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Institutional, regulatory and socio-economic factors limiting the success of mangrove restoration policies in the Biosphere Reserve of the Saloum Delta, Senegal

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Abstract: *The mangrove ecosystem of the Biosphere Reserve of the Saloum Delta (Réserve de Biosphère du Delta du Saloum, RBDS) in Senegal is subject to continuous degradation of its potential from the combined action of natural and anthropogenic factors, causing the reduction of its ecological and socio-economic functions. Despite policies for sustainable management and restoration initiated and adopted since the late 1990s and early 2000s, this study nevertheless finds that mangrove regression is ongoing. It is thus timely, and more than ever necessary, to evaluate the institutional, regulatory and socio-economic factors that have limited the expected success of these policies and strategies for mangrove restoration in the RBDS. This study adopts a scientific approach that integratesa documentary review and field work involving focus groups and interviews with local communities. The results reveal that ineffective implementation of the texts governing mangrove management constitutes a major barrier to mangrove restoration. In addition to this, stakeholders involved in restoration projects perceive the projects' collaborative approaches as unsatisfactory, resulting in a lack of synergy and sharing of efforts. Finally, the fragile socio-economic situation of the Sine Saloum region also encourages overexploitation of mangrove resources.*

Keywords: *Politics, mangrove, degradation, restoration, synergy, Saloum delta*

Résumé

L'écosystème mangrove de la RBDS subit une dégradation continue de son potentiel sous l'action combinée de facteurs naturels et anthropiques conduisant à la réduction de ses fonctions écologiques et socio-économiques. Malgré les politiques de gestion durable et de restauration initiées et adoptées depuis la fin des années 1990 et le début des années 2000, la régression de la mangrove est toujours obervée. Il est donc opportun, et plus que jamais nécessaire, d'évaluer les facteurs institutionnels, réglementaires et socio-économiques qui ont limité le succès attendu de ces politiques et stratégies de restauration de la mangrove dans la RBDS. La démarche scientifique adoptée intègre une revue documentaire et des travaux sur le terrain par des focus groupes et la réalisation d'entretiens avec les acteurs locaux. Les résultats montrent que la mise en application effective des textes régissant la gestion de la mangrove constitue une difficulté majeure. A cela s'ajoute la perception sur les approches des projets jugées mauvaises par les acteurs en terme de collaboration, ce qui se traduisent par un manque de synergie et de mutualisation des efforts sans compter la situation socioéconomique déjà fragile de la région du Sine Saloum favorisant une surexploitation des ressources de mangrove.

Mots clés : *Politique, mangrove, dégradation, restauration, synergie, delta du Saloum*

I. INTRODUCTION

In Senegal, mangroves are located in the Casamance estuary, the Saloum delta, the Petite Côte region (Joal and Somone) and the mouth of the Senegal River, covering an estimated 200,000 hectares [1]. These mangrove ecosystems are of interest to many different groups, due to their biological diversity and complexity[2]. In Senegal, halieutic resources and wood products in and around these ecosystems are intensively exploited to clear rice-growing land and meet demands for industrial and domestic firewood, endangering mangroves to a worrying degree.

Added to this is the decline in rainfall noted during the 1970s, whose effects on mangroves are still visible (CSE, 2018). Furthermore, roads built in the area block the circulation of water in some parts of the delta, leading to deficits in the supply of soft water and the fine solid flows that maintain the mudflat [3].

RBDS is subject to this degradation process. It is located in central-western Senegal in the Sine Saloum natural region, between 13°35 and 14°15 north latitude and between 16°03 and 16°50 west longitude. It covers an area of 234,000 ha and combines the characteristics of marine, estuarine, lacustrine and palustrine wetlands, and its various sites fulfill the classic functions of a wetland (ecological and socio-economic). It is located on the Senegalese coast about 150 km south of Dakar (Fig. 1). The Saloum, which forms an inverted estuary, is a true inlet bordered by vegetation characteristic of coastal areas, in particular mangrove forest [4, 5].

The Saloum hosts the northern margin of the mangrove swamps of the Southern Rivers [2]. The region's elevation does not exceed 40 m and is marked by low slopes, which explain the upwelling of the sea and a predominant marine influence. Tides reachup to more than 100 km inland. Salinity is very high (higher than sea water, estimated at 35g/l) and is a limiting factor for the growth of vegetation [6]. Surface water resources are characterised by the Saloum drainage basin, whose main direction of flow is from east to west (Kaolack to Foundiougne). It originates in Kaolack, where the depth of water in relation to the ground is often greater than 8 m. With a length of about 120 km, the Saloum divides into distributaries of low slope that dry up during the dry season beyond Kaolack[7,8]. To the southwest is the Nema watershed, with an area of 50 km^2 over a length of 11 km [9]. The uninterrupted rainfall deficit from 1970 to 1999 greatly modified its functioning. The Saloumis an important natural resource system, providing space and living and non-living resources for human activities since the early days of civilization [10].

As sources of many natural resources (fuel and fire wood, oysters, arches, etc.) and an important breeding ground for many fish species, mangrove ecosystems serve socio-economic and ecological roles for the Sine Saloum natural [3]. They provide food through fishing and shellfish harvesting, which are critical for local subsistence and income generation, as well as serving as wind breaks, breeding and refuge areas for fish and bird species, and sources of sediment fixation.

However, the mangroves in the RBDS have continuously degraded [2] despite the restoration policies initiated and adopted since the late 1990s and early 2000s. Various mangrove preservation and restoration programmes have been undertaken, initiated by the local populations, the State, various donors and NGOs. These programmes include initiatives by the West African Association for Marine Environment (WAAME), the International Union for Conservation of Nature (IUCN),Océanium(a Senegalese environmental NGO), the World Wide Fund for Nature (WWF), Wetlands International Africa (WIA), *Aide au Développement Gembloux* (ADG), and others. In addition, other programmes are coordinated by the National Parks Department (Direction des ParcsNationaux, DPN), the Department of Community-based Marine Protected Areas (Direction des Aires Marines Protégées Communautaires, DAMPC) and the Department of Water and Forests, Hunting and Soil Conservation (Direction des EauxetForêts, Chasse et Conservation des Sols, DEFCCS) [11]. These various governmental and non-governmental entities have recommended and implemented a number of management policy orientations, such as introducing biological rest periods and rotation in the collection of marine invertebrates. In addition, an institutional framework has been set up to ensure the sustainable management of renewable resources and the restoration of the ecosystem through reforestation and/or assisted natural regeneration – the aim of which is to return environments degraded by man and/or nature to their original natural state. In spite of these policies, mangrove degradation remains a serious issue in the RBDS.

In this context, this study examines the institutional and socio-economic limiting factors of mangrove restoration policies and programmes undertaken in the RBDS. It assessed the legislative, regulatory and institutional frameworks governing mangrove management, and the mode of intervention of projects and programmes in relation to the socio-economic situation of the area.

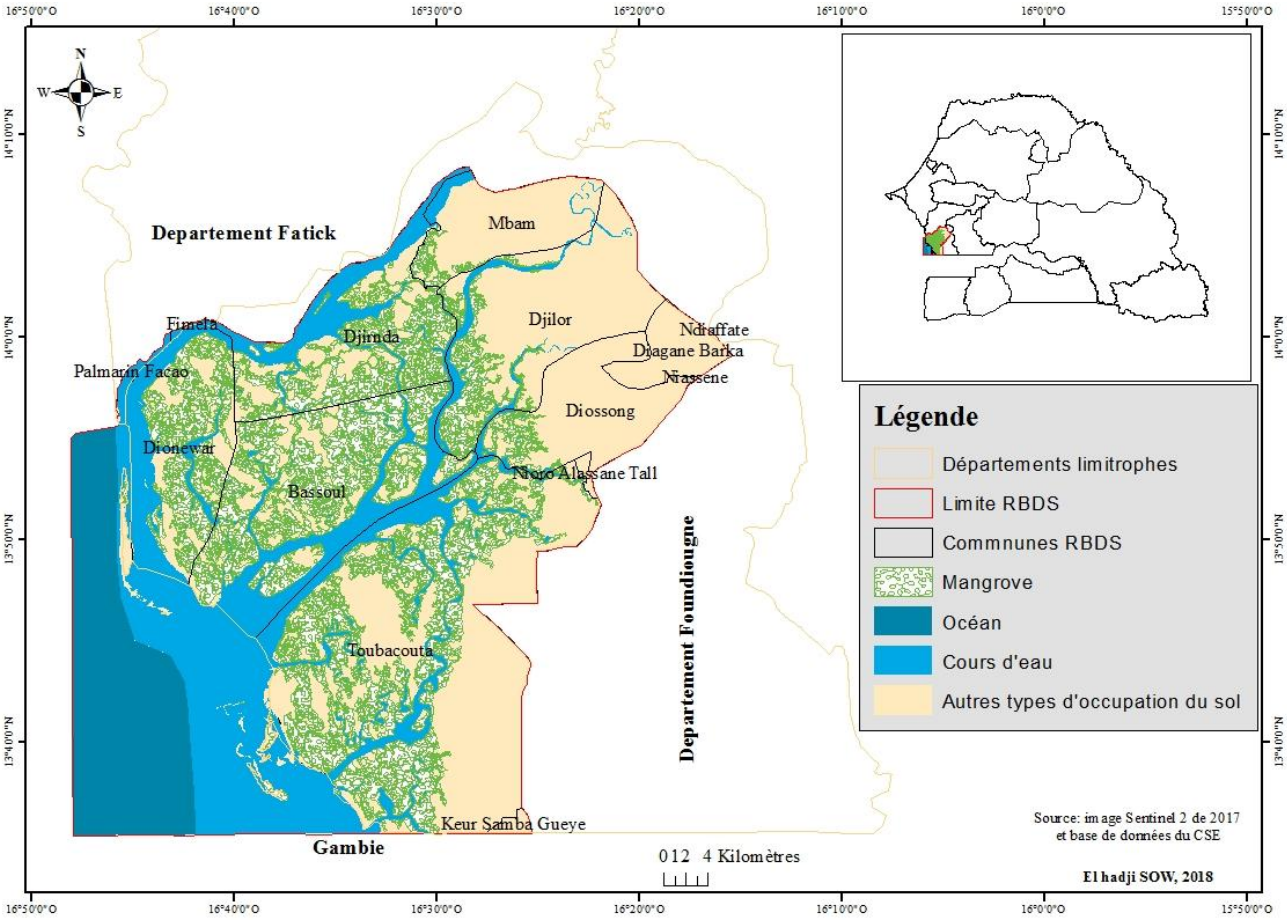

Fig 1. Location of the Biosphere Reserve of the Saloum Delta

As shown in Figure 1, the RBDS is a large area in the west of Senegal, very vulnerable with regard to its level of exposure marked by the massive presence of water.

II. DATA AND METHODS

Data was obtained via documents relating to the management of natural resources, particularly mangroves in Senegal, including the Constitution, forestry codes, local authority codes, and mangrove management plans. These were supplemented by reports on various programs and projects on mangroves and the latest report of ANSD (2013) on the economic and social situation in the Fatick region. In addition, surveys (6) and interviews were conducted with local actors, technical services and program agents.

Document analysis and literature review focused on the various institutional measures regulating the use of natural resources in general and mangroves in particular. This review also facilitated an appreciation and understanding of the different achievements of projects and programmes. Next, project limitations were analysed, focusing on organisations' modes of intervention, as well as on shortcomings noted in policy documents. In addition, these documents were used to analyse the socio-economic situation in the study area.

Field data collection was based on a survey administered to local populations, local authorities and organisations involved in mangrove restoration. Surveys administered to the local population focused on assessing their degree of knowledge and involvement in mangrove restoration and management. The questionnaire included five themes, as follows: 1) the current status and evolution of the RBDS mangroves; 2) factors in mangrove dynamics; 3) factors driving mangrove restoration policies; 4) mangrove restoration strategies; 5) the strengths and weaknesses of restoration policies.

For the authorities and entities involved in mangrove restoration and conservation, the themes of the questionnaire were as follows: 1) restoration policies adopted by the organisations; 2) the techniques and approaches used; 3) the strengths and weaknesses of the restoration policies; 4) the socio-economic situation of

the department of Foundiougne; 5) different institutional measures for natural resource management; 6) various mangrove management and development plans established in the region.

Field data was collected first in April 2018, in the form of surveys, and then in January 2019 in the form of semi-structured individual interviews and focus groups.

Individual structured interviews targeted the technical services of departments in charge of environmental management, listed above, as well as administrative and local authorities (including representatives of Foundiougne prefecture, municipal councils, and the Foundiougne departmental council), and programme managers (including project coordinators, monitoring and evaluation officers, and facilitators).

Focus groups were aimed at collecting data on the biophysical and socio-economic environment and local people's perceptions of the projects' actions, particularly their impacts and limits. The focus groups targeted village chiefs' representatives, economic interest groups (*groupementsd'intérêteconomique,* GIE)of women fish processors, mangrove resource users, Marine Protected Area (MPA) management committees, and representatives of sports and cultural association (CSA). A total of six (6) focus groups were conducted in six (6) *communes* (districts) (table 1). Participant selection focused on ensuring that all target groups were well represented.

Interviews and focus groupsmade it possible to collect quantitative and qualitative data in order to understand the degradation factors and local mangrove management strategies implemented in the Saloum Delta, but also and above all to assess the perception of local stakeholders on the limits of policies to restore this ecosystem.

Table 1. Summary of targets for focus groups

Municipalities	Villages	Number of representatives per village	Meeting place
Toubacouta	Sipo, Missirah, Néma Bah	4	Néma Bah
Diossong	KeurAliouDiop, BambougarMalick, BambougarMassamba	4	BambougarMalick
Djilor	Bangalère, Félane, Keur Mbar	4	Félane
Mbam	Mbassis, Mbam, Ndorong Log	4	Mbasis
Djirnda	Djirnda, Fambine, Baout	4	Djirnda
Dionewar	Dionewar, Niodior	4	Dionewar

Data was processed using Sphinx and Excel software and was then analyzed to understand the factors limiting the different restoration and conservation actions in RBDS mangroves.

III. RESULTS

3.1. The application of the texts and institutions regulating mangrove ecosystems

An initial review of the various texts governing natural resource management in Senegal has shown that several factors hinder the effective application of the established regulations. In particular, problems arise in relation to forest management by local communities and the application of the forestry code. Thus, these measures are struggling to facilitate the restoration and management of these resources, particularly the mangroves that are the subject of this study.

Numerousgovernmental agencies are involved in natural resource management of mangroves. Even though their main objective is sustainable resource management, the multiplicity of texts and sectors shows the absence of unifying legislation at the national level. This has negative consequences on local people's ability to comply with all the regulations, which are sometimes complicated. For example, Senegal's mangrove ecosystems are codified differently in the legislation for different sectors, as Gazetted Forests (e.g. Fathala), National Parks (e.g. the Salum Delta National Park, PNDS), and Biosphere Reserves (e.g. RBDS), Marine Protected Areas (e.g. Gandoul, Bamboug, Sangomar). These areas are all managed differently. However, the natural boundaries of

these various mangrove areas are sometimes confused and interconnected, which makes it difficult for the texts governing them to be applied and adhered to, especially by local populations.

Unlike national parks and integral nature reserves where no concessions are made, marine protected areas permit certain use rights. These rights are clearly specified in the decrees establishing the management rules or internal regulations for MPAs. In addition, the application of various sectoral codes is subject to the management rules specific to each MPA. This application is strictin the parts of the MPA called integral protection zones or central cores. These are generally critical habitat areas, reef and mangrove areas, and fish nursery and spawning grounds. Here, too, problems arise in raising awareness among local people – especially certain categories of stakeholders, such as fishermen from other areas who sometimes have a poor understanding and knowledge of how MPAs work. These fishermen only target those areas that are known to be very rich in fish. Therefore, in their activities they sometimes do not hesitate to trample the mangrove seedlings that are reforested to serve as a barrier to protect these sites. As a result, the young, reforested seedlings are destroyed by the fishermen's canoes (*pirogues*), leading to social conflicts or altercations with MPA agents and/or surveillance committees.

In addition to this, MPA agents, like those of other government services in charge of natural resource management, have stated that they have difficulty carrying out their functions properly because of often very limited means, especially in these environments where travel is generally by canoe.[1] In addition, the authority of local communities and their elected municipal councils[2] in forest management is very limited due to the legal and institutional particularity of the area, which falls under the diverse classificatory and management regimes of the RBDS, PNDS, and MPAs of Gandoul, Bamboung, and Sangomar. As a result, management is more the domain of technical services (Water and Forests agents, MPA agents and PNDS agents) than that of local governments.

Also, in the case of RBDS, the ecological particularity of the mangrove is not taken into account. Few management measures are designed exclusively for this ecosystem, taking into account its particularity (ecologically and socio-economically) and applied by mutual agreement throughout its area, which is a major shortcoming. Sometimes measures are undertaken and result in management plans, most often with the support of development projects. This is the case, for example, of the mangrove management plans for the department of Foundiougne (2014) and the district of Djirnda (2018), drawn up respectively by the Bundes ministeriumfûrwirtschaftlishe Zusammenarbeit und Entwicklung (BMZ) mangrove project and the Projet de Restauration et de Conservation de l'Ecosystème Mangrove dans la Réserve de Biosphère du Delta du Saloum (PRECEMA). These examples show that some projects are trying to work towards the restoration of this ecosystem, but their efforts are not shared. Each project intervenes separately according to its objectives, among which, most often, is the elaboration of a mangrove management plan, hence a plurality of plans that constitutes a constraint for their implementation. This is attested to by an oyster harvester from Bassoul, who stated in an interview that the multiplicity of management plans in the same territory creates difficulties in mastering the rules, which are often not the same (depending on the municipalities); this leads to misunderstandings, especially with oyster harvesters who usually have difficulty in identifying communal boundaries.

The Foundiougne Departmental Council, in collaboration with Wetlands International Africa (WIA) and others set up a mangrove platform in 2014 to correct this lack of collaboration and synergy between the different interventions and to ensure good coordination of the activities that were in progress, with a view to the efficient sharing of experiences between the different stakeholders. However, this structure was hindered by a lack of communication, insufficient involvement of all stakeholders, and lack of synergy between the different stakeholders, who preferred to work individually. As a result, the platform is still struggling to operate and achieve its objectives, hindering a mangrove restoration initiative in the RBDS that requires the effort of all stakeholders.

3.2. Shortcomings of project intervention methods

In addition to the limitations of the Senegalese government's interventions in mangrove restoration, discussed in the previous section, the projects of non-governmental organizations (NGOs) have also demonstrated significant shortcomings. Since the end of the 1990s, several mangrove restoration projects have been initiated in the RBDSby various NGOs and governmental development agencies, including Océanium, the Japan International Cooperation Agency (JICA), WAAME, PGIES, BMZ, PRECEMA, Wetlands International, the Global

[1] Interview with the head of the water and forest department of Foundiougne
[2] Since the passage of Senegal's Decentralization Law in 1996, authority has been progressively devolved to regional and local levels. Municipal councils of elected local officials represent multiple localities within a district and are granted a certain degree of decision-making power over various matters, including natural resource management. However, the authority of local communities and their municipal councils to manage forests is limited to those outside gazetted domains.

Environment Facility(GEF), Living Better from the Mangrove in the Saloum Delta (*Vivre Mieux de la Mangrove dans le Delta du Saloum,* VIMASA), and others.

These projects have the same main objective: restoration and sustainable management of mangroves and their resources in the RBDS. However, they do not have the same approaches and do not build upon the previous work of other organisations. As a result, local people reported during interviews and focus groups that projects have carried out similar activities in the same site without success. The example of oyster farms[3] is quite illustrative. Among its activities, the BMZ mangrove projectinstalled some of these farms in the villages of Djirnda and Moundé between 2012 and 2015. In these same sites, VIMASA installed other parks between 2015 and 2018, without following up on the previous project's activities. During focus groups with the GIEs of the villages of Moundé, Djirnda, Fambine, Baout, and Keur Mbar in April 2018, oyster farmers affirmed that out of more than 35 parks installed in 13 sites, only 10 are currently functional and only 3 have been used to harvest mature oysters. This is confirmed by project leaders, as well as by volunteers with the forest service. Study participants attributed the poor results of these farms to passing *pirogues* that destroy the garlands and to flood tides destroying some of the wooden posts holding up the garlands are attached. All this is linked to the lack of monitoring of these farms[4]. Consequently, if the goal of these farms was to limit or even stop the cutting of mangrove roots during the collection of oysters, this solution is not sustainable since they have ended up deteriorating.

Another example is the choice of reforestation sites. Most of these sites are concentrated in the district of Djirnda for the insular part of the delta and in Mbam for the continental part, to the detriment of other districts (e.g. Bassoul, Palmarin, etc.) that suffer from the same problems of mangrove degradation. In other words, projects' intervention rationales do not always depend on identifying especially degraded sites but instead on accessibility. In addition, targeted sites are often ecologically inappropriate for the species of mangrove that are reforested. For example, many projects prefer to reforest *Rhizophora mangle*, given the relative ease and low cost of obtaining and planting propagules, and have initiated these efforts even in less frequently inundated inland areas, where *Avicenniagerminans* naturally predominates. Consequently, survival rates of propagules planted in inappropriate soils remain very low. Even though some projects have tried to correct these errors by carrying out prospecting studies before intervening, they rarely mobilize sufficient expertise in doing so.

Moreover, mangrove restoration is not always limited to reforestation. Stakeholders, having understood this, are trying to find other ways to limit the pressure on this resource. These measures include the reforestation of village woodlands, which in the medium and long term should provide alternative sources of fuel and fire wood. The target species are most often eucalyptus, cashew (*Anacardium*) and mesquite (*Prosopis*). However, projects focusing on indicators related to "number of hectares" are more concerned with the area reforested than with the survival of the seedlings and therefore with the position and quality (of the substrate) of the reforestation site, which leads to high mortality. An evaluation of the reforestation sites of two ha of cashew trees in Mbassis (Mbam district) and one ha of *Prosopis* in Bambougar Malick (Diossong district) during a VIMASA project evaluation mission in April 2018 revealed survival rates of 13 percent and 16 percent respectively two years later, with an initial target of 75 percent. These rates are almost the same as those noted in Keur Aliou Diop, Ndorong Log, Mbassis and Néma Bah. Among the factors explaining the non-survival of these plants are roaming animals, increased salinity, lack of water supply, maladaptation of certain species, and, in short, a lack of prior studies.

Apart from the previously noted limitations of mangrove reforestation activities, village woodlots and oyster farming, it is also worth noting the investment support funds (*fondsd'appui à l'investissement,* FAI) initiated by some projects in support of GIEs. These funds provide financing to enable GIE members – especially women – to carry out income-generating activities that do not overuse mangrove resources. Projects implement these activities as alternative solutions for restoring the ecosystem, which has reached a high level of degradation in the Saloum Delta. However, these funds are considered too small and do not meet the needs of all the members, who end up with what one interviewee stated were "meagre shares." During field research in April 2018, out of the fifteen (15) GIEs whose representatives were interviewed, eleven (11) stated that they had received funding from projects, but that the funds allocated were too small. For example, the *Wahme*[5] GIE of Missirah, which has

[3] Oyster farming uses garlands, or strings of empty oyster shells, that are installed along the edges of the mangrove channels (*bolons*). This technique allows the capture of spat (oyster larvae), by replacing the natural substrate on which the oysters are attached (the roots of the mangrove tree species *Rhizophoraracemosa* and *Rhizophora mangle*) with the artificial surface provided by the garlands. During the oyster mating season, the new oysters will settle on this artificial surface rather than on the roots. The advantage of this technique is that the oysters produced are much easier to harvest and the mangrove roots are no longer cut.

[4] Monitoring of the oyster site must be done every two weeks, at low tide. The garlands or collectors must be cleaned and parasites or competitors (such as barnacles) removed to allow the oysters to settle (ADG, 2011).

[5] A word meaning flood period in the local Wolof language.

45 members, only received 1,500,000 F CFA (2.29 euro) in 2017 from a project. This comes back after sharing on average, a sum of 33,000 F CFA (50.38 euro) per member reimbursable in six months. This is also the case of the *Bole Bole*GIE, made up of 30 members who also benefited from 1,500,000 F CFA (2 290 euro) and received average individual shares of 50,000 F CFA (76.33 euro). This financing cannot cover the needs of these women, who shoulder many family responsibilities.

Some even prefer not to take the money, instead continuing their oyster farming activities. Comparatively, there is a large gap between the revenues from oyster aquaculture and those of the *FAI*. Indeed, according to the president of Wahme, each woman harvests an average of 5 kg of fresh oysters per day, earning 10,000 F CFA (12.26 euro) at a rate of 2,000 F CFA (3.05 euro) per kg. However, the funds from which women benefit within the framework of the FAI only allow them to do small trade and the daily income generated does not exceed 1,000 F CFA (1.52 euro). Some women therefore prefer to continue harvestingoysters, despite the drudgery and risks associated with this activity. Consequently, the FAI are still struggling to curb the exploitation of mangrove resources as attested by the representatives of the *JalkiJekk* GIE of Néma Bah in the district of Toubacouta during a focus group.

If these funds are considered insignificant, the same is true for the few market gardening plots set up by projects in some villages to serve as alternative income-generating activities. These are not often monitored and are subject to the effect of animal grazing.

Beyond the aforementioned aspects, all project agendas aim to raise the awareness of mangrove users about the importance of conserving these ecosystems. However, this process is often hindered by certain categories of actors who are not interested in the recommended measures. Most often, it is fishermen who feel that all their fishing sites are closed because of mangrove reforestation. Similarly, herders complain that they have been robbed of their grazing areas by projects that have reforested village woodlands. Beyond these concerns about losing economically important resource bases, fishermen, herders, and others also protest their non-involvement in decision-making. Even when they are involved, their proposals are not taken into account.

3.3 Effects of the socio-economic situation in the region

The region of Fatick has a relatively low economic level, and local people's incomes are based on primary resources: agriculture, breeding, fishing and artisanal processing of fish products, particularly in the department of Foundiougne (which is represented by the study area).

The largely rural Fatick region has a poverty rate of 84.5 percent, which is a limiting factor in mangrove restoration policies which is the main source of income in the Saloum Islands; the unemployment rate is around 28 percent, compared to the national average of 25.7 percent. Formal unemployment is higher among women, at 46.4 percent, compared to 18.8 percent for men. This unemployment rate is more pronounced in rural areas, mainly due to inadequate socio-economic infrastructure, a high illiteracy rate and a lack of planning for increased production facilities [12]. In this region, many localities are still difficult to reach or are practically inaccessible, especially when the seasonal rains render some rural roads impassable. A number of factors have acute impacts on regional poverty, including the increase in household size, the number of female-headed households, the absence and/or inadequacy of income, and access to basic social services. The level of access to basic social services – such as health, education, drinking water, and sanitation – is still largely insufficient.

In this context, women and other vulnerable groups have low levels of participation in the development process, linked to their overloaded work schedules and their non-involvement in training programs. For women in particular, this situation is explained by the lack of infrastructure that would enable them to lighten their domestic workloads. In addition to this domestic work (e.g. childcare, millet milling, water collection, laundry, washing dishes, searching for dead wood and tree leaves, building or repairing houses, etc.), they also earn incomes from work in agriculture and forest product collection. According to a report by the Territorial Approach to Climate Change project [13], the majority of women have not been affected by farm mechanization. So far, they have been only marginally integrated into the agricultural extension program and access to agricultural credit.

The State of Senegal has tried to improve the inadequacies in basic social services with a program known as the Emergency Community Development Programme (*Programmed'Urgence de Développement Communautaire*, PUDC), which provides agricultural equipment, supplies drinking water and repairs road infrastructure. Nevertheless, poverty still persists in the region, leading many to emigrate in search of a better life. Indeed, the region accounts for 2.4 percent of Senegal's international emigrants. This is not insignificant; according to the latest ANSD report (2013), it amounted to 3,883 emigrants, the majority of whom were young

people between 20 and 30 years of age. With the gradual salinization of the land (largely linked to the pressure of the salt wedge on the coasts, as well as coastal erosion), agricultural production is declining; as a result, people have difficulty finding other income-generating activities. They are increasingly turning to mangrove resources – practically the only remaining options as sources of income; this explains the human pressures on and destruction of the ecosystem.

IV. DISCUSSION

The degradation of the mangrove ecosystem in the RBDS has a considerable impact on biodiversity and on the socio-economic activities that depend on it: loss of animal and plant species, poverty, unemployment, etc. In response to this situation, several initiatives to restore the mangroves of the RBDS have been noted over the last two decades.

However, the results remain mixed due to several factors, including constraints for the implementation of the texts governing mangrove management. This ecosystem is managed by several actors from different sectors, including multiple departments within the Ministry of the Environment and Sustainable Development, as well as co-management with local communities and municipal councils. Concerning the technical services in charge of protecting mangroves, their missions are often hindered because of the lack of financial and human resources in this highly coveted territory. As a result, overexploitation of mangrove resources occurs, despite the existence of supervisory committees that support these agents. The management of mangroves requires a pooling of efforts of several actors, due to the complexity of mangrove ecosystem functions, its vulnerability and fragility, and the economic and ecological importance that it has. This should begin with the creation of a legislative and regulatory text for the construction of a legal corpus specific to mangroves. In addition, its application should be the subject of a service that merges representatives from all relevant technical services.

The rights and jurisdiction of local authorities are well specified; this has been the case since the reform of Law No. 96-06 of 22 March 1996 [14] on the Local Authorities Code. This reform gave local authorities more freedom in the management of natural resources in their territories. This freedom is also included in the new decentralization reform in Act No. 2013-10 of 28 December 2013 [15] on the General Code of Local Authorities in Senegal. Thus, local authorities are invited to participate actively in the development of human activities and environmental protection, including in marine and coastal areas. However, the application of the texts governing the management of natural resources is often limited by the illiteracy of some local authorities. In addition, timber traffickers, who are mostly autochthonous to the region, are rarely punished, because of various social and political reasons; namely, local authorities are often unwilling to sanction offenders who are related to them, and are afraid of losing the next election if their constituencies are angry with these punishments.

The powers of these local authorities are therefore constrained by social burdens that hamper the sanctions to which wood traffickers should be subject, since many of the latter are inhabitants of the same localities they administer. Moreover, some of them, even when involved in the process of setting up local measures (management plans, development plans, etc.), find it difficult to enforce them in their areas of administration. This is linked to their limited qualifications, which makes it difficult to convince mangrove users. This is why most elected officials and agents of decentralization have repeatedly expressed a need for training since the implementation of Act 3 of the Decentralization Law in Senegal, initiated in 2013; this is due to the significant progress made in the transfer of authority to regional and local levels, especially with respect to natural resource management.

Some local authorities also feel that present capacity building activities should mainly focus on adaptation measures in the context of climate change and the vulnerability of mangrove ecosystems. This was the opinion of the deputy mayor of the district of Mbam and the president of the environment commission of the departmental council of Foundiougne.

Moreover, even though new policies allowing for the refocusing of the DEFCCS are reflected in the field through advisory support and a desire for close supervision, and even though popular participation in local forest management is now a visible part of forestry activity [16], it must be recognized that this participatory management is blocked by the very limited power of local people. The monitoring committees that have been set up have no power to issue fines or seize illegal products and equipment. They are therefore in perpetual negotiations that rarely succeed. For example, during field research with members of the surveillance committee of the Gandoul MPA, a *pirogue* filled with mangrove wood was stopped in the vicinity of Baout by the agents, and the occupants claimed that it was dead wood (i.e., had not been illegally chopped down), which the agents did not even bother to check.

Finally, there is not yet a good governance charter specific to mangroves. The texts used to manage this ecosystem are generally those applied to the management of natural resources in general. However, as a reminder, mangroves have the particularity of being a mobile forest whose existence is closely linked to that of mud banks [17]. In addition, their functioning depends on three external parameters: regular and abundant supply of fresh water, nutrient supply, and substrate stability[18]. It goes without saying that each of these parameters is in turn linked to a number of other conditions that are generally difficult to study in the field. For example, substrate stability depends on the sediment load, *inter alia*, which is related to the geological nature of the catchment area, land use, regional climate, and other factors.

Moreover, mangrove ecosystems are among the most productive in terms of biomass. This particularity is linked to the fact that these environments provide important wood, fish and shellfish, and other resources for the populations living on the coasts. They are now considered to be among the most economically important ecosystems[17]. In the countries where they exist, the services provided are immeasurable.

In light of all this, their protection is therefore of paramount importance for the balance of the marine biosphere and tropical ecosystems of the islands. They constitute a complex chain of life, where the slightest physical or chemical variation can alter its balance or even destroy it. In the RBDS, this particularity is all the more evident since these ecosystems are almost the only sources of income for the population. They are the basis of multiple social and economic functions, and therefore they are used daily by a large part of the population.

Their management remains complex and requires the pooling of efforts of several actors. These efforts include the elaboration of common texts streamlining the governance of hydraulic works, coastal development and resource extraction, and the use of wood and non-wood products for various uses. This should make it possible to stabilize the water regime, substrates, and nutrients, which play a role in the good condition of these ecosystems.

In addition, most projects and investments aimed at restoring and protecting mangroves have emphasized reforestation. Reforestation actions have been developed in several villages and in theSaloum islands since the 1990s [19]. However, mangrove restoration is not limited to reforestation, because mangroves need a very unique environment located on the foreshore near an estuary, where salt water mixes with fresh water.

According to the Mangrove Action Project [20], it is important to remember that each site to be restored is different and that there will never be a single solution or method to rehabilitate this environment. As a result, local people are generally only aware of what is visible and their direct benefits. They are less attentive to phenomena occurring on a more expansive scale, such as climate change. They are also less interested in rehabilitation, the importance of hydrology and topography, or biodiversity in a general sense [20]. However, raising public awareness on these issues should be a priority for projects and programs. Consultation with local people would also allow for their cooperation and assistance. Because mangrove restoration is not a short-term project, local people should be involved in these projects to ensure their sustainability and successful results. This lack of involvement of local stakeholders is a notable oversight in the project implementation processes in the RBDS.

Finally, as the population of the region is mostly rural (84.5 percent), mangrove resource use is one of the main activities, especially in the Foundiougne department that was the focus of this study. The effective application of the rules for the management of this ecosystem will undoubtedly be marked by feelings of reticence by a population with an unemployment rate of about 28 percent.

V. CONCLUSION

Mangrove management in the RBDS has progressively evolved according to the different legislative acts regarding customary land management systems, community management regulations, local government and sectoral codes, and signed and ratifiedinternational conventions, in addition to the actions of the projects and programs. This complex ecosystem is under the control of several governmental agencies and non-governmental actors. In part because of these different (and sometimes contradictory) forms of authority, the management of mangroves and their resources is still a difficulty in the RBDS. The measures undertaken to restore mangroves are hampered by the multiplicity and complexity of the texts governing the mangroves and the unsatisfactory approaches of the projects, which result in a lack of collaboration and pooling of efforts. In addition, the socio-economic situation in the region is conducive to overexploitation of these resources. Thus, we are witnessing a situation of degradation of the mangrove that these initiatives are still struggling to reverse.

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