

AND WHEN THERE IS NO INFORMATION? THE CASE OF SÃO TOMÉ AND PRÍNCIPE

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Summary. *The first phase of any assessment project involves gathering alphanumeric and geographical data relating to the whole of the territory in question and the various segments involved in it. However, this is not always easy to achieve, sometimes because access is difficult and sometimes because the information does not actually exist. These were some of the obstacles found during the course of a project designed to assess the health of the population in São Tomé and Príncipe¹.*

In response, alternative sources were used, such as Google Earth, printed maps and information gathered on the ground by GPS. With these, it was possible to implement a methodology grounded in knowledge of the factors that influenced the health of the population. These were contextual (i.e. environmental conditions, both physical and socioeconomic in nature) and compositional (characteristics of population groups). This method enabled the creation of an interactive tool to provide support to any project to be carried out in the country, and also the construction of a geographic information system able to inform decision-makers, in time and geographic space, of issues such as: 1) the development of the health status of the São Tomé inhabitants; 2) the accessibility of healthcare for the population; 3) the population's health needs, whether these are satisfied or not; 4) the role of the physical and social environment in the health of a community, etc.

This tool will enable better planning of future investments, for example, by increasing the provision of drinking water at places without access to it and where cholera is common as a result of the use of contaminated water. In fact, by locating the focal points of contagious /infectious diseases, this tool can ensure that preventive measures directly target those populations that are potentially at risk. It will also allow improved planning of health service infrastructures, enabling health centres to be better sized and more accessible to the populations they serve.

1 INTRODUCTION

Public health and disease are major concerns for developing countries, and access to health care is an important factor for ensuring a healthy population. In fact, accessibility is one of the most important components of a health system, as it has direct impact upon the preponderance of disease afflicting many of these countries. However, despite various significant initiatives, there are still gaps to be bridged as regards access to health care². Measuring health care accessibility can thus help to shed light upon the performance of healthcare systems in and between countries, thereby facilitating the development of evidence-based health policies^{3,2}.

Recent studies into health inequalities have highlighted the role not only of personal characteristics (individual behaviours, and psychosocial and biological factors), but also of health inequities and micro- and mesosocial environmental aspects (such as social networks, social support, proximity of facilities, labour conditions and health care access) in influencing health outcomes^{4,5,6}. Dorling⁷ and Santana⁸, for example, have concluded that mortality and morbidity vary significantly between countries, regions, and even between different administrative or geographic areas of the same country, and that these variations cannot be explained by demographic composition alone.

Thus, if we wish to remedy situations of social and territorial injustice, it is necessary not only to identify obstacles to health and health care access faced by the most vulnerable groups (the poor, socially excluded and geographically isolated), but also to identify the social determinants of place and its impact upon health equity^{9,10}. This form of action may offer the key to improving health care systems throughout the world, particularly in countries whose population is most severely affected by obstacles to health care access.

However, despite the fact that, in the African countries, the preponderance of disease (transmissible, chronic and mental) directly and adversely affects the capacity to produce and generate wealth¹¹, the challenges raised are enormous, and health care systems are not always able to provide more and better health for their populations. This incapacity is due not only to political, economic and social instability, but also to the fact that action is not taken to modify environmental health determinants.

In order to draw up specific policies designed to change these conditions, it is crucial to understand the influence of Place upon the population's health¹². Geography has an important role here to play in deciding what facilities should be used by a particular population and what areas should be served by those facilities, thereby working towards greater equity as regards health care provision in order to cover all potential users^{13,14}.

Socio-environmental mapping using Geographical Information Systems (GIS) is a powerful tool to aid this kind of planning. Given the importance of analysing, comparing, interpreting and assessing the relationship between various characteristics of a place and the health of the population that resides there, this is an excellent tool for identifying regional discrepancies within a country, and for assessing and intervening in public health care systems¹⁵.

GISs allow data to be processed at different scales, and can carry out all-important spatial and temporal analyses. These may then influence decision-taking with regards to space, both through assessment and by explaining patterns and trends of demand/use¹⁶. However, it is

necessary to bear in mind that the availability and quality of the data fed into any GIS model have a direct influence upon the results, and consequently upon the quality of the decision taken as a consequence of them^{3,8}.

These systems also enable a range of variables to be incorporated into health studies, such as extension, location, time and socioeconomic characteristics, in addition to the environmental and health variables that permit the identification of indicators revealing the social, economic and environmental structure of places where health risks are present. Thus, by helping to identify environmental indicators, thereby enabling intervention methods to be planned¹⁷, the GIS is an essential tool for health care initiatives^{6,8,15,18,19}.

In fact, GISs have been increasingly applied in the field of health^{20,21,22}. They have been used for purposes such as epidemiological studies²³, facility localization²⁴, service areas²⁵ and for optimizing the routes used by the emergency services²⁶.

GISs also offer an extremely useful method for establishing the degree to which existing health care services fulfil the needs of the population, indicating where new services should be created and which current services should be reduced or closed down²⁷. This is because they permit: 1) the collection of data, and storage, management and manipulation of indicators and variables; 2) spatial analysis using algorithms such as buffering, overlay, proximity analysis, shortest path and raster cost-distance analysis; 3) the customization of existing algorithms and creation of new analytical tools; 4) the mapping and visualization of results, facilitating communication³.

A number of studies have used GIS to measure the physical accessibility of health care facilities^{28,29,30}. This is because GISs are able to identify the geographic catchment area of a Health Unit (where its user population resides) and can therefore respond to the latent need to determine the population's ability to access health care services, given the complex spatial relationship existing between the population and the health care supply available². Thus, accessibility is used to assess a population's capacity to obtain a particular cluster of health care services, depending upon their specific motives for requiring such care³¹. However, modelling health care accessibility requires large quantities of data from different sources, including the location of health centres, the district where the population is based, the distance between health care units, and the demand for them. This process requires account to be taken of the heterogeneity of the environment, in order to obtain results that are as accurate as possible³².

The literature refers to the need for quantitative indicators of health care accessibility^{28,29,30}. These indicators would be used to compare accessibility in different parts of a particular region and to assess the alternatives for new services and transport facilities³³. Examples of accessibility indicators are: health centre-to-population ratio; distance to the nearest facility; catchment area, and Euclidean allocations between facilities³⁴. Some authors have used straight line distances to determine the accessibility of health care services from the patients' area of residence³⁵, while others have applied buffers around primary health care centres in order to assess the "market" of users (total population)³⁶. However, isotropic accessibility modelling demonstrates that these methods cannot truly represent the real space "covered" by the medical service².

For example, Oppong & Hodgson³⁷ and Santana et al³⁸ have determined geographic accessibility to health care facilities using location-allocation modelling from two proxies, proximity and coverage. Neto et al³⁹ have defined accessibility indices in urban areas, taking account of the attractiveness of the units, using not only the distance from the centres of residential neighbourhoods to the health care centres, but also the users that make use of health care centres. Murad⁴⁰, on the other hand, employed gravitational models to identify population flows to health care centres, using a distance indicator and the availability of the existing health care units. In another study by the same author⁴¹, accessibility was measured using three different models: 1) distance to the nearest health centre; 2) health centre-to-population ratio; 3) a combined health care accessibility indicator. Studies such as those by Bazemore et al⁴², Guagliardo⁴³, Parker & Campbell⁴⁴, Luo⁴⁵, Noor et al⁴⁶, Noor et al⁴⁷, Mallick & Routray⁴⁸ and Perry & Gesler⁴⁹ show that it is possible to find different accessibility indicators applied in developed and developing countries.

The World Health Organization (WHO) has also been working to develop models to measure the physical accessibility to health care, using diverse variables integrated into a GIS system. As a result, a number of programmes have appeared, of which we can highlight AccessMod, which methodology was partially used in this work². This programme takes account not only of the travelling time^a, but also of the availability (supply) of health care provided by a particular unit, thereby offering a more realistic view of the situation.

In addition to methodology, scale is another important aspect in defining the model to be applied. In local studies, the most common techniques involve the analysis of networks through the use of a road system based upon high quality information, seeking the shortest route and incorporating the concept of "competition" between many potential health care providers. On the other hand, in regional studies, or when the population tends to use unmotorized methods of transport, the raster modeller^b is the most widely used, as it does not restrict "movement" to the road network, but incorporates routes over the whole of the available terrain. This is particularly relevant for rural areas of many developing countries³². In this type of method, the most common is the analysis of movements through a continuous cost-distance surface^{50,51}, which calculates the "cost of circulation" between two points, by summing the cost of crossing each cell of the route⁵².

^aThere are various reasons for using travel time instead of distance to measure accessibility: 1) it is easier for the patient to think in terms of travel time, rather than geographic distance, when taking decisions about which health care unit to go to; 2) it enables regions to be compared, as it takes account of means of transport and the traversibility of the terrain; 3) the level of care needed in emergency situations is commonly measured in terms of time³².

^b A raster surface representation is a grid with regular cells (i.e. of the same size), which are attributed values in accordance with the phenomenon to be modelled.

2 METHOD AND INFORMATION SOURCES

The aim of this study was to assess the health care interventions implemented by the Marquês de Valle Flor Institute (IMVF)^c in São Tomé and Príncipe¹. For this, it was necessary to develop and implement a GIS capable of analysing environmental factors affecting the health of the population. This would enable an assessment to be made of the impact of the “Health for All” project, finding out if it is possible to improve health indicators and development levels in poor countries by investing in health promotion and disease prevention through the proximity of health care facilities. In this study, the GIS was used to monitor the provision of health care services in São Tomé and Príncipe. The possibility was also considered of using the GIS to map out the spatial distribution of population (potential demand) and the location of supply points for this type of service. Thus, it offers a method for determining the accessibility of these types of services, identifying the most deprived areas.

To construct the GIS for São Tomé and Príncipe (GIS-STP), information was gathered from different sources: 1) Geographic and alphanumeric data collected from the relevant authorities in São Tomé and Príncipe (Health Ministry, National Institute for Statistics of São Tomé (INE-STP), UNICEF, United Nations Development Project (UNDP), World Health Organization^d, IMVF); 2) GPS survey of the coordinates of Health Units and water supply and sanitation infrastructures^e; 3) Information from the IMVF’s Activity Reports from 1990 to 2008; 4) Review of the scientific literature; 5) Studies and data from the World Bank and United Nations; 6) Reports from the Portuguese Institute for Development Support (IPAD); 7) Printed maps and charts.

The lack of up-to-date large-scale maps and the poor quality of the information published or made available by the institutions listed above also imposed certain restriction on the analysis. In particular, as regards health indicators, there was a disparity of data for the same indicator in the statistics for São Tomé and Príncipe. Moreover, some indicators did not distinguish aspects required for this type of study (geographic factors, sex, age, etc). Thus, a method was designed that managed to include all the geographic information collected from these various sources in a single system.

The method used for implementing and developing the GIS-STP was based upon the acquisition of georeferencable information, which was then fed into the information system and analysed, using data cross-referencing. For this purpose, ESRI tools were used, namely ArcGIS 9.2 and the following extensions: 1) *Add x,y Data*: function for the creation of point

^c A Non-Governmental Organization that has provided health care in São Tomé and Príncipe since 1988.

^d Namely, data from the workshop *Malaria Database Software Training*⁵⁴. With the data from this workshop, it was possible to obtain the population covered by each Health Care Unit, such as the units operated by the IMVF.

^e The main information-gathering phase took place during the months of January and February, 2008. Visits were made to all the Health Care Units of the IMVF Project and qualitative and quantitative data was collected. This was done through a questionnaire, and via a GPS survey of geographic location. The fieldwork also included the Central Hospital and some Health Care Units that were not managed by the IMVF (Community Health Centres and the Polyclinic), as well as schools, cemeteries, laundries, drinking fountains and latrines.

themes from a table with coordinates; 2) *Georeferencing*: extension that permits coordinates to be given to digitalized maps and topographic charts; 3) *Editor*: extension used for the creation and manipulation of geographic information; 4) *3D Analyst*: function used to generate the Digital Terrain Model and the consequent Altimetry; 5) *Spatial Analyst*: extension used to convert information into raster format, define the Euclidean Allocation and construct and analyse the accessibility model for the Health Care Units and Central Hospital.

Using a topographic map of São Tomé dating from 1961 at a scale of 1:75.000, another of the island of Príncipe from 1947 at the scale of 1:200.000 and an administrative map of the two islands from 1997, it was possible to gather data that served for various analyses, such as the location of the main population centres, the road network, water network and gradient contours. Other information considered essential for the project was introduced later, such as demographic data, and health and sanitation indicators, in addition to the data collected during the GPS field survey (location of Health Care Units, sanitation and water works carried out by the IMVF, markets, cemeteries and schools). *Google Earth* was also used to delimit the present extension of the city of São Tomé, capital of the country, and other urban agglomerations with a population of over 1500 inhabitants^f.

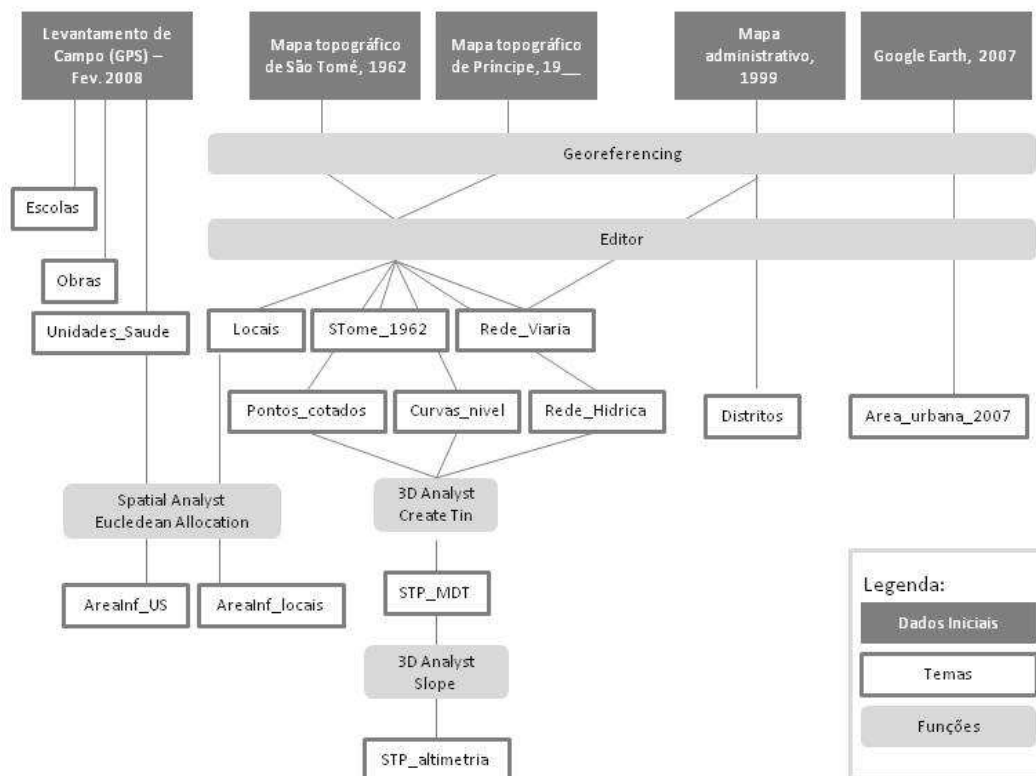


Figure 1: Diagram: Method used for the Implementation of the Geographic Information System.

^f Identified in the 2001 Census by the National Institute of Statistics of São Tomé and Príncipe⁵⁴.

As there were no administrative boundaries smaller than the district, it was necessary to carry out a demarcation. For this purpose, the concept of Euclidean allocations was used^g to distribute the territory by villages and Health Care Units.

Given the importance for this study of Health Centre accessibility, a model was designed to gauge the distances that populations would have to travel to reach their nearest Health Care Unit, while attempting to reflect the conditions of the terrain, and establish the time that would be taken for the journey. For this purpose, “raster” information was used as a way of representing the territory being modelled. As the choice of grid resolution is a function of the scale and dimension of the area under study, a resolution of 10 metres was chosen. This represented a compromise between rigour and processing capacity^h.

This method enabled the catchment areas to be determinedⁱ taking into account the accessibility of each health unit, which corresponds to a cost surface, created using the function *CostDistance*, available in the extension *Spatial Analyst*. This model is an isotropic algorithm, which means that each cost surface cell contains a single value that represents the cost of circulating within the cell, in any direction, seeking the cheapest route between two places².

In this model, three themes were fundamental: the road network, gradient^j and the water network. While the first two enable travel but limit its speed, the third functions as an obstacle, reducing travelling speed by 1 minute per cell. Moreover, the road and water networks resulted from the vectorization of the printed maps; here the gradient was obtained through the Digital Terrain Model, generated from the gradient contours and spot heights obtained from the same maps.

This method was based upon the one defined by Black et al³ in the construction of the WHO programme for assessing health care accessibility (AccessMod©). The necessary cartographic variables used in that one are: population and settlements, land use, road network, digital terrain model, water network, administrative boundaries and location of health care facilities. However, due to the lack of up-to-date quality information concerning land use^k, it was not possible to make use of this programme.

The core of this model is walking speed, on or off road, depending on the gradient of the terrain. This is due, firstly to the lack of public transport in the country, and secondly, to the fact that very few inhabitants have private means of transport, particularly in the south. However, travel by motorised vehicle along the country’s road network was also considered.

^g Euclidean distance is the real distance between two points (“as the crow flies”), attempting to define the “border” in space between them⁵⁶.

^h If a smaller resolution were used (for example 1-5 kms), the local gradient variations would be captured, and linear aspects, such as the road or water network, would appear much larger than they are in reality³³.

ⁱ The catchment area of a particular health unit is defined, theoretically, as the surface nearest to the patients³³.

^j Given the difficulty of travelling over surfaces with a gradient of more than 45°, the cells corresponding to this situation were removed from the analysis and defined as inaccessible areas.

^k Although satellite imaging is an excellent source of information about land use, particularly as it shows up the woodland cover, it was not possible to obtain an image of the island with sufficient resolution, due to its location.

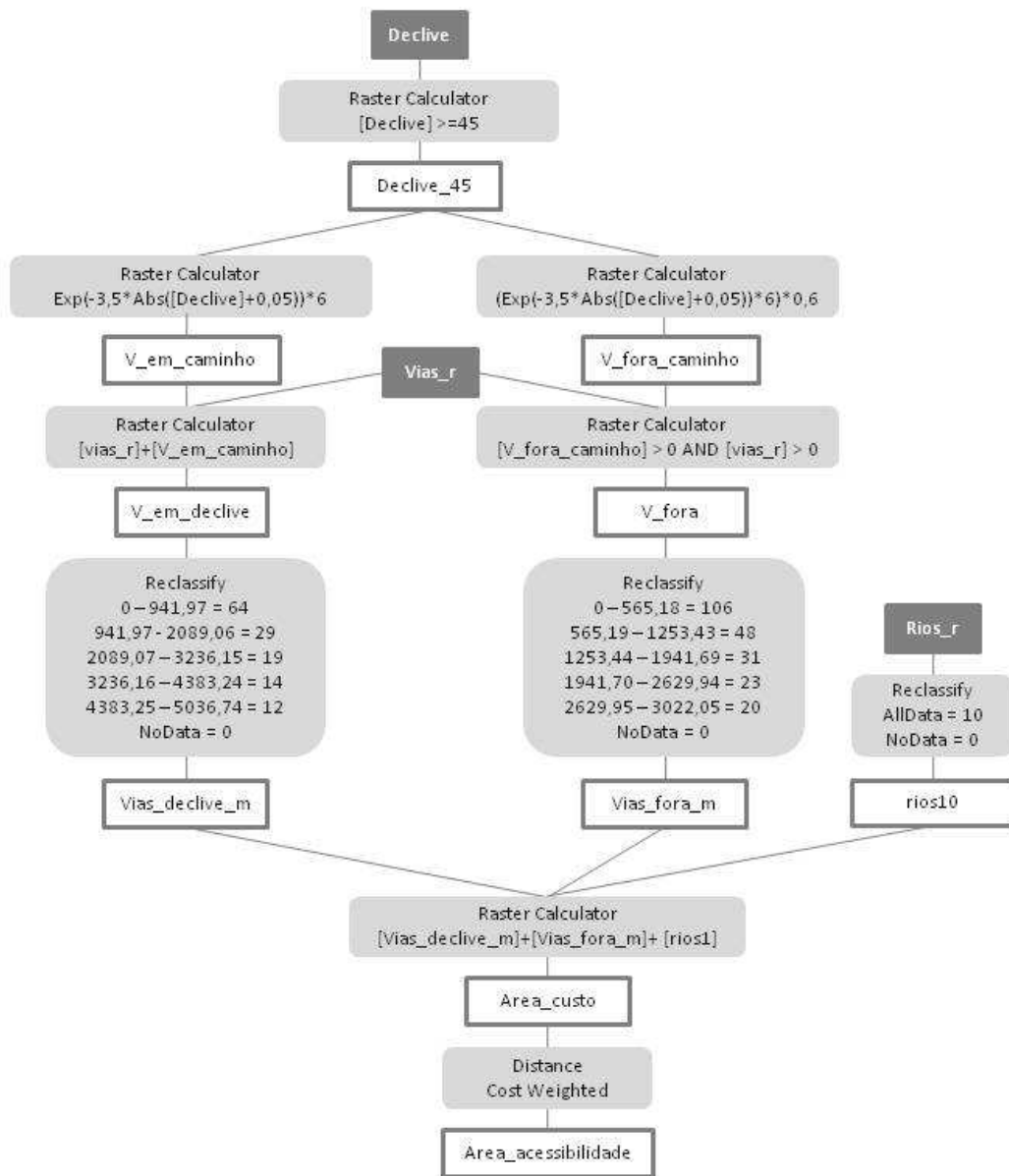


Figure 2: Diagram: Method of Accessibility Model on foot

To model the speed on foot, Tobler's formula was used to express the Hiking function^{1 57}; according to this, $V = \text{Exp}^{(-3,5 + \text{Abs}(S + 0,05))}$, when V is velocity in km/h and S the steepness, or gradient, in degrees.

The velocity was later reclassified, taking into account the travel time within the cell. Thus, the higher the value, the greater the difficulty in crossing, meaning that more time is

¹ The Hiking Function is used to model the speed of travel on roads in accordance with gradient. In a flat terrain, travel speed is considered to be 5km/h. For off-road travel, this is calculated as W/0.6.

required to make the journey. The final result was grouped into classes in accordance with accessibility on foot, and the areas furthest from the Health Care Units were identified.

Finally, the scores for the three aspects mentioned (on- and off-road travel, and rivers) were added together so as to create a coherent accessibility model of the variables introduced^m. The final theme consisted of a cost surface for crossing the cell, where each one has a value that indicates the time taken to cross it. This surface was later used to calculate the distance from each cell to the nearest Health Care Unit.

The model was applied to two different situations: travel on foot, and travel on foot as far as the road followed by travel by motorized vehicle (car or motorcycle) on the road network as far as the nearest Health Unit. These two applications were based on the same methodology. The difference was found in the speed of travel by road, which was defined in accordance with the type of road, with no influence of gradient.

The final result was grouped into classes in accordance with accessibility, and the areas furthest from the Health Care Units were identified. This information was subsequently cross-referenced with the location of villages that had been subject to population survey during the 2001 Census.

This spatial distribution and profiling of the population (representing the potential demand for health care) is of major importance for evaluating health care supply in developing countries. Public authorities can use this information to structure the healthcare system, in terms of both capacity of facilities and their location (supply) for the attendance of the population.

Despite the fact that this accessibility model yielded credible results, there were certain limitations to the analysis, due to the poor quality of the geographic information available. These limits were particularly noticeable as regards the use of motorized transport, firstly because the road network was outdated, and secondly, because the large-scale map used contained little detail. Moreover, it should be pointed out that, despite the occurrence of an error in the generalization of attributes with the rasterization process, this was not considered significant in the scale of this projectⁿ.

3 RESULTS OF THE GEOGRAPHICAL INFORMATION SYSTEM – SÃO TOMÉ & PRÍNCIPE (GIS-STP)

The method used for GIS-STP served four different objectives: 1) to create a profile of the country; 2) to find evidence of spatial inequalities as regards health indicators; 3) to assess the IMVF's initiatives; 4) gauge Health Centre accessibility.

^m In this equation, the same three variables were given the same weight, as this had already been quantified in the data processing phase and later reclassified.

ⁿ However, as the road network is modelled as a raster, the breadth appears to be 10m, which in reality it is not (roads are usually no more than 5m wide).

3.1 Results of the country profiling

São Tomé and Príncipe is a small island state of 157,847 inhabitants in 2008⁶² (of whom 59.7% are urban and 40.3% rural). Until 1975, it was a Portuguese colony.

The main road network does not enable travel around the whole island (Figure 3). There are only 117 km of fixed road outside the towns and villages, making a total of 212 km of paved roads. On Príncipe, there are only 7 km of road^o.

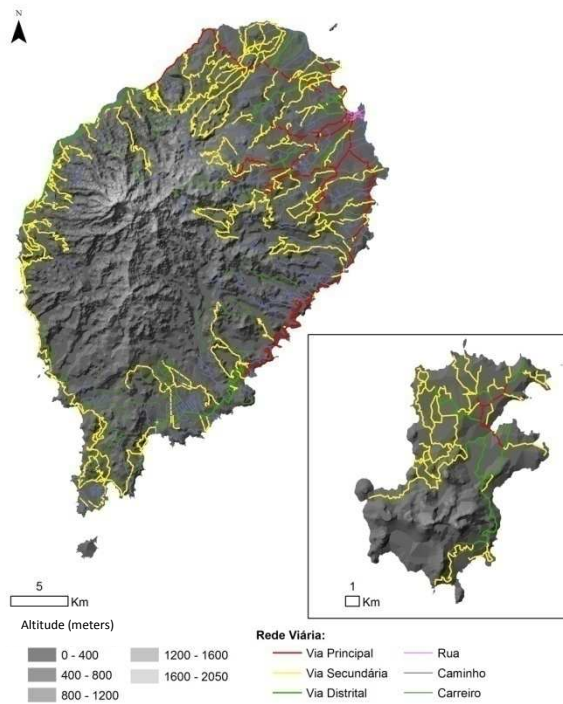


Figure 3: Altimetry and road network of São Tomé and Príncipe^{58,59,60}.

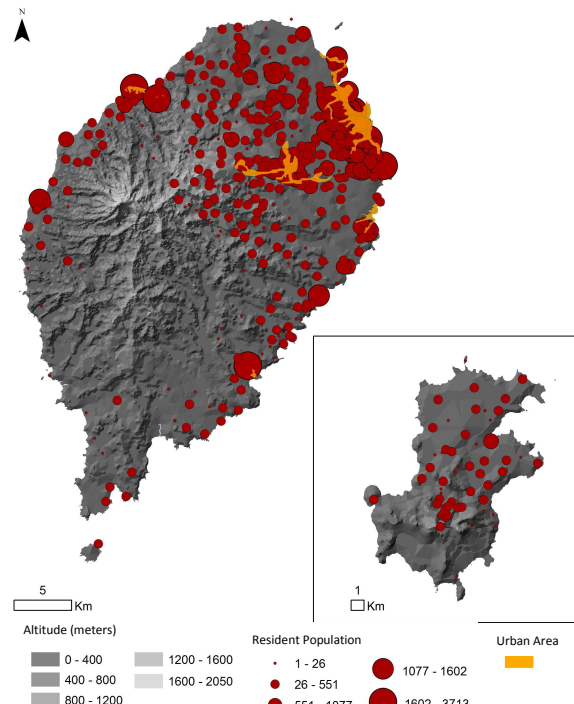


Figure 4: Population Distribution (2001)^{54,58,59}.

On São Tomé island, the location of the main urban centres reveals the influence of the physical relief; the upland areas clearly exert a repelling effect on the population, while the northeastern coastal strip has the opposite effect, attracting settlement. In fact, most of these agglomerations developed precisely because the physical conditions were propitious for human settlement: gentle slopes, near rivers and/or the sea, sheltered from the humid winds from the south, and therefore, with a more amenable climate than other parts of the island.

As for land use, the urban space, concentrated mostly in the city of São Tomé, has grown sharply. The area of the city has increased five-fold over the last 30 years, in the expanding “oil stain” pattern, influenced by the existing road network. In 1961, it covered an area of 1.47 km², which had increased to 7.25 km² by 2007 (Figure 5). Most of the agglomerations in

^o The country’s road network has not changed much since Independence, and most stretches are in an advanced state of decay. Many villages are joined only by dirt tracks^{1,56}.

the districts have resulted from the former large agricultural estates (*roças*)^p, housing 17% of the population. Most of the population (36.1%) live in the so-called *luchan*^q, much more than live in *idades* (*Cities*)^r or *bairros* (*Neighborhoods*)^s (26.4%)⁵⁴.

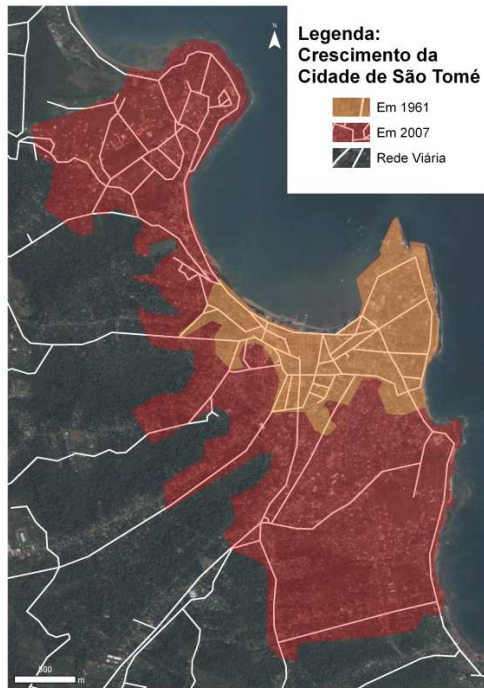


Figure 5: The growth of São Tomé city^{58,63}.

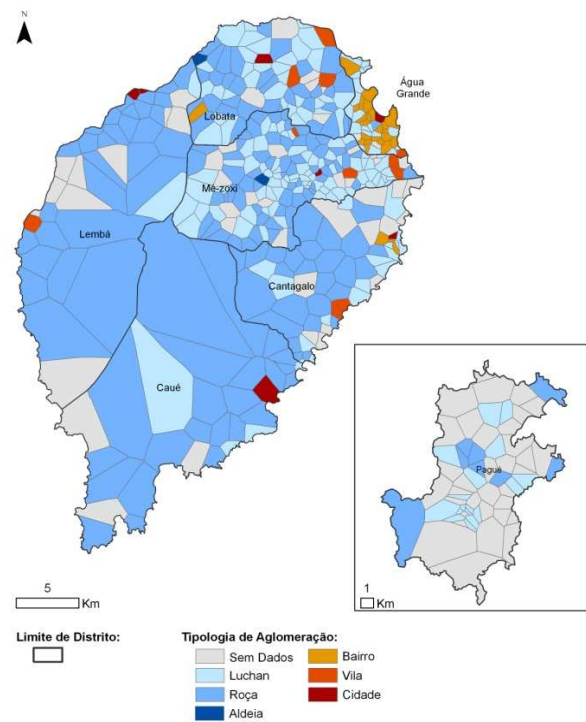


Figure 6: Type of agglomeration⁵⁴.

The population has not grown homogeneously in all districts. Água Grande and Mé-Zoxi have the greatest population densities, at district level as well as town level. It should be pointed out that Água Grande has the smallest territory, in terms of size, but the greatest concentration of residents, reflected by a high population density (3424 inhabitants/km²), much higher than the national average (138 inhabitants /km² in 2001). In contrast, Caué, which has a much smaller population and a bigger area, has a lower population density.

Poverty is one of the main problems afflicting the country, caused by a lack of job opportunities (and therefore, of income), an unfavourable socioeconomic environment and inadequate governance policies⁶⁴. In 2000, 54% of the population of São Tomé was below the poverty line⁶⁵. The most serious cases are found in the districts of Lobata and Lembá,

^p *Roça*: Plantation or agricultural estate, organized urbanistically with a central headquarters and subsidiaries, usually rural in nature⁶².

^q *Luchan*: Hamlet, small village or specific place, such as a concentration of huts or shacks around a cross, not considered as an urban settlement at the outset⁶².

^r *Cidade*: Densely inhabited urban agglomeration or continuum, with ordered roads, squares, etc, and certain services and functions, with which most of the population is involved⁶².

^s *Bairro*: Neighbourhood of a city or town that is not integrated in the city or town⁶².

which is where policies aimed at combating poverty should be directed in forthcoming years (Figure 8).

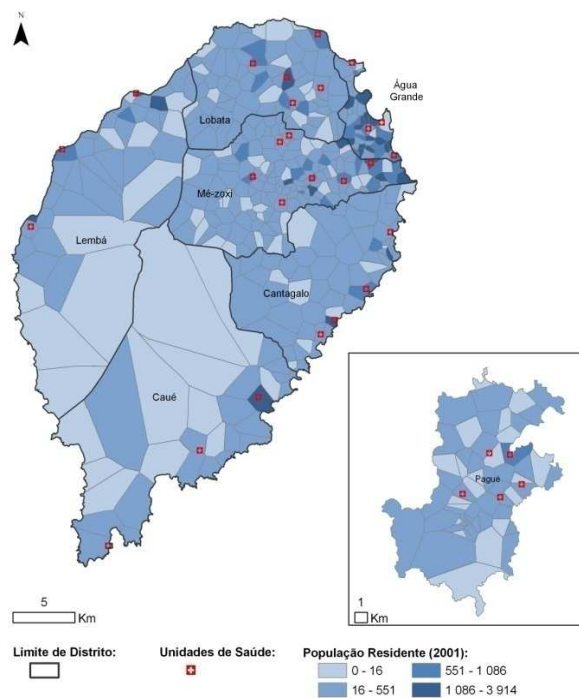


Figure 7: Resident population by village and location of IMVF Health Units^{54,58}.

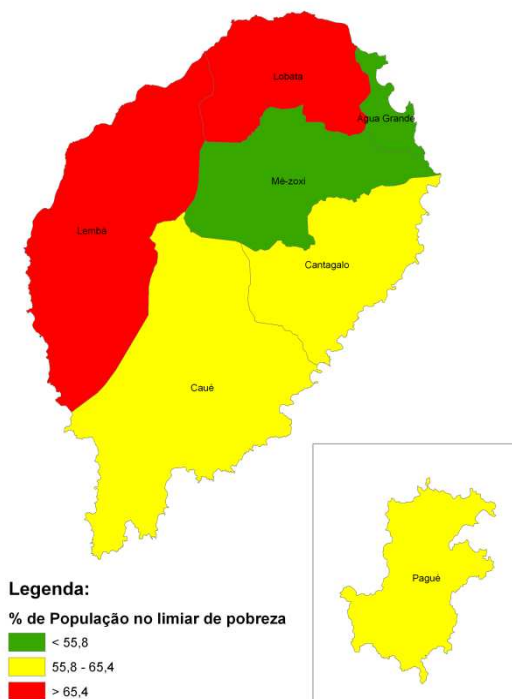


Figure 8: Proportion of the population on the poverty threshold per district, 2000/2001^{60,67}.

3.2 Results of the survey of population health indicators

As there is no operational system of epidemiological surveillance and information, nor any master plan for the supply of water and sanitation, the population of São Tomé and Príncipe suffer frequently from diseases that are largely preventable, such as outbreaks of cholera, and diarrhoeal and acute respiratory diseases. These are a problem not only for the children but for the general population.

Cholera, for example, is spread through contaminated water and foodstuffs, and people infected with it suffer from diarrhoea that frequently leads to serious dehydration and death. In such circumstances, it is necessary to expand the network of sewers and promote the construction and use of latrines, while at the same time promoting access to a quality water supply and encouraging the population to change its hygiene habits⁶⁸. Without such measures, the country will continue to fall victim to cholera and other diarrhoeal diseases.

The last cholera outbreak at national level occurred from October 2005 to March 2006, involving 2763 cases and 38 deaths. Based on the ratio of number of cases per 1000 inhabitants, the worst affected areas were the districts of Água Grande and Mé-Zochi, particularly the areas of Cantagalo and Lembá.

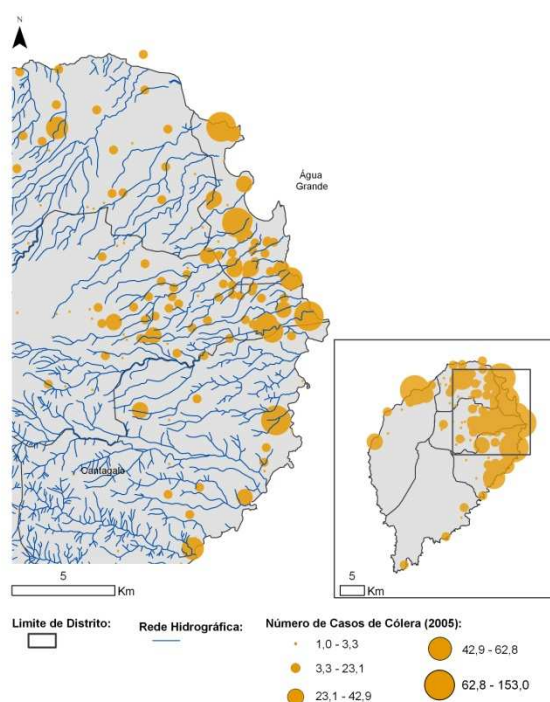


Figure 9: Location of cholera cases (Oct. 2005 – March 2006)^{58,68}.

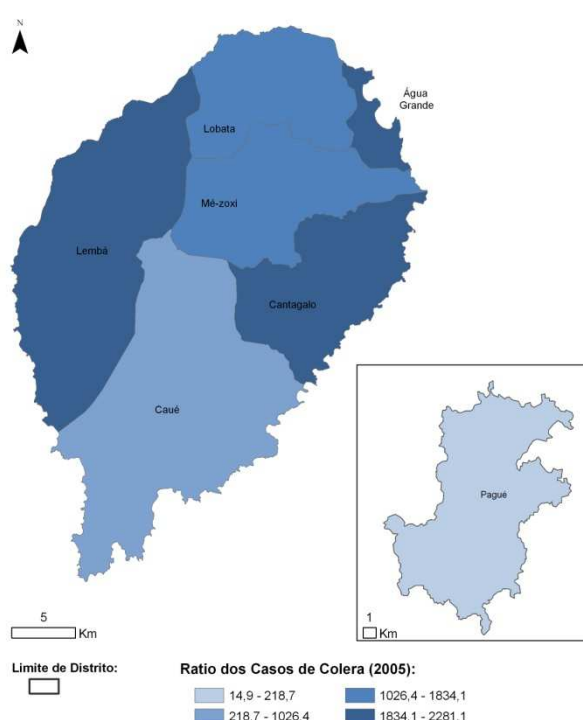


Figure 10: Cases of cholera per 1000 inhabitants – Oct. 2005 to March 2006 (resident population, 2001)^{60,61,68}.

3.3 Results of the profiling the IMVF's initiatives in the country

The health system in São Tomé and Príncipe is almost exclusively assured by public structures, organized on two levels: the central level, which is of national scope, based on secondary health care provided by the Ayres de Menezes Hospital^t (2 units); and the district level, coinciding with the administrative division of the territory, based upon primary health care. The latter is, for its part, comprised of three levels: District Health Centres^u (6 units), Local Health Centres^v (28 units) and Community Health Centres^w (17 units). The private

^t The most important hospital, as regards the provision of general and specialized treatment, which admits patients for hospitalization. In addition to this, there exists the Dr Quaresma de Graça Hospital^t (on the island of Príncipe), which is the only health care unit on that island^{57,69}.

^u The District Health Centres are located in district capitals (or villages large enough to justify them).

^v The Local Health Centres are the basic units in the health system, directed by a nursing assistant or general nurse, who provides basic nursing care. In some Local Health Centres, there are both general nurses and others specialising in maternity and child care, thereby ensuring full assistance for women (reproductive health and family planning) and children (vaccination, growth monitoring, nutrition, promotion of breastfeeding, etc) and yet others specialising malaria control⁷⁰.

^w Community Health Centres are informal structures and relatively autonomous, with regard to the official primary health care system. They are managed by community health officers, who are generally not properly trained, or by traditional midwives. These are often volunteers, farm workers at the plantations who have some training in community health, promoted by the Bamako Initiative (WHO). Due to the lack of support,

sector is practically non-existent, except for a very small number of “clinics” in the capital city.

Healthcare in São Tomé and Príncipe is afflicted by serious structural problems, aggravated by the context of generalized poverty, poor nutrition, lack of basic sanitation and drinking water, illiteracy, and poor awareness of healthy living habits. After independence in 1975, São Tomé and Príncipe maintained the colonial health structure that had been prevalent until then, with hospitals in the main agricultural estates (*roças*), combined with preventive public health care at district level assured by the State. This model persisted until the beginning of the 1990s, when, with the privatization of the agricultural estates and the disappearance of their respective hospitals, combined with a reduction in social spending resulting from the application of the Structural Adaptation Programme imposed by the IMF and World Bank, the situation deteriorated sharply.

The IMVF's policy in São Tomé and Príncipe has been to achieve as near as possible total health care. Thus, its intervention in the country is focused upon primary health care, at the level of district and local health centres. Each District or Local Health Centre set up by the IMVF has a target population of 4,415 inhabitants on average. The Health Centres with the largest number of users areas are Trindade and Bombom^x (with 10,834 and 10,626 users respectively)⁵³.

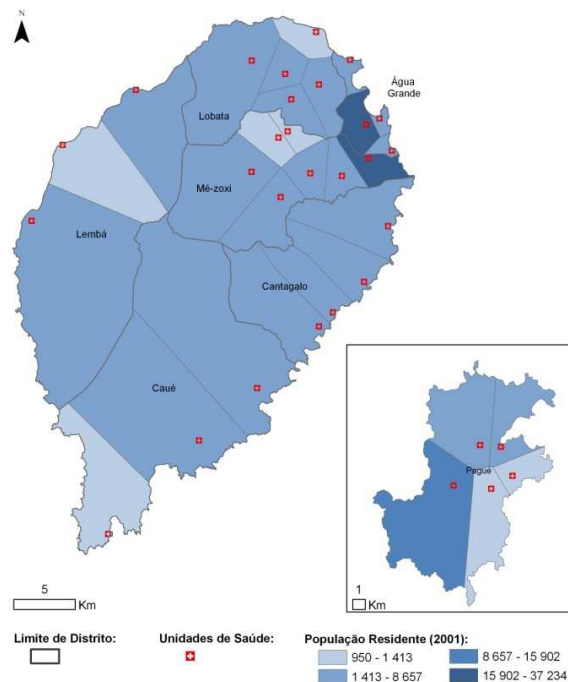


Figure 11: Catchment area of IMVF Primary Health Care units and the population covered^{53,66}.

motivation and supervision, the Community Health Centres are not particularly effective^{57,70} and many are now deserted or inoperative.

^xThe Polyclinic, located in the city of São Tomé, is the only Health Care Unit not run by the IMVF (it is managed by the Taiwan Cooperation) that has more users: 19,515 users⁵³.

No Health Unit (HU) has a full-time doctor. However, the district delegates and doctors operating within the sphere of the IMVF do consultations in practically all the HU. Considering the total number of IMVF Health Units, there is one doctor for every 1645 users and one nurse for every 1412 users^y. The Health Unit in the worst situation is Vila Fernanda, in the district of Água Grande, which has 12,411 users per doctor and per nurse. In contrast, the Reproductive Health Unit, in Água Grande, has 270 users per doctor, while the M.Graça Hospital on Príncipe has 128 users per nurse.

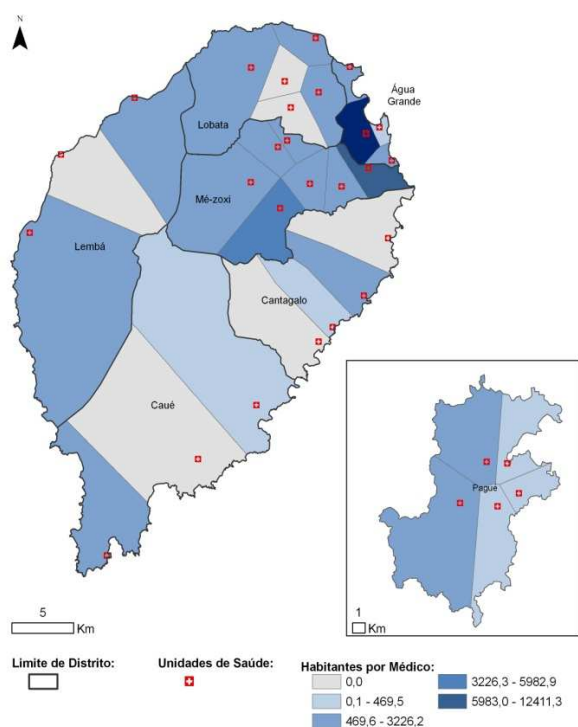


Figure 12: Number of users per doctor⁷².

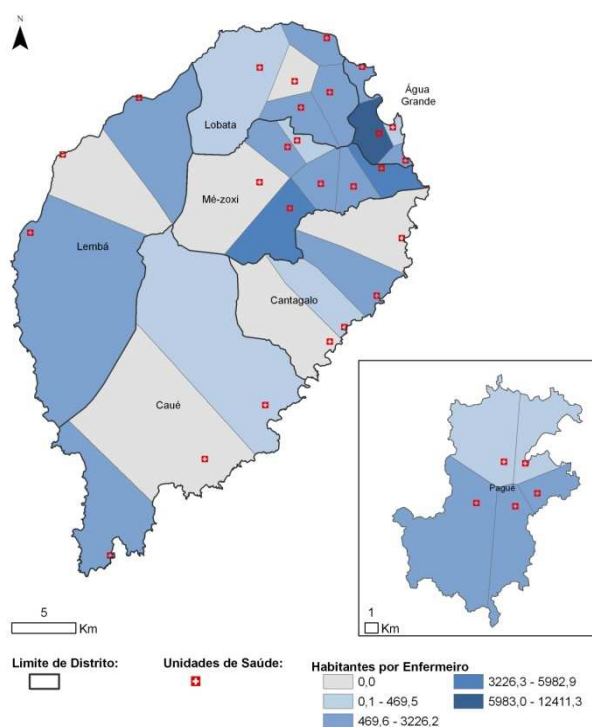
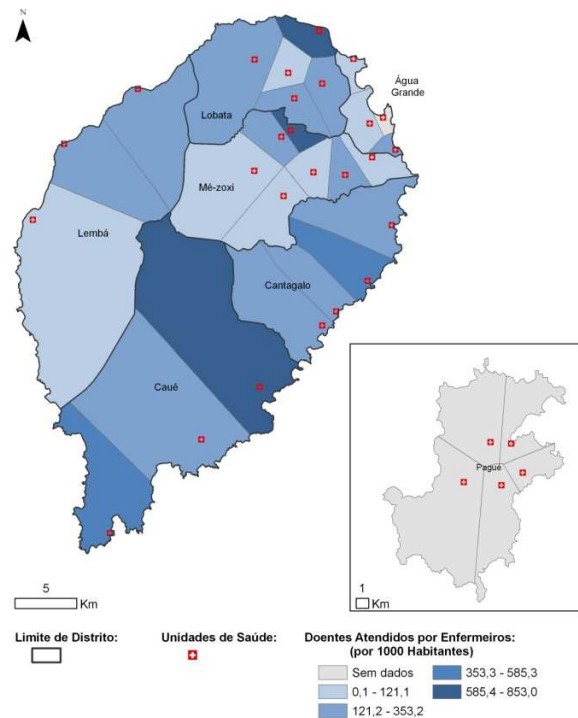
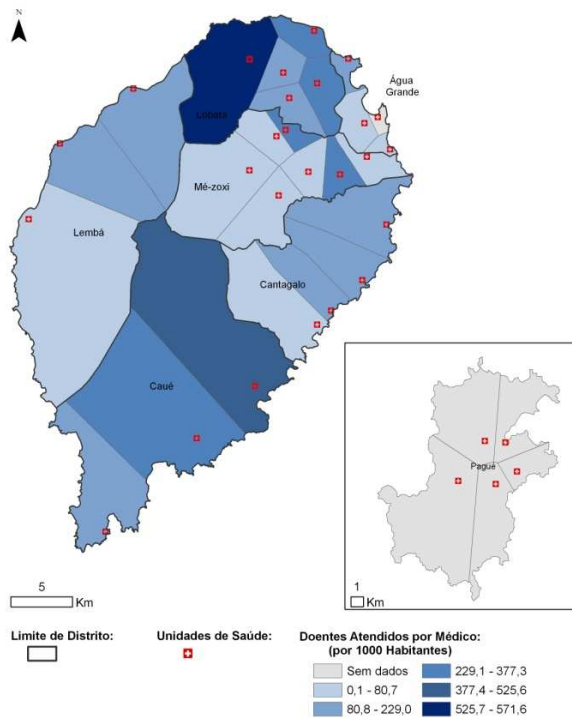


Figure 13: Number of users per nurse⁷².

The number of medical consultations given by a doctor or nurse in the first semester of 2008 also reveals some variation between Health Units. The Guadalupe Health Centre has the best ratio of patients seen by a doctor (25.6/1000 inhabitants) and the Lembá Health Centre the best ratio of patients seen by a nurse (13.52/1000 inhabitants). In contrast, the Santa Margarida Health Station has the worst ratio of patients attended by a doctor (0.06/1000 inhabitants) and the Praia Gamboa unit the worst ratio of patients attended by a nurse (0.19/1000 inhabitants).

^y We have been unable to obtain data concerning the number of doctors and nurses for 7 Health Care Units (Conde, Santana, Diogo Vaz, Emolve/Ribeira Peixe, Monte Café and PMI).



Since 1995, the IMVF has helped prevent disease by improving water quality and access to drinking water for a larger portion of the population. Sanitation has also been improved through works to connect septic tanks to sewage systems, and the construction of latrines.

In many places where the IMVF has provided water and sanitation, the population used to consume muddy water; this, associated to the practice of defecation in the open air, meant that cholera, diarrhoeal diseases and intestinal parasites were prevalent in rural communities⁶⁵. However, the construction of these works has improved the population's access to water and sanitation. During the cholera outbreak of 2006/2006, there were three agglomerations located near rivers which had undergone sanitation works and suffered no cholera cases (Praia das Conchas, Ototo and Trindade).

3.4 Results of health care accessibility

The development of the accessibility model has enabled travel times to the nearest Health Unit to be modelled and analysed. It is therefore useful not only for gauging the accessibility of these units but also the distribution of health care facilities.

In 2008, the IMVF's Health Care units covered a population of 116,331 inhabitants, corresponding to 85% of the country's total population, in a proximity relationship⁵³. Indeed, it has been the IMVF that has provided services to 100% of the population in all districts except for Água Grande, where the Ayres Menezes Hospital and the Polyclinic are located,

both managed by a Taiwanese cooperation. In rural and peripheral areas of São Tomé and Príncipe, the IMVF's Health Units are the only contact that the people have with the health services, offsetting the geographical lack of access to health care (due to the poor road network and lack of public transport). They provide mainly primary preventive care (vaccinations, diagnostic tests, counselling, etc), ante- and post-natal care, and advice about medication.

The maximum travel time defined for a patient that requires access to a particular health facility depends upon the severity of his/her condition. In the context of this study, the maximum travel time permitted was established as 1 hour^z 25, so as to be able to identify the parts of the country where accessibility is worse.

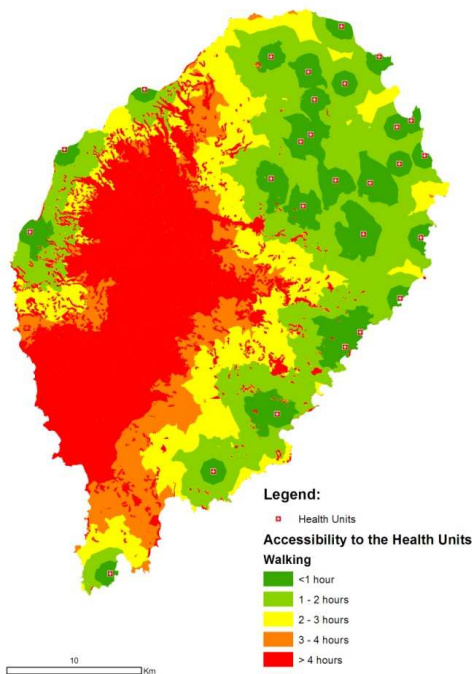


Figure 16: Walking Accessibility to IMVF Health Units (time)

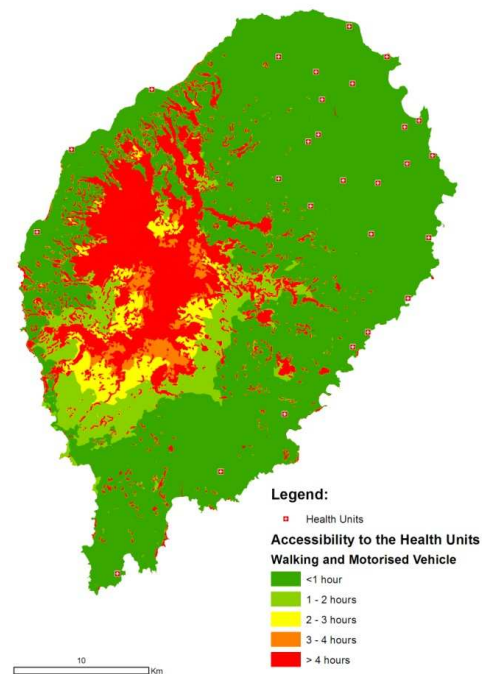


Figure 17: Walking and Motorised Vehicle Accessibility to IMVF Health Units (time)

^z This maximum travel time depends upon various factors, such as the type of services offered (eg. emergency) and the severity of the patient's condition. For example, a specific type of emergency requires travel of less than one hour, while a minor operation, planned in advance, offers the patient more time to reach the health centre³³.

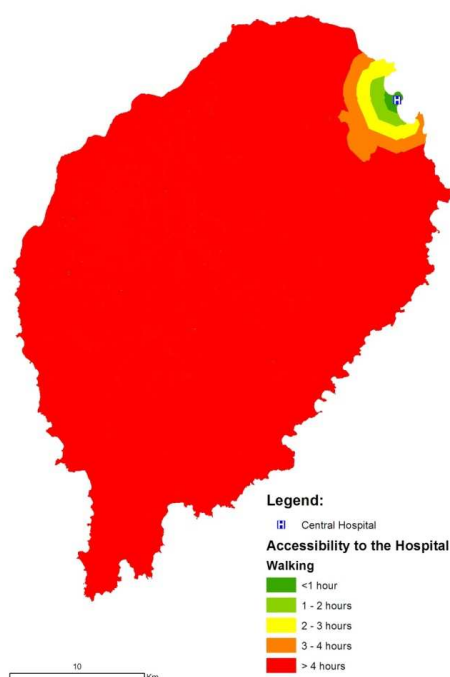


Figure 18: Walking Accessibility to the Hospital (time)

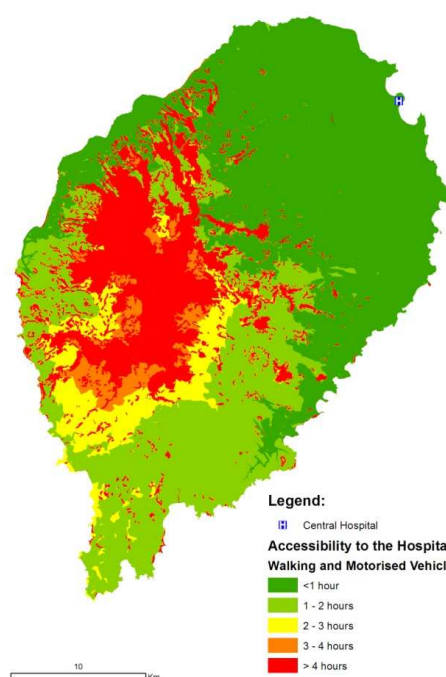


Figure 19: Walking and Motorised Vehicle Accessibility to de Hospital (time)

Almost half of the population reside less than one hour' walk from an IMVF-managed Health Unit and almost all the population reside less than one hour' walking or in a motorised vehicle. To the hospital, less than 10% of the population reside near in walking accessibility and 95% in walking and motorised vehicle accessibility.

4 IMPACT OF THE GIS-STP ON THE ASSESSMENT PROJECT

By focusing the assessment on a geographic information system, we were not aiming to evaluate the situation of the country as a whole or differentiate between districts, but rather to use disparate information to glean a better idea of health inequities existing in the country, and cross-referencing these indicators with environmental aspects that could explain them. This could only be possible using a geographic information system. However, the lack of information constituted a problem, which was overcome with the methodology described here. Indeed, the results of the implementation of the GIS-STP in this project are positive and the main aim was achieved – namely to assess the results of the IMVF's intervention in health care in São Tomé.

This institute has contributed to the improvement of health indicators over the last twenty years⁷², by assuring equity of access to quality health care (supplied by local professionals) on a level appropriate for the health needs of the populations.

In fact, the main needs of the population are related to the main causes of morbidity and mortality, namely preventable diseases (such as malaria, acute respiratory and diarrhoeal

diseases, etc) and conditions resulting from lack of access to medication or to ante- or post-natal care. These needs affect mostly the poorest members of the population, children and women that live furthest away from the Health Care Units, a situation which, if it persists, will have a direct adverse effect on the capacity to produce and generate wealth⁷³.

The progress registered in the country on the level of health care reflects the IMVF's contribution in the territory. Its intervention, aimed at improving the quality of life of the people by guaranteeing greater and better access to basic health care, has borne fruit. In fact, the number of District and Local Health Centres managed by this NGO is increasing, and there has been a notable improvement in the quality and variety of basic health care available. As Loevinsohn & Harding⁷⁴ pointed out, the health objectives of the Millennium Development Goals can only be attained if primary health care services are improved, particularly in rural and peripheral areas. In these geographic areas, health units are the only contact that populations have with the health services.

However, in order for health to be improved, maintained or recovered, the health system needs to be more than a mere cluster of public and private institutions that provide health care services to the individual and community. There has to be dialogue between the various sectors that directly or indirectly affect the health of populations, based upon scientific evidence that reveals strong associations between environmental determinants (physical, social, economic, cultural) and health.

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