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Article

Improving Transparency and Reliability of Tenure Information for Improved Land Governance in Senegal

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Abstract: In current literature, certain scholars have stressed the role of the private sector in the process of revitalizing agriculture through agribusiness-led development. Others have underlined the global risks of poorly negotiated land acquisitions that disadvantage farmers and of nontransparent trade arrangements that create suspicion within local communities. Official and unofficial data whose relevance is frequently questioned, because they differ from actual conditions found on the ground, are often built upon these narratives. This acknowledgement points to the need for reliable data in order to support constructive debates on models of agricultural development. Senegal is experiencing similar controversies involving the dynamics of agribusiness development within the context of inadequate information on land acquisitions. In this paper, we first acknowledge the existence of past and current efforts to address investments in the agricultural sector. After critical analysis of these documents, we propose another way to monitor investments with survey tools that are embedded in participatory action-research processes and then provide information that can be used as a boundary object. We advocate the use of mapping tools to identify and monitor land processes, and the use of geospatial information to help identify an initial inventory of various sources of data on large-scale land transactions.

Keywords: large-scale land acquisitions; geodata; Senegal

1. Introduction

Since the food crises of the mid-2000s, the paradigm for food insecurity has shifted from inadequate access to food to inadequate production of food [1]. As a result, it is now commonly accepted among international donors and researchers that the challenge of feeding the world requires enhancing the quantity and quality of agricultural commodities [2–7]. This statement is often related to the urgent need to free smallholders in developing countries from the cycle of subsistence farming [8]. This relates to a more capital intensive vision of agriculture, which includes (1) providing access to innovative agricultural technologies and productive assets in order to increase yields and generate marketable surpluses; (2) strengthening the linkages between farm-level production, processing, and marketing activities in order to improve access to markets; and, (3) developing commercial agriculture.

To address this vision, the majority of donors, as well as scholars, stress the need of a New Green Revolution, especially in Africa, linking farmers to global value chains. They also emphasize the role of the private sector and foreign investments in the process of closing the yield gap and revitalizing

agricultural production through agribusiness-led development [9–13]. Regional policies, such as the Comprehensive Africa Agriculture Development Programme (CAADP) and now the CAADP results framework, reflect these trends in agricultural development, emphasizing the importance of strengthening stakeholders' engagement and encouraging and supporting private sector investment in agriculture [14,15]. This development programme has been one of the seven pillars of the New Partnership for Africa's Development (NEPAD), a framework designed for addressing the challenge of improving agricultural productivity in Sub-Saharan Africa [16].

The term agribusiness, which generally comprises the collective business activities that are performed from farm to table [10], is used in this paper to describe large-scale, industrialized corporate farming. The sufficient development of agribusiness could enable a drastic increase in food production and achieve food security, but it could also offer opportunities at the local scale, for poor people to improve their livelihoods and escape poverty. Some research has shown that the development of agribusiness can generate jobs and create opportunities for smallholders, while also respecting the rights of local communities and the environment [17,18]. Other studies align with the paradigm of food security as being foremost about food production and highlighting the links between tackling yield gap issues and addressing food security objectives at national levels [19–22]. A recent report from Mirza et al. highlighted that responsible land investments by the private sector can foster positive incomes, especially regarding job opportunities [23].

Sub-Saharan Africa appears to be a natural place for the development of this new doctrine: the concern over food insecurity is increasingly relevant and Africa offers abundant natural resources, large and exploitable gaps in yields, as well as suitable "marginal or unoccupied lands" [19–21,24]. In pro-agribusiness documents [17], the availability of underutilized farmlands seems to be unquestionable, although Lambin et al. [25] warn that estimates of Potentially Available Croplands (PAC) are often overestimated and they overlook local land use issues that are associated with social and environmental realities (e.g., customary rights and traditional practices).

A number of scholars have specifically underlined the potential risks of the global land acquisition phenomenon [19,26]. However, the promotion of agro-industries is controversial beyond the debate of land availability. Some scholars wonder whether agribusiness, while improving overall agriculture production in Sub-Saharan Africa, will actually improve household food security or incomes [1]. Foreign agricultural investments could merely result in "enclaves of advanced agriculture" that offer little benefit to the host nations and result in "purely extractive neo-colonialism" [27,28].

Among other issues, large-scale land acquisitions are usually depicted as non-transparent, an aspect that engenders suspicion. At the local level, this means that land transactions are often poorly negotiated with local farmers and they suffer from a lack of accountability that creates questions about equitability [20]. Nevertheless, more generally, official information on land transactions is simply not available, despite the fact that there is an urgent need for relevant and accountable data on the forms and dynamics of agribusiness, as well as their contribution to economic and development goals [29]. Due to this lack of disclosure, the unofficial (e.g., NGO assessments) and rare official data sources at the national level are usually subject to discrepancies and they rarely present reliable statistics [30]. A speculative and dogmatic environment is nourishing the current debate regarding agro-industries and there are strong recommendations for the disclosure of large-scale land investments under the Free, Prior, and Informed Consent (FPIC) guidelines [31,32]. Global estimates of land transactions can be found in NGO reports, research papers and media newsletters [19,33,34], but the aggregate of global information only produces a blurred image of the phenomenon, and the lack of consistent methodology and accurate data beyond speculative figures only confuses the issue [30]. Global databases assemble the declarations of interest in land investments and allow for cross-country comparisons, but they do not necessarily provide precise indicators that can identify areas with verifiable production. For instance, in the case of the Land Matrix, even if precise information can be crowdsourced for certain case studies, this level of precision is not consistent across the whole database. Scoones et al. advocate for more local studies and ground-truthing processes to analyze the

LSLA (large-scale agricultural land acquisition) phenomenon beyond the accumulation of hectares. The authors underline that accessing authentic data could come from participatory action-research initiatives, with “researchers being the conduits for local voices rather than replacing them” [30] (p. 479).

In this paper, we report on the experience of a collaborative research process that was conducted in Senegal to provide dynamic and accurate geospatial information regarding land acquisitions. It aims to assess and comprehend agribusiness dynamics at the national level and provide inputs to improve the relevance of global databases.

In Senegal, previous agricultural programs have emphasized the need for the development of intensive agriculture and export-oriented farms in order to “respond to international demand” [35]. The economic opening of Senegal’s market took place in conjunction with the global rise of agricultural commodity prices, and these rising prices stimulated the interest of financial institutions, agribusiness industries, and sovereign wealth funds. The first two considered it to be an economic opportunity, while the latter saw the investment as a means to secure food supplies for the state they represent. This practice peaked in 2008, with the soaring prices of food products triggering several “food riots” around the world [21,29].

In Senegal, an opposition movement to large-scale land acquisitions culminated in 2012 with the creation of the CRAFS (Cadre de Réflexion et d’Action sur le Foncier au Sénégal). The framework, which groups different NGOs and civil society organizations, came together around the issue of transferring agricultural land that is used by family farming to private investors. In addition to supporting local farmers against “land grabbing” dynamics, the civil society organizations and NGOs advocate for improved transparency and reliability in land tenure information in a national context of Land Reform. Indeed, a campaign for National Reform on Land Tenure was initiated in 2012 and it resulted in the proposition of a National Land Policy that was presented to the Senegalese President in October of 2016. The process has been on hold since then. Land reform has always been a difficult subject for Senegalese policy makers and it has not been addressed since 1964 with the enactment of the National Domain Law that banned customary rights in theory but never in practice. Today, the country has overlapping land regulation systems that vary from legal rights that are aligned with official land policy to socially legitimate, but informal, customary rights. These systems coexist in a context of demographic growth, urban sprawl, and the increased commoditization of land.

Our research project stems from local demands and it brings together research and development partners to assemble accessible information on land transactions that could be useful for decision making and land use planning. The following section focuses on the Senegalese context, expanding on the agribusiness issue and the way that it has been treated in recent reviews. We then expose the methods that were used in the project and present preliminary results on agribusiness dynamics at different scales. From these results, we delineate future paths for research on agribusiness dynamics in Senegal and then discuss the role of accurate geospatial information on land acquisitions.

2. Materials and Methods

2.1. Context of Agri-Business Development in Senegal

Agriculture in Senegal (including forestry, livestock, and fisheries) accounts for only 15% of GDP, even though 65% of the working population is involved in farming [36]. Most Senegalese farms are small family farms, with 70% being under five hectares [37]. Senegal mainly relies on irregular, rain-fed agriculture, which occupies about 87.1% of agricultural families [37]. Water availability is thus one of the country’s biggest agricultural challenges.

Peanuts are the engine of the rural economy and are being cultivated on two-million hectares, which accounts for 40% of all cultivated land. Cotton accounts for about 3% of total exports and it represents the third source of export earnings for Senegal (roughly 28 million USD over the period

1995–2000). However these cash crops are declining, while horticultural products and grain crops are on the increase.

In fact, Senegal does not meet its self-sufficiency goals [38]. The production of food crops cover barely 30% of Senegal's food needs. In addition, agriculture remains extremely vulnerable to climatic variations and to fluctuations in international markets for exports of agricultural products. Economic, climatic, and sanitary constraints lead to declines in yields and cultivated surfaces, as well as the increasing degradation of soil. In general, local farmers lack the resources for the development of irrigation, and the purchase of fertilizers and pesticides along with mechanical and conditioning equipment.

These issues have long been identified. Successive Senegalese governments, as well as international donors, have stressed the urgent need for the modernization of agriculture through intensified practices. Following the recommendations of international donors, and hoping to boost the agricultural sector, the Senegalese government has gradually liberalized its market since the late 1990s. The development of this policy has occurred over the course of several legislations and programs that are designed to open the primary sector to foreign investors: This includes Senegal's involvement in the New Partnership for Africa's development [16], the vote of the Agro-sylvo-pastoral Act (LOASP) in 2004, the Accelerated Growth Strategy launched in 2005, and more recently, the Emerging Senegal Plan (2012). These initiatives were all promoted by the FAO, the World Bank, and several other international institutions [39–41]. On an international level, this rationale is also supported by the G8 New Alliance for Food Security and Nutrition (NASAN), which aims to improve food security through policy reforms in 10 African countries (including Senegal). NASAN brings together more than 200 private companies, along with the governments of the target country, the African Union, and NEPAD/CADDP. NASAN is also associated with the Grow Africa program (since 2011), which was set up by the World Economic Forum, African Union, and NEPAD through the New Vision for Agriculture initiative. This program structures a platform that promotes investments in public-private partnerships to improve productivity, environmental sustainability, and economic growth. In 2014, a report that was led by Oxfam highlighted that these international programs encouraged African governments to induce reforms that create favorable environments (e.g., access to land tenure, natural resources, and inputs) for private investments through liberal reforms and deregulation. However, they also stressed the fact that the direct beneficiaries of these policy changes were private companies that lacked transparency in their projects' implementation.

The opening of Senegal's market to foreign investors and the growing interest in developing agricultural land have led to the development of agribusiness industries in Senegal [42]. The Government has looked to these foreign investments in order to meet primary goals, such as the development of food self-sufficiency, the development of food exports, and income generation for the farmers, as well as the improvement of basic infrastructures in remote, rural, and less productive areas. In the Emerging Senegal Plan, which was drafted in 2013, the agricultural section explicitly targets the synergies between agro-industries and family-farms as the main lever to encourage rural development and the emergence of mid-sized farms. This win-win partnership is expected to improve self-sufficiency in rice, maize, onion, peanut, and other horticulture productions.

A large number of farmers' organizations, rural stakeholders, NGOs, and politicians have expressed disapproval of the liberal path that was followed by Senegal in terms of agriculture. They have specifically expressed concern about possible land-grabbing from local farmers that lack proof of ownership, the environmental impact of intensive unregulated agriculture, the threat to food security due to the development of export agriculture rather than subsistence crops, and the unwanted and disturbing social changes in the rural communities that are affected by the development of agri-business industries [21,41–44].

Civil society organizations and agricultural unions have also been worrying regarding the potential negative impacts that agro-industries may have on local communities.

Although agro-industries have been developing in Senegal since the 1970s, little information is available on the effects of the various initiatives (area, crops, destination of production, permanent

and temporary workforce, etc.) The combination of undisclosed investment contracts and insufficient communication from the government and agri-business companies makes access to information extremely complicated, which, in return, fuels doubts and distrust among NGO's and local farmer organizations [21,30,41,45,46].

Since it is often difficult to access accurate figures regarding the expansion of certain agri-industries, several Senegalese NGOs have decided to tackle this issue through the quantification of the dynamics at the national scale. A broad range of information was collected, from press releases to personal contacts within local communities. Two national inventories were released [42,47]. Land deals in Senegal were also described in more expansive documents that addressed the phenomenon at the international scale [33,34]. However, the methodologies and the results significantly differ and they do not provide geo-information on land acquisitions that are made by agri-business farms across the country. This led us to propose a new inventory method, which is partly based on a reasoned definition of the concept of agri-business, the critical inventory of existing sources, and the analysis and mapping of accessible geo-spatialized sources.

2.2. Defining Agro-Industrial Farms

The main objective is to identify, document, and accurately map the agribusiness farms in Senegal. Several terms have been used to describe the companies that are investing in the Senegalese agricultural sector: "agribusiness", "foreign investors", "corporate farming", or "agro-industrial firms". The process of larger-scale land acquisition is often and commonly referred to as land grabbing, which implies negative impacts on local agriculture [24,48]. As Oya [49] argues, the term and concept of land grabbing are elusive and it is important to define which indicators are being considered and taken into account. Here, we derived indicators from the context of what was at stake at a given moment, and thus responded to a demand for information. First, we considered it appropriate to provide another perspective regarding the size of land acquisitions (first indicator) in order to address the intense controversy over the amount of land "grabbed". Secondly, we chose to consider the origin of investors (second indicator), since land acquisition processes were largely perceived as being the responsibility of foreign actors. COPAGEN [42] reported that more than 80% of land deals were made by foreign stakeholders. Finally, we integrated an indicator that is related to market relations, because agro-industries are designated by the Senegalese government as direct contributors to food security and sovereignty [38]. All three indicators are developed below.

The size of farms is naturally variable, depending on the specificity of national contexts and many others parameters: there is no definitive size threshold. Agro-industries are generally implanted in high profitability farms, which require larger surfaces than the average area of agricultural land that is commonly cultivated in the host country. This size varies depending on the cost of the land, local production costs, and the value of cultivated products. In 2010, the World Bank provided insights at the global scale by synthesizing data provided by member countries, but it did not define a fixed threshold. Among the countries that contributed to the study, the thresholds vary from 500 to 2000 ha [21]. The other two organizations that have provided worldwide inventories (the Land Matrix and the NGO Grain) both have a threshold at 200 ha, without any further justification.

In Senegal, the inventories have a much lower threshold. For instance, previous inventories focused on 20 ha (IPAR) and 40 ha (COPAGEN) of possessed land. One can explain the gap between the global and local inventories by the difficulty for macro inventories to collect information at a finer scale, and by the choice made to identify the largest land acquisitions in priority. Nevertheless, not all these inventories and studies define or justify a threshold: the limits generally depend on the information that is available.

The choice of a threshold has to clearly distinguish between family farms and agribusiness farms. In this research project, the threshold of 20 hectares has been chosen. The rationale for this choice is as follows: first, the average size of farms in Senegal was 3.7 ha in 1960 and 4.3 ha in 1998 [50], and thus by extrapolation, 4.73 ha in 2015. This trend is confirmed by the 2013 national census, which

highlights that 69.8% of the farms range between 1 and 5 ha. Family farms are smaller, with 20.9% cultivating less than 1 ha, while 50.7% own less than 3 ha [51]. In 1998, 99% of farms cultivated less than 20 ha [50], and the number only slightly evolved in the 2013 national census, with 97.4% of farms below 20 ha [37].

The country of origin of the investors is another indicator. Data sources that are available for Senegal include national and international actors. For instance, they include investors from countries with a low GDP per capita, such as Nigeria, Indonesia, and Vietnam. Although a minority, these stakeholders seem to be important [41], despite the fact that the phenomenon of land grabbing is often exclusively attributed to investors from rich countries or countries linked to sovereign wealth funds (e.g., China, Saudi Arabia). Certain sources take into account the investments that are made by politicians, religious leaders, farmers, or local business men, whose investments are similar to foreign investments [49]. However, these types of investments are numerous, concern small areas, and are even more challenging to document. In this paper, we made the choice to only address foreign land acquisition, since our intent is to provide information on foreign land acquisitions in Senegal's agricultural sector. While we acknowledge that investments that were made by domestic stakeholders should be considered in a global assessment of land acquisition dynamics [52], we underline here that it was not our focus in this paper.

The destination of agricultural production (export or local market). This information is generally absent from land acquisition assessments. Nevertheless, at the international level, it is usually recognized that the majority of agro-industrial production is exported [53]. In 2012, a study from the Land Matrix database showed that, on a sample of 393 farms taken from the worldwide database, 91 farms (23%) were related to both international and national markets, whereas 36 farms (9%) exclusively channeled their production towards local markets [46]. For the purpose of this study, we decided to include both domestic and foreign destinations of agro-industrial production.

In summary, we have assembled an inventory meant to identify farms that were owned by foreign investors who own more than 20 ha of agricultural land with production that is either exported or sold on the domestic market. It is important to note that investments fitting this definition will be referred to as "agro-industrial farms" throughout this paper. Our inventory also includes all land acquisition projects that are related to this definition, such as those being abandoned, forecasted, or currently in the installation phase.

2.3. Inventory of Agro-Industrial Farms

Information on land transactions, such as investment approvals or contracts, is not publicly accessible from government sources. Therefore, alternatives need to be found in order to efficiently inventory the presence of agro-industries in Senegal.

We developed a methodology to identify, document, and accurately map the agribusiness farms in Senegal with a multi-source analysis. Based on the criteria that were previously described to define agro-industries, we focused on three tasks: (1) pooling and verifying the data collected in previous inventories, (2) collecting information from civil society at different scales, and (3) validating the information through the use of satellite imagery and/or fieldwork.

All of the available documents and assessment reports on the implementation of agro-industrial farms in Senegal were collected. We pooled, compared, and analyzed data from existing inventories in order to set up a provisional list of the agro-industrial projects, only selecting the projects that fit our definition of agro-industrial farms.

Given this provisional list, the second step consisted of confirming the existence of these projects. In order to update the list of agro-industrial farms, we used interviews with representatives from the national farmers union and from Senegalese NGOs that are familiar with the issue of agribusiness dynamics. For each project, the following data were collected: the name of the company, number of parcels, number of hectares in each parcel, number of cultivated hectares, types of crops, date of implementation nationality of investors, and source of information.

We then used satellite image visualization through Google Earth to record the presence of agro-industrial farms. When these farms were visible on satellite images, manual digitizing of their outlines was performed using ALOS satellite images (2.5 m of spatial resolution) that were available on the Senegalese Geoportal (<http://www.basegeo.gouv.sn/>), Landsat images (30 m of spatial resolution, available on the USGS geoportal, <http://www.usgs.gov/>), and Google Earth images (30 to 2.5 m of spatial resolution). This digitizing was performed with the following precautions:

1. confirm visible presence of a clear delimitation between the outlines of the plots and the rest of the territory (Figure 1a); and,
2. confirm the absence of continuity between fields with similar characteristics. The objective here is to be certain to distinguish between fields in close proximity that belong to different companies (Figure 1b).
3. The verification process included several field visits to farm sites where the available imagery was inadequate. In these cases, surveys of cultivated areas, implementation status, and location were completed with the aid of GPS handheld equipment.

Each step that was identified above involved a collaborative process in which we partnered with civil society, NGOs, and farmer unions. Representatives at the national scale and local contacts were engaged first to identify available information on agro-industrial farms from documented and/or informal sources. Secondly, they were trained and actively involved in the use of readily available satellite imagery to locate farms. Finally, they participated in field trips that enabled the verification of visual interpretations.



Figure 1. Illustration of spatial footprints for agro-industrial farms. The digitizing was performed with the following precautions: (a) confirm visible presence of a clear delimitation between the outlines of the plots and the rest of the territory, (b) confirm the absence of continuity between fields with similar characteristics. The objective here is to be certain to distinguish between fields in close proximity that belong to different companies.

The data that was generated through this methodology was combined with inventories that were previously assembled by Senegalese NGOs [42,47]. This database was then cross checked with the Land Matrix and the GRAIN land grab inventories [33,46], deleting the overlapping agribusiness farms and standardizing the data. The results are presented in the next section.

3. Results

3.1. Comparing Assessments from Literature

Comparing national inventories shows a large discrepancy in the estimations of land acquisitions by agro-industrial farms. Areas possessed by agro-industrial farms, range from 258,700 ha to 678,976 ha (Figure 2). At first, it appears that a dramatic increase in land deals may have occurred between 2011

and 2012. However, these figures may not be reliable, and the large disparities may be primarily related to methodological differences between inventory reports: inventory dates, knowledge of areas, data collection processes, etc. As a result, these reports differ from each other in terms of the information that they convey. For instance, the status of the land allocation appears to vary between reports. In most cases, the information that is provided for the same farm differs on important details, such as the name of the company, the location, and the area concerned. With the exception of Land Matrix, these draft lists do not come with maps, satellite images, or pictures of the land that makes their localization difficult. Inventories fail to include geo-referenced data. Most of the collected information has not been verified on the ground with field surveys and the collection of GPS points, and no mapping has been done to quantify cultivated areas. More generally, we notice that these reports lack comprehensive definitions of agribusiness and fail to define the required criteria that are needed in order to be categorized (size threshold, type of investments, etc.).

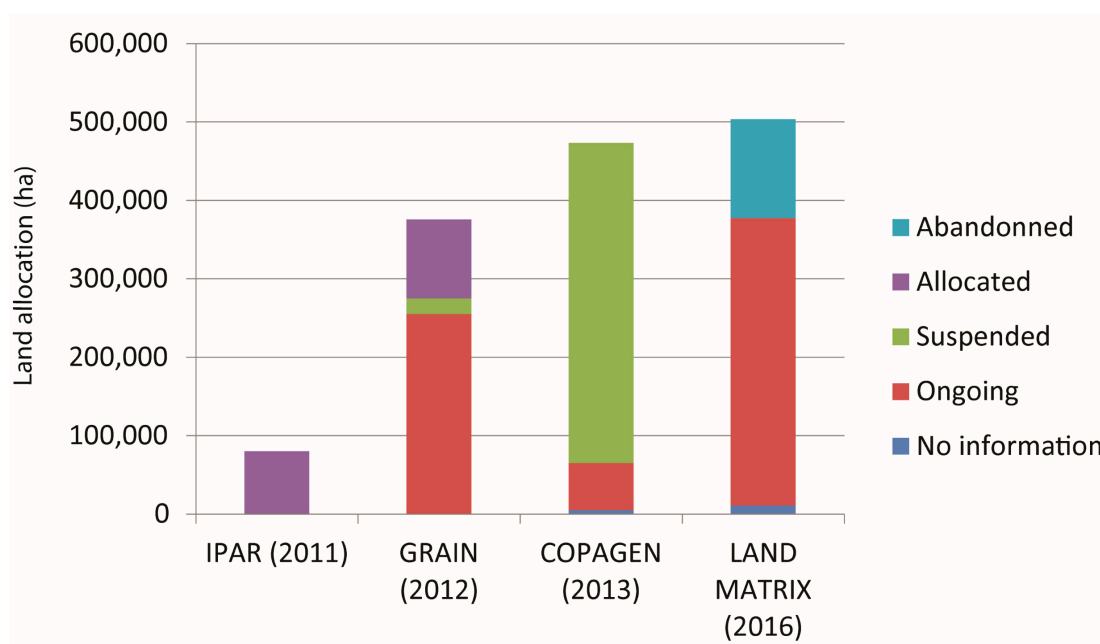


Figure 2. Status of reported land deals from different sources (IPAR: Initiative Prospective Agricole et Rurale; COPAGEN: Coalition pour la Protection du Patrimoine Génétique Africain).

Most of the numbers that were found in these reports come from secondary sources, farmer networks, or leaks during negotiations between State representatives, local communities, and the companies. The reports do not include validation processes that would require verifying the data. Some very large projects that are mentioned in the reports do not seem to have successfully materialized. For example, COPAGEN announced a 40,000 ha project by the Dangote company to grow sugar cane, GRAIN highlighted a Chinese investment of 100,000 ha for peanut plantation, and IPAR mentioned 10,000 hectares in the vicinity of Thies. Given the gap between the scale of these investments and the total absence of knowledge and media coverage on them, we can assume that these projects were only speculative and they did not materialize. In 2016, the Land Matrix database compiled 503 328 hectares of land transactions in Senegal [34]. While the number of hectares reported is important, details in the database show that only 4% of them are actually under cultivation, 52% of them were allocated with no information on the production status, and 44% of them are in land transactions that were reported but never implemented.

Moreover, the assessments are only based on the inventory of existing granted contracts without any ground-truthing. They either rely on firsthand land inventories (e.g., the original investment contract between the government and agribusiness companies to which farmland has been assigned) or second hand information (press releases, reports, etc.). Frequently, land concessions that are granted

on paper do not accurately reflect conditions on the ground, thus leading to inaccurate assessments and interpretations. Moreover, the investment contract is not necessarily the best source of information. The absence of mechanisms to enforce accountability means that there are no incentives to respect the contracts. We believe that the purpose of an inventory should be to assess the actual surface of developed agro-industrial farms rather than to record the allocated surfaces that are granted in contracts.

Finally, the development of agribusiness is a recent phenomenon and the situation is changing rapidly. As a result, existing contracts might be revised upwards or downwards and the intended projects might fail or be implemented without being noticed. Apart from the Land Matrix that incorporates regular updates of the database, the reports that we analyzed provide punctual assessments and have not published revised versions with more recent information. Therefore, it is impossible to verify whether certain projects have failed or if analyzing these types of databases has developed new projects. Existing reports should be considered more as a summary of all the projects announced at the time of publication rather than a recent estimation of the actual situation on the ground.

3.2. Interpreting National Inventories

The survey that we undertook compiles information of agro-industrial land transactions from various sources, such as grey literature and project reports, and interviews with local representatives of farmers associations. This work allowed for us to identify 60 agro-industrial farms (fitting the definition provided in Section 2.2) that intended to develop their activities in Senegal. Table 1 provides details on the different sources involved in the compilation and their respective contribution to the database. It is particularly notable that the participatory inventory identified 42 out of a total of 60 references and that 78% of the references in the participatory inventory were not present in previous inventories.

Table 1. Comparison of current and prior inventories compiled through different methodologies.

		COPAGEN	GRAIN	Land Matrix	IPAR	Participatory Inventory	Comments
Agro-industrial farms considered	Number	13	7	18	3	42	Total of 60 references
	Pct.	22%	12%	30%	5%	70%	
Exclusive references	Number	6	2	6	0	33	13 common references
	Pct.	46%	28%	33%	0%	78%	

Our inventory was designed to be exhaustive throughout the country and it had no time limit. The compilation of intended land transactions identifies some 750,373 hectares. Within the compilation, we distinguish four types of status: land currently being used (ongoing status, 6% of total); land allocated, but not yet used (installation process, 1.8%); land identified for agro-industrial farms, but not yet formally allocated (forecast status, 3.8%); and, land identified by agro-industrial farms, but never advanced beyond the intention process (abandoned status, 88.5% of the total). This last class represents more than 644,000 hectares, and for almost half of these intended land deals (314,700 hectares, 49% of abandoned projects), we found no information regarding the location of an intended implementation (see Figure 3). Figure 3 shows the location of the other abandoned project. We see that most of the projects that were located in the Peanut basin (departments of Kaolack and Kaffrine), Casamance (departments of Ziguinchor, Sedhiou and Kolda), and Eastern Senegal (departments of Tambacounda and Saraya) failed. On the other hand, three hotspots can be identified: the delta of the Senegal river (departments of Saint-Louis, Dagana and Louga), the Ferlo area (Linguere department), and the Niayes area between the cities of Dakar, Thiès, and Mbour (departments of Mbour, Rufisque and Thiès). These three hotspots harbor 92% of ongoing land transactions and 100% of the current and forecasted installations.

Figure 4 displays the types of crops cultivated or intended to be cultivated by agro-industrial farms. We observe that most abandoned projects were dedicated to biofuel crops (i.e., Jatropha and Sunflower). These crops were not located in a particular part of the country, but concerned seven

departments, from the delta of the Senegal River (i.e., Dagana), to the South-Western part of Casamance (i.e., Ziguinchor).

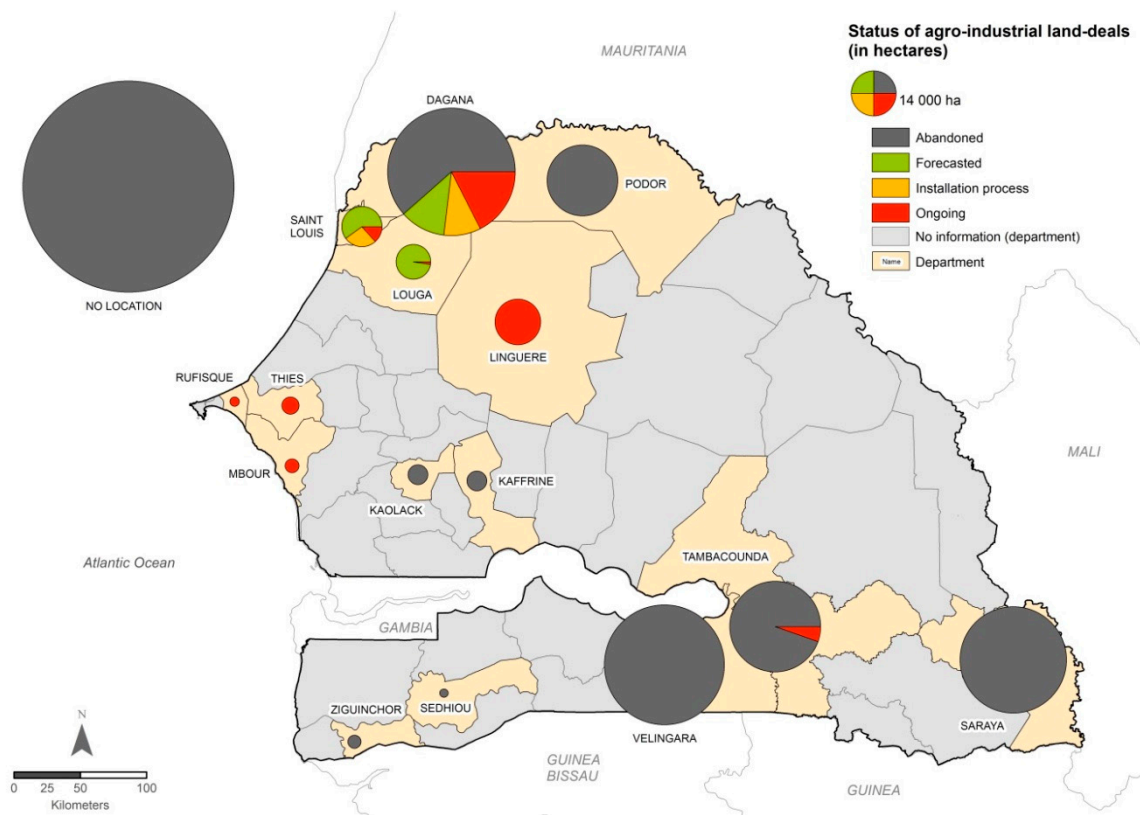


Figure 3. Location and status of agro-industrial land transactions.

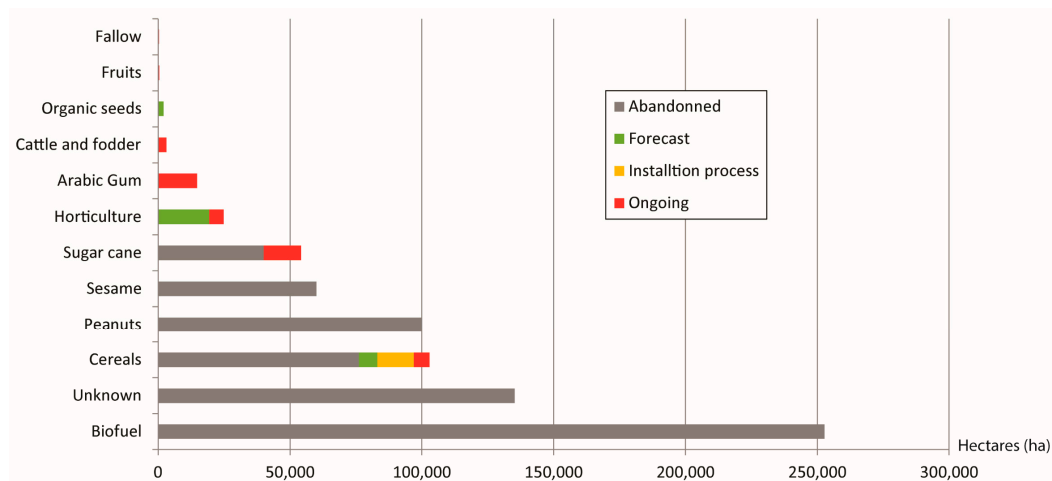


Figure 4. Status of the different crops cultivated or intended by agro-industrial farms.

Ongoing and forecasted land transactions are dominated by horticulture in the delta area, as well as the Niayes area that is closer to Dakar. The former is seen as the main production area due to its proximity with the Senegal River and the lake of Guiers, whereas the latter is closer to Dakar, the main market in the country (Figure 5).

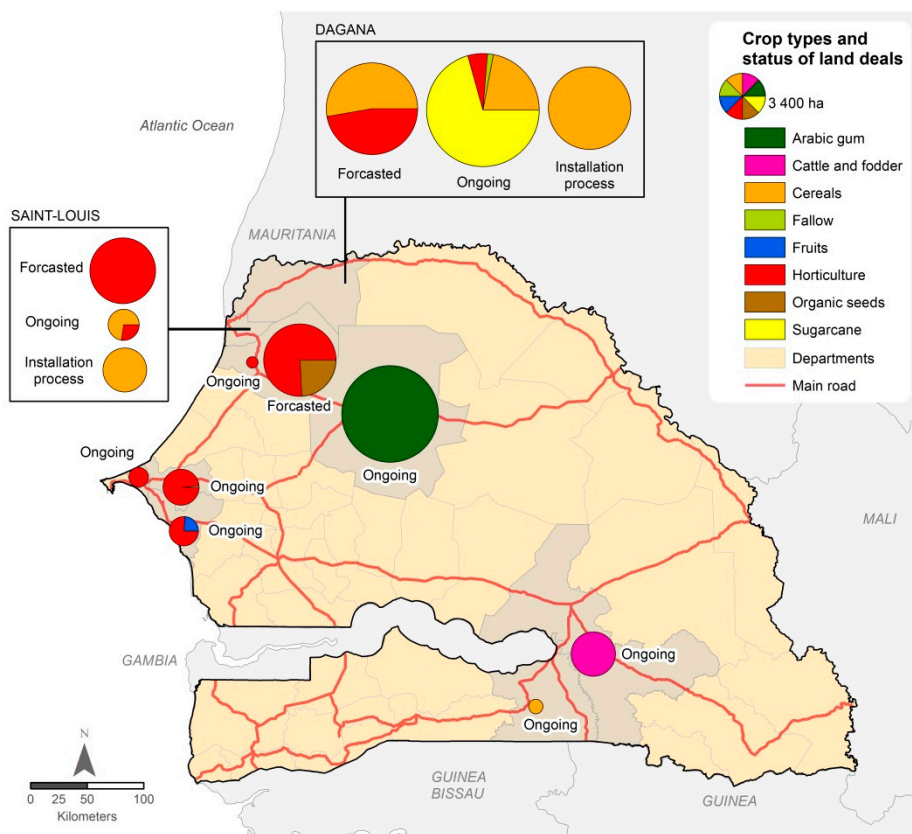


Figure 5. Location and diversity of crops under different status of land transactions.

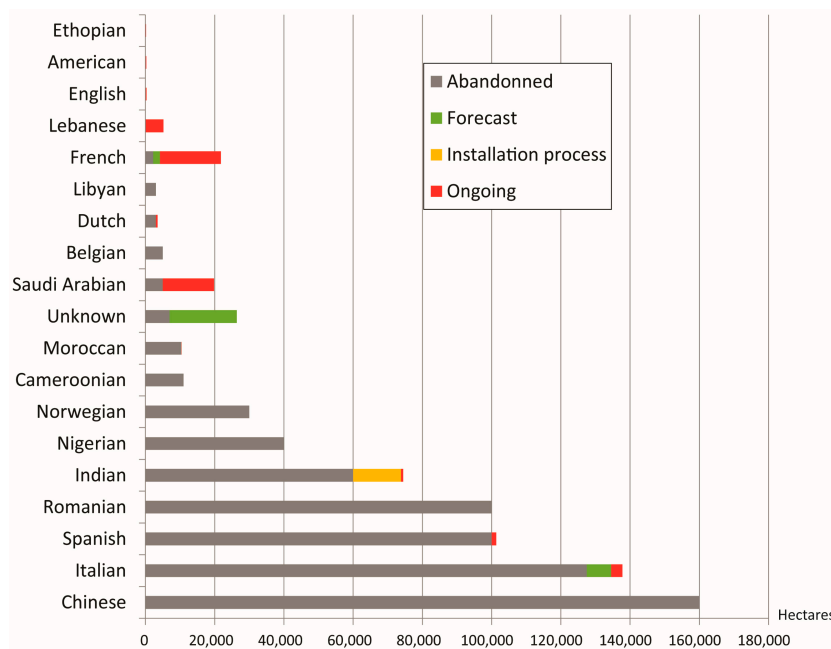


Figure 6. Nationality of agribusiness and status of land transactions.

In Figure 6, we observe that a range of nationalities (18 identified) can be found in the list of agro-industrial farms. Similarly, failed projects are applicable to investors from many countries. Nevertheless, failed attempts of land acquisition are dominated by Chinese companies, which account for more than 20% of all the recorded deals. Ongoing land transactions are mainly made by French companies, generally in the delta of the Senegal River and the Niayes area, and by a single Saudi

Arabian company in the Linguere department, where they extract Arabic gum from the plantations of Acacia trees. We note that most of forecasted land transactions have not yet been allocated to particular agro-industrial farms, mainly in the Delta of the Senegal River. This can be explained by the fact that the local administration has recently identified and delineated available land for agro-industrial farms through the PDIDAS project (still registered in the Unknown category). This information is synthesized in Figure 7.

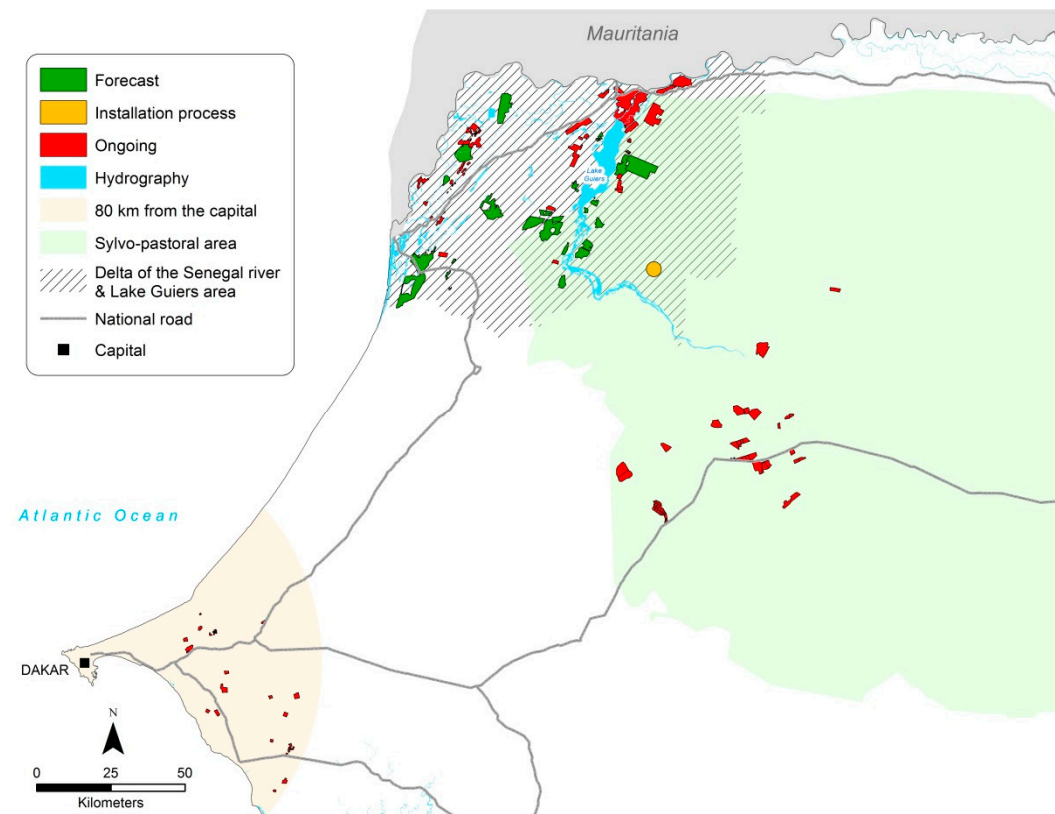


Figure 7. Identification of agro-industrial farms in three main hotspots.

4. Discussion

The land rush has been followed by numerous attempts to monitor the extent of the phenomenon and denounce its impacts (refs). From local case studies to global databases, these inventories are often legitimately criticized for the quality of the data and the relevance of their methods [49]. In this paper, we have demonstrated that previous inventories failed to grapple with a comprehensive representation of agro-industrial farms dynamics in large-scale land acquisitions in Senegal. This failure has primarily been the result of a lack of shared indicators and methodologies. Until now, only Laos (the Lao People's Democratic Republic) has produced a comprehensive inventory and mapping of its agro-industrial farms. The methodology that was used in Laos is particularly interesting, because it combines strong cooperation with authorities in the collection and analysis of existing administrative data, GPS surveys, satellite imagery analysis, and diachronic monitoring [54]. The main difference between our two studies is that, in the Laotian case study, the demand for the nationwide assessment originates from the government, whereas we present an initiative that was engaged by the civil society at the local and national levels.

Another difference from previous assessments is that, in a context of limited information regarding land investments, we believe that data and knowledge production should be seen as boundary objects that engage stakeholders in a federative project. We also argue that seeking unconditional accuracy is improbable, specifically at the national and subnational scales, and that assessing a phenomenon

is valuable in terms of the process and collective action it engenders. As a result, the method that was illustrated in this article was not designed to be generalized, but the process was. Indeed, we advocate for ownership of the process to be lodged in a group of actors that are gathered around a common issue and engaged in defining what needs to be observed and which indicators to measure and how. The quality of the research process, including designing methods, collecting, and analyzing data, was greatly facilitated by this partnership. Indeed, the research team benefited greatly from this collaboration with access to data and knowledge that required extensive experience and contacts at both the local and national scales. Nevertheless, our objective was not simply to improve the research through these partnerships: we also sought to engage in an action-research process that would address the needs of civil society and NGOs, particularly with respect to capacity building. We argue here that, in order to sustain this type of endogenous process, it needs to be reinforced by building capacity among stakeholders. In terms of methods, we believe that tools need to be tailored for a certain purpose and a given context. In this case, the tools that were used can be seen as elementary, but they serve as a means of fostering knowledge and understanding the process among stakeholders. As an answer to the syndrome of false precision, many projects focus time and financial efforts on addressing technical issues and developing cutting edge methodologies. In many research-development projects, the methods are passed onto stakeholders, but adoption rates often remain low due to the fact that these stakeholders were seen as end-users and not part of a process to co-develop the methodology. In our opinion, state-of-the-art identification and characterization processes of land acquisitions using advanced computer science need to be seen as part of the process and then mobilized at an appropriate time. This can upscale principles and methods that should be managed and overseen by the involved actors. Here, our position is not to propose yet another exogenous tool, in the hopes that it will be used, but to accompany a process of capacity building, to promote sustainability of a process that enforces continuity in the indicators being monitored, and to increase empowerment/intake by stakeholders. We advocate literacy in a process that is built around accessible tools, yet allowing for credible, legitimate, and salient results (at manageable scales) that provide important insights to enlighten the debate [55,56].

Here, we underline the potential of contributive cartography (associated with geoweb 2.0) that democratizes mapping and allows for laymen to create and share content with a community [57]. As we mentioned previously, geo-information should not be seen as the end-product, but rather as a boundary object that is generated by a collaborative process. In opposition to more conventional and project-based cumulative assessments, we highlight the pragmatic and iterative nature of the process that allows for updating and refining data as well as methods. Since mapping is “an intrinsically political act” [58], the access to—and the control of—geospatial information on land acquisitions inherently increases the negotiation capacity among stakeholders, and enhances transparency in land transactions, while strengthening the accountability of land investors.

The approach that is developed and discussed here is action-oriented and fitted to a particular context, but we highlight the importance of the upstream definition of what is to be observed. Weak positioning will attract discredit, although the aim is to display evidence that is supported by pragmatic and robust methods, and use this information to build and share knowledge. In Senegal, addressing the question of the extent of land acquisition is a necessary first step in enriching the debate and mobilize stakeholders. In fact, for a long time, assessing size was a challenge that shrouded questions regarding land acquisition processes and impacts [59]. In a context of land reform in Senegal, it is thus important for national stakeholders to address these questions in order to participate in a political and ideological debate that will shape future land and agrarian regimes.

5. Conclusions

In this paper, we report on the experience of a collaborative research process that was conducted in Senegal to provide dynamic and accurate geospatial information on land acquisitions by foreign agro-industrial farms. Our results are twofold: first, we analyzed past attempts to inventory such

investments at the national scale, and second, we highlight the levels of precision that resulted from partnering with stakeholders across scales. Combining participatory mapping and fieldwork was particularly beneficial in providing greater precision in the identification of investments in agro-industrial farms, their location, extent, nature, and status. Those results lead us to advocate for the importance of accurate geospatial information to support evidence-based debates on land and agricultural policies. We also demonstrate the value of a process that builds literacy among stakeholders rather than relying on top-down, generic, and normative approaches. We further argue that technical aspects should be seen as boundary objects, whereby the complexity can increase over time and be iteratively developed in parallel with capacity building among the involved stakeholders. Illustrating land transactions through participatory mapping can prove useful in disclosing questions that were previously obscured by a focus on their nature, number, and size. It represents a step forward that supports the questioning of relationships between land transactions and rural development, food security/sovereignty, and more globally, the development of choices and pathways.

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