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Vulnerability of the reef heritage: reflections from an interdisciplinary thematic school in the Western Indian Ocean

Xavier Koenig¹ , Clémentine Violette^{2,*} , Pascale Chabanet³ , Gilbert David⁴ , Georgeta Stoica⁵ ,
Florence Galletti⁶ , Ameer Ebrahim⁷ , Léo Broudic⁸ , Jean Jubrice Anissa Volanandiana⁹,
Sandra Ranaivomanana¹⁰ , and Alice Marque¹¹

¹ Sustainability science, Université des Mascareignes, Sustainability and Climate Change Programme (SCCP), Mauritius

² Ecology, IRD, UMR MARBEC, Montpellier, France and IRD, SFA, Victoria, Seychelles

³ Ecology, Université de La Réunion, UMR ENTROPIE, La Réunion, France

⁴ Geography, IRD, UMR ESPACE-DEV, Montpellier, France

⁵ Anthropology, Université de Mayotte, département des sciences de l'éducation, Mayotte, France and Université de la Réunion, UR ICARE, La Réunion, France

⁶ Public law, IRD, UMR MARBEC, Sète, France

⁷ Ecology, Ameer Ebrahim Consulting, Mahe, Seychelles

⁸ Ecology, Université de Rennes, UMR ECOBIO, Rennes, France and Agence de recherche pour la biodiversité à La Réunion, Saint-Gilles, La Réunion, France and CNRS, UMR CEVIPOF, Paris, France

⁹ Marine science, University of Toliara, Institut halieutique et des sciences marines, Toliara, Madagascar

¹⁰ Marine biology, University of Toliara, Institut halieutique et des sciences marines, Toliara, Madagascar

¹¹ Project manager, IRD, UMR PALOC, Paris, France

Abstract – Since 2014, the French National Research Institute for Sustainable Development (IRD) has hosted three interdisciplinary thematic schools on the vulnerability of the reef heritage (VulPaRe) in the Western Indian Ocean. Taking a sustainability science approach, the schools aimed to build capacity, facilitate knowledge transfer, and foster collaboration among a variety of stakeholders involved in research and the governance of coastal resources. The latest VulPaRe school highlighted 1) the need to strengthen the role of social sciences in interdisciplinary studies, 2) the opportunities and threats of market-based mechanisms integrating conservation and ecological restoration, and 3) concerns of justice on the access to common resources. An improvement of this educational process would be to provide more guidance for dialogues with decision makers in these reef areas.

Keywords: natural resources / conservation / governance / socio-ecosystem / sustainability

Résumé – **Vulnérabilité du patrimoine récifal : réflexions sur la 3^e édition de l'école thématique interdisciplinaire du Sud-Ouest de l'océan Indien (VulPaRe 2024).** L'Institut de recherche pour le développement (IRD) a initié un projet d'école thématique sur le sujet de la vulnérabilité du patrimoine récifal (VulPaRe). Cette troisième édition, qui s'est déroulée en juin 2024 aux Seychelles, était axée sur l'interdisciplinarité. L'école avait pour objectif de faciliter la communication et d'encourager la collaboration dans la gouvernance et la durabilité du management des ressources côtières de l'océan Indien. Elle a souligné 1) la nécessité de renforcer le rôle des sciences sociales dans les études interdisciplinaires visant à informer la gouvernance, 2) les atouts et dangers des mécanismes de conservation et de restauration écologique et 3) les préoccupations de justice sur l'accès aux ressources communes. L'école a offert une plateforme efficace aux acteurs non politisés pour discuter des problèmes régionaux actuels et des solutions. Une amélioration de ce processus pédagogique serait de parvenir à fournir davantage de conseils pour nourrir des dialogues avec les décideurs en charge de ces zones récifales.

Mots-clés : ressources naturelles / conservation / gouvernance / socio-écosystèmes / sciences de la durabilité

*Corresponding author: clementine.violette@ird.fr

Introduction

The Western Indian Ocean (WIO) is shared by several island states and coastal territories, each playing a role in the use and management of the region's coastal and marine resources. As such, ten WIO countries have entered the Nairobi Convention as a collaborative effort to 'protect, manage, and develop their coastal and marine environment'. In this context, the French National Research Institute for Sustainable Development (IRD, Institut de recherche pour le développement) has convened three thematic schools in the WIO region since 2014, gathering senior scientists, government representatives, including protected area managers and fisheries officers, members of civil society organizations and junior researchers (students) to support regional capacity-building on the theme of reef heritage vulnerability (VulPaRe, *Vulnérabilité du patrimoine récifal*, in French¹).

The objective of this paper is twofold: firstly, to disseminate the VulPaRe approach (and materials²) as a thematic school format rooted in sustainability science, that is, based on the co-construction of knowledge and know-how, out of the collaboration between scientists from different disciplines and between scientists and non-academic stakeholders in a participatory and action-oriented approach (West et al., 2020); secondly, although the attendance cannot be conceived as representative of the WIO stakeholders and their views, the paper seeks to relate key perspectives and lessons learned from regional interactions on the school's theme.

The VulPaRe approach

The first two VulPaRe thematic schools (2014 and 2016) were held in French in Toliara, Madagascar (Mahafina, 2024), where the local Vezo populations are known for their semi-nomadic fishing lifestyles (Astuti, 1995). While the wider WIO was considered, the schools were highly influenced by this specific setting, yielding strong theoretical debates on four foundational concepts (Morandi et al., 2018), namely: 1) Socio-ecosystems, 2) Heritage, 3) Vulnerability and 4) Interdisciplinarity (Unesco, 1972).

¹ Ce texte est en mémoire de Christian Chaboud, chercheur à l'IRD, économiste des pêches et de l'environnement. Il laisse une œuvre majeure sur les dynamiques halieutiques et la gestion durable des ressources marines. Cofondateur de la première école VulPaRe sur la vulnérabilité du patrimoine récifal à Madagascar, il se distinguait par son exigence, son sens du collectif, sa bonne humeur et son engagement pour les communautés du Sud.

² All the presentations are available in open access on the DiDEM website: <https://www.didem-project-en.org/>.

The third VulPaRe edition was held in English at the University of Seychelles in June 2024, as part of the DiDEM project, which aims to integrate scientific knowledge into decision-making for coastal and marine management in the WIO (Markus et al., 2018). Seeking an improved regional representation and exchange, the school gathered participants from Comoros, France (including Mayotte, Reunion Island and metropolitan), Kenya, Madagascar, Mauritius, Monaco (through its research in the WIO), Seychelles and Tanzania; and further explored the above foundational concepts through seven sub-themes, wherein knowledge, applications, and representations were considered:

- From ecosystem to reef socio-ecosystem
- The coral ecosystem in all its states
- Reef heritage monitoring and assessment
- Reef heritage, fisheries and conservation
- Integrated coastal management, blue economy and blue justice
- Reef heritage in relation to education and awareness-raising
- Ecological engineering

Each sub-theme was covered by a series of lectures followed by debates, animated by various experts and practitioners in the fields of anthropology, biology, ecology, fisheries, geography, law, governance, and socioeconomics. These presented the state of the art, theoretical and methodological foundations, complemented by regional experience sharing, especially by protected area managers and fisheries officers. In addition, three half-days were devoted to field trips, where activities were conducted in small interdisciplinary groups, introducing participants to different biological and social research methodologies, to foster exchanges between disciplines including coral reef monitoring, ethnographic surveys and local fisheries surveys. The following section provides a summary of the points which elicited most interest and reflection.

School outcomes: recurring observations and emerging concerns

Tipping the interdisciplinary scale towards social sciences

As a fundamental aspect of sustainability science and a defining feature of the school's attendance, interdisciplinarity was an essential topic of discussion (Haapasaari et al., 2012; Degraer et al., 2019). Within it, a particular challenge lied in the integration of natural and social sciences to inform governance, with those being contrasted by: 1) the striking consistency of natural science methods in providing increasingly high-quality

insights on ecosystems, as evidenced by presentations on reef geomorphology (Stoddart, 1969; Chong-Seng et al., 2014), reef health monitoring methods (Chabanet et al., 2000; Obura et al., 2021), and connectivity (Crochelet et al., 2016); 2) the comparative subjectivity and most importantly the lack of systematic social studies for socio-ecosystems, as social science is globally underfunded compared to natural sciences (Shrivastava et al., 2020). Participants involved in small-scale fisheries and protected areas stressed the need to understand the values of communities at the local level, in line with the IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) ‘Nature’s Benefits to Peoples’ framework (Ellis et al., 2019; Fromentin et al., 2022), to enable socially inclusive and participatory policy processes (Kosamu, 2015; Freed et al., 2016). For example, in Madagascar, certain locations are designated as ‘fady’ (taboo) by the local community and must be given special consideration (Jones et al., 2008). The issue of tenure loss was also raised, as conservation interventions can produce negative outcomes such as migrations, shifting the burden of resource overuse and degradation to other locations (Cripps and Gardner, 2016). As such socio-cultural challenges require significant time and effort to address, some believed that the Kunming-Montreal Global Biodiversity Framework (KMGBF) target of protecting 30 % of marine and coastal areas by 2030 would be difficult to achieve for most countries in the WIO. Finally, discussions turned to the concept of Socioeconomic Monitoring (SocMon) (Bennett et al., 2021a; Allen et al., 2022), which was introduced to deal with context-specific challenges at the local level, yet a lack of adequate training in social and interdisciplinary studies has hindered its potential benefits and must be corrected (David and Quod, 2018).

Sustainable solutions through novel interventions?

The thematic school held sessions dedicated to innovations undertaken in the WIO which may support socio-ecosystems, beyond traditional conservation endeavors. Those consisted of interventions that are integrated to economic activities, including:

- Multi-Trophic Aquaculture (MTA), which not only reduces pressure on ecosystems from fishing, but also enhances the production’s biomass and biodiversity in its surroundings (Barrington et al., 2009). Participants discussed the possibility of implementing MTA within marine protected areas (MPAs), as an opportunity for educating tourists (Le Gouvello et al., 2017). Others raised sanitary concerns, arguing tourists may have negative perceptions of aquaculture (Leow and Tan, 2020).
- The accounting of carbon sequestration by seagrass, as part of the Seychelles’ Blue Economy Roadmap (Bargain, 2018) to meet the country’s climate change mitigation targeted under the UNFCCC (United Nations Framework Convention on Climate Change) (Joubert, 2021). Under a high-effort scenario, the Seychelles would effectively become a net sequester of carbon, which introduces the potential of financial revenues from international carbon markets (Booth and Brooks, 2023).
- Rodent eradication, as rodents are responsible for decimating entire bird populations, feeding from the bird’s eggs, leading to nearly collapse of biodiversity and impacting the tourism industry (Harper and Bunbury, 2015). Their removal permitted remarkable species and ecosystem recoveries (Millett et al., 2019).

These, presented as ‘sustainable solutions’, captured the interest of participants, arguably because the proliferation of such activities implies a growing market-based demand for ecosystem restoration within economic development projects, which can stimulate supply. While this may seem encouraging in the global context of ecosystem degradation, relying too heavily on such approaches may steer interventions towards economic optimization, itself a major historical cause of ecosystem degradation (Visseren-Hamakers and Kok, 2022).

Legal protections for coral reef and Blue Justice

A key addition to the school program was a focus on legal matters, first describing key features of the International Law of the Sea, of the Nairobi Convention as UNEP (United Nations Environment Programme) regional legal framework, then highlighting gaps in coral reef protections across the ten WIO contracting parties. Despite management plans for MPAs and some inclusion of integrated coastal zone management provisions in legislation, expanses of coral reefs in most cases do not have a dedicated legal status ensuring their protection. This lack of legislation is global, with few exceptions like the USA (Coral Reef Conservation Act of 2000, 2000) and Australian (Great Barrier Reef Marine Park Act 1975, 1975) national laws. In response, it was suggested that recognizing coral reefs as national heritage in constitutions could grant them legal status, establishing a framework for their protection and promoting both conservation and social equity in marine resource management.

The notion of Blue Justice, here taken broadly as environmental justice, emerged as vital, emphasizing equitable access to marine resources, especially for

historically marginalized communities. However, Blue Justice is not reflected in the Nairobi Convention, with no framework to measure or enforce it. Defining Blue Justice was perceived as challenging, similar to defining the ‘Blue Economy’, which the Seychelles have been developing for nearly 20 years, resulting in its Blue Economy Roadmap and various associated governance structures and instruments (Bargain, 2018). Participants noted that governments often view the Blue Economy primarily as a means for economic growth, linked to oil and mining, rather than as a pathway towards sustainability (Tafon et al., 2023). This led to debate on whether Blue Justice is merely an academic concept, while others argued it is a social movement aimed at reducing inequalities and fostering inclusive decision-making. Indeed, civil society has used this concept to hold authorities accountable for forced expropriations in coastal areas and fishing areas (Blythe et al., 2023). The discussion addressed legal inequalities, with the poorest and vulnerable lacking access to information and legal support, thus being excluded from decision-making (Bennett et al., 2021b), as seen in Mauritius (Koenig and Deenapanray, 2024). One participant pointed out that excluding certain kinds of resource managers from policy design represents ‘blue injustice’, especially given the KMGBF’s 30 % protection goal, which could restrict access and rights. Language barriers further complicate community participation for reasons of capacity, procedures, the perception of being inadequate, or the fear of being unwelcome and unheard.

Referring to the coral reef connectivity within the WIO, a participant questioned if Blue Justice could be used to seek reparation between countries for environmental damage. This was seen as unlikely (further complicating the concept) and a comparison was made with Climate Justice, where global climate governance has taken a neoliberal direction instead of furthering compensatory, restitutive, and corrective forms of justice (Uri et al., 2024). Indeed, Global North countries, which are largely responsible for climate change, fail to adequately support vulnerable nations already suffering from climate change impacts. Under the UNFCCC, where they could not mitigate emissions, developed countries could fund emission reductions in developing nations. This created ‘economies of receiving’ which led to ‘fashionable’ initiatives such as mangrove planting that were often ecologically unsound (Silver and Campbell, 2018). Several participants thus warned against the potential pervasive effects of not sufficiently understanding Blue Justice mechanisms, should they be established.

Discussion and perspectives

The 2024 VulPaRe thematic school covered a rich and diverse range of topics pertaining to socio-

ecosystemic vulnerability, integrating ecological, cultural, economic, and legal aspects. Interactions focused less on theoretical notions, strongly debated in previous editions, and were instead oriented towards practical applications, as scientists and managers appeared more receptive to real-world interventions which may reduce socio-ecosystemic vulnerabilities. As such, debates gave little consideration to the structural problems that are causing the loss of marine ecosystems and social inequalities (Vatn, 2020). During the school, reef ecosystems were essentially viewed as a resource (a form of capital) yet also likened to a common good from which to derive benefits, without delving into the conceptual differences between the two and their operational implications. A pertinent addition to the school’s introductory lectures would be a presentation of sustainability frameworks such as the four sustainability problem conceptions, respectively reinforcing 1) commons, 2) economic optimization, 3) compromise, and 4) prioritization (Cashore and Bernstein, 2023). This would help situate the drivers of socio-ecosystemic change, as well as the current and proposed solutions (Koenig and Deenapanray, 2024).

Although the DiDEM project aims to foster dialogue between scientists and decision-makers, the link with governance was not strongly present throughout the school beyond discussions on current fisheries management and legal provisions for the protection of coral reefs. The Blue Economy and various economic developments were mentioned, such as the constructions of new hotels or other forms of coastal artificialization and watershed impacts. However, the school did not encourage participants to investigate future plans. For instance, national objectives on fisheries, tourism and infrastructure could have been examined, pointing to the future stressors to be expected for the reef heritage, and sparking discussions towards policy solutions or other future interventions.

Finally, discussions highlighted the crucial need to raise public awareness about the challenges of protecting marine ecosystems. Tools like the Coral Reef Education Toolkit can help make this information more accessible and stimulate critical thinking (Chabanet et al., 2018), while educational marine areas offer opportunities for active learning and participation in protecting the marine environment. Additionally, integrating art and science through creative projects can bridge the gap between science and society, attracting a broader audience and encouraging inclusive dialogue on ocean conservation. Beyond education for the youth, political understanding was perceived as critical and may be approached from political economy and political ecology perspectives (Fabinyi et al., 2014), especially as Mauritius and the Seychelles have recently agreed on petroleum exploration in their Joint Management Area of the Mascarene

Plateau (Nicette, 2024). If realized, petroleum extraction will further contribute to climate change and localized threats to the reef heritage.

Conclusion

The 2024 VulPaRe thematic school in the WIO was successful in bringing together a variety of regional stakeholders, fostering dialogue, knowledge sharing and collaboration both in-situ and on the present paper, which contributes further reflections on the debates held. These gave the most attention to three distinct areas of interest: 1) reinforcing social research to inform governance of the reef heritage, 2) cautiously exploring ecological conservation and restoration within economic activities, and 3) addressing legal gaps and issues of justice for access to common resources. The school would have benefited from spending more time on the different topics individually and to integrate them within the conceptual frameworks of governance and sustainability, which this paper begins as a preface for further research. This being said, much reference was made in the last VulPaRe edition to global biodiversity governance in the form of the KMGBF and its quantitative targets to 2030, which did not exist at the time of previous editions. The targets served as markers against which various struggles were expressed, demonstrating the general concern and dedication of participants to ensure the sustainability of the reef heritage. Considering the matters reviewed across the region, this VulPaRe edition underscored the continued challenges encountered since the initial schools and highlighted that much remains to be done to meet the KMGBF 2030 targets in the WIO.

Finally, on the last day of the thematic school, a member of the Seychelles' Silhouette Island community unexpectedly arrived at the school venue after learning about it on television, seeking the help of scientists against the construction of a new hotel on his native island, which is within a national park. This intervention served as a demonstration that citizens are concerned about the degradation of their natural heritage and believe in the power of science to serve the common good. More importantly, organizers and participants were confronted with a call to action for which their knowledge was directly applicable, but also a dilemma in their capacity to act, in the context of such a regional event which benefited from the support of various authorities. Though many independent scientists and non-academic stakeholders do get involved in such situations, time will tell if this call will be answered.

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