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Review

Passive Solar Systems for the Promotion of Thermal Comfort in African Countries: A Review

Michael M. Santos [1,*], Ana Vaz Ferreira [2] and João C. G. Lanzinha [1]

[1] Centre of Materials and Building Technologies (C-MADE/UBI), Department of Civil Engineering and Architecture, University of Beira Interior (UBI), 6201-001 Covilhã, Portugal
[2] Civil Engineering Department, Polytechnic Institute of Castelo Branco, 6000-084 Castelo Branco, Portugal
* Correspondence: michael.santos@ubi.pt

Abstract: Globally, the residential sector consumes a significant amount of energy. Therefore, bioclimatic architectural systems which consider passive solutions should be studied, analyzed, and implemented to reduce energy consumption. This review aims to promote thermal comfort in African countries by using passive solar systems. It begins with the keyword thermal comfort and then reviews articles published over the last ten years that consider bioclimatic architecture and construction strategies in Africa, the main trends in scientific research in this field, and the possibilities for each climate zone in achieving the highest degree of climate comfort. Following an extensive review, certain bioclimatic architectural strategies adopted in specific countries can be applied in countries with similar climates and this can contribute to significant energy savings through effective functional solar and ventilation design strategies. Several countries have been identified as having the most significant publications on thermal regulations in buildings, and the associated regulations and projects are discussed. Several studies have also examined static and adaptive models of thermal comfort.

Keywords: thermal comfort; passive solar system; passive design; bioclimatic building; African countries; building energy efficiency

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1. Introduction

1.1. Overview

In recent years, the threat of global warming and climate change has increased the awareness of the connection between economic growth, energy use, and environmental pollution [1]. There has also been an increasing concern regarding the use of fossil fuels and their implications for the environment. Simultaneously, Europe is currently facing an energy crisis. Africa has more recently experienced above-average global temperature rises, with the rate of climate change [2] in the subtropics and tropical central areas of the continent nearly doubling. As many countries on the continent are classified as developing countries, they are more vulnerable to the impacts of climate change. Consequently, inequalities within the population have also increased [3].

It is estimated that buildings account for approximately 40% of the world's energy consumption and contribute to more than 30% of CO_2 emissions. Most of this energy is used to obtain thermal comfort [1]. Excessive energy consumption in a building, which promotes the creation of an excellent indoor climate, is closely related to the comfort needs of its occupants. Yet, it negatively affects the sustainability of buildings and contributes to an increase in CO_2 emissions. Undoubtedly, the rapid penetration of air conditioning equipment into buildings has significantly affected their energy consumption. According to previous studies, refrigeration and air conditioning (AC) account for approximately 15% of the total electricity consumption in the world [4].

Given the importance of energy as a critical component in any global strategy for sustainable development, it is vital to closely monitor the effects of energy policies on thermal comfort, as they pertain to the social, economic, and environmental aspects of sustainable development [5]. Therefore, to reduce the use of energy, it is essential to study, analyze, and implement bioclimatic architectural systems that reduce energy consumption, and to consider the possibilities of passive and active construction solutions without overlooking the comfort level of the user [6]. It is also crucial to address building materials and technologies to reduce construction costs and the environmental impact of construction to find solutions to thermal comfort problems [1,7].

1.2. Thermal Comfort Models

It has been shown by different authors that there are many benefits to understanding thermal comfort when creating satisfactory built environments [8,9]. It is important to note that several factors can influence outdoor thermal comfort and can be classified as direct or indirect. Outdoor thermal comfort can be directly controlled by several physical, physiological, and psychological factors. Physiological and psychological factors, such as behavioral, personal, social, and cultural factors on a local scale, as well as historical and thermal factors, indirectly affect outdoor thermal comfort. Several categories of direct and indirect factors were identified. The physical factor of external thermal comfort can be defined as a combination of several parameters, such as air temperature, thermal radiation, wind, and humidity [10].

Thermal comfort standards must be met within buildings to provide occupants with a comfortable indoor climate. Thermal comfort has been extensively studied from the mid-twentieth century until the present day. In the 1970s, Fanger [11] was the first to present a study on thermal comfort models, also known as static models. Since then, some international standards have been developed [12,13] in which thermal comfort in buildings can be divided into two broad categories: static and adaptive models (Table 1) [14].

Table 1. Evolution of thermal comfort models.

Year	Thermal Comfort Models	Reference
1970	Fanger	[11]
1984	ISO 7730	[15]
1992	ANSI/ASHRAE 55	[16]
1994	ISO 7730	[17]
2004	ANSI/ASHRAE 55 ISSO 74	[18]
2005	ISO 7730	[19]
2007	EN 15251	[20]
2010	ANSI/ASHRAE 55	[21]
2012	GB/T 50785	[22]
2013	ANSI/ASHRAE 55	[23]
2014	ISSO 74	[24]
2017	ANSI/ASHRAE 55	[25]
2019	EN 16798-1	[26]
2020	ANSI/ASHRAE 55	[27]

The static comfort models regarding comfort standards are primarily based on Fanger's widely accepted PMV/PPD model developed in the 1970s. This model incorporates the interaction of six major parameters (air and radiant temperature, relative humidity, metabolic rate, air velocity, and clotting factor). To calculate the PMV index, these parameters were estimated or measured to evaluate the thermal sensation of the human body in a thermally proportioned environment. Based on an adaptive comfort theory, occupants adapt to a thermal environment according to their behavioral, physiological, and psychological responses to the environment [28].

Several countries, such as the Netherlands (ISSO 74) [24] and China (GB/T50785) [22], have developed specific models of adaptive thermal comfort that show significant differences from international standards. It should be noted that the two most used models are ASHRAE 55-2020 [27] and EN 16798-1:2019 [26,29] and both models are based on international research projects and contain large databases. There are some similarities between the two models in terms of their applicability. However, differences can be observed between the two studies (e.g., the categories considered).

Static and adaptive approaches are the two main approaches. According to research studies and standards, the conditions of thermal comfort can vary depending on factors such as the type of building, the user, location, and climate. There has also been recognition that existing operating patterns can have a significant impact on the oscillations of internal operating temperature. In recent years, international standards have been modified and studies have been published on thermal comfort (especially adaptive thermal comfort). As a result of adaptive models, users who live in buildings with natural ventilation are better able to adjust to changes in temperature, thereby increasing upper and lower temperature limits. Therefore, a greater number of thermal comfort hours can be maintained over a shorter period than with static operational patterns that require HVAC systems.

Therefore, many studies have examined the potential of adaptive thermal comfort models for buildings [12,30,31]. For example, Aljawabra and Nikolopoulou [32] demonstrated cultural differences in thermal comfort between residents of Marrakech and Phoenix, which share the same climatic conditions.

1.3. Objectives

The main objective of this critical review of the literature is to identify passive solar systems that promote better energy efficiency of buildings and users' thermal comfort, focusing on African countries. Starting from a literature review with the keyword thermal comfort and the different African countries, we analyze the articles published in the last ten years that consider bioclimatic architecture and building strategies in African countries.

2. Methods and Results

2.1. Methods

This bibliographic review, part of the 'Proposal for a Methodology for Sustainable Rehabilitation Strategies of Existing Building Stock—The Ponte Gêa Neighborhood' [33], identifies the main bioclimatic strategies compatible with the principles of sustainability that can be implemented in developing African countries.

This review process is illustrated in Figure 1, in which the general theme is passive solar systems for thermal comfort in African countries, with a literature search carried out in Scopus and Web of Science (WOS) conducted on 23 April 2022.

2.2. Results

Based on a literature search conducted in Scopus and WOS on 23 April 2022, this article discusses passive solar systems with a focus on African countries. Using the keyword "Thermal Comfort", 30,604 articles were found in Scopus and 23,833 in Web of Science. Figure 2 shows that the topic of thermal comfort has been studied since the mid-twentieth century, but it began to have a greater expression in 1969 with 12 articles found in Scopus and five in WOS, which coincides with the publication of Fanger's static thermal comfort model. However, it is evident that there has been a significant increase in publications over the last 20 years (Figure 2), thus suggesting a growing interest in the subject, possibly related to the concept of sustainable development and construction defined in Agenda 21 of the CIB.

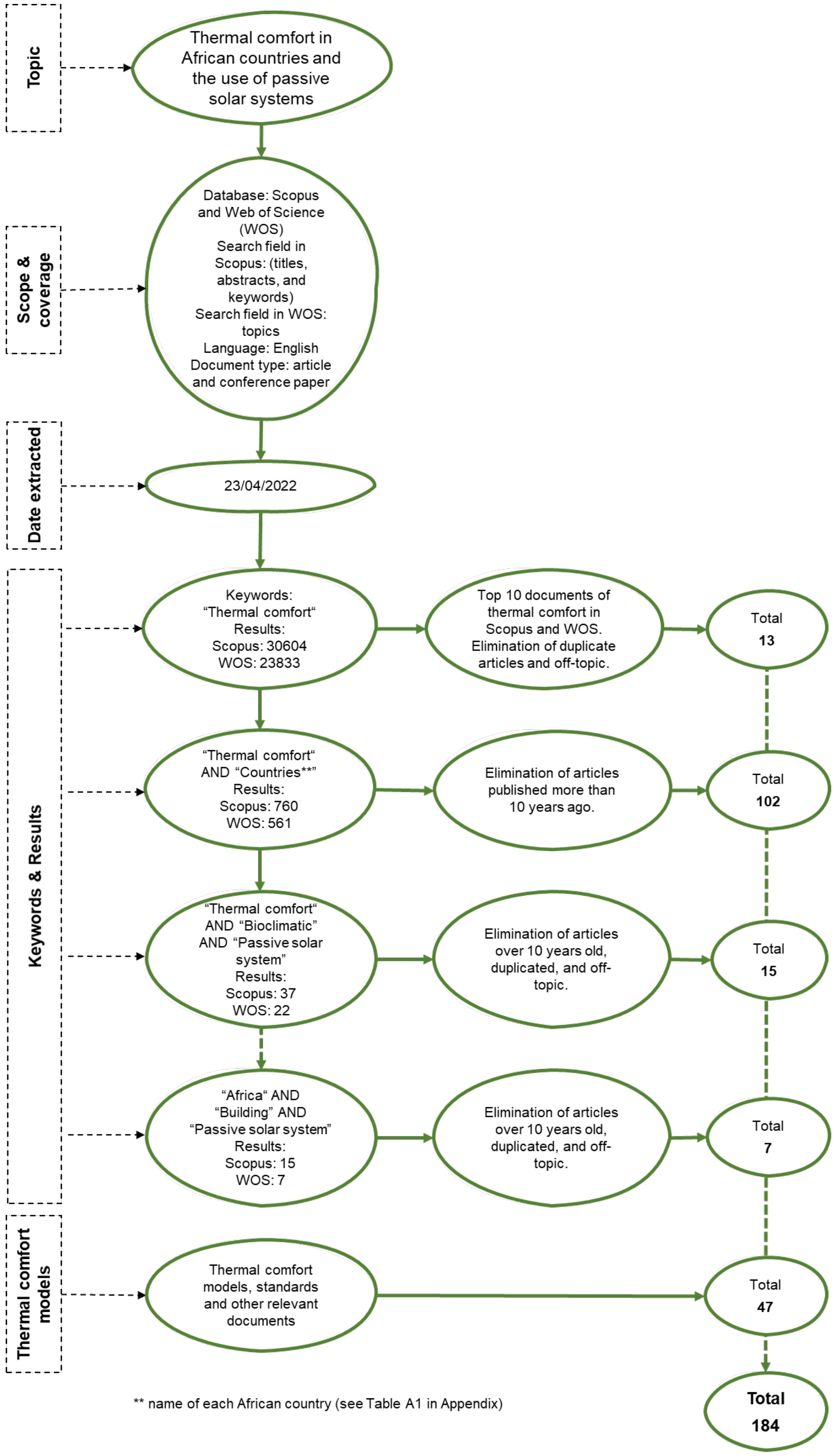

Figure 1. Literature acquisition method in the review process.

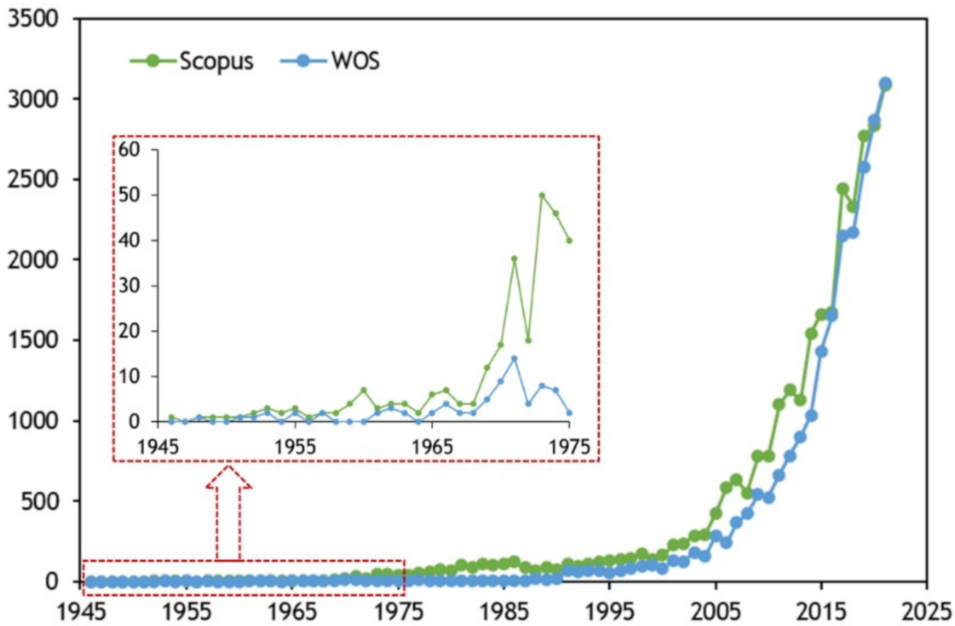

Figure 2. Evolution of the number of publications with the keyword "Thermal Comfort" in Scopus and WOS.

According to the number of citations, Tables 2 and 3 list the top ten most cited documents related to thermal comfort in Scopus and WOS.

Table 2. Top 10 documents regarding thermal comfort found in Scopus based on the number of citations.

No	Article Title	Published in	No. of Citations	Year of Publication/Reference
1	Developing an adaptive model of thermal comfort and preference	ASHRAE Transactions	1258	1998 [34]
2	The physiological equivalent temperature—A universal index for the biometeorological assessment of the thermal environment	International Journal of Biometeorology	1212	1999 [35]
3	Adaptive thermal comfort and sustainable thermal standards for buildings	Energy and Buildings	1144	2002 [14]
4	Review on thermal energy storage with phase change materials (PCMs) in building applications	Applied Energy	1120	2012 [36]
5	A review on energy conservation in building applications with thermal storage by latent heat using phase change materials	Energy Conversion and Management	1063	2004 [37]
6	Thermal adaptation in the built environment: A literature review	Energy and Buildings	946	1998 [38]
7	Thermal comfort in naturally ventilated buildings: Revisions to ASHRAE Standard 55	Energy and Buildings	894	2002 [39]

Table 2. *Cont.*

No	Article Title	Published in	No. of Citations	Year of Publication/Reference
8	Standard predictive index of human response to the thermal environment.	ASHRAE Transactions	828	1986 [40]
9	Thermal comfort and building energy consumption implications—A review	Applied Energy	726	2014 [1]
10	Comfort and thermal sensations and associated physiological responses at various ambient temperatures	Environmental Research	644	1967 [41]

Table 3. Top 10 documents regarding thermal comfort found in WOS based on the number of citations.

No	Article Title	Published in	No. of Citations	Year of Publication/Reference
1	Urban greening to cool towns and cities: A systematic review of the empirical evidence	Landscape and Urban Planning	1192	2010 [42]
2	The physiological equivalent temperature—a universal index for the biometeorological assessment of the thermal environment	International Journal of Biometeorology	1038	1999 [35]
3	Review on thermal energy storage with phase change materials (PCMs) in building applications	Applied Energy	999	2012 [36]
4	Modelling radiation fluxes in simple and complex environments: basics of the RayMan model	International Journal of Biometeorology	990	2010 [43]
5	A review on energy conservation in building applications with thermal storage by latent heat using phase change materials	Energy Conversion and Management	956	2004 [37]
6	Adaptive thermal comfort and sustainable thermal standards for buildings	Energy and Buildings	929	2002 [14]
7	Cooling the cities—A review of reflective and green roof mitigation technologies to fight heat island and improve comfort in urban environments	Solar Energy	815	2014 [44]
8	Thermal adaptation in the built environment: a literature review	Energy and Building	736	1998 [38]
9	Thermal comfort in naturally ventilated buildings: revisions to ASHRAE Standard 55	Energy and Building	691	2002 [39]
10	Thermal comfort and building energy consumption implications—A review	Applied Energy	621	2014 [1]

After this initial research, the search procedure with the keyword "Thermal comfort" was added, with the name of each of the 54 African countries and the previous names of those that changed their name since 1957 as the second keyword. Figure 3 (Appendix A, Table A1) shows the number of documents per country (keywords).

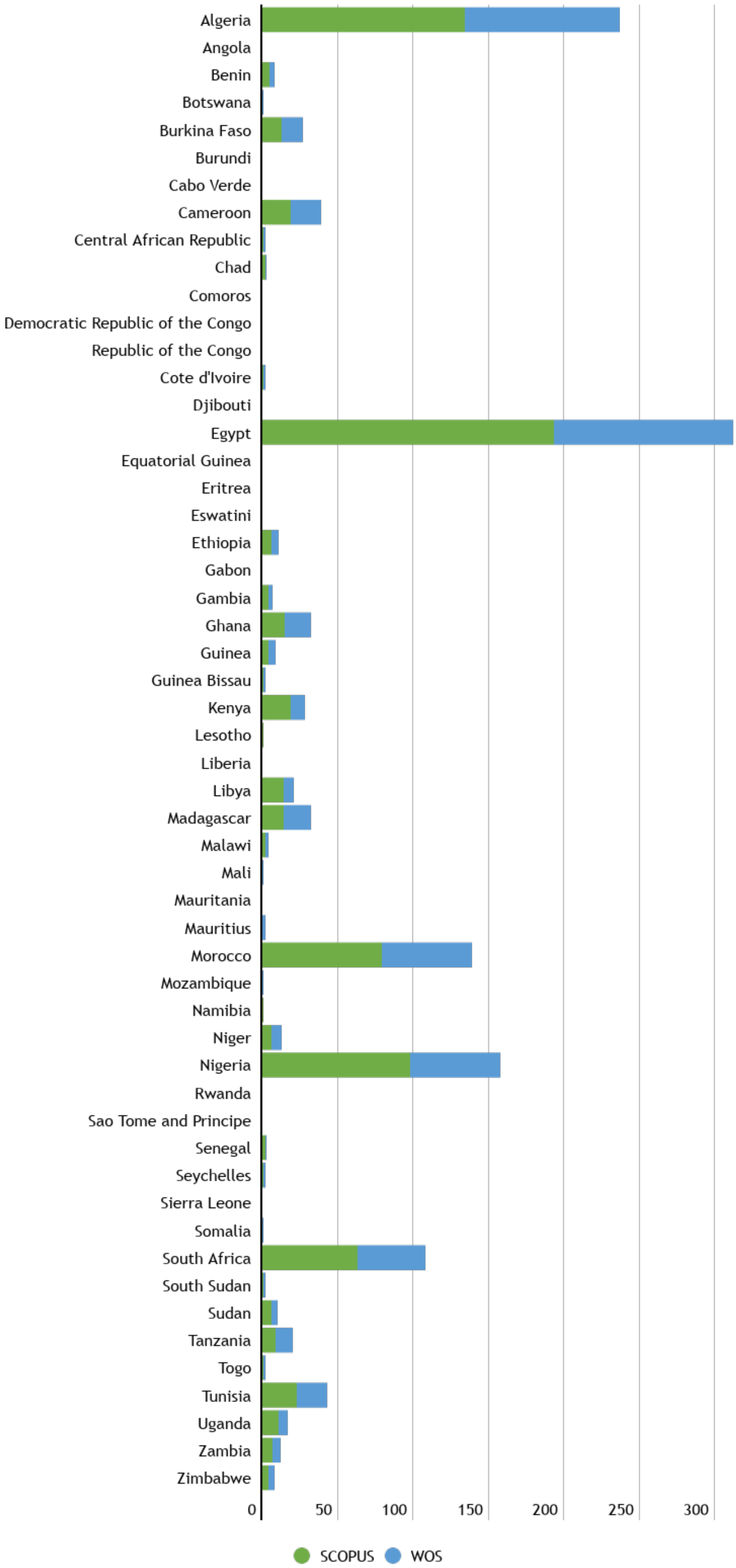

Figure 3. The number of "thermal comfort" documents including "name of the country" found in Scopus and WOS.

As mentioned before, the objective of this study was to show how thermal comfort using passive solar systems in African countries is considered. Articles from the last 10 years as well as the most relevant case studies from the previously identified countries (Appendix A, Table A2) were analyzed and categorized according to bioclimatic architecture construction strategies: heating internal gains, passive and active solar heating and materials, humidification, conventional heating, solar protection, cooling through a high thermal mass, evaporative cooling, cooling through high thermal mass with nocturnal renovation, cooling through natural and mechanical ventilation, air conditioning, and conventional dehumidification (adapted by Manzano-Agugliaro et al. [6]). In Appendix A, Table A2 presents the most relevant articles identified on African countries and study topics according to the previously defined categories in: North Africa or Northern Africa; West Africa or Western Africa; Central Africa (Middle Africa, or also Equatorial Africa); East Africa; and Southern Africa.

The keywords 'Thermal comfort' were searched in combination with 'Bioclimatic', 'Passive solar system', 'Africa', 'Construction', and 'Passive solar system.' After eliminating duplicates, abstracts were read, and 22 articles were selected as indicated in the discussion of this review. In addition to the previously selected articles, 47 additional documents were included in the body of the article as they correspond to thermal comfort models, standards, and other relevant documents.

3. Discussion

The significant global energy consumption of buildings, their vulnerability to climate change, and the current energy crisis in Europe caused by the Ukrainian War is a factor of growing attention. Studying, analyzing, and implementing bioclimatic architecture and building solutions that use both passive and active systems to reduce energy consumption is crucial.

Developing African countries often face extreme environmental conditions, according to COP26; despite their low contribution to climate change, they are the most affected [45] and have limited financial resources, making it challenging to adopt technologies to improve the thermal comfort of occupants in buildings. However, in the review of publications (in Appendix A, Table A2), it is possible to detect some evidence of how passive solar systems reflect the culture and traditions of African people and the differences arising from different climates and surrounding environments.

Climate classification maps use the Köppen–Geiger climate classification system which has been widely considered in studies worldwide. Based on an update of the climate maps of Köppen–Geiger, presented by Hylke E. Beck et al. [46], there are three climatic zones (A, B, and C) on the African continent. Of the three climate types, arid B is the most prevalent, followed by tropical A and temperate C (Figure 4a). Projections (2071–2100) show a reduction in zone "C" and an increase in climatic zones "A" and "B." In other words, in the future, African countries will be dominated by arid and tropical climates (Figure 4b).

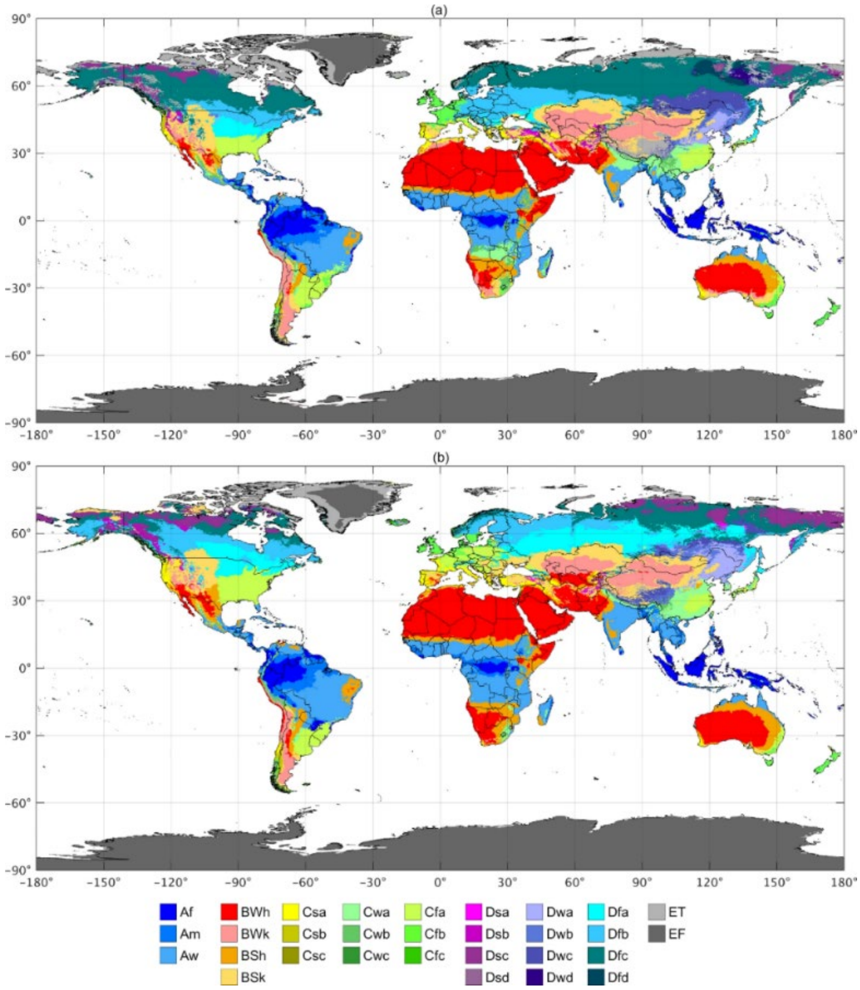

Figure 4. Update, presented by Hylke E. Beck et al. [46], on the climate classification maps of Köppen–Geiger. (**a**) displays the current map for between the years 1980 and 2016 and (**b**) the projections for the years 2071 to 2100.

3.1. Bioclimatic Architectural Strategies

Due to the existence of different climates and natural environments, specific passive solar systems have been incorporated into the architecture of the entire African continent. A psychometric graph created by Givoni [47] defined zones representing possible architectural bioclimatic strategies that could be implemented to achieve comfort within a building [6].

This review identifies possible predefined systematic responses to climatic demands. As shown in Table A2, passive solar systems were selected and categorized. Traditional techniques for naturally cooling buildings have also been examined for local construction [48]. In this set of regions, passive and active solar heating and materials, solar protection, and cooling through natural and mechanical ventilation have been the most studied by different authors (Figure 5).

Defining thermal comfort standards is vital for the development of a project and for providing a thermally comfortable indoor climate for its occupants [1]. The human body is most comfortable at temperatures between 21 and 26 °C, and the relative humidity is between 20% and 70%. Approximately 70% of the population is comfortable in this zone with light clothes and low activity, which is the zone of the Givoni diagram in which the human body does not require energy to remain comfortable, and no strategies are required [6].

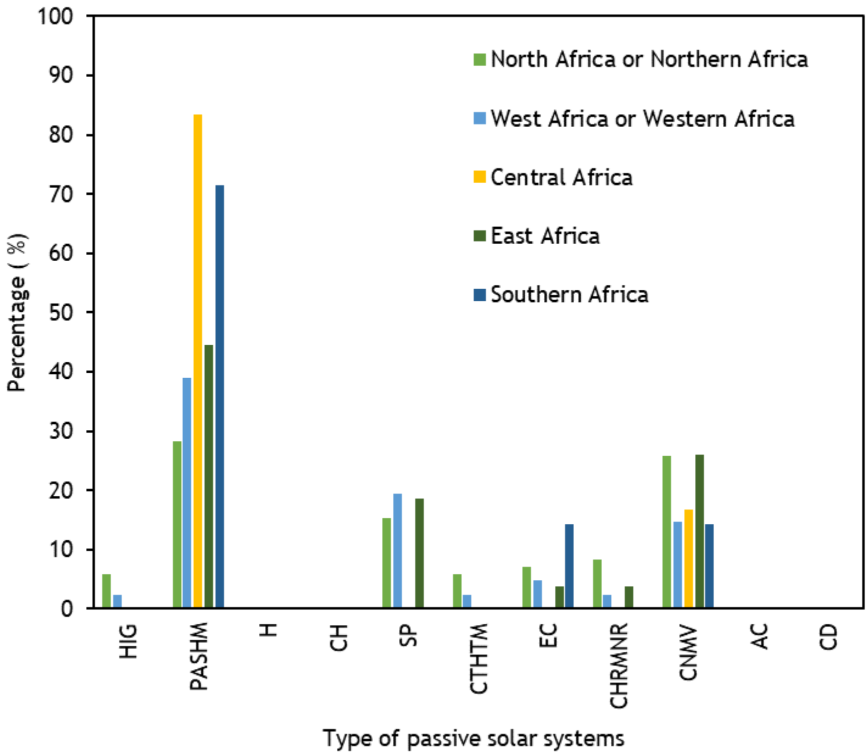

Figure 5. Identified solutions by region as a percentage. In which: HIG; PASHM; H; CH; SP; CTHTM; EC; CHRMNR; CNMV; AC; CD as mentioned in Appendix A, Table A2.

Simulating the behavior of different architectural solutions using computer programs is essential to analyzing the behavior of buildings. According to the literature review, the most used simulation software to compare building performance and optimization is Design-Builder [49], EnergyPlus [50,51], and TRNSYS [52]. Several criteria can be met to generate an efficient building. It should be comfortable, respect all construction requirements, minimize investment and energy costs, and minimize carbon emissions [53].

3.1.1. Passive and Active Solar Heating and Materials

In the Givoni diagram, zones are defined with bioclimatic strategies considering the characteristics of air, humidity, and temperature to assess thermal sensation and comfort. The necessity of passive and active solar heating is defined for a temperature range between 7 °C and 13.5 °C [6]. To move towards the comfort zone, a solar absorption strategy must allow thermal energy to be gained within the area.

Different solutions are available in this zone because any part of the building envelope, including the ground, walls, roof, and openings, can capture energy. When required, radiation can enter a building through good carpentry and glass windows; yet, it cannot escape. For example, large windows provide significant heat transfer to the environment during the Northern Hemisphere winter (Figure 6), and a passively heated house during the Northern Hemisphere summer.

The proper orientation of the building consists in avoiding insolation impacts during the summer and capturing the energy of the sun during the winter. Thus, longer façades oriented towards the underheated period result in improved daylight during the heating season, while the shorter façades towards the overheated period control excessive insolation during the cooling season. The smaller the surface area exposed to solar radiation, the greater the energy reduction for cooling is. Notably, the exposure of each façade to the sun in each hemisphere was different. Façades facing south in the Northern Hemisphere and those facing north in the Southern Hemisphere can be reached by the highest altitude of the sun during the cooling season and the lowest altitude of the sun during the cooling season [54], as illustrated in Figure 6.

The use of PCMs within the walls [43,55], ceilings, and floors of buildings can enhance energy storage and human comfort by capturing solar energy directly and reducing temperature changes. The indoor air can be kept close to the desired temperature for an extended period.

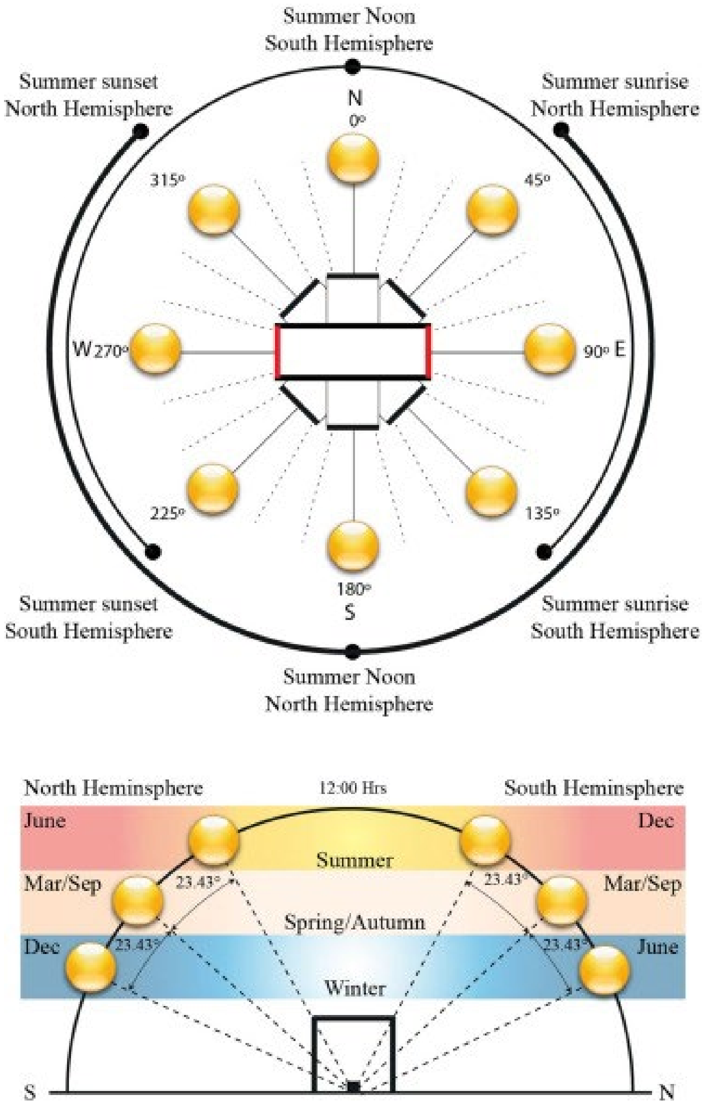

Figure 6. Schematic plan and section of an isometric rectangular building in the path of the summer sun [54].

Trombe wall solution is another classic therapeutic strategy [56–58]. There is an air channel between the layers of exterior glazing on this massive wall. Almost all the glass is closely attached to the wall, so there is no habitable space between the layers. By incorporating glazing, this massive wall can absorb and store solar energy. A certain amount of energy is transferred to the interior of the building through the wall via conduction. Meanwhile, cooler air enters the air channel of the room through an opening in the bottom wall, is heated by the wall, and flows upward due to buoyancy [56]. On the other hand, passive solar heating is similar to active solar heating, except that the fluid is heated and warms the interior of the building [6,59].

In such cases, architectural elements must permit radiation to enter the building envelope when necessary and prevent it from leaving outside. Good joinery and glass windows are essential for the walls, roofs, and openings. Moreover, solar thermal and photovoltaic cells can be used in buildings to capture energy and produce electricity for conventional thermal-conditioning systems [60,61].

For instance, Guechchati et al. [62] demonstrated in Morocco that 6 cm of thermal insulation reduced the annual heating requirement by 8.38% and the annual cooling requirement by 70.54%.

3.1.2. Solar Protection

The use of shading is recommended at temperatures above 20 °C, and it is a bioclimatic architectural strategy to avoid heat gain through solar radiation [63], where the openings of a building must be protected. However, they can also be applied in external environments [64]. This can be achieved naturally through trees, pergolas with vegetation, or architectural elements (Figure 7) [51]. In terms of shading the glazed areas, the building must be protected from significant solar gains in the windows, where proper orientation can help reduce the solar gains through glazing [65,66].

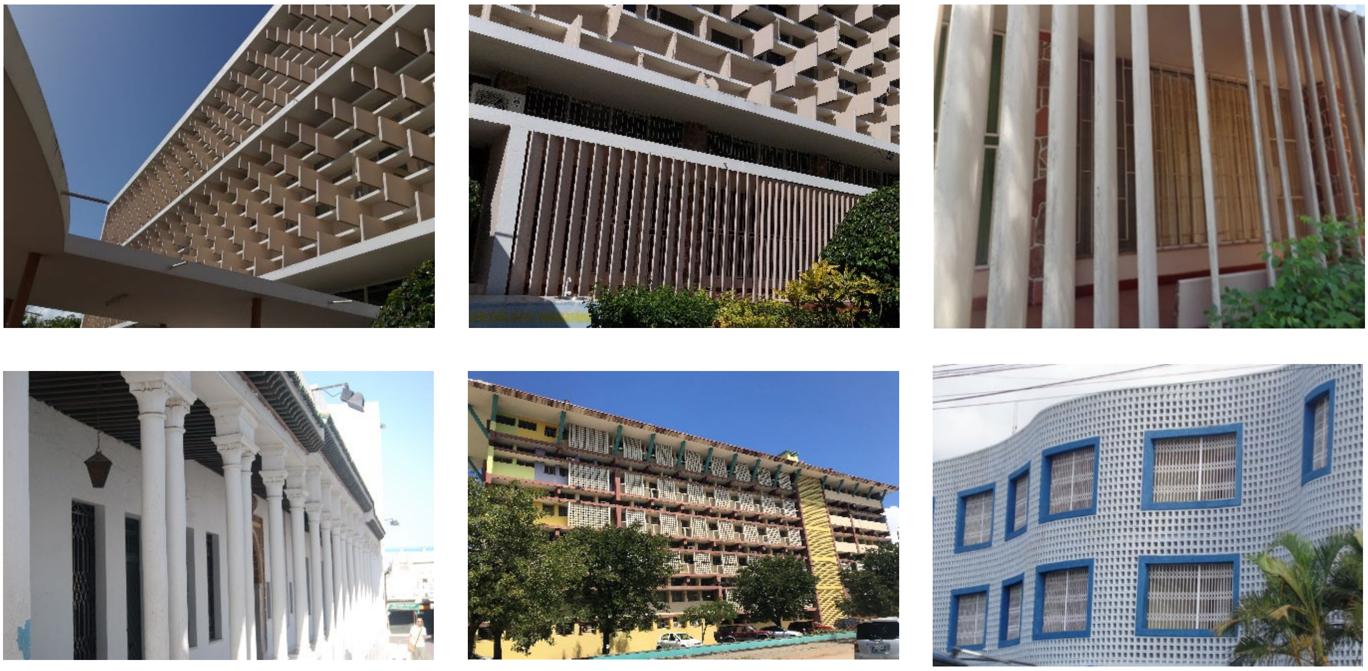

Figure 7. Examples of exterior elements that promote shading are integrated into the building architecture in Beira in Mozambique, including fixed (vertical and horizontal) canopies, movable vertical canopies, projecting balconies, fixed overhang grids, or the existence of an exterior façade with cast elements for shading.

Fixed devices, such as horizontal or vertical flaps [67], grilles, balconies, patios [68], and neighboring buildings, can reduce the incidence of sunlight before it passes through the glass [64,69], thus preventing the greenhouse effect, such as horizontal louvers used above window areas [70]. In Uganda, over 50% of the extreme overheating is prevented by shading strategies during the hottest months of the year [71]. It is essential to guarantee a certain distance between the shading element and glazed measurement such that the thermal radiation captured by the shading element is not transmitted to the interior of the building [72–74]. The use of light colors for shading improves solar radiation reflection performance [63,71].

However, adjustable devices such as blinds, shutters, louvers [75], swivel louvers, awnings, curtains [76,77], or pergolas can be more effective than fixed devices, as they can be adjusted for different angles of sunlight. They also allow for greater flexibility in taking advantage of natural light according to individual preferences.

Vegetation is another form of shading, especially in lower buildings [78]. Therefore, it is essential to pay attention to the vegetation type. Perennial leaves are needed for cases in which shading is required throughout the year, and deciduous leaves for cases in which shading is intended only for part of the year [6].

3.1.3. Cooling through Natural and Mechanical Ventilation

Natural ventilation involves the flow of air between the outside and inside of a building. This is caused by two natural forces: the first is due to the difference in pressure created by the wind around the building (wind action), and the second is due to a difference in temperature (effect chimney) [79]. First, the wind pressure is influenced by intensity, direction, and obstruction, in which the span distribution, size, and shape are fundamental elements for efficient ventilation. The second method is suitable for tall buildings, primarily when the wind cannot provide adequate air movement when there is low wind speed, or an unpredictable pattern. The chimney effect generates a vertical pressure difference that depends on the average temperature difference between the air column and outside temperature, opening size, location, and height of the air column. Cold air enters the building at ground level, and warm air rises and exits through the top. However, when the outside temperature is too high, it is necessary to prevent heat gain through ventilation [80,81].

Ceiling fans increase indoor air speed by increasing convective processes and improving comfort. Thus, unlike mechanical ventilation, which relies on fans or other mechanical equipment, natural ventilation requires little energy. However, insufficient natural ventilation can be reinforced with low-consumption mechanical cooling devices, such as fans [82–84].

Some measures to lower the temperature include insulating the roof, creating hot-air outlets in the upper part, and openings in the lower part of the air inlet to provide cross ventilation [85,86].

In hot climates, unilateral and cross-ventilation through vents, windcatchers, solar chimneys [87], and natural ventilation systems have been combined with evaporative cooling [59,88]. Furthermore, this effect can be achieved mechanically by using fans or blowers. In summary, cross-ventilation is characterized by openings on two or more façades (Figure 8), whereas unilateral ventilation is a condition in which the entrance is located in only one façade.

Figure 8. Example of ventilation using adjustable vents in windows to promote evaporative cooling. In addition, ventilation through the chimney effect with an air inlet at the bottom and outlet at the top of the roof (Beira, Mozambique).

Cross-ventilation is generally seen as more effective than unilateral ventilation because it can take better advantage of the high-pressure gradient around the building. In contrast, the efficiency of one-sided ventilation depends on the gradient shape of the single façade [51,84].

Proper ventilation can be achieved in residential buildings using solar chimneys and windcatchers, for example [89,90].

Windcatchers, also known as wind towers, are natural ventilation systems that resemble chimneys and aim to capture the wind outdoors to channel air into interior spaces. During the day, outside air entered the building from the positive-pressure side of the structure. The air inside the building rises and is drawn from the negative-pressure side, where the primary geometric parameters influencing the ventilation rate are height, cross-sectional shape, internal layout, external shape, input and output sizes, shapes, numbers, and positions [84,91].

A solar or thermal chimney [92] is a vertical shaft that uses solar radiation for direct ventilation through a building. During the day, the sun warms the chimney and the air inside [60]. This causes hot air to rise in the chimney, thereby creating an updraft. Fresh air is then drawn into the building through lower vents [84]. Geometric parameters, as well as orientation and slope, materials, building location, latitude and longitude, climate, and season [93] influence performance. In Ahmed Abdeen et al., in Egypt, a proposed solar chimney can passively induce air motion of up to 0.28, 0.47, and 0.52 m/s at mean solar radiation values of 500, 700, and 850 W/m^2, respectively [92], thus removing sensible and latent heat from the body.

3.1.4. Evaporative Cooling

The principle of evaporative cooling is to decrease temperature and increase the humidity of air through the evaporation of water [84]. This strategy is linked to temperatures between 20 °C and 40.5 °C, a strategy advisable in dry and arid climates. The objective was to achieve comfort by reducing the temperature through the evaporation of water and an increase in relative humidity. Humidification can be performed with outdoor vegetation, water, and patios, complemented by the presence of water and vegetation, plant cover, roof water spraying, and indoor water spraying to reduce air temperature and increase relative humidity [59,94,95].

Green roofs in buildings and urban environments are also good solutions to improve the thermal insulation of buildings, reducing summer solar heat gains by approximately 70–90% and winter heat loss by 10–30%. Moreover, photosynthesis reduces the carbon footprint of cities [96]. However, evaporative cooling combined with the high flux generated by a solar chimney can reduce indoor temperatures and provide better thermal comfort. However, this system is not always passive, because the water source is sometimes replenished via a low-power mechanical pump [6,97].

3.1.5. Air Conditioning

Because of the current climatic conditions, mechanical ventilation equipment and air conditioning are increasingly used in African countries [98]. Several other recommendations for air conditioning use include not lowering the thermostat below normal temperature, reducing energy consumption, and turning off air conditioners when leaving the house. During the hot season, the temperature must be maintained at 26 °C without consuming excessive energy [48,99].

The practice of bioclimatic architecture mentioned in this review is the first step towards a significant reduction in energy consumption in buildings, so it is urgent to promote the use of alternative, renewable energies, as well as the rationalization of consumption, avoiding unnecessary expenses and bearing in mind that the sun and wind are the two renewable energy sources that can be used mainly for the production of electricity for the consumption of this type of equipment and current use in the home [100].

There are some situations in which wind energy is used to pump water from wells and generate electricity. The electricity obtained through the generators can be connected to a distribution network and used later in the absence of wind [101].

On the other hand, photovoltaic energy converts solar radiation into electrical energy through solar cells. Photovoltaic panels do not produce noise or waste except at the end of their useful life. Photovoltaic and passive solar technology form an ideal system. In Africa, there is intense solar radiation throughout the year; therefore, a house with this system is self-sufficient in producing electricity [102,103].

3.1.6. Conventional Dehumidification

Generally, strategies for dehumidification must be implemented to absorb water from the environment and achieve comfort. One of the ways this can be achieved is by combining absorbent salts and saline cells with other approaches [6].

3.1.7. Conventional Heating

Passive heating strategies are insufficient to reach a comfortable temperature zone in spaces at temperatures between −5 °C and 1 °C, particularly in regions with extreme climates. For adequate comfort, a temperature of approximately 20 °C is sufficient during the cold season. To increase the average temperature to 20 °C, it is necessary to consume electricity, gas, oil, or coal. If the temperature is lowered by one degree, 8% more energy can be saved. In many climates, it is possible to turn off the heating at night because the heat generated during the day is sufficient [6].

3.1.8. Cooling through a High Thermal Mass

Cooling through thermal mass is a viable strategy when temperatures fluctuate between 20 and 35 °C. The thermal mass in a building envelope receives radiation from the exterior and transmits it to the interior with a phase difference throughout the day, to maintain a uniform climate. A phase difference is created when the energy intensity and temperament are transmitted through capacitive materials [104]. Mobile devices should be protected during the day to minimize gains and enhance nighttime dissipation [6].

3.1.9. Cooling by High Thermal Mass with Nocturnal Renovation

To efficiently transmit energy, the building envelope must be constructed using capacitive materials with the most remarkable phase difference (approximately 12 h) and some damping. The strategy is limited to temperatures between 20 °C and 44 °C. This method works well when day and night temperatures differ significantly. Openings, patios, and roofs should be used at night for dissipation and renovation [6].

3.1.10. Humidification

Humans are susceptible to developing respiratory disorders due to a lack of moisture in the air, which results in excessive dryness of the airways and causes dermatitis. Supplementing indoor air with water vapor in specific climatic zones is necessary to ensure optimal indoor air quality. Humidity can be introduced into buildings using air channels, which are common bioclimatic architectural strategies. Pressure differentials or mechanical devices can passively move the air. Air movement conditions must be considered to maintain relative humidity levels above 22.5 °C in the surrounding rooms. There is a common strategy for planting vegetation near or within buildings, such as near patios, surfaces, or water sources [6].

3.1.11. Heating Internal Gains

It is possible to obtain internal gains from people sharing spaces, artificial lighting, machines that generate thermal energy, and processes that generate heat, thus helping to obtain a comfortable temperature zone. Considering the temperature differences, internal gains can be applied as a sensible load in the building climate calculations [104,105].

3.2. Urban Spaces

Microclimate and outdoor thermal comfort were significantly influenced by urban design patterns in each urban morphology. Solar access, wind speed, and direction at street level are affected by factors such as building height and orientation, the distance between buildings, and lot coverage. Microclimate and comfort conditions can be improved by urban design elements, such as vegetation and shading [106].

In the tropics, indoor and outdoor air temperatures continue to be the dominant climatic factors that affect thermal comfort. It is well known that afternoons in the tropics can be uncomfortable due to the intense solar radiation that leads to high air temperatures during this period [107].

Outdoor thermal comfort plays a significant role in the health of urban environments where the urban microclimate also affects the energy consumption of buildings. As urbanization and climate change increase, the urban heat-island effect is likely to become more pronounced, and the form of the city affects the duration of direct sunlight, mean radiant temperature, and wind speed, which play important roles in achieving optimal thermal comfort [108]. Several strategies can be used to improve thermal comfort in outdoor spaces, including shading, increasing vegetation, and planting more trees [109].

Soheir S. Limona et al. [110] investigated the impact of urban forms on coastal cities in Egypt using different simulation methods (ENVI-met 4.0 simulation software). Based on the simulation results, air temperature, wind speed, relative humidity, and PMV affected outdoor comfort in different urban layouts [111]. Different orientations of urban layouts with the same height, volume, and width of buildings yielded different results in terms of comfort, thus indicating that the parameters of urban geometry have a positive effect on human comfort.

However, the popularity of green roofs in urban landscaping is growing because of their smaller footprint, aesthetic value, insulation benefits, and heat-island mitigation benefits [95]. Plants associated with building materials have also been investigated for their ability to reduce surface temperature [112].

For example, in the urban morphology of Ghadame in Libya, the settlements and the contiguity of houses prevents people from being exposed to the sun, and this, in turn, provides shade for people to rest, meet, and walk comfortably [113]. Urban morphology, however, can profoundly affect the amount of solar energy available on façades, and consequently, reduce solar gains [114].

3.3. Thermal Regulation in Buildings

Countries with the highest number of publications analyzed in this work present specific regulations or draft regulations in the area or are currently discussing them in their plans and strategies. Consequently, strategies and rules for improving the energy efficiency of buildings have become increasingly important. Building legislation generally includes minimum energy efficiency requirements.

For example, energy efficiency is incorporated into the Nigerian building code. To ensure better energy access and security for Nigerians, the NESP (Nigerian Energy Support Program) supports the Federal Ministry of Energy, Works, and Housing by integrating energy efficiency into the National Building Code [115].

In the Algerian Plan for the 'Development of Renewable Energy and Energy Efficiency 2011–2030′ [116], expanding the use of renewable energy and diversifying energy sources in the country are considered. The plan specifies improving the thermal insulation of buildings as the objective [117]. Consequently, thermal regulations were established (DTR C3-2, DTR C3-4, and DTR C3-31) in residential buildings characterized by six distinct climate zones [118]. In DTR C3-2, regarding the thermal regulation of residential buildings, calculation methods for determining building heat loss provides building professionals with methods for determining thermal winter losses by setting thresholds. Calculation methods for determining building heat gains and the thermal regulation of residential buildings are also considered under DTR C3-4. The natural ventilation of residential premises is addressed in DTR C3-31, which also considers the thermal regulation of residential buildings. General principles governing the design of natural ventilation installations and calculation methods are also introduced [72,119].

In October 2014, the Moroccan government issued a decree entitled 'The Thermal Regulation Code' (decree no. 2-13-874) [120]. New construction projects must comply with the minimum technical requirements for thermal performance, as of December 2015. Six climate zones were defined to meet the specific thermal requirements of residential and tertiary use.

In 2009, Egypt's National Housing and Building Research Center introduced energy efficiency codes for residential and commercial buildings with minimum design and application requirements being mandatory for project submission [121]. These codes are expected to result in approximately 20% energy savings and a reduction of up to 30% in discomfort hours [122].

In South Africa, SANS 204: Energy Efficiency in Buildings specifies the design requirements for energy-efficient buildings and services with natural ventilation and air conditioning [123] and SANS 204-1 provides a general set of energy efficiency requirements. These documents outline the new building code performance parameters (SANS 10400 series) using the approach used in the revised South African building regulations. To demonstrate compliance, either rational design or adequate rules were followed along the route. The first part of SANS 204 establishes the general requirements for achieving energy efficiency for all building types. It will eventually form part of the National Building Regulation. Parts 2 and 3, which deal with naturally ventilated and artificially ventilated buildings, respectively, form part of the National Building Code of SANS 10400.

It is understood that there is an effort to regulate thermal comfort and construction quality in African countries when designing new buildings, or undertaking significant renovations to improve indoor air quality and thermal comfort conditions, as well as reduce buildings' energy requirements and consumption.

3.4. Essential Recommendations and Limitation of the Study

To achieve comfort without using devices that consume electricity or others that leave large ecological footprints, comfort must be prioritized as a fundamental objective. Providing an adequate comfort zone is the premise of bioclimatic architecture, which must be incorporated into all societies to minimize the use of refrigeration devices. To achieve this goal, society must be aware of climate change and the environmental impacts of energy consumption.

In this review, relevant parameters to be considered in establishing the thermal comfort of building users in African countries are addressed, thus promoting more sustainable cities. Thus, the design of buildings and urban forms only reach actual sustainability value when they ensure the standards of efficiency and comfort necessary for human life. In general, new constructions tend to adopt air conditioning in a generalized way to promote cooling the interior space. However, there are already many examples that prove the effectiveness, better levels of comfort, and economic advantages of the use of passive techniques. There is still a great need to disseminate this knowledge and increase the number of passive buildings in terms of new construction and rehabilitation, where the cooling of buildings is essential to obtain comfortable environments.

The objective of passive cooling techniques is to prevent the accumulation of heat gains, provide natural cooling, and preventing overheating. The passive strategy aims to provide comfortable environments inside buildings and simultaneously reduce energy consumption. Some issues, such as the types of materials to be used, the selection of the place, and the shape and orientation of the building, are the main options to consider for optimizing exposure to the solar path and prevailing winds.

Optimizing the orientation and the passive area contributes to avoiding overheating situations, and is the first step in promoting strategies for protection and heat dissipation. Heat protection techniques such as shading, window sizing, reflective wrapping, or insulation provide thermal protection against the penetration of unwanted heat gains into the building and minimize internal gains. Vegetation elements along the facades or even the cladding of facades with plant elements also promote interior comfort and work as a filter from the sun's rays. Walls should, where possible, be insulated and sufficiently massive to retard heat penetration during the day and cold at night.

Heat dissipation techniques maximize the loss of heat accumulated inside the building, dissipating it through natural ventilation and thermal inertia, evaporation, radiation, or a "heat well", such as the ground. These techniques prevent overheating, bringing the indoor temperature values to levels close to, or even below, the outdoor air temperature.

Direct solar radiation is by far the primary source of heat. The use of solar control techniques in architectural design is a high-priority strategy to minimize the impact of solar gains on the building.

Designing passive cooling systems to achieve greater efficiency involves combining several strategies. Passive cooling techniques can be improved/complemented with mechanical renewable energy systems, such as solar or photovoltaic panels, or low-power fans.

Thus, a more in-depth study of geographic area and climate classification of Köppen–Geiger, using Table A1, may be helpful to understand and standardize more precisely the most efficient passive solar systems to achieve thermal comfort inside buildings, complemented by existing legislation, and considering the socio-cultural issues of each region, i.e., how people adapt to the climate.

4. Conclusions

Passive design strategies reduce energy consumption while providing a comfortable environment inside buildings. By designing buildings according to these bioclimatic principles and using materials and construction elements intelligently and efficiently, buildings can adapt to the surrounding environment, thereby avoiding or reducing fossil-fuel-burning mechanical systems.

Aiming to minimize energy consumption and achieve thermal comfort in buildings on the African continent, this article discusses architectural bioclimatic strategies. These principles can be applied if the global external climates are similar.

The selected studies identified passive and active solar heating, materials, solar protection, and natural and mechanical ventilation as the most significant factors.

Considering the negative impact of the use of fossil fuels on the environment, it is urgent to promote alternative energies. In this way, and considering the climatic characteristics of African countries, wind and sun are two sources of renewable energy that can be taken advantage of. We highlight the photovoltaic and passive solar technology due to the intense solar radiation throughout the year, thus promoting a self-sufficient building producing electricity.

At temperatures above 20 °C, sunscreen should be applied, and deciduous trees, pergolas with vegetation, or architectural elements should provide the shade. The principle of preventing heat gain by solar radiation is primarily used to protect the openings of a building and it can also be applied to its surroundings.

Both passive and active solar heating and materials are suitable for temperatures between 7 °C and 13.5 °C. To move into the comfort zone, a solar absorption strategy is necessary to gain thermal energy within the internal spaces, because large windows on the south-facing façade in the Northern Hemisphere contribute significantly to heating. The ground, walls, roof, and openings of this zone can capture energy, providing different solutions. High-quality carpentry and glass windows allow radiation to enter the building, when necessary, but mean it cannot escape. Energy storage can also be improved by encapsulating phase change materials in floors, ceilings, and walls of buildings. Trombe wall execution is one of the classic therapeutic strategies.

In hot climates, natural ventilation involves airflow between the outside and inside of a building, where solar chimneys, windcatchers, and evaporative cooling can improve thermal comfort. According to studies, the temperature inside can be reduced by 8 °C when the outdoor temperature exceeds 35 °C.

Microclimates and outdoor thermal comfort are significantly influenced by urban design patterns. Solar access, wind speed, and street-level direction are determined by building height and orientation, space between buildings, and lot coverage. Various urban design elements, such as vegetation and shading, can improve microclimates and comfort conditions.

African countries with the most publications have specific regulations or draft regulations in the area or are currently discussing them in their plans and strategies. Therefore, it is becoming increasingly important to design and implement building rules to improve energy efficiency. The minimum energy efficiency requirements are also included in the building legislation.

It is suggested to deepen the study on a smaller scale, per geographic area and Köppen–Geiger climate classification, to standardize the passive solar systems used to achieve thermal comfort, complemented by existing legislations and strategic plans in these regions.

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Abbreviations

PMV	Predicted Mean Vote
PPD	Predicted Percentage of Dissatisfied
HIG	Heating Internal Gains
PASHM	Passive and Active Solar Heating and Materials
H	Humidification
CH	Conventional Heating
SP	Solar Protection
CTHTM	Cooling Through a High Thermal Mass
EC	Evaporative Cooling
CHRMNR	Cooling by High Thermal Mass with Nocturnal Renovation
CNMV	Cooling through Natural and Mechanical Ventilation
AC	Air Conditioning
CD	Conventional Dehumidification

Appendix A

Table A1. The number of “thermal comfort” documents including “name of the country” in SCOPUS and WOS.

Name of Country	No of Articles	
	Scopus	WOS
Algeria	134	103
Angola	-	-
Benin	5	3
Botswana	-	1
Burkina Faso	13	14
Burundi	-	-

Table A1. *Cont.*

Name of Country	No of Articles	
	Scopus	WOS
Cabo Verde	-	-
Cameroon	19	20
Central African Republic	1	1
Chad	2	1
Comoros	-	.
Democratic Republic of the Congo	-	-
Republic of the Congo	-	-
Cote d'Ivoire	1	1
Djibouti	-	-
Egypt	193	119
Equatorial Guinea	-	-
Eritrea	-	-
Eswatini	-	-
Ethiopia	6	5
Gabon	-	-
Gambia	4	3
Ghana	15	17
Guinea	4	5
Guinea Bissau	1	1
Kenya	19	9
Lesotho	1	-
Liberia	-	-
Libya	14	7
Madagascar	14	18
Malawi	2	2
Mali	-	1
Mauritania	-	-
Mauritius	-	2
Morocco	79	60
Mozambique	-	1
Namibia	1	-
Niger	6	7
Nigeria	98	60
Rwanda	-	-
São Tomé and Príncipe	-	-
Senegal	2	1
Seychelles	1	1
Sierra Leone	-	-

Table A1. *Cont.*

Name of Country	No of Articles	
	Scopus	**WOS**
Somalia	-	1
South Africa	63	45
South Sudan	1	1
Sudan	6	4
Tanzania	9	11
Togo	1	1
Tunisia	23	20
Uganda	11	6
Zambia	7	5
Zimbabwe	4	4

Table A2. Relevant case studies identified by date/year found in SCOPUS and WOS regarding countries in Africa.

Country	**Article Title**	**Year of Publication/Reference**	**N. Citations**	**HIG**	**PASHM**	**H**	**CH**	**SP**	**CTHTM**	**EC**	**CHRMNR**	**CNMV**	**AC**	**CD**
North Africa or Northern Africa														
Argelia	Studying the influence of shading devices on indoor thermal comfort in desert and Mediterranean climates	2022 [64]	0					•						
	Simulation Investigation of Natural Ventilation on the Thermal Comfort in Arid Regions: Case Ghardaïa	2022 [82]	1		•							•		
	Towards Low Energy and Thermal Comfort of Buildings Through Passive Cooling or Heating Strategies in Hot Arid Climates	2022 [119]	0		•						•	•		
	Towards a Sustainable Building Material in Hot Arid Environments: Compressed and Stabilized Earth Brick (CSEB) Prototype	2021 [124]	0		•									
	Evaluation of summer thermal comfort in arid desert areas. Case study: Old adobe building in Adrar (South of Algeria)	2021 [125]	4						•					
	Judicious method of integrating phase change materials into a building envelope under Saharan climate	2021 [126]	4		•									

Table A2. *Cont.*

Country	Article Title	Year of Publication/Reference	N. Citations	HIG	PASHM	H	CH	SP	CTHTM	EC	CHRMNR	CNMV	AC	CD
	Exploring building's envelope thermal behavior of the neo-vernacular residential architecture in a hot and dry climate region of Algeria	2021 [73]	4		•			•	•			•		
	Experimental study of an earth-to-air heat exchanger coupled to the solar chimney for heating and cooling applications in arid regions	2021 [60]	11									•		
	Experimental study on the thermal behavior of exterior coating textures of building in hot and arid climates	2021 [127]	1		•									
	Contemporary architecture with glass façades facing the energy efficiency of solar materials (VPV-IGU) in the hot climate of the Saharan region—A case study in Bechar	2021 [128]	0	•	•									
	Comparative bioclimatic approach for comfort and passive heating and cooling strategies in Algeria	2019 [116]	21		•					•		•		
	Assessment of energy and environmental performances of a bioclimatic dwelling in Algeria's North	2018 [72]	5		•			•						
Egypt	Compliance with Building Energy Code for the Residential Sector in Egyptian Hot-Arid Climate: Potential Impact, Difficulties, and Further Improvements	2022 [122]	0		•									
	Optimizing daylight utilization of flat skylights in heritage buildings	2022 [129]	3		•									
	Study of Shading Device Parameters of the Mixed-Mode Ventilation on Energy Performance of an Office Building: Simulation Analysis for Evaluating Energy Performance in Egypt	2022 [130]	0					•				•		
	Towards an adaptation of efficient passive design for thermal comfort buildings	2021 [79]	3									•		
	Passive design strategies for residential buildings in a hot desert climate in upper Egypt	2019 [70]	7	•	•			•	•	•	•	•		•
	Solar chimney optimization for enhancing thermal comfort in Egypt: An experimental and numerical study	2019 [92]	48									•		

Table A2. *Cont.*

Country	Article Title	Year of Publication/Reference	N. Citations	HIG	PASHM	H	CH	SP	CTHTM	EC	CHRMNR	CNMV	AC	CD
	Thermal performance and comfort of vernacular earthen buildings in Egypt and Portugal	2017 [131]	4	•				•	•			•		
	Assessing the thermal performance of envelope parts under climate change scenarios: Residential case studies in Egypt	2017 [132]	0										•	
	The impact of different green roofs strategies on the indoor thermal comfort "with special reference to Cairo-Egypt"	2014 [95]	3							•				
	From construction to operation: Achieving indoor thermal comfort via altering external walls specifications in Egypt	2013 [83]	3		•							•		
Libya	Comparative study of traditional and contemporary Islamic dwelling design: The case of Benghazi, Libya	2020 [68]	0		•			•		•		•	•	
	Thermal comfort, adaptability, and sustainability of vernacular single-family houses in Libya	2017 [133]	3					•			•	•		
	Optimising residential courtyard in terms of social and environmental performance for Ghadames Housing, Libya	2017 [134]	1								•	•		
	Bioclimatic housing design to desert architecture: A case study of Ghadames, Libya	2014 [113]	2		•			•			•	•		
Morocco	Optimization of thermal efficiency in traditional clay-based buildings in hot–dry locations. Case study: the south-eastern region of Morocco	2022 [135]	0		•									
	Building Design Optimization to Enhance Thermal Comfort Performance: A Case Study in Marrakech Region	2021 [136]	0		•									
	The Impact of Arid Climate on the Indoor Thermal Comfort in the South-East of Morocco	2021 [137]	3		•									
	Energy savings and thermal comfort benefits of shading devices: Case study of a typical Moroccan building	2019 [138]	2						•					
	Bioclimatic Building Design Analysis. Case Study: Oujda, Morocco	2019 [139]	0								•	•		

Table A2. *Cont.*

Country	Article Title	Year of Publication/Reference	N. Citations	HIG	PASHM	H	CH	SP	CTHTM	EC	CHRMNR	CNMV	AC	CD
	Improving energy efficiency of Moroccan buildings through energy-efficient envelope design: A case study	2018 [140]	0		•			•						
	Shading devices optimization to enhance thermal comfort and energy performance of a residential building in Morocco	2018 [67]	50					•						
	Thermal performance assessment of passive techniques integrated into a residential building in semi-arid climate	2017 [105]	28	•	•			•			•	•		
	Experimental study of thermal properties of a new ecological building material based on peanut shells and plaster	2017 [141]	22		•									
Sudan	Low-Exergy Building Using Renewable Energy for Indoor Thermal Comfort: Experimental Study and Thermodynamic Analysis	2021 [142]	0									•		
	The impact of a passive wall combining natural ventilation and evaporative cooling on schools' thermal conditions in a hot climate	2021 [59]	6							•		•		
	Adaptation of climate-responsive building design strategies and resilience to climate change in the hot/arid region of Khartoum, Sudan	2019 [104]	44	•				•		•		•		
Tunisia	Thermal Performance Analysis of Trombe Wall for Passive Solar Building with Computational Fluid Dynamics	2022 [57]	0		•									
	Numerical Study on the Thermal Performance of Trombe Wall for Passive Solar Building in Semiarid Climate	2021 [58]	1		•									
	Design and simulation of a novel solar air-conditioning system coupled with solar chimney	2018 [88]	19									•		
	Model performance assessment and experimental analysis of a solar assisted cooling system	2017 [87]	13									•		
	Effect of glazing type on the performance of a Trombe wall in Tunisia	2015 [56]	1		•									

Table A2. *Cont.*

Country	Article Title	Year of Publication/Reference	N. Citations	HIG	PASHM	H	CH	SP	CTHTM	EC	CHRMNR	CNMV	AC	CD
West Africa or Western Africa														
Benin	Improving the energy efficiency of an office building by applying a thermal comfort model	2021 [143]	0		•									
	Evaluation of thermal comfort in an office building in the humid tropical climate of Benin	2020 [144]	6		•									
	TRNSYS Software Used for the Simulation of the Dynamic Thermal Behavior of a F2-building in Lokossa City in Benin Republic	2018 [145]	1		•									
Burkina Faso	Development of Bioclimatic Passive Designs for Office Building in Burkina Faso	2022 [51]	0		•							•		
	A model for thermal comfort assessment of naturally ventilated housing in the hot and dry tropical climate	2022 [146]	2									•		
	Hygrothermal performance of the building envelope with low environmental impact: Case of a hemp concrete envelope	2021 [147]	0									•		
	Improving thermal comfort of earthen dwellings in sub-Saharan Africa with passive design	2019 [148]	29		•			•					•	
	Thermal, hydric, and mechanical behaviours of adobes stabilized with cement	2018 [149]	36		•									
Cameroon, DRC, Cote d'Ivoire, Nigeria, Senegal, Madagascar, Ethiopia	Evaluation of bioclimatic potential, energy consumption, CO_2-emission, and life cycle cost of a residential building located in Sub-Saharan Africa; a case study of eight countries	2021 [150]	6		•			•					•	
Gambia	Measuring ventilation in different typologies of rural Gambian houses: A pilot experimental study	2020 [151]	5									•		
	Mitigating high energy consumption for residential buildings in the Gambia	2017 [66]	0		•			•					•	

Table A2. *Cont.*

Country	Article Title	Year of Publication/Reference	N. Citations	HIG	PASHM	H	CH	SP	CTHTM	EC	CHRMNR	CNMV	AC	CD
Ghana	Thermal State, Potential of Natural and Fan-Induced Ventilation in Enhancing Comfort of Nine Office Buildings in Southern Ghana	2022 [152]	1										•	
	An explorative study on the potential of green roofs providing thermal comfort conditions for indoor spaces in Kumasi, Ghana	2021 [94]	0							•				
	Minimizing heat transmission loads and improving energy efficiency of building envelopes in sub-Saharan Africa using bio-based composite materials	2020 [153]	8		•									
	Effects of climate change for thermal comfort and energy performance of residential buildings in a Sub-Saharan African climate	2019 [65]	12		•			•						
Guinea	The present and future energy performance of the first Passivhaus project in the Gulf region	2016 [154]	5		•			•					•	
Guinea-Bissau	Architecture for Refugees, Resilience Shelter Project: A Case Study Using Recycled Skis	2017 [155]	6		•									
Nigeria	Optimization of building envelopes using indigenous materials to achieve thermal comfort and affordable housing in Abuja, Nigeria	2022 [156]	1		•									
	Transient Simulation of a Building-Integrated Hybrid Solar Collector/Nocturnal Radiator with In-Built Thermal Storage for Space Cooling in Owerri, Nigeria	2021 [157]	1						•		•			
	Effects of wall openings on effective natural ventilation for thermal comfort in classrooms of primary schools in Enugu Metropolis, Nigeria	2021 [158]	1									•		
	Indoor comfort and adaptation in low-income and middle-income residential buildings in a Nigerian city during a dry season	2019 [77]	10		•			•						
	Perceived indoor environmental quality of hospital wards and patients' outcomes: A study of a general hospital, Minna, Nigeria	2019 [159]	2	•	•									

Table A2. *Cont.*

Country	Article Title	Year of Publication/Reference	N. Citations	HIG	PASHM	H	CH	SP	CTHTM	EC	CHRMNR	CNMV	AC	CD
	Indoor thermal comfort for residential buildings in the hot-humid climate of Nigeria during the dry season	2017 [160]	3									•	•	
	Impact of building envelope construction on thermal comfort: A parametric analysis of modern, low-income housing in south-west Nigeria for current and future climates	2017 [161]	0		•									
	The effect of vegetation on indoor and outdoor thermal comfort conditions: Evidence from a microscale study of two similar urban buildings in Akure, Nigeria	2016 [78]	16					•		•				
	An assessment of comfort levels of buildings with shaded and non- shaded windows in warm humid climates	2013 [69]	0					•						
Central Africa (Middle Africa, or also Equatorial Africa)														
Cameroon	Energy performance of earthen building walls in the equatorial and tropical climates: a case study of Cameroon	2020 [162]	3		•									
Cameroon	Building construction materials effect in tropical wet and cold climates: A case study of office buildings in Cameroon	2016 [163]	7		•									
Cameroon	Thermal comfort and energy consumption in modern versus traditional buildings in Cameroon: A questionnaire-based statistical study	2014 [164]	52		•									
Cameroon	A field study on thermal comfort in naturally ventilated buildings located in the equatorial climatic region of Cameroon	2014 [165]	49									•		
Chad	Mechanical and thermophysical characterization of local clay-based building materials	2020 [166]	0		•									
Chad	Effect of cow's dung on thermophysical characteristics of building materials based on clay	2015 [167]	6		•									
East Africa														
Ethiopia	An investigation of human thermal comfort and adaptation in naturally ventilated residential buildings and its implication for energy use in tropical climates of Ethiopia	2022 [168]	0									•		

Table A2. *Cont.*

Country	Article Title	Year of Publication/Reference	N. Citations	HIG	PASHM	H	CH	SP	CTHTM	EC	CHRMNR	CNMV	AC	CD
Kenya	Reducing cooling demands in Sub-Saharan Africa: A study on the thermal performance of passive cooling methods in enclosed spaces	2021 [63]	1		•			•				•		
	Solar-shading systems designed to increase user satisfaction in public buildings, a case study of Britam Towers in Nairobi, Kenya	2021 [75]	0					•						
	Comparison of the energy saving potential of adaptive and controllable smart windows: A state-of-the-art review and simulation studies of thermochromic, photochromic and electrochromic technologies	2019 [169]	0		•									
	Architectural passive solar design for three buildings in Kenya: Observations made in lowering energy use in non-domestic buildings	2017 [170]	0					•				•		
	Indoor overheating risk and climate change. Modelling sensitivity of building design parameters for a free-running building.	2014 [171]	0		•									
Madagascar	Comparative analysis of bioclimatic zones, energy consumption, CO_2 emission and life cycle cost of residential and commercial buildings located in a tropical region: A case study of the big island of Madagascar	2020 [172]	17		•									
	Energy efficiency and thermal performance of office buildings integrated with passive strategies in coastal regions of humid and hot tropical climates in Madagascar	2020 [173]	3		•									
	Adaptive approach of thermal comfort and correlation between experimental data and mathematical model in some schools and traditional buildings of Madagascar under natural ventilation	2018 [80]	21									•		
	Thermal comfort and comparison of some parameters coming from hospitals and shopping centers under natural ventilation: The case of Madagascar Island	2017 [81]	32									•		

Table A2. *Cont.*

Country	Article Title	Year of Publication/Reference	N. Citations	HIG	PASHM	H	CH	SP	CTHTM	EC	CHRMNR	CNMV	AC	CD
	Dynamic simulation of the green roofs impact on building energy performance, case study of Antananarivo, Madagascar	2015 [96]	20							•				
Malawi	Envelope thermal design optimization for urban residential buildings in Malawi	2016 [86]	9		•							•		
South Sudan	Architecture of the scape: Thermal assessment of refugee shelter design in the extreme climates of Jordan, Afghanistan, and South Sudan	2021 [174]	3		•									
Tanzania	Evaluation of building comfort in developing countries through CFD analysis and TENS method	2018 [175]	0		•							•		
Uganda	Assessment of solar shading strategies in low-income tropical housing: The case of Uganda	2018 [71]	4					•						
	Effects of Solar Shading on Thermal Comfort in Low-income Tropical Housing	2017 [176]	17		•									
	Effects of thermal insulation on thermal comfort in low-income tropical housing	2017 [76]	13					•						
	A study of thermal comfort and thermal preferences in the upland tropical climate of Uganda	2016 [98]	2								•		•	
	Climate Resilient Low-Income Tropical Housing	2016 [177]	11		•									
Zambia	Climate-based analysis for the potential use of coconut oil as phase change material in buildings	2021 [178]	1		•									
Zimbabwe	A parametric analysis on the regeneration performance of silica gel in a proposed comfort provision strategy for a typical office space in Harare, Zimbabwe	2016 [179]	0		•									
Southern Africa														
Lesotho	Experimental validation of an electrical and thermal energy demand model for health centers in sub-Saharan Africa	2017 [180]	0		•									
Namibia	Thermal efficient isolating materials from agricultural residues to improve energy efficiency in buildings	2019 [181]	0		•									

Table A2. *Cont.*

Country	Article Title	Year of Publication/Reference	N. Citations	HIG	PASHM	H	CH	SP	CTHTM	EC	CHRMNR	CNMV	AC	CD
South Africa	Effect of roof cooling and air curtain gates on thermal and wind conditions in stadiums for hot climates	2021 [85]	0							•		•		
	Factors Affecting Indoor Environmental Qualities of Social-Housing Projects in South Africa	2021 [182]	0		•									
	The three little houses: A comparative study of indoor and ambient temperatures in three low-cost housing types in Gauteng and Mpumalanga, South Africa	2020 [183]	3		•									
	Investigating thermal performance of PCM plates for free cooling applications in South Africa	2017 [55]	0		•									

References

1. Yang, L.; Yan, H.; Lam, J.C. Thermal Comfort and Building Energy Consumption Implications—A Review. *Appl. Energy* **2014**, *115*, 164–173. [CrossRef]
2. Fitchett, J.M. Perspectives on Biometeorological Research on the African Continent. *Int. J. Biometeorol.* **2021**, *65*, 133–147. [CrossRef] [PubMed]
3. Nangombe, S.; Zhou, T.; Zhang, W.; Wu, B.; Hu, S.; Zou, L.; Li, D. Record-Breaking Climate Extremes in Africa under Stabilized 1.5 °C and 2 °C Global Warming Scenarios. *Nat. Clim. Change* **2018**, *8*, 375–380. [CrossRef]
4. Santamouris, M.; Kolokotsa, D. Passive Cooling Dissipation Techniques for Buildings and Other Structures: The State of the Art. *Energy Build.* **2013**, *57*, 74–94. [CrossRef]
5. Schlör, H.; Fischer, W.; Hake, J.F. Methods of Measuring Sustainable Development of the German Energy Sector. *Appl. Energy* **2013**, *101*, 172–181. [CrossRef]
6. Manzano-Agugliaro, F.; Montoya, F.G.; Sabio-Ortega, A.; García-Cruz, A. Review of Bioclimatic Architecture Strategies for Achieving Thermal Comfort. *Renew. Sustain. Energy Rev.* **2015**, *49*, 736–755. [CrossRef]
7. Adegun, O.B.; Adedeji, Y.M.D. Review of Economic and Environmental Benefits of Earthen Materials for Housing in Africa. *Front. Archit. Res.* **2017**, *6*, 519–528. [CrossRef]
8. Xia, L.; Lan, L.; Tang, J.; Wan, Y.; Lin, Y.; Wang, Z. Bed Heating Improves the Sleep Quality and Health of the Elderly Who Adapted to No Heating in a Cold Environment. *Energy Build.* **2020**, *210*, 109687. [CrossRef]
9. Shen, J.; Zhang, X.; Lian, Z. Impact of Wooden Versus Nonwooden Interior Designs on Office Workers' Cognitive Performance. *Percept. Mot. Ski.* **2020**, *127*, 36–51. [CrossRef]
10. Lai, D.; Lian, Z.; Liu, W.; Guo, C.; Liu, W.; Liu, K.; Chen, Q. A Comprehensive Review of Thermal Comfort Studies in Urban Open Spaces. *Sci. Total Environ.* **2020**, *742*, 140092. [CrossRef]
11. Fanger, P.O. *Thermal Comfort*; McGraw-Hill: New York, NY, USA, 1970.
12. Bienvenido-Huertas, D.; Rubio-Bellido, C. Adaptive Thermal Comfort Models for Buildings. In *Adaptive Thermal Comfort of Indoor Environment for Residential Buildings*; Springer: Singapore, 2021; pp. 13–33. [CrossRef]
13. Rupp, R.F.; Vásquez, N.G.; Lamberts, R. A Review of Human Thermal Comfort in the Built Environment. *Energy Build.* **2015**, *105*, 178–205. [CrossRef]
14. Nicol, J.F.; Humphreys, M.A. Adaptive Thermal Comfort and Sustainable Thermal Standards for Buildings. *Energy Build.* **2002**, *34*, 563–572. [CrossRef]
15. *ISO 7730:1984*; Moderate Thermal Environments—Determination of the PMV and PPD Indices and Specification of the Conditions for Thermal Comfort. International Organization for Standardization: Geneva, Switzerland, 1984.
16. *ASHRAE 55-1992*; Standard 55-1992. Thermal Environmental Conditions for Human Occupancy. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.: Peachtree Corners, GA, USA, 1992.

17. *ISO 7730:1994*; Moderate Thermal Environments—Determination of the PMV and PPD Indices and Specification of the Conditions for Thermal Comfort. International Organization for Standardization: Geneva, Switzerland, 1994.
18. *ASHRAE 55-2004*; Standard 55-2004. Thermal Environmental Conditions for Human Occupancy. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.: Peachtree Corners, GA, USA, 2004.
19. *ISO 7730:2005*; Ergonomics of the Thermal Environment. Analytical Determination and Interpretation of Thermal Comfort Using Calculation of the PMV and PPD Indices and Local Thermal Comfort Criteria. International Organization for Standardization: Geneva, Switzerland, 2005.
20. *EN 15251*; Indoor Environmental Input Parameters for Design and Assessment of Energy Performance of Buildings Addressing Indoor Air Quality, Thermal Environment, Lighting and Acoustics. European Committee for Standardization: Brussels, Belgium, 2007.
21. *ASHRAE 55-2010*; Standard 55-2010. Thermal Environmental Conditions for Human Occupancy. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.: Peachtree Corners, GA, USA, 2010.
22. *GB/T 50785-2012*; Evaluation Standard for Indoor Thermal Environment in Civil Buildings. Chinese Standard; China Building Industry Press: Beijing, China, 2012.
23. *ASHRAE 55-2013*; Standard 55-2013. Thermal Environmental Conditions for Human Occupancy. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.: Peachtree Corners, GA, USA, 2013.
24. *ISSO 74:2014*; A New Hybrid Thermal Comfort Guideline for the Netherlands. NCEUB: Windsor, UK, 2014.
25. *ASHRAE 55-2017*; Standard 55-2017. Thermal Environmental Conditions for Human Occupancy. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.: Peachtree Corners, GA, USA, 2017.
26. *EN 16798-1:2019*; Energy Performance of Buildings. Ventilation for Buildings Indoor Environmental Input Parameters for Design and Assessment of Energy Performance of Buildings Addressing Indoor Air Quality, Thermal Environment, Lighting and Acoustics. Module M1-6. European Standards. Comite Europeen de Normalisation: Brussels, Belgium, 2019.
27. *ASHRAE 55-2020*; Standard 55-2020. Thermal Environmental Conditions for Human Occupancy. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.: Peachtree Corners, GA, USA, 2021.
28. Rahif, R.; Amaripadath, D.; Attia, S. Review on Time-Integrated Overheating Evaluation Methods for Residential Buildings in Temperate Climates of Europe. *Energy Build.* **2021**, *252*, 111463. [CrossRef]
29. McCartney, K.J.; Fergus Nicol, J. Developing an Adaptive Control Algorithm for Europe. *Energy Build.* **2002**, *34*, 623–635. [CrossRef]
30. Alexis, K.; Ange, T.; Ne, E. Thermal Comfort in Tropical Humid Climate to an Amendment of International Standards. *Eur. J. Sci. Res.* **2012**, *73*, 338–348.
31. Djongyang, N.; Tchinda, R.; Njomo, D. Thermal Comfort: A Review Paper. *Renew. Sustain. Energy Rev.* **2010**, *14*, 2626–2640. [CrossRef]
32. Aljawabra, F.; Nikolopoulou, M. Thermal Comfort in Urban Spaces: A Cross-Cultural Study in the Hot Arid Climate. *Int. J. Biometeorol.* **2018**, *62*, 1901–1909. [CrossRef]
33. Santos, M.M.; Lanzinha, J.C.G.; Ferreira, A.V. Proposal for a Methodology for Sustainable Rehabilitation Strategies of the Existing Building Stock—The Ponte Gêa Neighborhood. *Designs* **2021**, *5*, 26. [CrossRef]
34. De Dear, R.J.; Brager, G.S. Developing an Adaptive Model of Thermal Comfort and Preference. *ASHRAE Trans.* **1998**, *104*, 145–167.
35. Höppe, P. The Physiological Equivalent Temperature—A Universal Index for the Biometeorological Assessment of the Thermal Environment. *Int. J. Biometeorol.* **1999**, *43*, 71–75. [CrossRef]
36. Zhou, D.; Zhao, C.Y.; Tian, Y. Review on Thermal Energy Storage with Phase Change Materials (PCMs) in Building Applications. *Appl. Energy* **2012**, *92*, 593–605. [CrossRef]
37. Khudhair, A.M.; Farid, M.M. A Review on Energy Conservation in Building Applications with Thermal Storage by Latent Heat Using Phase Change Materials. *Energy Convers. Manag.* **2004**, *45*, 263–275. [CrossRef]
38. Brager, G.S.; de Dear, R.J. Thermal Adaptation in the Built Environment: A Literature Review. *Energy Build.* **1998**, *27*, 83–96. [CrossRef]
39. de Dear, R.J.; Brager, G.S. Thermal Comfort in Naturally Ventilated Buildings: Revisions to ASHRAE Standard 55. *Energy Build.* **2002**, *34*, 549–561. [CrossRef]
40. Gagge, A.P.; Fobelets, A.P.; Berglund, L.G. Standard predictive index of human response to the thermal environment. *ASHRAE Trans.* **1986**, *92*, 709–731.
41. Gagge, A.P.; Stolwijk, J.A.J.; Hardy, J.D. Comfort and Thermal Sensations and Associated Physiological Responses at Various Ambient Temperatures. *Environ. Res.* **1967**, *1*, 1–20. [CrossRef]
42. Bowler, D.E.; Buyung-Ali, L.; Knight, T.M.; Pullin, A.S. Urban Greening to Cool Towns and Cities: A Systematic Review of the Empirical Evidence. *Landsc. Urban Plan.* **2010**, *97*, 147–155. [CrossRef]
43. Matzarakis, A.; Rutz, F.; Mayer, H. Modelling Radiation Fluxes in Simple and Complex Environments: Basics of the RayMan Model. *Int. J. Biometeorol.* **2010**, *54*, 131–139. [CrossRef]
44. Santamouris, M. Cooling the Cities—A Review of Reflective and Green Roof Mitigation Technologies to Fight Heat Island and Improve Comfort in Urban Environments. *Sol. Energy* **2014**, *103*, 682–703. [CrossRef]
45. Adepoju, P. Africa Worst Hit by Climate Change Impacts, COP26 Told. *Nature Africa*, 7 November 2021; p. 11. [CrossRef]

46. Beck, H.E.; Zimmermann, N.E.; McVicar, T.R.; Vergopolan, N.; Berg, A.; Wood, E.F. Present and Future Köppen-Geiger Climate Classification Maps at 1-Km Resolution. *Sci. Data* **2018**, *5*, 180214, Erratum in *Sci. Data* **2020**, *7*, 274. [CrossRef]
47. Givoni, B. Comfort, Climate Analysis and Building Design Guidelines. *Energy Build.* **1992**, *18*, 11–23. [CrossRef]
48. Ramos, A.F.F.; da Silva, J.M.M. Adapting Portuguese Architecture to Former African Colonies Climate Conditions. *Int. J. Hous. Sci. Its Appl.* **2017**, *41*, 81–88.
49. DesignBuilder Software Ltd. Home. Available online: https://designbuilder.co.uk/ (accessed on 8 August 2022).
50. EnergyPlus. Available online: https://energyplus.net/ (accessed on 8 August 2022).
51. Zoure, A.N.; Genovese, P.V. Development of Bioclimatic Passive Designs for Office Building in Burkina Faso. *Sustainability* **2022**, *14*, 4332. [CrossRef]
52. Welcome | TRNSYS: Transient System Simulation Tool. Available online: http://www.trnsys.com/ (accessed on 16 August 2022).
53. Nematchoua, M.K. From Existing Neighbourhoods to Net-Zero Energy and Nearly Zero Carbon Neighbourhoods in the Tropical Regions. *Sol. Energy* **2020**, *211*, 244–257. [CrossRef]
54. Valladares-Rendón, L.G.; Schmid, G.; Lo, S.L. Review on Energy Savings by Solar Control Techniques and Optimal Building Orientation for the Strategic Placement of Façade Shading Systems. *Energy Build.* **2017**, *140*, 458–479. [CrossRef]
55. Madyira, D.M.; Mukhodobwane, R.P.; Jen, T.C. Investigating Thermal Performance of PCM Plates for Free Cooling Applications in South Africa. In Proceedings of the ASME International Mechanical Engineering Congress and Exposition (IMECE), Tampa, FL, USA, 3–9 November 2017; Volume 6. [CrossRef]
56. Mohamed, L.; Dehmani, L.; Gagliano, A. Effect of Glazing Type on the Performance of a Trombe Wall in Tunisia. In Proceedings of the 2015 6th International Renewable Energy Congress, IREC 2015, Sousse, Tunisia, 24–26 March 2015. [CrossRef]
57. Dhahri, M.; Aouinet, H.; Sammouda, H. Thermal Performance Analysis of Trombe Wall for Passive Solar Building with Computational Fluid Dynamics. In *Sustainable Energy-Water-Environment Nexus in Deserts*; Advances in Science, Technology & Innovation; Springer: Cham, Switzerland, 2022; pp. 409–417. [CrossRef]
58. Dhahri, M.; Khalilpoor, N.; Aouinet, H.; Issakhov, A.; Sammouda, H.; Emani, S. Numerical Study on the Thermal Performance of Trombe Wall for Passive Solar Building in Semiarid Climate. *Int. J. Photoenergy* **2021**, *2021*, 6630140. [CrossRef]
59. Mohamed, S.; Al-Khatri, H.; Calautit, J.; Omer, S.; Riffat, S. The Impact of a Passive Wall Combining Natural Ventilation and Evaporative Cooling on Schools' Thermal Conditions in a Hot Climate. *J. Build. Eng.* **2021**, *44*, 102624. [CrossRef]
60. Sakhri, N.; Menni, Y.; Chamkha, A.J.; Lorenzini, G.; Ameur, H.; Kaid, N.; Bensafi, M. Experimental Study of an Earth-to-Air Heat Exchanger Coupled to the Solar Chimney for Heating and Cooling Applications in Arid Regions. *J. Therm. Anal.* **2021**, *145*, 3349–3358. [CrossRef]
61. Chan, H.Y.; Riffat, S.B.; Zhu, J. Review of Passive Solar Heating and Cooling Technologies. *Renew. Sustain. Energy Rev.* **2010**, *14*, 781–789. [CrossRef]
62. Guechchati, R.; Moussaoui, M.A.; Mezrhab, A. Improving the Energy-Efficient Envelope Design for Moroccan Houses. *Int. J. Ambient Energy* **2012**, *33*, 184–192. [CrossRef]
63. Olawale-Johnson, O.P.; Ajwang, P.; Ondimu, S.N. Reducing Cooling Demands in Sub-Saharan Africa: A Study on the Thermal Performance of Passive Cooling Methods in Enclosed Spaces. *J. Sustain. Dev. Energy Water Environ. Syst.* **2021**, *9*, 1070313. [CrossRef]
64. Gouveia, J.P.; Palma, P.; Säynäjoki, A.; Heinonen, J.; Junnila, S.; Berkouk, D.; Bouzir, T.; Mazouz, S.; Boucherit, S.; Mokhtari, N. Studying the Influence of Shading Devices on Indoor Thermal Comfort in Desert and Mediterranean Climates. *IOP Conf. Ser. Earth Environ. Sci.* **2022**, *992*, 012004. [CrossRef]
65. Dodoo, A.; Ayarkwa, J. Effects of Climate Change for Thermal Comfort and Energy Performance of Residential Buildings in a Sub-Saharan African Climate. *Buildings* **2019**, *9*, 215. [CrossRef]
66. Author, S.S.; Wang, T.J. Mitigating High Energy Consumption for Residential Buildings in the Gambia. In Proceedings of the 34th International Symposium on Automation and Robotics in Construction ISARC 2017, Taipei, Taiwan, 28 June–1 July 2017; pp. 916–924. [CrossRef]
67. Sghiouri, H.; Mezrhab, A.; Karkri, M.; Naji, H. Shading Devices Optimization to Enhance Thermal Comfort and Energy Performance of a Residential Building in Morocco. *J. Build. Eng.* **2018**, *18*, 292–302. [CrossRef]
68. Ali, N.; Taki, A.; Painter, B. Comparative Study of Traditional and Contemporary Islamic Dwelling Design: The Case of Benghazi, Libya. *WIT Trans. Built Environ.* **2020**, *193*, 39–49. [CrossRef]
69. Odim, O.O. An Assessment of Comfort Levels of Buildings with Shaded and Non- Shaded Windows in Warm Humid Climates. *Adv. Mater. Res.* **2013**, *772*, 835–838. [CrossRef]
70. Elhadad, S.; Baranyai, B.; Gyergyák, J.; Istvan, K.; Salem, A. Passive Design Strategies for Residential Buildings in a Hot Desert Climate in Upper Egypt. *Proc. Multidiscip. Sci. GeoConference SGEM* **2019**, *19*, 495–501. [CrossRef]
71. Hashemi, A. Assessment of Solar Shading Strategies in Low-Income Tropical Housing: The Case of Uganda. *Proc. Inst. Civ. Eng. Eng. Sustain.* **2018**, *172*, 293–301. [CrossRef]
72. Belkacem, N.; Loukarfi, L.; Missoum, M.; Naji, H.; Khelil, A.; Braikia, M. Assessment of Energy and Environmental Performances of a Bioclimatic Dwelling in Algeria's North. *Build. Serv. Eng. Res. Technol.* **2017**, *38*, 64–88. [CrossRef]
73. Amraoui, K.; Sriti, L.; di Turi, S.; Ruggiero, F.; Kaihoul, A. Exploring Building's Envelope Thermal Behavior of the Neo-Vernacular Residential Architecture in a Hot and Dry Climate Region of Algeria. *Build. Simul.* **2021**, *14*, 1567–1584. [CrossRef]

74. Bamboo: An engineered alternative for buildings in the global South. In *Bioclimatic Architecture in Warm Climates*; Springer: Cham, Switzerland, 2019. [CrossRef]
75. Njunge, E.K.; Erçin, Ç. Solar-Shading Systems Designed to Increase User Satisfaction in Public Buildings, a Case Study of Britam Towers in Nairobi, Kenya. *Int. J. Adv. Appl. Sci.* **2021**, *8*, 98–109. [CrossRef]
76. Hashemi, A.; Khatami, N. Effects of Solar Shading on Thermal Comfort in Low-Income Tropical Housing. *Energy Procedia* **2017**, *111*, 235–244. [CrossRef]
77. Adaji, M.U.; Adekunle, T.O.; Watkins, R.; Adler, G. Indoor Comfort and Adaptation in Low-Income and Middle-Income Residential Buildings in a Nigerian City during a Dry Season. *Build. Environ.* **2019**, *162*, 106276. [CrossRef]
78. Morakinyo, T.E.; Adegun, O.B.; Balogun, A.A. The Effect of Vegetation on Indoor and Outdoor Thermal Comfort Conditions: Evidence from a Microscale Study of Two Similar Urban Buildings in Akure, Nigeria. *Indoor Built Environ.* **2016**, *25*, 603–617. [CrossRef]
79. Elshafei, G.; Vilcekova, S.; Zelenakova, M.; Negm, A.M. Towards an Adaptation of Efficient Passive Design for Thermal Comfort Buildings. *Sustainability* **2021**, *13*, 9570. [CrossRef]
80. Nematchoua, M.K.; Ricciardi, P.; Buratti, C. Adaptive Approach of Thermal Comfort and Correlation between Experimental Data and Mathematical Model in Some Schools and Traditional Buildings of Madagascar under Natural Ventilation. *Sustain. Cities Soc.* **2018**, *41*, 666–678. [CrossRef]
81. Kameni Nematchoua, M.; Ricciardi, P.; Reiter, S.; Asadi, S.; Demers, C.M. Thermal Comfort and Comparison of Some Parameters Coming from Hospitals and Shopping Centers under Natural Ventilation: The Case of Madagascar Island. *J. Build. Eng.* **2017**, *13*, 196–206. [CrossRef]
82. Kaddour, A.; Bezari, S.; Tearnbucha, C.; Sudsutad, W.; Lorenzini, G.; Ahmad, H.; Menni, Y. Simulation Investigation of Natural Ventilation on the Thermal Comfort in Arid Regions: Case Ghardaïa. *Int. J. Des. Nat. Ecodynamics* **2022**, *17*, 9–15. [CrossRef]
83. Mahdy, M.M.; Nikolopoulou, M. From Construction to Operation: Achieving Indoor Thermal Comfort via Altering External Walls Specifications in Egypt. *Adv. Mater. Res.* **2013**, *689*, 250–253. [CrossRef]
84. Ahmed, T.; Kumar, P.; Mottet, L. Natural Ventilation in Warm Climates: The Challenges of Thermal Comfort, Heatwave Resilience and Indoor Air Quality. *Renew. Sustain. Energy Rev.* **2021**, *138*, 110669. [CrossRef]
85. Zhong, F.; Chaudhry, H.N.; Calautit, J.K. Effect of Roof Cooling and Air Curtain Gates on Thermal and Wind Conditions in Stadiums for Hot Climates. *Energies* **2021**, *14*, 3941. [CrossRef]
86. Kalua, A. Envelope Thermal Design Optimization for Urban Residential Buildings in Malawi. *Buildings* **2016**, *6*, 13. [CrossRef]
87. Soussi, M.; Balghouthi, M.; Guizani, A.A.; Bouden, C. Model Performance Assessment and Experimental Analysis of a Solar Assisted Cooling System. *Sol. Energy* **2017**, *143*, 43–62. [CrossRef]
88. Nasri, F.; Alqurashi, F.; Nciri, R.; Ali, C. Design and Simulation of a Novel Solar Air-Conditioning System Coupled with Solar Chimney. *Sustain. Cities Soc.* **2018**, *40*, 667–676. [CrossRef]
89. Watson, D. Passive solar research and design for hot climates. In Proceedings of the Arab International Solar Energy Conference, Kuwait, Kuwait, 2–8 December 1983; Pergamon Press: Oxford, UK, 1983; pp. 28–37.
90. Fardeheb, F. Examination and Review of Passive Solar Cooling Strategies in Middle Eastern and North African Vernacular Architecture. In *Proceedings of the ISES Solar World Congress 2007, ISES 2007*; Springer: Berlin/Heidelberg, Germany, 2007; Volume 4, pp. 2511–2515. [CrossRef]
91. Farouk, M. Comparative Study of Hexagon & Square Windcatchers Using CFD Simulations. *J. Build. Eng.* **2020**, *31*, 101366. [CrossRef]
92. Abdeen, A.; Serageldin, A.A.; Ibrahim, M.G.E.; El-Zafarany, A.; Ookawara, S.; Murata, R. Solar Chimney Optimization for Enhancing Thermal Comfort in Egypt: An Experimental and Numerical Study. *Sol. Energy* **2019**, *180*, 524–536. [CrossRef]
93. Poshtiri, A.H.; Mohabbati, S.M. Performance Analysis of Wind Catcher Integrated with Shower Cooling System to Meet Thermal Comfort Conditions in Buildings. *J. Clean. Prod.* **2017**, *148*, 452–466. [CrossRef]
94. Koranteng, C.; Nyame-Tawiah, D.; Gyimah, K.A.; Simons, B. An Explorative Study on the Potential of Green Roofs Providing Thermal Comfort Conditions for Indoor Spaces in Kumasi, Ghana. *Open House Int.* **2021**, *47*, 389–407. [CrossRef]
95. Sheweka, S.M.; Magdy, N. The Impact of Different Green Roofs Strategies on the Indoor Thermal Comfort with Special Reference to Cairo-Egypt. *Adv. Mater. Res.* **2014**, *935*, 38–43. [CrossRef]
96. Rakotondramiarana, H.T.; Ranaivoarisoa, T.F.; Morau, D. Dynamic Simulation of the Green Roofs Impact on Building Energy Performance, Case Study of Antananarivo, Madagascar. *Buildings* **2015**, *5*, 497–520. [CrossRef]
97. Abdallah, A.S.H.; Yoshino, H.; Goto, T.; Enteria, N.; Radwan, M.M.; Eid, M.A. Integration of Evaporative Cooling Technique with Solar Chimney to Improve Indoor Thermal Environment in the New Assiut City, Egypt. *Int. J. Energy Environ. Eng.* **2013**, *4*, 45. [CrossRef]
98. Olweny, M.; Mugagga, L.L.; Nedala, T. A Study of Thermal Comfort and Thermal Preferences in the Upland Tropical Climate of Uganda. In Proceedings of the 9th International Windsor Conference 2016: Making Comfort Relevant, Windsor, UK, 7–10 April 2016; pp. 1202–1213.
99. Hassan Abdallah, A.S. Occupant Comfort and Indoor Temperature Reduction by Using Passive Air Conditioning System with Solar Chimney Concept in Hot Arid Climate. *Procedia Eng.* **2017**, *205*, 1100–1107. [CrossRef]
100. Guedes, M.C.; Lopes, L.; Coelho, A.B.; Cruz, H.; Ferreira, J.G.; Borges, K.E.; Cantuária, G.; Pinheiro, M.; Pinto, J.F.; Gomes, M.S.; et al. *Arquitetura Sustentável Em São Tomé e Príncipe*; IST Press: Lisboa, Portugal, 2015; ISBN 978-989-8481-43-6.

101. Guedes, M.C.; Forjaz, J.; Lage, L.; Lopes, L.; Borges, K.E.; Cantuária, G.; Pinheiro, M.; Pereira, M.; Lopes, A.; Aleixo, J.; et al. *Arquitectura Sustentável Em Moçambique: Manual de Boas Práticas*; CPLP—Comunidade dos Países de Língua Portuguesa, Ed.; CPLP Comunidade dos Países de Língua Portuguesa: Lisboa, Portugal, 2011; ISBN 978-989-97178-1-7.
102. PraveenKumar, S.; Agyekum, E.B.; Alwan, N.T.; Velkin, V.I.; Yaqoob, S.J.; Adebayo, T.S. Thermal Management of Solar Photovoltaic Module to Enhance Output Performance: An Experimental Passive Cooling Approach Using Discontinuous Aluminum Heat Sink. *Int. J. Renew. Energy Res.* **2021**, *11*, 1700–1712. [CrossRef]
103. Agyekum, E.B.; Praveenkumar, S.; Alwan, N.T.; Velkin, V.I.; Adebayo, T.S. Experimental Study on Performance Enhancement of a Photovoltaic Module Using a Combination of Phase Change Material and Aluminum Fins— Exergy, Energy and Economic (3E) Analysis. *Inventions* **2021**, *6*, 69. [CrossRef]
104. Osman, M.M.; Sevinc, H. Adaptation of Climate-Responsive Building Design Strategies and Resilience to Climate Change in the Hot/Arid Region of Khartoum, Sudan. *Sustain. Cities Soc.* **2019**, *47*, 101429. [CrossRef]
105. Mastouri, H.; Benhamou, B.; Hamdi, H.; Mouyal, E. Thermal Performance Assessment of Passive Techniques Integrated into a Residential Building in Semi-Arid Climate. *Energy Build.* **2017**, *143*, 1–16. [CrossRef]
106. Yahia, M.W.; Johansson, E.; Thorsson, S.; Lindberg, F.; Rasmussen, M.I. Effect of Urban Design on Microclimate and Thermal Comfort Outdoors in Warm-Humid Dar Es Salaam, Tanzania. *Int. J. Biometeorol.* **2018**, *62*, 373–385. [CrossRef]
107. Adunola, A.O. Evaluation of Urban Residential Thermal Comfort in Relation to Indoor and Outdoor Air Temperatures in Ibadan, Nigeria. *Build. Environ.* **2014**, *75*, 190–205. [CrossRef]
108. Kedissa, C.; Outtas, S.; Belarbi, R. The Impact of Height/Width Ratio on the Microclimate and Thermal Comfort Levels of Urban Courtyards. *Int. J. Sustain. Build. Technol. Urban Dev.* **2016**, *7*, 174–183. [CrossRef]
109. Abdallah, A.S.H.; Hussein, S.W.; Nayel, M. The Impact of Outdoor Shading Strategies on Student Thermal Comfort in Open Spaces between Education Building. *Sustain. Cities Soc.* **2020**, *58*, 102124. [CrossRef]
110. Al-hagla, K.S.; El-sayad, Z.T. Using Simulation Methods to Investigate the Impact of Urban Form on Human Comfort. Case Study: Coast of Baltim, North Coast, Egypt. *Alex. Eng. J.* **2019**, *58*, 273–282. [CrossRef]
111. Mahmoud, A.H.A. Analysis of the Microclimatic and Human Comfort Conditions in an Urban Park in Hot and Arid Regions. *Build. Environ.* **2011**, *46*, 2641–2656. [CrossRef]
112. Pinto, D.B.; Castro-Gomes, J. Waste Subtracts and Nutrients as Ingredients for Vegetation Growth in Construction Materials—A Review. *Clean. Eng. Technol.* **2022**, *10*, 100548. [CrossRef]
113. Alabid, J.; Taki, A. Bioclimatic Housing Design to Desert Architecture: A Case Study of Ghadames, Libya. *HVAC R Res.* **2014**, *20*, 760–769. [CrossRef]
114. Jouini, N.E.H.; Kharrat, F.; Achour-Younsi, S. Urban Morphology and Solar Gains in Cities with Warm Mediterranean Climate: Comparison of Two Collective Residential Complexes in Tunis, Tunisia. In Proceedings of the Euro-Mediterranean Conference for Environmental Integration, Sousse, Tunisia, 10–13 October 2021; pp. 2241–2245. [CrossRef]
115. Federal Ministry of Power Works and Housing. *Building Energy Efficiency Guideline for Nigeria Federal Ministry of Power, Works and Housing (Housing)*; Federal Ministry of Power, Works and Housing: Abuja, Nigeria, 2016.
116. Semahi, S.; Zemmouri, N.; Singh, M.K.; Attia, S. Comparative Bioclimatic Approach for Comfort and Passive Heating and Cooling Strategies in Algeria. *Build. Environ.* **2019**, *161*, 106271. [CrossRef]
117. Morini, M.; Calabrese, N.; Chello, D. Proposals for the Thermal Regulation of Buildings in Algeria: An Energy Label for Social Housing. *Int. J. Archit. Environ. Eng.* **2021**, *15*, 465–471.
118. CNERIB Centre National d'Etudes et Recherches Intégrées du Bâtimen. *Document Technique Réglementaire, Réglementation Thermique Du Bâtiment (DTR) C3.2 et C3.4*; Le Ministre de l'Habitat: Sidi M'Hamed, Argelia, 2016.
119. Ibtissame, B.; Imane, B.; Salima, L. Towards Low Energy and Thermal Comfort of Buildings Through Passive Cooling or Heating Strategies in Hot Arid Climates. *J. Adv. Res. Fluid Mech. Therm. Sci.* **2022**, *93*, 173–182. [CrossRef]
120. AMEE Agence Marocaine pour l'Efficacité Energétique. *La Règlementation Thermique Dans Le Bâtiment (RTCM) Décret N°2-13-874 Du 20 Hija 1435 (15 Octobre 2014)*; Ministère de l'Énergie, des Mines et de l'Environnement: Rabat, Morocco, 2014.
121. Edeisy, M.; Cecere, C. Energy Efficiency for Egyptian Housing: Code Compliance and Enforcement. *Int. J. Constr. Environ.* **2018**, *9*, 1–15. [CrossRef]
122. GamalEldine, M.; Corvacho, H. Compliance with Building Energy Code for the Residential Sector in Egyptian Hot-Arid Climate: Potential Impact, Difficulties, and Further Improvements. *Sustainability* **2022**, *14*, 3936. [CrossRef]
123. *SANS 204:2011*; Energy Efficiency in Buildings. SABS Standards Division: Pretoria, South Africa, 2011.
124. Laouni, I.; Mazouz, S. Towards a Sustainable Building Material in Hot Arid Environments: Compressed and Stabilized Earth Brick (CSEB) Prototype. *Int. J. Sustain. Dev. Plan.* **2021**, *16*, 1195–1208. [CrossRef]
125. Bassoud, A.; Khelafi, H.; Mokhtari, A.M.; Bada, A. Evaluation of Summer Thermal Comfort in Arid Desert Areas. Case Study: Old Adobe Building in Adrar (South of Algeria). *Build. Environ.* **2021**, *205*, 108140. [CrossRef]
126. Hamdani, M.; Bekkouche, S.M.E.A.; Al-Saadi, S.; Cherier, M.K.; Djeffal, R.; Zaiani, M. Judicious Method of Integrating Phase Change Materials into a Building Envelope under Saharan Climate. *Int. J. Energy Res.* **2021**, *45*, 18048–18065. [CrossRef]
127. Boukhelkhal, I.; Bourbia, F. Experimental Study on the Thermal Behavior of Exterior Coating Textures of Building in Hot and Arid Climates. *Sustainability* **2021**, *13*, 4175. [CrossRef]

128. Khencha, K.; Biara, R.W.; Belmili, H. Contemporary Architecture with Glass Facades Facing the Energy Efficiency of Solar Materials (VPV-IGU) in the Hot Climate of the Saharan Region—A Case Study in Bechar. *Int. J. Glob. Energy Issues* **2021**, *43*, 534–570. [CrossRef]
129. Marzouk, M.; ElSharkawy, M.; Mahmoud, A. Optimizing Daylight Utilization of Flat Skylights in Heritage Buildings. *J. Adv. Res.* **2022**, *37*, 133–145. [CrossRef]
130. Mohammed, A. Study of Shading Device Parameters of the Mixed-Mode Ventilation on Energy Performance of an Office Building: Simulation Analysis for Evaluating Energy Performance in Egypt. In *Advances in Architecture, Engineering and Technology*; Springer: Cham, Switzerland, 2022; pp. 285–297. [CrossRef]
131. Fernandes, J.; Dabaieh, M.; Mateus, R.; Silva, S.M.; Bragança, L.; Gervásio, H. Thermal Performance and Comfort of Vernacular Earthen Buildings in Egypt and Portugal. In *Vernacular and Earthen Architecture: Conservation and Sustainability*; CRC Press: Boca Raton, FL, USA, 2018; pp. 95–100. [CrossRef]
132. Mahdy, M.M.; Fahmy, M.; Barakat, M.; Abdelalim, M.F. Assessing the Thermal Performance of Envelope Parts under Climate Change Scenarios: Residential Case Studies in Egypt. In Proceedings of the 2017 International Conference on Sustainable and Renewable Energy Engineering, ICSREE 2017, Hiroshima, Japan, 10–12 May 2017; pp. 42–48. [CrossRef]
133. Shahran, A.; Reba, D.; Krklješ, M. Thermal Comfort, Adaptability and Sustainability of Vernacular Single Family Houses in Libya. *Teh. Vjesn.* **2017**, *24*, 1959–1968. [CrossRef]
134. Alabid, J.; Taki, A. Optimising Residential Courtyard in Terms of Social and Environmental Performance for Ghadames Housing, Libya. In Proceedings of the 33rd PLEA International Conference: Design to Thrive, PLEA 2017, Edinburgh, Scotland, 2–5 July 2017; Volume 3, pp. 4998–5005.
135. Lamrani Alaoui, A.; Amrani, A.I.; Alami Merrouni, A.; Daoudia, A.; el Hassouani, Y. Optimization of Thermal Efficiency in Traditional Clay-Based Buildings in Hot–Dry Locations. Case Study: The South-Eastern Region of Morocco. *Int. J. Energy Environ. Eng.* **2022**, *13*, 499–514. [CrossRef]
136. Benaddi, F.Z.; Boukhattem, L.; Benhamou, B.; Nouh, F.A. Building Design Optimization to Enhance Thermal Comfort Performance: A Case Study in Marrakech Region. In Proceedings of the 9th International Renewable and Sustainable Energy Conference (IRSEC), Virtual. Morocco, 23–27 November 2021; pp. 1–6. [CrossRef]
137. Lairgi, L.; Lagtayi, R.; Daya, A.; Elotmani, R.; Touzani, M. The Impact of Arid Climate on the Indoor Thermal Comfort in the South-East of Morocco. *Int. J. Photoenergy* **2021**, *2021*, 5554629. [CrossRef]
138. Chegari, B.; Simeu, E.; Tabaa, M.; Medromi, H.; Moutaouakkil, F. Energy Savings and Thermal Comfort Benefits of Shading Devices: Case Study of a Typical Moroccan Building. In Proceedings of the 4th International Conference on Smart City Applications, Karabuk, Turkey, 7–9 October 2019; pp. 1–8. [CrossRef]
139. Charai, M.; Sghiouri, H.; Mezrhab, A.; Karkri, M. Bioclimatic Building Design Analysis. Case Study: Oujda, Morocco. In Proceedings of the 2019 7th International Renewable and Sustainable Energy Conference, IRSEC 2019, Agadir, Morocco, 27–30 November 2019. [CrossRef]
140. Amine, L.; Rachid, S.; Miloud, R. Improving Energy Efficiency of Moroccan Buildings through Energy-Efficient Envelope Design: A Case Study. *Int. J. Energy Environ. Econ.* **2018**, *26*, 117–141.
141. Lamrani, M.; Laaroussi, N.; Khabbazi, A.; Khalfaoui, M.; Garoum, M.; Feiz, A. Experimental Study of Thermal Properties of a New Ecological Building Material Based on Peanut Shells and Plaster. *Case Stud. Constr. Mater.* **2017**, *7*, 294–304. [CrossRef]
142. Omara, A.A.M.; Abuelnuor, A.A.A.; Fadul, O.H.A. Low-Exergy Building Using Renewable Energy for Indoor Thermal Comfort: Experimental Study and Thermodynamic Analysis. In Proceedings of the 2020 International Conference on Computer, Control, Electrical, and Electronics Engineering, ICCCEEE 2020, Khartoum, Sudan, 26–28 February 2021. [CrossRef]
143. Kiki, G.; André, P.; Houngan, A.; Kouchadé, C. Improving the Energy Efficiency of an Office Building by Applying a Thermal Comfort Model. *J. Phys. Conf Ser.* **2021**, *2069*, 012172. [CrossRef]
144. Kiki, G.; Kouchadé, C.; Houngan, A.; Zannou-Tchoko, S.J.; André, P. Evaluation of Thermal Comfort in an Office Building in the Humid Tropical Climate of Benin. *Build. Environ.* **2020**, *185*, 107277. [CrossRef]
145. Aristide, H.C.; Anjorin, M.; Salomon, O.; Sadate, D.; Morel, N.F.; Antoine, V.; Gerald, D. TRNSYS Software Used for the Simulation of the Dynamic Thermal Behavior of a F2-Building in Lokossa City in Benin Republic. In Proceedings of the Conference on the Industrial and Commercial Use of Energy, ICUE 2019, Cape Town, South Africa, 26 November 2019. [CrossRef]
146. Ouedraogo, A.L.S.N.; Messan, A.; Yamegueu, D.; Coulibaly, Y. A Model for Thermal Comfort Assessment of Naturally Ventilated Housing in the Hot and Dry Tropical Climate. *Int. J. Build. Pathol. Adapt.* **2022**, *40*, 183–201. [CrossRef]
147. Kabore, A.; Maref, W.; Plamondon, C.O. Hygrothermal Performance of the Building Envelope with Low Environmental Impact: Case of a Hemp Concrete Envelope. *J. Phys. Conf. Ser.* **2021**, *2069*, 012006. [CrossRef]
148. Rincón, L.; Carrobé, A.; Martorell, I.; Medrano, M. Improving Thermal Comfort of Earthen Dwellings in Sub-Saharan Africa with Passive Design. *J. Build. Eng.* **2019**, *24*, 100732. [CrossRef]
149. Dao, K.; Ouedraogo, M.; Millogo, Y.; Aubert, J.E.; Gomina, M. Thermal, Hydric and Mechanical Behaviours of Adobes Stabilized with Cement. *Constr. Build. Mater.* **2018**, *158*, 84–96. [CrossRef]
150. Nematchoua, M.K.; Reiter, S. Evaluation of Bioclimatic Potential, Energy Consumption, CO_2-Emission, and Life Cycle Cost of a Residential Building Located in Sub-Saharan Africa; a Case Study of Eight Countries. *Sol. Energy* **2021**, *218*, 512–524. [CrossRef]
151. Knudsen, J.B.; Pinder, M.; Jatta, E.; Jawara, M.; Yousuf, M.A.; Søndergaard, A.T.; Lindsay, S.W. Measuring Ventilation in Different Typologies of Rural Gambian Houses: A Pilot Experimental Study. *Malar. J.* **2020**, *19*, 273. [CrossRef]

152. Koranteng, C.; Simons, B.; Abrokwa, K.G. Thermal State, Potential of Natural and Fan-Induced Ventilation in Enhancing Comfort of Nine Office Buildings in Southern Ghana. *J. Arch. Eng.* **2022**, *28*, 05021018. [CrossRef]
153. Opoku, R.; Obeng, G.Y.; Darkwa, J.; Kwofie, S. Minimizing Heat Transmission Loads and Improving Energy Efficiency of Building Envelopes in Sub-Saharan Africa Using Bio-Based Composite Materials. *Sci. Afr.* **2020**, *8*, e00358. [CrossRef]
154. Khalfan, M.; Sharples, S. The Present and Future Energy Performance of the First Passivhaus Project in the Gulf Region. *Sustainability* **2016**, *8*, 139. [CrossRef]
155. Salvalai, G.; Imperadori, M.; Lumina, F.; Mutti, E.; Polese, I. Architecture for Refugees, Resilience Shelter Project: A Case Study Using Recycled Skis. *Procedia Eng.* **2017**, *180*, 1110–1120. [CrossRef]
156. Jegede, O.E.; Taki, A. Optimization of Building Envelopes Using Indigenous Materials to Achieve Thermal Comfort and Affordable Housing in Abuja, Nigeria. *Int. J. Build. Pathol. Adapt.* **2022**, *40*, 219–247. [CrossRef]
157. Nwaji, G.N.; Okoronkwo, C.A.; Ogueke, N.V.; Anyanwu, E.E. Transient Simulation of a Building-Integrated Hybrid Solar Collector/Nocturnal Radiator with In-Built Thermal Storage for Space Cooling in Owerri, Nigeria. *J. Energy Eng.* **2021**, *147*, 04021003. [CrossRef]
158. Mba, E.J.; Okeke, F.O.; Okoye, U. Effects of Wall Openings on Effective Natural Ventilation for Thermal Comfort in Classrooms of Primary Schools in Enugu Metropolis, Nigeria. *JP J. Heat Mass Transf.* **2021**, *22*, 269–304. [CrossRef]
159. Alfa, M.T.; Öztürk, A. Perceived Indoor Environmental Quality of Hospital Wards and Patients' Outcomes: A Study of a General Hospital, Minna, Nigeria. *Appl Ecol. Environ. Res.* **2019**, *17*, 8235–8259. [CrossRef]
160. Adaji, M.U.; Watkins, R.; Adler, G. Indoor Thermal Comfort for Residential Buildings in the Hot-Humid Climate of Nigeria during the Dry Season. In Proceedings of the 33rd PLEA International Conference: Design to Thrive, PLEA 2017, Edinburgh, Scotland, 2–5 July 2017; Volume 1, pp. 949–956.
161. Ogunrin, S.; Sharples, S. Impact of Building Envelope Construction on Thermal Comfort: A Parametric Analysis of Modern, Low Income Housing in South-West Nigeria for Current and Future Climates. In Proceedings of the 33rd PLEA International Conference: Design to Thrive, PLEA 2017, Edinburgh, Scotland, 2–5 July 2017; Volume 1, pp. 112–119.
162. Wati, E.; Bidoung, J.C.; Damfeu, J.C.; Meukam, P. Energy Performance of Earthen Building Walls in the Equatorial and Tropical Climates: A Case Study of Cameroon. *Energy Effic.* **2020**, *13*, 735–750. [CrossRef]
163. Nematchoua, M.K.; Orosa, J.A. Building Construction Materials Effect in Tropical Wet and Cold Climates: A Case Study of Office Buildings in Cameroon. *Case Stud. Therm. Eng.* **2016**, *7*, 55–65. [CrossRef]
164. Nematchoua, M.K.; Tchinda, R.; Orosa, J.A. Thermal Comfort and Energy Consumption in Modern versus Traditional Buildings in Cameroon: A Questionnaire-Based Statistical Study. *Appl. Energy* **2014**, *114*, 687–699. [CrossRef]
165. Nematchoua, M.K.; Tchinda, R.; Ricciardi, P.; Djongyang, N. A Field Study on Thermal Comfort in Naturally-Ventilated Buildings Located in the Equatorial Climatic Region of Cameroon. *Renew. Sustain. Energy Rev.* **2014**, *39*, 381–393. [CrossRef]
166. Mahamat, A.D.; Ali, A.; Tanguier, J.L.; Donnot, A.; Benelmir, R. Mechanical and Thermophysical Characterization of Local Clay-Based Building Materials. In Proceedings of the 2020 5th International Conference on Renewable Energies for Developing Countries, REDEC 2020, Marrakech, Morocco, 29–30 June 2020. [CrossRef]
167. Mahamat, A.D.; Hamid, O.I.; Soultan, M.; Khayal, M.Y.; Elhamdouni, Y.; Garoum, M.; Gaye, S. Effect of Cow's Dung on Thermophysical Characteristics of Building Materials Based on Clay. *Res. J. Appl. Sci. Eng. Technol.* **2015**, *10*, 464–470. [CrossRef]
168. Yadeta, C.; Indraganti, M.; Alemayehu, E.; Tucho, G.T. An Investigation of Human Thermal Comfort and Adaptation in Naturally Ventilated Residential Buildings and Its Implication for Energy Use in Tropical Climates of Ethiopia. *Sci. Technol. Built Environ.* **2022**, *28*, 896–915. [CrossRef]
169. Tällberg, R.; Jelle, B.P.; Loonen, R.; Gao, T.; Hamdy, M. Comparison of the Energy Saving Potential of Adaptive and Controllable Smart Windows: A State-of-the-Art Review and Simulation Studies of Thermochromic, Photochromic and Electrochromic Technologies. *Sol. Energy Mater. Sol. Cells* **2019**, *200*, 109828. [CrossRef]
170. Ogoli, D.M. Architectural Passive Solar Design for Three Buildings in Kenya: Observations Made in Lowering Energy Use in Non-Domestic Buildings. In Proceedings of the 33rd PLEA International Conference: Design to Thrive, PLEA 2017, Edinburgh, Scotland, 2–5 July 2017; Volume 3, pp. 4219–4226.
171. Gichuyia, L.; Steemers, K. Indoor Overheating Risk and Climate Change. Modelling Sensitivity of Building Design Parameters for a Free-Running Building. In Proceedings of the Windsor Conference 2014: Counting the Cost of Comfort in a Changing World, Windsor, UK, 10–13 April 2014; pp. 510–527.
172. Nematchoua, M.K.; Orosa, J.A.; Buratti, C.; Obonyo, E.; Rim, D.; Ricciardi, P.; Reiter, S. Comparative Analysis of Bioclimatic Zones, Energy Consumption, CO_2 Emission and Life Cycle Cost of Residential and Commercial Buildings Located in a Tropical Region: A Case Study of the Big Island of Madagascar. *Energy* **2020**, *202*, 117754. [CrossRef]
173. Nematchoua, M.K.; Vanona, J.C.; Orosa, J.A. Energy Efficiency and Thermal Performance of Office Buildings Integrated with Passive Strategies in Coastal Regions of Humid and Hot Tropical Climates in Madagascar. *Appl. Sci.* **2020**, *10*, 2438. [CrossRef]
174. Domínguez-Amarillo, S.; Rosa-García, Á.; Fernández-Agüera, J.; Escobar-Castrillón, N. Architecture of the Scape: Thermal Assessment of Refugee Shelter Design in the Extremes Climates of Jordan, Afghanistan and South Sudan. *J. Build. Eng.* **2021**, *42*, 102396. [CrossRef]
175. Cocci Grifoni, R.; Ottone, M.F.; Prenna, E. Evaluation of Building Comfort in Developing Countries through CFD Analysis and TENS Method. *Int. J. Sustain. Dev. Plan.* **2018**, *13*, 246–257. [CrossRef]

176. Hashemi, A. Effects of Thermal Insulation on Thermal Comfort in Low-Income Tropical Housing. *Energy Procedia* **2017**, *134*, 815–824. [CrossRef]
177. Hashemi, A. Climate Resilient Low-Income Tropical Housing. *Energies* **2016**, *9*, 468. [CrossRef]
178. Eller, C.; Rida, M.; Boudier, K.; Otoni, C.; Celani, G.; Labaki, L.; Hoffmann, S. Climate-Based Analysis for the Potential Use of Coconut Oil as Phase Change Material in Buildings. *Sustainability* **2021**, *13*, 10731. [CrossRef]
179. Manyumbu, E.; Martin, V.; Fransson, T.H. A Parametric Analysis on the Regeneration Performance of Silica Gel in a Proposed Comfort Provision Strategy for a Typical Office Space in Harare, Zimbabwe. *Energy Build.* **2016**, *126*, 104–112. [CrossRef]
180. Orosz, M.; Altes-Buch, Q.; Mueller, A.; Lemort, V. Experimental Validation of an Electrical and Thermal Energy Demand Model for Health Centers in Sub-Saharan Africa. In Proceedings of the 30th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems, ECOS 2017, San Diego, CA, USA, 2–6 July 2017. [CrossRef]
181. Onjefu, L.A.; Kamara, V.S.; Chisale, P.; Kgabi, N.A.; Zulu, A. Thermal Efficient Isolating Materials from Agricultural Residues to Improve Energy Efficiency in Buildings. *Int. J. Civ. Eng. Technol.* **2019**, *10*, 2067–2074.
182. Ndou, M.; Aigbavboa, C.; Yaka, F. Factors Affecting Indoor Environmental Qualities of Social-Housing Projects in South Africa. In *Collaboration and Integration in Construction, Engineering, Management and Technology*; Advances in Science, Technology & Innovation; Ahmed, S.M., Hampton, P., Azhar, S., Day Saul, A., Eds.; Springer: Cham, Switzerland, 2021; pp. 259–263. [CrossRef]
183. Mabuya, B.; Scholes, M. The Three Little Houses: A Comparative Study of Indoor and Ambient Temperatures in Three Low-Cost Housing Types in Gauteng and Mpumalanga, South Africa. *Int J. Environ. Res. Public Health* **2020**, *17*, 3524. [CrossRef]