


Rethinking Fire Governance in Fire-Prone Ecosystems: Stakeholders Perspectives and Conflicts over Traditional Fire-Use in Paraguay's Grasslands and Savannahs

Janika Hämmerle

Leibniz Centre for Agricultural Landscape Research

Contact: janikahaemmerle@outlook.de

Date: 26.08.2025

- 
- A person wearing a blue shirt, a wide-brimmed hat, and a yellow saddle blanket is riding a brown horse through a large herd of white and brown cows. The scene is set in a rural area with green trees in the background.
1. Research Background
 2. State of the Art and Research Lacuna
 3. Research Design
 4. Theoretical and Methodological Framework
 5. Results
 6. Discussion & Conclusion
 7. References

- Natural grasslands and savannahs are **fire-adapted ecosystems**:
 - Rapid post-fire regeneration
 - Dependence on periodic burns for maintaining ecological processes and preventing woody encroachments
 - Presence of fire-resilient species (e.g., palm trees)
- However, recent shifts in land use, in conjunction with climate change, have led to **alterations in the natural fire regime**.
 - Poses a significant threat to local biodiversity and rural livelihoods.



Fig 1: Natural grassland in the Humid Chaco; own contribution

Fig 2: Burned Forest in the Humid Chaco; own contribution

- **Indigenous communities and local farmers** are often blamed for these developments.
 - Traditionally, they have employed controlled burns as a land management tool.
 - These practices are deeply rooted in **Indigenous and traditional knowledge systems**.
- **Fire uses are prohibited and criminalized** by *Law N° 4014 - Fire Prevention and Control*
 - Has contributed to (1) **knowledge erosion** and (2) the increasing use of **ecologically harmful alternatives** such as mechanized land clearing and pesticides.



Fig 3: Natural grassland in the Humid Chaco used for pasture;
Fig 4: Burned Grassland; own contribution

In the literature, several studies highlight **the limitations of fire suppression laws and burning bans**:

- In Brazil the implementation of zero-fire policies has resulted **in increased woody encroachment** in grasslands and savannahs, **leading to catastrophic wildfires** due to the accumulation of flammable biomass (Sühs et al., 2020)
- In the Pantanal, farmers have been prompted to switch to alternative management tools to compensate for the ecological benefits previously derived from controlled burning, including the use of pesticides and the **introduction of exotic grasses** (Garcia et al., 2021).
- The lack of understanding of **the necessity of fire use** in rural communities for land management has contributed to the prevailing narrative that they are primarily responsible for fire-related challenges.

This highlights the urgent need for **integrative and just fire management approaches** that address the socio-ecological complexity of fire-prone landscapes and incorporate Indigenous and local perspectives to effectively mitigate wildfire impacts in the future.



Research Objective: To examine the role of Indigenous and local fire-use practices in shaping fire regimes within Paraguay's grasslands and savannahs with the aim of informing the co-production of an integrative and just fire management framework that incorporates indigenous and local knowledge systems, needs, and perspectives.

Research Design:

- **Case study approach** (Gran Chaco and Pantanal)
- **Cross-case comparisons** of different land-use systems and their fire-related practices and knowledge
- **Multi-step** and **mixed methodology** combining qualitative and quantitative data
- **Participatory** and **ethnographic research methods** to include the perspectives of farmers and indigenous communities, and to document their knowledge

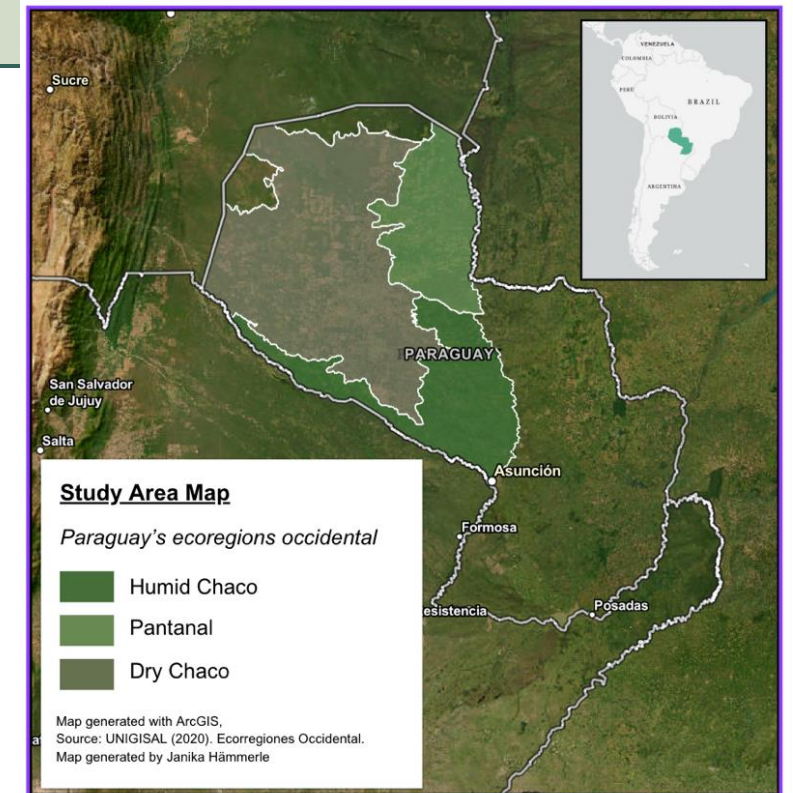


Fig 4: Study Area Map; own contribution

Case Study Description:

(1) **The Gran Chaco** is the second-largest biome after the Amazon, stretching across Argentina, Paraguay, and Bolivia. Located in its northeastern region, (2) **the Pantanal** is the world's largest wetland, extending across Brazil, Bolivia, and Paraguay.

- From a mosaic landscape, including grasslands, savannahs, palm groves, forests, and wetlands
- Recognized as **biodiversity hotspots** and provide **diverse ecosystem services**
- Support **food security** through extensive agricultural and livestock production
- Contain mix between **fire-adaptive** and **fire-sensitive** ecoregions



Fig 4: Natural grassland in the Humid Chaco; own contribution
Fig 5 - 6: Biodiversity in the Humid and Dry Chaco; own contribution

Current fire management strategies

(emphasis on suppression and legal prohibition of burning):

- Exclusion of local communities
- Criminalization of local fire practices
- Disregard of natural ecosystem dynamics

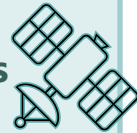


Integrative and just fire management

(including local communities as co-creators):

- Recognize fire as cultural and ecological management tool
- Includes local actors as knowledge holders
- Mitigate wildfire risks

Spatiotemporal analysis of fire regimes and their anthropogenic drivers



Anthropogenic drivers:

- Institutional and political mechanisms
- Land Use
- Climate Change

Phase 1

Phase 2

Systematization of fire-use practices and knowledge across different land use systems

- Development of land use system typology
- Documentation of fire-use practices, motivations, and knowledge through participatory mapping



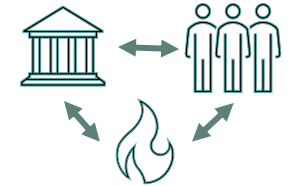
Collaborative framework development for an integrative fire management



- Comparative analysis of local practices and institutional strategies
- Stakeholder workshop for the development of management strategies

Phase 3

Phase 0: Initial understanding of local practices and governmental strategies



Preliminary fieldwork in Paraguay was conducted in November 2024

- **12 semi-structured interviews** with local stakeholders, including indigenous representatives, NGOs, firefighters, academic experts, government officials, and farmer associations

Actor Type	Interviews	Location
Indigenous people	<ul style="list-style-type: none">▪ n=2 NGOS▪ n=2 Indigenous communities	Asunción, Filadelfia, Yalve Sanga
Fire response units	<ul style="list-style-type: none">▪ n=1 Firefighter organization	Asunción
Political institutions	<ul style="list-style-type: none">▪ n=1 INFONA	Asunción
Agricultural producer	<ul style="list-style-type: none">▪ n=3 farmer associations	Asunción, Lomo Plato, Filadelfia
Other	<ul style="list-style-type: none">▪ n=3 Academia (University of Asunción/Forestry Department)	Asunción

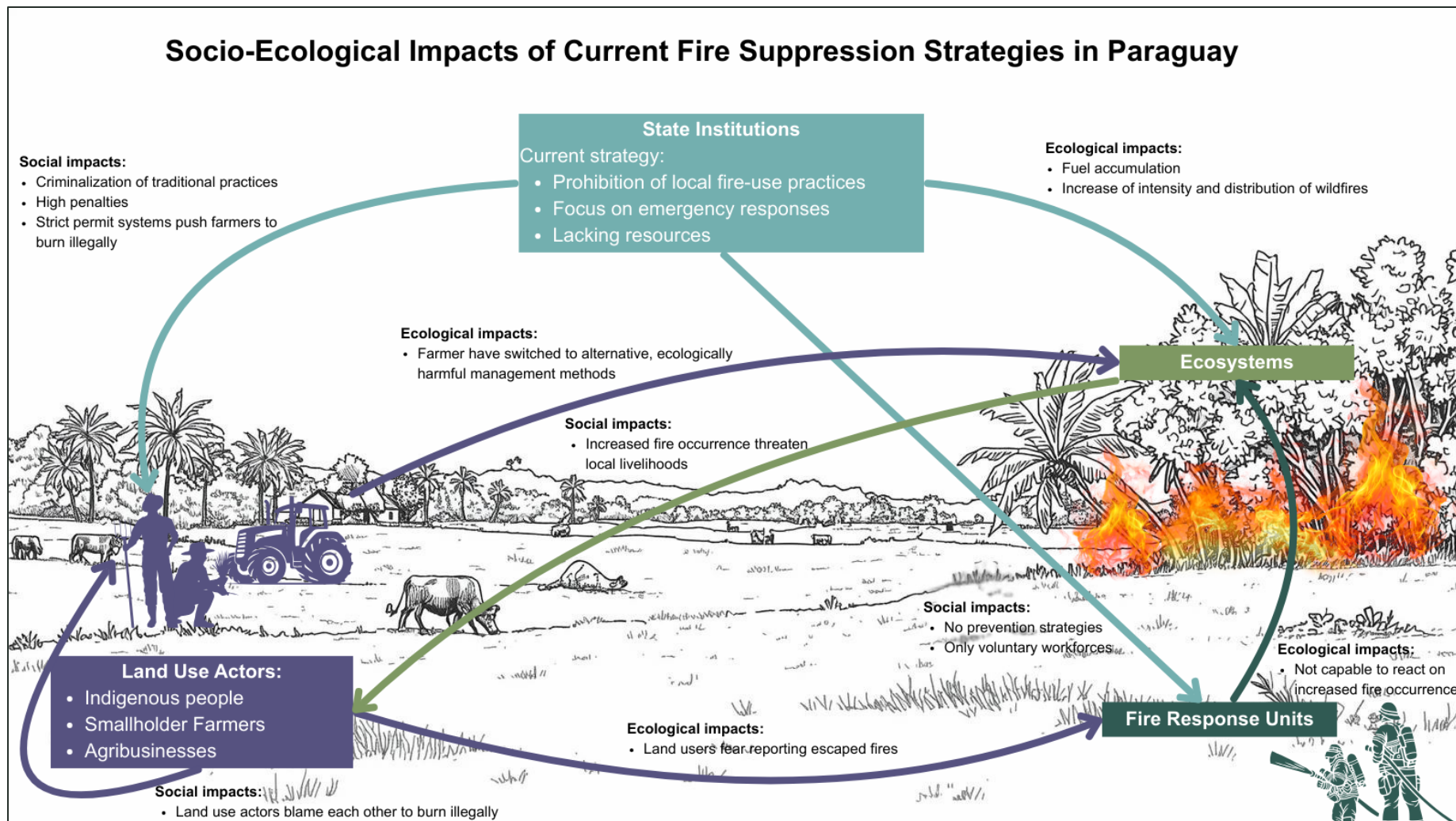


Fig 7: Socio-Ecological Impacts of current fire governance in Paraguay; own contribution

- Paraguay's fire management strategy remains **suppression-oriented** and **emergency-focused**, generating several negative socio-economic impacts.
 - By not accounting for the **natural role of fire** in grassland and savannah ecosystems, fire occurrence and intensity have increased.
 - The criminalization of indigenous and local fire-use practices has accelerated the **erosion of traditional knowledge** and fostered a shift toward **ecologically harmful practices** such as pesticide application.
- Findings indicate persistent **conflicts of interest** and **mutual blame among land use actors**, further complicating collective management efforts.
 - The exclusion of local communities from decision-making processes undermines knowledge exchange and hinders collaboration.
- The study highlights the urgent need to **foster inclusive dialogue** and **co-develop integrative and just fire management strategies** that account for ecosystems dynamics and reflect the diverse knowledge systems and perspectives of local actors.

- Arango-Quiroga, J., Kinol, A., & Kuhl, L. (2023).** Examining knowledge and epistemic justice in the design of nature-based solutions for water management. *PLOS Climate*, 2(9), e0000194. [haps://doi.org/10.1371/journal.pclm.0000194](https://doi.org/10.1371/journal.pclm.0000194)
- Bennett, N. J., Blythe, J., Cisneros-Montemayor, A. M., et al. (2019).** Just Transformations to Sustainability. *Sustainability*, 11(14), 3881. [haps://doi.org/10.3390/su11143881](https://doi.org/10.3390/su11143881)
- Berkes, F., & Davidson-Hunt, I. J. (2006).** Biodiversity, traditional management systems, and cultural landscapes: Examples from the boreal forest of Canada. *International Social Science Journal*, 58(187), 35–47. [haps://doi.org/10.1111/j.1468-2451.2006.00605.x](https://doi.org/10.1111/j.1468-2451.2006.00605.x)
- Brack, I. V., Cordeiro, J. L. P., Kindel, A., et al. (2024).** Spatial modelling and estimation of mammals' mortalities by Pantanal 2020 megafires. *Journal of Applied Ecology*, 61(11), 2848–2859. <https://doi.org/10.1111/1365-2664.14789>
- Casillo, J., Kunst, C., & Semmaryn, M. (2012).** Effects of fire and water availability on the emergence and recruitment of grasses, forbs and woody species in a semiarid Chaco savanna. *Austral Ecology*, 37(4), 452–459. [haps://doi.org/10.1111/j.1442-9993.2011.02306.x](https://doi.org/10.1111/j.1442-9993.2011.02306.x)
- Coughlan, M. R. (2016).** Wildland Arson as Clandestine Resource Management: A Space–Time Permutation Analysis and Classification of Informal Fire Management Regimes in Georgia, USA. *Environmental Management*, 57(5), 1077–1087. [haps://doi.org/10.1007/s00267-016-0669-3](https://doi.org/10.1007/s00267-016-0669-3)
- Carrión-Paladines, V., Correa-Quezada, L., Valdiviezo Malo, H., et al. (2024).** Exploring the ethnobiological practices of fire in three natural regions of Ecuador, through the integration of traditional knowledge and scientific approaches. *Journal of Ethnobiology and Ethnomedicine*, 20(1), 60. [haps://doi.org/10.1186/s13002-024-00699-4](https://doi.org/10.1186/s13002-024-00699-4)
- Coria, R. D., Kunst, C. R., & Bravo, S. J. (2021).** Un aporte al entendimiento de la lignificación de los pas+zales/sabanas del Chaco Semiárido sudamericano. *Ecología Austral*, 31(3), 456–474. [haps://doi.org/10.25260/EA.21.31.3.0.1615](https://doi.org/10.25260/EA.21.31.3.0.1615)
- Coronel, G. et al. (2021).** Wildfires in Paraguay: Environmental and Human Impacts. In: Leal Filho, W., Azeiteiro, U.M., SeT, A.F.F. (eds) Sustainability in Natural Resources Management and Land Planning. World Sustainability Series. Springer, Cham. https://doi.org/10.1007/978-3-030-76624-5_25
- Correa, D. B., Alcântara, E., Libona, R., et al. (2022).** Increased burned area in the Pantanal over the past two decades. *Science of The Total Environment*, 835, 155386. [haps://doi.org/10.1016/j.scitotenv.2022.155386](https://doi.org/10.1016/j.scitotenv.2022.155386)
- Cummings, S., Dhewa, C., Kemboi, G., & Young, S. (2023).** Doing epistemic justice in sustainable development: Applying the philosophical concept of epistemic injustice to the real world. *Sustainable Development*, 31(3), 1965–1977. <https://doi.org/10.1002/sd.2497>
- Fricker, M. (2007).** Epistemic justice: Power and the politics of knowledge. Oxford University Press.
- Fricker, M. (2017).** Evolving concepts of epistemic injustice. In *The Routledge handbook of epistemic injustice* (pp. 53–60). Routledge.
- Fricker, M. (2013).** Epistemic justice as a condition of political freedom? *Synthese: An International Journal for Epistemology, Methodology and Philosophy of Science*, 190(7), 1317–1332. [haps://doi.org/10.1007/s11229-012-0227-](https://doi.org/10.1007/s11229-012-0227-)
- Garcia, L. C., Szabo, J. K., De Oliveira Roque, F., et al. (2021).** Record-breaking wildfires in the world's largest continuous tropical wetland: Integrative fire management is urgently needed for both biodiversity and humans. *Journal of Environmental Management*, 293, 112870. [haps://doi.org/10.1016/j.jenvman.2021.112870](https://doi.org/10.1016/j.jenvman.2021.112870)

- Grau, H. R., Torres, R., Gasparri, N. I., et al. (2015).** Natural grasslands in the Chaco. A neglected ecosystem under threat by agriculture expansion and forest-oriented conservation policies. *Journal of Arid Environments*, 123, 40–46. [haps://doi.org/10.1016/j.jaridenv.2014.12.006](https://doi.org/10.1016/j.jaridenv.2014.12.006)
- Kumar, S., GeYrana, A., LibonaY, R., Hain, C., et al. (2022).** Changes in land use enhance the sensitivity of tropical ecosystems to fire–climate extremes. *Scientific Reports*, 12(1), 964. <https://doi.org/10.1038/s41598-022-05130-0>
- Landi, M. A., Di Bella, C. M., Bravo, S. J., & Bellis, L. M. (2021).** Structural resistance and functional resilience of the Chaco forest to wildland fires: An approach with MODIS time series. *Austral Ecology*, 46(2), 277–289. <https://doi.org/10.1111/aec.12977>
- Löhr, K., Weinhardt, M., & Sieber, S. (2020).** The “World Cafe” as a participatory method for collectng qualitative data. *International journal of qualitative methods*, 19, 1609406
- Mistry, J., Schmidt, I. B., Eloy, L., & Bilbao, B. (2019).** New perspectives in fire management in South American savannas: The importance of intercultural governance. *Ambio*, 48(2), 172–179. <https://doi.org/10.1007/s13280-018-1054-7>
- Oliveras Menor, I., Prat-Guitart, N., Spadoni, G. L., et al. (2025).** Integrated fire management as an adaptation and mitigation strategy to altered fire regimes. *Communications Earth & Environment*, 6(1), 202. <https://doi.org/10.1038/s43247-025-02165-9>
- Pott, A. (2020).** What is the Flora of the Pantanal Wetland? *Wetland Science & Prac2ce*, 37(4), 261–266. <https://doi.org/10.1672/UCRT083-203>
- Pratzer, M., Meyfroidt, P., Antongiovanni, et al. (2024).** An actor-centered, scalable land system typology for addressing biodiversity loss in the world’s tropical dry woodlands. *Global Environmental Change*, 86, 102849
- San Martin, R., Otle, C., & Sörensson, A. (2023).** Fires in the South American Chaco, from dry forests to wetlands: Response to climate depends on land cover. *Fire Ecology*, 19(1), 57. [haps://doi.org/10.1186/s42408-023-00212-4](https://doi.org/10.1186/s42408-023-00212-4)
- Sühs, R. B., Giehl, E. L. H., & Peroni, N. (2020).** Preventing traditional management can cause grassland loss within 30 years in southern Brazil. *Scientific Reports*, 10(1), 783. <https://doi.org/10.1038/s41598-020-57564-z>
- Vázquez-Varela, C., Marknez-Navarro, J. M., & Abad-González, L. (2022).** Traditional Fire Knowledge: A Thematic Synthesis Approach. *Fire*, 5(2), 47. <https://doi.org/10.3390/fire5020047>
- Vidal-Riveros, C., Currey, B., McWethy, D. B., et al. (2024).** Spatiotemporal analysis of wildfires and their relationship with climate and land use in the Gran Chaco and Pantanal ecoregions. *Science of The Total Environment*, 955, 176823. [haps://doi.org/10.1016/j.scitotenv.2024.17682](https://doi.org/10.1016/j.scitotenv.2024.17682)
- Vidal-Riveros, C., Souza-Alonso, P., Bravo, S., et al. (2023).** A review of wildfires effects across the Gran Chaco region. *Forest Ecology and Management*, 549, 121432. [haps://doi.org/10.1016/j.foreco.2023.121432](https://doi.org/10.1016/j.foreco.2023.121432)

Thank you for your attention!



Leibniz Centre for
Agricultural Landscape Research
(ZALF)