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Groundwater supply sustainability in fragile states: a case study examining challenges and approaches

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Sustainable groundwater supply development in developing countries remains an ongoing challenge due to a range of technical and community related factors. The challenge in fragile states becomes increasingly difficult due to often adverse operational environments and rapid NGO interventions. Such challenging conditions reduce the likelihood of achieving sustainable supplies in the long term. Recent practical experiences in Wau, South Sudan are presented and used to examine groundwater supply sustainability challenges and potential solutions that can be applied in wider fragile state contexts. It should be recognised that groundwater supply sustainability cannot always be realistically achieved in fragile state environments; however, long term financial and developmental incentives exist to maximise sustainability potential wherever the context allows. A combination of preparedness and informed early-phase decision making in collaboration with capable local partners can maximise groundwater supply sustainability potential in challenging fragile state working environments.

Introduction

Rural groundwater supply sustainability remains a challenge across developing countries with international Non Government Organisation (INGO) - installed supplies across Africa reported to have a failure rate within a few years of up to 67% (Rural Water Supply Network, 2009). Achieving a sustainable supply requires 1) an understanding of the hydrogeological system to establish the available groundwater resource, 2) application of suitable technology to abstract the groundwater resource, and 3) local capacity to operate and maintain a supply.

Achieving sustainable supplies becomes increasingly difficult in fragile states often characterised by complex operating contexts and prolonged insecurity, requiring rapid INGO interventions within adverse political climates. Fragile state challenges include recurrent instability, restricted access, insecurity, transient population movement, intentional sabotage, market breakdown and lack of institutional support often associated with short term INGO interventions. The challenges are further exacerbated by climate-change related environmental pressures. However, clear long term financial and developmental incentives exist to maximise sustainability potential where the context allows.

This paper focuses on the development and management of groundwater supplies in fragile states to examine challenges and approaches to maximise long term sustainability potential. A case study from South Sudan is presented based on recent Oxfam practical field experience with examination of how these experiences can be applied to broader fragile state contexts.

Case study: Wau, Western Bar el Ghazel, South Sudan

Context

Wau is a state in northwest South Sudan and forms part of the former Western Bahr el Ghazal state. The state capital is Wau town with a population of approximately 150,000. The capital is serviced by a treated public water supply connected to approximately 1800 households and public access standpoints across the town. In areas of the town not supported by the public supply, groundwater provides the most viable

alternative and is abstracted using a combination of boreholes installed with manual pumps and open shallow, unprotected hand dug domestic wells.

In late June 2016 armed conflict broke out in Wau between government and opposition forces. The events resulted in the displacement of approximately 55,000 IDPs from both within Wau town and nearby rural areas relocating to camps within Wau town. This resulted in Wau town remaining under control of government forces and surrounding rural areas being under control of opposition forces.

Oxfam has been operating in Wau for sixteen years running WASH, Food Security and Livelihoods development programmes. An immediate emergency response was implemented with INGO partners included provision of groundwater supplies across the IDP camps as well as provision of support to host communities. As of late 2016 free access exists within Wau town although restrictions are in place hindering access to the rural areas west of Wau town. Much of the recent INGO focus has been the provision of ongoing support to the IDP camps and host community within Wau town with limited interventions possible in the surrounding rural areas.

Hydrogeological conditions

No detailed historical geological or hydrogeological studies have been completed for the Wau region. Data from drilling contractors and the local government water department (Department of Rural Water Supply and Sanitation (DRWSS)) staff indicate that geological conditions are characterised by laterite underlain by crystalline bedrock. The conditions present a complex hydrogeological environment comprising discontinuous shallow intergranular aquifer systems underlain by deeper crystalline basement aquifers relying on secondary permeability fracture flow. The hydraulic connectivity between the shallow and deep aquifer systems is variable across the region with consequences for long term groundwater resource sustainability and contamination risk management. The reliance on secondary permeability fracture flow within the crystalline bedrock sequence results in highly variable conditions controlled by the presence or absence of faults and fracturing. The conditions therefore makes groundwater supply planning challenging as borehole yields can be locally extremely variable dependent on the extent of fracturing present at a particular location.

Village and community boreholes within Wau town are typically installed with India Mark II pumps in line with the local DRWSS preferences. Boreholes installed with mechanised submersible pumps are not common but where present can achieve yields of up to $10m^3$ / h. A high borehole failure rate is however reported by local contractors (of the order 70%) for locations intended for submersible pump use due to inadequate aquifer capacity.

Emergency water supply response

The initial emergency response focussed on the immediate needs of the IDP camps within Wau town. Three IDP camps were located within church grounds enabling, through engagement with church authorities, placement of boreholes to enable adoption for long term usage. Oxfam works were supported by an experienced EP&R (Emergency Protection and Response) WASH team. Manual drilling is used elsewhere in South Sudan by Oxfam in emergency situations to further develop local technical skills although geological conditions are unsuitable for this approach in the Wau area.

Working with INGO partners the response involved initial water trucking followed by borehole installations within the camps (equipped with mechanised pumps for the larger camps and manual India Mark II pumps in less populous camps). Due to the emergency situation, initial reliance was on groundwater supplies without a good understanding of the aquifer systems which resulted in unsuitable borehole designs and some failed borehole supplies. A hydrogeological study is in the process of being completed to assist with longer term groundwater supply management.

Manual pump selection was undertaken in consultation with DRWSS to ensure consistence with existent pump standardisation, local parts availability and local technical skills. For mechanised submersible pumps, assessment works are currently being implemented to evaluate the suitability of solar powered pumps as a lower cost long term solution for selected IDP camps.

Oxfam and INGO partners across Wau have undertaken additional programmes to improve the resilience of the host community water supplies including;

- Upgrade of host community based water supplies (selected schools and hospitals).
- Upgrade and repair of community level groundwater supplies to provide functional facilities for IDPs to return to once the security situation has improved.

Community and partnership with local authorities

Community development work has been challenging due to continued population movements and restricted INGO access in certain areas. Oxfam´s long term development projects across Wau town and surrounding rural areas applied conventional Water Management Committee (WMC) approaches to improve operation and maintenance mechanisms; the conflict has resulted in access restrictions that prevent Oxfam and partners from continuing the WASH programs in these rural areas. Such restrictions prevent systematic programme implementation and ongoing monitoring of handpump functionality across the rural areas.

Due to recurrent problems within the case study area, Oxfam has partnered with DRWSS as a mechanism to improve long term resilience. Ideally such an institution will set standards and establish consequences where committees are not performing while ensuring that INGOs follow a consistent approach that wouldn't undermine resilience and tackle dependency on aid. The local DRWSS office is limited by resources and capacity building remains an ongoing process requiring long term support. Training programmes have been ramped up through the response to further develop DRWSS capacities in both the immediate and long term.

With Oxfam technical support DRWSS provides capacity building at a local level focussed on communities within Wau town and accessible rural areas. This has focussed on providing support to 1) local IDPs displaced by conflict, 2) host communities near to IDP camps, and 3) community areas affected directly affected by conflict (where accessible). To maximise sustainable supply potential, capacity building activities delivered by DRWSS has focused specifically on training the following groups:

- Community-selected camp based IDPs in manual pump repairs to facilitate the transfer of technical capacities to home communities upon return.
- Host community WMCs to provide additional resource and resilience to help deal with the additional population pressures associated with the IDPs.

Although pump mechanic training has been successful, an ongoing challenge is the development of long term working relationships between trained mechanics and communities that possess the motivation and capacity to raise funds independently to finance technical services. Ongoing WMC development is also challenging due to ongoing population displacements within the host communities and subsequent lack of a direct sense of ownership of groundwater supplies. The greatest successes have been experienced in more remote but accessible rural areas where independent supply management is observed and particularly herders who depend on groundwater supplies for the livelihoods.

The complex operating environment makes the implementation of the community based works challenging; lasting progress is dependent on the establishment of long lasting stability in the region. The provision of the required emergency response by the NGO community ultimately conflicts with the aim of empowering communities to be capable of operating and managing water supplies independently; in cases this has resulted in increased reliance upon INGOs and DRWSS to provide support.

Coordination and data management

To encourage improved coordination between the WASH partners and help improve programme delivery Oxfam currently provides a WASH Cluster State Focal Point (SFP) for the former Western Bahr el Gazel state area. The cluster continues to provide an important platform for information sharing and coordination of ongoing response activities.

A national database of groundwater supply locations (Water Information Management System (WIMS)) was developed (pre-conflict) by the Ministry of Water with the latest available version being 2012. Oxfam is actively working at both local and national levels to maintain WIMS use in combination with GIS to form the basis for longer term strategic planning.

Challenges

Groundwater supply sustainability challenges experienced in Wau can be related to factors common to fragile state environments in general. Recognition of these common challenges can assist in the development of approaches to help maximise sustainable groundwater supply potential:

1. *Rapid response time*: Programme implementation in fragile state environments is often undertaken in an emergency context requiring rapid programme design and proposal preparation where days and hours matter. This can be an underlying causal factor by not allowing adequate time to fully assess the technical and social challenges required enable appropriate programme design.
2. *Technical implementation*: Rapid programme implementation under difficult and pressurised working conditions can result in sub-standard works that in other less pressurised contexts would be expected to be completed to a high standard enabling longevity. A simple example would be a rushed borehole completion that is not adequately developed to save time; in the short term the result may be perceived as positive due to the rapid completion but resulting fine material within the pumped water may reduce community uptake of the borehole and ultimately reduce the longevity of the pump installation. Furthermore, pressured implementation timescales can often result in rushed and poorly implemented community development and prevent the required long term support and monitoring.
3. *Community structure*: Transient population movements can result in the breakdown of community structure in both the short and long terms. Remaining community members may be vulnerable and lack basic capacities to maintain and manage basic groundwater supplies independently. Coping mechanisms for host communities are likely to become stressed or broken. These situations may result in an increased reliance on external support (e.g. INGOs, local authorities or private sector) which can have a detrimental effect on the community capacity to operate and maintain supplies in the long term.
4. *Government institutions*: Where present, government water departments are likely to suffer from reduced and limited capacities in fragile states. Breakdown of government institutions resulting in reduced resources (e.g. unreliable salaries, lack of power, no vehicles) at field level will adversely affect motivational levels and remove or reduce the effectiveness of local institutions that are needed to play a critical role to achieve long term groundwater supply solutions.

Solutions

Informed decision making at the response planning stage is critical to enable selection of appropriate groundwater supply solutions to maximise resilience. For example solar powered borehole supplies may not be suitable due to poor aquifer conditions or vandalism risks; in such cases it may be more appropriate to invest in lower technology solutions that can be maintained and repaired at a local level. However, an early understanding of the technical and social context is required to arrive at the correct solution.

Maximum preparedness is important to inform decision making to maximise groundwater supply sustainability potential and maximum preparedness can be achieved where organisations have long term operations within fragile states. Where advance preparedness is not possible, interventions should take appropriate early response actions to maximise use of the available information to establish an understanding of the technical and social contexts to ensure appropriate response implementation. Table 1 presents an overview of relevant preparedness and response considerations which include:

- Understanding hydrogeological conditions, groundwater resource sustainability and associated supply risks (e.g. long term risks associated with derogation or contamination).
- Awareness and application of the most suitable groundwater supply technology for the local context.
- Recognition of capacity building needs for local partners (for immediate and long term application).
- Clear identification of target interventions (e.g. IDPs, host communities, affected community areas).
- Clear designation of responsibility of who is expected to manage groundwater supplies in the long term.

Preparedness and response also includes the need for having appropriately experienced staff and efficient systems to help overcome challenges associated with pressurised timescales and challenging operating conditions.

Table 1. Considerations for sustainable groundwater supply development in fragile states

Consideration	Preparedness	Response
1. Hydrogeological conditions	• Establish an understanding of hydrogeological and hydrological conditions to form the basis for groundwater supply projects design (and further more detailed studies if necessary) • Identification of competent local drilling contractors • Identification of appropriate borehole drilling techniques for the local geological conditions • Identification of key risks (e.g. risk of contamination of deep aquifer system from a shallow aquifer system)	• Initiate rapid hydrogeological study if required • Engage staff with hydrogeological experience • Ensure borehole designs are appropriately tailored to local hydrogeological conditions • Ensure borehole drilling and installation is correctly completed • Ensure pump testing is properly conducted over an appropriate duration • Undertake long term aquifer sustainability assessment where relevant • Systematic monitoring of groundwater levels and water quality during borehole operations to capture long term trends • Facilitate data and information sharing between partners and authorities
2. Operation and maintenance	• Partnering with capable local authorities and understand local technical capacity • Understand local pump standards, spare part types, markets and availability • Technical training and capacity building for immediate and future application (drilling, pump maintenance, groundwater level and groundwater monitoring, data management and interpretation)	• Adherence to local and national standards • Provision of contingency spare parts • Delivery through local partners • Appropriate focus on IDPs, host communities and original IDP communities (to ensure functional facilities in place for their return) • Ensure emergency interventions are consistent with existing operation and maintenance framework / standards
3. Community development	• Partnering and capacity building with local authorities • Understand community structures and where responsibility lies for supply management • Assessment of spare part supply chain networks and / or potential for development of networks • Establish baseline community water management capacities	• Clear identification of who will take responsibility for supply management (village chief, local authority, private sector) • Work with IDPs in camps to provide capacity development for future transfer to home communities in the future • Work with host communities to improve resilience to cope with additional IDP population pressures • Use Displacement Tracking Matrix (DTM) data to understand current population dynamics to develop intervention strategy • Allocate long term accountability mechanism (e.g. monitoring through local partners and / or institutions)
4. Data and communication	• Advocate for coordinated local and national groundwater database • GIS application to assist with technical understanding and gap analysis • Encourage active cooperation coordination between partners through WASH cluster	• Regular information sharing between partners • Activity mapping and coordination through WASH Cluster mechanism

Conclusions

Fragile state environments present extremely complex challenges for sustainable groundwater supply development and it must be recognised that sustainable approaches will not always be feasible in such contexts. Maximising supply sustainability potential and resilience should be maintained as an objective; success will however depend on the local context and the presence and capacity of local institutions.

Preparedness and informed early response decision making are two significant factors affecting ability to implement interventions that maximise groundwater supply sustainability. A combination of these factors while working in collaboration with reliable and capable local partners will therefore help maximise groundwater supply sustainability potential under difficult operational conditions.

Four key areas have been identified to focus on for preparedness and response in fragile states:

1. Understanding local hydrogeological conditions and supply development techniques.
2. Operation and maintenance mechanisms.
3. Community development through partnership with local institutions.
4. Data management and interagency coordination.

These factors are of course common to non fragile state environments. However pressurised, rapid response fragile state interventions will reduce the extent to which these areas can be assessed / implemented and shortcomings are more likely to be exposed through premature groundwater supply failures. The need for the use of appropriately experienced staff and efficient systems is important in such interventions.

Sustained emergency intervention can result in increased community reliance on external support which is likely to have a detrimental effect on the long term ability of communities to independently manage groundwater supplies. Response intervention should therefore attempt to incorporate transition strategies into emergency programme development where viable; delegation of responsibly for long term supply management to capable local partners, even in fragile state environments should be a key part of this.

Although sustainable groundwater supplies in fragile states will not always be feasible, it should be possible to maximise longevity through systematic assessment of the key factors to enable implementation of appropriate strategies and techniques for local contexts.

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