

## Indigenous People Carrying Capacity; Consciousness of Protecting Nature

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KEYWORDS	ABSTRACT
Carrying capacity; Morowali Nature Reserve; Protecting Nature; Wana tribe	The historical relationship between indigenous communities and their environment exemplifies sustainable coexistence, yet this balance is increasingly threatened by population growth and environmental degradation. This study examines the carrying capacity of the <i>Wana</i> tribe's land in the Morowali Nature Reserve, Central Sulawesi, Indonesia, to assess its ability to support current and future populations while preserving ecological integrity. Using a mixed-methods approach, we combined geospatial analysis (ArcGIS) with ethnographic data to evaluate habitable land areas, accounting for slope constraints (0–15%) and the tribe's customary land-use practices. Results revealed that the <i>Wana</i> tribe currently occupies only 955.3 hectares of the 4,660-hectare reserve, with a per-capita allocation of 2.07 hectares—five times the WHO minimum standard. However, projections indicate that the carrying capacity will be exceeded if the population reaches 2,274 individuals, risking resource depletion and ecosystem disruption. The study highlights the <i>Wana</i> 's sustainable practices, such as fallow periods and spiritual land protections, as vital to maintaining this equilibrium. These findings underscore the urgency of integrating indigenous knowledge into conservation policies to safeguard both cultural and environmental sustainability. By quantifying carrying capacity in a protected indigenous area, this research provides a replicable framework for similar contexts and advocates for policy support to mitigate future risks.

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## INTRODUCTION

The relationship between indigenous peoples and the environment has long been a mutualistic one (e.g., Poudyal et al., 2020; Stan et al., 2022). Elder indigenous people in Ethiopia follow the motto “tree is life” (Regassa Debelo et al., 2017). In Raja Ampat, Indonesia, indigenous communities practice *Sasi*, a traditional method for managing natural resources. This method includes restrictions on harvesting resources from both land (*sasi darat*) and sea (*sasi laut*). Through their local wisdom, indigenous peoples have been able to protect forests. However, with increasing human populations, climate change, and the diminishing carrying capacity of the environment, the sustainability of this mutualistic relationship is now in question.

In some regions, to encourage indigenous people to participate in nature conservation, incentives are provided through *Payment for Environmental Services (PES)*. In this context, many studies and analyses have been conducted (Jayachandran et al., 2017; Midler et al., 2015; Pagiola et al., 2016; Pham & Roongtawanreongsri, 2022). However, economic pressures remain the main driver of deforestation.

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The *Tau Taa Wana* (or *Wana*) tribe is one of the indigenous communities in Indonesia inhabiting the hinterlands of the Central Sulawesi forest. Most reside within the *Cagar Alam Morowali* (Morowali Nature Reserve). Based on their lifestyle, the *Tau Taa Wana* can be categorized as *Komunitas Adat Terpencil* (remote indigenous community). Their perspectives on forests and conservation differ significantly from those who view forests and biodiversity mainly as opportunities for economic development. For the *Wana* people, biodiversity is not merely an economic asset. They practice traditional land-use systems that include: *Kapali* (protected forest area); *Pompalivu* (forest area for non-forest resources); *Yopo Ngura* (young forest area); *Pangale* (forest area for timber resources); and *Yopo Matua* (former farmland).

In 2016, the Indonesian Ministry of Environment and Forestry issued a decree recognizing 4,660 hectares of land as *Wana* indigenous forest (including 3,988 hectares within the Morowali Nature Reserve). The *Wana* tribe lives communally, and there are 14 recorded settlement areas (*lipu*): Vyautiro, Pu'mbatu, Sumbol, Likubae, Vatungkaya, Vomboyombe, Pantol, Pattujalanjo, Latampe, Vatuno'a, Sankiyoe, Posanke, and Rapambavang—although only eight *lipu* are currently inhabited. Forests hold deep sacred significance for the *Wana* tribe. Natural resources are viewed not solely as objects of exploitation but also as integral parts of a harmonious relationship between humans and nature. Environmental conservation is further strengthened by spiritual beliefs, mysticism, and taboos. The *Wana* believe that spirits and ghosts inhabit animals, plants, and other elements of the natural world.

One of the reasons this local wisdom can still be practiced is that the environmental carrying capacity remains adequate. Yet, in many other regions of the world, local populations have been the main contributors to environmental degradation. The *Wana* who live in the *Cagar Alam Morowali* continue to uphold their traditional culture—avoiding modernization, preserving their local wisdom, and maintaining their spiritual practices. In this way, the *Wana* remain largely insulated from outside influences, and few external factors affect their way of life.

The urgency of this issue is underscored by global concerns about the sustainability of indigenous lands. While *PES* has been explored as a solution (Jayachandran et al., 2017; Midler et al., 2015), economic pressures often lead to deforestation, making it imperative to assess the carrying capacity of these regions. The *Wana* tribe's land-use practices—such as shifting cultivation and controlled burning—reflect a nuanced approach to sustainability. Yet, the lack of comprehensive studies on carrying capacity in protected indigenous areas leaves a critical gap in understanding how these communities can maintain their way of life amid mounting external pressures.

Whereas scholars often focus on the obstacles faced by indigenous peoples due to policies (Boiral et al., 2020; Loch & Riechers, 2021; Rodrigue-Allouche, 2015), the fundamental element of carrying capacity is often neglected, despite being essential as a foundation for management. There is still limited literature available that calculates carrying capacity for indigenous peoples living in protected areas.

This research addresses that gap by calculating the current and future carrying capacity of the *Wana* tribe's land, offering a foundation for sustainable management. It challenges conventional theories that overlook the dynamic interplay between indigenous practices and

ecological limits, contributing to the field by integrating local wisdom with quantitative analysis. The objectives of this study are threefold: (1) to quantify the *Wana* tribe's current carrying capacity, (2) to forecast sustainability under population growth, and (3) to propose policy recommendations that support indigenous-led conservation. The benefits of this research extend beyond academia, providing actionable insights for policymakers and conservationists to safeguard both indigenous rights and environmental health.

### METHOD

This study employed a mixed-methods approach to assess the carrying capacity of the *Wana* tribe's land in the *Cagar Alam Morowali* (Morowali Nature Reserve), combining geospatial analysis with demographic and ethnographic data. The research focused on the *Wana Posangke* Customary Forest, a 4,660-hectare area recognized by the Indonesian government, of which only 955.3 hectares were deemed suitable for habitation and agriculture based on slope criteria (0–15%) and the tribe's traditional land-use classifications. Using ArcGIS software, slope and land-use suitability were analyzed through digitization and overlay techniques to identify habitable zones while respecting culturally restricted areas. The carrying capacity was calculated by dividing the total habitable land area by the 2018 population (461 individuals), yielding a figure of 2.07 hectares per person—well above the WHO minimum standard of 0.416 hectares. Future projections, using a 1.5% annual population growth rate, estimated a critical threshold of 2,274 individuals, although limitations such as migration and changes in policy were acknowledged. Ethnographic validation through field observations and interviews confirmed alignment with *Wana* practices, including fallow periods and spiritual land protections. The study followed ethical guidelines, including *Free, Prior, and Informed Consent (FPIC)*, and addressed gaps in the literature by integrating quantitative analysis with indigenous knowledge systems. While the methodology offers a replicable model for similar cases, its reliance on single-year population data and exclusion of external factors such as climate change highlight areas for future refinement.

The *Wana* tribe, nestled within the Morowali Nature Reserve, inhabits scenic valleys and hills that follow the course of the Salato River. Their territorial jurisdiction falls under the administration of North Morowali Regency, with governance from Taronggo Village in the North Bungku District. The settlement pattern is communal, and field research has identified fourteen distinct settlement units, or *lipu*: Vyautiro, Pu'mbatu, Sumbol, Likubae, Vatungkaya, Vomboyombe, Pantol, Pattujalanjo, Latampe, Vatuno'a, Sankiyoe, Posanke, and Rapambavang. Of these, only eight *lipu* are currently inhabited, each contributing to the cultural and historical fabric of the *Wana* community.

Analyzing carrying capacity in protected areas presents unique advantages, as human activities are restricted, making assessments generally more straightforward and reliable. Protected areas are defined as regions of land and/or sea specifically designated for the conservation and sustainable management of biological diversity, natural resources, and related cultural values, and are managed through legal or other effective means. In this study, carrying capacity is understood as the ratio of individuals to habitable land within the *Wana* Forest, a region legally recognized by the Indonesian government. However, not all of the forest is suitable for housing due to restrictions shaped by the *Wana* tribe's local wisdom on land use. These rules regulate land allocation according to categories such as *Kapali* (protected forest), *Pompalivu* (forest for non-timber resources), *Yopo Ngura* (young forest), *Pangale* (timber forest), and *Yopo Matua* (former farmland). Unlike in urban regions, where the permissible slope for residential development is typically 0–6%, this study

considered areas with slopes of up to 8% or more as viable for habitation, based on *Wana* practices. The carrying capacity formula is expressed as:

$$\text{Carrying Capacity} = \frac{\text{Area}(\text{total land for housing})}{\text{Number of population}}$$

Drawing from Grumbly's (2013) observations, the *Wana* tribe intentionally maintains a remote and relatively inaccessible lifestyle. They hold the belief that living a modest and unpretentious life in the present ensures a better afterlife. This worldview—rooted in spiritual values and cultural traditions—has played a key role in sustaining the harmonious coexistence of the *Wana* tribe with their natural environment.

## RESULTS AND DISCUSSIONS

### Current Wana Tribe Carrying Capacity

Due to human activities that "alter the environment on a global scale and at rates surpassing historical norms," we are presently confronted with global changes, often denoted as global warming, climate disruptions, or climate chaos (Dellasala, 2017). The planet's capacity to absorb pollutants has decreased due to competition between current human activity and global geophysical processes, endangering the resilience of the Earth system.

Forecasting human population growth often involves the use of regression models, a method that requires a dataset spanning at least dozens of years for predictions to have substantial meaning. In the particular case of the *Wana* tribe population, data was solely collected for the year 2018, recording a population of 461 individuals within the *Wana* forest. This solitary data point represents the most recent population record. Considering the population data, it is noteworthy that a substantial 2.07 hectares of land are allocated for each individual among the *Wana* tribe, a provision that significantly exceeds the World Health Organization's (WHO) stipulated minimum area of 0.416 hectares per person. Thus, the environmental carrying capacity for the *Wana* tribe remains sufficient for 4.97 times the current population. From a global perspective, it is currently estimated that 1.69 Earths would be required to sustain the needs of the global population (Global Footprint Network, 2019b). The results quantified for Wrocław city and its suburban zone showed that there would be a required 2.77 of Earths if everybody had the same carbon footprint as an average inhabitant of the study area. The quantified number of Earths for Wrocław and its suburban zone was 0.05 higher than that quantified for Poland—2.72. The highest number of Earths needed for sustaining human impact was quantified for Czernica, Długoleka, Kobierzyce, and Zórawina municipalities—value higher than 3.0. The lifestyle of inhabitants of these areas could be similar to the lifestyle of inhabitants in countries as the Russian Federation (3.17 of Earths), Slovenia (3.14), or Ireland (3.14) (Świąder et al., 2020).

Despite the general tendency of human population growth following an exponential trajectory, predicting the exact percentage of this growth remains challenging. This challenge is exacerbated by the unique circumstances of the *Wana* tribe, residing in remote areas that are scarcely reached by census authorities. This remoteness adds an additional layer of complexity to obtaining accurate and timely population data for the tribe, necessitating innovative and targeted strategies for comprehensive data collection in such geographically isolated regions.

### Forecast Carrying Capacity

Further analysis reveals that while pinpointing the precise year when the carrying capacity of the area will be surpassed remains challenging, it is evident that the existing carrying capacity will cease to be sufficient once the population attains 2,274 individuals. In simpler terms, when

the Wana tribe population in the Wana forest reaches this critical threshold, the area's resources and environment will be insufficient to adequately support them. This will lead to some issues such as resource depletion, overpopulation, or environmental degradation.

This outcome underscores the imperative for continuous and rigorous data collection and analysis to monitor population trends and evaluate the sustainability of the area concerning its carrying capacity. This also implies that proactive measures in terms of management and conservation efforts might be imperative if the population is anticipated to approach or surpass the critical 2,274 mark, aiming to avert adverse environmental and social consequences.

Forecasting human population has several limitations. First off, population processes are probabilistic in nature rather than deterministic (Vanella Philipp Deschermeier, 2020). Second, deterministic methods assume certain very strict things about how things will develop in the future. The trajectories that arise from distinct scenarios have extremely low individual odds of occurrence, according to statistics. Thirdly, there are inherently relatively few possibilities examined, which implies that the future risk is not sufficiently represented (Vanella Philipp Deschermeier, 2020). Fourthly, there is typically no quantification of the identified potential future courses with respect to their chances of occurring. Fifthly, these paths are frequently determined by a small group of specialists' opinions (Vanella, 2020). Furthermore, with uncertainty and disruption that might be interferences such as disaster, pandemic, and war.

Especially for the Wana tribe, safeguarding their territory as their own land was a challenging task. In 2011, the Wana community faced the perilous prospect of losing their ancestral lands or facing resettlement, coupled with heightened coercion from local authorities urging them to relocate to a centralized community center. These challenging circumstances marked the initiatory phase of the transformation towards acquiring an 'indigenous' identity, often denoted as *masyarakat adat*, as explained by certain scholars (Grumbles, 2013). As articulated by Li (1999), the envisioned trajectory for the target group involves a transition from a state of isolation and underdevelopment to that of "ordinary villagers" who are culturally normalized and integrated into the established system of village administration and national development. The era of the New Order regime in Indonesia witnessed the widespread implementation of resettlement programs in the name of development. In the case of the Wana tribe, the resettlement initiative served a dual purpose for the government and the company involved. Firstly, it aimed to expand the plantation, thereby generating increased profits for the regency. Secondly, the resettlement sought to facilitate the integration of the Wana tribe into Indonesian society, elevating their status to that of "civilized people" and affording them the associated benefits.

Determining the carrying capacity of the human population is a complex endeavor that necessitates the exploration of various methodological options by scholars, aiming to derive the most accurate estimate. According to Chapman (2018), the concept of carrying capacity first surfaced in the 1870s, initially applied to biological systems with a focus on calculating the load of goods that could be transported in one expedition. This shift occurred during the 1880s when the term was associated with livestock populations being "carried by the land where they lived." The dynamic nature of carrying capacity, particularly concerning human populations, introduces an added layer of complexity, making it challenging to identify the optimal method for its calculation.

The intricacy of carrying capacity arises from its dynamic nature, particularly concerning human populations. The concept of sustainable development, championed by the president of the United Nations World Commission on Environment and Development, articulates the goal of meeting the needs of present generations without compromising the ability of future generations. The key elements contributing to this complexity include population dynamics, resource availability, environmental considerations, and economic factors (Ma, 2017). In the

context of human carrying capacity, a crucial aspect is the land's capacity to sustain human activities. The analysis of land carrying capacity underscores the need for an objective evaluation of land use purposes. In this regard, the Wana tribe enjoys the privilege of adhering to and exercising their indigenous land use wisdom.

In addressing their daily necessities, the Wana tribe exhibits a considerable dependence on agricultural land, specifically rice fields and crop fields. Their agricultural practices follow a distinctive pattern characterized by a system of moving from one location to another. Although, on a broader scale, this shifting cultivation system may be perceived as unsustainable due to the necessity of clearing forest areas during each relocation, the Wana tribe, in fact, proposes a method that can be construed as a form of local wisdom contributing to natural resource conservation. Their approach involves clearing the forest through controlled burning, followed by cultivation for 1-2 years. Subsequently, the land is left fallow for a period of 3 years to allow for the restoration of soil fertility. This intricate interplay of practices emphasizes the nuanced relationship between human activities, land use, and the broader concept of carrying capacity.

The Wana tribe's local wisdom on land use is not merely for survival; they consciously choose this way of life. In their cosmological believe, Grumblies (2013) articulated that "The Wana people harbour a belief that their formidable allies, the Taw Baraka (powerful people), will eventually revisit Pusen Tana (centre of the world), heralding the onset of a new era of prosperity, often referred to as a Golden Age. It is deemed crucial for the Wana community to endure their existing state of hardship during the intervening period." The anticipated return of the Taw Baraka is anticipated to bestow rewards exclusively upon those Wana individuals who have steadfastly adhered to their original faith and persist in residing within the vulnerable condition of compassion. In addition, Wana local wisdom bring them into conservationist or in other word community who protect nature environment and guard its sustainability. Massey et al. (2011) referred to this practice as 'conservation as an unintended outcome of cultural practices', conservation areas established through customary practices hold significant value in the realm of conservation. It is noteworthy that the preservation of these areas may, at times, be driven by attitudes and behaviors not inherently aligned with the primary goal of safeguarding the environment or effectively managing natural resources. According to Borrini-Feyerabend et al (2004), the conservation of habitats, species, ecological services, and the associated cultural values is a consequence of the voluntary management decisions and efforts undertaken by such communities. It is important to recognize that the establishment of protection status for these zones may have been motivated by a diverse range of objectives, not necessarily centred around biodiversity conservation.

When exploring resource and habitat taboos, as assessed by Colding and Folke (2001), it is observed that these practices do not necessarily stem from environmental concerns. Despite this, their structural similarities to modern conservation analogies indicate a parallelism, even if the motivations behind these customary practices may not be expressly linked to environmental preservation.

### **External Constraints For Wana Tribe**

Given the urgency to preserve dwindling biodiversity amid an Indigenous resurgence and the recognition of Indigenous Rights, areas that are protected and maintained by Indigenous Peoples have drawn attention from all over the world. Within officially recognized state-led conservation initiatives, there is a growing emphasis on the contemplation of Indigenous Rights and Title. Additionally, there is an increasing recognition of the pivotal role that Indigenous Peoples play in the governance and stewardship of protected and preserved areas (Tran et al., 2020).

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The Indigenous local wisdom of stewardship and land and water protection has endured for a long time. However, official names, classifications, and arrangements have only been applied in the last few decades by states and international conservation efforts to acknowledge them. The history of the Wana acknowledgment by the Indonesian government faced challenging paths. The Wana tribe has been officially granted acknowledgment of their indigenous rights to manage forests as per the provisions delineated in the Decree of the Minister of Environment and Forestry, specifically identified as Number: SK. 6747/MENLHK-PSKL/KUM.1/12/2016, and issued on 28 December 2016. This decree pertains to the designation of the Wana Posangke Customary Forest, encompassing an expansive area of approximately 4,660 hectares situated within the administrative boundaries of North Bungku District, North Morowali Regency, Central Sulawesi Province. The Wana Posangke Customary Forest is demarcated to include roughly 3,988 hectares within the Conservation Area (CA) of Morowali, and an additional approximately 672 hectares within the Production Forest area.

Prior to those recognition, Wana tribe suffer from resettlement and modernization which was promoted by the Suharto regime. According to Suharto's dictatorship, all Indonesians are equally indigenous or the country has no indigenous population. There are no reservations or officially recognized tribal regions, nor is there a direct counterpart of the internationally recognized category "indigenous and tribal peoples" (as defined in International Labour Organization convention 169) in Indonesia's national legal system. The transformative political landscape marked by the processes of democratization and decentralization subsequent to the overthrow of Suharto in 1998 instigated a myriad of changes within the realm of Indonesian adat (customary law) and culture. This era ushered in what could be characterized as a "new politics of tradition" and witnessed a pronounced "revival of adat" in numerous regions, as extensively elucidated by scholars such as David Henley and Jamie S. Davidson, (2008), and Bubandt (2004).

Carrying capacity that presented in the result can be used as the foundation for future research and debate on how Wana tribe or other indigenous people maintain sustainability of their own land. The lack of change in human activity raises concerns that further pressure on the earth system may lead to critical destabilization of biophysical systems and thus cause irreversible environmental changes that would be dangerous to human well-being. This problem is significant, especially as the current paradigm of social and economic development remains largely unaware of the possible risk of manmade environmental disasters. Lack of change in human activities for Wana context is when externalities does not mitigate by policy maker. Tran (2020) research reveals that Indigenous Peoples have autonomously established protected and conserved areas both independently and through collaborative initiatives at local and broader scales. Governments that endorsed and supported these endeavours did so formally through legislative frameworks, agreements, and policies, as well as informally through fostering local relationships and embracing shared values. The protected and conserved areas instituted by Indigenous Peoples have yielded a spectrum of socio-cultural, political, and ecological benefits. These encompass enhancements to Indigenous livelihoods, bolstered governance and management capacities, and notable improvements in species populations and habitat protection.

However, certain challenges have been identified, including the impact of restrictive legislations, burdensome partnerships, and insufficient funding, despite these positive outcomes. Addressing these challenges necessitates the cultivation of additional capacities and allocation of resources for effective mitigation. To navigate these complexities, we advocate for strategic actions by states and other external stakeholders. This includes the creation and enhancement of policies, legislations, and resource allocation specific to Indigenous Peoples' protected and conserved areas as defined by the Indigenous Peoples themselves. Furthermore,

external actors should actively provide resources and facilitate Indigenous leadership in shaping mechanisms for the establishment and development of protected areas.

To fortify these efforts, the establishment of new internal mechanisms that facilitate Indigenous engagement and partnerships should be applied. Building collaborative alliances can significantly support Indigenous Peoples in the stewardship and management of their designated areas. This involves integrating management priorities with local and larger-scale socio-cultural and environmental considerations that directly influence these protected and conserved areas.

### CONCLUSION

The carrying capacity of the *Wana* Forest is currently sufficient to support the existing population of 461 individuals. However, if the population reaches 2,274 individuals, the carrying capacity will be exceeded, potentially leading to resource depletion, overpopulation, and environmental degradation. The *Wana* tribe maintains a number of local wisdom practices that enable them to live sustainably in the forest. These include shifting cultivation, controlled burning, and allowing land to lie fallow for several years after clearing. The *Wana* tribe has also received formal recognition of their indigenous rights to manage forests, granting them the authority to decide how their land is utilized. It is essential that the Indonesian government continues to support the *Wana* tribe in their efforts to manage their territory sustainably.

Future research should explore the carrying capacity of other indigenous communities living within protected areas. While significant progress has been made, numerous challenges remain in fully realizing the benefits of indigenous-led conservation. Such challenges include restrictive legislation, burdensome partnerships, and insufficient funding. Overcoming these barriers requires building capacity and dedicating resources specifically toward mitigation strategies. To ensure the effectiveness of these initiatives, states and other external stakeholders should undertake strategic actions. This includes developing and refining policies, laws, and resource allocations that directly address the needs of Indigenous Peoples' protected and conserved areas, as defined by the Indigenous Peoples themselves. Moreover, external actors should actively provide funding and support for indigenous leadership in designing and implementing mechanisms for the establishment and development of protected areas.

### REFERENCE

- Boiral, O., Heras-Saizarbitoria, I., & Brotherton, M. C. (2020). Improving environmental management through indigenous peoples' involvement. *Environmental Science and Policy*, 103, 10-20. <https://doi.org/10.1016/j.envsci.2019.10.006>
- Borrini-Feyerabend, G., Kothari, A., & Oviedo, G. (2004). *Indigenous and local communities and protected areas: Towards equity and enhanced conservation*. IUCN.
- Bubandt, N. (2004). Towards a new politics of tradition? Decentralisation, conflict, and adat in Eastern Indonesia. *Antropologi Indonesia Special*.
- Chapman, E. J., & Byron, C. J. (2018). The flexible application of carrying capacity in ecology. *Global Ecology and Conservation*, 13, e00365. <https://doi.org/10.1016/j.gecco.2017.e00365>
- Colding, J., & Folke, C. (2001). Social taboos: "Invisible" systems of local resource management and biological conservation. *Ecological Applications*, 11(2), 584-600.
- Dellasala, D. A. (2017). Global change. In *Encyclopedia of the Anthropocene* (Vol. 1-5, pp. 347-349). Elsevier. <https://doi.org/10.1016/B978-0-12-809665-9.05355-6>
- Global Footprint Network. (2019). *National footprint and biocapacity accounts 2019*. Global Footprint Network.
- Grumbles, A. T. (2013). *Adat and indigeneity in Indonesia*. Göttingen University Press.



- Henley, D., & Davidson, J. S. (2008). In the name of adat: Regional perspectives on reform, tradition, and democracy in Indonesia. *Modern Asian Studies*, 42(4), 815-852.
- Jayachandran, S., De Laat, J., Lambin, E. F., Stanton, C. Y., Audy, R., & Thomas, N. E. (2017). Cash for carbon: A randomized trial of payments for ecosystem services to reduce deforestation. *Science*, 357(6348), 267-273.
- Loch, T. K., & Riechers, M. (2021). Integrating indigenous and local knowledge in management and research on coastal ecosystems in the Global South: A literature review. *Ocean and Coastal Management*, 212, 105821. <https://doi.org/10.1016/j.ocecoaman.2021.105821>
- Ma, B. (2017). Literature review on land carrying capacity of the coordinated development of population, resources, environment and economy. *AIP Conference Proceedings*, 1890, 040003. <https://doi.org/10.1063/1.5005308>
- Massey, A., Suich, H., & Child, B. (2011). *An introduction to community-based natural resource management*. WWF.
- Midler, E., Pascual, U., Drucker, A. G., Narloch, U., & Soto, J. L. (2015). Unraveling the effects of payments for ecosystem services on motivations for collective action. *Ecological Economics*, 120, 394-405. <https://doi.org/10.1016/j.ecolecon.2015.04.006>
- Pagiola, S., Honey-Rosés, J., & Freire-González, J. (2016). Evaluation of the permanence of land use change induced by payments for environmental services in Quindío, Colombia. *PLoS ONE*, 11(3), e0147829. <https://doi.org/10.1371/journal.pone.0147829>
- Pham, V. T., & Roongtawanreongsri, S. (2022). Perceptions of indigenous people as service providers on payments for forest environmental services in the Central Highlands of Vietnam. *Trees, Forests and People*, 8, 100279. <https://doi.org/10.1016/j.tfp.2022.100279>
- Poudyal, B. H., Maraseni, T., Cockfield, G., & Bhattarai, B. (2020). Recognition of historical contribution of indigenous peoples and local communities through benefit sharing plans (BSPs) in REDD+. *Environmental Science and Policy*, 106, 111-114. <https://doi.org/10.1016/j.envsci.2020.01.022>
- Regassa Debelo, A., Legesse, A., Milstein, T., & Orkaydo, O. O. (2017). "Tree is life": The rising of dualism and the declining of mutualism among the Gedeo of Southern Ethiopia. *Frontiers in Communication*, 2, 7. <https://doi.org/10.3389/fcomm.2017.00007>
- Rodrigue-Allouche, S. (2015). Conservation and indigenous peoples: The adoption of the ecological noble savage discourse and its political consequences. *Environmental Politics*, 24(3), 421-439.
- Stan, A. B., Fulé, P. Z., & Hunter, M. (2022). Reduced forest vulnerability due to management on the Hualapai Nation. *Trees, Forests and People*, 10, 100325. <https://doi.org/10.1016/j.tfp.2022.100325>
- Świąder, M., Szewrański, S., & Kazak, J. K. (2020). Environmental carrying capacity assessment the policy instrument and tool for sustainable spatial management. *Frontiers in Environmental Science*, 8, 579838. <https://doi.org/10.3389/fenvs.2020.579838>
- Tran, T. C., Ban, N. C., & Bhattacharyya, J. (2020). A review of successes, challenges, and lessons from Indigenous protected and conserved areas. *Biological Conservation*, 241, 108271. <https://doi.org/10.1016/j.biocon.2019.108271>
- Vanella, P. (2020). A probabilistic approach for measuring the robustness of demographic forecasts. *Genus*, 76(1), 1-28.
- Vanella, P., & Deschermeier, P. (2020). A probabilistic cohort-component model for population forecasting—the case of Germany. *Journal of Population Ageing*, 13, 513-545.