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Vernacular and low-tech technologies in humanitarian architecture on the example of Senegal

Introduction

Economic and social status inequalities within individual societies and countries pose one of the most serious civilization problems in the modern world. This situation is especially visible in developing countries, whose unstable economies are of little importance in international politics. By and large, these countries are engulfed in poverty; apart from a small group of economic elites, their communities are mostly unable to provide themselves with basic living conditions, such as sustainable and secure housing premises. Support provided to emerging countries and those affected by natural disasters is generally known as humanitarian aid. Analogically, various sources such as scientific literature refer to the effects of activities related to assistance in terms of architectural infrastructure as *humanitarian architecture* [1]–[7]. However, this concept may be controversial.

According to the definition provided by the *Słownik języka polskiego PWN* [Polish language PWN Dictionary], "humanitarian" is understood as […] *aimed at human good, respecting their rights and dignity; sparing them suffering* [8]. Undoubtedly, all architecture should be characterized by such features. Various sources published in English offer expressions that function alongside *humanitarian architecture*, but differ slightly from the term (as they refer to the design approach or architecture), e.g. *humanitarian-directed design*, *humanitarian-focused design*, or *first aid architecture.* However, none of these terms captures the aid through architecture approach discussed in this article more accurately than the original *humanitarian architecture*. Therefore, for the following article, the adopted definition is the one quoted by Maria Lubelska in her doctoral dissertation defended at the Faculty of Architecture of the Cracow University of Technology in 2015 [2]. According to her, humanitarian architecture is a design trend that focuses on available architectural and urban solutions to aid people in crisis situations, i.e., when they are unable to improve their situation with their own efforts. Thus, humanitarian architecture belongs to a broader trend known as socially engaged architecture, whose main goal is to bring new values to a community's quality of life, but not necessarily in the context of poverty [2]–[4], [6], [7].

Activities related to humanitarian aid in architecture can be observed in three main areas. Firstly, such action is undertaken by architects who combine successes in their commercial architectural practice with the non-profit operation, which is their response to crisis situations in specific communities (e.g., Shigeru Ban, Toshiko Mori) [1], [5]. This issue is also present in academic circles, where scientists and specialists from various fields cooperate in research on the key issues of humanitarian design, whereas students develop their skills through competition projects and participation in humanitarian actions [1], [2], [5]–[7]. The third area includes non-governmental and non-profit organizations (e.g., the global UN-Habitat or Balouo Salo which mainly operates in Senegal), which associate international groups of activists and specialists, including architects [1]–[3]. Such organizations exert an extensive impact on the effectiveness of architects' activities; they allow designers to become involved in the wider social and economic processes that arise in a given region. Such non-governmental bodies provide the vital link between the local community and third parties that offer help.

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The economic constraint context, characteristic of humanitarian architecture, poses a particularly serious challenge to architects and builders. In this case, it becomes a natural necessity to seek cheap materials and solutions that are available locally and can be implemented by unskilled labor. The present article discusses the possible use of such solutions and their significance to humanitarian architecture. The research has focused on the context of a specific West African country, Senegal. Recently, dynamic economic growth was observed there, but the effects of these initial economic successes have only been available to a very limited group of inhabitants. The majority of Senegal remains plunged into poverty; therefore, a need for humanitarian architecture emerges in this case. The article aims to analyze material and construction solutions applied in the buildings erected or designed in Senegal, which are devoted to humanitarian aid and development support for the local population. The initial stage of the research, i.e., the analysis of literature sources, led to the identification of the basic social problems of the Senegalese population. These problems are to be confronted by facilities erected within the scope of humanitarian aid activities. A synthetic review of construction technologies characteristic of Senegal's traditional construction was also performed. In the second stage of the research, four examples of buildings located in the Senegal area are analyzed, i.e., three implemented objects (Polyvalent Cultural Center in the city of Tanaff, schools in the Dixième district of Thiès and schools in Fass) and a designed object (Women's House in the village of Baghere, the Cassamance region). The basic criteria adopted for the analysis included the facility's social purpose, as well as the materials and technologies applied. Detailed conclusions were derived concerning the types and scopes of native and low-tech technology applications. General conclusions, on the other hand, focus on the correspondence between the analyzed objects' design and construction and the idea of sustainable development. The study is intended to provide a starting point for further research, with the potential of being extended to include more cases and a wider territorial scope.

Social issues of Senegal

Senegal is one of the smallest and most stable African countries. Since its independence in 1960, the country has undergone three major peaceful political changes [9]. Between 2014 and 2018, Senegal's economic growth was among the highest in Africa, with a GDP increase of around 6% per year [9]. Dakar's developing technology center has been compared to Silicon Valley [10]. Despite the generally impressive economic enhancement, its effects apply only to selected urban areas rather than the entire country [10]. In addition, the country's economic situation was aggravated by the pandemic, which weakened services such as tourism, transport, and exports [9]. It remains difficult for young people to find a job outside urban centers, such as Dakar and other Senegalese agglomerations. In rural communities, the underemployment rate is estimated at 31% [10]. Additionally, years of rapid population growth have put the labor market under considerable pressure, whereas a large proportion of the country's most important agricultural regions have been devastated by climate change. Currently, Senegal holds the highest population growth rate in the world, but the infrastructure to help meet society's growing needs has not been developed yet. In West and Central Africa, more than 75% of the population is under 35 years of age and suffers from a chronically high poverty rate [10].

In Senegal, sectors that require support include those directly related to people's basic needs, such as housing, access to healthcare, education, and livelihood. It also seems crucial to create conditions for social transformation through action supporting education, culture, and social competence development, as well as by combating the conspicuous gender inequality in most African countries [10].

The examples of humanitarian architecture analyzed in the article address the issues that fall into the above-listed categories. The primary concern is on rural or poorly developed urban areas which are unlikely to experience the effects of the country's economic growth anytime soon.

Senegal's traditional building technologies

The development of traditional construction technologies in a given region usually stems from the climate and the available raw materials. Senegal's climate is formed by the tropical latitude in which it is located. Three main climatic zones are distinguished in the area: coastal, Sahel, and Sudanese. The coastal zone (a strip of the Atlantic coast, approximately 16 km in width) is characterized by clear temperature differences between the summer and winter (17°C in winter and 27°C in summer) and the rainy season from June to October (annual rainfall equals around 500 mm, on average). The Sahel climate is present in the northern part of the country. Winter is slightly cooler than the summer (in the summer, temperatures exceed 40°C). The dry season starts in November and continues until May. Between July and October, the average rainfall totals around 360 mm. The Sudanese zone in the southern part of the country is the hottest and most humid one (the average annual rainfall reaches up to 1270 mm). In this area, cultivation is possible without artificial irrigation [11].

In traditional Senegal construction, soil and its mixtures are the most important building materials. Soil is easily accessible, does not require complex processing, and is suitable to the prevailing climatic conditions, i.e., dry climate in the north and humid one in the south of the country. This material is characterized by high heat capacity and great possibilities for regulating air humidity. The great potential of construction using soil as the main building material is evidenced by the fact that this technology has developed independently in various regions of the world and different climatic zones, not only the hot ones [12], [13]. In Poland, examples of soil being used as a building material can be found in various historical periods, including not too distant ones, e.g., in crisis situations of the interwar and postwar periods. The technologies for erecting soil-based buildings are still developing;

they align with the current pro-ecological trends due to their extremely low carbon footprint and advantageous microclimatic properties. These technologies are also appreciated by architects who focus on socially engaged architecture; this is especially true in hot climates, where the thermal insulation of building partitions poses a marginal problem. Building construction with soil as the main component was applied in the projects by such architects as Hassan Fathy (in Egypt) and Nader Khalili (in Iran), who based their designs on more or less processed native technologies.

Various building technologies unique to each country and culture use soil as a component. In the case of Senegal, two basic ones can be distinguished, i.e., layered forming and block forming. The former is one of the oldest earthen-based techniques, known as *cob* or *cobb* [14]. In this case, the main building block comprises clay or laterite earth, and sometimes the material derived from termite mounds. Chopped grass is often added as a binder to such a base [15]. To achieve high levels of structural strength, sand or clay can be added in various proportions. The mixture is placed manually, directly onto the foundations. The walls are arranged in layers upwards. Each layer is given sufficient time to dry before the consecutive ones are applied. This way, the walls are built evenly, narrowing slightly towards the top. Traditionally, the ready walls are kept raw or are only covered with a layer of lime. The average thickness of the wall is about 60 cm, which is appropriate for the erection of two stories with proper thermal insulation and heat capacity. The roof eaves with a radius of about 20 cm are sufficient to protect the walls against moisture. *Cob* is an easy technique that offers great opportunities to independently shape the building form. A structure erected with this technique is fireproof, marked with seismic resistance, and cost-efficient. However, it requires time and commitment to manual labor.

Block formation is the second earthen-based technique, also widespread in the Senegalese regions. Laterite soil requires no strengthening additives. On the other hand, using clay soil obtained from the river banks or dry swamps requires finely chopped grasses to be added as a binder. When mixed with water, the mixture forms a building block. Wooden forms are filled with it and turned over. The blocks formed in this way are dried in the sun for about 15 days, then brick-laid with the use of soil-based mortar [15].

Rafter roofs are a feature characteristic of traditional Senegalese architecture. Roof frames are usually made of dry bamboo, or if this material is inaccessible in the area, simple unshredded wood of various types is collected. Straw is the basic traditional roofing material. There are three main methods to cover a roof structure. The first and the simplest one consists of evenly spreading bundles of straw onto the frame and fixing them with a plant-based string (such coverage lasts up to five years). Straw is sometimes replaced with palm leaves. The second method is based on straw woven into strips, which are then laid in overlapping bands over the roof structure and fixed with bamboo stalks (this roofing lasts from three to eight years). The third, most robust method uses straw sheaves tied with bamboo stalks. They are arranged in strips and then into overlapping layers (this roofing lasts from seven to twenty years) [15].

Houses erected with the use of the above-described traditional, vernacular techniques are abundant in rural areas, as well as in underdeveloped urban areas. However, the displacement of traditional techniques in favor of more modern ones emerges as the consequence of the country's economic growth, including the flourishing of the construction sector [16]. Concrete is being used more commonly as a material for erecting walls and ceilings; metal roofing and glazing are on the increase. While such a process seems understandable and inevitable in the case of developing urban districts, it seems rather disturbing that it also applies to rural areas. Especially since these technologies are relatively expensive from the point of view of the still poor inhabitants. Additionally, they are insufficiently adapted to climatic conditions. Furthermore, professional knowledge and skills in traditional techniques are also beginning to disappear among the local population.

Analysis of selected examples of humanitarian architecture in the context of the construction techniques applied

Polyvalent Cultural Centre in Tanaff

Polyvalent Cultural Center is an educational center that promotes the preservation of Senegal's culture and traditions as a factor in the local community development. The Center is intended primarily for young people. Its implementation began in 2018 in Tanaf, whose population equals nine thousand inhabitants [17]. Balouo Salo, a non-profit organization, initiated this investment. The facility operates in the social space, i.e., in the context of education, safety, health, and human rights; the ecological space understood as environmental protection, emission reduction, and accumulation of resources; and the economic space in terms of self-sufficiency, development, and sustainability. The projects undertaken by Balouo Salo are related to building construction, but also to education and research on improving the methods of creating a sustainable, resilient and self-sufficient living environment.

The Center's complex comprises five one-story buildings with a museum, offices, training rooms, and a developed yard for outdoor activities and local community meetings (Fig. 1). The total internal space area is 800 m^2, with 1,200 m^2 of open external space. The space was designed by Raoul Vecchio, the director and founder of the Balouo Salo organization, who also acted as the construction manager.

The building of the Center was mostly erected with the use of natural materials. The architects' objective was to obtain local materials available within a radius of 15 km. Laterite soil, clay, sand, polypropylene bags, plastic film, wood, recycled ceramics, straw, and cut grass were applied. The supporting structure consists of soil-filled bags and is finished with a mortar of laterite soil mixed with

Fig. 1. Polyvalent Cultural Centre, Tanaff, Senegal. In the construction phase (source: image courtesy Balouo Salo – humanitarian organization)

Il. 1. Polyvalent Cultural Centre, Tanaff, Senegal. Na etapie budowy (zdjęcie dzięki uprzejmości Balouo Salo – organizacji humanitarnej)

Fig. 2. Polyvalent Cultural Centre, Tanaff, Senegal. Processing of sack walls with earth mortar (source: image courtesy Balouo Salo – humanitarian organization)

Il. 2. Polyvalent Cultural Centre, Tanaff, Senegal. Pokrywanie zaprawą ziemną ścian z worków (zdjęcie dzięki uprzejmości Balouo Salo – organizacji humanitarnej)

Fig. 3. Polyvalent Cultural Centre, Tanaff, Senegal. Development of the surrounding area (source: image courtesy Balouo Salo – humanitarian organization)

Il. 3. Polyvalent Cultural Centre, Tanaff, Senegal. Zagospodarowanie otoczenia (zdjęcie dzięki uprzejmości Balouo Salo – organizacji humanitarnej)

cut straw and cement (Fig. 2). Above the walls, a wooden structure was stretched on which the straw roof covering rests (Fig. 3). Between the wall and the roof structure, openings for ventilation and illumination of the interior were made. The window openings were filled with wooden openwork panels, whereas broken ceramics mixed with mortar were used for the floors.

The applied solutions are a unique combination of low-tech techniques inspired by vernacular architecture. The construction process itself was crucial. It was conducted by specialists in the field of sustainable low-tech techniques (construction architects and engineers), who used it as an opportunity to integrate and, most importantly, educate the local community in the field of construction techniques. This action strengthened the identification of future users with the new facility well before its launch. Moreover, the process was aimed at equipping the local community with new skills to gradually improve the living conditions in their own environment.

School in the Quartier Dixième, Thiès

Although Thiès is the third largest Senegal city, its infrastructure (apart from the most developed centers) does not differ significantly from that in the rural area. Thiès districts are located away from national roads and have the character of suburban villages. Bassirou Mbacké High School building was erected in the Quartier Dixième in 1967 when the local community donated private plots of land to support the education sector in their area. Until now, the school consisted of 9 classrooms built of concrete. Over time, the building proved too small for the local community's needs. In 2017, the school was enlarged by a new one-story building with two classrooms and an office room for up to 62 youngest students (Fig. 4).

Architects and activists who work for *Let's build my school*, a British charity organization, were the initiators of this undertaking and the project's contractors [18]. The

Fig. 4. Primary School, Quartier Dixième, Thiès, Senegal (source: image courtesy Let's build my school – humanitarian organization)

Il. 4. Szkoła podstawowa, Quartier Dixième, Thiès, Senegal (zdjęcie dzięki uprzejmości Let's build my school – organizacji humanitarnej)

Fig. 5. Primary School, Quartier Dixième, Thiès, Senegal. Foundations made of tires filled with soil (source: image courtesy Let's build my school – humanitarian organization)

Il. 5. Szkoła podstawowa, Quartier Dixième, Thiès, Senegal. Fundamenty z opon wypełnionych ziemią (zdjęcie dzięki uprzejmości Let's build my school – organizacji humanitarnej)

Fig. 6. Primary School, the Quartier Dixième, Thiès, Senegal. Sand and cement plaster (source: image courtesy Let's build my school – humanitarian organization)

Il. 6. Szkoła podstawowa, Quartier Dixième, Thiès, Senegal. Tynk z piasku i cementu (zdjęcie dzięki uprzejmości Let's build my school – organizacji humanitarnej)

idea behind the *Let's build my school* group is that education is a basic and universal human right. Their missions and projects focus on building schools in underdeveloped areas. The organization aims to equip local communities with new skills and transfer practical, economically available methods. The organization constantly researches and implements innovative, low-cost construction techniques, especially if they require little or no construction knowledge. The organization cooperates with residents and global professionals intending to develop sustainable, most appropriate methods for a given situation. The design process begins with identifying the community's needs and determining available materials and the prevailing climate conditions. The construction progresses in cooperation with the future users, who are involved in each stage of the facility construction. This approach allows the transfer of knowledge and skills useful for further independent development.

The new school building was erected with laterite soil, clay, sand, polypropylene bags, used tires, plastic film, metal mesh, wood, and trapezoidal sheet. The foundations, about 1 m in depth, are made of two layers of tires (placed upon a plastic film to protect them against moisture), filled with compacted clay and sand (Fig. 5). The tires were also used as elements of the school's fence. The walls were made of polypropylene bags filled with local soil. They were stiffened with a metal mesh and finished with three layers of sand and cement mixture (Fig. 6). Oblong openings were introduced between the walls and the roof to enable natural room ventilation. Roofing made of thin trapezoidal metal sheets was suspended on a wooden pillar-supported lattice structure (Fig. 7).

Due to climatic conditions, the proposed solutions in the form of massive walls with high heat capacity and openings to enhance natural ventilation proved more favorable than those implemented in the original school building.

Fig. 7. Primary School, the Quartier Dixième, Thiès, Senegal. Roofing structure (source: image courtesy Let's build my school – humanitarian organization)

Il. 7. Szkoła podstawowa, Quartier Dixième, Thiès, Senegal. Konstrukcja dachu (zdjęcie dzięki uprzejmości Let's build my school – organizacji humanitarnej)

The school in Fass

The school in Fass was established as the first secular school in the region of over 110 villages. In cooperation with the Josef and Anni Albers Foundation, the Le Korsa non-profit organization, and a group of local leaders, Toshiko Mori, a famous Japanese architect, designed a facility for 300 students aged 5 to 10. The building was erected in 2019 [19]. The building's shape and form resemble a traditional impluvium, i.e., an apartment typical of Senegal's Casamance region. Those typical residential structures were erected of soil on a ring plan. In the center, they featured a trench fed with rainwater flowing in from the sloping roof. During hot days, this form kept the building cool. The school is a transformation of this spatial concept (Fig. 8). Around the inner courtyard, the facility features classrooms and two multi-purpose spaces. The oval shape makes it possible to move freely between classrooms. Perimeter walls of different heights, together with the roof, create various cross-sections throughout the building. The chimney effect was used to improve ventilation and to recover water from the extensive roof.

The building was constructed by a team of local builders with traditional skills. Natural materials obtained locally were used. The architects provided detailed instructions on how to dimension and assemble structural elements to achieve the geometry outlined in the design. The building walls, supported by steel elements and bamboo, were made of mud brick. Wall perforation was introduced to light the interior and enable airflow throughout the building. Additionally, the walls were painted white to limit heat accumulation. The roof was based on a bamboo structure covered with a thick layer of straw to provide effective insulation against the heat. The floors were made of mortar mixed with recycled ceramics elements (Fig. 9). The local community was involved in the construction process; by doing so, they strengthened bond with the new building as a place and received adequate training in maintenance and future minor repairs.

The Women's House and Women's Village in Baghere

The Women's House project emerged as part of a Master's thesis at the Faculty of Architecture, Gdańsk University of Technology. It is an original project by Aleksandra Karpińska, the co-author of the present article, created under the scientific supervision of Robert Idem, the co-author of the article [20]. The problem area on which the project was based concerned the struggle for gender equality in poverty-ridden rural areas. The issue provided the main theme for the international Kairac Looro competition, 2021. This annual competition aims to promote socially engaged design. The proposed building development is located in the village of Baghere, in Casamance, the poorest region of Senegal. Its objective is to empower women in the rural community and to support an integrated socio-economic process with which to enable the entire community to overcome the crisis.

The project involves the construction of a village as a social and investment process initiated by constructing the first complex of buildings, i.e., the Women's House (Fig. 10). The building is intended to serve as the headquarters for the already established organizations that work on behalf of women in Baghere. The complex features the House of Dialogue as the most important facility. The building includes a space for managing organizations, conducting talks, and providing training. The complex also

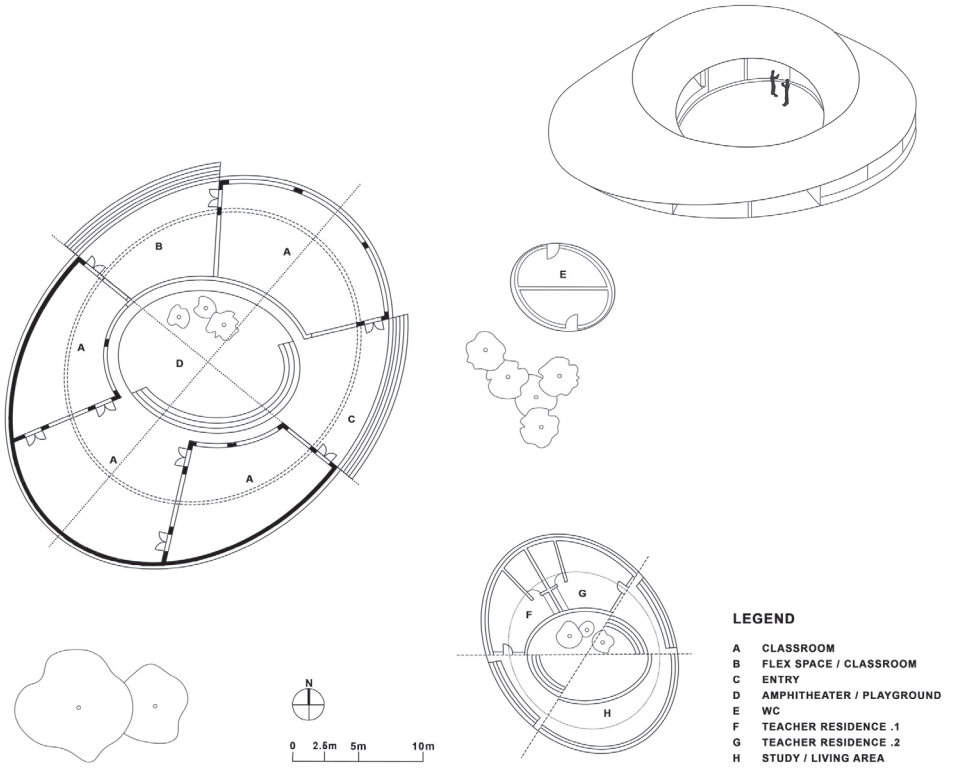

Fig. 8. Primary School in Fass, Senegal. Ground floor layout of two buildings (elaborated by A. Karpińska based on [19])

Il. 8. Szkoła podstawowa w Fass, Senegal. Rzut przyziemia zespołu dwóch budynków (oprac. A. Karpińska na podstawie [19])

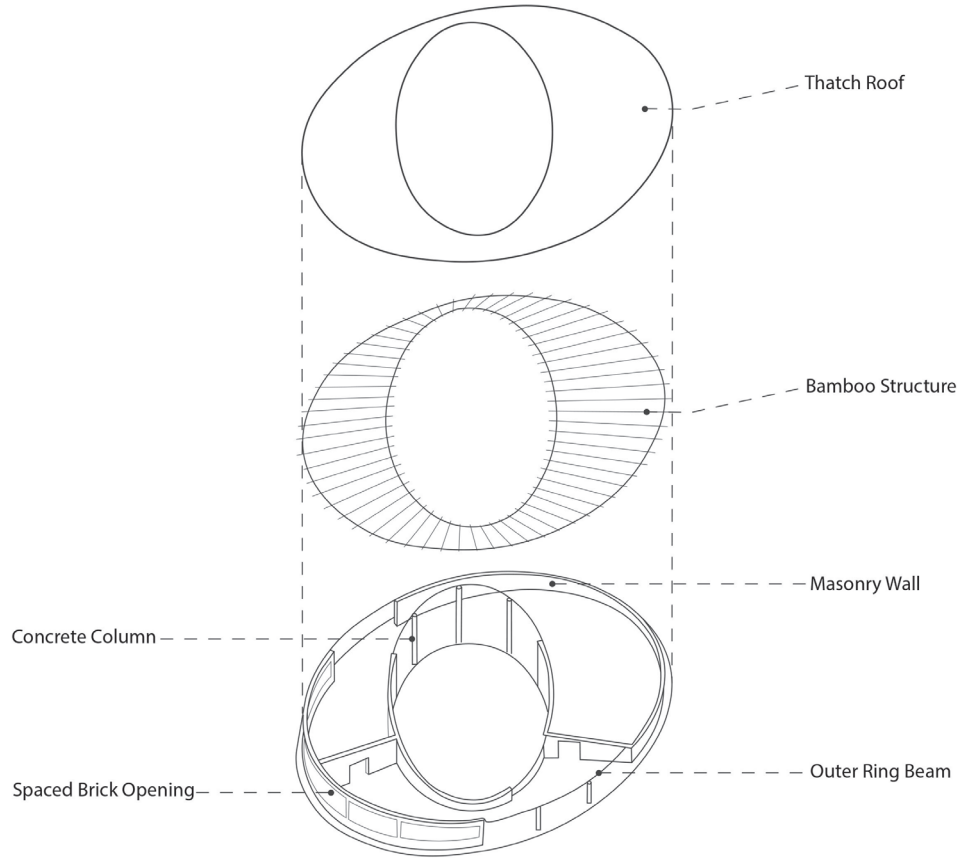

Fig. 9. Primary School in Fass, Senegal. Spatial scheme of main building (elaborated by A. Karpińska based on [19])

Il. 9. Szkoła podstawowa w Fass, Senegal. Schemat przestrzenny głównego budynku (oprac. A. Karpińska na podstawie [19])

includes a medical facility with treatment rooms, nurseries that may serve as temporary stay rooms for women suffering from domestic violence, and a Production Center where basic personal hygiene products are produced and stored. It is intended that in the subsequent stage, a residential complex consisting of private houses and shared buildings would be erected (Fig. 11). The construction of the latter would provide an opportunity to share spaces unaffordable to many in their homes, as well as offer mutual support in the form of child care or meal preparation. The construction of the housing complex could be implemented in stages by the villagers, who would acquire building knowledge and skills while participating in the construction of the Women's House.

The project uses natural materials that are both cheap and easy to obtain from local resources, including laterite soil, clay, sand, wood, bamboo grass, straw, and recycled ceramics. Traditional technologies are to be applied. In accordance with the traditional cob building technology, the walls' main building materials are to consist of a mixture of soil, clay, sand, and fine fibrous plants obtained at the construction site and in the nearby Casamance River basin. Beams made of wood available in the immediate vicinity would be used to construct the roof truss and supporting columns, whereas the roof covering would consist of traditionally tied straw. It is intended that the floors inside and around the buildings be made using broken ceramic elements bound with the mortar.

A modular single-story system is proposed in the project. The buildings that belong to the Women's House complex were designed as a combination of several identical basic modules on a rectangular plan to cover an area of approximately 20 m^2 (Fig. 12). An identical module is to be applied at a later stage, during the construction of the housing complex. Consequently, it is intended that the residents will gain experience in the field of construction technologies from the beginning of the process, on elements that can be repeated numerous times in future construction activities.

Furthermore, the project provides for the possibility of collecting rainwater from roofs in tanks placed on the ground in order to use it for watering home crops. A system of dry toilets is proposed for the discharge of waste. As part of this system, special tanks are to be used to

Fig. 10. Women's House in Baghere, Senegal – visualisation (visualisation by A. Karpińska)

Il. 10. Dom Kobiet w Baghere, Senegal – wizualizacja (wizualizacja: A. Karpińska)

Fig. 11. The Womens' House in Baghere (a) and a residential complex with arable crops and livestock erected as the subsequent stage (b) (elaborated by A. Karpińska)

Il. 11. Dom Kobiet w Baghere (a) oraz zespół mieszkalny z uprawami rolnymi i hodowlą wzniesiony w kolejnym etapie (b) (oprac. A. Karpińska)

produce humus for soil fertilization. Composted organic waste would act in a similar way. In the following phase of Baghere village development, investments in fields of photovoltaic panels would likely be made so as to supply homes and farmland irrigation systems.

Discussion and conclusions

In all the facilities analyzed in the above article, technologies based mainly on low-processed and natural, locally obtained materials were used. All objects were made of materials used in Senegal for centuries, i.e., soil. It can be applied in the form of vernacular technologies or in a new method, namely using polypropylene bags. The new technology is probably less labor-intensive than the traditional one, although the need to use plastic has its drawbacks from the point of view of ecological criteria. The roof structures are based on the traditional material, i.e., wood. However, the roof cover may be implemented in two ways, namely using traditional straw-based techniques, or using simple modern material, i.e., a trapezoidal metal sheet. The latter is less adapted to the climatic conditions prevailing in Senegal, but it is durable and relatively cheap (it can also be obtained as a secondary material). Additionally, applying a trapezoidal metal sheet significantly saves the time required for execution, compared to straw-based techniques. Solutions involving recycled materials, such as old tires as foundations or broken ceramics as floors, are also noteworthy.

Based on the presented analysis of facilities, it may be emphasized that the selection of building materials and technologies is of great importance for the basic humanitarian purposes these objects are intended for. This significance can be sought in three spheres: the economic, social, and ecological ones. These spheres define the entirety of the sustainable development concept.

Maximum economic rationality, i.e., the low cost of materials, their transport, and facility execution, is of key importance for activities in the field of humanitarian architecture. This factor often conditions the possibility of

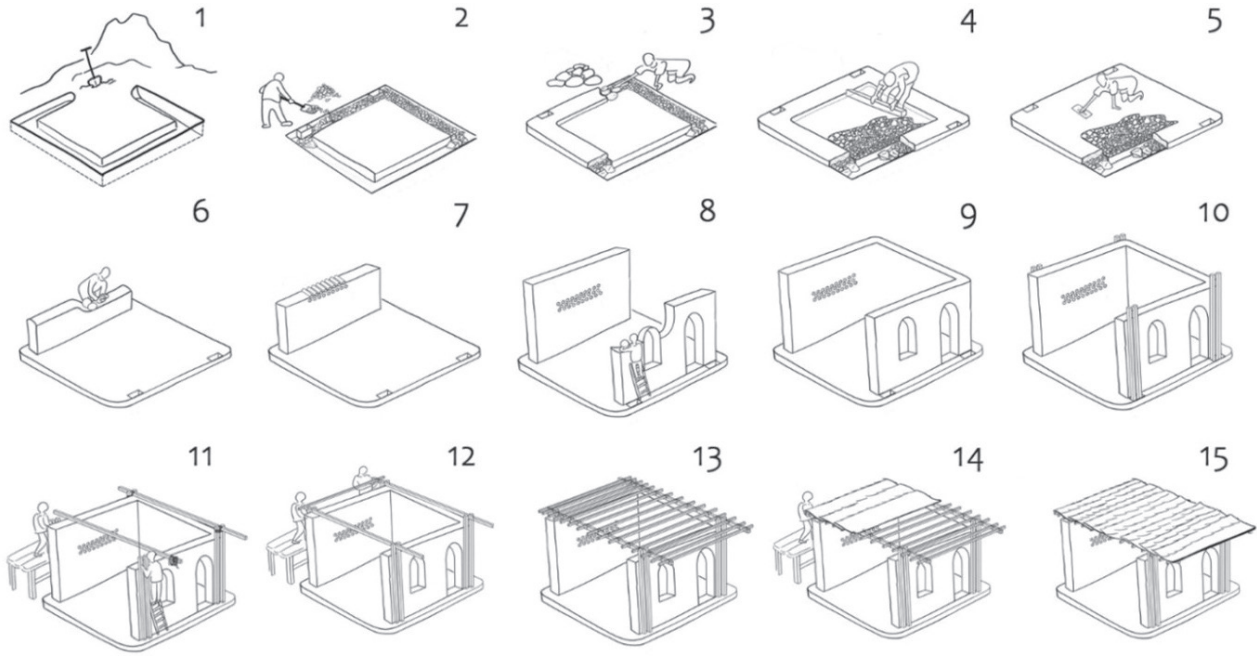

Fig. 12. Womens' House in Baghere, Senegal. The process of building the module (elaborated by A. Karpińska)

Il. 12. Dom Kobiet w Baghere, Senegal. Proces budowy modułu (oprac. A. Karpińska)

a building being erected, but it also allows for its subsequent maintenance, renovation, and demolition. These stages are usually handled by the local community rather than the founder. The local materials characteristic of traditional Senegalese construction and the recycled materials meet strict economic criteria, especially given the designers' attitude to creatively combine traditional technologies with new, simple ones. This approach aims to shorten the construction time and enable its execution by low-skilled people with only basic tools. Thus, economic and social goals can be combined in this manner. By participating in the construction process, the local population can contribute to lowering the investment costs, but also becomes integrated around a common goal and learns to build on their own. This goal was observed in the case of all analyzed objects. Thanks to this approach, the new building becomes more than just a space to be used; it marks the onset of the process of subsequent changes with which it is possible to improve the population's standard of living through their own efforts.

In the case of Senegal, it is also important to maintain the link with local building traditions as cultural heritage. In Senegal, the process of abandoning tradition has only just begun; it is much less advanced than in more developed countries, therefore, it is easier to reverse. Senegal's landscape, especially its rural and suburban landscape, is still marked by construction based on soil, wood, bamboo, and straw. Therefore, targeting technological changes to creatively combine technologies based on these materials with new ones can protect this country from unfavorable landscape changes observable in diverse developed countries (including Poland) and ensure the valuable cultural continuity of local construction.

Finally, native technologies and technologies based on low-processed or re-used materials follow the pro-ecological directions directly. Without detailed calculations, it can be concluded that the objects discussed above are characterized by a low carbon footprint and high adaptation to climatic conditions. Such characteristics would be difficult to achieve by proposing alternative solutions.

In conclusion, it can be stated that the technological solutions applied in the context of humanitarian goals fulfilled by the above-analyzed buildings fit in with the sustainable development concept. The role of an architect involved in such projects requires designing the building itself. However, full participation in co-creating social, economic, and environmental processes conducive to the long-term development of future users is also required. The research presented above may contribute to further studies. In order to get a better insight into the specificity of Senegal, it would be necessary to extend the research to include a larger number of sites and to analyze the applied solutions in more detail, for instance, according to the LCA (Life Cycle Assessment) criteria. The authors intend to extend the research scope to other cultural and climatic zones in search of a possibly universal model with which to combine community-based pro-social goals with ecological ones in the context of the use of native and low-processed construction technologies.

Translated by
Emilia Mełgieś

References

[1] Charlesworth E., *Humanitarian Architecture. 15 stories of architects working after disaster*, Routledge, Abingdon-on-Thames 2014.

[2] Lubelska M., *Architektura humanitarna. Wybrane zagadnienia*, PhD thesis. Wydział Architektury, Politechnika Krakowska, Kraków 2015.

[3] Boylston S., *Designing with society*, Routledge, Abingdon-on-Thames 2019.

[4] Charlesworth E., *Architects without frontiers*, Routledge, Abingdon-on-Thames 2006.

[5] Martins N., *Humanitarian architecture in practice: reducing risk and building resilience in incremental housing and post-disaster reconstruction*, [in:] N. Martins, L. Hobeica, A. Hobeica, P.P. Santos, N. Eltinay, J.M. Mendes (eds.), *8th International Conference on Building Resilience, 14–16 November 2018, Lisbon, Portugal. Book of Papers*, Universidade de Lisboa, CiAUD, FCT, Lisbon 2019, 523–529, https://3a5cb13e-4d06-41e6-9768-4b9fc2524ae2.filesusr.com/ugd/954133_d7043527605f40d69d220d1345c724a7.pdf [accessed: 18.03.2021].

[6] Ajith Kumar G., Priyadharshini S., Narayanan M., Shalini Kumari M., *Role of humanitarian architecture*, "Journal of Architecture and Civil Engineering" 2021, Vol. 6, Iss. 10, 01–05, https://www.academia.edu/57114006/Role_of_Humanitarian_Architecture [accessed: 20.01.2022].

[7] Smith C.E., *Design with other 90%: Cities*, Cooper Hewitt, Smithsonian Design Museum, New York 2011.

[8] *Słownik języka polskiego PWN*, https://sjp.pwn.pl/ [accessed: 26.05.2022].

[9] The World Bank in Senegal, https://www.worldbank.org/en/country/senegal/overview#1 [accessed: 16.02.2021].

[10] *Africa must follow Senegal's lead and ensure rural communities are not forgotten*, "Africa Times" 30.09.2019, https://africatimes.com/2019/09/30/africa-must-follow-senegals-lead-and-ensure-rural-communities-are-not-forgotten/ [accessed: 16.02.2021].

[11] *Climate of Senegal*, https://www.britannica.com/place/Senegal/Climate [accessed: 16.05.2022].

[12] Kelm T., *Architektura ziemi. Tradycja i współczesność*, Oficyna Wydawnicza PW, Warszawa 2014.

[13] *In Detail: Building Simply*, Ch. Schittich (ed.), Birkhäuser, Berlin 2005.

[14] Weisman A., Bryce K., *Building with cob*, UIT Cambridge, Cambridge 2006.

[15] Pelmoine T., Mayor A., *Vernacular architecture in eastern Senegal: Chaînes opératoires and technical choices*, "Journal of Material Culture" 2020, Vol. 25, Iss. 3, 348–378, doi: 10.1177/1359183520907929.

[16] Federal Ministry of Environment, *Nature Conservation and Nuclear Safety, Sustainable Buildings and Construction in Africa*, https://www.cscp.org/wp-content/uploads/2016/05/28_Tessema_Taipale_Bethge__2009__Sustainable_Building_and_Construction_in_Africa_en.pdf [accessed:12.11.2021].

[17] https://www.balouosalo.com/project/tanafcenter.html [accessed: 20.01.2021].

[18] https://www.letsbuildmyschool.org/keurracine [accessed: 20.01.2021].

[19] https://tmarch.com/fass [accessed: 25.05.2022].

[20] Karpińska A., *Architektura społecznie zaangażowana. Dom Kobiet w Senegalu*, MSc thesis, Wydział Architektury, Politechnika Gdańska, Gdańsk 2021.

Abstract

Vernacular and low-tech technologies in humanitarian architecture on the example of Senegal

Humanitarian architecture belongs to the broader trend of socially engaged architecture, whose main goal is to introduce new values to the quality of life of particular communities. Specifically, humanitarian architecture deals with aid to poverty-stricken communities. The context of economic constraints poses a particular challenge to architects and builders. It is a matter of natural necessity to look for cheap, locally available materials and solutions that can be applied by unskilled labor. The above article discusses the applicability of native and low-tech technologies as basic construction methods for humanitarian architecture. The research focuses on Senegal, located in West Africa. The article aims to identify material and construction solutions in buildings related to humanitarian aid and social support on behalf of the local community, erected or designed in Senegal. An analysis of four examples in Senegal was conducted, namely, two implemented facilities and two planned ones. The basic criteria for the analysis were provided by the social purpose these objects serve, as well as by the materials and technologies applied. The conclusions concern the types and scope of vernacular and low-tech technologies applied, as well as the correlation between the analyzed objects' design and construction and sustainable development.

Key words: humanitarian architecture, vernacular architecture, sustainable development

Streszczenie

Technologie rodzime i low-tech w architekturze humanitarnej na przykładzie Senegalu

Architektura humanitarna mieści się w szerszym nurcie tak zwanej architektury zaangażowanej społecznie, której celem nadrzędnym jest wniesienie nowych wartości do jakości życia określonych społeczności. Konkretnie w przypadku architektury humanitarnej mamy do czynienia z pomocą niesioną społecznościom dotkniętym ubóstwem. Kontekst ograniczeń ekonomicznych jest szczególnym wyzwaniem dla projektantów i budowniczych. Naturalną koniecznością staje się poszukiwanie materiałów i rozwiązań tanich, dostępnych lokalnie, możliwych do wykorzystania przez niewykwalifikowaną siłę roboczą. Artykuł dotyczy możliwości zastosowania technologii rodzimych i low-tech jako podstawowych metod budowlanych dla architektury humanitarnej. Badania ukierunkowano na kontekst konkretnego państwa zachodniej Afryki – Senegalu. Celem artykułu jest rozpoznanie rozwiązań materiałowo-budowlanych w budynkach wzniesionych lub projektowanych w Senegalu związanych z pomocą humanitarną i wsparciem społecznym lokalnej ludności. Przeprowadzono analizę czterech przykładów zlokalizowanych na obszarze tego kraju: dwóch obiektów zrealizowanych oraz dwóch obiektów projektowanych. Jako podstawowe kryteria analizy przyjęto cel społeczny obiektów oraz zastosowane materiały i technologie. Wnioski dotyczą rodzajów i zakresu zastosowania technologii rodzimych i low-tech oraz odniesienia procesu projektowania i wznoszenia analizowanych obiektów do idei zrównoważonego rozwoju.

Słowa kluczowe: architektura humanitarna, architektura rodzima, rozwój zrównoważony