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### **DELIVERING WATER, SANITATION AND HYGIENE SERVICES IN AN UNCERTAIN ENVIRONMENT**

## **In a state of uncertainty? Mogadishu Water Supply**

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*Following twenty years of conflict, the context of stabilization and early recovery in Mogadishu has supported a strategic water supply assessment. Traditionally supplied by shallow wells, at the outbreak of civil war the program of reticulated supply development collapsed, and the town has since reverted to an un-centralized network of wells, small scale reticulated distribution systems and vendors, with limited water treatment options. Access to sufficient safe affordable water is biased disproportionately against the poorest. The trend of well expansion driven by diaspora/national investment and humanitarian/aid programs continues. Although a planning framework is coming into place to address rehabilitation of a centrally regulated system required in the future, taking account of uncertainty, purposive research has produced an inference-based analysis. A fresh problem statement underpinning national efforts to improve prospects for sustainable water supply development for Mogadishu has been framed.*

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### **Context**

After twenty years of conflict, Somalia can be considered the world's most fragile state. Since 2012 the newly transitioned sovereign Federal Government exercises control over the capital Mogadishu through support from the African Union Mission for Somalia (AMISOM). Following the famine and the withdrawal of Al-Shabaab from parts of Mogadishu in August 2011, the city received a sizeable influx of internally displaced people (IDPs), currently hosting 185,000 from a population of around 1.1 million. Since 2011 there are positive signs of stabilization with significant reconstruction underway, thriving markets and greater access across the city due to improved security.

In line with a growing UN presence a large-scale humanitarian programme is being implemented by the UN, NGO, Red Cross/Crescent and Islamic Relief in partnership with national and district authorities and communities. Mogadishu is a challenging and risky city in which to work; security remains the priority and the political scene is unforgiving. The newly transitioned authorities carry a heavy burden/mandate to manage public expectations, with very limited experience to draw from. There is an identified need for dismantling the 'fadlan' culture of financial mismanagement and developing credible institutions to manage public finances and programs almost from scratch, although a measured optimism prevails (Menkhaus 2011). Remittance flows from the diaspora and aid are stimulating recovery and improving coverage of basic services the community need; education, health, water and sanitation.

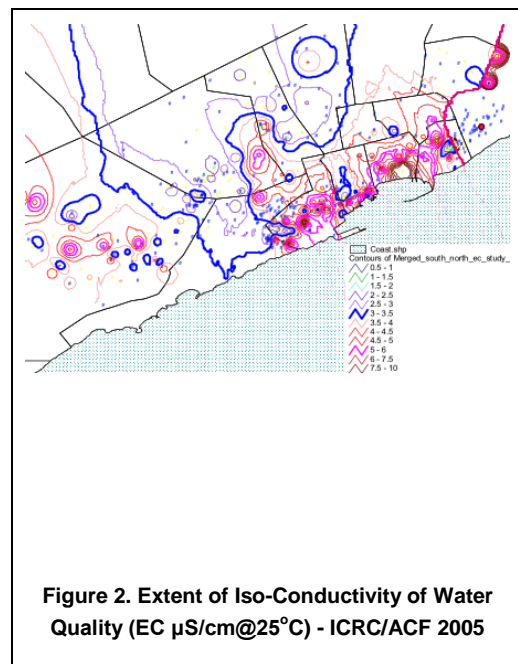
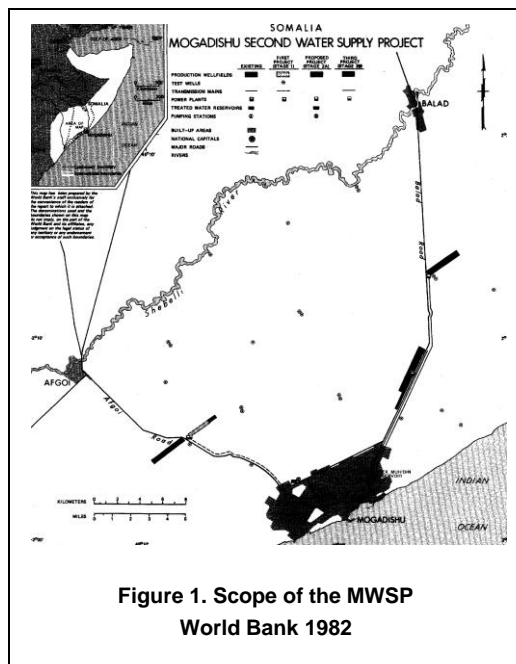
UNHabitat recently conducted a strategic analysis of the water supply sector in Mogadishu, ostensibly to serve programming of aid at the project identification/formulation stages, and with future sustainable water supply development as the aim in mind. Building on original water quality data from 1999 and 2006, from November 2012 through January 2013 a purposive approach was employed in the case study. Factors influencing uncertainties included field access limitations, paucity of current/relevant technical and socio-economic data and information, capacity level of national public institutions and private sector working in water supply, and the diverse opinions/expectations of stakeholders involved. However using a mixed research method of key informant and focus group discussions, basic technical surveys of selected sites, constant triangulation, and mass balance with respect to data/calculation confidence, a first stage analysis has been produced (Laws 2003).

## Water resources

Influenced by the Indian Ocean monsoon, Mogadishu climate has been defined as tropical and semi-arid, with average annual rainfall of around 490mm intensifying during the Gu and Deyr rainy seasons, and daily humidity up to 70%. Extensive hydro-geological studies have been completed in the area extending from the Shabelle River to the Benadir coastal plain from 1960 onwards, and the main aquifers and water quality characteristics identified. The groundwater gradient follows the geological profile from the littoral and alluvial deposits to the coastal zone covered by sand dunes, and there is thus a large lens of fresh water under the dunal area that is recharged mainly by the Shabelle, since annual precipitation recharge is negligible except during unusually wet years. The two main aquifers generally tapped are the buff marine sand and the reef limestone nearer Mogadishu which overlays it (Faillace 1986).

## The Mogadishu Water Supply Project

An old coastal town, Mogadishu traditionally had shallow wells and a thriving vendor market. The centralized reticulated system – Mogadishu Water Supply Project (MWSP) - begun in the 1960s was still being developed/expanded in 1990 but relied heavily on AID and international technical assistance. One rationale cited for the system development was to reduce the public health risks associated with contamination of the traditional wells. MWSP was initiated by the Somalia Government with USAID support to Phase I (Balad Road) and continuing with International Development Association, Arab Fund for Economic and Social Development, European Development Funding in Phase II, which alone cost \$42.3M at 1988 rates. With additional bilateral assistance reflecting Mogadishu's strategic location the project was always politically charged. The General Manager of the Mogadishu Water Supply Agency (MWA), which executed MWSP, reported to The President and naturally the intention for MWA to become a private operating company was never realized (World Bank 1982, 1990).



Mogadishu water supply (figure 1) was derived from a relatively small number of high production wells along the Balad (21) and Afgoi Roads (32). These well fields supplied about  $12.4\text{Mm}^3/\text{pa}$  to three  $14,000\text{ m}^3$  storage tanks at K7, Milk Factory and Sanaa junction, before gravity feeding 78km of distribution mains covering a design gross reticulated service area of 45 sq.km. During the years 1979 through 1988 for which records are available the average growth rate in consumer connections was 20% p.a., increasing from 2,974 connections in 1973 to 41,425 connections in 1988. By then residences made up 51% of consumers connected, public kiosks 6%, with the remainder split between government/institutions and the industrial/commercial sectors. The project was judged successful in meeting its physical targets and in 1985 supply was able to match demand, with water production at around  $27\text{m}^3/\text{cap}/\text{pa}$  (74 l/c/d) for all citizens. However, with a rapidly growing population and without Phase III's identified groundwater development

strategy coming online, by 1989 the total output from Afgoi and Balad Road well-fields were meeting just 50% of demand. During the build up to the civil war the institutional performance of MWA declined and was judged less successful than anticipated, specifically in improving financial administration, and billing and collections (World Bank 1990). Recommendations to the authorities to provide services to the un-served were not fully implemented and the reticulated system never fully replaced the traditional wells or the informal market (Davies 1987). The MWSP system subsequently fell apart during the civil war when the assets were either destroyed or appropriated.

## Water quality

Mogadishu relies almost exclusively on groundwater recharge from the Shabelle River for its water supply, so future management of the city water supply should naturally be closely tied to basin management (Houghton-Carr 2011). Extensive regional well drilling, testing and monitoring programs underpinned the groundwater development strategy identified for Phase III MWSP, which suggested that recharge abstraction be limited to 31Mm<sup>3</sup>/yr to avoid deterioration from saline intrusion after 2010. The presence of poorer quality water in the alluvial deposits to the North could also limit abstraction to about 46Mm<sup>3</sup>/yr to avoid deterioration in water quality after 2020 (IH 1990).

The civil war and rising population have created serious environmental problems and put unprecedented pressure on Mogadishu's groundwater resources, whose exploitation cannot be dissociated from groundwater quality. Studies have shown that the saline ingress had been considerable in the pre-war period up to and including 1998 when the El-Nino flood significantly but temporarily raised well water levels and reversed the inland movement of fresh water contamination (Nembrini 1998). Nevertheless figure 2 highlights the boundary of 3,000 EC measures ( $\mu\text{S}/\text{cm}@25^\circ\text{C}$ ) extending over much of Mogadishu in 2005, and without certainty of extreme recharge events, the risk remains of steadily increasing salinity through poorly planned development and/or increased well drilling densities in the city.

Although bulk quantity of groundwater resources are thought to be enough to sustainably meet current and mid-term-future demands, city raw water quality does not meet WHO guidelines for potable supply and is most likely deteriorating. High densities of shallow wells are at risk of faecal contamination, and there is currently little effective small-scale treatment that the poorer can access/afford besides the blanket chlorination campaigns. Perhaps understandably though, the focus of recent efforts has been driven more by reducing the death toll of epidemic cholera/AWD than addressing salinization of resources. Cluster sampling studies by ICRC/ACF however showed a weaker correlation between water sources and cholera/AWD cases than vendor managed water and poor end use hygiene, which present greater health risks, again impacting the poor disproportionately (Nembrini 2005).

## Current water supply and distribution

The current scenario is one of an un-centralized network of wells, small scale reticulated distribution systems and vendors, with limited water treatment options and affordability for 'safe' water for most. As there is no 'formal' regulation of the water market in the city at this point in time, it is effectively a city of informal/'private sector' water suppliers and vendors. The precise number of city supply wells needs to be verified but for 20 years there has been steady increase in motorized shallow wells and boreholes tapping into the underlying coral limestone and dunal aquifers. Some of the increase can be attributed to aid and much of that is of Islamic origin. UNICEF funded recent baseline survey identified 56 boreholes, 234 traditional wells (DoW 2012), which is most likely an under-estimation given earlier UNICEF surveys (576 wells). ICRC identified 633 wells (Nembrini 1997) at which time 265 were fitted with a motorized pump and only 21 boreholes were identified. Triangulated interviews in Mogadishu suggest confidence with the shallow well data although as many as 80 boreholes may currently be operating.

Typically new boreholes are comparatively low yielding (15-20m<sup>3</sup>/hr) compared to the production wells of the MWSP, due most likely to technical constraints for national agencies in drilling and developing the wells to internationally set standards. For the wells recently assessed, rating of generators and pumps has produced "fit for purpose" facilities rather than being optimally designed and engineered. Absence of water resources and supplies education and training opportunities in Mogadishu in the past 20 years has influenced this 'cautious' approach. Due to the high rate of well failures reported throughout Somalia and the cost of initial investment and replacement pumps, the current standard is an understandably pragmatic response to maintaining the flow. However, the wells make sense at the local economic level - a 120m borewell in Hodan producing 20m<sup>3</sup>/hr through a 10kw pump driven by a 30KVA engine with a 5 man crew has

operating costs of around \$6,500 per month which compare favorably with sales of \$14,500 assuming \$1 per  $1\text{m}^3$ . The margin of 0.55 \$/m<sup>3</sup> does not account for capital reinvestment however, nor unforeseen downtime/periods of low production.

The boreholes, motorised shallow wells and open wells feed into a variety of distribution means, of which there is a thriving vendor market dominated by donkey carts (200l drums) and hand drawn carts transporting 20l jerries. Water tankers operate beyond the city boundaries and are supplying the construction market in the main. The economies of scale and the high density of wells in the town thus support the mobility of the small-scale vendor, which supplies the majority of small enterprises throughout the city since less than 10% are directly connected according to UNHabitat GIS driven analysis.

Current patterns of access for non-IDPs in line with stratified cluster sampling data of 2006 suggest that as with other regions of Somalia access is strongly correlated with status of education and income of the head of household (HH), and by national comparison Benadir citizens sampled were on average wealthier than citizens from other regions. Accordingly 63% of HHs in Mogadishu have access to an improved water source with 42.2% receiving water piped into the dwelling and further 12.5% receiving water piped into the yard. Of all HHs 75% were treating water to make it safe for drinking, the majority adding chlorine, while of those 37% not meeting 'improved water source' MDG standard 32.3% were receiving vended water from a cart (UNICEF 2006). Water access is unevenly spread across the city however, influenced by conflict areas. Districts that have traditionally been 'water poor' due to excessive salinity of the hand dug wells - Xamar Weyne, Cabdi Aziz and Shangaani are amongst the oldest while the newer and faster growing districts - Karaan, Yaqshiid, Wardigley and Hodan – now support the highest numbers of boreholes. In the pre-war period these districts supported the majority of 188 public standpipes working during MWSP. The distribution of access to water in districts historically varied according to growth factors and morphology of district housing (Tuzo 1972), which are also reflected in the 2006 data.

The volume of water available to households in Mogadishu is determined by patterns of consumption, cost and quality factors; at least a conscious effort is often made to differentiate water by quality and cost. A national engineer interviewed described how, at an average cost of \$100 per month, 87 l/c/d is consumed by the HH of eight consuming three supplies of water. Of this consumption only 1.5% is potable (high grade) water while increasing drinking jerries from 10 to 15 per month and maintaining constant washing and cooking water supplies results in just a 0.48% increase in l/c/d consumption, HH water costs increase by just over 36%. Water prices are determined at the local level, usually in cooperation with community elders/leaders, and there is some variation according to the seasonal demand. Water costs average  $1\text{m}^3$  for \$1 from wells/reticulated supplies, a 200l barrel \$0.6 and a 20l jerry \$0.1. So when barrel water is delivered its cost has risen to \$3m<sup>3</sup>, and for jerried water the cost has risen to \$5m<sup>3</sup>. In this way the pricing structure is not pro-poor and the poor predictably pay high prices for water per unit volume than those with household connections. Amongst the negative consequences of this is that the most vulnerable work to minimize the amount of water they use. If there is an added value it is in income and livelihood support to the 10,000 or so current vendors who are within the lower income brackets.

## **Institutions and management**

In 2006 Somali engineers estimated the value of public water supply assets lost due to the civil war to be \$87.5M, with a budget requirement of \$27.14M for short-term rehabilitation needs to produce a functional reticulated system (KEI 2006). Attempts then by the ICU to organize Afgoi well field operators into a private company to restart supply met with considerable resistance from well owners in the city. Fearing that a revitalized MWA would overtake their services, about 300m of the 600mm dia transmission mains from K17 to the K7 reservoir were looted. Although the ICU stopped the looting, and the Afgoi well field operators association continues to provide services to local communities and water tankers for the construction industry, the difficulties then in combination with trend of continued growth in city wells now demonstrate that the water supplies are key resources that are protected and managed as such.

At the time of writing there is no formal regulation of well suppliers, although disputes arising over water supply are referred to the courts. With the re-emergence of the Benadir Regional Administration (BRA), there are indications of willingness by well owners and those working in the water sector to become better organized and support sector reform. The MWA was re-established in 2012 with a framework document outlining policy objectives, priorities, powers and responsibilities, tariff and revenue generating system, but with little capacity at present has an urgent need for *"office and database, training, tools and authority"*. Tariff *"set/differentiated according to volumes abstracted"*, equity, pro-poor approach, limitations and recognition of the competing uses of water in a water scarce environment are the core principles outlined

(BRA 2012). However, public sector performance is generally poor in Sub-Saharan Africa where less than 50% of the population is supplied. Although small water enterprises often fill the gap and can stimulate improved utility performance, there is little evidence to show the extent to which service coverage has been extended to the urban poor (WELL 2006).

The challenge the MWA currently faces is highlighted between the vision of re-establishing a public reticulated supply and effectively managing current city wells, suppliers and vendors. The city barely has a planning department working to resolve economies of scale and competing interests, and neither the private nor public sector seem likely to resolve management and technical problems without an holistically driven participatory process/dialogue. Elsewhere in Somalia socially driven consensus building has delivered long term successes in water development and the water sector has been cited as producing ‘*fit-for-purpose*’ public-private-partnership (PPP) contracting arrangements (Print 2011), so there are lessons learned from the initiative of private sector and the Somali community, combined with studies, piloting, roll out and monitoring of PPP agreements in major urban towns of the North (Weir 2009). However, recent governance studies cite the water sector as, in some ways, being the least effectively regulated provider of basic services (compared to health and education) in Somaliland/Puntland (GeoPolicity 2012).

This apparent dichotomy may be explained when considering customary and traditional roots of access to wells, which run deep within the Somali community (Lewis 1963). Although water is a shared resource and wells often named after the venerable as a gift to the wider community, fluxes of conflict and co-operation over access appear common. If sustaining the water business by any means during the recent years of absence of credible government is an understandable resilience strategy, it is an uncertain environment for the outsider to fathom the informal norms that apply, and in turn the design and application of credible ‘*do-no-harm*’ development cooperation frameworks remain complex and challenging. If residents aren’t free to choose between suppliers of water, then that is almost certainly an outcome of chronic conflict and no doubt clan affiliation/vested interests influence current practices.

However, while “the imposition of local authority control of the water supply will probably be resisted” the authors concur that a form of PPP is “likely to form basis of an acceptable solution” for Mogadishu (Marchal 2002). Participation in capacity building to re-establish a water authority (MWA) that regulates through a “reliable means to pay suppliers for water pumped into a public network” and billing/collection for services provided, while also planning for the “rehabilitation, operation and maintenance of the reticulated system” are also strongly recommended.

## Discussion

The current UNHabitat role in Somalia focuses on institutional capacity building in municipal planning, regulatory and revenue frameworks, in order to enhance delivery of essential infrastructure and basic services. Analysis conducted with sufficient data may use statistical methods to construct of probabilistic models that decision makers use to make informed choices. Decision-making and risk assessment are essential aspects of every engineer’s life but recent research has been conducted in an environment constrained by data (Jordaan 2005). There are no recent benchmark indicators, very little has been published on Mogadishu’s water supply in recent years, there is a dependence on grey literature, and there remain significant and excessive variance between, and inconsistencies within, much of the data assessed.

Typically, without confidence in solutions optimized from sufficient information a viable alternative is inferential methods applied to objective and subjective uncertainties (Jordaan 2005) of which there are many inherent to the context of Mogadishu. Recommendations for further hydrological research begin with a need to know the extent to which abstraction patterns are impacting the irreversible salinization of Mogadishu’s fresh water aquifers. Conversely, the working model for sustainable water development for the city remains open, although growth in community wells has demonstrated a remarkable resilience and self-reliance through un-centralized management practice that is arguably functional at the lowest appropriate level. A re-emerged BRA/MWA and national authorities face major obstacles in addressing the problems and challenges ahead, not least of which are deficits in capacity of the water sector institutions in order to have basic planning, management and regulatory functions in place.

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