Economic Benefits of **Stabilized Soil Block Technology** in Sudan

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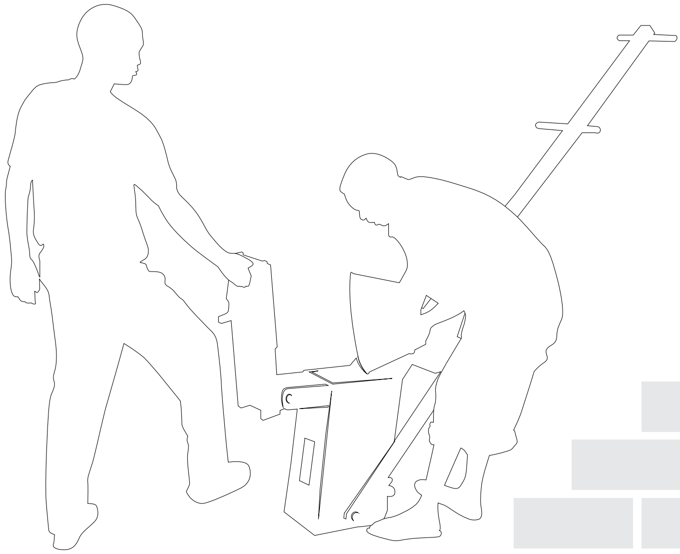

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Cover Photo: Construction of houses in 2010 using stabilized soil block technology for vulnerable families of former internally displaced persons integrated at the Sakali Settlement, South Darfur State, Sudan. © UN-Habitat

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ACRONYMS AND ABBREVIATION

BB	Burned Brick
BMPTC	Building Materials and Production Training Center
DDRR	Disarmament Demobilization Rehabilitation and Reintegration
DFID	Department for International Development
GOS	Government of Sudan
HRDF	Housing Reconstruction and Development Fund
IDPs	Internally Displaced Persons
ILO	International Labour Organization
MPUD	Ministry of Planning and Urban Development
NGOs	Non-Governmental Organizations
NHDF	National Housing Development Fund
PIU	Project Implementation Unit
PPP	Public Private Partnership
SDF	Social Development Fund
SGD	Sudanese Pound
SSB	Stabilized Soil Block
TRI	Technology Research Unit
UNAMID	African Union/United Nations Hybrid Operation in Darfur
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UN-Habitat	United Nations Human Settlements Programme
UNHCR	United Nations High Commission for Refugees
UNICEF	United Nations Children's Fund
UNOCHA	United Nations Organization for Coordination of Humanitarian Affairs

Executive Summary

This assessment report presents the economic benefits of the use of the stabilized soil block technology in the Darfur and Khartoum states of the Republic of Sudan. The report recommends scaling up the use of the technology since it is a more environmentally friendly and affordable building practice than tradition technologies to be used in the reconstruction efforts of Sudan.

Sudan has a long history of war. A part of this history is the war in Darfur between the Government and its allied militia on one hand and, on the other, armed groups that have sprung up since 2003. The civil war between these two groups has resulted to tens of thousands people killed.

On 5 May 2006, the Government and the largest armed group, the Sudan Liberation Movement, signed the Darfur Peace Agreement. The deal marks the start of intense efforts to usher lasting peace to the region. In July 2011, a new Darfur Peace Agreement was signed between the Government and the Liberation and Justice Movement.

With these agreements some 300,000 households (average 5.6 persons per HH) still thought to be displaced in Darfur are expected to return to their places of origin or integrate into already existing urban settlements. They all need to rebuild their homes.

Moreover, reconstruction of homes needs to be of superior quality to that which existed prior to the latest conflict. Past mistakes must be avoided. For example, past practices of large-scale felling of trees for firewood and making burnt bricks for homebuilding has resulted in massive deforestation of the country. Such destruction has given rise to the realization that alternative building methods are needed for Darfur. The region simply cannot afford to slash 16 million mature trees that would be needed for the reconstruction using traditional methods.

Therefore, the Government acknowledges the need for affordable "woodless" building technologies to support a sustainable return and reintegration of internally displaced persons in the state of Khartoum and the five that form the Darfur area. One such innovation is stabilized soil block technology (Box 1). This technology emerged in its present form approximately 60 years ago, evolving from unbaked earthen bricks. The technology has already proven its quality in South America and India. It is equally true for Sudan, where UN-Habitat has developed and integrated the technology into its programmes for rebuilding homes, schools, health facilities and other social infrastructure.

This economic assessment complements efforts of UN-Habitat and its partners to scale up use of the technology in Darfur and Khartoum states, thereby supporting their recovery and sustainable urbanization.

Readily available, the stabilized soil block technology is cheaper and more environmentally friendly than the traditional building methods. Additionally, its production generates employment. All of these aspects can make the reintegration of the internally displaced persons easier; engender social cohesion; thereby laying the foundation for lasting peace and sustainable economic development of Darfur.

The economic assessment was conducted in cooperation with national institutions in Khartoum, and in Nyala, capital of Southern Darfur State. Additionally, stakeholders such as the United Nations Development Programme, the United Nations Office for the Coordination of Humanitarian Affairs, the World Food Programme, The Office of the United Nations High Commissioner for Refugees, the African Union - United Nations Mission in Darfur, etc. and targeted communities were consulted. The assessment reveals the following:

- Stabilized soil block technology is cost-effective and environmentally friendly
- The stabilized soil block is at least 18 per cent cheaper to produce than burned bricks, since firewood is not used and the process requires less water. The stabilized soil block technology can cut regional and local government expenditure while providing the needed housing and social facilities for residents. The technology is a sustainable strategy for housing and reintegration of internally displaced persons and can boost the peace process
- Establishment of a Building Materials Production and Construction Training Centre stimulates employment and income generation
- Transfer of technology for local building material production can be achieved when there is an adequate local capacity and the means to sustain the proposed technology
- Establishing a Building Materials Production and Construction Training Centre will facilitate scaling up of the stabilized soil block technology by providing training to:

(a) Enhance housing construction, rehabilitation and upgrading of settlements and basic services for easier reintegration of internally displaced persons, ex-combatants and returnees.

(b) Facilitate expansion of environmentally friendly commercial production, marketing and application of affordable building materials.

(c) Support training of small-scale businesses and revolving funding mechanisms for commercialization of stabilized soil block technology.

Joan Clos
Under-Secretary-General of the United Nations, Executive Director, UN-Habitat

01 Introduction

A house made of SSBs for a vulnerable former IDP family integrated at Sakali Settlement in 2010. © UN-Habitat

1.1 BACKGROUND

Before South Sudan gained independence after a referendum on the motion in 2011, it was part of Sudan which was the largest country in Africa in terms of landmass. Sudan attained independence in 1956. It had its first civil war in the Ananya I rebellion (1955 to 1972) and the Ananya II revolt in 1978. In 1983, the country entered a devastating second civil war between successive governments and the Sudan's Liberation Movement/Army (SPLM/A), lasting two decades. The war was compounded by drought and floods and has retarded development and used up much of the country's resources.

The signing of the 2005 Comprehensive Peace Agreement by the Government and the Sudanese People's Liberation Movement/Army provided opportunities for the international community and the United Nations to provide support for protection, recovery and development activities in Sudan. The country is facing major challenges in providing decent housing and basic infrastructure for the resettlement of internally displaced persons in Khartoum State and the Darfur area.

Situated at the confluence of the White and Blue Nile rivers, the nation's capital, Khartoum, has emerged as a modern metropolis. It owes its good fortune to oil revenues it once controlled but has been unable to provide decent housing for all. The site and services policy applied in Khartoum city to provide accommodation for all residents - by subdividing and leasing land using three basic categories for plot allocation - is outdated. Furthermore, since more than half of the beneficiaries have been unable to build their homes there are enormous areas of unoccupied land. This has generated urban sprawl, low-density neighbourhoods and the lack of infrastructure. Additionally, there has been a tendency of driving the poor to the city limits. Due to these issues, sustainable urban planning and adequate housing for all is a major task of peacebuilding in the area.

Sudan's conflicts have resulted in large-scale displacements. In July 2011, before the independence of South Sudan there were still between 4.5 million and 5.2 million internally displaced persons in Sudan. Of these, 1.9 million were in the area of Darfur[1]. There, an estimated 300,000 families (average 5.6 person per HH) are still displaced. If these families rely on traditional methods to rebuild their homes this would apply intense pressure on an already dire situation of the country's forest resources, especially in central Sudan and Darfur. This has led to massive deforestation in the Darfur where timber is needed for firewood and homebuilding, using bricks baked in inefficiency kilns. Deforestation causes desertification and tensions between groups scrambling for scare supplies of wood. In an assessment in 2007, the United Nations Environment Programme noted there was increasing demand for construction materials in Sudan, particularly for bricks.

The large-scale reconstruction presents an opportunity to introduce sustainable and cost-effective building techniques to Dafur and avoid past mistakes. "Woodless" construction technologies are already in small-scale use in Sudan. UN-Habitat has developed a programme to enable internally displaced persons and the

1 *IDMC, International displacement monitoring centre, www.internal-displacement.org*

governments in Khartoum and Darfur to use stabilized soil blocks for homes and other social infrastructure. This is response to the deforestation and high demand for building material. The blocks are more affordable than the traditional burned bricks.

1.2 THE EMPLOYMENT-CREATION POTENTIAL OF HOUSING AND INFRASTRUCTURE SUPPLY

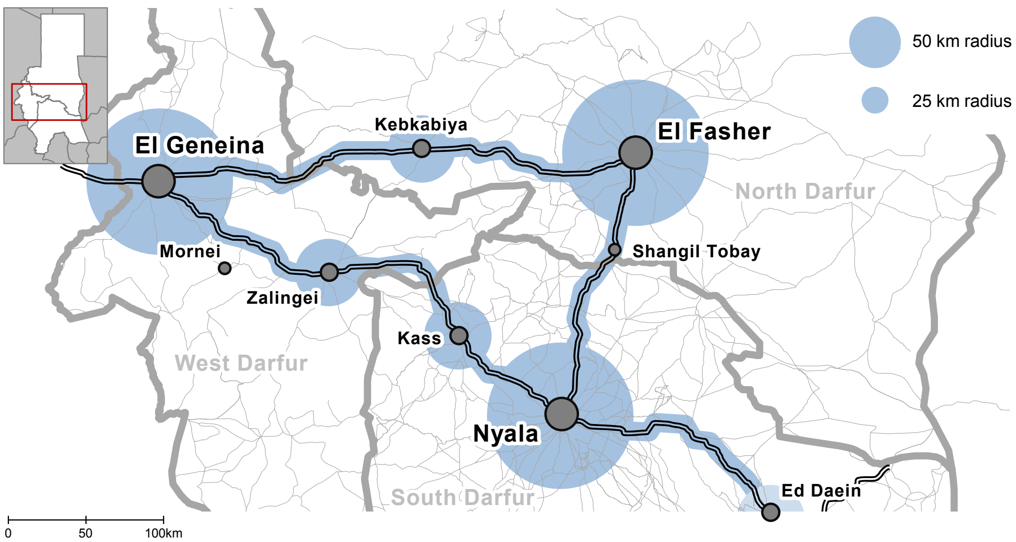
In housing segment the greatest benefits for development accrue from homes built by the informal sector. Such homes tend to be built by small firms using indigenous techniques and a large pool of semi and unskilled labour.

Investment of a given amount in informal housing tends to generate approximately one to five more jobs than the formal housing. Additionally, it provides six times as many dwelling units - although of poorer quality.

Furthermore, labour-based construction technologies and local materials used by local contractors maximize the local economic benefits.

FIGURE 1: URBANIZATION IN DARFUR

Almost half the population now lives in urban centres and near the axes that link them



Source: UN Office of the Resident and Humanitarian Coordinator, 2010

1.3 UN-HABITAT INTERVENTION IN SUDAN

UN-Habitat in Sudan has developed programmes that focus on sustainable urbanization, public and basic services delivery, as well as housing development and livelihoods. UN-Habitat's activities in Sudan include policymaking, forming strategy, doing studies and assessments, training and capacity development, implementation of physical interventions at the local level, using participatory approaches and alternative construction technologies. UN-Habitat also facilitated the national conference on sustainable urbanization, in November 2010. During the conference, UN-Habitat introduced the stabilized soil block technology. It demonstrated its effectiveness in preventing deforestation, its affordability and the good quality of reconstruction it provided in Khartoum and Darfur.

The Government acknowledges the need to use alternative and affordable building technologies to support return and reintegration of internally displaced persons in Khartoum State and those of Darfur which, at the same time, would not have a devastating impact on the environment. UN-Habitat is, therefore, exploring strategies to scale up its application to support the recovery process. It is also exploring ways in which the technology can be commercialized and disseminated further; stimulate microfinance or revolving mechanisms to make homebuilding more affordable, accessible and be a source of employment.

An overview of UN-Habitat programmes and project activities is presented in the following section for Khartoum and Darfur states.

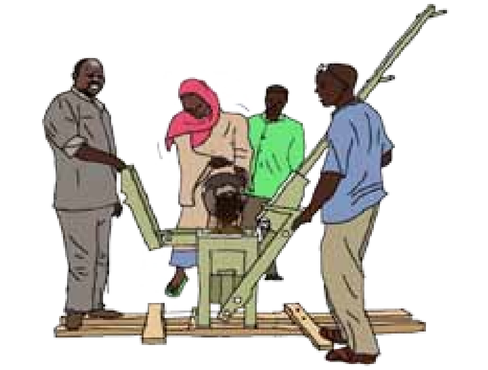
1.3.1 Khartoum State

Khartoum (covering 22,122 km^2,) is the smallest of Sudan's states but has the highest populous, which accounts for more than 26 per cent of the total national figure. Khartoum State's three cities - Khartoum, Khartoum North and Omdurman (the seat of the national Government) - constitute a metropolis of more than 7 million inhabitants with serious social and environmental problems[2]. Despite these challenges Khartoum, the largest city, continues to attract more inhabitants. The State's hinterland, shaped by the River Nile, presents a wide range of villages and towns with very different livelihood opportunities. Massive migration of poor people to Khartoum in the last decades - mostly because of war, drought and poverty - explains the mismatch between supply and demand of low-cost housing and basic urban services.

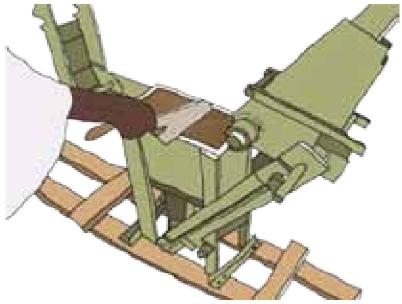
Khartoum is facing rapid horizontal expansion. The presence of several low-density residential areas causes problems for the other areas to access infrastructure (especially water, sanitation and electricity), social services (such as schools, clinics and markets) and decent housing, especially for the urban poor. There is an urgent need for designing an integrated urban development programme to improve existing slum areas, preventing the

2 *Source: UN-Habitat 2010, Khartoum Pro-Poor: From Policy Design to Pilot Demonstration Projects*

FIGURE 2: AWARANESS TOOLS FOR PRODUCTION AND APPLICATION OF SSB TO REPLACE BURNED BRICKS

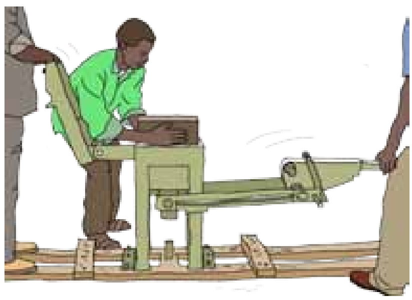


Pour sieved soil into a steel press after mixing soil, sand and stabilizer.



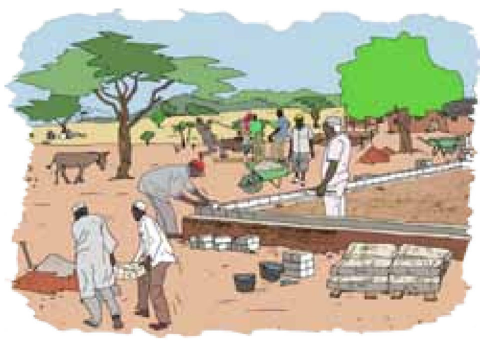
Even the surface of the brick.

Compress the blocks by pulling down the handle.



Collect compressed blocks.

Cure the blocks for 28 days.



Use the blocks similarly to fired bricks in construction.

Source: UN-Habitat.

BOX 1: Stabilized soil block technology

The stabilized soil block production process is a technique consisting of mixing at least 5 per cent cement (less than that of normal bricks) or lime stabilizer with soil and a minimal amount of water (and possibly waterproofing agents). The blocks are compressed using steel hand press machines or mechanical presses machines to produce good quality blocks (Figure 2). Compared with burned bricks, the benefits of this technology include greater energy efficiency and savings on money and on firewood. Other good qualities include the ability for local production; flexible sizing; labour intensiveness that can create jobs; as well as good stability and strength.

Sources: Skat, Swiss resource center and consultancies for development (2006), Building material leaflets,http://www.skat-foundation.org/publications/prarticle. 2005-09-29.1982292338/skatpublication. 2009-09-30.0248134508/file, retrieved 22.5.2012; Venkatarama Reddy B. V. (2004), Sustainable building technologies, Special section: application of S&Tto rural areas, Current Science, 87 (7). pp. 899-907.

urban sprawl and formation of new informal settlements. At the same time, creating the conditions for a more balanced spatial development of the region, by stimulating the growth of poles around Khartoum city, is of crucial importance.

UN-Habitat has been providing support to the Government in preparation and implementation of programmes designed to meet these challenges in a more sustainable manner. Since 2007, two important and complementary initiatives were implemented for formulation and application of pro-poor urban planning, strategies and policies.

The programmes have been funded by the European Commission and the Italian government. Diagnostic studies of various urban sectors, planning and rapid urban assessments in three informal areas around Khartoum city were conducted. Under the project, "Khartoum State Urban Planning and Development Programme".

The following results were achieved:

- **Development of Mansura:** In Mansura, building a Women's Development Centre, a health centre and a kindergarten; installing drainage and a low-cost sewage system; building self-help housing and a small park for youth recreation; and a microcredit scheme for roofing and ferrocement production.
- **Development of Mayo-Mandela:** In Mayo-Mandela, two schools (girls and boys), 200 self-help housing units and sanitation through microcredit have been constructed. In addition, the resettlement of those internally displaced persons who benefited from the regularization of land titles has been facilitated.
- **Development of Al Rasheed:** In Al Rasheed, six model houses demonstrating appropriate technologies to build multistorey low-income units as a test to verify costs have been constructed. This effort is expected to be replicated with the construction of 400 self-help housing facilities. Additionally, public and private pit

latrines have been built and 10,000 trees planted. Other actions taken are:

- **Formulation of strategic plans for villages/towns:** Two national teams of personnel drawn from the Ministry of Planning and Urban Development, the University of Al Azhari, national consultants and experts have been formed to undertake the formulation of strategic plans for villages and towns
- Establishment of a revolving fund for self-help housing construction using stabilized soil block technology
- A project within the programme has been implemented in partnership with the Social Development Foundation for enhancing the capacity of Khartoum State in the formulation and implementation of pro-poor urban planning policies

Measures being taken to improve access to affordable shelter for low-income communities in Khartoum are:

- The establishment of a credit revolving fund for construction materials such as roofing and cement
- Provision of technical aid
- Promotion partnerships with local authorities and communities in slum and squatter settlements

1.3.2 Darfur States

Darfur is divided into three states with a total population of 7.5 million in 2008. The population of North Darfur is 2,113,626, South Darfur, 1,765,380, East Darfur 1,111,495, Centre Darfur 553,515 and West Darfur, 754,710. When taking a closer look to South Darfur it can be seen that 37 per cent of South and East Darfur Population live in cities such as Nyala, Buram, Kass, Aldein and Reheid Elberdi; 30 per cent are internally displaced person (IDP) in camps; 20 per cent are nomads/pastoralists; and 13 per cent live in villages. Al Fasher is the capital of North Darfur State, and El Geneina is capital of West Darfur State[3]. Darfur states are urbanizing rapidly (Figure 1).

Around two million people have been displaced from their homes in Darfur since the fighting broke out in 2003[4]. Now, regional governments are facing major challenges to provide infrastructure and basic services for the resettlement and reintegration of internally displaced persons and returnee populations, which has resulted in increased urbanization and a high demand for building materials.

UN-Habitat initiated its Darfur programme activities in 2007. Funded by the United Kingdom's Department for International Development, the Government of Japan and Office of the United Nations High Commissioner for Refugees; the programme has been implemented in the state capitals, main cities and villages. The UN-Habitat programme includes community involvement in building model homes, school and clinics using the stabilized soil blocks. As a part of this programme, other activities have also been carried out. These are:

- **Profiling of urban settlements:** Urban profiles were prepared and published

3 Source: Ministry of Planning and Urban Development
4 UNDP Sudan, 2011

in 2009. They included detailed assessments of land and security of tenure, access to adequate shelter, local economic development, and the impacts of migration among returnees, resettled people and others displaced by the conflicts. Recommendations were formulated indicating that sustainable settlements represent a concrete first step for peacebuilding.

- **Skills training in stabilized soil blocks technology and housing construction:** Several on-the-job training sessions and the formation of trainers were conducted for almost 2,000 people in the production and use of stabilized soil blocks. The State Ministry of Planning and Urban Development and various non-governmental organizations were engaged in the training process and in building more than 100 demonstration schools, clinics and model homes.
- **Slum upgrading and sustainable housing development in the Sakali settlement in Nyala, South Darfur:** In a settlement on the outskirts of Nyala town, the seat of the South Darfur State Government, 2,000 legally demarcated 15x20-metre plots were offered free of charge, through the State Ministry of Planning and Urban Development, for the voluntary resettlement of internally displaced persons from Kalma Camp, one of the most congested of the region.
- UN-Habitat in partnership with the Office of the United Nations High Commissioner for Refugees is currently supporting this effort by building public latrines, classrooms, a clinic and a community centre as well as 50 housing units, with community participation.
- **Awareness-raising and consensus-building programmes:** Training was conducted on the adoption of alternative building technologies in order to lay the foundation for a sustainable and environmentally sound recovery process in terms of support to return, resettlement, peacebuilding and urbanization of Darfur.

1.4 OBJECTIVE OF THE REPORT

The main objective of this report is to undertake a solid assessment of the economic implications of scaling up the use of stabilized soil block technology in Sudan, especially in Darfur, for an informed promotion of low-cost housing construction at a larger scale.

The target group of the report contains people and institutions involved in the reconstruction of Sudan. This group includes authorities, donors and development actors. The report also proposes concrete strategies for the following, all related to the stabilized soil blocks technological scaling up process:

- Stimulating either the establishment of housing construction co-operatives or microfinance mechanisms, or both
- Establishing mechanisms for income generation and the creation of new entrepreneurs

- Exploring the feasibility of the three-block approach[5]

1.5 ASSESSMENT OF THE ECONOMIC IMPACTS OF STABILIZED SOIL BLOCKS

The methodology adopted in conducting the assessment was three-fold. It consisted of:

- A review of existing data on the subject
- Consultations with stakeholders
- Site visits to Khartoum and Nyala

5 *The three-block approach refers to a system in which an SSB hand press machine is provided to a single family who could produce: (i) one block for self-help housing construction, (ii) one block to be given to the govern¬ment for building a public facility (as a means of paying the rental of the machine), and (iii) one block for selling for profit.*

The assessment process was conducted over four weeks, two of which were dedicated to field visits in Khartoum and Nyala. During the visits several stakeholders were consulted. These included the United Nations Development Programme, the Office for the Coordination of Humanitarian Affairs, the World Food Programme, the Office of the United Nations High Commissioner for Refugees, the United Nations – African Union Mission in Darfur. National stakeholders consulted included the National Housing and Reconstruction Fund in Darfur; the State Ministry of Planning and Urban Development; the Federal Ministry of Environment, Forestry and Physical Development; the private sector and targeted communities. UN-Habitat's project managers in Khartoum and Nyala led the consultation process. The aim was to seek opinions, knowledge and experiences

Houses made of SSBs for former IDP families at Sakali Settlement in 2010. Project funded by UNHCR. © UN-Habitat in the use of stabilized soil block technology, its impacts in the construction sector, and the economic development of the targeted communities.

Site visits to Mansora in Khartoum and Sakila in South Darfur were organized to assess ongoing projects and impacts at the community level. A critical review of the stabilized soil block technology application in homebuilding and other basic infrastructure was made in terms of construction methods, quality of work, beneficiary perception of the new product, and economic and financial benefit to the targeted communities.

An institutional review on the housing sector's performance in Sudan was conducted with particular attention to issues relating to conventional and non-conventional housing finance mechanisms, availability and access to building materials and technical skills, and likely environmental, economic and financial impacts of the stabilized soil block technology transfer. The Technological Research Institute was engaged in the analysis of the current market prices and the National Housing Fund in the assessment of the average housing costs and frequently used technologies, with a focus on social housing requirements in Khartoum and Darfur. Despite the constraints of the inadequate time to visit projects in the Western and Northern Darfur states, the process was completed by a critical review of all recent documentation UN-Habitat and its partners in the region produced on the stabilized soil block technology. The assessment reports from previous consultancies on evaluation of the projects implemented was also reviewed.

02

Findings

Construction of 6 houses using SSB for reintegrated IDPs at Sakali Settlement in South Darfur in 2009.

2.1 CURRENT TRENDS IN CONSTRUCTION IN KHARTOUM AND SOUTH DARFUR

High demand for building materials prevails in the current construction sector in Khartoum and South Darfur. Construction is concentrated in large infrastructure projects. There are many investment opportunities in the building of roads, railways, waterways, schools and health facilities.

Building materials used are divided into three categories: local materials; domestically manufactured with partially imported materials; and fully imported materials such as steel, glass and finished products. Portland cement is a key material used almost everywhere in construction.

The main walling material for homebuilding is burned bricks. The demand for wood to bake these bricks in a kiln has intensified the pressure on forests in most of the country, especially in central Sudan and Darfur. At the same time, the construction sector is facing serious challenges to provide cost-effective buildings and investment in low-cost housing development to meet high demand.

In 2008, the National Housing and Development Fund in Khartoum compiled a baseline study on an integrated solution for cost-effective building practices. The study identified various construction technologies applicable as low-cost solutions for the main building components. These components are:

- Walling: consists of red bricks, hollow red bricks, stone blocks, cement blocks, light concrete systems, 3D panels[1] and stabilized soil blocks
- Doors and windows: consists of locally manufactured and imported steel, glass and timber
- Flooring: consists of plain concrete, cement and ceramic tiles
- Roofing: consists of concrete convention casted *in situ*, precast concrete, jack arch, sandwich panels, steel sheets, ondulines[2], corrugated iron and plastic sheets.

The study further elabourates on the main building components of walling and roofing, the two critical components that generally determine the price of the construction. It also suggests that more research is needed to achieve optimal and reasonably cost-effective buildings.

The Technological Research Institute has been actively involved in the construction of building demonstrations and the testing of the stabilized soil block technology during the implementation of the UN-Habitat pilot project. It is also a key player in the search for alternative building materials to burned bricks. A recent comparative cost analysis was done between the burned and stabilized soil blocks for the construction of a two-bedroom house with a kitchen and toilet facilities on a 225-square metre plot, applying market prices in May 2011 (Figure 3). The detailed analysis is shown in the Annex IV. The cost difference

1 *3Dpanel is a prefabricated three dimensional lightweight structural panel.*

2 *Onduline is the multipurpose long lasting and extremely tough light¬weight corrugated roofing and wall cladding material manufactured from bitumen saturated with cellulose fibres under intense pressure and heat.*

between the two types of bricks is SDG 6,240 (Sudanese pounds). Applying the May 2011 exchange rate (SDG 2.9 for USD 1), the dollar cost for a house made of burned bricks is USD 11,870 whilst one made of stabilized soil blocks costs USD 9,718. Use of stabilized soil blocks saves USD 2,152 or 18 per cent in comparison with burned bricks.

2.2 PROMOTING USE OF STABILIZED SOIL BLOCKS

Using stabilized soil blocks instead of burned bricks is estimated to save the felling of 14 trees when building a 4 x 4-metre house. Training for 123 people on stabilized soil block technology was undertaken to help the residents of Mayo and Al Rasheed upgrade their homes. Training was on the following aspects:

- Soil identification, testing and selection
- Production procedures
- Stabilized soil block curing procedures
- Field tests on stabilized soil block to enhance quality assurance

Training of professional masons to produce stabilized soil blocks and build with them has introduced the technology into the construction market. It is expected that low-income groups familiar with these blocks will develop an affordable housing supply system facilitating self-help construction processes. Providing skills on the technology is expected to generate cash for low-income communities and vulnerable groups.

During the training families were organized into clusters. They then received a hand press soil block-making machine and cement for building public utilities as well as model homes for themselves.

The training also included techniques in building alternative roofing and the use of plaster.

The Khartoum State Structure Plan recently approved a policy recommendation to be applied in slum upgrading activities benefiting the urban poor. It includes housing and public services building using low-cost and environmentally friendly techniques and mainstreaming the use of stabilized soil blocks. In furtherance of this action, UN-Habitat conducted seven capacity-building training programmes. These were:

- Stabilized soil blocks production and construction
- Alternative low-cost sanitary system for the poor
- Flood resistance housing and land tenure legal access
- Model housing and multistory building design
- Construction
- Participatory planning and design
- Strategic planning
- Data entry and geographic information system

At the same time UN-Habitat initiated several pilot upgrading projects in informal settlements. These included development of pro-poor policies that were introduced under the Khartoum Structural Plan; capacity-building measures for the Ministry of Planning

FIGURE 3: COMPARATIVE COST ESTIMATES OF SSB AND BURNED BRICK (BB)

Comparative cost estimates of ssb and bb for construction of a two bedroom house with kitchen and toilet f acilities on a 225 square meters plot.

Cost component	Burned Brick	Stabilized Soil Blocks	Cost Difference in SGD
Materials	22,155	17,020	5,135
Labour	12,267	11,162	1,105
Total Cost of Construction	34,422	28,182	6,240

Estimated materials and labour cost inputs in SGD.

Source: UN-Habitat

FIGURE 4: BENEFITS OF THE SSBS VS BURNED BRICKS

Advantages of SSB versus burned bricks
Better comprehensive strength
Higher and thinner walls
Better energy efficiency
Better water resistance
Economic savings
Savings of water

Sources: Skat (2006), Venkatarama Reddy B. V. (2004)

and Urban Development; and development of Rapid Urban Sector Profiling for Sustainability.

Furthermore, implementation of these capacity-building projects made it easier to identify specific challenges affecting the delivery of urban services for the poor, issues related to spatial planning, land management, social housing, basic urban services, environmental problems and local economic development. All these are crosscutting issues and have direct bearing on the supply and demand factors in the construction sector.

The pilot housing projects have demonstrated stabilized solid block as a positive alternative to traditional building materials. The viability of the technology was validated through case studies in the states of Mansura, Mayo-Mandela, Al Rasheed and South Darfur.

In South Darfur the construction sector is under pressure to meet demand for social housing and economic development. This is because recent central Government policy has provided an enabling environment for the expansion of cities and the development of new towns. This policy has helped the National Housing and Development Fund to work such aspects as the provision of basic services and infrastructure and self-help housing development. These aspects create prospects for investment in the construction sector, with huge demands for durable and cost-effective building materials. The typical housing construction materials used in the different settlements in the five Darfur states consist of the following:

- Urban areas: extensive use of fired brick
- Peri-urban areas: mud blocks (temporary)
- Rural areas: timber structures and mud blocks

According to the Ministry of Planning and Urban Development, most of the people of South Sudan State live in rural areas, with 80 per cent of the population being farmers and herders. The rest are engaged in activities such as trade.

Approximately 63 per cent of the population has used local materials to build their homes.

These materials include such farm by-products as straw, herbs and trees; cow dung; and mud. Dwellings put up with these materials are poor and need renovations every 3 to 5 years. These dwellings and were easily burnt during the conflict. However, the construction process of the traditional houses is easy and does not require skilled labour or huge financial resources. Therefore, the cost of housing in the rural areas is very low.

In the urban areas, modern architecture has been introduced in the new construction of public and private buildings using burned bricks as the main walling material. This is increasing demand for building materials to the detriment of the natural environment.

In accordance with the guidelines and mechanisms which have been followed in the studies and assessments of the governments in the region, the stabilized soil block technology has been adopted as being best for housing reconstruction projects (Figure 4)[3]. This has created an enabling environment for investment in the technology. Stabilized soil block production utilizes 95 per cent laterite (red soil), which is abundant in the region and does not impact the environment negatively. In addition, 5 per cent cement is added for stabilization. The block is now being used in the region to build homes for the voluntary return of displaced people.

2.3 SOCIAL HOUSING NEED IN DARFUR STATES

During the conflict, entire villages were burnt down while others were abandoned as the inhabitants fled to safety. According to a joint assessment mission (Darfur Peace Agreement in May 2006), some 1,670 villages need to be rebuilt. The Ministry of Planning and Urban Development mandated the development of action plans for model villages with services to accommodate about 1,000 households (average 5.6 persons per HH) per village. It also estimated that 734,800 housing units are needed for the resettlement of internally displaced persons and those of nomadic origin. Figure 5 shows the estimated distribution of the required new housing units in the model villages and cities.

The Housing and Reconstruction Fund in Darfur is implementing the mandate of the Ministry of Planning and Urban Development and is currently preparing action plans. It has the responsibility to provide housing for government officials, other sectors and for the voluntary resettlement of internally displaced persons. For Darfur, the Housing and Reconstruction Fund has prepared

FIGURE 5: ESTIMATED DISTRIBUTION OF THE REQUIRED NEW HOUSING UNITS IN THE MODEL VILLAGES/CITIES

Location	Quantity
Model villages	85% of total housing need = 624,580
Around cities	15% of total housing need = 110,220
Total housing units	734,800

Source: UN-Habitat

3 Presentation by Ministry of Planning and Urban Development on Experi¬ences and Strategies proposed in the Darfur region at the National Confer¬ence on Sustainable Urbanization in Khartoum, Sudan, November 2010.

FIGURE 6: PLOTS ALLOCATED AND STATUS OF CONSTRUCTION OF HOUSES IN DEMONSTRATION TOWNS

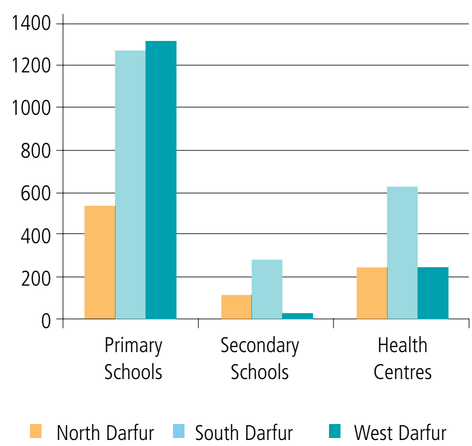
Location Name of Town/City	Number of Planned Plots	Construction Completed	Construction Pending
Aldaien	1,000		1,000
Gadelhabwb	3,000	604	2,396
University of Nyala	200	200	
Nyala El asher Rd	1,000		1,000
Almogtarbeen	1,000		1,000
500 plots in 26 Localities (Districts)	13,000		13,000
Total	19,200	804	18,396

Source: Housing and Reconstruction Fund, Darfur

settlement layout plans under the model village strategy. It has started implementing some projects such as 30 to 50 residential units in each respective model village in South Darfur State. The village strategy supports voluntary resettlement and reintegration of internally displaced persons. The action plans will enable new settlement development in the peri-urban areas of the cities, supporting their natural growth.

Some public sector officials working in social services and some local community leaders have already received houses in the new demonstration towns and model villages (Figure 6). Several others are attracted to settle in these locations because land has been allocated and preliminary documentation has been provided. Of the 804 houses already built, 134 were of stabilized soil blocks and 670 burnt bricks. Additionally, a number of primary and secondary schools and health facilities need to be built. (Figure 7).

FIGURE 7: THE REQUIRED NUMBER OF PRIMARY AND SECONDARY SCHOOLS AND HEALTH FACILITIES



Sources: The joint assessment mission. UN-Habitat.

2.4 AVERAGE SOCIAL HOUSING COSTS IN DARFUR

The National Housing Development Fund has developed plans for low-cost housing units on plots varying from 300 to 400 square metres. Housing is used for three purposes in Darfur - domestic space, space for cattle and for agricultural products as well as storage for feed. The Fund has adopted an incremental process to build the units starting with the domestic space of 4 × 4 metres, followed by a kitchen of 3.5 × 3.5 metres, a toilet and a bathroom. Using burnt bricks, the cost for this residential unit amounted to SDG 21,250 - which is equivalent to USD 8,500.

2.5 ECONOMIC AND FINANCIAL IMPACTS OF THE STABILIZED SOIL BLOCK TECHNOLOGY IN KHARTOUM AND SOUTH DARFUR

Some of the challenges generally affecting wider use of the stabilized soil block technology are:

- Lack of technological know-how
- Unavailability of the raw materials
- Unsuitability of local stabilizers; access to the market
- The institutional frameworks to utilize and promote the technology

Recent Government policies have resulted in a considerable reduction in cement prices; the opening of new cement factories; and research on optimizing the use of other stabilizers in concrete production such as pozzolanas, lime and gypsum. These changes have revealed positive indicators paving the way for sustainable utilization of the stabilized soil block technology in Sudan to construct decent, affordable and environmentally friendly housing and social infrastructure.

The Fund's fundamental challenge is to optimize the production of the technology to facilitate social housing construction while using the region's abundant soils. The UN-Habitat stabilized soil block technology transfer approach in Sudan has demonstrated potential economic and financial benefits to communities, as well as to local and national governmental institutions. The use of imported materials can be reduced by using locally-made Portland cement and locally-sourced stabilizers. Timely replication of the technology transfer strategy will contribute immensely to the growth of the construction sector; sectors which supply construction through its backward linkages; and the subsequent economic development.

UN-Habitat designed and implemented a three-prong approach as a strategy for transfer the technology. These are

- The training of trainers - initial transfer of the technology by national and international experts
- An agreement with national and international partners working on the construction projects in Darfur and who are willing to share the cost of the construction of the stabilized soil block pilot demonstration buildings
- Provision of the equipment and trainers while the partners procure the materials

and select the labour for the pilot demonstration buildings, on-the-job training and construction works

The three-prong approach was applied in Mansura, Mayo Mandela, Al Rasheed in Khartoum and in Al Fasher, Nyala, Zalingei and Sakali in Darfur. The approach has been very effectively implemented and has provided significant cost savings and created jobs.

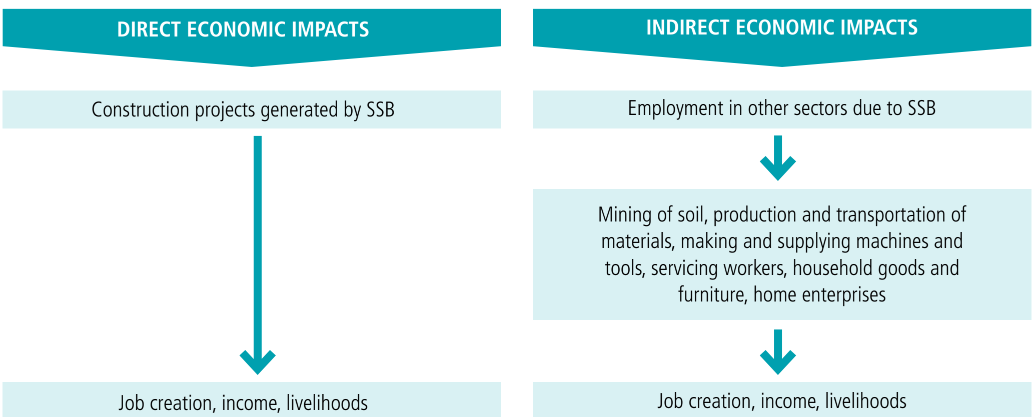
Scaling up the use of the technology can provide a positive platform for State authorities to obtain sustainable construction and urban upgrading in Darfur, especially when combined with other affordable technologies reducing the use of cement. The pilot projects UN-Habitat has implemented combine different methods for applying and testing the technology and its efficacy in driving the transformation process away from the use of traditional burned bricks, in a reasonable time.

Any increase in labour-based construction provides job opportunities for the unskilled, especially for the young and the unemployed[4]. If these results can be replicated in a timely manner, they should translate into economic and financial benefits for Khartoum and the Darfur states. They should also serve as a good example for post-conflict processes, ranging from policy design to pilot projects, and resulting in the economic growth and sustainable development of settlements. This is congruent with the "relief to development" concept commonly featured in disaster literature, which argues that relief efforts should fit within a process of development rather than being one-off interventions.

Direct economic impacts are connected to job creation, income and livelihoods that will be generated by the various construction projects resulting from the development of settlements. Indirect economic impacts will be reflected by employment created through the stabilized soil block technology in such

4 *Source: UNCHS/ILO, 1995 "Shelter Provision and Employment Generation", Nairobi and Geneva, UNCHS and ILO.*

FIGURE 8: DIRECT AND INDIRECT ECONOMIC IMPACTS



Source: Housing and Reconstruction Fund, Darfur

activities as mining of lateritic soil; production and transportation of the building materials; making and supplying machines and tools; and servicing the workers with food on-site (all backward linkages in the economy) (Figure 8). In the medium-term, employment related to household goods and furniture, including home-based enterprises (both forward linkages) will arise due to the new housing.

These employment benefits will be further augmented by the spending generated by all these activities in the local economy, much of which, given the relatively low-income of construction labour[5], will be spent in the community. Thus, local shopkeepers and other entrepreneurs will benefit from the local income multipliers. There could also be change in employment patterns in the male-dominated construction sector as women could acquire new skills in soil preparation, production, curing and block-laying, which would improve their status in their communities. As local people work on housing construction, a sense of ownership will emerge, further strengthening social cohesion in the communities.

A United Nations Educational, Scientific and Cultural Organization (UNESCO) report in July 2010 on “Compressed Stabilized Earth Block Manufactured in Sudan” indicated that the local manufacturing and processing of

5 *Low-income households tend to use little of their money on the things which stop it from circulating in the local economy: buying imported goods, saving or paying tax.*

Construction of school classrooms by UN-Habitat in Sakali settlement in 2010.
© UN-Habitat

building materials that require the import of expensive equipment could sharply reduce the foreign reserves of developing countries.

Therefore, production of building materials which do not require such imports are cheaper and should be encouraged. This is the case for compressed stabilized soil blocks.

The UNESCO report further concluded that the Al Haj Yousif experimental prototype school, build of compressed stabilized soil blocks in Khartoum, was cost-effective by the Sudanese standards. The total savings achieved through the project were at approximately 40 per cent.

Equipment and tools needed for the manufacturing of these blocks can be made locally and, in most cases, under license. Stabilizers may also be produced locally, especially if lime is used. In comparison with other building materials, the production of stabilized blocks does not need energy for drying or firing.

This blockmaking technology is, therefore, of good quality and cheap, as demonstrated in the United Nations Development Programme/UN-Habitat supported post-conflict reconstruction projects in Sierra Leone 1996, Liberia 2001 and Eritrea 2003. The technology uses subsoil, for which the only cost is that of the labour needed for its extraction. Additionally, it reduces the use of relatively expensive cement. Materials for fittings and finishes normally constitute a low proportion of construction cost in low-cost housing. The main costs are generated from walling and roofing materials, as shown in the Annex IV, as estimated by the Technological Research Institute. The cost comparison shows that the use of stabilized soil blocks can contribute to major savings for regional and local governments in the context of providing much-needed social housing and basic facilities. These savings can then be channelled to other pressing needs and expenditures related to pro-poor programmes.

03

Recommendations

Houses made of SSBs for former IDPs families at Sakali Settlement in 2010. Project funded by UNHCR.
© UN-Habitat.

3.1 SCALING UP THE STABILIZED SOIL BLOCK TECHNOLOGY FOR RECONSTRUCTION AND DEVELOPMENT OF SOCIAL HOUSING

According to UN-Habitat's studies done from 1985, it was generally observed that despite favourable factors for promoting indigenous materials, there were some constraints to their widespread production and use. In some countries, inadequate production capacity or low demand for local building materials are the limiting factors. In others, it is the scarcity of local experience for the production and use of such materials. However, there are constraints that are characteristic of most developing countries and are the reason why local materials are unable to make a positive impact on the building industry. These are related to at least five issues which are:

- Technology of production
- Investment requirements
- Quality of output
- Demand for indigenous products
- Inappropriate use of materials in construction

UNEP's Environmental Assessment from 2007 identified brickmaking as an important source of income for internally displaced persons in Darfur. However, this activity increases water consumption, damages farmland and causes deforestation. Banning such activities is neither appropriate nor feasible. A practical solution that still provides a livelihood for brick makers is urgently needed for Darfur and for other parts of Sudan. One such option could be to use compressed stabilized soil block technology. This would require a comprehensive introduction programme meeting the needs of demand and supply.

It is recommended that stabilized soil block technology be used in large-scale social housing construction in order to support the sustainable urbanization and reconstruction of Khartoum and the Darfur states. Against the background of the UN-Habitat support in Sudan and the successful transfer of the technology, the following sections 3.1.1, 3.1.2 and 3.1.3 give some recommendations for accelerating and up-scaling use of the blocks.

3.1.1 Housing cooperatives, revolving mechanisms using stabilized soil blocks

Establishing housing cooperatives and revolving financing mechanisms are pivotal components for the commercialization of stabilized soil block technology. This cannot, however, be achieved in the absence of the productive infrastructure to ensure availability of the blocks. Therefore, it is imperative that a centre for training and production of building materials be established as has been done in other post-conflict countries.

Transfer of technology for the local production of building materials can be fully achieved when the local capacity has the means to sustain the technology; that is when the country invests in the local capacity development, optimizes the use of local resources and creates adequate infrastructure. In Sudan, this would require establishing block production and training centres linked to the existing research institutions, especially those which have participated in UN-Habitat's "training of trainers". These institutes could be used as the training centres.

Khartoum State

A suitable location for the stabilized soil block production and training centre should be identified in consultation with the Ministry of Planning and Urban Development, the Ministry of Basic Infrastructure of Khartoum State, the Ministry of Education, and the Technological and Research Institute. However, locating the centre close to Mayo-Mandela Camp and the Mansura area would be ideal because model housing and demonstration units have already been put up in these locales.

Darfur states

In the establishment of the Building Materials Production and Training Centre cooperation of different instances is needed (Figure 9). The following institutions are potential sites for establishment of the Centre in Darfur:

- Nyala Technical College - South Darfur Nyala
- El Fasher Technical School - North Darfur
- Zalingei University - Centre Darfur

These institutions have existing structures but they may require additional facilities and space for expansion to accommodate a material-testing space, curing tanks and a new workshop for ferro-cement production, equipment storage facilities and additional training workshops.

These new facilities will strengthen the capacity of the institutions. A special unit under their respective engineering departments may be dedicated to participating in the management and operation of the Centre. UN-Habitat's role would be to provide at least two years of technical support and oversight in the implementation of training activities; coordination with the Technological Research Institute; and the mobilization of resources for additional training on the stabilized soil block technology.

The Centre should have a mobile set of equipment consisting of machines, exhibition boards, soil testing equipment, and moulds for ferro-cement production to facilitate a programme of outreach in camps to train young people and others. Taking the technology to the people will facilitate the transfer of know-how to internally displaced persons, thereby providing them skills with which to join trade groups building co-operatives after the reintegration. The Centre will facilitate scaling up of the stabilized soil block technology by providing the skills needed for enhanced housing construction, rehabilitation and upgrading of settlements and basic services. This will make for easier reintegration of internally displaced persons, ex-combatants and returnees, and facilitate the expansion of an environmentally friendly system of commercial production, marketing and application of affordable and appropriate construction technology.

Training component

This component consists of the following activities:

- Formal and informal practical training in the production and application of local building materials for affordable housing.

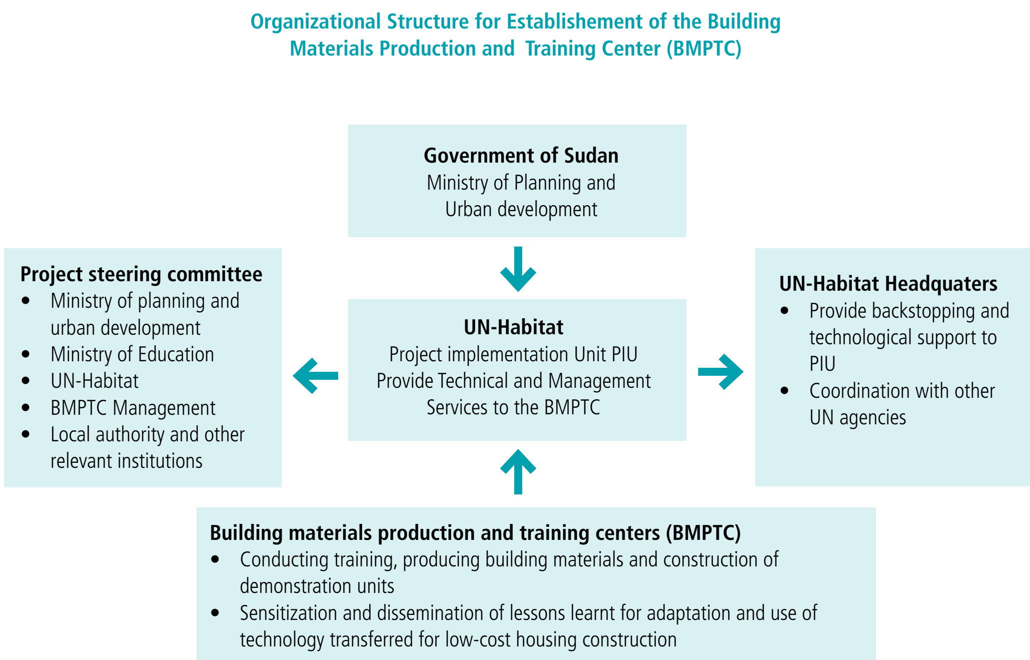
Different training levels may include crash courses for technicians; and seminars for contractors, construction engineers and building inspectors from central and local government institutions

- Training of internally displaced persons, returnees and community members in stabilized soil block production and construction techniques
- Training in micro-enterprise development skills
- Training in different quality control standards, material testing and product inspections

Production component:

- Support the Fund to procure equipment and provide stabilized soil block production capacity for low-cost housing projects in cities/ villages; and integrating, promoting and maximizing the utilization of the local building materials and construction technology in the project areas.
- Research and testing for ensured quality of local materials and components and their application in the construction of better houses and infrastructure facilities.
- Special programmes: implementation of the rehabilitation and reintegration component

FIGURE 9: ORGANIZATION STRUCTURE FOR ESTABLISHMENT OF THE BUILDING MATERIALS AND TRAINING CENTER (BMPTC)



Source: UN-Habitat

of the disarmament, demobilization, rehabilitation and reintegration vocational skills

During the assessment in Nyala and discussions with several stakeholders including United Nations agencies and national institutions, one of the key concerns expressed was the dire need to increase capacities for production of stabilized soil blocks to meet local demand in reconstruction. Increase in this capacity could be easier to attain with additional human resources and equipment during the planning process for disarmament, demobilization, rehabilitation and reintegration programmes. A programme for rehabilitation and reintegration of ex-combatants in South Darfur should be developed. This would enable them to gain vocational skills, with emphasis on stabilized soil block technology. In turn, this would make them more employable and able to reintegrate easier into society. The result would be a positive impact on the recovery processes and the economic development in the region.

3.1.2 Establish mechanisms for income generation and sustainable livelihoods using stabilized soil block technology

Mechanisms for income generation and sustainable livelihoods using the stabilized soil block technology can be developed when there are adequately skilled artisans. The process can be more effective when complemented by training in basic business management. Individuals trained in the technology can market the blocks and provide construction services.

The existing partnership with the Social Development Foundation should be strengthened. The partnership provides services in micro credit and revolving fund mechanisms; financial management and monitoring; implementation of credit; and revolving fund for self-help housing construction. An impact assessment and evaluation of the planned programme outcomes would be an important step in identifying future directions and additional strategies to ensure improved service delivery.

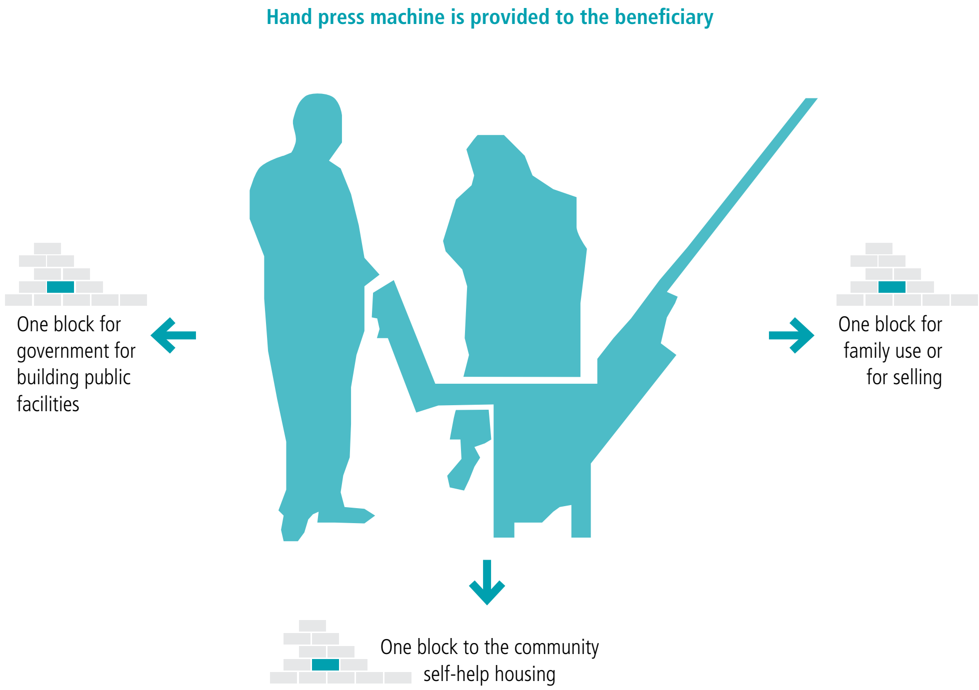
Microcredit programmes should be introduced where internally displaced persons are reintegrated and in slum upgrading projects, as they may be a good way of financing the stabilized soil block technology. Awareness of this should be raised at the community level and with groups formed after the basic training. Microcredit combined with "start-your-business" training programmes would empower vulnerable groups, particularly women, to work their way out of poverty. The required startup capital for small-scale income-generating schemes is small, allowing a wider range of people to participate. To ensure a more effective participation in the process, additional training and a sensitization programmes should be considered.

3.1.3 Three-block approach, two systems of production and community contracts system

Three-block approach

Increasing stabilized soil block production capacity and promoting the technology can be facilitated through support to community construction enterprises, organized family

FIGURE 10: THREE BLOCK SYSTEM



Source: UN-habitat

cooperatives and other small-scale construction businesses. The pilot schemes in Al Rasheed in Khartoum, where the approach was implemented, have demonstrated the feasibility of the process. The process needs to be institutionalized by setting up guidelines and training of potential beneficiaries to ensure effective understanding of the regulations.

The three-block approach is a system of providing a hand press machine to the beneficiary. The beneficiary will produce bricks with the machine providing one-third of them for community self-help housing construction, one-third to the government for the building of public facilities (as a rent for the machine), and one-third for the family to use or to sell (Figure 10).

Considering that housing construction will represent a major economic activity in the region in the immediate future, this strategy will stimulate the establishment of the local construction market. The approach will be regarded as effectively managed and sustainable when the beneficiaries acquire management skills and are able to maintain stabilized soil block machines, safely.

The three-block approach should be tested through pilot demonstration projects implemented by local communities and institutions, which are the key actors. These actors should have clear roles and responsibilities.

Upgrading settlements from tents to houses made of SSB. © UN-Habitat

Two systems of production

The two systems can be facilitated through two procurement options. The first is to launch an "expression of interest" for the supply, training and manufacturing of the block-making machines in Khartoum and Nyala. The expression of interest is intended to identify reputable companies with the capacity to supply manual and automatic machines and to provide training for their manufacture in Sudan. The second option is to support local mechanical workshops through a public-private partnership programme to manufacture and supply the block-making machines in both cities.

Viable companies are to be identified and a public-private partnership programme for training in the manufacture of the machines is to be initiated. In Khartoum, two workshops already have experience in manufacturing the machines. The workshops may be able to help identify reputable companies to submit tenders and boost productive capacity.

Either of the above options will produce the same results. The first will deliver machines quicker whereas the second requires more time. This will enable transfer of technology and investment interest, paving the way to increase the capacity for manufacturing the machines locally at lower cost.

Community contracts system

The concept of community contracts was developed in Sri Lanka when a group of community leaders approached a government agency, complaining about the quality of construction of a public bathing-well built by a local contractor. The community asked to be given the next contract. This happened at the time of Sri Lanka's Million Houses Programme, when many innovative approaches were pioneered and neighbourhoods had legally recognized Community Development Councils. Thus, the idea of granting a construction contract to the community was developed. In early 1986, the first official contract was awarded to the Development Council of Wanathamulla, a poor urban settlement in Colombo, for the construction of a public bathing-well[1].

The implementation of the contract utilized many skills already present among community members such as construction, bookkeeping and developed management and other skills along the way. The first Development Council to complete a contract went on to bid for others in their own neighbourhood and outside the community. The benefits in terms of direct income and income multipliers within the community were considerable.

UN-Habitat promotes community contracts within the framework of the Community Action Planning approach. In line with the International Labour Organization's concern about expecting community members to work for free on infrastructure projects in their own neighbourhoods, the paid nature of the contracts helps to gain the collective ownership without the exploitation of work for no pay. The paid nature of the community contracts has also important capacity-building and wealth creation functions.

A government agency or non-governmental organization may award a contract for physical works that are identified in the community action plan. In most cases the community organization representing a defined community is the registered Community Development Council for a particular settlement. Appropriate activities done in the frame of a community contract can be the construction of small-scale infrastructure, for example.

Over time, community contracts have also been used for a number of innovative activities beyond the construction of simple infrastructure, such as provision of services and skills enhancement. According to good practice, typical civil work projects to which the community contract system can be applicable include physical improvements within a settlement. These have the following characteristics:

- Technically simple
- Mostly labour rather than mechanized or capital intensive
- No requirement for highly specialized skills
- Relatively easy to manage

1 *UN-Habitat Community Contracts*

Another important criterion is that the implementing communities should be involved in a process of identifying and prioritizing their problems. They should also agree on the action plans to be implemented in order to identify and respond to commonly agreed development goals. Usually, the technical preparation of the plan should be done by the organization that is either assisting the community or commissioned by the community. These prerequisites for engaging communities in implementing contracts have all been successfully demonstrated in the pilot projects in Khartoum and Darfur states. The work experiences in Khartoum and the Sakali project in Nyala are clear manifestations of the communities' ability to manage construction work under the community contract system.

The infrastructure and community facilities targeted for construction through such contracts in Sudan are identified as follows:

- Community schools and clinics
- Community centres and recreational areas, parks and playgrounds
- Access roads in the settlement
- Drainage systems
- Low-cost housing
- Wells and water tanks
- Public toilets and small-scale sewer systems

When the construction contract for basic community infrastructure is awarded by commercial contractors the community benefits from the output of the contract and not from the process of the construction. Several advantages can be achieved when contracts are awarded to a community (Figure 11).

FIGURE 11: UN-HABITAT COMMUNITY CONTRACTS

Process	Conventional contract	Community Contract
Planning	Outside professionals do the work, no advantages	Community benefits from control
Design	Outside professionals do the work, no advantages	Community assisted by professionals
Physical works	Outside contractor does the work may employ some community people	Community does all the work and gains all
Labour	Machine intensive, few advantages	Labour intensive, provides much
Experience	Goes out of community	Stays within the community
Quality of work	Changes of being inferior	Good, it is their own
Profit margin	High, but none to the community	Low, but all within the community
Feeling of ownership	None	Very high

Source: UN-habitat

The community contract system provides a collective responsibility that instills accountability and places monitoring in the hands community members the facilities will serve. Transparent procedures and open economic and financial transactions are cornerstones of accountability in the contract system. The system strengthens trust between the players and within the community. This process makes the communities more responsible for their own development work and the management of their facilities. It also enhances the sense of ownership, thereby ensuring sustainability of the development intervention.

In furtherance of scaling up the stabilized soil block technology in Sudan, the introduction of a community contracts system should accelerate the reconstruction of housing and basic facilities, and promote the use of the technology[2].

2 *UN-Habitat Community Contracts*

04

conclusion

Construction of houses made of SSBs for former IDP families integrated at Sakali Settlement, in 2010.

Sudan has a long history of war. A part of this history is the Darfur conflict originating from 2003. The conflict has resulted in large-scale displacements. Internally displaced persons are expected to return or reintegrate and reconstruct their homes. Reconstruction in the areas of Darfur and Khartoum needs to be qualitatively superior to those prior to the conflict. In the context of continuous desertification and major deforestation in Darfur, alternatives for the use of traditional building practices with timber structures and burned bricks are crucial.

One such environmentally friendly, 'woodless' technology is stabilized soil block technology. UN-Habitat has already developed and introduced the stabilized soil block technology within its programme in Sudan. Produced by trained locals in project locations, the blocks have proven to be a good quality and cheaper. Scaling up soil block production would generate employment, thereby supporting the reintegration of the internally displaced persons and recovery process in Darfur and settlement upgrading in Khartoum. It would also create social cohesion, thus laying the foundation for lasting peace and sustainable economic development of Darfur.

In order to build the capacities of the local population in stabilized soil block-related employment, Building Materials Production and Construction Training Centres are to be established. This transfer of the technology for local building materials production supports scaling up of the block technology in the reconstruction and reintegration efforts. The community contract system is the best framework for further community ownership over programme planning and implementation, economic development, and transparency and accountability in rebuilding efforts.

SSB production training at Nyala central prison. © Ingrid Jeunhomme, UN Department of Peacekeeping Operations

Annexes

Construction of houses made of SSBs for former IDP families integrated at Sakali Settlement, in 2010. © UN-Habitat

ANNEX I: LIST OF REFERENCES

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16	Mr. Mohamed Ali Hamad	Site Engineer	UN-Habitat	Nyala
17	Mr. Mohamed Ireg	Reintegration Officer	UNDP	Nyala
18	Mr. Abdalla Eltelaib	Livelihood officer	UNDP	Nyala
19	Gen. Abdelrahim Mohamed Ahmed	Director of South Darfur Sector	NSDDRC	Nyala
20	Hussein Ibrahim Adam	Reintegration Officer	NSDDRC	Nyala
21	Mr. Faisal Ahmed	Consulting Civil Engineer	UNICEF	Nyala
22	Ms. Hwatif Dawelbait	Project Assistant	UNICEF	Nyala
23	Eng. Mansour Abdalla Yahia	Director of Housing & Reconstruction Fund	Ministry of Urban Developments	Nyala
24	Mr. Alfred G. Kolubah	Associate Programme Officer	UNHCR	Nyala
25	Ms. Anne Nardini	Programme Officer	WFP	Nyala
26	Ms. Pedro Maros	Programme Officer	WFP	Nyala
27	Ms.Mbabazi B. Specious	Officer – Prisons Advisory Unit	UNAMID	Nyala
28	Ms. Mungai Lucy	Officer – Prisons Advisory Unit	UNAMID	Nyala
29	Mr. Yahya Ibrahim Mohamed	Branch Manager	Real Estate Commercial Bank	Nyala
30	Sheikh Abdelmutalab Adam Suliman	Traditional Leader	Sakali Project	Sakali
31	Mr. Mohamed Eldoma	Director of Tchnical Education	Ministry of Education	Nyala
32	Eng. Adam Ahmed	Community Elder	Dakar Halal Village	Dakar Halal
33	Mr. Musa Ali Abdelnabi	Deen	Nyala Technical College	Nyala
34	Mr. Hussein Mohamed Gibreal	Deputy Deen	Nyala Technical College	Nyala
35	Mr. Ismail Bakheet	Head of Civil Engineering Dept.	Nyala Technical College	Nyala
36	Eng. Mohamed Elhassan Ibrahim Aboshosha	Manager	Sudanese Construction Union, South Darfur Branch	Nyala
37	Mr. Tarig Mohyeldeen Osman	Coordinator of South Darfur	Qatar Charity	Nyala

ANNEX III: UN-HABITAT TRAINING IN SSB TECHNOLOGY AND CONSTRUCTION OF DEMONSTRATION UNITS IN DARFUR STATES (2008-2011)

UN-HABITAT TRAINING IN SSB TECHNOLOGY AND CONSTRUCTION OF DEMONSTRATION UNITS IN DARFUR STATES (2008-2011)

Location **City/Town**	**Implementing partner**	**Number of participants/trainees**				**Type of structures Number of participants/trainees / facilities**							
		TOT	OJT	Total	PDB	SSB Perimeter wall	Latrine	School (Classrooms)	House	B.wall	Clinic	Status of training and construction of structures/facilities	Donor
	NTC	60		60	1			1				Completed	DFID
	NTC		12	12	1	1						Completed	DFID
Nyala	NTC	80		80								Completed	GoJ
	NTS		12	12	1			1				Completed	GoJ
	UNHABITAT/SMPPPU	96		96	6				6			Completed	DFID
Sakali & Baba	UN HABITAT/SMPPU	54	36	90								Completed	GoJ
Sakali	SMPPU		60	60	5		2	3				Completed	DFID
	SMPPU	120		120								Completed	GoJ
	SMPPU		120	120	3			2			1	Completed	GoJ
Total		410	240	650	17	1	2	7	6		1		
	University of Zalingei	67		67								Completed	DFID
Zalingei	University of Zalingei		10	10	1			1				Completed	DFID
Z+Umshalya	University of Zalingei	80		80								Completed	GoJ
	University of Zalingei		20	20	1	1						Completed	GoJ
Total		147		177		1		1					
	CRS		20	20	2			2				Completed	DFID
Geneina	CRS		20	20	1			1				Completed	DFID
	CRS		40	40	2			2				Completed	GoJ
	CRS 40 40 2 2		40	40	2			2				Completed	GoJ
Total	294 150 120 9 7	249	150	120	9			7					
	El Fasher TS	63		63	1		1					Completed	DFID
	El Firdous TS		20	20	2			2				Completed	DFID
	El fasher TS		25	25	1	1						Completed	DFID
	QIP RDN		20	20	2			2				Completed	DFID
El Fasher	El Fasher TS	80		80	1					1		Completed	GoJ
	El Fasher TS	120		120	1					1		Completed	GoJ
	QIPs (Ali Sanosy)		40	40	2	2						Completed	GoJ
	QIP (youth Assoc)		40	40	2			2				Completed	GoJ
	RDN (mason As)		80	80	2	1		1				Completed	GoJ
	Total	263	225	488	14	4	1	7		2			
Tawilla	Save TCS		20	20	4		2	2				Completed	DFID
Kutum	Save TCS		20	20	4		2	2				Completed	DFID
Golo	QIP RDN		20	20	2			2				Completed	DFID
Kambi	SSCA RDN		20	20	1	1						Completed	DFID
Um Gaedabou	SSCA RDN		20	20	1	1						Completed	DFID
Abunahla	Wara SSCA RDN		20	20	1	1						Completed	DFID
Matbaa	QIP RDN		20	20	2			2				Completed	DFID
Buram	QIP RDN		20	20	2			2				Completed	DFID
Kass	Buram TS		20	20	1	1						Completed	DFID
Aldein	Kass TS		20	20	1	1						Completed	GoJ
Nertity	Aldein TS		20	20	1	1						Completed	DFID
Garseila	Nertity TS		20	20	1	1						Completed	GoJ
Fasi	Garseila TS		20	20	1	1						Completed	GoJ
Treije	DRC	60		60	12			12				Completed	GoJ
Abata	DRC		20	20	4							Completed	GoJ
Asoum	DRC		20	20	4							Completed	GoJ
	DRC		20	20	4							Completed	GoJ
	Total	60	320	380	46	8	4	22					
	Grand Total	1174	935	1815	86	14	7	44	6	2	1		

ANNEX IV: COMPARATIVE COST ANALYSIS OF STABILIZED SOIL BLOCK (SSB) AND BURNED BRICK (BB).

Comparative Cost Analysis of Stabilized Soil Block (SSB) and Burnt Brick (BB) for Construction of a Two Bedroom House with Kitchen and Toilet Facilities on a 225 Square meter plot. Estimated cost inputs from research conducted by the Engineering Unit of Technological Research Institute (Khartoum, Sudan)

Materials cost for BB House in SDG				
			Unit Cost	Total Cost
Description	**Qty**	**Unit**	**SDG**	**SDG**
Granite	18	M^3	45	810.00
Fine sand	33	M^3	22.5	742.50
Cement	127	50kg bag	25	3,165.00
Red brick	40	thousand	160	6,400.00
Mud mortar	30	M^3	14	420.00
Hard soil	23	M^3	14	322.00
Course sand	10	M^3	25	250.00
Gravel	9	M^3	40	360.00
Steel rod	53	Number	35	1,855.00
Steel rod	47	Number	10	470.00
Ceramic grade 1	50	M^3	20	1000.00
Ceramic grade 3	45	M^3	14	630.00
Pamastic emulsion	8	Number	95	760.00
Painting material	4	Number	50	200.00
Chicken mesh	7	Number	70	490.00
Wire	1	Number	40	40.00
Gypsum	10	Number	2	20.00
Ceiling fan	3	Number	115	345.00
Fluorescent lamp	9	Number	40	360.00
Blug 5 Amber	5	Number	10	50.00
Plastic pipes ¾ inches	35	Number	2	70.00
Electric wire	4	Number	90	360.00
Electric connection	20	Number	1	20.00
Rectangular steel pipe 4x8	20	Number	50	1,000.00
Rectangular steel pipe 3x6	23	Number	35	805.00
Pipe ¾ inches	26	Number	10	260.00
Steel sheet	16	Number	50	800.00
Locker	3	Number	10	30.00
Handle	4	Number	20	20.00
Emulsion	4	Number	25	100.00
Total Materials				**22,154.50**

Labour cost for BB House in SDG				
			Unit Cost	Total Cost
Description	**Qty**	**Unit**	**SDG**	**SDG**
Block puchased from supplier indicated in material cost				
Excavation	54	ML	6	324.00
Construction of foundation	54	M^2	6	324.00
Wall construction ½ Block wall thickness	155	M^2	12	2,325.00
Parapet 60 cm	28	M^2	15	420.00
Filling with hard soil	23	M^3	6	138.00
PCC 1:3:6	43	M^2	7	301.00
Beam 1:2:4	75	ML	16	1,200.00
Ferro cement channels	75	ML	15	1,125.00
Plastering 1:8	380	M^2	5	1,900.00
Painting	380	M^2	4	1520
Painting of ceiling	45	M^2	5	225.00
Concrete for joining the channels	86	ML	25	215.00
Filling Sand soil between channels	8	M^3	10	80.00
Fixing ceramic tiles grade 1	50	M^2	10	500.00
Fixing ceramic tiles grade 3	45	M^2	10	450.00
Installation of ceiling fan	3	No.	25	75.00
Installation of florescent lamp	9	No.	20	180.00
Installation of electric plug	5	No.	15	75.00
Installation of windows	7	No.	50	350.00
Installation ventilation windows	3	No.	25	75.00
Installation of doors 90x220	3	No.	75	225.00
Installation of door 70x200	4	No.	60	240.00
Total Labour cost				**12,267.00**

Total Construction cost with BB= Material +Labour Cost	22,154.50	12,267.00	34421.50

Materials cost for SSB House in SDG				
			Unit Cost	Total Cost
Description	**Qty**	**Unit**	**SDG**	**SDG**
Granite	18	M^3	45	810.00
Fine sand	35	M^3	22.5	787.50
Cement	185	50kg bag	25	4625.00
SSB Produced on Site	5490	Number		
Mud mortar	Not required			
Hard soil	63	M^3	14	882.00
Course sand	10	M^3	25	250.00
Gravel	9	M^3	40	360.00
Steel rod 10mm	53	Number	35	1855.00
Steel rod 6mm	47	Number	10	470.00
Ceramic grade 1	50	M^2	20	1000.00
Ceramic grade 3	45	M^3	14	630.00
Pamastic emulsion	4	Number	95	380.00
Painting material	4	Number	50	200.00
Chicken mesh	7	Number	70	490.00
Wire	1	Number	40	40.00
Gypsum	10	Number	2	20.00
Ceiling fan	3	Number	115	345.00
Fluorescent lamp 2 feets	9	Number	40	360.00
Blug 5 Amber	5	Number	10	50.00
Plastic pipes ¾ inches	35	Number	2	70.00
Electric wire	4	Number	90	360.00
Electric connection	20	Number	1	20.00
Rectangular steel pipe 4x8	20	Number	50	1000.00
Rectangular steel pipe 3x6	23	Number	35	805.00
Pipe ¾ inches	26	Number	10	260.00
Steel sheet	16	Number	50	800.00
Locker	3	Number	10	30.00
Handle	4	Number	20	20.00
Emulsion	4	Number	25	100.00
Total Materials				**17,019.50**

Labour cost for SSB House in SDG				
			Unit Cost	Total Cost
Description	**Qty**	**Unit**	**SDG**	**SDG**
Block production on site	5490	No	0.2	1098.00
Excavation	54	ML	6	324.00
Construction of foundation	54	M^2	6	324.00
Wall construction ½ Block wall thickness	155	M^2	12	1,860.00
Parapet 60 cm	28	M^2	140	392.20
Filling with hard soil	23	M^3	6	138.00
PCC 1:3:6	43	M^2	7	301.00
Beam 1:2:4	75	ML	16	1,200.00
Ferro cement channels	75	ML	15	1,125.00
Plastering 1:8	190	M^2	5	950.00
Painting	190	M^2	4	760.00
Painting of ceiling	45	M^2	5	225.00
Concrete for joining the channels	86	ML	25	215.00
Filling Sand soil between channels	8	M^3	10	80.00
Fixing ceramic tiles grade 1	50	M^2	10	500.00
Fixing ceramic tiles grade 3	45	M^2	10	450.00
Installation of ceiling fan	3	No.	25	75.00
Installation of florescent lamp	9	No.	20	180.00
Installation of electric plug	5	No.	15	75.00
Installation of windows	7	No.	50	350.00
Installation ventilation windows	3	No.	25	75.00
Installation of doors 90x220	3	No.	75	225.00
Installation of door 70x200	4	No.	60	240.00
Total Labour cost				**11,162.20**

Total Construction cost with SSB = Material +Labour Cost	17,019.50	11,162.20	28,181.70

BB Cost less	SGD	34,421.50
SSB Cost	SGD	28,181.70
Cost difference is 18%		6,239.80
Cost in USD @ Ex.rate SGD 2.9 to USD 1	2.9	US$ 11,869.48 For House constructed with Burnt Brick
		US$ 9,717.83 For House constructed with Stabilized Soil Block

Economic Benefits of Stabilized Soil Block Technology in Sudan

This report presents the economic benefits of the use of the stabilized soil block technology in Darfur and other regions of Sudan. It recommends scaling up the use of the technology since it is more environmentally friendly and affordable building practice than traditional technology which has usually been used in Sudan.

Construction of housing and public infrastructure needs to be of greater quality than what was previously used. Past practices of large-scale use of firewood to make burned bricks for construction of housing have resulted in massive deforestation of the country. Such destruction has given rise to the realization that alternative building methods are needed.

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