Summary

The motive

The Banc d’Arguin plays crucial role in both flyway and swimway contexts. It is a home for the largest wintering shorebird concentrations in the world and the largest breeding seabird colonies in Africa. It is also the most important fish nursery in the region including endangered species. The Banc d’Arguin contains the largest intertidal seagrass beds in Africa and one of the most pristine along the East Atlantic Flyway. It is the only know fossil estuary in the world.

The objectives

Despite their important ecological values, the seagrass beds of Banc d’Arguin, however, have received little attention compared to the more northern meadow along the Flyway, if only for the lack of resilience studies. The central goal of this thesis was to gain more understanding into the functioning of seagrass beds in Banc d’Arguin, with a focus on seagrass dynamic and resilience. To do so, I aimed to (i) first assess seagrass dynamic history using long-term Landsat imagery and compare benthic community structure (biomass, species composition) and secondary productivity (P/B) between historical (1986) and recent (2014) large-scale benthic surveys; (ii) study the effect of hydrodynamic on seagrass stability, morphology, nutrient-content, and its response to nutrient overload; (iii) assess the recovery potential of seagrass after disturbance along an intertidal elevation gradient and identify the main environmental factors affecting the recovery rate; (iv) investigate the underlying mechanisms driving the functioning of the mosaics of Banc d’Arguin; and (v) study waterbird populations dynamics over the last four decades in Banc d’Arguin and discuss possible drivers of changes.

The main findings

In chapter 2, we found compiling evidence of a large-scale benthic community shift from polychaete to bivalves dominated intertidal flats, in concordance with twofold increase in seagrass cover. This shift resulted in a substantial decrease in the secondary production as well as important prey items for shorebirds. These outcomes add further concerns to the future of shorebirds along the East Atlantic Flyway; beside the loss of habitats the loss of favourable food items appeared to be an important aspect that should be taken into account for future conservation and management measures.

In chapter 3, we found that hydrodynamic gradient had strong spatial and temporal effects on seagrass nutrient-status and stability, with increasing nutrient limitation and stability with increasing wave energy. We found also that the magnitude effect of nutrient addition on seagrass varied tremendously across the wave-exposure, with the most exposed site being most sensitive to biomass
loss due to fertilisation and the sheltered one being least sensitive. The results also suggest that the intertidal seagrass beds of Banc d’Arguin are N-limited to a large extent.

In chapter 4, we found evidence for a critical slowing down response in Z. noltii along a desiccation gradient at the southern edge of its range. The results revealed that the Z. noltii in Banc d’Arguin has a low capacity to recover after die-off events, providing a clear sign that these meadows are on the verge of tipping points especially higher on the intertidal gradient. We also experimentally illustrated that the recovery was size-dependent and identify perturbation size as a new dimension that should be considered for future critical slowing down assessments. Finally, assessing critical slowing down along intertidal elevation may provide a good indication of vulnerability of seagrass to desiccation stress and extreme weather events due to global warming. At Banc d’Arguin, the slowing down along the elevational gradient is likely to manifest itself in an elevation-related loss of resilience and a decreasing capacity of the higher intertidal flats to withstand disturbances.

In chapter 5 we empirically demonstrated that the mosaics of Banc d’Arguin are the result of three-way biogeomorphic engineering loops between flamingos, crabs, biofilms and hydrodynamics. This feedback loop can be considered as the first marine example of ecological autocatalytic loop, where flamingos and crabs on one side and biofilms on the other mutually promote resource recycling and productivity. This chapter highlighted that many ecological interaction can only demonstrated in pristine habitats where animals can still live in harmony.

In chapter 6 we compiled six complete counts since January 1980 with additional yearly counts made in a subunit (Iwik region) since 2003, and presented evidence of changes in waterbirds community composition in the past four decades. Our results suggest a general decline in species that are dependent on the intertidal mudflats for feeding and an increase in species depending on fish and shrimps in the sublittoral and the offshores.

Directions for future research: what is still missing?

This thesis answered some fundamental questions in intertidal ecology especially with respect to subtropical seagrass resilience. As is the rule in science, several questions, remain unanswered even though they may be key to the conservation and understanding of Banc d’Arguin ecosystem. Here, I suggest future directions for research and long-term monitoring programs to better protect the area.

Seagrass clearly is very dynamic with consequence on ecosystem functioning such as benthos species composition and productivity (chapter 2). The causes of the observed seagrass change are quite well, but certainly not fully understood. The response of benthic community to seagrass change was based on only two snap-shot surveys rather than a time-series, and this leaves an important gap
about seasonality (Ahmedou Salem et al., 2014) and inter-annual variability at the landscape scale. Furthermore, our benthic analyses did not take into account the large African bloody cockle Senilia senilis, which limited our understanding to the observed benthic community shift and seagrass dynamic. In fact, assessments of the role of this abundant species in the functioning of the system are still lacking. For example, it is so far not clear what the drivers of Senilia abundances are? And what is the effect of Senilia dynamic on seagrass, Loripes, and Dosinia population dynamics?

The recovery experiment was conducted on one site (chapter 4) without taking into account the effect of hydrodynamic, sediment type, and nutrient states. These factors appeared to play important role in seagrass resilience (chapter 3). Thus, to make better prediction about seagrass recovery at the landscape scale, the study should be replicated on contrasting hydrodynamic forces sites.

Finally, the results of waterbird populations’ changes highlight also the need for regular and long-term research and monitoring plans to better understand waterbird dynamics, with the birds give us a window of observation and understanding the sustainability of the Banc d’Arguin ecosystem. Banc d’Arguin managers should strive to have long-term monitoring programs that include biological (birds, mammals, benthos, seagrass, and phytoplankton) and physical (temperature, wind, sedimentation, nutrient fluxes, and turbidity) indicators. Our current understanding to the functioning of Banc d’Arguin intertidal flats is based notably on the efforts of a group of Dutch scientists from NIOZ Royal Netherlands Institute for Sea Research and the University of Groningen, who keep on organising annual expeditions since the 1980s. Furthermore, the IMROP long-term monitoring to fisheries is now put to good use and should considerably improve our understanding to the fish dynamics in Banc d’Arguin (Lemrabott in prep.).

The area, however, will greatly benefit from long-term assessments of its benthic and avifauna as well as the main prevailing abiotic conditions. Giving the ongoing decline along the flyways, waterbirds in Banc d’Arguin should be subjected to a long-term mentoring program “IMROP style” with fixed researcher “enquêteurs” on the ground. Also the Dutch-Mauritanian monitoring program to the Mauritanian Spoonbill Platalea leucorodia balsaci has helped in understanding its environmental requirement and attempts to improve the breeding success of this endemic subspecies (Piersma et al., 2012). The Mauritanian Grey Heron Ardea cinerea monicae, another endemic subspecies, has a conservation status that is not known. It is of great concern that there is hardly any information on their ecology and an urgent ringing program is needed to assess their population state and survival.

In offering this thesis for public defence, I am also offering my commitment to help reach all these goals. I believe that the Parc National du Banc d’Arguin has the potential to become the
international hub for evidence-based coastal conservation efforts and be part of the ‘planetary’
monitoring of our connected global ecosystems that should be all’s concern.