

A Settlement Strategy for Health Facilities in Emerging Countries: A Case Study in Brazil

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Abstract—A settlement strategy is to anticipate and respond the needs of existing and future communities through the provision of primary health care facilities in marginalized areas. Access to a health care network is important to improving healthcare coverage, often lacking, in developing countries. The study explores that a good sanitary system strategy of rural contexts brings advantages to an existing settlement: improving transport, communication, water and social facilities. The objective of this paper is to define a possible methodology to implement primary health care facilities in disadvantaged areas of emerging countries. In this research, we analyze the case study of Lauro de Freitas, a municipality in the Brazilian state of Bahia, part of the Metropolitan Region of Salvador, with an area of 57,662 km² and 194.641 inhabitants. The health localization system in Lauro de Freitas is an integrated process that involves not only geographical aspects, but also a set of factors: population density, epidemiological data, allocation of services, road networks, and more. Data were collected also using semi-structured interviews and questionnaires to the local population. Synthesized data suggest that moving away from the coast where there is the greatest concentration of population and services, a network of primary health care facilities is able to improve the living conditions of small-dispersed communities. Based on the health service needs of populations, we have developed a methodological approach that is particularly useful in rural and remote contexts in emerging countries.

Keywords—Primary health care, developing countries, policy health planning, settlement strategy.

I. INTRODUCTION

THE primary health care (PHC) facilities in emerging countries are the point of first contact of patients. PHC centers should be established in both urban and rural areas ensuring easy access, immediate care and providing basic care and treatments. An appropriate settlement strategy could improve the quality of life in developing countries, especially in a rural context where health coverage is more and more lacking, leaving segments of the population uncovered. The rural community usually tends to have poorer health indicators than urban areas, because in these contexts there is no possibility to treat the most common diseases. The health outcomes are also influenced by socio-environmental conditions: an example is the life of the poor population in buildings with low maintenance and lack of hygiene due to a shortage of education in marginal contexts. Therefore, poor

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housing, unsatisfactory environmental health, scarcity of water and electricity lead to infectious diseases.

Careful planning of health facilities ensures the structured development of these disadvantaged areas also investing in transport and communication, water and sewerage and social facilities, while protecting environmentally sensitive areas and natural resources. The development of a network of health units increases the standard of living, providing access to healthcare and education, but also strengthening the public transport network.

II. OBJECTIVE

The main goal of this study is to establish a settlement strategy for PHC facilities in deprived areas, especially in the rural settlements where populations are displaced outside the cities with weak infrastructure systems. There is an urgent need for an effective method to identify and implement the living conditions of poor populations in the most hidden settings, before proceeding with the design phase of health facilities. In this way, the health, social and environmental quality of life will bring benefits to the rural community.

A health settlement strategy should start at the earliest stages of planning. The health system planning must be a generalizable element to be applied in those countries with similar characteristics. In this way, the paper applies the methodology in a Brazilian area demonstrating that it is just one of the possible application contexts.

The health localization system should be an integrated process involving several factors through quantitative and qualitative choices. It should consider carefully the specific area in which we suppose to act overlaying all the data available: environment characteristics, the infrastructure network, distribution of public services, supply of water and electricity, population density and health facilities distribution. This analysis allows us to have an awareness of the structure of the territory to establish a proper settlement method.

As a result, in order to define a strong methodology, a multi-disciplinary approach should be applied.

III. METHODOLOGY

The settlement strategy of health facilities in rural deprived areas is one of the essential aspects to which attention must be paid in the future to improve the quality of life of communities. The demand for health treatments will always be on the rise if we do not find a solution to improve basic sanitary conditions. Most problems can be solved through better planning and organization of the available resources within different lines of research.

The proposed health system strategy is divided into various steps shown in Fig. 1:

- The first methodological step is the identification of the specific context on which to act, understanding the limitations and the possibilities that exist within the area. It is important to identify the qualitative aspects of the research.

Starting from the topographical development of the territory and the rise of urban settlements over time, it is proposed establishing some assumptions about the conditions of the territory from the beginning, and the possible initial benchmarks, up to reconstructing its various territorial stages until today. The anthropic organization of a place is therefore reached in a systematic succession of steps: paths, settlement, production areas, proto-urban and urban centers. It should be observed that the structures induced by human activity do not lie in an area "free of structures", but rather the territory has its own independent natural man-made structure. We can, therefore, consider that a reading for the reconstruction of the formative processes, leading to a feasible plan for reality [1].

- The second step focuses on quantitative data: the accessibility of the site, the proximity of rivers, the availability of infrastructure and the presence of areas exposed to environmental preservation and land management, if any, to find out which the building areas are.

Accessibility can be enhanced by relocating the existing PHC centers, or even better by adding other medical units within the remote settlements to bring the facilities within walking distance of the population of the catchment area.

Another important quantitative aspect is the collection of demographic data, especially to understand the density and distribution of the population on the territory, the main health

status in the area and the localization of the existing health care facilities (if any) and their radius of action, trying to figure out how many people a day are visiting a health center.

The distance is an important key factor, which influences the use of health facilities. If on one hand in the urban area, the distance affects the decision on the kind of health facilities, such as health center or hospital; on the other hand in the rural areas, the distance is the fundamental factor indicating whether or not the PHC facilities are used. For this reason, in rural areas of developing countries, PHC facilities close to the settlements of populations become important to proper medical supply. Each settlement should be reached within a certain distance (maximum 10-15 km), but the limit of distance cannot be the same for all contexts, it changes according to the situation. Therefore, the problem is to determine the location and number of PHC centers. This depends on the walking distance from the patient; in this way, the walking distance will decrease with the numbers of health facilities [2].

- The final step is to compare and overlay all collected available data to have a complete view of the context in which we are interacting, in order to check all the factors listed in previous steps. We can overlap all data using programs that allow the acquisition, storage, analysis, visualization and the restitution of information derived from geographic data. These programs plan strategies in the territory in the most accurate and appropriate way. They facilitate some operations that would be complicated, if not impossible, to be made in the absence of such tools.

Finally, the results will be shown through maps and graphs showing a possible location of new health centers according to the data and the line of reasoning adopted.

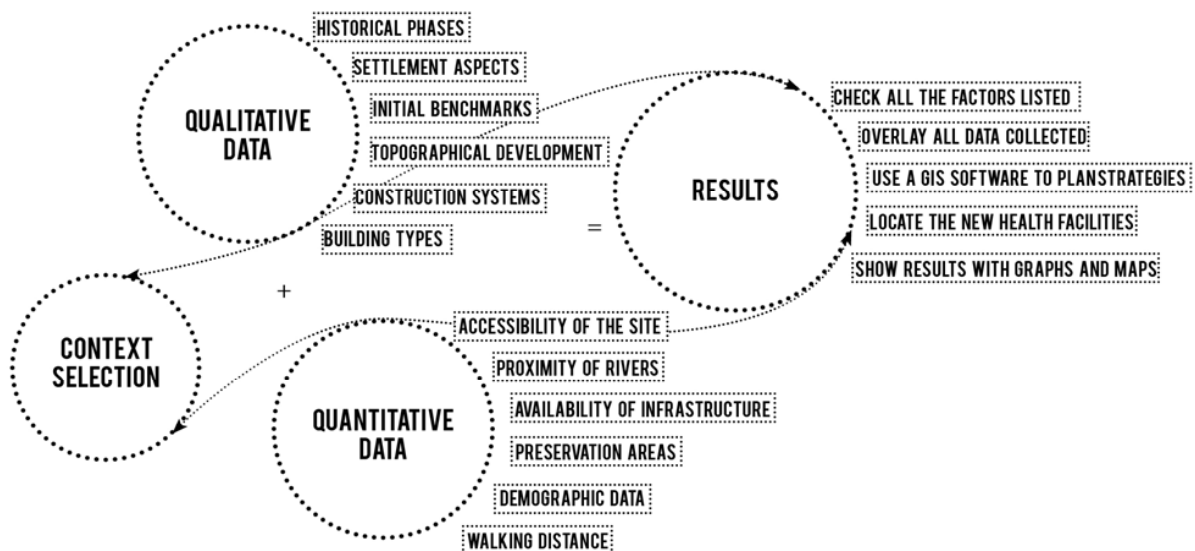


Fig. 1 Methodology to locate health facilities in deprived areas

IV. CASE STUDY ANALYSIS

A methodology to enhance PHC facilities settlement will be applied in Lauro de Freitas, a municipality in the Brazilian state of Bahia, part of the Metropolitan Region of Salvador (RMS). The RMS is composed of 13 municipalities, some of which are crossed by fresh and salt waters, including the municipality of Lauro de Freitas, as depicted in Fig. 2.

The Municipality of Lauro de Freitas, bordering and with a high degree of the conurbation with the Bahian Capital, was created on July 27, 1962.

Recently, in 2015, by Law No. 1.596 of November 19, Lauro de Freitas was divided into 19 districts with 1,510 streets, see Fig. 3. The mentioned document laid down the official basis for streets and for the delimitation and denomination of the districts, defining the individual limit of each district that has been described by georeferenced geographical indications. Prior to 2015, the municipality was divided into zones for urban planning purposes.

According to official data of IBGE (Brazilian Institute of Geography and Statistics), the total estimated population in 2016 in the municipality of Lauro de Freitas was 194,641 within a territorial area, which in 2015 reached 57,662 (km²). Official data show that the total population census in 2010 was 163,449, whose population density was 2,833.38 (hab/km²) [3].

It is considered as a dormitory for the movement of workers towards Salvador (Bahian Capital) and Camaçari (industrial zone), and it is one of the regional development poles, including the education, due to the building of universities, as well as in the sectors of industry, services, tourism and leisure due to the presence of 7 km of beaches (Buraquinho, Ipitanga Beach, and Vilas do Atlântico) [4].

A. Morphological and Settlement Aspects Over Time

The City of Lauro de Freitas, located in a privileged geographical area within the Metropolitan Region of Salvador, is an example of a demographic explosion and "chaotic" urban growth. In order to understand the contemporary reality, it is necessary to read the territory over time, observing the morphological evolution of the municipality and its structuring process of anthropic space. An aspect to investigate is to recognize if beyond an apparent randomness there is a balanced system that allows heterogeneous objects forming our living environment to coexist and to stay together in the course of time, and to change developing time after time a certain degree of organicity.

The analysis of the construction of the territory has been divided into different historical thresholds, from the origins to the present day. Four main phases were chosen to represent the persistence and changes in the course of time: 1952, 1970, and 1980 until today, as shown in Fig. 4. The territorial configuration is composed of the settlement, urban and production structures and by extra-urban path related to the primary production (agriculture, industry, etc.). The territory is, therefore, the result of four classes of structures that have gradually developed: the paths, settlements, production areas and urban centers.

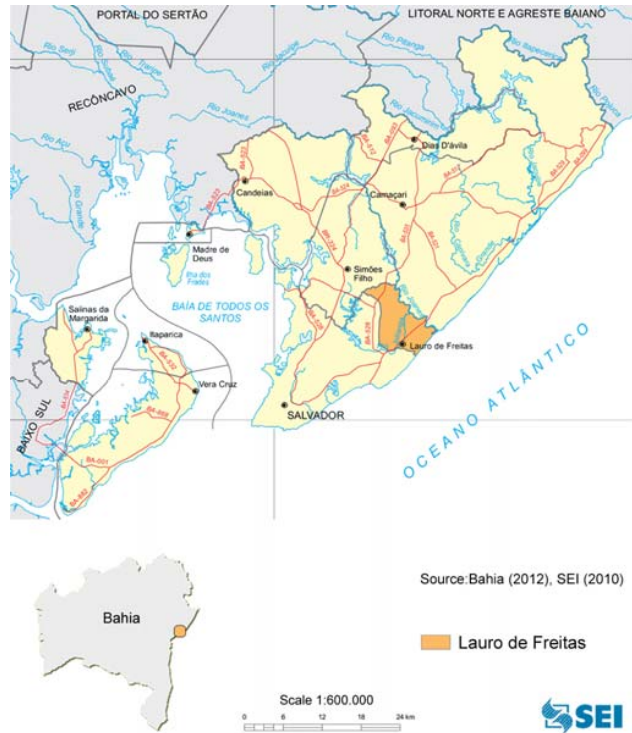


Fig. 2 The Metropolitan Region of Salvador

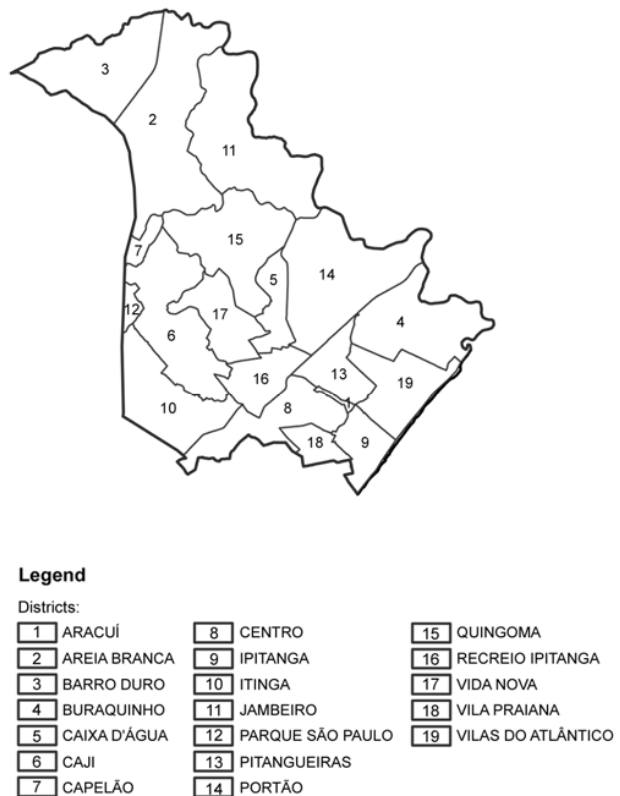


Fig. 3 Lauro de Freitas: districts

The territory has its own structure covered by mountains, valleys, ridges, rivers of a place and climate, rainfall, altitude, soil productivity, etc.; that is the set of morphological and climatic characteristics that identify each place. In this case, it was observed that the Joanes River has always been an important benchmark in the territory because it is considered as a municipal boundary. Observing the persistence in the area, the parish Santo Amaro, founded by Jesuits, has always had a great importance. From the church, the first urban core of the city was generated, which over time has increasingly extended. The Church of Santo Amaro is considered the Lauro de Freitas matrix that has affected the urban structure of the city. The reconstruction of the development phases of the territory is an essential basis on which to establish a proper design in the present. The past is a concrete object of research to which the project is to be related.

The two other important presences are the airport and the highway BA-099, better known as “Estrada do Coco”. The air base, built during World War II, brought a population growth in its neighboring areas, as well as an economic rise, contributing to the growth of the municipality. Instead, the highway, where the Ipitanga and Portão centers are located, has brought a gradually increasing settlement along the axis.

On the map of the ‘50s, the district of Santo Amaro de Ipitanga (now called Lauro de Freitas) was presented as a predominantly agricultural area with some rural properties, specializing in horticulture and coconut production; in the 70s it appeared as an area more densely populated due to the different events that led to the present configuration and its function as a metropolitan city, including the access to the main road, the construction of the Petrochemical Pole in Camaçari and the Industrial Complex of Aratú (CIA), and the realization of the “Avenida Paralela” which facilitated the connection of Lauro de Freitas with Salvador city.

In the ‘80s, we can observe how the principal road is considered the main “framework” of Lauro de Freitas from which branches off urban settlements, and at the same time, it also becomes a strong break in the territory dividing the most urbanized areas near the coast reserved for the upper classes, from the rural areas located in the north of the road, where the lower and middle classes have settled. The popular classes settled in outlying areas of the city, due to the higher cost of urban areas, seeking to establish their own home in the most remote areas, where cost was more accessible.

Today, Lauro de Freitas looks like a fragmented city. The disadvantaged classes have settled over time even in the Itinga, a privileged area located near the airport and the border with the city of Salvador. The wealthy classes instead, were placed along the coast or near the river Joanes (Vilas do Atlântico), where since the 1970s, large plots with infrastructure have been distributed, increasing the number of the blocks of flats during the 1990s.

The urbanization process of Lauro de Freitas is not represented only by spatial transformations, but mainly by social changes. The social structure and urban space are articulated through the workforce reproduction process; therefore, it is creating a hierarchical society divided into

social classes that define heterogeneously the place of living. The city adapts in a different way according to the citizens that compose it. This territory is a scenario of contradictions, conflicts, class struggles, that materialized in the different aspects of the urban landscape. This lets us to have an urban vision in all social and historical dimensions. This makes clear the diversity and heterogeneity between the housing types and the socio-spatial relationships developed within the urban context; a mosaic that is often contrasting, but also full of local resources [5], [6].

B. Lauro de Freitas: A Metropolitan Rurality

Lauro de Freitas is an expression of tensions between the rural and the urban framework. The rural is thought in terms of the notion of “metropolitan rurality” that integrates the countryside and the city in metropolitan areas mediated by the relations with nature [7]. Considering rural and urban in relation to the intensity of construction in the environment, the Lauro de Freitas spatial division would be roughly equal between the constructed environment (60% urban) and non-built environment (40% rural). The boundary between rural and urban is defined from “Plano Diretor de Desenvolvimento Municipal” (PDDM). The rural area is divided, according to the PDDM, in two areas: the protection of sources zone “Zona de Proteção de Mananciais” (ZPM) and the agro-ecological zone “Zona Agro-ecológica” (ZAE), as shown in Fig. 5; the ZPM is the extreme portion of the municipality, pertaining to the Cachoeirinha river basin, whose water network flows into the Cachoeirinha dam, which is an integral part of the Joanes supply system, constituting a protection area of supply sources; the ZAE is the area of the Cabucu river basin, with remnant forest fragments and small agriculture to be preserved [8]. About half of the rural area, localized around Via Parafuso BA-535, is considered an Environmental Protection Area (Área de Proteção Ambiental – APA Joanes Ipitanga); this means that it corresponds to the district ‘Barro Duro’, which is part of the ZPM. APA is composed of eight municipalities of RMS (Camaçari, Simões Filho, Lauro de Freitas, São Francisco do Conde, Candeias, São Sebastião do Passé, Salvador and Dias D’Ávila), and has a total area of 64,463 ha. It includes ten zones, four of which are in Lauro de Freitas, namely: Zona de Proteção Rigorosa, Zona de Ocupação Controlada, Zona de Uso Diversificado, Núcleo Urbano Consolidado [7]. Therefore, this area should have more soil occupation restrictions, mainly due to the intense stage of degradation of the basins of the Ipitanga and Joanes rivers. Consequently, no strong real estate expansion is expected. To be more precise, the rural area mainly comprises five districts: Barro Duro, Areia Branca, Jambeiro, Quingoma, and Capelão. These areas are currently occupied by small farms, which in recent years have been subject to intense speculation. Due to the current features, they have a low population density. According to PDDM, it would be better to keep these areas under the present conditions, preserving the area with low population density. However, it is expected that these areas will have an urban expansion in the coming years, despite the restrictions of use [8].

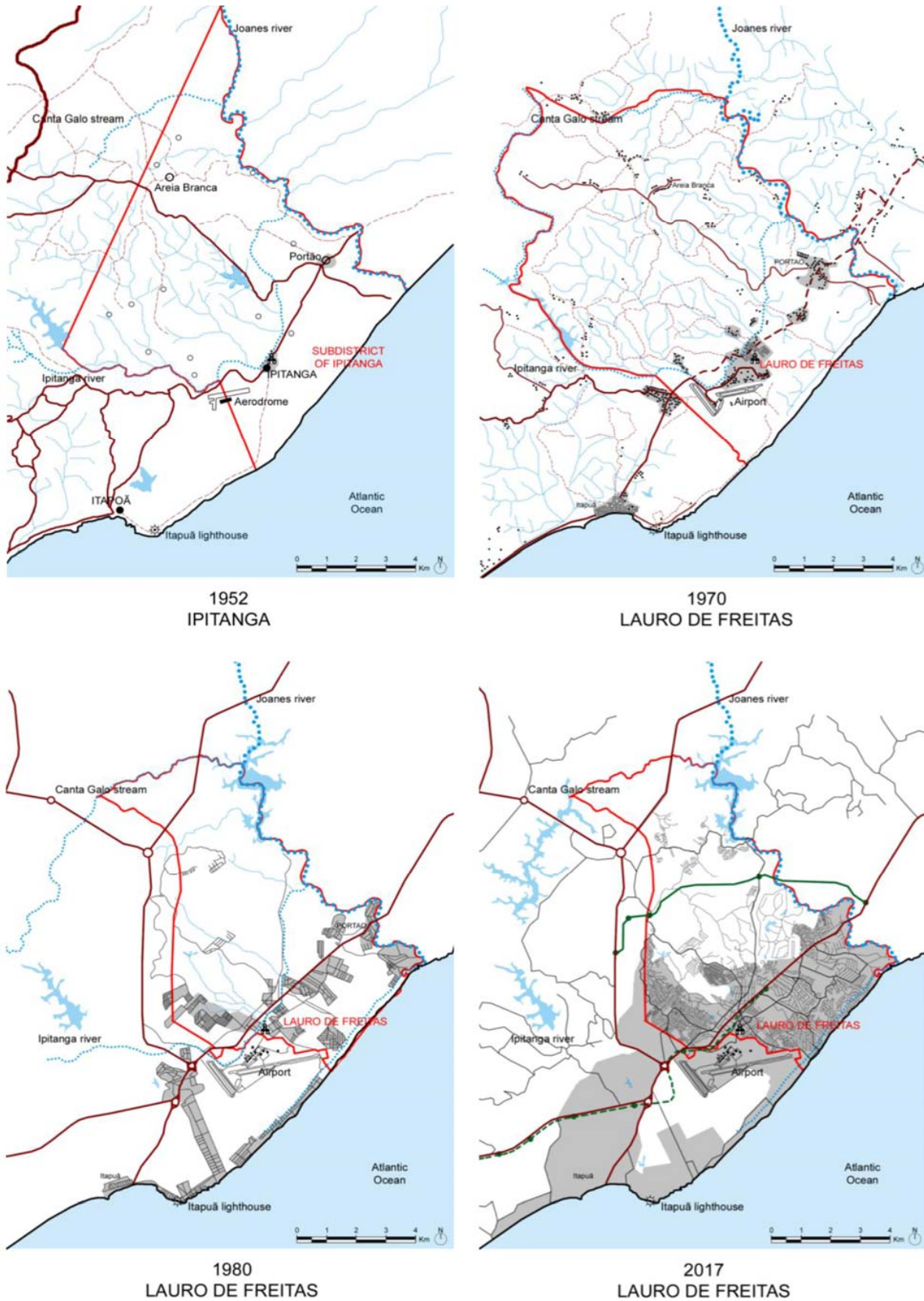


Fig. 4 Reconstruction of territorial development in four historical thresholds

Following a future prediction of urban expansion and population increase in rural area, it is necessary to think of proper land use planning, first strengthening the infrastructure network, enhancing the supply of water and electricity and above all, to find a settlement strategy for PHC facilities to better the living conditions for local people.

C. Distribution of Population

The great urban expansion in the municipality of Lauro de Freitas, from 1970 until today, has compromised the quality of life of the local population, especially the low-income segment, since it does not have adequate public services, such as security, health care treatment, leisure areas (squares and gardens). The distribution of the population follows the spatial dynamics of productive activities, which reallocate themselves in space, due to economic factors. It should be noted that the dynamics of demographic processes would serve to focus even more the population in areas already densely populated [9].

Lauro de Freitas is basically divided into parts by the main road, which cuts the municipality, accelerating the process of subdivision of its rural areas. A process that delineates a spatial structure with the following fundamental features:

- the area between the Atlantic Ocean and the road, so the coastal strip of 12.5 km², was parceled out in seven districts (Centro, Aracuí, Pitangueiras, Buraquinho, Vila Praiana, Ipitanga, Vilas do Atlântico) corresponding to the most valued areas with a sparse occupation, including segments of the population with high yields;
- the area located on the other side of the highway BA-099 hosts the most popular settlements with a low-income population. There is a high population density near the highway in the districts of Itinga, Caji, Portão, according to the map shown in Fig. 6. The remaining area is considered a rural context with low population density and poor inhabitants.

A particular context is a rural district of Quingoma (530.59 ha) inhabited by "Quilombolas" communities and a group of indigenous "Kariri-Xoco".

- Quilombolas are rural black communities, formed mostly by descendants of Afro-Brazilian slaves of the former quilombos. About 3,500 quilombolas are living in the community of Quingoma (data updated to 2016).
- "Kariri-Xocó" is a group of indigenous also known as indigenous reserve "Thá-Fene". Two families of about 12 people compose the group [10].

Quingoma is an example of a neighborhood that needs to be developed, making feasible the road network and going to strengthen the infrastructure and transport system, see Fig. 7. One of the most serious problems of the area is the lack of a health center; the population needs to have health coverage, even if the area is not densely populated; 3,500 people need at least a doctor in the district, as well as an implementation of the school network. The methodological research about the location of health facilities will start just from Quingoma, a particular and disadvantaged context that needs a strategy for effective intervention for a better quality of life of the poor population. Quingoma is considered an area with the highest

potential for future population aggregation, due to the new real estate developments planned. If now the total population of Lauro de Freitas is 194,641 inhabitants, in 2040 the estimated population will reach 299,289 inhabitants. Thus, within 24 years, an increase of about 100,000 people to distribute on the territory should be expected [8].

D. Health Facilities Organization

Brazil's Unified Health System (*Sistema Único de Saúde*) is better known by the acronym SUS. This is a collective term for the public, private, and supplemental healthcare systems. The system was created in 1988 and is free for all people, including foreigners. The Unified Health System is a project that establishes several basic principles of universality, equity, and integrality of health care of the Brazilian population [11].

In order to offer a more specific and adequate health care, the health system was decentralized to better relieve specialized centers with the high complexity of cases of less urgency or easy resolution. In this way, the healthcare delivery is divided into three levels: primary, secondary and tertiary. The organization by levels of attention takes into accounts the available material technology, training of personnel and the morbidity profile of the system's target population.

The tertiary level includes the latest and therefore more expensive generation equipment, and the staff requires more specialized training. The tertiary level must address the situations to the secondary level, since it has not been able to solve less frequent events.

At the secondary level, there is an intermediate level of technological innovation and the training of personnel is located in specialized areas. Secondary care services should be provided with staff and equipment to address situations that have been referred by the primary level.

The primary level is the one with the lowest degree of incorporation of the technological system. Staff training at this level has a general education level to solve the most usual health problems and doctors are general practitioners [12].

PHC is known as the "gateway" of users in health systems. Its objective is to provide guidance on disease prevention, to solve a possible case of diseases and to direct the most serious ones to higher levels of care. Basic care, therefore, works as a filter capable of organizing the flow of services in health networks, from the simplest to the most complex.

In Brazil, there are several government programs related to PHC; one of them is the Family Health Strategy (ESF), which takes multidisciplinary services to the communities through the Basic Health Unit (UBS). Consultations, exams, vaccines, radiographs and other procedures are made available to users of the basic health unit.

The basic care also involves other initiatives, such as the teams that help poor people, the program for home care, the oral health program, as well as the Community Health Agents Program (PACS), which seeks alternatives to improve the health conditions of their communities, and more.

The Family Health Strategy was started in 1994 and has grown significantly in recent years. Its purpose is to reorganize the basic care in Brazil in accordance with the

provisions of the Unified Health System.

This strategy is actualized through the professional team (Equipe de Saúde da Família) inside the Basic Health Unit that is responsible for a defined number of families located in a delimited geographical area. The teams conduct actions of health promotion, prevention, recovery, and rehabilitation from diseases and most frequent pathologies, and the maintenance of the health of the community.

A team is multidisciplinary, and is composed at least by a general practitioner or by a medical specialist in Family Health Strategy or by the family doctor; a generic nurse or family health specialist; an auxiliary or nursing technician; Community Health Agents (ACS), with a maximum of 12 ACS for a team. The oral health professionals can be added to this composition, as part of the multi-professional team: the general surgeon-dentist or specialist in Family Health, auxiliary and/or the oral health technician. Each Family Health team should be responsible for a maximum of 4,000 people, with a recommended average of 3,000 people [13]. Every Basic Health Unit can hold up to five teams, and therefore, have a greater population coverage, as depicted in Table I.

The Lauro de Freitas Health Network is organized according to the three levels: primary, secondary, and tertiary, as shown in Fig. 8. At the tertiary level, there are isolated Specialty Clinics, Basic Hospitals, and Specialized Hospitals. The secondary level includes Ambulatories of General Hospitals, Local and Regional Hospitals. At last, the primary level includes the Health Centers, where activities of prevention, sanitation, and simplified diagnosis are carried out, with actions of promotion, protection, and recovery of basic care [14]. These health units are managed by the “Secretaria Municipal de Saúde”, which operates in the “Programa Nacional de Saúde” taking care of prevention.

At present, the criteria to locate health facilities in the municipality are related according to the following points:

- organizational guidelines of the Family Health Strategy, defined by the National Policy Warning Base (cf. Portaria GM / MS No. 2,488 / 2011);
- health situation of available territories (data on mortality and morbidity, epidemiological profile, the welfare state, etc.);
- the social situation of the available territory (conditions of basic sanitation, water and electricity supply, garbage collection, average family income, etc.);
- the geographical situation of the available territories (relief, climate, vegetation, demographic and population density, etc.);
- among other factors and determinants of the health-disease process. All these factors are evaluated together so that the most vulnerable territories are identified and prioritized.

Lauro de Freitas, according to updated data of September 2016, has 15 Primary Health Care centers (USFs) in operation distributed in the district, see Fig. 9.

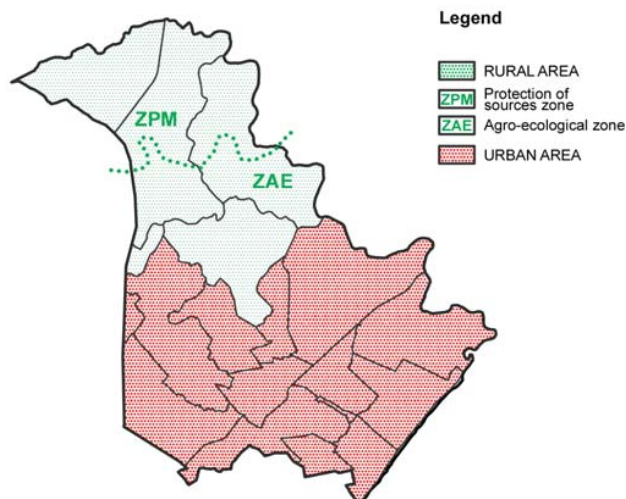


Fig. 5 Rural and urban area



Fig. 6 Density population according to the census of 2010

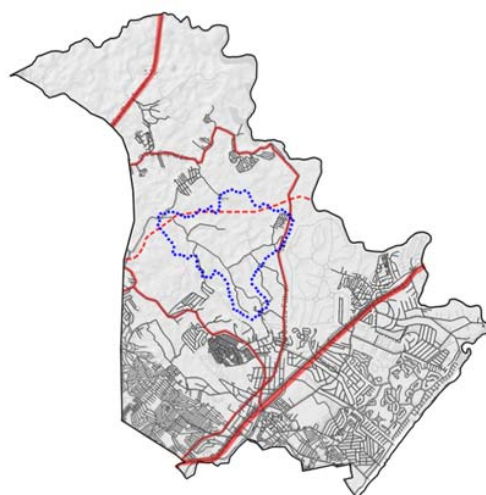


Fig. 7 Road networks and Quingoma district

The distribution is uneven in the territory; most of the PHC centers are located in the most populated urban settlements, especially in Itinga; that is an area adjacent to Salvador, where there is the greatest concentration of the population, leaving some areas completely uncovered; an example is the Quingoma district with 3,500 people with no first aid center. At present, there are currently 33 multi-professional teams are distributed in 15 Basic Health Units of Lauro de Freitas; in addition to these 15 structures, there is a USF closed for renovation for two years (USF Santa Barbara), and also another two health facilities are planned to be built (USF Jardim Taruma; USF Lavanderia). As a result, considering all these 18 facilities soon active, the professional teams will be 39, as shown in Table II, and the municipality will have a maximum population coverage of 156,000 inhabitants.

E. Epidemiological Data

Comparing the needs of the community, according to the on-site interviews conducted, it can be observed that the main claims are related to the expansion of the sanitary sewer system, the regulation of the water supply, the expansion and the humanization of the provision of health services, as well as the strengthening of public transport. The lack of sanitary sewage system or water supply network, together with the environmental deterioration, is one of the main factors for the proliferation of diseases, especially waterborne diseases, such as schistosomiasis and diarrhea.

The Health Management report and the statistics provided by the websites of the Ministry of Health and SESAB make it possible to draw up a public health panel in Lauro de Freitas. According to the most recent mortality data of SESAB, in 2014 Lauro de Freitas had 188,011 inhabitants. For the 1,226 death of all ages registered in 2014 in the municipality, the most obvious diseases were: 303 (25%) related to external causes of morbidity and mortality, 262 (21%) to diseases of the circulatory system, 193 (16%) to tumors, 106 (9%) to the respiratory apparatus; followed by the deaths related to diseases of the digestive tract 74 (6%), endocrine nutritional and metabolic diseases 62 (5%) and infectious and parasitic diseases 57 (5%) [15]. Based on these data, we can deduce that, in addition to the problems caused by the lack of basic sanitation, which occurs mainly in “pockets” of poverty, the municipality has yet to address the issues relating to urbanization, such as circulatory diseases and urban violence, which represent a significant aspect in the framework of Municipal Public Health. The public health care network in Lauro de Freitas is deficient in terms of installed capacity, whether in the physical aspect (facilities, equipment, the number of service stations, the size of teams) and also in terms of the quality of services, medical specialties, emergency care etc. Considering that the diseases from external causes of morbidity and mortality and the diseases of the circulatory system represent, respectively, the main causes of death in the municipality, the administration should do even more than the work done in recent years (expansion of medical specialties, investments in equipment for emergency care, etc), trying to implement health care facilities for a total coverage of the

current population, but above all, to think of a future implementation with the increase of the estimated population.

TABLE I
No. OF MULTIDISCIPLINARY TEAMS (ESF) IN A BASIC HEALTH UNIT

No. ESF	Minimum population covered	Maximum population covered
1 ESF	2.400	4.000
2 ESF	4.000	8.000
3 ESF	8.000	12.000
4 ESF	12.000	16.000
5 ESF	16.000	20.000

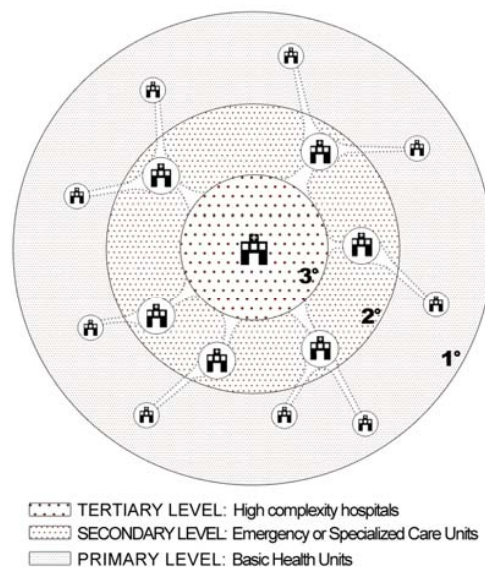


Fig. 8 Health System Network in Brazil

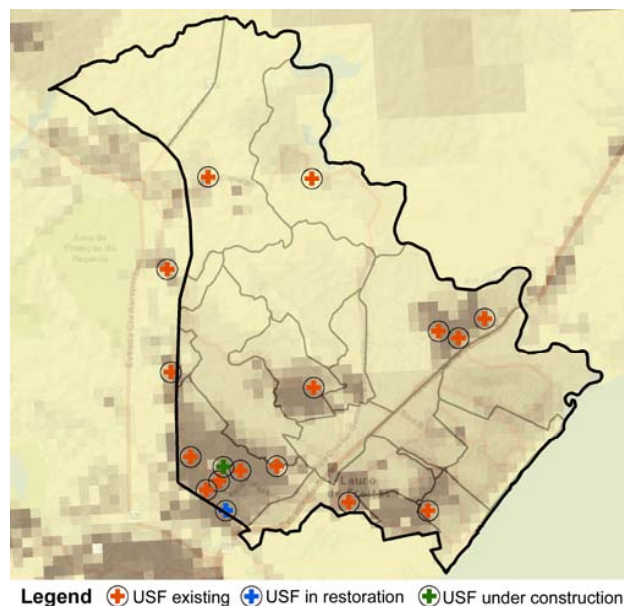


Fig. 9 Localization of PHC facilities

F. Method and Technique for Data Collection

In order to realize this research, first, we have identified the key figures to better understand the health issue of the municipality of Lauro de Freitas: the Professor Andréa Monteiro De Amorim of the “collective health group” of UNIME, University of Lauro de Freitas, and Thiago Barbosa Vivas of the Lauro de Freitas Municipal Health Department (Secretaria de Saúde).

After identifying these two important key figures for the realization of this study, we have carried out visits in some basic health units, interviewing the administrative managers to understand the various services provided in health facilities, the influx of population, the number of medical staff, and so on. Moreover, we have interviewed some citizens of Lauro de Freitas, who benefit from the National Health Service, in particular, the inhabitants of the rural District of Quingoma. We chose this district for a set of problems, not only from the health point of view, since there is no first aid center, but also in terms of infrastructure, housing, water and electricity supply, and waste disposal. Furthermore, it appears to be a particular area of the inhabitants who have settled over the years: the population Quilombolas and some indigenous families. It is an area rich in culture and tradition that should be preserved and at the same time disseminated.

The interviews were focused on the population of Quilombolas, descendants of Afro-Brazilian slaves, to understand the problems and needs of the area in which they live. The research was therefore initially carried out through a qualitative study. Qualitative research works with people, and this leads us to fully understand the real problems on the site.

At the same time, we focused on quantitative research, collecting data that were supplied by the Municipal Health Department and using the available literature in virtual libraries. The literature review began from scientific texts published in journals, mainly Portuguese-speaking, available in virtual libraries, including that of UFBA (University of Salvador). The site of the municipal prefecture of Lauro de Freitas has been very useful to have a general view of the municipality. Other sites used are

- SEPLAN: Department of Planning;
- IBGE: Brazilian Institute of Geography and Statistics;
- SESAB: Department of Health of the State of Bahia;
- DATASUS: Health Data in Bahia;
- SEI: Superintendence of Economic and Social Studies of Bahia.

V. APPLICATION OF SETTLEMENT STRATEGIES

A complete view of Lauro de Freitas's structure has been described in the previous paragraph through a collection of quantitative and qualitative data. The overlapping of the most significant data allowed us to locate the PHC facilities in those most needed areas. Therefore, to achieve the aim of the research, the application of the methodological process to locate new PHC facilities has been divided into various phases.

TABLE II
BASIC HEALTH UNIT (USF) AND MULTIPROFESSIONAL TEAM (ESF)

Name USF	No. ESF	MIN population covered	MAX population covered
Antônio Carlos Rodrigues	2	4.000	8.000
Espaço Cidadão	3	8.000	12.000
Irmã Dulce	2	4.000	8.000
Manoel José Pereira	1	2.400	4.000
Noel Alves da Cruz	2	4.000	8.000
Padre João Abel	1	2.400	4.000
Parque São Paulo	3	8.000	12.000
Pastor Israel Moreira	3	8.000	12.000
Sao Judas Tadeu	1	2.400	4.000
Caji Vida Nova	4	12.000	16.000
Vila Nova	2	4.000	8.000
Vila Praiana	2	4.000	8.000
Cidade Nova	4	12.000	16.000
Centro	2	4.000	8.000
Jardim Independência	1	2.400	4.000
Santa Barbara (in restoration)	1	2.400	4.000
Jardim Taruma (under construction)	2	4.000	8.000
Jardim Lavanderia (under construction)	3	8.000	12.000
TOT.	39	9.600	156.000

- The first step has led us to be aware of the territory's structure of Lauro de Freitas. It was possible to reconstruct the territory through the study and the redesign of some historical maps, observing both its natural structure and the anthropic space, looking at its evolution over time.

This interpretation for reconstruction of various historical thresholds led to the identification of a connection between the different components (road, production, settlement and urban systems), highlighting the fundamental connection between history and structure. The man-made structure is given by time or by decisive anthropization development time of that place. In short, our reading led us to recognize Lauro de Freitas as a fragmented territory resulting from a disorderly expansion and social inequalities, visible through the type of dwelling and different infrastructure. Population growth has caused changes in the structure of the territory, and a clear separation between the homes of different social classes, as well as residential segregation. If on one hand there is a population living in poor conditions, with marginal employment, low productivity and remuneration, without a formal register and out of state standards, on the other hand there is a population with a job, a home, an infrastructure system properly regularized within state laws. The main road is, therefore, a strong break in the town of Lauro de Freitas, which separates areas with higher yield from the poorest. Nevertheless, even in areas where the better-off are located, there are the poor areas where poverty is visible from the housing conditions. As a result, it is difficult to understand the social processes within a very dynamic reality. The structure of space verifies the social changes through the forms, which are a mixture of time and processes. The second step focused on quantitative data of the case study. Numerous data were collected: the split of territory between

rural and urban area, the subdivision into districts, the population distribution and its possible evolution over the next two decades, the existing PHC facilities and their location in the municipality, the infrastructure network, the epidemiological data, the division of the territory into building lots, etc.

- In the third step, each data has been represented through geo-referenced maps developed with GIS program (Fig. 10); all information has been overlapped to have a global view of Lauro de Freitas, getting the current situation which corresponds to Fig. 11.

From the existing situation, overlaying the population with PHC centers, it is clear that the primary health coverage is greater in Itinga, namely the predominantly residential area bordering Salvador with the highest concentration of population belonging to the low-income class, moving to the neighboring Salvador in search of employment. Since Lauro de Freitas is composed of 60% from the urban area and 40% from a metropolitan rurality. We chose to define a radius of 1 km around each health center, corresponding to about 15-20 minutes of the walking path. There are three areas in Lauro de Freitas lacking first aid units, as depicted in Fig. 12.

The first area corresponds to ZPM, which is the environmental preservation area; for this reason, it is clear that no health care facilities have been provided, given the environmental importance and the low number of the population present in this extreme portion of the territory.

The second area corresponds to the Quingoma district, where there are currently nearly 3,500 people in precarious conditions. They are poor people; some of them are descendants of African slaves, used in the cultivation of sugar cane during the colonial period. According to interviews conducted on site, there are people from interior rural areas of the state of Bahia and who decided to settle in the last 5-10 years in the rural area of Quingoma to preserve their habits, rather than moving to the busy and urbanized Salvador. Nevertheless, the population needs to be safeguarded trying to maintain the characteristics of a rural area, simply by improving the road surface, which is still in a bad condition with additional difficulties during the rainy season; improving housing quality, as currently their "homes" are constructed from recycled materials recovered from the nearby dump; strengthening the electricity and water supply and the means of public transport, and finally, improving the quality of life of the population by implementing the district with some services, such as a first aid center and a school. Also, part of the coast is partially uncovered by the PHC services; this area that, from the overlap of data, corresponds to the districts of Vilas do Atlântico and Buraquinho, is mainly composed of high income population that mainly benefit from private services, without recourse to the aid with low efficiency and characterized by long waiting time. These are mostly residential districts, with tourist facilities and holiday homes.

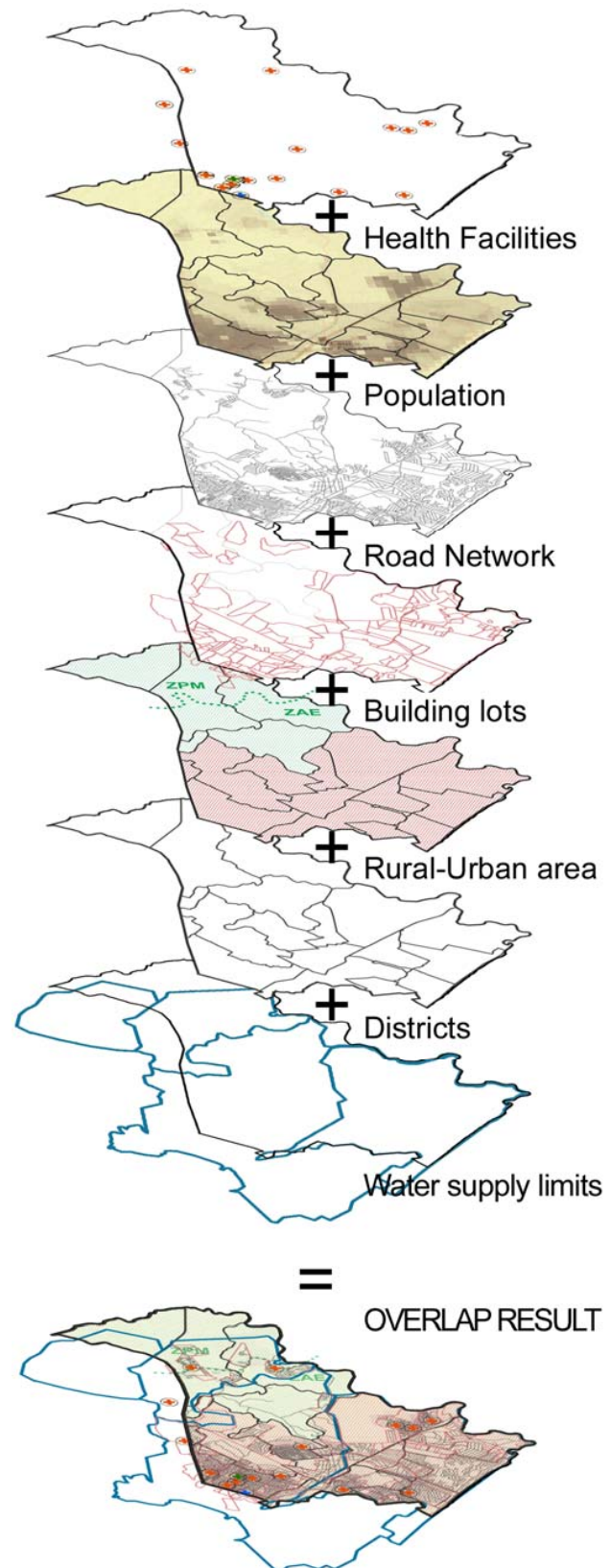


Fig. 10 Overlap data collected

The data collection about the population shows Lauro de Freitas with 194,641 inhabitants in 2016. The maximum population covered by the 18 PHC centers (considering the unit in renovation and the two future structures) is about 156,000 inhabitants, leaving about 38,641 people uncovered by PHC in the territory.

As a result, the first approach has been to ensure the basic health service to the whole population currently uncovered, with 10 Family Health teams. These teams cover a maximum of 40,000 people, so we have identified a minimum of two sanitary units (with five teams each one) and a maximum of 10 health units (from one team each one).

Subsequently, we tried to find an intermediate hypothesis that meets our specifications, in order to place a sufficient number of first aid facilities also through qualitative choices. In Fig. 13 we therefore placed four facilities (two units with two teams and the other two units with three teams) to cover 40,000 people).

So, two units will be located in the north of the principal road, so that the Quingoma inhabitants and the nearby areas are covered by a first aid service within easy walking distance in 15-20 minutes; these two structures were located on lots with building opportunity and close to the two exits of the future "Via Metropolitana" (currently under construction). This road will be a second significant break in the territory, after the existing highway, since it will cross the Quingoma northern area, destroying part of the country. With the construction of this thoroughfare, a greater influx of people and a possible future settlement near the exit ways are expected.

A third facility will be built near the future exit of the metro station, near the main road. The subway will connect Salvador to Lauro de Freitas, speeding movements around the area; as a result, a possible future population increase near the metro station is expected.

Finally, the fourth property was located in the coastal area; despite being an urbanized area populated by wealthy classes covered by private medical insurance, some first aid services should be provided in a uniform manner on the territory, without distinction between rich and poor. Every citizen has the right to a public facility that performs primary activities; certainly, it would be better to intervene primarily in disadvantaged rural areas where there is a greater need and then take action in favored areas.

In conclusion, these four new facilities enhance the health care system today, but in anticipation of increased future population: in 2020 (208,833 inhabitants), in 2025 (231,701 inhabitants), in 2030 (254,168 inhabitants), in 2035 (276,773 inhabitants), in 2040 (299,289 inhabitants); our prediction is not to add more health units according to the increase of population, but our goal will be to enhance and expand the four new facilities in a modular way (located in extensive grounds), increasing the number of teams and offered services within the unit, thus adequately covering the entire population.

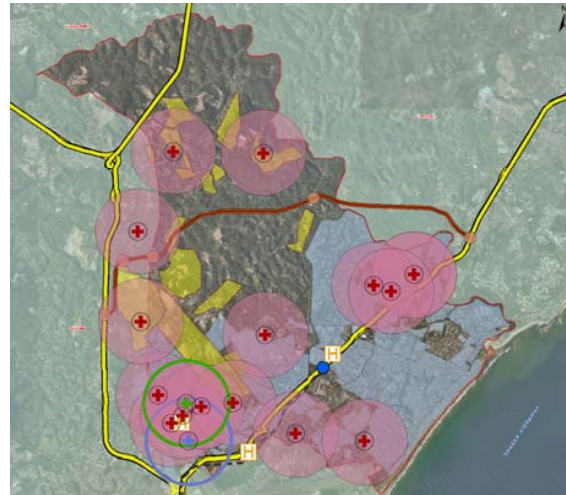


Fig. 11 Present situation

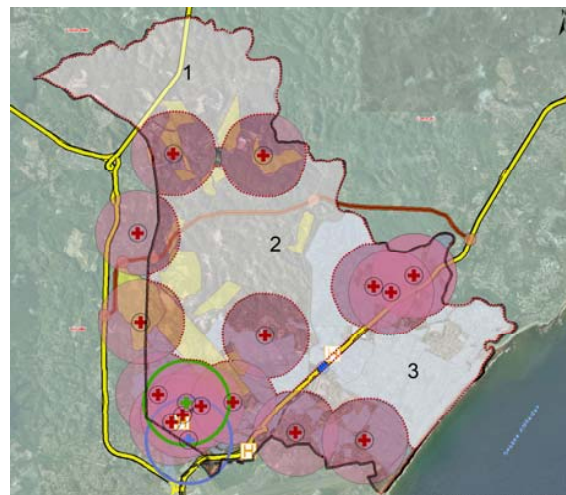


Fig. 12 Areas without first aid units

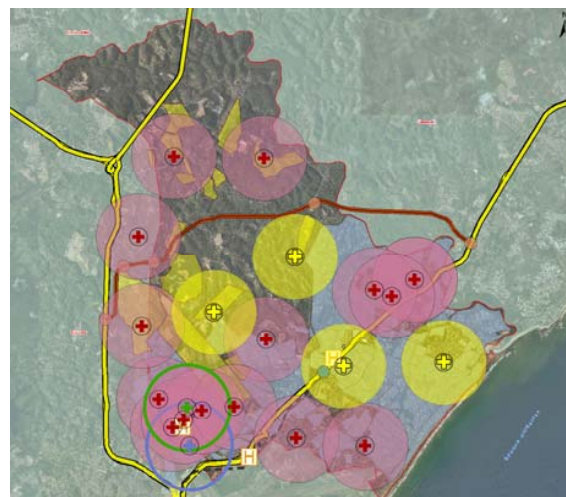


Fig. 13 Implementation of the health network

VI. CONCLUSION

This research identifies a methodological process to locate the basic healthcare units in areas requiring priority action. The health facilities are not meant to work alone, but they are part of a transformation process of the city, capable of generating settlement. Each newly built health center goes hand-in-hand with an infrastructure expansion and implementation of services in the selected area based on local needs, such as the enhancement of the electricity, water and sewer networks; and primary services such as schools, markets, and cultural centers. This leads to the improvement of the quality of life of city residents, both from the social point of view and from a health perspective.

The methodology identified aims to be generalizable, and thus, to be applied in other contexts of developing countries, according to the available quantitative and qualitative data. In this paper, we have chosen to focus on a particular context, where urban and rural environments coexist in the same municipality; where the rural area, although sparsely populated, requires a priority in order to improve current and future living conditions.

ACKNOWLEDGMENT

M. M. thanks the Professor Antônio Pedro Alves de Carvalho of UFBA (Universidade Federal da Bahia), located in Salvador, for the availability and support in carrying out this research at the UFBA University. The Author also thanks the Professor Andréa Monteiro De Amorim of UNIME (União Metropolitana para o Desenvolvimento da Educação e Cultura), located in Lauro de Freitas, for the information and site survey in the district of Quingoma. Grateful thanks are expressed to Thiago Barbosa Vivas of “Prefeitura Municipal de Lauro de Freitas, Secretaria Municipal de Saúde” for the data provided regarding the PHC centers in Lauro de Freitas.

REFERENCES

- [1] Q. Fatehi (R. N. Chattopadhyay), *Planning for Health System Development*, Kharagpur: Indian Institute of Technology, Department of Architecture and Regional Planning, January 2001.
- [2] D. R. Feikin, L. M. Nguyen, K. Adazu, M. Ombok, A. Audi, L. Slutsker, and K. A. Lindblade, “The impact of distance of residence from a peripheral health facility on pediatric health utilisation in rural western Kenya”, in *Tropical Medicine and International Health*, vol. 14, n. 1, pp. 54–61, Jan. 2009.
- [3] IBGE: Brazilian Institute of Geography and Statistics, <https://cidades.ibge.gov.br/v4/brasil/ba/lauro-de-freitas/panorama>
- [4] M. P. Silva, A. D. De Jesus, and G. M. Hadlich, “Evolução do uso do solo no município de Lauro de Freitas, Bahia – 1995-2007”, in *Cadernos de Geociências*, vol. 8, n. 1, pp.19–24, May 2011.
- [5] P. Chame Dias (S. C. Bandeira de Mello e Silva), *A Construção Da Segregação Residencial em Lauro de Freitas (Ba): Estudo das Características e Implicações do Processo*, Salvador: Universidade Federal da Bahia, Instituto de Geociências, Mestrado em Geografia, 2006.
- [6] A. Andrade Carigé (C. Santos Lago), *Cidades Metropolitanas: A cidade de Lauro de Freitas na RMS/BA*, Salvador: Universidade Federal da Bahia, Instituto de Geociências, Departamento de Geografia, Programa De Pós-Graduação Em Geografia/Mestrado, 2007.
- [7] C. M. M. de Alencar, “O Território Em Lauro De Freitas – Ba: Diversidades Sob Tensões Entre Rural E O Urbano”, in *SBS – XII Congresso Brasileiro de Sociologia, GT – 11: Mundo Rural na Sociedade Brasileira: Território, Atores, Projetos*, pp. 1–22.
- [8] Secretaria de Infraestrutura Hídrica e Saneamento - Governo da Bahia, *Plano de abastecimento de água da Região Metropolitana de Salvador, Santo Amaro e Saubara*, Tome II, Vol. 01, Cap. 2-R03 - Estudo populacional e demanda do município de lauro de freitas, May 2015.
- [9] L.A. de Menezes, “Expansão urbana e impactos sócioambientais: estudo de caso no município de Lauro de Freitas – Bahia”, in *Anais do X Encontro de Geógrafos da América Latina*, Universidade de São Paulo, pp. 9300–9313, 20–26 March 2005.
- [10] S. S. Queiroz de Moraes Pacheco, K. Oliveira Xavier, “Food practices of the Kariri-xocó indigenous group from Lauro de Freitas-BA: sustainability and challenges in times of change”, in *Demetra*, vol. 10, n. 3, pp. 649–662, 2015.
- [11] C. Teixeira, “Os princípios do sistema único de saúde”, in *Conferências Municipal e Estadual de Saúde*, Salvador, Bahia, June 2011.
- [12] P. E. Elias, “Sistemas de Saúde”, in *Disciplina de Atenção Primária à Saúde I*, Msp 0670, pp. 1–8, 2011.
- [13] Ministério Da Saúde, Secretaria de Atenção à Saúde, Departamento de Atenção Básica, *National Primary Health Care Policy*, Brasilia-DF, 2011.
- [14] A. P. Alves de Carvalho, and L. F. Batista, “Unidade de Atendimento Ambulatorial: diretrizes arquitetônicas básicas”, in *Architectural Programming of Functional Health Units*, Brasília-DF, vol. 1, pp. 9–14, 2011.
- [15] Sesab, Mortality data in the town of Lauro de Freitas, 2014. <http://tabnet.datasus.gov.br/cgi/tabegi.exe?sim/cnv/obt10ba.def>

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