2013 On Site Review Report

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by Hanif Kara

Salam Centre for Cardiac Surgery

Khartoum, Sudan

Architect
Studio Tamassociati

Client
Emergency NGO

Design
2004 - 2007

Completed
2007 - 2009

Salam Centre for Cardiac Surgery
Khartoum, Sudan

I. Introduction

The Republic of Sudan (before the secession of 2011) was the largest country in Africa, often referred to as a "continent within a continent." Bordering the Red Sea along its eastern coast, it is about a quarter of the size of the United States, with a total area of 2,600,000 square kilometres (1 million square miles). Sudan has a population of 34 million; approximately 65% of its people are Muslim and, poignantly, 45% are between 1–14 years old, many without parental care.

The political capital, Khartoum, is located in central Sudan, close to the point where the Blue and White Nile merge. The city is believed to have a population of around five million, though within the metropolis many informal camps and settlements have reportedly increased this figure by a further three million. The inhabitants tend to identify with their ethnic origins rather than a unifying religion, and claim descent from Arabic, Nubian and Neolithic Negro tribes.

Working at the heart of this culturally complex environment, EMERGENCY is a small independent Italian NGO founded in 1994, acting primarily to provide free, high-quality medical and surgical treatment for victims of war, landmines and poverty.

"In the experience of EMERGENCY, creating a hospital is something more than constructing a functional building. It is designing a place suited to human reconstruction," said Gino Strada, founder of EMERGENCY.

In 2005 EMERGENCY chose to intervene in Sudan to provide specialist medical and surgical assistance: the Salam Centre for Cardiac Arrest in Soba, Khartoum, was one of the projects initiated. Following a site review in April 2013, this report discusses the Salam Centre as a whole, comprising both its hospital and adjoining medical staff sleeping compound, as this seemed the most comprehensive way to present it to the Jury.

A second project undertaken by EMERGENCY was opened in 2011 in Nyala Darfur and shortlisted; however, services were suspended within its first year (with the support of the Sudanese government), following the kidnapping of one of its staff due to a lack of security. Currently this project is inaccessible and will not be considered on this occasion.

II. Contextual Information

A. Brief historical background

The city of Khartoum has expanded significantly over the last 50 years, inundated with refugees in a country marred by internal conflict; it is more urbanised than any other part of Sudan and today 43% of the populace has no access to water and 66% no access to sanitation. Following the country's

recent division, three quarters of the overall land mass has become “North Sudan”, separated from “South Sudan” which has most of the country’s natural resources (oil in particular).

The Salam Centre was founded 20 kilometres south-east of the present centre of Khartoum in the suburb of Soba. This former village, which in the Coptic era (AD 540–1604) was cited as the capital of Sudan, lies on the east bank of the Blue Nile River.

In 2004, following EMERGENCY’s first interventions to support the existing hospitals at Mellit and Al Fashir in Northern Sudan, Gino Strada, the visionary surgeon and leader of the organisation, suggested opening a new “hub” of the programme for paediatrics and cardiac surgery. With the help of the Sudanese government, and in particular the Minister of Health, Dr Ahmed Bilal Osman, a greenfield plot about 14,000 square metres in area on the eastern bank of the river was allocated for the construction of the new Salam Centre facility.

B. Local architectural character, including prevalent forms and materials

Khartoum, with the White Nile to the west and the Blue Nile on its eastern side, its latitude 15°36’N and longitude 32°32’E, lies 386 metres (1,266 feet) above sea level. The town was established in 1821 but it was not until 1900, after the railway was built, that it became the capital of Anglo-Egyptian Sudan. Throughout the 1900s colonial buildings, including various churches, the School of Medicine, and the Acropole Hotel, were representative of the architecture, and began to punctuate a skyline of traditional single-storey mud structures.

In 1956 Khartoum became the capital city of the Republic of Sudan and throughout the second half of the 20th century a plethora of modern brick buildings emerged, including banks, a modern American school, university buildings, a main mosque, the Mair Shaid Hospital, and, in 1992, a new airport; in terms of infrastructure, the Greater Nile Oil Pipeline opened.

The architectural history of Khartoum was therefore affected by its political, geographical and climatic influences. As Dr Fathi Bashier Tahir says: “Before independence, all aspects (...) were largely shaped by foreign presence and the dominant European culture. Despite the influences of westernisation and later globalisation, assimilation of modernity and foreign cultures has been the norm in Khartoum.”

Most recently the government has taken control of several of the new developments, including the airport and skyscraper city, maintaining a crucial balance between modernity and tradition. According to Dr Bashier, “these characterisations have had a great impact on architecture and the rise of modern regionalism”.

As one drives south-east towards the village of Soba, it is apparent that new developments of fairly low quality, such as housing complexes and even a new golf course, have sprung up, but the majority of these suburbs are still characterised by single-storey mud constructions, mostly “self-made”.

C. Climatic conditions

Khartoum is one of the hottest cities in the world, with an average annual temperature of 38°C, which can peak at 53°C in summer; night-time temperatures can fall to 15°C. There is very little rain (even in the August wet season, an average of 72 millimetres can fall within a seven-day period), and humidity values are also very low.

A significant consideration for the design of buildings is the frequency of desert sandstorms in the area – known locally as *Haboobs* – during which dry winds carry clouds of sand dust, often reducing visibility to zero; these winds are so strong that they can cause disruption to travel.

D. Topography

Historically there were small houses on the chosen site for the Salam Centre, but these were demolished in the last century and the remains of their well-fired bricks were transported to Khartoum and recycled, exposing a clay and sandy surface. The adjacent riverbanks are populated by rich *Acacia* desert scrubs, with a transitional zone of long grassland and the low bush typical of semi-arid regions.

The most striking feature of the site is that on the river's edge (about 40 metres from the site) there is an abrupt increase in height, suggesting that the river may have originally followed a slightly different course, forming an alluvial plain which today is full of handmade-brick "factories".

III. Programme

A. History of the inception of the project

The Human Development Index (HDI) is used to calculate an accepted broad definition of well being, attempting to measure three dimensions of human development; health, education and income. This index has been in existence since 1990 and in the period between 1990–2012 Sudan's HDI index has increased by 1.2% annually from 0.269 to 0.414, ranking the country 171 out of 189 comparable countries. The most recent HDI figure of 0.414, published in March 2013, ranks Sudan just above war-torn countries such as Afghanistan, Liberia, Mali and the Democratic Republic of Congo.

Sudan has generally failed to implement ambitious, well-conceived policies that could sustain human development and expand them into rural areas. It is therefore unsurprising that the World Health Organisation (WHO) data indicates an average life expectancy of 58 years, with only 31% of the population having access to healthcare and a high infant mortality rate.

Beyond this, Sudan and the surrounding countries are facing a crisis highlighted during the 55th session of the WHO regional committee for Africa, when it was revealed that *cardiovascular diseases, in particular congenital and acquired pathologies,* cause 10% of the deaths in the region.

Most acquired heart disease originates from rheumatic fever which predominately affects children and adolescents and is widespread in this region.

According to statistics, 50% of those who have rheumatic fever develop an inflammation of the cardiac muscle that can result in cardiac insufficiencies. Studies have shown 15–20 cases of this per 1,000 people in the region and two thirds of those are children between 5 and 15 years old; the WHO states that 300,000 deaths a year result from cardiovascular diseases alone.

A novel response to these findings was proposed by EMERGENCY, with their extensive experience in war-torn areas of the world. They initiated the idea of bringing *excellence in healthcare* to Africa, putting into practice their belief in the unquestionable right of every human being to receive free, high-quality medical treatment.

In 2005 they began by opening a paediatric centre beside a refugee camp in Mayo, working in partnership with the Sudanese government. In tandem with this they started the design and construction of the Salam Centre, proposing this as a "hub" from which satellite projects would reach out to Sudan and its neighbours.

B. How were the architects and specialists chosen?

Raul Pantaleo, an architect at studio tamassociati in Milan, Italy, has been a volunteer with the EMERGENCY group since the mid 1990s. His role has included providing advice on the construction of shelters, working with the board of the NGO in fundraising, strategic planning and shelter construction in Afghanistan, Bangui, Iraq and so on.

At the inception of the Salam Centre project he was engaged by EMERGENCY on a not-for-profit basis to design, procure and deliver the facility.

With the design and construction of the facility underway, Roberto Crestan acted as the client and main general contractor, with a tamassociati associate providing technical support, including sub-consultancy for all engineering design. Essentially a "self-build" project managed by EMERGENCY, the NGO was able to establish links with medical experts and construction experts for specialised areas using its existing contacts.

As far as was practical, construction of the Salam Centre was contracted to local builders and suppliers, while the mechanical, specialised medical equipment and high-quality finishes were procured or accepted as charitable donations from international sources.

C. Functional requirements

The Vision

The costs of the facility had to be kept to an affordable level, but the vision set out by Gino Strada, surgeon and founder of EMERGENCY, was not to be compromised:

"*We want our hospital to be beautiful, 'scandalously beautiful', because that beauty becomes a token of respect towards people devastated by war or disease and a beautiful place offers the conditions essential to regaining dignity in suffering. For this reason in all our hospitals the utmost importance is attached to children's playrooms, social spaces and gardens. Treatment is not confined to operating theatres and wards only, but applied through care devoted to each person as an absolute human being."*

Qualitative brief

EMERGENCY's objective was to develop a pilot project that would not only meet the urgent healthcare needs of the country and continent, but also develop a "centre of excellence" comparable to any in the world that would provide free healthcare as a fundamental right even in developing countries, aiming at social, political and humanitarian agendas.

Quantitative brief (refer also to Section III)

To provide a facility that deals with surgery, medicine and rehabilitation as a "one stop" facility. The centre would be designed, built and managed by EMERGENCY once in use. It would also provide accommodation for highly trained professionals from around the world, while providing training facilities for new experts in the region. Specific medical activities would include: paediatric cardiac surgery, adult cardiac surgery and interventional cardiology.

The architect also developed a brief to add a prayer and contemplation facility for all religions.

Outreach programme and regional capacities brief

The Salam Centre "hub" would also act as a support facility for:
- Mayo Paediatric Centre (examining up to 60 children daily);
- a paediatric centre for Port Sudan (opened 2011);
- a paediatric centre in Nyala Darfur (now closed).

IV. Description

A. Building data

The site is about 250 metres long along the north-south axis, and 80 metres wide east to west. The facility is broken down into several building types, the main structures being the hospital/surgical block and the medical accommodation compound for international staff:
- hospital block: "U" shape (gross area 12,000 m^2). Approximately 90x60 mmetres on plan housing with external height of 7.5 metres overall. This includes:
  - surgical block + 3 theatres + 15 intensive care unit beds and laboratories 12,500 m^2
  - ward with 48 beds and nurse's room 2,000 m^2
  - diagnostics wing, reception 2,000 m^2
  - basement space with pharmacy and storage 4,000 m^2

A covered walkway and colonnade between the ward and diagnostics wing links to the external courtyard;

- relatives' guest house for up to 50 people;
- main plant room facilities, including a chiller and water towers;
- prayer and meditation building approximately 1000 m^2;
- separate facilities building housing oxygen, a vacuum and compressed air production unit and generator room;
- support services building – providing laundry and ironing facilities, a children's playroom, conference and teaching spaces;
- medical staff accommodation compound made of 100 containers of 2400 m^2 sleeping about 150 people with its own communal space and cafeteria.

B. Evolution of design concepts

1. Response to physical constraints

Given that the plot is long in the north-south direction, the architect chose wherever feasible to keep the construction massing to a single storey for the sake of economy, and ease of construction and maintenance, but also to maintain sufficient spaces between buildings. This arrangement also makes full use of shading from the large trees.

The medical staff accommodation compound is located at the northern end of the site (approximately 40 metres back from the edge of the Blue Nile) while the southern edge of the site connects to the village and is where the main entrance to the hospital block is located.

This orientation allows a view of the Nile through the windows of the elevated cafeteria, while accommodating the flatness of the site to avoid a cut-and-fill exercise for the remaining ground. This provides shelter for the hospital from the prevailing winds from the north, while allowing an east-west orientation for the main diagnostic and ward wings (shielding them from direct sunlight but permitting a view of the surrounding greenery).

To protect them from noise and maintenance issues, all other ancillary buildings are separated from the hospital. The prayer and meditation pavilion is equidistant between the housing and the hospital, permitting ease of access. The walk between the hospital and housing is carefully crafted to enjoy tree-lined gardens and help unwind after a day's work.

2. Response to user requirements

Hospital block

The hospital block is approximately 90 metres long with two 20 metre side wings (diagnostic and ward) hugging a 60x30 metre open courtyard. It incorporates generous volumes all served by natural light, with views to the outside and clear wayfinding. The entrance and waiting areas for patients are well-shaded and well-organised, with decent seating spaces at the reception. All the spaces are organised around the open courtyard, with its large retained mango trees.

Prayer and meditation pavilion

In order to demonstrate sensitivity to the area's recent inter-ethnic and inter-religious wars, the architect tried to develop a space equally appropriate for use by practitioners of various faiths. This was achieved by avoiding any motifs or symbols dominated by any one religion, with the exception that male and female spaces are separated. The cubic volumes sit comfortably in a shallow water base, using the water symbolically but also drawing a cool breeze through to the pavilion.

Medical staff housing compound

The sleeping quarters are organised like an Arab house – in a "U" shape around a traditional tree-lined courtyard. It has two primary wings orientated north-south, connected by an east-west wing at one end while the cafeteria and communal space overlook the river and its banks.

3. Purely formal aspects

Hospital block

This block was conceived around a space originally occupied by two enormous mango trees located at the centre of the site. In line with the region's traditional housing structures, the configuration focuses on creating angles, perspectives and sensations that are forever changing and are never monotonous. The courtyard marks an ideal separation between the internal microcosm – bound, protected and secure, dominated by the symbolism of its trees – and the external macrocosm – hostile and scorched.

The structure's reduced height inspires in patients and hospital staff a sense of "homeliness" that is also present in many construction details: a successful attempt to soften the environment. The designers refer to a *"...philosophy that aims to create a cosy space where patients can feel like 'subjects', with a right to an often missing respect, rather than mere 'objects' of care, trying to mitigate the sensation of feeling lost and away from home so typical of hospitals."*

Medical Staff Accommodation Compound

The initial idea of a dedicated "container compound" designed to host the medical personnel of the Salam Centre for Cardiac Surgery came while the architects were gazing at the mountain of containers parked around the construction site: the architect was also aware of the freight village in Soba that collects containers and had previously used containers for emergency units.

As Jure Kotnik explains in his book *Container Architecture* (2008), containers have many good points in terms of architectural use: they are prefabricated and produced in large numbers; they are available globally, due to their compatibility with nearly all current transport systems; they are economical and mobile, tough and resistant as well as durable and stackable; and modular, recyclable and reusable.

As the architect Raul Pantaleo states: “We were fascinated by the idea of putting these veteran travellers to good use, giving them a rest and a comfortable retirement. Also because they are a symbol of globalisation, described by Marc Levinson in *The Box* (2006) as ‘the pivot on which rotates a highly automated system of worldwide freight transport, reducing travel incidents to a minimum...’”. To exploit these boxes would be a functional way of reusing the containers that they had brought to Sudan in recent years, some abandoned at the back of the hospital or in the nearby Soba freight village. The challenge the architects wanted to take up was to transform these dilapidated metal boxes into houses. Exploiting the tight internal proportions of these outwardly unattractive containers was a way of extending their hospitality to those helpers who dedicate their skills to the hospital’s wards. They were intrigued by the symbolic content of a container: the inherent life story and journey of each. They liked the idea of providing a resting place where the memories of many voyages might be contemplated, and putting these carriers to use in a very utilitarian, positive way. Indeed, as Jure Kotnik tells us in his book, before becoming part of a house, a container will have sailed the oceans and called on the world’s major ports, without ever revealing its contents.

4. Landscaping

The design concept for the complex was to create a pavilion set within a large garden. The architects recognised four large tree species (*neem*, *ficus*, *mahogany* and Saudi *damas*) as particularly appropriate, and made extensive use of these. Large mango trees in both courtyards (hospital block and medical staff housing) are plentiful and provide both shade and cooling. All buildings were arranged to fit around existing trees. In addition, low maintenance shrubs, colourful flowers and well-manicured grass are plentiful, covering all areas that are visible from the wards, sleeping accommodation and pathways.

C. Structure, materials, technology

1. Structural systems

Hospital block

The architect recognised the local capacity of the region and opted to design a system that was easy to source and readily assembled within that context. The primary structure for this block is formed out of standard structural portal frames of 20-metre span, 7.5 metres high at their apex, with sloping roofs, and placed at 5 metre centres. This primary system is then complemented by a secondary system, leading to a “box within a box” with a large void above the ceiling that acts as a plenum for air, protected by an insulated metal outer skin.

The rendered external wall panels, typically up to 7 metres high and 5 metres wide, infill the structural “bay”. Locally made fired bricks were used to create 60-centimetre-thick cavity walls with insulated panels to provide an effective low-tech thermal barrier that works in combination with the mixed-mode ventilation system, regulating indoor temperatures to between 18 and 24^{O}C for clinical and ward areas.

For users, the height and treatment of the “inner box” are such that there are no signs of the external “shed”, either inside or outside.

The guest house, plant building and support services. This is constructed in the same manner as the main hospital block.

The prayer and meditation pavilion is a rendered brick construction with bamboo shading.

Medical Staff Accommodation Compound

As described earlier, this system was also inspired by local availability. Ninety 6-metre (20 ft) containers were adapted to create a housing compound with 20-square-metre lodgings, each 2.7 metres high and formed from one and a half containers. A particularly successful integrated feature is the use of bamboo *brise-soleil* panels on the roof and external walls to limit the containers’ exposure to direct sunlight. The roof has an additional external insulation, while inside the container a 50-millimetre insulating panel covers the entirety of the structure’s surface.

2. Building services, site utilities

The facility has to be self-reliant wherever possible in terms of services. Water is obtained from deep aquifer wells pumped into a cleansing system. Power is from the grid, but back-up generators are provided throughout the hospital and sleeping quarters. The production of oxygen and gas is critical for hospital operations and any risks associated with power cuts need to be minimised through resilient self-sufficiency.

D. Origin of

1. Technology, materials and labour force

Frames, bricks and containers were sourced from the surrounding region wherever practical. Materials such as bamboo and the woven *brise-soleil* on the hospital block were produced through the transfer of ancient techniques, often including skilled local craftsmen and furniture makers. Medical and mechanical equipment was imported from elsewhere.

International staff from EMERGENCY, supported by local staff, played a key role throughout the construction of the building. Labour forces were also developed and trained, and many continue to work for EMERGENCY here and on other sites.

2. Professionals

Persons involved (refer to Section VIII)

V. Construction Schedule and Costs

A. History of project design and implementation

Salam Centre for Cardiac Surgery:

- design: 2004–05
- timetable: 2004–07

Medical Staff Accommodation Compound:

- design: 2006–07
- timetable: 2007–09

B. Total costs and main sources of financing

Salam Centre for Cardiac Surgery:	14,000,0000 EUR (18,451,448 USD), mainly private donations
Medical Staff Accommodation Compound:	1,037,495 EUR (1,367,356 USD), mainly private donations

C. Qualitative analysis of costs

Salam Centre for Cardiac Surgery:	950 EUR (1,252.05 USD) per square metre
Medical Staff Accommodation Compound:	457 EUR (602 USD) per square metre (almost half of a typical hotel in the city)

D. Maintenance costs

2011–12

Hospital gas consumption	2,134 USD
Hospital electricity power consumption	203,229 USD
Fuel for generators, heating system and conditioning system – hospital	188,232 USD
Hospital construction works	17,315 USD

E. Ongoing costs and 'life performance' of building

Hospital maintenance – structure	42,669 USD
Hospital maintenance – medical equipment	134,780 USD
General equipment	76,934 USD
Equipment rental	947 USD

VI. Technical Assessment

A. Functional assessment

Hospital Block

Good design of the hospital is apparent in the way the architect has integrated the site's functional requirements and human needs within the context of local constraints, budget and available technology. The provision of an "external shell" has allowed the architect to ensure:

- optimal functional adjacencies (diagnostic, operating laboratory, care beds) as required by good practice. The wide range of functions has been articulated to take on board mandatory regulations, and a therapeutic environment has been achieved;
- aesthetics and accessibility that are closely related to the internal use, creating a "homely" and "intimate" environment, views to the outside, wayfinding for all users, controlled circulation for the most secure areas, clinical safety and sanitation facilities. From the outside the aesthetics relate to the idea of a "hospital in a garden", with ample cheerful colours symbolic of nature, yet also appropriate for the function of each building;
- the interior design manifests an attention to detail characteristic to the architect; 1-millimetre tolerances are achieved in the ceramic tiles made by Italian specialists to the high standards required. Careful attention to separation of children and adult spaces, as well as staff, is evident throughout;
- the technical requirements on the whole are so well-organised that internal and external functions seamlessly combine to create a space where architectural separation is almost invisible;
- the architect had to balance interaction with medical specialists with architectural demands and limitations, and therefore his previous close relationship with various specialists at EMERGENCY as designer, operator and contractor was crucial. A great deal of magnanimous effort was required to coordinate the needs of patients, visitors, support staff, volunteers and suppliers during the space planning.

Medical Staff Accommodation Compound

It is not a novel idea to use shipping containers for buildings, and in particular living quarters; great examples exist in London, Amsterdam and the Ukraine. Here the architect maximised the potential of these freely available, second-hand resources, taking their utility to a new level. Previous experimentation at the Mayo outreach clinic provided a foundation of knowledge; here he now took on the challenge of providing accommodation for medical staff that could compete with international standards.

Rather poetically, some of the containers used had originally brought medical equipment to the site; the architect claimed that this was a deliberately symbolic, political act to draw attention to "reuse" and "rethinking of consumer and freight".

Following my recent stay, I can vouch from experience that the accommodation provides all the comforts and requirements of a modern hotel room, or even home, technologically and economically.

Ancillary buildings, prayer and meditation pavilion, and spaces between buildings

Despite these facilities being secondary to the two primary functions above, the levels of design and construction are consistently economical, well detailed and appropriate.

B. Climatic performance

Heating and cooling

A “mixed-mode” ventilation system that combines the use of mechanical and natural systems has been used for all the buildings.

The desert climate and very high temperatures represented a challenge, since, for clinical reasons, indoor temperatures of 18 to 24°C are essential for the hospital block.

The external walls of the hospital are built with “massive cavity walls” interspersed with panelled insulation and insulated air chambers, giving a total thickness of about 60 centimetres. The windows are double glazed with a sunscreen coating.

The site around the building has been very extensively planted with trees and hedges, and the walkways around the building screened by panels of intertwined vegetable fibres, employing a traditional technique used by the locals to build their beds.

All of the above measures contributed to shielding the buildings from the sun, thus reducing the energy requirements for cooling and air conditioning, and facilitating the optimal use of the locally available resources, the sun and the Nile’s water.

Protection against sandstorms and dust

To filter the huge quantity of sand and dust that fill the air in the region, a 60-metre long “sand trap” was built in the basement, taking advantage of simple mechanical principles. The air, sucked in from the outside, is forced through this labyrinthine tunnel. As the air hits the walls and loses speed, most of the sand and dust are removed and the air starts to cool down. The air is then “washed” and cleaned by vaporised water, flushing away the smallest particles. Via this process the air, 9 °C cooler than the outside temperature, is ready to enter the air treatment units and eventually the ventilation and conditioning systems.

Solar panels

Every hour, the Salam Centre as a whole needs to circulate 28,000 cubic metres of cold air; this has been achieved by a system employing 288 vacuum-sealed solar collectors (for a total surface of 900 square metres) producing 3600 kWh with zero CO2 emission. This amount of energy would otherwise require burning 335 kg of gasoline per hour.

Every solar collector houses copper tubing to circulate water; copper pipes are lodged inside vacuum-chambered glass tubes, allowing the sun to heat the water by irradiation, without heat dispersion. The water running through the pipes constitutes the vector fluid, transferring heat to a 50-cubic metre reservoir, where water is stored at a temperature of around 90°C.

The transformation of heat into cooling power takes place in two absorption chillers, where the circulating hot water heats up a solution of lithium bromide. In reaching its gaseous state, lithium bromide loses heat, and cools the water down to around 7°C.

This cold water is then circulated in the air treatment units (ATU), cooling air to the desired temperatures. From the eight ATU installed in the Salam Centre, air is then further filtered by F7, F9 or absolute filters, according to the needs of the different areas of the Centre.

Should solar energy be insufficient to meet the Centre's cooling requirements, two gasoline boilers switch on automatically, readjusting the water temperature in the reservoir and ensuring optimal functioning of the chillers.

C. Response to treatment of water and rainfall

The Blue Nile flows at a steadier rate and greater velocity than the White Nile, and holds a greater volume of water. The river is only a little below the plain of some areas adjacent to it, and prone to flooding.

The flood of 1988 inundated some areas, including the site in front of the Salam Centre, and it is understood to have a return period of 10 years. A risk assessment was thus undertaken during the design and allows for such an emergency. However, due to the raised level and distance of the hospital block from the riverbank, the risk is considered to be low.

D. Environmental response

At the heart of the design, both main buildings are conceived around the courtyard spaces and held in tension between inside and outside. The low forms are more easily protected against the sun and sand storms. In each case, unifying covered walkways with shading – bamboo in the staff accommodation block and woven shades in the context of the hospital – provide not only a harmonious integration of low- and high-tech, but also an efficient shading device.

During particularly sunny periods, the *brise-soleils* stitch a pattern of light and shadow without blocking views to the courtyards full of native flora and fauna; the marriage of nature and built environment critical to the project's narrative is evident.

E. Choice of materials, level of technology

On the whole, all of the materials used are robust, wearing well and require little maintenance. It is difficult to judge the quality of the instrumentation and M&E plant but I am assured that these meet the highest international standards.

The solar farm, which has to be exposed to the sun, carries the risk of losing efficiency due to damage from sandstorms, as experienced in the Middle East; it is, however, kept clean and well maintained.

VII. Users

A. Description of those who use or benefit from the project

The Salam Centre is the only centre providing free cardiac surgery in Africa. In the six years it has been operating, it has not only treated patients from Sudan and its neighbours but also from the following 23 countries: Afghanistan, Burkina Faso, Burundi, Central African Republic, Chad, Democratic Republic of Congo, Djibouti, Eritrea, Ethiopia, Jordan, Iraq, Italy, Kenya, Liberia, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, Tanzania, Uganda, Zambia and Zimbabwe.

The vast majority of patients are very poor, and are often unable to access any type of paid treatment for economic or logistical reasons.

From April 2007 to December 2012, *4415 patients* underwent surgical operations at the Salam Centre. Patients' ages ranged from 13 days to 65 years, with a mean age of 25.9 ± 14.7.

From April 2007 to December 2012, *5485 patients* were admitted to the Salam Centre.

Up to 31 March 2013	
Patients triaged	45,068
Cardiovascular examinations	37,100
Number of patients admitted	5,647
Number of surgical operations	4,795
Catheterisation laboratory procedures	1,180
Foreign patients	792
Mortality rates	3–30%

B. Response to project by clients, users, community, etc.

The project has had an unprecedented impact on many levels. In 2009 the African Network of Medical Excellence was created, with the express aim of promoting medical centres of excellence on the African continent, following the model of the Salam Centre. Its member states are all African and have committed to the improvement of regional cooperation in dealing with the urgent need to establish new centres of excellence in Africa.

I was also able to meet a number of those directly affected by these changes, to try to gauge a wider response:

- Dr Ahmed Bilal – Federal Minister of Information and Communications (former Federal Minister of Health)
- Dr Fathi Bashier Tahir – National Ribat University, Khartoum, Sudan

- Ms Amira Gornas – Ambassador of Sudan to Italy
- Mr Armando Barucco – Italian Ambassador to Sudan
- Mr Ognijen Predja – hospital manager
- Mr Isam Abubaker – container contractor

Dr Bashier has written widely about heritage and "modern regionalism" in Sudan. In our meeting he assured me that the Salam Centre is an excellent case study and that he has used this to educate many students of architecture and practitioners since its inception. He states that: *"The design draws on the legacy of traditional environmental techniques, including the use of a central green courtyard that acts as thermal insulation of interior spaces from the harsh climatic condition. The design also incorporates the traditional use of massive walls, shading screens, trees and planting to protect the building against excessive heat"*.

Dr Bilal is now the Minister of Communications and was instrumental in selecting and donating the site. His view was that EMERGENCY have not only delivered what they set out to do, but they have done so with aplomb. He was keen to promote the model to the United Nations and to his equals on the African continent.

The two ambassadors made time to come to the site during the review process, demonstrating how much value they place on the united efforts and outcomes of the project. They were keen to convey the message that Sudan is "misunderstood" and it now contributes as a government 30% of the annual cost of the Salam Centre, despite challenging domestic conditions.

Mr Isam Abubaker commented that his container business has expanded ten-fold since he built the compound. He now has many sites both in and outside Sudan.

"Open Heart" documentary

In addition to being widely publicised, the project was showcased in a documentary (*Open Heart*, by Kief Davidson, 2012) that followed patients from Rwanda. This documentary was nominated for Best Documentary Short Subject at the 2013 85th Academy Awards in Los Angeles.

VIII. Persons Involved

Salam Centre for Cardiac Surgery

Design team:	Studio tamassociati – Raul Pantaleo, Massimo Lepore, Simone Sfriso, Sebastiano Crescini with Pietro Parrino and Gino Strada
Project manager:	Pietro Parrino
Programme coordinators:	Rossella Miccio, Pietro Parrino
Structural engineering:	Francesco Steffinlongo
Mechanical/services engineering:	Studio Pasquini, Jean Paul Riviere with Nicola Zoppi
Operating theatre design:	Franco Binetti

Site engineer:	Roberto Crestan with Alessandro Giacomello
Feasibility project:	Gino Strada, Emiliano Cinelli, Fabrizio Fasano, Andrea Cioffi

Medical Staff Accommodation Compound

Design team:	Studio tamassociati – Raul Pantaleo, Massimo Lepore, Simone Sfriso
Programme coordinator:	Pietro Parrino
Structural engineering:	Francesco Steffinlongo
Mechanical/services engineering:	Nicola Zoppi
Site engineer:	Roberto Crestan, Alessandro Tamai, Claudio Gatti

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- "Emergency Paediatric Centre in Nyala", *Boundaries*, no.1, Italy, July–September 2001.
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- "Container Medical Compound", *Domus*, no. 934, Italy, March 2010, pp. 27–32.
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- Martelli, Samuele, "Design of Religion Architecture", *id+c. Interior Design and Construction*, China, November 2008, pp. 88–91.
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- EMERGENCY Activity Report 1994–2012.
- Bashier, Dr Fathi, "Heritage and Modern Regionalism in Khartoum", international conference *Sustainable Futures: Architecture and Urbanism in the Global South*, Martyrs University, Kampala, Uganda, June 2012.

Books and catalogues about studio tamassociati:

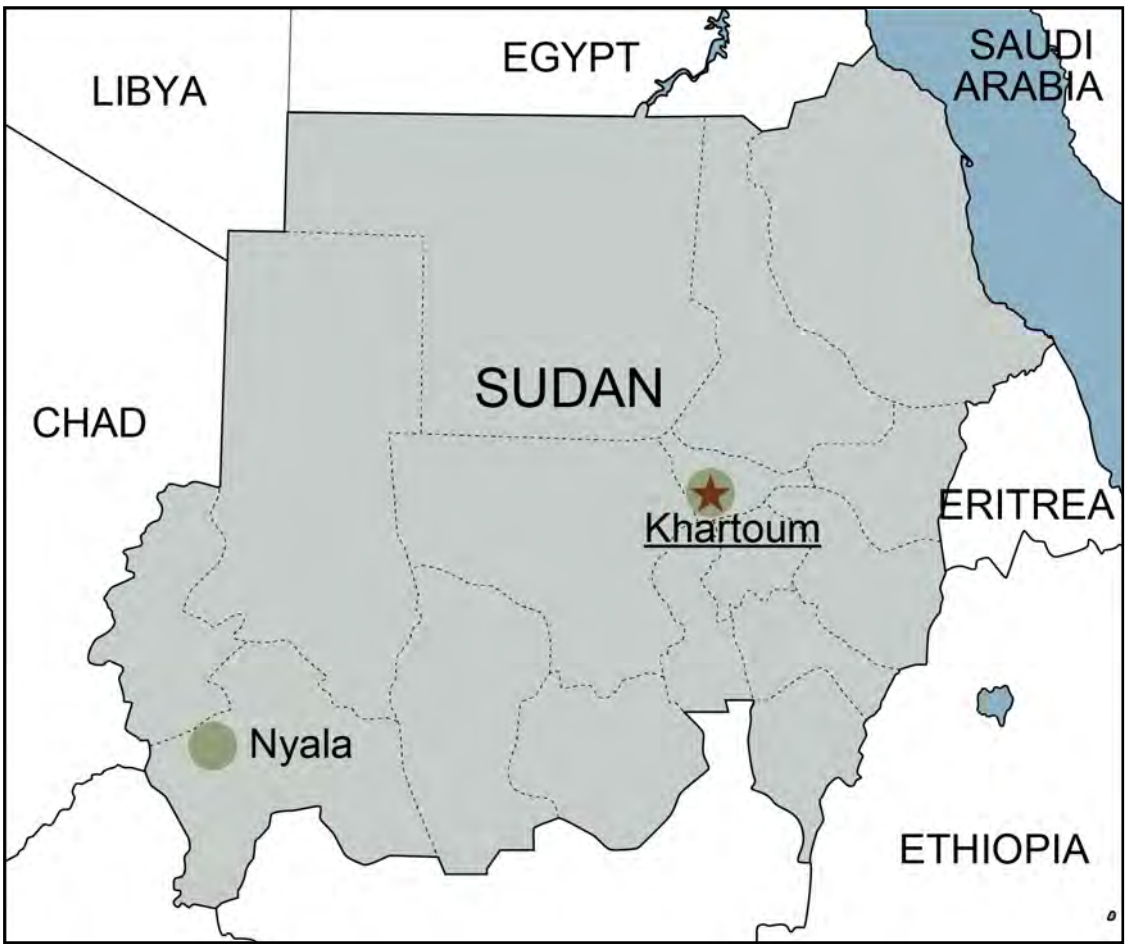
- Fernàndez-Galiano, Luis, *Atlas. Architectures of the 21st Century. Africa and Middle East*, Madrid: Fundaciòn BBVA, 2011.
- Aquilino, Marie J. (ed.), *Beyond Shelter: Architecture and Human Dignity*, New York: Bellerophon Publications Inc., 2011.

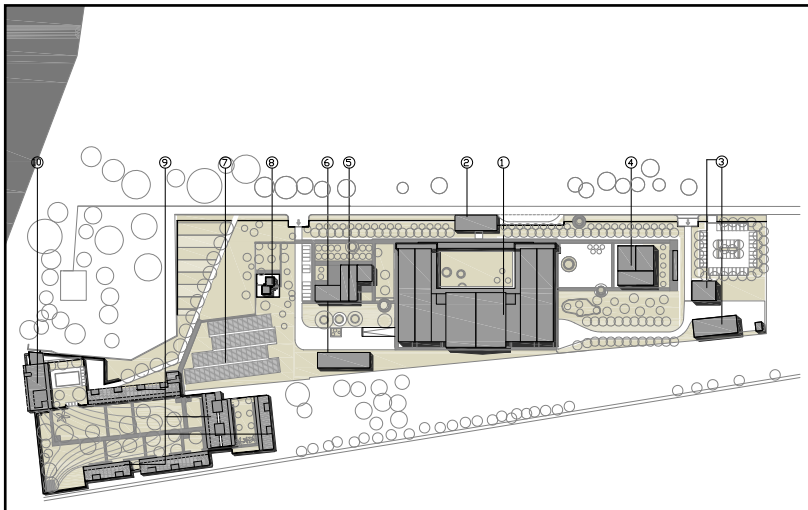
- Jodidio, Philip, *Temporary Architecture Now!*, Cologne: Taschen, 2011.
- Magrou, Rafael, *Habiter un container?*, Ouest France, 2011
- *The Phaidon Atlas of 21st Century World Architecture*, London: Phaidon Press, 2009.
- Jodidio, Philip, *Green Architecture Now!*, Cologne: Taschen, 2009.
- Minguzzi, Gianluca, *Architettura sostenibile*, Milan: Skira Ed., 2008.

Main awards:

- Italian Architecture Gold Medal 2012 – Container Compound, honourable mention in the "Architecture and EMERGENCY" category.
- 12th Venice International Biennale of Architecture exhibition 2010, Italian Pavilion – Salam Centre for Cardiac Surgery.
- Middle East Architect Awards 2010 – Salam Centre for Cardiac Surgery – 1st prize as "Sustainable Project of the Year".
- "Sustainable Architecture" Fassa Bortolo Prize 2010 – Container Compound, shortlisted.
- "Best of Green Award" 2010 (Treehugger Discovery Company, USA) – Container Compound, selected.
- Italian Architecture Gold Medal 2009 – Salam Centre for Cardiac Surgery in Sudan, commented.
- "Dedalo Minosse" International Awards 2008 – Salam Centre for Cardiac Surgery in Sudan, special prize.

Hanif Kara
April 2013





1 SURGERY CENTER
2 MAIN ENTRANCE
3 TECHNICAL BUILDING
4 RELATIVES HOUSE
5 SERVICE BUILDING
6 FACILITIES BUILDING
7 SOLAR PANELS
8 PRAYER AND MEDITATION PAVILLON
9 MEDICAL COMPOUND
10 CAFETERIA

1 BLOCCO OSPEDALIERO
2 INGRESSO
3 BLOCCO TECNICO
4 FORESTERIA
5 SERVIZI
6 EDIFICIO IMPIANTI
7 IMPIANTO A PANNELLI SOLARI
8 PADIGLIONE DI PREGHIERA E MEDITAZIONE
9 ALLOGGI PERSONALE
10 CAFFETTERIA

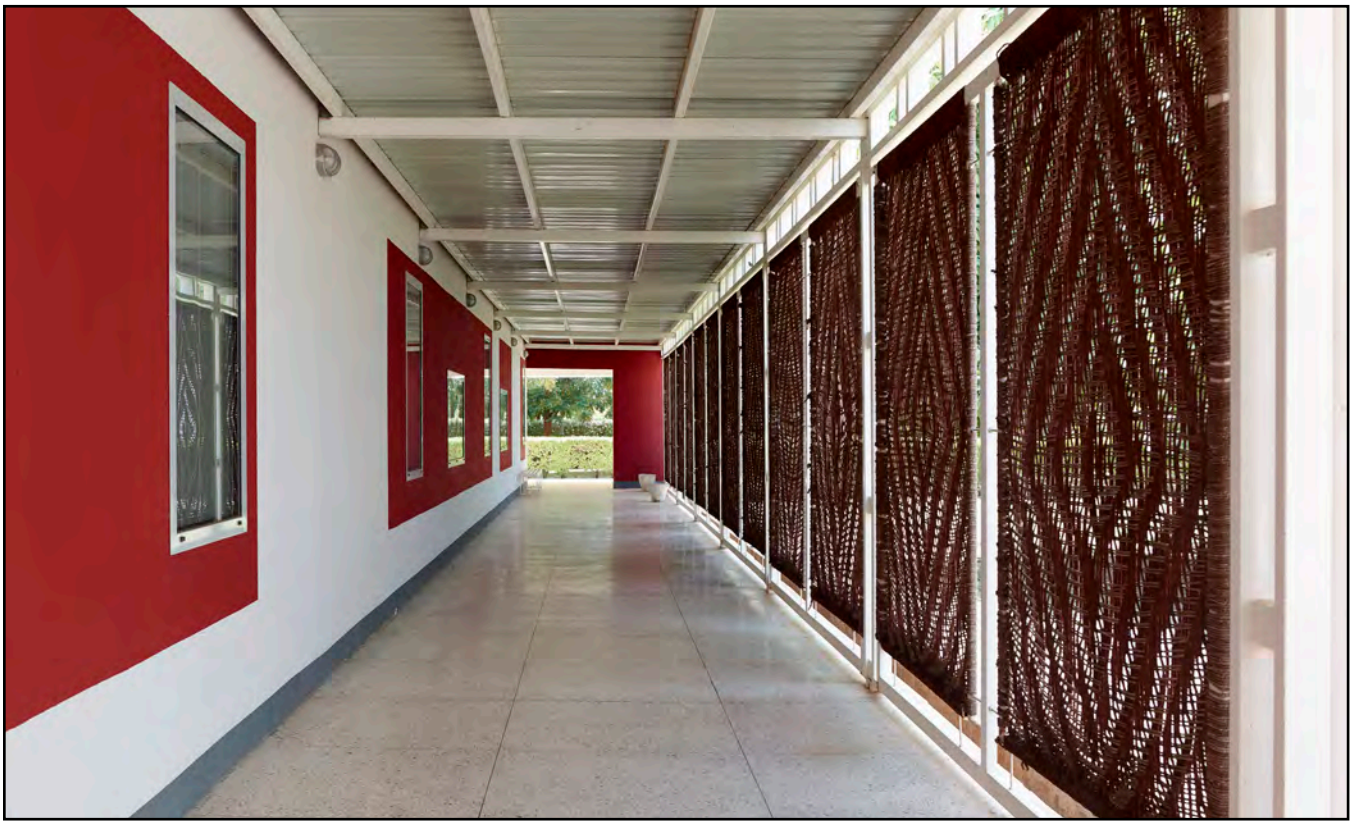
0 10 20 40 80 m

the main entrance to the hospital block is located at the southern edge of the site and connects to the village.

The design concept for the complex was to create a pavilion set within a large garden. The architects recognised four large tree species (Neem, Fikus, Mahogany and Damas Saudi).

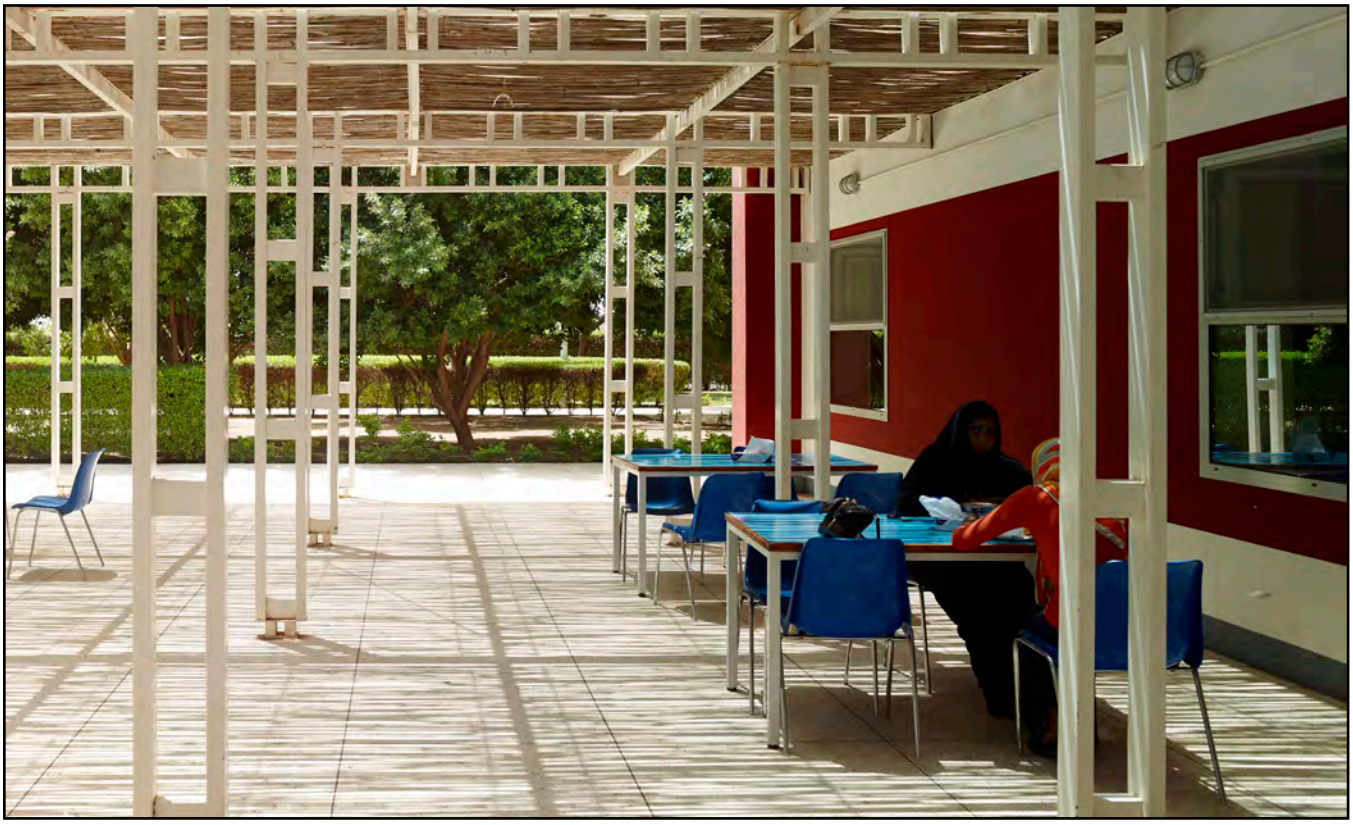
The entrance and waiting areas for patients are shaded well and well-organised, with decent seating spaces at the reception.

All the spaces are organised around the open courtyard, with its large retained mango trees.



In line with the region's traditional housing structures, the configuration focuses on creating angles, perspectives and sensations that are forever changing and are never monotonous.

The medical staff accommodation compound is made of 100 containers of 2400 m2 sleeping about 150 people with its own communal space and cafeteria.



In order to demonstrate sensitivity to the area's recent interethnic and interreligious wars, the architect tried to develop a space equally appropriate for use by practitioners of various faiths. This was achieved by avoiding any motifs or symbols dominated by any one religion, with the exception that male and female spaces are separated.

The sleeping quarters are organised like an Arab house - in a 'U' shape around a traditional tree-lined courtyard.

Locally made fired bricks were used to create 60cm thick cavity walls with insulated panels to provide an effective low-tech thermal barrier which works in combination with the mixed-mode ventilation system, regulating indoor temperatures to between 18 and 24°C for clinical and ward areas.

Large mango trees in both courtyards (Hospital and medical staff housing) are plentiful and provide both shade and cooling.