Re-Building Sudan
AFTER THE WAR

INDUSTRY, INNOVATION
AND INFRASTRUCTURE

CHAPTER

27

CONCEPTUAL

Transforming Sudan's War-Torn Cities: A Sustainable Rebuilding and Recovery Framework

Sara Elhussein

Architect and Senior Sustainability Consultant, I Design, London, UK

Email: sara.elhussein.20@alumni.ucl.ac.uk
ORCID: 0009-0006-0824-3527

ABSTRACT

PURPOSE: In the wake of Sudan's war, which has displaced over 14 million people and devastated major cities and cultural landmarks, this paper investigates the urgent need for a sustainability-led recovery model. It presents a Sustainable Rebuilding and Recovery Framework (SRRF) to address Sudan's deep-rooted urban vulnerabilities and promote an inclusive, climate-resilient transformation based on the country's environmental, cultural, and socio-economic context.

DESIGN/METHODOLOGY/APPROACH: The study employs a multidisciplinary methodology combining policy review, architectural case studies, stakeholder insights, and best practices in post-war reconstruction. The SRRF offers a structured roadmap built on six key pillars, each addressing a vital dimension of recovery. The framework aligns with the Sustainable Development Goals (SDGs) and Build Back Better (BBB) principles and provides practical tools for local urban transformation.

FINDINGS: The framework proposes key strategies such as low-carbon infrastructure, decentralised public services, community-led housing, renewable energy adoption, circular economy principles, and integration of cultural heritage in urban planning. The findings emphasize the critical role of inclusive governance and climate-adaptive design in building long-term resilience and preventing the repetition of past planning mistakes.

ORIGINALITY/VALUE: This paper offers a recovery model uniquely adapted to Sudan's realities. It contributes a locally grounded, globally relevant approach to sustainable urban reconstruction and serves as a replicable reference for other conflict-affected regions facing similar rebuilding challenges.

RESEARCH LIMITATIONS/IMPLICATIONS: The study emphasizes strategic frameworks over field-based data collection. Additional research is necessary to assess on-the-ground implementation, economic viability, and policy effects. The framework presents a transferable model that could be tested and adapted in other post-conflict contexts with comparable challenges.

PRACTICAL IMPLICATIONS: The SRRF provides government agencies, architects, planners, and development partners with a coherent roadmap for rebuilding climate-resilient, economically inclusive, and culturally rooted cities.

KEYWORDS: *Post-War Reconstruction; Sustainable Urban Development; Climate Resilience; Cultural Heritage Preservation; Renewable Energy; Sustainable Architecture; Circular Economy; Disaster Risk Reduction; Inclusive Urban Planning; Sudan Rebuilding Framework.*

INTRODUCTION

Sudan is a land of rich history, vibrant culture, and significant architectural landmarks. From the ancient Nubian pyramids of Meroë, dating back to the 10th century BC (Elzain, 2009), to the modernist cityscape of Khartoum, the built environment reflects a rich interplay of indigenous traditions, Islamic empires, and colonial legacies (Ibrahim, 2022). For millennia, the Nile River has shaped urban life, economic prosperity, and cultural identity. Today, this legacy faces unprecedented destruction. Since April 2023, armed conflict has displaced over 14 million people, devastated cities, collapsed essential services, and endangered both Sudan's future and its cultural past (UNESCO, 2024; UNICEF, 2023; Bashir and Näser, 2025). The UN expert Radhouane Nouicer describes the crisis as "horrifying, tragic, and brutal" (Jedicke, 2023). It demands not just rebuilding but a reimagining rooted in sustainability.

Yet, within this devastation lies an opportunity to reshape Sudan's urban future by addressing past mis-steps. Through selected architectural case studies and expert insights, including key sites in Khartoum and nationally significant heritage buildings, this chapter illustrates the scale of loss and the contextual challenges of post-war reconstruction. It then introduces a Sustainable Reconstruction and Recovery Framework (SRRF), a model tailored to Sudan's socio-cultural and environmental realities and adaptable to similar regional and global recovery efforts. Grounded in Build Back Better (BBB) principles and aligned with the UN's Sustainable Development Goals (SDGs), the SRRF seeks to protect heritage, empower communities, and foster long-term resilience.

FROM PAST FAILURES TO FUTURE RESILIENCE: WHY SUDAN NEEDS A RECOVERY FRAMEWORK

Sudan's urban fragility stems from decades of unregulated expansion, informal settlements, overstretched infrastructure, and weak governance. Conventional construction practices ignored environmental and cultural realities, resulting in unsustainable energy use and heightened vulnerability to climate risks (Liyanage *et al.*, 2024; Kutty *et al.*, 2023). The absence of disaster preparedness and sustainable policies left cities exposed to shocks (Wijenayake *et al.*, 2024), and these systemic weaknesses have deepened the devastation caused by conflict, marked by destruction, displacement, and public service collapse. A major cause of Sudan's architectural crisis is the reliance on standardised, imported models that overlook local climate and culture. One of Sudan's most established architects, Jack Ishkanes, known for his sustainable vernacular architectural designs, notes: "Moving away from Western-imported models toward more context-sensitive, locally rooted solutions involves a blend of architectural, social, and environmental strategies". Without deliberate intervention, post-conflict rebuilding risks repeating past mistakes, fuelling environmental degradation and compounding vulnerabilities to floods, droughts, and urban overheating (Roach and Al-Saidi, 2021; UNISDR, 2017).

Cities like Khartoum face a convergence of environmental pressures, policy failures, and social inequality. Neglecting heritage in this process could mean the irreversible loss of cultural identity. Disorganised recovery also risks widening inequality and exacerbating social fragmentation (Amer, 2018). As Ishkanes articulates: "Sudan does not have to choose between past and future. It can design a bridge between them". The SRRF responds to this urgent need as both a corrective mechanism and a strategic blueprint. It aligns with the SDGs and the BBB principles, emphasising integrating disaster risk reduction with reconstruction, social cohesion, and environmental renewal (UNISDR, 2017). The SRRF aims to protect heritage, empower communities, and drive Sudan's shift from reactive rebuilding to inclusive, resilient transformation.

KEY STAKEHOLDERS IN SUDAN'S SUSTAINABLE REBUILDING AND RECOVERY FRAMEWORK

The SRRF addresses the challenges of rebuilding Sudan's post-conflict built environment and offers a model adaptable to similar regional and global recovery efforts. Urban reconstruction demands collaboration among diverse stakeholders, whose roles and needs vary by local context. To ensure effective outcomes, Stakeholders should begin the process with a clear assessment that aligns stakeholder efforts and supports an holistic, sustainable, and resilient approach.

Building on SRRF principles, this requires close co-ordination and inclusive planning. In Sudan, key stakeholders and users of the Framework include, but are not limited to:

- policy-makers and urban planners: lead regulatory reforms, implement zoning policies, and oversee climate-resilient infrastructure;
- architects and engineers: innovate low-carbon, climate-adaptive designs that respect Sudan's cultural identity.
- international organisations (e.g., UN, UNESCO, World Bank): provide funding, technical assistance, and ensure alignment with global best practices;
- local communities: serve as co-creators of the recovery process, grounding efforts in real community needs and cultural authenticity.

ARCHITECTURAL DEVASTATION AND HERITAGE UNDER THREAT: CASE STUDIES FROM SUDAN'S WAR ZONES

The scale of Sudan's reconstruction challenge is best understood through its architectural losses. The ongoing conflict has destroyed critical infrastructure, cultural landmarks, and urban centres, displacing millions and erasing centuries of political, economic, and cultural history. Violence has come from both airstrikes and militias, who have forcibly displaced civilians and occupied institutions to launch further attacks, deepening the urban crisis.

From UNESCO-listed sites such as Meroë and Jebel Barkal to Khartoum's modernist landmarks, the devastation is widespread. Militias have damaged, looted, and reduced ancient temples, public libraries, government institutions, and iconic towers to ruins. These acts jeopardise Sudan's identity, institutional continuity, and collective memory. Among the most symbolic losses are the Ministry of Justice, a representation of state authority; the looted National Archives, once home to irreplaceable records; and the University of Khartoum, Sudan's leading academic institution, now severely affected and with its academic future in jeopardy.

To deepen the understanding of Sudan's architectural devastation and explore recovery pathways, insights were gathered from Jessica L. Wagner, Mohamed Elgadi, Dr Huda Elshareif, Ammar Osman, Dr El Kheir who are experts in heritage conservation, urban design, and sustainable architecture; quotes taken from the interviews are given in the case studies below. Their critical analysis highlights both the symbolic significance and deterioration of key structures, as well as their potential to serve as anchors in the country's recovery. This underscores the urgent need for a process that integrates context-sensitive approaches and supports sustainable, resilient rebuilding. The following seven case studies of significant buildings offer insight into the scale of destruction and the complexities of post-war recovery. Each structure holds symbolic, functional, or historical importance, offering critical insights into the broader implications of architectural loss and the necessity of strategic reconstruction.

Historic Structures: Guardians of Sudan's Cultural Legacy

Sudan National Museum: a vault of lost history

The Sudan National Museum in Khartoum, inaugurated in 1971 and partly designed by German architect Friedrich Hinkel, was a key repository of Sudanese history, showcasing artefacts from the Nubian, Christian, and Islamic periods. Its layout symbolised Sudan's connection to its past, aligning relics with the flow of the Nile River (Adam, 2017), and featured antiquities from ancient kingdoms, including temples relocated due to the Aswan High Dam (Hill, 2021). Amid the current conflict, the Rapid Support Forces (RSF) have looted and vandalised the museum, compromising its structure; they have caused substantial damage (Jedicke, 2023), with antiquities trafficked on the black market. Environmental degradation, the lack of security, and halted conservation efforts have accelerated its decline. The destruction not only represents a loss of priceless artefacts but also a rupture in Sudan's cultural continuity, making its restoration critical to national recovery. The following images show the museum's condition before and after the recent conflict.

The Sudan National Museum before its destruction.
Source: Jack Maguire / Alamy Stock Photo

The Sudan National Museum after its destruction
Source: Photo by Al mujtaba Ahmed

The Khartoum Presidential Palaces: political and cultural symbols under attack

The Presidential Palaces in Khartoum, both old and new, stand as enduring symbols of Sudan's political history and architectural evolution.

The Old Presidential Palace, built in 1913 and designed by Sir William Garstin, is a colonial-era structure blending Islamic and British architectural influences. Built at an estimated cost of £120,000, it reflects Sudan's architectural heritage with its arches, plasterwork, and courtyards, constructed using local sandstone and mud brick. Once home to Sudan's first Prime Minister, Ismail

al-Azhari, the palace housed a motorcade of luxury vehicles symbolising presidential power, and preserves artefacts from Sudan's ruling history, including heritage collections.

The New Presidential Palace, constructed by a Chinese company as a gift from China following a pledge by former Chinese President Hu Jintao in 2007, was completed in 2021 at a cost of approximately US$50 million. Featuring a 50-metre-high dome, the palace incorporates local materials and traditional motifs, balancing Sudan's cultural heritage with modern security needs. Grand reception halls feature intricate woodwork and mosaics by Sudanese artisans, showcasing national craftsmanship.

Airstrikes and looting by the RSF have caused significant damage to both palaces, resulting in the loss of historical archives and state records. Their targeting underscores the symbolic collapse of Sudanese governance and identity. Restoration efforts must prioritise architectural authenticity and cultural significance, involving local expertise and integrating climate adaptation measures to safeguard their resilience.

The New Presidential Palace before its destruction.
Source: https://www.presidency.gov.sd/eng/page/Rep-Palace

The New Presidential Palace after its destruction.
Source: Photo by Ebrahim Nugdalla

The Old Presidential Palace before its destruction.
Source: Photo by Hisham Karouri

The Old Presidential Palace after its destruction.
Source: Photo by Mohsen Mohamed

Reflecting on the broader implications of this cultural devastation, Jessica L. Wagner, Heritage and Preservation Officer and Director of Education Services at The Durham Museum, notes:

> "The damage and destruction suffered within Sudan's museum system and historic sites, such as the Presidential Palace, are more than simply the loss of physical objects and buildings. Cultural property, or physical cultural heritage, is an intrinsic element of people, or personhood; it is a part and piece of collective identity and the materiality that connects the present to the past. The loss of artefacts and historic sites is an erosion of the cultural fabric of the Sudanese people".

She further emphasises:

> "Physical heritage is material proof of a group's existence, worth, and place in history. Therefore, the repair, return, and restoration of Sudanese cultural property post-war is a vital mechanism through which the nation can begin to heal collective trauma, foster dialogue, and create economic value for rebuilding".

Modernist Icons: The Loss of Post-Independence Identity

Sudan's post-independence era witnessed a surge in modernist architecture, evident in landmarks such as the Sudan National Theatre, Friendship Hall, and Khartoum's high-rises. Conflict has erased much of this progress, with key structures heavily damaged or destroyed. Major buildings, including Sudan Airport and the Petrodar Tower, lie in ruins, further crippling the nation's infrastructure and economy. These once-symbolic icons of development now stand as haunting reminders of the war's impact on Sudan's built environment.

Greater Nile Petroleum Operating Company Tower

The Greater Nile Petroleum Operating Company (GNPOC) Tower, designed by KEO International Consultants with Tekno as local consultants, was completed in 2010 and symbolised Khartoum's economic aspirations during the oil boom. Situated in Al-Mogran Central Business District, Sudan's key commercial hub, the 20-floor tower featured a curvilinear steel structure clad in dramatic glass elevations. Its three distinct façades offered panoramic views of the Blue Nile, White Nile, and their iconic confluence. At night, a jewel-shaped peak illuminated the skyline, marking it as a luminous city landmark. Spanning 14,000 m² and costing around US$92 million, the GNPOC Tower embodied Sudan's drive for global visibility and economic transformation. The war completely destroyed the building and reduced its once-innovative design to rubble and ash. The following images show the condition of the GNPOC Tower before and after the conflict.

The GNPOC Tower before its destruction.
Source: Photo by Ayman Algaily

The GNPOC Tower after its destruction.
Source: Photo by Ebrahim Nugdalla

The GNPOC Tower after its destruction.
Source: Google Maps

Architect Mohamed Elgadi, founder of the award-winning Sudanese firm Iskan, views the tower's destruction as more than material loss. He describes it as "an icon of Sudan's modern ambition", whose fall "ruptured a collective dream". Yet, he sees opportunity in the ruins. Rather than demolishing the remains, Elgadi advocates for sustainable retrofitting and adaptive reuse, suggesting that reimagining the building through a climate-responsive lens could align future development with Sudan's urban realities. In his words: "The building's reinvention can honour its symbolic weight while correcting its environmental shortcomings". Elgadi proposes a dual approach: in the short term, stabilising the structure and adapting it to new, local uses; in the long term, shifting architectural priorities away from imported aesthetics toward rooted, resource-conscious design. "Let this landmark rise again", he writes, "not as a replica, but as a wiser version of who we are".

Corinthia Hotel ("Burj Al-Fateh")

The Corinthia Hotel Khartoum, originally known as Burj Al-Fateh, is a distinctive sail-shaped building completed in 2008 and situated at the confluence of the Blue and White Nile. Located in one of the city's most vibrant districts, it was among the first five-star establishments in the capital. With its sweeping, sail-like glass façade, the hotel quickly became a striking symbol of Sudan's cultural and economic revival. Designed by EM Architects and constructed by the Italian firm Cooperativa Muratori e Cementisti (C.M.C.), the 85 metre high structure offered panoramic views of Khartoum and stood as a US$113 million embodiment of the country's international economic ambitions, built to rival iconic landmarks across the globe. Beside the main tower stands

a four-floor shopping mall and conference centre, together spanning 5,300m² and built with 1,230 tonnes of steel. The total combined surface of all areas amounts to 60,000m². The conflict has left the Corinthia severely damaged. Militia attacks shattered and burned large portions of the façade, leading to internal deterioration; this raised concerns about the building's structural integrity. The following images illustrate the Corinthia Hotel before and after the recent conflict.

The Corinthia Hotel before its destruction.
Source: Photo by Hisham Karouri

The Corinthia Hotel after its destruction.
Source: Photo by Al mujtaba Ahmed

According to Dr Huda Elshareif, a lecturer at the University of Kent and a Chartered Environmentalist, the hotel's façade attempted to reduce the glazing-to-wall ratio compared to a fully glazed skyscraper. However, it still relied heavily on exposed glazing, posing significant environmental challenges in Khartoum's climate. In the absence of shading from neighbouring structures, this design choice compromised the building's energy performance. Dr Elshareif explains that "reducing the building's energy consumption is going to be technically and financially challenging", given the context of Sudan, where advanced glazing, insulation, and advanced HVAC systems remain costly and difficult to implement. She further emphasised that the decision to renovate or demolish the Corinthia should take into account its cultural significance, financial feasibility, the embodied carbon impact of demolition, and the limitations of Sudan's electrical grid in supporting a high-performance retrofit.

National Telecommunications Corporation Tower

Among the notable casualties of recent conflicts is the National Telecommunications Corporation (NTC) Tower, the tallest building in Khartoum and the 60th tallest in Africa, which embodies Sudan's modern architectural aspirations. Designed by CENTECS Engineering Consultation & Studies Co. Ltd and completed in 2009 at an estimated cost of US$60 million, the tower rises to 130 metres and spans approximately 5,000m². Its 29-floor structure features a sleek glass façade

overlooking the Blue Nile, integrating modern materials such as aluminium cladding, double-glazing, and natural stone finishes at the ground level. As part of its sustainability efforts, the tower incorporates a Building-Integrated Photovoltaic (BIPV) system, supplying approximately 20% of its electricity demand while aiming to reduce environmental impact. However, subsequent evaluations have raised concerns about its actual performance under Sudan's harsh climatic conditions (Abuelzein and Osman, 2018). The ongoing war has inflicted structural damage on the NTC Tower, including shattered façade sections and looted interior offices, severely disrupting Sudan's telecommunications infrastructure. The following images illustrate the condition of the NTC Tower before and after the recent conflict.

The The NTC Tower before its destruction.
Source: Telecommunications and Post Regulatory Authority

The NTC Tower after its destruction.
Source: Photo by Waddah Eltahir

Architect Ammar Osman, researcher at Bauhaus University Weimar and energy and sustainability consultant, offers a critical assessment of the tower's energy design:

"Including photovoltaic (PV) modules on the façade of the NTC Tower in Khartoum highlights challenges in energy efficiency and data management. For the high-transmissive fabric (overall U-value: 3 W/m²K), PV's role in cooling is limited due to the lack of principles of energy efficient design. Researchers emphasise the importance of redesign of the façade to reduce heat gain resulting from the effect of ambient temperature on the PV efficiency. The efficiency of the on-grid BIPV is uncertain, particularly on a SWW-facing façade, with the absence of battery storage. The adoption of renewable energy in Sudan requires tailor-made energy-efficient planning, considering climate-specific obstacles like extreme temperatures, dust storms and cleaning methods. In addition, accurate performance records are essential for further evaluation".

 RE-BUILDING SUDAN

His critique underscores the need for passive design strategies, orientation-aware planning, and robust monitoring when integrating renewable technologies in harsh climates. Despite its technological ambition, the NTC Tower reveals how innovation must be rooted in context-sensitive, sustainable design to ensure long-term viability.

KHARTOUM INTERNATIONAL AIRPORT

Khartoum International Airport (KIA), located in the centre of Sudan's capital, was originally designed in 1947 to serve general aviation using DC-3 aircraft. Over time, it evolved into a critical hub for both domestic and international travel. Major expansions in the 1970s and renovations in 2010 aimed to modernise facilities and accommodate increasing passenger traffic. As newer long-haul aircraft, such as the Boeing 787 and Airbus A380, entered service, the airport was adapted to support wide-body aircraft, including the B777 and A380 (Zumrawi *et al.*, 2022). Despite these improvements, KIA faced severe limitations due to overcrowding and its urban location. In response, Sudan's Civil Aviation Authority began planning a new airport 40 kilometres south in Omdurman. However, construction was halted due to financial challenges and lack of international funding (Zumrawi *et al.*, 2022). The outbreak of war caused catastrophic damage to the airport. The conflict destroyed terminal buildings, runways, and essential infrastructure, rendering the facility inoperable and halting all air traffic. This event underscored the risks of placing critical infrastructure within conflict-prone urban areas. The following images illustrate KIA's condition before and after the recent conflict.

The KIA before its destruction.
Source: https://amairports.com/ar/project/

The KIA after its destruction.
Source: Photo by Al mujtaba Ahmed

According to Dr Osman El Kheir, planning expert, academic researcher, and board member of ARC-PEACE International, KIA's location had long been a point of concern due to its proximity

to the city centre and surrounding residential areas. Urban planners, environmentalists, transport officials, and safety experts had raised alarms well before the war about the risks of operating a major aviation hub within such a congested setting. Dr El Kheir views the airport's destruction as both a national challenge and a planning opportunity. He proposes a dual-track solution:

> "first, temporarily rehabilitating the existing runway and key facilities such as the Hajj and Umrah terminal to restore essential connectivity; and second, fast-tracking the construction of the long-delayed airport at the new Omdurman site to meet long-term national needs."

He further warns against redeveloping the old airport grounds for housing, arguing that "such a move would replicate past urban planning mistakes". Instead, he advocates that "transforming the site into a central park would offer enduring environmental and social benefits despite the significant investment required".

These case studies highlight the scale of devastation and the urgent need to rethink Sudan's rebuilding approach in ways that address both historical weaknesses and future challenges. The magnitude of Sudan's architectural and cultural loss underscores the urgency for a strategic and sustainable response. However, documenting destruction alone is not enough. In the aftermath of such profound damage, rebuilding must go beyond merely restoring what was lost to fundamentally reimagining Sudan's urban future.

Comparative international experiences further emphasise what is at stake and what is possible. Japan's post-tsunami reconstruction in 2011 prioritised climate resilience and disaster risk reduction in urban planning, helping to build a safer future for vulnerable communities (Fan, 2013). Rwanda's post-genocide recovery illustrates the power of community-led reconstruction in achieving both social healing and long-term sustainability (Clark, 2010). Bosnia and Herzegovina integrated heritage preservation with economic revival to reinforce cultural identity during the rebuilding process (Calame and Charlesworth, 2012). Similarly, Beirut's Solidere model demonstrated the potential for balancing heritage preservation with modern urban development, although challenges in social inclusivity highlighted the need for more equitable planning (Fawaz, 2009).

Recognising this critical juncture, the following section introduces the SRRF, a forward-looking roadmap designed to integrate heritage conservation, climate resilience, and social equity into every stage of the rebuilding journey.

SUDAN'S SUSTAINABLE REBUILDING AND RECOVERY FRAMEWORK

Sudan's post-conflict reconstruction requires a strategic approach grounded in resilience, sustainability, and cultural preservation. The Sustainable Rebuilding and Recovery Framework (SRRF) offers a structured roadmap built on six key pillars, each addressing a vital dimension of recovery. These pillars are aligned with the United Nations Sustainable Development Goals (SDGs) while remaining rooted in Sudan's distinct environmental and socio-cultural realities.

To translate its principles into actionable outcomes, the SRRF outlines specific strategies under each pillar, detailing:

- sub-themes: core focus areas;
- intent: the contribution of each pillar to national recovery;
- strategies: practical actions to guide reconstruction;
- Sudan-specific context: localised challenges and considerations;
- SDG alignment: links to relevant global development targets.

Before examining each pillar in depth, Figure 1 provides a visual overview of the SRRF. It illustrates the key pillars, associated sub-themes, and their alignment with the SDGs. This infographic offers a concise, high-level view of the framework's integrated design. Together, these elements form a comprehensive blueprint for Sudan's sustainable and resilient recovery.

Figure 1: Sustainable Rebuilding and Recovery Framework (SRRF)
Infographic Design: Author and Sidahmed Zaki
Source: Constructed by Author

1. Environmental and Climate Resilience

Sudan's reconstruction must confront the combined impacts of climate change and war-related environmental damage. Rising temperatures, extreme weather, and deforestation threaten both urban and rural livelihoods. This pillar focuses on ecosystem restoration, climate-adaptive infrastructure, and sustainable urban growth (Table 1).

Table 1: Environmental and Climate Resilience

Subtheme	Intent	Strategies	Sudan-Specific Context	Alignment to SDGs
Resilience: Ecology & Engineering	Strengthen climate-adaptive infrastructure and restore ecosystems.	- Restore wetlands and forests to combat desertification. - Develop flood defences and heat-resistant urban planning. - Promote locally sourced, climate-adaptive materials (e.g., rammed earth).	- Deforestation and poor drainage increase urban heat and flooding risks.	- SDG 11: Sustainable Cities & Communities - SDG 13: Climate Action
Sustainable Land Use & Planning	Reduce environmental degradation through responsible urban expansion.	- Prioritise climate-safe areas for development. - Increase green spaces, shaded walkways, and pedestrian zones.	- Khartoum's green cover is severely damaged, worsening urban heat effects.	- SDG 11: Sustainable Cities & Communities - SDG 15: Life on Land
Environmental Impact Assessments (EIA) & Remedial Action	Prevent environmental damage in new developments.	- Mandate EIA before reconstruction. - Adopt a lifecycle approach to sustainable construction. - Remediate war-damaged land.	- Post-war reconstruction has lacked formal EIAs.	- SDG 13: Climate Action - SDG 15: Life on Land
Mitigation & Emissions Monitoring	Reduce Sudan's carbon footprint.	- Establish national greenhouse gas (GHG) monitoring systems. - Promote low-carbon materials and energy-efficient designs.	- Sudan's reliance on fossil fuels increases air pollution and carbon emissions.	- SDG 7: Affordable & Clean Energy - SDG 13: Climate Action
Adaptation & Risk Reduction	Reduce vulnerability to climate hazards and integrate disaster risk reduction (DRR) into long-term resilience planning.	- Mainstream DRR policies in post-crisis reconstruction and local development planning. - Develop climate-resilient infrastructure and water-efficient urban planning. - Strengthen water harvesting, flood control, and drought-resistant agricultural practices. - Implement nature-based flood strategies (e.g., bioswales, permeable surfaces).	- Sudan is one of the most climate-vulnerable countries, with increasing droughts and erratic rainfall patterns. - Urban flooding worsens due to deforestation and poor drainage.	- SDG 6: Clean Water & Sanitation - SDG 13: Climate Action

Subtheme	Intent	Strategies	Sudan-Specific Context	Alignment to SDGs
Sustainable Reconstruction	Minimise environmental harm during rebuilding efforts.	- Restrict deforestation and reduce high-carbon construction methods. - Encourage circular economy principles, material reuse and promote local, sustainable building materials.	- Unregulated rebuilding and unmanaged debris exacerbate environmental degradation.	- SDG 12: Responsible Consumption & Production - SDG 13: Climate Action
Policy & Legal Frameworks	Strengthen environmental governance and regulatory enforcement.	- Develop enforceable environmental policies and strengthen governance frameworks for sustainable reconstruction. - Strengthen environmental oversight institutions to monitor compliance.	- Weak environmental policies lead to unsustainable development.	- SDG 11: Sustainable Cities & Communities - SDG 16: Peace, Justice & Strong Institutions

Source: Constructed by Author

2. Sustainable Mobility

Sudan's transport infrastructure has been severely damaged, worsening congestion, pollution, and limiting mobility in both urban and rural areas. Reconstruction must modernise public transit, enhance walkability, and promote low-carbon, inclusive mobility for long-term sustainability (Table 2).

Table 2: Sustainable Mobility

Subtheme	Intent	Strategies	Sudan-Specific Context	Alignment to SDGs
Rebuilding Public Transport Infrastructure	Develop an affordable, reliable transit system.	- Rehabilitate and modernise bus networks, railways, and river transport. - Introduce Bus Rapid Transit (BRT) corridors in dense neighbourhoods. - Establish multi-modal transit hubs integrating bus, rail, and water transport.	- Most public transport systems were informal before the war and are now further damaged. - Fuel shortages and high costs reduce transit affordability.	- SDG 9: Industry, Innovation & Infrastructure - SDG 11: Sustainable Cities & Communities
Walkable & Bike-Friendly Cities	Improve walkability and cycling infrastructure for safer, more accessible mobility.	- Build dedicated cycling lanes and pedestrian pathways. - Implement traffic calming measures to enhance pedestrian safety. - Promote compact, walkable neighbourhoods that reduce car dependency.	- Cities prioritise cars, with limited infrastructure for cyclists and pedestrians. - Lack of sidewalks and safe crossings increases pedestrian risks.	- SDG 3: Good Health & Well-being - SDG 11: Sustainable Cities & Communities

Subtheme	Intent	Strategies	Sudan-Specific Context	Alignment to SDGs
Low-Carbon & EV Mobility	Reduce emissions and encourage sustainable transport alternatives.	- Expand electric and alternative transport options. - Develop EV charging infrastructure. - Establish low-emission zones in urban centres.	- Sudan lacks EV infrastructure; fuel shortages and rising costs worsen transport inequality. - Diesel and petrol vehicle pollution is worsening urban air quality.	- SDG 7: Affordable & Clean Energy - SDG 13: Climate Action
Smart Mobility Systems	Improve transport efficiency through digital tools.	- Implement Intelligent Transport Systems (ITS) for better traffic management. - Introduce real-time transit tracking apps to improve reliability. - Modernise fare collection with contactless payment systems. - Train urban mobility planners and designers in sustainable transport design.	- No formal transport data exists, making system management inefficient. - Public transport remains unreliable without tracking or route optimisation.	- SDG 9: Industry, Innovation & Infrastructure - SDG 11: Sustainable Cities & Communities
Inclusive Mobility	Ensure inclusive & equitable transport access for all users.	- Improve accessibility with ramps, elevators, and inclusive buses. - Enhance safety measures for women and vulnerable groups. - Provide affordable transit fares for low-income commuters.	- Limited mobility options for disabled individuals, restricting mobility. - Women and vulnerable groups face safety risks on public transport.	- SDG 5: Gender Equality - SDG 10: Reduced Inequalities
Sustainable Freight & Logistics	Modernise freight systems while reducing environmental impact.	- Upgrade rail and river freight systems to reduce congestion. - Promote low-emission freight transport and last-mile delivery solutions.	- Heavy reliance on trucks increases emissions and costs. - War has damaged rail infrastructure, limiting efficient freight movement.	- SDG 8: Decent Work & Economic Growth - SDG 12: Responsible Consumption & Production

Source: Constructed by Author

3. Resilient Health and Wellbeing

Over 80% of Sudan's healthcare infrastructure has been damaged or destroyed, leaving millions lacking access to medical services, clean water and sanitation. Recovery must rebuild resilient health systems, restoring Water, Sanitation and Hygiene (WASH) services, and embed public health in urban planning to address current and future crises (Table 3).

Table 3: Resilient Health and Wellbeing

Subtheme	Intent	Strategies	Sudan-Specific Context	Alignment to SDGs
Health Systems	Rebuild essential healthcare facilities and ensure access to medical services.	- Establish decentralised healthcare centres to improve access. - Deploy mobile clinics and telemedicine for rural and displaced populations.	- Over 80% of hospitals in conflict zones destroyed (WHO, 2024). - Mobile clinics are the only healthcare option for many displaced communities.	- SDG 3: Good Health & Wellbeing - SDG 9: Industry, Innovation & Infrastructure
WASH Services	Provide clean water and sanitation to prevent disease outbreaks.	- Rebuild and upgrade water purification and sewage systems. - Implement rainwater harvesting and grey-water recycling. - Improve waste management to reduce contamination.	- Over 12 million Sudanese lack access to clean water, leading to frequent cholera and malaria outbreaks. - Destroyed sanitation systems worsen health conditions in displacement camps.	- SDG 3: Good Health & Wellbeing - SDG 6: Clean Water & Sanitation
Urban Wellbeing & Biophilia	Create urban environments that enhance mental and physical health.	- Design shaded, green spaces and community hubs to improve urban health. - Use nature-based solutions (e.g., green roofs, vertical gardens) to reduce heat and pollution.	- Many displaced communities live in overcrowded, barren environments with no green spaces. - Urban heat and air pollution contribute to respiratory illnesses.	- SDG 11: Sustainable Cities & Communities - SDG 3: Good Health & Wellbeing
Disaster Safety & Preparedness	Strengthen Sudan's ability to respond to health crises and climate disasters.	- Develop disaster risk mitigation plans for healthcare facilities. - Establish emergency protocols in medical centres and public spaces.	- Sudan has faced repeated health crises, including COVID-19, cholera, and malnutrition-related diseases. - Lack of emergency response systems leaves communities vulnerable.	- SDG 3: Good Health & Wellbeing - SDG 13: Climate Action
Pollution & Environmental Health	Reduce health risks from air, water, and soil pollution.	- Monitor air pollution and control emissions. - Ensure safe waste disposal and industrial pollution regulation.	- Industrial waste, war debris, and untreated sewage have worsened air and water quality. - Respiratory diseases are increasing due to urban pollution and desertification.	- SDG 3: Good Health & Wellbeing - SDG 6: Clean Water & Sanitation

Subtheme	Intent	Strategies	Sudan-Specific Context	Alignment to SDGs
Occupant Comfort & Wellbeing	Enhance public health through environmental and sustainable architectural design.	- Incorporate traditional architectural elements (e.g., Nubian vaults, internal courtyards, water features, vegetation) to support passive cooling, thermal comfort, and air quality. - Optimise natural lighting and ventilation to improve occupant well-being and reduce reliance on mechanical systems. - Enhance indoor environmental quality through sustainable materials, thermal and acoustic insulation. - Implement shading strategies, urban noise reduction, and air quality monitoring systems.	- Most existing homes lack insulation, shading, or proper airflow, worsening indoor air quality. - Extreme heat (up to 47°C) increases air conditioning use, leading to high energy costs and grid instability. - Noise pollution and overcrowding impact mental wellbeing. - Historically, Sudanese homes used courtyards, vegetation and water elements for natural cooling, reducing energy demand.	- SDG 3: Good Health & Wellbeing - SDG 11: Sustainable Cities & Communities

Source: Constructed by Author

4. Efficient Resource Utilisation

Rebuilding Sudan demands efficient use of materials, energy, and water to minimise costs and environmental harm. The country's severe energy shortage crisis is a major challenge: Khartoum consumes 70% of the national electricity supply despite hosting just 12% of the population (ILOSTAT, 2008) and faces a 40% supply deficit; this forces the National Electricity Authority to implement regular power cuts (Ghandour, 2016). Widespread reliance on costly, polluting diesel generators deepens social inequality in energy access. This supply-demand gap not only causes frequent outages but also drives annual increases in electricity costs (Elsherif *et al.*, 2020). In this context, reducing energy consumption is both an environmental necessity and a matter of social equity. A shift towards local material production, renewable energy, and circular economy practices is essential for sustainable, equitable recovery (Table 4).

Table 4: Efficient Resource Utilisation

Subtheme	Intent	Strategies	Sudan-Specific Context	Alignment to SDGs
Sustainable Materials	Reduce waste and promote material reuse to reduce resource depletion and support sustainable rebuilding.	- Implement Life Cycle Assessment (LCA) to assess material and construction impacts. - Repurpose war debris to support circular economy models for reconstruction. - Use green materials and integrate vernacular techniques such as adobe, Nubian vaults, and coral stone that are locally sourced, low-carbon, and climate-adaptive. - Conduct pre-refurbishment waste audits and integrate modular/adaptable building designs to extend material lifespan.	- War has generated massive amounts of debris that can be repurposed. - Dependence on imported materials and lack of reuse increase costs and delay rebuilding.	- SDG 9: Industry, Innovation & Infrastructure - SDG 12: Responsible Consumption & Production
Energy Efficiency & Renewables	Cut fossil fuel dependence and transition to clean energy.	- Follow a 'Fabric First' strategy: improve insulation, airtightness, and shading before adding mechanical cooling. - Apply passive design principles from traditional homes - thick walls, courtyards, natural shading to reduce cooling loads. - Develop off-grid solar micro-grids for homes and public facilities. - Monitor energy use and assess performance to optimise efficiency. - Specify energy-efficient HVAC systems and integrate energy modelling to optimise building performance.	- High temperatures (up to 47°C) have made air conditioning essential, increasing electricity demand. - Traditional Sudanese homes, with thick walls and shading, reduce heat gain, minimising the need for cooling. - Frequent power outages and fuel shortages disrupt daily life. - Most buildings lack passive cooling, increasing energy dependency.	- SDG 7: Affordable & Clean Energy - SDG 11: Sustainable Cities & Communities
Water Management	Ensure sustainable water use to address scarcity and improve resilience.	- Rainwater harvesting and grey-water recycling for water conservation. - Restore wetlands and protect natural water bodies. - Improve storm-water management and groundwater recharge. - Recover AC condensate and install smart meters to detect leaks in real time.	- Many areas lack access to clean water, worsening health risks. - Desertification and droughts are intensifying water scarcity.	- SDG 6: Clean Water & Sanitation - SDG 13: Climate Action

Subtheme	Intent	Strategies	Sudan-Specific Context	Alignment to SDGs
Waste Reduction	Develop sustainable waste systems to handle war debris and urban waste.	- Establish construction waste recycling programmes. - Develop biogas systems and convert waste into energy. - Promote community-led waste systems.	- Sudan lacks a formal waste management system, leading to uncontrolled dumping. - Agricultural waste could be converted into energy but remains under-utilised.	- SDG 9: Industry, Innovation & Infrastructure - SDG 12: Responsible Consumption & Production
Local & Green Supply Chains	Strengthen local industries to reduce dependence on imports.	- Invest in local production of construction materials. - Develop low-emission supply chains to reduce transportation costs. - Establish shared resource hubs for rebuilding projects.	- Limited manufacturing capacity forces reliance on expensive imports. - High transportation costs and supply chain disruptions slow recovery.	- SDG 8: Decent Work & Economic Growth - SDG 9: Industry, Innovation & Infrastructure

Source: Constructed by Author

5. Social and Economic Recovery

The conflict has displaced millions, destroyed homes, and collapsed Sudan's economy, pushing many into informal settlements. Recovery must prioritise affordable housing, job creation, and economic revitalisation to achieve sustainable, inclusive development (Table 5).

Table 5: Social and Economic Recovery

Subtheme	Intent	Strategies	Sudan-Specific Context	Alignment to SDGs
Affordable & Resilient Housing	Promotes cost-effective, climate-aware rebuilding.	- Promote incremental housing models for flexible, phased construction. - Use local, climate-responsive materials like adobe and compressed earth bricks. - Support community-led housing to enhance long-term resilience and ownership.	- Millions displaced by war live in overcrowded shelters without permanent housing. - High construction costs and economic instability slow rebuilding.	- SDG 1: No Poverty - SDG 11: Sustainable Cities & Communities

 RE-BUILDING SUDAN

Subtheme	Intent	Strategies	Sudan-Specific Context	Alignment to SDGs
Employment & Skills Development	Generate jobs and provide training in sustainable construction and urban services.	- Encourage local employment over imported labour. - Promote small business growth in construction and urban services. - Offer training in traditional construction skills to strengthen local employment and preserve cultural techniques.	- High unemployment, with many skilled workers displaced. - Limited expertise in green construction hinders sustainable rebuilding.	- SDG 8: Decent Work & Economic Growth - SDG 9: Industry, Innovation & Infrastructure
Market & Economic Revitalisation	Realistically tackles market recovery and investment attraction	- Rebuild war-affected marketplaces to revive economic activity. - Provide micro-finance and grants for small businesses. - Develop special economic zones (SEZs) to attract investors.	- Markets in major cities destroyed, affecting thousands of businesses. - War-related economic collapse has made business recovery difficult.	- SDG 8: Decent Work & Economic Growth - SDG 9: Industry, Innovation & Infrastructure
Inclusive Infrastructure & Services	Ensure all communities have access to essential services.	- Expand roads, electricity, water, and sanitation in marginalised areas. - Ensure equitable access to clean water, sanitation, and reliable energy.	- Many war-affected regions lack basic utilities (e.g., clean water, sanitation, and electricity). - Informal settlements continue to grow, often without legal infrastructure access.	- SDG 6: Clean Water & Sanitation - SDG 7: Affordable & Clean Energy
Community-Led Urban Planning	Engage local communities in decision-making for urban rebuilding.	- Engage communities in participatory design that reflects local needs and spatial customs, including gendered spaces and shared compounds. - Promote co-operative housing and adapt existing structures to support displaced families without expanding into new areas. - Rethink urban layouts, not as rigid grids but as organic systems that reflect Sudanese social life, with access to water, markets, religious sites, and other cultural spaces. - Reclaim passive features - courtyards, verandas, and shaded communal spaces to reduce cooling needs and support communal life. - Adopt flexible, mixed-use zoning that adapts to evolving community needs.	- Past urban projects ignored community needs, leading to displacement. - Informal settlements lack legal recognition and basic infrastructure.	- SDG 10: Reduced Inequalities - SDG 16: Peace, Justice & Strong Institutions

Subtheme	Intent	Strategies	Sudan-Specific Context	Alignment to SDGs
Finance for Rebuilding	Secure sustainable funding for long-term recovery.	- Leverage international donor funding for infrastructure rebuilding. - Expand micro-credit programmes to help families and businesses rebuild. - Mobilise diaspora investment in housing and business development.	- Sudan's economy is fragile, limiting government funding for large-scale reconstruction. - Lack of credit access slows business and rebuilding recovery.	- SDG 8: Decent Work & Economic Growth - SDG 17: Partnerships for the Goals

Source: Constructed by Author

6. Heritage Preservation

Conflict has devastated Sudan's cultural and architectural heritage, damaging landmarks, looting museums, and threatening national identity. Recovery must document, restore, and integrate heritage into urban planning to protect and revitalise Sudan's historical narrative (Table 6).

Table 6: Heritage Preservation

Subtheme	Intent	Strategies	Sudan-Specific Context	Alignment to SDGs
Heritage Protection & Documentation	Prevent further destruction and create a record of lost or damaged sites.	- Undertake emergency documentation of heritage sites using digital mapping and satellite imagery. - Develop and implement risk assessment frameworks to safeguard vulnerable heritage sites.	- War has destroyed landmarks such as the Khartoum Presidential Palace and ancient Nubian sites. - Looting of museums and archives has led to the loss of irreplaceable artefacts.	- SDG 11: Sustainable Cities & Communities - SDG 16: Peace, Justice & Strong Institutions
Post-War Restoration	Rehabilitate damaged heritage sites using sustainable methods.	- Develop local expertise in heritage restoration through specialised training. - Secure international funding and partnerships for large-scale restoration projects.	- Many historic buildings have suffered extensive damage, requiring urgent intervention. - Lack of skilled conservation workers is delaying recovery.	- SDG 11: Sustainable Cities & Communities - SDG 8: Decent Work & Economic Growth

Subtheme	Intent	Strategies	Sudan-Specific Context	Alignment to SDGs
Heritage Integration in Urban Planning	Ensure that heritage preservation is included in modern reconstruction efforts.	- Implement heritage-sensitive zoning laws to protect historic districts. - Guide new developments to respect and reflect Sudan's architectural heritage.	- Rapid urban expansion is threatening historic districts. - Traditional Nubian and Islamic architectural styles are being replaced by generic modern buildings.	- SDG 11: Sustainable Cities & Communities - SDG 4: Quality Education
Community & Culture	Involve local communities in heritage preservation efforts.	- Establish heritage education programmes in schools and universities. - Empower communities in heritage preservation projects. - Promote sustainable cultural tourism as a tool for economic revitalisation and heritage awareness	- Displacement and war have weakened communities' connections to cultural heritage. - Lack of public awareness has led to further unintentional damage to historical sites.	- SDG 11: Sustainable Cities & Communities - SDG 8: Decent Work & Economic Growth
Heritage Sites Risk Management	Protect historical sites from future threats such as climate change, looting, and armed conflict.	- Develop disaster risk reduction plans for key sites. - Use climate adaptation strategies to protect heritage from environmental damage. - Establish security measures to prevent looting and illegal trafficking of artefacts. - Collaborate with Interpol and international agencies to trace and repatriate looted artefacts.	- Flooding and desertification are damaging ancient sites, including pyramids and temples. - Ongoing conflict increases the risk of intentional destruction and looting.	- SDG 13: Climate Action - SDG 16: Peace, Justice & Strong Institutions

Source: Constructed by Author

Effective heritage recovery must also draw lessons from past international efforts. One landmark example is UNESCO's historic Nubian monument rescue, offering critical insights for Sudan's path forward.

UNESCO's Role: Past Preservation Efforts and Future Support Needed

Effective heritage recovery in Sudan must learn from previous international efforts, most notably UNESCO's historic Nubian monument rescue in the 1960s. When Egypt's Aswan High Dam threatened to submerge the monuments, UNESCO launched and co-ordinated an unprecedented international campaign that successfully relocated them. Over 50 countries contributed more than US$80 million (approximately US$305 million in 2024 value) to the operation (Hill, 2021; UNESCO, 1962). This effort not only preserved irreplaceable heritage but also demonstrated the power of global solidarity and cultural diplomacy.

Today, the stakes are higher than ever. War, looting, and neglect actively threaten Sudan's millennia-old sites, manuscripts, and intangible traditions. Unlike past conflicts, when preservation came too late, this moment demands immediate mobilisation to prevent irreversible loss. International institutions such as UNESCO must act decisively, not only by providing resources and co-ordination, but by reaffirming that heritage in Africa holds equal value within global cultural governance.

Whether international donors will offer Sudan the same level of support it once received remains uncertain. As global priorities shift, will heritage preservation still command the attention of policymakers and funders?

A VISION FOR SUDAN IN 2050: WHAT THE FUTURE COULD LOOK LIKE

Looking ahead, Sudan's post-war recovery presents a chance not just to rebuild, but to build forward. If national leadership grounds recovery efforts in sustainability, equity, and cultural continuity, Sudan could emerge as a regional model for climate-resilient development and heritage-driven innovation. By 2050, cities may become climate-resilient, run on solar micro-grids for energy and rely on eco-friendly public transportation systems. Rebuilt infrastructure would reflect both modern engineering and Sudanese architectural heritage. A diversified economy, rooted in regenerative agriculture, green industry, and technological innovation, could replace reliance on extractive sectors while generating inclusive jobs and empowering local communities. At the same time, a revitalised heritage sector and thriving cultural tourism industry could reinforce national identity and attract global attention.

If Sudan makes bold, locally grounded choices today, could it become Africa's leading model of sustainable, post-conflict recovery by 2050?

CONCLUSIONS: A CALL TO ACTION

Sudan stands at a pivotal crossroads. The choices its leaders make today will define the country's future trajectory. A vision of a resilient, inclusive Sudan by 2050 remains within reach, but only if action begins now. Reconstruction must go beyond rebuilding physical structures; it should redefine Sudan's identity through sustainable development rooted in equity, climate resilience, and cultural heritage. To avoid repeating past mistakes, Sudan's government must implement transparent policies, invest in long-term urban planning, and actively engage communities in decision-making. Without strong governance, the country risks environmental degradation, economic instability, and deepening social divides.

International institutions such as UNESCO, UN-Habitat, and the World Bank must support this work by offering financing, technical guidance, and cultural heritage protection. However, the vision must remain Sudanese-led. Local architects, engineers, planners, historians, and civil society, both within Sudan and across the diaspora, must drive a recovery that is adaptive, climate-conscious, and deeply grounded in local identity.

This moment will define Sudan's future. Will the country rise as a model of resilience and renewal, or repeat cycles of fragility? The global community must approach Sudan's reconstruction not as just another post-conflict scenario, but as a shared responsibility to protect humanity's cultural and ecological legacy.

REFERENCES

Abuelzien, O. and Osman, R. (2018): Solar power in building design, the case of NTC Tower in the Sudan. *International Journal of Engineering and Technology*, Vol. 10, No. 4, pp.1155-1165. Available at: https://doi.org/doi:10.21817/ijet/2018/v10i4/181004219

Adam, A.H.A. (2017): Museums in the Sudan: History, current situation and challenges. *Der Antike Sudan. Mitteilungen der Sudanarchäologischen Gesellschaft zu Berlin*, Vol. 28, pp.103-113.

Amer, M.S. (2018): Rebuilding Cultural Identity. *International Journal of Environmental Science & Sustainable Development*, Vol. 3, No. 1, pp.17-30. Retrieved from https://doi.org/doi.org/10.21625/essd.v3iss1.279

Bashir, M. and Näser, C. (2025): Archaeology and development: Post-conflict rebuilding of the Archaeology and Heritage Sector in Sudan. *African Archaeological Review*, pp.1-6. Available at: https://doi.org/doi:10.1007/s10437-025-09614-y

Calame, J. and Charlesworth, E.R. (2012): *Divided cities: Belfast, Beirut, Jerusalem, Mostar, and Nicosia*. Philadelphia, PA: University of Pennsylvania Press.

Clark, P. (2010): *The Gacaca Courts, post-genocide justice and reconciliation in Rwanda: Justice without lawyers*. Cambridge: Cambridge University Press.

Elsherif, H.Z.T., Nikolopoulou, M. and Schoenefeldt, H. (2022): The devolution of thermal resilience in residential houses in Khartoum. In Nicol, F., Rijal, H.B. and Roaf, S. (Eds): *Routledge Handbook of Resilient Thermal Comfort* (pp.175-192). Available at: https://doi.org/doi:10.4324/9781003244929-15

Fan, L. (2013): *Disaster as opportunity? Building back better in Aceh, Myanmar and Haiti*. Humanitarian Policy Group Working Paper, Overseas Development Institute. Available at: https://media.odi.org/documents/8693.pdf

Fawaz, M. (2009): Neoliberal urbanity and the right to the city: A view from Beirut's periphery. *Development and Change*, Vol. 40, No. 5, pp.827-852. Available at: https://doi.org/doi:10.1111/j.1467-7660.2009.01585.x

Ghandour, D. (2016): Struggles for electrical power supply in Sudan and South Sudan. *International Journal of Business and Management Study*, Vol, 3, No. 2, pp.28-34.

Hill, A.C. (2021): 'The Battle for Abu Simbel': Archaeology and Postcolonial Diplomacy in the UNESCO Campaign for Nubia. *Journal of Contemporary History*, Vol. 56, No. 3, pp.502-521. Available at: https://doi.org/10.1177/0022009421997884

Ibrahim, A.O. (2022): The Afro-Arab unique hybrid architecture in search for a socio-cultural unification symbolism in the Sudan. *Technium Social Sciences Journal*, Vol. 28, pp.705-733. Available at: https://doi.org/10.47577/tssj.v28i1.5680

Jedicke, P. (2023): *Sudan's cultural treasures destroyed in conflict.* DW In Focus. 15 June 2023, dw.com. Available at: https://www.dw.com/en/sudans-cultural-treasures-destroyed-in-conflict/a-65904076 Accessed: 21 April 2025.

Kutty, N.A., Barakat, D., Darsaleh, A.O. and Kim, Y.K. (2023): A systematic review of climate change implications on building energy consumption: Impacts and adaptation measures in hot urban desert climates. *Buildings*, Vol. 14, No. 1, p.13. Available at: https://doi.org/10.3390/buildings14010013

Liyanage, D.R., Hewage, K., Hussain, S.A., Razi, F. and Sadiq, R. (2024): Climate adaptation of existing buildings: A critical review on planning energy retrofit strategies for future climate. *Renewable and Sustainable Energy Reviews*, Vol. 199, p.114476. Available at: https://doi.org/10.1016/j.rser.2024.114476

Roach, E.L. and Al-Saidi, M. (2021): Rethinking infrastructure rehabilitation: Conflict resilience of urban water and energy supply in the Middle East and South Sudan. *Energy Research & Social Science*, Vol. 76, p.102052. Available at: https://doi.org/10.1016/j.erss.2021.102052

Elzain, I.S. (2009): Meroe: The City State, the Kingdom, the Empire – Why Meroe? *Beitrage zur Sudanforschung*, Vol. 10, pp.35-46.

International Labour Organisation (ILOSTAT) (2008): Sudan - Population and Housing Census 2008. Available at: https://webapps.ilo.org/surveyLib/index.php/catalog/1360#:~:text=The%20total%20population%20enumerated%20was,peace%20Agreement%20was%20in%201972

United Nations Educational, Scientific and Cultural Organization (UNESCO) (1962): *Financial aspects of the International Campaign to Save the Monuments of Nubia*. Available at: https://unesdoc.unesco.org/ark:/48223/pf0000247975

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2024): *Crisis and Consequence: The Escalating Humanitarian Emergency in Sudan*. [online] Available at: https://www.unesco.org/en/articles/crisis-and-consequence-escalating-humanitarian-emergency-sudan

UNICEF (2023): *Palais briefing: First UN mission in Khartoum since war broke out in Sudan*. Available at: https://www.unicef.org/press-releases/palais-briefing-first-un-mission-khartoum-state-war-broke-out-sudan

United Nations Office for Disaster Risk Reduction (UNISDR) (2017): *Build back better in recovery, rehabilitation and reconstruction*. Switzerland: United Nations Office for Disaster Risk Reduction. 48pp.

Wijenayake, V., Stevenson, L.A., Takemoto, A., Ranjan, A., Mombauer, D. and Ismail, N. (Eds): (2024): *Linking climate change adaptation, disaster risk reduction, and Loss & Damage*. Palgrave Macmillan

Zumrawi, M., Ismail, A.A., Mohamed, A.O., Ahmed, E.A. and Hassan, M.M. (2022): Improving performance of Khartoum International Airport, Sudan. *University of Khartoum Engineering Journal*, Vol. 10, No. 1. Available at: https://doi.org/10.53332/kuej.v10i1.933

BIOGRAPHY

Sara Elhussein is a Chartered Architect and Sustainability Lead with 10+ years of experience across Africa, Middle East, and Europe. She holds an MSc in Environmental Design and Engineering from University College London, juror for the RIBA Middle East Awards 2025, research paper reviewer for Journal of Climate Change, and key member of Sudan Heritage Preservation Council. She is an expert in climate-responsive and parametric design, AI, environmental modelling, retrofit strategies, circular economy, and LCA. Sara has held senior roles at leading UK firms, including Hydrock and ME Engineers and is the founder of I Design Studio and Sudan Arts & Architecture Foundation. Her portfolio includes major projects like $1B Qiddiya Stadium (KSA) and Aylesham Centre Redevelopment (UK). She has won the design competition of Sudan Pavilion at Expo 2020 Dubai, and curated Sudan's first Venice Architecture Biennale Pavilion. She has published several works, and her current research focuses on climate-conscious design strategies for sustainable architecture beyond the 2030 Agenda.