K4D | Knowledge, evidence and learning for development

Water infrastructure in fragile- and conflict-affected states

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Question

What are the key vulnerabilities in the water infrastructure system in urban and peri-urban areas in fragile and conflict-affected states (FCAS)?

What practical measures, including nature-based solutions, could be taken to address these vulnerabilities and make water systems in urban and peri-urban areas in FCAS more resilient (particularly to climate change impacts)?

Contents

1. Summary

The key weaknesses identified in water infrastructure systems in urban and peri-urban areas in FCAS are:

- **Internal displacement increases demand** for water in urban areas as well as increasing wastewater discharge. Sewage systems are poor.
- **Alternative service providers** which are **unregulated**, more expensive and of lower quality.
- Naturally where the state is not functioning, **coordination of water services and funding is lacking**. This includes unclarity of roles and decision-making powers.
- The **humanitarian system** which supports FCAS can be **uncoordinated and changeable**.
- There may be **physical damage to infrastructure** caused by violence.
- **Emigration of qualified water engineers**.
- In some urban areas in Syria **conflict has affected electricity supply which in turn affects water supply**.
- Conflict damages **financial sustainability** of utilities.
- **Climate change** is an underlying factor putting greater pressure on water systems.
- **More knowledge is required** on water quality and processes.

Some literature suggests that **urban needs are under-recognised** as traditionally water projects have focussed on agricultural needs in rural areas and population growth in urban areas needs to be given more consideration (Steduto et al 2018).

Problems specific to FCAS highlighted here **may not detail underlying water shortage problems** which are common in arid countries.

Practical measures to address vulnerabilities in water infrastructure

Practical measures **to address increased demand** from refugee or internally displaced persons (IDPs) influx is context dependent. In Jordan, the national water company focussed on **addressing leakage issues and commercial losses**. Where Jordan and Lebanon have not been able to provide for refugees international agencies have had to provide **bottled water or simple distribution systems** which is not preferred from a resilience perspective. Accommodating refugees should, where possible, take an **integrated area-based approach**. Tensions are reduced when water-supply improvements can benefit both hosts and the displaced.

Addressing physical damage to infrastructure should **use local capacity** and **aim to be resilient** which is difficult when repairs are urgent. In post-conflict Senegal the national army was involved in rebuilding infrastructure which also helped to build trust.

Institutional reform is needed to improve regulation and coordination. Investment in infrastructure must come alongside improvement in service provision management. Transformation should be led nationally where possible with third parties taking on an intermediary role to promote data transparency. To replace **lost human resources** young people should be placed on fast track training.

Coordination of the sector should involve **multi-stakeholder groups** which can **clarify roles** and agree policy documents. Groups benefit from training to effectively coordinate water system activities. **WASH management committees** in the DRC developed business plans which included strategies for revenue to cover service costs. Community water committees assist communications for responsive service provision in refugee camps.

It can be favourable to work with where state capacity is weak. **Regulation to ensure quality** is required where there are private sector providers. **Public-private partnerships** have worked in contexts including Somalia.

Resilience and nature-based solutions

The key recommendations for **resilience programming** are **efficient resource management**, making interventions sustainable with prior **research and analysis**, working more closely with the **private sector**, and maintaining **strong relationships with communities**. **Examples of resilience programming** include **reduction of dependency on a single source**, **contingency planning for emergencies** including warehouses for emergency stocks, **ensuring efficient power** supply to effectively run water systems, **installing meters**, and **improving cost-recovery**.

Alternative water resource solutions from wider contexts may be useful in FCAS depending on the local situation. These include rainwater collection, stormwater collection, water reuse, demand management, and water loss reduction.

Examples of the use of nature-based solutions (NBS) identified in FCAS were for flood management in urban areas or drought reduction in rural areas. All of the projects identified included a training and capacity building component. The current evidence base is lacking as this area is still emerging. It seems a viable option when addressing flooding.

Nature-based and alternative water resource solutions should be considered in FCAS where they can be aligned with resilience recommendations. They must be efficient in solving the weaknesses specific to the context. They should be implemented following research and analysis, have private sector involvement, and strong relationship with communities.

WASH Agenda for Change emphasise the importance of context analysis for planning and implementation in fragile settings (Tillett et al 2020). WASH systems analysis tools with conflict and power analysis are recommended. Adaptive management is required for dynamic shifting contexts.

Evidence base

There was a very small amount of evidence on NBS in FCAS as this in an emerging area. A certain amount of the literature on FCAS relates to refugees and emergency WASH provision. A lot of the evidence base focuses on water supply in terms of getting water to people with less detail on water supply infrastructure such as water supply reservoirs or dams for drinking water.

2. Introduction

Water challenges in fragile states are expected to intensify as climate change continues (Sadoff et al., 2017). Higher temperatures mean greater surface water evaporation, lower rainfall and increased risk of flooding (Steduto et al 2018). Water scarcity in the Middle East and North Africa (MENA) has been compounded by extreme weather events associated with climate change (Diep et al 2017).

Literature on water security in fragile contexts highlights the reciprocal relationship between conflict and water, "water security is more difficult to achieve in fragile contexts—and the failure to achieve water security has greater consequences" (Sadoff et al 2017). Fragility compounds water infrastructure issues which may in turn can compound fragility (Steduto 2018). Weak government structures and distorted incentives exacerbate water scarcity. Water security is also harder to achieve in fragile contexts because human and financial resources are more strained and infrastructure degraded (Sadoff 2017). Fragile states were reported to have achieved less than half of the progress towards the water-related Millennium Development Goals than nonfragile states (OECD 2015). World Bank data show a small amount of progress in water supply coverage in rural areas within fragile states but negative progress in urban areas within fragile states (WSP 2011).

To identify weaknesses in water infrastructure systems this review searched for documents synthesising information on a number of fragile and conflict affected states (FCAS). Information reported at this level did not always distinguish between urban and rural issues, and peri-urban areas were rarely reported on specifically. High-level search results were often reporting country-wide and more commonly covering rural areas and agricultural systems. Literature focussing on a single country or area were clearer in distinguishing between rural and urban water systems. Section 3, identifying water system vulnerabilities searched for documents on FCAS overall, and then on the countries identified as highly fragile in the World Bank list of fragile and conflict-affected situations[1] Somalia, Afghanistan, Syria and Libya. Sufficient information in Libya was not identified for inclusion within the scope of this report.

Underlying water shortage problems relevant to all arid countries may not have been highlighted as problems specific to FCAS, particularly water shortages due to rainfall deficits.

Examples of practical measures to address the identified vulnerabilities were identified in both countries rated high or medium-level of fragility in section 4. Section 5 provides some useful perspective on resilience approaches to water servicing in FCAS. Section 6 outlines practical measures for addressing water vulnerabilities in different contexts which may be workable in FCAS depending on the local situation. Section 7 identifies examples of where nature-based solutions are being used in FCAS.

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[1] http://pubdocs.worldbank.org/en/888211594267968803/FCSList-FY21.pdf

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3. Water infrastructure system vulnerabilities

Information is presented here from reports on water vulnerabilities in FCAS broadly, followed by information specifically on Somalia, Afghanistan, and Syria.

FCAS

An issue particularly of note in urban areas identified in a World Bank Group Water Global Practice report on water security in fragile states is the emergence of **alternative service providers** (Sadoff et al 2017). Alternatives, such as privately drilled water, are generally **more expensive** and of **lower quality**. These systems are largely unregulated and lead to overexploitation. **Urban areas experience extra stress from displaced rural migrants**.

A recent collaborative discussion paper on applying **WASH systems in fragile contexts** (Tillett et al 2020) identifies a number of issues including **impaired role of the state** to lead the sector, the presence of the **humanitarian system** "with its cluster architecture, actors, mandate and processes" (pIV), a mixture of **uncoordinated non-state actors**, informal providers, and **humanitarian focus** of WASH actors. It is noted that planning is difficult due to the highly changeable nature of the context. Learning and adaptation is difficult with a high turnover of government and humanitarian actors.

A paper from a World Bank and Food and Agricultural Organization (FAO) collaboration explores water issues in fragile states in the Middle East and North Africa (MENA) (Steduto et al 2018). The primary effects of armed conflict in the region are **damaged water infrastructure**, **low funding of water utilities**, and **increased vulnerability to climate shocks**. On urban issues the report notes poor service delivery with **lack of bulk water** under increased strain as population rises and urban areas expand. **Expensive tank water** is common and of questionable quality in urban areas. **Poor families in urban areas reside on marginal lands that are more prone to flood and at greater risk of contaminated water**. **Policy distortions are identified where allocations to agriculture are favoured** and the growing needs of urban and industrial centres are under-recognised.

An International Institute of Environment and Development paper on water service resilience in MENA notes the **vulnerabilities** in this region **existing before** the series of **conflicts** (Diep et al 2017). These include **unsustainable management practices** and **reliance on scarce freshwater** resources. **Reactive response measures risk increasing vulnerability by creating a dependency on external support**.

Serving newcomers in MENA is identified as more difficult where **central governments restrict local decision making processes or retain decision making powers** (Diep 2017). Where local utilities have devolved authority it is easier to supply an influx of refugees. **Financial**

sustainability is an issue for utilities as conflict leads to decreasing revenues which in turn lead to problems with service provision.

Somalia

Water in Somalia is becoming increasingly scarce. **Unpredictable rainfall** leads to **flooding** and **drought**. Management of water resources is poor and required in both rural and urban areas. **Internal displacement** puts **increased demand** on resources particularly as rural inhabitants leave crisis areas (Taruri et al 2020). 30 percent of urban dwellers do not have access to improved water resources (Infrastructure and Cities for Economic Development, 2018). **Lack of coordination in water sector governance** is a key weakness in the water system in Somalia (Akkaraboynia & Adem 2018; Mourad 2020; Jam 2018). Failure of public provision has led to **unregulated private provision** which varies in scope and quality (Benadir Regional Administration 2018). Issues reported from the Benadir region include **additional wastewater from increasing population** being discharged into the drainage network leading to unsanitary conditions; and lack of engineered storm water drainage causing floods.

Apart from inhabitants along the rivers in Somalia the population are dependent on **groundwater**. **Salinity** levels of the water are above the required standard for drinking water in many areas (FAO-SWALIM 2012).

Somaliland

Peri-urban areas have **problems with access to water** and sanitation services in Somaliland (African Development Bank Group (ADB) 2016). **Limited capacity in water resources management** is a constraint (NIRAS 2019). There is a **heavy reliance on groundwater** and some is too **saline** for drinking and the region suffers regular and **severe droughts**. **Flash floods** are also an issue with cyclone activity migrating from the Indian Ocean. High energy costs and **low levels of investment** in water resources infrastructure makes water expensive and inaccessible. The Ministry of Water Resources Development (MoWRD) **struggles to remunerate and retain staff** (NIRAS 2019). More **knowledge is required on surface water location and factors affecting groundwater quality**. Regulation for the development and use of groundwater is required to meet demands in urban areas. There are no sewer systems in Somaliland and **wastewater discharge** is a problem in urban areas. There is also no monitoring of **industrial liquid waste**. The WHO Environmental Health Report (WHO 2011) estimates that 87 tonnes of **domestic waste** are abandoned in the city of Hargeisa each day **leading to contamination of surface and groundwater**. There is also risk of cold war era liquid missile fuels stored underground near Berbera and the presence of banned pesticides near Hargeisa (NIRAS 2019).

Afghanistan

An assessment published in 2019 found that only twelve percent of residents of Kabul had access to the public water supply system (Brati et al 2019). Fifty percent of Kabul residents rely on private wells. Groundwater is the main source of drinking water and shows **high concentration of nitrate** in some places. The **sewage system is poor** with only twenty percent of households connected to wastewater treatment systems or toilets with storage tanks. This has likely resulted in **groundwater pollution**. **Infrastructure** of the municipal waterworks in Kabul

are **in poor condition** with rundown pipelines and pumping stations (GIZ 2019). **Many buy drinking water from tankers** but those who cannot afford it use polluted surface water or groundwater. **Digging of deep wells affects the urban water table** and requires greater controls (Habitat 2015; World Bank 2019). The state-owned Afghanistan Urban Water Supply and Sanitation Corporation (AUWSSC) has been made more corporate which has contributed to somewhat improved efficiency and sustainability (Habitat 2015). However, the sector remains fragmented and institutional capacity is weak (World Bank 2019).

Population growth is high and demand continues to outstrip supply despite significant donor investment in the urban water supply networks and development of the technical and managerial capacity of the AUWSSC (Habitat 2015). A World Bank project report finds water sources to be adequate in volume but under-utilised (World Bank 2019). Although **declining and erratic precipitation associated with climate change** is putting additional pressure on water resources.

A paper from the manager of AUWSSC and the director of Urban Water Supply Improvement Programme (GIZ) describes **challenges for water management in post-conflict situations** based on experience in Afghanistan (Baheer & Koch undated):

- **Lack of** suitable **legal and regulatory framework**
- **Unclarity in roles**, responsibilities and decision-making powers. High levels of **political interference** make services ineffective and inefficient.
- Qualified and experienced **water engineers emigrate**. There are limited funds to employ skilled personnel.
- Both hardware and institutional **infrastructure are damaged** during war. Huge investments are required for rehabilitation.

Syria

In Syria, infrastructure support systems have become strained by protracted conflict and water has been used as a weapon of war (Sikder et al 2018). As piped water has been disrupted many are **reliant on water trucking networks** which come at a **high cost**.

Water is scarce in urban areas because of **poor management rather than actual scarcity**, and rainwater harvesting has good potential.[2] Laws protecting water are in place but are not enforced.

Experience from different cities includes:

- **Emergency water trucking** services are used in Ar-Raqqa city to provide for internally displaced people (OCHA 2017).

[2] https://water.fanack.com/syria/water-challenges/ accessed 23.10.20

- Aleppo city has water infrastructure in place but **problems with power supply** from the national grid. **Backup power generators are used to pump water to the city which has high fuel costs** (OCHA 2017b).
- Besieged areas in Deir ez Zor City have been **reliant on** insufficient amounts of **unprocessed river water** delivered through the water network (REACH 2017).

A damage assessment for the cities of Aleppo, Hama, and Idlib describes how the water services rely on electricity for functionality and that **lack of electricity is the most common reason for water outages** (World Bank 2017). **Damage to pumping stations and piping networks** is the second most common reason. The water treatment plant in Aleppo was partially damaged in an airstrike and repaired by government engineers supported by the Red Crescent. 22 out of the 205 wells assessed were damaged. 34 out 110 water towers or tanks were damaged.

4. Practical measures for addressing vulnerabilities in water infrastructure systems in FCAS

Increased demand from influx of IDPs or refugees

Influx of refugees in Jordan increased demand and therefore pressure on the water system damaging pipes (Diep et al 2017). The non-revenue water[3] rate in Jordan was already 60-65 percent with between 20-50 percent of this due to leakage. **The Jordan Water Company[4] focussed on addressing leakage issues and commercial losses** to improve the situation for the local population.

National governments in Jordan and Lebanon have considered themselves unable to provide services for influxes of Syrians so leave international agencies to provide (Diep et al 2017). The **provision of bottled water or simple distribution systems** have been common practices for relief provision in camps.

In Lebanon some funds were leveraged to improve supply by investing in benefits for both newcomers and the existing population (Diep et al 2017). **Integrated approaches addressing the needs of refugees and host communities have benefited water-supply systems as well as reducing tensions and building local provider capacities** in MENA countries.

Addressing displacement into urban contexts **should take an integrated area-based approach** rather than traditional sector-based programming targeting individuals based on their status. In Somalia the UN and NGOs developed a set of programing principles to transition to integrated area-based programming in different sectors (Taruri et al 2020). The principles were endorsed by the Federal Government of Somalia and aimed to coordinate across humanitarian, development, and peace actors. Multi-year, multi-sector consortia were put in place to ensure the programming principles were put into practice.

[3] water that is produced and then lost before it reaches the consumer

[4] Miyahuna

Physical damage to infrastructure

In Somaliland the African Development Bank (ADB) are contributing to **construction and rehabilitation of water infrastructure for resilience** (ADB 2016). This includes building 9 new damns, improving 6 existing damns, augmenting the water system in Hargeisa to support internally displaced persons (IDPs), rehabilitating boreholes, construction of 20 solar powered mini water systems with draw-off and sanitation facilities, and procurement of a drilling rig. It was not outlined which of these were relevant specifically for urban areas apart from the Hargeisa water system support.

Construction in urban Afghanistan includes well fields, transmission, and storage and distribution networks (Baheer & Koch undated). The urban water sector in Afghanistan was controlled by a parastatal organisation called the Central Authority for Water and Sewage at the that the source was written. Infrastructure projects were undertaken by the International Committee of the Red Cross, the Danish Committee for Aid to Afghan Refugees, and CARE International with donor support from GIZ, USAID, and World Bank. In Kabul, Afghanistan the German government have supported installation of household water mains, built new wells, refurbished pumping stations and new collector facilities (GIZ 2019).

In war zones in MENA utilities deal with direct damage to infrastructure by either hiring external companies or carrying out repairs themselves, for example, on pumping stations, treatment plants, power stations or pipes (Diep et al 2017). **Urgent repairs are often short-term and lack resilience**.

Following independence in Senegal, the **national army was involved in improving infrastructure** which had the additional benefit of rebuilding trust between civilians and security forces (Partners for Democratic Change 2010).

Capacity development and human resources

Government and institutional reform is a priority in fragile contexts (Steduto et al 2018). This includes improving efficiency, accountability, regulation capacity, use of participatory approaches, and investment planning processes. Experience in MENA suggests that it is important to invest in both physical infrastructure and the management side of service provision (Diep et al 2017).

It is difficult for outside support to reform institutions where confidence and transformation need to be nationally led, though **international actors can take an intermediary role** (Saddof et al 2017). Saddof et al (2017) recommend particularly that **third parties have a key role in promoting data transparency**.

In Somaliland the **ADB are supporting the Hargeisa Water Technology Institute and the water quality laboratory** (ADB 2016). They are supporting the Ministry of Water Resources with equipment, logistics, and project management.

Government agencies across the **MENA region** have received **training through the Arab Countries Water Utilities Association** (ACWUA) and the German development agency (GIZ) to **increase technical abilities of local staff** (Diep et al 2017). The International Committee of the Red Cross **trained 127 technicians to independently operate and manage water supply**

facilities that were constructed in Iraq (ICRC 2015). Skills audits are important to identify gaps and support needs.

A report on urban water planning in Afghanistan notes that lost human resources are very difficult to replace (Baheer & Koch undated). **Young people that are available should be engaged and placed on fast-track training**. Hiring outside contractor should be avoided otherwise local institutional weakness is perpetuated. In some circumstances, international agencies directly finance utility staff salaries to retain personnel (Diep et al 2017).

Oxfam organised **integrity management training** in Northern Kenya to improve infrastructure and strengthen financial management to reduce financial wastage (Tillett et al 2020). E-billing and wastage reductions resulted in a water utility able to meet its costs and able to subsidise the poor to access water. Improved finances created greater staff morale.

Coordination

Water projects are often split over different areas and it is difficult to get an overall view for country-level coordination (UN-Water 2014). **Coordination is ideally led by government** to achieve "an appropriate enabling environment of policies, laws and institutions for sustainable and efficient implementation of water resources management, water supply and sanitation and other water related programmes" (p7). There is generally a lack of reporting to assist management coordination. Water Accounting[5] is a database which aims to improve information for decision makers in the water sector in different countries. It integrates hydrological processes with land use, managed water flows and the services which result from water consumption in river basins.

In response to the lack of **clarity of roles** within institutions and between stakeholders in Afghanistan **a policy document was formulated, the Afghanistan Urban Water Supply and Sewerage Policy** (Baheer & Koch undated). **A new Water Act** was drafted and passed in 2009. **A new corporation** was formed, the Afghan Urban Water Supply and Sewerage Corporation. Plans for the short-, medium-, and long-term were included.

With training, **utility staff in the Gaza Strip and West Bank were able to coordinate with other sectors to integrate emergency plans for wider national and local response** such as with shelter and settlement response plans (Diep et al 2017).

Examples of groups and committees include:

- Coordination from the **global WASH cluster supported the local water and sanitation corporation in Yemen** (Diep et al 2017). Humanitarian roles were distributed between international organisations to meet needs. UNICEF took on fuel provision, ICRC supplied parts and equipment to maintain infrastructure, and the local corporation had an emergency team funded by Oxfam. Cluster coordination aims to gather to support governments.

[5] https://www.wateraccounting.org/

- In DRC transitioning from humanitarian aid to self-sufficiency is being achieved with **WASH Management Committees** supported by the DRC WASH Consortium[6] (Nilsson et al 2018). Business plans were developed including **strategies for revenue to cover service costs**. Fees were collected from households with concessions for vulnerable households. **Life cycle cost analyses were useful**. Some committees diversified revenue sources with additional income generating activities.
- Effective provision in **refugee camps** in MENA is supported by **community water committees** (Diep et al 2017). This improves communications between stakeholders. Service users have a platform to voice their needs and concerns, and service providers can respond quickly to issues.
- **Participatory decentralised groundwater resource management**, such as water user associations or community natural resource management groups, has seen some success in the Republic of Yemen and Egypt (Studuto et al 2018). Decentralisation schemes **need to manage the risks of power dynamics** which can induce inequalities.
- **Stakeholder workshops** led by the Ministry of Water Resources and Welthungerhilfe in Somaliland were held to analyse the strength of the WASH system and prioritise key actions (Tillet et al 2020). A sector task force was established to ensure agreed actions were implemented.
- **Community management committees** have been successful in the Ituri Province of the DRC supporting the operation of gravity flow water schemes (Tillett et al 2020). An umbrella organisation was created, in the place of previous committees which operated separately, to assist with administration and technical management.
- In Mozambique there is a **WASH technical group led by the Department of Water**. It brings together key actors to showcase their programmes and exchange their experience (UN-Water 2014). Actors also gather for an annual sector review. Mozambique have a donor group who have pooled their support to channel funds through the treasury.

Effective area-based programming must identify interventions that already exist to identify gaps rather than trying to address all of the needs and vulnerabilities in that area (Taruri et al 2020). Different actors must complement each other.

Systems approaches aim to understand and strengthen linkages between different actors and factors of which systems diagnostics are a core part (Tillet et al 2020). **Climate Risk Informed Decision Analysis** (CRIDA) is recommended **to engage local communities in design and analysis of programming** (Mendoza et al 2018). The multi-step process identifies water security hazards with sensitivity to indigenous and gender-related vulnerabilities. The approach starts by establishing a collaborative approach for assessment, then uses bottom-up implementation, formulates alternative plans, uses techniques to compare and recommend plans, and finally, formalises the decisions.

To improve engagement with the service authority in the Karamoja district of Uganda Welthungerhilfe used a **point asset inventory mapping process which served an entry point for communications** and helped to strengthen asset management arrangements (Tillet et al

[6] 2013-2019, led by Concern Worldwide with ACF, ACTED, CRS, Solidarités International, and funded by UK Aid.

2020). The **work on systems strengthening deepened the relationship with the service authority and improved trust**.

Private sector provision

Private sector can provide stability where the state is weak and can be seen to be **more independent** (Tillett et al 2020). Private companies may be connected to overseas finance so be less affected by local economic problems. Markets can provide relief and basic services and require market assessments and supporting market actors (Global WASH Cluster Technical Working Group for WASH and Market Based Programming 2019).

Research in Syria suggests that market forces can work effectively in managing urban water resources with support (Sikder et al 2019). **Support is required to make these services affordable** for example with well-targeted subsidies such as vouchers or coupons. **Regulation is also required to ensure quality**.

In Tripoli, Lebanon, private sector participation was used to service and manage drinking water services in 2003 (Diep et al 2017). The contract with the company, financed by the French Development Agency, included infrastructure construction and capacity support to the water supply institution. Water losses were reduced, supply and quality of drinking water was good, and staff training was carried out. Billing rate and debt recovery targets were not met. The private operator found it difficult to operate in an uncertain institutional environment and did not re-negotiate the contract in 2007.

Public-private partnerships (PPPs) have been active in conflict-affected MENA countries to manage utilities (Steduto 2018). The asset remains a public utility and management and performance-based contracts are used. This has helped **reduce leakage and improve efficiency gains**. Contractors can be offered financial incentives for volume of water saved.

A **PPP** has been shown to play an important role in providing drinking water in the **city of Garowe in Somalia** (Jama & Mourad 2018). However, lack of clarity in roles and responsibilities has been an issue. A case study in **Dollow town in the Gedo region of Somalia** found a PPP to have been successful in providing stable and sustainable water supply (Were & Odongo 2018). The Dollow **Water Management Company**, established in 2011, included **representatives from different sectors on its Board of Directors**. This included businesses, women, NGOs, religious leaders, and local elected administration. The Board developed **guidelines for its operations and its relationship with the community, with training in water supplies management**. A project-level **legal framework** was developed following **analysis of the operating environment, training on the importance of PPP, and stakeholder empowerment**. The Company have increased service from 50 connections to 850 in seven years. 36 communal water points were installed in IDP camps. And a number of schools, hospitals and religious buildings were serviced. Success was attributed to collaboration between the company managers, local authorities, and NGOs. The key lessons emphasised are the **need for a regulatory framework, close supervision from state and local authorities, continuous mentoring,** and funding support.

Political issues

The World Bank's Water and Sanitation Programme (WSP) have found greater success in improving water availability where **political incentives are in place to make services work** (Sadoff et al 2017). Where crises have reduced central government presence, **local-level politicians are incentivised by improvement in water supply as it demonstrates local competence**. **Water supply also has the potential to bolster the local tax base**. For example 5 percent of water sales by the Hargeisa Water Agency go to the Somaliland central bank.

Recommendation on government engagement

Engaging with government to assist with water systems in fragile contexts must always be **context specific** (Tillett et al 2020). It may not be appropriate to work with a state accused of war crimes for example, or it may be inappropriate to be seen to be aligning with a particular party. WASH service delivery may inadvertently legitimise or empower parties in a conflict. Therefore support must engage at the appropriate level; **engage at a technical rather than political level**; and set realistic objectives without trying to address all the gaps at once. Tillett et al (2020) further recommend that where it is not possible to engage with the government, outside actors should focus on practical aspects of the system and engage when possible. Where engagement is possible system strengthening efforts could be similar to in non-fragile contexts with additional areas of focus such as including elements of emergency response. In Somaliland Welthungerhilfe is supporting decentralisation by working at regional rather than district level as capacities and budgets were limited at district level.

5. Resilience

An International Institute of Environment and Development (IIED) paper on conflict-affected MENA countries describes **resilient systems in the water sector as characterised by "flexibility, resourcefulness and responsiveness, redundancy** (in systems' design or with the availability of spare resources), **modularity** (self-organisation) and **safe failure** (minimum damage)" (Diep et al 2017, p8).

IIED recommendations for resilience in water management based on experience from conflict-affected MENA countries (Diep et al 2017):

- Building resilience through **efficient resource management**. This includes emergency plans and contingency stocks; training to build sustainable human resources and internal capacity; reducing non-revenue water;[7] increasing efficiency of water and power use; and keeping up-to-date with data.
- **Making interventions sustainable**. Humanitarian and development agencies must **research and analyse the needs and capacity gaps** of utilities. Relief support should be complemented with improving preparedness and response capabilities.

[7] Water that is pumped and then lost without account

- **Work more closely with private sector**. Partnering with independent providers has multiple benefits. Regulatory frameworks must be strengthened and enforced to monitor this activity. Examples in the previous section.
- **Maintain strong relationships with communities**. Engagement and building relationships between utilities and communities improves accountability and trust. Community mobilisation can build shared efficiency when social tensions affect service provision.

Examples of resilience programming include (Diep et al 2017):

- **Reduction of dependency on a single source** in Syria with secondary wells and emergency treatment equipment.
- **Contingency planning** in Palestine includes a series of national crisis plans prepared for different emergencies. This includes an action plan for the Coastal Municipalities Water Utility to operate in the Gaza Strip in times of conflict. There is also a decentralised warehouses for emergency stocks.
- **Reducing reliance on emergency power supply** which carries high costs, UNICEF supported Yemen by installing direct electricity lines and by building pilot solar systems. The production is limited but a step in the right direction.
- **Pre-existing issues such as cost-recovery** must be addressed for improved resilience. Reducing non-revenue water has been found to be the most useful way of addressing cost-recovery in MENA.
- **Upgrading meter-reading systems** to better manage water resources. Having the appropriate equipment to collect and monitor data to bill customers accurately and provide incentives to conserve water. For example the e Holding Company for Water and Wastewater in Egypt replaced old meters in a number of cities and achieved reductions in non-revenue water rates.
- **Payment of bills online** in Baghdad has reduced water consumption and increased revenues.
- The Palestine Water Authority is constructing **desalination** plants to serve the Gaza Strip where alternative sources of water were required. A low-volume plant has been built with the support of the European Union and UNICEF.
- **Training community representatives** provides a resilient approach such as in the creation of WASH centres in Iraq where displaced natives and NGO staff serve displacement affected areas.

6. Water programming in non-fragile states

Whether lessons from non-fragile states are relevant to a fragile situation will depend on the context of the fragile state under consideration. Ideally, local governments and communities would be given information and training on different solutions so that inclusive shared decisions can be made.

Country-led service delivery

Transformations in Africa which have enabled progressive government ownership include economic growth increasing resources to domestic budgets; more predictable environments as conflict subsides; and donors shift towards national ownership (WSP 2011). Identified in the second round of Water and Sanitation Programme (WSP) Country Status Overviews (CSO2), **capabilities** must be built **for countries to utilise government systems, private sector systems and community capacity**. **Assessment frameworks** such as the CSO2 scorecard **identify drivers and barriers along service delivery pathways**. Managers with data on inputs and outputs often need support in terms of what happens in between and this is where scorecards can help.

Management

Urban water systems are complex and require a systems-level approach such as **Integrated or Sustainable Urban Water Management** (IUWM), Total Water Cycle Management, and Water Sensitive Urban Design (Jensen & Khalis 2020). IUWM focuses on **small-scale distributed systems combining water, wastewater and solid waste treatment to reduce costs**. This approach is recommended as effective in cities where water systems are highly fragmented. Governance structures can be restrictive for incentivising innovation and costs of retro-fitting may be prohibitive. Local interventions need to be aligned and coordinated by strong city-level strategy.

Portfolio approaches may resemble IUWM but focus on mitigating risk by spreading between different resource options rather than relying on one source (Hardy 2015). There are inherent challenges in each water supply option so diversifying water supplies is an important strategy. Environmental, social, political and institutional factors need to be taken into account.

Measures

A very brief outline of practical measures to improve water availability in low-income countries:

Rainwater and stormwater collection

Rainwater harvesting has potential for increasing resilience in urban water systems as a useful back up for temporary water supply problems (Hardy et al 2015). Stormwater runoff has potential use but in urban areas may be contaminated and therefore useful for non-drinking water uses.

Water reuse and treatment

Indirect potable reuse (IPR) treats to remove contaminants from waste water to drinking standards (Hardy 2015). Full knowledge of source water quality is required to decide appropriate treatments. Non-potable water reuse produces water largely for agricultural or industrial use.

Distillation or evaporation methods can be used to desalinise water (Treacy 2019). These methods use a lot of energy which make them costly (Hardy 2015). Costs can be reduced by use of solar or wind energy (Treacy 2019).

Demand management

Demand management may include financial incentives for companies using reused water, certification for eco-efficient homes, free water efficiency diagnoses, public guidelines on water management, installation of meters for suppliers and consumers, and appropriate pricing structures based on volume of water used (Hardy 2015).

Water loss reduction

This includes responding to burst pipes or drops in pressure (passive leak management) and leakage monitoring (active leak management) (Hardy 2015).

7. Nature-based solutions

An earlier K4D report reviewed nature-based solutions for water security (Cooper, 2020). These include “source water protection, wetlands restoration, protection, and construction, water harvesting, agricultural best management practices, soil conservation, afforestation and protecting mangroves amongst others” (p2). Best practice examples are identified in both rural and urban settings. One urban example is green infrastructure approaches in China including green roofs, pervious pavements, rain gardens and peri-urban wetland restoration (Wang et al 2018).

The nature-based solutions project database[8] was mined and the following examples identified in FCAS:

- Two projects in **Mozambique** address issues of **urban flooding**. A World Bank Project builds climate resilience with **green infrastructure** including an urban park in the city of Beira. And a USAID project assessed **mangrove restoration** to protect the most climate-vulnerable residents in peri-urban areas in Quelimane City, Icídua and Mirazane. Economic evaluation is positive and net present values were higher than the without-project case (Narayan et al 2017). To reduce drought in rural areas World Bank are supporting the Government of Mozambique with natural resource management engaging with agriculture and forest-based value chains. And securing land rights to reduce topsoil erosion, land degradation and biodiversity protection.
- A United Nations Environment Programme (UNEP) funded by the European Commission aims to improve the capacity of communities to cope with **droughts and floods** with **forests and vegetation** for sustainable drylands management in North Darfur, **Sudan**.
- A World Bank project in **Myanmar** uses afforestation and vegetation to address urban flooding. The project includes **slope stabilisation** and bio-engineering techniques.
- The World Bank **Disaster Risk Management and Urban Development Project in Niger** includes nature-based solutions to reduce flood risk.
- Ecosystem-based disaster risk reduction in Koh-e Baba Mountain, **Afghanistan** with UNEP funded by the European Commission. This included **stabilising streambanks**

[8] https://naturebasedsolutions.org/map

and degraded slopes through re-planting. Local and national skills were developed in this area.

- A World Bank project decentralises **forest and woodland management to help reduce drought in Burkina Faso**. For rural communities to improve climate shocks.
- A World Bank project in **Mali** adopts **sustainable land and water management** (SLWM) practices for climate vulnerable communities. It aims to conserve biodiversity and support poverty reduction activities applying an ecosystem-based adaptation approach.

All of the projects included training and capacity building components for strengthening local involvement. Evaluations or lessons from these projects were not available.

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This report is based on twelve days of desk-based research. The K4D research helpdesk provides rapid syntheses of a selection of recent relevant literature and international expert thinking in response to specific questions relating to international development. For any enquiries, contact helpdesk@k4d.info.

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