Piloting the collection of geographic information from Longitudinal Population Studies (LPS) for future climate-health research

Tejedor-Garavito, N., Bonnie, A., Bondarenko, M., Abbott, T. and Tatem A.J.

PROJECT RATIONALE

Populations are highly vulnerable to the effects of climate change (IPCC, 2022). Most affected are those living in low-resource settings (Romanello et al., 2021). Quantifying the specific health and livelihood outcomes associated with climate change risks remains a challenging and largely unexplored area of research (Nissan et al., 2022).

Putting health at the heart of climate action is central to the Wellcome Trust's Climate and Health strategic program. The use of LPS for research at the health-climate interface was identified in a recent report commissioned by Wellcome (Nissan et al., 2022) as a key element in the alignment between the spatial and temporal scales of the climate hazards and individual health outcomes.

This project builds on this recommendation, producing openly-available geographical information for 64 HDSS sites across two key LPS networks visualized through an interactive online portal, actively enhancing LPS geographic data accessibility and quality.

BACKGROUND

Longitudinal Population Studies (LPS): Used to study how health outcomes are influenced over time by biological, social, and environmental factors.

Health and Demographic Surveillance Systems (HDSS): A type of LPS that monitors demographic and health characteristics in specific geographic areas.

- Used in low- and middle-income countries (LMICs) to assess health outcomes and determinants, serving as an alternative to national civil registration and vital statistics.
- Their temporal resolution allows for matching health and demographic data with climate data, enabling studies on the impacts of climate change on health.
- A challenge is that digitized site boundaries from HDSS research are not available as an open resource, limiting collaboration between the climate and health sectors.

HDSS Networks: HDSS sites were selected based on previous WorldPop work funded by the Wellcome Trust, encompassing 64 sites across two key LPS networks: INDEPTH and CHAMPS.

Table 1: Tabular summary of key characteristics for HDSS networks. Note: Total population refers to the total population as established in official HDSS site sources.

Network	Number of sites	Total population	Date Network established	Earliest site start date	Focus
INDEPTH	49	4,500,000	1998	1961	Health & demographic
CHAMPS	8	1,170,000	2015	2015	Child mortality

INDEPTH

- Established in 1998, includes 49 HDSS sites across 42 health research centers and 7 associate members, totaling 56 HDSS sites.
- Sites are spread across 21 countries in Africa, Asia, and Oceania, with populations ranging from 8,200 to 260,000.
- INDEPTH's vision is to be a trusted source for evidence supporting and evaluating progress towards health and development goals.

CHAMPS

- CHAMPS was established in 2015 and focuses on child health and mortality.
- The network consists of 8 sites, across 7 countries in sub-Saharan Africa and South Asia, identified as having notably high child mortality rates.
- The network aims to identify and track causes of neonatal and child mortality to support the development of health and policy interventions.

METHODOLOGY

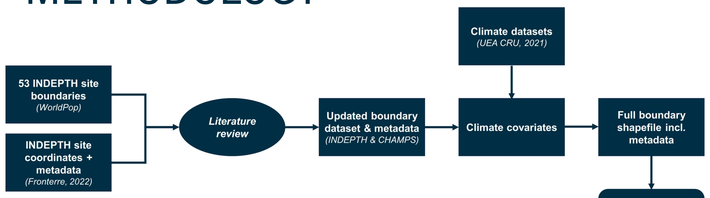

Figure 1: Flowchart illustrating the project pipeline.

Boundaries

Our initial datasets consisted of 53 digitized INDEPTH HDSS boundaries from previous work led by WorldPop (Tatem et al., 2006; Jia et al., 2015; Utazi et al., 2016; Utazi et al., 2018), and cartesian coordinates for all INDEPTH sites provided by Fronterre, C. (2022).

The first step in our methodology was to spatially compare these existing datasets. This highlighted a number of disagreements between the two, leading to an in-depth literature review of official and supporting materials to produce an updated, cohesive boundary dataset. The nature of these updates varied, as explored in table 2:

Table 2: Tabular summary of boundary characteristics and approaches to updating.

Scenario	Original boundary	Digitize new boundary	Use subnational boundaries	Digitize based on satellite imagery
No clear site map or description	✓			
Site map matches original boundary	✓			
No site map but clear site description			✓	✓
Site map different to original boundary		✓		

Climate covariates

A selection of example climate data from the University of East Anglia Climate Research Unit (UEA CRU, 2021) - total annual precipitation (mm), total annual evapotranspiration (mm), and mean annual temperature (°C) - were extracted for each HDSS site.

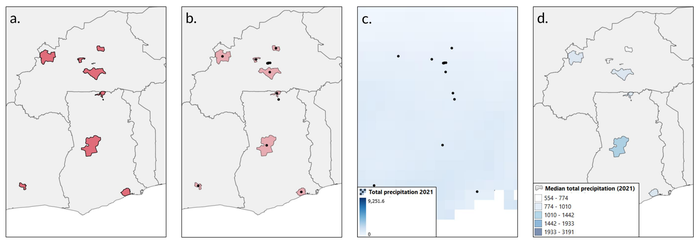

Figure 2: Process of climate covariate extraction. a) HDSS site boundaries, b) centroids for all parts of each HDSS site, c) input of climate raster data and extraction of values to centroids, d) joining median of extracted raster values back to the HDSS site boundaries and visualization of these values.

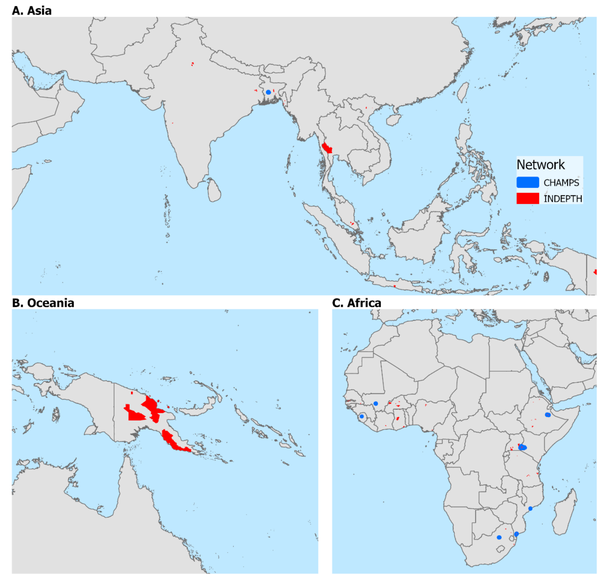

Figure 3: LPS sites displayed by network name across the continents, CHAMP sites (in blue) and in INDEPTH (in red) (Bonnie et al, 2023). Underlying data source: GADM, 2022

OUTPUTS

64 sites (Figure 3) were collated from the CHAMPS and INDEPTH networks. These include updated boundaries for 32 out of 56 INDEPTH sites and GADM/digitized boundaries for all 8 CHAMPS sites. The boundaries, metadata and climate covariates were compiled into a shapefile and visualized in an interactive online portal.

The outputs of this study provide a foundation on which climate-health research can be carried out, by producing a reproducible methodology and a standardized open-source set of LPS site boundaries under one dataset. The full report, and the online portal, can be accessed using the provided QR code.

ACKNOWLEDGEMENTS

The authors would like to thank Andy South and Anelda van der Walt for their initial input on this project and Claudio Fronterre for his support. Additionally, to the PMO team at WorldPop for the support received and Wellcome for the funding received for this project, especially to Isabel Fletcher and Talia Caplan.

For the full reference list, please refer to the project report, which can be accessed using the QR code (Tejedor-Garavito, N., Bonnie, A., Bondarenko, M., Abbott, T. and Tatem A.J. Piloting the collection of geographic information from Longitudinal Population Studies (LPS) for future climate-health research. WorldPop, School of Geography and Environmental Science, University of Southampton, UK and Wellcome Trust, March 2023.)