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## (INTER)NATIONAL AND (TRANS) REGIONAL AGENTS

### The coastal sand dunes of Mozambique

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#### Introduction

The environmental humanities scholarship has long acknowledged that knowing, thinking, and feeling are not exclusive from humans. Dunes do not know, think, or feel. They are not beings, but things. Dunes have agency, though. Dunes result from a sensitive balance between multiple elements, processes, and forces, non-human and human; they cannot be taken as outcomes but must be seen as ongoing processes (Kreike 2013). Looking at their history, morphology, and ecology, one finds, as Isenberg (2014: 135) points out about grasslands, “not unidirectional trajectories of progress or decline, but dynamic environments that shift unpredictably and without regard for human purpose”. Much has been written in line about rivers and forests; this literature is useful to reflect about dunes, which to this point have evaded humanities scholars’ attention. Contrary to rivers and forests that were always main concerns for societies, dunes are less familiar. Geographically and socially peripheral, dunes are strange landmasses; they behave like water, moving, invading, permeating their surroundings like a flood, but are made of solid substances.

Dunes can influence human choices, activities, vulnerabilities, and futures, so they were chosen to be the main character of this collaborative chapter, whose authors have different expertise. An environmental historian, a social geographer, a forestry engineer/historian of science, and a coastal scientist looking at the same subject matter do not ask the same questions, do not use or interpret data the same way, and do not present their findings on an equivalent basis (Greer et al. 2018). By mixing and blurring their knowledge and skills, combining distinct terminologies and practices, the authors produced a multi-layered study, made of historical and scientific data, geographic information, and personal observations, that brings “heterogeneity as a key lens” (Tsing 2015: 161) to cast a light into dunes as agents of (inter)national and (trans)regional webs.

Dunes do not adhere to borders (conceived as land and power) (Soen et al. 2017). Even though they stand in a territory belonging to a state, in the fluid world of the drifting sands and flowing waters, there is no real division between land and sea, nor is it possible to establish an effective line between countries. Dunes don’t respect other limits, either; set in

motion, they silt rivers and lagoons and cover agricultural fields and houses. Even though dunes are attached to specific geographies, their association to particular socio-ecological processes and interactions – colonial networks, knowledge transfer, migrations, climate change, conservation concerns – spreads throughout a large spatial magnitude, making them borderless. Sand infiltrates the human sphere – local folk, administrations, experts, tourists – and bridges along and across the territorial edges of empires and states, and the social and cultural lines within groups and peoples. Sand even pervades the traditional disciplinary frontiers, as it hides, fades, pushes the bounds of what is geography, geomorphology, history or anthropology, by working as the cement of diverse ideas and materials, making no divide between them. This chapter is then dedicated to point out what makes dunes both unique and representative of the poly-vocal (inter)national and (trans)regional histories, taking place in the coasts of Mozambique, in the 20th and 21st centuries, and how these relate to the environmental issues at the cusp of global concern.

### **The coast of Mozambique**

The Republic of Mozambique is a southern African country, formerly a Portuguese colony up to 1975, bordered by South Africa, Eswatini, Zimbabwe, Zambia, Malawi, Tanzania, and the Indian Ocean (Ministério da Educação 1986; Muchangos 1999). The climate is predominantly humid tropical, with two seasons: from October to March, a wet summer, and from April to September, a dry winter. The average annual temperature varies along the coast, from 26°C in the North, to 23°C in the South. Generally, temperature increases with the distance from the coast and decreases with the latitude. Annual average precipitation ranges from 400 mm/year in the inland semiarid areas of the southern region to 1,010 mm/y and 1,780 mm/y in the northern and central provinces. The winds in the southern and central regions are mainly from the south-east (SE) and in the northern region from the north-east (in summer) and south-west (in winter) (Palalane et al. 2016). Due to its geographical location, Mozambique is one of the most hazard-prone countries in Africa, being highly exposed to extreme events, such as floods, cyclones, and droughts (Instituto Nacional de Gestão de Calamidades et al. 2003).

Mozambique has a high diversity of coastal ecosystems. Coral reefs are more abundant in the North, seagrass and mangroves occur along the entire coast but are more extensive in the country's central part. Parabolic dunes characterise the southern region, stretching in the Mozambican territory for about 850 km, from Bazaruto Island to Ponta do Ouro, in the border with South Africa, extending as the same ecological unit well beyond that political limit (Pereira et al. 2014). On the provinces of Gaza and Maputo, a sand coastal ridge runs almost parallel to the shore, backed by lakes and lagoons, forming barrier-lagoon systems. The Limpopo and Incomati Rivers are the main sediment suppliers to this region (Miguel and Castro 2018). The geomorphological evolution of the transgressive dune fields shows a high aeolian transport potential on the coast. The highest rates of dune migration landward are experienced during the dry season, from April to September (Miguel and Castro 2018; Miguel, Nehama, and Castro 2019). Miguel and Castro's (2018) study of the coast of Maputo and Gaza provinces reveals that sand mobility is connected to wind activity, rainfall, and vegetation cover. In the Maputo region, the vegetation cover is less than 30%, and the dunes are migrating at a rate of 23 m/year into the lacustrine system in the rear, contributing to the silting of lakes and lagoons, which have important socio-economic functions, such as subsistence farming, fishing, and salt production (Miguel and Castro 2018; Pereira et al. 2014).

The Gaza stretch, protected by a headland, located downdrift (littoral drift runs south to north in this area) and less exposed to wind action, is characterised by 70% of vegetated dunes that reach about 150 m height, having no considerable dune migration. Leeward of the lacustrine-lagoon systems, extend the paleodunes that result from changes in paleoenvironmental conditions from the last Holocene transgression. The inner paleodunes of both areas are vegetated and stable (Miguel and Castro 2018; Miguel, Castro, and Nehama 2017); as a more or less continuous cover of dune forest reaches out from Bazaruto to Ponta do Ouro (Massinga and Hatton 1997: 13).

## **Agents of poly-vocal histories**

### ***Peoples, empire, foresters, and dunes***

In Mozambique, as in other African countries, the universe of local communities is not easy to grasp, especially for outsiders, particularly in the past. In a territory with plural ethical groups and more than 40 native languages, only 10% of the population speak Portuguese as the first language. Nevertheless, to acknowledge the locals' views of nature and the changes that have occurred in the Mozambican coast since the 16th century, Portuguese records are in most cases the only known written sources (Roque 2016). The peoples of Mozambique, stated Friar João dos Santos in 1609 from his experience at the Catholic mission of Sofala, did not read or write or have books, and all the stories and things they knew came from tradition (Santos 1891: 81). Orality for these communities up to the present is not just a way of preserving relevant knowledge, a form of collective wisdom; it is also a creative force, an action upon life. In Mozambique, there are many peoples, countless traditions, each telling their own stories, frequently connected to a worldview and to temporal and spatial dimensions that elude western comprehension (Garbinatto 2010; Guimarães, Barbosa, and Fonseca 2004: 490–1, 500–1). Knowing how these communities perceived the dunes is as hard as holding sand in one's hand; the grains keep trickling through the fingers. Furthermore, in many coastal areas, human settlement is quite recent and made of populations coming from inland rural areas. In these cases, there are no coastal or maritime cultures, and folk stories are connected to land experiences (Guimarães, Barbosa, and Fonseca 2004: 500). According to the historian Ana Roque, the continuous variability of the coastline, subject to marine erosion, sea flooding, storms, and cyclones, explains the existence of ways of life marked by such oscillations and settlement patterns characterised by temporary occupancy. This mobility, based in an ancestral wisdom about the region, was disturbed by the arrival of the Portuguese and the establishment of fixed outposts in the littoral (Roque 2016: 170). The newcomers aimed to make use of a pivotal space for exchanges between inland areas and the Indian Ocean trade routes, connecting Africa, Asia, and Europe and previously controlled by Muslim merchants (Roque 2017).

For the Portuguese, coastal zones were always key areas in the process of strengthening political dominance and economic development in Mozambique, but particularly from the 19th century onwards. After the Berlin Conference (1885), Portugal put a great effort to make its presence more effective in overseas territories while optimising their populations and resources. In line with the imperialist drive of the time, science, technology, and progress became the tools for the European states to achieve their interests in the colonies. Scientists, engineers, and other experts were crucial to the development of the main institutions of the empire, working to identify local resources, developing colonial agriculture, and

building railroads, ports, and telegraphs to facilitate the circulation of goods, people, and information (Diogo and Amaral 2012). Ports and rivers, as gateways to the mainland and connections to Europe, became priority issues. This is where dunes and forests come in.

Public debate about forestry issues in Portugal and its colonies was particularly active in the last decades of the 1800s. The lack of wood, soil erosion, and frequent floods in the metropolitan territory brought the matter to Parliament and other high-ranking intellectual institutions, like scientific societies and academies (Joanaz 2017). At the beginning of the 20th century, colonial agriculture and forestry training were taking their first steps, based on the teachings and knowledge developed at the Institute of Agriculture in Lisbon, where the course of Forestry was established in 1864 (Garcia-Pereda 2011). For the students, the first contact with the environmental conditions of Africa came through the colonial garden of Lisbon, created in 1906 (Nunes and Abelha 2014). After the First World War, the administration of Mozambique, directly dependent on the central state, put into practice the first forestry projects set by Portuguese trained in Lisbon. The first forester working for the colonial administration was Fernando Almeida Bello (1914), from 1920 to 1923. After his return to Portugal for health reasons, Bello was replaced by Raúl Silva Guardado, in 1926, who had previously worked for the Angola Department of Agriculture (Guardado 1926, 1929). Júlio Alvaro Cardoso succeeded Raúl Guardado in Mozambique. Cardoso had the time and the stability that his predecessors did not have. He worked in the colony for about 20 years, from 1932 to around 1954 (Cardoso 1954), having laid the foundations of systematic forestry in Mozambique, based in European methods and standards. These three men were the main responsible for coastal afforestation or the planting of dunes.

In Mozambique, forestry work started by fighting dune migration, in an attempt, to prevent the silting of rivers and the destruction of lighthouses, through the planting of protective woods. The initial experiments were made on the Limpopo River banks. On the Limpopo's mouth, sand was imperilling navigation, by the continual changing of the position of the bar. The sand was also obstructing the water flow, favouring the occurrence of floods that destroyed settlements on the river margins and in the adjacent Xai-Xai region (Cardoso 1939, 1954). The Forestry Service began its intervention in this area in 1920, driven by an agricultural colonisation scheme presented by the English engineer John Balfour to the provincial government. Balfour (1920) proposed the creation of a 20,000-hectare irrigated range in the valley of the Limpopo River. The territory had favourable conditions for the installation of European farmers, but the dunes at the river mouth had to be stabilised for the plan to work. The agricultural part of the project would start only two decades later; still, Fernando Bello, responsible for the afforestation, strived on the dunes matter, from his first months in Mozambique.

The works were based in the setting of foredunes in the river banks and on the beach, using fences to break the winds and propitiate sand accumulation. Protected by these structures, vegetation was planted to stabilise the sands. Exotic and local species, like *Ammophia arenaria*, *Ipomea biloba*, *Eragrostis* spp., and *Canavalia rosea* were used. Trees, such as the *Casuarina equisetifolia*, *Acacia melanoxylon*, *Eucalyptus diversicolor*, and *Pinus* spp., were planted. Since the *Casuarina equisetifolia* proved to be the more suitable to the climate of this African coast, growing fast and helping to create a soil layer with its leaves, it was adopted as the main tree species to colonise the dunes of Mozambique (Cardoso 1948, 1954). In 1926, around 33 ha near the Limpopo river were fixed. In the following years, Silva Guardado proceeded with the task, before being replaced by Alvaro Cardoso in 1932.

In 1939, almost 575 ha of dunes had been planted using more than half a million trees (Cardoso 1939). In 1948, a total of 1,026 ha were afforested (Cardoso 1948).

Another example of dune stabilisation in Mozambique using casuarinas were the attempts to protect the lighthouses erected along the coast and in rivers' mouths. Many of these infrastructures were built on the dunes, in high places exposed to strong wind and, therefore, vulnerable to the drifting sands. In 1917, for instance, the lighthouse of Inhaca needed new windows to prevent the sand from coming in; also, the house of the keeper was almost buried under the dunes (Sousa 1918). In other cases, the foundations of the buildings were in danger because of the instability of the sandy ground. These complaints compelled the colonial government to take measures. Between 1929 and 1948, the Forestry Service proceeded to stabilise the dunes near the lighthouses of Ponta do Ouro, Inhaca, Monte Belo, Boa Paz, Závora, Inhambane, Barra Falsa, Bazaruto, Timbué, Ponta Caldeira, and Uifundo (Cardoso 1948; see Figure 9.1).

In many African regions, local communities were often blamed for environmental degradation, accused of destroying forests and vegetation through agricultural and grazing practices. Repeatedly, colonial declensionist environmental narratives were used to justify the imperial appropriation of land and resources (Davis 2007). This is not the case with the dunes of Mozambique, as there are no references in the foresters' reports about a previous greener state of the dunes, ruined by human activities. According to Cardoso (1948), most of the dunes were vegetated and represented no danger. Some were mobile and often invaded marginal lands, but since those areas were uninhabited, uncultivated, or used, no damage was done. In certain places only, the drifting sands were causing problems. Problems connected to the Portuguese enterprises: the development of agricultural schemes, lighthouses, and river and maritime navigation. Therefore, using European techniques and African labor – recruited from neighbouring regions and brought to the coast – the dunes were stabilised and afforested to safeguard Portuguese settlement on the littoral. However, the afforestation with casuarinas did not end with the independence of Mozambique: the works proceeded in the 1970s and 1980s, finishing only in the 1990s due to the lack of financial and human resources (Ministério da Agricultura 2006).

### ***Dunes, an international affair***

The problems caused by the sand dunes agency were neither new nor specific to Mozambique. Invasions in nature are usually associated to biological threats, but other natural features can be invasive too, like the glaciers in the Alps during the Little Ice Age, or the oceans encroaching upon islands and shores nowadays. Due to their mobile character, sand drifts were (and are) a common hazard, menacing human activities and assets placed near the coast. The abundant writing on the topic, coupled with efforts of many governments and private citizens to immobilise the dunes, speak to the significance of the issue. There are plenty of historical sources, from different provenances, and literature telling the stories of villages, houses, and agricultural lands buried by the sands and silted streams and lagoons converted into swampy ill areas (Clarke and Rendell 2014). By the 1920s, when Mozambique's dunes were starting to be afforested, the battle against the moving dunes was an old one, so the planting methods used were fully known. They had been thoroughly developed by experimentation, in Portugal and other European and non-European countries, for more than a century. Stabilising the sands was then a task that required only the adaptation of the existing principal model to local environments.

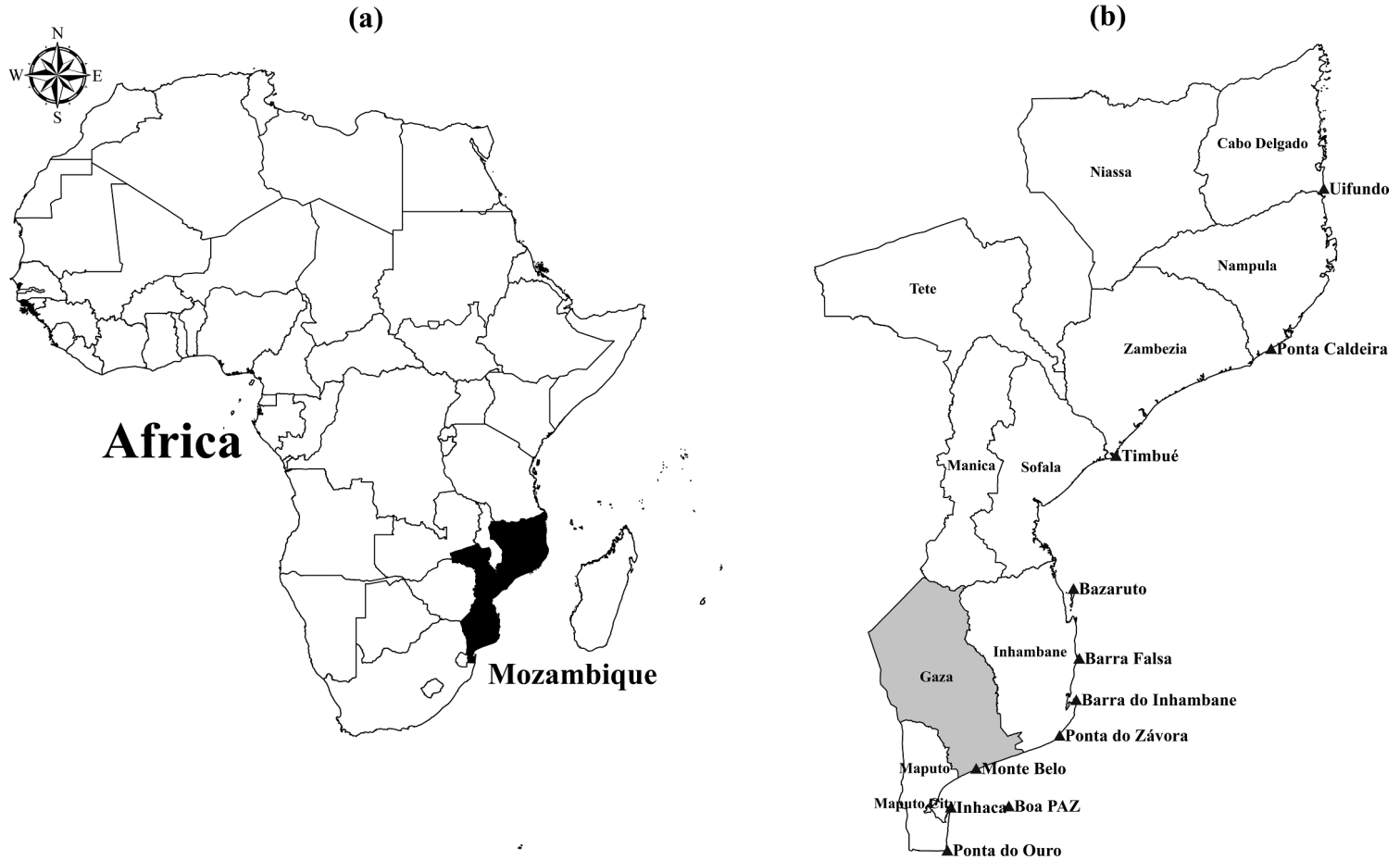


Figure 9.1 (a) Mozambique in the African continent. (b) The provinces of Mozambique, the lighthouses (the triangles) mentioned in the text, and the localisation of the Limpopo River mouth, including Xai-Xai area (the square).

The initial technique – the installation of sand-catching fences and planting of vegetation leeward of these structures to fix the sands with their roots – was based on the experiences of Nicolas Brémontier (1738–1809), engineer of the French *Ponts et Chaussées* Services in Gascony, since 1787. Brémontier did not invent the method, which was grounded on local traditional practices, also common to other regions of Europe, he simply managed to synthesise it, making it more efficient and, to have the support of the state to apply it at a large scale. After the success of the French Forestry Service in the afforestation of the dunes of Gascony, using Brémontier's technique, other nations promptly followed the example, transforming their sandy wastelands into pine forests. In the 19th century, dunes fixing was perceived as the final solution for many dune fields in Europe. The knowledge to do it was disseminated first by men of science and scientific societies, until it was adopted by technical schools, like the Forestry School of Nancy (France) and the Institute of Agriculture (Portugal). In these, a new generation of foresters was trained, before being incorporated in the recently created national (and colonial) Forestry Services, following a general tendency for the professionalisation of administration, in areas like surveying, agriculture, and forestry (Oosthoek 2018). These expertise and practices soon spread across the globe, as people, ideas, and organisms moved through the webs of the empires (Beattie 2011; Beattie, Melillo, and O'Gorman 2015).

At the beginning of the 19th century, dunes were said to be causing damages in Truro, Cape Cod (US), and, for that planted with beachgrass, by the descendants of the British settlers (Dwight 1828). In 1869, Golden Gate Park in San Francisco was created from barren sand, using the European afforestation methods. On the coast of Oregon, years later, experiments were made to find the right sand-binding plants to stop the dunes from drifting. In the 1930s, a major planting scheme, the Warrenton Dune Demonstration Project, was developed in Clatsop County, by the Soil Conservation Service, and thereafter replicated in other beaches of Oregon (Freitas 2022). In New Zealand, dune migration was being discussed by farmers and scholars as early as the 1870s, in newspapers and scientific societies. The reclamation of the sand wastes, using the French model, was promoted by erudite men and locally applied by privates and institutions (Sampath, Beattie, and Freitas 2021). In Australia, the situation was quite similar: in Newcastle and Perth, people requested the government's help for fencing and planting the moving dunes (Beattie 2011). According to Avis (1992), in the Western Cape (South Africa), problems of drifting sand arose in the mid-18th century, but it was not until 1845 that an organised stabilisation programme was initiated. From 1875, sand stabilisation became a function of the Cape Forestry Department. In Angola, the Portuguese also promoted the plantation of the dunes of Porto Alexandre, nowadays Tombwa, in 1928 (Moreira 1965).

At first glance, dunes are local things; they are connected to a specific beach-dune system, in a particular region. However, the sedimentary cells that feed them can be much broader and easily cross national borders. Littoral currents, waves, and rivers are not restrained by political frontiers. On a second look, it is possible to say that the agency of the dunes made them an international affair. The dynamic nature of dunes, by interfering with human business, ended up connecting them globally: the damages caused and the techniques adopted to stabilise the sands became a common concern and a shared solution. The history of the dunes of Mozambique must be perceived within a network of human and non-human agents and agencies, that connect local issues to multiple regions and nations, through the knowledge and practices used in the attempt to domesticate complex coastal systems. This is not, however, a linear history of Europeans as re-creators of colonial environments

(Kirchberger and Bennett 2020), at least intentionally. The examples provided about the United States, New Zealand, Australia, and South Africa can also be pointed as empirical case studies on how Europeans lost control over the new environments. What is striking from the narrative about the dunes of Mozambique are the provisional, ephemeral, and fleeting interconnections between different actors, agencies and processes (Beattie, Melillo, and O’Gorman 2015), that turn it into a poly-vocal history. There is no straight path where plurality rules, and in the search to find intelligible patterns to provide explanations, many other possible interpretations are lost.

## **Dunes, present-day challenges**

### ***The intricate web of agents and agencies shaping Mozambique’s coast***

In Mozambique, around 80% of the population needs forestry resources as a source of energy, food, medicine, building material, agricultural practices, culture, and tourism. Between 2003 and 2013, the biggest deforestation rates took place in the littoral, affecting the dunes forest cover. Population growth, urbanisation, food production, illegal cutting and mining are the biggest threats to the forests (Conselho de Ministros 2020). These factors also cause major disturbances to other ecosystems, including coastal areas.

In the Limpopo River area, satellite pictures from 1979, 1989, and 2001 show an extremely rapid growth of settlements and the clearing of the woodlands, which used to cover the dunes. The population of the coastal city Xai-Xai has tripled in the last three decades, due to the floods of 1997 and 2000 that resulted in the resettlement of the inhabitants from the Limpopo flooded valley in the higher and safer coastal dune area. To satisfy food demand, the entire dune sector was agriculturally developed (Brandt, Baumier, and Samimi 2009). The geographer Inês Raimundo made some fieldwork in the region, analysing the rural-urban migration to Xai-Xai, motivated by the civil war (1976–1992) and the great flood of 2000. She describes it as an inflow of people trying to survive the armed attacks and the destruction caused by the waters. These migrants, “poorly educated and unskilled, with a high dependence on agriculture for subsistence” (Raimundo 2005: 160), were pushed to marginal areas, like the dunes, because of land scarcity, due to the need of accommodating so many displaced people.

In other vicinities along the coast, local communities make use of the natural resources of dunes, planting coconuts (Tofo-Barra-Tofinho), grazing cattle (Bazaruto), and cutting the forest for charcoal production (Macaneta Beach). Prior to independence in 1975, but mostly after the war and in recent years, touristic infrastructure has increased along Mozambique’s littoral, especially in the South: Ponta do Ouro, Ilha de Inhaca, Bilene-Xai-Xai-Chinguene, Tofo-Barra-Tofinho and Vilanculos, which are sensitive dune regions. The opening of access to the beach, through the dunes, by the locals to explore coastal and maritime resources, and vegetation clearance by touristic enterprises for the installation of camps, are disturbances that propitiate blowouts and changes in dunes topography, making them more vulnerable to other forcing mechanisms (e.g., winds and waves). The use of 4 × 4 off-road vehicles on the dunes is also believed to have major impacts on their vegetation, geomorphology, and biodiversity (Louro 2005; Massinga and Hatton 1997). Mega industrial projects, like the construction of ports within the Maputo Special Reserve and Ponta do Ouro Partial Marine Reserve, and titanium mining in the coastal sands of Moma, increase pressure on dunes and beaches (Pereira et al. 2014). The ASCLME (2012) report mentions that coastal



mining – the extraction of aluminium, coal, titanium, zircon, and rutile from sand dunes – is one of the fastest-growing sectors in Mozambique. The report also states that informal sand mining (mainly illegal) is done along the entire coastline. Port infrastructures, and dredging activities for improving navigation channels, groins, and seawalls, induce changes in the local sediment dynamics, causing negative effects in adjacent areas (Langa 2007; Palalane et al. 2016).

Anthropogenic factors, however, are not the only ones putting pressure on coastal ecosystems. Researchers from Eduardo Mondlane and Lund universities point to “waves, tides, tropical cyclones and depressions, fluctuations in the sea level, and long-and short-term climatic variations” (Palalane et al. 2016) as additional determining agents in the evolution of beaches and dunes. The strong wind and storm surges caused by the storms and cyclones that strike Mozambique’s coast often produce massive destruction, causing significant coastal recession, especially affecting dunes not covered by vegetation. These are easily blown by strong wind and migrate inland silting the adjacent freshwater lagoons and agricultural areas, threatening the livelihood of the populations that depend on them (Gove 1997; Louro 2005; Palalane et al. 2016). Changes in the nearshore sediment dynamics, determined by these same natural and anthropogenic factors, are also responsible for increasing erosion rates in certain areas of Mozambique. Coastal erosion is a natural phenomenon that becomes a problem only when human infrastructures are built too close to the beach, since coastline retreat puts them at risk (Freitas and Dias 2017). In the 1970s, for example, part of the structure of the Hotel Tofo Mar, in Tofu Beach, Inhambane, collapsed due to severe coastal retreat (Palalane et al. 2016).

### ***(Trans)regional solutions, (trans)national problems***

A 2011 report from the Mozambican Ministry of Environment recognised the relevancy of dunes as natural barriers against the sea, habitats for biodiversity, freshwater reservoirs, tourism attractions, and the basis for the lighthouses. The report also stated that these ecosystems should be preserved so the next generations could benefit from dunes covered with vegetation, offering shelter from the sun, fruits, wood, charcoal, honey, and diverse fauna, providing groundwater and supporting ecotourism. To achieve this, the dune forests could not be cut down and had to be rehabilitated; paths could not be opened or infrastructures built (Balidy and Jacinta 2011).

In the 21st century, Decree 45/2006, on Protection of the Marine and Coastal Environments, acknowledged the dunes as fragile ecosystems, easily degraded and difficult to recover. Only basic infrastructures – water and power supply, telephone and sewage facilities – can be built on them. Access to the beach is a public right, yet paths cannot put the dunes at risk or potentiate erosion (Conselho de Ministros 2006). In spite of the protection conferred by regulation to primary dunes and beaches, including special licences to infrastructure development and the prohibition of driving on the beach, Pereira et al. (2014) assured that law enforcement and compliance were almost non-existent throughout Mozambique.

More recently, the National Forest Plan setting the strategy for 2019–35, promoted the rehabilitation of degraded areas, dune stabilisation, and urban afforestation as a goal to reinforce resilience to climate change and natural disasters. The Plan announced the purpose of stabilising 50,000 ha of coastal dunes in two decades (Mitader 2019). A year later, the 2020 Forest Policy, recognising the threat upon the Mozambican forests, approved

several measures to protect and rehabilitate them. Goal 2, connected to economic growth, sets the target of having, in a period of 6–12 years, new plantations with the purpose of mitigating the impacts of environmental degradation. This is to be achieved by stabilizing dunes and watersheds, restoring degraded areas and regions subject to erosion, promoting activities to reduce greenhouse gases, and minimising global warming. According to this policy, forests in areas of public and scientific interest – like the dunes – fall under state protection and management (Conselho de Ministros 2020).

These laws follow an international trend that recognises dunes as highly valuable ecosystems, for the multifunctioning services they provide related to nature conservation, recreation, freshwater catchment and coastal defence (Heslenfeld, Jungerius, and Klijn 2004). This is neither original nor specific to dunes; ideas and values regarding ecosystems and species change over times: the Caribbean climate went from deadly to healthy; oceans moved from dark void spaces to blue full-lived deeps; whales, the monsters of the past, are now iconic wonders. The characteristics of these environments or species are no different from what they used to be. The main modification occurred in societies, within “culture, ideology, economics, politics and social relations” (Carey 2011: 141). Moreover, even in the same period there are crucial variations. For instance, most European and American dunes were stabilised by afforestation programmes and/or have been lost progressively due to erosion and urban development in the 20th century. This is not the case in Mozambique, where the dunes are still in a relatively natural state. Coastal dunes in Europe and the United States have become open-air recreational spaces for walking, cycling, and enjoying nature. They are also used as protective barriers against sea flooding and, for that dune rehabilitation programmes (including sand beach nourishment) are being implemented. Stabilisation is applied only selectively, since mobile dunes are now considered as part of the natural successional landscape and should be allowed to function normally. Furthermore, western countries are available to pay for the high costs of dune management, which have been politically and socially accepted (der Meulen, Bakker, and Houston 2004; Heslenfeld, Jungerius, and Klijn 2004; Martínez, Maun, and Psuty 2004).

All these aspects point to a scenario that is very different from the reality in Mozambique, where coastal deforestation and dune resources use/destruction are linked to poverty, basic needs, abrupt population growth and displacement, small-scale agriculture, and the demand for firewood and charcoal. In fact, many of the people interviewed by Inês Raimundo in Xai-Xai were aware of the impact of overexploitation on their environment: “As far as I know, there is no rain because we cut trees for charcoal production”. The reason why they keep doing it is simple and difficult to stomach: “We are involved in the charcoal business because we are hungry” (Raimundo 2021: 294). Too many hungry people around the world cause local and (trans)regional environmental problems, like cutting down trees and burning charcoal, to expand cumulatively and infiltrate the large (trans)national spheres, reaching planetary impacts.

Meanwhile, global connectivity opened Mozambique, and many other areas worldwide, to foreign investors interested in exploring forest and mining resources, as well as coastal tourism, activities that have major significance to the national gross domestic product and huge consequences to local shores. Recent laws and protection plans are important to restrain the predation of this fragile ecosystem. However, to effectively implement those measures, the country also has to overcome its economic and social constraints. Additionally, coastal dunes in Mozambique (like dunes everywhere) face escalating planetary-size variations: climate change, sea-level rise, alterations in moisture regimes, and sediment supply.

These multi-scale environmental and socio-economic settings menace the capacity of dunes to be responsive to change, adapt, and endure as self-sustaining systems.

This could be the end of the story, but it is not. Dunes have no life or emotions; they are masses of sand grains that come together or desegregate according to circumstances. Dunes will not be victims of human-driven environmental changes, since they are components of enduring coastal systems with their own agency to abide to the new conditions. The more certain sufferers will be the human and non-human populations, whose subsistence depends on the continued existence of present-day coastal environments and their life forms, and who will not be able to adapt as quickly as the situation will demand.

### **Final remarks**

In this chapter, dunes are key elements; as long-lasting non-human agents within socio-historical contexts, dunes showcase the attempts of the Portuguese empire to control colonial environments, the pressure of poverty upon natural ecosystems, the present divide between exploring and preserving resources, and the local and global scales of problems and solutions. Each dune field is unique in its characteristics, its processes of change, and, in its relationship with other elements, its co-agents in the making of local worlds. Each have singular eco-socio-historical contexts, which are not reproducible or shared. Yet, dunes also transcend the regional and national frames, as part of eco-cultural networks of knowledge and practices linked to what humans think dunes should be and serve for. Moreover, within the conjuncture of the global anthropogenic pressures and environmental changes, dunes worldwide face common challenges and threats.

To do the history of dunes is to follow these manifold trajectories of change and those involved, over the long run. Historians can call up the dunes in the archives and use them as proxies to retrospectively see the natural and the social environments that produced them (the material dunes and the paper ones). However, historians do not have the skills to unfold the complete story, as they do not master the knowledge on all the beings, things, and phenomena that exist and thrive beyond human reach. In this chapter, distinct types of expertise came together to present a multi-perspective narrative that meshes the science of coastal dynamics and dune physical and biological features; the human geography of Mozambique, based on fieldwork observations of the consequences of the country's recent history on its people; the colonial setting, the role of experts, and knowledge transfer to solve some of the problems of the Portuguese settlement on the coast; and, the outlook of Mozambican dunes from a global angle, connecting past concerns on sand drifting and present anxieties about dunes conservation. This transdisciplinary collaboration activated other ways of thinking and perceiving the potential of the stored information, making possible to apprehend phenomena of largely different spectrums under the same critical examination, revealing many inconspicuous relations, disentangling the plural interconnected agencies that lie within and beyond the sand dunes.

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