



# Geographical characterization of the Zanzibar coastal zone and its management perspectives



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## ARTICLE INFO

### Article history:

Received 7 November 2016

Received in revised form

9 September 2017

Accepted 1 October 2017

### Keywords:

Africa  
Coastal zone management  
Indian ocean  
Marine spatial planning  
Tanzania  
Zanzibar

## ABSTRACT

The coastal zone of Zanzibar, Tanzania, is culturally, socially, economically, and ecologically unique but there is a lack of baseline information about its state characteristics as a whole. This paper provides a holistic assessment of the environmental and socio-economic settings of the Zanzibar coastal zone with its unusual physiographic characteristics and key habitats such as coral reefs, mangroves, and seagrass meadows. The human livelihood of Zanzibar is unmistakably coastal with its many cultural adaptations but the most recent decades have shown drastic changes in the prevailing seaborne and coastal activities. This development has not been without disputes among the different interest groups. The driver-pressure-state-impact-response approach allows to scrutinize the socio-ecological system circles of the Zanzibar coastal zone. Systematically, the approach provides interlink of the drivers and with their impacts on the socio-economic systems and the appropriate responses necessary to combat the impacts. The main drivers identified to be the population increase, urbanization with settlement expansion, and the rapid expansion of the shore-dwelling tourism with its associated infrastructures. These factors are adversely impacting the coastal and marine nature and the traditional socio-economic systems. The Zanzibar government has put forward several initiatives to protect the health of the coastal ecosystems and the endurance of the traditional cultures. The effective implementation of measures, for example, the Zanzibar Coastal and Marine Spatial Planning as part of the National Land Use Plan, have not yet been sufficient to restore the situation. However, there are also signs of commitment being fostered and an improvement in the know-how for making changes. We conclude by asserting the need for coastal and marine spatial planning as the holistic and robust approach for sustainable coastal and marine planning while emphasizing community participation throughout the process.

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## Contents

1. Introduction .....	117
2. Material and methods .....	117
2.1. Study area .....	117
2.2. Data collection and analysis .....	118
3. Results .....	120
3.1. Biophysical characteristics .....	120
3.1.1. Geophysical environment .....	120
3.1.2. Hydrodynamic environment and sea water .....	121
3.1.3. Coastal and marine ecosystems .....	122
3.2. Socioeconomic characteristics and drivers .....	125
3.2.1. Use of organic resources .....	125
3.2.2. Other coastal activities .....	125
4. Discussion .....	127

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4.1. Drivers and pressures in the Zanzibar coast .....	127
4.2. Steps towards sustainable coastal planning and management .....	130
4.3. Community participation for sustainable coastal management .....	130
5. Conclusion .....	131
Acknowledgements .....	131
References .....	131

## 1. Introduction

The coastal zone is a naturally dynamic, fragile, and complex environment where multiple forces and processes intermingle with each other and as a part of the global system (Masalu, 2000). It also attracts and supports a plethora of human activities from industrial interests to aesthetic values which entices people to the seaside for recreational and leisure purposes (Yao, 2013). Although being an integral part of the development of many coastal regions, human influences are now increasingly disturbing the coastal systems (FAO, 2006). The changes are largely due to the drastic increase in the population and other human activities in both the urbanized and rural coastal settings (Small and Nicholls, 2003). Problems have also been created by transitory needs which have steered the coastal development into piecemeal solutions (Francis and Bryceson, 2001). These developments have prompted a need for better coastal planning and management. Consequently, Integrated Coastal Zone Management (ICZM) (Hopkins and Bailly, 2013; Khakzad et al., 2015) and the Marine Spatial Planning (MSP) have been considered as the main frameworks for achieving good outcomes in space and time (Douvere et al., 2007; Douvere and Maes, 2010; Ehler and Douvere, 2009; Shipman and Stojanovic, 2007). Their forward-looking approach aims to avoid conflicts from incompatible uses or overlapping stakeholders' interests through holistic and participatory practices.

Many tropical coastal areas with an attractive nature and stable societal conditions have experienced notably rapid changes with a growing tourism industry and a disappearance of traditional cultures. Hotels, resorts, and camping houses are now overcrowding the most attractive coastal areas at an alarming rate that may, if not already, exceed the ability of the coast to support their existence. Where the shoreline has become a scarce, even reclamation to extend the land seaward has occurred (Yao, 2013). The vulnerability of the coastal zone in the face of such activities depends on their specific natural conditions such as geology and climate, hydrography and vegetation (Christian and Mazzilli, 2007; Shaghude et al., 2002). Seagrass, coral reefs, mangroves, sand, and mud flats are good examples of fragile but valuable key habitats (Martínez et al., 2007) which should be treated with special attention. Their characteristics may be sensitive even to changes taking place far inland through river transported nutrients or toxic chemicals (Klemas, 2012; Nosakhare et al., 2012; Stuart, 2010).

Zanzibar on the Tanzanian coast of East Africa is facing exactly the type of challenges described above. The islands are entirely coastal where no in-land parts of even the largest islands are further than 12 km from the shoreline. As one of the most densely populated regions of the world, its current planning and management challenges are confronted especially in the interface between land and sea. Unique tropical ecosystems, traditional Swahili culture and livelihoods, and modern infrastructural and often massive developments co-occur and create conflicts and management challenges on the shores of the two main islands of Unguja and Pemba. The implementation of sound management demands good knowledge about the state of the coastal environment (Ehler and

Douvere, 2009) and its socioeconomic and cultural conditions. Such documentation is unfortunately lacking or has a very patchy existence. For example, the intertidal habitats have been addressed by only a few studies (Arthurton et al., 1999; Ndaró and Ólafsson, 1999). Research has also been made on fisheries (de la Torre-Castro and Lindström, 2010; Dorenbosch et al., 2004; Lugendo et al., 2005, 2007), tourism (Christiansen et al., 2010; Gössling, 2001; Makame and Boon, 2008), seagrasses (de la Torre-Castro and Rönnbäck, 2004; Gullström et al., 2006; Knudby and Nordlund, 2011; Lyimo et al., 2006), coral reefs (Grimsditch et al., 2009; Johnstone et al., 1998; Mbije et al., 2002), mangroves (Mchenga and Ali, 2014, 2015; Shunula, 2002), coastal forests and land uses (Fagerholm and Käyhkö, 2009; Käyhkö et al., 2011; Kukkonen and Käyhkö, 2014). Despite all of these studies, there is still no good overview of the Zanzibar land-sea interaction that could support holistic coastal planning and management.

The present study aims to establish a comprehensive geographical depiction of the state of the Zanzibar archipelago based on geospatial and temporal assessment of its physical, biological, and human dimensions. In addition to its regional relevance, this assessment also introduces new themes to the overall scientific literature about coastal management. Whilst the prevailing scientific literature mainly focusses on Europe, North America and Australia, the East African outlook, adjacent to the Indian Ocean, is unmistakably distinct. We also show the effectiveness of the Drivers-Pressures-State-Impact-Response (DPSIR) framework in distinguishing the principal causes and consequences that need to be considered in future coastal management in this unique tropical coastal area (Binder et al., 2013; Bowen and Cory, 2003; Carr et al., 2007; Eurostat, 1999; Kristensen, 2004; Ojeda-Martínez et al., 2008).

## 2. Material and methods

### 2.1. Study area

Zanzibar archipelago is located in the tropical Western Indian Ocean adjacent to the East African coast (Fig. 1). It is a constellation of two major islands and about 50 small islets. The mean elevation of the Zanzibar islands is less than 20 m a.s.l. (above mean sea level) with the highest peaks on Unguja (1670 km<sup>2</sup>) and Pemba (990 km<sup>2</sup>) reaching 119 m a.s.l. and 96 m a.s.l., respectively. Zanzibar has a humid tropical monsoon climate with an annual average temperature of about 27.5 °C and a biannual rainfall pattern (DoE, 2009). The Southeast Monsoon brings heavy rainfall (in Swahili: Masika) between March and May and the Northeast Monsoon is associated with light rainfall between October and January (in Swahili: Vuli) (Fig. 1). Pemba has a slightly higher annual average rainfall (1900 mm) compared to Unguja (1600 mm). On both islands, the western parts have higher precipitation than the eastern sides due to the orographic setting and evapotranspiration. In addition, the deeper soils make the western parts more favorable for permanent agriculture compared to the east coasts where coral rag and shallow soils are predominant.

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