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# PATH TOWARDS CLIMATE CHANGE-RELATED INDICATORS AND STATISTICS IN SLOVENIA

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***Abstract***

*In this article, the author discusses the initial steps of development of climate change-related indicators – from reviewing the methodologies, searching available data, analysing the suitability of calculated indicators, to forming a framework of the first experimental set of climate change-related indicators. Their calculation is based on the methodology laid down in the Set of Core Climate Change-related Indicators and Statistics, which was prepared by the UNECE Task Force. The work highlights the significance of climate change-related indicators in understanding and addressing environmental changes, which are being witnessed more and more with each year.*

## I. INTRODUCTION

1. Although Slovenia is a rather small country with an area of just over 20,000 km$^2$, three climate types intertwine in its territory: submediterranean climate in the southwestern coastal region, subcontinental climate prevailing in the lowlands, and mountainous climate in the higher regions. Due to increasingly severe climate events (droughts, floods, heat waves, shortages of drinking water in the coastal areas in the summer, wildfires, etc.), the awareness of climate changes and with it the public interest have been rising in the past few years in Slovenia as well. Moreover, the growing need and demand for environmental and climate change-related data dictate the development and further upgrade of data availability on this topic.

2. The Statistical Office of the Republic of Slovenia (SURS) started more in-depth work on climate change-related indicators in 2020, when it received an invitation from the United Nations Statistics Division (UNSD) to participate in the implementation of the pilot-test task. At the end of 2021, SURS started developing a draft set of climate change-related indicators for Slovenia. In the second half of 2023, it intends to publish the first news and data release with an experimental set of climate change-related indicators on its official website.

## II. LEARNING THE METHODOLOGY AND GETTING TO KNOW THE SET OF CLIMATE CHANGE-RELATED INDICATORS

3. The first contact with the climate change-related indicators was in 2020, when SURS responded to UNSD's invitation and participated in the pilot-test task of reviewing and supplementing the draft set of

more than 170 climate change-related indicators. These indicators were divided into five groups – drivers, impacts, vulnerability, mitigation and adaptation. Three employees from SURS were involved in this mission for over a month. For each indicator, this group had to determine data sources, the existence of the methodology, possible upgrades/changes, and whether the indicator had already been included in any of the other, already existing international sets of indicators. Participating in this thorough and intensive review enabled SURS to be informed about the initial extent of the set of climate change-related indicators, and to be prepared for future development. With this step, SURS also carried out the first review of existing methodologies and availability of data for a possible Slovenian set of climate change-related indicators.

4. The next step took place when a new, updated set of UNSD indicators was released in 2021, where SURS also participated by completing the requested UNSD's questionnaire. Upon review, a global set of climate change-related indicators and statistics was introduced. Later in the same year, at the Conference of European Statisticians (CES), a special working group under the UNECE auspices presented a basic set of 44 internationally comparable climate change-related indicators and statistics.

5. Before preparing the national set of climate change-related indicators for Slovenia, SURS closely reviewed both sets (UNSD and CES). A special list with additional important information was made for each indicator. Pieces of information that proved the most valuable for further development were the availability of data, the name of the institution that collects or could collect these data, and information if the methodology has already been developed. This list was also the main decision-making tool for SURS when the preparation of the national set started. Since the time frame for this task had already been extended due to special health measures introduced in the country due to the covid-19 pandemic and their impact on regular work, and because SURS wanted to prepare the first set in 2023, it was decided to lean on the indicators that could be calculated from the available statistical data or available data from other national or international institutions. Based on the findings, it was also decided that a draft set of indicators will follow CES recommendations. In the first step the set of selected national indicators will cover 20 of the 44 proposed indicators and will provide an insight into the current situation in Slovenia.

## III. SELECTION OF THE CLIMATE CHANGE-RELATED INDICATORS

6. Climate change-related indicators encompass a broad spectrum of measurable parameters, including temperature changes, greenhouse gas emissions, sea-level rise, extreme weather events, and shifts in ecological patterns. By monitoring and analysing these indicators, countries can gain vital insights into the evolving climate patterns and their potential impacts on ecosystems, human societies, and the economy.

7. In line with the decision to follow the CES recommendations, methodology and available metadata for indicators prepared by the UNECE Task Force, the framework for climate change-related indicators was made. SURS followed the structure and hierarchy of the five climate change-related areas called drivers, emissions, impacts, mitigation and adaptation. Already at the beginning of the process of indicator selection, it was identified that the number of indicators will be the highest in the first and the second areas. The drivers area focuses on human causes of climate change that deal with sources of emissions, while the emissions area covers GHG emissions and their human causes.

8. In Slovenia, environmental accounts and energy statistics have been developing for quite some time, so the availability of data for calculating drivers and emissions areas indicators was not quite as questionable as for the remaining three. Namely, the number of indicators produced in the following

three areas (impacts, mitigation and adaptation) was not as high as expected. The impacts area deals with the impacts of climate change on human and natural systems, the mitigation area shows efforts of humans to avoid the consequences and the last area adaptation gives us an insight into efforts to adapt to the consequences. For all three of these areas, data coverage is not provided only by SURS, but must be obtained and methodologically coordinated with other institutions. Since this process requires more time for successful implementation, these last areas still need improvement and will be further developed in the near future.

## A. Drivers

9. For the drivers area, in the first step data for five indicators were selected. The indicators were calculated in line with the methodology proposed by the UNECE Task Force in the document "Metadata for the set of core climate change-related indicators and statistics (add. 2)". The indicators on drivers were prepared based on data calculated from environmental accounts statistics and energy statistics. The indicators total energy use by the national economy, total energy intensity of production activities of the national economy, and energy use by resident households per capita were calculated based on the physical environmental flow accounts data. The indicators total primary energy supply (TPES) and share of fossil fuels in total primary energy supply (TPES) were prepared according to data from the energy balances statistics. Due to lack of information, the methodological framework, and the fact that the proposed indicator share of fossil fuels in total energy use by the national economy is still being developed, its calculation has not been possible yet. For each indicator, the longest possible time series of data was calculated.

*Table 1: Set of drivers indicators*

| DRIVERS | TIME SERIES |
|---|---|
| Total energy use by the national economy | 2008–2020 |
| Total primary energy supply (TPES) | 2000–2021 |
| Share of fossil fuels in total primary energy supply (TPES) | 2000–2021 |
| Total energy intensity of production activities of the national economy | 2008–2020 |
| Energy use by resident households per capita | 2008–2020 |

## B. Emissions

10. According to the Paris Agreement, which entered into force in 2016, the countries that are Parties to the United Nations Framework Convention on Climate Change committed to a binding target of a net domestic reduction of at least 55% in greenhouse gas emissions by 2030 compared to 1990. Currently, emissions are the area with the highest number of indicators calculated for Slovenia. This group of indicators measures the amount of GHG emissions and what their human causes are. The need for information in this topic is perhaps even more important than the availability of data sets. Therefore, SURS calculated some indicators according to both, national and residential principles: e.g. GHG emissions in the national territory as well as GHG emissions of its residential entities. The methodological basis for data calculation of eight indicators was mostly SEEA air emission accounts.

*Table 2: Set of emissions indicators*

| EMISSIONS | TIME SERIES |
|---|---|
| Total greenhouse gas emissions from the national economy | 2008–2021 |

| | |
|---|---|
| Total greenhouse gas emissions (excl. LULUCF) from the national territory | 1986–2021 |
| $CO_2$ emissions from fuel combustion attributable to the national economy | 2008–2020 |
| $CO_2$ emissions from fuel combustion within the national territory | 1986–2021 |
| Greenhouse gas emissions from land use, land use change and forestry (LULUCF) | 1986–2021 |
| Total greenhouse gas emissions from production activities | 2008–2021 |
| Greenhouse gas emission intensity of production activities | 2008–2021 |
| Direct greenhouse gas emissions from households | 2008–2021 |

## C. Impacts

11. One of the areas with fewest calculated indicators in SURS's experimental draft set is impacts. According to the CES Set of Core Climate Change-related Indicators and Statistics, it consists of several indicators measuring direct consequences of nature's extreme climate phenomena and its effects on human and natural systems. In the early phase, data were available for calculating the indicators mean temperature anomaly (compared to climate normal 1961–1990) and the level of water stress: freshwater withdrawal as a proportion of available freshwater resources.

12. The indicator of temperature anomalies was calculated by the Slovenian Environment Agency (ARSO). During its calculation it was determined that the methodological explanations and respective metadata were not consistent. In the title of the indicator – as in the base period – climate normal refers to 1961–1990, while in the methodology references (WMO Guidelines on the Calculation of Climate Normals) the base period is expected to be 1981–2010. For the first experimental release, data for this indicator were recalculated to the base period 1961–1990. However, the final calculation of this indicator and which base period to use remains open for future discussion. Data for the level of water stress indicator were obtained from the Aquastat database (maintained by FAO).

*Table 3: Set of impacts indicators*

| IMPACTS | TIME SERIES |
|---|---|
| Mean temperature anomaly (compared to climate normal 1961–1990) | 2000–2021 |
| Level of water stress: freshwater withdrawal as a proportion of available freshwater resources | 2002–2020 |

## D. Mitigation

13. Human efforts for avoiding the consequences of extreme climate events are investigated in the fourth area of climate change-related indicators called mitigation. Data availability enabled the calculation of the indicators share of energy from renewable sources in gross final energy consumption, the share of energy and transport related taxes in total taxes and social contributions, and net emissions/removals of carbon dioxide by forest land from the national territory.

14. Data for calculating the indicator share of energy from renewable sources in gross final energy consumption were prepared according to the energy statistics survey. The share of energy and transport related taxes in total taxes and social contributions was calculated from environmental taxes accounts, and the data for net emissions/removals of carbon dioxide by forest land from the national territory were based on emission inventories on land use, land change use and forestry (LULUCF) data obtained from ARSO. SURS also considered calculating the indicator renewable energy share in total energy use by the

national economy, but due to the methodological framework, lack of information, and the fact that the indicator is still being developed, its value could not be calculated accurately at this point.

*Table 4: Set of mitigation indicators*

| MITIGATION | TIME SERIES |
|---|---|
| Share of energy from renewable sources in gross final energy consumption | 2004–2021 |
| Share of energy and transport related taxes in total taxes and social contributions | 2008–2021 |
| Net emissions/removals of carbon dioxide by forest land from the national territory | 1986–2021 |

### E. Adaptation

15. The last area deals with human efforts for adapting to the consequences of extreme climate changes. Although only two indicators were calculated, they present a half of all indicators currently listed in this area of the CES Set of Core Climate Change-related Indicators and Statistics.

16. The indicator change in water use efficiency over time was obtained from the online Aquastat database (maintained by FAO). The preparation of data for calculating the proportion of agricultural area under productive and sustainable agriculture indicator does not fully adhere to metadata from CES. In the phase of data preparation and methodology evaluation, it was discovered that according to the CES methodology the indicator should be calculated as the ratio of area under productive and sustainable agriculture to the total agricultural area. Through discussion with national experts in the field of agricultural land use, it was decided that for this indicator the same methodology that Slovenia had used for calculating the SDG indicator "share of utilized agricultural areas with organic farming or in conversion" should be used. Consequently, the indicator is defined as the share of total utilized agricultural area occupied by organic farming (existing organically farmed areas and areas in the process of conversion).

*Table 5: Set of adaptation indicators*

| ADAPTATION | TIME SERIES |
|---|---|
| Change in water use efficiency over time | 2010–2020 |
| Proportion of agricultural area under productive and sustainable agriculture | 2004–2021 |

## IV. CONCLUSION

17. Climate change is one of the most pressing global issues of our time, with far-reaching consequences for ecosystems, human societies, and the planet's overall well-being. To comprehend and effectively address this complex phenomenon, the use of climate change-related indicators has become imperative. These indicators serve as crucial tools for scientists, policymakers and the public to monitor, analyse, and respond to the changing climate and its impacts.

18. Climate change-related indicators play a central role in guiding the countries' responses to climate change. With the implementation of indicators, SURS is actively paving the way towards regular calculation of indicators and their future dissemination through accessible channels. Nevertheless, the work is not done yet and a lot of development still needs to be carried out. One of the most important next steps is expected to be SURS's cooperation with other national institutions (e.g. ARSO, National Institute of Public Health, etc.) as well as, if needed, international institutions. Another key goal is an increase in the number of indicators. In the first step, the set of twenty climate change-related indicators

was calculated for Slovenia. It will be published in the form of a first release on SURS's official website in the coming weeks.

## V. REFERENCES

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