Engaging Communities and Monitoring Climate Change Impacts: The Eco_Pop_ER Database as a Model of Open Science

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Introduction

The Eco_Pop_ER Database is a central component of the MEMOREC project, a pioneering initiative designed to address the complex interactions between demographic dynamics and climate change in Emilia-Romagna. This innovative resource consolidates diverse data sources into an open-access repository, allowing researchers, policymakers, and the general public to explore critical questions about climate resilience and vulnerability.

Central to this project is a commitment to data FAIR principles (Findable, Accessible, Interoperable, Reusable). The database aligns with global movements for open science and data activism, promoting transparency and inclusivity in population studies. By bridging historical and contemporary datasets, Eco_Pop_ER offers a unique platform for longitudinal analysis, enabling the study of climate change's impacts across spatial and temporal dimensions.

The MEMOREC project website is available at this web address: https://site.unibo.it/memorec-resilienza-memoria-climatica-emilia-romagna/en

The Role of Open Data and Citizen Engagement

Eco_Pop_ER stands out for its approach to open science, emphasizing collaboration and data democratization. The project integrates demographic, climatic, and geographical indicators from dispersed and heterogeneous sources, unifying them within a single database deposited in Zenodo repository. This consolidation addresses critical gaps in metadata consistency and the absence of standardized identifiers, such as DOIs, that previously hindered research efforts.

Beyond academic circles, the project fosters public engagement by inviting citizens to participate in the ongoing development of the database. This citizen science approach not only democratizes access to information but also empowers individuals to contribute to and engage with data that directly affect their communities. Forms of data activism, such as crowdsourcing updates and promoting climate awareness, represent a vital component of Eco_Pop_ER's philosophy.

Data4Resilience: Engaging Students in Climate-Demographic Analysis

The data challenge "Data4Resilience" invites University of Bologna students to explore the EcoPop-ER database to analyze the effects of climate change on the demographics of Emilia-Romagna. The challenge promotes data literacy and encourages innovative approaches to leveraging open-access resources while contributing to a deeper understanding of the region's climate impacts.

The Data4Resilience challenge is part of the MEMOREC project (Resilience and Climate Memory in Emilia-Romagna), which integrates demographic, climatic, and geographic data into an open-access platform. Its aim is to map sociodemographic vulnerabilities and support the development of effective territorial policies to mitigate the impacts of extreme climatic events.

In addition to fostering innovative analyses, Data4Resilience serves as a peer review mechanism for the EcoPop-ER database, enabling participants to identify potential errors, suggest enhancements to metadata, and provide input on additional indicators to make the database more inclusive. The challenge acts as a social peer review for the database, identifying potential errors, improving metadata, and gathering valuable input for expanding the repository with additional indicators. These contributions help make the database more inclusive and representative of the diverse realities within Emilia-Romagna.

More about Data4Resilience: https://site.unibo.it/memorec-resilienza-memoria-climatica-emilia-romagna/en/data-challenge-data4resilience

Database Architecture and Innovations

The EcoPop-ER database, which contains over 5.5 million observations and 516 indicators spanning demographic, climatic, and territorial variables, is central to this challenge. With its rich dataset covering a significant historical period from 2000 to 2024, the database offers participants an invaluable foundation for analyzing the evolution of populations and climatic conditions across the Emilia-Romagna region.

The database encompasses comprehensive data for all municipalities in Emilia-Romagna, including historical reconstructions of municipal boundaries and geospatial shapefiles. Indicators span a wide array of variables, capturing population characteristics, climate dynamics, and environmental risks. Significant technical challenges, such as ensuring continuity in time series and integrating data from nomadic or temporary populations, were addressed through innovative methodologies.

The main topics covered by the EcoPop_ER project database include:

1. Demographic indicators (births, deaths, resident population, population age)
2. Climatic characteristics (average, maximum, and minimum temperature, and precipitation)
3. Territorial and geographic indicators (surface area, altitude, coastal/mountain municipalities, land use)
4. Natural and environmental risks (landslide risk, flood risk)
5. Residential buildings (structure, construction period, condition)
6. Social and demographic vulnerability indicators (municipal fragility index, access to essential services)
7. Family characteristics (average number of members, families with elderly or minors)
8. Socioeconomic indicators (education, employment, waste collection).

The database user-friendly design and robust metadata standards enhance accessibility and usability for diverse stakeholders, from statisticians to community planners. Open-access availability ensures that Eco_Pop_ER serves as a model for FAIR data initiatives in other regions.

The database can be freely accessed and downloaded from the MEMOREC project website, which redirects users to the Zenodo repository for the actual download:

MEMOREC project website: https://site.unibo.it/memorec-resilienza-memoria-climatica-emilia-romagna/en/database

Zenodo DOI: https://doi.org/10.5281/zenodo.13951348

Applications and Insights

The Eco_Pop_ER Database provides a versatile toolkit for advanced statistical and spatial analyses. The final paper will showcase applications including:

- **Clustering Analysis**: Identifying population segments with varying degrees of climate vulnerability.
- **Principal Component Analysis**: Simplifying complex relationships among climate and demographic indicators.
- **Spatiotemporal Modeling**: Assessing the effects of heatwaves on seasonal mortality and identifying patterns of mountain depopulation in regions prone to extreme meteorological events.
- **Exposure Analysis**: Estimating population exposure to hydrogeological risks and exploring disparities among vulnerable groups.

These analyses highlight how integrated datasets can inform policies to mitigate climate risks and foster resilience.

Future Directions

Looking ahead, Eco_Pop_ER aims to expand its database by incorporating additional data sources and refining temporal continuity in its indicators. Plans include partnerships with local statistical offices to ensure the long-term sustainability of the resource. By maintaining and updating the repository post-project, the MEMOREC team aspires to create a dynamic platform that continues to serve as a cornerstone for climate resilience research and public engagement.

The database not only serves as a tool for cutting-edge statistical applications but also exemplifies the transformative potential of open science. Eco_Pop_ER bridges the gap between academic research and societal impact, setting a benchmark for future endeavors in demographic and climate studies.