International Journal of Social Science and Economic Research

ISSN: 2455-8834

Volume:10, Issue:03 "March 2025"

Bridging Traditions and Global Goals: Using GIS to Harmonize Local Marine Conservation Practices with the UN SDGs in the Face of Climate Change

Azad Parikh

Sevenoaks School, Sevenoaks, England

DOI: 10.46609/IJSSER.2025.v10i03.012 URL: https://doi.org/10.46609/IJSSER.2025.v10i03.012

Received: 6 March 2025 / Accepted: 16 March 2025 / Published: 27 March 2025

ABSTRACT

Marine ecosystems across the globe face escalating threats from climate change, necessitating innovative and culturally inclusive approaches to conservation. This paper explores how local and indigenous marine management traditions can work in tandem with global conservation strategies under the United Nations Sustainable Development Goals (SDGs)—specifically SDGs 11, 13, and 14. It also highlights how Geographic Information Systems (GIS) are critical in analysing climate impacts and guiding marine-protection policies. By reviewing case studies of traditional marine stewardship, examining spatial data in changing marine environments, and evaluating the integration of global and local approaches, this paper demonstrates the benefits and challenges of uniting scientific and indigenous knowledge systems in a rapidly warming world. The findings suggest that the coalescence of cultural wisdom, modern technology, and high-level policy frameworks can create holistic, sustainable solutions that foster both resilience and equity in coastal and marine conservation efforts.

Keywords: marine conservation, UN SDGs, climate change, indigenous knowledge, fisheries management

1. Introduction

Oceans are vital to planetary health. They serve as a climate regulator, a carbon sink, and a source of livelihood for billions of people (*Why Protecting the Ocean and Wetlands Can Help Fight the Climate Crisis*, 2022). However, mounting evidence indicates that climate change manifests in sea-level rise, ocean acidification, and biodiversity loss while undermining global marine ecosystems *(Marine Protected Areas in a Changing Climate)*. Equally pressing is the need to find conservation solutions that not only reduce environmental impact but also respect the needs and rights of coastal communities that have long managed their resources sustainably.

ISSN: 2455-8834

Volume:10, Issue:03 "March 2025"

Local and indigenous environmental practices possess a rich heritage of ecological knowledge that naturally aligns with the United Nations Sustainable Development Goals (SDGs)—particularly SDGs 11 (Sustainable Cities and Communities), 13 (Climate Action), and 14 (Life Below Water) (*Sustainable Development Goals*; *Indigenous Knowledge*). These time-tested traditions in marine stewardship offer adaptive frameworks that can improve modern conservation efforts, yet they are often overshadowed by standard scientific or policy-driven approaches (Bansal et al., 2023). Bridging that gap requires not only policy alignment but also technological tools that can capture and analyse complex ecological changes over time.

One such tool is Geographic Information Systems (GIS). GIS facilitates the collection and interpretation of geospatial data and has become integral in climate-change research, allowing researchers to model sea-level changes, map marine biodiversity shifts, and evaluate ecosystem vulnerabilities (*GIS in Climate Change Analysis*). By correlating local knowledge with GIS-based spatial data, conservation strategies have the potential to become more precise and culturally sensitive, resulting in effective Marine Protected Areas (MPAs) and fisheries management approaches that benefit both the environment and local populations (*Marine Conservation and the Valuable Local Communities, Guardians of the Sea*, 2024).

This paper examines how local and indigenous marine conservation traditions can be utilised along with the UN SDGs in the wake of rising climate change conditions. It also explores the role of GIS as a linchpin technology for integrating localised knowledge with broader policy frameworks.

2. Background

2.1 Climate Change Impacts on Marine Environments

Climate change has destabilized marine ecosystems worldwide. According to the European Environment Agency (EEA), shifts in ocean temperatures, changes in salinity, acidification, and sea-level rise collectively compromise habitat quality and push numerous marine species to relocate or diminish in number. Furthermore, the United Nations underscores that ocean acidification and rising sea levels threaten not only biodiversity but also coastal infrastructure and community livelihoods. These processes are especially harmful to coral reefs, mangroves, and seagrass beds, which act as natural buffers against extreme weather and serve as critical nursery habitats for fish (*How Climate Change Impacts the Ocean*, 2024).

2.2 SDGs 11, 13, and 14: Coastal Communities and Conservation

The UN SDGs make up an international roadmap for sustainable development. Three of these goals have especially close ties to marine environments and coastal societies:

ISSN: 2455-8834

Volume:10, Issue:03 "March 2025"

- SDG 11 (Sustainable Cities and Communities) emphasizes responsiveness in urban planning, including coastal regions prone to flooding and sea-level rise.
- SDG 13 (Climate Action) calls for urgent measures to combat climate change, which directly impacts marine biodiversity and coastal infrastructure.
- SDG 14 (Life Below Water) focuses on preserving and sustainably using the oceans, seas, and marine resources *(Sustainable Development Goals)*.

Together, these goals encourage integrated management approaches. By aligning local conservation methods with SDG targets, communities can cultivate persistence against climate threats while safeguarding their cultural identity and traditional livelihoods *(Goal 14)*.

2.3 Traditional Marine Conservation Practices and Fisheries Management

Coastal and indigenous communities often practice holistic resource management that predates modern regulations *(Coastal and Marine Protected Areas and Sustainable Fisheries Management)*. Traditional fisheries management, for instance, includes:

- Seasonal fishing closures and other temporal restrictions to allow fish populations to recover.
- Rotational harvesting, which designates certain areas as no-take zones on a cyclical basis.
- Cultural taboos that inadvertently serve as conservation regulations and limit overfishing and habitat destruction *(Climate Change Impacts on the Ocean and Marine Resources, 2025)*.

These localized strategies often share core values with the SDGs, such as protecting ecological integrity and ensuring long-term sustainability for communities (Smallhorn-West et al., 2022). However, challenges arise in integrating traditional management within modern policy frameworks, as recognition of indigenous rights and sovereignty is generally inconsistent, and local communities lack the resources to influence nationwide climate policy.

2.4 Role of Geographic Information Systems in Climate Change Analysis

GIS is a suite of technologies for mapping, analysing, and visualizing spatial data *(Geographic Information System (GIS))*. In the context of marine conservation, GIS can:

1. Map climate impacts: Identify hot spots of biodiversity loss or areas prone to coral bleaching.

ISSN: 2455-8834

Volume:10, Issue:03 "March 2025"

2. Model sea-level rise: Provide simulations of future inundation zones and threats to coastal habitats.

3. Overlay data layers: Integrate ecological data with socio-economic and cultural data—e.g., local fishing territories or customary marine tenure—to guide policy decisions *(GIS in Climate Change Analysis)*.

By coupling indigenous knowledge—often mapped mentally via oral traditions and localized spatial markers— with GIS-based climate models, stakeholders gain an enriched perspective on areas of concern and where to direct conservation efforts and adaptation measures (Singh, 2024).

3. Discussion

3.1 Aligning Indigenous Practices with UN SDGs

Local and indigenous marine traditions often reflect principles akin to sustainability and conservation, effectively mirroring SDG 14's emphasis on preventing overexploitation. For example, ceremonial restrictions on fishing certain species can function as a fishery closure, thus matching the goals of "sustainable fisheries" (Smallhorn-West et al., 2022). Moreover, community-driven resource management can strengthen SDG 11 by enhancing local collaboration and strength. Indigenous fire management in some coastal regions, for instance, supports biodiversity by controlling invasive species and preventing large-scale habitat destruction *(Indigenous Knowledge is Crucial in the Fight against Climate Change – Here's Why, 2024)*.

At the same time, these practices are inherently adaptive, having evolved through generations of close ecological observation. They align seamlessly with SDG 13, which focuses on climate action because such culturally ingrained systems naturally respond to environmental changes by adjusting fishing quotas, shifting areas of cultural significance, and adopting new stewardship roles for younger generations (Mishra et al., 2024).

3.2 Case Studies of Successful Indigenous Adaptation

Examples from around the world can illustrate the effectiveness of blending indigenous and modern knowledge systems to confront climate change:

- Australian Aboriginal Communities: Use of "fire-stick farming" in coastal areas to manage vegetation and preserve biodiversity. This approach reduces fuel loads that could lead to uncontrollable wildfires, thus maintaining ecosystem balance.

ISSN: 2455-8834

Volume:10, Issue:03 "March 2025"

- Pacific Island Communities: Rotational closures in fishing areas to maintain fish stocks and protect reefs from overexploitation. This supports local food security and cultural practices and aligns with formal MPA regulations (Bang, 2024).

These studies highlight that bridging global goals and indigenous practices can address both ecological and socio-cultural concerns, thereby strengthening the comprehensive effectiveness of marine conservation.

3.3 Spatial Data Analysis in Climate Change and Conservation

Spatial data is invaluable for assessing environmental vulnerabilities. By utilizing GIS, researchers can identify which reefs, mangroves, or seagrass meadows face the highest risk from warming sea temperatures or ocean acidification (Jones et al., 2016). The overlay of local knowledge—such as sacred areas or spots traditionally spared from fishing— enhances the ecological data, helping pinpoint areas that not only serve ecological functions but also hold cultural or community significance (Jacquemont et al., 2022).

In parallel, GIS tools enable analyses of multiple scenarios, incorporating sea-level forecasts and oceanographic models. This scenario-based approach offers insights into the potential impacts of future flooding or coral bleaching events, allowing local communities to anticipate changes (Jacquemont et al., 2022). Incorporating local knowledge further refines these models by accounting for how people adapt, such as shifting fishing seasons or altering gear types.

3.4 Challenges of Integrating Tradition with Scientific Climate Modelling

Despite steps taken towards enhancing the potential synergy, significant barriers remain:

1. Policy Gaps: Many national frameworks do not formally recognize indigenous knowledge systems. Without legal reinforcement, local communities struggle to secure the rights required for co-management (Jacquemont et al., 2022).

2. Technological Barriers: Advanced GIS modelling can be expensive and requires specialized expertise. Coastal or island communities with limited resources may find it difficult to operate such tools independently (Singh, 2024).

3. Data Ownership: Indigenous knowledge is often collectively held, raising concerns about how data is shared and mapped and the possibility that external stakeholders may exploit it. Ensuring equitable data governance becomes essential.

4. Cultural Misalignment: Government agencies and scientific organizations sometimes prioritize quantitative data, undervaluing local qualitative insights. Bridging these

ISSN: 2455-8834

Volume:10, Issue:03 "March 2025"

cultural divides demands trust-building and mutual respect between communities, researchers, and policymakers (Bang, 2024).

Effectively confronting these challenges requires flexible policy mechanisms and capacity-building programs that involve local people as active decision-makers. Moreover, broader climate policies need to allocate funds and technological support so that GIS tools can be equally accessed by indigenous communities.

3.5 Toward Global Sustainability

Incorporating local marine conservation traditions with the UN SDGs not only bolsters ecological preservation but also furthers social justice by centering the experiences and rights of indigenous peoples. It helps break the pattern where top-down conservation regulations overshadow or even exclude, community-led stewardship. This approach is echoed in high-level policy dialogue, where integrated management frameworks call for inclusive governance and collaboration among local, regional, and global stakeholders (*Marine Conservation and the Valuable Local Communities, Guardians of the Sea*, 2024).

GIS amplifies this integrated approach. Spatial analyses that combine climate data with socio-cultural layers can pinpoint priority conservation areas, refine climate adaptation strategies, and minimize conflict. Overall, the synergy between traditional ecological knowledge, modern GIS-based modelling, and the SDGs, can produce robust, equitable solutions for marine conservation and climate action (*How Climate Change Impacts Marine Life*, 2024).

4. Conclusion

Marine conservation efforts must swiftly and accurately adapt to the accelerating pressures of climate change. Local and indigenous traditions are proving invaluable in this context, offering adaptive management strategies that reflect centuries of ecological research and insights. By aligning these practices with global standards—particularly SDGs 11, 13, and 14— nations can create cohesive policies that safeguard both marine ecosystems and the cultures that rely upon them. Central to achieving this goal is the use of GIS, which can map shifting ecological baselines, foretell future risks, and integrate diverse knowledge systems into actionable strategies.

Realising this integrated vision necessitates addressing policy gaps, tackling technological inequities, and ensuring that traditional rights are formally recognized and protected. As climate change continues to impact marine environments, forging a collaborative path that unites local wisdom, global targets, and advanced spatial analytics stands as a hopeful and pragmatic

ISSN: 2455-8834

Volume:10, Issue:03 "March 2025"

approach. This synergy not only ensures biodiversity protection but also upholds the sovereignty and resilience of coastal communities worldwide.

References

Bang, H. N. (2024). Sustainable development goals, disaster risk management, and indigenous knowledge: a critical assessment of the interlinkages. *Sustainable Earth Reviews*, *7*(29).

Bansal, S., Sarker, T., Yadav, A., Garg, I., Gupta, M., & Sarvaiya, H. (2023, November 14). Indigenous communities and sustainable development: A review and research agenda. *Global Business and Organizational Excellence*, *43*(4). Wiley.

Climate Change Impacts on the Ocean and Marine Resources. (2025). EPA. https://www.epa.gov/climateimpacts/climate-change-impacts-ocean-and-marine-resources

Coastal and Marine Protected Areas and Sustainable Fisheries Management [Curriculum for Field-Level MPA Managers]. Indo-German Biodiversity.

Geographic Information System (GIS). ESRI. https://www.esri.com/en-us/what-is-gis/overview#:~:text=Geographic%20information%20system(s)%2C,what%20things%20are%20like%20there

GIS in Climate Change Analysis. GIS People. https://www.gispeople.com.au/gis-and-climate-change-analysis/

Goal 14. United Nations. https://www.un.org/sustainabledevelopment/oceans/

How climate change impacts marine life [Briefing]. (2024, November 12). European Environment Agency. https://www.eea.europa.eu/publications/how-climate-change-impacts

How climate change impacts the ocean. (2024, May 28). IFAW. https://www.ifaw.org/international/journal/climate-change-impact-ocean

Indigenous Knowledge. SDG Resource Centre. https://sdgresources.relx.com/indigenous-knowledge

Indigenous knowledge is crucial in the fight against climate change – here's why. (2024, July 31). UNDP. https://climatepromise.undp.org/news-and-stories/indigenous-knowledge-crucial-fight-against-climate-change-heres-why#:~:text=Aboriginal%20Peoples%20in%20Australia%20have,manage%20vegetation%20and%20promote%20biodiversity

ISSN: 2455-8834

Volume:10, Issue:03 "March 2025"

Jacquemont, J., Blasiak, R., Cam, C. L., Gouellec, M. L., & Claudet, J. (2022, October 21). Ocean conservation boosts climate change mitigation and adaptation. *One Earth*, *5*(10). Science Direct.

Jones, K. R., Watson, J. E.M., Possingham, H. P., & Klein, C. J. (2016, February). Incorporating climate change into spatial conservation prioritisation: A review. *Biological Conservation*, *194*. Science Direct.

Marine Conservation and the Valuable Local Communities, Guardians of the Sea. (2024, October 1). Pharos Project. https://pharosproject.eu/blog/local-communities-marine-conservation/

Marine Protected Areas in a Changing Climate. Marine Protected Areas. https://marineprotectedareas.noaa.gov/climate-change/

Mishra, D. P., Joshi, D. B., Agarwal, D. P., & Varshney, D. I. (2024). Sustainable Development Goals – Role Of Indigenous Knowledge. *Educational Administration: Theory and Practice*, *30*(5), 4521-4522.

Singh, S. (2024, June 5). *How Geospatial Tools Can Help Mitigate Climate Change*. https://agiindia.com/how-geospatial-tools-can-help-mitigate-climate-change/

Smallhorn-West, P., Cohen, P. J., Phillips, M., Jupiter, S. D., Govan, H., & Pressey, R. L. (2022, October 19). Linking small-scale fisheries co-management to U.N. Sustainable Development Goals. *Conservation Biology*, *36*(6). Wiley.

Sustainable Development Goals. Sustainable Development Goals Knowledge Platform. https://sustainabledevelopment.un.org/topics/sustainabledevelopmentgoals

Why protecting the ocean and wetlands can help fight the climate crisis. (2022, November 11). UNEP. https://www.unep.org/news-and-stories/story/why-protecting-ocean-and-wetlands-can-help-fight-climate-crisis

