

Shared Socioeconomic Pathways (SSPs) literature database 2014-2019 v1

Methodology and Definitions

October 11, 2020

This document describes methodology and definitions for the SSP Literature Database v1:

Green, C., D. Carlisle, B. C. O'Neill, B. J. van Ruijven, C. Boyer, and K. Ebi. 2020. Shared Socioeconomic Pathways (SSPs) literature database 2014-2019 v1 (preliminary release). Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). <https://doi.org/10.7927/HN96-9703>. Accessed DAY MONTH YEAR.

A slightly abbreviated version is included as part of the supplementary information in:

Achievements and needs for the climate change scenario framework, 2020, Nature Climate Change, by Brian C. O'Neill, Timothy R. Carter, Kristie Ebi, Paula A. Harrison, Eric Kemp-Benedict, Kasper Kok, Elmar Kriegler, Benjamin L. Preston, Keywan Riahi, Jana Sillmann, Bas J. van Ruijven, Detlef van Vuuren, David Carlisle, Cecilia Conde, Jan Fuglestedt, Carole Green, Tomoko Hasegawa, Julia Leininger, Seth Monteith, Ramon Pichs-Madruga

The full version of this document is included as the documentation of the SEDAC SSP Literature Database v1, sent to SEDAC on October 9, 2020. It includes a description of the literature database generation, the process of coding, and definitions used in the coding.

Literature Database Generation

Initial versions of the analysis of literature were carried out using a database developed by the International Committee on New Integrated Climate change assessment Scenarios (ICONICS, Publications Library, <https://depts.washington.edu/iconics/publications/>). The final version of the database was generated using a single Google Scholar search that captured the ICONICS database citations, filled in gaps, and extended results to a wider range of publications. That search used the search string “shared socioeconomic pathways’ OR ‘shared socio-economic pathways’ OR ‘shared socioeconomic pathway’ OR ‘shared socio-economic pathway” with a timespan of 2014-2019. It resulted in 4,353 papers that potentially used the SSPs.

Papers that made substantive use of the SSPs (defined below) were then identified from this set of potential SSP publications. First, the 586 citations in the ICONICS database as of October, 2019, were identified as using the SSPs. The ICONICS database is generated from an ongoing, automated search of Google Scholar using the phrase “Shared Socioeconomic Pathways”. References produced from that search are examined individually by the ICONICS database team and retained if they make substantive use of the SSPs.

Next, the remaining 3,767 papers in the larger set of potential SSP publications were then checked for SSP use, yielding an additional 802 relevant papers. Final coding checks of various types (see Coding below) led to removal of an additional 28 papers. Thus, the final version of

the database captured a total of 1360 papers dating from 2014 through the end of 2019. Note that the database includes 15 papers from 2013 and one paper from 2012 that were either returned in the Google Scholar search for 2014-2019 or were part of an extended version of the ICONICS database developed at an interim stage. While relatively few papers using SSPs were published from 2012-2013, this database does not include all the papers from this period.

The database includes peer reviewed publications (journal papers, book chapters) as well as gray literature (working papers, reports, substantial conference proceedings, etc.). It does not include chapters of major assessment reports such as those from the Intergovernmental Panel on Climate Change. We retained, but did not code, 209 publications in non-English languages, due to lack of resources, and 7 publications that we could not obtain access to. Papers were retained if they made substantial use of the SSPs (many also used the RCPs, but retention was based on SSP use). "Substantial use" included use of components of the basic SSPs (narratives, quantitative projections), their extensions (regional or sectoral), and/or IAM scenarios based on the SSPs. It included papers that used these aspects of the SSPs primarily for comparison to other information if that comparison was a central element of the study. It included review papers if SSPs (or the framework) was used to organize results or draw conclusions. It included drawing on the SSP-RCP framework in assessing or critiquing scenario approaches. It also included papers that planned future work if the use of SSPs if that planning was substantial. It did not include papers that only referred to SSPs incidentally. It also did not include papers that used SSP emissions and land use scenarios only to drive climate model outcomes to study the climate system.

CODING

Each paper was then coded along a number of different dimensions.

- Four categories of types of papers or analysis: SSP Development, Scenario Methodology, SSP Applications, SSP Extensions
- A number of subcategories for SSP Applications and SSP Extensions
- The particular SSP(s) used, including which SSP elements, SSP-based integrated assessment model (IAM) scenario elements, or SSP extensions were used
- The particular RCP(s) used, focused on the four RCPs originally defined for 5th Phase of the Coupled Model Intercomparison Project (CMIP5)
- The particular SSP-RCP combinations used, including concentration pathways from both CMIP5 and CMIP6

Coding was carried out by co-authors David Carlisle, Carole Green, and Brian O'Neill, with supervision by O'Neill. Carlisle and Green carried out an initial coding of about half the papers each. A number of different checks on results were then carried out by all three, for internal consistency of results, spot-checking of particular categories of papers to ensure consistency of interpretation of category definitions, and a cross-check of 10% of papers by Carlisle and Green for consistency of coding between coders.

Definitions for categories of papers

SSP papers are assigned to one of four broad categories: (1) SSP Development, (2) Scenario Methodology, (3) SSP Applications, and (4) SSP Extensions. In a small number of cases papers were assigned to more than one category when the paper contributed in equally important ways to different areas. For example, some papers developed a new method, or a new SSP extension, and then applied it to a particular sector. We therefore distinguish two kinds of totals for the database: total number of papers categorized and total number of analyses, in which the latter may exceed the former.

SSP Development. Papers that contributed to the initial creation of the basic SSPs including the conceptual framework, narratives, and quantitative elements (population, education, GDP, urbanization). These papers were not included in the set on which figures 1 and 2 in the main text were based.

Scenario Methodology. Methods for scenario development, application, or extension, including regional extensions. Also includes critiques of SSPs or their use. Includes papers that plan study designs for analyses based on SSPs, for example climate model comparison exercises driven by SSP emissions and land use scenarios. A paper can be coded as containing analyses that fall both within methodology and applications (or extensions), for example if the paper develops a new method and applies it to a specific topic area.

SSP Application. The use of SSPs to analyze a particular topic. If the study addresses more than one topic, but has a primary focus on one of them, it is categorized under that primary topic. An important determinant of the primary focus of an article was the prominence of a topic(s) in the title or abstract. If a publication addresses more than one issue equally, it is categorized as either “Multiple impacts,” or “Multiple drivers” (defined below), and we separately code the multiple topics included in the analysis (although this information is not used in the analysis in this paper). For the purposes of Figure 1 in the main text, we combined these two categories into a single “Multiple topics” category.

SSP Extensions. SSP extensions add either qualitative or quantitative information to the basic SSPs in order to extend the framework’s applicability to different scales, sectors, or issue areas. A paper is coded as creating an extension when its primary purpose is to develop information consistent with SSPs that can be used by other researchers. Papers can be coded as containing analyses that fall both within SSP extensions and applications, for example if an extension is created and then applied to a specific topic in the same paper. A paper can also be categorized as creating more than one type of extension, if for example it creates both a spatial population and income extension.

Definitions for subcategories of SSP Applications

Emissions. Future emissions of greenhouse gases or other radiatively active species, including mitigation analyses. This category includes the development or analysis of projections with or

without emissions reduction policy or the impacts of climate change, and includes those focused on the costs of emissions reductions. It also includes studies of Solar Radiation Management as an approach to reducing climate change. It does not include papers that use existing emissions projections to carry out analyses of other topics, such as the difference in climate change impacts between alternative emissions scenarios.

Energy. Energy production or use, including use of fossil fuels, renewables, bioenergy, nuclear, or other sources. Also includes issues of energy efficiency, access, and energy poverty, as well as impacts of climate change on energy systems. Papers that include energy projections but whose main focus is on emissions consequences are categorized under Emissions.

Land Use. The use of land for agriculture, forestry, urbanization, or other sectors. Includes studies of impacts of climate change on land use. Papers that include land use but whose main focus is on outcomes for agricultural production are categorized in Agriculture. Those whose main focus is on emissions outcomes are categorized under Emissions.

Agriculture. Agricultural systems, the production of agricultural products, climate change implications for yield, aspects of food security, livestock, and fisheries. It also includes forestry when the focus is on the production of forest products. If a paper focused on health implications of impacts on agriculture, and health was the primary outcome of interest, it was categorized in Health. Papers on hunger were categorized in Agriculture. If it was focused on the amount of land used for agriculture, it was categorized in Land use.

Water Supply/Demand. Effect of climate and/or societal change on the supply or demand for water. Includes topics such as impacts on streamflow, population in water stressed conditions, water use for agriculture, and adaptation including desalinization. Also includes papers on water quality for human use and water, sanitation, and hygiene (WASH). Irrigation is included in water demand when the authors' focus is on the water demand from irrigation. If it is focused on the outcome of agriculture from irrigation, it was classified under agriculture.

Water Hazards. Natural disasters related to water, including most prominently floods and their impacts. If the focus is specifically on floods in coastal areas, the paper was categorized under Coastal/SLR.

Health. Effects of societal and/or climate change on human health, including malnutrition through obesity or hunger, heat morbidity or mortality, children's health, or the effects of air pollutants. These analyses frequently include emissions or land use, but were categorized in Health if the primary outcome of interest was health-related.

Multiple Impacts. A roughly equal focus on more than one type of impact. If the study addresses more than one issue, but has a primary focus on one of them, it is categorized under that primary topic. If it addresses more than one impact equally, it is categorized as "Multiple impacts". Some publications may address multiple topics spanning both impacts and drivers (see next application type) and are coded as one or the other of the multiple topic categories

according to the predominant focus of the publication. An important determinant of the primary focus of a publication was the prominence of a topic(s) in the title or abstract. We separately track which multiple topics were included in the publication (although this information is not used in the analysis in this paper).

Multiple Drivers: A roughly equal focus on more than one driver, typically emissions, energy, or land use. Similar to Multiple Impacts, this category was chosen if the drivers were equally addressed. Some publications may address multiple topics spanning both impacts and drivers (see previous application type) and are coded as one or the other of the multiple topic categories according to the predominant focus of the publication. An important determinant of the primary focus of a publication was the prominence of a topic(s) in the title or abstract. We separately track the multiple topics included in the publication (although this information is not used in the analysis in this paper).

Living Standards. Economic effects at various scales, ranging from the macroeconomics of GDP, labor productivity, welfare, multiple industries, to household income or livelihoods. Analyses focused on impacts on the poor were categorized in Poverty.

Ecological. Changes in marine, coastal, or terrestrial ecosystems or biotic communities. This included but was not limited to changes within forests, animal populations, water systems (including eutrophication), or plant growth.

Other. A focus on any other impact beyond those listed above, used to aggregate across categories with substantially fewer entries. Any paper coded as “Other” was also categorized in one of the categories that follow.

Population. Studies of demographic processes or outcomes, including population growth, urbanization (when it applies to population as opposed to land use), ageing, and education. Papers that focus on demographic determinants of other outcomes (emissions, welfare, impacts) are categorized under those other outcomes.

Poverty. Effects of societal and/or climate change on the poorest sub-populations.

Tourism. Effects on the tourist industry.

Material Flows. The supply, demand, trade, or other flows of materials in physical units, including construction materials or materials used to produce solar panels or other energy infrastructure.

Coastal/SLR. Effects of societal and/or climate change on coastal regions, including the effects of sea level rise. Includes impacts on people, property and infrastructure due to inundation or flooding.

Conflict. Effects of societal and/or climate change on conflict including violent or non-violent. Includes crime.

Waste. Effects of societal and/or climate change on waste and sanitation.

Fire. Effects of societal and/or climate change on fire occurrence and its consequences.

Perception. Potential changes in how the climate is perceived by individuals or nations.

Miscellaneous: Topics for which no other subcategory was appropriate. The topic was then listed in a comments column in the database. An example is open ocean pollution, a topic that does not fit within the coastal/SLR or other subcategories.

SDGs: Analyses related to the Sustainable Development Goals (SDGs) or closely related indicators. This designation was generally used in parallel to other application subcategories in order to be able to identify papers that address the SDG topic. For example, a study of climate and health that also measured outcomes in terms of progress toward health-related SDGs was coded as both a health application and an SDG application, but not as a multiple impacts paper. A handful of papers were solely marked as an SDG application, when their only focus was sustainable development.

Definitions of subcategories of SSP Extensions

Regional. The development of additional qualitative and/or quantitative information at the regional or local level that enables the application of SSPs at that scale, and that is created with the intention that the broader community of researchers could draw on that information for their own analyses.

Population. The development of additional qualitative and/or quantitative demographic information consistent with the SSPs, created with the intention that the broader community of researchers could draw on it for their own analyses. Includes sub-national projections of population, urbanization, or age structure, and national-level projections of urban land.

Economics. The development of additional qualitative and/or quantitative economic information consistent with the SSPs, created with the intention that the broader community of researchers could draw on it for their own analyses. This includes sub-national GDP or income distributions, and national-level measures of inequality.

Other. Any other type of extension beyond regional, population, or economics extensions, used to aggregate across categories with substantially fewer entries.

Health. The development of additional qualitative and/or quantitative health-related information consistent with the SSPs, created with the intention that the broader community of researchers could draw on it for their own analyses.

Forests. The development of additional qualitative and/or quantitative forestry-related information consistent with the SSPs, created with the intention that the broader community of researchers could draw on it for their own analyses.

Infrastructure. The development of additional qualitative and/or quantitative infrastructure-related information consistent with the SSPs, created with the intention that the broader community of researchers could draw on it for their own analyses. Includes changes in buildings and road networks.

Oceans. The development of additional qualitative and/or quantitative information related to oceans consistent with the SSPs, created with the intention that the broader community of researchers could draw on it for their own analyses.

Water. The development of additional qualitative and/or quantitative information related to freshwater consistent with the SSPs, created with the intention that the broader community of researchers could draw on it for their own analyses. This refers to

Energy. The development of additional qualitative and/or quantitative information related to energy with the SSPs, created with the intention that the broader community of researchers could draw on it for their own analyses. Includes extensions of narratives to support quantification of energy-related assumptions in integrated assessment models.

Use of specific SSPs, their elements, and extensions

Papers were coded according to which SSP(s) were employed in the paper, along with which SSP elements (narratives or specific quantitative elements), SSP extensions, and, if the study drew on IAM scenarios based on the SSPs, which elements of the IAM projections were used.

SSP Used. Records the use of one or more of the five SSPs, where “use” indicates that a paper not only mentioned a particular SSP but used one or more of its elements in the analysis. This included uses of the SSPs for the purposes of comparison to results of an analysis that did not draw on the SSPs, if this comparison was an important element of the paper.

SSP Elements Used. SSP elements include the narratives as well as the quantitative elements (population, education, urbanization, GDP).

Narratives. The SSP narratives as described in O’Neill et al. (2017). Use included drawing on the narratives or further interpreting them to support assumptions in or approaches to a particular analysis.

Population. The national-level population projections from KC and Lutz (2017), including their age and sex structure.

Education. The national-level educational attainment projections from KC and Lutz (2017), including their age and sex structure.

Urbanization - The national-level urbanization (percent urban population) projections from Jiang and O'Neill (2017).

GDP. The national-level projections of Gross Domestic Product (GDP) from Dellink et al. (2017), Leimbach et al. (2017), or Crespo et al. (2017).

SSP extensions used. Records the use of SSP extensions in an analysis. This category differs from the “SSP extensions” category described above in that it indicates which papers use, rather than develop, extensions to the SSPs. For the types of extensions used, refer to the definitions of subcategories of SSP extensions above.

Use of IAM elements

Papers were coded according to whether they used specific outputs from the SSP-based integrated assessment model (IAM) scenarios that provided the initial quantification of energy, emissions, and land use associated with the SSPs. These IAM outcomes are provided in the publicly accessible SSP Database hosted by IIASA (<https://tntcat.iiasa.ac.at/SspDb/dsd>). Specific categories coded are Emissions, Energy, Land Use, and Shared Policy Assumptions.

RCPs Used

The use of forcing pathways or climate model output based on the RCPs. Includes papers (such as mitigation studies) using RCP-based forcing or concentration targets. Specific RCPs coded are those used in CMIP5 (RCP 2.6, RCP 4.5, RCP 6.0, RCP 8.5), which also include the CMIP6 versions of these pathways. An additional column records the use of “other” pathways. The specific forcing pathway used when coded as “other” can be found in the SSP-RCP combinations (see columns SSPx-Other-ID). This includes additional concentration or forcing pathways from CMIP6 (ScenarioMIP) characterized by forcing levels in 2100 of 1.9, 3.4, and 7.0 W/m².

SSP-RCP Combinations Used

The use of specific SSP-RCP combinations. All combinations of five SSPs and the seven forcing pathways from CMIP5 and CMIP6 (see RCPs Used, above) are included. In addition, a column for “SSPx-Other” captures the use of other pathways, and the specific forcing pathway in this case is provided in the column “SSPx-Other-ID.”