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Abstract

The Senegalese delta, like many other agricultural territories in the Global South, is experiencing changes in agricultural trajectory. These changes are related to the promotion of competitive and performance-based forms of agriculture. In a context of tense relations between farmers and herders, the quest for equitable access to land, which is a guarantee of peace, stability, and balanced economic and social development, is being called into question by the arrival of capital investors and new actors that are highly supported by the State. This situation raises questions about two important issues: (i) the challenge of the sustainable management of natural resources, especially land; and (ii) the socio-political stakes related to the fact that land is a sensitive resource, both politically and socially. The situation is exacerbated by the fact that dominant discourses are being built around representation of

unused and available lands. The aim of this article is to address this controversy by questioning land-use planning processes and tools and underlining the reality depicted. We demonstrate that discourses around land availability are built upon sectoral visions that tend to overshadow the realities of land use. Indeed, livestock farming and particularly its mobile form (i.e., pastoralism) is rendered invisible by not being considered in the majority of land-use and agricultural policies. Through a participatory survey of campsites, we show that gathering basic information on livestock farming should not to be reduced to technical issues. Beyond that, we acknowledge that these land-use issues are rooted in sector-based and neoliberal visions of development. We conclude by discussing the importance of effective decentralization in financial and technical means and the development of systemic proficiency that goes beyond normative sectoral views to acknowledge and act on territorial development.

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Declaration of Competing Interest

Authors declare no conflict of interest. All authors have read and agreed to the published version of the manuscript.

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1. Introduction

Hunger and other forms of malnutrition continue to be society's great challenge (Godfray et al., 2010), while the increasing climate variability jeopardizes global food systems and agricultural development, notably in the most vulnerable areas such as Sub-Saharan Africa (SSA) (Thornton et al., 2011).

Certain policy efforts seek to eradicate food insecurity by 2030 (FAO, 2015). In order to align these goals with the looming prospect of feeding 9.7 billion people by 2050, transformative changes in the agricultural sector seem indispensable (Cole et al., 2018). Notwithstanding fervent and continuous support in favor of agricultural intensification, a large corpus of literature has underlined certain limits in terms of ethics, diminishing returns, and increasing externalities (Matson and Vitousek, 2006). Land conversion is seen as a complementary pathway, promoting the dedication of even greater amounts of arable lands for agricultural purposes (Cole et al., 2018). This paradigm follows the rationale that investing in land considered underutilized will compensate for production shortfalls (Byerlee et al., 2013). In practice, land investments in the agricultural sector are increasingly targeting SSA (Interdonato et al., 2020), portrayed a decade ago as underutilizing land. "Of the 183 million hectares (ha) of cultivated land in SSA, 95 percent is rain-fed and less than 5 percent benefits from some type of Agricultural Water Management (AWM)—by far the lowest irrigation development rate of any region in the world" (World Bank, 2013:30).

Along with underutilized land, marginal lands are also targeted to expand production schemes. Considered as uncultivated, these lands may harbor other types of value but are nevertheless seen as "suitable for commercial agriculture" (Exner et al., 2015:652). In the last decade, researchers have shown the costs associated with converting land from other uses to agricultural. For instance, Smith (2013) showed that out of the 3 billion ha suitable for crop production at the global scale, one-half was cultivated. Converting the other half, covered by forested areas, would entail high environmental and

operating costs. Others have shown concerns regarding increasingly scarce land (Lambin et al., 2013), and the multiple and often conflicting demands for land that engender that scarcity (Smith et al., 2010). This apparent scientific consensus is challenged by studies identifying potential for land conversion at regional levels, often under the term of Potentially Available Cropland. Studies by Bruinsma (2003) highlighted that land conversion will still be on the agenda in Sub-Saharan Africa until 2030, when it is expected to contribute 27% of the region's crop production. In 2011, the World Bank reported that 445 million hectares of potentially available uncultivated lands (globally), almost half of which is located in SSA, could benefit from agricultural investment (Deininger and Byerlee, 2011).

This rationalization is generally combined with the promotion of land investments led by agro-industries with the assumption that they will better address the challenge of reducing yield gaps (Deininger and Byerlee, 2011). Additionally, the emphasis on business in agriculture is justified by its contribution to alleviating global food insecurity and poverty (World Bank, 2019), and the expected trickle-down benefits to localized food security (Stiglitz, 2015). These narratives have taken root in rural areas of developing countries, propelled by government and Foreign Donor Funded Projects, where economic development and food security agendas are intertwined and bound by neoliberal ideologies (Mediavilla and Garcia-Arias, 2019). In line with Rostow's stages of development (1990), narratives are built upon indicators of productive efficiency with horizons of modernity and economic growth (Weis, 2010). This dominant conceptualization of agricultural productivity for development has fostered the global emulation of industrial capitalist agriculture (Ross, 2013), manifesting in the rise of large-scale land acquisitions (Johansson et al., 2016; Nolte et al., 2016) and the worldwide proliferation of land grabbing (Zoomers et al., 2016; Edelman et al., 2018).

In this international context of pressure on agrarian land and the commodification of agricultural space, the Senegalese government has undertaken policy and institutional reforms that sustain a vision of rural development directed towards highly productive sectors and the promotion of private agricultural initiatives (Bourgoin et al., 2019). The meta-analysis on agribusiness investments proposed

by Bourgoin et al. (2019) showed hotspots for land investments, and in particular the delta of the Senegal River valley (commonly called "delta" throughout the article). Here, "modern forms of agriculture" (Ancey and Monas, 2005) are propelled by government-led projects. One example is the Project for Inclusive and Sustainable Agribusiness Development (PDIDAS), which has been operating since 2014 with a 43 billion XOF loan from the World Bank. The project's rationale was justified by the fact that land is available for private investors to further develop horticultural production (PDIDAS, 2015, Mbaye Diop et al., 2017). This vision of modernity seems to be in contradiction with historical depictions of the area, portrayed as rich in pastoral activities (Michel and Sall, 1984; Tourrand, 1993; Corniaux et al., 1998). In practice, the discourses on land availability have met resistance within civil society, fostering the federation of a network of NGOs against the dynamics of land grabbing under a common umbrella organization called CRAFS (Faye et al., 2011; Kanoute et al., 2011; GRAIN, 2012; Bagnoli et al., 2015; Fall and Ngaido, 2016). At another scale, the Delta experienced several, more quantifiable local uprisings that opposed land acquisitions by agribusiness projects in the 2010s (d'Aquino et al., 2017).

The aim of this article is to address the controversy around unused and available lands by questioning land-use planning processes and tools. How inclusive are these tools and which reality do they depict? Current representations of land use seem inconsistent. Either pastoral activities, often portrayed as anachronistic (Magrin et al., 2011), have naturally declined in number and been replaced by what the government defines as "modern forms of agriculture" (Ancey and Monas, 2005), or, as we hypothesize, discourses on land availability have obscured the existence of practices that do not fit the values of a certain vision of agricultural development. Our specific intention here is to compare the representation of agricultural practices by current information systems with the reality of actual practices found in the field. We use simple but efficient methods to expose practices that have a limited spatial footprint in a data scarce environment. We also discuss current and future risks related to overlooking these practices.

2. Study area

2.1. *The Delta, an agricultural hotspot*

Since 2014, the current Government of Senegal has been conducting a development program, the Plan Sénégal Emergent (PSE), which is based on various key sectors of the economy, mainly commercial agriculture and the agri-food sector. The government also intends to modernize family farming through the implementation of microprojects aimed at enhancing the value of existing farms by intensifying production and diversifying sources of agricultural income through additional high value-added production. This vision is translated within the framework of a program to revive and accelerate the pace of Senegalese agriculture (PRACAS), which is based on four main areas of focus: (i) achieving self-sufficiency in rice, (ii) developing the groundnut sector, (iii) promoting horticulture, and (iv) strengthening food security. These are all aggregation projects aimed at positioning Senegal as a major exporter of high value-added fruit and vegetables and ensuring food sovereignty.

Since 2014, the government has also initiated a decentralization reform in order to revitalize territorial development and territorialize the ambitions of the PSE and PRACAS. This third act of decentralization proposes a redefinition of the territorial architecture by elevating the regions to the status of development centers. Within this framework, the Senegal River Valley (SRV) has been identified as an agro-industrial production area that can meet the challenges of agricultural production. To this end, the government is supporting the implementation of several large-scale projects in the delta of the SRV, including the Guiers Lake area (Bourgoin et al., 2019). The article will focus on this study area, characterized by multiple challenges around the use of land and water resources. Recent depictions of the study area by Bourgoin et al. (2016), describe the issues related to harboring different uses, namely agriculture (irrigated, flood recession, rainfed), pastoral livestock, fishing, and tourism. The strong intensification of agricultural activities described in literature is questioned from the angle of its impacts in terms of transformations of spaces and practices. It also questions i) the impact of decentralized land use planning processes and their role in articulating these dynamics; and ii) how data is used to plan current and future agricultural development in the area.

2.2. *Implementation of land use policies and the role of SAED*

SAED (Société d'Aménagement des Terres du Delta) was created in 1965, five years after Senegal's independence, with a threefold mission: "to develop 30,000 ha for rice cultivation in 10 years, to organize the settlement and agricultural colonization of the Delta and finally, to train and supervise the farmers" (Seck, 2009:23). Between 1965 and 1975, SAED developed nearly 30,000 ha of rice fields, followed by the settlement of nearly 900 families from neighboring regions (Louga, Podor, Dagana, Saint-Louis) and the creation of new villages (Boundoum Est and Boundoum Nord, Boundoum Barrage, Kassack Nord and Kassack Sud, Savoigne) in the delta. This dynamic of hydro-agricultural development was accompanied by immigration movements organized and supervised by the central authorities (forced migration during the colonial period and voluntary migration after independence) to provide the necessary manpower for the exploitation of newly irrigated areas.

The Delta experienced a socio-economic recomposition in the national political and economic context of the 1980s and 1990s. The disengagement of the State and the liberalization of economic sectors, imposed by financial partners, reduced SAED's maneuverability and resulted in the establishment of favorable conditions for peasant empowerment. The concurrent transfer of responsibilities to producers meant a transfer of financial expenses to producers as well (Lavigne Delville, 1991). The management of irrigation was thus transferred to the farmers, stimulating private initiatives and triggering the multiplication of privately irrigated areas. Beyond this euphoria, many of these private irrigation systems rapidly declined due to difficulties such as a lack of financial means, insufficient development, a credit crunch, or the devaluation of the CFA franc (D'Aquino et al., 2000; Bélières et al., 2002).

Piloted in the SRV in the late 1990s, Land Use and Allocation Plans (LUPs) were designed to provide a guiding framework for local managers to analyze and plan land uses. The idea of developing POAS was first formulated by the Senegalese government as part of the Integrated Development Master Plan for

the Left Bank of the Senegal River (1994), which recommended that rural communities adopt this tool in order to "control" their land.

The POAS pilot operation was launched in the rural community of Ross Béthio in 1997, at the request of its Rural Council, and led by a research team from the Institut Sénégalais de Recherche Agricole (ISRA), SAED, and the Centre français de recherche agronomique pour le développement international (CIRAD). The objective was to provide local communities with an institutional and technical tool to support land management (SAED, 2002). The POAS was created with the following objectives: (i) to clarify the land tenure situation, for better control and management of rural land by local elected officials and local communities, (ii) to strengthen complementarity between agriculture and other productive activities for integrated and sustainable rural development, and (iii) to promote the involvement of populations in development actions.

After the completion of this experiment in the rural community of Ross Béthio, the tool was transferred to SAED for large-scale implementation. The POAS is a model for the participatory development of rules for the management of space and natural resources, which can have a large number of positive impacts. It is also a tool for dialogue between populations and institutions, which can thus enrich or influence the conduct of any planning and development operation with regard to land use constraints or their repercussions on land (d'Aquino et al., 2001). At the local level, the modalities for the allocation and management of customary land are diverse and adaptable to the particular conditions of territorial development. This flexibility is generally opposed to fixed territorial management that encourages land speculation. The POAS was supposed to provide an answer to this problem, by allowing the integration of various local information systems at the territorial level, a dissemination of information and thus the establishment of a basis for land governance.

Since the beginning of the 2000s, agricultural policy can be analyzed through the agricultural programs and policies defined in the Accelerated Growth Strategy (ACS) and the Poverty Reduction Strategy Paper (PRSP). As the framework for the development of the government's objectives in all areas, the

SCA and the PRSP defined objectives for the agricultural sector and led to the development of several measures: the Loi d'Orientation Agro-sylvo-Pastorale (LOASP), the Programme de Développement des Marchés Agricoles du Sénégal (PDMAS), the REVA Plan (Retour vers l'agriculture), and other special programs. Here the common denominator is the intention of the State to regain control of the agricultural sector by reorganizing seed collection and distribution systems and promoting diversification of food crops to farmers through special programs (maize, sesame, cassava, bissap). Over the last two decades, SAED has been supported financially and technically by international projects. It has been involved in, or initiated, multiple technical and institutional innovations, especially in the field of land and territorial management, the policy of transferring the management and maintenance of hydro-agricultural developments to the users, and the promotion of a public-private partnership in the development of irrigation. In 1990, SAED generated its first geographic information system (GIS). The project, which was developed with The French Agricultural Research Centre for International Development and funded by the French Ministry of Cooperation, was designed to evaluate development in the Senegal River Valley through the monitoring of irrigated lands (Faye et al., 1995). That project was followed by the survey and cartography of irrigated plots for the Delta area (Passouant 1997). Between 1992 and 2000, SAED was also involved in a research process that intended to empower local authorities to develop their own land use plans. An initial pilot phase successfully demonstrated how SAED could accompany local authorities, in the context of decentralization, to collectively identify and map zones dedicated to specific activities (e.g., agriculture, pastoralism), and more importantly, plan endogenous investments (d'Aquino, Seck, et Camara, s. d.). This pilot phase was upscaled to all municipalities in the Delta area (and most of the municipalities in the Senegal River Valley), and SAED became the leading institution for geographic information on land tenure. Notably, SAED received funding from the French Development Agency (AFD), for the "Projet d'Appui aux Communautés Rurales de la Vallée du Fleuve Sénégal-PACR/VFS" (2007-2013). The objective there was to strengthen land information systems to (i) promote a better knowledge of space and land management rules, (ii) enable a good knowledge of land resources in the rural communities, (iii)

modernize and facilitate land monitoring and management by rural communities, and (iv) support decision-making.

3. Methods

3.1. *Building a cartographic diagnosis*

Using geographic information systems and cartographic tools, we mapped the current extent of official knowledge on land use. The cartographic diagnosis of the study area, was built during a scientific and technical partnership, funded by AFD in 2017-2018, and involving SAED, the University of Gaston Berger, CIRAD, and ISRA. In this context, partners pooled geospatial information which included a geo-database from SAED that referenced all hydro-agricultural developments. The database included irrigation scheme and georeferenced plots. Within this database, we extracted areas officially listed as registered irrigated lands (under SIF for "Système d'Information Foncier"). If POAS served to clarify the rules of access and sharing of natural resources, and thus ease the climate of social tensions and conflicts between users, they did not constitute a real tool for planning, securing land tenure and supporting decision-making in land use planning. The SIF intends to provide a rural cadaster, indicating land allocation status.

SAED also gave access to georeferenced POAS, including cattle tracks. The geodata used for the identification of current and future agro-industrial schemes in the study area comes from a partnership between CIRAD, the Land Matrix Initiative (https://landmatrix.org) and the Senegalese Observatory on Land Governance. To complete land-use datasets, we used BaseGéo Sénégal (www.basegeo.gouv.sn), which is an online and free geospatial database that gave access to broad classes of land use. Under the "Agence Nationale de l'Aménagement du Territoire "(National Land Use Planning Agency), those classes give us an account of the extent of irrigated and rain-fed agriculture. It also includes other base geographic layers, such as the location of roads, localities, hydrography, and protected areas.

Historical pastoral activities were identified through bibliographic work. We used digitalization tools to overlay historical cattle displacements depicted by Bonnet-Dupeyron (1950). Complementary

sources of information regarding current displacements were gathered using Google Earth Pro. Satellite imagery was used to digitizing all visible tracks. Although all of them are not used by cattle, they show that human-led activities do exist in these areas. All of these sources of information were used to build a Geographic Information System (GIS), within which thematic layers were combined, intersected and overlayed to highlight territorial dynamics. The GIS and subsequent maps were designed with ArcGIS software.

3.2. *Fieldwork and rapid appraisal of campsites*

The study area, commonly called delta throughout this article, is composed of 11 communes and includes 8,484 square kilometers. Initial field work included gathering information on pastoral activities in each commune in appointments with local government councilors. Decentralization was initiated in 1972 and reinforced in 1996 with increased autonomy regarding land management. Decentralization policies incrementally provided enhanced responsibilities to rural councils, but unfortunately, they were not backed up by institutional frameworks that could ensure sustainable and equitable, human and financial capital for the communities (Piveteau, 2005; Sané, 2016; Wilfahrt, 2018). These initial interviews revealed that no data on pastoral activities were available at the local level, and there was no recent census. The last national survey of agricultural was published in 2000 (RNA, 2000) and has not been updated since. To gather data on pastoralism at this meso-scale, we designed a protocol in partnership with the different rural councils to co-produce information on campsites and pastoral activities. The research team designed a succinct digital questionnaire administered by trained interviewers from ISRA. Surveys were conducted by a team of 11 trained interviewers, alongside 11 knowledgeable focal points appointed by the municipalities. Over a 2-month period, the questionnaire was administrated in all municipalities and at each campsite encountered, identified by the focal point and by snowballing sampling. The rapid appraisal of campsites was done through a light questionnaire recording the location of camps, number of animals (cattle, sheep, goats), the human population (men, women, children), annual and seasonal displacements, as well as any conflicts encountered. The subsequent database would serve as a

reference to measure the dynamics of pastoral livestock in the area. The survey was operationalized by using Kobotoolbox on affordable electronic tablets, gathering qualitative and quantitative data, and recording campsites coordinates. Based on ODK standards, Kobotoolbox is an open source survey tool that has proven efficient in crisis environments (Sapkota and Siddiqi, 2019).

3.3. *Data analysis*

To further analyze the data, we also modeled the information about displacements in a spatialized network. In the database, displacements originate from a specific (geolocalized) camp to a path including one or more Senegalese departments. In the model, we aggregated the information about camps according to their corresponding municipalities to reduce the noise in the network and provide a clearer representation of displacement paths and flow hubs across the entire country. This defined a network where each node represents either a department or a municipality, and each directed edge *(a,b)* between two nodes represents the presence of one or more displacements from location *a* to location *b*. Each edge is weighted according to the number of displacements between the two locations. In order to visualize and analyze the obtained network, we utilized *networkx* (https://networkx.github.io) and *matplotlib basemap toolkit* (https://matplotlib.org/basmap/) Python libraries.

4. Results

4.1. *Historical representations of livestock footprint*

The Senegal River delta was originally a region devoted almost exclusively to extensive pastoral livestock farming. In the dry season, livestock farmers exploited the paths left by the receding waters of the Senegal River, and during the winter, the dune pastures of the non-floodable lands in a river valley (called Dieri) provided quality grass cover (Corniaux et al., 1998). Depending on the amplitude of the season's last rains, herders could begin a long transhumance at the end of the dry season. As mapped by Bonnet-Dupeyron in 1950 (Figure 1-A), the herds were led to camps in the drylands in the rainy season, where agriculture was also practiced. In the dry season, the herdsmen went to Lake

Guiers, the wet lands or the Ferlo Valley, to exploit the flood-recession routes and water points (Figure 1-A). Authors have highlighted that, throughout the Delta, the low population density and limited extent of agricultural activities meant there was little competition between agriculture and livestock farming (Hervouët, 1971). The activities of the pastoralists and those of the farmers were complementary in a system that functioned smoothly and guaranteed ample food production. Beginning in the 1970s, repeated droughts and generally low rainfall forced herders to reduce their mobility (the main characteristic of the livestock system in the Sahelian zone) and move closer to water points (Jamin and Tourrand, 1986; Santoir, 1994).

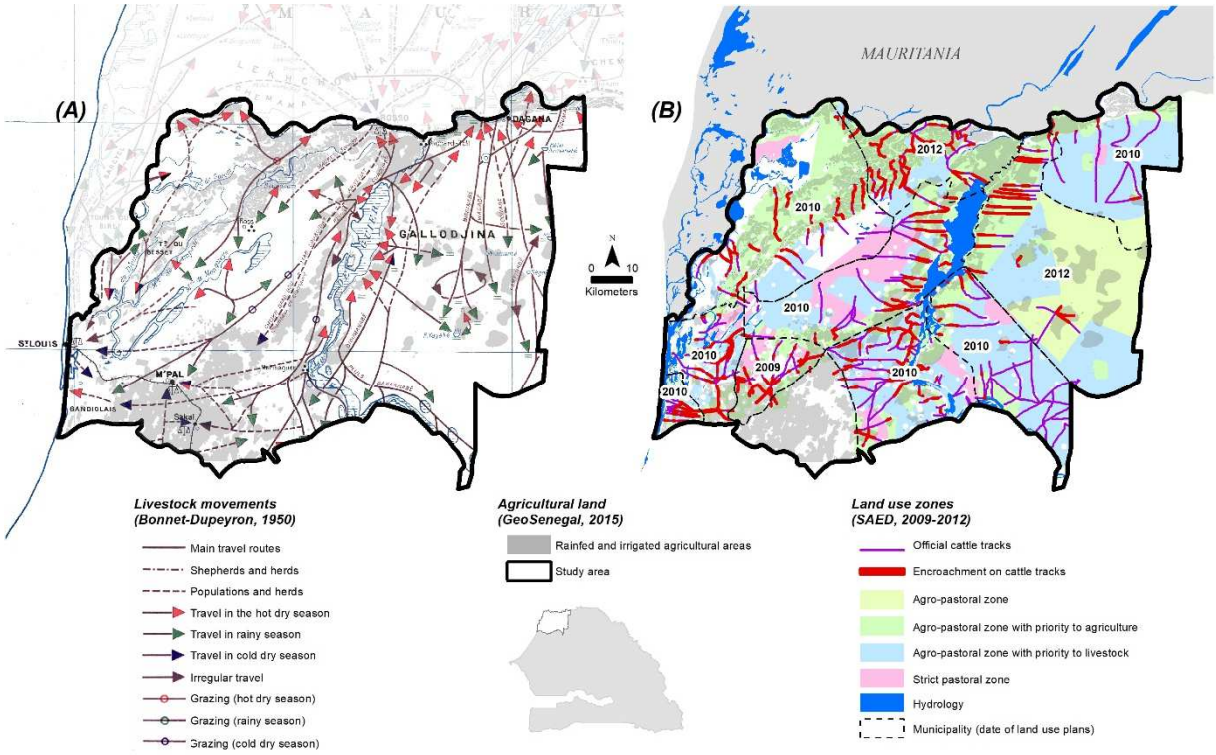


Figure 1. Comparison between the evolution in cartographic representation of livestock farming (from 1950 (A) to 2009-2012 (B)) and the existing extent of agricultural development (2015)

As shown in Figure 1, agriculture (rain-fed and irrigated, represented in grey) has acquired an important spatial footprint. The significant potential for irrigation has resulted in considerable allocations of public land for private agricultural use in a context characterized by the momentum of various private investors (national and international agribusiness, local populations, religious leaders,

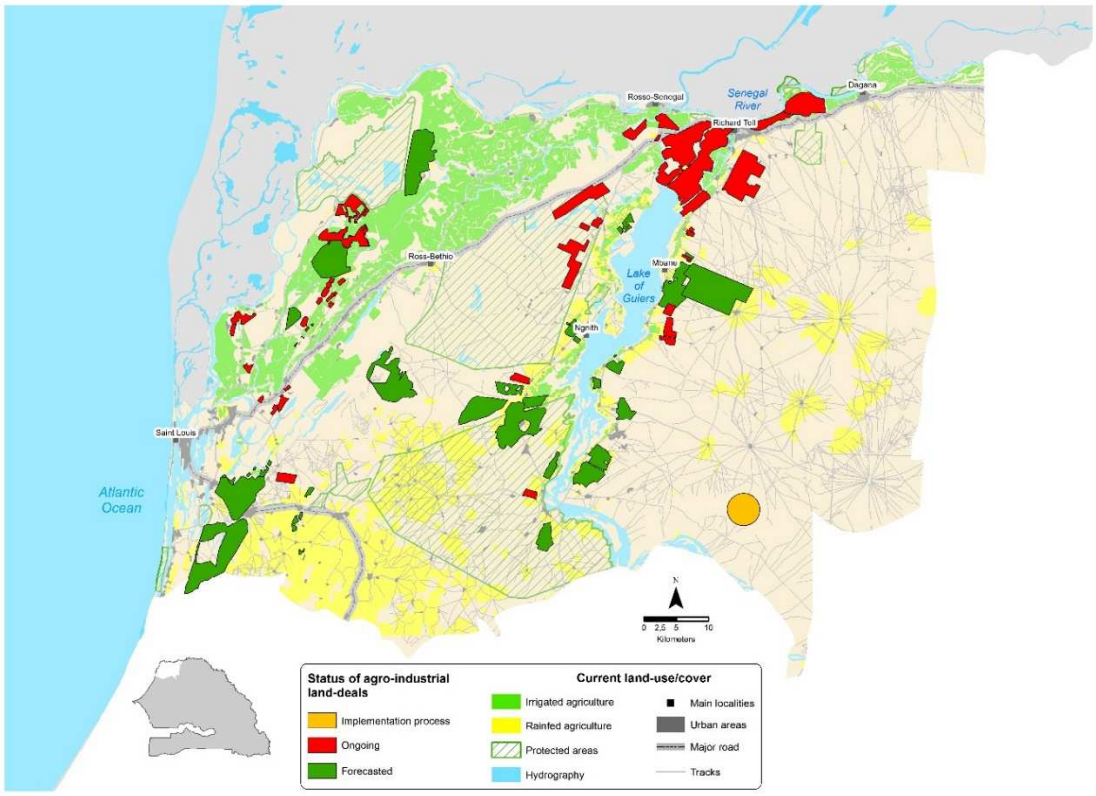
etc.) benefiting from easy access to agricultural credit. The Farmers' Organizations (FOs) of the Delta have not been outdone in this race for land. They have adopted a collective approach, based on the creation of large federated farmers' organizations, to increase their capacity to put pressure on the rural councils and play an intermediary role with the Caisse Nationale de Crédit Agricole du Sénégal (CNCAS). As a result of these transactions, private irrigated areas of 5 to 100 ha have proliferated in the Delta, rapidly exceeding the expansion of agriculture in areas funded by the State. The surface area of private developments has thus increased from about 10,000 ha in 1989 to 38,750 ha in 2005, and now represent 63% of the developed surface area in the Delta (SAED, 2012). Some donors did not hesitate, at the time, to praise the benefits of privatization, arguing that the private sector had developed more agriculture activity in the Delta in 15 years than the State had in 40 years. Since the early 2000s, this rush has accelerated in the Delta with the arrival of agribusinesses seeking access to large tracts of land.

Beyond the implementation of hydro-agricultural developments with complete control of water, innovations to support and encourage agricultural intensification aimed at improving production have focused on certain aspects: (i) agricultural mechanization, (ii) provision of equipment for production, (iii) improvement of soil fertilization, (iv) use of fertilizers and phytosanitary products, and (v) introduction and use of skimmed, improved, and certified seeds. Agricultural supervision and advice were provided by dedicated institutions such as the State's regional development entity, SAED. In addition to these technical aspects, economic innovations have been introduced, notably the facilitation of access to agricultural credit (campaign and equipment credit) through the creation of the CNCAS.

The combined decrease in sizes and accessibility of rangelands and flood recession fields—about 70% according to Tourrand (1989)—significantly increased conflicts between farmers and herders because of animal crop-raiding in the new agricultural areas. This dynamic of agricultural expansion occurred in conjunction with changes in land laws and episodes of severe drought. In concrete terms, the chronic

drought that has affected the region since the 1970s has significantly reduced the quantity of fodder on the wintering dune ranges (Tourrand, 2000). Some annual herbaceous species have disappeared and overgrazing in some areas has led to a qualitative and quantitative reduction in the pastoral resources in the drylands (Faye et al., 2016).

The changes in the agricultural context have led to precarious living conditions for livestock farmers. The mobility of herds, the basis of this farming system, is threatened. The land zones identified through POAS are presented in Figure 1-B. In practice, municipalities were divided into different areas, certain of which gave priority to livestock farming. In addition to zoning, livestock footprint was highlighted by the definition of cattle tracks that were meant to ensure secure and sustainable mobility to fodder and water resources. However, beyond providing information on the distribution of uses, POAS did not constitute a real tool for planning, securing land tenure and supporting decision-making, as these tools lack appropriation by local councils (Diop et al. 2016). Cattle track disregard can be acknowledged by intersecting agricultural extent in 2015 and POAS cattle tracks identified in the different municipalities (Figure 1-B). This blur surrounding livestock practices may have favored discourses of land availability and the development of agribusiness. Figure 2 displays the location of current and future agro-industrial schemes that settle in the remaining open spaces of irrigated lands, and make an incursion in non-irrigated agro-pastoral lands (Figure 2).



311

312 **Figure 2.** Identification of current and future agro-industrial schemes in the study area

313 ### 4.2. *Acknowledging current livestock footprint*

314 The Delta's land information system, developed by SAED and its technical partners, is unique source
315 of information on land allocation and a knowledge base for monitoring the dynamic of irrigated
316 agriculture. Figure 3 maps the three different inputs gathered through data collection. It overlays data
317 from the SAED's information system and from the digitized tracks using Google Earth, as well as the
318 location of campsites obtained through fieldwork. One initial observation concerns the spatial extent
319 of SAED's geodata as seen in Figure 3. This valuable information was assembled in the era of funding
320 from PACR/VFS and then the Millennium Challenge Account (MCA) and covers more than 56,000 ha of
321 agricultural plots. However, it remains limited by SAED's decades of control with its mandate to
322 manage irrigated agriculture. As presented by table 1, this dynamic has been supported by successive
323 agricultural development projects.

324

Project name	Timeframe	Technical and Financial partner	Sectoral objectives	Total area (ha)	Budget (million USD)
Millennium Challenge Account (MCA)	2011-2015	The Millennium Challenge Corporation (MCC), United States of America	Hydraulic and hydro-agricultural facilities for rice and horticulture	43500	540
Project for the Promotion of Rice Partnership in the Senegal River Delta (3PRD)	2011-2015 (+4 years extension)	French Development Agency (AFD), the West African Development Bank (BOAD), the Senegalese government and private operators.	Rice cultivation	2500	36,8
Senegal's agricultural and agri-food market development program (PDMAS)	2007 - 2014	World Bank and other financial partners (Canadian International Development Agency, French Development Agency, European Union)	Horticulture and Hydraulic Infrastructures	2500	35
Inclusive and Sustainable Agribusiness Development Project in Senegal (PDIDAS)	2014-2020	World Bank and Global Environment Facility (GEF)	Horticulture	67467	86
Local Economic Development and Agro-ecological Transition Project in the Senegal River Delta (DELTA)	2021 - 2026	French Development Agency	Rice, Horticulture, fodder towards agroecology	6000	55,3

Table 1. Identification of past, current, and future flagship agricultural development projects in the study area (not exhaustive)

The information gathered from satellite imagery (Google Earth) and through fieldwork enables the recognition of practices outside of these irrigated areas. For instance, Figure 3 shows 6,462 kilometers of digitized tracks and 1,187 campsites located and surveyed. The map illustrates the extensive footprint of livestock farming, structured as a network of camps connected by paths. We acknowledge that campsites are present in all communes, but even if irrigation schemes still allow campsites in their vicinity, it seems that most of the campsites are located in Dieri areas, away from irrigated zones. Figure 3 also distinguishes sedentary and mobile cattle. It seems that proximity to irrigated zones or to the road, are both parameters that influence the mobility of livestock farming. For instance, the markets of Mpal and Keur Momar Sarr have many campsites in their vicinity, mostly with sedentary livestock. Among almost 78% of people surveyed in campsites, the access to pastures is key to the choice of settlement. The presence of open spaces remains central to 45% of people interviewed, but seasonal transhumance does not concern all herders, and 45.6% of those interviewed indicated that the vicinity of agricultural areas offers jobs and crop residues. The presence of agribusinesses also offers job opportunities in farm work (Girard, 2020) and/or access to crop residues for cattle. The extensification of agricultural irrigation schemes has also offered the opportunity for sedentary herders to diversify their activity, by facilitating access to already existing water infrastructure. This is the case for canals in the vicinity of agribusinesses and other irrigated schemes, but also deep wells that have been developed extensively in Northern Senegal (Rasmussen et al., 2018). Other opportunities have been offered locally as niche markets have developed. For instance, Richard Toll a dairy company collects milk from pastoralists in the area to supply markets in the cities (Bourgoin et al., 2018). In addition to providing economic opportunities to herders, this strategy of sedentarization also reflects an urgent issue of livestock feed security. With the reduction of grazing areas, agreements are increasing between herders and agribusinesses for access to crop residues, and negotiations for agribusiness implementation often entail the creation of artificial ponds.

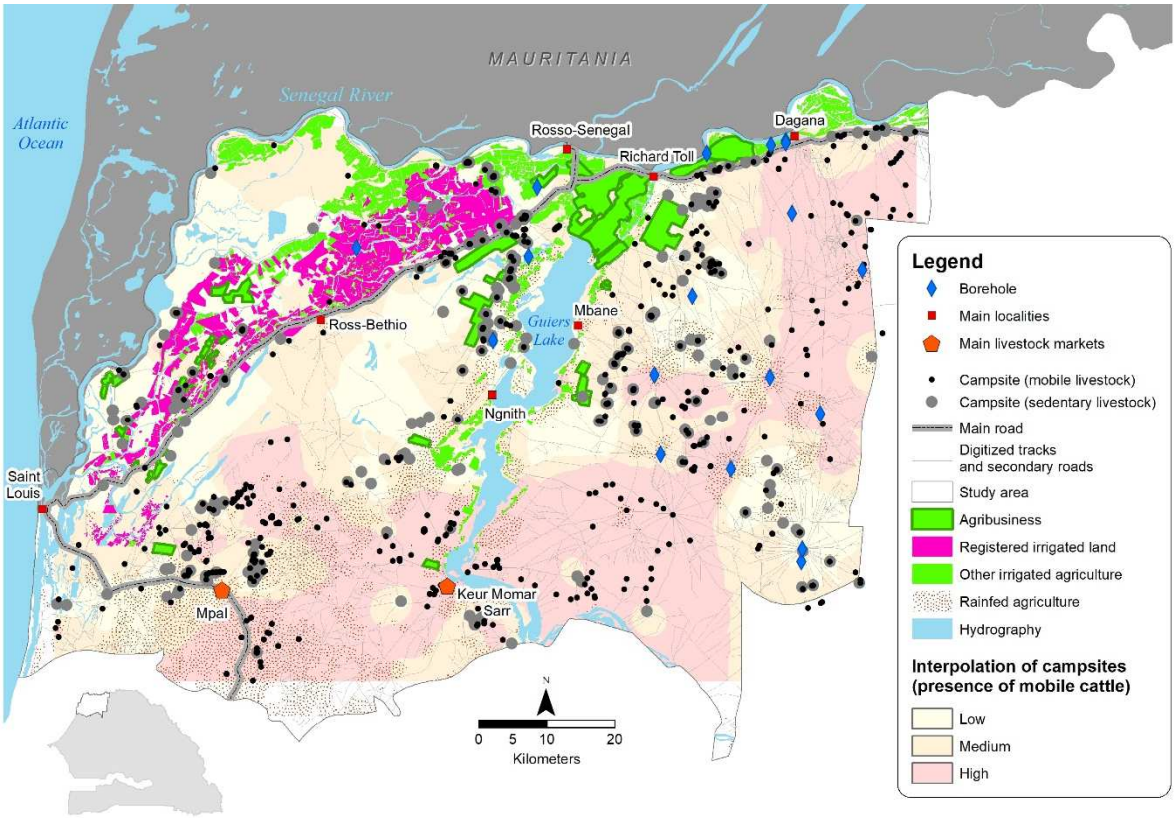


Figure 3. Spatial distribution of campsites in the Delta and the current state of land-related geographical information

4.3. *Weight of current livestock farming practices in the Delta*

Examples in literature have identified a trajectory for pastoralism suggesting that the encroachment of intensified agriculture may drive herders to lead sedentary lives (Benjaminsen et al., 2012; Benjaminsen and Ba., 2018). The landscape has evolved since the 1950s (Figure 1-A), but livestock mobility does not seem to be marginal in the area. Figure 3 shows that 63% of campsites rely on transhumance for their cattle. Table 2 summarizes the main figures regarding human and animal demographics. These numbers are declarative and originate from a rapid assessment method that will need to be complemented with in-depth surveys and interviews in order to understand more complex elements of diagnosis and strategies. Notwithstanding, trends can be observed through these

estimates. For instance, a larger number of animals are related to pastoral activities. The same trend can be observed with human population.

	#camps	#cows	#sheep	#goats	#men	#women	#children
Sedentary	438	30,387	25,184	23,569	5,788	8,012	10,129
Mobile	749	142,663	179,661	122,428	15,449	20,321	21,308

Table 2. Demographic figures related to sedentary or mobile herding practices

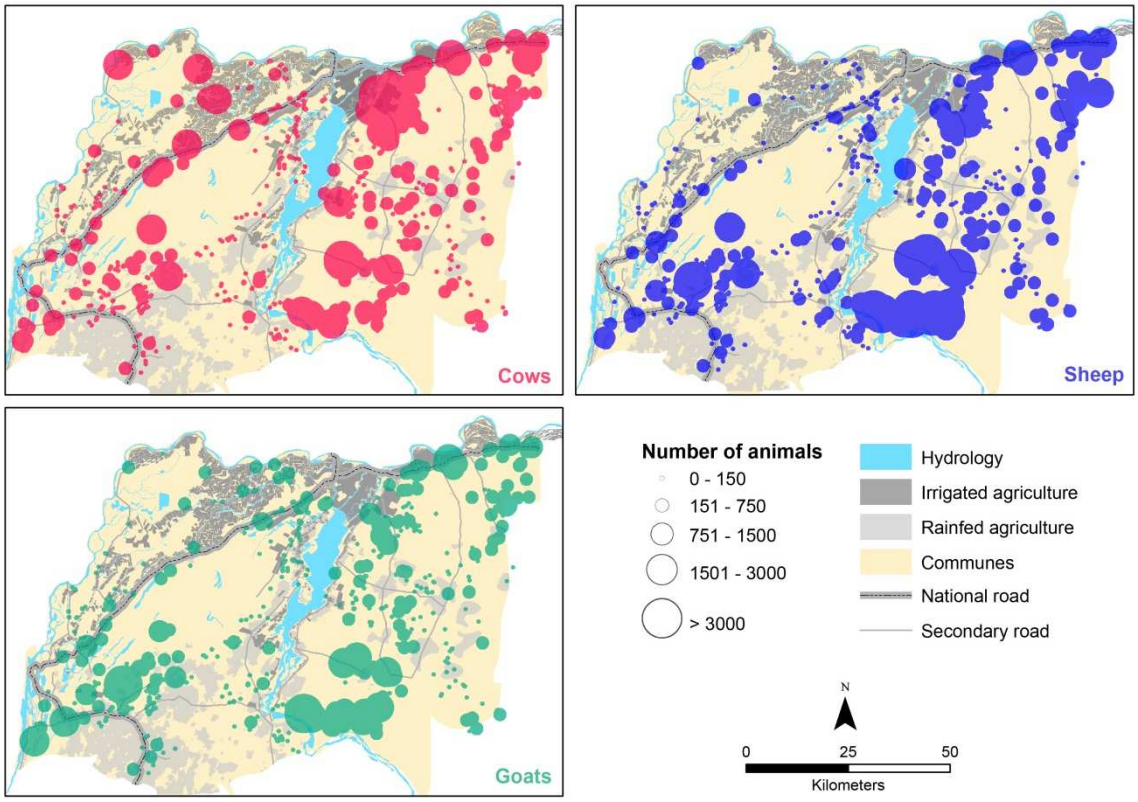


Figure 4. Distribution of animals for the surveyed camps

Figure 4 displays the spatial distribution of the main types of livestock in the Delta. This demographic distribution gives an idea of the economic weight represented by herders (sedentary and mobile). In terms of location, smaller animals seem to be concentrated in the Southern and South-Western area of the study map. Both of these areas harbor the principal livestock markets. The Eastern area also shows large numbers. This can explained by their proximity to the Ferlo region which is mainly

dedicated to livestock farming. On the contrary, cattle seem quite evenly distributed across the study map, although there is a significant concentration around Richard Toll (see Figure 3). This town harbors two important businesses that have developed a strong partnership: since the 1990s, the cane plantation of the CSS sugar company has grown to 15,000 ha. Despite a high level of mechanization, the company has opted to keep cane cutters who constitute the bulk of its seasonal workforce. This makes it one of the largest private employers in Senegal with nearly 2,000 permanent employees and 4,700 seasonal workers (company numbers in 2015). The second company is LDB, which collects milk from 1,000 herder families. Both companies are members of a consortium of agribusinesses (Vallagri group). They signed a partnership agreement in 2015 which gives LDB access to some CSS fields for baling sugarcane straw which can then be used in the dry season by farmers delivering milk to the dairy. Through this agreement, the agribusinesses are supporting further development of the dairy farmers.

4.4. *Visualizing and assessing mobility*

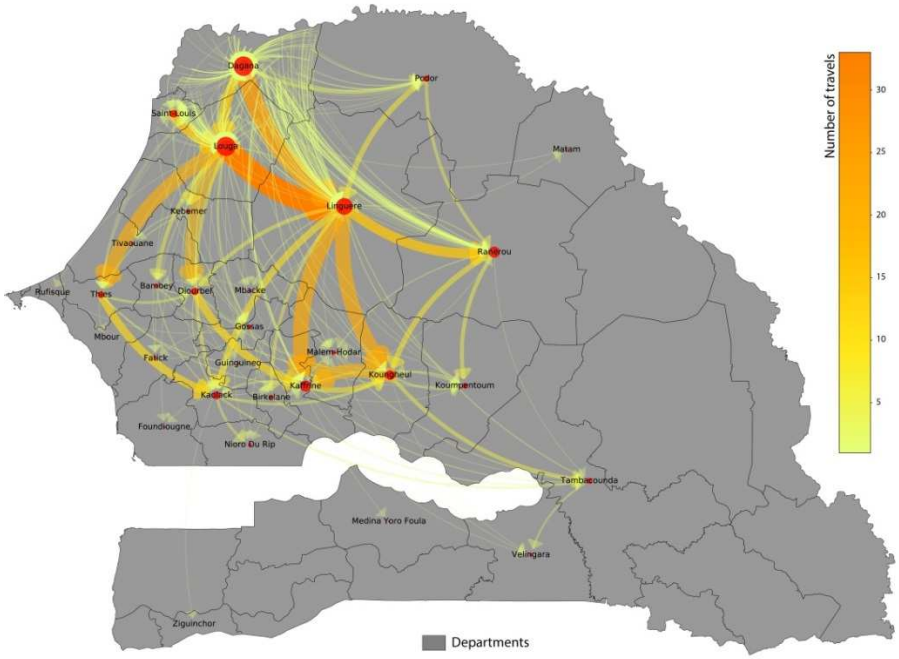
Among all campsites, 63% declare that their livestock is mobile. The analysis indicates more precisely that 15.8% of the displacement occurs within the same municipality, while another 22.6% stays within departmental boundaries. Thus, approximately 60% of the displacement from mobility affirming campsites extends to a regional scale, and for 92% of those herders, livestock is moved into other regions. Network analysis allows us to dwell further into the analysis of displacements.

Number of Edges	176
Number of Nodes	41
Transitivity	0.31
Average Clustering Coefficient	0.59
Assortativity	-0.2

Average Degree	8.58
Average Path Length	1.57
Reciprocity	0.16

Table 3. Structural characteristics of the displacement network.

Table 3 reports the main structural characteristics of the displacement network. The statistics indicate that the network is quite dense. In fact, it shows a relatively high average clustering coefficient of 0.59 (i.e., probability for each node, that its neighbors are connected between them) and transitivity of 0.3 (i.e., fraction of all possible triangles present in the network, where a triangle is composed of two edges with a shared vertex). Moreover, the average path length is relatively low (1.57), indicating that each location is separate from each other by less than two edges on average. By contrast, we can also note that the network is relatively disassortative (assortativity of -0.2) and shows low reciprocation (16% of reciprocal edges). These are expected values, derived from the way the network was modeled. Since the nodes can represent either departments or municipalities, it is reasonable to have a low assortativity (i.e., tendency of the nodes to be connected to structurally similar ones) because the departments will likely serve as flow hubs and be structurally different from the nodes connected to them, which may often represent municipalities. For the same reason, reciprocal edges may happen between nodes representing departments, but not between municipalities or between a municipality and a department.



409

410 **Figure 5.** Spatial representation of the mobility network. The color, proportional to the size of the arrows, is
411 correlated to the importance of the flows (see legend) and the size of the nodes (in red) is related to the sum of
412 the passages recorded in the department

413 The surveyed campsites identify important movements from the Saint-Louis region towards the
414 departments of Louga and Linguere, which are at the heart of the pastoral area, or Ferlo (Figure 5).
415 These areas, iconic for pastoralists, harbor important grazing areas and institutional mechanisms to
416 facilitate mobility (Wane et al., 2006). Other important movements are directed towards the Peanut
417 Basin and from the department of Thiès to the department of Koungheul, where historical
418 relationships exist between herders and farmers (Ancey and Monas, 2005). Most of these
419 displacements outside the department of residence are scheduled between December and January
420 when herders in the Delta face decreasing pasture and the loss of temporary watering pools (Figure
421 6). They reach larger grazing areas in the Ferlo (e.g., departments of Linguere, Ranerou), or large
422 livestock markets (e.g., departments of Louga, Diourbel), or large agricultural plots with crop residues
423 (e.g., Thies, Kaolack, Kaffrine, Koungheul). Seasonal displacements still define livestock mobility. Figure
424 6 shows the opposite displacements starting in June for herders outside the region and up to
425 September for cattle within department and regional boundaries. This dynamic is initiated by the

beginning of the rainy season in “hosting” areas, where farmers start preparing the fields for rain-fed agriculture.

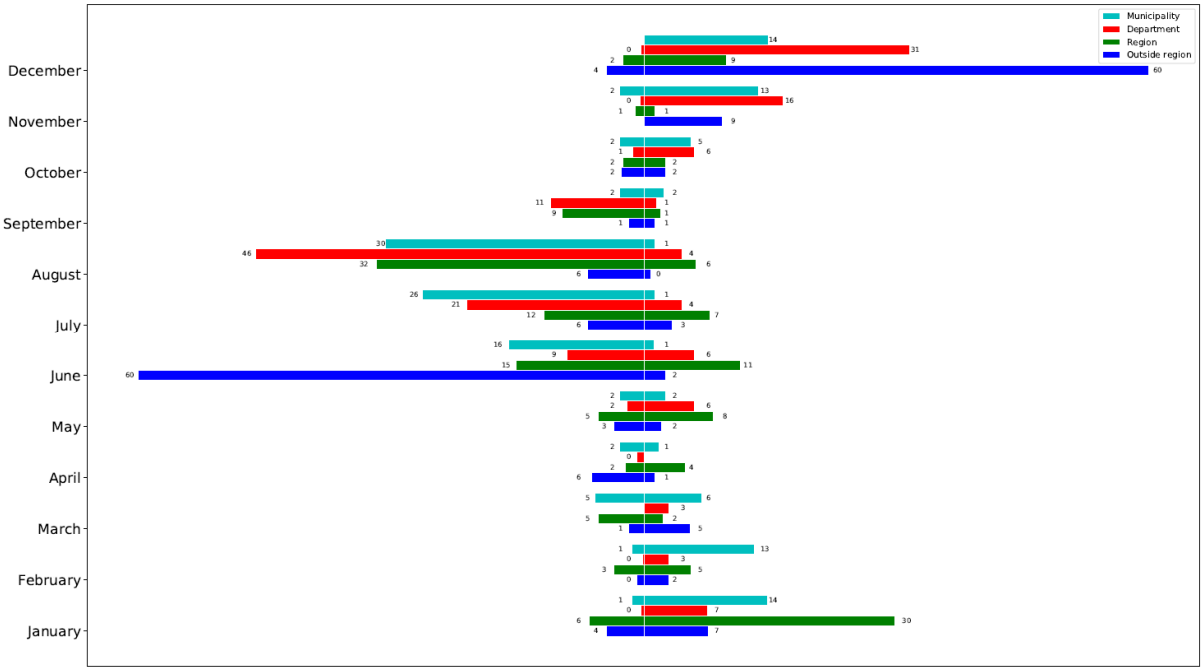


Figure 6. Displacement calendar within municipality, departments, other departments within the same region, or outside region (right-side leaving residencial base; left-side returning to residencial base in the delta)

5. Discussion

5.1. *Acknowledging current trajectories at a territorial scale*

For more than 50 years, the Senegal River delta and Guiers Lake areas have seen constant growth in hydro-agricultural developments. Propelled by the incentives of various mechanisms facilitating investments, around 25,500 ha of land have been irrigated between 2000 and 2015, almost 11,000 ha of which were developed by foreign agro-industries (Bourgoin et al., 2016). In 2019, eleven agro-industries were operating farms that averaged 600 hectares. One of these agribusiness, present since early 1970, accounts for more than 14 000 hectares on its own (Bourgoin et al., 2019). This trajectory for rural development is the result of the territorialization of agricultural programs promoting the development of intensive agriculture in Senegal (e.g. LOASP, 2004; PRACAS, 2014), and expected spillover effects from agribusinesses adherence to the rationale of mainstream economics (Pimbert,

2018). Despite its invisibility, our results show that livestock farming remains an important economic activity for a substantial, yet underestimated, part of the population. Influenced by these driving forces, land use and agricultural practices are evolving. For instance, sedentary livestock farming seems to expand in close proximity to infrastructure, services, and communication axes, as well as in the vicinity of roads, markets, and water schemes (Bourgoin et al., 2018). The construction of roads to access irrigable areas of the delta and the periphery of Lake Guiers, are also indirectly favoring the livestock sector by increasing market opportunities for animals and their by-products. This is particularly the case for dairy products (Bourgoin et al., 2018).

It seems that livestock farming has been able to adapt either by evolving towards a more sedentary and intensive model or diversifying their activities (Tourrand, 2000:63). Many authors have mentioned this adaptation in the Senegal River Valley, suggesting that herders grow rice, consider the partial abandonment of transhumance (Pouillon, 1990; Tourrand, 1993) and produce milk for dairies (Corniaux, 2005; Bourgoin et al., 2019). At the same time, farmers have developed hut farming. Agricultural by-products (rice straw and bran, various leaves) and agro-industrial by-products (tomato dregs, sugar cane molasses, peanut cake) have been increasingly used to support this gradual but radical transformation. However, this practice is not systematic despite the relative abundance of these new feed resources related to the increase in irrigated agriculture.

Behnke and Kerven (2011) showed that for the past 30 years, research has contributed to an effort to dispel the illusion of pastoralism as unproductive in comparison to highly efficient irrigated areas (Horowitz, 1995). Our results in this Senegalese case study have added to the momentum of this evolving perspective. Indeed, with 63% of the surveyed campsites still practicing pastoralism, this article proves that mobility is not a myth related to a romantic perspective, but remains a modern strategy to cope with scarce and uncertain resources in inhabited areas (Darre, 1996; Hodgson, 2000).

Beyond acknowledging the presence of livestock farming in this area, more questions arise regarding its management: Is recognizing livestock farming in the heart of the rice paddies sufficient to lead

467 authorities to reconsider their point of view on the merits of this activity? Does pastoralism have a
468 future in the delta that is likely to attract the funds needed to secure the activity? Is pastoralism
469 destined to evolve into more sedentary forms in the face of pressure exerted by the expansion of
470 intensified agriculture? History has showed that pressuring communities through social and spatial
471 exclusion hardly guarantees social peace (Bukari and Keuusaana, 2018; Nwankwo, 2020). In fact,
472 Benjaminsen and Ba (2018), demonstrated that the expansion of armed insurgency in Mali has a direct
473 correlation with the loss of pastures and blocked livestock corridors that resulted from national and
474 international development policies and programs. The subsequent marginalization fueled a movement
475 of pastoral resistance that took the presence of jihadist groups as an opportunity to leverage power
476 relationships and led to insurgency.

477 In our study area, analysis of territorial dynamics by Bourgoin et al. (2019), showed that, for the time
478 being, agro-industrial development will continue to impose its footprint on the territory through areas
479 already designated as "available for investment" (Figure 2). The map in this figure shows that future
480 investments are mainly forecasted in dry agro-pastoral areas, which may further impact the
481 displacement of cattle to pastoral resources (e.g. water, fodder). The progress of irrigated agriculture
482 in pastoral areas will continue to impose its footprint on livestock farming, driving its conversion to
483 more sedentary forms. As described by Shettima and Tar (2008:163), "farmer-pastoralist conflict … is
484 deeply rooted in the history, ecology, and political economy of the region." The combination of a lack
485 of consideration for livestock farming and the development of capitalist agriculture can only
486 exacerbate farmer-pastoralist conflicts in the Delta area (Benegiamo, 2020).

487 **5.2.*The construction of a narrative***

488 Perspectives regarding the future of the territory are even more uncertain because development
489 narratives and tools continue to be associated with reductive visions of agricultural practices.

490 Like other sub-Saharan countries, Senegal underwent a decentralization and deconcentration process
491 as a means of improving governance (Erk, 2015). In 1972 (law 75-25), rural municipalities were

492 designated and in 1996, a decentralization policy concretely transferred shared competences to local
493 authorities. These competences include land-use planning, thus giving local authorities control over
494 the management and organization of territorial and development planning. In practice, human and
495 financial resources remain limited. For instance, our study reveals important gaps at the municipal
496 level between intentions to monitor and map land uses and the authorities' technical capabilities (i.e.,
497 knowledge, training, and tools required). For Wilfahrt (2018), decentralization in Senegal has led to an
498 elite monopolization of rural development projects and local decision-making. Piveteau (2005)
499 previously underlined that this weak decentralization was bound by asymmetrical power relationships
500 and related to an increasing influence of external parties, such as development aid and projects that
501 follow sectoral agendas under national guidelines. This process in Senegal was characterized by
502 Platteau (2004) as "decentralized development." Outside of shallow discourses associating
503 development issues with technical concerns due to imperfect decentralized processes, we agree with
504 Piveteau (2005) in the assertion that choices of development are greatly influenced by governments
505 and their technical and financial partners. In recent decades, for example, the largest agricultural
506 development projects propelled by the Senegalese government and its financial and technical partners
507 have mainly focused on developing irrigated schemes for rice or horticultural sectors (Table 1). Some
508 of these projects included a land-use planning component, which delineated cattle tracks (Bourgoin et
509 al., 2018). Unfortunately, these tools lacked enforcement and most of the tracks, delineated in the
510 early 2000s under the PACR project (AFD funding), were obstructed by rain-fed or irrigated agriculture
511 (See Figure 1-B). Due to the lack of dedicated funding (from projects or communal budgets) these cattle
512 tracks never physically materialized as lines on a planning map. As a result, recent assessments of land-
513 use planning tools, designed and enforced by SAED and its financial and technical partners, have shown
514 extremely low, almost nonexistent, levels of dissemination and appropriation by local stakeholders
515 (i.e., farmers, village leaders, and local governments).

516 This situation may suffer from concrete technical and financial reasons. Nevertheless, we hypothesize
517 that the natural complexity of the situation is made more so by design and as a consequence of choices.

These orientations are bound by a vision of agricultural progress, which promotes enhanced productivity and land conversion, essentially converting territories into what Exner et al. (2015) called a “land of value.” In Senegal, land-use planning tools proved useful for confirming the spatial footprint of certain farms and crops. For instance, SAED has been assisted by successive projects in assembling geographic information systems (GIS) that specifically monitor the development of rice paddies. This rather narrow focus, in terms of territorial development, has led to a skewed understanding of the complete agricultural system and to information systems that materialize and legitimize a particular vision of agricultural development (Nalepa and Bauer, 2012). Gautreau (2018), has recently showed how GIS can become normative tools despite their initial focus on specific sectors. In many cases reported by the author, this has led to the overestimation of “available land,” resulting in land dispossession of stakeholders with the lowest visible footprint (e.g. pastoralists). Authors like Scott (2009) also question the transparency of the underlying rationale for development. The eclipsing of certain practices and extensive support received by others may exceed the “purported efficiency, productivity, or contribution to the national economy” and be more related to potential government tax revenues (Behnke and Kerven, 2011:25). According to the World Bank, the modernization of rural land sectors will follow cadastral imperatives (Byamugisha, 2013; World Bank, 2019). In Senegal, the land tenure reform initiated in 2012 has been supported by development institutions, and recently the land sector has been driven by the Senegal Cadastre and Land Tenure Improvement Project.

If the recognition of existing rights, individual and collective is on the agenda, it will be interesting to analyze how uncertainty, particularly with regard to the availability of pastoral resources, is taken into account. Many authors have underlined the urgency of addressing climate issues, the Sahel being particularly vulnerable (Mirzabaev et al., 2019), and identified mobility as a crucial strategy to deal with the annual variability in temperature and rainfall, which in return conditions the availability in pastoral resources (i.e., water and fodder). Defining definite boundaries for specific land uses might impede mobility and force the transition towards fixed settlements (Retaillé, 2003).

5.3. *Putting livestock farming on the map*

In this paper, we have shown that putting livestock farming on the map should not suffer from technical issues. Combining a partnership with local authorities and a rapid appraisal of campsites allowed us to paint a clearer picture of the livestock footprint. In addition to the location and spatial extent of this activity, we identified that mobility is still a reality for a majority of livestock farmers, despite an increasingly unfavorable context (Brottem and McDonnell, 2020). In terms of land governance, we underlined that local authorities were without such basic information, and it has not been integrated into development projects. Identifying this gap in the representation of pastoral mobility is important and calls for a paradigm shift.

In a context of neoliberal processes, where governments decentralize land-use planning, while delegating the financial means for development to foreign aid or private investors, it seems that the autonomy and empowerment of local authorities remains limited (Kohl, 2002). Projects and development agencies seem to have followed agendas that are inherently sector-based without considering a wider vantage point. This bias does not favor a systemic understanding of the dynamics and needs at territorial level (Pimbert, 2018). As a result, certain activities or sectors, like pastoralism in this case, are considered secondary or simply overlooked by design. This is a significant drawback to developing land-use planning that take account of pluralism. Beyond a critical post-development posture toward those development practices and discourses (Ziai, 2017) and the pitfalls of romanticizing grassroots dynamics (Ziai, 2017), we believe that there are other paths to take. In practice, this implies overcoming issues of the participation that is needed to legitimize the "modalities, agency, and procedures" of development (Ziai 2017:2552) and foster positive social change which includes pluralism without depoliticizing society.

In more concrete terms, we advocate for the implementation of approaches evolving from traditional sector-based initiatives, technical innovations (such as improved numeric technologies for land-use assessment), as well as projects willing to acknowledge the diversity of people and resources (Suttie

568 and Hussein, 2016). Beyond rhetoric and good principles, many development approaches lack
569 inclusive, participatory processes of negotiation and planning that explicitly include the construction
570 of trade-offs between development objectives (Sayer et al., 2013).

571 Instead of focusing on outcomes, we advocate for initiatives that favor processes in which actions are
572 based on facilitating dialogue in a context of pluralism. The first, basic step would be to associate the
573 discourses with an explicit assessment of the existing socio-ecological systems and governance
574 mechanisms (Nassauer and Opdam, 2008). A second step would be to explicitly challenge current
575 mechanisms of inequality and address the asymmetries in power and influence (Reed et al., 2017).

576 Pragmatic technical and organizational changes should be implemented to secure livestock mobility.
577 The capacity to plan future activities and investments could be increased by providing communal land
578 managers with access to reliable and dynamic geo-spatial information on land dynamics. In contrast
579 to historical and current land management projects, this would improve transparency in land
580 transactions and strengthen the accountability of land investors to the community. Our proposal is in
581 line with the initial POAS rationale. However, lack of ownership of such tools at local level (Diop et al.
582 2016) calls for different approaches.

583 Aside from technical solutions and promises (Briday, 2019; Joly, 2015), innovative proposals regarding
584 data and cartography should be accompanied by structural organizational changes. This would entail
585 cooperation between local authorities, decentralized state services, and new external services that do
586 not yet exist but would provide important support outside of the partisan and political logics that are
587 not always focused on the common good. Initial steps have been taken in this direction with PDIDAS
588 project and the support of locally based “land agents” in the study area. Future research should focus
589 on analyzing their role in supporting cross-sectoral, land-use planning. We propose that such “land
590 agents” would be integrated into official deconcentrated land administration, beyond current
591 precarious project-based status. If POAS lacked legal-basis, we propose that dynamic land information
592 system manipulated by land agents become rooted in a strong legal basis. Here administrative

593 authorities would rely on such tools to exercise legal control over all land transactions, but also to
594 manage certain conflicts of use in agreement with the technical services. This reflection will have to be
595 carried out within the framework of the land reform process, which is still undergoing. If POAS were
596 designed at communal level, we propose that SAED play the role of facilitating inter-communal land
597 use planning and exchange in the network of communal-based "land agents". This change of scale
598 would allow SAED to promoting integrated territorial development, with a strategic view on the
599 interconnections between several land uses. We believe that SAED will play a great role in
600 strengthening the skills of communal agents with a view to (i) mastering the updating of a territorial
601 diagnosis, and (ii) having an wider understanding of land dynamics. Hence, we propose that the
602 production of reliable and shared assessment on territorial dynamics should accompany public
603 discussions on land governance and lead to more efficient and inclusive construction of development
604 policies at communal scale.

605 **6. Conclusion**

606 In recent years, pastoral mobility has become emblematic of resilience in the Sahel, as evidenced by
607 the Nouakchott and N'Djamena Declarations issued in 2013, affirming the contribution of pastoralism
608 to the Saharo-Sahelian areas. In practice, information related to pastoral activities at the municipal
609 level is still lacking and development projects supporting sustainable development through land-use
610 planning have not aimed at overcoming this issue and have difficulty freeing themselves from sectoral
611 logic and constraints. In Senegal, the delta is experiencing strong pressure on natural and land
612 resources. This area is characterized by the historical variety of activities and inhabitants (physically
613 present, such as farmers and pastoralists, or absentee farmers like those living in Dakar). Over the past
614 decades, the area has experienced significant agricultural expansion, particularly hydro-agricultural
615 facilities, reducing spaces for extensive practices, while creating new opportunities and services. The
616 trajectory of agricultural intensification continues to be supported by political viewpoints. Our
617 research shows that this trend is strongly related to neoliberal and productivist visions of agricultural

development and the lack consideration for practices that have been rendered invisible by normative land-use planning tools and processes. Livestock farming is evolving towards more sedentary practices, attracted by better access to schools, jobs, markets, but also forced by conflicts and reduced access to pastoral resources (i.e., water and grazing areas). Notwithstanding, we highlight that livestock mobility is still present in great numbers, and we advocate for its consideration in land governance mechanisms, the sake of equality, social justice, and peace.

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