International Cartographic Association
Association Cartographique Internationale

Towards a fuzzy model for the cartography of fishing areas in the Moorea lagoon

Clément Iphar [a,*], Teriitutea Quesnot [a,b]

[a] *Univ Brest, CNRS, LETG – UMR 6554, Plouzané, France, clement.iphar@univ-brest.fr, quesnot@univ-brest.fr*
[b] *Institut Universitaire de France, Paris, France*

* Corresponding author

Keywords: lagoon fishing, fuzzy logic, spatial predicates, indigenous mapmaking

Abstract:

Lagoon fishing practices in Moorea, an island in French Polynesia, are deeply embedded in an intangible cultural heritage that reflects the continuum between humans, the land, and the sea. This cultural framework is rooted in the Polynesian concept of fenua, which integrates land, sea, and culture into a unified whole. For the people of Moorea, the lagoon is not merely a physical space or resource but a vibrant, lived environment filled with memories, emotions, and symbolic meanings. However, contemporary management frameworks such as the Plan de Gestion de l'Espace Maritime (PGEM – for Marine Space Management Plan) have struggled to reconcile this cultural specificity with conventional zoning methodologies. The PGEM and other land-related and sea-related legally-defined areas rely on Aristotelian cartographic principles that view space as fixed, bounded, and discrete, under the principle of excluded middle, imposing rigid areas for marine protection and regulated fishing. While this approach has achieved ecological benefits, it has failed to resonate with the local fishing community, who perceive the lagoon as a relational and dynamic environment. This dissonance has fostered a sense of injustice among fishermen, who perceive the PGEM as favouring tourism and external interests over traditional practices and cultural heritage.

To address this gap, we propose an alternative methodology, under the principles of "non-Aristotelian cartographies", which reconceptualises space as fluid, relational, and affective *per se* (Quesnot, 2024; Quesnot et al., 2024). Drawing on Polynesian spatial ontologies, our cartographic approach seeks to represent the lagoon as a "lived space" rather than a rigidly defined territory. This approach is grounded in several theoretical frameworks, including the cultural continuum between nature and culture, the integration of fuzzy spatial representations, and the incorporation of affectivity into mapping practices. By adopting fuzzy logic, initially developed by Zadeh (1965), the methodology goes beyond the binary boundaries typical of Western cartography, enabling the representation of overlapping, ambiguous, and culturally significant spaces. Furthermore, it incorporates participatory methods to capture the mental representations and lived experiences of fishermen, ensuring that their narratives and spatial perceptions are central to the mapping process.

The methodology unfolds in several stages. First, fishermen are invited to create sketch maps of their fishing territories, capturing physical landmarks, cultural symbols, and areas of emotional significance. These drawings serve as the foundation for further participatory engagement. Through narrative interviews, fishermen then share their life stories, detailing their emotional connections and symbolic associations with specific spots within the lagoon of Moorea. These narratives are analysed to identify spatial predicates, and then digitised and integrated into a Geographic Information System (GIS) using fuzzy spatial modelling techniques. This process enables a nuanced representation of vague territories. Additionally, this digitisation process introduces new possibilities for identifying patterns in the spatial practices of fishermen that might remain obscured in conventional cartographic outputs.

More specifically, the digitisation process involves extracting triplets {subject, spatial predicate, geographical feature}, in which the subject is the fisherman's fishing area, the spatial predicate is the relationship in natural language, and the geographical feature is the punctual, linear or surface landmark that enables the location of the fishing area. So far, out of 16 narrative interviews of fishermen, 90 of such triplets have been extracted. Two examples of such triplets are: [fisherman09area, just past, the AMP Pole], [fisherman44area, in front of, Tahiamanu Beach] and [fisherman02area, near, Haapiti mangrove] with a punctual, linear and surface geographical element, respectively.

Abstracts of the International Cartographic Association, 10, 122, 2025
32nd International Cartographic Conference (ICC 2025), 17–22 August 2025, Vancouver, Canada.
https://doi.org/10.5194/ica-abs-10-122-2025

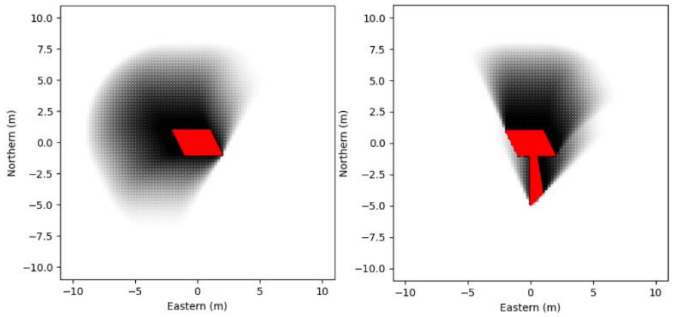

Figure 1: Spatial predicates with respect to an object (red). Left: "Near and North-West of the object". Right: "Near and North of the object". From Iphar (2021).

The variery of spatial predicates allow a faithful representation of the spatial relationship between the subject and the geographical feature, while the use of fuzzy logics accounts for the natural uncertainty that pertains to natural language. In order to be mapped, the space was divided into equal squares with a 25-meter side. Each square was assigned a score between 0 and 1, where 0 indicates "not a fishing area", 1 signifies "definitively a fishing area", and intermediate values represent a degree to which this location is considered as a fishing area.

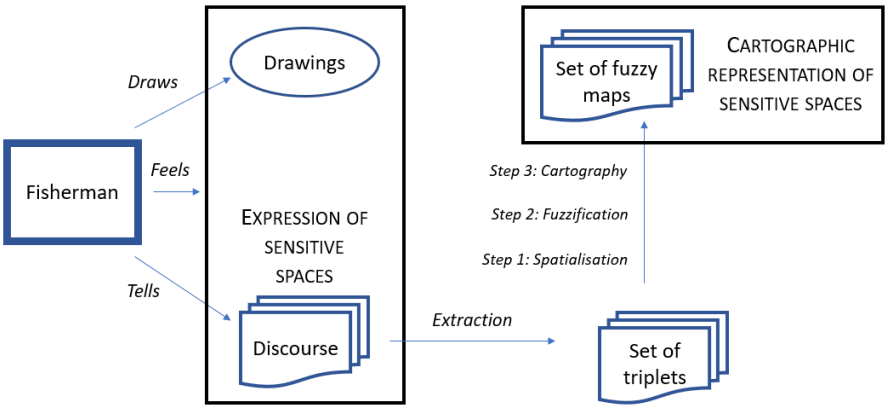

Figure 2: Methodological approach

Building on this methodological foundation, the maps we aim to create serve multiple purposes. First, they enhance the representation of Polynesian cultural heritage, preserving the intangible dimensions of lagoon fishing practices. This preservation effort not only safeguards traditional knowledge but also elevates the voices of local communities in discussions about resource management. Second, they offer policymakers a more inclusive tool for lagoon resource management, bridging the gap between ecological goals and cultural values. This inclusive approach has the potential to mitigate conflicts between stakeholders by presenting a holistic perspective on lagoon use and management. Third, the approach advances cartographic innovation by demonstrating the potential of fuzzy logic to capture the fluidity and complexity of human spatial experiences.

Acknowledgements

This work is supported by the French National Agency for Research (grant n° ANR-21-CE17-0012).

References

Iphar C., Boudet L., Poli J.P. (2021) Topography-based Fuzzy Assessment of Runoff Area with 3D Spatial Relations. In: Proceedings of the 2021 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE), 6p., 11-14 July 2021, Luxemburg, Luxemburg. doi: 10.1109/FUZZ45933.2021.9494395

Quesnot, T. (2024). *Approches (dés)incarnées des Espaces-Temps en Océanie – Pour une décolonisation des savoirs et des méthodes anthropogéographiques dans l'aire océanienne* (Mémoire d'habilitation à diriger des recherches). Université de Bretagne Occidentale, Brest, France.

Quesnot, T., Schmitter, E., Wencélius, J. & Bambridge, T. (2024). Moorea lagoon fishers' mental maps: an exploratory analysis of Polynesian spatial knowledge. Ethos, 52(1), 114-137.

Zadeh, L. (1965). Fuzzy sets. *Information and Control*, *8*(3), 338