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SESAME: Software tools for integrating Human - Earth System data

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Human activities have extensively modified over 70% of Earth's land surface and two-thirds of marine environments through practices such as agriculture, industrialization, and urbanization. These activities have resulted in a wide range of environmental problems, including biodiversity loss, water pollution, soil erosion, and climate change. However, human data is often available only in tabular form, is difficult to integrate with natural Earth variables, and can pose significant challenges when trying to understand the complex integration between human activities and natural Earth systems. On the other hand, scientific datasets, which are spread across websites, come in different formats, may require preprocessing, use different map projections, spatial resolution, and non-standard units, are difficult for both beginner and experienced researchers to access and use due to their heterogeneity. This discrepancy hinders our understanding of complex interactions between human activities and the environment.

To bridge this gap, we have created the Surface Earth System Analysis and Modelling Environment (SESAME) software and dataset package, which aims to solve the problem of fragmented and difficult-to-use human-Earth data. It can handle various data formats and generate a standardized gridded dataset with minimal output. SESAME is a software infrastructure that automatically transforms five input data types (raster, point, line, polygon, and tabular) into standardized desired spatial grids and stores them in a netCDF file. The ability of a netCDF file to store multidimensional timeseries data makes it an ideal platform for storing complex global datasets. SESAME utilizes the dasymmetric mapping technique to transform jurisdiction-level tabular data into a gridded layer proportional to the corresponding surrogate variable while considering changes in country boundaries over time. It maintains the consistency between input and output data by calculating the global sum and mean.

By converting human tabular data into a gridded format, we can facilitate comprehensive and spatially explicit analyses, advancing our understanding of human-Earth systems and their complex interactions. These gridded datasets are intended to be used as inputs to a range of different Earth system models, potentially improving the simulation and evaluation of scenarios and leading to more informed and strategic future policy decisions.