Urban Environment and Environmental Health

The Port Sudan dumpsite. Improvements in solid waste management will first and foremost require increased government investment in disposal facilities.

Urban environment and environmental health

6.1 Introduction and assessment activities

Introduction

Urban environment and environmental health issues are some of the most visible symptoms of the challenges facing Sudan. Sprawling slums, litter and polluted waterways are prevalent in most urban centres, and health and development statistics quantify in some detail the massive impact of this situation on the quality of life of the Sudanese population.

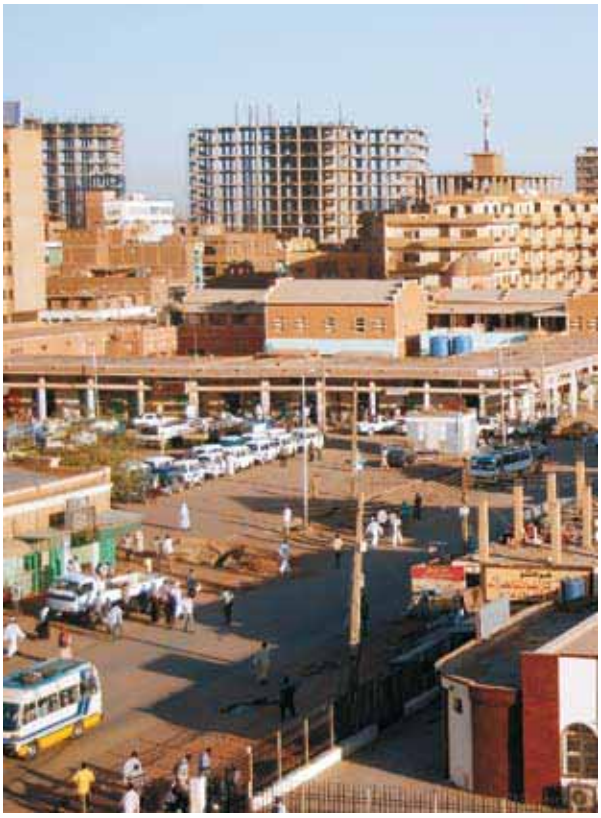
Shelter, potable water, sanitation and waste management are cross-cutting issues, and deficiencies in any of these areas can be categorized as development, health or environmental problems. This chapter focuses on the environmental aspects of these issues and the associated challenges in development and governance.

Assessment activities

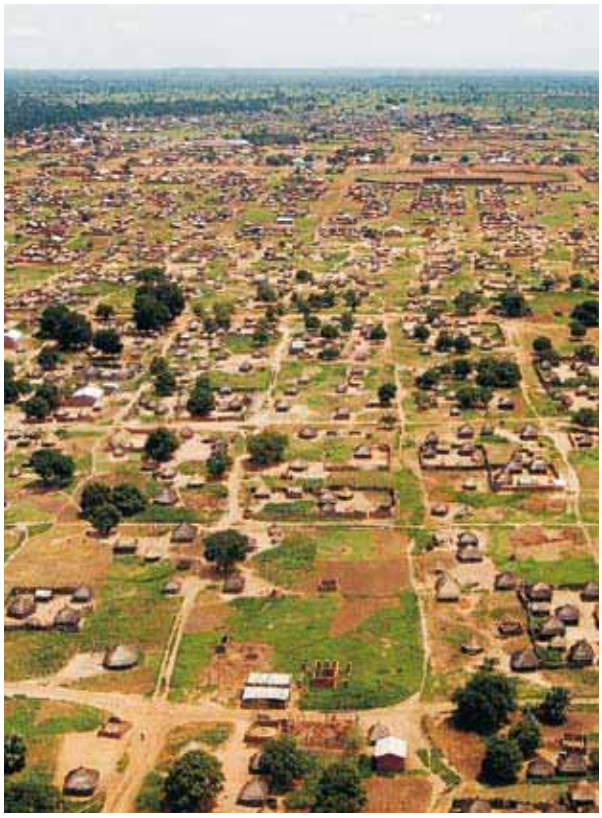
Detailed desk study information was available on urban and environmental health issues, though statistical data on Southern Sudan was relatively scarce. UNEP's fieldwork included visits to urban centres of all sizes in twenty states. Particular attention was paid to the investigation of unplanned settlements, camps, waste management and sanitation. Three cities – Khartoum, Port Sudan and Juba – were selected for a closer assessment of urban services and housing.

Available statistics on environmental health and services, which are a combination of government and UN data, tell a sombre story of poverty and underdevelopment. On the national scale, even these numbers are overly optimistic, as much of the detailed data has historically been collected in the more developed areas of the northern states. On a more positive note, however, the economic development resulting from the oil boom is completely absent from older statistics, so that some areas such as Khartoum state are expected to show significant improvement from 2000 onwards.

Introductory field training in Juba for the newly recruited staff of the GOSS Ministry of Environment, Wildlife Conservation and Tourism



The capital Khartoum is by far the largest city in Sudan



In Southern Sudan, the major towns, such as Wau, consist of a small centre built in colonial times and a large fringe of informal settlements

The scope of the assessment was considered adequate to address but not fully quantify the issues at the national level. In addition, the statistical evidence collected and presented here should be treated with caution; it is considered sufficient to present trends but not to form the basis for detailed planning.

6.2 Overview of demographics and major urban centres

Demographics

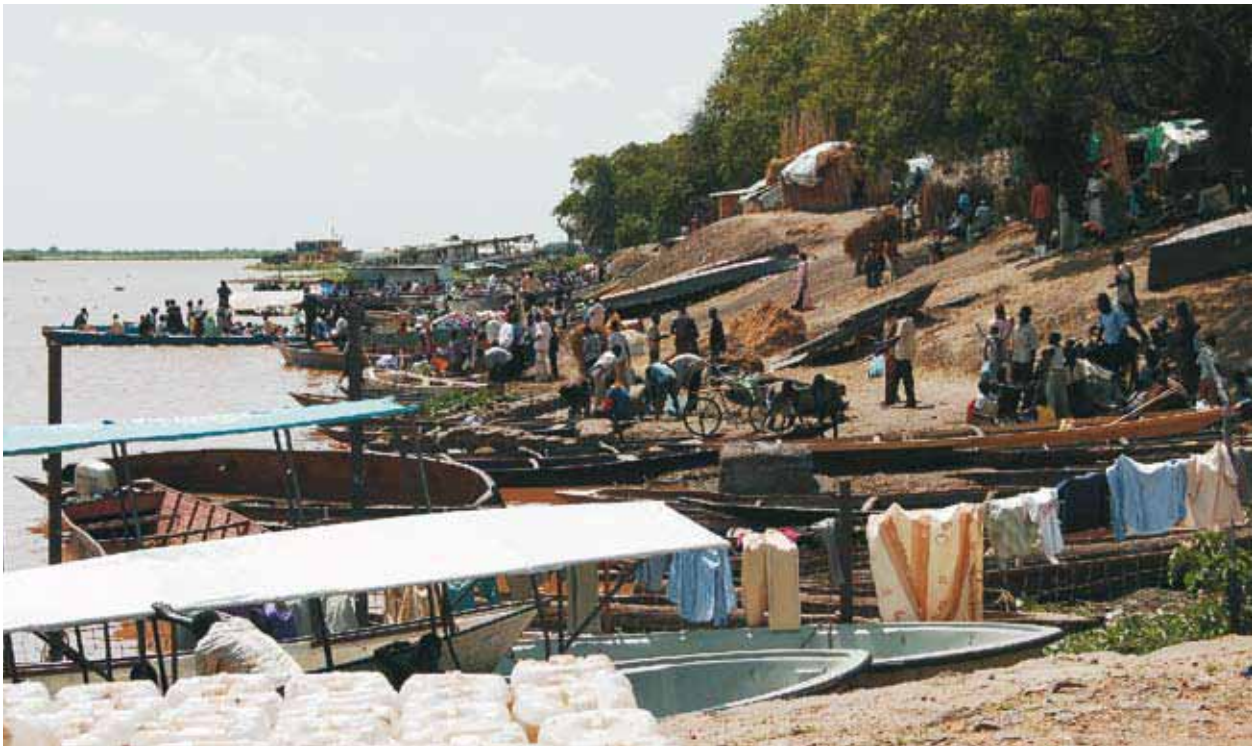
The majority of Sudan's population (estimated to be between 35 and 40 million) lives in villages and hamlets in rural areas. Exact figures on the rural and urban populations are not available, but UNEP estimates, from a compendium of incomplete and obsolete sources, that approximately 70 percent live in villages, hamlets or lead a semi-nomadic existence, and 30 percent are town and city dwellers, or live in displaced persons settlements [6.1, 6.2].

Major urban centres

The urban population is concentrated in only a few cities. Greater Khartoum is by far the largest: its population was 2,918,000 in 1993, but it is estimated to have grown to more than five million in 2006. A study using 1993 census data for the northern cities showed that 64 percent of the total population of the nine largest urban centres lived in Khartoum.

Table 7. Populations of the major cities in northern Sudan in 1993 [6.1]

City	Population	Percentage of total
Khartoum	2,918,000	64
Port Sudan	308,616	7
El Obeid	228,139	5
Nyala	220,386	5
Wad Medani	212,501	5
Gedaref	185,317	4
Kosti	172,832	4
El Fasher	141,600	3
El Geneina	127,187	3
Total	**4,427,578**	**100**



The busy port of Malakal, on the White Nile. Virtually all of the major urban centres in Sudan are located on rivers

Data on the size of the urban centres in Southern Sudan is extremely scarce. The largest towns are the state capitals of Juba, Wau, and Malakal, and the town of Yei. A 2005 urban planning study of Juba estimated the town population at 250,000 [6.3].

6.3 Overview of urban environment and environmental health issues

The UNEP assessment identified a long list of urban and environmental health issues in Sudan, but focused on those with the strongest link to the environment. In this sector, most issues are closely linked, so while the assessment could focus on individual problems, the solutions will need to be integrated. The issues investigated by UNEP were:

- rapid urbanization;
- urban planning;
- drinking water, sanitation and waterborne diseases;
- solid waste management;
- air pollution and urban transport;
- urban energy; and
- sustainable construction.

6.4 Urbanization and urban planning

Rapid urbanization

The two dominant demographic trends in Sudan are rapid population growth (estimated to be over 2.6 percent) and even faster urbanization, fuelled by population growth and a range of compounding factors including:

- drought and desertification eliminating rural livelihoods;
- mechanized agriculture schemes taking rural land from traditional farming communities;
- conflict-related insecurity forcing abandonment of rural livelihoods; and
- general flight from rural poverty in search of better livelihoods and services, such as hospitals and schools in the cities.

Moderately good data is only available for Khartoum (see Case Study 6.1). It shows growth estimates of over five percent per year from 1973 to 1993. Anecdotal evidence and data from studies conducted between 1993 and 2006 indicate that

the explosive growth of Khartoum has not ceased [6.4, 6.5, 6.6]. Given the Khartoum-centred economic boom, the Darfur crisis, and the rural environmental problems of the north, UNEP's forecast for the capital is continued growth, with rapid inflows from northern states somewhat countered by outflow to Southern Sudan.

Following the signing of the Comprehensive Peace Agreement (CPA) in January 2005, displaced persons from the north and outside of Sudan have started to return to their homelands in the south. Only very approximate numbers of returns are available as of the end of 2006, but these are thought to be in the order of 300,000.

The exact percentage of these returnees relocating to southern towns is unknown, but the larger urban centres, such as Juba, Yei, Malakal, Wau and Rumbek, are clearly experiencing very rapid growth. Available data and estimates for Juba, for example, show a population increase from 56,000 in 1973 to 250,000 in 2006, which converts to a growth of 450 percent, or 14 percent (linear) per year [6.3, 6.7]. Growth rates since 2005 are expected to be much higher than this thirty-three year average.

This explosive urbanization is a severe challenge which has not been – and still is not – managed or adequately controlled by regional or local authorities. The result is chaotic urban sprawl and widespread slums, which are in turn associated with a number of health, environmental and social problems. UNEP teams observed informal settlements or slums on the outskirts of virtually every town visited in Sudan.

Urban planning

To date, not only has urban planning mostly been focused on metropolitan Khartoum, but the plans that have been developed have not been fully implemented due to under-investment in infrastructure and utilities, and underlying deficiencies in land tenure and the rule of law. While the capital has recently seen considerable investment, its size, high growth rate and historical lack of planning still constitute major challenges (see Case Study 6.1).

Large-scale informal settlements have multiplied in the Khartoum area since the 1980s. Most of these settlements have very limited access to water, and no sewage or waste management

CS 6.1 Urban planning and informal settlements in Khartoum

Metropolitan Khartoum, which comprises Khartoum, Khartoum North and Omdurman, has an area of 802.5 km^2. It is located at the point where the White Nile, flowing north from Uganda, meets the Blue Nile, flowing west from Ethiopia.

Founded as a military outpost in 1821, Khartoum soon became established as an important trading centre. It was chosen as the seat of government in 1823. Within the past century, the city has expanded 250 times in area and 114 times in population. The population of metropolitan Khartoum is now estimated to be more than five million, and it has a current estimated annual average growth rate of four percent, making it by far the largest and most rapidly increasing concentration of people in the country [6.6]. Some 40 percent of Khartoum residents are internally displaced persons (or children of IDPs) [6.17].

The capital is sprawling rather than dense: population density in metropolitan Khartoum was estimated at approximately 163 persons/km^2 in 2004 [6.4]. This low figure is due to the fact that 92 percent of Khartoum's dwelling plots contain one-level developments of 300-500 m^2 per plot. There are few multi-story residential buildings.

Key statistics for Khartoum are all obsolete and incomplete, but nevertheless illustrate the challenges in urban planning, transportation and provision of utilities and services.

Four master plans have been established for the development of Khartoum since independence. Most were only partially implemented, and a new plan is currently in process.

The most significant environmental health problems can be observed on the outskirts of the city, where the majority of unauthorized settlements are located. These settlements cover vast areas, contain no paved roads and offer negligible facilities for water, sanitation and solid waste management. The result is very poor sanitation, high disease rates, and difficulties in accessing basic services.

Khartoum authorities have attempted to address the issue of unauthorized settlements and squatters through a range of plans, initiatives and new settlement deals. Almost all of these have failed, and over the last ten years, authorities have turned to removing squatters by force, by bulldozing slum areas with little warning or compensation. Displaced persons settlements have been particularly vulnerable to this campaign.

At the same time, a sixty-five hectare central business district is currently being developed at the junction between the Blue and While Nile. The Almogran business district development, which is probably the largest such development in the region, includes plans for a six-hundred hectare residential estate and an eighteen-hole golf course built partly over the Sunut Forest Nature Reserve.

In sum, Khartoum's urban planning and utility provision challenges are considerable. In the absence of major investment and fundamental reforms in areas such as land tenure, the situation is likely to get significantly worse as the capital's population continues to grow.

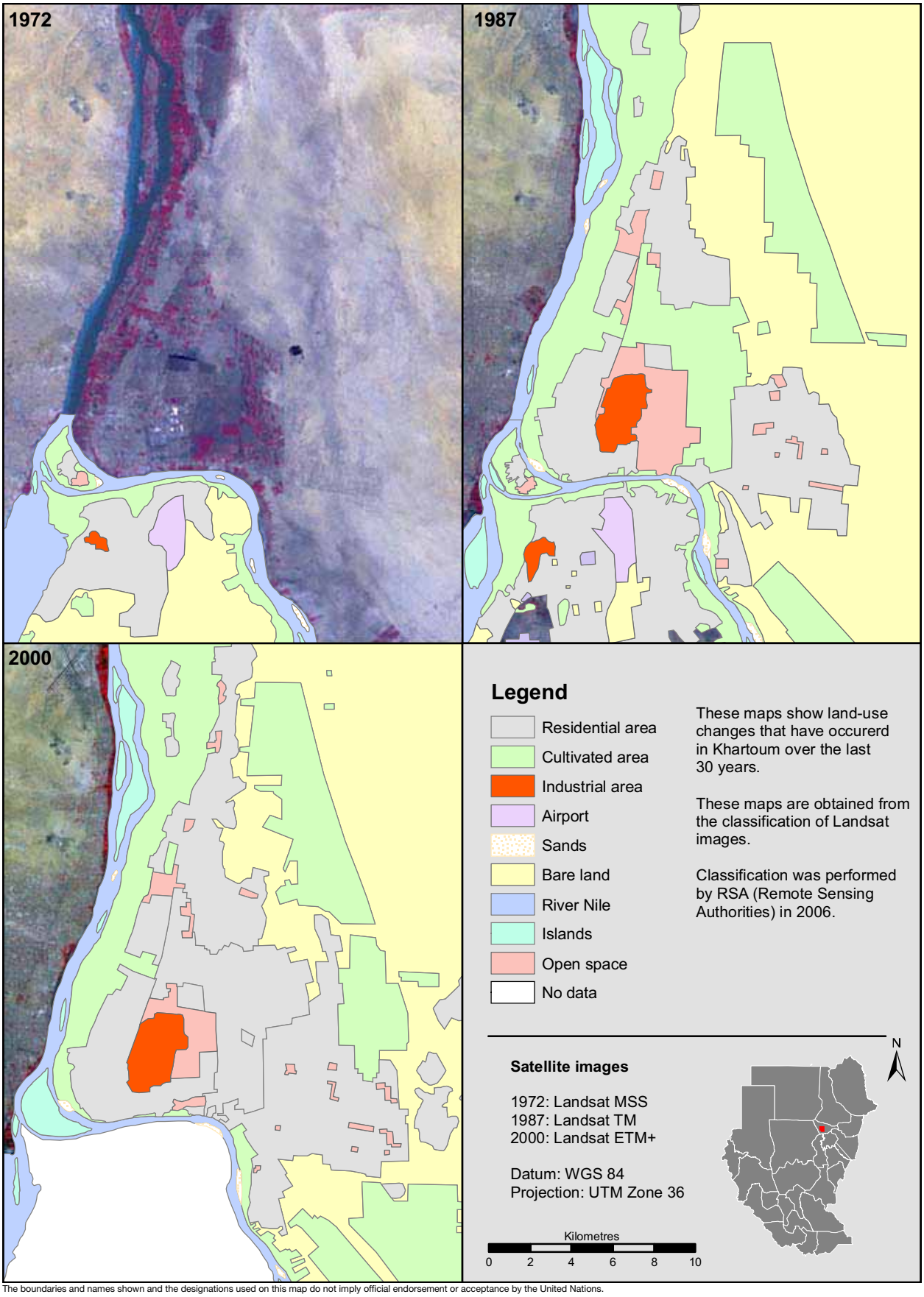
Table 8. Key statistics for Khartoum [6.5]

Indicator	Statistic
Annual growth rate	4 %
Number of shanty towns surrounding metropolitan Khartoum (1986)	96
Estimated population of unauthorized settlements	2-3 million
Percentage of central Khartoum covered by water network	71 %
Percentage of Khartoum connected to sewage system	28 %
Percentage of Khartoum using pit latrines or other basic systems	68 %

In Darfur, the cities of El Fasher, Nyala and El Geneina, as well as other urban centres, are severely impacted by the massive influx of displaced persons since the start of the conflict in 2003. The majority of the two million displaced are found on the fringes of urban centres which, in some cases, have increased in population by over 200 percent in three years [6.8, 6.9]. The experience of Southern Sudan indicates that a significant percentage of these 'temporary' settlements in Darfur will become permanent additions to the towns.

In Southern Sudan, urban planning challenges are twofold. First, urban populations are swelling due to the return of displaced people, and second,

Figure 6.1 Growth of Khartoum 1972-2000



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

some of the towns are inherently badly located: the Nile swamps and floodplains are home to several million people, but are very difficult places to develop urban centres in, due to high water tables, annual flooding and a lack of building materials such as sand, gravel, rock and suitable clay. Malakal is a classic example of the constraints imposed by location (see Case Study 6.2).

The Government of Southern Sudan launched a major urban development initiative for the ten state capitals in 2005. Planned infrastructure works include water and sanitation, roads and drainage, power supply and government buildings. The Juba civil works contracts, funded partly through the Multi-donor Trust Fund, were awarded in 2006 and on-site work is in progress. Discussions are currently being held to explore the financing of works in the other nine state capitals.

In parallel, UNDP has set up an Urban Management Programme for 2006-2009 to provide broad policy and technical support. UN Habitat has also commenced operations, and an international aid programme funded by USAID has started to conduct assessments and capacity-building in urban planning for Southern Sudan.

With limited soil absorption capacity and no gradient to allow for drainage, sewage remains stagnant in Malakal's town centre, increasing the risk of waterborne diseases

CS 6.2 Malakal: the environmental health challenges of urban development in the southern clay plains

Malakal (population approximately 200,000) is the capital of Upper Nile state. It is located on a flood plain near the junction of the White Nile and Sobat river. The town's location and local geology exacerbate the usual water and sanitation problems that afflict all of the major towns in Southern Sudan.

Indeed, the town is located on very flat ground consisting of heavy clay soil, and the water table is only 0.5 to 1.5 m below the surface. As a result, drainage is difficult. In the wet season, the town is frequently flooded for long periods of time. Because there are no significant rock or gravel deposits in the region, straightforward corrective measures like surface paving, minor relocations and raising settlements above the flood level are all extremely complex and costly, due to the need to import bulk materials.

Malakal's population is rising rapidly as people return from the north and from Ethiopia, and the limited public services are completely overstretched. There is no effective sewage system, and the open rainfall drains that serve as sewers in most of the town's streets commonly overflow in the wet season. Unsurprisingly, Malakal was one of the towns affected by the cholera epidemic of 2005-2006. Unless the problem of town sewage is addressed through a combination of investment and urban planning, preventing further outbreaks of waterborne diseases will be problematic.

6.5 Drinking water, sanitation and waterborne diseases

Access to safe and adequate drinking water

Sudan is one of the few countries in the world where the percentage of people with access to safe and adequate drinking water has declined over the last decade. Water access rates are comparable to poorer countries in sub-Saharan Africa.

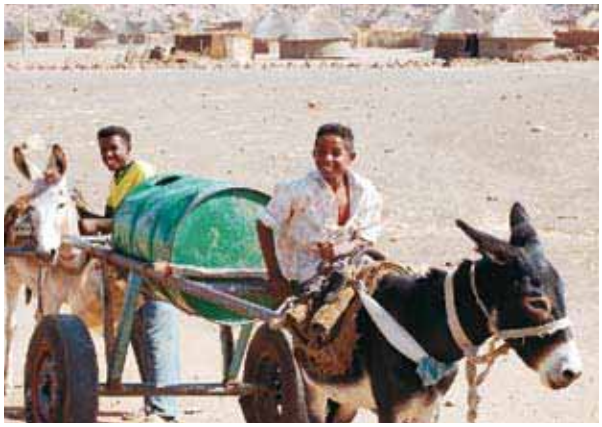
Table 9. Overview of potable water statistics in Sudan [6.10, 6.11, 6.12]

Indicator	Statistic
Northern and national figures	
Urban populations without access to 20 litres per day (North, 2005)	40 %
Rural populations without access to 20 litres per day (North, 2005)	60 %
Khartoum population with improved water access (2005)	93 %
Blue Nile state population with improved water access (2005)	24 %
Primary schools without access to safe water	65 %
Percentage of daily income spent on water purchase by the urban poor	Up to 40%
Average water consumption per person per day from rural water points	< 6 litres
Darfur	
Average water consumption per person per day	< 7 litres
Southern Sudan	
Rural population without access to safe water supplies (2005)	75 %
Percentage of the estimated 6,500 water points currently not functioning properly	65 %

Sudan actually has sufficient natural water resources in the form of rivers, lakes, seasonal streams and groundwater to supply drinking water for the population in virtually all areas, except for some parts of the northern desert (see Chapter 10).

The constraint in supplying adequate and safe drinking water is principally due to a lack of extraction and purification infrastructure. Under-investment and poverty are core obstacles for the supply of water throughout Sudan, and historical and current conflicts have exacerbated the problem.

Water availability for agriculture and industry (which can use over twenty times the amount required per capita for potable purposes) is much more limited, and constrained by the scale and reliability of the resources rather than just under-investment.



Water carts in Kassala state. Reliable water points are few and far between in the drier parts of Sudan. Many people rely on water purchased from vendors

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A major aid-funded water drilling programme in Darfur has provided over a million people with access to clean water since 2003

Hand-operated well pumps provide a reliable water supply to millions of Sudanese people

The majority of the urban population of Sudan relies on basic latrines or septic tanks that are emptied by truck. In this case, the load is transferred to the Khartoum sewage works

Sanitation and sewage

Problems with sanitation are evident throughout Sudan, and inadequate facilities are the norm rather than the exception outside metropolitan Khartoum. Village fringes, disused lots and seasonal watercourses are commonly used as open toilets, with predictable health consequences.

Table 10. Overview of sanitation and sewage statistics in Sudan [6.10, 6.11, 6.12, 6.13]

Indicator	Statistic
Northern and national figures	
Urban population using improved sanitation facilities	80 %
Rural population using improved sanitation facilities	46 %
Primary schools with improved sanitation facilities	50 %
Percentage of Khartoum connected to sewage system	28 %
Darfur	
Population using improved sanitation facilities	< 20 %
Southern Sudan	
Population using improved sanitation facilities	< 30 %

Sanitation issues are most apparent in displaced persons settlements that have not been reached by international aid efforts. Such settlements are typically found on the outskirts of towns, and are generally very crowded and unsanitary. Large-scale aid-organized camps are usually in better condition but often face major challenges due to crowding and poor location.

Sewage systems have been installed in Khartoum, but these facilities, which cover only a quarter of the population [6.5], are now massively overstretched and not functioning properly. As a result, a large amount of untreated sewage is pumped back into the Nile, with obvious health implications for downstream communities. Most other cities have some form of sewage drainage system but no treatment, so that effluent is discharged directly into the nearest watercourse.

In the very dry areas and in towns without a sewage network, the standard solution for the more affluent communities (including the international aid community) is to use a septic tank. When tanks are full, they are emptied by a suction tanker and the contents are dumped, usually in the dry bed of a local seasonal watercourse. This process is particularly inequitable as it essentially transfers the waterborne disease risk from the affluent to the poor, who take their water from such watercourses.

In towns without sewage plants, septic waste tankers empty their loads on the city outskirts, in this case into the main wadi supplying drinking water to Port Sudan

Raw sewage flowing to the White Nile. Though there is a sewage network in Khartoum, it does not cover the entire city and no longer works properly, as it is stretched well beyond capacity

Waterborne diseases are a particularly severe problem in towns in Southern Sudan, due to the lack of water supply and sewage infrastructure in crowded informal housing areas like here in Juba

Waterborne diseases

The shortcomings in water quality and sanitation in Sudan are directly reflected in the incidence of waterborne diseases, which make up 80 percent of reported diseases in the country. The incidence of disease is highly seasonal: the greatest problems usually occur at the start of the wet season as the rains and run-off mobilize the faecal matter and pollution that have accumulated during the dry season.

The very limited water monitoring that has been carried out has confirmed bacteriological contamination of the Nile in Khartoum state and elsewhere in northern Sudan [6.12]. Limited groundwater monitoring in metropolitan Khartoum also confirmed bacteriological contamination [6.5]. There is practically no data for Southern Sudan.

Apart from the routine waterborne illnesses such as cholera, dysentery, hepatitis A and a range of parasitic

infections like schistosomiasis, a number of tropical diseases including malaria, sleeping sickness, river blindness, guinea worm and visceral leishmaniasis are still prevalent. Southern Sudan is particularly afflicted, with an estimated 70 percent of the world's cases of guinea worm occuring there [6.13].

In 2005 and 2006, Southern Sudan experienced a major cholera outbreak in several cities including Yei, Juba, Bor and Malakal. The total number of victims recorded by WHO was over 16,000, with over 470 deaths [6.14]. Cholera is a waterborne disease linked to faecal pollution of drinking water. A UNEP team visited one of the epicentres of an outbreak in Juba in February 2006 (see Case Study 6.3) and found that water and sanitation problems were so severe and endemic that it would have been very difficult to pinpoint a single source, though according to WHO, untreated water from the White Nile and shallow open wells were the most likely suspects [6.15].

6.6 Solid waste management: consistent problems on a national scale

Solid waste management practices throughout Sudan are uniformly poor. Management is limited to organized collection from the more affluent urban areas and dumping in open landfills or open ground. In the majority of cases, garbage of all types accumulates close to its point of origin and is periodically burnt.

Carefully designed water points, such as this one that is connected to a deep well in Western Darfur, can help control the spread of waterborne diseases

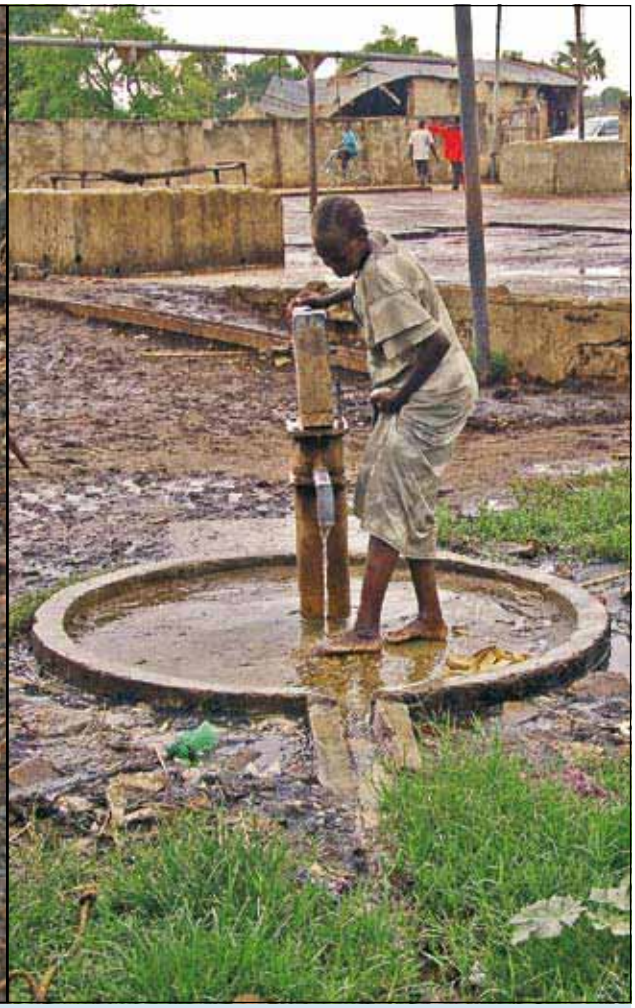
Litter – plastic bags in particular – is a pervasive problem across the country, with Khartoum state being worst affected due to its population density and relative wealth.

UNEP field teams visited a number of municipal dumpsites in Port Sudan, Khartoum, El Obeid, El Geneina, Wau, Juba, Malakal and Bor, as well as in smaller towns and villages. Of all of the sites visited, only Khartoum and Juba were found to have organized systems of dumping waste into pre-defined moderately suitable locations. In all other cases, dumping took place on the outskirts of urban centres (see Case Study 6.4). Moreover, there was no waste separation at source, and slaughterhouse offal, medical wastes, sewage and chemicals were seen within the normal waste stream. Waste was also commonly dumped directly into seasonal watercourses or rivers, thereby contributing to water pollution and waterborne diseases.

Open air burning is the most common method of waste disposal in IDP settlements such as this one on the southern fringe of Khartoum

Wind-blown litter is an endemic problem in the countryside around major towns in northern and central Sudan

Offal and effluent from the slaughter yard flow past the well towards the White Nile



UNEP found that this hand-pump supplied both the slaughter yard and the nearby local settlement. Waterborne diseases such as cholera occurred in this area in 2006

CS6.3 Juba slaughter yard and community well

The slaughter yard on the eastern edge of Juba is the largest of several relatively small and primitive facilities used for slaughtering cattle, sheep and goats in the town. The site is surrounded by IDP settlements, and is approximately 200 m from the Nile and 400 m upstream of the town's municipal water extraction point.

The facility consists of an open concrete yard with a number of drains and open washbasins. On the day of UNEP's inspection, the facility was covered in blood and offal. Most of the non-commercial offal was washed into an open drain leading towards the river. The edges of the facility were used for dumping non-usable solid animal waste, and as an open latrine.

A community water point in constant use was located on the premises, within five metres of the offal drain and communal latrine. The surface of the water point was surrounded by stagnant noxious water and waste. The depth of the water table was estimated by the team to be in the order of two to three metres. Interviews of water point users revealed that many people in IDP settlements nearby had been struck with cholera.

This particular case of apparent contamination of community water supplies illustrates the problem of locating shallow groundwater wells in an urban setting in the absence of any real form of water and sanitation infrastructure or protection measures.

Since UNEP's visit, however, it has fortunately been reported that the replacement of the slaughter yard is being carried out as part of current infrastructure works in Juba. A new abattoir with modern facilities will be constructed on a new site to the north of the city.

A waste picker burns tires in order to retrieve wire to sell as scrap metal (left)

Abattoir waste was left in the open air for scavenging dogs and birds (top right)

Medical waste was found across the site and along the main road (bottom right)

CS6.4 The Port Sudan landfill

The case of Port Sudan (population approximately 500,000) illustrates the solid waste management problems that exist throughout Sudan. The city has several uncontrolled waste disposal sites on its fringes. The largest by far is located along the banks of a broad *wadi*, approximately six kilometres from the city centre.

The boundaries of the site are difficult to determine, as open dumping takes place along the access routes and in vacant or common land throughout the district. In total, it is estimated that no less than 5 km^2 are covered with a layer of mixed waste ranging from 0.1 to 1 m in thickness.

The site is virtually uncontrolled and presents obvious health and environmental hazards. Waste is burned and recycled by a resident group of waste pickers who live in terrible conditions on site. Animals observed feeding on the waste include dogs, goats, cattle and camels, as well as crows, kites and vultures.

The types of waste dumped on site include clinical wastes (syringes, catheters, blood packs, drugs and bandages), plastics and paper, drums and other metal scraps, small-scale chemical wastes, abattoir and food wastes, and septic tank solids and liquids.

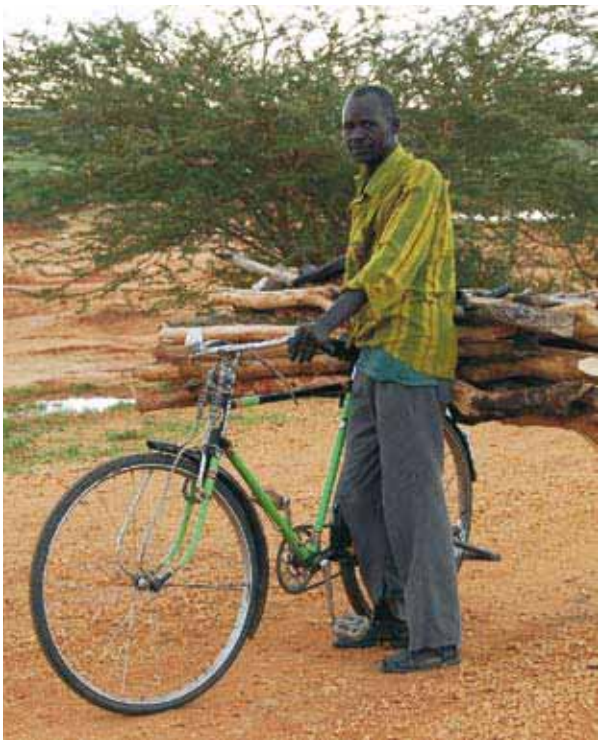
The root cause of problems such as those seen at Port Sudan is inadequate investment in public services, including in all aspects of sanitation and waste management.

6.7 Air pollution and urban transport: a complete data vacuum

UNEP found no evidence of systematic air quality monitoring in Sudan. UNEP itself did not conduct any quantitative analysis, and thus cannot present any solid findings on the topic.

With respect to health, the most significant air pollutant in most of Sudan is dust generated by wind moving over dry and exposed soil. Indeed, large parts of northern Sudan are routinely enveloped in sand and dust storms, with high levels of atmospheric dust persisting for days at a time. This extent of exposure undoubtedly takes a toll on the population's respiratory health, although UNEP was not able to find solid statistics on this issue.

According to local authorities, the last significant air pollution and associated environmental health survey was conducted in Khartoum in 1990. This study reportedly focused on health impacts to traffic police, but the results were not available for interpretation. In 1979 and 1981, limited studies investigated particulate (dust) and sulphur dioxide (SO2) levels in Khartoum; again, the results were not available.



Carting firewood back to Juba: towns in Southern Sudan rely on a combination of firewood and charcoal for most energy needs

On an anecdotal basis, industrial- and vehicle-based air pollution do not appear to be regional-scale problems in Sudan, though localized issues with factory and traffic emissions are evident in central Khartoum.

The current Environmental Framework Act of 2000 does include some general prohibitions on air pollution, but no numerical quality standards. As a result, there are no criteria against which the performance of individual facilities can be judged. There is also no measurement capacity within the regulatory authorities. Nonetheless, at least one state government has taken action on air pollution issues, forcing a cement factory to treat its emissions (see Case Study 7.3).

These and other positive steps at the local level should be supported via technical and legal development work, including data collection and the establishment of air quality and plant performance standards.

6.8 Urban energy: a declining dependence on wood

Sudanese cities are unusual even in the developing world in that the level of electrification is overall extremely low, and that the majority of the urban population still relies on wood for energy: a 1998 survey reported that 90 percent of urban households still depended on charcoal and wood for fuel. It is the energy needs of these ten million urban dwellers of northern and central Sudan that drive the large-scale and very unsustainable commercial charcoal industry (see Chapter 9).

There is some cause for optimism, however. Liquefied petroleum gas (LPG) is being introduced into northern Sudan – and Khartoum in particular (see Chapter 7). In addition, the electricity supplied by the Merowe dam project is expected to double the national electrical output in 2007-2008, ushering in a major switch to electricity (see Chapter 10). This move from one energy source to others with different environmental impacts is a typical example of the environmental trade-offs that occur with development.

6.9 Sustainable construction opportunities: alternatives needed to reduce deforestation rates

Sudan is currently experiencing a construction boom, which is greatly increasing the demand for construction materials, and particularly for bricks. All bricks in Sudan are baked using a low efficiency kiln system fuelled by firewood. The demand for wood has intensified the pressure on forests in most parts of the country, and especially in central Sudan and Darfur.

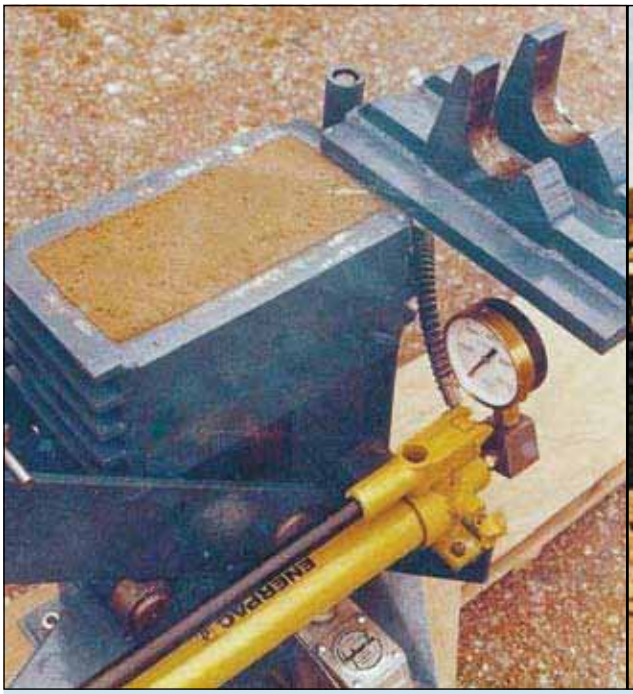
The cost of 'modern' construction remains extremely high, especially in Southern Sudan and Darfur, where transportation costs can be punitive. For example, the cement used for UN compounds built in 2006 in remote parts of Southern Sudan was generally airlifted – an extremely expensive approach for bulk commodity transport.

This building boom represents an opportunity to introduce sustainable and cost-effective construction techniques into the country. Techniques such as stabilized earth technology are already used on a small scale in Sudan and simply need promotion. Other practices, such as solar-aided hot water systems, have been introduced but have yet to be widely adopted.

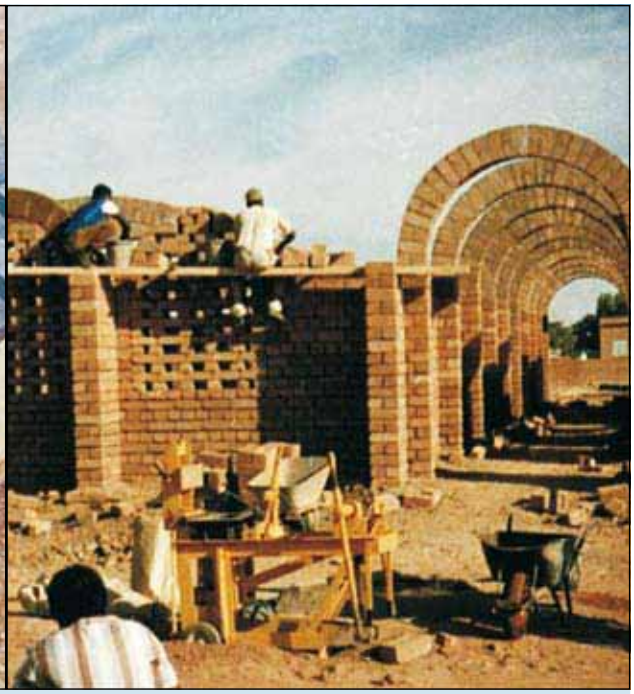
6.10 Urban and health sector environmental governance: local management and funding issues

Under the terms of the 2005 Interim Constitution, practical management of the urban and health sectors in Sudan is largely the responsibility of state governments, which in turn delegate down to county and city governments. Cross-cutting this structure are federal ministries for physical development, health, water and irrigation, and transport.

Traditional buildings such as this barn under construction near Mabior in Jonglei state require a large number of young trees



Stabilized earth bricks are obtained by placing a mixture of clay, silt, sand and a stabilizing agent into a mechanical or hand-powered press, which crushes the mix into a hard, dense block that is then dried naturally



Stabilized earth construction techniques combine the advantages of traditional earth and modern brick construction. Compressed earth blocks have been used in the construction of several buildings in Khartoum

CS 6.5 Sustainable construction using stabilized earth blocks: an opportunity for the UN and others to do less harm to the environment

Traditional soil construction techniques are used in 80 percent of buildings in Sudan, and this figure rises to over 90 percent in rural areas (2000 data). The advantages of soil are its very low cost, its local availability and the simplicity of construction. Its disadvantages are its low strength and durability, particularly in high rainfall areas. The more affluent Sudanese therefore rely on brick construction instead, and the demand for fuel to fire bricks is one of the causes of the deforestation occurring in Sudan.

Compressed and stabilized earth construction techniques combine the advantages of both traditional earth and modern brick construction. The method can be summarized as follows: suitable moist soil consisting of a mixture of clay, silt and sometimes sand, is blended for uniformity before a stabilizing agent such as cement, lime, gypsum or bitumen is added. The material is then placed in a mechanical or hand-powered press, which crushes the soil-stabilizer mix into a hard, dense brick that is dried naturally, gaining strength in the process. The bricks obtained can be used just like fired clay or concrete bricks.

Modern compressed earth technology has proven effective in many parts of the world, and several buildings, such as the Haj Yousif experimental school in Khartoum North, have already been constructed in Sudan as demonstration projects [6.18, 6.19].

The environmental savings are significant, as studies have shown that compressed earth construction uses approximately only one to two percent of the energy for material development per cubic metre that cement and fired bricks use [6.18]. For Sudan, this translates into potentially major savings in fuelwood.

The economics of compressed earth indicate that – if introduced correctly – the technology can be commercially self-sustaining, as it can compete with brick and cement on cost grounds. The main obstacle to market entry is its novelty and a lack of local knowledge.

UN agencies in Sudan and elsewhere in developing countries use considerable amounts of fired bricks to build their offices and residential compounds. In fact, the MOSS (Minimum Operating Security Standard) requirement for a two-metre high solid wall surrounding compounds is the direct cause of the felling of thousands of trees in Sudan and elsewhere. Compressed earth technology offers the opportunity for the UN and other international aid organizations to reduce the negative impact of their presence and extend the 'do no harm' principle to include the environment.

The main issue for state governments in Sudan (outside of Khartoum) in areas such as urban planning and environmental health is insufficient funding: local officials are generally quite aware of the problems but cannot act in the absence of funds.

The second major obstacle to tackling urban and environmental health issues is the pace of urban growth and slum development: it is difficult to enforce basic planning and environmental health standards when uncontrolled settlements are set up on land that is either unsuitable for inhabitation or needed for the provision of adequate infrastructure. A particular problem arises where illegal settlements are established in flood plains and partly block existing drainage basins and corridors, resulting in increased flooding and the spread of waterborne diseases.

6.11 Conclusions and recommendations

Conclusion

While urban environment and environmental health issues are clearly apparent to all living in Sudan, attempts to change this situation have met with little success to date. The main obstacle for improvement in these areas is a lack of investment, but other problems, such as the widespread lack of adequate urban planning, also play a role.

Background to the recommendations

Water and environmental sanitation are major areas for international humanitarian funding; in the UN, work in these sectors is led by UNICEF. Solid waste management and urban planning are traditionally not well supported, though this is now changing.

It is extremely clear that neither humanitarian nor development aid efforts in these sectors will be fully successful or sustainable without greater government support, principally increased government funding. Issues such as land tenure, unauthorized settlements and chronic solid waste management problems can also only be resolved by national and local authorities.

On this basis, UNEP's recommendations are focused on increasing government capacity and support for these sectors rather than implementing site-specific projects. The exceptions are the need for practical solid waste management and sustainable construction projects in one or more locations to demonstrate the way ahead. It should be noted that a substantial humanitarian water and sanitation programme is separately promoted and managed by UNICEF and others on an annual basis, and is hence not repeated here.

Recommendations for the Government of National Unity

R6.1 Invest in urban planning capacity-building for all northern and central states, and for Darfur. This will entail a process of importing expertise and 'learning by doing' through improved master planning for each state capital. Particular attention should be given to Darfur state capitals, where the need is greatest due to the influx of people displaced by the conflict. To improve political support, assistance should be channeled in part by the Governor's office in each state.

CA: CB; PB: GONU state governments; UNP: UN Habitat; CE: 2M; DU: 3 years

R6.2 Increase investment in environmental health-related infrastructure and services in all northern and central states, and in Darfur. There is no substitute for significant investment in solving issues such as sanitation and solid waste management. Any major investment programme should proceed in stages, attempt to introduce self-sustaining financing and involve the private sector. A proportion of the total cost should be directed toward human resource capacity-building and awareness-raising. Note that this recommendation is not costed, but that the investment required to attain even a basic level of service is anticipated to be in excess of USD 1 billion over a period of more than a decade.

CA: GI; PB: GONU state governments; UNP: UN Habitat; CE: NC; DU: 10 yrs+

R6.3 Promote the growth of the LPG market in major urban centres. This measure will directly reduce the pressure on remaining forests in dryland Sudan by substituting for charcoal

as an urban fuel source. Promotion may entail some form of initial subsidization of the LPG cylinders. Fuel should not be subsidized, as this would create a distorted market in the long term. Costs and duration of the programme are flexible and scalable.

CA: GI; PB: Public via MoF; UNP: UNEP; CE: 1M; DU: 2 years

R6.4 Complete a stabilized earth technology demonstration project for Khartoum and three other states including Northern Darfur. This should entail the construction of a UN and government-used building in a prominent position to maximize exposure, and should include extensive capacity-building components. The technology and capacity already exist within the Ministry of Environment and Physical Development.

CA: CB; PB: MEPD; UNP: UNOPS; CE: 1M; DU: 2 years

R6.5 Complete a stabilized earth technology demonstration project for Juba and three other states. The technology and capacity already exist within the GONU Ministry of Environment and Physical Development, and GONU assistance to GOSS on this topic would be a positive example of north-south cooperation.

CA: CB; PB: MEPD; UNP: UNOPS; CE: 1M; DU: 2 years

Recommendations for the Government of Southern Sudan

R6.6 Invest in urban planning capacity-building for all southern states. This will entail a process of importing expertise and 'learning by doing' through improved master planning for each state capital. To improve political support, assistance should be channeled in part by the Governor's office in each state.

CA:CB; PB: GOSS state governments; UNP: UN Habitat; CE: 2M; DU: 3 years

R6.7 Increase investment in environmental health-related infrastructure and services in all southern states. This recommendation matches R6.2 above with similar anticipated costs and time scales.

CA: GI; PB: GOSS state governments; UNP: UN Habitat; CE: NC; DU: 10 yrs+

Recommendations for the United Nations in Sudan

R6.8 Construct a MOSS-compliant compound perimeter for at least one base in Southern Sudan using stabilized earth technology. Such a demonstration project potentially has very high added value if explicitly endorsed by the UN.

CA: PA; PB: GONU MEPD; UNP: UNMIS and UNOPS; CE: 1M; DU: 2 years