# ADDRESSING THE SOCIO-SANITARY EMERGENCY IN AFRICA: THEORIES AND TECHNIQUES FOR DESIGNING A COMMUNITY


# 5th INTERNATIONAL ACADEMIC CONFERENCE ON PLACES AND TECHNOLOGIES

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# PLACES AND TECHNOLOGIES 2018

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# IMAGE, IDENTITY AND QUALITY OF PLACE: URBAN ASPECTS

# ADDRESSING THE SOCIO-SANITARY EMERGENCY IN AFRICA: THEORIES AND TECHNIQUES FOR DESIGNING A COMMUNITY HEALTH CENTRE IN MALI

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## ABSTRACT

The contribution communicates the results of a research that has as its background the critical study of typological and technological aspects for socio-sanitary emergencies in highly critical contexts such as sub-Saharan Africa. The research, supported by *Gente d'Africa Onlus* and carried out in the Departments of Architecture of the Universities of Florence and Roma Tre University, had the general objective of determining the guidelines for the design of a Community Health Centre (CSCom).

For this purpose, during the research it was possible to:

- define the quality and utility thresholds of the spatial and distributive-functional relationships of a minimal typological plant for a CSCom, related with the use of local communities;

- explicate the transmittable constructive technologies taking into consideration the local constructive possibilities in terms of both material and human resources;

- check the local climatic conditions, in terms of thermal comfort and the lighting conditions of the interior spaces, also in relation to the local attitudes;

- identify the operating methods for the resolution of traditional technological systems in a

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context without networks and the design of special elements to guarantee hygienic conditions by defining new (but vernacular) technological systems.

The theoretical assumptions of the researchhave been characterized by an approach based on a continuous comparison between local knowledge and the reference sciences in technical-constructive matters (materials and construction techniques), socio-economic (economic evaluations) and climatic-environmental (thermal wellness, natural lighting).

The theoretical framework has determined technical and technological criteria for the definition of the guidelines that have been applied in a design program for the construction of a CSCom (of more than 1,700 $m^2$) that will be built in Mali, near Kita, between the villages of Dyalaya, Koronji and Tounbouba.

**Keywords:** Socio-sanitary Emergency, Community Health Centre, Traditional Techniques, Guided Self-Containment, Local Communities.

## Introduction

The contribution expounds the results of the research project implemented by the Department of Architecture of Florence University and Roma Tre University for the *non-profit organization (NPO)*Gente d'Africa, which for over a decade has been engaged in building public works in Africa. The aim of the research is to draw up guidelines for planning a Community Healthcare Centre (CSCom) in Mali. By means of the adoption of appropriate investigation methods, the activities, which involved teachers and students[2] of the two departments, were split up into:

phase 1: analysis of the state of the art of the peculiar and difficult territorial context, with attention to environmental criticality, to the application limits of operating tools and to the results achieved by previous research both in terms of methodology and application results. The analysis, in addition to the study of existing literature, was supported by surveys on the territory (survey in February 2017);

phase 2: synthesis of the analyses for the correct definition of the guidelines, through the evaluation of the application results existing on the territory, the definition of the potential quality of the built environment and the definition of parameters and design and process tools broken down according to the nature of the resources: material, technological, energy-environmental and economic-financial;

phase 3: definition of the guidelines on the basis of the parameters identified in the synthesis through the adoption of technical solutions and locally sustainable technologies based on availability, durability and low maintenance requirements, as well as the technical and construction culture to be implemented;

phase 4: application of the guidelines to the CSCom case study serving 12 villages around Tounbouba, near Kita, 150 km from Bamako.

The peculiarity of the environmental and area context and the type of building were the two factors that conditioned the definition of the specific project guidelines.

## CONTEXT

Mali is the largest West African state in the sub-Saharan region: 1.25 million $km^2$ of desert, in which live 18 million people. A land poor in natural resources, mainly desert and uncultivated, with very irregular rainfall (nearly absent rainfall in winter and alluvial in summer) and lack of

2 Novella Lecci, Valentina Luperto, Francesca Maioli, Sofia Pistolesi, Lucrezia Pucci, Francesco Rappelli, Domenico Rivetti, Alessandra Venturoli, Alessandra Vezzi, Benedetta Zamboni, Marta Zerbini of University of Florence; Emma Allegretti, Francesca Carfagna, Luigia Capristo, Ottavio Minella of Roma Tre University.

suitable land areas, which means that only 2% of the territory is ploughed or under arborescent crops. Extension complicates land management, producing food scarcity, poverty and instability and triggering problems of social equity and cohesion. The political situation is unstable: after the 2012 *coup d'état*, despite United Nations intervention and the peace agreement signed by armed militias in 2017, many smaller groups did not accept the government's development plan, making the situation fragile (De Georgio, 2017). The instability of the country aggravates health conditions. Health policies, directed by the *Ministère de la Santé* and implemented by the *Direction Nationale de la Santé* of Bamako, are applied by the Regional Health Directorates. The country has three national hospitals (Point G, Gabriel Touré and Kati) and seven regional hospitals. In the *Cercles* (Districts) there are 56 *Centres de Santé de Référence* which link the hospitals with the 930 *Centres de Santé Communautaire* (CSCom), managed by the *Associations de Santé Communautaire*. This pyramidal system (fig. 1) counts on twenty thousand volunteers (Community Health Volunteers) who together with qualified operators (Community Health Workers) make up the sector's major resource (USAID, 2013), but are not enough. Mali suffers from emergency social-healthcare conditions with unsolved problems of child mortality[3]: 78% of the population lives in conditions of poverty (13 million people) and 55.9% are in conditions of extreme poverty (Jahan et al., 2016). The social-healthcareemergency is therefore among the country's major problems.

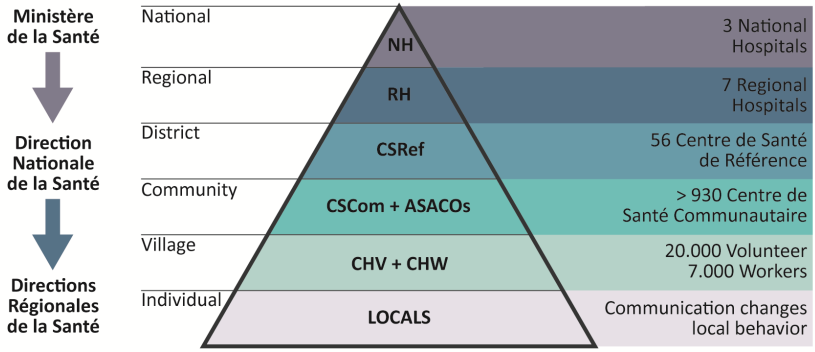


Figure 1: Mali Health Pyramid.

## Project

The subject of the research work is a Community Health Centre that performs a public function but is managed by a private association linked to the community. For this reason, in theplanning stage, the choice of location for the Centre was a particularly delicate one. Thanks to the *NPO*experience, the decision was taken to locate the Centre in an area near the village of Tounbouba, in the Kayes region.

The village is centrally located with respect to 11 other villages[4], close to the main road that leads to the Capital and the area is crossed by the Bamako-Dakar railway line. The research work began with the analysis of the typological characteristics of the traditional Malian dwelling with the aim of becoming acquainted with the building and social conditions of the local inhabitants. The traditional houses provide, above all, minimum conditions of well-being, given the climatic-environmental context and usability and in view of gradual family-growth conditions.

The buildings are developed, first of all, defining the boundary around the family property and

3 In Mali, 11.5% of deaths are children under 1 year of age [Unicef, 2016].

4 Balambougou, Baléyani, Bandigoula are all within a distance of 20 km.

then erecting a first rectangular building raised off the ground to protect it from flooding. Mainly intended for night shelter,the house does not contemplate specialisations or hierarchies. In accordance with changes extending over time, a series of cells are placed on top of each other as needed. Despite the insertion of space hierarchy, made recognizable by loggia filters, the primitive functional living pattern is well present in the CSCom, as is demonstrated by:

a composition made up of modular cells contained in an introverted enclosure and with the presence of courtyards that make it easy to use the rooms;

the location of the various environmental units in separate single-functional modules for health-care activities (emergency, childbirth, outpatient), service (canteen, storage of medicines and equipment, toilets) and residential (housing for medical and paramedical personnel);

the dislocation of service spaces in cells separated from the main cells, such as areasintended for the management of water resources (*château d'eau*) and for the incineration of organic and hospital waste.

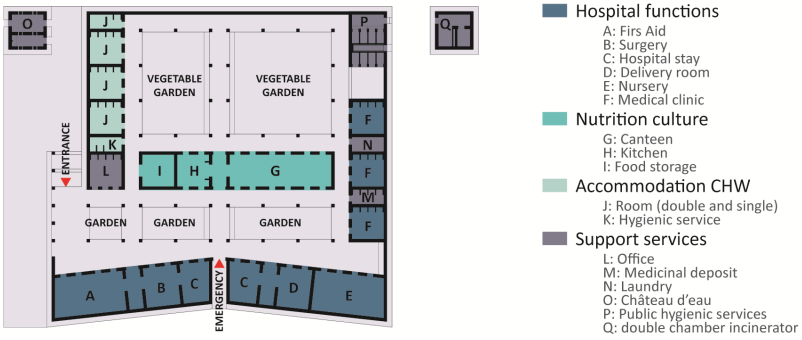


Figure 2: Functional and distribution scheme of the CSCom.

## Cognitive insights

Among the cognitive insights of stages 2 (available resources and critical parameters) and 3 (technical and technological solutions) of the research work, the following are those related to material, environmental, plant engineering and waste aspects.

## Material issues

Raw earth is widely used[5] to build houses using adobe stabilized with straw. Humidity conditions, particularly in the violent rainy seasons, are severe. As a result, the adobe is waterproofed, before drying, with Karité butter, which is produced in abundance throughout the entire Malian Niger Basin. However, the hygiene and health standards of a healthcare facility are hardly guaranteed by the use of adobe, without forgetting the difficulty of maintenance. For this reason, a more tenacious and durable brickwork solution was adopted, in part plastered with lime. In particular, foundation and elevation structures are made of UNI bricks, a model also widespread in former French-speaking colonies, internally covered with ceramic elements or plaster.

Clay tables were used for the wall slab, which allows ventilation and sufficient detachment from the ground in case of flooding, while the roof slab is in brick vaults and steel profiles. The

5 In the north of the Country are the splendid Great Mosque of Djenné and the ancient city of Timbuktu.

modularity of the minute brick element allows this property to be transferred to the cells that go to form the building, making it possible to spread a correct and economic building culture.

## Environmental issues

Excepting rainfall periods[6], climatic conditions are constant throughout the year. Solar radiation persists,approximately, during all the seasons with high average radiation values[7]and prevalent horizontal radiation[8]. Average temperatures are always high[9], with little difference between night and day. There is therefore no preferable orientation: the presence of shading and natural ventilation systems is preferable to horizontal closures, while the façadescan be designed with a uniform layer of masonry.

The use of natural ventilation layers on the roof avoids direct heat gain; the optimal dimensioning of the wall thickness should vary between 30.5 and 40.6 cm (Olygay, 1990), without the need for thermal insulation. In the study case, the wall thickness was hypothesized as 38 cm and a second floor of spaced roof determines a strong overhang on the courtyard triggering convective motions that guarantee cooling by ventilation, fed by vents of air on the front. The roof overhang also makes it possible to widen the openings, guaranteeing indirect lighting of the interior spaces. Window frames with insect and fine dust nettingmaintain internal hygienic conditions. Verification of performance relating to the natural lighting of the section where the outpatient surgeries and delivery rooms are located shows an average daylight factor of 8% with minimum illuminance on a horizontal plane[10] of 560 lux.

## Plant issues

Water scarcity, especially in the phases of use and operation of an activity, is one of the most critical aspects: at present, water is generally supplied by means of wells. Since the flow capacity of a well is insufficient to ensure the normal operation of a CSCom, storing rainwater is of crucial importance, given that there are months in which 300 mm of rainfall is reached. In the case study, the solution was suggested of a château d'eau (fig. 3) with a lower floor for the use of the water resource and raised with the tank. The recovery of rainwater was conceived through a system of underground tanks connected in series, filled by gravity, able to store up to 60 thousand litres of rainwater recovered from the roof surface for non-drinking purposes. The sun remains the only sure and exploitable resource through active systems for the production of energy. In case of using photovoltaic solar systems must take into account that power requirements, due to the power input of CSCom medical equipment, are easily covered by RES. It should be noted that in 2016 the per capita electricity consumption in Mali was 80 kWh/year, compared to 4.790 kWh/year in Italy (Indexmundi, 2018). In order to exploit the sun's resources on the roof, the installation has been suggested of photovoltaic solar panels with estimated electricity production of 3,9MWh (JRC, 2018).

6 Heavy rains from June to September, then 6 mm of rain from November to April.

7 2,200 kWh/m$^2$.

8 The sun remains rather high during all the hours of daylight and during all the seasons.

9 Between March and June, the temperature exceeds 40°C nearly every day.

10 Checked at 180 cm from the natural ground level, 110 cm from floor by means of Ecotect software.


Figure 3: Château d'eau: sections and functional schemes.

## Waste management

Currently, the use of toilets is not widespread, and in fact physiological activities occur in conditions of poor hygiene and low safety, putting at risk the health conditions of people who, through contact with soil contaminated by excrements and insects, can contract very serious diseases (Moroni et al., 2014). In addition to organic waste, in the case of CSCom other organic waste is generated by important activities. The scarcity ofwater makes it impossible to transfer commontechnical solutions to the African context, but requires the adoption of dry solutions that can be managed, especially in the emptying phases, while maintaining the best possible hygienic conditions. Hospital organic waste must be managed with the same care and using solutions that guarantee a minimum risk of infection. In existing literature, it is considered possible to apply the principle of compost toilette or clivus multrum (fig. 4) which operates on the basis of the separation of human excrements into dry and leachate, responsible for the proliferation of pathogenic germs. Besides the composting of such waste, solutions must be provided for final-stage waste management. In the case study, this integrated principle has beenapplied to the design of an incinerator; the emptying of the containment chamber is carried out by means of a waste transport system on a trolley with a moving bottom as far as the incinerator. The latter operates according to the double chamber principle (Rogers, Brent, 2006).

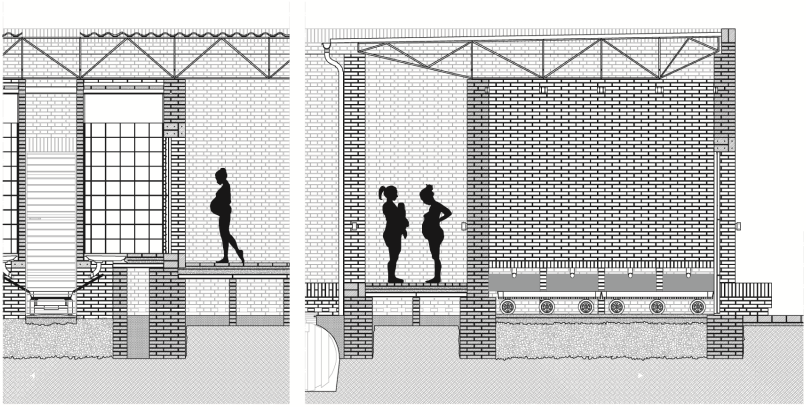


Figure 4: Waterless bathroom's system.

## Conclusions

The Tounbouba case study illustrates the potential and possible application of the guidelines. The research work, which is continuously tested through discussion with specialists and operators in the sector, is now facing the development of economic models for its implementation. It is therefore a question of verifying its financial and economic viability, favouring economies of scale and overall greater social sustainability. The scarcity of resources, the environmental context and the critical issues have been taken into account in defining the economic-financial instruments that can be used. Since it was not possible to refer to technologies, techniques or labour costs for works or similar solutions because not described and non-existing, it was decided to carry out a quantitative and economic analysis of the materials, checking things out on local markets and with European producers operating in the territory in order to elaborate a parametric cost to compare with the costs of similar jobs. The main reference was a database of multi-parameter prices (CYPE, 2018) which generates realistic prices for the most common jobs, breaking down each item into the cost of individual materials, equipment and labour to determine the cost of each material to be produced on site and evaluating the cost of other materials "to measure". For the completion of CSCom, a crowdfunding charity is currently being set up, which will go to join the sponsorships of economic operators who can give a boost to fund raising.

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