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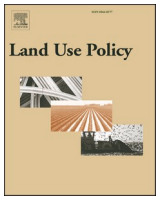

Sustainable land use: Policy implications of systematic land regularization in Mozambique

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ABSTRACT

Security of land tenure is key to achieve the sustainable development goal of eradicating poverty and can be improved through the regularization of rights to land, property, and natural resources. Making cities and human settlements sustainable, requires participatory and integrated land use planning, accounting for the land's potential and constraints, with a view to medium and long-term use. The government of Mozambique is actively promoting a process of massive regularization, under common terms of reference for service providers. The terms of reference also intend to achieve a linkage between regularization and community land use plans. The aim of this research is to assess the robustness of such plans to detect and overcome potential conflicts between the given and the potential land use, as well as constraints, weaknesses and threats. This research uses a mixed documental analysis to undertake an ex-ante assessment of 15 participatory community land use plans. Five categories are assumed as a reference of good practices in land use planning suggested by universal and African literature. It was found that the common terms of reference and guidelines promote participatory capacity and provides general directions of community development. However, good practices of land use planning such as effective participation in all phases, alternative scenarios for future land use, regional integration, and disasters risk management are less promoted. It is suggested that the guidelines go beyond the immediate needs of land register, to consider that such interventions in rural areas shape the culture of land use, which, in turn, will influence sustainability in higher level settlements.

1. Introduction

This research paper evaluates if the process of jointly developing land use plans and recognizing land use rights to individuals and groups at a massive scale, such as being implemented in Mozambique, can contribute to solve the problem of improving sustainability of land systems, in view of supporting conducive land policies. A pragmatist inspired solution follows socially acceptable processes and ensures the best desired outcomes for the majority of affected parties, their interests and needs (C. Palmer et al., 2014; Saunders et al., 2019). Sustainability refers to the constant search for balance between society and the natural surroundings in a way that both improve and reproduce. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) defines sustainable land use as "land use that serves the needs (for food, energy, housing, recreation etc.) of all human beings living on Earth today and in the future, respecting the boundaries and the resilience of ecological systems" (IPBES, 2018, p. 668). Social and cultural cohesion, diversity, growth and justice as well as territorial cohesion (Farinós, 2008; Monteiro A., 2019), biodiversity and frugal resource use are the aims and rules in a sustainable socio-ecosystem. The following sections are arranged as follows. A section on the background follows, linking sustainability to land use and settlements, justifying the interest in land tenure regularization and its close relationship to land use planning, closing with the policy problem statement. The context of Mozambique is then briefly presented, with a broad comparison between the old and new technical and legal guidelines constituting the

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Ministerial Diploma 02/2020 (henceforth "guidelines"), and the section closes with the specification of the research questions that follow the policy problem statement. The section on methodology follows, informing on the categories of analysis, the process of collecting and sampling the materials as well as the methods to collect, process and analyse the data. The following section presents the results structured by the categories of analysis. The section of discussion brings together the results to assess the response to the research questions. A seventh section on policy recommendations, is followed by the eight and concluding section, which provides a summary of the discussion and recommendations.

2. Background and problem statement

2.1. Land systems governance and sustainability

Land systems combine land cover and land use resulting from natural and social processes and interactions. These have an expression in the physical territory, in terms of land cover and land use changes (Verburg et al., 2013). The way such changes are governed determine the balance between society and the environment. Governance of land systems refers to processes and institutions both formal and informal, with their different ontologies and socially constructed realities on what is land, how tenure is best expressed and secured, what is the role of planning on the use of land (Palmer et al., 2009) . Good land management implies a policy framework that is adjusted to the country context and impact upon sustainability through land administration with its four main functions of: providing land tenure security; ensuring that land is sustainably used, planning for, and managing land development; and regulating the land valuation for individual and societal benefit (Williamson et al., 2010). By managing the direction and pace of changes, good governance of land systems impacts all dimensions of sustainability. For this research, the focus in on the functions of cadastre and land use planning.

The land cadastre, a function of land administration, is the public and faithful, precise and update register of georeferenced deeds, titles and other proofs of land tenure and land interests, its value and use status, by which the administration recognizes the land-people relationship (Des Géomètres, F. I, 1995). By providing security of tenure, among other things, it facilitates promotes the reduction of poverty, hunger and vulnerability by contributing through providing security of tenure. A good cadastre accommodates different worldviews. For some, such relationship ought to be based actual occupation and use, on capacity, equity and social and environmental sustainability, which requires security of access to land as part of the assets to build livelihoods that addresses risks of eviction, societal changes, uncertainties and diversity generated by and increasing population and migrations (Chambers and Conway, 1992). Under this worldview, recognition of multiple rights of the poor and gradual formalization is what cadastre should do. Priority is given to livelihoods. For others, land is where real capital, as opposed to money, rests dead on the hands of the poor, and can be mobilised through legal and institutional changes that go beyond recognition and involves registration, as legal security of tenure promotes investment and leads to a more efficient markets and resource allocation (de Soto, 2000). Under this worldview – challenged among others, by Gilbert (2002), and, in the context of Africa by Nyamu-Musembi (2006) – cadastre ensures formal registration of the property rights of the poor and is a precondition for capitalist development. Priority is given to economic growth. Payne et al. (2009) offer a review of the debate and stress that instruments other than titles may provide security of tenure, while the land systems evolve and mature.

Recognizing different realities, the need for flexibility and the features required to have a good cadastre, of being truthful, precise, scalable and updatable, governments and geopolitical regions, for example the African Union (2009), and institutions (FAO, 2006, FAO, 2019, UN-HABITAT, 2002), (or as ISO, 2012; The World Bank., 2013) have developed guidelines and tools in the middle ground, for rights *regularization*, promoting a gradual formalization along the "continuum of rights", and implementing methods that are fit for specific purposes, place and time. These guidelines and tools are based on collaboration between institutions, such as the International Federation of Surveyors (FIG) and Global Land Tools Network (GLTN), as well as on scholarly research (inter alia, Antonio, 2013; Augustinus et al., 2006; Enemark et al., 2014; Hendriks et al., 2019; van Oosterom and Lemmen, 2015). Local solutions need to be developed. In rural communities, especially in the homestead, with one or more families, in disperse settlements, fit-for purpose solutions imply to register the combination of farm and the house or other durable property.

Other way land management impacts sustainability is through land use planning. A challenge that is usually faced in the implementation of policies for a more responsible and sustainable land administration is the tension between private interests and priorities, and those of the society, be it a local, regional or national community reflected in both formal land use plans and informal socio-culturally recognised practices of land use.

Formal land use planning models have been changing, from those top-down normative suitability-based to those more use and allocation-based, with more participation and negotiation, to address conflicting alternative uses and users and corresponding trade-offs (Bourgoin et al., 2012; Metternicht, 2018; Sante Riveira and Crecente Maseda, 2006). Tenure responsive land use planning is a possible route to bridging the conflicting parties (Chigbu et al., 2017).

The aim of sustainable land use plans and practices is to ensure the balanced and as close as possible distance between production and consumption of water, food and energy, the link between rural and urban areas, for instance under a city-region foodshed (Karg et al., 2016; Peters et al., 2009). Sustainable land use plans are expected to: limit the conversion of agricultural land for urban and peri-urban expansion; limit loss of vegetation, soil and other land resources; and serve as platforms of consensus and conflict prevention and mitigation; while addressing socioeconomic risks and building collective resilience (Metternicht, 2018). Indicators for these goals are to be applied.

Planning and policies are rarely neutral, and trade-offs need to be agreed upon, with long lasting consequences of choices made (Meyfroidt et al., 2022; UN-HABITAT, 2021) regenerating its path dependency. To satisfactorily and sustainably resolving the tensions between social or collective interests and needs, and private expectations and priorities, require the participation and inclusion of individuals and stakeholders in almost all phases of the collective land use-related decision-making (Metternicht, 2018). Participation is grounded on legitimacy, inclusion and diversity (Quick and Bryson, 2022), and are opportunities for information and knowledge sharing and agreeing on collective – usually second-best – choices. But it should be possible to periodically review such choices.

2.2. Sustainability and settlements

Urban areas will remain as major opportunities and challenges for sustainability and development. While occupying a relatively small proportion of land (2–3% (Liu et al., 2014)), they require large areas from where to acquire the material and immaterial resources that make them liveable, such as food, water, energy and or green open spaces. The definition of "urban" varies widely, but half of the countries, including Mozambique, use administrative consideration to designate urban areas. Others use some combination of physical and socioeconomic considerations (Weeks, 2010). Peri-urban areas are equally difficult to define (Sahana et al., 2023) but a rule of thumb is to use those located towards the urban areas along the rural-urban continuum, from as close as 10 Kilometres (km) to as far as 150 km from the edge of an urban area (Webster and Muller, 2009), where the interface between urban and rural areas occurs. Even considering the broad and contested definitions of what constitute urban and peri-urban areas, Africa lags behind in

terms of urbanization, and urbanize at a rate higher than any other region (United Nations, 2019).

Most African rural settlements still lack the compactness, social and private infrastructures in concerted functioning and governance typical of cities and towns in developed countries. They are, however, relevant to study as the frontier in the context of urban and peri-urban sustainability. In fact, while the population continues to grow in the continent, its urbanization rate is higher, signalling the importance of rural to urban migration (Teye, 2018). The population of a rural community today will become the population of a peri-urban or urban area tomorrow. With the improvement of transport and communications infrastructure, rural areas totally isolated and not relating to the closest urban area are increasingly rare.

The drivers of peri-urban occupation, which imply land use changes and patterns, impact upon the sustainability in their territory. These drivers include history and geography, the tenure systems, power systems and governance, and population growth, structure and movement. Agriculture land changes to built-up land, often in an informal mode, the landscape is fragmented, natural environment is depleted of resources at high rate, and biodiversity is threatened. Together with the rapid interaction of culturally diverse population in regions where governance capacity is in place, result in imbalances in the relationship between the society and the land they occupy (Carrilho and Trindade, 2022). Rural communities, and clusters of contiguous and interconnected communities are the origin and destination of migration to and from cities and towns or the embryos of future towns (Yakubu, 2021; Krishnan, 2017; Laursen and Møller, 2014; Quan et al., 2013). The combination of their historical and geographical roots, their spatial organization as well as their interaction with other rural communities and with cities and towns gradually build a spatial culture (Othengrafen and Reimer, 2013) that will impact upon the sustainability along the rural-urban continuum.

The impact on sustainability of both land tenure rights regularization and land use planning is, then, well established in the literature. There are several programmes worldwide dedicated to these activities. The policy problem is *how to better combine the activities of land tenure rights regularization with land use planning to catalyse sustainable land use along the rural-urban linkage*. Lessons are extracted from the experience of Mozambique, where these activities are implemented in tandem for the last 25 years under different methodologies and where a new set of technical and legal procedures have recently been approved.

3. The context in Mozambique

In their review, Carrilho and Trindade (2022) noted the importance of history, geography and institutions in shaping land use sustainability in peri-urban informal settlements. Furthermore, Meyfroidt et al., (2022, p. 3) point to the fact that "some land-use changes have irreversible social and environmental impacts at the scale of decades to centuries". For these reasons, a brief review of the historical, geographical and institutional context of the case in study is justified.

3.1. Land use for settlements in Mozambique

Mozambique is below the African average of urbanization, measured by the proportion of urban population, but above average in terms of growth rate. The structuration of the territory to reach cohesion requires a certain number and distribution of well-functioning and serviced settlements at all levels. In Mozambique, the distribution of cities and towns (*villas*) is uneven. This opens the space – and opportunity – to the growth of large informal settlements in rural communities (OECD and Sahel and West Africa Club, 2020).

These informal settlements are not necessarily disordered or chaotic. Following a policy of effective occupation, from the second half of the nineteenth century, the Portuguese government granted land to Crown companies in most of the territory and these companies promoted settlements and labour reserve villages with some land use planning considerations (Galvão, 2013; Pedro, 2012). Later, a policy of settlement of Portuguese settlers was largely followed (Castelo, 2021; Filipe, 2018). After independence, a programme of villagization (*aldeias comunais*) was implemented throughout the country (Araújo, 1998). These policies and processes were accompanied by intensive migratory movements, and helped creating a spatial culture which came to manifest later in peri-urban informal settlements (Masquete, 2022; Nielsen, 2011).

The country spans for several latitudes, is geographically diverse, as well as is culturally. This explains, in part, the constitutional recognition of legal pluralism and the carefully crafted incompleteness and ambiguity in related legislation. There is, notwithstanding, a role for a nomothetic approach in managing the complex relation between society and environment (Alexander et al., 2012). When talking about residence or community, either in rural or urban contexts, it is common to talk about the sizes of residential plots (15×30m, 20×40m, 40 ×40 or even 50 ×50, but not arbitrary). The use of regular networks of streets, a playground, a place for meetings, a washing place close to the water source or a commercial zone are also generalised norms, which are gradually incorporated into the culture. But, for instance, it is not common to talk of regular agriculture plot size of any place – it depends on how much one can labour and its availability. It is also uncommon to know about homesteads, green parks or reserved places along the waterways or ciliary woods. These did not enter the physical expression, or "planning artifacts" (Othengrafen and Reimer, 2013) of spatial culture in Mozambique yet.

3.2. Regularization of land tenure and land use planning in Mozambique

As in other countries, Mozambique is implementing, for some years, programmes of rural community delimitation and massive land tenure regularization, with a pro-poor (Hendriks et al., 2019) and fit-for-purpose approach, being the purpose the improvement in land administration (Balas et al., 2017; Quan et al., 2013). Furthermore, even if it may contribute to improve security of tenure and land administration, further research is needed on the impacts of such programmes (Bizoza and Opio-Omoding, 2021; Earle, 2014) and some flexibility is accepted.

To date, the total number of communities delimitated under a non-systematic massive process is slightly more than 2000, and regularized land use titles are approximately two million. The programme plans to delimitate 4000 communities and register five million individual land holdings (DNTDT, 2021). In line with the concept of "tenure responsive land use planning" (Chigbu et al., 2017) where tenure security is the paramount goal, rather than the overall socially responsive use of land resources, the government of Mozambique has a stated policy objective to linking land use planning with land tenure regularization (J. Monteiro et al., 2017). By linking regularization and land use planning it is possible to ensure the protection of critical natural resources and infrastructure, to reduce the likelihood of resettlement by preventing occupation of areas subject to disaster risk. It is also possible to reduce or mitigate intra and inter-community conflicts. Thus, before land tenure regularization, proper consultation as well as an assessment of social and environmental risks needs being done and mapped, seeking to provide social and environmental safeguards.

While with experiences being acquired since 2006 (Quan et al., 2013), the systematic development of these plans under the *Terra Segura* Programme started in 2018 and accelerated by the end of 2021. The plans follow four key principles: (1) community participation; (2) "delimitation first", with land use zoning and planning; (3) fit-for-purpose "pro-poor" cadastre; and (4) work in clusters of communities whenever possible. Some are in contiguous and closely interlinked communities (locally known as community "clusters"), within a third level territorial unit (*postos administrativos* or administrative posts).

The law and by-law on land use do not define the content and procedures to produce a land use plan at the level of community. To this end, appropriate guidelines were developed, culminating with a formal

piece of legislation (Governo de Moçambique, 2020. Diploma Ministerial n° 2/2020, 21-Jan).

3.3. Brief assessment of the Ministerial Diploma 2/2020, of January, 21

Six phases are stated in the guidelines of the Ministerial Diploma 2/2020, of January, 21: (1) preparatory activities, to announce and prepare the process; (2) field surveys and participatory diagnostic and planning; (3) populating the land management information system with field data; (4) georeferencing field survey data, including protected, conflict areas and other exclusion zones, as well as expansion areas; (5) delivery of certificates (for communities) and titles; and (6) maintenance of certificates and titles.

The participatory activities are intensive in phase 2. For that, the guidelines are not complete, compared with the national legislation on land use planning. The participatory field survey precedes the planning exercise, and include: (a) historic profile and timeline; (b) social organization; (c) natural resource use; (d) farming systems; (e) borders identification; (f) identification of protection areas; (g) population dynamics; (h) participatory mapping to describe the borders reference points; (i) cartograms by women and men, without metric scale; (j) identification of conflicts; (k) economic activities; (l) identification of gender issues. It does not, however, have any reference to need to obtain and analyse climate and weather issues or map risks of disaster or other information which are considered of general character in the Law on Territorial Planning (Lei no 19/, 18-Jun, 2007). The national guidelines suggest that it is possible to complete this phase, including the community land use plan, in 60 days.

Implementation monitoring reports of these plans are not possible yet, considering their dates. It is also noted that the guidelines are primarily oriented to the function of cadastre of rights of the global land administration perspective (Williamson et al., 2010), and to a lesser extent, the function of land use.

Compared to previous practices, the above-mentioned Ministerial Diploma 2/2020, reflects some improvements, but also several drawbacks. It has the hallmarks of a legislation targeted to implement a specific programme, privileging commercial service providers and compromising alternative approaches. While it consolidated the principles of community involvement and "delimitation first", i.e., before the start of regularization of individual tenure rights, and also expands on the practice of zoning and agreeing on development priorities, it introduced more rigidity and centralised the process, jeopardising the future of one of the major features of a good cadastre, since no provisions are made to promote an institutional organization that facilitates the updating of cadastre. The set of technical and legal procedures approved by the Diploma practically excludes bottom-up initiatives, making the whole process more costly and user-unfriendly (Norfolk et al., 2019). Furthermore, no provisions are made so as the local natural resources management committees can evolve into community services with cadastral functions and capacity to enforce the land use plans. It can only be hoped that its implementation can accommodate gradual adjustments, the main of which would be the possibility to create community cadastre and land use planning services.

3.4. The research questions

This article contributes to the knowledge on the links between land use planning and regularization of land tenure rights, in a context of systematic and massive fit-for-purpose registration. In such context, good or bad practices are generalised and end up in the spatial culture of the society, as mentioned above, with impact on sustainability wherever participants in the process live or migrate to. This article intends to assess the robustness of processes and plans resulting from phase 2 of the current guidelines, as well as of the guidelines themselves.

The assessment is based on a conceptual framework of land use planning evolution, which moves from informal to formal, from unregistered to regularized land tenure. Transitional policies and rules are designed based on actual land use and land use practices and customary norm. They should be the result of a participatory process. Such policies and rules also depend on the assessment of the impacts of the informal occupations on sustainability that can be observed or expected and would also be based on higher order plans such as of a cluster, district, territorial or regional land use plans. Fig. 1 depicts this conceptual framework, indicating the main direction of the flow. This framework is based on the literature review for this research, the current guidelines and legislation in Mozambique, and in the review by Carrilho and Trindade (2022).

Based on the policy problem statement and on this framework, the research questions were:

a) Are the plans useful land use plans, because (1) they are responsive to, and strengthen the security of current tenure rights holders, and (2) they build on the local practices?
b) Are the plans robust enough, because (1) they can adapt to changes resulting from the expansion of existing or new settlements; (2) they are regionally integrated, and (3) they include provisions to reduce natural and human-made risks?

The hypothesis being that if these questions are responded affirmatively, then they promote sustainability through social and territorial cohesion, economic development and well-managed environment. Communities will extensively use them for sufficient time to generate practices taken when people migrate from rural to town, peri-urban areas or cities.

4. Methodology

Fig. 2 presents the methodological framework bridging the research questions to the discussion, conclusion and recommendations.

Only documents leading to and after the approval of the new guidelines (Governo de Moçambique, 2020. Diploma Ministerial n° 2/2020, 21-Jan) were considered, and pre-2018 cases were not considered. Access was granted to all 39 documents referring to the processes of community delimitation and land tenure rights regularization contracted to service providers following public procurement legislation. These documents consist of reports of the process of community delimitation and do not include the cadastral information of individual parcels. These are the first of a total of 400 planned processes.

Three service providers developed these plans with the same guidelines. Out of the total 39 proposed plans, 15 where conveniently sampled, and submitted to a mixed document analysis, with interpretative content analysis and a critical review. One of the service providers (SP) was testing and developing the guidelines.

The convenient sampling selection criteria were:

a) Five per service provider, from a cluster whenever possible. While they are distributed differently (SP1 =19; SP2 =15; and SP3 =5), they operated at separate times along the last 5 years. This allows to understand how similarly the SPs are approaching the guidelines.
b) Representation of agroecological regions (AER) of the country (Muhacha, 2021; Sitóe, 2005) where they were developed (8 regions out of a total of 10, with 2 regions not covered by any SP). This allows to understand how the SPs adapted their land use plans to different contexts.
c) Representation by location, such as peri-urban, coastal or inner-continental border areas, or extremes of community land area. This also allows to understand the adaptation to specific contexts.

In turn, Fig. 3 shows the general location of the communities for which land use plans were proposed. The figure also shows the location relative to cities and towns which relate more closely with the communities. It should be noted, however that distance is not the only

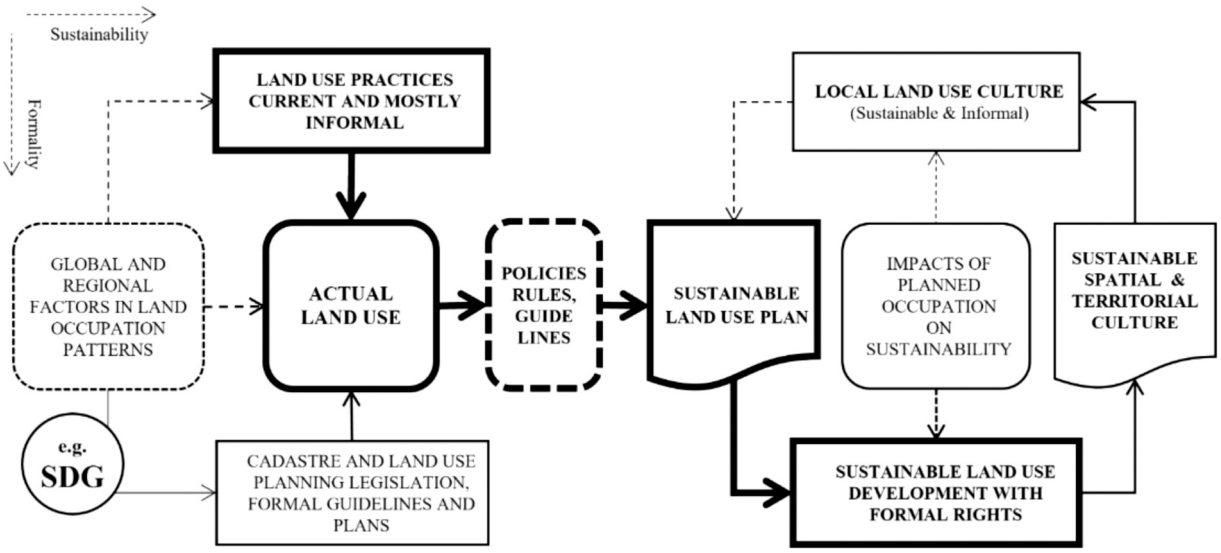

Fig. 1. - Conceptual framework of land use regularization - from informal occupation and tenure to sustainable land use plans with legal value [***1.5 column fitting image***].

determinant of migration and interaction.

Table 1 lists the selected plans. As stated, seven (7) selected communities are parts of clusters. This implies that characteristics of one selected plan can be compared for consistency with other members of the cluster.

Note that SP3 was developing the guidelines, and their plans are dated between 2018 and 2020, while SP1 and SP2 submitted all plans by the end of 2022. To undertake a partial and targeted content analysis, two document batches were compiled, being one of all the thirty-nine (39) documents and other of the fifteen (15) selected ones. All documents were read in full to extract expressions, words and logic, related to the main concepts and constructs. These were grouped under categories of analysis corresponding to the goals and targets of the Sustainable Development Goals (SDG), namely SDG 11, and related SDGs 1, 6, 13 and 15, on participation, property rights, settlements, urban and peri-urban and regional planning (UN-Habitat et al., 2016; UN General Assembly., 2015). Five categories were adopted:

a) participatory planning and capacity (targets 1.4 and 11.3): include cases of participation in meeting and practical exercises (e.g., field identification of community limits or cartogram drawing), participation of formal and informal or traditional organizations that are recognised.
b) service provision and inclusion (targets 1.4 and 11.7): sociocultural, economic activities and infrastructure, including social services such as education, healthcare, solid waste management, public entertainment spaces; it also includes words associated with food security, social safety and violence; finally, include words associated with economic activities, such as grain marketing, employment, financing and partnerships.
c) resources use (targets 6.3 and 11.b): efficient current and futures use of available resources, including land for agriculture, water, energy, and housing.
d) planning integration and governance (targets 11.a): the rural urban continuum and territorial cohesion, including integration in regional or district plans.
e) environment (targets 11.4, 11.b, 13.1 and 15.9): protection of natural heritage and biodiversity, adaptation and resilience in face of climate change natural or human-caused disasters. This includes education, information and threats awareness, risk causes, such as floods, droughts, erosion, forest fires and deforestation or cyclones, adaptation, mitigation and protection activities. It is worth noting the correspondence between the above mentioned SDGs and the Sendai framework indicators (UNDRR, 2021).

Selected statistical data were also manually collected, such as population, total community area, area with current specific uses, area allocated to new uses, existence of infrastructures, to assist in the sampling process and analysis. Table 2 present a sample of such information. It was decided to complement the reading with a mixed method qualitative analysis, through machine text processing. QDAMiner software (Provalis Research, 2021) was the chosen software.

The expressions, words and constructs were transformed into codes related to each category. Since all documents were in Portuguese, the codes were also in this idiom. The first batch, which include all the 39 reports, was processed to adjust the codes. Given the options of using the entire document, the paragraphs and the sentences, the unit of analysis chosen was the paragraph within each document. The retrieval expressions were composed in view of avoiding duplications. The same rules of text processing, expressed in a codebook, were applied to both batches and the word retrieval was done with replacement. This was used to subjectively evaluate the co-occurrence of codes and interpret the report on the general links between codes.

Since all the plans in the sample follow the same outline of contents for the same guidelines, it was expected to find repetitions and a high degree of correspondence between the cases, i.e., coding co-occurrence and sequence. It is not possible to say that these plans are uncorrelated, and the differences, rather than the similarities, were the focus of the critical analysis: considering the context of the occurrence and co-occurrence of codes, the analysis compared (1) the actual with planned land uses and (2) the identified problems with the corresponding proposed remedies.

This process faced limitations. While the process was repeated three to four times, using a single coder does not reduce completely the subjectivity in coding. Furthermore, there were differences in the definition of land cover types. Maps and drawing were copies at a reduced scale and did not have the quality to process a complete evaluation and a visit to the sites to ascertain missing information was not planned.

The critical assessment of the technical and legal guidelines approved by the Ministerial Diploma 2/2020 was also refined.

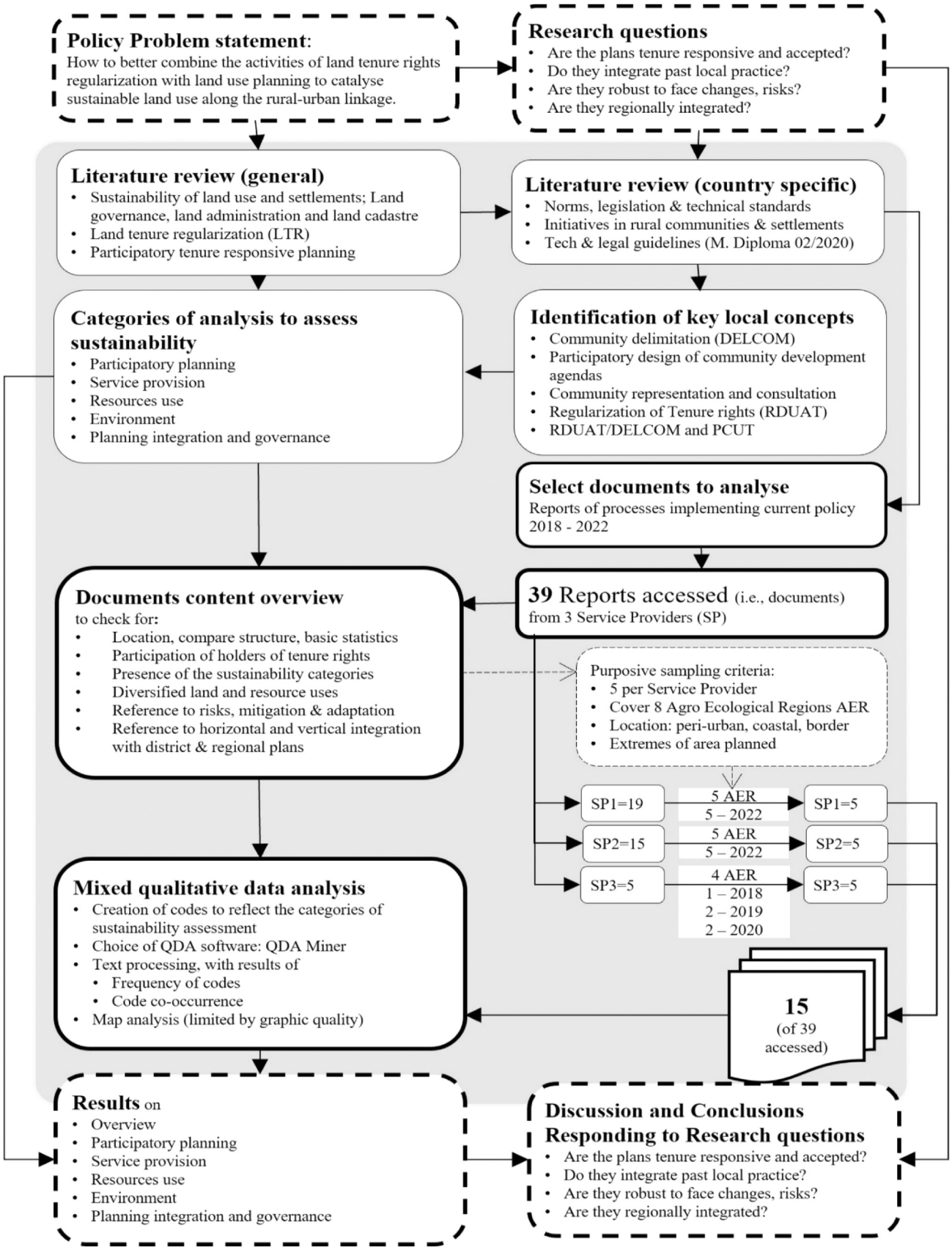

Fig. 2. - Methodological framework [***full width fitting image***].

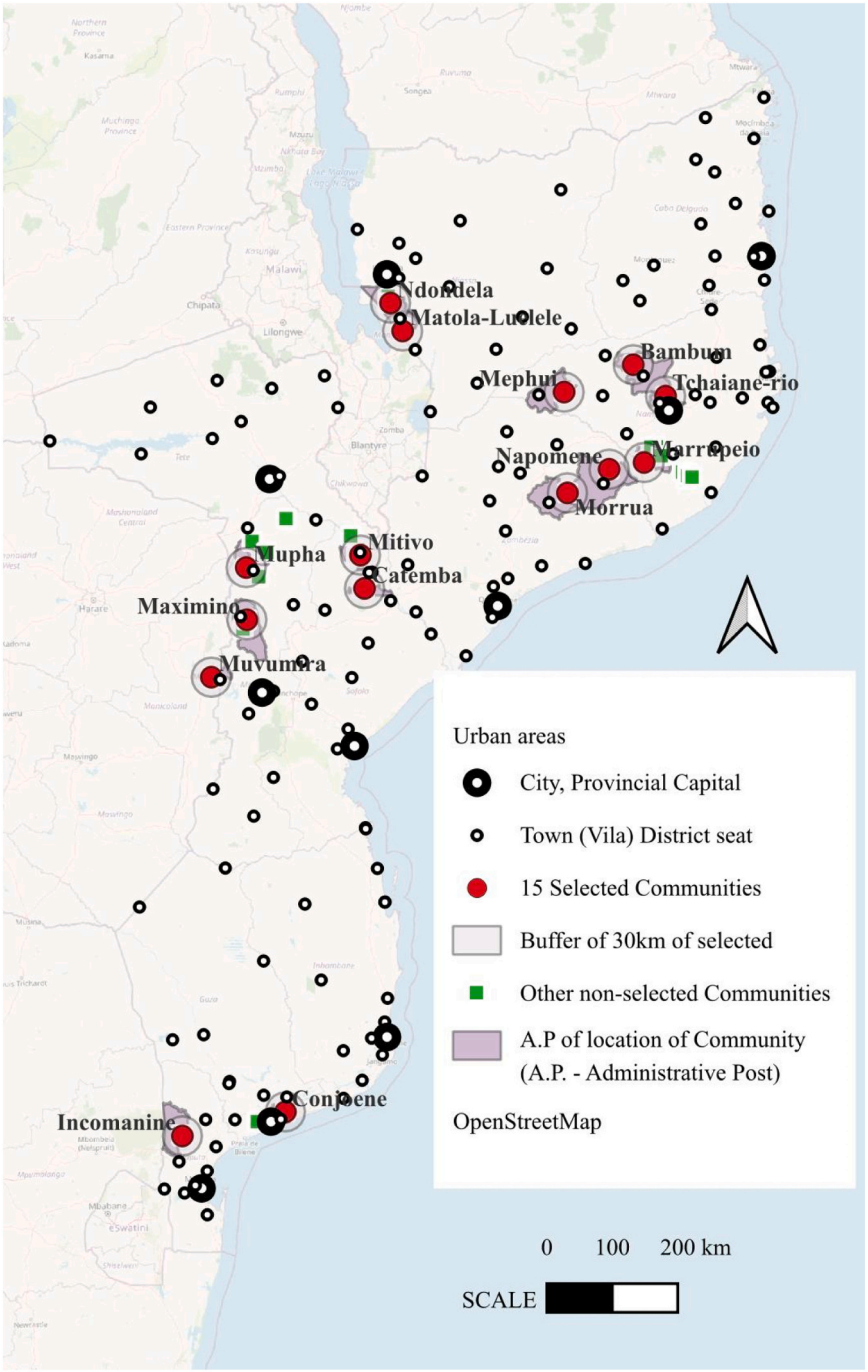

Fig. 3. - Map of location of the community plans sampled for the study [***1 column***].

5. Results

5.1. Overview

The analysis of the chosen codes showed, as illustrated in Fig. 4, that the three strongest links were (1) between food security and social safety, highly influenced by safe and not war-conditioned access do land; (2) between agricultural use of land resources, economic activity, employment and energy; and (3) between institutions and capacity and legitimacy. Institutions are also related to regional integration of land use plans and representations at various levels. Weaker links also showed between communication and participation, and between risk of, or disasters on one side and agricultural use of resources, economic activity, employment and food security on the other.

The internal similarity in plans of the same service provider was around 68% for SP1, 79% for SP2 and 58% for SP3. In the two last plans of SP3, the similarity fell to 32%.

The plans follow the sequence diagnostic – land cover – land use plan. The georeferenced infrastructure is either included in the diagnostic or in the land cover sections. With one exception, the plans do not include information on current individual land use rights before planning. None include explicit alternative scenarios. General maps of risks and their relationship with the definition of public domain areas and exclusion areas were found in the provided documentation. Criteria do classify residential and agricultural land face challenges in dispersed settlements (see Figs. 5 and 6).

Table 1
List of community plans in the study.

Nº	AER region (AER)	Community	Area km^2	Service Provider (SP)	Criteria	Administrative Post (AP)
1	R6	Catemba	53.97	SP2 (EIM)	Zambzi	Murraça
2	R4	Maximino	46.26	SP2 (EIM)	Border	Catandica-Sede
3	R6	Mitivo	30.31	SP2 (EIM)	Zambezi	Chemba
4	R4	Mupha	25.26	SP2 (EIM)	Border	Guro-sede
5	R10	Muvumira	2.82	SP2 (EIM)	Peri-urban. Min. area	Machipanda
6	R2	Conjuene	33.74	SP1 (TV)	Peri-urban. Coast	Sede
7	R1	Incomanine	41.74	SP1 (TV)	Hinterland	Sabie
8	R8	Marrupeio	9.04	SP1 (TV)	Hinterland	Iuluti
9	R7	Matola-Luelele	33.97	SP1 (TV)	Hinterland. Border	Massangulo
10	R10	Ndolela	25.30	SP1 (TV)	Hinterland. Border	Lione
11	R7	Bambum	13.18	SP3 (VA)	Hinterland	Mecuburi-sede
12	R10	Mephui	31.56	SP3 (VA)	Hinterland	Malema-sede
13	R5	Morrua	70.74	SP3 (VA)	Mining	Chiraco
14	R8	Namopene	14.58	SP3 (VA)	Nat. Reserve	Gilé -sede
15	R7	Tchaiane	84.94	SP3 (VA)	Peri-urban. Cluster	Rapale-sede

AER: national agro-ecological regions, characterized and mapped in Muhacha (2021); Sitóe (2005). SP1 =Terra Vital (Terra Vital, 2022i; Terra Vital, 2022j; Terra Vital, 2022f; Terra Vital, 2022g; Terra Vital, 2022h); SP2 =ETOP+IGNFI+METOP (ETOP-IGNFI-METOP, 2022e; ETOP-IGNFI-METOP, 2022a; ETOP-IGNFI-METOP, 2022d; ETOP-IGNFI-METOP, 2022b; ETOP-IGNFI, 2022c); SP3 =Verde Azul (Verde Azul, 2020b; Verde Azul, 2019a; Verde Azul, 2019b; Verde Azul, 2020a; Verde Azul, 2018)
Source: MOZLAND-FNDS

Table 2
Selected statistical data on the communities.

	Community	Observations	Area (ha)	Population Total	Population density (pop/km2)	House & farm holding (ha)	Open Forest (ha)	Shrub (ha)	Water bodies (ha)	Flooded area (ha)
1	Catemba	cluster, Zambeze	5397.00	2316.00	42.91		338.03	2148.71	94.00	353.08
2	Maximino	border, Zimbabwe	4625.63	2400.00	51.88	2.66		1553.83		226.63
3	Mitivo	cluster, Zambeze	3030.70	1559.00	51.44	2.00	155.28	636.51	443.61	180.67
4	Mupha	livestock	2525.50	302.00	11.96	4.31		1842.45	34.05	50.43
5	Muvumira	border, Zimbabwe	281.80	3179.00	1128.11	4.30				
6	Conjuene	coast, peri-urban	3373.58	3981.00	118.01		1086.40	1227.38		
7	Incomanine	close to private farm	4173.81	234.00	5.61		3160.76			
8	Marrupeio	cashew plantations	904.13	3300.00	364.99					
9	Matola-Luelele	Wood fuel economy	3396.58	3540.00	104.22		94.42	563.80		
10	Ndolela	forestry plantation	2530.32	3050.00	120.54	19.06	137.87	409.31		
11	Bambum	timber economy	1318.00	675.00	51.21		88.00	319.00		31.00
12	Mephui	agri-food & cotton	3156.00	1573.00	49.84		78.00	606.00	14.00	
13	Morrua	mining, pegmatites	7074.00	4260.00	60.22		1992.00	1130.00	200.00	18.00
14	Namopene	natural reserve	1458.00	2300.00	157.75		32.00	334.00	51.00	
15	Tchaiane	peri-urban, Nampula	8494.00	1670.00	19.66		983.00	1000.00	103.00	1013.00

5.2. On participatory planning and capacity

The planning process involved both the community members, in general, and their local representatives in organizations dealing with natural resources management, the Community Management Committee (CGC), with women participation. In three communities, the CGC was created along the process. These committees have their member selected and legitimised by the communities and include members of the traditional authorities. Facilitators are chosen among their members, and they receive a specific training for the task. The concern to involve women was present in the meetings and in the organizations, as well in the participatory mapping of the community and gendered activities. In specific cases, the meetings were fragmented so has women could have their voice without male peer pressure. All plans had the participation of traditional authorities (*r é gulo*) of the community itself and neighbouring communities. In two communities, with matrilineal succession rules, the traditional leader are women (*rainha*). Mapping and cartograms were done separately by male and female in 11 communities and the process was public in all communities. Participation of community members and organizations as well as of administrative representative in the initial moments, participatory GIS and the training of facilitators provided legitimacy to the process in all plans.

5.3. On service provision and inclusion

The plans surveyed and georeferenced infrastructures of education, health care, water source, churches, police stations. In general, schools are precarious and barely offer alphabetization services, being women the most excluded.

Table 3 collect selected data on challenges related to service and utilities provision faced by the communities.

Eight communities noted the absence of secondary education, and

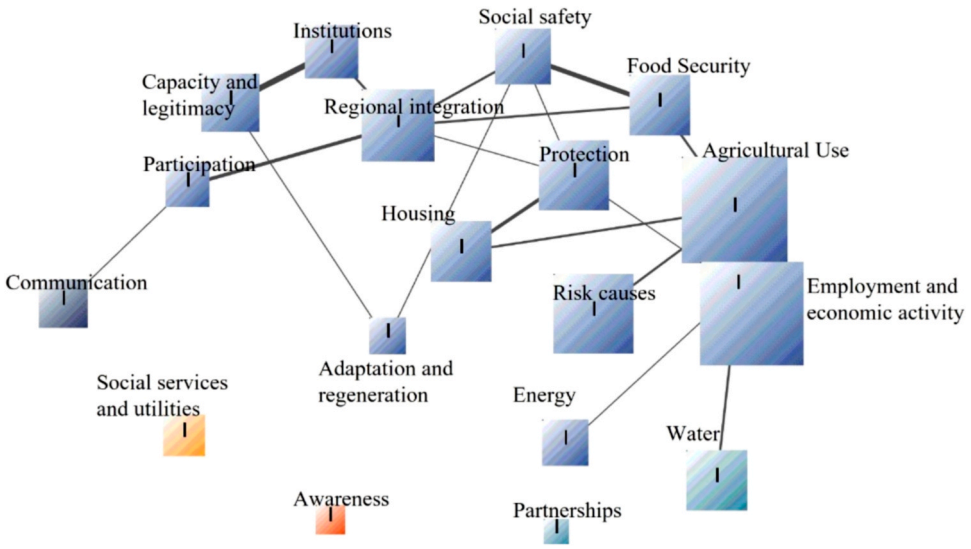

Fig. 4. – Links in 2D multidimensional scaling among codes. [***1.5 column fitting image***]. Note: Colours represent clusters of themes. Size of squares are according to frequency of code. Width of links, indicate strength, according to co-occurrence.

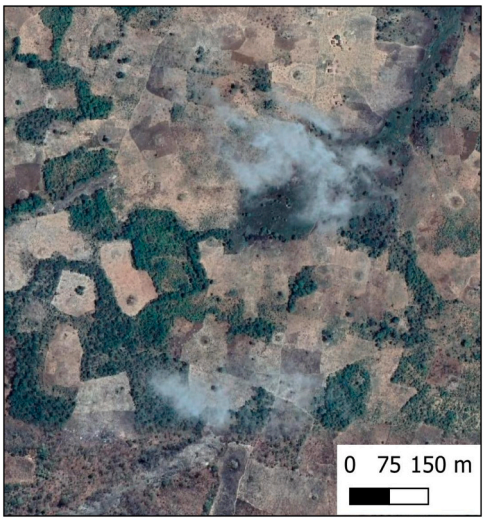

Fig. 5. - Community of Mephui, (R10, savanna). Small fields, of 0.5 to 2 ha, in the fringe of the settlement, separated by open forest patches with smoke indicating controlled fires. [***1 column fitting image***].

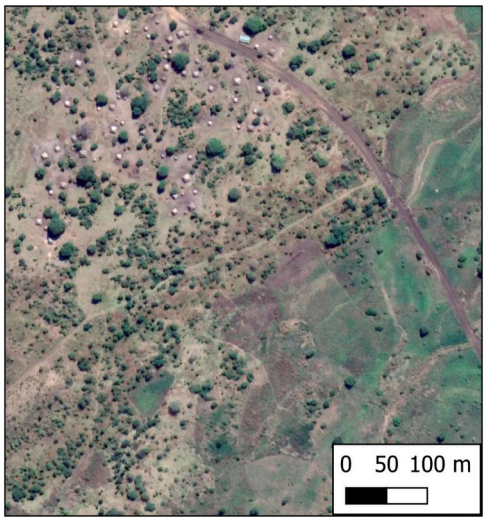

Fig. 6. - Community of Catemba (R6, prairie in the Zambezi Valley). Settlement area, close to small fields, showing farms vulnerable to flooding. [***1 column fit. image***].

one mentioned the need of a professional school. Long distances to school are noted also in eight communities. Seven communities have no healthcare infrastructure but indicated the presence of sanitary agents or midwives. Ten communities indicate lack of organised marketplaces. Seven communities have a type of piped water distribution, and three have only superficial and shallow wells despite having considerable water resources. Distance to sources is indicated as one main reason for unequal access to water. In terms of sanitation or waste disposal, while there is little information in the diagnostics, there are 11 mentions in the plans, to reserve – or prevent the use of – areas for domestic solid and hospital waste. Conflicts were registered within families – inheritance and domestic violence, within the community – land related, and between communities – related to borders. All communities informed of traditional dances and plays, sometimes practiced in separate by gender, by young and elderly. Community police provide policing. Two communities planned to expand police posts.

All communities reported that food insecurity is associated to armed conflicts or natural disasters, which cause displacement and migration, low levels of production and search for new areas to live and for agriculture. Migration can reduce land use in original places but increase pressures on land resources in destination settlements. Only one community,[1] with a developed organization lead by traditional authorities, does not mention war and civil unrest as a cause for displacement.

Recommendations were standardized per SP and copied without adapting to the specific conditions in each community.

5.4. On resources use

In half of the plans, on balance agricultural areas were proposed to decrease and residential areas to increase, at the cost of open forest, prairies and agricultural areas. The definition of protected areas, where titles cannot be issued, followed the national legislation. Areas reserved

[1] Catemba. It is interesting to note that this community on the banks of Zambezi River was at the centre of the civil unrest for 16 years.

Table 3
Selected data on service provision in the communities.

	Community	Schools	Health care units	Water source distribution	Waste disposal	Power and energy	Communi-cations	Market stands	Police stations
1	Catemba	Dur+Stf	Dur+Staf	SWell	0	B+sol	UnpR+Cel	Infrml	0
2	Maximino	Dur+Stf	Neig Comm	Well+Fnt	0	B+sol+Grd	UnpR+Cel	Infrml	0
3	Mitivo	Dur+Stf	Neig Comm	Well+Fnt	0	B+sol	UnpR+Cel	Neig Com	0
4	Mupha	P	P + Stf	Well+Fnt	0	B+sol	UnpR+Cel	Dur+Infrml	0
5	Muvumira	Dur+Stf	Neig Comm	Well+Fnt	0	B+sol+Grd	UnpR+Cel	Dur+Infrml	0
6	Conjuene	Dur+Stf	D+Staf	Well+Fnt+Res	na	B+sol	UnpR+Cel	Infrml	1
7	Incomanine	Dur+Stf	D+Staf	Well+Fnt	cemetery	B+sol+Grd	UnpR+Cel	Dur+Infrml	0
8	Marrupeio	Dur+Stf	Neig Comm	Well+Fnt	na	B+sol+Grd	UnpR+Cel	Infrml	0
9	Matola-Luelele	Dur+Stf	Dur+Stf	Well+Fnt	cemetery	B+sol	PavR+Cel	Infrml	0
10	Ndolela	Annex; P	Neig Comm	Well+Fnt	cemetery	B+sol	UnpR+Cel	Infrml	0
11	Bambum	Neig Comm	Neig Comm	SWell	na	B+sol	UnpR+Cel	Infrml	0
12	Mephui	Dur+Stf	Dur+Stf	Well+Fnt	na	B+sol	UnpR+Cel	Infrml	0
13	Morrua	Dur+Stf	Dur+Stf	Well+Fnt	na	B+sol+Grd	UnpR+Cel	Dur+Infrml	CommPol
14	Namopene	Dur+Stf	Dur+Stf	Well+Fnt	na	B+sol	UnpR+Cel	Infrml	0
15	Tchaiane	P + Stf	Neig Comm	SWell	na	B+sol	UnpR+Cel	Infrml	

Neig Comm=none; use facilities in neighbouring communities
B=biomass: woodfuel; charcoal; grass
Cel=cellular network access
CommPol=community policing
Dur=durable
Grd=grid
Infmrl=informal
P = precarious construction
Res=reservoir
sol=solar panels
Stf=staffed
SWell=shallow well
UnpR=unpaved road
Well+Fnt=covered well, with manual pump; fountain

for initiating nucleation were proposed in all plans. On water resources, except for the first plan of 2018, none of the plans undertakes an analysis of rainfall and waterways network. Six plans mention lack of use of rainwater and four mention the lack of water management capacity on water resources. General recommendation on their uses is provided, Main recommendations refer to the use of water for irrigation, to improve productivity, without referring to measures to avoid inequalities in access. For agricultural land use, two plans mention the criteria to calculate the area of expansion.

All fifteen (15) plans record the use of timber, wood fuel, charcoal and grass as sources of energy and building material. Thirteen plans mention the use of medicinal plants, and eleven mention fauna for domestic consumption. Main recommendations related to these issues are to control deforestation and forest fires. Four plans record solar panels as means to produce power for water collection and distribution of for domestic use. In what refers to geology only one plan undertakes a description of the resource, two refer to mineral water, one to limestone and one to conflicts generated by mining activity. Other references are related to risks of pollution that may be generate by mining activity.

5.5. On planning integration and governance

Community delimitations were made with the participation of neighbouring communities. some are in clusters, but no reference is made to the integration of the community plans in those communities. Eight plans refer to instruments of territorial planning at the level of district. These instruments are the District Land Use plan (PDUT), the Strategic Plan for District Development (PEDD) and the District Economic, Social and Budget Plan (PESOD). It was noted that none of the plans of communities located in the Zambezi basin refer to a strategic territorial plan formulated for the basin approved in 2021, i.e., before these plans were formulated. While authorities at the level of administrative posts were regularly involved in the initial meetings, they were either not informed or simply did not add to the process of regional planning integration.

Consulting handwritten and scanned pages of the reports, it was possible to conclude that the meetings for the devolution of plans involved neighbouring communities and sufficient time, from 15 to 90 days, elapsed between the invitation for, and the realization of the meetings. There is no indication that the plans were publicly available during that period.

5.6. On environment

Table 4 provides the counting of communities where natural and human-made environment related events recorded during the participatory land use planning.

All 15 communities recorded uncontrolled forest fires and soil erosion due to intense rainfall as primary causes of loss of harvests.

Table 4
Selected data on recorded natural and human-made stress generating events.

	Code (event)	Cases (Communities)	% Cases	Notes
1	Erosion	15	100%	Include wind- and water-caused
2	Forest fires	15	100%	Include uncontrolled fires for hunting
3	Droughts (not floods)	14	93%	
4	Epidemies and pests (not cyclone)	14	93%	Include plant pests and diseases
5	Deforestation	12	80%	
6	Floods (not cyclone)	11	73%	
7	Cyclone (not floods not drought)	10	67%	
8	Flooded areas	8	53%	Include residential and agricultural areas

Fourteen communities also recorded droughts and epidemies and plant pests and diseases as causes for reduced harvests, as well as involuntary community displacement. Deforestation is due to expansion of agricultural areas and settlements. Flooded areas are mentioned in eight communities. And yet the mapping and georeferenced areas of risks associated with these events are almost absent. Irrespective of the specific vulnerability in each community, general recommendations are copied-and-pasted between plans, such as improvement of sanitation, undertake environmental education to reduce forest fires, planting trees, improve roads and start irrigation schemes to improve yields and thus reduce the expansion of agricultural areas.

6. Discussion

This section addresses the research questions.

6.1. Are the plans useful land use plans?

This research question addresses the tenure regularization component. In the context of this work, plans are considered useful it they are tenure responsive in such a way that security of tenure is improved and when they build on local practices in a way that make them attractive tools to be used.

The short answer is that they only partially incorporate the current tenure rights. The documents provide a rich set of information and reflect a focused effort on participation and legitimacy, and on the local practices. The plans reflect efforts to construct instruments that can be used to negotiate with neighbouring communities. The plans include mapping of land cover and land use and indicate expansion areas, but most of this information can be obtained simply by imagery interpretation and it is not clear how much they incorporate participatory co-produced information – two plans incorporate suggestions of community forests. It may happen that additional parts of the reports, such as those referring to the regularization of parcels, include easements and indications on the recommended land use, but that was not reflected in the process of community land delimitation. However, no indication was found on mechanisms to keep the cadastre and land use plans up-to-date, integrating local and national or other upper-level institutions of land administration. This may jeopardise both the usefulness of the cadastre.

It was also observed that:

- These plans represent more a logistical preparation for the regularization of current visible land use, to identify zones of exclusion of registration of individual rights.
- The plans were developed without a previous survey of individual claims on land, (with one exception). This practice goes against the tenure responsive land use planning approach.
- As such practice is specifically mentioned in the guidelines, this is but one indication of insufficient use of both the official guidelines and terms of reference for the contracting parties. No mention was made to the use of guidelines and toolkits of recognized international organizations of reference, some already translated into practices (Chigbu et al., 2016; Rodrigues et al., 2006; UN-Habitat, 2014), and of existing legislation (Lei no 19/, 18-Jun, 2007; Governo de Moçambique, 2008. Decreto n° 23/2008, 01-Jun).

6.2. Are the plans robust enough?

This research question is related to the land use planning component.

The analysis indicate that the plans provide the communities with opportunity for and capacity to adapt to changes resulting from the growth of existing or new settlements. All plans include expansion areas for residential, infrastructure and agricultural uses. As for integration, the results show that almost half of them seek to follow upper-level regional plans. Integration of individual community plans into broader land use plans including neighbouring communities was not sufficiently considered – the plans are circumscribed to the territory of each community. While it can be said that the plans are sufficiently robust to face changes in the medium term, it is noted that:

- The overall strategy was to improve current land use only incrementally. These improvements included: i) the indication of activities that must be avoided in existing areas – residential, agricultural, protected and expansion areas, which are mostly regulated, ii) or general good practices, already recommended by either national or international guidelines.
- The answers to the problems and needs were general, disregarding opportunities and constraints in specific agroecological regions. For example, the recommendations for Catemba, close to Zambezi River and for Muvumira, in the highlands of Manica province are the exact same for residential and social equipment, agricultural and grazing areas, as well as for protected areas, conservation and forestry.
- Risks are not reflected spatially. As an example, there is no mapped information on the places which are more subject to forest fires, to attacks from wildlife, and potential soil loss.

7. Recommendations

Three sets of recommendations can be adduced from the case of combining land tenure regularization *cum* community land use planning being implemented in Mozambique: (1) general recommendations, addressing policy formulation to achieve sustainable tenure responsive land use plans; (2) specific recommendations, addressing technical and legal procedures, and participation; and (3) recommendations on further research.

7.1. General recommendations

The main recommendation is that policies combining tenure regularization and participatory land use planning are encouraged and should continue to be studied and refined. The technical and legal procedures approved by the Ministerial Diploma 2/2020 in Mozambique resulted in useful and partially robust land use plans, but fragilities remain. While a target to be achieved, regularization must be preceded by mapping and taking advantage of co-produced information as well as recordation of current rights, some of which overlap. Overall, policy formulation should pursue sustainability with efficiency and effectiveness, while creating a "culture" of attention to social and territorial cohesion. Policy formulation should resist ad-hoc pressures and becoming hostage of a single well-funded but temporary programme. The recentralization of land administration of community lands because of fiscal or commercial considerations, should not obfuscate the purpose of improving land resources management nor facilitate the formulation of hasty and poor community land use plans to accelerate regularization.

A broader interpretation is required for "tenure responsive land use planning": a tenure responsive sustainable land use plan implies the informed and substantive participation of the tenants, not only in the diagnostic of the status, but also in shaping futures states. This is reflected in Fig. 7, showing the implementation through participation of the conceptual framework exposed in Fig. 1. A (current) tenure responsive land use planning is more amenable to a regulatory functionalist paradigm (Saunders et al., 2019). However, by suggesting rules regarding land use changes and expanding nucleation and pre-urbanization, such plans open space for transforming current tenure systems and promote future sustainable development.

7.2. Specific recommendations

7.2.1. On the technical and legal guidelines

Several practices adopted in the process under study may be generalised and bring value added for interaction between the delimitated

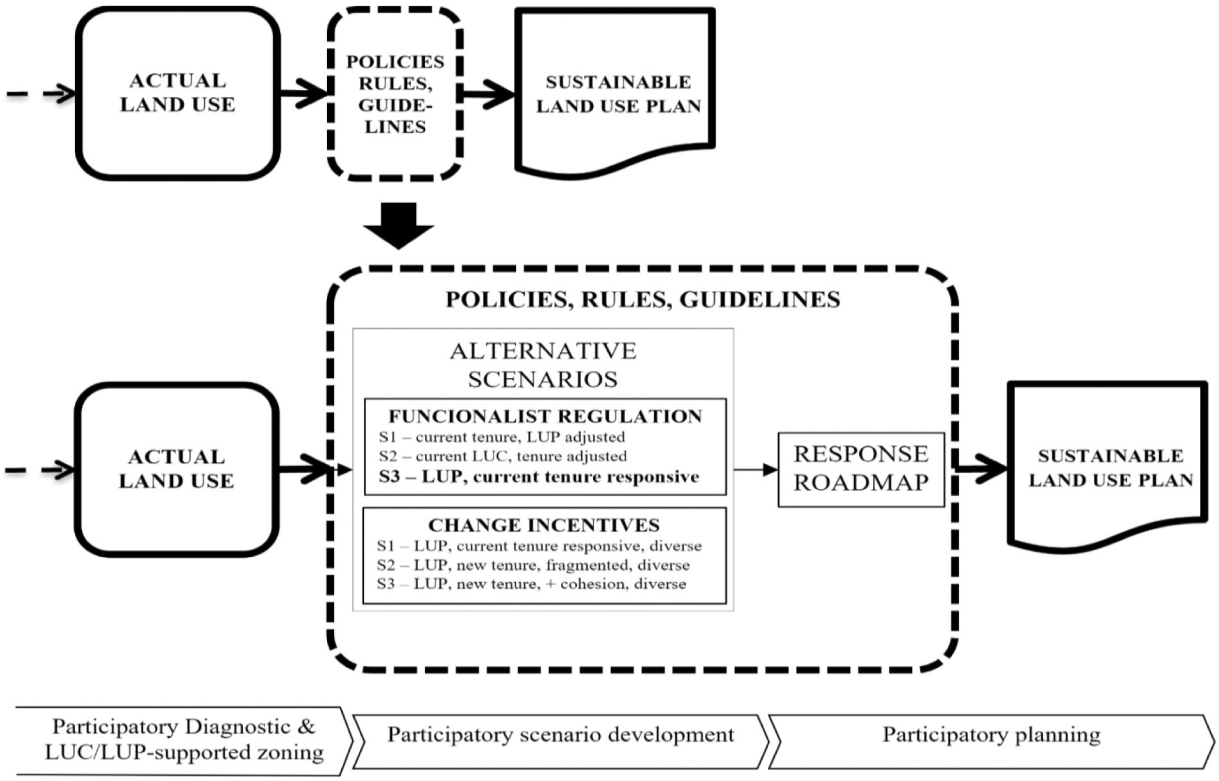

Fig. 7. – Implementation of the conceptual framework of land use regularization in Fig. 1. [***full width fitting image***].

communities and other settlements in peri-urban areas. These are:

- The model of participation and involvement of community members consolidate the need for participatory land use planning, strengthening the use of participatory GIS.
- The involvement of both formal and informal institutions in the process.
- The definition, from the onset, of mechanisms for conflict resolution.
- The definition of indicative parcel sizes for expansion areas, including agricultural, and generous reserves of environmental and cultural interest.
- The use of monitoring and quality control tools, and safeguards protocols, which are especially relevant when commercial service providers are involved. Institutional arrangements and the terms of reference and contract terms, particularly in what refers to team composition, should be regularly revised and adjusted accordingly and iteratively
- Ensure that residential land should not increase at the expense of agricultural land and that agriculture should not expand with loss of forest, water resources and natural biodiversity.

7.2.2. On participation

Effective participation of tenants is necessary to yield land use plans that address all the social, cultural, economic, environmental and institutional dimensions of sustainability, where the tension between the collective and individual interests manifest. Effective participation intends to ensure that local constraints and limitations are identified, exclusion areas and easements are correctly understood, making rights recordation informative and able to provide sufficient and informed security of tenure, before fully registered land titles, making pro-poor cadastre a dynamic land administration process.

7.3. Further research

Further research on how the guidelines will ensure that the processes are reflected on the products is suggested, such as building participatory deliberation that contemplates collective and public interests of the community with the least losses for private interests. Fit-for-purpose techniques need also be further studied to account for detached homesteads (housing + farm) in dispersed settlements, which are common in rural communities. More research should also be devoted to promoting participatory GIS that go beyond acquisition of coordinate identifying practical issues and activities to attract interest in participation[2] in the design and implementation of the land use plans, with practices that can be applied elsewhere.

8. Conclusion

The research preconises that linking land use planning and regularization of claimed rights has the potential to improve sustainability in rural, peri-urban and urban settlements. Such linkage is to be gradually formalized, according to the framework in Fig. 1. The main contribution is intended for the knowledge on linking land register and land use planning. The methodology adopted provided the answers to the research questions. This research has shown that the goal of securing land tenure rights is better done in conjunction and simultaneously with a land use planning. Participation was stimulated in the diagnostic phase, and in the devolution meeting. Accepting that during the devolution process the participation was beyond the collection and confirmation of information for the diagnostic, it can be said that the result are plans that better protect rights and respect local and customary practices. There are also indications that measures to reduce risks from

[2] Examples: discuss and learn how to define the sizes and pre-demarcate plots in the agreed expansion areas, collect data on universal indicators of sustainability of settlements including the ratio of residential to agricultural area, collect data of weather and water cycle variables, such as temperature, rainfall and river debit, choose methods to materialize reserved and protected areas through contracted sustainable use.

stressful events were considered, adding robustness to the plans.

Overall, the national guidelines approved by the Ministerial Diploma 2/2020 provide a good roadmap to regularization and sustainable land use planning for the delimited communities. It should, however, be noted, that the implicit recentralization may result either good or bad because of its rapidly multiplying effect: good practices can be quickly multiplied with added legal security, but so can bad practices.

Experiences such as the one being implemented in Mozambique were studied for other countries, in Africa. The case in Mozambique is of particular interest because of its massive and systematic nature, and its implementation by private service provider companies. This fact introduces commercial interests that may preclude the time required for an adequate field work. There are limitations introduced by the guidelines and contract terms themselves, such as the absence of specific requirements on sustainability and resilience development, and the need to incorporate the results of participation in all phases of the process. Furthermore, the evaluation of quality of land use plans for contractual reasons might be subject to pressures for regularization.

Limitations: Apart from the limitations referred to under Section 2 on methodology, a noted limitation of this research is that pre-2018 cases were not studied to rigorously evaluate how well the current guidelines incorporate previous experience.

CRediT authorship contribution statement

Carrilho João: Writing – original draft, Methodology, Formal analysis, Conceptualization. **Santos Pedro Manuel Pinto dos:** Writing – review & editing, Methodology. **Dgedge Gustavo:** Writing – review & editing, Methodology, Conceptualization. **Trindade Jorge:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

The authors do not have permission to share data.

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