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**Sense-making and shaping of temporary wetlands: A socio-hydrological analysis of dichotomous ontologies of *merjas* in Morocco**

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1 **Abstract**

2 There are quite different ways of making sense of wetlands: as wastelands to be drained and reclaimed,  
3 as hotspots of biodiversity to be preserved or restored, or as hydrosocial territories in which people live  
4 and produce. We argue that such ontologies not only represent ‘a reality out there’ but help bring this  
5 reality into being by shaping the way wetlands are developed and used. The present study was conducted  
6 on temporary wetlands (*merjas*) in the Gharb plain (Morocco). Using a socio-hydrological approach,  
7 this research probes the origin of these ontologies and how they shape field realities. Qualitative data  
8 were collected during field surveys and focus groups and hydrological data were obtained by remote  
9 sensing. There are two main ways of seeing merjas that have led to two different enactments – a ‘State’  
10 one, that has drained and developed the land and re-distributed it to farmers of its choice; and a ‘local’  
11 one, that of riverine people who have learned to live with land-water dynamics, who now also claim part  
12 of this reclaimed land for their own children. The view of temporary wetlands as ecological systems has  
13 been restricted to three particular merjas, thereby obliterating the ecological role of others. Since the  
14 2009/2010 floods, the idea of merjas as buffer zones to protect agricultural and urban areas has been  
15 under discussion. Although the idea is rejected by most actors, in practice, merjas will continue to play  
16 this role during major floods in the future, as upstream dams are generally managed with the aim of  
17 resilience to drought. We show how each ontology is connected to different networks of people,  
18 resulting in different enactments that sometimes co-exist and sometimes clash. Creating space for  
19 negotiation for the future of merjas remains challenging, given the changing water flows and the  
20 persistent co-existence of ontologies, as the people connected to it aim to enact their own version of the  
21 merja.

22 **Keywords:** seasonal wetlands, ontologies, stakeholders, buffer zone, agricultural land, Morocco

23 **1. Introduction**

24 *"Instructed in March 1917 to do a reconnaissance of*  
25 *the Rharb for its agricultural development, he [an*  
26 *engineer of the Public Works Department] thought of*  
27 *carrying out his mission with the car and horse that the*  
28 *administration had put at his disposal...he had to give*  
29 *up the car very quickly...The horse itself was*  
30 *abandoned. And our engineer took place, like the*  
31 *Moroccan fellahs on a miserable boat... But let us*  
32 *imagine the dismay of the traveler who returns in*  
33 *September... He wonders if he was not victim of a*  
34 *mirage. The water has almost completely disappeared;*  
35 *no more boats, no more rafts; donkeys and camels*  
36 *circulate on already dusty tracks... "* (Célérier, 1922:  
37 109-110).

38 Temporary wetlands are intrinsically fluid and slippery environments that challenge dominant land-  
39 centered ways of making sense of such areas, but are also difficult to fit in water-centered frames,  
40 questioning how humans live (and should live) in places where there is dynamic interplay between land  
41 and water (Biggs, 2010). The dynamics and ambivalences of temporary wetlands, and more largely of  
42 delta environments are linked to the fact that these “vary between not quite firm land and not quite open  
43 water, or sometimes one and sometimes the other, with water periodically in excess and repeatedly  
44 scarce” (Krause, 2017: 403), as illustrated in the epigraph. In such hybrid environments, watery lands  
45 or muddy waters often escape or overflow theorizations – due to how difficult it is to fully understand  
46 and predict water-land dynamics, and to the agency of water – with water reacting to interventions in  
47 sometimes unexpected ways (Lahiri-Dutt & Samanta, 2013). As highlighted by the work of Cortesi  
48 (2022), this has led to recent calls for a shift from the binary ontology of land and water toward an  
49 “amphibious approach” to temporary wetlands that explicitly recognizes the dynamic interplay of land

50 and water, while paying particular attention to the intricate relations between the social and the natural  
51 (Krause, 2017: 404).

52 Wesselink et al. (2017) define sociohydrology as relational, where the social and the hydrology engage  
53 in a serious dialogue to clarify some of the complex and messy water situations currently encountered.  
54 Sociohydrology aims to analyze “the dynamic interactions and feedbacks” between hydrology and  
55 societies (Sivapalan & Blöschl, 2015). This is particularly important in amphibious environments where  
56 “social relations must not be seen as add-ons to an assumed material, hydrological backdrop, and water  
57 flows must not be conceived of as external,  
58 pre-given dynamics” (Krause, 2017: 404). The way water flows (or does not flow) depends on socio-  
59 political relations, while water flows importantly shape social relations and practices.

60 The hydrological processes of wetlands have been extensively studied, particularly in relation to the  
61 ecological functions fulfilled by wetlands, including “water purification, flood reduction, streamflow  
62 maintenance, fish production and as a habitat for wild species” (Liang et al., 2020: 1). Such hydrological  
63 analyses are important, including when they report counterintuitive findings, for example when they  
64 show that some wetlands cause floods rather than attenuate them (Bullock & Acreman, 2003). In flat  
65 and complex wetlands, a spatial understanding of hydrology – both short-term changes and long-term  
66 trends – is important, thus explaining their decades-long investigation through remote sensing (Klemas,  
67 2013; Tiner et al., 2015).

68 Making sense of what temporary wetlands are – their ontology – and why such ‘sense-making’ matters,  
69 has been the subject of multiple debates. (Cortesi, 2021: 872) showed that the simplification and  
70 “standardized description” of delta environments, stereotyping them as land to be reclaimed, played an  
71 important role in large-scale reclamation projects. Indeed, prevailing conceptualizations (theorizations,  
72 definitions) not only represent a ‘reality out there’ but help bring this reality into being. This is obvious  
73 when ‘sense-making’ of temporary wetlands, by conceiving them as land to-be-reclaimed, is so directly  
74 linked to reclamation projects. In the case of temporary wetlands, there is an additional fault line that is  
75 often exploited when planning their reclamation by questioning whether, given their “progressive  
76 disappearance in intensive farming landscapes”, they really are wetlands at all (Merot et al., 2006: 258).

77 Over the last century or so, there has been a massive worldwide drive to reclaim wetlands to separate  
78 land from water (Lahiri-Dutt & Samanta, 2013). At the heart of this drive was the quest for productive  
79 land (from the point of view of state revenues) linked to a hydraulic vision of regulated ‘modern’ water,  
80 “forcing a linked legal and technical arrangement - land as property and water as resource” ( D’Souza,  
81 2011: 5-6; see Linton, 2010, for the concept of modern water). Large scale drainage schemes and  
82 wetland reclamation into agricultural and urban systems have caused considerable damage to wetlands  
83 (Cooper & Moore, 2003). This has led to controversy about the massive decline of wetlands and the  
84 breakdown of biodiversity worldwide (MEA, 2005; Saha & Pal, 2019). We argue that at the heart of  
85 this controversy is a semiotic conflict about how wetlands should be considered (Cortesi, 2018) as  
86 useless wastelands and negative ecosystems that need to be drained and ‘reclaimed’ to turn them into  
87 profitable agricultural or urban lands, or as rich biodiversity hotspots of that need to be preserved,  
88 conserved, and, more recently, restored, for the ecosystem services they provide, including flood  
89 protection or purification of polluted water (Verhoeven, 2014).

90 Just as wetland reclamation was all about dominating their “obstinate natures” to transform them into  
91 “productive national assets” (D’Souza, 2011:1), policy makers and technocrats also gave much thought  
92 to who deserved to cultivate these newly created lands and how the land should be cultivated, as the  
93 way of life and practices of the people living in the wetlands were by and large illegible to the State  
94 (Lahiri-Dutt & Samanta, 2013). For instance, in Gambia, the explicit aim of the colonial administration  
95 in their swamp development projects was “drawing men into rice growing”, paradoxically leading to  
96 “loss of control over productive swampland” by women farmers, who previously cultivated these  
97 ecosystems, while increasing their burden of labor (Carney, 1993: 407, 412). Of course, the State and  
98 riverine populations often have diverging or even antagonistic “perspectives, values and interests” and  
99 “competing claims” about what wetlands are and should become, and call on and enroll science in their  
100 negotiations (Schut et al., 2010: 612). Although the inhabitants of wetlands have always intervened and  
101 modified these ecosystems, local stakeholder initiatives rarely become visible (Edelenbos et al., 2017).

102 This article focuses on temporary wetlands in the Gharb plain located in the delta of the Sebou River,  
103 Morocco’s largest river. Over the course of a century, a massive effort has been invested in land  
104 reclamation and agricultural development. The large-scale Gharb irrigation and drainage scheme now

105 extends over more than 100,000 ha plus another estimated 80,000 ha of privately irrigated land. Yet,  
106 throughout the plain there remains an area of more than 30,000 ha of seasonal wetlands (Le Coz, 1964),  
107 called *merjas*, that can be inundated from autumn to spring. Jean Célérier, author of the epigraph, would  
108 certainly have recognized this part of the landscape, even though a boat was no longer needed for access  
109 to the field during our study from 2021 to 2023. The starting point of our investigation was the aftermath  
110 of the devastating floods of 2009-2010 that inundated more than 135,000 ha despite the numerous dams  
111 upstream of the plain and an extensive drainage network. After the floods, one of the points of debate  
112 was whether the *merjas* could serve as buffer zones to protect agricultural and urban areas, thus adding  
113 yet another way of making sense of temporary wetlands.

114 Adopting a socio-hydrological approach, we seek to understand the reasons for the dichotomous  
115 ontologies of *merjas* from the perspective of hydraulic and agricultural institutions as well as riverine  
116 communities, and how these ontologies have shaped the *merjas* as we know them today.

## 117 **2. Methodology**

### 118 **2.1. Description of the study site**

119 The Gharb plain (**Fig. 1**) is located in the delta of the River Sebou in north-western Morocco. With its  
120 micro relief and flat topography, the plain has the typical characteristics of delta regions. The plain has  
121 a depression-like geomorphology, characterized by altitudes ranging from 4 to 40 meters and a slope of  
122 less than 0.5%. The Gharb plain is marked by water flows that can occur in multiple directions and  
123 stagnation of water during the rainy period or when the River Sebou overflows its banks.

124 Perhaps not surprisingly, little information is available about the *merjas* in the Gharb plain (Gharb means  
125 land to the West) in the Sebou River Delta. At the beginning of the 20<sup>th</sup> century there were around 100  
126 *merjas* in the Gharb plain (Le Coz, 1964) that accounted for about 60,000 ha or one-fifth of the plain  
127 (Célérier, 1922: 111). Two geographical studies have been carried out in the Gharb plain that (partially)  
128 concerned the *merjas*, at strategic moments of time. The first was conducted at the beginning of the  
129 colonial project to reclaim the Gharb plain by Jean Célérier (1922), who clearly aimed to identify  
130 possible “solutions to drain and reclaim these temporary wetlands”. This colonial geographer considered  
131 geography to be a science of action, “in the noble sense of creating wealth, transforming nature, patiently

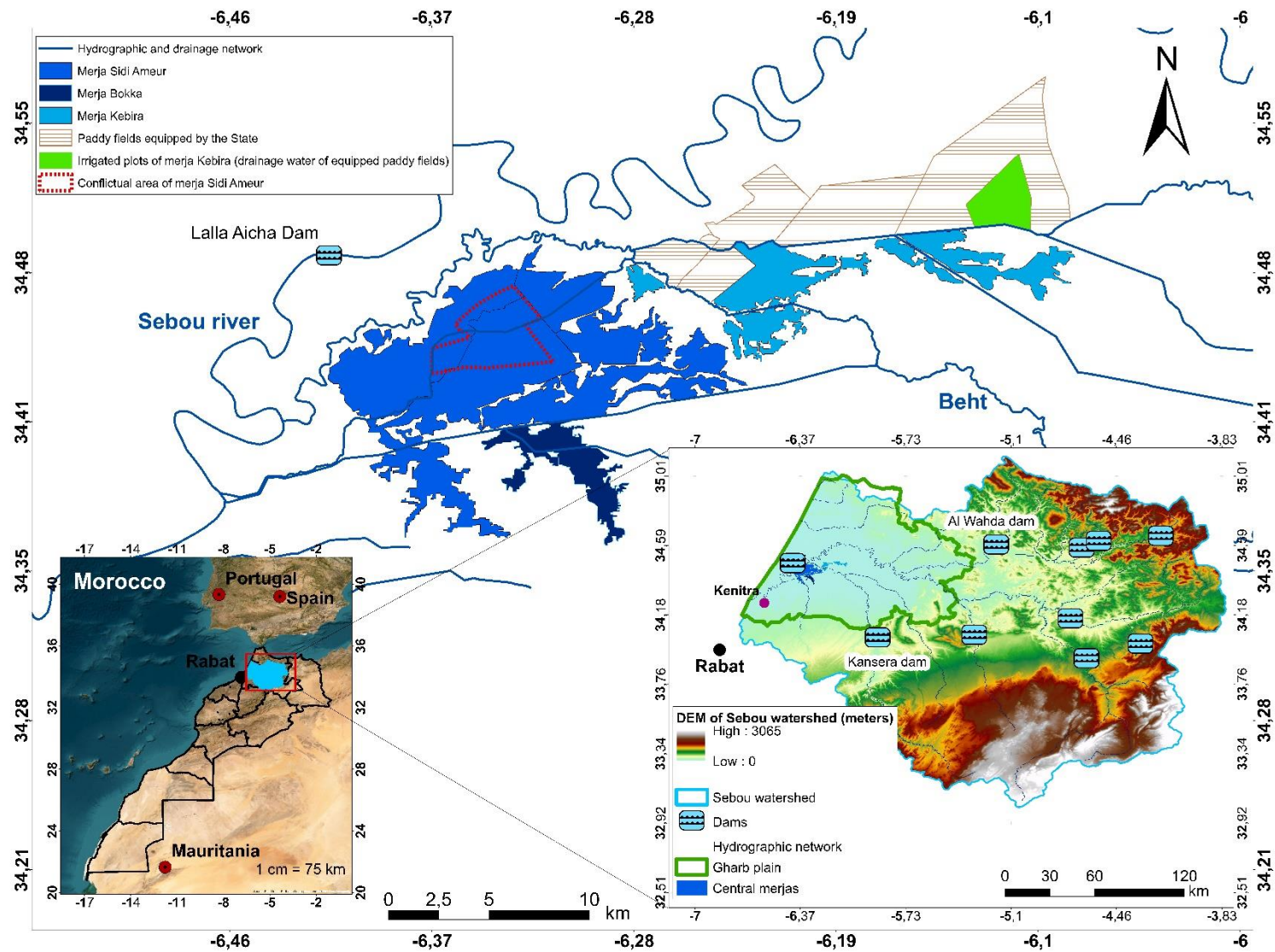
132 creating landscapes that would remind one of one's country" (Naciri, 1983). The second study was  
133 conducted by Jean Le Coz (1964) during the last years of the colonial period and just after Independence  
134 to reflect on the rapid agrarian changes that had occurred during colonial times. In plans for the large-  
135 scale Sebou project, which would lead to the development of the large-scale Gharb irrigation scheme,  
136 he made a plea for a comprehensive overhaul of the dual agrarian structures, favoring the social  
137 emancipation of Moroccan peasantries (Le Coz, 1968).

138 In this paper, we focus on the central merjas located in the middle of the plain on the left bank of the  
139 River Sebou. The three central merjas are named (from east to west, in the general direction of the flow):  
140 Merja Jouad-Tidjina, Merja Kebira and Merja Sidi Ameer (**Fig. 1**). These merjas have an ambiguous  
141 status, as for many decades, they have been considered as lands to be reclaimed, but in practical terms,  
142 their reclamation is considered too difficult and costly. At the same time, riverine communities use the  
143 merjas for agriculture and grazing if they are connected to the drainage system. We also investigated  
144 Merja Bokka, an officially recognized protected natural area (**Fig. 1**). The extent of surface water in the  
145 central merjas varies seasonally from inundated to dry (Choukrani et al., 2023), making their dynamics  
146 difficult to manage and inviting different interpretations of the landscape where the borders between  
147 land and water are fluid and at times imperceptible. Together, they cover an area of about 20,000 ha,  
148 although clearly demarcating them is challenging. First, due to the only minute differences in altitude,  
149 major floods are never limited to the areas designated as merjas. Second, the different actors have  
150 different views of what and where merjas are, as we show in this paper. Several villages are located  
151 around these merjas, although there are no houses inside the merjas due to the risk of flooding, and the  
152 village inhabitants currently use the land for rainfed agriculture and pastoralism, taking advantage of the  
153 water retained in the soils.

154 The central merjas (**Fig. 1**) have a flat topography and geomorphology. They form a bowl-shaped  
155 receptacle for water inflows from different tributaries including Oueds Beht and Rdom, and other  
156 secondary affluents (Le Coz, 1964). Based on the reports to which we had access, it can be inferred that  
157 the floods in the Gharb plain are not torrential. Rather, they are likely caused by the gradual overflow  
158 of water from the Sebou and Beht rivers in areas where the river's flow capacity decreases. This type of  
159 flooding, where water gradually spreads to merjas through the force of gravity, is known as plain



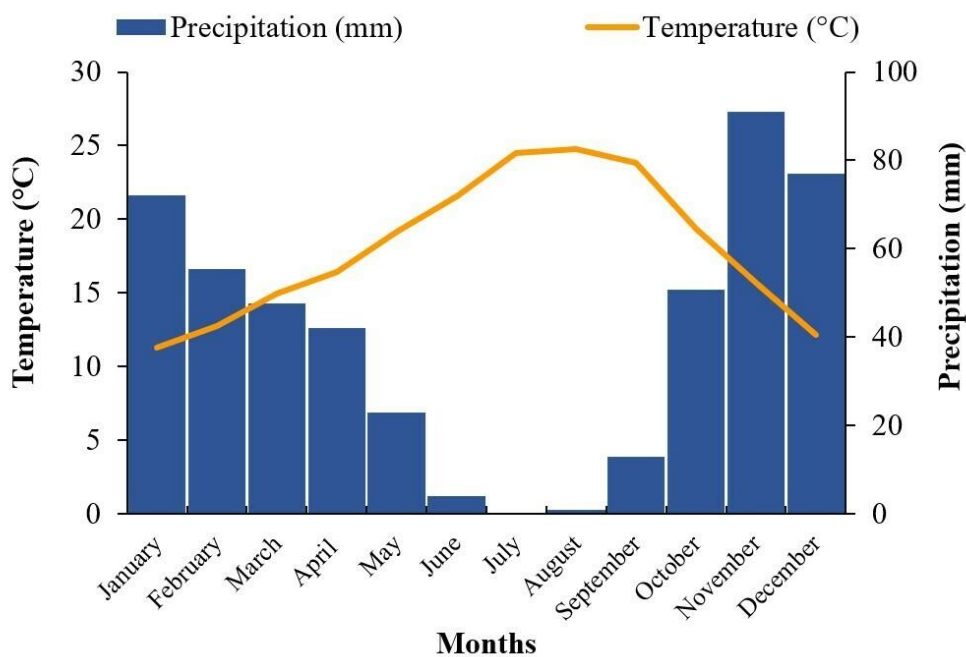
160 flooding (FAO & MAPM, 2010). Additionally, the tributaries in this area are not regulated by dams,  
161 and thus themselves also present a risk of overflowing water.



162

163 **Fig. 1** Study site: Central merjas in the Gharb plain: (a) General overview, (b) Sebou watershed, (c) Gharb plain. (Geographic Coordinate System: WGS1984,  
 164 Decimal Degrees).

165 The bowl-shaped topography of the Gharb plain makes it difficult for the River Sebou to naturally  
 166 evacuate the large volumes of water that originate from its 40 000 km<sup>2</sup> watershed. The raised riverbed  
 167 of the Sebou river (caused by post-floods) created a topographic barrier near the estuary (Le Coz, 1964).  
 168 The amount of rainfall in the Sebou watershed is significantly higher than the national average. The  
 169 Sebou River Basin Agency (ABHS) reports that the watershed accounts for almost a third of Morocco's  
 170 surface water (ABHS, 2019), making these water resources particularly important. As shown in **Fig. 2**,  
 171 the seasonal distribution of rainfall in the Gharb is characterized by a relatively wet winter - 435.6mm  
 172 from October to April (averaged from 1980 to 2019) and a dry summer - 40.6mm from May to  
 173 September (averaged over the same period). This explains the description used by Le Coz (1964) to  
 174 refer to the Gharb: lowlands in a semi-arid zone.



175  
 176 **Fig. 2** Ombrothermal diagram of the Gharb plain (1980-2019).

177 **2.2. Field Surveys and focus groups**

178 We used the following approach. First, we questioned the ontology that represents merjas as buffer  
 179 zones, we cross-checked and compared the results of interviews with agents from the State water  
 180 department with the results of our interviews with local communities. We also compared these results  
 181 with the results of a hydrological analysis enabled by remote sensing. Second, we analyzed the  
 182 agriculture of the merjas, triangulated quantitative data (remote sensing) with field surveys conducted

183 to examine access to irrigation water. We compared the results of our field surveys with data collected  
184 in focus groups when the participants were talking about the complexity of merjas land tenure and its  
185 impact on the agricultural development of the merjas.  
186 To analyze the interplay between ontologies, we conducted semi-structured interviews with local  
187 communities, and six focus group discussions (four in merja Sidi Ameer, two in merja Kebira) (**Fig. 3**).  
188 The interviewees belonged to diverse communities with diverse experience of merjas. We also  
189 conducted two semi-structured interviews with engineers from the State water department (Ministry of  
190 Equipment and Water), three semi-structured interviews with employees of the Ministry of Interior and  
191 with three employees from the Regional Office of Agricultural Development of Gharb (ORMVAG),  
192 between February 2021 and April 2023. The questions concerned agricultural practices, access to  
193 irrigation water, flood protection mechanisms, and strategies used to cope with floods and drought  
194 events. The aim of the interviews with ORMVAG employees was to understand State orientations  
195 concerning agriculture. The interviews with the agents of the Ministry of the Interior informed us about  
196 the land tenure of merjas. In addition to qualitative data (field surveys), we used secondary data from  
197 study reports and from the literature.



198  
199 **Fig. 3** A focus group with members of a local community.

### 200 **2.3. Satellite data processing**

201 To understand the hydrological dynamics of the study area, we mainly used satellite images. Google  
202 Earth Engine (GEE) is a cloud computing platform "accessed and controlled through a web-accessible

203 application programming interface (API) and a web-based interactive development environment (IDE)  
204 that enables rapid prototyping and visualization of results” (Gorelick et al., 2017). All data processing  
205 was done in GEE Code Editor (<https://code.earthengine.google.com/>).

206 We calculated the water index MNDWI (Xu, 2006) to analyze the water dynamics of the merjas in wet  
207 and dry seasons and to monitor the dynamics that govern the presence of water (Yang et al., 2020). We  
208 also calculated the NDVI, which is used to distinguish vegetated from non-vegetated areas (Tuxen et  
209 al., 2008). The NDVI has already been used to identify irrigated areas in the Gharb plain (Lamhamedi  
210 et al., 2017).

$$211 \quad \text{MNDWI} = \frac{\text{Green} - \text{SWIR}}{\text{Green} + \text{SWIR}}$$

$$212 \quad \text{NDVI} = \frac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}}$$

213 Using the maximum value of MNDWI of each pixel during the period of availability of Sentinel2 images  
214 (from 2018 to 2022) after excluding the years with extreme floods (1995-1996, 2009-2010), we  
215 delineated different types of waterbodies: permanent waterbodies (the River Sebou, dam reservoirs) and  
216 seasonal waterbodies (temporary flooded wetlands, paddy fields). We then calculated the spatial mean  
217 MNDWI and NDVI for each feature for each available date to produce time series. We also calculated  
218 the MNDWI value of the wet period (between October and April) averaged over different sections along  
219 the River Sebou for each year between 1984 and 2011.

220 We computed the Palmer Drought Severity Index (PDSI) (Palmer, 1965) for the Gharb plain and the  
221 Sebou watershed, using the GEE platform (**Fig. 4**). The PDSI considers other parameters like  
222 precipitation, temperature, and soil moisture.

223 We relied on CHIRPS (Climate Hazards Group InfraRed Precipitation with Station data) for data on  
224 precipitation, which can be accessed through the GEE platform.

### 225 **3. Results and discussion**

#### 226 **3.1. Different ontologies of merjas, different enactments**

227 The presence/absence of water in the *merjas* lies at the heart of contrasting viewpoints and a dichotomy  
228 of ontologies related to a complex land and waterscape. Interestingly, the merjas of the Gharb have

229 followed very distinct trajectories, influenced, as we will argue, by the dichotomous ontologies that  
230 concern them.

231 First, over the past century, most of the merjas have been progressively incorporated in the large-scale  
232 Gharb irrigation scheme. At the beginning of the 20<sup>th</sup> century, the European settlers, in a close alliance  
233 with the colonial administration, assumed that, as semi-aquatic areas, merjas needed to be drained for  
234 agricultural purposes. Water in merjas was perceived as a natural disaster, and an obstacle for irrigation  
235 and modern agriculture. This “drain and develop” ontology underlines a binarization of water and land,  
236 as merjas were deemed valuable when drained of water. However, drainage alone was insufficient and  
237 was accompanied by the construction of dams, both for flood protection in winter and to provide  
238 irrigation water in spring and summer (Célérier & Charton, 1925). The Kansera dam (**Fig. 1**) was  
239 completed in 1935, enabling the development of the Beht irrigation scheme, intended by colonial settlers  
240 for citrus orchards (Swearingen, 1987). After Independence, over a period of 35 years (1972-2005), the  
241 Gharb irrigation scheme was progressively extended to 114,000 ha, including 12,000 ha of merjas. These  
242 merjas can still be identified indirectly because they were dedicated to rice production, considered  
243 particularly adapted to such low-lying areas. The remaining merjas, including the central merjas, are,  
244 even today, on stand-by, waiting to-be-reclaimed. On the one hand, they are part of the projected  
245 250,000 ha Gharb irrigation scheme, constituting a land reserve for further State-led reclamation and  
246 the further development of irrigation schemes. On the other hand, feasibility studies have revealed the  
247 difficulties (topography, heavy clayey and hydromorphic soils) and the cost of land development in  
248 these low-lying areas (Choukrani et al., 2023).

249 Second, three merjas were dedicated to nature. Merja Zerga and merja Sidi Boughaba are permanent  
250 coastal wetlands (7,300 ha and 650 ha, respectively) which are protected and recognized by the  
251 international Ramsar convention since 1980. The third one, Merja Bokka (about 1,600 ha), is a national  
252 protected area – one of the 160 Sites of Biological and Ecological Interest (SIBE) in Morocco.  
253 According to official documents, since the 1980s it is no longer a permanent but rather a temporary  
254 wetland, under water from six to eight months a year. The fact that the idea of biodiversity was confined  
255 to a restricted area perhaps explains the absence of ecological studies and the lack of interest on the part

256 of environmental associations in any of the other merjas in the area, including the central merjas, except  
 257 for the peri-urban merja Fouarat (Choukrani et al., 2023).

258 Third, a more conjunctural existence of merjas, generally after big floods, such as the recent 2009/2010  
 259 ones, is related to their supposed capacity to mitigate floods as buffer zones. We elaborate on this in the  
 260 following section as the starting point of our investigation. The floods that occurred in 1996 and 2009-  
 261 2010 served as a reminder of the limits of the current civil engineering infrastructure with nature  
 262 reclaiming the upper hand. The floods that invaded the *merjas* and surrounding areas required the  
 263 evacuation of many thousands of people and resulted in massive crop losses on agricultural lands (FAO  
 264 & MAPM, 2010; MHUPV-IRHUPV, 2013). This prompted a contrasted debate on what to do next. The  
 265 River Basin Agency and the agricultural services urged the creation of flood protection infrastructure,  
 266 for example the construction of dams upstream of the Gharb plain, while pinpointing *merjas* as low  
 267 areas that could serve as buffer zones when floods occur.

268 By contrast, local communities no longer consider the central merjas as wetlands but rather as  
 269 agricultural lands that could be cultivated in most years if the drainage system is improved, and irrigation  
 270 water provided. During our interviews, local communities stated that they even consider settling in the  
 271 merjas and not only on the (higher) banks of neighboring rivers. The communities believe that they are  
 272 protected by the dams built upstream of the Gharb plain. However, as demonstrated by Di Baldassarre  
 273 et al. (2015), such measures can have unforeseen consequences because they reduce social preparedness.  
 274 **Table 1** summarizes the contrasted ways of making sense of merjas by different actors, linked to the  
 275 spatial and temporal scales considered by the actors.

276 **Table 1.** Spatial and temporal dimensions of merjas through actors' lenses with a focus on water.

Types of actors	Spatial scale	Hydrologic time scale of action	Amplitude of the hydroclimatic event	Roles of merjas
Farmers	Local (merja)	Daily life	Moderate with very exceptional large floods	Agricultural and cultural services

Agricultural institutions	Gharb plain	Seasonal crop cycles	Dam-regulated mean seasonal river flow and water level determines irrigation water supply (pumping stations on Sebou River)	Agricultural production only in reclaimed merjas
Water department	Sebou watershed	Rare event (overflow of the Sebou river and its affluents in the plain)	Regular dam releases for hydro-electricity and agricultural demand. Exceptionally high during floods.	Regulation service: partial flood protection

277 **Table 1** emphasizes the different societal responses to flood events. The spatial and temporal scales are  
278 key determinants of the actors' responses.

279 **3.1.1. Origin of the “buffer zone” ontology: are merjas a landscape or a waterscape?**

280 According to an engineer we interviewed in the State water department, “*Merjas are buffer zones*”. The  
281 engineer explained that a study had been conducted after the devastating 2009-2010 floods in which  
282 more than 135,000 ha were inundated and many thousands of people had to be evacuated. Sixty days  
283 after the floods in 2010, more than 3,000 people who had lost their houses were still living in tents and  
284 major damage to crops had occurred in irrigated areas, for example to citrus orchards and agricultural  
285 enterprises<sup>1</sup>. Sugar factories for sugarbeet and sugarcane had been closed since the floods. Considering  
286 merjas as retention areas or buffer zones was not a recent idea, as we found out by immersing ourselves  
287 in the (often grey) literature on the study area. In fact, after devastating floods in 1960 and 1963, many  
288 flood protection studies of the Gharb plain were conducted as part of the large-scale integrated Sebou  
289 development project. The studies suggested that the merjas could serve as buffer zones or retention

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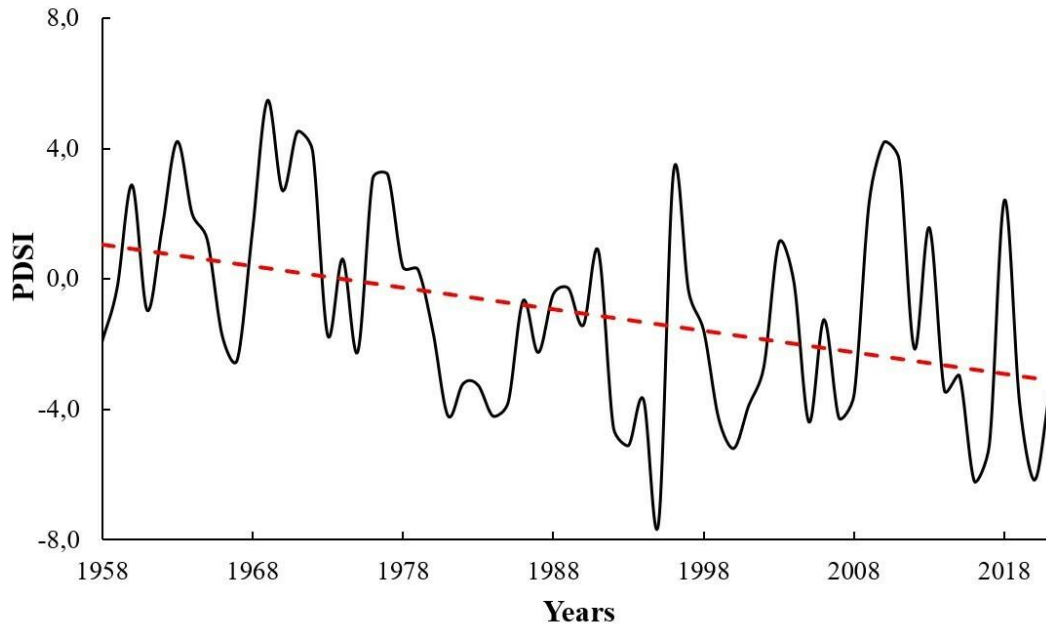
<sup>1</sup> [https://lematin.ma/journal/2010/Inondations-dans-le-Gharb-et-le-Souss\\_180-millions-de-DH-de-pertes-pour-les-agrumes/128689.html](https://lematin.ma/journal/2010/Inondations-dans-le-Gharb-et-le-Souss_180-millions-de-DH-de-pertes-pour-les-agrumes/128689.html)



290 basins and the “*temporary storage of floodwater in low-lying areas*” was mentioned as one of the  
291 possible management scenarios for flood protection (Enneking & Vierhout, 1982). However, this option  
292 was not further explored by the State at the time, and attention was focused on alternative scenarios  
293 presenting a combination of interventions such as building dams upstream of the Gharb plain and  
294 constructing a drainage network in the plain itself. A total of 10 reservoirs (and 45 small or medium-  
295 sized hill reservoirs) have been constructed since the 1920s, including Al Wahda in 1996 (**Fig. 1**) which  
296 is the biggest reservoir in Morocco (regulated volume of 1.74 billion m<sup>3</sup>). A drainage network with a  
297 total length of 4,500 km was built to allow irrigated agriculture in the plain.

298 The construction of reservoirs had a double objective. First, the stored water was to be delivered to the  
299 expanding public irrigation scheme for agricultural intensification, but also serves privately irrigated  
300 land. An institutional interviewee stated that private irrigation accounts for approximately 50% of the  
301 water from dam releases. Second, the reservoirs protect the plain from flood damage in the rainy season  
302 from October to April.

303 The two objectives are, of course, at times contradictory as the River Basin Agency would like to store  
304 as much water as possible for dam releases in spring and summer for irrigation, without necessarily  
305 leaving sufficient storage capacity in the reservoir. In addition, the Sebou watershed has faced a cycle  
306 of consecutive years of drought in the past 30 years, as depicted in **Fig. 4**. The question of flood  
307 protection was consequently no longer a top priority on policy makers’ and institutional stakeholders’  
308 agendas, making it difficult for the River Basin Agency to maintain a high level of protection for the  
309 plain. The entity responsible for dam managements did not release water before the 2009/2010 floods,  
310 as they foresaw a prolonged period of drought. As a result, the heavy rainfall in 2009-2010 far surpassed  
311 the capacity of Al Wahda reservoir. Flood control was not possible due to insufficient preliminary  
312 releases. The Gharb plain was submerged, and the River Sebou formed a “flood corridor”, going  
313 through, but not limited to, the central merjas, as shown in the studies of this flood conducted by the  
314 FAO under the supervision of the Ministry of Agriculture (FAO & MAPM, 2010).



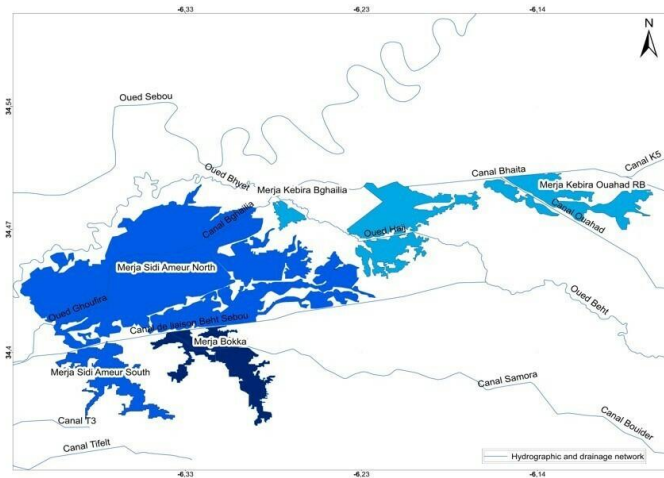
315

316 **Fig. 4** Palmer Drought Severity Index (PDSI) (1958-2021) of the Gharb plain.

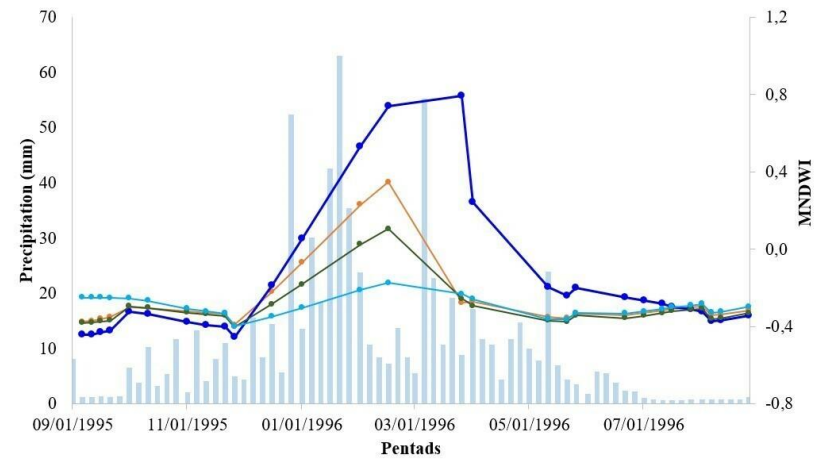
317 **3.1.2 Local topography, geomorphology, and soil texture determine the submersion of**  
 318 **merjas outside major floods**

319 The graphs in **Fig. 5** show the different responses of the merjas to Sebou watershed precipitation over  
 320 the course of three hydrological years: 1995-1996, 2009-2010, and 2020-2021. These years were  
 321 selected because they were the wettest years in the period from 1984 to 2023. Total rainfall between  
 322 October and April in the period 1995-1996 was about 638 mm. The year 2009-2010 stands out as the  
 323 wettest year during this period, with total rainfall between October and April exceeding 746 mm. But,  
 324 during the same period, cumulative rainfall in the year 2020-2021 was 469 mm, lower than in the two  
 325 other years.

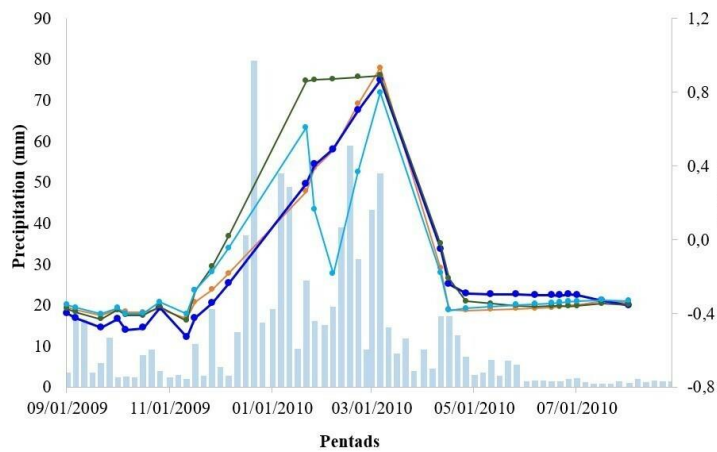
326 The MNDWI peaks differ from one merja to another over the years. These results suggest that local  
 327 drivers such as topography, geomorphology, and soil texture play a role in determining the submersion  
 328 of merjas during different hydrological years, as shown in **Fig. 5** (b), (c), and (d).



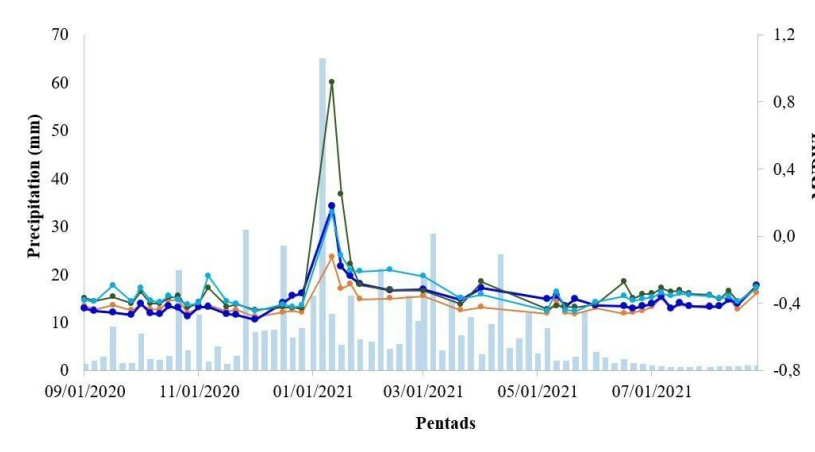
(a)



(b)



(c)



(d)

■ Sebou watershed precipitation    
 —●— Merja Sidi Ameur North    
 —●— Merja Bokka    
 —●— Merja Kebira Bghailia    
 —●— Merja Kebira Ouahad RB

329

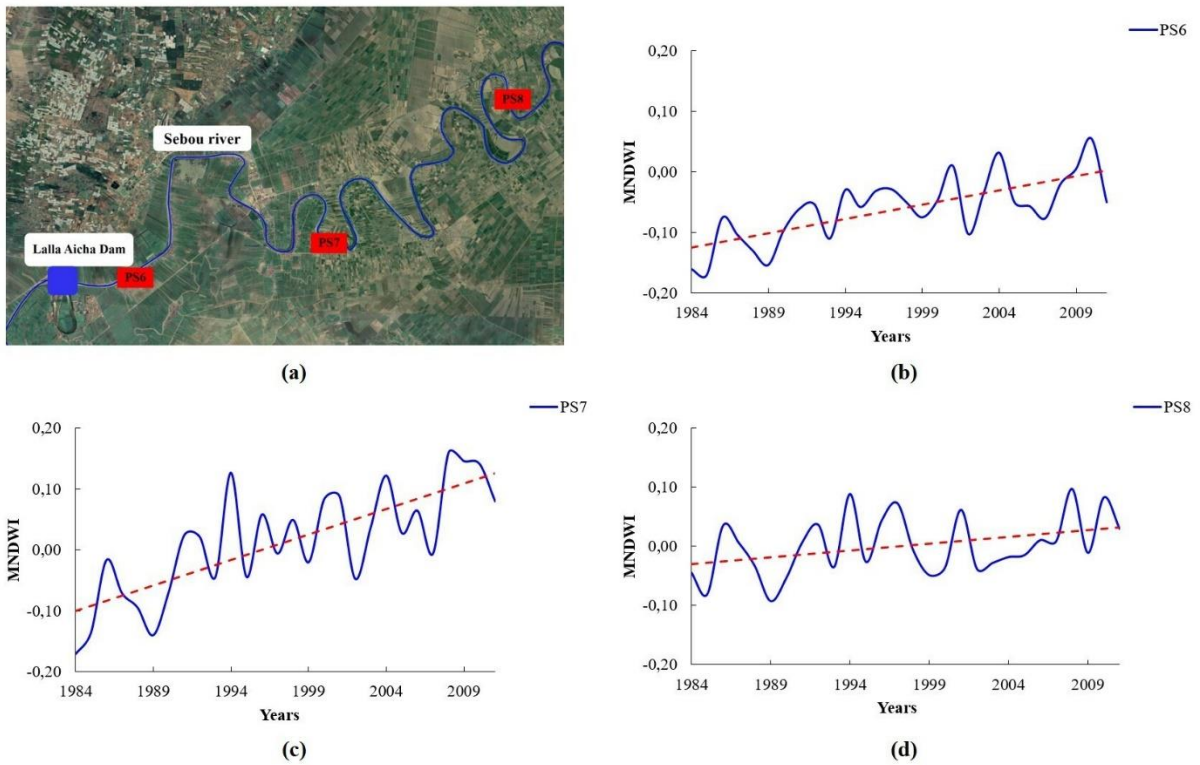
330 **Fig. 5** The responses of the merjas to different hydrological years: (a) Map of the central merjas, (b) Merjas responses to rainfall in the Sebou watershed in 1995-  
 331 1996 rainfall, (c) Merjas responses to rainfall in the Sebou watershed rainfall in 2009-2010, (d) Merjas responses to rainfall in the Sebou watershed in 2020-  
 332 2021.

333 For instance, the merja Bokka is deeper and more bowl-shaped than the other merjas, leading to higher water  
334 levels. Additionally, the soil texture of merja Bokka is characterized by a mix of sandy and clayey soils, while  
335 the other merjas are made of clayey soils (Le Coz, 1964). The proximity of the merjas to the river and drainage  
336 network and overflow points is another factor. We conclude that flooding of the merjas depends on local factors  
337 and only in the case of extremely severe floods, like those in 2009-2010, do all the merjas come under the  
338 influence of the hydrology of the River Sebou due to overflow. One can infer from **Fig. 5** (c) that there is a  
339 spatial homogeneity of MNDWI values among the merjas observed in 2009-2010 that contrasts with the values  
340 observed in the other two years. In the study of the 2010 flood, a total of 12 overflow points were identified  
341 along the banks of the River Sebou, explaining the massive floods during this event. These results suggest, first,  
342 the importance of dams, if managed with this objective, in reducing the impacts of major floods in the Gharb  
343 plain, including in the central merjas. Second, the results also indicate the importance of local rainfall events  
344 that, depending on topography and soil texture, lead to local submersion of the merjas and have a considerable  
345 impact on cropping systems.

### 346 *3.1.3 Unpacking the impact of the Lalla Aicha dam on the potential risk of flooding*

347 While analyzing the institutional ontology that considers the merjas as buffer zones, we identified an additional  
348 factor that may have influenced the flooding phenomenon. Our analysis of series of droughts, along with surveys  
349 and statements made by agents of the different State institutions, led us to envisage that Lalla Aicha dam was a  
350 possible contributor to the floods.

351 Lalla Aicha dam, which is located at the river mouth (**Fig. 1**, **Fig. 6**) and was put into service in 1991, was built  
352 to limit the amount of saltwater that enters the River Sebou and can adversely affect agricultural production.  
353 The Lalla Aicha dam also ensures a sufficient and stable level of water upstream to facilitate the pumping of  
354 irrigation water for agriculture in public irrigation schemes and by private farmers along the River Sebou.  
355 The results of our analysis showed that MNDWI values increased over time in three sections upstream of the  
356 dam (**Fig. 6**). The sections are PS6, PS7 and PS8 located respectively 3 km, 24 km, and 50 km upstream from  
357 the Lalla Aicha dam. Other sections located farther upstream or downstream of the dam showed no significant  
358 trend.



359  
 360 **Fig. 6** Assessment of the flood risk associated with the Lalla Aicha Dam: (a) Location of the Sebou sections  
 361 PS6, PS7 and PS8, (b) MNDWI values of PS6 (p value = 0,00013) located 3 km upstream of the dam, (c)  
 362 MNDWI values of PS7 (p value =0,000003) located 24 km upstream of the dam, (d) MNDWI values of PS8 (p  
 363 value = 0,03128 ) located 50 km upstream of the dam. (Trend analysis using the statistical Mann-Kendall test).

364 The positive trend in the MNDWI index observed upstream of the dam cannot be attributed to precipitation, as  
 365 can be seen in **Fig. 4** of the PDSI which, on the contrary, indicates a tendency to drought. To explain the  
 366 increasing value of MNDWI, we hypothesize that silting caused the bed of the River Sebou to rise thereby  
 367 increasing the risk of overflow. This hypothesis is in line with the results of studies undertaken in similar  
 368 contexts, which considered sedimentation as a non-climatic factor that amplifies flood risk (Abbasov &  
 369 Mahmudov, 2009; Liu et al., 2022).

370 This hypothesis is also supported by a study undertaken after the 2010 floods showing that the beds of the Rivers  
 371 Sebou and Beht have a roof-like structure making them vulnerable to deposits of sediment in the main riverbed  
 372 during flood periods (FAO & MAPM, 2010). When floods occur, even during ‘normal’ times, the water flow  
 373 exceeds the capacity of the riverbed, resulting in successive overflows that deposit large amounts of sediment  
 374 into the major riverbed. Consequently, the main riverbed progressively rises, forcing the minor bed to also rise

375 and dominate the plain. Due to the raised bed height, the volumes of water that overflow in the lower plain fail  
376 to join the minor bed downstream.

377 However, further research on sediment transport and deposition is needed to confirm this hypothesis and advance  
378 our understanding of the factors responsible for the observed increasing trend of MNDWI in some sections of  
379 the River Sebou due to changes in the water levels and in the flow patterns of the river. It is crucial to identify  
380 and understand these factors to design effective strategies to mitigate the risks of flood events.

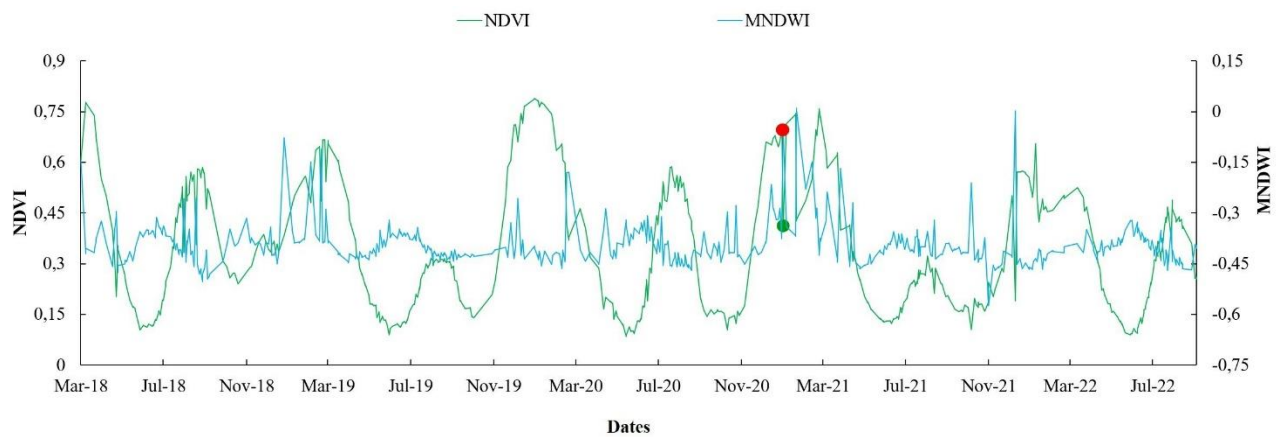
### 381 **3.2 Living with water-land dynamics: adapting agriculture to the “no longer merjas” paradigm**

#### 382 **3.2.1 Supplying irrigation water from paddy fields to neighboring merjas**

383 The large-scale reclamation projects implemented in the Gharb plain over the past century occurred at the  
384 expense of the merjas, which were progressively drained and reclaimed. The central merjas have been connected  
385 to the drainage network of the plain but are not supplied with irrigation water. The riverine populations observed  
386 these changes and adapted their agricultural practices to these new realities. Today, the merjas are mainly used  
387 for rainfed agriculture in winter and spring (cereals, fodder, and sunflower) and (some) irrigated agriculture in  
388 summer (melon, tomato, corn) (Choukrani et al., 2023). While some farmers told us “*We miss the floods*”, others  
389 said: “*Thanks to El Wahda Dam, we are protected from floods*”. They thus conclude that “*It is no longer a*  
390 *merja*”. These statements lead us to conclude that the farmers in the local communities have developed coping  
391 mechanisms and no longer perceive floods as a constant threat. They see the 2009/2010 events as exceptional  
392 floods that should be measured against the 15-20 years, they have been able to cultivate with no serious  
393 problems. During our interviews, farmers explained that the inhabitants of a village refused to be relocated to  
394 another village following the 2010 floods, and in other villages, some of the inhabitants returned to their original  
395 villages once the floods had subsided, to be near their plots.

396 We observed how farmers adapted their agricultural practices to the hydromorphic nature of the soils even  
397 though they are now rarely submerged. Farmers explained that after heavy rains, wild grasses grow in wheat  
398 fields thereby reducing yields. Consequently, the mixture of wheat and natural vegetation is harvested and fed  
399 to livestock as a forage crop. Moreover, in wet years when it is not possible to grow cereals, farmers use the  
400 residual soil moisture to cultivate sunflower, which is considered as a spring catch-up crop. Those who do not  
401 have access to irrigation water, practice rainfed agriculture and mainly cultivate wheat, barley, Alexandria  
402 clover, alfalfa, and sugar beet in winter (Choukrani et al., 2023).

403 The drop in NDVI values in winter in some years and in specific locations in the merjas, (represented by the  
404 green dot in **Fig. 7**), is an indicator of waterlogging of soils and explains why the vegetation is entirely covered  
405 by water. This was confirmed by our field observations in January 2021 where the sugar beet was under water  
406 following heavy rainfall (**Fig. 8**). The high value of MNDWI on the same date is represented by the red dot on  
407 the graph (**Fig. 7**).



408  
409 **Fig. 7** Water drained from paddy fields is used to irrigate neighboring plots in merja Kebira: NDVI and MNDWI  
410 graphs of some of the merja Kebira irrigated plots.



411  
412 **Fig. 8.** Partially flooded plot of sugar beet in merja Kebira (photo taken in January 2021).

413 A minority of farmers grow irrigated crops including melon, tomatoes, artichokes, and corn in summer.  
414 However, access to irrigation water is complicated. First, the merjas are not considered to be part of the public  
415 irrigation scheme and are consequently not supplied with irrigation water. Second, the phreatic aquifer is very

416 salty (up to 1.85 g/l)(El Mahmoudi et al., 2018), which is a constraint for agricultural intensification. Some  
417 farmers have been able to drill (costly) boreholes to depths of between 60 and 100m to access the deeper and  
418 less saline aquifer.

419 MNDWI (water index) and NDVI (vegetation index) were plotted for merja Kebira paddy fields which are not  
420 part of the irrigation scheme (in green) (**Fig. 1, Fig. 7**). The graphs reveal peaks in MNDWI and NDVI during  
421 summer (from July to September) that cannot be attributed to irrigation from boreholes or wells since there are  
422 none in either area. In fact, the plots in the merjas located close to paddy fields (equipped by the State) in the  
423 public irrigation scheme (**Fig. 1**), use their drainage water for irrigation. However, the paddy fields and the areas  
424 of Merja Kebira are not irrigated systematically every summer. In drought years, no water is available to irrigate  
425 the paddy fields, which in turn impacts the water supply to the areas neighboring merja Kebira. This information  
426 was confirmed by the farmers during our field surveys, who want more reliable access to irrigation.

### 427 **3.2.2 Land tenure of Merjas: land of our children or land to develop?**

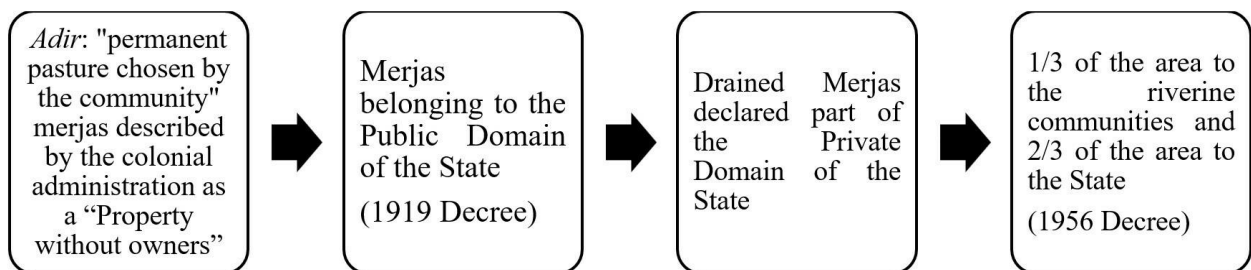
428 Land tenure of temporary wetlands is notoriously complex and *de jure* rights of states keen to appropriate and  
429 reclaim wetlands often conflict with the *de facto* rights of riverine communities (Nguyen et al., 2017). The  
430 merjas in the Gharb are no exception, because of the original intention to drain and develop these merjas. Before  
431 the 20<sup>th</sup> century, merjas were used collectively by tribes, mainly for pastoralism. Merjas were declared to belong  
432 to the State's Public Domain through the decree of November 8, 1919, thereby ignoring pre-existing land use  
433 by qualifying the lands of the merjas as "property without owners" (Sonnier, 1935). Such "outright legal  
434 chicanery" occurred in several places in Morocco not only concerning land but also water rights, whenever the  
435 colonial administration coveted these resources for agricultural development (Swearingen, 1987: 46).  
436 Recovering such resources generally involved their reallocation to more deserving people, be it European settlers  
437 or Moroccan peasants who could be coerced into the modern agricultural project (Kuper et al., 2023).

438 According to the 1919 and 1956 laws, the merjas were first incorporated in the public domain of the State so  
439 that it could plan its reclamation "for public purposes and utility" according to the official decree of July 1, 1914  
440 (**Fig. 9**). This was thus a temporary tenure status. Once the merja was being reclaimed, it was incorporated in  
441 the private domain of the State (**Fig. 9**), after which it becomes subject to all administrative acts and disposal  
442 including sale, exchange, assignment and exploitation either directly by the State or indirectly by private  
443 individuals through a long lease. The private domain of the State is managed by the Ministry of Economy and



444 Finance. On this basis, the State bears the costs of land development and recovers two thirds of the land that is  
 445 then handed over to farmers of its choice, providing them with land use titles or even property rights. After  
 446 Independence, the usual criteria for accessing land in merjas, explicitly intended for agricultural purposes,  
 447 included being the head of a family (and therefore, implicitly, being male), residing in the area, being a farmer,  
 448 and not possessing any land in the region.

449 On this same basis, the riverine communities obtained one third of the land (*tulut*). Because the land of the  
 450 central merjas of Jouad-Tidjina, Kebira and Sidi Ameur have not been reclaimed, the situation concerning their  
 451 land use rights is confusing. While the *tulut* is fully cultivated by the riverine communities, the remaining two  
 452 thirds are rented by *barani* (outsiders, according to the riverine population), through the Ministry of Interior,  
 453 either for rainfed agriculture in winter or for irrigated agriculture in summer. At times, this is fiercely contested  
 454 by the villagers, who have even blocked part of the merja Sidi Ameur (1,200 ha) for cultivation since 2003.  
 455 While officially, the private domain of the State is managed by the Ministry of Economy and Finance, according  
 456 to the riverine population, it is currently managed by the Ministry of Interior, which is accustomed to dealing  
 457 with confusing and conflicting situations. In the case of merja Bokka, which is an important site for biodiversity  
 458 it remains part of the public domain of the State and farming is officially banned.



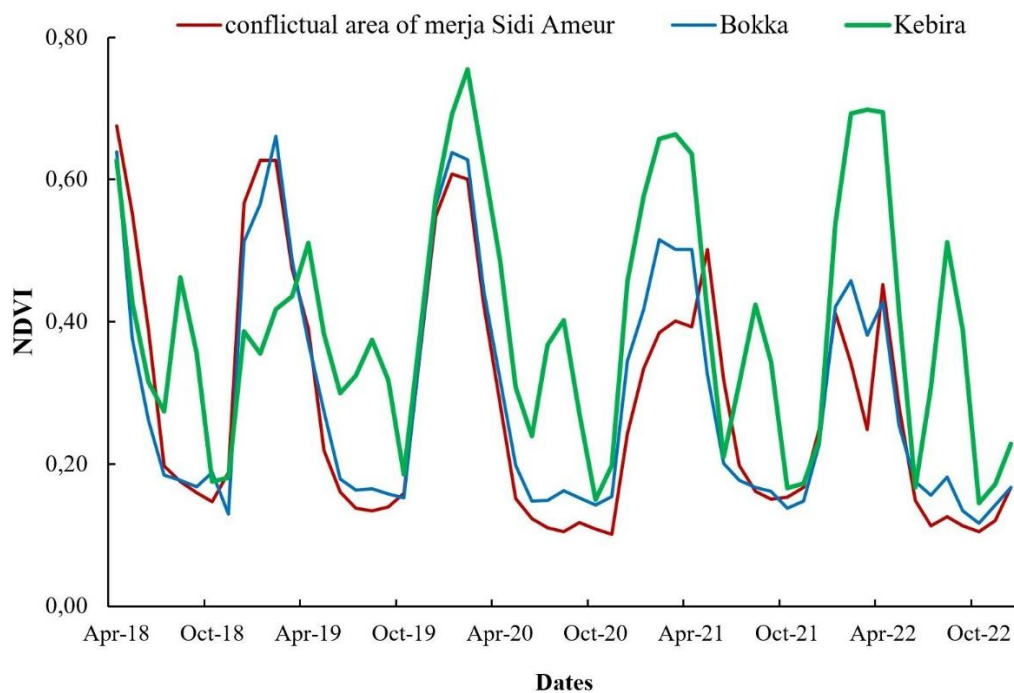
459  
 460 **Fig. 9** Changes in merjas land tenure.

461 According to the members of the communities we interviewed, after many years of hidden conflict in the Gharb  
 462 plain, located at “the gates of Rabat” (Bouderbala, 1999), in 2003, open conflict emerged between the State and  
 463 the riverine communities in the merja Sidi Ameur. The communities claimed access to the lands in the merja  
 464 that were being exploited by outsiders (*barrani*), that is, on the two thirds of land taken by the State. The  
 465 interviewees stated that the land rights they inherited from their ancestors were not recognized by the official

466 institutions. They insisted that the land in merja Sidi Aneur should be given to the local communities,  
467 particularly to the younger generation to develop the area, as there was not sufficient land for them.

468 These two contradictory points of view concerning land tenure in the merja Sidi Aneur led to the exclusion of  
469 outsiders from 1,200 ha of land by the communities. However, the land was not given to the communities for  
470 agricultural use. Each land tenure regime thus neutralised the other, which affected the agricultural development  
471 of the western part of the merja Sidi Aneur (represented by the red graph in **Fig. 10**). Instead, the local  
472 communities use the land for grazing, thus returning the land to its original use.

473 **Fig. 10** shows a NDVI graph of three merjas: merja Kebira, merja Bokka, and the conflictual area of merja Sidi  
474 Aneur (**Fig. 1**). Merja Kebira belongs to the private domain of the State. Merja Bokka belongs to the public  
475 domain of the State. The fought-over area of merja Sidi Aneur belongs to the private domain of the State but  
476 cannot be cultivated because of the above-mentioned conflict, and the area is now used as pasture for livestock.



477

478 **Fig. 10** Impact of land tenure on the agricultural development of merjas.

479 **Fig. 10** shows the difference in the NDVI during irrigation period between the three above-mentioned merjas.  
480 There was an increase in the vegetation index in the merja Kebira during the irrigation season, because there  
481 was no land-tenure conflict. The NDVI did not increase in the fought-over part of the merja Sidi Aneur or in  
482 the merja Bokka where cultivation is not allowed by the State since it belongs to the public domain.

483 Local communities prioritize access to water and land for agriculture, while acknowledging the need to solve  
 484 land tenure conflicts. They are accustomed to rare flooding events and do not perceive them as a serious risk.  
 485 According to these communities, youth unemployment is a pressing issue that can be addressed by granting  
 486 access to the fought-over area, which the communities perceive as an inherited right. The interviewees expressed  
 487 concerns about the merja, which is a hot spot of tension due to land tenure insecurity. These riverine  
 488 communities, who have learned to live with land-water dynamics in ‘their’ hydrosocial territory (Boelens et al.,  
 489 2016), now also claim part of the reclaimed land for their own children.

490 In a context of land tenure insecurity, interviewees in local communities frequently and spontaneously provided  
 491 proof of their “right” to the merjas. For example, the land representative of one of the riverine communities  
 492 referred to written proof of access to the merja Sidi Ameur dating back to the 19<sup>th</sup> century. The former laborers  
 493 on colonial farms who obtained land in the merjas from the State (out of the two thirds recovered by the State)  
 494 considered the receipts for the yearly payment they used to make to the State’s domain delegation, as proof of  
 495 their ownership of the merja (Fig. 11). However, this payment stopped in the 1990s. When the communities  
 496 approached the domain delegation to inquire about their situation, the State’s domain delegation denied such  
 497 yearly rents, leaving them in a state of uncertainty and without a clear resolution.



498  
 499 **Fig. 11** Receipt for annual community payment to the State domain delegation.

500 **4. Conclusion**

501 This paper has shown how the different perceptions of what temporary wetlands (merjas) are – hotspots of  
 502 biodiversity, lands to-be-reclaimed, buffer zones, or the land of our children – have produced at least three

503 different enactments in the Moroccan Gharb plain: a ‘State’ enactment that ‘drained and developed’ the land to  
504 then re-distribute it to outsiders and former workers on colonial farms; a ‘local’ enactment by riverine people  
505 who have learned to live with land-water dynamics and now also claim part of the reclaimed land as ‘their’  
506 hydrosocial territory, for their own children; and limited natural reserves for biodiversity and migratory birds.  
507 The fourth, a more conjunctural enactment of merjas as buffer zones did not gain much traction among actors,  
508 but merjas will surely continue to play that role during major floods in the future. By combining hydrological  
509 analyses to understand the complex water flows, and ethnographic observations to understand current ways of  
510 practicing agriculture in these temporary wetlands, and using a sociohydrology analytical framework, we  
511 questioned the ontologies concerning temporary wetlands. We showed how each of them is connected to  
512 different networks of people, funds, political support, and result in different enactments that sometimes co-exist  
513 and sometimes clash. Co-creating a conducive environment for negotiation remains challenging due to the  
514 dynamic water flows and the existence of diverse ontologies. Creating a space where the voices of the people of  
515 the merjas (*nas dial merja*) can be heard in negotiations concerning their still uncertain future is a priority, given  
516 their essential role and experience in living and working in these spaces and their aim to enact their own version  
517 of the merja.

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