CONFERENCE PROCEEDINGS

3RD INTERNATIONAL ACADEMIC CONFERENCE ON PLACES AND TECHNOLOGIES

EDITORS
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MILENA VUKMIROVIĆ
ALEKSANDRA KRSTIĆ-FURUNDŽIĆ
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PLACES AND TECHNOLOGIES 2016

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CONFERENCE PROCEEDINGS OF THE 3RD INTERNATIONAL ACADEMIC CONFERENCE ON PLACES AND TECHNOLOGIES

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URBAN MOBILITY, TRANSPORT AND TRAFFIC SOLUTIONS

SUSTAINABLE MODEL FOR REGIONAL HOSPITALS IN HUMID TROPICAL CLIMATE

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ABSTRACT

Developing countries are facing numerous challenges in the process of providing adequate health care to often deprived and diminished social groups. In countries and regions with poor road infrastructure, this often means that the population outside major urban centres is even physically incapable of getting some sort of health aid in a timely manner. Being a country made up of a mainland territory and five islands in Gulf of Guinea, almost entirely covered by tropical rainforest, Equatorial Guinea is a showcase of various obstructions in developing effective health care system.

The sustainable primary, secondary and tertiary health care assumes good accessibility as well as proper understanding of local conditions. The paper presents a model for sustainable health care building – a local hospital capable of providing all basic types of health service while retaining a high level of technical independence. The architectural design for a regional hospital was developed aiming to maximize the use of natural ventilation, daylight and rainwater management, leaving the operation block, laboratory and intensive care unit practically the only parts of the structure that would need mechanical air conditioning. The layout was designed having in mind local culture and customs, thus offering a possibility of strong integration with local community, and the building technology was thought over to enable efficient and cost-effective construction and proper resilience for tropical rainforest environment. The result is a structure providing for contemporary, high quality medical service, interpreting local climatic and cultural contextual premises through modern architectural expression. Some design features developed for regional hospital were also explored in somewhat different conditions – a major clinical centre (in Malabo, the capital) and a local health centre with the basic services for the most remote areas.

Keywords: Sustainable architecture, Tropical climate, Health care, Hospitals

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INTRODUCTION

Developing countries are facing numerous challenges related to providing adequate health care to often deprived and diminished social groups. Apart from well-known medical issues (insufficient personal, professional, financial and pharmaceutical support), infrastructure and communal services also play a very important role in many African countries. Lack of paved roads often means that the population outside major urban centres is even physically incapable of getting some sort of health aid in a timely manner. Power supply, potable water supply and instable communication services yield for sustainable solutions that could become reliable sector of social services and healthcare provisions. The aim of this paper is to explore the options for sustainable architectural design that could encompass various aspects in healthcare buildings in this specific climatic and social context.

Basic postulates for the development of the concept were derived from the experience of visiting a local hospital near Lambarene. Established in 1913 by Albert Schweitzer, the Nobel Prize laureate, and in operation ever since, it successfully integrates local building tradition with western medical approaches and proves the principle of cross-cultural partnership to be a valid one. It has to be noted that main goal of the design process was to create a modern, self sustained structure that can adopt to different programmes, various location specificities and that could be easily managed by the local workforce.

Local community

Local community is strongly intertwined with formal and traditional institutions. Republic of Equatorial Guinea consists of 7 administrative provinces (3 in Insular Region and 2 in Continental region), 18 districts, 12 towns, 827 village councils and 163 neighbourhood communities. Traditional tribal chiefs and councils still play important role in everyday life. Respectively, according to World Health Organisation (WHO), at the moment there are 18 public hospitals (2 regional), 42 centres for public health and 161 medical posts, but they are not all functional.

It is quite common for family members to accompany patient for consultations, check-ups, and stay with them even while hospitalised. For this reason, special attention has been dedicated when accommodating different functional parts, especially waiting rooms and common areas where visitors can stay with the patient.

DESIGN CONTEXT AND CORRESPONDING STRATEGIES

Idea behind the design can be explained through the analysis of the major influencing parameters that are of the different origin, ranging from climatic to technological and traditional. Programme for the particular project consists of primary health care unit with examination rooms, laboratory, maternity and surgery wards with patient and staff rooms located on the first floor. All functional parts have been designed as separate elements grouped in two major and a smaller rectangular building, connected together by the elliptic based volume serving as a centre of the composition. Form of the complex, as illustrated on Figure 1, has been divided in various segments enabling independent usage and access, as well as multi-phased construction process. Also, subdivision of programme through construction of separate buildings organized on identical design principle allows for accommodation of different size units, ranging from local healthcare units to larger hospitals, keeping the recognizable architectural language that can be symbolically identified with the primary function. In this way, the proposed design can be considered as a model, setting the ground for different developments.

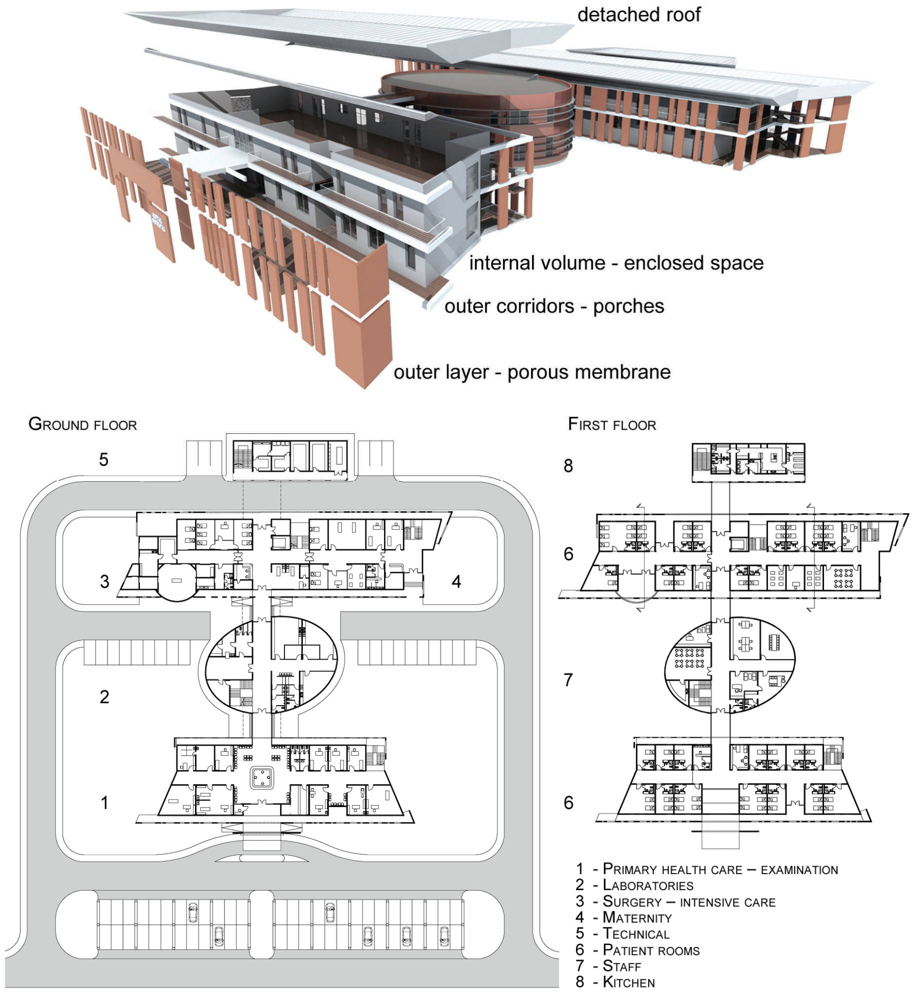

Figure 1 "Exploded perspective" of the Hospital building (top) and floor plans (bottom)

Climate

The climate in Equatorial Guinea is predominantly tropical-monsoon (*Am* by Köppen Climate Classification System) and tropical-wet (*Af* by Köppen Climate Classification System) in some areas. This means that the average temperatures are rather constant throughout the year, the precipitation level is high with some minor seasonal variations and the relative humidity also high throughout the year, as shown in Figure 2. Being close to the Equator, the number of daylight hours is approximately 12 throughout the year, but regular clouds reduce the number of sunlight hours to 3-5 per day[2]. Low wind speeds (daily mean 2-3m/s)[3] are also typical for this area, with

[2] Climate data from: http://www.equatorial-guinea.climatemps.com, accessed April 2015.
[3] Wind speed data from: https://weatherspark.com/averages/29071/Malabo-Bioko-Norte-Equatorial-Guinea, accessed April 2015.

predominant wind direction depending on geographical position. Climatic context can be translated to the following design considerations:

a. Thermal comfort,

b. Ventilation and moisture control

c. Daylighting and Sun control, and

d. Rainwater management.

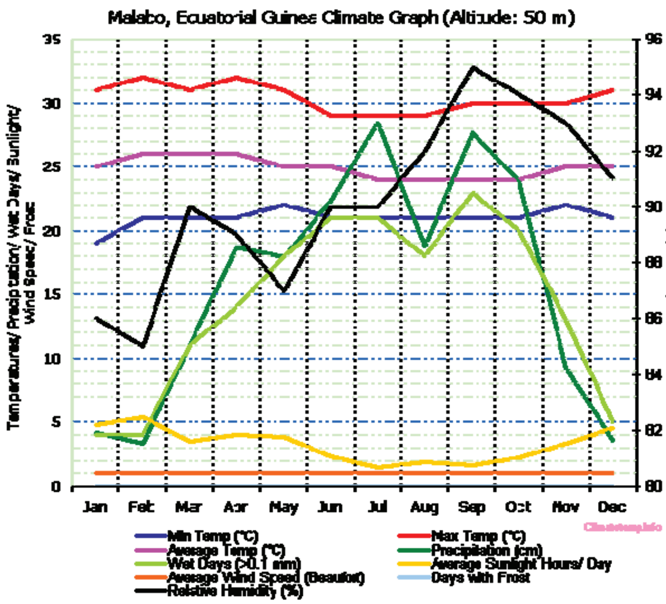

Figure 2 Climate graph for Malabo, the capital of Equatorial Guinea (source: http://www.equatorial-guinea.climatemps.com, accessed April 2015.)

a. Thermal comfort: Temperature is constant, averaging around 25°C, with average min. temperature never below 19-20°C (annual: 21°C) and average maximum temperature never above 31-32 (annual: 30°C). This means that only some basic cooling should be provided for the hottest days and that no heating is needed. Good bioclimatic design should provide adequate thermal comfort with basic passive design strategies. Unlike construction process in moderate or cold climates, where the main goal is to prevent buildings from loosing energy, design challenge in tropical climate is to protect buildings from overheating and enable easy cooling when needed. For this reason, building concept is based on segregation of thermal mass by creation of porous external envelope composed of the alternating wall parts and voids and massive internal sections. By applying the concept of two outer layers, it was possible to create different thermal building zones: internal zone that is fully enclosed and which can be, if necessary, easily conditioned and outer, semi-enclosed zone that reinterprets the traditional porch, and prevents from overheating. For this reason, the roof has been designed with large overhangs, providing sufficient shade for the most of the day.

b. Ventilation and moisture control: High humidity presents a special design challenge, where much attention should be dedicated to providing adequate ventilation. Standard (contemporary) building practice in Equatorial Guinea includes use of variety of mechanical systems, from split-system air conditioning units to complex HVAC systems, but one of our design goals was to minimise the need for use of such systems in order to provide climate-responsive architectural design that would be less dependent on external power supply, taking advantage of natural ventilation.

In order to provide for natural ventilation, the building was composed of several volumes arranged in parallel manner, with enclosed intermediate green areas. In this way, surface to envelope area ratio has been significantly increased, with large openings on all sides, thus maximizing the ventilation potential. Also, the green areas between the built sections are designed as a tool for minimizing the heat island effect and reduction of the albedo effect that would have been much more influential if paved surfaces were to be applied. External corridors are practically open, enclosed only by mosquito nets in the form of sliding panels. They are, through the voids in internal mass that are serving as waiting rooms or meeting places, connected to the internal corridors, enabling the cross ventilation throughout the building. For this reason, doors and windows are equipped with the “grille” systems that can be, if needed, efficiently closed. In this way, we are actually creating another envelope that is permeable to air but closed for the insects and other pests.

The large roof has been designed detached from the mass of the buildings and it has been separated from the main volume by cross-ventilated area, minimizing the secondary radiation coming from the metal sheeting. Space beneath the roof covering has been planned as the technical area, designated for placement of external units of split systems and other auxiliary items.

c. Daylighting and Sun control: Permanent 12 hours of daylight throughout the year offer good starting point for extensive use of natural daylight, but the fact that is often cloudy has to be taken into consideration. Dominant strategy was to use the building form as the controlling mechanism and to avoid any sophisticated technical solutions that are in need of expert maintenance. Double-layered outer facade with external corridors and balconies and large roof overhang were designed to provide sufficient shading, having in mind the trajectory of the Sun. Fixed Sun louvres systems were only applied in central oval area that has standard flat roof without overhangs. All floor areas were designed in the form of paved, white, surfaces symbolically emphasizing the cleanness of the hospital, but, at the same time, providing enough reflected daylight for users.

d. Rainwater management: Very high precipitation rates could strongly influence architectural design in terms of form, materials and rainwater management. Since the infrastructure is poor, rainwater collection would provide for higher level of independence. One of the main components of the design - the large roof - has been used for protection from heavy rainfall as well as for rainwater collection. Storage has been placed in the technical area between the roof and upper level, making the use of the collected water possible just by gravitational flow. By implementation of adequate filtering and surplus water evacuation, design has incorporated rainwater management, in the form of technical water for flushing and cleaning purposes, as one of the main strategies. Further use of purified rainwater as potable one is possible, but has not been investigated nor planned due to the lack of adequate systems.

Materials and building technology

Rainforests offer some of the most noble and durable construction wood. Yet, in countries like Equatorial Guinea, wood is not perceived, nor appreciated, as a contemporary building material except for houses or smaller residential buildings. Some explanation might be found in the fact that, despite the abundance of this resource, there are no processing facilities or any type of industrialized production – tropical wood is mainly directly exported as timber or applied in simple way as the sidings. Modern industrial techniques that would provide adequate treatment of wood and its wider application are not available and standard practice can’t meet the maintenance standards needed for public buildings. Clay is scarce, leaving concrete and lightweight concrete blocks as the main construction material. Construction steel can be used as well, but one should keep in mind the necessity of specialized workers and some more demanding engineering related to steel construction. For these reasons, the structure for the proposed hospital is designed as a combination of massive bearing walls and low-tech steel roof construction. Basic idea was to use this development as a training ground for the local work force by introducing them to new, but, at the same time, rather simple building techniques so that they could gain skills needed for future building construction, both public and residential.

Finishings were chosen having in mind extremely high relative humidity and heavy rainfalls, coupled with often-troublesome maintenance. Therefore, durable, low-maintenance finishings were considered: ceramic tiles, composite aluminium panels, sheet metal etc. both for the envelope and internal surfaces. Previous experiences on other projects developed in the same climate have proven this kind of finishings to be adequate for these specific conditions. Use of wood was, for the sake of easy maintenance, restricted only to the elements that are intended for internal use and could be produced locally.

Building size, form and construction technology have been adjusted to the local potential which is rather modest, so planned construction process does not require sophisticated machinery or skills and can be executed with available workforce and minimal training.

Infrastructure

The development has been planned as a self-sufficient complex, so all needed infrastructure has to be provided on site. For this reason, a separate technical building designated to electrical generation and water supply (well) has been designed. Use of renewable power generation in the form of photovoltaic panels has also been planned.

CONCLUSIONS

In order to develop sustainable model for regional hospitals in humid tropical climate, one has to "read" and learn from local customs, building principles and logic but, at the same time, apply a modern architectural language, construction technique and materials. This synergy of tradition and modernity can provide an adequate answer to many of the challenges that are arising from the local environment, resulting in recognizable and adaptable model building.

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