



HAL
open science

SCO CHOVE-CHUVA: A Web-Platform to Monitor Socio-Environmental Dynamics in the Southern Amazon

Damien Arvor, Julien Denize, Léa Rouxel, Vincent Dubreuil, Uelison Ribeiro, Beatriz Funatsu, Julie Betbeder, Agnès Bégué, Vinicius Silgueiro, Carlos da Silva, et al.

► To cite this version:

Damien Arvor, Julien Denize, Léa Rouxel, Vincent Dubreuil, Uelison Ribeiro, et al.. SCO CHOVE-CHUVA: A Web-Platform to Monitor Socio-Environmental Dynamics in the Southern Amazon. IGARSS 2024 - 2024 IEEE International Geoscience and Remote Sensing Symposium, Jul 2024, Athènes, Greece. pp.2013-2017, 10.1109/IGARSS53475.2024.10642730 . halshs-04815204

HAL Id: halshs-04815204

<https://shs.hal.science/halshs-04815204v1>

Submitted on 2 Dec 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

SCO CHOVE-CHUVA: A WEB-PLATFORM TO MONITOR SOCIO-ENVIRONMENTAL DYNAMICS IN THE SOUTHERN AMAZON

Damien Arvor^{a,}, Julien Denize^{a,b}, Léa Rouxel^{a,b}, Vincent Dubreuil^a, Uelison Ribeiro^a, Beatriz Funatsu^a, Julie Betbeder^c, Agnès Bégué^c, Vinicius Silgueiro^d, Carlos A. da Silva Jr^e, André Pereira Dias^f, Margareth Simões^{g,h}, Rodrigo Ferraz^g, Patrick Kuchler^h, Laurimar Vendrusculoⁱ, Cornelio Zolinⁱ, Arnaud Bellec^b*

^aCNRS, Univ Rennes 2, LETG-UMR 6554, F-35000 Rennes, France

^bALKANTE, F-35530 Noyal-sur-Vilaine, France

^cCIRAD, UMR TETIS, UPR Forêts et Sociétés, F-34398 Montpellier, France

^dInstituto Centro de Vida, Alta Floresta-MT, 78580-000, Brazil

^eUNEMAT, Sinop-MT, 78555-000, Brazil

^fSecretaria de Estado de Meio Ambiente do Mato Grosso, Cuiabá-MT, 78053-128, Brazil

^gEmbrapa Solos, Rio de Janeiro-RJ, 22460-000, Brazil

^hUERJ, DESC/PPGMA/PPGEO, Rio de Janeiro-RJ, 20550-900, Brazil

ⁱEMBRPA Agrossilvicultoril, Sinop-MT, 78550-000, Brazil

ABSTRACT

The CHOVE-CHUVA project is a Space for Climate Observatory initiative aiming at developing operational tools to monitor socio-environmental dynamics in the Brazilian state of Mato Grosso, in the Southern Amazon. This project focuses on the dissemination of remote sensing-based spatial information to monitor the evolution of climate variables and land use dynamics, especially regarding agriculture, natural vegetation and hydrological resources. The platform is enhanced by the collection of collaborative data about the adoption of specific land use types (e.g. forest restoration and crop-livestock-forest integrated systems) encouraged by the Brazilian program for a low-carbon agriculture (ABC plan).

Index Terms— Climate change, Land Use dynamics, Spatial information, Citizen science, Web platform.

1. INTRODUCTION

The Brazilian state of Mato Grosso, in the Southern Amazon, has long been the scene of intense socio-environmental transformations, exacerbated in a context of global change.

*This work is supported by 1) the the French National Centre for Space Studies (CNES) through the SCO CHOVE-CHUVA project and the SEMTISENT project, and 2) the French National Research Agency (ANR) through the TELKANTE LAB project, 3) the EJP SOIL-ES project (ANR-23-SOIL-0001) and 4) the employment of two engineers under the France Relance plan. The work is also strongly supported by Brazilian partners (*Secretaria de Meio Ambiente de Mato Grosso, Instituto Centro de Vida, Fundação Ecológica Cristalino, Clube Amigos da Terra*). The CHOVE-CHUVA web-platform is being implemented by the ALKANTE company.

These transformations are mainly due to a very dynamic agricultural sector acting as a driver of environmental degradation. However, beyond the expansion strategy, this sector is also evolving in order to intensify and diversify its practices, particularly to adapt to the effects of climate change [1]. In this regard, Brazil is committed to a voluntary reduction of greenhouse gas emissions, especially in the agricultural sector [2]. This evolution is taking place in Brazil in the context of a sectoral plan for climate change mitigation and adaptation (ABC plan for Low-Carbon Agriculture) whose objective is to encourage the adoption of sustainable management practices such as the restoration of degraded pastures, the reforestation of riparian areas and the promotion of agricultural practices such as crop-livestock integration systems or no-tillage practices.

Whereas a wide range of remote sensing-based spatial data has been regularly released to monitor such socio-environmental transformations, tools enabling citizens and community associations to access synthetic information at a local scale (e.g. in their areas of interest) are still sorely lacking. In this regard, we here introduce the CHOVE-CHUVA web-platform that aims at monitoring territorial dynamics in Mato Grosso.

2. THE CHOVE-CHUVA WEB-PLATFORM

The CHOVE-CHUVA project was funded by the French National Center for Space Studies (CNES) under the frame of the Space for Climate Observatory (SCO) initiative whose goals are threefold : (1) facilitate interoperability of satellite and lo-

cal data and thus “make them talk”; (2) establish vulnerability indicators in support of climate change mitigation or coping strategies; (3) pool these tools and transpose them to other territories through an open data rationale. The CHOVE-CHUVA project is constituted of a multi-disciplinary consortium of partners (research labs, NGOs, associations, companies, local and national stakeholders, justifying the large number of co-authors of this paper) engaged in a long-term partnership in order to support adaptation and mitigation strategies to climate change.

The CHOVE-CHUVA web-platform then relies on two major pillars:

- Map visualisation and derived spatio-temporal indices
- Collaborative science

2.1. Map visualization and spatio-temporal indices

The primary objective of the CHOVE-CHUVA web-platform is to enable the visualization of spatial information made freely available by scientific teams, NGOs and administrations. Secondly, this information can be processed to derive spatio-temporal indices testifying for the territorial dynamics observed in Mato Grosso. These indices can be computed for administrative units (i.e. counties or protected areas) or by manual delineation of study areas. A major asset of the platform is to gather, visualize and process spatio-temporal information covering a wide range of thematics such as climate, land use, land tenure, hydrology, natural vegetation and agriculture.

2.1.1. Climate

The climate theme resumes information developed by researchers from the project’s consortium based on rainfall estimates from CHIRPS data. The indices illustrate the evolution of 1) precipitation quantities (i.e. monthly and annually estimates), 2) the temporality of the rainy season (i.e. onset dates, end dates and duration of the rainy season, figure 1) [3] and 3) the evolution of precipitation extremes (e.g. number of rainy days, Simple Day Intensity Index, maximum consecutive 5-days rainfall, maximum number of consecutive wet days) as defined by ETCCDI (Expert Team on Climate Change Detection and Indices) [4].

2.1.2. Natural vegetation and land use

The Natural vegetation section provides information on the land use dynamics considering information about deforestation [5], forest degradation [6], forest fires [7] and selective logging [8] (figure 1). The main indices refer to the annual and cumulative areas for each category. In addition, landscape metrics (number and density of forest patches, Shannon Diversity index (processed with the R landscapemetrics

package) are computed based on land use maps from the Map-biomas initiative [9] in order to bring another perspective on landscape dynamics than simple estimates of areas impacted by land use changes.

2.1.3. Hydrology

The hydrology section includes information on rivers and sources. This data has been provided by the State Secretary of Mato Grosso (SEMA), a partner from the project’s consortium. Based on this data, it is possible to compute basic statistics for a given area, i.e. number of sources and cumulative length of water courses. In addition, we provide information on the evolution of artificial water surfaces (number and cumulative area of water reservoirs) and the monitoring of degraded riparian forests (legally protected under the forestry code) since 1985.

2.1.4. Agriculture

The agriculture theme includes information on the evolution of agricultural practices, including maps on center pivot irrigation systems and crop types derived from the classification of MODIS time series [10]. In this regard, we pay special attention to the evolution of intensive practices such as double cropping systems [11].

2.1.5. Land tenure

In addition to these main themes, complementary information on land status is also provided. It includes maps of conservation units, indigenous lands and public settlements. It also integrates information on the evolution of the Rural Environmental Registry (CAR, *Cadastro Ambiental Rural*). Finally, it shows the map of consolidated rural areas produced by the NGO ICV and SEMA (2 project partners), which serves as a reference to define environmental infractions according to the New Forest Code [12].

2.2. Citizen data

The second objective of the project is to collect collaborative data from citizens in order to feed potential future research. The collected information especially refers to the monitoring of land use types that are still unusual in Mato Grosso and for which it is thus difficult to obtain sufficiently complete information to perform statistically significant analysis (e.g. validation of satellite image classifications). To collect this collaborative information, a tool has been implemented to enable the users to locate and delineate the land use types on Sentinel 2 satellite images (Figure 2). The land use types of interest are:

- Forest restoration: many farmers are encouraged to restore natural vegetation in degraded riparian areas to

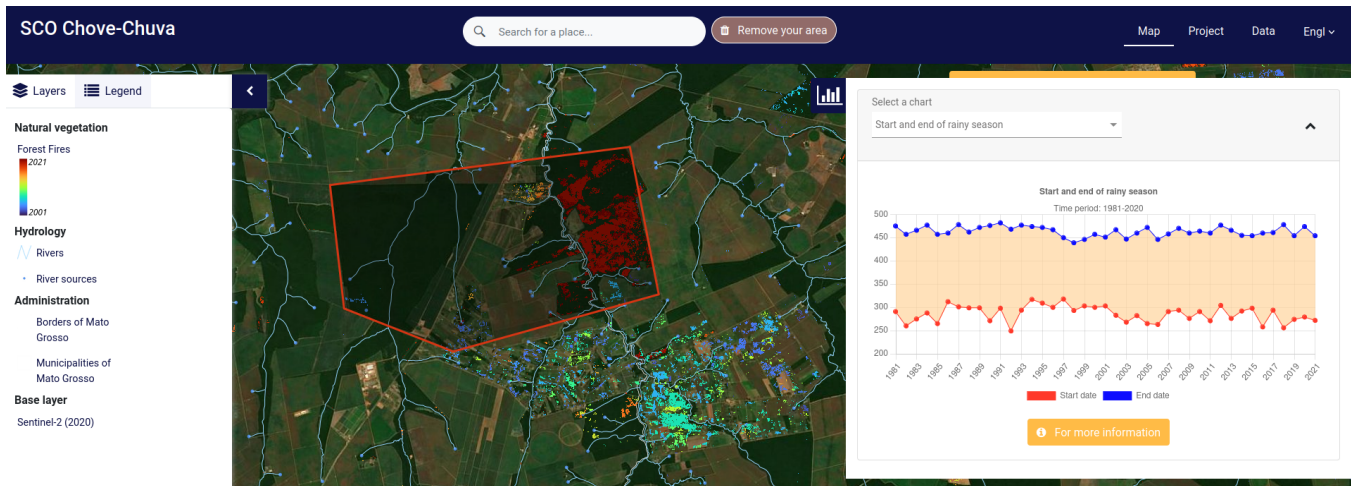


Fig. 1. Visualization of the evolution of forest fires and dashboard of the evolution of the onset and end dates of the rainy season for a manually-defined study area (red polygon).

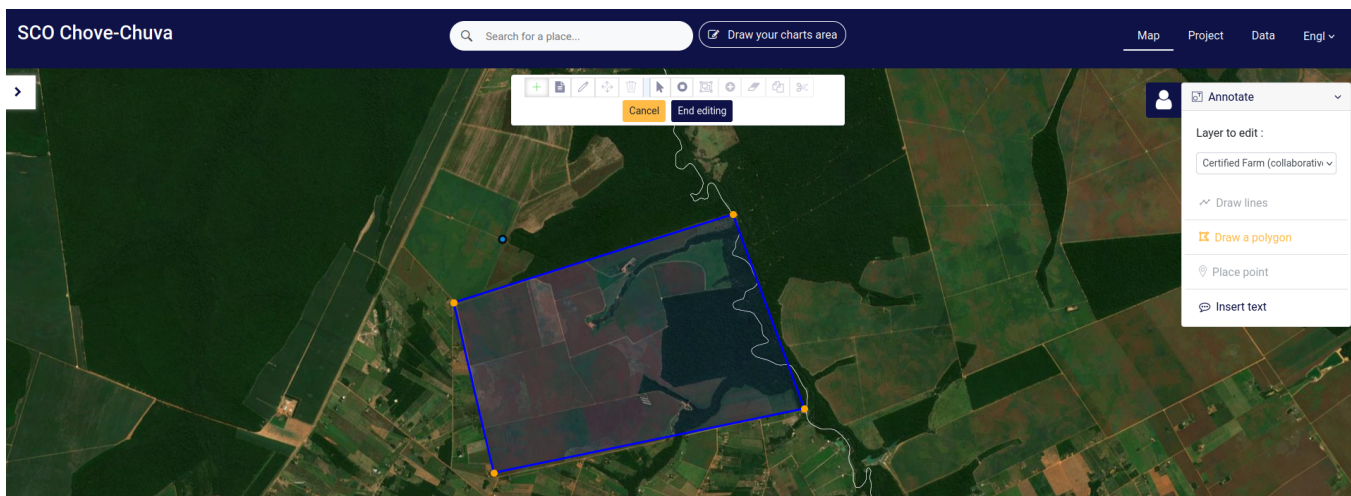


Fig. 2. Illustration of tool for collecting citizen data. Users can manually delineate areas about given land use practices (forest restoration, agricultural practices and RTRS certification) and provide some qualitative information (e.g. area, date).

comply with environmental legislation. These refer to many small areas spread across the state territory.

- Crop-Livestock-Forest integrated systems: farmers are encouraged to adopt low-carbon agricultural practices under the frame of the ABC low-carbon agriculture program [13]. Yet, there is still little information on the level of adoption of such practices.
- RTRS Certified farms: farmers are encouraged to comply with high-standard social and environmental rules in order to get access to specific markets.

3. ARCHITECTURE OF THE CHOVE-CHUVA WEB-PLATFORM

The CHOVE-CHUVA data portal is based on an opensource geospatial data infrastructure named PRODIGE. Identified and referenced in the SILL, a French free software reference catalog, PRODIGE is a Digital Commons for the acquisition, storage, cataloging, enhancement and distribution of geographic data. Co-constructed with the project partners, the platform is based on dockerized environments supported by the symfony 5.4 and phalcon 4.2 frameworks on a Linux Debian-based operating system. The database management system is PostgreSQL (version 15), with its PostGIS 3.3 spatial cartridge and MapServer being used to display data on a map. Data processing is carried out and automated with the

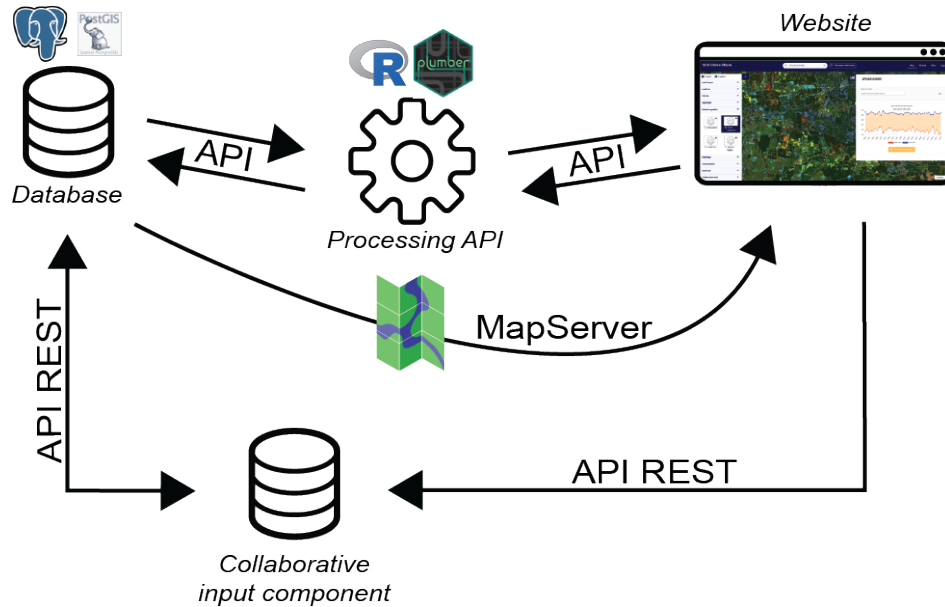


Fig. 3. Architecture of the CHOVE-CHUVA web-platform.

R software environment. The results are processed by API (Rplumber) before being interpreted by the Chart.js javascript library, enabling the generation of interactive graphics (Figure 3).

4. INTERACTIONS WITH END-USERS

This tool is designed to disseminate scientific data to the widest possible audience. It has been designed with local associations, NGOs (*Instituto Centro de Vida* in Alta Floresta, *Clube Amigos da Terra* in Sorriso, *Fundação Ecológica Cristalino* in Alta Floresta) and public administrations (Mato Grosso State Secretary of Environment, SEMA-MT). A major objective is also to enable every citizen to share information on the evolution of their territory, e.g. their municipality or farm. PRODIGE's data management, combined with the management of user rights, enables users to enter spatial data while entering specific information. This functionality should enable the research team of the project to manipulate this data in order to investigate the field of collaborative sciences applied to the Mato-Grosso territory.

5. CONCLUSION

The CHOVE-CHUVA project, implemented under the frame of the Space for Climate Observatory initiative, aimed at developing a web-platform to monitor socio-environmental dynamics in Mato Grosso based on remote sensing-based spatial information. The CHOVE-CHUVA tool will continue to be improved for the next 4 years under the frame of the TELKANTE Lab project funded by the French National Re-

search Agency (ANR) to strengthen the scientific collaboration between the LETG research unit (UMR 6554 CNRS) and the ALKANTE company. The new perspectives for the improvement of the web-platform include: 1) improving the processing of raw remote sensing data instead of ready-to-use remote sensing products, 2) improving the interactions with end-users, for example through the integration of online surveys about the perception of climate change, 3) integrating other types of spatial information (e.g. from in-situ sensors or social media) to compare with the remote sensing-based information and 4) implementing new platforms on other territories and thematics (i.e. monitoring the urban heat island in Rennes city, France).

6. ACCESS

The CHOVE-CHUVA web-platform can be accessed at: www.sco.chove-chuva.org.

7. REFERENCES

- [1] D. Arvor, I. Tritsch, C. Barcellos, N. Jégou, and V. Dubreuil, "Land use sustainability on the southeastern amazon agricultural frontier: Recent progress and the challenges ahead," *Applied Geography*, vol. 80, pp. 86–97, Mar. 2017.
- [2] R.C. de Abreu Lima and F.K. Lemos, *Brazilian Agriculture and the Global Environmental Agenda*, p. 85–105, Springer International Publishing, 2023.

- [3] D. Arvor, B. Funatsu, V. Michot, and V. Dubreuil, "Monitoring rainfall patterns in the southern amazon with persiann-cdr data: Long-term characteristics and trends," *Remote Sensing*, vol. 9, no. 9, pp. 889, Aug. 2017.
- [4] B. Funatsu, R. Le Roux, D. Arvor, J.C. Espinoza, C. Claud, J. Ronchail, V. Michot, and V. Dubreuil, "Assessing precipitation extremes (1981–2018) and deep convective activity (2002–2018) in the amazon region with chirps and amsu data," *Climate Dynamics*, vol. 57, no. 3–4, pp. 827–849, Apr. 2021.
- [5] L.F. F. G. Assis, K.R. Ferreira, L. Vinhas, L. Maurano, C. Almeida, A. Carvalho, J. Rodrigues, A. Maciel, and C. Camargo, "Terrabrasilis: A spatial data analytics infrastructure for large-scale thematic mapping," *ISPRS International Journal of Geo-Information*, vol. 8, no. 11, pp. 513, Nov. 2019.
- [6] C. Vancutsem, F. Achard, J.-F. Pekel, G. Vieilledent, S. Carboni, D. Simonetti, J. Gallego, L. Aragao, and R. Nasi, "Long-term (1990-2019) monitoring of tropical moist forests dynamics," Sept. 2020.
- [7] A. Tyukavina, P. Potapov, M.C. Hansen, A.H. Pickens, S.V. Stehman, S. Turubanova, D. Parker, V. Zalles, A. Lima, I. Kommareddy, X.P. Song, L. Wang, and N. Harris, "Global trends of forest loss due to fire from 2001 to 2019," *Frontiers in Remote Sensing*, vol. 3, Mar. 2022.
- [8] V. Silgueiro, B. Cardoso, A.P. Valdiones, and L. Batista, "Mapping illegality in logging in mato grosso in 2020," 2021.
- [9] C.M. Souza, J. Shimbo, M.R. Rosa, L. Parente, A. Alencar, B.F.T. Rudorff, H. Hasenack, M. Matsumoto, L. Ferreira, and Souza-Filho et al., "Reconstructing three decades of land use and land cover changes in brazilian biomes with landsat archive and earth engine," *Remote Sensing*, vol. 12, no. 17, pp. 2735, Aug. 2020.
- [10] M.C.A. Picoli, G. Camara, I. Sanches, R. Simões, A. Carvalho, A. Maciel, A. Coutinho, J. Esquerdo, J. Antunes, R.A. Begotti, D. Arvor, and C. Almeida, "Big earth observation time series analysis for monitoring brazilian agriculture," *ISPRS Journal of Photogrammetry and Remote Sensing*, vol. 145, pp. 328–339, Nov. 2018.
- [11] D. Arvor, M. Meirelles, V. Dubreuil, A. Bégué, and Y. E. Shimabukuro, "Analyzing the agricultural transition in mato grosso, brazil, using satellite-derived indices," *Applied Geography*, vol. 32, no. 2, pp. 702–713, Mar. 2012.
- [12] D. Arvor, V. Silgueiro, G. Manzon Nunes, and A. Nabucet, J. Pereira Dias, "The 2008 map of consolidated rural areas in the brazilian legal amazon state of mato grosso: Accuracy assessment and implications for the environmental regularization of rural properties," *Land Use Policy*, vol. 103, pp. 105281, Apr. 2021.
- [13] P. C. Kuchler, M. Simões, R. Ferraz, D. Arvor, P.L.O. de Almeida Machado, M. Rosa, R. Gaetano, and A. Bégué, "Monitoring complex integrated crop–livestock systems at regional scale in brazil: A big earth observation data approach," *Remote Sensing*, vol. 14, no. 7, pp. 1648, Mar. 2022.