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DETERMINANTS OF CLIMATE SECURITY – AN ATTEMPT AT INDICATOR ANALYSIS

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ABSTRACT: The article addresses the issue of climate security, a topic not sufficiently explored in the literature. The purpose of the article is to fill the gap in the literature on explaining the link between climate change and security, defining the term climate security, and attempting to select indicators (based on a selection from those already existing) for diagnosing the level of climatic security. The research established a lack of studies clarifying the term climate security. Hence, the authors' definition was adopted. In turn, a review of existing indicators indicated their limitations. Nevertheless, it allows us to verify whether there is a threat to climate security.

KEYWORDS: climate security, climate security indicators, national security

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Introduction

The growing climate crisis caused by, inter alia, anthropogenic greenhouse gas emissions is a fact that many governments and, above all, European Union (EU) member states are reckoning with. Therefore, a number of adaptation and mitigation measures are being taken.

The purpose of the article is to define climate security, taking into account all of its elements, determine its possible impact on national security, and attempt to select indicators to ascertain whether climate security is at risk. It is necessary to clarify the issue of the climate crisis in the context of the consequences. Next, the issue of the connection between climate change and national security needs clarification. And in this case, it is important to define the concept of climate security and its relationship to other national security sectors. Then, we should answer the following question: Can we talk nowadays about climate security? Is it a state when the risk of change (disruption) will be close to zero, which is possible with economic, social, and environmental security? Going one step further, it is worth asking whether climate security is at risk.

We conducted a literature review, then reviewed the indicators and finally made a selection for the conceptual category of climate security.

Literature review – climate crisis: social, economic and environmental dimensions

The current climate change is considered one of the most significant challenges of the 21st century. It strongly affects nature, including the risk of extinction of some plant and animal species and human living conditions. In the latter regard, both environmental and socioeconomic consequences of progressive climate change can be distinguished (IPCC, 2013; IPCC, 2018). Environmental impacts can affect the quality of life through the deterioration of food quality and/or reduced access to food and drinking water, among others. There is also an increased risk of many diseases. Socio-economic consequences, on the other hand, include an increase in the cost of adapting to climate change, tensions caused by migration (or, in extreme cases, climate refugees (UNHCR, 2022)), conflicts over resources (mainly water), and changing regional balances of political power as a result of these conditions. In practice, climate conflicts cannot be ruled out. The scale of these consequences of progressive climate change is difficult to predict, but it is estimated that they will have a strong impact. For this reason, in the long term, climate change will leave a significant mark on the face of the world (Prandecki, 2021).

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The current consequences of climate change are being felt in all corners of the globe, including in areas where they were not yet expected. To make matters worse, those predicted in the near future will be unprecedented in the history of civilisation. Therefore, more and more people are talking not about the negative consequences of climate change but about the evidence of the ongoing climate-environmental crisis (Jasikowska & Pałasz, 2022).

The literature contains a growing number of analyses on the impact of the (mostly negative) climate on several aspects related to the economy, society, and the environment. These analyses include:

- the impact of extreme weather events on short-term and long-term development. Albala-Bertrand (1993), Raddatz (2007), Noy (2009), Hochrainer (2009) and Loayza et al. (2012) indicate a negative correlation between extreme weather events and development,
- climate impacts on the following sectors:
  - agriculture. The first studies on the subject appeared in 1989 (Adams) and 1993 (Kaiser et al.). Based on regression lines, they indicated the negative impact of climate on agricultural production. Later analyses were conducted by, among others, Lobell and Field (2007), Olesen et al. (2011), Tubielo and Schmidhuber (2008), Gornall et al. (2010), Trnka et al. (2011), Kozyra and Górski (2008), Stempel (2011), Florek and Czerwińska-Kayzer (2013), Koźmiński and Michalska (2010), Olkiewicz (2015), and Janowicz-Lomott and Łyskawa (2014). The issue is also addressed in reports/analyses of the World Bank (2010), the IPCC (2014) and the European Commission (2013). Studies by many authors, e.g., Dillon et al. (2015), Seddon et al. (2016), Tripathi et al. (2016), Kłoczko-Gajewska and Sulewski (2009), Sulewski (2014), Sobiech and Kurdyś-Kujawska (2014), Kurdyś-Kujawska (2016), and Palinkas and Szekala (2008) indicate that climate change is the most significant threat to farm operations for farmers,
  - energy. The following have been analysed: the impact of climate change on the energy performance and thermal comfort of a building (Firląg et al., 2020), the impact of extreme weather events on the power supply (Kongorld, 2014), and energy security (Cevik, 2022). The negative correlation between temperature change resulting from climate change and the amount of energy purchased (Michalak, 2012), as well as climate change challenges for the energy sector (Ashford & Hall, 2018), have been identified,
  - tourism. The impact of variations in thermal, solar, and wind conditions on the number of tourists and revenues in this industry was analysed (i.e., Biernacik & Jakusik, 2016; Michalak, 2013),

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- the impact of climate on society, including health (Hajat et al., 2007; Szwed et al., 2010; Robine et al., 2008) and employee productivity (Kjellstrom et al., 2008; Michalak, 2018; Brenner & Lee, 2014),
- the impact of climate on the environment, including water resources (i.e., Kundzewicz et al., 2008; Piniewski et al., 2014; Schneider et al., 2013; Van Vilent et al., 2013; Wang et al., 2016; Vatter et al., 2016), forest ecosystems (Kornatowska & Smogorzewska, 2010), losses in the world of living nature (Nordhaus, 2021) and the threat to the seas and oceans (Nordhaus, 2021).

Climate change significantly conditions the functioning of the economy, society, and the environment. However, this dependence is not one-sided. Intensification of the greenhouse effect due to human activity (Hoegh-Guldberg et al., 2018), such as through fossil fuel energy consumption (Elias, 2017) or agricultural practices, e.g., converting natural land to agricultural use, overexploitation of the water resource for irrigation, and the use of fertilisers (Sadowski, 2018) exacerbates climate change.

In November 2019, the scientific journal Nature published an article entitled "Climate tipping points – too risky to bet against". The authors wrote, "Here we summarise evidence on the threat of exceeding tipping points, identify knowledge gaps and suggest how these should be plugged. We explore the effects of such large-scale changes, how quickly they might unfold and whether we still have any control over them". They went on to say, "the consideration of tipping points helps to define that we are in a climate emergency and strengthens this year's chorus of calls for urgent climate action – from schoolchildren to scientists, cities and countries" (Lenton et al., 2019).

In turn, in January 2020, "BioScience" published a letter by Ripple, Wolf, Newsome, Barnard, Moomaw and 11,258 scientists from 153 countries. It stated, "Scientists have a moral obligation to clearly warn humanity of any catastrophic threat and to 'tell it like it is.' On the basis of this obligation and the graphical indicators presented below, we declare, with more than 11,000 scientist signatories from around the world, clearly and unequivocally that planet Earth is facing a climate emergency" (Ripple et al., 2020). So, we have diagnosed conditions that, according to scientists, have led to a situation of alarm, which is referred to in the press as a climate crisis. The question arises as to how this state of affairs is related to ensuring climate security. To answer it, it will be necessary to clarify the following:

a) What is climate security, and where can this sector be placed in the national security system?
b) Can the level of climate security be measured based on certain indicators?
c) Does analysing selected indicators appropriately make it possible to clarify when we can speak of a secure climate?

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Climate security

A discussion of the concept of climate security should begin with the issue of the climate-security nexus. This is how the issue is clarified by the United Nations Environment Program (UNEP): “Security concerns linked to climate change include impacts on food, water and energy supplies, increased competition over natural resources, loss of livelihoods, climate-related disasters, and forced migration and displacement. Despite growing recognition of the interlinkages between climate change, peace and security, few examples of integrated programmatic approaches that address specific risks at the intersection of climate change and insecurity exist. Conflict and crisis-affected contexts are more susceptible to being overwhelmed by climate change, but too often, peacebuilding and stabilisation efforts often do not consider climate-related impacts or environmental hazards. At the same time, insecurity hinders climate change adaptation efforts, leaving already vulnerable communities even poorer and less resilient to interlinked climate and security crises, but climate change adaptation initiatives often fail to fully integrate peacebuilding or conflict prevention objectives” (UNEP, 2022).

It is worth returning to the genesis of the issue of climate security in the activities of the UN, or rather UNEP. In 2008, UN Special Envoy for Climate Change Jan Egeland asked for an analysis of climate change and security risks in the Sahel region. “The UN Special Envoy visited the region in 2008 and concluded it was ‘ground zero’ for climate change risks due to its extreme climatic conditions and highly vulnerable population” (UNEP, 2022). In 2009, the report “Livelihood Security Climate Change, Migration and Conflict in the Sahel” (UNEP, 2011) was published. There have been opinions in the literature that the conflict in Darfur is the first to be traced back to climate change (Mazzo, 2009). However, “Climate change and natural hazards generally do not directly produce intra-state violence or conflict. More often, climate change acts as a threat multiplier by triggering or aggravating existing pressures within societies, including demographic, social, economic, or political strains, that potentially develop as underlying drivers of instability and insecurity. Especially when climate change overburdens the capacity of governments to effectively deal with these accumulating pressures, societies become more vulnerable to social or political instability” (Remmits et al., 2020).

According to the UN Secretary-General’s Peacebuilding Fund: “Climate security means preventing and resolving violent conflicts caused by global warming by improving the management of transhumance corridors, resolving land ownership issues, reducing competition over access to natural resources and extractive industries and fostering agreements over climate adaptation strategies as well as local level resilience and livelihoods” (UN, 2020). According to the Transnational Institute, climate security is "a political and policy framework that analyses the impact of climate change on security. It anticipates that the extreme weather events and climate instability resulting from rising greenhouse gas emissions (GHGs) will cause disruption to be economic, social and environmental systems – and therefore undermine security" (TNI, 2021). In turn, the Pacific Northwest National Laboratory states: "Climate security represents the physical, economic, or societal impacts associated with climate change that substantially alter political stability, human security, or national security infrastructure" (PNNL, 2022).

The term "climate insecurity" also appears in the literature, which has been explained by, inter alia, Mason (2014): "Climate insecurity denotes a condition under which the effects of climate variability and/or change are represented as threatening to a group of affected actors".

In analysing these two terms, one can see common features:

- the impact of climate change on national security,
- the impact of increased greenhouse gas emissions on disruptions in social, economic and environmental dimensions,
- conflicts resulting from the consequences of global warming,
- the political dimension.

On this basis, the following definition of climate security was formulated: the materialisation of threats resulting from the dynamic growth of greenhouse gases in the atmosphere implies serious multidimensional consequences, i.e., social (climate refugees), economic (limited water resources, and limited quantity and quality of food) and environmental (limitation and disappearance of biodiversity), which in turn can cause political and, in extreme cases, military conflicts.

Another issue is the placement of climate security in the national security system, which has not yet been identified as one of its elements (Figure 1).

The impact of climate security on national security is multidimensional. As indicated in Figure 2, climate security depends on and simultaneously affects ecological and economic security, indirectly on food and energy security, and directly and indirectly on social and water security. The illustrated two-way dependencies signal that a disruption of one of the presented elements of national security is enough for climate security to be threatened; on the other hand, a disruption of climate security reflects negatively on all three pillars of sustainable development and national security.

As Trombetta (2008) points out, "Climate security suggests a concern for the security of the climate which is understood as the maintenance of stable climatic conditions as a prerequisite of all human enterprises, rather than the security of the climate itself. Climate security is evoked to secure people and societies that depend on it".

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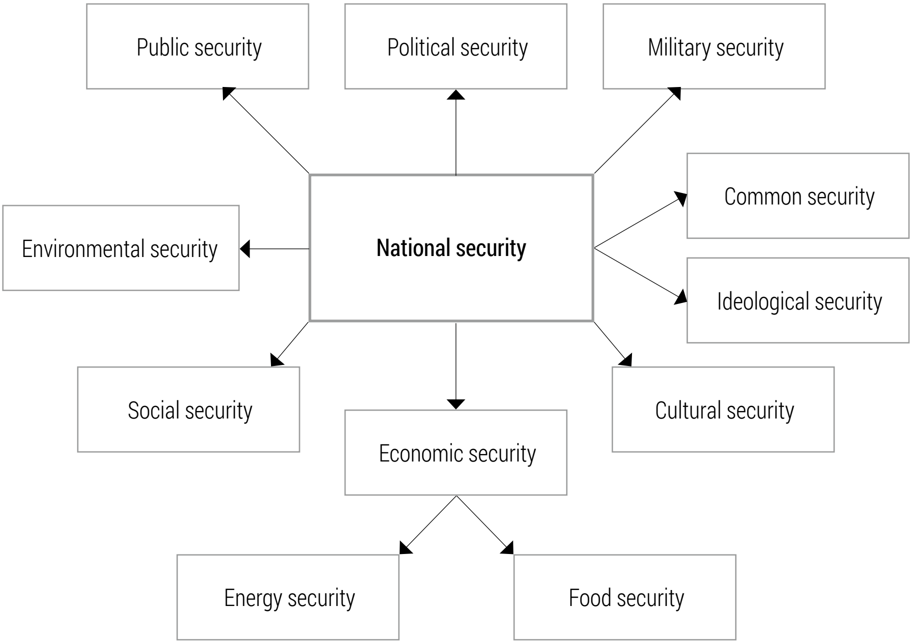

Figure 1. National security sectors
Source: authors' work based on Kitler, 2011.

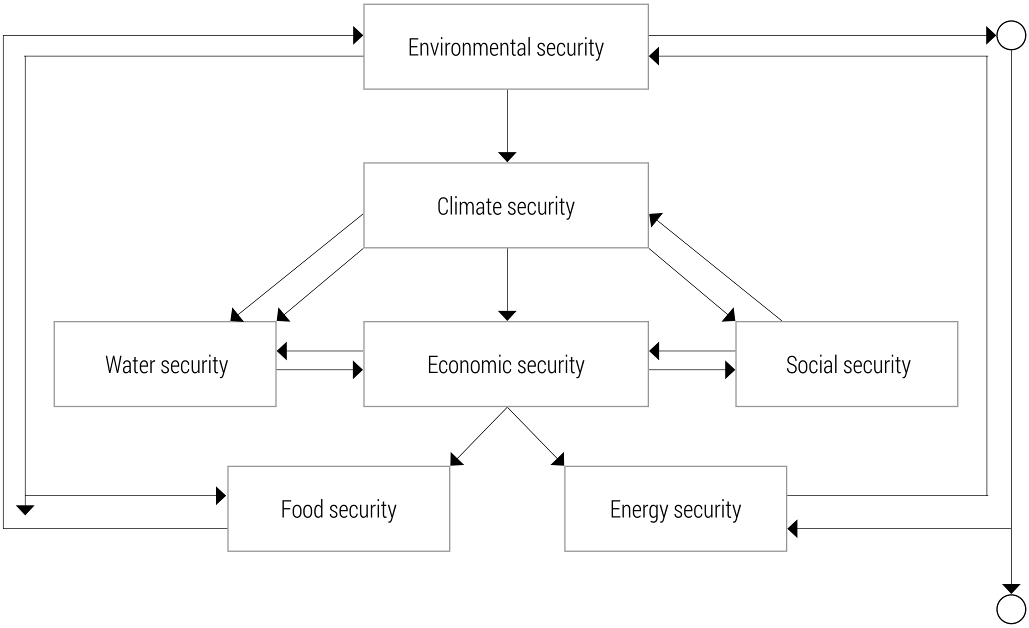

Figure 2. The multidimensionality of climate security

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Climate security indicators – research method

So, when can we talk about a safe climate? According to the above considerations, it is a state where the risk of change (disruption) is close to zero, which is possible with economic, social, and environmental security. Going one step further, it is worth asking whether climate security is at risk at the moment.

In order to answer such a question, an attempt was made to select indicators, which were classified into three areas according to the above-mentioned division:

1. economic – including selected factors that affect energy, water, and food security,
2. social – covering selected factors that affect social security, including health and welfare,
3. environmental – covering selected factors that affect environmental security.

The main limitations of the analysis relate to its narrowness to the countries of the EU, since climate security is a global issue, and the selectivity of indicators, which is mainly due to the lack of availability of data and its low quality.

In order to keep the analysis transparent, the indicators were classified; however, the dividing line is fluid, and the very selection of indicators reinforces the above-presented conclusions about the interdependence of different areas on each other.

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Table 1. Climate security indicators

Area	Indicator	Description
Economic	Energy balance	This indicator allows users to see the total amount of energy extracted from the environment, traded, transformed and used by different types of end-users. It also makes it possible to see the relative contribution of each energy carrier (fuel, product). The energy balance makes it possible to study the overall domestic energy market and monitor the impacts of energy policies. The energy balance offers a complete view of a country's energy situation in a compact format, such as the energy consumption of the whole economy and individual sectors. The energy balance presents all of a country's statistically significant energy products (fuels) and how they are produced, transformed and consumed by different types of economic actors (industry, transport, etc.). Therefore, an energy balance is the natural starting point for studying the energy sector.
	Energy efficiency	This indicator covers indicators for monitoring progress towards energy efficiency targets of the Europe 2020 strategy implemented by Directive 2012/27/EU on energy efficiency. Targets for 2030 are included on the basis of Directive (EU) 2018/2002.
	Share of energy from renewable sources	This dataset covers the indicator for monitoring progress towards renewable energy targets of the Europe 2020 strategy implemented by Directive 2009/28/EC on the promotion of the use of energy from renewable sources.
	Available energy, energy supply and final energy consumption per capita	Annual data on quantities for crude oil, petroleum products, natural gas and manufactured gases, electricity and derived heat, solid fossil fuels, renewables and wastes covering the full spectrum of the energy sector from supply through transformation to final consumption by sector and fuel type.
	Water statistics on the national level	Yearly data on freshwater resources, water abstraction and use, connection rates of resident population to wastewater treatment, sewage sludge production and disposal, generation and discharge of wastewater collected biennially by means of the OECD/Eurostat Joint Questionnaire – Inland Waters. Data aggregation: national territories.
	Agricultural factor income per annual work unit (AWU)	The indicator is a partial labor productivity measure in agriculture. Agricultural factor income measures the income generated by farming, which is used to remunerate borrowed or rented factors of production (capital, wages and land rents) as well as own production factors (own labor, capital and land). Factor income corresponds to the deflated (real) net value added at the factor cost of agriculture. The implicit price index of GDP is used as a deflator. AWUs are defined as full-time equivalent employment (corresponding to the number of full-time equivalent jobs), i.e., total hours worked divided by the average annual number of hours worked in full-time jobs within the economic territory.
Social	Healthy life years by sex	The indicator of healthy life years (HLY) measures the number of remaining years that a person of a specific age is expected to live without any severe or moderate health problems. The notion of a health problem for Eurostat's HLY reflects a disability dimension and is based on a self-perceived question which aims to measure the extent of any limitations, for at least six months, because of a health problem that may have affected respondents as regards activities they usually do. HLY is a composite indicator that combines mortality data with health status data.

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Area	Indicator	Description
Social	People at risk of poverty or social exclusion	This indicator corresponds to the sum of people who are: at risk of poverty after social transfers, severely materially deprived or living in households with very low work intensity. People are counted only once, even if they are affected by more than one of these phenomena. People are considered to be at risk of poverty after social transfers if they have an equivalized disposable income below the risk-of-poverty threshold, which is set at 60% of the national median equivalized disposable income. Severely materially or socially deprived people have living conditions severely constrained by a lack of resources, and they experience at least 7 out of the 13 following deprivations items: cannot afford i) to pay rent or utility bills; ii) keep their home adequately warm; iii) face unexpected expenses; iv) eat meat, fish or a protein equivalent every second day; v) a week's holiday away from home; vi) have access to a car/van for personal use; vii) replace worn out furniture; viii) replace worn-out clothes with some new ones; ix) have two pairs of properly fitting shoes; x) spend a small amount of money each week on him/herself ("pocket money"); xi) have regular leisure activities; xii) get together with friends/family for a drink/meal at least once a month; and xiii) have an internet connection. People living in households with very low work intensity are those aged 0-64 living in households where the adults (aged 18-64) worked 20% or less of their total work potential during the past year. In order to measure child poverty, the indicator is available for the age group 0-17.
	Years of life lost due to PM2.5 exposure	The indicator measures the years of life lost (YLL) due to exposure to particulate matter (PM2.5). PM2.5 are particulates whose diameter is less than 2.5 micrometers and which can be carried deep into the lungs, where they can cause inflammation and exacerbate the condition of people suffering from heart and lung diseases. YLL is defined as the years of potential life lost as a result of premature death. It is an estimate of the average number of years that a person would have lived if they had not died prematurely.
	Population connected to public water supply	Percentage of the population that has access to public water.
	Crop production in the EU	Harvested production, mainly dried pulses, root crops, fodder, and industrial crops.
Environmental	Air emissions accounts totals bridging to emission inventory totals	This indicator includes so-called bridging items, which show the differences between the national totals derived from two internationally established approaches/methods for reporting emissions of greenhouse gases and air pollutants.
	Environmental protection investments of the total economy	This indicator presents investments of the total economy (general governments and corporations) to provide environmental protection services (e.g., waste and wastewater management, decontamination of soil). Investments undertaken by corporations to manage their own environmental pressures are included.
	Resource productivity	This indicator provides ratios of gross domestic product (GDP) over domestic material consumption (DMC) in various units of measure. The term "resource productivity" designates an indicator that reflects the GDP generated per unit of resources used by the economy. This is typically a macro-economic concept that can be presented alongside labor or capital productivity.

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Area	Indicator	Description
Environmental	Water exploitation index, plus	The Water Exploitation Index plus (WEI+) is a measure of total freshwater use as a percentage of the renewable freshwater resources (groundwater and surface water) at a given time and place. It quantifies how much water is abstracted and how much water is returned after use to the environment. The difference between water abstraction and return is regarded as water use and illustrates the pressure on renewable freshwater resources due to water demand. In the absence of Europe-wide agreed formal targets, values above 20% are generally considered an indication of water scarcity, while values equal to or bigger than 40% indicate situations of severe water scarcity, i.e., the use of freshwater resources is clearly unsustainable. The indicator is presented as annual average values. Annual calculations at the national level, however, cannot reflect the uneven spatial and seasonal distribution of resources and may therefore mask water scarcity that occurs on a seasonal or regional basis. The indicator is a result of estimations by EEA based on data from the WISE SoE – Water quantity database (WISE 3) and other open sources (JRC, Eurostat, OECD, FAO) and including gap-filling methods.
	Protected areas	The indicator measures the surface of terrestrial and marine protected areas. The indicator comprises nationally designated protected areas and Natura 2000 sites. A nationally designated area is an area protected by national legislation. The Natura 2000 network comprises both marine and terrestrial protected areas designated under the EU Habitats and Birds Directives with the goal of maintaining or restoring a favorable conservation status for habitat types and species of EU interest.

Source: authors' work based on Eurostat.

Research results

The indicators are presented in detail below.

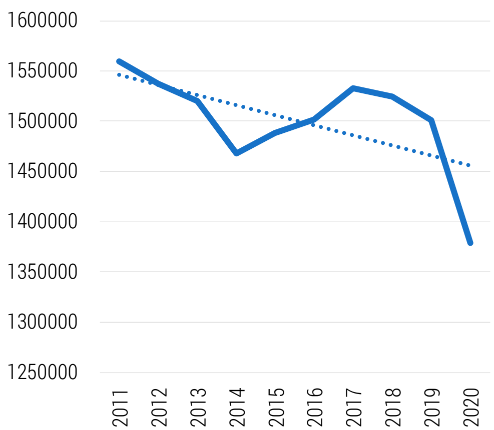

Figure 3. Energy balance 2011-2020 [annual, total, gross available energy, millions tonnes of oil equivalent]

Source: authors' work based on Eurostat.

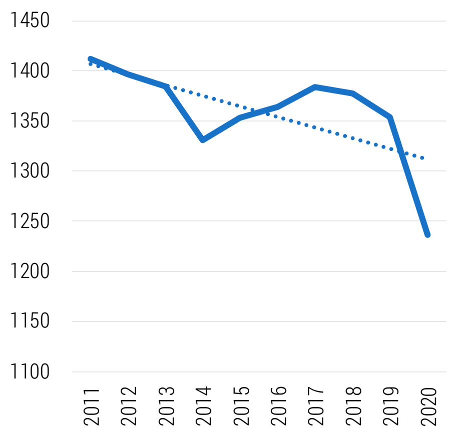

Figure 4. Energy efficiency 2011-2020 [annual, primary energy consumption, million tonnes of oil equivalent]

Source: authors' work based on Eurostat.

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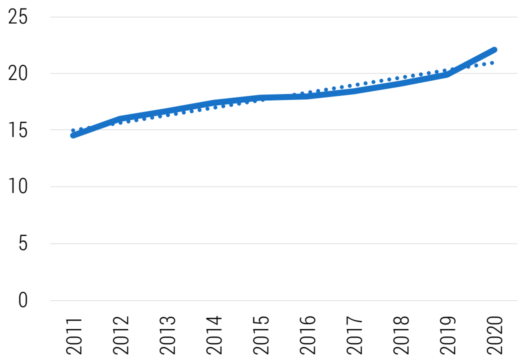

Figure 5. Share of energy from renewable sources [annual, percentage]

Source: authors' work based on Eurostat.

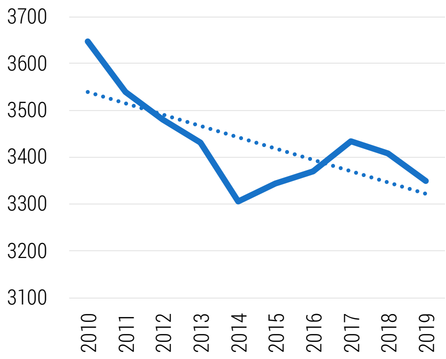

Figure 6. Available energy, energy supply, and final energy Consumption per capita 2010-2019 [annual, total, gross available energy, kilograms of oil equivalent (KGOE) per capita]

Source: authors' work based on Eurostat.

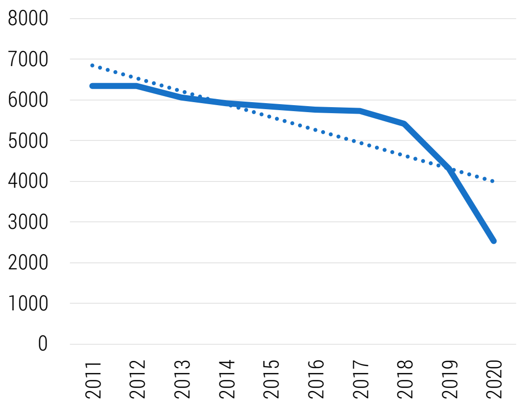

Figure 7. Water statistics on the national level 2011-2020 [total gross abstraction, fresh surface and groundwater, million cubic meters]

Source: authors' work based on Eurostat.

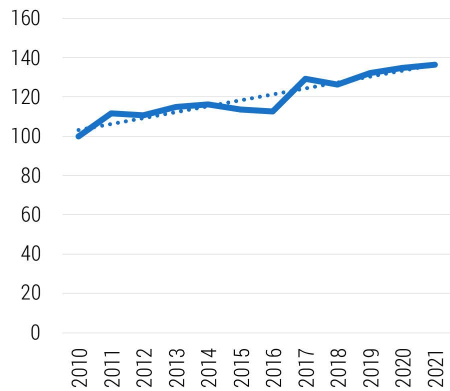

Figure 8. Agricultural factor income per annual work unit 2010-2021 [Index, 2010=100]

Source: authors' work based on Eurostat.

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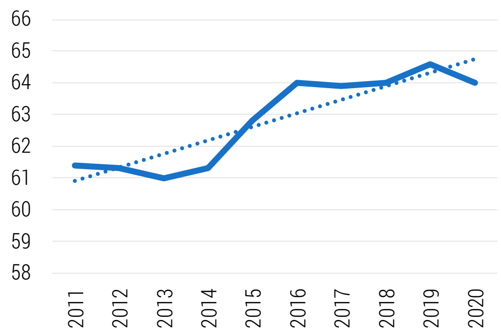

Figure 9. Healthy life years by sex 2011-2020 [annual, year, total]

Source: author's work based on Eurostat.

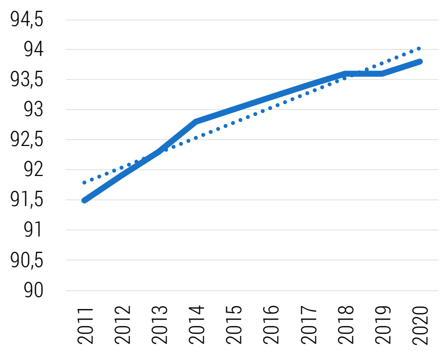

Figure 10. Population connected to public water supply 2011-2020 [annual, percentage]

Source: authors' work based on Eurostat.

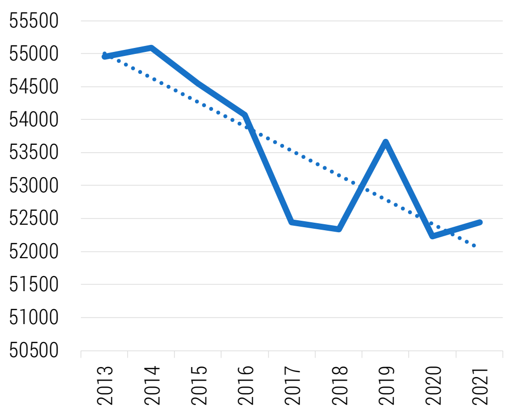

Figure 11. Crop production in EU standard humidity 2013-2021 [annual, crop production in EU standard humidity, area -cultivation/harvested/production, 1000 ha)]

Source: authors' work based on Eurostat.

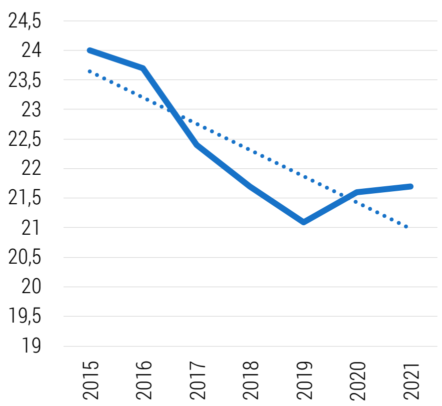

Figure 12. People at risk of poverty or social exclusion [annual, percentage]

Source: author's work based on Eurostat.

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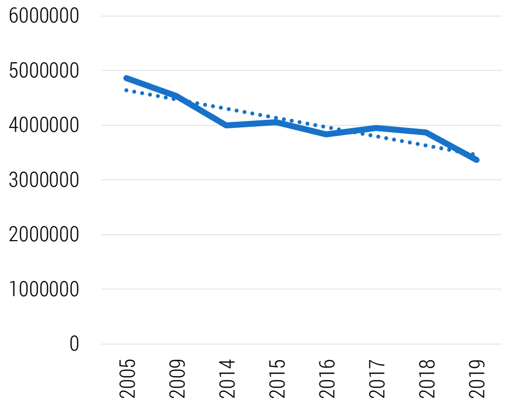

Figure 13. Years of life lost due to PM2.5 exposure [annual, particulates < 2.5μm, years of life lost]

Source: authors' work based on Eurostat.

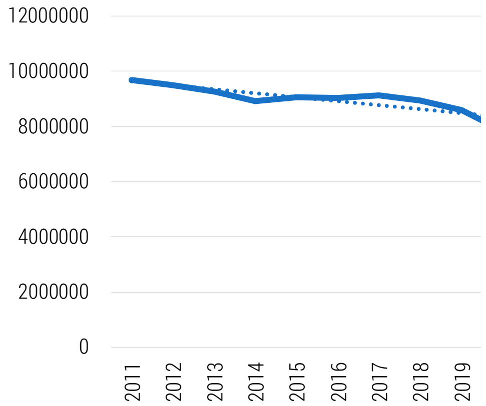

Figure 14. Air emissions accounts totals bridging to emission inventory totals [annual, greenhouse gases (CO_2, N_2O in CO_2 equivalent, CH_4 in CO_2 equivalent, HFC in CO_2 equivalent, PFC in CO_2 equivalent, SF6 in CO_2 equivalent, NF3 in CO_2 equivalent)]

Source: authors' work based on Eurostat.

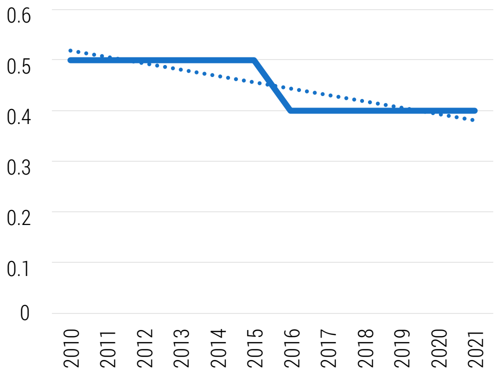

Figure 15. Environmental protection investments of total economy 2010-2021[annual, percentage of GDP]

Source: authors' work based on Eurostat.

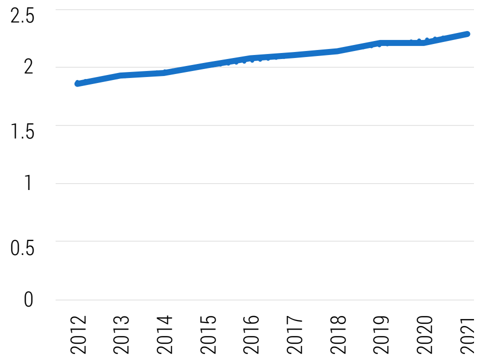

Figure 16. Resource productivity 2012-2021 [annual, euro per kilogram]

Source: authors' work based on Eurostat.

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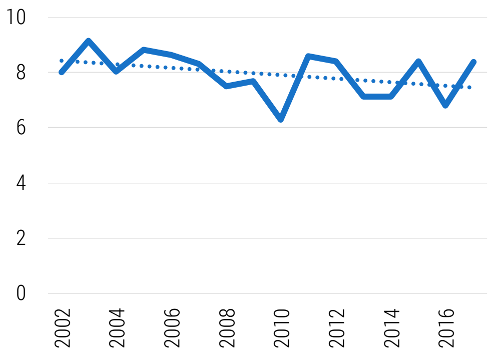

Figure 17. Water exploitation index 2002-2017 [annual, percentage]

Source: authors' work based on Eurostat.

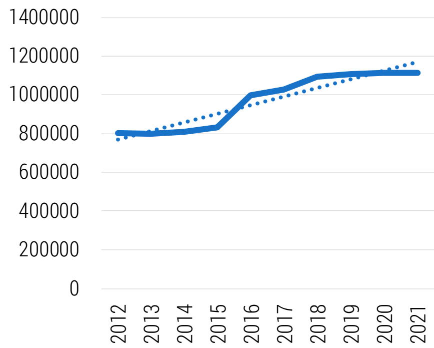

Figure 18. Protected areas 2012-2021 [annual, square kilometer, terrestrial protected area]

Source: authors' work based on Eurostat.

Analysis of the selected indicators of the economic area of climate security (Figures 3-8) indicates a decline in the effectiveness of energy policy, as well as declining energy efficiency in the countries of the EU. The index of energy balance, energy efficiency, as well as available energy sources is characterised by a decreasing trend line (the decrease between the first year of the analysis and the last year was 11.5%, 12.4%, and 8.2%, respectively). Freshwater resources and water intake are also characterised by a declining trend line; this indicator fell by 60% between the first and last years of the analysis. Of the selected economic indicators, only those for the share of Renewable Energy Sources (up 34 percentage points) and agricultural factor income per annual work unit (up 36.65 percentage points) increased.

The desired direction of change is shown by the indicators selected for the social area, i.e., the number of years of healthy life (an increase of 2.6 years between the first and last years of analysis, Figure 9), the population with access to public water (an increase of 2.3 percentage points, Figure 10), the number of people at risk of poverty (a decrease of 2.3 percentage points, Figure 12), and the number of years of life lost due to exposure to PM2.5 particulate matter (a decrease of 30%, Figure 13). The indicator aimed at determining food security, i.e., crop production, is characterised by a declining trend line; a decrease of 4.5% was recorded (Figure 11).

Indicators of the environmental area show increases in resource productivity (up by 18.7%, Figure 16) and protected areas (up 28%, Figure 18). Despite the decreasing trend line for water exploitation, in the last year of the analysis, the indicator increases between the first and last years by 0.39 percentage points (Figure 17). Figure 15 illustrates the declining trend line for environmental investment (down 0.1 percentage points).

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The analysis reveals the weakest areas of climate security. In the case of the economic area, it is energy and the endangered energy security of the EU countries, as well as water security and the declining freshwater resource, with increasing water exploitation and pressure on renewable freshwater resources resulting from the demand for water. Data for the energy sector is available through 2020. Thus, events in 2022, i.e., Russia's attack on Ukraine, will exacerbate the declining trend. Despite rising agricultural income, crop production is declining, which may threaten food security. Declining spending on environmental investment means a decline in the measures taken in this area, which may ultimately threaten environmental security. Resuming the above considerations, we can answer the question posed earlier and conclude that climate security is under serious threat.

Conclusions

Climate change is causing a number of consequences in environmental, social, and economic dimensions. The literature addresses this issue in a very broad way. Qualitatively new to these considerations is the issue of ensuring climate security. This paper addresses this issue, filling a gap in the literature by identifying the links between climate change and security in the context of the climate crisis, then de-emphasizing the concept of climate security (due to the limited number of texts containing a definition of the issue), and finally answering the question of when we can talk about climate security and whether we can determine the level of climate security based on properly selected indicators. A selection of indicators was made, which were classified into three groups. The limitation of the analysis is mainly the de-selectivity of the indicators, which is mainly due to the lack of data availability and their low quality. Analysis of the data for selected indicators showed weak areas in each of the areas mentioned and allowed us to conclude that climate security is at risk. Based on the argument thus made, there is a need for detailed development of climate security indicators based on the criterion of vulnerability to climate change.

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The contribution of the authors

Conception – D. Michalak (50%), P. Szyja (50%).

Literature review – D. Michalak (50%), P. Szyja (50%).

Acquisition of data – D. Michalak (50%), P. Szyja (50%).

Analysis and interpretation of data – D. Michalak (50%), P. Szyja (50%).

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