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Coastal erosion in the Comoros: How are perceptions and risks of maladaptation linked?

Coastal erosion and marine flooding today pose a major challenge for the Comoros and are likely to increase in the future. To cope with this, the local population mainly favors “hard” adaptation by stabilizing the coast, in particular through seawalls. However, this approach appears to be rather ineffective and sometimes proves to be maladaptive. What accounts for this preference? What would be the alternatives? To answer these questions, a sociological study has been conducted, focusing on the perceptions of local stakeholders.

On the three islands[1] that make up the Comoros, coastal erosion, meaning shoreline retreat, is a major problem. The archipelago is one of the countries in the world most at risk of losing its sandy beaches. It is estimated that 45% of them have already disappeared (Union des Comores, 2016). The perceptions that local stakeholders have of these changes and the measures taken to cope with them are a key factor in risk anticipation and management, as they strongly influence the motivation to adapt. The sociological study by Klöck (2023) addresses this issue of perceptions, both of the causes of coastal erosion in the Comoros and the effectiveness of the current protection measures and possible alternatives. This study is based on a literature review, semi-structured interviews with local experts, and a field survey[2] among the population conducted on five sites located on two islands (Fumbuni and the neighboring villages of Hantsindzi and Ndrude in Ngazidja; Niamachoi and Hamavuna in Mwali). We present the main findings here.

[1] This study focuses on the three islands Ngazdija/Grande Comore, Mwali/Mohéli and Ndzuani/Anjouan.

[2] The field research was conducted in July 2022.

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Coastal erosion, a threat for the Comorian population

The surveys, literature and interviews all identify two main causes of coastal erosion in the Comoros: sea-level rise, caused by global warming, and local human pressures, meaning local human activities that cause or increase erosion. Reliable data on sea level rise in the Comoros are scarce, as there is no *in situ* measurement or continuous monitoring. According to the Nationally Determined Contribution, the mean sea level has increased by about 20-25 cm over the last 100 years. This increase is continuing and accelerating and has now reached 4 mm per year. The additional rise by 2050 is expected to be about 20 cm. Furthermore, cyclones are expected to become more powerful and their paths less predictable. At the same time, human pressures, in particular sand mining on the beaches or near the coast, increase coastal erosion. While the extraction of sand and any other marine and coastal materials (rocks, corals) has been strictly prohibited since 1994, in reality, the population still widely uses marine sand for the construction of houses, as the alternatives, such as crushed sand produced by grinding up volcanic rocks of the archipelago, are too expensive for much of the population.

The housing sector is therefore a major cause of coastal erosion, but it is also highly vulnerable to coastal hazards. Both the Comorian population and the country's infrastructure are highly concentrated in coastal areas at risk. The constructions are of low quality, as shown by Cyclone Kenneth in 2019, which destroyed a large number of houses. While they have been rebuilt, this reconstruction has often been rushed, resulting in lower quality. This has therefore increased vulnerability, which is set to increase further in the coming years due to the high population growth in the Comoros. In the absence of urban planning and better spatial management, the number of slums and households in risk areas is increasing. Both the exposure of the population to coastal hazards and human pressures on natural resources are therefore likely to increase. Consequently, between 10% and 20% of the population may be forced to relocate by 2050, according to estimates by the World Bank (2019).

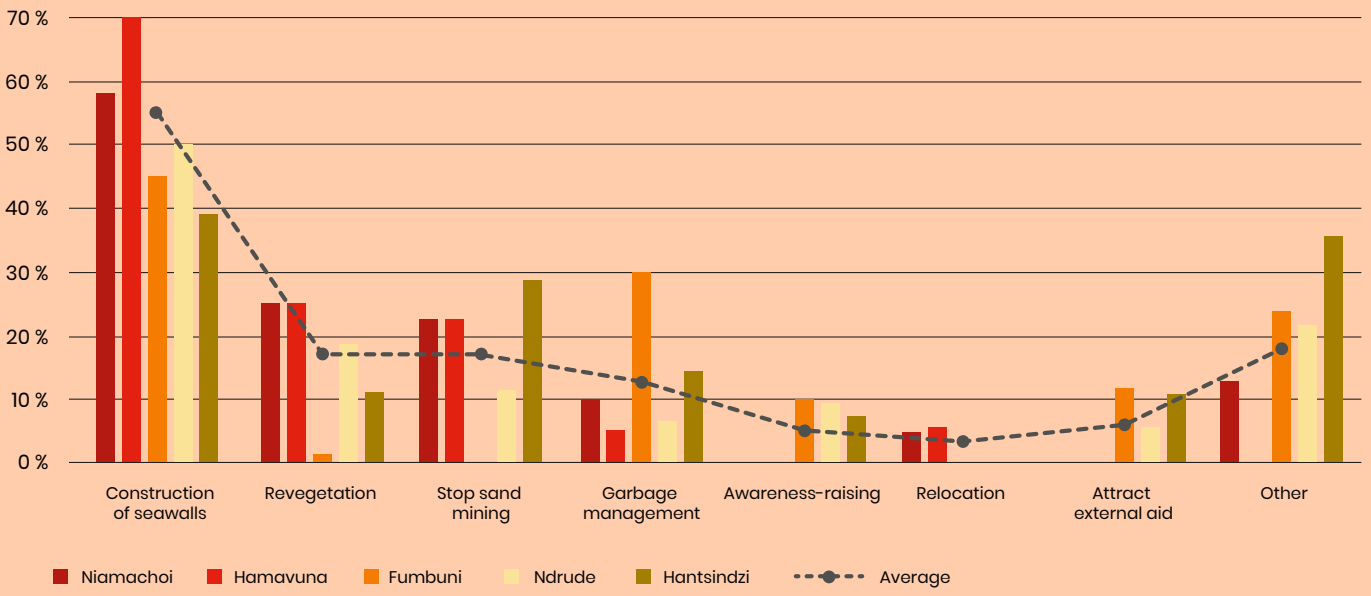
The Comorian population is aware of the problem of coastal erosion, which causes "coastal villages (...) to disappear" (interviews). Sea-level rise is described as "worrying" by most of the respondents. Between 59% and 82% of the respondents say that they feel "somewhat" or "very" exposed to coastal hazards, in particular to coastal flooding. Niamachoi and Fumbuni are two sites where the respondents feel very exposed. In both cases, the seawalls that had been built collapsed during Cyclone Kenneth.

Predominance of "hard" coastal protection: a maladaptation?

Seawalls are the dominant response to coastal erosion in the Comoros, even if they have no effect on sand mining and can prove to be maladaptive. Indeed, seawalls are often poorly built and put in the wrong place. They consequently have a short lifespan and often collapse shortly after their construction, as is the case in Niamachoi and Fumbuni. Some seawalls are even built with sand and corals from the beaches they are supposed to protect, which exacerbates erosion. Villagers "destroy while protecting. Or they protect while destroying" (interviews).

For these reasons, in island environments like the Comoros, seawalls are often classified as "maladaptive" measures (for example, Nunn *et al.*, 2021). Despite this negative assessment by scientists, and despite the collapse of the seawalls in Niamachoi and Fumbuni during Cyclone Kenneth, a large proportion of the Comorian population remains in favor of "hard" adaptation: 85% of the respon-

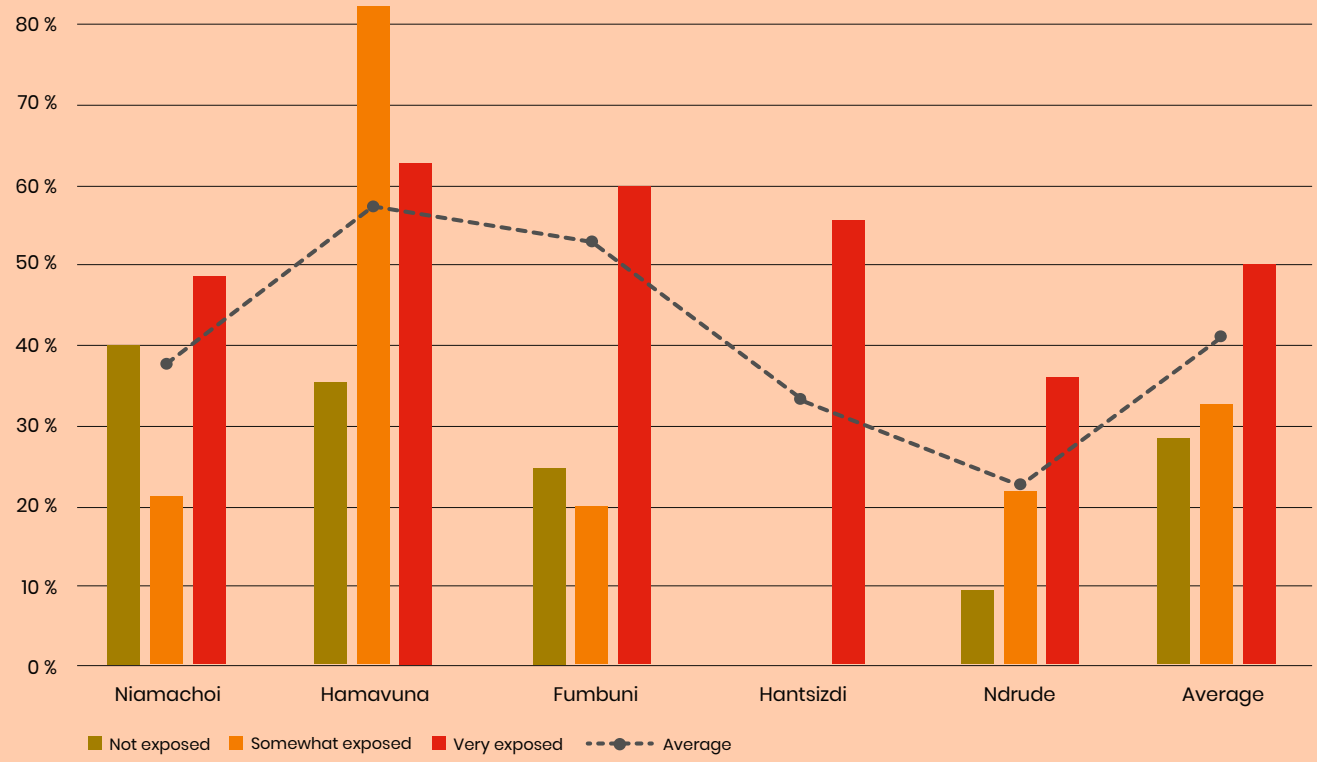
Figure 1: Measures proposed by respondents to tackle coastal erosion, by site.



SOURCE: PREPARED BY THE AUTHOR.

N.B.: RESPONDENTS COULD PROPOSE MORE THAN ONE MEASURE

Figure 2: Percentage of respondents having considered relocation, by degree of exposure and by site



SOURCE: PREPARED BY THE AUTHOR.

dents believe that seawalls are a sustainable solution to coastal hazards, and 55% propose this solution when asked what they would do to control coastal erosion (Figure 1). These figures may seem paradoxical, as the respondents mainly attribute coastal erosion to sand mining (56% of the respondents on average), which seawalls have no control over. This factor is mentioned more frequently than sea-level rise – 51% of the response on average (Note that the respondents could select more than one response to this question).

Alternative measures, such as planting coastal vegetation, stopping sand mining, or garbage management,[3] are mentioned less frequently: 17%, 17% and 13%, respectively, of the respondents propose these measures. There are already a few examples of softer approaches, such as the "wooden seawall" in Hamavuna, a sort of breakwater made of tree trunks. However, these measures appear to be less known and less approved by the population than hard coastal protection via seawalls.

A softer approach is also favored by the experts that were interviewed. They mostly share the view that "hard" coastal protection is maladaptive. Seawalls are described as "investments with regrets" that should be "struck off the agenda". According to the experts, it would be better to turn towards more varied forms of adaptation, for example, by using rockfill dikes rather than vertical seawalls, or focusing on revegetation by planting mangroves and other coastal plants. A combination of these measures is also conceivable. In addition, there is a need to raise public awareness of the negative effects of seawalls and apply existing laws and regulations, in particular concerning the prohibition of sand mining.

Whatever the protection measures envisaged, it is clear that it will not be possible to protect certain areas against erosion and floods. In the long term, part of the population will inevitably need to be relocated. This is a sensitive issue, in particular due to the strong attachment to villages in Comorian culture. But this more radical response would appear conceivable, at least for some of the respondents: in the surveys, five people specifically suggest relocation as an adaptation measure (two in Niamachoi, three in Hamavuna); 44% of the respondents also say that they have already thought about relocation. This percentage rises to 50% among the respondents who consider themselves to be exposed to climate hazards. In Hamavuna, as many as 82% of the respondents who feel somewhat exposed, and 63% of those who consider themselves very exposed have already considered moving (Figure 2).

[3] Garbage management could improve the health of coastal ecosystems in general, but would have no effect on coastal erosion.

Lack of capacity for adaptation

The predominance of "hard" coastal protection and the lack of alternative measures are therefore partly due to perceptions. But means and resources also restrict adaptation: governance, financial resources and technical expertise are all essential for the implementation of effective and sustainable adaptation strategies – and are all weak in the Comoros.

Indeed, the Comoros is characterized by weak state institutions. They do not have the financial or human resources to implement laws, plans and programs for adaptation or environmental protection. In addition, according to the interviews, the Government is not very responsive to ecological issues and has relatively little interest in long-term solutions. State presence in the villages is also weak.

The lack of financial resources also poses a challenge for the Comorian State, which "has no budget for the environment" (interviews). Both adaptation and institutional functioning itself therefore rely on external financing. This external financing mainly arrives in the form of projects, which tend to have a short lifespan and are not sustained: "The projects address emergencies and have a limited duration of five or at most seven years" (interviews). This is partly related to the problems of governance mentioned above. There is also little or no ownership of the projects by the Comorian Government and local population. As an expert explains in an interview: "They [the authorities] will undoubtedly tell you that 'it's a project of AFD, the World Bank', but they'll never say that 'it's a Comorian project'. And this is where the mistake lies."

The respondents also regret the lack of monitoring and evaluation, especially in the long term. Consequently, in many cases, the projects do not lead to tangible and sustainable results: "We've had a lot of projects in the past, billions of francs have been spent here, but without leaving a trace" (interviews).

Finally, this lack of concrete results is related to human resources and technical expertise, which are both limited. As shown by the surveys, the various possible measures to address coastal erosion are not well known and their respective strengths and weaknesses hardly understood. This lack of knowledge and expertise is also seen among decision-makers, in particular at the local level, which is key for adaptation: "The municipality's staff are not up to the task. They don't have a very good understanding of the issue of climate change, they don't understand the risks" (interviews). The experts interviewed therefore stress the need for awareness-raising, education and the dissemination of information.

This is also one of the findings of this study. To diversify the responses to coastal erosion, it is necessary to strengthen (i) capacities; (ii) local structures; and (iii) project monitoring and evaluation. The need to raise awareness, train and inform seems crucial, especially at the local level. This will need to involve direct exchanges, which are more accessible and understandable by the local population, rather than written reports and documentation. Local structures, such as village associations, play an essential role. To involve them more, it is necessary to both strengthen their capacities and facilitate their access to financing, not only to implement adaptation projects, but also to reduce socio-economic vulnerabilities. Finally, long-term monitoring and evaluation is necessary to ensure that projects are implemented and lead to tangible and sustainable results.

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