

Shared Socioeconomic Pathways (SSPs) literature database v2, 2020-2021

Methodology and Definitions

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Previous Literature Database Generation

The reference for the initial iteration of the SSP literature database, covering the years 2014-2019, is:

Green, C., D. Carlisle, B. C. O'Neill, B. J. van Ruijven, C. Boyer, and K. Ebi. 2021. Shared Socioeconomic Pathways (SSPs) Literature Database v1, 2014-2019. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). <https://doi.org/10.7927/hn96-9703>.

Note: While this literature database (V2) follows similar methods for identifying and categorizing papers that employ SSPs as V1, differences between the two literature database methods are clarified below. The majority of the tags remain the same between the two versions to facilitate cross-database comparisons.

Literature Database v2 Generation

The database was generated using a search to capture the citations of papers employing an SSP or multiple SSPs. The search used the string “‘shared socioeconomic pathways’ OR ‘shared socio-economic pathways’ OR ‘shared socioeconomic pathway’ OR ‘shared socio-economic pathway’” with a time span of 2020-2021. Terminology for the search was determined in the first version, when it was found that the full ‘Shared Socioeconomic Pathways’ was more effective than the shortened ‘SSP’ at capturing relevant publications. The search resulted in approximately 2000 citations of papers that included SSP terminology from Google Scholar and an additional approximate 2000 citations from 8 other selected literature databases.

In the previous iteration of the SSP Literature Database, Google Scholar was employed as the sole search tool. The limitations from Google Scholar on the number of citations that can be downloaded meant that this updated version included publications from an additional 8 databases: EBSCO(Complete and Green), GeoRef, JSTOR, PAIS, ProQuest, Web of Science,

and University of Helsinki's library catalog. When adding additional papers through other databases, citations were not included if they fell under the following categories: Dissertations & Theses, Newspapers, Wire Feeds, Blogs, Podcasts & Websites, Magazines, Other Sources, and Miscellaneous.

Papers that made substantive use of the SSPs were identified from this set of potential SSP publications. The approximately 4000 papers in this initial set of potential SSP publications were then checked for SSP use, yielding over 1500 relevant papers that used SSPs. All retained papers made substantial use of the SSPs (many also used the RCPs, but retention was based on SSP use). 'Substantial use' of the SSPs was determined by whether the publication either directly modeled with SSPs, heavily relied upon SSP modeling for their analysis, or used quantitative SSP elements or extensions. The record of publications that did not use SSPs includes why the publication was not included in this database and can be accessed upon request.

The database includes peer reviewed publications (journal papers, book chapters) as well as gray literature (working papers, reports, substantial conference proceedings, etc.). Papers that could not be accessed were archived.

The database includes papers that used SSPs for significant comparison to other studies or potential outcomes from climate change. It includes review papers if SSPs (or the framework) was used to organize results or draw conclusions. It includes drawing on the SSP-RCP framework in assessing or critiquing scenario approaches. Following Scenario-MIP, the literature evolved to use the scenarios created by combinations of the SSPs and RCPs: SSP5-8.5; SSP3-7.0; SSP-4.5; and SSP1-2.6. SSP1-1.9 was added to include a scenario that stays close to the 1.5°C Paris Agreement goal.

After initial checks for SSP inclusion, papers were sent to trained team members for coding. Training included an overview of the scenario framework, supervision from the supporting organizations (Finnish Environmental Institute, Ludwig Maximilian University of Munich' Department of Geography, and National Institute for Environmental Studies, Japan), and team meetings throughout the coding process. The coding process consisted of an initial training with each coder. Afterwards, each coder was sent 5 initial papers to code. These initial 5 papers were then coded by the team lead to ensure key areas were addressed.

Once coders were deemed ready, each coder received papers to code in a batch ranging from 20-50 papers. These were then sent back to the team lead with comments or revisions before continuing. Throughout the process team meetings occurred every other week.

Cross-coder Checks

Once approximately half of the papers were coded, intra-coder checks were completed to further clarify key areas to address. Ten percent of each coder's completed papers were randomly selected. Then each coder received a proportional number of papers from each of the other 3 coders to review. Review comments were documented and a discussion afterwards

highlighted key areas to expand upon. The conversation after these checks resulted in applications being expanded to include 'Cities', and both 'Climate Modeling' and 'Population' tags. After this meeting coders reviewed their previous coding to ensure all coding was updated with the new tags.

Members of the ICONICS board were given a week to review the preliminary database prior to release.

Additional reviews on the finalized coding will be done by members of ICONICS and the board for this project.

Other Languages

In the initial collecting of SSP literature, papers in other languages were collected and archived. The use of SSPs was not accessed in these publications. A future aim of this work is to include coding for papers in other languages.

CODING

Included Tags for all papers

After papers were initially sorted, they were coded according to the following tags. The boxes denote the overall category, with the individual tags within each category. These tags were decided on based on v1, with subsequent input from the ICONICS team.

SSP developments

- o **Framework:** *Papers that contributed to the initial creation of the basic SSPs including the conceptual framework, narratives, and quantitative elements (population, education, GDP, urbanization). There are very few of these papers in v2 because the majority were captured in v1.*

- o **Narratives:** *Papers that created narratives consistent with the SSP conceptual framework. This differs from extensions in that papers solely focused on the narrative aspects from the existing 5 pathways.*

- o **Methods:** *Methods for scenario development, application, or extension, including regional extensions. 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 methods and applications (or extensions), for example if the paper develops a new method and applies it to a specific topic area.*

o Extensions: *SSP extensions add either qualitative or quantitative information to the basic SSPs 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.*

Study Type: *This category captures the purpose of the coded paper. If the type of study did not fall into one of the categories listed below, none were marked. Assessment refers to papers that assessed the SSP framework, not other methods. Multiple study types could be selected when applicable.*

- o Adaptation Study- Papers that specifically analyzed how humans have or may adapt to changes in the climate, in ecological changes, increased sea levels, etc.
- o Mitigation Study- Papers that analyzed the methods taken to reduce the anthropogenic forcing of the climate system and slow climate change, through changes in emissions, innovations in technology, shifting forms of energy creation, etc.
- o Impact Study- Papers that assessed impacts of changing climate, related environmental conditions and socioeconomic development on human activities, ecology, natural resources, societies, economies, etc. This includes analyses of risk and vulnerability.
- o Assessment- Papers that assessed the SSP framework. This did not include other types of assessment but captured analyses of the functionality or quality of SSPs.
- o Policy Paper- Papers that used SSPs to inform policy recommendations.

SSP Application: *The use of SSPs to analyze a topic. Unlike previous iterations of the database, this can include multiple tags. Multiple tags were only used where there were explicitly two or more key applications (seen mostly with Climate Modeling). The SSP application refers to the purpose of SSP modeling within the paper.*

o Emissions- Future emissions of greenhouse gases or other radiatively active species. This category includes the development or analysis of projections with or without emissions reduction policy or the impacts of climate change; includes those focused on the costs of emissions reductions; and includes studies of Solar Radiation Management to reduce climate change

o Climate Modeling - This is coded for papers that were focused exclusively on modeling climate or weather trends or events This tag was used for papers that used CMIP6 (or RCPs in previous iterations of the CMIPs) SSPs to focus around climatic themes. Precipitation events are coded in the water availability tag, unless referencing stratospheric events.

*Note: This tag was often paired with other SSP tags. Climate Modeling was tagged for papers where SSP climate projections were used but not always the aim of the entire publication. Hence this tag was both an SSP application and a stand-alone category.

o Negative emissions- Includes but not limited to, carbon capture, negative emissions technology, and any form of carbon dioxide removal. This tag includes mitigation or policy papers about how to lower carbon levels in the atmosphere.

o Energy- Energy production or use, including use of fossil fuels, renewables, bioenergy, nuclear, or other sources. Also includes issues related to energy efficiency, access, and energy poverty, as well as impacts of climate change on energy systems.

o Land use- The use of land for agriculture, forestry, urbanization, or other sectors. Includes studies of impacts of climate change on land use. When articles analyzed the use of land for agriculture, tags included both land use and agriculture, contrary to v1.

o Terrestrial ecosystems- Focuses on terrestrial ecosystems or biotic communities. This includes but is not limited to changes within forests, animal and insect populations, or plant growth outside of agriculture. This is distinct to agriculture in that it is not focused on any form of food production.

o Freshwater ecosystems – Changes to river basins, lake ecosystems, ponds, wetlands, streams, and springs. This includes but is not limited to impacts on or adaptation in freshwater plant life, animal and insect populations, or water systems (including eutrophication). This is distinguished from water supply/demand in that articles did not solely focus on precipitation.

o Ocean and coastal ecosystems- Changes in marine, coastal, or aquatic ecosystems. This includes but is not limited to impacts on or vulnerability for marine biodiversity, seawater systems, coral bleaching, or sea ice.

o Agriculture (food and fiber)- Agricultural systems, the production of agricultural commodities, climate change implications for agricultural soils, yield, aspects of food security, livestock, and fisheries. It also includes forestry when the focus is on the production of forest-based commodities. Papers on hunger/food insecurity were categorized under 'Agriculture', to match with v1.

o 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 on 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 is classified under agriculture. Additionally, this tag is applicable for publications focused on continued water access, rather than extreme events such as seasonal droughts, which would be categorized under 'Water Hazards'.

o Water hazards - Natural disasters related to water, including most prominently impacts of floods, severe droughts, and sea-level rise. In contrast, water supply/demand includes continuous access to water instead of immediate impacts from weather disasters.

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

o Economics- Global, national, or societal levels of impacts on economies in the broader sense. This includes but is not limited to studies on countries' economies, shifting GDP levels, global trends in economics, and aggregate economic impacts of climate change.

o Key economic sectors- Economic impacts on, for example energy supply and demand, transportation, infrastructure, recreation, etc. This indicator included articles focused on labor when the aim of the paper was focused on the broad economic impacts from labor, such as labor productivity.

o Poverty / livelihoods - Effects of societal and/or climate change on the poorest sub-populations. This also captures economic impacts on individuals or household incomes.

o 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 applications.

o Cities and settlements- Policy approaches or adaptation involving urbanization, urban governance, and targeted approaches to highly populated regions.

o Migration and conflict and security – Effects of societal and/or climate change on conflict (including violent or non-violent), crime, international security, and movements of people.

o SDGs - Analyses related to the Sustainable Development Goals (SDGs) or closely related indicators. Papers needed to make clear their analysis around an SDG or a Millennium Development Goal, etc. As an example, policy papers that analyzed climate impacts on poverty were not tagged here, but under poverty/livelihoods.

o Other - A focus on any other category beyond those listed above, used to aggregate across categories with substantially fewer entries. Any paper tagged in "Other" then included comments by the coder.

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 of more of its elements in the analysis.*

O SSP 1

O SSP 2

O SSP 3

O SSP 4

O SSP 5

Time horizon: *This refers to the time horizon for the analyses / models. If no time horizon was given, no category was tagged. Multiple categories were chosen for papers that forecasted out to later periods, unless they explicitly stated otherwise.*

o 2030s or sooner

o 2050s or mid-century

o 2100s or end of century

Notably, a fraction of the papers did not use time horizons for foresight and projection, instead focusing on the degree of future climate change along policy targets.

Geographies: *This category was used when papers specifically focused on a type of geography. Multiple geographies can also be chosen, if the paper clearly analyzed more than one type of geography. These geographies could be paired with regions when applicable.*

o Coasts - "The land near to the sea. The term 'coastal' can refer to that land (e.g., as in 'coastal communities'), or to that part of the marine environment that is strongly influenced by land-based processes." - IPCC

o Cities (Urban)

o Rural

o Mountain regions

o River deltas

o Deserts and semi-arid regions

o Forests - "A vegetation type dominated by trees. Many definitions of the term forest are in use throughout the world, reflecting wide differences in biogeophysical conditions, social structure and economics." - IPCC Glossary

o Oceans - "The interconnected body of saline water that covers 71% of the Earth's surface, contains 97% of the Earth's water and provides 99% of the Earth's biologically habitable space. It includes the Arctic, Atlantic, Indian, Pacific and Southern Oceans, as well as their marginal seas and coastal waters." - IPCC Glossary

Regions: *This category was applicable for papers modeling either at the global scale or within a particular region. Most papers are within one of these tags, with some having multiple tags. This was used alongside 'Geographies' to provide further context.*

o Global

o North America

o Central and South America

o Europe

- o Africa
- o Asia
- o Small Island nations - “as recognised by the United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, are a distinct group of developing countries facing specific social, economic and environmental vulnerabilities” (IPCC Glossary)
- o Australia

Climate Projections Used*: *The use of climate forcing pathways is captured under these tags. Note below that the specific RCPs used are not provided in the final publication of the tags. Instead, the RCPs were included as a guide to coders. The tags provided are Low, Medium, and High, per the ScenariosMIP categorizations.*

- o RCP 1.9 (Low)
- o RCP 2.6 (Low)
- o RCP 3.4 (Low)
- o RCP 4.5 (Medium)
- o RCP 6.0 (Medium)
- o RCP 7.0 (High)
- o RCP 8.5 (High)
- o None

Scenarios combining SSPs with RCPs*

- The RCP/SSP pairings included specific categories for Scenario-MIP scenarios, specifically Titer 1. These were: SSP1-1.9; SSP1-2.6; SSP3-3.4; SSP2-4.5; SSP3-7.0; and SSP5-8.5. Publications that referenced ScenarioMIP, including by citing O'Neill et al. 2016, were tagged under ScenarioMIP tags. These were separated from other SSP forcing pairings as codes for climate forcings, that could be paired with SSP narratives or quantitative components.

Public availability of data (yes / no)

Availability of data is selected if papers noted the public availability of data in another major report or publication, if data is included in the appendix, or if data is clearly detailed in the methodology.

Differences to Version 1

Literature Search

- As is highlighted in the main methods section, this V2 of the literature database used additional databases to Google Scholar. For more detail see above.

Tags and categories removed from the v1

- Extensions:
 - The extensions category was removed and combined into one tag, whether or not the paper created extensions based on the SSPs. This simplified the database.
- SSP Elements Used:
 - The elements used category was removed. This was largely done in anticipation of the changing use of SSPs, especially in light of the developments of CMIP6 to create climate scenarios under the ‘SSPs’
- IAM elements used:
 - This element was removed as both a simplification and in light of the complexities that underlie the IAMs. It was decided that to make these categories longer-term this would have to be removed.

Tags and Categories Added:

- Time Horizon:
 - Time horizon was added for additional clarification on time frames that SSPs are used for.
- Geographies:
 - The category of ‘Geographies’ was added to provide context on the key geographic and spatial focuses of papers using SSPs.
- Regions:
 - Regional categorizations were added to provide additional context for the regional and geospatial areas that SSPs were used for.
- Data availability
 - This category was created based on feedback from the previous iteration for users of the database.
- Key Tags within ‘SSP Applications’:
 - Climate Modeling
 - This specific tag was added to capture papers that used CMIP6 to make projections from the additional SSP climate framework.

Changes Made to Tags and Categories in v1

- Climate Projection(s)
 - As mentioned above, Climate Projections were changed to use different levels of climate forcings, instead of the specific RCPs. This change was made in light of potential changes to naming of models or potential changes forcing levels. With CMIP6, there is a transition towards using climate models within SSPs, which can create confusion for interpreting papers. This decision was made to mitigate that confusion.

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