% of CO2 emissions. If properly managed, the sector can contribute to mitigating the effects of climate change and achieving the EU's low-carbon strategy through - afforestation on larger, vacant and infertile areas. Besides being carbon absorbers, forests serve as reservoirs for biodiversity and a source of woody biomass that replaces fossil materials and further develops a biologically based circular economy, both in Bulgaria and in the EU.

The data on the volume of afforestation activities and the total annual size of the afforested forest areas in the period 2013-2021 is uneven by year: 2013 - 1255.8 ha, 2015 - 2638.2 ha, 2021 - 1793,5 ha. (фиг. 12) [20]

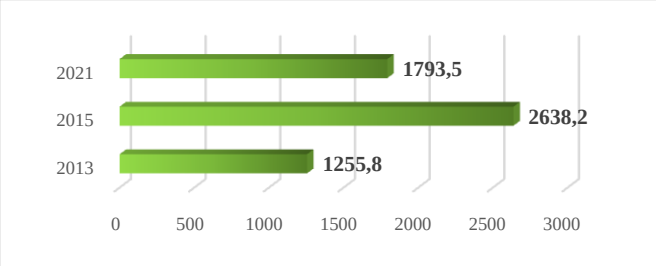


Fig.12. Total annual amount of forested forest areas for the period 2013-2021, in hectares

In fig. 13 shows the distribution of forest territories according to the type of ownership. [21]

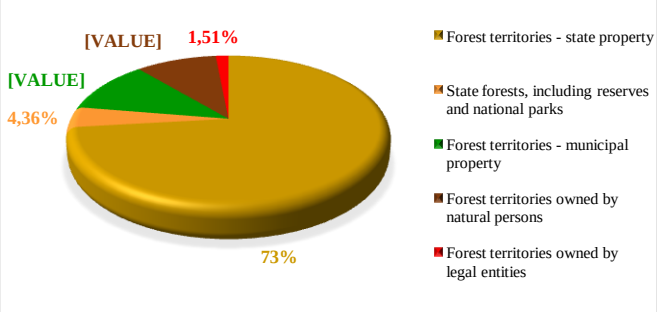


Fig.13. Distribution of forest territories by types of ownership, in %
Source: Forestry Executive Agency, Annual Report, 2021
https://www.iag.bg/data/docs/Doclad_str20_04.pdf

The data show that only 1.51% of the forest territories are owned by legal entities. Considering that the enterprises from the industry and energy sector in the country are the largest generators of carbon emissions, it is striking that they do not commit to acquiring, afforesting and maintaining forest areas to absorb the emissions emitted by their activities.

Conclusion

Forest massifs have a key role in maintaining ecosystems in nature and in balancing the emissions of greenhouse gases formed as a result of human activity. The "polluter pays" principle can be used as the "polluter pays". Achieving carbon neutrality does not mean not generating emissions, but using technical means or natural carbon sinks to clean up CO2 emissions to achieve carbon neutrality in terms of climate.

Acknowledgments:

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