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Data quality assessment of Copernicus Climate Change Service health domain data for the development of disaster risk reduction plans

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ABSTRACT

Bulgaria, located in the Balkans, is subject to a number of natural disasters including floods, earthquakes, landslides, forest fires, strong winds, droughts, heavy snowfall and extreme temperatures. In addition to natural disasters, the country is at risk for man-made events like industrial and nuclear accidents, transport accidents, and infectious diseases. Disaster planning and prevention is a complex process that requires multiple data sources. At the same time, spatial data are often not available on-line, so the country's GIS specialists may find existing spatial data to be a great challenge. This research analyses the application of the health sector data provided by the Copernicus Climate Change Service to support the development, implementation and evaluation of disaster risk management plans in Bulgaria. The climate data visualizations provided by the service enable scientists and other stakeholders to view climate change data in a format that is simple to use, visually understandable, and usable for decision makers in government, business, and non-governmental organizations. Many of these visualizations are interdisciplinary and may be critical for gathering and applying information needed to develop disaster risk reduction plans.

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1. Introduction

Bulgaria, located in south-eastern Europe, is subject to a number of natural hazards including floods, earthquakes, landslides, forest fires, strong winds, droughts, heavy snowfall and extreme temperatures. Additionally, the country is at risk for man-made events such as industrial and nuclear accidents, transport accidents and infectious diseases. Disasters are defined in the Disaster Protection Act as

"a significant disruption of the normal functioning of society caused by natural phenomena and / or human activity and leading to negative consequences for the life or health of the population, property, economy and the environment, prevention, mastering and overcoming of which exceeds the capacity of the system for servicing the usual activities for the protection of society"

Disaster protection is provided at a national, district and municipal level. Disaster risk reduction planning is also carried out at a national, district and municipal levels. Planning includes the development and updating of a number of programs and plans, including the development of municipal disaster risk reduction plans. They contain operational objectives and the activities to achieve these operational objectives.

Geospatial data used for disaster risk management is related to several technological and scientific fields - Geographic Information Systems (GIS), Earth Observation (EO), GNSS. In Bulgaria, these technologies have been applied in different fields in the last several decades, but have not been fully adopted by most municipalities. Spatial data is owned, managed and shared by many types of organizations in the country, for example state agencies, (Agency for Geodesy, Cartography and Cadaster, Executive Environmental Agency), ministries (Ministry of Environment and Water, Ministry of Regional Development and Public Works, Ministry of Interior), and municipalities. Efforts are required by these multiple organizations to share their spatial data effectively. The European Union established the INSPIRE directive in 2007, which was intended to advance national and international GIS initiatives, establishing a framework for the collection and distribution of spatial information throughout the EU. INSPIRE was introduced into the Bulgarian legislation through the Law on Access to Spatial Data in Bulgaria. The Data Department in the Information Systems and Interoperability Directorate of the State Agency for Electronic Government is the national contact point under the Directive.

The portal containing open data from the Bulgarian government can be found at https://data.egov.bg/. It provides access to tens of thousands of data sets in machine-readable format. In December 2020, the National Spatial Data Portal was launched, which aims to provide geospatial data to citizens and interested organizations (Fig. 1).

In addition to the two portals, spatial data can be found on the websites of other organizations that collect, store and share it, as well. Due to its diverse nature, disaster planning and prevention requires multiple data sources. At the same time, spatial data are not always available on-line, so the country's GIS specialists may find existing spatial data, if they are not already published in the two portals mentioned above, to be a great challenge.

On December 6, 2019 in Sofia was announced the start of the activities related to increasing the efficiency of the disaster risk management system of the Ministry of Interior (The World Bank, 2019). They included collecting historical data on damage and losses from disasters and developing a concept for their collection in the future, developing a proposal for a National Disaster Risk Profile of Bulgaria and developing a report with a proposal for a National Disaster Risk Management Plan. These strategic documents aim to improve the existing system in Bulgaria for disaster prevention, preparedness and response, as well as to meet the need for rapid actions and increased investments to address the growing risks of disasters due to changing climate. In the Annual plan for 2021 for implementation of the National Program for Disaster Risk Reduction 2021-2025 the following activities are included:

- Preparation of a proposal for a national disaster risk profile in Bulgaria.
- Collect data to model susceptibility, determinism or probability of any hazard included in the proposed national risk profile. Validation and verification of results by comparison with the database on damages and losses from past disasters collected in the framework of activity 1.2.1.1
- Documenting identified data gaps that should be addressed in the future to allow for a more detailed and accurate risk profile.
- Preparation of a report on the national disaster risk profile (with digital links to the relevant technical data, documents and data sets) for further discussion with the relevant national and sub-national authorities and subsequent public dissemination and, depending on the outcome, sharing of relevant hazards, degree of exposure and risk maps through one or more geospatial platforms.

By the time this paper was submitted (1st of June 2022), the proposal for National Disaster Risk Profile was not publicly available. In the draft for Annal plan for 2022 for implementation of the National Program for disaster risk reduction 2021-2025 there is a goal *„Establishing a system for measuring, storing, sharing and providing data on disaster losses, and information on the effects on the economy, social sector, health, education, environment and cultural heritage."* This proves the relevance of the study and the need to take further steps to study the applicability of data in this area in our country.

The key future vulnerabilities for Bulgaria, defined in the National Climate Change Adaptation Strategy and Action Plan (MOEW, 2019), are the impact of temperature and humidity on health, urgent health consequences related to weather conditions, changes in the health effects related to precipitation. The strategy also states that climate-related health impacts affect disproportionately more vulnerable groups, in particular children and adults, people with chronic diseases, people of low socio-economic status, those

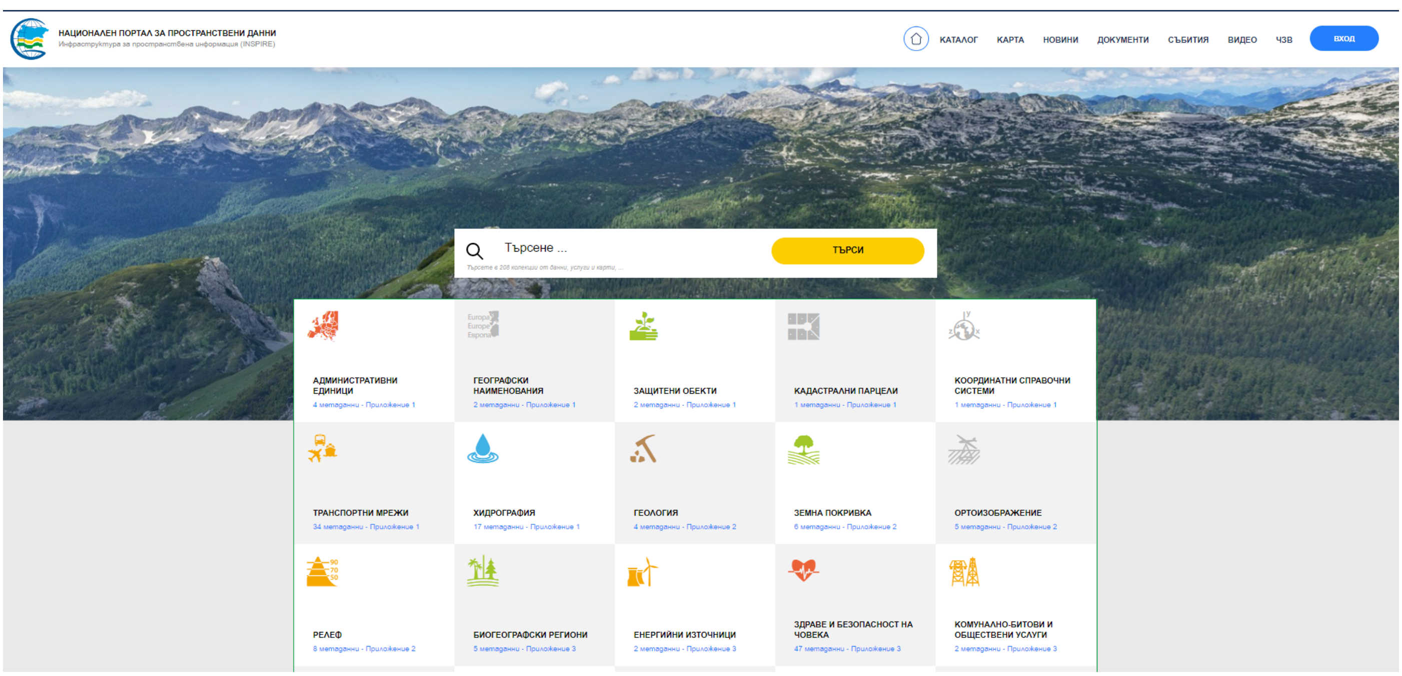

Figure 1. National Spatial Data Portal of Bulgaria – thematic data collections.

living in poverty and those with bad habits (alcohol, drugs and tobacco use). Indicators of the most vulnerable groups in recent decades show that the country is at a disadvantage compared to many other EU countries. Appendix 5 of the Strategy is dedicated to the evaluation of the Human Health Sector in Bulgaria. It defines the impact of climate change on the following health aspects:

- heat-related morbidity and mortality;
- diseases and mortality caused by catastrophic meteorological phenomena;
- cardiovascular diseases and strokes;
- asthma, respiratory allergies and respiratory diseases;
- carcinomas;
- vector-transmitted transmissible infections in humans;
- food and nutrition related diseases;
- water-borne diseases;
- mental health and stress-related disorders;
- neurological diseases and disorders.

The wide variety of human health effects seen in this list can be modeled and mapped using a variety of data sources in GIS environment. The National Strategy also clearly defines the problem of access to data related to the impact of climate change on human health:

"...the assessment of health outcomes in the field of climate change is a complex task with many ambiguities that must be addressed, including those related to greenhouse gas emission scenarios, limited data and models of the climate-health relationship. Therefore, it is necessary to deepen the knowledge and evaluations of climate change in Bulgaria and the mechanisms for their impact on human health."

Copernicus is the European Union's Earth observation programme, created and managed to benefit all European citizens. It offers data and information services received from satellite Earth Observation and in-situ (non-space) data (Copernicus Program, 2022). Its Climate Change Service (C3S) supports society by providing authoritative information about the past, present, and future climate in Europe and the rest of the world. C3S offers free and open access to climate data and tools based on the best available science (C3S, 2022). Currently the data store of the service contains tens of datasets, including 44 items with spatial coverage of Europe. The variable domains include Atmosphere (surface) (9 datasets), Atmosphere (upper air) (5 datasets), Land (biosphere) (3 datasets), Land (hydrology) (15 datasets) and Ocean (physics) (7 datasets). Product types are classified into Climate indices (4 datasets), Climate projections (19 datasets), In-situ observations (3 datasets), Reanalysis (11 datasets), Satellite observations (3 datasets) and Seasonal forecasts (3 datasets). Data is divided also by the sector that can benefit from them, like Agriculture, Energy, Forestry, Health, Tourism and many others. There is a dedicated sector named Disaster Risk Reduction, providing climate monitoring and volcanic eruptions, but as Bulgaria doesn't have any active volcanoes this data will not be taken into account in the current research.

The aim of this study is to examine the quality of the health sector data provided by the Copernicus Climate Change Service to support the development of disaster risk management plans in Bulgaria.

2. Materials and methods

2.1. Spatial Data Sources and Data Quality Conceptual Framework

The sources of spatial data for disaster domain are many international organizations, ministries, agencies, municipalities, private organizations. Data sources from a technological point of view include satellites that image the Earth, in-situ sensors, official or crowdsourcing spatial databases. According to their type, data sources can be divided into several main categories:

- Data from Earth Observation - this is the data obtained by observing the Earth from space (for example Copernicus satellites, Copernicus Services)
- Data from sensors - this category includes data received from ground stations or in-situ sensors - for example, to measure temperature, atmospheric pressure, humidity, particulates matter, etc.
- Data from vectorization of maps - vectorization of topographic maps for example
- Text sources - these are all kinds of rules, orders, laws, regulations, ordinances, textbooks, books, articles, etc., that can be used in developing geospatial data in different formats
- Statistical sources - in Bulgaria this is the National Statistical Institute, and in Europe - Eurostat. Numerous arrays of data and information can be found on the websites of these organizations.
- Graphic - this category includes maps, charts, diagrams and any graphs that can be interpreted.
- Objects and artifacts - this category from a geographical point of view includes samples that can be collected in the field, artifacts - everything that is a physical object and which can be a source of information about the state of the environment.

Providing access to spatial data that meets international standards and requirements defined above is an extremely actual issue. There are many organizations in the country that are sources of geospatial data, but for many specific areas there is a lack of official publicly available data. Often data from crowdsourcing initiatives are used when implementing projects or national initiatives, as the authorities responsible for collecting and storing data in the corresponding domain do not make them available for free use. Numerous methods for assessing data quality have been introduced and used in the scientific literature. Wang & Strong (1996) look at data sources through the prism of consumer needs known and researched by marketing. One of the main factors considered by the two authors is the accessibility of the data and the question of how well the users of this data know the official sources from which they can access them, incl. the method of access (Fig. 2.).

Wang & Strong (1996) put user needs in focus which determines the need for the author to know well the subject he/she is mapping. The authors of the study emphasize data properties shown in Fig. 2., insisting that *"to improve data quality, we need to understand what data quality means to data consumers (those who use data)"*.

Therefore, the present study will look at data sources from the Copernicus program, Climate Change Service, health domain, for disaster risk planning. For each data set, a critical analysis, based on the conceptual framework proposed by Wang and Strong (1996) will be performed.

2.2. Copernicus Climate Change Service

2.2.1. Overview – open data source for disaster risk management plans

C3S provides information to enable the evaluation of disaster risk reduction policies and practices to address weather-related risks. Climate change affects every place on Earth through mean climate changes and extreme events, as well as their combined effects on natural and human systems. Currently there are numerous applications and datasets developed with the C3S data, which allow policy makers to examine different scenarios and take action. This information is critical for multiple sectors, particularly as their exposure to physical climate risks is changing and reporting

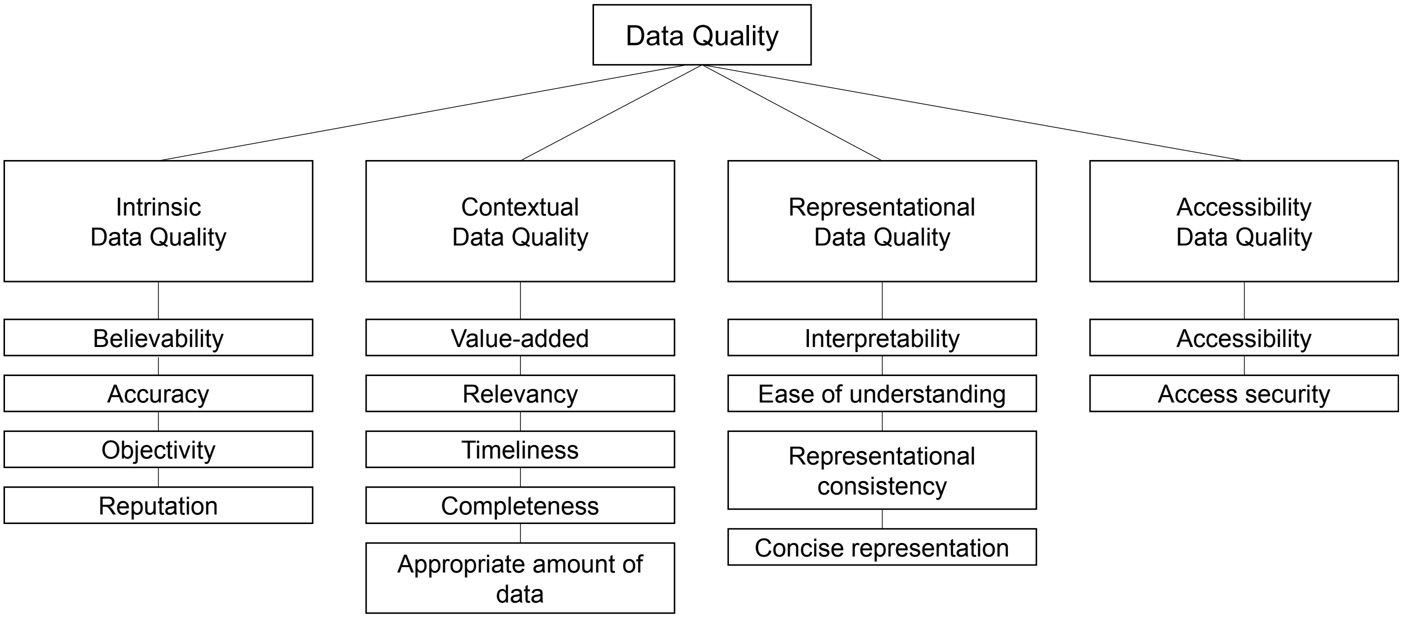

Figure 2. Conceptual Framework of Data Quality. Source: Wang and Strong, 1996.

is expected to become better and sooner after an event happens. Currently there are also authoritative, public, and up-to-date datasets developed to accelerate the uptake of physical risk assessments by financial practitioners and support them in their forward-looking climate resilience strategies (C3S, 2022).

In the coming decades, climate change is likely to increase the frequency of extreme events and natural disasters such as heavy rainfall, heat and cold waves, floods and droughts, hurricane winds, wildfires and landslides in Bulgaria (CECILIA Project, 2008). When developing a risk management strategy or plan, authorities should consider the climate change scenarios (RCP4.5 and RCP8.5), introduced by the Intergovernmental Panel on Climate Change (IPCC) in 2013 to quantify the impact of greenhouse gases (GHGs) on climate change. Datasets and applications from C3S include these two climate change scenarios.

The Health sector in the CCS website contains 11 items, 9 of which are applications:

1. Climatic suitability and seasonal activity of the tiger mosquito for Europe
2. The number of heat wave days for European countries derived from climate projections
3. Heat wave days and heat related mortality for nine European cities derived from climate projections
4. European temperature statistics derived from climate projections
5. Heat wave days for Europe derived from ERA5 reanalysis
6. Date of birch pollen season onset from 2010 to 2019 derived from reanalysis
7. Urban climate for cities in Europe from 2008 to 2017
8. Urban heat island intensity for European cities from 2008 to 2017 derived from reanalysis
9. European temperature statistics derived from ERA5 reanalysis

and 2 datasets:

1. Climatic suitability for the presence and seasonal activity of the Aedes albopictus mosquito for Europe derived from climate projections
2. Heat waves and cold spells in Europe derived from climate projections

They can be used in combination or as a separate data sources in in developing and updating disaster protection plans for municipal, regional or national level.

2.2.2. Copernicus Climate Change Service: datasets and application

Invasive Species – Climatic suitability and seasonal activity of the tiger mosquito for Europe Dataset

The Asian tiger mosquito (Aedes albopictus) is a species native to Southeast Asia that can transmit many dangerous diseases - dengue, chikungunya and zika. According to the National Center for Infectious and Parasitic Diseases of Bulgaria (NCIPDB, 2021), climate change is a major factor in the increasing frequency of Europeans with this type of mosquito. The reason is related to climate change, which leads to warming and changes in rainfall. Thus, the habitat conditions in the temperate regions for several species of mosquitoes are becoming more favorable.

According to C3S's report "Suitability of survival of Aedes albopictus for future climate" tiger mosquito's natural habitat are small ponds of water. The suitability maps available in the application are based on the Multi-criteria decision analysis (MCDA), performed in the ECDC's Technical Report from 2009 (Fig. 3). According to this study, which was published in 2009 and was taking into account the current IPCC climate change scenarios, the long term (2030) presence in the 'Balkan zone' was not expected to expand any farther and was going to even shrink, with parts of Romania and Bulgaria becoming unsuitable for Aedes albopictus. However, its presence was confirmed in Bulgaria in 2011 in Sozopol (BFSA, 2013), and in the years after that also in Burgas (DnesBG, 2014), Plovdiv, Varna, Blagoevgrad, Pazardzhik (DarikNews, 2016).

The suitability functions, based on the research of Caminade et al. from 2012, are visualized on Figure 4. They are the foundation of the results presented in the Suitability Index of the application. The methodology connects a number of aggregated climate variables to the suitability of a habitat. The functions range from 0 to 255.

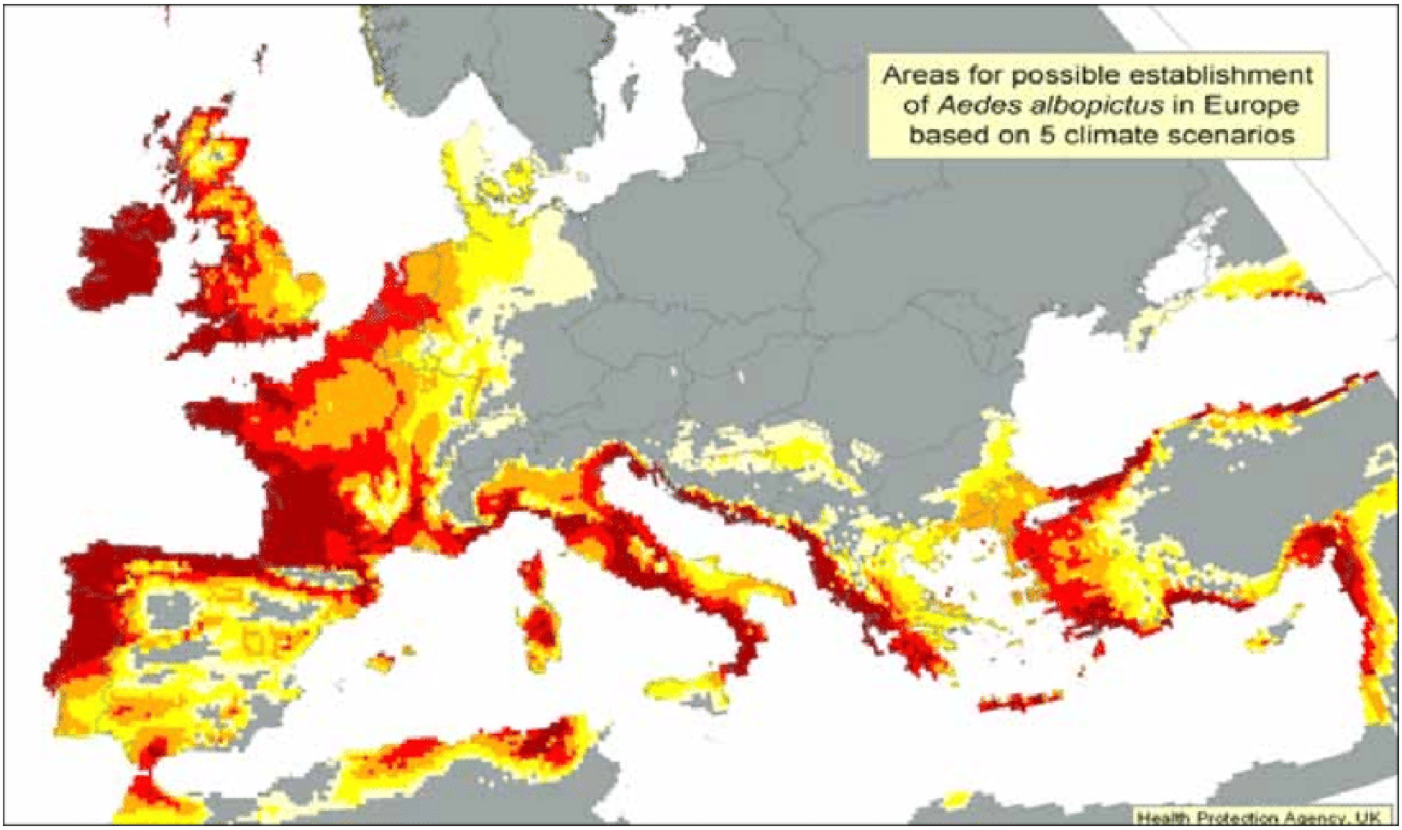

Figure 3. Possible seasonal activity of Aedes albopictus in Europe: weeks between spring egg hatching and autumn egg displause. Source: ECDC, 2009.

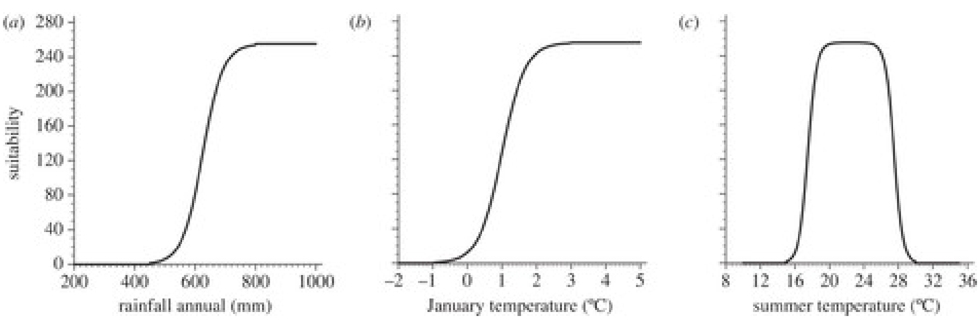

Figure 4. Suitability functions for tiger mosquito. Source: Caminade et al., 2012.

According to the requirements of the species for survival in the environment, the following values of the variables are defined:

- Zero suitability when rainfall is lower than 450 mm
- Max suitability when annual rainfall is higher than 800 mm
- Zero suitability when summer temperatures are lower than 15°C and higher than 30°C
- Max suitability when summer temperatures are between 20°C and 25°C
- Zero suitability when January temperatures are lower than -1°C
- Max suitability when temperatures are above 3°C.

Number of heat wave days for European countries derived from climate projections

According to a study by the European Commission's Joint Research Center (JRC), heat waves in Europe are expected to be more frequent and intense (Feyen, 2020). If no action is taken, the number of deaths on the continent caused by heat waves is expected to increase 30 times by the end of the XXI century. Based on the JRC report, there are two additional factors related to urban heat islands. The first factor is people's health, and the second is life in large cities. Research by Ivanov and Evtimov (2014) has shown that the effects of heat waves vary from region to region in Bulgaria; for example, people living in rural areas generally suffer fewer effects of heat than those living in cities such as Sofia, where there are many large apartment buildings. Dimitrov and Spasova (2015) have found that between 2007 and 2011, 24 cases of heat waves were registered in Sofia, which makes a total of 148 days or 19.3% of the total time during the warm half of the year. Dimitrov et al/ (2020) used UAV images to highlight the differences in surface temperature in the urban area of the capital city. Similar results were provided by Sentinel-3 data for the 2021 summer heat wave in Sofia, Plovdiv, Varna and Burgas (Sarafova, 2021).

European temperature statistics derived from climate projections

The application delivers exposure statistics for the historical period (1976-2005), and both future 30-year periods 2031-2060 and 2071-2100, under different climate change scenarios (C3S, 2022). This data was derived from the mean, minimum, and maximum air temperatures at 2 m using a bias-adjusted EURO-CORDEX climate projections dataset. Such statistics are typically employed in epidemiology and public health when assessing health risks associated with climate change. In the application users may choose between seasons (summer, winter and annual data); temperature statistic variable between minimum, mean or maximum 2-metre air temperature and statistic - ensemble mean,10th, 50th, 90th percentile (Demo web-application HEAT-COLD.2, 2020).

Urban Climate Statistics and Heat Island Effect

Urban climate for cities in Europe from 2008 to 2017 data visualizations show the urban temperature, humidity and wind speed data for 2008 through 2017. The data is derived from the dataset 'Climate variables for cities in Europe from 2008 to 2017', which is underpinned by the UrbClim model (European urban climate from 2008-2017 User Guide, 2021).

Urban heat island intensity for European cities from 2008 to 2017 derived from reanalysis

Urban Heat Islands (UHI) are areas in cities where the temperature is higher than in the surrounding rural areas. This can increase the risk for humans' health, especially for vulnerable groups such as children and elderly people. The effects of urban heat island have been studied in Bulgaria using UAV (Dimitrov et all, 2020,) and Copernicus Sentinel-3 data (Sarafova, 2021). The application in C3S provides data for visualization of UHI effect over the ten-year period from 2008 to 2017. Users can select from 100 European cities for each of the four seasons. UHI maps are provided for the annual mean daytime and nighttime UHI for the selected year, as well as the mean daytime and nighttime UHI over 10 years.

Date of birch pollen season onset from 2010 to 2019 derived from reanalysis

According to Appendix 5 of the National Strategy for Adaptation to Climate Change and Action Plan, the climate change effect defined as "Increased allergies" is likely to be 99% -100%. According to the document, a 10% to 30% increase in the number of allergic diseases is expected, thanks to the earlier flowering and the increased concentration of pollen, spores and other allergens in the air. In this regard, data for the Date of birch pollen season onset from 2010 to 2019 derived from C3S reanalysis may be useful in developing and updating disaster risk reduction plans in the country.

3. Results

3.1 Invasive Species – Climatic suitability and seasonal activity of the tiger mosquito in Bulgaria

These functions presented in section 2.2 were rescaled to a range between 0 and 100, which can be seen in the application viewer (Fig. 5.). The season length data product for Burgas is visualized in Fig. 6.

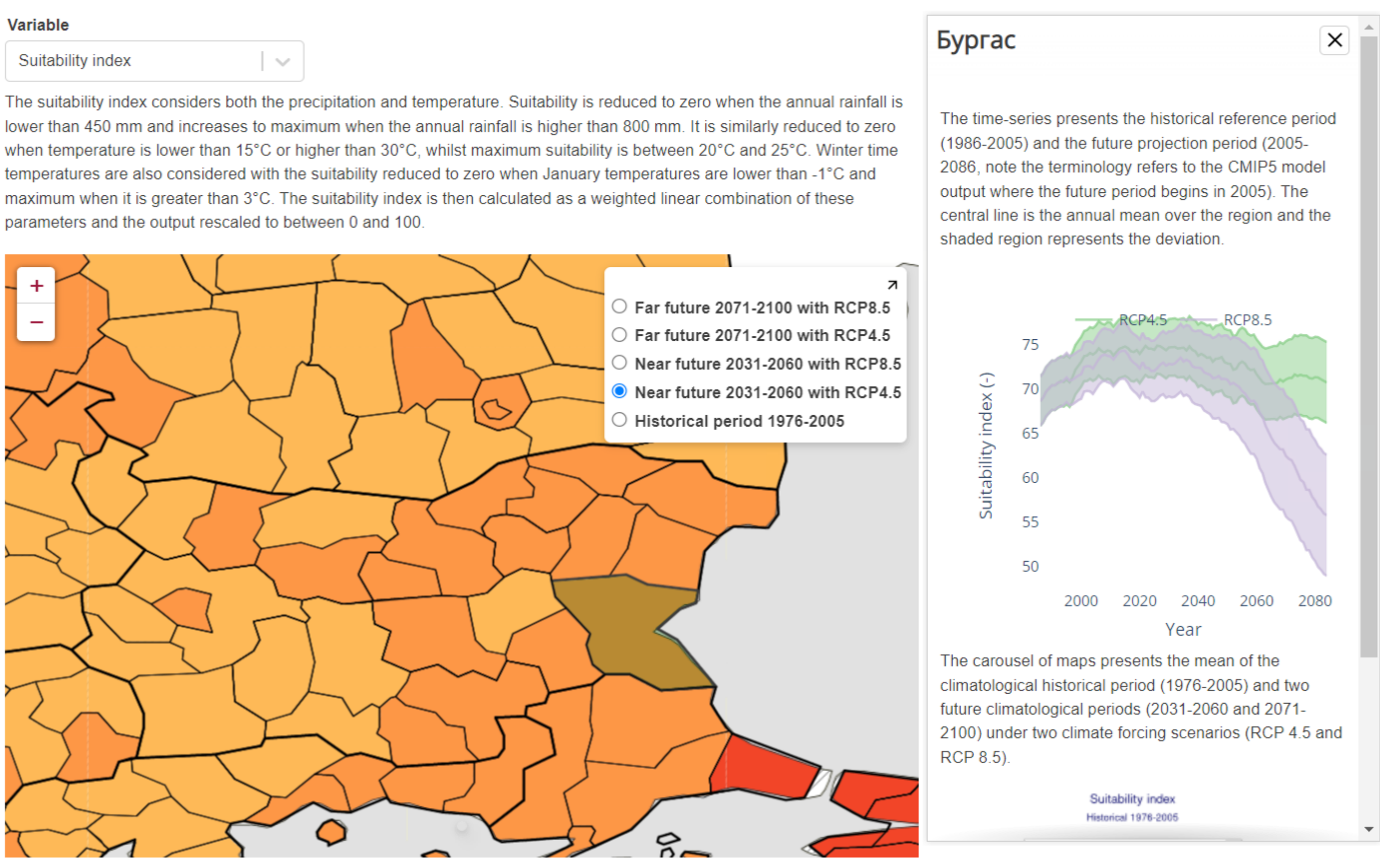

Figure 5. Application viewer of the Climatic suitability and seasonal activity of the tiger mosquito for Europe data product – Suitability index over the territory of Bulgaria at regions level, visualized for climate change scenario RCP4.5. On the right side is the detailed information for the Burgas region. The purple and green lines visualize the suitability index according to the two IPCC climate change scenarios RCP8.5. and RCP 4.5.

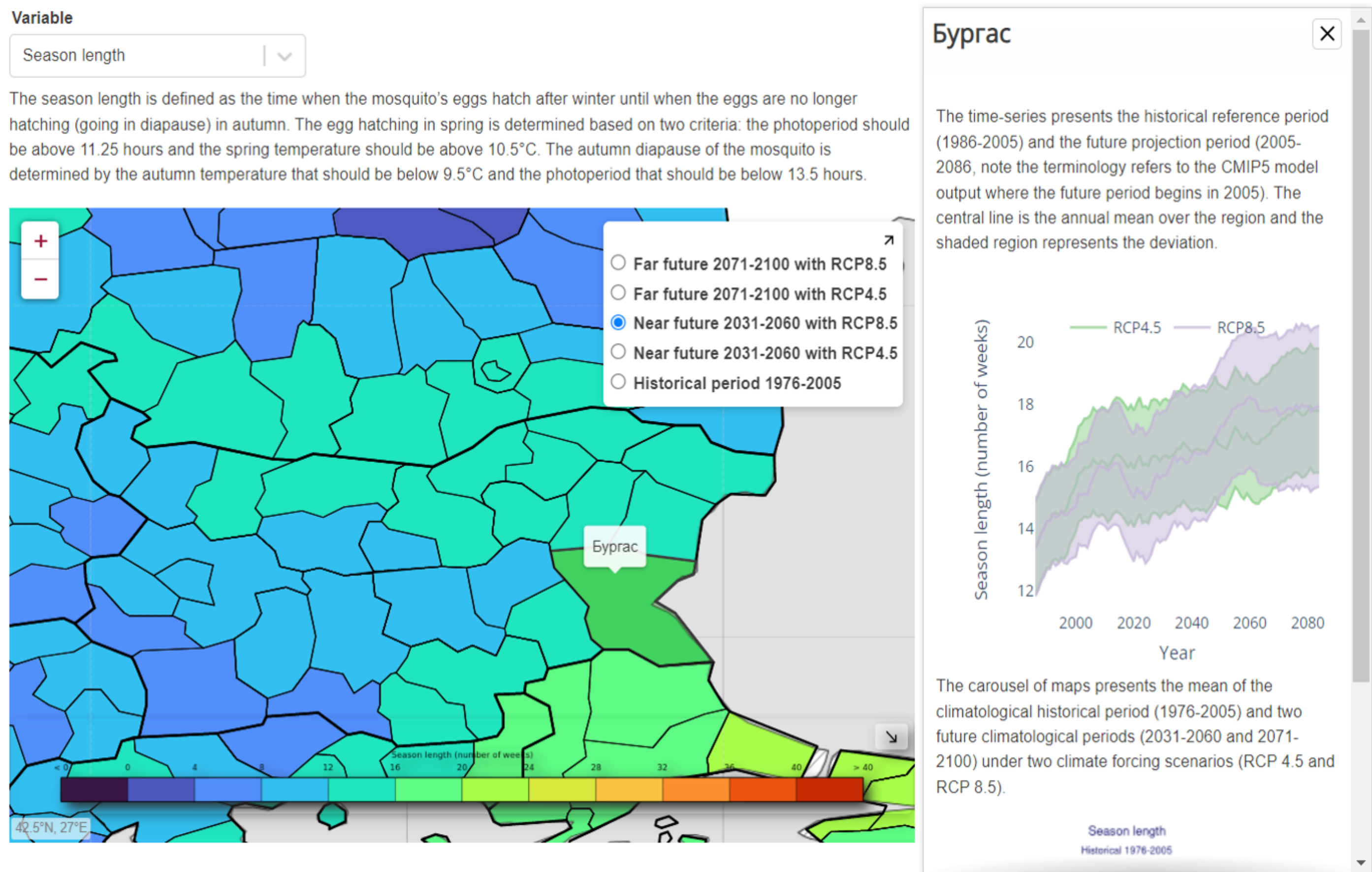

Figure 6. Season length visualization for Burgas region, according to IPCC's RCP8.5 climate change scenario for 2031 – 2050.

According to climate change scenarios, nearly half of Bulgaria will likely be affected by tiger mosquitoes by 2080. This information can be used by regional and municipal administrations to conduct information campaigns, create plans for disease prevention and protection of the population from infectious diseases.

3.2 Number of heat wave days for Bulgaria derived from climate projections

The results generated by the application (Fig. 7.) represents the number of heat wave days experienced in Europe for both the historical period 1976–2005 and the projected 30-year periods 2031–2060 and 2071–2100 under different climate change scenarios. A heat wave is defined as a prolonged period of extremely high temperature for a particular region. Two European definitions are used: the Climatological EURO-CORDEX definition, and a Euroheat project definition, as well as one set of specific country definitions available for a limited number of European countries.

Maps visualize the total number of heat wave days that will occur in a year for given definitions: climatological EURO-CORDEX, Euroheat project & national definitions, according to the IPCC's RCP4.5 and RCP8.5 scenarios. The historical period 1976-2005 shows that for the whole territory of Bulgaria there were 0 to 5 heatwave days.

The pessimistic EURO CORDEX's RCP8.5 scenario demonstrates 10 to 20 heat wave days a year for the southern part of the Struma valley for the near future period (Fig. 8.).

The maps are interactive and users may focus on a particular country or administrative region by selecting it. When a country or administrative region is selected, a window opens focusing on this region as well as displaying a time-series of the 30-year running mean, with upper and lower confidence intervals, of the number of heat wave days per year for this region. These functionalities make the data easy to use and apply in the process of planning for future disaster protection. The application visualizing Heat wave days for Europe derived from ERA5 reanalysis' data can be used in conjunction with the data described above to achieve a more complete description of the picture regarding the threat of heat waves in Bulgaria.

3.3 Temperature statistics for Bulgaria derived from climate projections

The results derived from the application show that the upper limit of the mean annual near-surface temperature for the whole country is 10.6°C in 1986. The pessimistic RCP8.5 scenario shows changing to 14.7°C mean temperature in 2084. Yugozapaden (Southwest) region, part of which is a mountainous with peaks above 2000 m above sea level, visualizes warming from 9.0 °C (upper limit of the mean temperature) in 1986 to 13.7°C upper limit of the mean annual near-surface temperature, according to RCP8.5 scenario. The overall data for Bulgaria, for the year 2030, according to the regions shown on the map is presented in Table 1.

The data shown in Table 1 indicates the need to take measures related to the impact of these temperature changes and to reflect them in the development and updating of municipal plans, especially given that the data for the long term are even more disturbing.

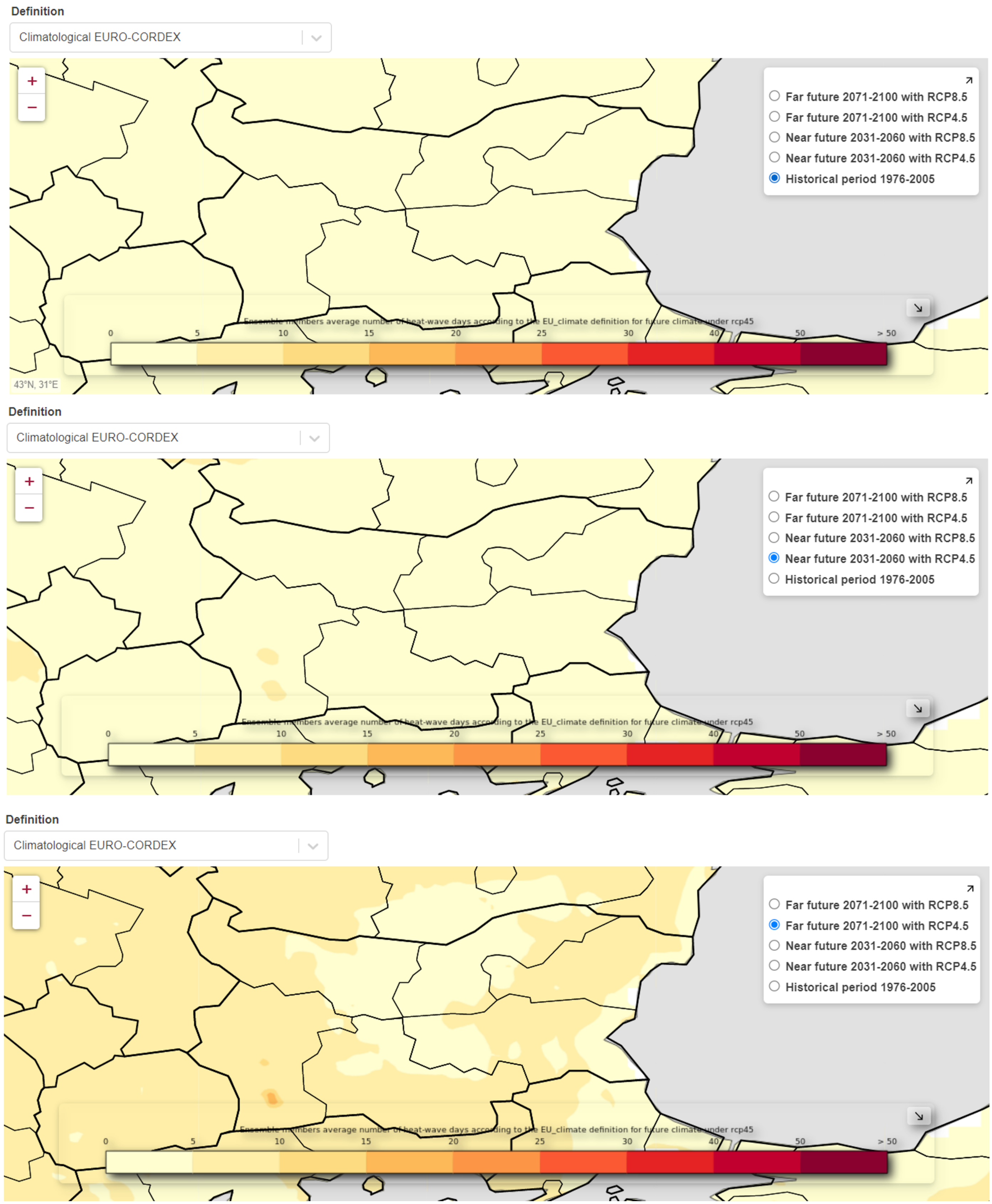

Figure 7. EURO CORDEX's RCP4.5 maps 5 to 10 days a year for the period 2031 – 2060 for a small region in the Struma valley in Southwest part of the country. The far future period 2071 – 2100, same scenario, shows that the same area will have 20 to 25 days a year and most of the country will have 10 to 15 days a year.

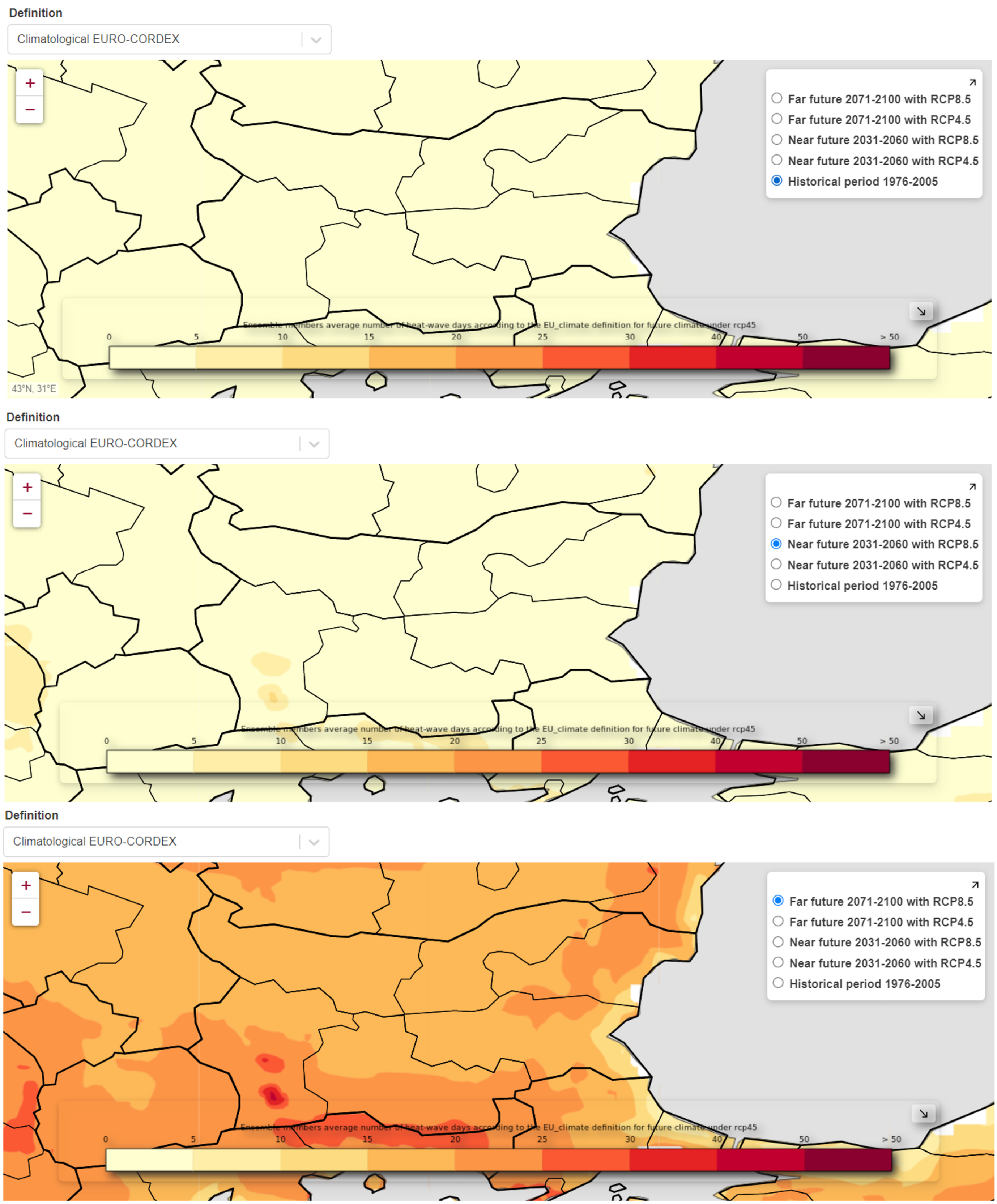

Figure 8. The far future period 2071-2100 with RCP8.5 maps worrying picture - the areas along the Struma Valley will have hot waves lasting between 25 and 50 days a year, the southern parts of the country and part of Dobrudja – 20 - 25 days a year, and the rest of the country, with the exception of small linear area near the Black Sea coast, will have between 15 and 20 heat wave days a year.

Table 1. 2030 year's expected annual mean temperatures in Bulgaria's NUTS2 regions.

NUTS 2	RCP4.5 2030 (°C)			RCP8.5 2030 (°C)		
	Upper limit	Mean	Lower limit	Upper limit	Mean	Lower limit
Severozapaden (Northwestern)	12.2	12.0	11.7	12.5	12.2	11.9
Severen tsentralen (Northern Central)	12.2	12.0	11.8	12.5	12.2	12.0
Severoiztochen (Northeastern)	12.5	12.3	12.1	12.8	12.6	12.3
Yugoiztochen (Southeastern)	12.8	12.5	12.3	12.5	12.8	13.0
Yugozapaden (Southwestern)	10.3	9.9	9.5	10.6	10.1	9.7
Yuzhen tsentralen (Southern Central)	11.6	11.3	11.0	11.8	11.5	11.2

3.4 Urban Climate Statistics and Heat Island Effect for Bulgaria

The data available for Bulgaria covers Sofia and Varna and includes Summer/ Winter visualizations for variables minimum and maximum temperature, specific and relative humidity and surface wind speed. The annual/ seasonal statistic may be the mean or 10th, 25th, 50th, 75th, 90th percentile.

Table 2 shows selected values for the cities of Sofia and Varna, which are downloaded in tabular form from the application. The data allows additional value to be added to local terrestrial climate measurements or as a supporting material in the implementation of the recommendations of the National Climate Change Adaptation Strategy and Action Plan.

Table 2. Example of data available for download - summer mean temperatures, 90th percentile data for Sofia and Varna.

Year	Mean temperature in Sofia (°C)	Mean temperature in Varna (°C)
2008	25.50415	26.11455
2009	24.68458	25.59354
2010	26.29695	28.10253
2011	25.48755	25.50209
2012	28.3389	28.04578
2013	25.70482	25.41671
2014	24.59677	26.1023
2015	26.23322	26.6664
2016	25.59587	26.72649
2017	27.28037	26.36896

Urban heat island intensity for Bulgarian cities from 2008 to 2017 derived from reanalysis

The results presented in figure 9 show the UHI effects modelled for the period 2008-2017 for the cities of Sofia and Varna. This dataset is providing additional information to stakeholders on the negative effects of UHI in Sofia and Varna, which can lead to better decision making for limiting the negative health effects of this phenomenon.

3.5 Date of birch pollen season onset from 2010 to 2019 for Bulgaria

The results derived from the web application presents the onset date of birch pollen for the period 2010 to the last full year of ERA5 reanalysis, that is available (Fig. 10.). In Northern and Central Europe, birch pollen is one of the most common airborne allergens in the spring.

Risk management in relation to the spread of allergic reactions is a specific topic, which can, however, be found in strategic documents on the subject in the EU, as stated in Appendix 5 of the National Strategy for Adaptation to Climate Change and Action Plan - for example, the 2012 Climate Change Adaptation Strategy of the Republic of Austria. The presence of pollen in Bulgaria and their impact on human health can be predicted, modeled and mapped through satellite and terrestrial data.

All data available in the C3S are scientifically proven, with a high reputation, objectivity and could be considered reliable. The fact that Copernicus data is by definition "*full, free and open*" allows anyone interested to freely access, use and apply it in their work. Disaster protection plans developed in Bulgaria often include only a few major types of disasters - e.g. floods, earthquakes, fires. In the data examined in the study, one can see various aspects of the study of human health, concerning the modeling with geospatial data of climate elements, invasive species and others. This shows the extreme interdisciplinarity in terms of understanding, using and actual application of this data in practice.

As a key point and in our opinion, one of the biggest challenges to the application of these data in the development of disaster protection plans, is the lack of public awareness of their existence, use and application.

4. Discussion and conclusions

Climate change is expected to have a far-reaching and significant impact on human health and biodiversity, as well as on the economy, including agriculture, energy, forestry, tourism, transport, urban infrastructure, water supply and many other sectors. The use of reliable and scientifically sound spatial data in the development of disaster protection plans and programs can play a key role in terms of their relevance and reliability, precisely because of the challenges in modeling climate change and its impact on the territory.

Disaster protection plans are established and implemented at local, regional and national levels in Bulgaria. They are developed by the members of the municipal and district councils and are specific to the dangers in their area. The National Climate Change Adaptation Strategy and Action Plan from 2019, has adopted different climate change strategies for government sectors, such as health, environment, transport, etc. Climate data visualizations provided by C3S enable users to obtain climate change data needed to inform stakeholders involved in the development of disaster risk reduction plans. This data is critical for multiple sectors, particularly at a time when their exposure to climate change increases.

The next logical step to raise the awareness of experts dealing with disaster issues is to conduct surveys according to the methodology described in the present study (Wang and Strong, 1996). In this way, the necessary actions needed by experts to make wider use of service data and thus improve the quality of disaster protection plans can be assessed by implementing up-to-date and scientifically based publicly available data showing the impact of climate change of different parts of the country.

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