Overseas Development Institute

Pipelines and donkey carts

A social risk analysis of water availability, access and use in Nyala, South Darfur

Alan Nicol, Mohamed Abdulrahman Elamin and Nawal Hassan Osman with Mahbouba Abdelrahman Ali, Suleiman Mohamed Nour, Tayalla Elmedani, Sumaya Mohamed Yagoub and Aisha Mustafa El-Neima Mohamed

UKaid from the Department for International Development

UNOPS

hpg Humanitarian Policy Group

Acknowledgements

First and foremost we thank all the study respondents—including householders, vendors, farmers, internally displaced persons, members of different professions and associations, government officers and members of the State Legislative Council—who took part in the surveys and contributed time to answering our detailed questions. Their patient, good-humoured and sincere responses made this study possible and contributed rich material for analysis.
We are also grateful to Hamid Omer, a UN Environmental Programme (UNEP) consultant, and to Hussein Bagadi of the African Union/United Nations Hybrid operation in Darfur (UNAMID) for insight and steer provided during the study's opening stages—and to Brendan Bromwich (UNEP), who helped and supported us with background information and useful feedback on a draft of this report. We extend particular gratitude to the State Water Corporation and Urban Water Administration in Nyala, especially to Fadl Mustafa and Ahmed Hamza, whose good offices generously provided a full-time secondee to our team, Abdel-Hadi Hassan Abdel Gadir.

The UN's Office for the Coordination of Humanitarian Assistance (OCHA) in South Darfur supported and hosted the team during fieldwork, for which we specifically thank Malan Amara, Yussef Abdi, Jabeldin Abdalla and Hassan Ahmed. Their critical logistical and informational support was especially helpful. We also acknowledge the input provided by Mohamed Adam (Humanitarian Aid Commission, Nyala), the UNEP team in Nyala (specifically Magda Nassef) and the UN Development Programme for housing the team leader during fieldwork.

DFID Khartoum, and Simon Narbeth in particular, continually supported this work and contributed key insight and feedback at all stages. Nihal Samarasinghe at UNOPS provided tireless overall logistical support and, as the study contractor and implementing partner, oversight for the project as a whole. Margie Buchanan-Smith contributed critical insight at the design stage, during the analysis and through feedback on the draft report.

Last but by no means least, the team leader extends his sincere thanks to the wonderful hospitality and generous support provided by George and family at the Acropole Hotel in Khartoum. Their capacity to provide a soft landing is never diminished, and hugely appreciated.

About the authors

Alan Nicol, a research fellow at the Institute of Development Studies (IDS) within the Knowledge, Technology and Society team, provided overall leadership for this study. The local study team comprised two senior consultants, Mohamed Abdulrahman Elamin, who led on institutions and supply, and Nawal Hassan Osman, who led on livelihoods and gender (assistance was also provided by senior consultant Aisha Mustafa El-Neima Mohamed during the latter part of the assignment). In addition, the team included three junior consultants: Mahbouba Abdelrahman Ali (gender and households), Suleiman Mohamed Nour (water points) and Sumaya Mohamed Yagoub (livelihoods). The team also had the support of a hydrogeologist seconded from UNEP—Tayalla Elmedani—who contributed to the water point analysis and wider resource assessment. The State Water Corporation kindly seconded their employee Abdel-Hadi Hassan Abdel Gadir to assist our team during fieldwork.

Overseas Development Institute
111 Westminster Bridge Road
London SE1 7JD, UK

Tel: +44 (0)20 7922 0300
Fax: +44 (0)20 7922 0399
www.odi.org.uk

Contents

Boxes, figures, tables and maps

Boxes

Figures

Tables

Maps

Abbreviations

AWD	Acute watery diarrhoea
DFID	Department for International Development
DUWSP	Darfur Urban Water Supply Project
GoS	Government of Sudan
GWWD	Groundwater and Wadis Directorate
IDP	Internally displaced person
IDS	Institute of Development Studies
IWRM	Integrated water resources management
LC	Legislative Council
MIWR	Ministry of Irrigation and Water Resources
OCHA	Office for the Coordination of Humanitarian Assistance
PWC	Public Water Corporation
SDG	Sudanese pound
SWC	State Water Corporation
TDRA	Transitional Darfur Regional Authority
UNEP	United Nations Environment Programme
UNAMID	African Union/United Nations Hybrid operation in Darfur
UWA	Urban Water Administration
WAPS-2	Water Resources Assessment Program in the Sudan 2
WES	Water and Environmental Sanitation Programme (Public Water Corporation)

Glossary

Borehole	Water supply drilled into alluvial aquifer or basement complex
Dug well	Well that is hand-dug into alluvial aquifer, often brick-lined; roughly two metres in diameter
Feddan	Unit of land equivalent to 0.42 hectare
Fontass	Square tank drawn by a donkey, horse, or mule; equivalent to two barrels (or about 400 litres or 24 jerrycans, with one jerrycan holding about 20 litres)
Hai	Neighbourhood
Kiosk	Small fixed water vending point that is run privately but provided by the State Water Corporation
Wadi	Ephemeral river valley
Water yard	Usually the bounded location for a high-yielding borehole used for livestock and households, with standpipes and troughs
Motorised dug well	Hand-dug well with a motorised submersible electrical pump

Executive summary

Context: Darfur is emerging from a period of protracted conflict, much of it concentrated in rural areas.[1] During the conflict hundreds of thousands of internally displaced persons moved to urban Darfur, their presence posing unprecedented challenges regarding access to water supplies given the unanticipated surge in demand.

The UK Department for International Development (DFID) is funding the Darfur Urban Water Supply Project (DUWSP), which will support water supply development in three Darfur state capitals—Nyala, El-Fasher and El-Geneina—plus Zalengei town. The project is being implemented by UNOPS in collaboration with the State Water Corporation (SWC) in Darfur. This study was commissioned to examine the social impact of increased water availability in Nyala, provided for through this project. The purpose is to understand in more detail how the existing 'water economy' of Nyala may change as the resource is made more available via an expanded town network, and how this change may affect the poor and contribute to or mitigate future conflict. Nyala has been chosen as a case study on the basis that other urban contexts are likely to be affected in a similar way.[2]

For much of the 20th century Nyala grew fairly slowly, as commerce emerged and transport links to central Sudan gradually improved—particularly the extension of the railhead in the 1950s. The past 30 years, however, have witnessed numerous droughts and intermittent conflicts that have driven many people from towns in search of aid, protection and alternative livelihoods. With the onset of far wider and deeper conflict in Darfur as of 2003, Nyala's population mushroomed to well over one million people, many of whom are classified as internally displaced persons. Their influx has caused specific stresses on natural resources, including water, an already limited resource in the region.

The core focus of this study is on the town's water supply, much of which is provided by the Wadi Nyala alluvial aquifer. Some additional sources are available from the basement aquifer, but the bulk of public water comes from the wadi. In recent years this aquifer has been increasingly unable to meet demand, particularly during the peak of the dry season, from April to June. Combined with an outdated and leaking distribution network, supplies scarcely cover 13,000 households (representing about 10% of the total population); even if connected, many households suffer supply interruptions. The resulting gap between household demand and available supply is filled largely by informal water vendors.

Vendors on the whole use the same alluvial aquifer that serves the formal system by filling up at privately owned boreholes. In that sense they are in direct competition with the Urban Water Administration (UWA) for supplies. Without effective regulation, private well owners are free to draw water and distribute it via the informal vending community—and to profit in the process. Vendors are only loosely regulated by local authorities and inspection of water quality—which is often described as poor—does not take place. Vended water is also costly compared to public water. The system of vending, however, provides a key income-earning opportunity for thousands (by this study's estimates) of young displaced persons, invariably young men or boys. This private water market thus has a substantial humanitarian and welfare dimension that needs to be accounted for in future decision-making.

A new government scheme—with support from DFID—is extending the piped network and tripling the number of household connections over the next two years. This expansion is accompanied by increasing available water from a new well field in the lower wadi, near

[1] Darfur is just under the size of Spain at about 500,000 km^2.

[2] There are, of course, challenges to this assumption. An important starting point for wider impact analysis could involve comparing the results of this research with those of studies conducted in other urban contexts.

Kondowa. If, as anticipated, this results in substantially more households receiving water supplies at the public tariff, the impact on vendors will be substantial. If these connections are extended to the poorer and middle-income households in Nyala, the net benefits in welfare terms will also be substantial. Understanding the nature of this trade-off is critical to future tariff setting. The major governance challenge, therefore, is to find a way of ensuring success in augmenting and sustaining public water supplies while protecting the livelihoods of those dependent on vending, many of whom are from the most vulnerable households.

In examining these relationships we used both qualitative and quantitative analysis, combining household surveys with focus group discussions, water point visits and interviews with key informants. We shared and received feedback on our immediate findings at key stakeholder meetings in both Nyala and Khartoum in May 2011. While considerable data was gathered, the project did face significant limitations, principal among which was the short timeframe available for the survey and the security conditions under which it was conducted. These restrictions placed specific constraints on the time available to verify and cross-check data in the field and to survey a wider number of households. The 100 households interviewed are not, therefore, a representative sample in statistical terms, but they do help to provide indications of trends that can serve as a baseline for follow-up in subsequent assessments and monitoring by the government and others working in and around Nyala. Conclusions that are drawn from household survey data are backed up by cross-referencing with focus group discussions and key informant interviews.

***Findings**:* In terms of relative size, we estimate that the water vending economy generates nearly twice as much revenue each month as the public water system in Nyala, as represented by the Urban Water Administration. This raises a number of important challenges, including the final direction of this huge informal revenue (one of the largest industries in the town) and the multiplier effects, if any, on the wider economy. Our analysis suggests that most of this revenue was redistributed through the informal vending community, largely comprised of sole traders, rather than being captured by a small number of operators. Although some 660 vendors were officially registered with the municipality, we estimate that the actual figure is at least twice that number, based on the volume of water being vended, the size of the tanks used and the number of trips being made (and the estimated overall demand based on an average daily per capita consumption of some 34 litres). This figure was derived from our household survey and was backed up by key informant interviews and focus group discussions (see, for example, Table 5 and 6 in the Annex).

On the cost side, the huge revenues represent a significant burden on household income for the poor in Nyala. Given inadequate network extension and unreliability, most households surveyed (and most focus group discussions) indicated reliance on vended water. We estimated that middle-income households pay up to SDG170 ($40) per month for this water for a household of five. Some poor households were spending roughly half of their income on water each month. The very poorest—for whom such expenditure is an impossibility—are forced to rely on water supplied by neighbours with piped connections.

If Nyala's population remains at or increases beyond current levels, even with substantial increases in public water supplies, there will still be a substantial—though reduced—market for water. The price that vendors can charge for the resource will probably decline, given the greater competition with public water, though even this is likely to remain fairly constant in the long term as income levels and demand for the resource rise. Much will also depend on system reliability, even if further household connections are provided, particularly in the driest months of May and June, and regardless of whether additional supply augmentation takes place through the Baggara Basin scheme.[3]

Yet the most substantial change to the overall water economy in Nyala will take place if the UWA and the municipality introduce an overall governance structure that seeks to strengthen

[3] The Baggara Basin scheme is to provide Nyala with water by pipeline from a well field some 70km to the south.

regulation and resource management at source, challenging but supporting the private water system in transitioning from an almost wholly unregulated market to a more regulated system. This would be a positive step, aimed at supporting water vending as a supplementary supply activity, but paying closer attention to water quality—and price. A more regulated vending market would enable a better understanding of competition for the resource, in particular the wadi aquifer; it would also encourage more careful reflection regarding pricing across different livelihood uses, helping to restrict, for instance, excessive use in brickmaking and other highly consumptive sectors. In the longer term, this tighter regulation would also enable support to alternative livelihoods for the vending community as the public system is extended further.

Recommendations: One thread throughout this report is the challenge implicit in moving from vended water supplies to a more extensive and reliable water supply network. This involves significant regulation and governance in order to build confidence at the household and business levels in public network water supply. At the moment, a failure to deliver services effectively results in a default reliance on vended water, which is delivered at high cost and leads to unregulated abstraction from the wadi aquifer, against which the public water system then has to compete.

A significant shift to more networked water will rebalance the nature of these costs and benefits, substantially altering Nyala's water economy. The recommendations below are about supporting this shift and ensuring that emerging benefits are pro-poor in nature.

1. **Stakeholder engagement:** Two key relationships need improving. The household–UWA relationship is critical given the anticipated additional connections to some 40,000 households by early 2012. This increase anticipates a rise in revenue for the UWA of some SDG1.2m ($450,000)[4] per month. With this substantial increase, consumer expectations will rise considerably, including with respect to more reliable service, improved billing and enhanced communication over future supply issues.

It is therefore recommended that a **Consumer Advice Forum** be established as soon as possible. This would draw together representatives of householders from different districts of Nyala (perhaps represented by Popular Committee officials) to meet with the UWA on a regular basis, preferably quarterly. These meetings would serve to discuss progress against the plan in service upgrading, to increase communication on proposed billing and tariffs and to raise any specific issues relating to services across the town—including involvement in future master planning in the water sector. The format could follow that of the WES Forum; meetings could be convened by the SWC at its offices, with the active support of relevant committee members from the State Legislative Council and from Nyala Municipality.

The forum should begin with a confidence-building exercise, based on discussion of the management challenges in supply delivery (and starting with a full description of the water supply challenges facing the SWC), followed by opportunities for consumers to raise concerns and discuss the complexities they face in managing risk and vulnerability at a household level due to poor water supply. In addition, and in preparation for a single future forum, the SWC should also host a **Major Users Forum**. One of the first tasks would be the presentation of compiled data on all existing water points in and around Nyala, including ownership, the type of users and uses, and approximate yield across the year. This would provide a major support function to help raise levels of accountability and transparency and improve the overall level of trust and confidence between public water providers and major users and consumers. Score cards, community monitoring and outcome mapping could all serve as tools to influence the development of these forums. A basic yet comprehensive inventorization of all water access points in Nyala is a crucial starting point.

[4] The dollar equivalents provided throughout this report reflect the average exchange rate of January 2012. Note that the exchange rate is subject to drastic fluctuations.

2. **Livelihood security:** The second major recommendation is about enhancing livelihood security and easing transitions from private water markets to public water supplies. The steps required to move this hugely important sector of the urban economy from one political-economic configuration to another call for substantial support. This study recommends a threefold approach to supporting ancillary programmes and projects that:

- support the vending community through a concerted push to map and manage the activities of individual vendors, promoting the establishment of an association of water vendors to advocate on their behalf, represent cases when conflict arises and help in establishing water quality standards;

- involve training of water vendors in a range of alternative occupations, so that they can become qualified to take on other work as the market for vended water declines or becomes less profitable. Training could cover skills needed in building and construction, electrical installation and metal working. The good offices of the Artisans Association, the Zakat Chamber and other supporting organisations should help to establish a flexible training programme for the vending community; and

- support financing and credit. Based on analysis presented in this study, the impact on livelihoods—and disposable income—of increased household access could be substantial. The DUWSP aims to supply water to 52,500 households through their own connections for more than six hours per day all week by February 2012. Assuming success in achieving this level of improvement in water supply delivery (and that household connections cost no more than SDG30, or $12 per month), this would represent an increase in disposable income of about SDG120 ($47) per month per household; multiplied by 39,500 extra households, that would mean SDG4.74m ($1.87m) will have been taken out of the informal water market and made available for investment elsewhere (for instance, it would pay for 10,000 extra children to attend school each month). The longer-term impact on livelihoods of improving access to credit would provide important longer-term support to Nyala's economy and household livelihood security.

1 Introduction

This study addresses water availability, access and use in Nyala, South Darfur. It has been carried out to support the Darfur Urban Water Supply Project (DUWSP), funded by UKaid at the Department for International Development (DFID).[5] The purpose of the DUWSP is to 'increase the availability of water sources and the reliability of water supply in the four principal urban centres of North, South and West Darfur' (DFID, 2010). See Box 1 for a description of the project.

The aim of this study is to 'provide analysis of the potential social, economic and conflict impacts (both positive and negative) and social and economic risks arising from the planned DUWSP'. In addition to this analysis, the study provides recommendations and a risk management matrix to help inform project implementation. An explicit aim of the study is to draw on a range of voices and opinions in order to provide a balanced view of potential impacts. To this end, a number of personal case histories are included alongside the survey results (see Boxes 14–20 in the Annex).

As stated in the terms of reference, in order to understand the potential impact of the project it is important to assess how water as a productive asset, in combination with other assets, can generate financial and non-financial benefits for poor people. It is also important to build an understanding of how the resource behaves and how this affects costs associated with water access in Nyala. Knowledge of both the benefits of use and the costs of access will inform future sector interventions and investments.

During the dry season, donkey-drawn water carts rattle along Nyala's streets. This is the most visible sign that informal water markets play an important role in supplying households. These markets include a number of actors, from water 'producers' (those with wells and boreholes) and water vendors to those who make vending equipment and, finally, household consumers. In addition, there are various intermediaries who provide licences and lease vending equipment. Within this market is a political economy with specific interests in maintaining control over resources. It is part of a far wider and more complex water economy—one that extends across Darfur and whose effective management underpins much future development and conflict mitigation. A 2007 UN Environmental Programme (UNEP) assessment finds that across Darfur there are 'strong, mutually reinforcing links' between environmental pressures and conflict, of which water is a key component (UNEP, 2007). Any intervention in water supply therefore draws considerable attention and has a variety of impacts.

The formal water system—Nyala's public piped network—is under extreme pressure. At present it covers less than 20% of the demand generated by about 70,000 households. New programmes funded by the government are designed to increase coverage to some 50,000 households by 2012, although this plan for a four-fold increase faces formidable challenges, including current leakage from the system, reduced water availability during the dry season and a persistent consumer unwillingness to pay for connections that are perceived as unreliable. At the time of writing, most people were continuing to rely on vended water, potentially paying up to ten times more than they would for public network water. The cost per litre of water far exceeds that paid by UK consumers.[6]

Growth in domestic demand accounts for most of the resource pressure and is likely to continue for many years, both naturally and as a result of continued inward migration. It is

[5] For a recent note on the British Ambassador to Sudan's visit to Nyala, see FCO (2011).

[6] The calculation is based on the UK Water Services Regulation Authority's figures for average usage and cost in the UK (£1 for 1m^3). See Ofwat (n.d.).

also anticipated that many of the internally displaced persons (IDPs) in and around the city will settle permanently in new urban neighbourhoods and will shift their demand from the basement aquifer (which provides water to many of the camps) to the wadi aquifer. This will exacerbate existing pressures.

In examining these challenges, Section 2 provides background on water availability, access and use in Nyala. Section 3 presents the major findings of the study, exploring the linkages between issues of livelihood security and the production, management and consumption of water. Section 4 then draws together conclusions and recommendations, presenting a risk matrix and a set of recommendations.

Box 1: Darfur Urban Water Supply Project

The Darfur Urban Water Supply Project intends to bring a range of benefits to the overall water supply environment in three state capitals (Nyala, El-Fasher and El-Geneina) as well as in Zalengei. Its basic aim is to increase groundwater production from a current level of approximately 35,500m^3 per day across all four towns to some 64,440m^3 per day. This would represent an 80% increase in availability. In view of the fact that in many places the resource itself is under pressure, the project seeks to enhance water security by shifting demand from already stressed aquifer locations to less resource-stressed areas. For this reason the DUWSP is designed to have strong synergies with the DFID-funded[7] integrated water resources management (IWRM) work under the Sudan Integrated Environment Project being implemented by UNEP.

In Nyala, Phase I of the DUWSP involves drilling six new boreholes in the Wadi Nyala aquifer to augment supply to the town's network. The wells will be connected to a collecting tank south of the wadi, transferring water to south Nyala through a booster station. A pipeline from this collecting tank will connect to the Mahjouk tank north of the wadi and then on to the main town system during Phase II. The cost of drilling each borehole is an estimated SDG35,800 ($14,000).

UNOPS will install the booster pumps and the transmission line connection from the Mahjouk collection tank via a booster to the main town system. Hourly yield from all six wells is an estimated 180m^3 (amounting to some 4,320m^3 per day). This is equivalent to roughly one-third of production by all existing UWA wells.

In anticipating the project's impact, DUWSP documentation states that availing extra water to households will significantly reduce the 'proportion of household income expended on water supplies, while simultaneously increasing the quantity of water available to poorer households'. To do this effectively, the project also envisages supporting the rehabilitation of defective supply infrastructure.

Overall the DUWSP is designed to achieve benefits for some 1.1 million people across Darfur 'in terms of resilience against possible drought, reduced household expenditure on expensive private water supplies, increased productivity and improved health incomes arising from more water for sanitation'. This will contribute to Millennium Development Goal 7 (specifically 7.8, the proportion of the population using an improved drinking water source). UKaid is providing £7m ($11m) in funding for the project.

Source: DFID (2010)

A note on constraints and limitations: The terms of reference for the study are comprehensive and wide-ranging. They include reference to encouraging demand-responsive approaches to improving supply delivery in Nyala. It was evident early on in responding to the terms of reference that the institutional and policy climate necessary for such an approach did not exist and that levels of demand were so great and the informal market so extensive that there was little space within which to engineer a stronger demand-responsive environment through the DUWSP.

In addition, the study was constrained by budgetary limitations that constricted the timescale and the extensiveness of our methodology; for example, we would have conducted additional key informant interviews for cross-referencing. In the future, a more detailed study could build on this work and more effectively map the ability to pay across household types.

[7] See UNEP (n.d.).

We would argue, therefore, that the figures presented in this study need to be treated as indicative and not fully representative. What the study lacked in sample size, however, was compensated for by the wide range of methodologies utilised.

Study details and methodology: The study draws on understandings of household water economy.[8] The methodology for the study combined a pre-visit literature review with 25 days of fieldwork, including two weeks in Nyala (20 April–4 May 2011). The fieldwork was carried out by a team of Sudanese professionals under the guidance of the team leader. One team member was seconded from UNEP Sudan and another from the Urban Water Administration, under the State Water Corporation (SWC). The overall approach followed a series of steps:

- a background review of the literature and question set was followed up in Khartoum with an initial research protocol shared with key team members and those acting in an external advisory capacity. This formed the basis for subsequent survey questions with households, in focus groups and at water points;
- meetings were held in Khartoum with academics, water sector professionals and consultants to complement the literature review and to receive up-to-date feedback on the DUWSP and wider water sector development. A kick-off meeting was held with DFID and UNOPS at DFID in Khartoum on 17 April 2011;
- the first fieldwork stage involved question set design as well as agreeing key focus groups, a shortlist of key informants and an overall timetable;
- our purpose and approach was then presented to a small stakeholder workshop at the Office for the Coordination of Humanitarian Assistance (OCHA) on 20 April 2011. Participants at the workshop included representatives from the Darfur Reconstruction and Development Fund Water Sector, the Urban Water Administration, the Network Extension Project Coordinator, the Sudanese Ministry of Education and UNEP; and
- initial piloting of the research approach took place on 21 April 2011.

Our purposive sampling frame was based on a subdivision of Nyala into five sectors based on the advice of the lead consultants (see Table 1).

[8] See, for example, Coulter and Calow (2011), Kibreab and Nicol (2002) and Nicol (2000; 2001).

Table 1: Characteristics and households sampled per sector

Sector	Characteristics	Number of households sampled
Northern	Most affected by water shortages, with many newcomers and one IDP camp (Otash)	30
Eastern	Regarded as poor and with many households unserved by the formal network (including Direij IDP camp), large numbers of livestock	20
Western	Anticipated higher-income households, more private well owners and one IDP camp (Alseraif), not receiving a regular water supply even though in closer proximity to the wadi aquifer	20
Southern	Relatively better off than other sectors in terms of water supply and with a high population of livestock	20
Central	Generally higher incomes and better water network supplies	10

Over a period of ten days the team visited 100 households (see table 2) This was not intended to be a representative sample of Nyala's estimated 7,000 households, but to provide an indicator of major household challenges involving availability, access and use of water. We triangulated the results from this survey as far as possible with focus group discussions and key informant interviews (see Table 5 and 6) The team also recorded specific case study interviews with households in Nyala and at one IDP camp.

In each sector a semi-random household selection took place with team members moving in different directions from a central point and interviewing households along these specific transects on the basis of availability and willingness to be interviewed.

Water point visits were based on purposive division of the town into six areas: Hai Elwadi East (5 points visited), Hai Elwadi West (10), South Nyala Sakali (5), Domaya (5), northern sector (5) and Mose (5). Out of a total of 32 kiosks, it was decided that ten would be covered.

Interviews were carried out with 78 vendors at water points. Fieldwork was then carried out in two blocks over a period of 11 days, comprising:

Focus group with team members, Nyala, May 2011. © Alan Nicol, IDS

- interviews with 100 households (20 more than originally envisaged);
- interviews with some 30 key informants (see Table 6 in the Annex);
- 15 focus group discussions (see Table 7 in the Annex);
- secondary data collection at the main teaching hospital, the Ministry of Social Affairs, the Groundwater and Wadis Directorate (GWWD) and other institutions.

At the end of the fieldwork, the team carried out an initial analysis of the results, which it presented to a meeting of 30 stakeholders in Nyala on 3 May 2011 and to the Water and Environmental

Sanitation Programme (WES) coordinating group in Khartoum the following day.[9] The names of all interviewees have been changed.

Table 2: Research schedule

Timetable	Households	Focus groups	Water points	Key informants
Friday, 22 April 2011	20 (northern)	1 (dairy farmers)	6 Hai Elwadi / Sherek	
Saturday, 23 April 2011	15 (central)	1 (vegetable sellers)	8 (Domaya/Sereif)	Legislative Council
Sunday, 24 April 2011	25 (eastern)	3 (youths, Legislative Council, vendors)	10 (Jebel, Sharq, Elfania)	GWWD, WES, SWC, Baggara Basin project drillers
Monday, 25 April 2011	20 (western)	4 (Artisans Union, Farmers Union, Trade Union, Sudanese Environment Conservation Society)	8 (northern)	WES water quality department
Tuesday, 26 April 2011	0	1 (Women's Union)	0	Hospital
Wednesday, 27 April 2011	20 (5 western, 15 southern)	1 (community based organisations)	6 kiosks, 6 handpumps	UWA Transitional Darfur Regional Authority, Social Affairs, field visit (Kondowa)
Thursday, 28 April 2011	6 case studies	0	GPS mapping of water points	Municipality, WES
Friday, 29 April 2011	Analysis	Analysis 1 (wadi engineers)	Analysis	Analysis
Saturday, 30 April 2011	6 case studies (IDPs)	1	0	0
Sunday, 1 May 2011		1 (WES, NGOs)		
Monday, 2 May 2011	Preparation	Preparation	32 boreholes; 6 kiosks; 6 handpumps	Preparation
Tuesday, 3 May 2011	Nyala stakeholder feedback meeting, WES conference room, 11:30–13:30			

[9] The Nyala meeting was attended by 10 NGO representatives, 8 from the government, 2 from academia, 3 from the private sector and 8 from other agencies, including the UN.

2 Background to water availability, access and use

2.1 The historical setting

Nyala's location and development is largely the result of the presence of an accessible, perennial water source provided by the Wadi Nyala alluvial aquifer (see Map 1 in the Annex). Even during the dry season, this resource provides water at relatively shallow depths of 6–20 metres. Prior to the 1950s the main constraints to expansion were remoteness and lack of transport linkages to the rapidly growing central region. The arrival of rail passenger and goods services in the 1950s rapidly connected Nyala to central Sudan, increasing commercial activity (and population growth) in and around the town (Buchanan-Smith and McElhinney, 2011). Demand for water supply increased, and public boreholes increased in number from two in the 1950s to seven in the 1960s and 14 by the 1970s, when a town public water supply network was established to service most domestic and industrial demand (see Box 2).

However, the public system was rapidly overwhelmed as the population continued to expand after a series of external drought shocks in the 1970s and mid-1980s, forcing many rural households to abandon farming and move to urban and peri-urban areas in search of alternative livelihoods in the wage-labour economy. Since conflict erupted in the early 2000s a further wave of in-migration has taken place, augmenting demand for domestic water—and for other resources that place a demand on the resource, including local vegetable production and brickmaking (see Box 13). Nyala now comprises some 36 planned neighbourhoods[10] and around 96,000 plots, many of which are not serviced by the public network. According to the Government of Sudan (GoS), about 69% of the population lives in these planned neighbourhoods, 29% in squatter settlements and 2% in villages that are 'functionally related' to the city (GoS, 2009).

Box 2: Historical precedents

In 1973 Public Works operated five pumped wells that delivered 2,000m^3 throughout the year. There were also a reported 152 'garden wells' with an estimated maximum daily abstraction of 4.6 million gallons, used both to irrigate vegetable gardens and to supply much of the town with domestic water. About 40 hand-dug wells in the wadi bed had low abstraction rates of about 5m^3 day. By the end of the dry season many of the 'garden wells' were drying up and town wells showed reduced yields; for several hours per day, no water was available. The situation had reportedly begun to deteriorate in the late 1960s. Total estimated abstraction from the wadi in 1973 was 4.35 million m^3, comprising 700,000m^3 from town wells, 3.6 million m^3 from garden wells and 50,000 m^3 from 'stock wells'.

Source: HTS (1973)

The unifying feature of this population–resource landscape is that the vended water market reaches all corners thanks to the ready availability of donkey-drawn transport. During rapid population expansion the informal market has traditionally helped to bridge the gap between excess demand and supply. This capacity has existed since at least the 1970s, when future water availability began to be recognised as a critical constraint on Nyala as a market for irrigated crops and as a site for agro-processing industries (HTS, 1973). At that time, curtailment of the network supply towards the end of the dry season was already in place, accompanied by a visible street water vending community. Daily consumption in the early 1970s was estimated at about 500 litres per household, which was regarded as high and suggestive of considerable use in gardens or as high wastage from the system. Based on this

[10] Neighbourhoods are classified as A, B and C based on criteria including date of development, settlement, land value, type and quality of buildings, income levels and wealth (GoS, 2009).

analysis, average daily consumption per household (across a high range) is around 300 litres, which represents a substantial decline in consumption.

Projection of the future population in Nyala is one of the most pressing planning challenges. As Buchanan-Smith and McElhinney (2011) and others note, there is no overall consensus on the size of the current population, or on its future trajectory. In such an environment, planning for future demand is risky.

2.2 The physical setting

Nyala's physical setting is one of the chief reasons for its location. The town lies downstream of two major tributaries on the wadi, the Domaya and Kabris; where they meet, the wadi leaves the basement complex and spills out onto the flood plain. This is where the sponge of the alluvial aquifer is at its most productive, drawing humans and their livestock to the relatively abundant resource (see Figure 3). To the north lies the basement complex and to the south the Baggara Basin. While it yields more output, extraction from the Basin is more costly. In general, the thickness of the Wadi Nyala aquifer is 0–20m; in the Baggara Basin the thickness varies from a few metres at the margin to over 500m at the centre.

Wadi Nyala receives annual runoff of about 75 million m^3 each year during the rainy season, which usually falls between June and November. Some runoff is received from the Jebel Marra massif about 90km to the northwest, where rainfall is more reliable, even in drought years. According to GoS (2009), annual rainfall in Nyala declined from an average of 650mm in 1921–62 to 377mm in 1965–92 (with just half that amount in the 1984 drought year). The average rose slightly, to 404mm, in 1993–2007. The Jebel Marra system maintains flow rates even in very dry years and is probably the chief reason for continuous settlement in and around the Wadi Nyala. Most runoff falls during the rainy season, when, at its peak, rapid surface flow recharges the unconsolidated alluvial aquifer by some 3–4m per day, according to some sources.[11] For the human and animal population it is also a time of hazard, however, and flash flooding regularly claims lives in the wadi.

Borehole rehabilitation by the SWC in Wadi Nyala, May 2011. © Alan Nicol, IDS

The wadi's shallow aquifer is bounded by a trough of weathered basement complex metamorphic rocks, which act as the 'basin' in which water accumulates (HTS, 1973). Normally, the water table drops from a peak in November until March–April, when there is a rapid decline in well yield and some public and private wells dry up. The causes of the drop are rapid abstraction, direct evaporation and evapotranspiration via vegetation.

There is evidence of earlier depletion of the aquifer each year, particularly in its upper and mid-sections. In lower sections the relationships to static water levels and demand are more complex and require further hydrogeological analysis. One thesis is that the behaviour of this lower aquifer—around Kondowa—is related to the presence (or lack) of large forest cover. For the DUWSP this relationship is important because the Kondowa section will deliver water to the six new boreholes. Further details on resource behaviour is provided in Section 3.1.

[11] Author communication with a GWWD official, May 2011.

Most wells in the wadi are dug using centrifugal pumps. These are expensive (due to fuel demand) and fail when there is a lack of power. Wells are commonly brick-lined and can be deepened when required. Overall, from Domaya in the north to Kondowa in the south, there are an estimated 300–400 wells and boreholes, though a definitive figure remains elusive, and this uncertainty is a major challenge for future regulation and governance of the resource. A chief reason for this lack of clarity is that nearly all the privately owned wells are on private land and have yet to be fully surveyed.

Irrigated farm near the Wadi Nyala, in Mose. © Alan Nicol, IDS

2.3 Social, institutional and policy processes

Nyala was formerly Sudan's second industrial city. Conflict and the limitations on water availability are severe impediments to commercial activity, particularly in the town's important processing industries. In spite of the presence of a large aid community and the African Union/United Nations Hybrid operation in Darfur (UNAMID)—and the associated demand for goods and services)—few industrial activities are expanding.

Nyala's population rose from 95,600 in 1973 to 113,623 in 1983, reaching 400,000 in 1998. In the past ten years the population doubled; according to the municipality, it now exceeds one million, about 250,000 of whom are IDPs.[12] There are some 90,000 households, about 10% of which are classified as poor.[13] The age structure is highly youthful. Future employment will be dependent on the growth of industrial activities, rather than agriculture, given limitations on water for irrigation and continued insecurity in rain-fed areas.

At present, many livelihood occupations in Nyala—and Darfur more widely—remain seasonal, including farm labouring, brickmaking, and trade in goods and services (particularly transport). Much of this employment is wage labour and insecure, leaving livelihoods precarious and households often dependent on multiple occupations. A stronger, more regulated resource base that enables reliable supplies of water to households and commercial businesses could be an important factor in fostering and sustaining greater economic activity in Nyala.

The institutional environment for policy development and implementation is complex. At the national level, the Ministry of Irrigation and Water Resources (MIWR) is the overall umbrella for the water sector (with the exception of the Dams Implementation Unit, which comes under the Ministry of Electricity and Dams). The Public Water Corporation (PWC) and the Rural Water and Urban Water Administrations both come under the MIWR. The PWC is responsible for design standards and plays a coordinating role between donors and agencies, but it does not implement directly, except at the state level. In Nyala it plays a key role in implementing the Baggara Basin project (see below).

[12] Author communication with Nyala Municipality, May 2011.

[13] Author communication with a Zakat Chamber official, April 2011. The national poverty line in Sudan is SDG114 ($45) per person per month.

At the state level, some federal institutions, including the GWWD, deal directly with resource assessment and management but have no direct relationship to either the SWC or the MIWR at the state level (see Figure 1). During this study we found that important monitoring data appears not to have been utilised effectively, potentially hampering future decision-making on resource development. The GWWD office in Nyala collects information on the key wadi aquifer through a series of monitoring sites, but it has not examined this data in detail or shared results with the SWC. This is an important area for future strengthening.

The key implementation organ is the Urban Water Administration, one of two branches under the SWC (see Figure 1). In conjunction with the municipality, the SWC has the power to shut down wells in Nyala; in the last year, it has shut down wells for farm irrigation in Kondowa wherever these interfered with public water production through boreholes. The role of the UWA is to manage, develop and regulate the town's water supply. The UWA's board of directors includes two people from the municipality, one of whom is at the level of vice president. The municipality licences the drilling of new boreholes.

At the political level, the Legislative Council (LC) plays an overall budget review role. With 48 members representing all of South Darfur state (from three major parties), the LC has expressed some concern about the nature of the institutions that manage and supply water in Nyala. As an overseer of these authorities and legislation, the LC has a political mandate to balance social interests with executive capacity to deliver services. In recent years it has been instrumental in keeping tariffs down (against the wishes of the UWA). The Council's specialised committee on water and water development takes the lead role and is 'overwhelmed', it says, by requests for political-level intervention to improve access to the resource. At the same time, members were clearly concerned about their lack of direct engagement in federally driven projects, including the Baggara Basin pipeline development. Improving this governance arrangement and strengthening communication between the political, executive, and social and economic institutions involved in managing and using the resource would be an important future step.

Approaching a borehole near a temporary settlement, Hai Elwadi, May 2011. © Alan Nicol, IDS

A number of donor and agency initiatives are ongoing, including the UKaid-funded work under the UNEP Sudan Integrated Environment Programme to increase the uptake of IWRM in resource management and implementation across Darfur. Urban water management has been highlighted by project stakeholders as a key theme of IWRM implementation in Darfur.

Other key sector relationships include water networks such as the WES project, created in 1996 and led by UNICEF. WES coordinates different agencies working on water supply in Darfur and manages a database of key sector information, including water point availability and access and water quality monitoring at some sites. In Nyala, WES is in charge of IDP water supply development and installs handpumps in Nyala town, where there is currently high demand but low public network supply. The challenge is looking ahead to future demand projection within and in response to the IDP community (see Boxes 6 and 12 for examples). Their resource base is commonly the basement aquifer, which is under enormous stress due to overabstraction (see Figure 3). Future financing of access to groundwater at greater depth will require more financial input by the user community. This is a major social and institutional challenge on the horizon.

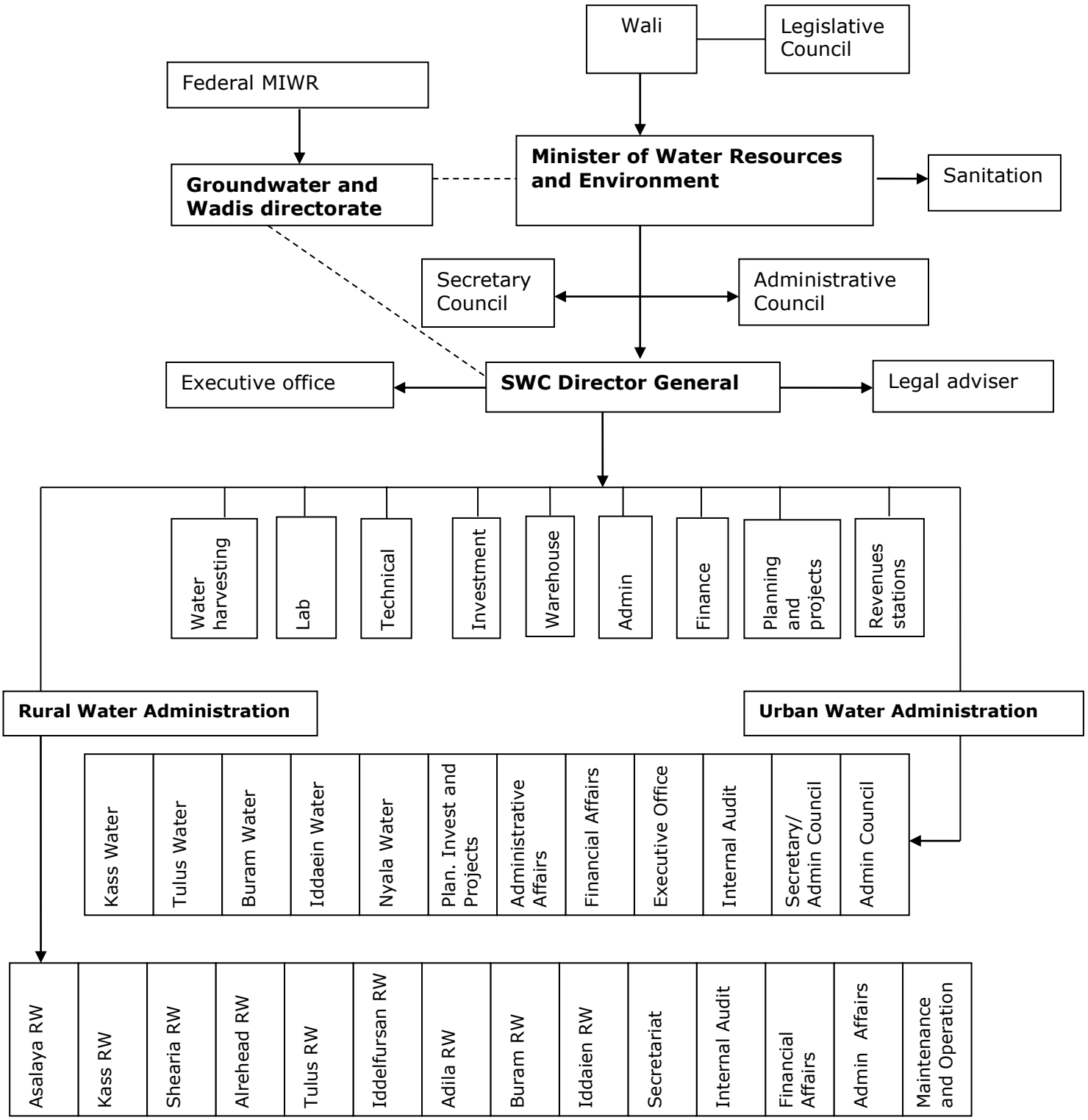
A motorised pump and borewell, Wadi Nyala. © Alan Nicol, IDS

In the future, the chief social and institutional challenge will be to establish a financial model that enables operation and maintenance of the public system at a level that provides affordable water for all users in the long term. The existing tax base of the state government is low even though taxation of businesses and individuals is high, according to focus groups and key informants. This suggests that future financing will be largely, if not wholly, derived from user fees, as there is no guarantee, for instance, of future public financing from the federal government via the Darfur Development Fund. The reality of budget shortfalls between planned and actual expenditure by the central government is spelt out in Buchanan-Smith and McElhinney (2011). Given the poor service level in Nyala, most people (who can afford it) opt out altogether and spend more to receive a more reliable, but informal, supply.

Figure 1 illustrates the state-level institutional structure under the Ministry of Water Resources and the Environment, which is responsible for developing policy and overseeing sector development. Under the minister is a board of directors that oversees the State Water Corporation, which is subdivided into Urban and Rural Water Administrations. Each major urban centre has its own water department branch office. The Rural Water Administration has a number of sub-divisions, including the Nyala Water Maintenance Centre. Most of the work of the Rural Water Administration is part of the government- and UNICEF-supported WES project, which provides an overall coordinating umbrella for the many NGOs working in the sector (most of which focus on emergency water supply in camps). The Rural Water Administration is also responsible for the 400 or so water yards in South Darfur. Each one of the 30 localities in the state has a water commissioner and an engineer

A main UWA pump station, Nyala. © Alan Nicol, IDS

Figure 1: Institutional structure of the state water sector



2.4 Structural pressures and responses

The supply: The SWC estimates that Nyala needs around 100,000m^3 of water per day to match current demand. During the rainy season the wadi aquifer supplies about half this amount from 23 boreholes in or adjacent to the wadi.[14] However, in the dry summer months, all sources supply no more than 25,000m^3 per day, meaning that there is a major demand–supply gap, particularly from April to June.

DFID project documentation, based on a water demand of 560 litres per household per day, states that total demand for 13,000 household connections is an estimated 7,280m^3 per day. Total available water produced by the UWA is 7,000–8,000m^3 in the dry season, rising to about 18,000m^3 in the rainy season.

In May 2011 the production of water was 12,000 m^3 per day and was predicted to fall as supplies dwindled. Given that the system probably delivers less than 70% of this amount (the UWA estimates leakage loss of about 30%), however, actual supply is likely to be far lower. Storage capacity in the system is also low, representing only one-fifth of daily output, which exacerbates the challenges of supply interruptions and leakages during the day and overnight. It also means that pumps have to work for 24 hours to maintain supplies at critical times, which can cause localised or even general depletion of the wadi aquifer (see Figure 3).

Unregulated pumping from the many private boreholes or 'garden wells' adjacent to the wadi produces an estimated 8,500m^3 per day, reports the UWA. There are an estimated 130 registered and 170 unregistered such wells, regarded as the chief reason for supply shortfalls in Kondowa, which is a productive area providing some 6,000m^3 per day. The UWA now only receives some 30% of production from these boreholes, which are in competition with about 20 private wells, many sited less than 200m from UWA boreholes, according to UWA officials. The challenge between public and private access to the resource is therefore intense, not only at local levels, but also more generally. Stronger regulation and control is a management imperative.

The household squeeze: Water is both expensive and scarce during the dry season in Nyala. More than half of households are classed as vulnerable (according to the Ministry of Social Affairs)[15] and survive on SDG3–4 ($1.20–1.60) per day. These poor households probably have to spend at least SDG1 ($0.40) per day to access domestic water, entailing at least one-quarter of their disposable income. Accessing this water can be time-consuming, with householders spending hours in queues, filling up, or seeking water vendors (for example, see Box 7).

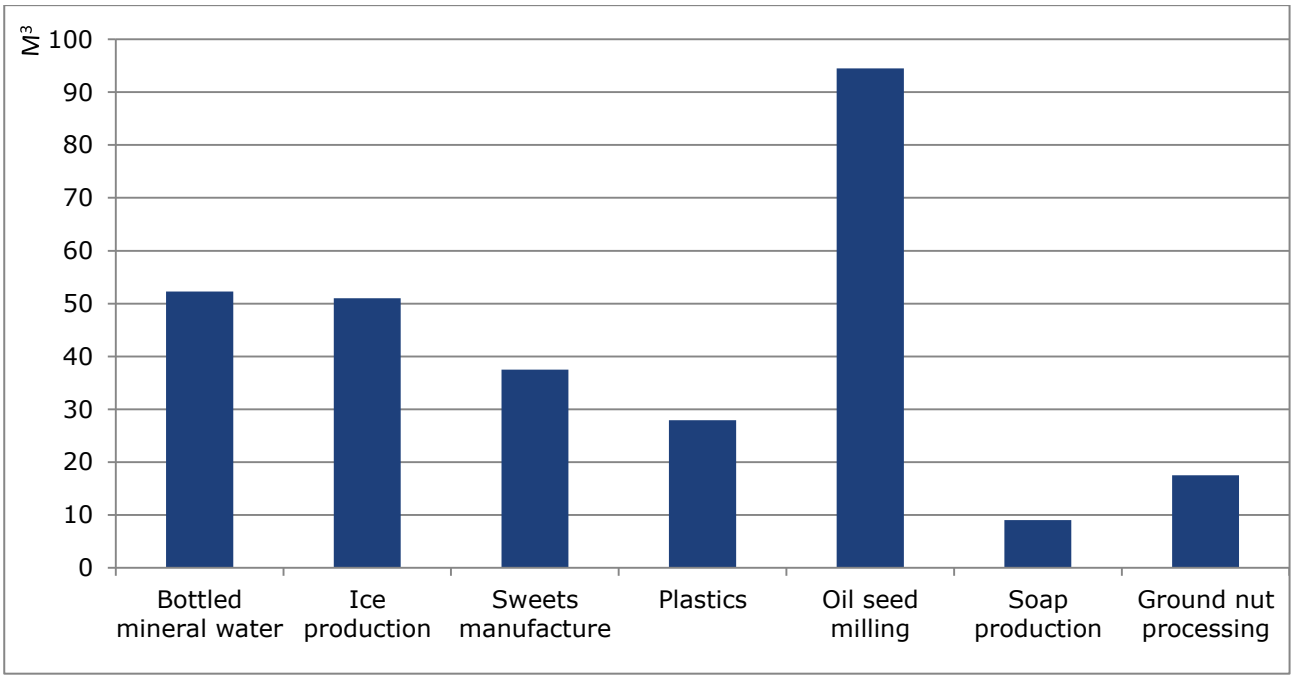
Households that are able to connect directly to the system have a theoretical threshold of 15m^3 per household per month (500 litres per household per day). Once they exceed that amount, they pay an additional SDG2 ($0.80) for every m^3 (up to 30m^3 when a commercial rate is applied). The initial tariff structure is set according to the pipe diameter: SDG30 ($12) per month for a one-inch pipe; SDG25 ($10) for a ¾-inch pipe; and SDG21 ($8) for a half-inch pipe. Those able to pay these fees for a connection pay substantially less for a far greater supply of water (if it is available), but the reality is that many households with piped connections do not receive water through the system, or only at such a low volume and erratically that filling up is a very lengthy task. The monthly expenditure for service to a household can therefore represent a considerable financial risk to poorer households. Many opt out of seeking connections as a result.

[14] Each borehole yields about 25m^3 per hour and operates almost continuously.
[15] Author communication with the Ministry of Social Affairs, May 2011.

Even during the rainy season some households reported having to collect tap water 'drop by drop' during the night. The resulting squeeze on time means that most households still require vended water. During the Women's Union focus group discussion, only five out of 30 interviewees said they did not purchase from a water vendor. Those who did paid SDG5 ($2) for a barrel of water in the rainy season and SDG7 (nearly $3) in the dry season, with the price varying notably by district—SDG8 (more than $3) in the north of Nyala in the dry season, but only SDG4–5 ($1.60–2.00) in the south. Household location therefore has additional impacts on disposable income. According to this focus group, the average Nyala household spent about SDG210 ($83) per month on water over the year (see Table 8 in the Annex). This represents a significant squeeze on the household budget, affecting available income for education, health and food security.

The industrial challenges: The second major source of pressure on the resource is competition with agricultural and industrial use. Figure 2 presents selected water demand by industrial unit (per ten-hour shift). It indicates a large bottled water industry, which uses water straight from the wadi (after it has been processed in several purification systems).

Figure 2: Selected water demand by industrial unit, per 10-hour shift, Nyala factories



Source: author communication with the Artisans Union, May 2010

As revealed during discussions with the Artisans Union, which represents small-scale industry in Nyala, most small industry uses vended water rather than the public network due to supply interruptions and unreliability. Having failed to receive reliable supplies from the network, factories tend to cut their connections to the UWA and return their meters. An artisanal metalworking workshop that produces basic manufactures consumes about 3–4 barrels per day at a cost of SDG15–20 ($6–8). Most of the larger factories purchase water that is delivered by tanker,[16] not donkey carts, with a capacity of 35 barrels at a cost of SDG80–100 ($32–40).

[16] Water from large tankers is commonly SDG4 ($1.60) per barrel, as opposed to SDG6.5 ($2.60) from vendors.

According to members of the Artisans Union, from February to June the search for adequate water supplies has a significant impact on the activities of small businesses (see Box 3). A future move to the newly planned industrial area in the north of Nyala was welcomed by the Union, but concerns were also raised about access to water in this area (and its higher cost). Union members had a delicate trade-off to negotiate between lower rents for larger spaces in the new area, but potentially higher water costs. Delivery of public network water to this area should be a social and economic priority, given the important employment function such small businesses will provide.

Overall, the demand for labour in the industrial sector has shrunk significantly since the onset of the Darfur conflict. There are only 400 employees now, compared to some 5,000 when industrial production was at its peak prior to the conflict, according to the Artisans Union. Wages for factory work, per shift, vary between SDG7 and SDG30 ($3–12), depending on the skills required.

Box 3: An ice maker

My name is Waleed. I work for an ice-making factory in Nyala. Although our factory is connected to the network—we pay SDG500 [$200] per month—we don't receive water in the dry season. We only receive water for about 4–5 months. Otherwise we use a large tanker that brings water from private wells in the wadi. One tanker has the capacity of 50 oil drums [each of which is 44 imperial gallons]. This costs is about SDG250 [$100]. Some 80 drums of water makes about 200 ice blocks, which we sell for SDG6 [$2.40] each. These are then sold on to consumers in the market for SDG10 [$4] per block.

Agricultural pressures: Agricultural use is mainly from dug wells in the wadi aquifer. The Farmers Union estimates that some 80% of the population in Nyala is engaged in farming, directly or indirectly. Much of this production is for consumption by the town inhabitants (see Box 4). The Farmers Union helps to support farmers in accessing loans from the agricultural bank, which provides tractors and pumps directly with instalments that are repayable over 3-5 years (or provides loans and takes a portion of the crop as repayment).

Box 4: Vegetable sellers in Nyala souk

The Vegetable Sellers Union represents vegetable sellers; its members reported a difficult relationship with local authorities. They pay many taxes, they say, from a trade licence 'pro forma' that costs SDG26 ($10) per year and a 'final' trade licence—which costs SDG65 ($26) per year—to garbage collecting fees of SDG26 ($10) per month. If they own a shop, rent is SDG26 ($10) per month. They also need a health card (SDG12, or $5, per month), a medical examination of the seller (SDG15, or $6, per month) and a work ID card (SDG13, or $5, per month). In total, they pay about SDG100 ($40) per month.

Since the Darfur conflict, the quantity of vegetables received from producers has declined, largely because many producers became IDPs. Before the crisis it was easy to get vegetables and at a good price, they argue. Some of the sellers were producers themselves but left the job because of the increase in the costs of fuel, water, seeds and transportation.

Today vegetable sellers face marketing problems. Demand has decreased because of price increases and limitations on household incomes and, in other states and localities, security issues. Customers, they argue, now mainly buy staples such as potatoes, tomatoes and onions. One box of tomatoes could take three days to sell, they report. In general, they can make about SDG50 ($20) per day, at best. This is insufficient to maintain a family and they say they lose about half their produce due to the absence of cold storage.

Any increase in water costs affects vegetable sellers since producers will increase the price of their goods and pass the increase on to consumers. This, in turn, decreases vegetable demand in the market and results in lower income (and more perishing of goods). Vegetable sellers buy

water from vendors and pay SDG10–15 ($4–6) per day for drinking water and other needs. This cost is high compared to the cost of other family needs, causing them to cut other expenditures in order to provide enough water. In the market there is no tap to provide water for vegetable sellers, so they buy water to clean their vegetables and shops. This is an additional cost.

The population of Nyala is dependent on fruit and vegetables grown in and around the wadi (particularly as a result of security restrictions during the conflict). Demand for these products therefore increases pressure on water and other resources.

Most irrigation uses the traditional furrow method with the application of water during the daytime, leading to inefficiencies and high evaporation losses.

Agriculture remains a profitable occupation (particularly for basic foodstuffs) which is driving increasing numbers to seek land at or beyond the periphery of the town. Members of the Farmers Union underscored the trade-offs between land and water availability on the one hand, and the capacity to safeguard assets in these areas, particularly pumps and other machinery, on the other. While profitability could be significant, there were also important risks involved.

Future issues regarding the production and marketing of crops include South Darfur becoming a potential supplier of food crops to newly independent South Sudan. Other important products, such as honey, already have markets in Bahr al-Ghazal, just south of the state. Developing the sector to supply such markets is an important role of the Farmers Union. Constraints include the costs of fuel to pump water out of the wadi aquifer, with fuel costs varying widely—from SDG10 to SDG20 ($4–8) per gallon—if tankers are disrupted on supply routes from Khartoum.

Dairy farming without pastures, near Mose, Nyala. © Alan Nicol, IDS

There is also a strong relationship between IDPs and farming (as consumers and producers of farm products). Significant agricultural activities surround IDP camps, most notably Kalma camp, close to which IDPs have established small farms and thatching businesses. Stresses on the resource base in this area, as mentioned above, are growing (see Box 5).

Livestock watering is less of an issue now than in the past, when Nyala was a major livestock slaughtering location and had far higher livestock densities. At that time there was a lucrative market in frozen meat that was exported directly to the Gulf countries. A growing dairy farming community on the outskirts of Nyala is using zero-grazing techniques to rear Friesian–local crossbreed cattle. These can produce some ten litres per animal per day (a relatively low yield), one constraint on which is water availability.

Dairy farmers explained that more water would reduce the costs of inputs for farmers and would also enable them to grow more fodder, including alfalfa. Some 30 individuals are members of the Dairy Famers Association, which is dominated by more well-off and commercially oriented farmers.

A single cow costs SDG7,000 ($2,800); while a cow can produce milk for up to eight years, it consumes some 125 litres of water per day. According to market rates, this would cost some SDG3 ($1.20) per day. Based on the volume of milk produced and the wholesale price, each cow can produce a profit of some SDG10 ($4) per day.

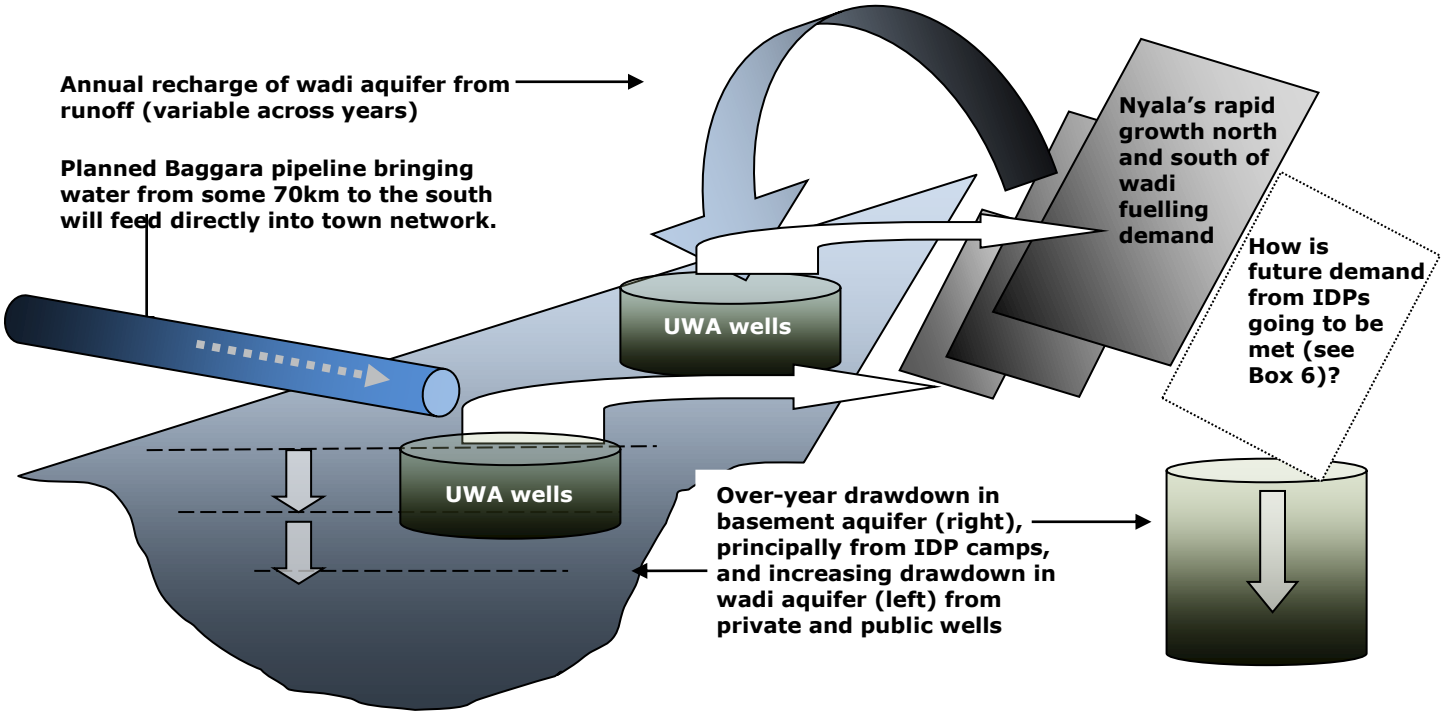
Box 5: Rapid environmental change in Kondowa forest

In the past, Kondowa forest was made up of valuable hardwoods and at its maximum, it covered some 21,000 *feddans*. It was a solid feature of the town from the 1960s. Yet between 2007 and 2008 the forest was almost completely cleared. The establishment of neighbouring Kalma IDP camp in 2004–05 is commonly cited as the key reason for this, although some describe the destruction as more 'organised' and taking place over a period of about two years.

After the land had been cleared it was distributed to farmers and the National Forest Corporation (the land owner) encouraged IDPs to plant trees, providing individuals with leaseholds of 2–5 years. Instead, and in response to market demand, most farmers used the land and water available (Kondowa being the most productive part of the wadi aquifer) to produce vegetables, as well as *berseem* (livestock fodder), onions and tomatoes, for which there is significant demand in Nyala. Many new wells have been drilled in the area, including around 40 private wells and eight UWA boreholes, with which the wells are in competition. The farmers—who usually farm plots of some 1–2 *feddans*—use electrical submersible pumps to a depth of about 7m. Land prices in Kondowa have risen steeply and it is estimated that there are now some 10,000 *feddans* under irrigation.

There are some indications that the major change in land use in this area is now beginning to affect this key part of the wadi aquifer. The volume of the Kondowa section of the wadi aquifer was an estimated 50,750 mm^3 in the 1970s (HTS, 1973). This area was reported to have relatively high evapotranspiration in the past because of the vegetation density, the volume of which was estimated to be equivalent to twice the total volume in storage at the end of the dry season (about 3.95mm^3) (HTS, 1973). At that time the need for a control system of irrigation abstraction was emphasised. While there are signs that significant 'cones of depression' are forming around some of the farm wells, this report discusses broader evidence that the extent of the aquifer as a whole may be increasing as a result of reduced evapotranspiration loss after the reduction in forest cover. A better understanding of aquifer behaviour in this important area is required.

Figure 3: Schematic of pressures on water resources around Wadi Nyala



Institutional responses: Nyala's water supply challenges have been the subject of study and review since the 1990s. The supply options presented have included augmenting water in the wadi, supplying water directly from Jebel Marra, or building a connection to the Baggara Basin to the south. The preferred option was to build a network extension in the town and feed this through the construction of a pipeline from the Baggara Basin some 70km south of the town. This pipeline would supply an additional 317km of new pipes in Nyala, extending the network three-fold, and would deliver an additional 40,000m^3 of water per day. In theory this would be sufficient to serve up to 800,000 individuals, based on assumed average daily consumption of 35 litres per consumer per day.

To cover the whole town, a total of 525km of pipes are required. About 60km had been laid at the time of the team's visit and, according to officials, completion was expected in 2013. The project also augments storage capacity, with two new storage tanks of 4,000m^3 and 5,000m^3. In the Baggara Basin, 20 deep boreholes will each provide 300m^3 per day. Of the 85km pipeline to Nyala, 13km have been completed. The network project is being led by a federal agency set up for the purpose under the Transitional Darfur Regional Authority (TDRA) and is being implemented by NAPTA, a Khartoum-based company. Study and financing has come from the federal level.

The TDRA is an implementing agency of the Darfur Rehabilitation and Development Fund. Delays in implementation by a Chinese contracting company[17] have already been caused by insecurity (as well as by a political decision to change the initial project design and location of the well fields).

[17] The contractor is the China National Machinery and Equipment Import and Export Corporation, or CMEC.

Network expansion underway in Nyala. © Alan Nicol, IDS

The project was restarted in early 2011 although the original contract was for three years from 2008. These delays have produced substantial (and raised) public expectations regarding the project and the benefits it will bring. One of the chief challenges is that only one of 20 wells has so far been drilled in the Baggara Basin—and eventual yield has yet to be determined. Each well will have to provide a yield of 85m^3 per hour to almost double network capacity during the dry season. The eventual cost of this water (in contrast to cheaper options from water vendors) is one of the key questions hanging over the project.

The federal government is providing SDG55.37m (nearly $22m) for the TDRA project, in which the SWC is working as a sub-contractor to the Chinese contracting company. So far, the SWC has only drilled one test borehole in Gereda. The depth to the basement is 210m, but this is to the northern boundary of the Baggara Basin, where the water table is some 59m from ground level. Testing using a 77m^3/hour pump showed the dynamic water level at 62m—that is, a drop of only 3m—which is a good indication for high yield. After delivery to the surface, water is pumped 85km via three booster stations (at 26, 44 and 72km). Each booster has two generators of 750KW and anticipated total energy demand is the equivalent of about 200 barrels of oil per day for generation, which will be the chief determinant of volumetric water cost from the system.

Although there are questions regarding the economic viability of the project, given its importance and profile, members of the services committee at the Legislative Council underscored their willingness to produce legislation that would guarantee continuity of the Baggara Basin project after execution. This will be a critical test of future changes in Nyala's water governance environment. A key issue will be tariff levels after completion of the project. The administrative council of the SWC sets tariffs, but these have to be passed by the Legislative Council. The politicians are not in favour of tariff increases.

In addition to the Baggara Basin project, other options considered to augment supplies in the wadi aquifer itself include a sub-surface dam in the lower part of the Wadi Nyala to capture seasonal groundwater flow. A surface dam upstream at Ramalia is another option and would provide a strategic reserve with which to recharge the wadi aquifer, capturing water at the tail end of the rainy season in September, thereby reducing siltation and negative impact on downstream flows.

Box 6: Focus group with IDP camp sheikhs

This IDP camp has about 70,000 people (approximately 15,000 households). Most provide domestic labour or are workers in Nyala. Only about 5% are estimated to be involved in water vending. In the camp WES has installed submersible pumps in boreholes and handpumps. There are 11 submersible pumps working at depths of around 40m. Most people get their domestic water from the tap stands, which are fed by tanks from these boreholes.

The sheikhs of the camp state that there is insufficient water for current needs and that availability varies greatly between the dry and rainy season. Each sheikh has a sector (ten in total) and each sector has a water committee. A female water point guard is appointed in each sector and collects fees of SDG2 ($0.80) per month for water; the number of jerrycans each family can fill up is regulated by the size of the household. A larger family (with more than ten individuals) can fill up to nine jerrycans, a smaller household up to six. Both can only access water every other day so as to reduce demand and pressure on the aquifer. Water vendors also operate in the camp. On average, families buy four jerrycans from vendors in addition to the existing supply; these cost SDG0.50–1.00 ($0.20–0.40) per jerrycan in June 2010. In April 2011 the cost was SDG0.75 ($0.30). There is no charge for animals consuming water at waterpoints.

Box 7: Focus group with youths from northern Nyala (Hai Almsanee)

This meeting was conducted with young people and focused on their development and their perceptions of the water supply in Nyala. A young teacher started by stating that 'there is no water in Nyala, so the government has to move people or find a source of water even if it is far'. Another pointed out the difficulty in buying water. Piped water supply to his area had been cut for 4–5 months, he said, and when it came back it took a long time to fill one barrel. Another youth complained that sometimes water vendors brought salty water and that piped water arrived just four times per month, and with just enough flow to fill three or four barrels. The same youth added that the most difficult time of the year was from March to July. Another young man stated that there were 42 wells in the city, of which only 26 were working. Consumption of water was very high, he said, and water from vendors expensive (at SDG0.50–SDG0.70, or $0.20–0.30, for a pair of jerrycans, or 'joze'). Water from handpumps (from the basement aquifer) is salty and cannot solve the problem, he argued.

Another youth said that pumps were important despite the salty water because they provide water for other usage, including washing, bathing and cooking. Even during the rainy season, he continued, water from pipes arrived only three times per week and the pressure was weak. As an alternative, it could take three to four hours to bring water from the handpump. He suggested that more pumps must be constructed to reduce queues. He also emphasised that it was important to know who the poorest were and to find ways of relieving them of the cost of having to join the water network. Someone else responded that even those who joined the network suffered because water could come only late in the evening and very slowly. According to one person, joining the network in northern Nyala is extremely expensive, costing about SDG1,000 ($400), which puts joining far beyond the reach of most poor households. The distance from the wadi (and the main network) is the problem. As a result, vendors tend to bring them the poorest quality water, which has a bad 'smell and colour', respondents claimed. Four members of the group used to work as vendors themselves during school vacations (when they were at primary school). They sold water for SDG0.50 ($0.20) for a 'joze'. Asked about their families' access to water, most said the cost of a connection was SDG26 ($10) per month. For families buying from vendors, the cost varies between SDG4 and SDG12 ($1.60–4.75) per day. The Baggara Basin project has been known about for some three or four years, but focus group members had not heard of the town network expansion as part of the project. They stated that water consumption was directly related to the level of income. Although large tankers providing water are cheaper than donkey- and horse-drawn water carts, they only come once a week. Many households are paying a monthly fee for a connection although they receive little or no water. There is some rainwater collection, particularly for use in construction.

Of the individuals interviewed, three were employed and seven were in school. Work varied, from renting out 'Playstation' at SDG1 ($0.40) per hour, to electrical repair, satellite dish installation, building work and photography. For many, there was a desire to start a business, but a lack of credit. Most wanted to move abroad for work.

3 Water point and survey results

3.1 Water point analysis

Nyala has a range of water point types (see Table 3). These respond to different needs and access issues described in preceding sections. Central to the range of uses is the 'public–private' competition for access to the wadi aquifer. During fieldwork, a total of 32 water wells were visited and interviews were conducted with either the well manager or owner at eight locations.[18]

Table 3: Types of water supply in Nyala

Supply type	Number	Key characteristics/source
Wadi wells / hand-dug wells (private)	>300 During the 2008 cholera outbreak, there were an estimated 200 hand-dug wells.	Supply water to vendors Problems of water quality / WES (UNICEF estimate)
Boreholes (public)	29 (24 working) GoS (2009) reports that 22 are functioning; other sources suggest there are as many as 34.	With cumulative production of some 10,000–20,000m3/day
Kiosks	32	SWC
Handpumps	243 Other sources estimate around 100, of which 30% are functioning.	WES

Wells and boreholes: Our survey shows that most wells in the town were constructed after the onset of the Darfur crisis in 2003, in response to increased pressure for access to water as displaced people converged on the town. Most such wells (69%) were 'hand dug' by local contractors. The remainder are bore wells drilled under the WES project. Hand-dug wells are located mainly in the wadi. From these wells, demand for water came from farming, brickmaking and households. Just over half the wells (56%) were operated for four to six hours per day and the same number had worked throughout the last six months.

Average well production varied widely. Some 68% of wells produced 50m^3 or less per day during April 2011. The average yield of the wadi wells was estimated to be about 8m^3 per hour, compared to boreholes in the basement complex with roughly half the yield. The majority of well operators (97%) highlighted that well production was high during the rainy season and low during the dry season due to a decline in water levels, especially in Wadi Nyala.

[18] The locations were Domaya, Eljebel, Elriyad, Elsereif, Elwihda, Hai Elwadi Sharg, Sakali and Sharg Elfania.

Water point survey questioning. © Alan Nicol, IDS

In the majority of locations visited the cost of two barrels (one *fontass* of 400 litres) ranged from SDG1 to SDG2 ($0.40–0.80) at the source. However, in northern Nyala, due to limited supplies from the basement complex, the cost was about SDG2.50 ($1.00). Most of the water point operators believed that the cost of water had risen over the past three years, the defining factor being the availability (and cost) of fuel. It was observed that in all locations operators or well owners were chlorinating water only during the rainy season, with support from UNICEF and the state government.

The GWWD also has a network of 60 boreholes and dug wells at which it monitors water levels every three months. More than two-thirds of the wells were drilled privately. At least half stop more than ten times per day to allow for recharge around the well (where cones of depression can form in the aquifer). We found that the time during which wells were not functioning could be quite substantial; more than 60% reported that wells were non-functioning for several days at a time. More than 96% of respondents stated that the quantity declined in the dry season.

Kiosks: There are 32 SWC kiosks distributed across Nyala, of which the majority (29) are in northern Nyala to ameliorate supply deficits due to the lack of public network water. The remainder are in southern Nyala. The SWC rents kiosks to private operators through a bidding process and sells water to the owners at a rate of SDG2 ($0.80) per m^3. All of the kiosks have flow meters that are checked on a weekly basis by an SWC team. Contractors sell water on to the community at about SDG0.10 ($0.04) per jerrycan. According to our survey, about 50% of the kiosks were constructed prior to the Darfur crisis. Most work between eight and ten hours per day, from 8am to 3pm. Contractors indicated that they sold 5–12m^3 per day, depending on availability of supply. Water vendors interviewed at kiosks indicated that they spent from 30 to 60 minutes collecting water, whereas it takes 1–2 hours to collect water from a motorised well due to longer queues (though the cost of water from kiosks is relatively high compared to water from motorised wells). Most vendors interviewed (83%) indicated that they collected water from different sources depending on the ease of access, taking into consideration queues and the distance from customers.

Handpumps: Of the handpumps visited, most had been constructed by the WES project and about 50% after the Darfur crisis. In general they are managed by the SWC and communities. They are distributed in areas that face water shortages away from the Wadi Nyala course, and most tap into the basement complex. Most of the handpump water was described as slightly salty and is commonly used for household activities other than drinking. Households use the vendor water (from the wadi) for their own consumption. Usually handpumps work 8–10 hours per day. Unlike other water points, handpumps provide water free to the community; there is no direct charge for use, which explains the very long queues that can form.

Aquifer behaviour: A secondary data assessment was undertaken by the team that looked at Wadi Nyala water level measurements from 2000 to 2010 based on GWWD data.

The alluvial aquifer is one of the most vulnerable aquifers in Darfur, due to high water demand coupled with limited capacity and a high discharge rate. The aquifer has been divided into three portions: 1) upstream with respect to the town, 2) the Nyala town area and the lower wadi and 3) the Kondowa area (WAPS-2, 1985). The classification is based on aquifer thickness and nature.

The recharge by groundwater inflow across the aquifer boundary was estimated at 20,000m^3 per year and the groundwater losses by evapotranspiration at 1.4 million m^3 and 0.3 million m^3 annually during the dry and rainy seasons, respectively. The estimated groundwater capacity

for the Wadi Nyala aquifer was estimated at 24.3 million m^3 as of 1985. In the town area the groundwater storage was estimated at 6.0 million m^3, whereas in the downstream area the groundwater storage was about 18.3 million m^3, the majority being lost by evapotranspiration.

The GWWD established groundwater level monitoring in 2000 for more than 15 wells distributed over the town and downstream areas during the dry and rainy seasons. Measurements and records of depth to water level conducted by the GWWD during dry and rainy seasons over the past ten years indicate that there are possibly two different trends in water level behaviour in Nyala town and in Kondowa. In general, the Wadi Nyala alluvial aquifer groundwater flow is parallel to surface runoff flow following the surface gradient. Nyala town represents a recharge area, whereas Kondowa is a discharge area. Due to extensive pumping for domestic use, farming and other purposes, water levels decline precipitously during the dry period—from March to June—in the Nyala town area.

Based on GWWD records for the past ten years, six wells were assessed to understand water level behaviour.[19] The first three are located in the town (upstream area) and the remainder at Kondowa (downstream). The mean depth to water level showed two different sets of trends. In the town area the water levels in three wells located at Gabat Elneem close to the bridge, Nyala technical school and Karari, moving downstream, declined by about 2.2m, 1m and 0m, respectively. This suggests that water decline is more limited farther downstream in the wadi. This finding may be supported by depth to water level measurements at three other locations at Kondowa, farther downstream. The average water level is rising in these wells, which is a normal hydrogeological phenomenon in this type of aquifer.

In 1985, the Water Resources Assessment Program in the Sudan 2 (WAPS-2) concluded that downstream of Jebel Nyala, the majority of the groundwater was lost annually by evapotranspiration, which in the dry season in an average year is 7.8 million m^3. The recharge of downstream areas by groundwater inflow from the town areas was estimated at 210,000 m^3 per year (WAPS-2, 1985). Evapotranspiration is thus more than groundwater recharge through base flow along the wadi course. If all six wells are viewed as part of one aquifer, it appears that the water level is declining in upper recharge areas, is then at balance in the middle and rises in the lower, discharge areas. The growth in water level in the Kondowa area may be related to the accumulation of groundwater in this part of the aquifer, following removal of the Kondowa forest cover. This may be contributing to reduced evapotranspiration and possibly additional recharge from other areas is taking place. Indicative results derived from these secondary data sources require further detailed investigation (and monitoring) for verification, in particular because the performance of the six new wells under the DUWSP will be directly affected by the behaviour of this portion of the wadi aquifer.

3.2 Household survey

The purpose of the household survey and case study interviews (see Box 8) was to look in detail at the water–livelihoods relationship. This was premised on the assumption that water is a major constraint on livelihood security, particularly in terms of income and expenditure effects. Overall, in terms of per capita use, it appears, based on our results, that levels of consumption in Nyala are about the same as, or perhaps slightly below, expected levels for urban centres in East Africa, and Sudan in particular.

In the five sectors in Nyala, the team surveyed 49 low-income, 44 middle-income and seven high-income households. This bias to low income reflects the focus of the study and our need to ensure stronger representation of the views and experiences of the poor.

[19] The six wells were Nos. 5, 74, 525, 648, 651 and 653.

Most householders were owner occupiers (74%), which accords closely with other data sources, including a 2009 GoS survey (GoS, 2009). The average amount that households were willing to pay for an improved household connection working day and night was SDG76 ($30) per month, more than twice the highest rate that households currently paid for a piped connection.

Average household size was seven people, with a slight variation (higher-income households were marginally larger). Based on analysis of consumption habits, the survey shows that average consumption of water was 27 litres per person per day in low-income households, 33 litres in middle-income households and more than 100 litres per day in high-income households. Most households, even if they had a connection, pointed out that it rarely worked and that they relied on additional sources, mainly vended water (see Table 4).

Most household income activities were not highly water-dependent. The majority of incomes were from service-related industries or the selling of daily labour. Households were commonly paying SDG0.50–1.00 ($0.20–0.40) for a 'joze' or pair of jerrycans (about 40 litres). Expenditure on water per household varied from about SDG170 ($67) per month for low-income households to SDG183 ($72) for middle-income households. Higher-income households used and spent far more on water, because the distinction between household and productive uses became blurred (such as with the raising of livestock or use in agriculture). Many such households ran their own businesses in their compounds.

It is important to note that these figures represent at least twice the amount estimated for monthly expenditure on water in the El-Fasher pilot study conducted prior to DUWSP implementation. This may be specific to Nyala but could also be indicative of a general underestimation of the cost burden on poor households in accessing water. As has been noted elsewhere (and is borne out in these results), demand remains relatively inelastic at 25–35 litres of water per person per day.

More than one-third of households had heard of the Baggara Basin project, mainly through the local media. Many were sceptical that a better service would be provided, particularly given the experience of those with piped connections who usually did not receive water or, if they did, only at very low pressure. As a result, filling up a 20-litre jerrycan could take several hours.

Box 8: Case study of Safia, IDP camp householder

I have six children. We live here with my husband, two brothers and their families. In total we are 30. We all share one house, making and eating our food together. My husband has been absent for more than one year. He travelled to the south looking for better work. He sent us money once. His two brothers work in Nyala as labourers, if they find work in building, factories, and so on. Our children [boys] work in the town so that they can provide for their personal needs.

I was trained by an organisation in health education. The organisation supported and provided some projects. I was given a chicken farm, which earns me about SDG35 [$14] per day. The chicken food costs SDG20 [$8], and the rest (SDG15 [$6]) we divide up for our needs. I usually buy the house needs each week [such as sugar, tea, oil, soap and onions] and save one pound each day for emergencies [bringing in about SDG7, or $3, per week].

We get water from the tank in the camp and pay SDG2 [$0.80] per month. They let us take five jerrycans every two days. We also buy water from water vendors (8–10 jerrycans), of which the chickens drink five jerrycans per day. In total we spend about SDG2–3 ($0.80-$1.20) per day on water. A vendor sells a 'joze' for SDG0.70 ($0.30).

The vendor usually gets the water from wells in the Gad Alhaboub and Al Reiad areas. All my children are at school, which costs SDG5 ($2) per child each month. My children are all vaccinated. There are many diseases in the camp—measles, conjunctivitis and some psoriasis. Before we were displaced we had cows and goats, and we cultivated many types of vegetables and seeds. Even the salt we got for free by evaporating water in an area called Safga.

Table 4: Representative water coping strategies across social and income groups

Income	Availability	Access	Use
High income	Usually resident in area with more reliable network, or have 'high-speed' connection. Capacity to choose between sources.	Capacity to purchase water directly (or labour time) to access water. Fewer trade-offs in terms of expenditure foregone if more reliant on vended water.	Can use capacity to access large volumes of water to combine with land and labour to produce goods for sale and raise income. May have gardens and livestock and can invest in bulk water supply (such as dairy farmers).
Middle income	Likely to be close to the wadi and therefore water will be more available and less expensive. Will combine access to different sources.	Has a tap connection but supplants supply with purchase from vendors. May use sources for other (non-consumptive) uses.	Most water for domestic use, but may also engage in small-scale cottage industry (such as ice cream production).
Low income / IDP	May be involved in water vending directly. Uses a range of sources dependent on cost and income availability. Hand-dug wells in wadi, handpumps, vended water, kiosks. May also receive water 'charity' from neighbours.	Own access, handpumps, kiosks (and occasionally from water vendors). Charity of neighbours.	Own consumption. Some may be used for brick production and small vegetable gardens but more likely to be wage labour for others.

3.3 Water vendors

Water vending generates up to twice as much revenue per month as that collected by the UWA. Major issues surround this private–public relationship, including ownership of wells that serve the private vending market (and therefore determine private profits from the private sale of water), the nature of the market itself—who regulates, profits from and manages quality and quantity of water bought and sold—and how incremental change can be made to improve the overall performance of the informal sector in parallel with improvements to the public water system.

Of the 78 interviewed water vendors, all of whom were boys or men, 58% started vending during the period of the Darfur crisis. Some 40% described themselves as IDPs; another 52% said they were from Nyala (see Boxes 9 and 10).

A large percentage (69%) were of primary school age, from both Nyala and the IDP camps. Many of the child vendors sell water during their school holidays or before or after school,

leaving carts with their families during school time. Most of those spoken to utilise part of their income to pay for schooling.

Although the municipality claims there were only about 660 registered vendors in 2011, our estimate is that at least twice that number are involved in this market, based on the number observed during the research fieldwork and the huge gap in supply and demand during the dry season.[20] The official figure is derived from records kept because vendors are required to pay the municipality, Ministry of Health and the police for licences and permits. Yet during the study we were unable to cross-reference numbers provided by the municipality with those of other sources. We suspect that many vendors are not properly registered.

A child vendor fills up a tank from a borewell in Wadi Nyala.
© Alan Nicol, IDS

Many vendors are engaged in other livelihood activities in addition to selling water. More than half the vendors highlighted that they work in farming during the rainy season and go to school and start water vending during the dry season. Only around 25% sell water continuously throughout the year. This seasonality in water vending is an important characteristic of the market.

The main advantages of vending are the instant cash provided and the minimal skills required, allowing relatively easy entry into the market (including by those receiving financial support from the Ministry of Social Affairs). The costs of water vending per day include the donkey (SDG7, or almost $3) and *berseem* (fodder) for the donkey (about SDG1, or $0.40). The owner of the donkey and cart (if not owner-operated) takes half of the revenue. If a vendor makes a net profit of SDG11 ($4) per day, then he will give SDG5.50 ($2) to the owner and keep SDG1.00–1.50 ($0.40–0.60) for himself. The remainder will go to his family, according to interviewees.

About one-third of the vendors only use one water source (the site of their interviews), suggesting that they have a particular arrangement with or live in close proximity to that source.

In terms of revenue, nearly 80% collect SDG5–15 ($2–6) per day from customers; about 20% collect more than SDG15 ($6). This suggests that vendors only regard the activity as worthwhile if they collect more than the daily wage rate (about SDG10, or $4) available through other occupations (although some of these occupations, such as construction, may not be available to young boys).

[20] The Zakat Chamber supports vending. It allocates about 30% of its expenditure to the poor for water vending (spending about SDG5m, or $2m, on the provision of carts and tanks). The Chamber supports about 500 water vendors and officials estimate that some 30% of supported households are involved in vending. Author interview with a representative of the Zakat Chamber, May 2011.

Vendors near a water point in Hai Elwadi. © Alan Nicol, IDS

Water vendors may be grouped into three categories: those who use their own carts and donkeys (55%); those who rent carts only (22%) and bring their own donkeys; and those who rent carts and donkeys from one owner (23%).

Vendors in the first group are the richest, followed by those in the second group, who pay the cart owner SDG40–50 ($16–20) per month. The last category comprises those who have no money and share equally the net revenue with the donkey cart owner, after taking into account money for donkey fodder. Most of this latter group seem to be IDPs. Those who rent the donkey carts and the donkey make on average a profit of SDG6 ($2.40) daily, whereas the other two groups collect from SDG10–15 ($4–6).

About 68% of the vendors conducted 4–7 trips per day, depending on the availability of water. Half of them (50%) collected water within an hour; the rest took more than one hour to fill a tank of two barrels. Some three-quarters sold farther afield (not locally) and 63% stated that their customers varied during the rainy season. Asked about their customers, 74% said they were selling to the poor only, while 18% said they were selling to the rich. This probably reflects the relative difference in access to piped connections between rich and poor households.

Vendors have to pay for three permits: SDG14 ($5.50) per year to the Veterinary Department for a permit to have a donkey in town, SDG15 ($6) to the traffic police for a licence to use public roads, and SDG15 ($6) every six months to the municipality. A tank for a donkey cart costs SDG200 ($80). Members of the Artisans Union estimate that 1,000 tanks are made each month and every metalworking business produces about three per day.

Box 9: Mubarak's story

My name is Mubarak. I am 18 years old and come from Khartoum Bilal. My family is from an IDP camp. I have been water vending for six years and I do it because there is no other job for me. I make about SDG6.00–6.50 [$2.40–2.60] per day for myself and my family. I also work selling oranges in the vegetable market.

The income is used for food and daily expenses. But water vending is getting harder because the place in which I sell water previously had no taps, but now it does. If all the houses are connected (in Khartoum Bilal) then I will have to look for other work.

I want to study in the future and become a doctor to treat people. Nearly half my friends work in water vending, the other half are casual labourers. I own my own cart, tank and donkey. I saved up for it from my own income with support from my father.

Box 10: Ismail's story

I am Ismail. I'm 15 years old and am from Legidibia, about 200–300km south of Nyala. My family came here in 2004 and I have been water vending for three years. I fill three tanks per day and make about SDG17 ($7) in total. The donkey and cart cost SDG5 ($2). I keep SDG5 ($2) and give SDG5 ($2) to the owner.

For filling up, I keep SDG2 ($0.80) for the next day. I use this money for food at home. My father works as a trader, selling clothes in the market. I'd say more than half my friends are also water vending. We all use the money for schooling.

Vending has got harder because the number of vendors has increased and there is more competition. In the future I want to become a teacher.

3.4 Vulnerability and poverty

Water scarcity plays a contributory role in poverty and vulnerability by reducing disposable household income. Almost half of Nyala's population survives on around one dollar per day, of which about 25–30% pays for access to a basic water requirement.[21] This suggests that the prevailing water economy in Nyala is preventing access to education, health and greater food security. Safety nets of SDG150 ($60) per month are provided to some 2,000 of the poorest households, but this only covers the cost—at vended water rates—of a month's supply. This major drain on income levels is the chief contributor to vulnerability of poor households.

If water provision through the network could be made reliable and priced at around SDG60 per month (twice the current maximum tariff of SDG30 per month and not much less than average suggested willingness to pay in our survey of SDG76 per month), that would already represent major savings for poor households. The resulting savings of SDG100 ($40) per household is equivalent to the monthly cost of schooling for two children. The impact on women's labour time and household activities could also be substantial. As many of the Women's Union members pointed out, with a better household supply they would move to the production of fruit and other small-scale horticultural produce, which would buttress nutrition and provide small amounts of additional income.

The impact of more water at lower cost is also likely to support stronger social cohesion and reduced exclusion, by dampening pressure on the resource at a critical juncture in the late dry season, and in particular by ameliorating disputes and conflicts over the resource at water points. Across the town this is likely to reap specific benefits in areas including Hai al-Intifada in northern Nyala and Hai Salam Wasat. These 'unplanned areas' have some handpumps, but many are broken down at any one point in time. Long queues of perhaps 200 jerrycans are often visible (especially from 1pm to 4pm).

Water consumption in these areas is typically one barrel per household at a cost of about SDG7 (almost $3) per day. Such households average more than ten people, according to local Popular Committee heads, and are a mixture of traders (such as in clothing), grain sellers, labourers and those involved in water vending (about one-quarter). Households have to pay SDG150 ($60) for connections to the network, but a tap costs extra and the unreliability of water supplies through the network can mean that the investment actually leads to greater water insecurity. New connections could save these households SDG100 ($40) per month, but only if they become more reliable, with important expenditure impacts, which is the equivalent of ten days spent in wage labour.

In summary, benefits of improved quantity, quality and reliability may be anticipated as the poorest households will spend far less on water as a proportion of daily income. Since most of these households are involved in insecure wage labour, added capacity to save or spend on more consumption items that have net benefits—including health, nutrition and education—will increase future development opportunities, particularly for children and young people.

Numerous households—probably a few thousand—gain a net income benefit from being active in the market for vended water (see Box 11). It is not a hugely lucrative enterprise, but it provides cash income and a fairly reliable revenue stream (given the prevailing gap in public water availability). While it is likely that the piped system extension will change the market in the future, it is not expected to remove it entirely (nor should it necessarily do so). The likely absorption of a large section of the surrounding IDPs will continue to contribute to overall domestic demand for water, placing pressure on the public supply system. Many of these households will seek access to the wadi water, with implications for longer-term management of the resource.

[21] Figures provided to the author by the Sudanese Ministry of Social Affairs, May 2011.

Other forms of vulnerability include exposure to disease and contaminated water. There are reportedly serious problems of water quality in the dry season and during the early onrush of the rainy season, when initial floods wash rubbish into the wadi. In 2006 there was a serious outbreak of cholera. Much of this is linked to the use of untreated water from the wadi, including through informal water vending. WES now has an acute watery diarrhoea (AWD) contingency plan and is targeting vendors, though no vendors spoken to were purifying their water during the dry season. In addition, for some industrial users, the high salinity content of sources (particularly in the basement aquifer) means that metalworking industries are competing for the same water that domestic consumers and farmers use.

Every rainy season there are cases of AWD; some 30 people die each year according to a senior medical source at Nyala Teaching Hospital. Chlorination of boreholes and public wells is carried out six months of the year and some private boreholes are chlorinated by owners using UNICEF-provided tablets and under the supervision of the SWC and the Ministry of Health. However, regulation is light. The Water Quality Lab at WES carries out the only periodic monitoring of water point quality, but there is no overall systematic testing of all the town's sources. Recent data reveals high concentrations of fluoride in some sources, particularly in south Nyala. Figure 4 shows that diarrheal diseases peaked with the first rains in 2010. This suggests that contamination takes place in the wadi aquifer but then diminishes. Further investigation of this potential trend is important, particularly for recommendations on solid waste management in the town.

Box 11: Case study of Amina, IDP camp householder

My name is Amina and I come from El-Mallam. I came to this IDP camp in 2005. We were originally farmers and livestock owners. Our land is rich, and we used to grow all kinds of vegetables, fruit and seeds. We depended on cultivation and on our animals for most of our subsistence. When conflict came, we moved.

My husband does not work, but I work on a daily basis as a brickmaker. If there is any opportunity I go to the town and do some washing or cleaning. I get SDG7 [$2.80] daily for brickmaking and SDG6 [$2.40] for household work. My eldest son also works and gets SDG5 [$2] as a water vendor, so in total we make about SDG330 [$130] per month. Out of this we pay SDG200 [$80] for food, SDG25 [$10] for education, SDG20 [$8] for health and about SDG30 [$12] per month for water.

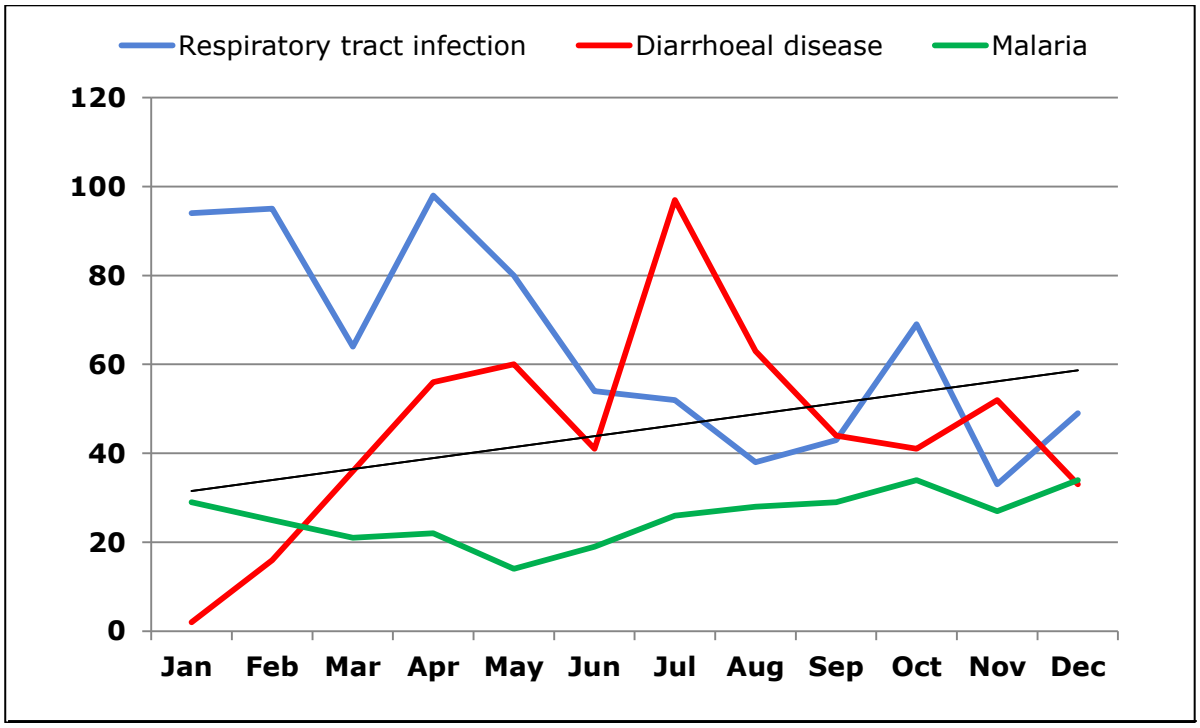
We receive free health services but have a water problem because the camp manager has changed water collection to every two days, for which we pay SDG2 [$0.80] per month. We only get five jerrycans per family every two days for this amount. We therefore have to buy from the vendor to cover our requirements. As a large family of 14 people, we need to buy four jerrycans per day.

Box 12: Case study of Naima, IDP camp householder

I am 25 years old and am in a family of nine people. We were originally farmers, growing all kinds of crops, selling some for cash and keeping the rest for the household. I was married and had two children when conflict suddenly started. We found ourselves without food, water or clothes, and were displaced, eventually arriving in this camp.

My husband is not working but I make local wine (*araki*) for a living. People know me and come straight to my house. If the police catch me because this work is forbidden, I give them some cash and talk to them nicely so they leave me doing my business. I can make only three bottles in a day, but that makes around SDG30 [$12]. I spend SDG150 [$60] per month on food, SDG50 [$20] for education, SDG30 [$12] for health and SDG75 [$30] for water. The rest (if any) is saved. We collect water from vendors and pay SDG0.50 [$0.20] for two jerrycans and use 12 jerrycans per day. I do not go to the water point because once a woman had problems there and she miscarried, so my husband prevents me from going there.

Figure 4: Indicated trends in infection based on admitted cases, 2010



Source: Author communication with staff at Nyala Teaching Hospital, May 2011

Poor washing caused by a lack of water can help the spread of rotovirus, which, according to a senior medical source in Nyala, is probably responsible for 70% of diarrheal disease cases in children. This suggests that an overly strict approach to water quality should not lead to source closure and that the quantity of water available could have critical health impacts on children as water can help to prevent water-washed diseases. Typhoid is also a problem and is responsible for some 70% of admissions to clinics. Malaria is a year-round threat, which may be explained by the fact that the lack of reliable water sources encourages people to store water at home. The storage of water in barrels within households thus provides a potential year-round breeding ground for mosquitoes (most of which are *Plasmodium falciparum*). There is no sewer system in Nyala. All collection, disposal and treatment is handled in individual private septic tanks or other on-site systems. Five factors are contributing to a growing waste problem: the rapid growth of the population; small plot sizes on average (and hence a concentration of waste); poor soil types that exacerbate localised pollution through septic tank systems and pit latrines; the septic tanks adjacent to Wadi Nyala, the main water source in Nyala; and, the lack of legislation and regulation on the design and depth of septic tanks and wells (GoS, 2009). There is, furthermore, no proper storm water drainage, so that annual flushing of the town's drains deposits waste into the wadi and shallow aquifer, leading to contamination.

Box 13: Brickmaking stories

Brickmaking businessman: I am Ishaak Abdalla, a brickmaker in Nyala. I bring a truck with soil from Mose and make about 6,000–7,000 bricks per day. I've been in the business for 15 years and the business is getting better. There is more money in it, caused by high demand for bricks during the building boom. The process uses a lot of water. One thousand bricks consume about 7 donkey carts of water, which cost SDG35–40 [$14–16]. In the winter there is no work, so effectively I only work in this business for six months of the year. Labour costs are about SDG40 [$16] for the production of 1,000 bricks pre-firing. Transport costs SDG10 [$4] per 1,000 bricks.

Girl employed as a brickmaker near Wadi Nyala. © Alan Nicol, IDS

The price of production includes SDG30 [$12] for fuelwood and SDG15 [$6] for *gisher* or groundnut husks to help bind the bricks. Most of the water comes from the wadi, but in May I have to collect it from Domaya, which is when it rises to SDG10 [$4] for one donkey cart.

Brickmaking labourer: My name is Faisal Abdul Rahim from Gereda, about 90km from Nyala. I've been coming to work here for about six years because of the employment opportunities. I'm married and have seven children. They live with their mother and grandmother. This is the only work I have.

Two of my kids—two boys—go to school. Six of my children are dependent on me. I make about 300–400 bricks per day and in one month I can earn SDG400–600 [$160–240] if I work every day, which is what I usually do. The bus journey to Gereda costs about SDG20 [$8] return.

Three child workers in the brick industry: Abdul (12), Mohamed (11) and Mokhtar (14).

Our mothers look after us. We work here during our holidays [four months—from March to June]. We make about 300 bricks per day. After school we come to work in the afternoons. Our mothers depend on this work. We would like to be water vendors, but there is competition for the carts.

4 Conclusions and recommendations

4.1 Implications for social risk and the development of water resource infrastructure

In conclusion, water access problems provide a huge structural constraint on development in Nyala. Changes in water availability—depending on how and where that resource is distributed—will affect social groups in many ways, largely according to the importance of water as a factor in household expenditure.

There is a distinct lack of trust between managers and consumers. DFID has made provision in the budget to install bulk water meters fitted at source works and in key locations in the distribution networks. This, in tandem with support for management training, could help to improve perceptions of management strength and efficiency. At this writing, there was deep consumer concern—be it from households or major industry—that management of the system was inadequate.

One of the crucial structural challenges is achieving greater reliability. Unreliable water supply is a constraint on the labour market at all levels. Government employees 'waste time' chasing water vendors for household supplies, and private business is unable to expand due to supply constraints, reducing the potential for employment generation. The only upside to this situation seems to be the employment and income for vendors themselves, as well as for those producing and leasing the necessary equipment—vending carts, tanks and donkeys.

A key political–economic question is, 'Who accrues this substantial market-generated revenue?' Based on evidence gathered in this study, at least half goes to the vendors themselves and their families (to pay for food, education and other expenditure items). Another portion goes to cart owners, to water 'producers' and to the various forms of 'taxes' levied on the official vendors. The study reveals no immediate evidence that substantial vested interests are keen to perpetuate such a market, though the potential certainly exists and remains a governance challenge.

The starting point for shifting the unregulated market to a more publicly accountable and well-governed system is a combination of better regulation, resource governance and communication between management institutions, political institutions and consumers at all levels.

4.2 A risk management strategy

The major risks identified by this project are continued consumer reliance on vended water and the financial and social undermining of a formal, publicly driven water supply in Nyala. If this situation persists, the development costs to poverty reduction and wider economic growth will be substantial over the long term.

At the same time, the economic benefits of vending are significant for some vulnerable households, perhaps as much as 2–5% of the total. Yet the drawbacks for at least 75% of households include average water bills surpassing the equivalent of $1.50 per day. If this situation continues, it would be a sign that augmented bulk water delivery and network supply under the DUWSP–TDRA partnership had largely failed to address major development challenges.

Table 5 examines risks associated with this project and proposed mitigation measures. It considers technical, economic, socio-political, and environmental risks in high-, medium- and low-risk scenarios.

Table 5: Preliminary risk assessment matrix

Risks	Technical	Economic	Socio-political	Environmental
High	TDRA network extension not finished on schedule or suffers technical problems		Continued public dissatisfaction with SWC is politicised and consumers stay away from household connections	Dry year causes drying of wells dependant on direct recharge
Mitigation actions	Establish close project liaison with TDRA and SWC		Bolster confidence and provide a system of compensation if supplies are interrupted (such as cash credits for purchase from alternative sources)	Community-based and city-wide contingency plans to address these communities
Medium	DFID consider termination of funding to cover Phase I only	Baggara Basin water too expensive for a large number of households, leading to slow or low uptake in connections	Deterioration in security environment Increase in demand under changes in IDP status leads to greater competition and possible conflict over water resources	Unsustainable draw-down in aquifer offset by recharge Significant low rainfall years affect total aquifer storage
Mitigation actions	Close liaison with TDRA project	Subsidy programme funded by government from revenue sharing under more regulated water vending (in return for greater support and security to vendors) Poorest households (means-tested) receive free basic water	New water users forum helps increase understanding and confidence between different producers and user groups, preventing disputes over access and improving longer-term uptake in network connections, particularly by businesses (helping to cross-subsidise household consumption)	Emergency measures to reduce farmer abstraction of water at end of dry season Recharge structures Ramalia dam (or other) built as matter of priority
Low	Sustainability of new assets in jeopardy or in question		Poor or non-existent communications strategy Contributing to poverty and lack of income	Adverse impact on aquifer of increased farming abstraction
Mitigation actions	Strategy in place, within an		Development of communication strategy	Manage and regulate farm

	IWRM framework, to ensure sustainability of water infrastructure and use	abstraction and increase metering and tariff implementation

4.3 Recommendations

One thread throughout this report is the challenge implicit in moving from vended water supplies to a more extensive and reliable water supply network. This involves significant regulation and governance in order to build confidence at the household and business levels in public network water supply. At the moment, a failure to deliver services effectively results in a default reliance on vended water, which is delivered at high cost and leads to unregulated abstraction from the wadi aquifer, against which the public water system then has to compete.

A significant shift to more networked water will rebalance the nature of these costs and benefits, substantially altering Nyala's water economy. The recommendations below are about supporting this shift and ensuring that emerging benefits are pro-poor in nature.

1. **Stakeholder engagement:** Two key relationships need improving. The household–UWA relationship is critical given the anticipated additional connections to some 40,000 households by early 2012. This increase anticipates a rise in revenue for the UWA of some SDG1.2m ($450,000) per month. With this substantial increase, consumer expectations will rise considerably, including with respect to more reliable service, improved billing and enhanced communication over future supply issues.

It is therefore recommended that a **Consumer Advice Forum** be established as soon as possible. This would draw together representatives of householders from different districts of Nyala (perhaps represented by Popular Committee officials) to meet with the UWA on a regular basis, preferably quarterly. These meetings would serve to discuss progress against the plan in service upgrading, to increase communication on proposed billing and tariffs and to raise any specific issues relating to services across the town—including involvement in future master planning in the water sector. The format could follow that of the WES Forum; meetings could be convened by the SWC at its offices, with the active support of relevant committee members from the State Legislative Council and from Nyala Municipality.

The forum should begin with a confidence-building exercise, based on discussion of the management challenges in supply delivery (and starting with a full description of the water supply challenges facing the SWC), followed by opportunities for consumers to raise concerns and discuss the complexities they face in managing risk and vulnerability at a household level due to poor water supply. In addition, and in preparation for a single future forum, the SWC should also host a **Major Users Forum**. One of the first tasks would be the presentation of compiled data on all existing water points in and around Nyala, including ownership, the type of users and uses, and approximate yield across the year. This would provide a major support function to help raise levels of accountability and transparency and improve the overall level of trust and confidence between public water providers and major users and consumers. Score cards, community monitoring and outcome mapping could all serve as tools to influence the development of these forums. A basic yet comprehensive inventorization of all water access points in Nyala is a crucial starting point.

2. **Livelihood security:** The second major recommendation concerns enhancing livelihood security and easing transitions from private water markets to public water supplies. The steps required to move this hugely important sector of the urban economy from one political-economic configuration to another call for substantial support. This study recommends a threefold approach to supporting ancillary programmes and projects that:

- support the vending community through a concerted push to map and manage the activities of individual vendors and that promotes the establishment of an association of water vendors to advocate on their behalf, represent cases when conflict arises and help in establishing water quality standards;

- involves training of water vendors in a range of alternative occupations, so that they can become qualified to take on other work as the market for vended water declines or becomes less profitable. Training could cover skills needed in building and construction, electrical installation and metal working. The good offices of the Artisans Association, the Zakat Chamber and other supporting organisations should help to establish a flexible training programme for the vending community; and

- support financing and credit. Based on analysis presented in this study, the impact on livelihoods—and disposable income—of increased household access could be substantial. The DUWSP aims to supply water to 52,500 households through their own connections for more than six hours per day all week by February 2012. Assuming success in achieving this level of improvement in water supply delivery (and that household connections cost no more than SDG30, or $12 per month), this would represent an increase in disposable income of about SDG120 ($47) per month per household; multiplied by 39,500 extra households, that would mean SDG4.74m ($1.87m) will have been taken out of the informal water market and made available for investment elsewhere (for instance, it would pay for 10,000 extra children to attend school each month). The longer-term impact on livelihoods of improving access to credit would provide important longer-term support to Nyala's economy and household livelihood security.

5 Annex

Table 6: Meetings with key informants

Name	Institution
1. Abdel-Moneim Arayah Babiker	Farmers Union
2. Abdalla Rahman	Ministry Social Affairs (Zakat Chamber)
3. Ahmed Hamza	UWA
4. An Nil Osman	GWWD
5. Abdu-median Abdurahman Rejal	Nyala Teaching Hospital
6. Babiker Bushkash	Ahfad University, Omdurman
7. Musa Salih	University of Nyala
8. Salah Yousef	MIWR
9. Eissa Mustafa	UNICEF (WES)
10. Mohamed Hassan Amar	PWC
11. Modawi Ibrahim	PWC (WES)
12. Fadul Mahmoud Nasr	State Water Corporation
13. Hamid Omar	UNEP
14. Hamid Sulayiman Ibrahim	Artisans Union
15. Hussein Bagadi	UNAMID
16. Ibrahim Adam	General Secretary of the Trades Union
17. Ibrahim Shuttur	Baggara Basin drilling contractors
18. Mesfin Lemma	UNICEF
19. Mohamed Adam	Humanitarian Aid Commission South Darfur
20. Mohamed Adam	Bagara Basin project manager
21. Mohamed Ali	UNEP, Nyala
22. Mohamed Mahzoub Fidiel	Practical Action
23. Mohamed Mustafa	WES
24. Mubarak as-Sherif	Former commissioner
25. Salah Hasabu	Trades Union, South Darfur

26. Showki Ahmed Jubari	Nyala Municipality
27. Sulaiman Arabi	UNICEF (WES)
28. Deka Abdu-rahman	Head of Popular Committee, Hai as-Saba
29. Tom Mutasaiba	UNEP Darfur
30. Yussef Abdi	OCHA

Table 7: Focus group discussions

Focus groups held	Key question sets
1. Dairy farmers	Society development, production and consumption, water as a constraint
2. Vegetable sellers	Income variation, gardens and own production, how affected by water (home/market), livelihood before and during the crisis, household and water vending
3. Youth group	Water situation, livelihoods, development perceptions
4. Labour Union	Employment situation, unemployment, vendors, water as a labour constraint
5. Women's Union	Use of water, cost of water, livelihoods, ideas for improvement and engagement
6. Popular committees	Situation in north Nyala, household challenges and livelihoods, future developments
7. Artisans Union	Water and small-scale production, provision of tanks, relationship to vending
8. Women's Union	Household consumption of water, problems in water access
9. IDP sheikhs	Camp situation, development and use of resource, management issues
10. IDP women	Background and access to water, water uses and livelihoods, challenges in access
11. Water vendors	Amount of time spent selling water, average net income, ownership of donkey cart, origin
12. Farmers Union	Extent and nature of farming activity, impact of water scarcity
13. Community-based organisations	Understanding of water situation impact
14. NGOs	Involvement in health, water and sanitation activities, knowledge of issues in IDP camps, wider sector development issues
15. Academics	Key challenges in bringing more water to Nyala, existing government

and engineers	and water development challenges, cost of water supply
16. Legislative Council members	Processes of oversight and scrutiny, Baggara Basin development, water governance issues

Table 8: Women's Union focus group

No.	No. of barrels per day	Daily cost (SDG)	Family size	Water source	Location in Nyala
1	1	4.00	7	Water vendors	Southern
2	3	10.00	15	Kiosk	Central
3	2	5.00	10	SWC & vendors	Northern
4	3	10.00	15	SWC & vendors	Central
5	1	7.00	5	SWC	Northern
6	1	8.00	9	Water vendors	Eastern
7	3	7.00	15	Water vendors	Southern
8	1	4.00	8	SWC	Northern
9	1	0.70	5	SWC	Northern
10	2	0.70	7	SWC	Southern
11	3	0.70	8	SWC	Southern
12	3	8.00	10	Water vendors	Western
13	3	7.00	11	Water vendors	Western
14	3	0.80	9	SWC	Northern
15	4	1.70	10	SWC & vendors	Southern
16	2	7.00	8	Water vendors	Northern
17	2	8.00	8	Water vendors	Northern
18	3	0.90	7	Water vendors	Northern

19	4	4.50	14	Water vendors	Southern
20	2	12.00	10	Water vendors	Southern
21	2	14.00	8	Water vendors	Northern
22	3	0.80	11	SWC	Northern
23	2	6.00	8	Water vendors	Northern
24	4	14.00	8	SWC & vendors	Central
25	2	3.00	7	SWC & vendors	Central
26	1	0.80	3	SWC	Central
27	2	3.00	8	Water vendors	Northern
28	1.5	2.00	6	Water vendors	Northern
Average	2	5.00	9		

Note: The above figures show an average daily consumption per capita of 44 litres. This is higher than the household survey average and may be due to the relatively higher income levels of the women present at the meeting.

Box 14: Mohamed's story

I am head of a household consisting of ten members, including my mother. I am 30 years old, am married and have seven children. I'm originally from Joroof village, eastern Nyala.

My village was attacked in 2004. We moved together as a family to Manwashi village, about three hours by foot. We lived there in an IDP camp before moving to Nyala at the end of 2005. Currently we live in my brother's house, who is away working in Saudi Arabia. I used to own a shop in the village and lived comfortably. Now I work as a daily labourer in Nyala market and earn about SDG20–25 [$8–10] per day, of which I spend about SDG6 [$2.40] on water alone. My brother sometimes sends money, around SDG500 [$200].

Box 15: Focus group with women householders in an IDP camp

Female team members held interviews with six households in three different blocks in the IDP camp. They also explored the water points and water sale at the other end of the camp. At one point there was a queue of more than 15 women and girls at the pump, which was reported to be permanent. There was also a traffic jam of young water vendors and their four donkey carts in the camp's narrow middle alley.

The camp has 18,016 families, with a total population of 70,709 people. There are 12,409 household pit latrines, 12 permanent and 10 temporary school latrines, and 22 temporary and 4 permanent health centres. The camp has 12 submerged pump wells, 11 handpumps and 10 tanks provided by Oxfam. Water production stands at about 1,040 m^3 per day, which means an average availability of some 15 litres per person per day.

Focus group discussion: All participants reported being displaced by armed violence that specifically targeted women. Some households were consequently dispersed between camps and other locations.

According to focus group participants, women shoulder more of the workload to earn income than men. Some men grow sorghum. Women are employed as casual workers in construction; the collection of fuel, wood and dry straw; domestic work in Nyala; food preparation and childcare (unpaid); and the making of handicrafts for sale and personal use. The income earned per woman is roughly SDG7 (almost $3) per day. This income is used to buy food for one meal per day. Sorghum rations are distributed by card, but one-quarter of the IDPs do not have cards. Boys work whenever possible to cover their needs, while girls help their mothers. Men's traditional work in agriculture and animal rearing is not available because they are displaced. Small ruminants are raised but theft is common in the camp. Women are afraid to collect firewood away from the camp. The sole advantage of camp life is physical security.

Women do all water procurement from handpumps and water points. The main source is well water. Water availability is now negatively affected by the withdrawal of relief organisations, with only WES working on water supply. Now a household, paying SDG2 ($0.80) per month for the pump guard, only receives water every other day instead of daily. Money paid is also used to enclose the water yard and to pay for repairs and fuel. This was previously done by relief organisations. No women are trained in the repair of handpumps. The quantity of jerrycans bought daily varies among households, from three to five depending on a household's location in the camp. Water quality varies. The women find that tank water (from tapstands) is clean, but vended water is polluted. Handpump water may be salty, so it is used for cleaning and washing. Water vending is common and disputes are common when water is short. The cost of a jerrycan varies from SDG0.50 to SDG0.70 ($0.20–0.30) in the rainy season and up to SDG1 ($0.40) in the dry season.

Khadieja has a nine-member household and does not sell water. She collects from the Girba (SDG2, or $0.80, per month) and also the water vendor (SG1–3, or $0.40–1.20, per day). Accessing sufficient water takes her about 1–3 hours. She collects about five jerrycans per day from the vendor. Water is scarce at the Girba in summer and she takes more time waiting for the vendor. Interruptions of supply at the Girba are due to fuel shortages and the need for repair.

Mariam has a large family of 17 members. She sells water to people in the camp, which involves paying a worker, feeding a donkey and occasionally paying 'taxes'. She makes a net income SDG90 ($36) per month. She uses her donkey cart to supply household water. Delays at the well occur sometimes. She collects 21 jerrycans per day and up to 30 jerrycans in the summer.

Box 16: Case study of Fatma

My name is Fatma. I'm 62 and a widow for the second year now. I have four daughters and two sons. My late husband was a trader in spare parts as our main source of income. One of my daughters, an employee in Medani, is married with children. Two others are school teachers; one has graduated and is looking for employment in Nyala. My eldest son is a migrant in Libya; the second works for a computer lab in Nyala. My parents, both Khartoum-born, came to Nyala for trade from a trading family in Shendi.

Our future plans are to leave Nyala for Khartoum when my son comes back from Libya. Things have changed in Nyala and Darfur, generally negatively, and specifically for the migrant trading community. My children's employment is at risk. If my daughters get married in Nyala, they can stay in Nyala. But we are intent on going to live in Khartoum as soon as possible. We fear racial violence based on possible political changes, like in the South. We own no house in Khartoum, but it is better for us to leave Nyala.

Box 17: Case study of Fatema in an IDP camp

I am 29 years old and from Haloof. We are eight. I have three boys and three girls; my husband's nephew also lives with us. My husband makes charcoal and collects wood. Because he does not have a cart to transfer it to town he sells it at the forest to those who own carts and who then sell it in town for a higher price. He spends a whole week there, sometimes ten days and then he returns with the money. He usually gives me SDG10 [$4] per week for the household. I don't have any work. We pay SDG2 [$0.80] per month for water and they give us five jerrycans every two days. We also buy water from water vendors [eight jerrycans per day for SDG2, or $0.80]. I spend the SDG10 [$4] a week on basic things: sugar at SDG0.50 [$0.20], milk [not daily] at SDG0.50 [$0.20], fuelwood, oil, onions and soap at SDG1 [$0.40] each. We don't buy meat or vegetables. Our children are at school, and we pay the school SDG5 [$2] monthly for each one of them. The school will expel them if we don't. Originally we were farmers, cultivating *dura* [maize], sesame, vegetables and many other things. We were satisfied and sold any excess for our other needs: clothes, sugar, tea and so on. But now we have no stable source of income. Sometimes we spend days without any money.

Box 18: Case study of Najlaai

My name is Najlaai. I'm 35 years old and am the mother of three children, aged 7, 5 and 3. I'm now expecting a fourth. My husband, Mohamed, is 40 years old. My extended family and I are from Omdurman. My husband and his family were all born and live in Nyala. They're a family of business people. I have been in Nyala for 15 years, and my late father was buried in Nyala, to which he had migrated for employment. Some of my husband's family left for Khartoum when they were married or for work. I am trained as a veterinarian and worked after graduation, but I left my job when I had my first child. I have no idea if I have any chance of returning to work; there is no one to assist me with child care in Nyala.

I intend to go and live in Khartoum as it is very difficult to keep living in Nyala. My husband has no plans to leave Nyala; his brothers are employed as traders in Khartoum and Nyala. Even if services of water and power improve, children's education is a problem. My husband is socially and economically tied to Nyala. But I dream of leaving Nyala to live in Khartoum one of these days, although I do not hope to go to work again with my children so young, but I may get some help from my relatives in Khartoum. I do not feel bad that we did not invest in Khartoum, though many Nyala residents did and made money out of organisations by renting out houses and then migrating to Khartoum. Such sources of investment tend to dry up in the end.

Box 19: Case study of Wafaa

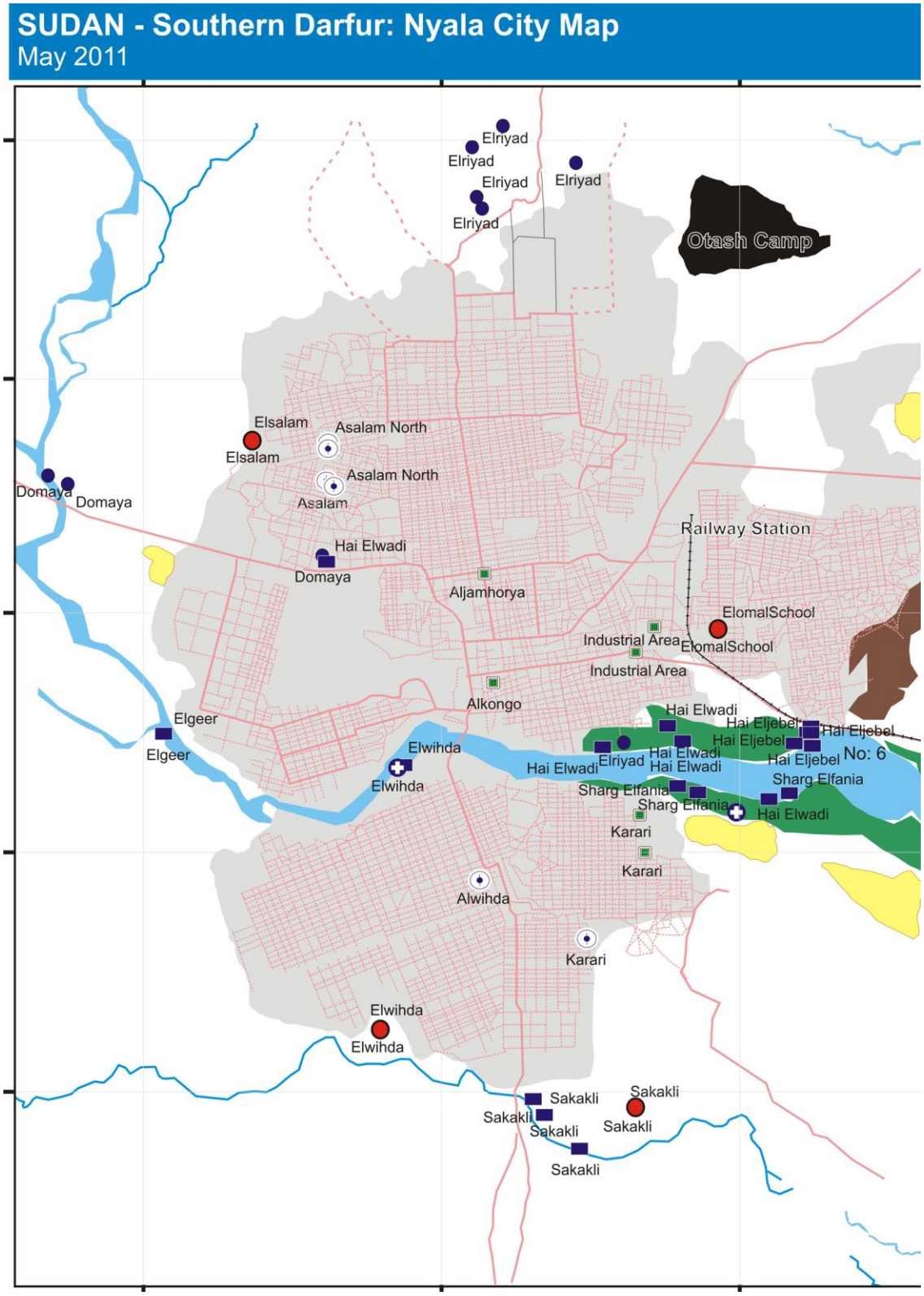
I am 25 years old and the mother of a one-year-old child. Currently I am a housewife. My husband is 35 and works as manager of an Islamic humanitarian assistance organisation office in South Darfur. We were both born in Nyala, and so were our parents. I moved from Hai El Cinema, from my parents' house, to Texas, Hai El-Wihda, when I got married. I have three sisters and four brothers; two of my brothers live in Nyala and two have been looking for employment since they graduated in Khartoum. My sisters are married and live in Ed-Dein, Nyala and Dubai. Two go to work as school teachers in Nyala and the migrant keeps a Khartoum-based professional job. I worked one year for an organisation in Nyala, after graduation, but I had to quit and stay at home to care for my child. My father was a government employee and my mother a school teacher. My husband has had a stable job for three years now and was a government employee previously. He used to have a vehicle to rent out. His parents' main source of income is a vegetable farm, which they manage in Nyala's periphery. Our future plans are to stay in Nyala. My two brothers who are seeking employment may go anywhere. One is applying to the armed forces and one for part-time work at an aid organisation. We mean to stay in Nyala as we all went through bad times and are now hoping for positive change. We did not lose family members or property during the conflict, and things will hopefully improve for all.

Box 20: Case study of Dowla, an IDP living in Nyala

I am 48 years old and from Bouram locality. My village is called Tegreeba. My father was a policeman; my mother died when I was 13 years old. My father forced me to marry my cousin, who is 20 years older than I am, and prevented me from staying in school. I am not happily married to my husband; he is only a shepherd and has never been to school. But all the same, I have borne him four children. After Darfur rebels attacked Bouram five years ago, we moved to Nyala, assuming that we might find better livelihoods and schools for our children. We found a plot and established our house, even though we know that it is a government area and expect to be moved sooner or later. We found schools for our children; all of them are now in primary school. My husband works as a labourer on someone's cart. The owner pays him one-third of the income from the cart; another third is spent on the donkey and the final third goes to the owner. My husband makes about SDG12 [$5] per day. I work as domestic help, washing, cleaning and sometimes grinding dry vegetables. I make about SDG7 [$3] per day. We both work every day unless someone—especially one of our children—is sick. Our employment situation is ok.

Given the Darfur situation, we say, 'Alhamdullilah'. Even though our income is only around SDG20 [$8], we only spend a small amount of it on food because I bring ready-made food from the houses I work in, so we don't need to cook or buy food. We pay only for sugar and tea every month, about SDG12 [$5]. My children bring water from the neighbours or the handpump.Education takes up almost 75% of our income [SDG35, or $14, per month], and health sometimes takes around [SDG20, or $8, per month]. Our life is changing gradually; I have found more work, my husband's work is stable and three of our children work locally [selling ice cream]. The future is not guaranteed because we don't have job security, have no permanent house and no ability to buy a house. The government needs the place where we live and talks about our return to our place of origin. If we have to go back to our village, we will have nothing to rely on; we will have lost everything. The best solution is to leave us here in the town where we can manage our life. If we are forced to go back the first thing we will lose is our children's education.

Map 1: Water points visited



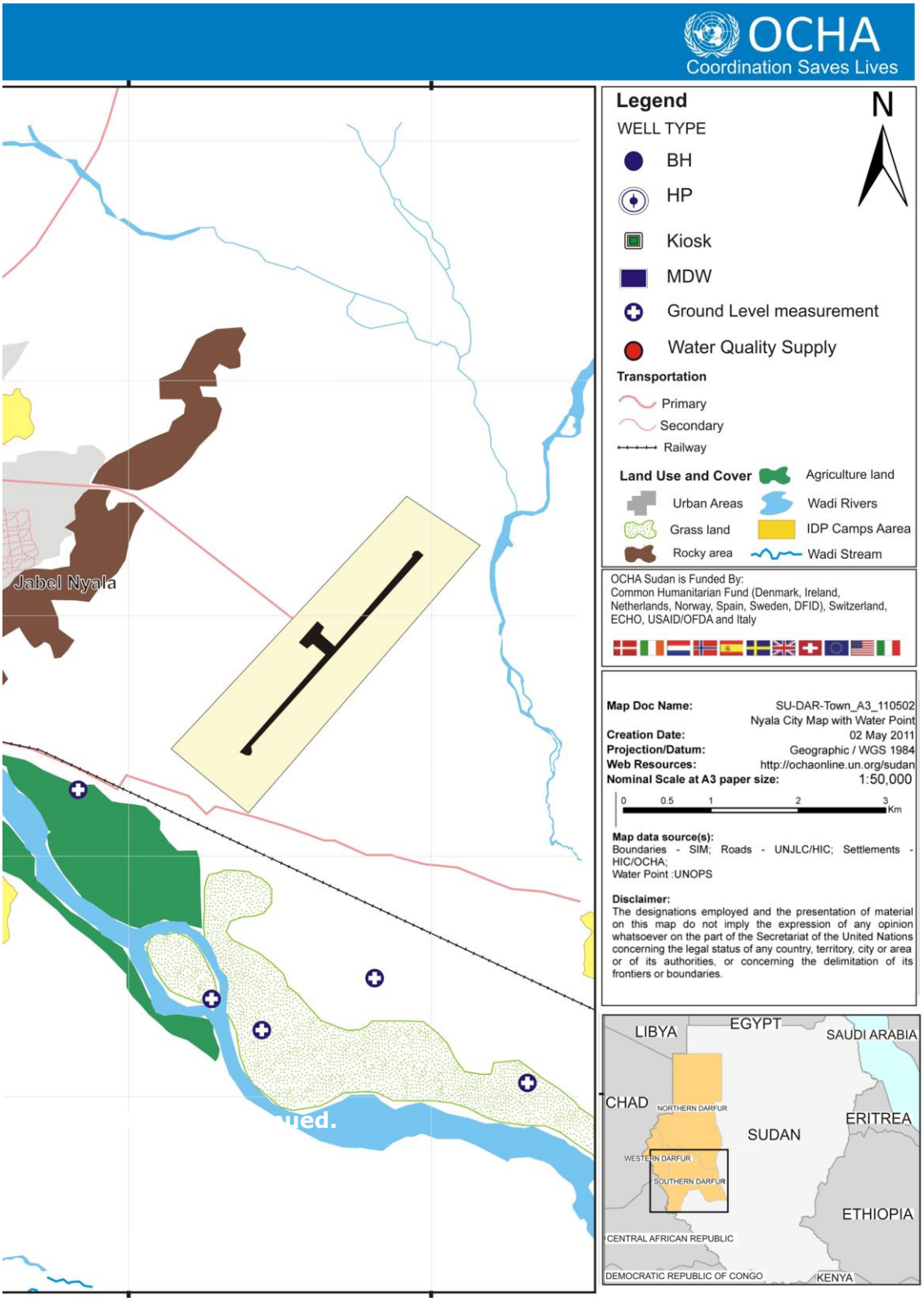


Photo Source OCHA ©

Bibliography

Abdallah, Seifeldin H. and Kamal A. Mohamed (n.d.) *Water Policy of Sudan: National and Co-Basin Approach*, Khartoum, http://www.rcuwm.org.ir/En/Events/Documents/Conferences/Articles/Con2/10.pdf.

Buchanan-Smith, M. and H. McElhinney (2011) City Limits: Urbanisation and Vulnerability in Sudan—Nyala Case Study, HPG Report, London: Overseas Development Institute, January, www.odi.org.uk/resources/docs/6515.pdf.

Coulter, L. and R. Calow (2011) Assessing Seasonal Water Access and Implications for Livelihoods, Ripple Toolkit, revised edn., Addis Ababa: Ripple Office, http://www.rippleethiopia.org/library.php/files/file/20110406-toolkit-guidance-on-hwea.

DFID (Department for International Development) (2010) Darfur Urban Water Supply Project—Project Document, September. DFID, London

DFID and UN-HABITAT (2008) *Darfur: Profile of Nyala Town and Its Environs*.

Faulkner, B. (2010) 'A Framework for Coordinated Water Management in the Darfur Towns: A Briefing Paper from the DFID Perspective', December.

FCO (Foreign & Commonwealth Office) Blogs. 2011. 'Darfur is Complicated', 7 June, http://blogs.fco.gov.uk/nicholaskay/2011/06/07/darfur-is-complicated-2/.

Foster, Mick, et al. (2010) *Country Programme Evaluations: Sudan*, Evaluation Report EV708, March, London: Department for International Development.

Frenken, Karen (ed.) (2005) *Irrigation in Africa in Figures: AQUASTAT Survey 2005*, Rome: Food and Agriculture Organization of the United Nations (FAO).

GoS (Government of Sudan) (2009) Study of Nyala City to Define the Need for a Sanitary Sewage Collection and Treatment System, Khartoum: Ministry of Urban Planning and Public Utilities, South Darfur State, and GoS, September.

HPG (Humanitarian Policy Group) (2004) *Humanitarian Issues in Darfur*, HPG Briefing Note, March.

HTS (Huntings Technical Services) (1973) 'Southern Darfur Land Use Planning Survey', Hertfordshire, UK: HTS.

Humphreys and Partners (1991) *Nyala Water Supply: Preliminary Report*, unpublished report.

Kibreab, G. and A. Nicol (2002) Returning Thirsty: Water, Livelihoods and Returnees in the Gash-Barka Region, Eritrea, Water Policy Report No. 1, London: Overseas Development Institute, http://www.odi.org.uk/resources/download/2969.pdf.

Nicol, A. (2000) Adopting a Sustainable Livelihoods Approach to Water Projects: Implications for Policy and Practice, Working Paper 133, London: Overseas Development Institute, http://www.odi.org.uk/resources/download/1093.pdf.

Nicol, A. (2001) Secure Water Building: Sustainable Livelihoods for the Poor into Demand-responsive Approaches, London: Overseas Development Institute, May, http://www.securewater.org/inceptionphase/inceptionreport.pdf.

Ofwat (Water Services Regulation Authority) (n.d.) 'Price Review 2009', http://www.ofwat.gov.uk/pricereview/pr09faqs.

Pantuliano, Sara and Samir El-Hawary (2009) *Uncharted Territory: Land, Conflict and Humanitarian Action*, HPG Policy Brief 39, London: Overseas Development Institute.

Pantuliano, S., Buchanan-Smith, M., Metcalfe, V., Pavanello, S. And Martin, El., (2011) *City Limits: Urbanization and Vulnerability in Sudan*, Synthesis Report, London: Overseas Development Institute.

Pavanello, Sara (2011) *Urbanization in Sudan: An Overview of International Engagement*, Washington, DC: Middle East Institute and Fondation pour la recherché stratégique, January.

Practical Action (2009) *Greening Darfur*, Practical Action Project, https://practicalaction.org/sudan/region_sudan_aim1_greendarfur

Tearfund (2007) *Darfur: Water Supply in a Vulnerable Environment*, Phase Two of Tearfund's Darfur Environment Study—Summary Report, Teddington, UK: Tearfund, UK Department for International Development, United Nations Environmental Programme, and US Agency for International Development.

UN (United Nations) Sudan (2010) *Beyond Emergency Relief: Longer-term Trends and Priorities for UN Agencies in Darfur*, Khartoum: UN Sudan.

UN (2011) *Sudan: UN and Partners Work Plan 2011*, Geneva: Office for the Coordination of Humanitarian Affairs.

UNEP (United Nations Environmental Programme) (2007) 'Sudan Post-Conflict Environmental Assessment', Khartoum, June, http://hqweb.unep.org/sudan/post-conflict/.

UNEP (2008) *Water Resource Management in Humanitarian Programming in Darfur: The Case for Drought Preparedness*, Khartoum: UNEP.

UNEP (2009a) 'Darfur Integrated Environment Programme', Project Note, July.

UNEP (2009b) 'Darfur Integrated Environment Programme: IWRM Infrastructure', Project Note, 1 July.

UNEP (n.d.) 'Country Operations: Republic of the Sudan', http://www.unep.org/sudan/.

UNICEF (2004) *Darfur Humanitarian Response*: *WES Sector Report*, Khartoum: UNICEF, July.

UNICEF (2009a) *Humanitarian Action in Darfur, Sudan*, Progress Report, June.

UNICEF (2009b) *Water, Sanitation and Hygiene 2009: South Darfur State*, Official Report.

USAID (United States Agency for International Development) (n.d.) *Sudan: Water and Sanitation Profile*, Washington, DC: USAID.

WAPS-2 (Water Resources Assessment Program in the Sudan 2) (1985) Geneina Water Resource Study Report to the National Water Corporation.

World Bank (2010) *Sudan: Data Profile*, Washington, DC: World Bank.

Young, H., Osman, A. M., Aklilu, Y., Dale, R., Badri, B. And Fuddle, A. J. A., (2005) *Darfur: Livelihoods under Siege*, London: Overseas Development Institute.

Young, H., Osman, A. M., Abusin, A. M., Asher, M., Egemi, O., (2009) *Livelihoods, Power and Choice: The Vulnerability of the Northern Rizaygat, Darfur, Sudan*, Medford, MA: Feinstein International Center, Tufts University.

Overseas Development Institute
111 Westminster Bridge Road
London SE1 7JD
UK

Tel: +44 (0)20 7922 0300
Fax: +44 (0)20 7922 0399
Email: publications@odi.org.uk

Website: www.odi.org.uk