26 (2025) 100584

Contents lists available at ScienceDirect

The Journal of Climate Change and Health

journal homepage: www.elsevier.com/locate/joclim

Case report

Transdisciplinary approach to addressing climate-environment-health nexus: Developing a data platform for informed decision-making

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ARTICLE INFO

Keywords:
Health
Environment
Climate change
Data integration
Data-driven decision making
Data governance

ABSTRACT

Introduction: Argentina's wide range of climates, from arid regions to humid subtropics, makes it particularly vulnerable to climate change. Extreme weather events disproportionately affect marginalized populations, underscoring the need for localized, data-driven interventions. PladCAS (Plataforma de Datos en Clima, Ambiente y Salud, by its acronym in Spanish) is a platform under development by a transdisciplinary team to support decision-making on climate-environment-health (CEH) issues. The platform adopts the FAIR principles (Findable, Accessible, Interoperable, and Reusable) to enable scalability and sustainability for health and environmental policy data management. By integrating these principles, PladCAS would enable stakeholders —including policymakers, health and environmental professionals, organizations, and communities— to address CEH challenges through evidence-based policies at local, regional, and national levels.

Case Presentation: The design and development process of a CEH digital platform in Argentina is discussed. Employing a transdisciplinary approach, the team engaged stakeholders to identify indicators, select relevant data sources, and co-design the platform's structure. The result is a prototype design for interoperability, accessibility, and reusability, supporting evidence-based decision-making across sectors.

Discussion: Effective stakeholder communication is crucial for collaboration. Fieldwork requires place-based indicators, underscoring the importance of representative data. Involving stakeholders from the planning stage fosters ownership and strengthens commitment to the platform's iterative improvement.

Conclusion: While the platform is not yet publicly available, it has completed its design phase. Next steps include developing models, agreements with data providers, and funding for implementation. PladCAS will provide a replicable framework to improve CEH data integration, contributing to resilience and equity.

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https://doi.org/10.1016/j.joclim.2025.100584
Received 28 November 2024; Accepted 24 August 2025
Available online 3 October 2025

1. Introduction

The growing frequency and severity of extreme weather events (EWE) driven by climate change severely impacts public health, especially in South America [1]. EWE are directly linked to numerous health issues, including respiratory and cardiovascular diseases, vector-borne diseases, and mental health challenges [2,3]. However, the effectiveness of responses to these health impacts is critically hindered by fragmented, inconsistent, and inaccessible Climate, Environmental, and Health (CEH) data. Stakeholders—such as policymakers, health professionals, and researchers—face challenges in using available information for decision-making.

While several initiatives have attempted to integrate CEH data, South American countries still struggle with infrastructure limitations in rural areas, which contributes to data gaps. Issues of governance and interoperability remain significant barriers [4,5]. Limited investment in integration systems further restricts the generation of actionable insights. Fluctuations in political priorities and financial instability exacerbate these issues, highlighting the need for coordinated intersectoral and sustainable data strategies [6].

In this context, developing an integrated digital platform for CEH data is essential. Such a platform would enable comprehensive analysis and evidence-based decision-making by revealing the interdependencies between environmental changes and health outcomes. Unified access to diverse datasets would support proactive responses to climate-related health risks and inform public policies more effectively.

National and local platforms -such as the Climate and Health Observatory by Fiocruz [7] in Brazil and Bogotá's Health, Environment, and Climate Change Observatory [8], Colombia- have made progress in CEH data integration. However, their focus and scope vary. Fiocruz promotes research and networks, whereas Bogotá's platform prioritizes communication of health indicators to the public. PladCAS (Plataforma de datos en Clima, Ambiente y Salud, in Spanish) is a new initiative, led by a transdisciplinary team to support research and decision-making related to EWEs and health. It aims to consolidate dispersed and underused Findable, Accessible, Interoperable, and Reusable (FAIR) data and engage stakeholders in co-designing a scalable platform that could be replicated in other regions.

This case report outlines the conceptual and technical design process of the PladCAS in Argentina. It focuses on improving data availability and use to mitigate climate-related impacts on health and the environment.

2. Case presentation

The primary objective of this project is to promote accessibility, quality, and utilization of CEH data through the co-development of a digital platform in Argentina, with potential scalability across South America. Using a transdisciplinary approach will engage stakeholders throughout the design process, ensuring the platform meets user needs. Ultimately, the goal is to build a tool that supports research, informs policy, and raises awareness about the health impacts of climate change.

The PladCAS project is developing a Platform to integrate CEH data in Argentina. This initiative addresses key challenges by proposing a flexible, standardized approach to managing data from multiple sources, ensuring it is FAIR [9]. PladCAS seeks to reduce fragmentation, set data-sharing criteria, and enhance regional collaboration and is designed with scalability in mind, ensuring adaptability to South America's diverse socio-political landscape. Adopting the FAIR principles improves data management in the CEH nexus. Standardizing data format and storage fosters greater collaboration across health, environment, and policy sectors, leading to actionable insights for informed decisions.

The project's transdisciplinary approach is essential to address complex CEH issues [10]. Experts from epidemiology, climatology, economics, environment, and social sciences contribute to solutions that are both scientifically sound and contextually relevant. This diverse expertise, spanning policymakers, researchers, and local communities, strengthens platform legitimacy. Transdisciplinary work requires substantial time and resources, as it involves reconciling different methods, terminologies, and priorities. However, it is essential for shared data governance and inclusive solutions.

PladCAS extends beyond improving data accessibility and quality by aiming to support informed policies addressing climate and environmental impacts on health. Access to high-quality, interoperable data enables the timely identification of trends and vulnerabilities and supports the design of responsive, evidence-based interventions. Integration of community-level data helps amplify the voices of marginalized populations and ensures their perspectives shape the platform's design and functionality.

3. Methods

3.1. Stakeholder mapping

A stakeholder mapping process was used to align the platform with user needs [11,12]. It identified key actors -data providers, users, social organizations, and those with relevant expertise, perspectives, and interests in the CEH nexus. Participants were categorized based on their roles, influence, and potential contributions to platform design. Out of 73 invited participants, 45 engaged in the project. Most stakeholders were from government institutions (70 %), spanning national (43 %), regional (24 %), and municipal (4 %) levels. Others represented academia (18 %) -including universities and scientific bodies, and non-governmental organizations (14 %), both national (10 %) and international (4 %).

Workshops (one in-person, one virtual) helped identify data gaps. The virtual session introduced project objectives and initial survey findings. The *in-person* workshop prioritized key indicators and laid the groundwork for a Minimum Viable Product (MVP) [13]- a basic version of the platform built to gather feedback and validate design choices.

3.2. Co-Selection of PladCAS indicators

PladCAS indicators were selected to address five priority areas: food systems, noncommunicable diseases, gestational health, occupational health, and water security. Their selection and ranking followed cross-cutting criteria including alignment with the Sustainable Development Goals (SDGs) [14], the protection of human rights, and the principles of equity, diversity, and inclusion, particularly attention to gender perspectives.

Indicators were chosen for their capacity to inform specific actions, such as decision-making, monitoring and visualization, and had to meet at least one of the following conditions: (1) highlight levels of impact on specific populations or sectors, (2) support risk monitoring (e.g. through predictive models, trend graphs, or risk maps), or (3) identify vulnerable populations exposed to adverse environmental conditions. The process followed a standardized work guide, adopting the Pan American Health Organization (PAHO) model for indicator descriptions to ensure coherence and comparability [15]. The result was a preliminary list of CEH indicators detailed in Supplementary Table S1, which remains under review by the PladCAS team and stakeholders.

3.3. Selection of data sources

The selection of data sources was guided by the FAIR principles, prioritizing health, demographic, and climate/environment datasets. Sources reviewed included population censuses, vital statistics, health information systems, climate services, and other relevant public data reports. To systematize the evaluation, the PladCAS team developed a structured form to document the relevance, quality, and interoperability of each dataset, especially regarding their utility for constructing CEH

indicators. Particular attention was paid to the spatial and temporal harmonization of datasets and the degree to which they adhered to FAIR standards. This included evaluating metadata completeness, access conditions, update frequency, and geographic coverage. The outcome was a catalog of CEH-relevant sources compiled and made available in the Harvard Dataverse repository [https://doi.org/10.7910/DVN/5ZU7LZ].

3.4. Platform structure design: minimum viable product (MVP)

The preliminary design of the platform was informed by stakeholder feedback and developed by an interdisciplinary IT team including a product manager, designer, and technical experts. The MVP comprises modules for data import, processing, visualization, and FAIR data creation.

- **Home Page.** Features project information, news, and key indicators. It serves as the entry point for researchers and institutions to access and manage data, including tools for converting datasets to FAIR standards.
- **The Indicator dashboard.** Integrates CEH data and provides visual outputs (bar charts, maps, scatter plots, etc.). The dashboard supports several processing steps: 1) data import, 2) processing, conversion, and visualization, and 3) indicator creation.
  a. Data Import: Digital objects can be sourced via APIs or file formats (CSV, Excel, JSON, XML, etc.). Filters can be applied to limit input scope. Data are verified and stored in the platform's database.
  b. Data processing, conversion, and visualization. Once the data is imported into the platform, a visual analytics platform connects to the PladCAS database to begin the process of data conversion and visualization, creating a draft of the data to be displayed. The actions available to the user at this stage include: 1) Variable selection, 2) Creation of calculated fields using R or Python, 3) Preview, and 4) Copying the link.
  c. Using the graphical tools, the user can test which representations best fit the information they want to display, combining, adding, and editing as needed until achieving the visualization deemed appropriate for the indicator.
  d. Creation of the indicators webpage: Once finalized, each indicator gets a dedicated webpage with technical and communication content.
- **FAIR data creation.** All data -internal or imported- are converted following ISO standards to ensure interoperability. This includes metadata validation, unique identifier assignment, and public release.
- **User Management.** Role-based access control defines user permissions for working with digital objects and datasets.
- **Communication Module:** Connects the platform with the broader community. When users subscribe to an indicator, their preferences (based on keywords) determine the type of updates and content they receive.

At the time of writing, the platform is not yet publicly available. Next steps include finalizing statistical models, establishing agreements with data providers, and securing funding for implementation. A beta version is under development and will undergo testing with selected stakeholders before full release.

The general process of the platform is summarized in Fig. 1.

4. Discussion

The development of PladCAS will offer an integrated view of data related to the CEH nexus. Improved data access will enhance the ability to identify patterns, assess risks, and develop interventions. The platform is expected to facilitate communication between sectors, enabling coordinated responses to climate challenges. The project's emphasis on stakeholder engagement is another crucial factor in its success. By involving stakeholders at all stages of the design process, PladCAS design ensures that the platform is responsive to the needs of its users and can effectively support decision-making. The co-selection of indicators, in particular, was a valuable exercise in fostering ownership and ensuring that the platform reflects the priorities of key actors in the CEH nexus.

However, challenges remain, including data fragmentation, interoperability issues, and infrastructure disparities. Unequal investment in certain regions may limit data generation in rural or under-resourced areas. Future efforts should prioritize setting common standards, broadening geographical scope, and enhancing intersectoral collaboration. Further research is needed to evaluate the platform's impact on public policies and health outcomes.

Despite its progress, PladCAS faces several challenges that must be addressed for its long-term sustainability. These include the need for ongoing data quality assurance, the potential for data gaps, and the challenges of maintaining stakeholder engagement over time. To overcome these challenges, PladCAS learned that investing in capacity building, developing robust data governance mechanisms, and establishing partnerships with other relevant organizations are key strategies for addressing these issues.

Pladcas completed the platform's design phase by the end of 2024. The team is currently working on the development of statistical models to estimate indicators adapted to international standards, the generation of specific agreements with data providers and users, and the search for funding for the implementation of the platform.

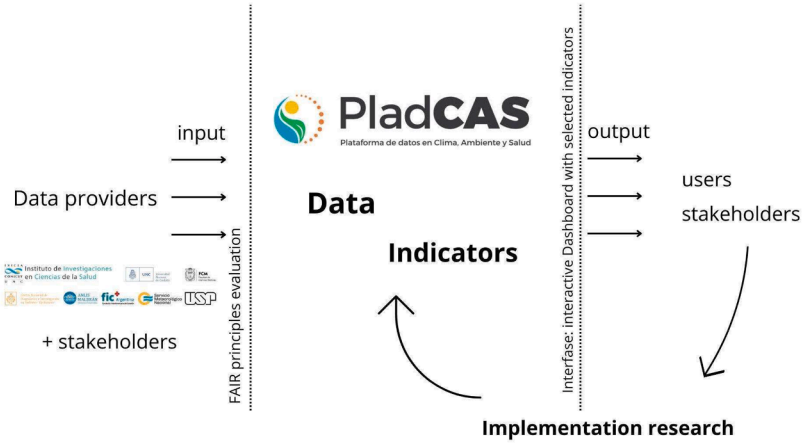

Fig. 1. Representation of the intricate connections among stakeholders, distinct research phases, and data flow within the framework of the platform structure.

5. Conclusion

The PladCAS project represents a significant step forward in addressing the pressing challenges of climate change and its impacts on health in Argentina. By prioritizing data integration, transdisciplinary collaboration, and stakeholder engagement, PladCAS has the potential to inform evidence-based policies and interventions that enhance resilience and promote health equity.

However, the project's success will depend on its ability to overcome ongoing challenges and sustain its momentum. By investing in data quality, capacity building, and partnerships, PladCAS can continue to serve as a valuable resource for policymakers and researchers seeking to address the complex interconnections between climate, environment, and health. The team is currently focused on completing the platform's development phase to make it publicly available shortly.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used ChatGPT to polish English writing, ensuring clarity and readability. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Funding

This work was supported by the Interamerican Institute for Global Change Research (IAI) https://www.iai.int/es/ [grant numbers**SG-CEH-11**].

CRediT authorship contribution statement

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors would like to thank María Laura Gonzalez for her valuable assistance, as well as the coordinators of the Global Consortium and the Inter-American Institute for Global Change Research (IAI) for their guidance and ongoing support. Special thanks to our respective institutions, whose support enabled us to come together as a new collaborative team, and to the stakeholders who generously agreed to participate in this process.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.joclim.2025.100584.

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