

Short Communication

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Embracing diversity: enhancing the management of South Africa's kelp forests in an era of change

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Abstract: In an era of climate change, South Africa's kelp forests offer important opportunities for sustainable resource utilization. However, these opportunities also bring risks of over-exploitation. The mismanagement of kelp forests through monistic and exclusionary strategies must therefore be avoided. Emphasizing the value of plural knowledges and cultural norms associated with kelp, here we advocate for inclusive and integrated marine resource management to ensure the resilience of South Africa's kelp forests and the well-being of coastal communities that depend on them.

Keywords: kelp; plural knowledges; climate change; values-led management

Kelp – large brown seaweeds belonging to the Order Laminariales – occur along temperate to Arctic shores, with many species forming forest ecosystems in lower-intertidal to shallow sub-littoral reefs (Wernberg et al. 2019). Kelp forests may extend from the shoreline to depths of 30–40 m, with vertical limits to their distribution determined by wave action, grazing, and irradiance (Bennett et al. 2016). Kelp forests are complex in structure and impart a variety of uses to humans and the environment, from providing habitats for various species of associated fauna and flora, to carbon capture and shoreline protection (Eger et al. 2023).

In the past 50 years, there has been a global decline of kelp abundance of ~2 % per annum due to increasing threats

associated with a changing climate and anthropogenic pressures, with associated losses in the contributions that kelp make towards ecosystem functioning (Krumhansl et al. 2016). However, some regions, including South Africa, have instead shown an increase in kelp abundance, biomass and distribution (UNEP 2023; Wernberg et al. 2019). The increase in kelp productivity in South Africa has been attributed to an increased intensity and duration of the south-easterly wind, which causes the upwelling of cool, nutrient-rich water (Abrahams et al. 2021; Bolton and Blamey 2017).

In South Africa, kelp forests occur over approximately 1000 km of coastline in the southern portion of the Benguela Current Large Marine Ecosystem (Blamey and Bolton 2018). The common kelp species in this region, specifically along the western Cape coast, include *Ecklonia maxima* ('sea bamboo'), *Laminaria pallida* ('split-fan kelp') and *Macrocystis pyrifera* ('bladder kelp') (Manevelde 2011; Manevelde and Frans 2001). Of these, the dominant kelp species used for commercial purposes, and those considered in this communication, are *Ecklonia maxima* and, to a lesser extent, *Laminaria pallida* (DFFE 2013).

As the environmental challenges facing kelp forests around the world become increasingly evident (UNEP 2023), there is a need to explore solutions that harness the potential of these underwater forests. In recent years, there has been a growing interest in the possible contributions of seaweeds, particularly kelp to climate-friendly economic opportunities. These include their use in combatting food insecurity, as a biodegradable replacement for single-use plastics, as part of livestock feed that reduces methane emissions, and more (Millin 2019; Price 2020; Roque et al. 2021). The reasons for this shift could be attributed, in part, to the increasing urgency of the climate crisis (Hoegh-Guldberg et al. 2019) and to the growing belief that morphologically complex species such as kelp, may offer 'blue carbon' solutions to mitigate climate change (Lovelock and Duarte 2019). As such, kelp have witnessed a notable surge in both present and potential applications, encompassing a wide range of potential uses such as food and food supplements (Millin 2019), livestock feed that reduces methane emissions (Roque et al. 2021), fertilizers and plant growth enhancers (Rothman et al. 2020), bioplastics (Price 2020), and biofuels (Shapiro and Evstatieva 2017).

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The South African kelp industry currently produces approximately 10,000 tonnes of fresh kelp per annum, which represents 3 % of the global ‘wild-harvested’ kelp production, but only 0.1 % of the total global kelp production, which includes wild-harvested and aquaculture sources (CSIR 2022). The management approach of maximum sustainable yield (MSY) is applied to each designated kelp concession zone and is capped at 10 % of the estimated annual kelp forest biomass (CSIR 2022). In total, the maximum sustainable yield for kelp is approximately 25,500 tonnes per year (CSIR 2022). The primary market for kelp in South Africa currently centres around its use as a feed for the abalone industry and, between 2011 and 2020, fresh beach-cast and harvested kelp designated for abalone feed peaked at 7000 tonnes per year (Rothman et al. 2020). The second significant market for kelp is its application in plant growth enhancers, which has displayed consistent growth over several years, reaching over 3000 fresh tonnes per year in 2017 (Rothman et al. 2020). Stirk et al. (2004), examined potential new applications for Southern African kelp, highlighted promising new uses, including as bio-absorbents in heavy-metal wastewater remediation, potential medicinal value, and their use in the brewing and distilling industries for the manufacture of alcoholic beverages, though not all these applications have since been realized. The Commonwealth and Development Office of the Government of the United Kingdom and the Bivalve Shellfish Farmers Association of South Africa’s Kelp Project subsequently identified additional potential uses of kelp (CSIR 2022), such as serving as an integrated multi-trophic aquaculture (IMTA) platform, contributing to climate change mitigation efforts, and generating carbon credits (Hossain et al. 2022). In IMTA systems, the inclusion of kelp is common due to their efficient capacity to absorb carbon dioxide (CO₂) from the water (Lovelock and Duarte 2019). Theoretically, the carbon regulation performed by seaweeds have the potential to offset CO₂ emissions, and the quantified carbon units can be utilized to generate carbon credits. However, the effectiveness of this system in South Africa, particularly in generating carbon credits, hinges on the refinement of the IMTA platform, alongside wider policy questions about the efficacy of such approaches. To achieve this, there is a prerequisite for regulatory frameworks that recognize and assign value to the societal benefits of carbon removal from the water (Ross et al. 2023).

As mentioned previously, kelp forests in South Africa are expanding (Bolton and Blamey 2017). Market applications already exist in South Africa for kelp products, including fresh kelp for abalone farmers, whole fresh kelp for plant growth enhancer manufacturers, and dried, milled, and graded kelp for local and international markets

(CSIR 2022; Rothman et al. 2020). Paired with the existing and increased interests in kelp applications, the current kelp forest expansions make South African kelp a potentially viable species of interest to many stakeholders. This includes an untapped global market potential for economies of scale, particularly through successful commercial aquaculture development for using kelp in the pharmaceutical, nutraceutical, and food industries (CSIR 2022).

Amidst the heightened demand and increasing utilization, the sustainable management of kelp ecosystems becomes paramount to avoid the potential over-exploitation of this resource, and the marginalization of communities that depend on it. Given the diverse set of stakeholders, from different knowledge systems and social-cultural systems in South Africa, inclusive and integrated management of kelp ecosystems is especially important to prevent the management and governance of changing kelp forests from taking the form of ‘ocean-grabbing’, which refers to acts of dispossession or appropriation of marine resources (Bennett et al. 2015; Bennett and Roth 2019). Historically, South Africa’s marine resource management strategies have been exclusionary. The absence of meaningful consultation during policy implementation, particularly regarding amendments to the Marine Living Resources Act No. 18 of 1998 to accommodate a new small-scale fisheries sector policy, had resulted in excluding local values, principles, and practices from the planning and decision-making process (Sowman and Sunde 2021). In 2017, the rights to certain kelp concession areas were provisionally allocated to the Small-Scale Fishing sector, which, for unknown reasons, has yet to be activated. As a result, the temporary (unfortunate) solution was to give previous rights-holders (i.e., commercial entities) exemptions to continue harvesting kelp (Rothman et al. 2020). Consequently, some marine resource management strategies continued to separate scientific decisions from those that are social in nature. For example, total allowable catch limits are often based on species biology and stock assessments, with little consideration of the socio-political elements of the allocations. Similarly, the impact of climate-induced changes on cultural aspects, such as the significance of kelp forests to local communities in terms of recreation and as places of social cohesion, is often neglected in marine resource management strategies (Mehta et al. 2023; Sunde and Kumar 2014). While there is no doubt that ecological assessments are necessary in informing total allowable catch limits to prevent the over-exploitation of natural resources, the permit allocation process must be socially inclusive and sensitive to ensure the fair and equitable use of these resources.

It has become increasingly apparent that marine resource management strategies must be inclusive and

should consider cultural practices and traditions that remain deeply rooted in marine ecosystems. Mehta (2022) found that, although awareness of historical knowledge of indigenous kelp use in Southern Africa exists, most stakeholders were not privy to this knowledge. For example, some who held this knowledge spoke of kelp's use in 'potjies' (a South African stew that is slow-cooked in a three-legged, cast iron pot, over an open fire). Still others, as a direct and natural fertiliser for marijuana and other indigenous plants, and still others, of its medicinal properties stemming from high iodine levels that were harnessed through salves and creams (Mehta 2022). History suggests that although *Homo sapiens* has exploited the resources from kelp forests for at least 10,000–70,000 years, people's intimate connections with kelp forests could be as old as the human species itself (Filbee-Dexter and Wernberg 2018). Unfortunately, the historical, traditional, and indigenous knowledge surrounding kelp in South Africa is rapidly being lost (Mehta 2022). Incidentally, several indigenous cultures around the world, that depend on marine resources, including seaweeds and kelp, have for millennia successfully utilized traditional and local knowledge, well-established social networks, as well as cultural norms, to sustainably manage their resources (e.g., Jabali et al. 2020; Poepoe et al. 2003; Proulx et al. 2021). Drawing from their experience, local knowledge holders can provide valuable models for adopting more inclusive approaches to resource management to prevent unfavourable outcomes. Thus, holistic marine resource and ecosystem management is essential to safeguard the remaining ties between local peoples and kelp forests. By embracing plural knowledges and cultural norms associated with kelp, we can help to ensure that the interests and well-being of coastal communities are safeguarded, and that the management of kelp forests is sustainable (Bennett and Roth 2019).

To achieve true resource sustainability, a values-led management system is needed, one that builds on the foundational values concerning the relationship between a community and nature (Artelle et al. 2018). These values guide peoples' conduct with nature, place, and each other, ultimately shaping the management approach and objectives, and potentially leading to favourable policies and practices. Such models already exist in place-based cultures (e.g. Stephenson et al. 2014; Turner and Spalding 2013). In South Africa, Lucrezi (2021), assessing recreational divers' interest in kelp monitoring, showed that all participants felt that kelp species deserved to be protected. Similarly, Mehta et al. (2023) found that 88 % of local stakeholders in the South African kelp sector believe they have an ethical and moral obligation to protect kelp forests. These examples demonstrate the prevalence of strong relational values and a sense of custodianship towards kelp forests among individuals

with vested interests. The foundational values of relationality and reciprocity – or the right to use kelp as a resource existing alongside the responsibility to maintain and protect it – is seen across several stakeholder groups in South Africa (Mehta et al. 2023). This underscores the significance of considering these values in decision-making processes and management strategies to effectively protect and sustainably use kelpforests.

Knowledge about kelp, amongst individuals in the South African kelp industry, is (not surprisingly) very high, with 62 % of stakeholders in the kelp sector holding knowledge about kelp forests for more than 10 years (Mehta 2022). The most common way of acquiring knowledge of kelp is through personal interaction with it, resulting in the existence of rich place-based, local knowledge(s) of these forests (Figure 1). By building on existing cultural and ecological knowledge, community-based initiatives can be developed to promote sustainable practices in using, monitoring, and protecting kelp forests. Involving local communities in decision-making processes is thus paramount in fostering a sense of ownership and responsibility.

All things considered, how might these values-led management systems manifest in practical terms? First, tangible objectives that are shaped by underlying values towards kelp forest ecosystems must be determined. For example, if reciprocity and respect are recognized values,

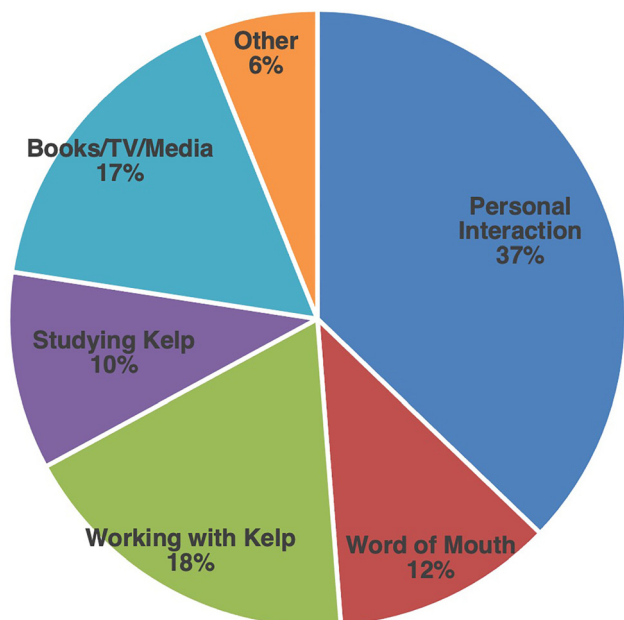


Figure 1: The relative proportions of the different modes of kelp knowledge acquisition across a sampled population ($N = 74$) elicited through survey questionnaires and semi-structured interviews. Stakeholders were asked to choose all the sources of knowledge that applied to them from the given options. For details, see Mehta (2022).

an objective related to these could be to ensure that the kelp populations are not excessively exploited. One way to achieve this objective could include regulations that specify that kelp should be harvested only at specific times of the year. The next step could be to align laws and policies with the identified approach to meet a value-led objective. Building on this example, a method to ensure that individuals do not exceed harvest levels could involve establishing community-led monitoring systems and policies explicitly outlining these restrictions, with associated enforceable penalties.

Acknowledging the broad range of values and knowledges linked to kelp forests is crucial to ensure decision-making processes recognise and respect the perspectives of all individuals, communities, and social entities, including those at risk of exclusion due to the consequences of such decisions (IPBES 2016). By fostering collaboration and promoting a mutual understanding of the diverse knowledges and values linked to kelp forests, it becomes possible to ensure the long-term resilience and conservation of these ecosystems, while simultaneously safeguarding their cultural heritage and the well-being of coastal communities.

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