Planning without Baseline Information: Delimitation of Urban and Rural Settlements in Oé-Cusse Ambeno, Timor-Leste

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Abstract: Urban and rural perimeters are boundaries that outline urban and rural areas. The delimitations of these areas are established according to a set of criteria supported in detailed baseline information such as resident population, the existing infrastructure, and the existence of public facilities. However, in situations where all the basic information needed to enable the current method of delimitation is not available or suitable, the planning process can be compromised. In these situations, it is necessary to create an alternative method that enables the delimitation of urban and rural perimeters in order to establish development conditions according to these perimeters and ensure the promotion of a correct and efficient transformation of the territory. This paper presents and discusses the method developed for the delimitation of urban and rural perimeters in the regional plan for Oé-Cusse Ambeno in Timor-Leste [Plano Director de Ordenamento Territorial da Região Administrativa Especial de Oé-Cusse Amben (PDOT)], supporting the elaboration of this plan by the Special Administrative Region of Oé-Cusse Ambeno. This method was developed specifically to enable the delimitation of urban perimeters in a context where the most basic baseline information is lacking, a characteristic situation in the majority of developing countries. In order to carry out the planning process, the method developed integrates a set of criteria from which it identifies the most determinant criteria to allow the establishment of a hierarchy of existing clusters (settlements) and the delimitation of the urban and rural perimeters. This activity has made use of a group of experts from the fields of architecture, territorial planning, geography, environmental sciences, landscape architecture, civil engineering, economics, and the law, all disciplines required to inform the applicability and weighting of each criteria. The result of the developed method has been applied in the conception of the PDOT in which the minimum baseline information to conduct future planning practices has been put in place. The conclusions show that the method applied provides an efficient delimitation of the urban and rural perimeters, which was validated on the PDOT framework and is able to be integrated into future plans. DOI: 10.1061/(ASCE)UP.1943-5444.0000462. This work is made available under the terms of the Creative Commons Attribution 4.0 International license, http://creativecommons.org/licenses/by/4.0/.

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Introduction

In developing countries, there is a lack of reliable and easily available data sources on key aspects of territorial development (Li and Yeh 2004). This lack of data includes simple issues such as the distribution of buildings and resident population (Chadwick 2016), which are crucial for defining land uses, and the often poor quality of available information has become a growing concern for planning authorities (of both developed and developing countries) (Ferrão and Mourato 2011; Gonçalves et al. 2015; Healey 2004). For instance, keeping up with fast population growth rates (López et al. 2001), especially within lower-income groups, is increasingly recognized as a key tool for improving the planning process by monitoring these dynamics (Chadwick 2016), ensuring that the plan adapts to the socio-territorial situation (Amado and Cavaco 2015) and therefore contributing to sustainable territorial development (Tietenberg and Lewis 2016).

The research question addressed in this paper is how to get the baseline information needed to start the planning process in context of a developing country in Asia that does not have a strong administrative and technical structure to deal with urban and territorial issues and demarked by a complete absence in terms of monitoring and collecting data related to territorial development.

This paper aims to contribute to understanding how administrations and planning agents could deal with this lack of baseline information by presenting the methodology that was adopted to the PDOT. The PDOT and the reality of Oé-Cusse, Timor-Leste, is a relevant case study due to its incredibly high level of lack of information and by the complete absence of planning culture in the administration. In addition, the paper discusses several questions related to how the lack of territorial baseline information can affect the quality and the efficacy of the planning process and how planners can overcome these difficulties.

Literature Review: Planning Practices and Methodologies

Planning practice is an organized activity with social character. It develops a strategy to achieve a specific group of predefined objectives that are aimed at improving current situations. It is therefore an instrument for regulating urban development and at the same time a product of the necessity to implement territorial intervention (Amado 2005). It is a process where rational decision-making methods are used to determine the appropriate action to be taken to achieve planning objectives. These methods are also used to help find the solution to any problem that may arise during this process (Davidoff and Reiner 1962; Friedmann 1987; Hall and Tewdwr-Jones 2010; Rittel and Webber 1973). Thus, planners use wide-ranging theoretical knowledge and extensive practical skills (Kempenaar et al. 2016) when developing and disseminating knowledge in the form of analysis, plans, and recommendations (Tennöy et al. 2016).

Developing analyses to determine the real state of a territory, namely, land use transformation, requires a set of information and knowledge including regulations, norms, and planning procedures (Tennöy et al. 2016). These need to be handled and then analyzed from many points of view through a multidisciplinary approach. However, in some situations the context of the local reality requires alternative methodologies and approaches. These can fit within existing available data or adapt to an existing planning framework that is not clearly defined. In developing countries with low demographic occupation, planning processes need to address human concentration patterns carefully. In these situations, the patterns of human concentration are completely different when compared with developed countries, and their analysis can spatialize day-to-day activities because commuter flows tend to be significantly lower than in developed countries.

One of the most important issue in order to understand territory occupation and human concentration patterns during the planning process is the delimitation of urban and rural areas achieved by marking out perimeters according to existing settlements.

Urban and rural perimeters are boundaries that usually incorporate existing built-up areas, public spaces such as squares or parks, and the immediate surroundings. These perimeters can be defined according to a set of criteria that uses detailed baseline information such as resident population, existing infrastructure, and available public facilities (Lang 1986).

The concept of urban and rural perimeters is one of the most usual and traditional parts of Lusophony countries’ planning processes and has support from the fact that these delimitations represent boundaries that mark out urban and rural areas. Because they distinguish the territory according to a set of criteria, they have the capacity of inform the planning process regarding major territorial aspects that need to be taken into account when planning the transformation according to a strategic vision of the future development. The delimitation of urban and rural perimeters has been given significant attention by planners, researchers, stakeholders, and governments within strategic planning and territorial development. Planners and governments are aware that it is crucial to distinguish between urban and rural areas to ensure that decision makers address urban growth and territorial development appropriately (Ma et al. 2017). In addition to this, knowing these boundaries according to their perimeters is crucial to the planning process due to the ability to distinguish between urban and rural areas, allowing planners to adapt strategies according to different territorial, social, and economic factors and requirements (Camarano 2002; Ferreira et al. 2010). Moreover, urban and rural perimeters can be used as a tool to define areas of development according to the expansion needs of each settlement, ensuring an environmentally friendly framework (Dale et al. 2014). Useful delimitation of urban and rural perimeters contributes to better planning practices (Ferreira and Condessa 2012). This process also considers the provision of an adequate amount of green and ecological areas within future expansion to safeguard significant ecological values, social opportunities, and economic functions (Bradley 1995; Li et al. 2005; Lütz and Bastian 2002; Shafer 1999; Tyrväinen 2001). Providing a sufficient amount of green and ecological areas is extremely important because the typology, quantity, and structure of green spaces can have a positive effect on the future population’s well-being (Amado 2005; Richards et al. 2017), also potentially reinforcing local values (Bedini and Bronzini 2016; Stephenson 2010) and making the future territorial governance more flexible.

Delimiting urban and rural perimeters is not an easy task and is certainly not consensual. During the last decades of planning process improvements, many methods were developed (Caldera 2003; COMET 2009; Ferrão et al. 2002; Porta et al. 2013; Ramos and Silva 2007), mostly by researchers and planners [and some by administrations as in the case of the delimitation of rural settlements in Galicia, Spain (Law 2/2010)] in order to address this issue. However, within the academic world there is still an endless discussion regarding what to take into account when defining urban and rural perimeters. When comparing existing methods and past empirical evidence, it is possible to see that these methodologies tend to differ fundamentally in the way they adapt to an existing context (urban scale, territorial nature, the level of information, and planning framework, among others), although there are some confrontations that are the result of essentially subjective political criteria (Ramos and Silva 2007).
Methodologies to establish urban and rural perimeters will lead to mapping the existing perimeters of urban clusters. This task is usually handled at the beginning of the delimitation process and it is necessary to understand the existing context, allowing the planners to understand the territorial scale and nature of the case study. There are several methodologies to establish the perimeters of urban clusters (Caldera 2003; Ferrão et al. 2002; Ferreira and Condessa 2012; Ramos and Silva 2007) based on different concepts, supported by different techniques and distinct sets of criteria (Ferreira and Condessa 2012).

Concepts and methods may vary according to the territorial nature and cultural context and from the case to case reality. One example of this could be the United Nations’ contiguous built-up area concept [Network on Urban Research in the European Community (NUREC)] or the population density concept used by the Group for European Metropolitan Area Comparative Analysis (GEMACA). Also, different techniques such as field survey, geographic information system (GIS)—integrated data, satellite images, drone vision, questionnaires, and land proprietors’ surveys are selected to be used influenced by the data that are available, the objective and defined goals, and also the scale. Satellite images, which become a prime instrument used for the delimitation of urban clusters (Pauleit and Duhme 2000), are not completely accurate in very compact and dense settlements, compromising analysis that requires a lot of detail such as the average distance between buildings by way of buffer generation (Ferreira and Condessa 2012). Digital processing of satellite images is a technique that achieves better results at a metropolitan scale when delimiting metropolitan clusters (Bosselmann 2008). However, in developing countries not all tools and instruments can be applied, which means that in some cases planning teams must build their own tools.

Other current techniques conduct distinct analysis based on several levels of detail and using different amounts of data. These techniques focus on analyzing land use patterns (Rashed and Jürgens 2010), using remote sensing and GIS (Sudhira et al. 2004; Li and Yeh 2004), using Landsat and the Defense Meteorological Satellite Program Operational Linescan System (DMSP-OLS) nighttime images (Imhoff et al. 1997; Roychowdhury et al. 2011, 2009), or using a grid approach (van Leeuwen 2006).

On the other hand, establishing criteria tends to adapt to the urban scale and current local planning practices where they can be based on the economic and social structure (Caldera 2003) or the functional perimeters (COMET 2009), among others.

However, in developing countries the absence of a planning structure has the effect of lacking conditions for the application of criteria. Associated with this situation is the absence of reliable and systematized statistical data or fieldwork that may be used in the design of planning processes. Given the advantage of planning instruments that support the ordering of the territories of countries, an effort is made to ensure that this is not an impediment to the development of plans that support the development of society.

The paper is structured in seven parts. The first part describes the methodology that was created in order to define urban and rural perimeters in the PDOT. The second part introduces the case study and provides a general description of the current situation; the third part provides a brief overview of the existing methods for defining urban and rural perimeters.

The fourth part deals with the lack of baseline information and discusses how to overcome this issue. It provides a brief overview regarding the management system, territorial data, and the timeline required in order to distinguish urban and rural settlements. This section emphasizes that the lack of information and the administrative constraints cannot be addressed within the timeline set out by the administration for the development of the PDOT.

The fifth part describes the need for a hierarchy of existing sucos and highlights where new development areas will be located, leaving the delimitation of urban and rural perimeters to the following part.

This hierarchical process is a significant contribution to the delimitation of urban and rural settlements in that it enables the understanding of development trends such as the identification of employment subcenters (McDonald 1987).

The sixth part explains how urban and rural perimeters can be defined in order to provide operational support for planning practices (Ferreira et al. 2010). Although territorial development and future urban growth areas do not follow historical rules (Ma et al. 2017), it was assumed that new development areas need to be located near current settlements or fill in gaps in the built fabric. This is due to risk areas, natural constraints such as vulnerability to climate change (Lwasa et al. 2014; Ponte 2014), and dependence on pedestrian mobility.

The last part focuses on the main conclusions and findings, though it is important to note that results and findings are presented throughout the entire paper.

Methodology

The research methodology adopted a sequential and incremental process to deal with the Oé-Cusse scenario that is demarcated by the existing lack of data and the inexistence of monitoring practices.

The adopted process for establishing urban and rural perimeters in a territory without any baseline information or any preceding plan has been discussed during the construction of the methodology used to address this issue in the regional plan for Oé-Cusse in East Timor (PDOT). The overall objective was to define these perimeters based on sustainable indicators for urbanization that are capable of measuring the most efficient use of urban areas, the extent and direction of changes in land use, environmental sustainability (da Cruz 2012), and transportation requirements (Amado 2005; ZEESM et al. 2016) within future planning processes.

In the Oé-Cusse scenario, planners had to establish a method to create a viable work base that defines urban and rural perimeters based on existing settlements and territorial dynamics. Thus, a team composed of architects, urbanists, civil engineers, environmental engineers, landscape architects, social and anthropological experts, and other technical experts established a 5-step procedure. The procedure was established by this team of experts based on several meetings where the possible scenarios to deal with the lack of baseline information were discussed. Representatives of the regional authority attended these meetings to ensure viability and efficacy in terms of implementation, acceptance, and achievement of regional strategic goals. The steps were as follows:

1. Collect every piece of current data that could be useful for the planning process, preferably data that present a territorial basis or are spatialized. This step is crucial and represents the major work and collaboration of the population and all administration departments. It is very important to ensure that all the data are collected and to do that it is imperative that population and administration staff are integrated into the process.
2. Inspect the data in order to understand how accurate they are and what they cover. This makes it possible to understand gaps in existing data.
3. Verify whether the data are workable and organize the data by source reliability.
4. Join the data and design the layout for a database system. This step was handled with GIS tools and allows any gaps identified...
at Step 2 to be filled by crossing different sources. For instance, when combining data related to existing facilities, different sources that cover different parts of the territory can be joined together, achieving an output that covers the whole territory.

5. Aim to spread information and enable future use of the data (Fig. 1).

This method was created to help in the delimitation of urban and rural perimeters to the conception of PDOT and this helps planners to overcome the existing lack of baseline information. A group of techniques such as field survey, GIS-integrated data, satellite images, drone images, questionnaires, land proprietors’ surveys, and the use of a group of experts from the fields of architecture, territorial planning, geography, environmental sciences, landscape architecture, civil engineering, economics, and the law has been defined to provide the required data to inform the methodological process.

Case Study

The Oé-Cusse region in East Timor, also known as Oé-Cusse Ambeno, is an enclave within the Indonesian province of Nusa Tenggara Timur (Yoder 2016) that is currently almost completely isolated from the rest of the East Timor territory in terms of land access, with only one road connection. This is partly due to the topography, which is generally steeply mountainous (International Crisis Group 2010; Sanchez et al. 2012; ZEESM et al. 2016).

The Oé-Cusse district encompasses the whole of the enclave and occupies about 815 km². It is composed of four subdistricts: Nitibe, Osilo, Passabe, and Pante Massacar, with the latter housing the capital city of the same name of the Special Administrative Region of Oé-Cusse (ZEESM et al. 2016). Each subdistrict is then divided into sucos (similar to villages) with a total of 18 sucos (Abani, Bobometo, Costa, Cunha, Naimeco, Taiboco, Benafi, Bene-Ufe, Bobocasse, Lalisuc, Lela-Ufe, Lifau, Melalei, Nipani, Suni-Ufe, Usi-Ta-a, Usi-Taco, and Usi-Taqueno). These 18 sucos are subdivided into quite a few small hamlets (the so-called aldeias), with 63 hamlets in the whole district (Direcção Geral de Estatística Timor-Leste 2013) (Fig. 2).

In Oé-Cusse there has been no structured planning process at all during its past and current development (ZEESM et al. 2016), despite the few examples of planning during the Portuguese colonial period (1702–1974) (Burnett 2016; Yoder 2016) and the Indonesian occupation (East Timor declared its independence at the end of the Portuguese colonial period in 1975 and obtained it only in 2002 after the Indonesian occupation) (Gomes et al. 2015; Tejado Rüland 2015) and there is a management consultant committee for each suco (concelho de suco).

In reality, these management consultant committees meet as necessary to discuss particular issues that tend to be related to the management of land ownership (ZEESM et al. 2016). The current model based on these management consultant committees is not capable of developing a plan with a clear strategy for a medium- to long-term future.

The development of Oé-Cusse was always tied to natural resources availability (ZEESM et al. 2016). For instance, when analyzing the subdistricts of Nitibe, Osilo, Passabe, and Pante Macassar, the way water resources and agricultural potential are preserved can be seen, as well as the natural constraints. The preservation and adaptation of natural resources is not just a necessity in terms of preservation, proximity, and resource utilization (Chandra et al. 2016; López et al. 2001); it also works as insurance regarding natural phenomena such as floods (Chandra et al. 2016; Greiving et al. 2016; Hurlimann et al. 2014) because the traditional building techniques in Oé-Cusse and their level of resistance are not prepared for them (Cinatti et al. 2016; ZEESM et al. 2016).

Regarding urban aspects, there is no fixed urban center and urban development is characterized by linear-based structures that follow the main roads, giving shape to small hubs of detached buildings with a maximum of two floors (ZEESM et al. 2016) and a very low population density (Cinatti et al. 2016). The road system comprises two main axes, east-west and north-south, intersecting in Pante Macassar. This is the only area that can be considered urban (ZEESM et al. 2016), although it has low economic activity due to a lack of concentration of trade and services.

Settlements are dispersed across the territory and are adapted to activities such as rice paddies, textile manufacturing (Sávio 2016), and other types of handicrafts. Although they are adjacent to main roads, they are not connected to any basic sanitation infrastructure because they do not have one (ZEESM et al. 2016). Energy provision is also a weakness of the region, making all houses that are not located in Pante Macassar dependent on generators and solar energy. In the eyes of the new regional administration, this can also be seen as a strength. Due to low territorial development, the provision of different solutions for the urban development of Oé-Cusse is possible, as well as taking into account its solar energy potential (Amado and Poggi 2014).

This kind of gradual and nonregulated development model led to a predominance of precarious housing, while the lack of basic infrastructure (water and sewage) increased the risk of public health issues (Douglas n.d.; Gonçalves et al. 2015). Furthermore, the lack of spatial planning procedures and territorial development regulations led to individualized development. In these cases, there were no connections established among the intervention work, and developments were carried out on a case-by-case basis (ZEESM et al. 2016). In these cases, the individual developer (normally under a self-construction process) is focused on the private space without any concerns regarding public space and its use (Amado et al. 2016). It is a case of gradual and unregulated territorial development following a rural diffused and scattered urbanization model that has certain similarities to urban sprawl (Squires 2002; Sudhira et al. 2004). This is at a much lower density level [low-density settlements (Salvati et al. 2012)], but still requires urban plans that integrate new rules and mechanisms that somehow limit construction outside urban perimeters and define specific areas available for expansion within existing settlements (Ferreira et al. 2010).
These past practices have also led to a lack of mobility infrastructure. This has accentuated the isolation of rural settlements, not only in terms of mobility but also in terms of social (Kenyon et al. 2002) and economic development (Cass et al. 2005), thereby clustering almost all urban activities in the district capital of Pante Macassar (Asian Development Bank 2013). In addition, the lack of employment opportunities forces locals to migrate to Dili, the capital city of East Timor, in order to improve their living conditions.

To deal with the lack of an evolved spatial and territorial planning process, a new administration department was created to manage territorial and urban development from scratch, exclusively dedicated to the region of Oé-Cusse Ambeno: Zonas Especiais de Economia Social de Mercado de Timor-Leste (ZEESM) (Law 3/2014, Government Resolution No. 7/2015 (TIMOR-LESTE); Kammen 2015; Sousa 2014; ZEESM et al. 2016). The creation of ZEESM represents an important step toward sustainable territorial development because it functions as a tool that the administration can use to regulate the urban development pattern (Long et al. 2012).

This new administration has its own individual funding [Government Resolution No. 8/2015 (TIMOR-LESTE)] to start developing Oé-Cusse with a dedicated and trained management staff. However, regarding the operational level, there is a lack of qualified technical staff because there is little availability in the local labor market and payment and working terms make it difficult to hire abroad. This lack of available workforce results in low amount of skilled labor to start construction projects (H. A. Beck, “Timor-Leste: Oecusse economic and trade potential,” presented at World Bank, Washington, DC, 2016; World Bank Group 2016). For example, when constructing the new main roads, the administration was forced to fall back on the Indonesian labor market and contractors (ZEESM et al. 2016).

The new administration is seeking to develop a regional plan so that it can ensure that the development of the territory is undertaken in a regulated and programmed way (Kammen 2015), preserving natural resources, as well as attracting and generating qualified labor by investing in human capital (H. A. Beck, “Timor-Leste: Oecusse economic and trade potential,” presented at World Bank, Washington, DC, 2016).

This new regional administration and the several management consultant committees for each suco are currently the only two planning authorities on site, operating at different levels. ZEESM operates at a regional level, establishing the regional strategy, developing the regional plan, and supervising the implementation of major projects such as public infrastructure. ZEESM also arranges meetings with the management consultant committee in order to articulate, supervise, and plan the implementation of regional development projects.
policies at these two different levels. Communication between these two levels is crucial because ZEESM, due to its recent origin, does not yet have a suitably sized team to be able to manage the close monitoring of every suco, therefore the management consultant committee is responsible for some of the detailed operational aspects regarding decisions based around daily life.

In the strategic vision of this regional plan, environmental and agricultural activities are at the heart of the social market economy. Strong focus is given to rural poverty reduction and rural nutrition, as well as making more efficient use of natural resources (Gibson and Marks 1995; Hulme and Murphree 2001; López et al. 2001; Tietenberg and Lewis 2016), not forgetting the creation of opportunities to develop other economic activities that can offer job opportunities to the local labor market (ZEESM et al. 2016).

In order to achieve this, the PDOT defines a clear spatial development framework that supports the transformation of existing land use and at the same time is capable of functioning as baseline information to support the construction of a new territorial and management system, as well as a pilot project on the link between physical land use and economic parameters (ZEESM et al. 2016). The PDOT faced many difficulties in terms of acquiring baseline information. The lack of information covered almost the entire region, in several fields of expertise with which urban and spatial planning has to deal. This includes administrative registers as well as a complete topographical survey that could function as a work base covering issues such as population distribution, land property registry, and location of public facilities. In addition to this, there is also an information gap related to the existence of urban and rural perimeters that mark out urban and rural areas.

As mentioned, urban and rural perimeters are considered to be a continuous piece of territory classified as an urban or rural area, which is intended for the process of urbanization and edification viability. This continuous piece of territory includes land that is totally or partially urbanized or built and land destined for agriculture (Ignatieva et al. 2011; Searns 1995). The land that is allocated for agricultural purposes is necessary in order to balance urban and natural systems, ensuring ecosystem services (Ignatieva et al. 2011; Tzoulas et al. 2007).

The delimitation of perimeters was seen as the first step to start the planning process (ZEESM et al. 2016). Therefore, a set of criteria to enable this was required, knowing that it had to be able to deal with the lack of crucial baseline information as well as boost what little information there was.

According to past urban development patterns and practices and considering the limited availability of soil for expansion, it is possible to assume that the future scenario of settlement development will follow the current linear tendency (ZEESM et al. 2016). New development areas will certainly be located near existing ones or fill in gaps in the built fabric.

**Difficulties in Applying Existing Methods**

The process of delimiting urban and rural settlements can be achieved according to several objectives and can be based on various types of information (Caldera 2003; Ferrão et al. 2002; Ramos and Silva 2007). In general, this has a functional, morphological, or demographic basis, or an economic and social structure (Ferreira et al. 2010; Ferreira and Condessa 2012).

The Network on Urban Research in the European Community applies a morphological delimitation of urban settlements that is supported by the contiguous built-up area concept. Hence, a minimum distance of approximately 200 m (656 ft) between buildings is expected, generating a buffer of 100 m (328 ft) around existing buildings. This is a well-suited parameter to apply to planned and uniform cities, but is inadequate when applied to situations of unregulated urban development with a population density as low as that of Oé-Cusse (ZEESM et al. 2016).

This type of morphological delimitation is also used at Statistics Norway (Ferreira and Condessa 2012) and also in Portugal when delimiting urban settlements for the municipal plan (plano director municipal (PDM)). In the Portuguese case, this was suggested by one of the five coordination commissions for regional development in 2012. A shorter distance between buildings was proposed [15 m (49 ft)] and until recently it was possible to distinguish between rural and urban settlements, whereas rural settlements are currently considered as a rural area (Grego and Gabriel 2012).

This method is well suited to low-density areas in Portugal and gives an idea of a density and hierarchy, allowing planners to distinguish between two major groups (rural and urban settlements). However, even though it has already been used in the design of plans in Cape Verde and Angola by GEOTPU-LAB, when applied to the situation of Oé-Cusse, it is considered inadequate (ZEESM et al. 2016). The buffer method is also a way defining urban and rural perimeters. For instance, the Portuguese council of Tomar has its urban and rural settlements marked out using the buffer method (Ferreira and Condessa 2012). Delimiting rural and urban settlements in the Portuguese planning framework is a task handled by planners at the municipal level and is also linked to the PDM, the main territorial instrument at the local level. In these cases, the methodology used consists of applying a buffer method organized into eight steps, starting by generating a buffer of 25 m around each building, identifying clusters of buildings whenever the buffers meet, and ending with the delimitation of the consolidated area (Ferreira and Condessa 2012). It is a simple and straightforward approach that is well suited to low-density municipalities in Portugal, but has some constraints when considering its application to the situation in Oé-Cusse. The concept of net urban areas and the buffer dimensions used were not tailored to the situation in this developing country or the amount of data available. For instance, there is no cartography base with building polygons that enables buffer generation, therefore the mapping of all buildings through satellite images is first required.

Urban and rural settlements can also be defined based on demographic data in order to reflect population density and define a hierarchy of urban settlements. An example of this is the methodology developed by the Group for European Metropolitan Area Comparative Analysis based on the economic core (jobs), housing (inhabitants), and the functional urban region (commuting mobility) (Ferreira et al. 2010).

During preliminary analysis, a sociodemographic-based delimitation model seems to be adequate. However, the situation in Oé-Cusse in terms of its economic core and the dynamics of the urban system is not easy to fully understand (ZEESM et al. 2016). Using commuting to express the concentration of employment and economic influence can be problematic when applied to low-density settlements, especially to the specific socioeconomic situation of Oé-cusse where walking is the primary mode of transportation. First, this is due to the fact that the extremely small average budget of families is not enough to purchase a car or to be able to afford the expensive cost of everyday microlet journeys (microlet is similar to public transportation, usually using a 7-person van), which forces them to have daily activities within walking distance. That turns microtransactions into activities handled within the vicinity of the workplace and home, making almost all urban economic activities only possible in the district capital of Pante Macassar (ZEESM et al. 2016). Second, this is due to the fact that the
inadequate mobility infrastructure originates from the isolation of few settlements (Cass et al. 2005), making any commuting, meaning any mobility that requires any type of transportation that is not on foot, very difficult (ZEESM et al. 2016).

Perimeters based strictly on the economic and social structure are considered to be unsuitable for the Oé-Cusse situation. This is due to the fact that there is a relatively homogeneous pattern in socioeconomic terms (ZEESM et al. 2016), with the major disparities only occurring in the district capital.

Social and economic aspects seem similar in areas with extremely different or even opposite levels of density. In these cases, the major differences that can be identified among the several sucos are the school attendance rates and dropout rates. Effectively, children are required to take a long journey to get to school. This can present a problem, not only because of long distances and time-consuming journeys, but also because of small family budgets and the need to help the family with agricultural and domestic activities. In addition, past practices in terms of urban development, characterized by linear-based structures concentrated along the main roads, result in unclear boundaries between rural and urban perimeters.

Functional delimitation based on distinguishing between land use activities is not suitable for this territory for the same reasons, i.e., it requires analysis of commuter flows between the home and the work place, as well as social and economic criteria.

Delimiting urban and rural settlements is a task that is usually handled in the context of urban or suburban scenarios with significantly different levels of density regarding settlements (Ferreira et al. 2010). Thus, current methodologies seem to be unsuitable for the delimitation of low-density settlements in Oé-Cusse (ZEESM et al. 2016).

In addition to this, these methodologies (that have been analyzed) are not suitable for incorporating the relevant physiographic constraints such as slopes and floodplains due to their mainly statistical nature, allowing some key aspects of spatial planning to go unacknowledged (Ferreira and Condeza 2012). Moreover, considering the lack of baseline information regarding Oé-Cusse, the delimitation of urban and rural settlements requires an adjustment to the available sources of data, resulting in a new methodology to deal with such scenarios, which are often the prevailing ones in developing countries.

Dealing with the Lack of Baseline Information

Oé-Cusse is a very heterogeneous region regarding territorial and environmental aspects (ZEESM et al. 2016). To allocate the current expansion demands, it is critical that the delimitation of urban and rural areas is grounded on a sustainable path (Tietenberg and Lewis 2016) toward an environmentally friendly land use framework. Besides administrative registers, topographical surveys and data related to population distribution, land property registry and location of public facilities, other issues such as housing in risk areas (landslide and flood) need to be taken into account when delimiting areas for settlement expansion. In order to provide a clear baseline for the development of the PDOT, an exhaustive collection, interpretation, and assessment of a variety of data within the short timeline and budget has been necessary.

Due to the short timeline to build the territorial and management system and to elaborate the PDOT, the survey and fieldwork tasks led to additional work. This situation could have easily been overcome if all surveys could have been done at the local level because it is closely related to the territory and field knowledge (Ferrão and Mourato 2010). At present, the administrative structure is not (yet) able to address these tasks properly. Because the planning system is still under construction, it does not incorporate current strategic decisions being made in the central government by Timor’s president (ZEESM et al. 2016). These decisions are then sent to the regional administration of Oé-Cusse by the president of the regional authority and these decisions are then implemented and made operational at the local level through the community leader (chefe de suco).

The community leader is responsible for the establishment of a management consultant committee and together they represent one of the smallest political units in East Timor (Holthouse and Grenfell 2007). The community leader and the consultant committee are considered a rather important local government entity to the majority of Timorese citizens because of their relevance to their daily livelihood, especially in rural settlements (Tan and Li 2013). The community leader is the representative of the community abroad and also guides the community in solving day-to-day problems (Maia et al. 2012; ZEESM et al. 2016). This close relationship between the community leader and the citizens is considered an important factor to be preserved because it plays a crucial role in the connection between the citizens and the land, historical factors, and sociopolitical relationships (Tan and Li 2013).

Nonetheless, a large gap exists in their capacity to conduct formal governmental activities regarding spatial and territorial development such as collecting technical data to support the development of the PDOT.

The community leader is usually a trusted person who is deeply connected with the community and who, normally, has been born, grown up and lived in the community their entire life. This strong relationship and dependence on the community (at social and territorial levels) represents one of the main obstacles regarding making certain planning actions operational, such as collecting technical data. This situation makes it more difficult to implement local monitoring, because despite the fact that the community leader has a good relationship with their community and is a highly respected person, the leader does not have access to the level of education to have the expertise necessary to address some of these technical and complex issues (de Oliveira 2011).

Furthermore, in some cases the return to Portuguese as the official language is an issue because the majority of citizens use the local Baikeno and Tetum dialects (Nikolaos and Ilenia 2016) as their daily language and do not speak or read Portuguese (Soares 2015; ZEESM et al. 2016).

This is currently one of the administration’s concerns. Together with the lack of territorial information, these are the main difficulties regarding the creation of a structured planning and management system in Oé-Cusse. It is important that the new management system carry out an operational planning process at the local level that is connected to the regional level (Ferrão and Mourato 2010) and also to the other sucos, and which is able to produce territorial-based information to support the decision-making process (de Oliveira 2011) and monitor territorial dynamics (Amado and Cavaco 2015).

The current lack of a structured planning and management system creates a situation of misunderstanding of powers and stakeholders. This scenario is not compatible with the growth objectives within the local government’s capacity and responsibilities (ZEESM et al. 2016). In addition to this, the continuing lack of spatial development regulations highlights the lack of baseline information and creates obstacles in the creation of any territorial and management system and its respective instruments such as plans and programs.

Urban planners usually rely on a set of criteria that is drawn from detailed baseline information to define urban and rural areas
Indicators were defined based on the available information and its liability. All data were handled at the suco scale, except the information provided by Instituto Nacional de Estatística (INE) such as dwellings, which was handled at 1/50,000 by INE and is available in GeoRef points.

The weighting for each factor was determined through a consultation process in which seven (international) specialists in the various fields anonymously participated in a survey specially designed for this case study. In this survey, the various experts, who included architecture and territorial planning, geography, environmental sciences, landscape architecture, civil engineering, economics, and legal, contributed to determining the weight of each factor according to what they thought influenced the relative importance of a given settlement. Local specialists were involved in this group of specialists in areas such as environmental engineers and social. Since there is a lack of information and part of the existing data was not fully accurate, specialists were encouraged to take into account reliability and coverage of data when proposing the importance of each factor.

The surveys were gathered and reissued to each specialist so that they could reanalyze their decisions, much like the process of the Delphi approach. The final score for each suco was calculated by adding all the different weighted indicators and assigning the three defined levels.

The outcome was the following (Fig. 3):

- Level I: Abani, Bobometo, and Costa;
- Level II: Cunha, Naimeco, and Taiboco; and
- Level III: Benafi, Bene-Ufe, Bobocasse, Lalisuc, Lela-Ufe, Lifau, Melelai, Nipani, Suni-Ufe, Usi-Tacae, Usi-Taco, and Usi-Taqueno.

The matrix that supports the hierarchy of existing sucos also presents the dimension of every indicator regarding the hierarchy determination process in the description column.

The matrix is composed of nine fields, namely:

- Population: Population was carefully addressed because the two indicators forming this field (demography and housing) come from the most reliable information sources within the various data sources (Table 1). The population figure comes from Census (Resultados do Censos 2010) and the incorporated suco official records of the resident population. Regarding demography, Bobometo stands out with 14% of Oé-Cusse’s population. This is a large amount when compared with Malelai, Nipanim and Suni-Ufe, which have values of 2%. Bobometo (14%), Costa (12%), and Abani (12%) together represent 38% of the total population. As was expected with regards to housing, these three sucos represent 37% of the total number of houses (Bobometo = 11%, Costa = 17%, and Abani = 9%).
- Transport and accessibility: These indicators have been developed to reflect specific means of transportation (Table 2). Nevertheless, there is no information available that can be added to indicate the level of service in relation to a specific type of transport such as public transport. During field work it was understood that there is a direct relation between the number of cars and microlets (collective mini bus-taxis) and the attractiveness of the settlement. Suco Costa has 40% of the cars and microlets within the district, with 740 motorcycles and 95 cars.
- Sanitation infrastructure: These indicators concern basic infrastructure systems such as energy, water, sewage, and solid waste (Table 3). There is no sewage network in Oé-Cusse and a public water network is only available in Pante Macassar. Moreover, there is a significant amount of houses that depend on natural sources such as rivers. These are mostly located in the following sucos: Usi-Tacae (55 dwellings), Nipani
Table 1. Population

| Field                          | Indicator                                               | Unit   | Weight | Description       |
|-------------------------------|---------------------------------------------------------|--------|--------|-------------------|
| Demography                   | Urban center resident population                        | Number | 8      | Dimension         |
|                               | Relative weight of resident population within the district | %      | 1      | Relative dimension|
| Housing                       | Dwellings                                               | Number | 7      | Dimension         |
|                               | Relative weight of existing dwellings within the district | %      | 4      | Relative dimension|

Table 2. Transport and accessibility

| Field                          | Indicator                                               | Unit   | Weight | Description       |
|-------------------------------|---------------------------------------------------------|--------|--------|-------------------|
| Individual transport          | Ferry                                                   | Yes/no | 5      | Existence         |
| (collective transport)        | Daily journeys                                          | Number | 4      | Polarization      |
|                               | Biking                                                 | Yes/no | 1      | Existence         |
|                               | Bicycles                                               | Number | 1.5    | Dimension         |
|                               | Motorcycling                                            | Yes/no | 1      | Existence         |
|                               | Motorcycles                                            | Number | 2      | Dimension         |
|                               | Automobile use                                         | Yes/no | 2.5    | Existence         |
|                               | Cars (microlets)                                        | Number | 3.5    | Dimension         |
|                               | Relative weight of existing cars and within the district | %      | 4.5    | Relative dimension|
|                               | Boating                                                | Yes/no | 1      | Existence         |
|                               | Boats                                                  | Number | 1.5    | Dimension         |
| Roads                         | Existence of structured network                        | Yes/no | 2      | Polarization      |
|                               | Primary roads                                           | Number | 2      | Polarization      |
|                               | Population within primary road influence area           | Number of inhabitants | 3     | Polarization      |

Fig. 3. Delimitation of urban and rural perimeters.
(54 dwellings), Cunha (71 dwellings), and Bene-Ufe (76 dwellings). Weighting should reflect the territorial reality based on the service level of each settlement. It should also highlight access to a public water supply network and should not consider the use of the river as sufficient access to water. There is a significant number of houses that depend on natural sources such as rivers. These are located mostly in Usi-Tacae (55 dwellings), Nipani (54 dwellings), Cunha (71 dwellings), and Bene-Ufe (76 dwellings).

- Educational facilities: Several indicators express the level of educational facilities available. These are detailed in Table 4. Regarding the relative weight of preprimary students within the district, Bobocasse is of note with 32%, followed by Lifau with 19%, together representing 51% of the total student population.

- Health, social, and public safety: From the institutional information and field work surveys, it is possible to learn that all sucos except Bobocasse have at least one health facility. Suco Costa has a privileged situation due to the fact that it is the only suco with a hospital (Table 5).

- Economy and culture: In the field of economics there are indicators related to the labor market and employment ratios (Table 6). Costa (25%) and Bobometo (18%) represent 43% of the unemployed workers within the district. Regarding cultural aspects, the only possible indicator with the available data is the number of religious buildings, where Suco

| Table 3. Basic sanitation infrastructure |
| Field | Indicator | Unit | Weight | Description |
| --- | --- | --- | --- | --- |
| Energy | Connected to public electricity network | Number | 6 | Urban center service level |
| | Relative weight connected to public electric network within the district | % | 5 | Relative dimension |
| | Using solar panels | Number | 4 | Urban center service level |
| | Using biogas, kerosene, candles, wood, or resin | Number | 1 | Urban center service level |
| Water | Dwellings connected to a public water network | Number | 7 | Urban center service level |
| | Dwellings using community spigots | Number | 4 | Urban center service level |
| | Dwellings using well water or rain water | Number | 1 | Urban center service level |
| | Dwellings requiring going to the river to get water | Number | −1.5 | Urban center service level |
| | Using bottled water | Number | −1 | Urban center service level |
| | With septic tank and latrine | Number | 3 | Urban center service level |
| | Others | Number | −3 | Urban center service level |
| | Dumps | Number | 4 | Urban center service level |

| Table 4. Educational facilities |
| Field | Indicator | Unit | Weight | Description |
| --- | --- | --- | --- | --- |
| Facilities | Preprimary schools | Number | 2 | Urban center service level |
| | Capacity (preprimary) | Number | 2 | Urban center service level |
| | Preprimary students | Number | 2.5 | Urban center service level |
| | Relative weight of preprimary students within the district | % | 1.5 | Relative dimension |
| | Average number of preprimary students | Number of students/number of facilities | 1.5 | Urban center service level |
| Primary schools | Number | 2 | Service level |
| | Primary students | Number | 2.5 | Urban center service level |
| | Capacity (primary) | Number | 2 | Urban center service level |
| | Relative weight of primary students within the district | % | 1.5 | Relative dimension |
| | Average number of primary students | Number of students/number of facilities | 1.5 | Urban center service level |
| Secondary schools | Number | 2 | Service level |
| | Secondary students | Number | 2.5 | Urban center service level |
| | Relative weight of secondary students within the district | % | 1.5 | Relative dimension |
| | Average number of secondary students | Number of students/number of facilities | 2 | Urban center service level |
| | Secondary schools | Number | 2 | Service level |

| Table 5. Health, social, and public safety |
| Field | Indicator | Unit | Weight | Description |
| --- | --- | --- | --- | --- |
| Health facilities | Health center | Number | 4 | Urban center service level |
| | Health post | Number | 3 | Urban center service level |
| | Hospital | Number | 5 | Urban center service level |
| Social facilities | Sport facilities | Number | 1.5 | Urban center service level |
| | Social facilities | Number | 2 | Urban center service level |
| Safety facilities | Social facilities users | Number | 1.5 | Urban center service level |
| | Police or fire station | Number | 3 | Urban center service level |
mental constraints (ZEESM et al. 2016).

Pante Macassar, it is easy to understand the way water resources and agricultural potential were preserved, as well as the environmental planning process and it can also be used to estimate the concentration, and centrality (Ferreira et al. 2010).

Existing settlements (that will incorporate urban and rural perimeters) have been developed according to a linear model that was designed to follow main roads with very low population density and the prevalence of houses with a maximum of two floors (ZEESM et al. 2016).

Oé-Cusse has two main roads, east-west and north-south, which intersect in Pante Macassar, the only area that can be considered as urban (ZEESM et al. 2016), whereas the remaining rural areas are characterized by low-density structures and a strong relationship with agricultural activities (Porta et al. 2013) and handicrafts (Sávio 2016).

Although settlements are linearly developed in the areas adjacent to the roads, these are not connected to any basic sanitation infrastructure because they do not have one, which can be assumed to be common in less developed areas of East Timor (Rand et al. 2012).

According to past development patterns and considering the limited available soil for expansion [according to biophysical and risk analysis carried out under the process of delimiting urban and rural perimeters due to the fact that there were no preview studies specialized in these environmental areas (ZEESM et al. 2016)], it is possible to predict that the future scenario of settlement development will follow the current linear tendency.

Therefore, when delimiting urban and rural perimeters, new development areas were located near existing settlements or filling in gaps in the built fabric.

Furthermore, the delimitation of urban and rural perimeters was considered the first step to ensure that future territorial development will be handled in a programmed way and prevent the current development trend that has allowed disorderly occupation without the implementation of the required infrastructure.

Costa (six buildings) and Cunha (11 buildings) are the most represented.

### Delimiting Urban and Rural Perimeters

The development of Oé-Cusse has always been tied to natural resource availability (Cinatti et al. 2016; ZEESM et al. 2016). In fact, when analyzing the settlements of Niñibe, Oesilo, Passabe, and Pante Macassar, it is easy to understand the way water resources and agricultural potential were preserved, as well as the environmental constraints (ZEESM et al. 2016).

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Taking into account the current lack of information, it was decided that a 4-step methodology would be developed. Orthophoto maps from 2014 and census information from 2010 (Resultados do Censos 2010) were used as primary input (Fig. 4).

The first step involved advanced surveying of existing settlements using photogrammetric instruments. The second step considered the mapping of constraints and risk areas. These data were related to existing settlements and analyzed through modeling processes at the regional level. The third step involved the identification and mapping of possible expansion areas by excluding all areas that are susceptible to risk or affected by constraints or easements.

### Step 1: Mapping Settlements

During the first step, all settlements were mapped using Orthophotomap (2014 survey) and groups of residential units that formed a recognizable street pattern were identified. This procedure was carried out based on four variables, namely, density, continuity, concentration, and centrality (Ferreira et al. 2010).

Density introduces the notion of dimension into the development planning process and it can also be used to estimate the number of inhabitants living in a particular area when correlated with the average number of people per household. It is demonstrated by the average number of houses per square kilometer of developed land and is determined by a grid method (Fig. 5) using orthophoto maps as a base.

The grid was built with 100-m² units (10 × 10 m) and the mapping procedure considered the amount of buildings per 2,500 m² (corresponding to a 5 by 5 grid with the 10 × 10 m units) as well as political orientations and the development strategy and planning team considerations.

This mapping creates a work base for experimenting with possible development scenarios in order to allocate future expansion areas, taking into account the fact that concentration and centrality bring up the notion of attractiveness and interest by identifying the more appetizing areas.

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### Table 6. Economy and culture

| Field       | Indicator                                      | Unit  | Weight | Description |
|-------------|------------------------------------------------|-------|--------|-------------|
| Economy     | Employment                                     | Number | 5      | Dimension   |
|             | Relative weight of employed workers within the district | %     | 4      | Relative dimension |
|             | Unemployed workers                             | Number | 2      | Dimension   |
|             | Relative weight of unemployed workers within the district | %     | 1.5    | Relative dimension |
| Economic specialization | Professional groups                        | Number | 3.5    | Specialization |
| Commerce    | Markets                                        | Number | 4      | Economic specialization |
|             | Commercial establishments                      | Number | 2      | Economic specialization |
| Services    | Restaurants and coffee houses                  | Number | 2      | Economic specialization |
|             | Municipal services                             | Number | 2      | Service level |
|             | Municipal services with public attendance      | Number | 3      | Service level |
|             | Relative weight of municipal services with public attendance within the district | %     | 3      | Relative dimension |
| Tourism     | Official hospitality establishments or similar  | Number of beds | 2 | Tourism ability |
| Culture     | Religion                                       | Number  | 1.5    | Attractiveness |
|             | Events                                         | Number  | 1      | Attractiveness |

Taking into account the current lack of information, it was decided that a 4-step methodology would be developed. Orthophoto maps from 2014 and census information from 2010 (Resultados do Censos 2010) were used as primary input (Fig. 4).

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This mapping creates a work base for experimenting with possible development scenarios in order to allocate future expansion areas, taking into account the fact that concentration and centrality bring up the notion of attractiveness and interest by identifying the more appetizing areas.
Continuity allows the understanding of how far the settlement has evolved, and at the same time creates a possible scenario of the natural development trends in order to allocate future expansion areas. Both concentration and centrality bring up the notion of attractiveness and interest to the developmental planning process and also help to identify the attractiveness of the areas.

Health and education facilities were used to analyze public centrality. They were located on the map in order to identify the extent to which residential and nonresidential buildings are located close to a possible central area and in order to assess the importance of these activities for the settlement or region (Fig. 6).

Concentration was also assessed by applying the grid method to all existing settlements (Fig. 7).

Continuity was assessed by linearity (Fig. 8). As stated previously, Oé-Cusse followed a structured planning process during its past and current development, resulting in linear-based structures that follow the main roads.

When mapping settlements there were two options: delimiting by plot area or delimiting by building. The first option (delimiting by plot areas) fails in terms of accuracy due to the fact that typical plot size in Oé-Cusse is usually medium or large sized (between 2,000 and 2,500 m²) (ZEESM et al. 2016) (Fig. 9). This was
confirmed in field visits and verified by analyzing the 2014 orthophoto maps. The plot dimensions in rural areas are bigger than in urban areas (ZEESM et al. 2016). If the mapping is done by plot areas, it can lead to misunderstanding because an area of five rural plots can appear bigger than an area of 10 urban plots, therefore giving the impression of more occupation (households) in rural areas when in fact they usually have much less.

Therefore, it was decided to map existing settlements using a maximum distance of approximately 50 m (164 ft) between the building façade and the border of the perimeter, except in duly justified cases when there is close proximity to roads (Fig. 10). This distance was defined based on the average size of the existing plots. During the field survey it was possible to verify that although plots tend to be large (especially in rural areas), the distance between the fence and the building tends to be shorter than 50 m (164 ft). However, even if the plot extends to more than 50 m (164 ft), it does not present a problem because it will be considered as natural land and can be used for agriculture purposes (Rivera 2016) according to the strategic visions defined in the PDOT.

Agricultural activities are considered as crucial, not only due to the potential of Oé-Cusse for agricultural proposes, but also due to the low income levels of the rural population. In rural areas the problem is not that there is no food, but that citizens (especially...
Fig. 8. Delimiting by plot areas.

Fig. 9. Mapping existing settlements.

rural citizens) cannot afford it (Prain and Lee-Smith 2010), so they need to produce their own food.

In addition to this, the PDOT is based on an ideology of development where one of the main short-term goals is to connect the existing plots to basic infrastructure (water and sewage), which requires the future buildings to be in close proximity to the roads in order to optimize the infrastructure grid.

These delimitations were made on a scale of 1 to 10,000 in order to be able to assess the entire enclave within the very short time frame (Fig. 11).

Step 2: Constraints and Risk Areas

The second step aimed to deal with all existing settlements that have been mapped in the first step, with constraints and risk areas being analyzed through modeling processes at a regional level. This step considered the following constraints: landslide risks, structural projects, infrastructural projects under implementation, river streams, existing flooding areas, coral reefs, dugongs (habitat), mud volcanoes, mangroves, forest areas, and highly valued environmental areas (Figs. 12 and 13).

Step 3: Possible Expansion Areas

The third step aimed to map possible expansion areas by excluding all areas that are susceptible to risk or affected by constraints or easements (Fig. 14).

Step 4: Refine and Organize by Hierarchy

The final step aimed to identify a complete set of perimeters outlining the possible expansion of existing settlements present in the regional development plan (Fig. 15).

During this step, it was necessary to take into account the hierarchy of sucos because this is able to reflect current needs and development trends. The hierarchy of existing sucos facilitates the understanding of the territory and helps to predict its main social and economic dynamics, enabling sustainable and programmed territorial development.

The majority of possible expansion areas (only taking into account risk, easements, and constraints) are located in Lifau and Lalisuc due to their relatively low slopes, and this correlates with the aspiration of the regional administration, which considers Lifau and Lalisuc as priority development areas due to their morphological conditions and also to their proximity to Cunha and Costa (Pante Macassar). The hierarchical framework that orders the existing settlements is fundamental in supporting further investment
in infrastructure and public facilities, allowing the safeguarding of areas for those investments.

**Discussion of Results**

As is well known, delimiting urban and rural perimeters is a difficult task requiring large amounts of baseline information that in this specific case simply did not exist. It is an issue that can affect the quality and the efficacy of the planning process in several aspects. For instance, in the Oë-Cusse case it could have led to social and territorial injustice by promoting inequalities in terms of building rights because urban and rural perimeters differ in gross floor area (GFA) ratio and have different access levels to both public facilities and government housing provision programs. Moreover, at the building scale, being integrated in an urban-rural perimeter or left out of one are two completely different realities in terms of coverage by government infrastructure provision programs. These programs include main infrastructures and will improve the quality of life in ways such as roads, power grid, sanitation,
and water provision networks, which will be phased in starting with urban areas, and only then extending to rural settlements. Therefore, houses included in rural and urban settlements will have direct access to these new infrastructures at different times and in different ways, which requires strong and effective public participation in order to maximize acceptance by every stakeholder (administration, community leaders, and population). Furthermore, this simultaneously needs to reflect PDOT guidelines in order to contain urban sprawl and consolidate urban systems by filling in gaps in the urban fabric. By limiting any expansion in the near future by filling in gaps in the built fabric, it is possible to ensure the release of existing risk areas and areas with natural constraints such as climate change vulnerability that are currently occupying the areas. This compact vision will also allow more rational use of the territory and maintain the preservation of natural resources, reduce administration expenses on infrastructure provision, enhance public facility accessibility, and promote a closer relationship between citizens.

Through reviewing existing methodologies, it is evident that the nature of developing territories requires alternative methods in order to deal with its specific context in terms of scale, density, culture, planning systems, and available information. Moreover, the Oé-Cusse territorial context, in terms of physiographic constraints, makes existing methods appear unsuitable to fully deal with these realities. The methodology that was adopted to overcome this issue shows that it is possible to deal with this lack of information. In fact, it was found that the lack of data has in fact accelerated the process.

This paper shows that it is possible to delimit existing settlements using GIS tools and satellite and aerial imagery (orthophoto maps), creating a work base that can be combined with other analyses in order to create a hierarchy of existing clusters, a critical task for the future programming of public investment.

By overlapping existing constraints and risk areas assessed through spatial modeling, the team was able to create an integrated picture of possible future development areas, which is also in accordance with the strategic vision developed for Oé-Cusse.

Although the integrated methodology presented in this paper will both reduce the time to design the plan and increase its efficiency, there is a possibility that the use of data from different sources with diverse scales could compromise the reliability of the method. However, better and more detailed information can reduce the uncertainty that is latent in the planning process and it can also increase the rigor of the outcome. To achieve these positive outcomes and avoid a bigger error margin, a multidisciplinary team is required with a strong capacity for both coordination and competency (Amado 2005).

The integration of constraints and easements during the delimitation of urban and rural perimeters will increase the overall fluidity of the plan’s implementation. On the other hand, the integration of a large amount of data and information into the perimeter delimitation process could delay the process. For instance, in contexts where the data are more available, this methodology may increase the time necessary to integrate the different sources. This requires
investment in the domain of information management and will lead to better technical capabilities to deal with the growing uncertainty.

Significant limitations of the methodology include the following:

- It is difficult to replicate in different contexts.
- There is a need to combine data from different sources and from different times. This approach is not usually very accurate because one of the sources may not have been updated at the time of use.
- It requires constant updates to the main GIS database.
- In contexts where there is better availability of data, this methodology may increase the time necessary to integrate the different sources.
- There is a need for greater control of data management and it requires highly technical competences in several specific fields because planners will have to deal with complex information that is less reliable.
- The methodology uses techniques that can be influenced by existing available data, intended objectives, and urban scale.
- Public participation only occurs twice, at the beginning of the process. There is no possibility to discuss the final outcomes.
- The success and accuracy of the results could be compromised in very compact and dense settlements due to the level of detail required and the clarity of the orthophoto maps.

Significant limitations of the application to the PDOT Oé-Cusse include the following:

- It is a very recent territorial and management system with a short time frame in order to carry out the delimitation of urban and rural settlements;
- The lack of baseline information, territorial data, or any previous plan in the recent past;
- It is the first planning process for the region;
- The only available orthophoto maps were from 2014 and were therefore a bit outdated, although in some parts of the territory, especially in the Citrana area, there were some overlaps;
- Some of the data sources do not cover the whole territory;
- It is difficult to distinguish between residential and nonresidential buildings through the orthophoto maps;
- The lack of a fixed urban center and the lack of urban development characterized by linear-based structures that follow the main roads, giving shape to small hubs of detached buildings, makes it difficult to build a viable urban consolidation strategy;
Existing settlements are adjacent to main roads and are dispersed throughout the territory, resulting in very-low-density levels; the situation in Oé-Cusse, in terms of its economic core and dynamics of the urban system, is not easy to fully understand; and it is difficult to communicate with the population and to promote public participation due to social and organizational skills, as well as cognitive and communication skills. Locals do not speak the official language of the country (Portuguese) and opt to use the local dialects (Tetum and Baikeno).

Significant strengths of the application to the PDOT Oé-Cusse include the following:
- There is political will to develop the PDOT;
- The fact that there is not a large amount of data to be processed has accelerated the process;
- It allows the creation of a work base that was combined with other analyses, creating a hierarchy of existing clusters;
- Increasing the skills of local staff through training, and integrating them into the planning process; and
- The integration of local staff into the planning process enabled the development of case studies, namely, the on-the-ground validation of the proposed perimeters.

Innovations and adaptations in relation to the other reviewed methodologies include the following:
- Ability to integrate relevant physiographic constraints and easements;
- It allows the creation of a work base that was combined with other analyses, creating a hierarchy of existing clusters integrated within the delimitation of urban and rural perimeters;
- New criteria can be incorporated easily;
- Integration of local staff into the planning process, beyond the initial talks of supporting public participation workshops and meetings; and
- It is a simple and straightforward approach to data analysis.

Conclusions

This paper presented the method that was adopted to outline urban and rural perimeters in the regional plan of Oé-Cusse in East Timor (PDOT). The paper focused on describing the process that was adopted and the theoretical basis regarding urban and rural perimeters and the fact that they are essential in this specific case in order to make the PDOT an efficient plan. The conclusions presented are directly linked with the solution that was reached in order to overcome the main issue: the lack of baseline information.

This paper and its findings are an important contribution to the potential to achieve higher goals within the delimitation of urban and rural perimeters in future plans. It shows that there is a clear distinction between urban and rural areas when defining urban and rural perimeters according to the hierarchy of existing settlements. It is clear that delimiting urban and rural perimeters is one of the most difficult tasks at the beginning of the planning process, requiring large amounts of baseline information, that in some developing countries simply does not exist. The lack of territorial baseline information can affect the quality and the efficacy of the planning process. It is an issue that the authors argue can affect the viability of the planning process and the quality and efficacy of its results (plan implementation). However, it was found that when initiating planning procedures in developing countries, the fact that there was not a large amount of data to be processed could in fact accelerate the planning process, especially at the early stages. Integrating a large amount of data and information into the perimeter delimitation process can delay the process, and in some cases inhibit concluding the delimitation process due to the amount of data to be processed and articulated. Besides delaying the process, the integration of large amounts of data and information from different sources with diverse scales into the perimeter delimitation can compromise its reliability.

Although the dichotomy between rural and urban areas is becoming less clear these days, there is still a clear distinction between urban and rural areas and therefore planners need to have a clear work base allowing them to distinguish these areas in order to be able to address them properly. This distinction should also reflect the hierarchy of existing clusters and settlements and be combined with physiographic aspects. For that, the authors argue that constraints and easements such as best agricultural soils, slopes, flood plains, and other risk areas should be considered from the beginning of the process of defining urban and rural perimeters because they can increase the overall fluidity of both the planning process and the implementation.

With these outcomes, the planning team, as well as the decision makers and stakeholders, were able to go through the planning process efficiently and with a satisfactory degree of certainty. This is critical because time and budget constraints would not allow for further investment in data collection efforts or for hiring extra teams. The planning exercise was therefore able to be concluded successfully and contribute to putting Oé-Cusse Ambeno on a more sustainable development model. One of the outcomes of the research and exercise was the identification of critical information for future planning actions, which the administrative authority ZEESM has wisely set out as priorities, because they now understand their value more accurately. The PDOT has been deliverable and approved by the regional authority and is in implementation at the moment.

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Supplemental Data

Table S1 is available online in the ASCE Library (www.ascelibrary.org).

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