pSESYNTH project: Community mobilization for a multi-disciplinary paleo database of the Global South

Charuta Kulkarni[1], I.A. Jara[2], M. Chevalier[3], X. Benito[4] and pSESYNTH participants*

How to enhance paleoscientific research, collaboration and application in the Global South? The INQUA-funded multi-year pSESYNTH project envisions the first multi-disciplinary Holocene paleo database through a collaborative vision for past human–environmental systems in the Global South, and their future sustainability.

The value of, and theoretical basis for, inter-disciplinary approaches in paleosciences has been widely recognized (e.g. Dearing et al. 2011; Fischer et al. 2021). Meanwhile, it has also been realized that identifying feasible and inclusive strategies to put interdisciplinarity into practice requires continued community mobilization and collaboration (Swanson et al. 2021). Here, we bring an example of scientific community mobilization and collaboration focused on the Global South; the geographical region covering Latin America and the Caribbean, Africa, Asia, and parts of Oceania (Fig. 1), where researchers have been historically, and often continue to be, marginalized from international collaborations (Maas et al. 2021).

The study of past global changes and their interactions with socio–environmental systems is highly underrepresented in the Global South. Yet, its diverse landscapes, including tropical forests, high-latitude alpine areas and grasslands, coastal wetlands, as well as polar regions under climatic and anthropogenic pressures, urge for an unbiased understanding of human–environmental dynamics at different spatial and temporal scales.

Moreover, most, if not all, developing countries are part of the Global South, bringing an additional challenge in relation to ecosystem conservation, management, and exploitation of natural resources (Lebel and McLean 2018; Monsarrat and Svening 2021; Raja et al. 2021). Given the long histories of human occupation and the influence of past climates and land-use practices in shaping landscapes of the Global South, understanding the interactions among climate, human societies, and ecosystems is key to improving the knowledge of pressing environmental challenges.

pSESYNTH: genesis and objectives
Stemming from the PAGES-INQUA supported early-career researcher workshop on "Past Socio–Environmental Systems (PASES)" (pastglobalchanges.org/calendar/26972) in 2020, the INQUA-funded project "The whole is not the sum of the parts: building a synthesis database of past human–environmental systems in the Global South (pSESYNTH)" has initiated research collaborations among paleoscientists from, and/or working on, the Global South and other underrepresented regions of the world (e.g. Australia, Southeast Europe).

Pursuing the Integrated, Coordinated, Open, and Networked (ICON) approach (Koren et al. 2022), the overarching goal of pSESYNTH is to establish, articulate and strengthen regional, interdisciplinary teams for studying past socio–environmental systems of the Global South, and to build the first multi-disciplinary paleo database representing its regions.

pSESYNTH primarily focuses on the Holocene (the last 11.7 kyr) because: (i) there is greater spatial availability and better chronological controls of the datasets compared to the Pleistocene, and (ii) the Holocene is characterized by a progressive degree of anthropogenic influence over landscapes, offering ways to explore the evolution of diverse socio–environmental systems. Under the pSESYNTH framework, linking proxies of environmental change with climatic signals and societal processes (e.g. subsistence strategies, growth rates, migrations) will provide baselines to pose and test multiple hypotheses for explaining the trajectories of socio–environmental systems. Specifically, pSESYNTH activities are being developed around three main objectives (Fig. 2):

1) To **explore** drivers of past environmental change combining a diverse set of proxy information, organized into three themes: paleoecology (e.g. pollen, charcoal, diatoms), paleoclimatology (e.g. biomarkers, stable isotopes, varves, numerical simulations), and archaeology (e.g. radiocarbon dates, phytoliths, archaeobotanical remains, material culture).

2) To **quantitatively analyze** the links among paleoecology, paleoclimatology and archaeology, with an emphasis on research questions that can be generic across the Global South (e.g. are there connections, or commonalities, between colonial legacies and the evolution of socio–environmental systems in the Global South?) or specific to each subregion (e.g. at what spatial and temporal scales were human–environmental systems coupled or uncoupled to climatic fluctuations?).

3) To **share** the outputs and products of the project in the form of a database that meets the FAIR (Findable, Accessible, Interoperable and Reusable) principles (Wilkinson et al. 2016). pSESYNTH participants will capitalize on existing single- and multi-themed databases (e.g. Neotoma, NOAA, PANGAEA, p3k14c, ArchaeoGlobe) in complementing their data contributions in the novel Global South database. Together, the FAIR–ICON principles will underpin the database organization and will ensure geographic coverage, comparability, and accessibility for time-series data synthesis, which is crucial for mainstreaming paleoscience research from the Global South.

Paleoscientific synthesis: Early insights
Drawing upon the newly built Global South network (Fig. 1), the pSESYNTH project has been facilitating discussions on how varied datasets from different Global South regions can be effectively consolidated, and to achieve this goal, how critical it is to continue strengthening dialogues across
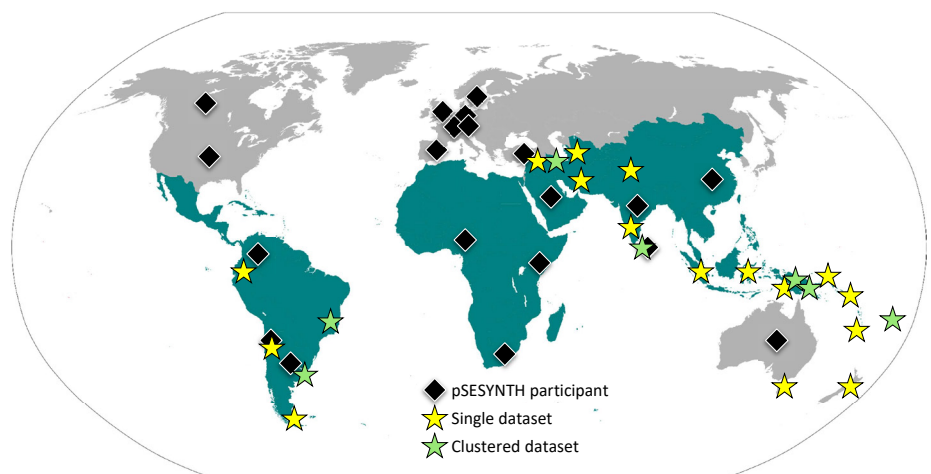
Figure 1: Map showing the regions of the Global South (in green), which is the geographical focus of pSESYNTH. Black diamonds show distribution of pSESYNTH participants from and/or working on the Global South. Yellow and green stars show the location and nature (single or clustered) of the datasets gathered so far.

pSESYNTH: A Multi-Themed Paleo Database for the Global South
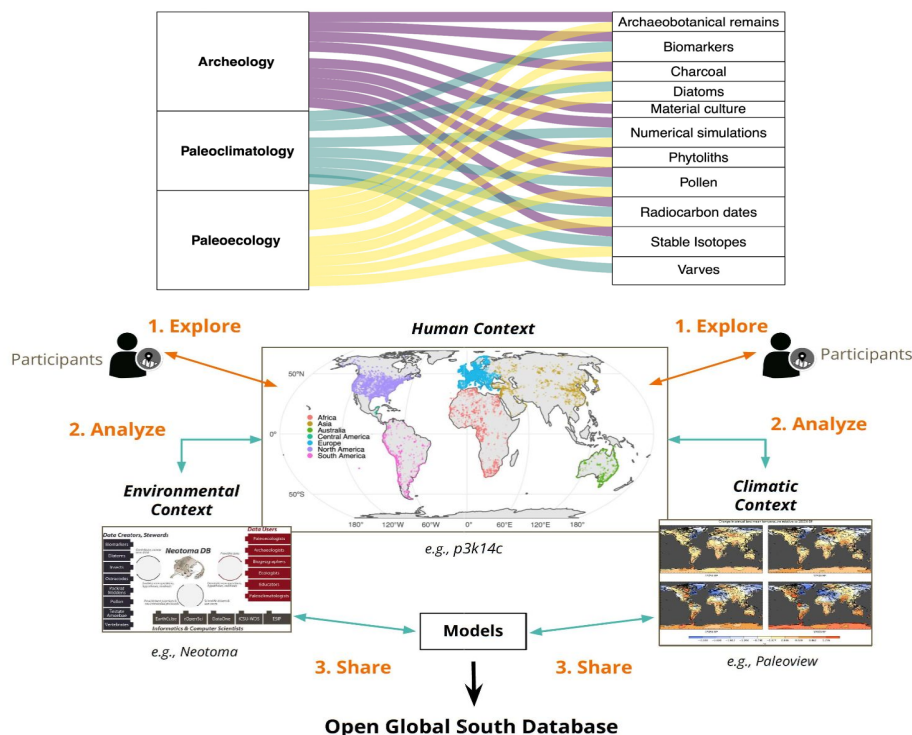
Figure 2: Schematic diagram showing pSESYNTH's objectives (explore, analyze, and share) and the core themes (paleoecology, paleoclimatology, and archaeology) under exploration, driving the synthesis of ideas, as well as datasets, provided by the project's participants and published databases.

the sub-disciplines of paleoscience. To this end, pSESYNTH has encouraged hands-on opportunities for developing three region-specific subgroups – the Americas, Asia-Africa, and Australasia-Oceania – that have been stimulating community-led research questions and syntheses of datasets at the intersection of climate, humans, and environment.

While there are multiple lines of inquiry (e.g. fire history, food production, extreme events, island colonization) that appeal to the respective subgroups, the topic of collective interest across the Global South is spotting changes in land-use patterns under pre- and post-colonial contexts. For example, in the case of the Americas, a preliminary exploration of pollen sites in the Neotoma database yielded 18 records, out of which 15 sites contain non-native pollen taxa such as *Rumex* and *Plantago* from 500 cal yr BP onwards, suggesting rapid and widespread European influence on the landscapes.

In the current pSESYNTH database, eight datasets contain lake sediment records from the Americas, yet they represent a small proportion of the >1300 cores available in the Latin American Pollen Database (latinamericapollendb.com) to unravel the complexities of colonization processes in the subregion (Flantua et al. 2015). Similarly, questions of when and how colonization altered island ecosystems has also been the focus of the data synthesis for the Australasia-Oceania subregion, where most of the database entries are high-resolution lacustrine pollen records. These records can be used to develop hypotheses on the role of colonial legacies in the evolution of

socio–environmental systems in the Global South (e.g. Burney 1997).

Unlike the other two, the Asia-Africa sub-region is visibly the most paleodata-poor subregion of the Global South (Fig. 1), currently lacking the spatial coverage and temporal resolution in identifying the impacts of colonialism. The available paleorecords from the Asia-Africa subregion, however, can help discern region-specific, perhaps continental scale, patterns for long-term vegetation change, land use, and landscape management, thereby complementing knowledge emerging from other subregions of the Global South.

Through as many as 64 records are integrated in the pSESYNTH database so far, the topics of common interest within and across the subregions find direct links to identifying historical baselines to constrain scenarios toward practical strategies for sustainable management of the Global South landscapes.

Future directions

The prime goal of pSESYNTH is to design a functional database structure, containing curated sets of interdisciplinary case studies from the Global South, aimed at providing reference data to foster collaborations among paleoscientists. The database produced as the final outcome of pSESYNTH will be publicly available online, and accessible via R shinyApp (Chang et al. 2022), which will work as a platform for visualizing the datasets, as well as for locating complementary datasets from other databases.

Raw data assigned with DOIs will be securely stored in a repository (e.g. Zenodo), ensuring ownership credits to the original

contributors along with secured and transparent data reusability guidelines before the final products are released. In the upcoming years, pSESYNTH activities will continue to cross-fertilize knowledge and methods, utilizing the INQUA HABCOM support and upcoming PAGES–INQUA synergistic activities as platforms, all oriented towards enhancing paleoscientific research, collaboration and application in the Global South.

AFFILIATIONS
[1]Independent researcher, Chennai, India
[2]Departamento de Ciencias Históricas y Geográficas, Universidad de Tarapacá, Arica, Chile
[3]Institute of Geosciences, Section of Meteorology, Rheinische Friedrich-Wilhelms-Universität, Bonn, Germany
[4]Marine and Continental Waters Programme, Institute of Agrifood Technology and Research, IRTA, La Ràpita, Spain
*See the online version for the complete author list

CONTACT
Charuta Kulkarni: ckulkarni@gradcenter.cuny.edu

REFERENCES
Burney DA (1997) Hum Ecol 25: 437-457

Chang W et al. (2022) shiny: Web Application Framework for R

Dearing J et al. (2011) PAGES Mag 19(2): 43

Fischer H et al. (2021) PAGES Mag 29(1): 7-9

Flantua SG et al. (2015) Rev Palaeobot Palyno 223: 104-115

Koren G et al. (2022) Earth Space Sci 9: e2022EA002231

Lebel J, McLean R (2018) Nature 559: 23-26

Maas B et al. (2021) Conserv Letters 14: e12797

Monsarrat S, Svening J-C (2021) Ecography 4: e06354

Raja N et al. (2021) Nat Eco Evo 6: 145-154

Swanson HA et al. (2021) One Earth 4: 226-237

Wilkinson MD et al. (2016) Sci Data 3: 160018