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Coping with Climate Change to Safeguard the Seaweed Industry in Eastern Africa: Spotlight on Tanzania



Highlights

- The seaweed industry makes a significant contribution to Tanzania's economy, but this has been severely impacted due to climate-induced pest and disease outbreaks in the recent years.
- Seaweed farming is a crucial livelihood option for coastal communities, which may be marginalised or hindered in their income generating options, particularly the women in the Tanzanian context.
- The sustainable expansion of the seaweed industry in the East African region requires the acceleration of evidence-based knowledge and strategic investments.
- In Tanzania producers spend much time trying "to grow seed" and by the time they are ready to expand their farms the seasonal conditions are no longer favourable. In these circumstances financial losses are inevitable.
- A combination of good quality seeds and supportive policy mechanisms can make the East African seaweed industry more lucrative.

In collaboration with



Authors

Flower E. Msuya¹
Ivy Matoju¹
Amelia Buriyo¹

Sadock Rusekwa¹
Louise Shaxson²
Virginie Le Masson²

Nidhi Nagabhatla³
Elizabeth J. Cottier-Cook⁴
Philippe De Lombaerde³

¹ Department of Botany, University of Dar es Salaam, Uvumbuzi Road, Dar es Salaam, Tanzania

² Overseas Development Institute, 203 Blackfriars Road, London, UK

³ United Nations University Institute on Comparative Regional Integration Studies (UNU-CRIS),
Bruges, Belgium

⁴ Scottish Association for Marine Science, Scottish Marine Institute, Argyll PA37 1QA, United Kingdom

www.globalseaweed.org

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Five Critical Issues in the Seaweed Industry in Tanzania and the Region

1. The **seaweed industry makes a significant contribution to the Tanzanian economy**, but production has been decreasing since 2015 owing to the occurrence of pests such as epiphytes and diseases such as Ice-Ice disease (IID) syndrome. The impacts of climate change, particularly the increase in seawater temperatures from 31°C (max) in the 1990s to 38°C (max) in 2020 have led to a greater incidence of pest and disease outbreaks.

2. The **high-value red seaweed *Kappaphycus* is highly sensitive to increases in seawater temperature**. It has been particularly affected by diebacks induced by pests and diseases, and its production has decreased significantly since 2002.

3. A **key challenge facing Tanzanian seaweed farmers is a lack of good quality seedlings** they can use to repopulate their farms after pest or disease outbreaks. Developing a supply of healthy seedlings means maintaining genetic diversity within seaweed production, conserving indigenous species and varieties, developing quarantine protocols to ensure that seaweed is only produced from healthy stock, and providing clear messages to the (mainly women) farmers about how they can improve their farm management strategies. However, there are very limited seed production and research facilities within Tanzania and the East African region to support this.

4. In most African seaweed producing countries, the **institutional structures and policy support systems for seaweed production and research are limited or completely lacking**. In addition, the science-policy interface is weak and



Women harvesting seaweed in Zanzibar Islands, Tanzania. | © F. Msuya

consequently, policy decisions are not typically based on scientifically robust and up-to-date evidence. Policy and institutional responses should not only be sought at the national level but should include regional and bilateral cooperation.

5. Seaweed has the potential to make a significant contribution to economic growth in coastal communities in Africa. Governments could do more to develop policy frameworks that strengthen the science-policy interface, design and adopt appropriate protocols for maintaining seedling health, strengthen genetic diversity and conserve wild stocks, and recognise its relevance as nature-based solution and reckon the specific roles women and men play in the seaweed value chain. Doing this will help develop a sustainable, inclusive, and thriving seaweed industry for the region and the states.

Current Status of the Seaweed Industry in Tanzania

a) Production and markets. While Tanzania has an extensive range of indigenous seaweed species, only three seaweeds are currently commercially produced and all of them originate from imported stock. Production stands at about 11,000 t yr⁻¹ (dry weight, DW) with a typical price of USD 0.3 kg⁻¹ for *Eucheuma denticulatum* (commonly known as Spinosum)

and USD 0.5 kg⁻¹ (DW) for two species of *Kappaphycus* - *K. alvarezii* and *K. striatus*, (commonly known as Cottonii), although the prices can vary, dependent on fluctuations in the world market (Valderrama et al 2015). Most of the seaweed produced in Tanzania is exported as dry, unprocessed raw materials to multi-national processing companies in France, United States, and Denmark. A small proportion (2.7%) of the crop, however, is retained and used by local small-scale processors to produce cosmetic and food products.

b) Employment and economic significance. Seaweed farming is one of the best livelihood options for coastal communities, which may be marginalised or hindered in their income generating options, particularly the women in the Tanzanian context. Women farmers, who dominate the industry, view seaweed production as a lucrative source of income that has enabled them to meet and improve their living standards. The seaweed industry in Tanzania employs about 30,000 farmers (Rusekwa et al 2020) and a further >150,000 people benefit indirectly from the industry. It contributes significantly to the country's economy, particularly on the Zanzibar Islands, where it contributes 7.6% of GDP (Msuya 2020). It is also the 3rd largest source of foreign exchange income for the islands. Despite its importance in the country, the sector is not well regulated as current regulatory norms are

encapsulated within the fisheries policies and do not relate specifically to the seaweed industry. There is limited attention paid to data collection about seaweed farming, which means there is limited awareness of who exactly is farming seaweed.

c) Environment and climate change. Since 2005, the industry has been severely affected by changes in the environment attributed to climate change, in particular increasing seawater surface temperatures (SST), which are linked to disease and pest outbreaks. SST has increased in shallow waters from a maximum of 31°C in the 1990s to 38°C between 2014 and 2020 where seaweeds are cultivated (Msuya and Porter 2014; Largo et al 2020). During the hot season (December-February), water temperatures typically range from 33-38°C in the shallow waters, severely affecting seaweed farms and resulting in a decline in production, even for the more heat-tolerant species, *Eucheuma*. Consequently, the value of seaweed production in Tanzania declined from USD 4.3 million in 2015 to USD 2.4 million between 2016 and 2020 (Figure 1). Production losses are discouraging for farmers, and some have opted to suspend farming during the hot season, farming only during the rainy and cold seasons, whilst others have stopped farming completely.

In Tanzania producers spend much time trying “to grow seed” and by the time they are ready to expand their farms the seasonal conditions are no longer favourable. In these circumstances financial losses are inevitable.

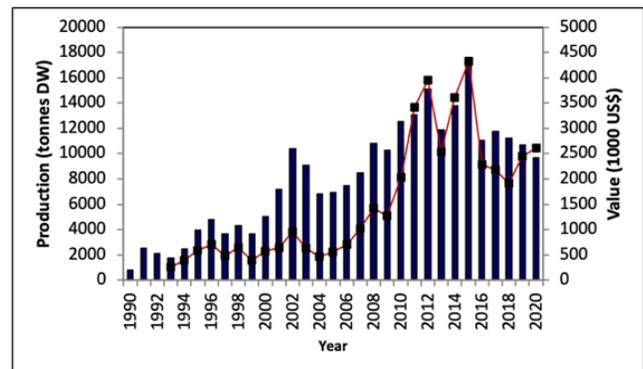


Figure 1. Seaweed production (tonnes DW and value (1000USD) in Tanzania from 1990-2020. Source: Department of Fisheries Zanzibar and mainland Tanzania (2021)



Figure 2. Seaweed affected by ice-ice (A) and epiphytes (B)
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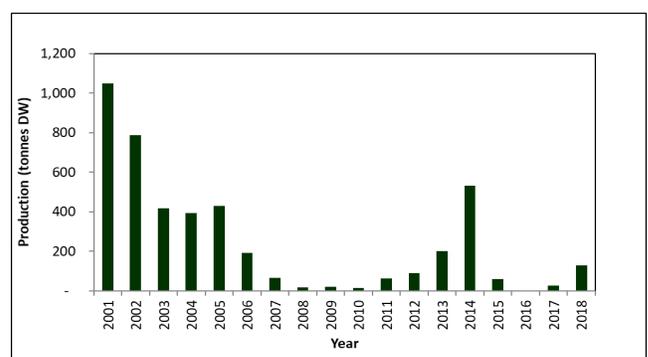


Figure 3. Trend in *Kappaphycus* production from 2001 to 2018. Source: Msuya (2020).

KEY CLIMATE CHANGE IMPACTS ON THE SEAWEED INDUSTRY IN TANZANIA

Persistent Occurrence of Ice-Ice Disease Syndrome and Epiphytes: As noted above the main challenge facing the seaweed industry in Tanzania is the impacts of climate change, particularly the increase in SST. The SST is linked to persistent outbreaks of ice-ice disease syndrome, which causes the whitening of the thallus (Figure 2A) and results in the disintegration of the seaweed. Additionally, epiphytes have also become an increasing problem to the industry, particularly the filamentous alga *Melanothamnus* (formally *Polysiphonia/Neosiphonia*) (Figure 2B). Epiphytes compete with the commercially grown seaweed for nutrients, as well as, creating vulnerable points on the surface of the thallus for harmful microbes to enter.

Massive Diebacks of *Kappaphycus*: As of 2014, production of the higher value *Kappaphycus* (priced about USD 0.5 kg⁻¹ compared with USD 0.3 kg⁻¹ for *Eucheuma*) has declined to 129t y⁻¹ (DW) (Figure 3) and has not returned to pre-2014 levels. The massive and consistent diebacks of *Kappaphycus* have been attributed to the rising SST, with a decline in production recorded from 1,048t in 2001 to below 200t between 2006-2018.

Farmers Practicing “Seasonal Farming” And Discontinuing: Farmers are often forced to stop farming during the hot season and only resume during the rainy and cold seasons. *Kappaphycus* farmers’ have adapted and now practice seasonal farming, tagging growing seasons as either “good” or “bad”.

Lack Of Healthy Seed Supply Mechanisms for Farmers: There are no seed production facilities, such as seed nurseries or tissue culture laboratories in Tanzania or in the Western Indian Ocean Region. When pest and disease outbreaks occur, farmers usually find themselves without healthy seed and the time remaining in the ‘good’ season to grow new seed.

Eight Recommendations to Support a Sustainable Seaweed Industry in Tanzania and more widely in Eastern Africa

The GlobalSeaweedSTAR project intervention in Tanzania helped to outline this set of recommendations based on empirical observations and scientific analysis to facilitate the acceleration of evidence-based knowledge towards the sustainable expansion of the seaweed industry, particularly in the East African region.

1. Support for shifts in production habitat

Moving farms to deep waters (2-6 m depth during low tide) can alleviate the thermal stress caused by elevated sea surface temperatures in shallow waters. Seaweeds grown in deeper waters are less prone to disease and pest outbreaks and their carrageenan quality is higher compared to those grown in shallow water. Moving farms to deeper waters, however, will require the farmers to invest in boats, protective equipment such as life jackets, and to improve their swimming skills. However, many farmers lack the financial or technical means to own their boats and are unable to swim, particularly women. Such challenges could be addressed through relevant policies and funding schemes to ensure a safe and financially sustainable transition to growing seaweeds in deeper waters (Cottier-Cook et al 2021).



Seaweed farmers working in farms in Zanzibar, Tanzania.
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2. Early warning systems for disease management

All stakeholders, including the farmers, need to be aware of the initial signs of yield-limiting pests or diseases. A seaweed disease manual has been recently produced under the GlobalSeaweedSTAR Project (Matoju et al 2021). Additionally, Information and Communication Technology (ICT) tools, including radio, television, and online social media, could be used to inform farmers of outbreaks and the various available training materials. Capacity building should be paramount, and ICT tools, which are accessible by a smartphone can be an effective way of conducting on-farm or community scale training programmes.

3. Intensifying the farming during “good” growing seasons

The cold (June-August) and rainy seasons (March-May and September-November) provide relatively better growing conditions and less risk

of disease and pest outbreaks compared with the hot season (December-February). Communication with farmers could encourage them to increase production during the cold and rainy seasons to maximise their yield.

4. Ensuring healthy seed supply chains for farmers

Providing a steady supply of disease and pest-free seedlings is essential to help the industry recover after an outbreak, but there are no nurseries in Tanzania (Msuya 2020) or the region. The private sector, universities, research institutions, governments, and regional organisations could collaborate to create laboratory-based facilities which could develop new temperature and disease- and pest-tolerant cultivars. Such facilities would support ongoing research to meet the needs of the seaweed industry and ensure its continued viability. Measures to quarantine imported variants and deter the re-planting of infected seaweed should be introduced to seaweed farming communities through training programmes and field demonstrations.

5. Use of non-exploited naturally growing seaweed species

Tanzania is endowed with rich abundance and diversity of naturally growing seaweeds that are yet to be domesticated, such as *Gracilaria*, *Hypnea*, and *Sargassum*. Further research on the domestication of native seaweeds for cultivation

should be encouraged and supported by relevant stakeholders to reduce the dependence on imported cultivars, and their associated pests and diseases.

6. Scaling-up value addition

In addition to increasing the supply of raw dried seaweed, more could be done to boost local production of value-added seaweed products and the gel carrageenan for both domestic use and export. This would provide more income generating options, particularly for women, thus improving their living standards and contributing to employment and economic growth. The Zanzibar government and the Union authorities are key stakeholders, who can encourage the involvement of the private sector to expedite this process.

7. Greater focus on seaweed-specific policies and strategies

Developing seaweed-specific policies and strategies is necessary to improve the seaweed industry in Tanzania in both the short and long term. Such policies would help establish a supportive framework to bridge the gap between the research community and other industry stakeholders. It would also support the capacity building initiatives throughout the value chain, thus ensuring the sustainability of the seaweed industry. Such collaborations should also take into consideration issues of socio-economic inclusion such as gender

representation, and the formation of social networks such as cooperatives and leverage agendas such as nature-based solutions and sustainable development goals.

8. Complement national policies with regional policies and bilateral cooperation

Because of the nature of the challenges of the seaweed industry, it is recommended to complement national policies with new policies at the level of the East African Community and/or bilateral cooperation with neighbouring Kenya, where seaweed farming is of more recent date than in Zanzibar but where the seaweed market capacity is like Tanzania (van Hoof and Steins 2017). Strengthened regional cooperation, preferably in the context of the EAC, could serve various purposes thanks to the scaling-up effect: risk management, seed production, strengthening research facilities, development of regional value chains (an increase of regional absorption capacity and value-added generation), and development of an adequate regulatory framework.

Regional Relevance of the Lessons Learned

The eight recommendations point to enhancing the resilience of the seaweed industry. And suggestions to minimise the introduction and spread of seaweed diseases and epiphytes and provides measures to deal with an outbreak, both to sustain the industry and ensure that farmers remain engaged with the industry for Tanzania (Charisiadou et al 2022) and the wider region. African governments and industries are looking into options to tap into seaweed market growth, increase seafood production, introduce nature-based solutions with climate adaptation potential, and restore overexploited marine and coastal ecosystems (Cai et al 2021). This empirical study from Tanzania—which is a top seaweed producer in the region—highlights specific areas for future interventions to ensure that the seaweed industry contributes to economic growth in ways that are environmentally sustainable, socially inclusive, and can adapt to the challenges of climate change.



Seaweed affected by ice-ice | © F. Msuya

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