Developing Water and Sanitation Services in Refugee Settings from Emergency to Sustainability – The Case of Zaatari Camp in Jordan

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Abstract: Three years after Zaatari camp was established in the Hashemite Kingdom of Jordan, to host Syrian refugees, its population has grown to 82,000 persons. Zaatari is one of the largest refugee camps in the world, in one of the most water scarce areas on earth. Since its establishment, drinking water has been delivered by trucks to communal facilities across the camp. Wastewater is trucked out from these facilities, and from unregulated, self-constructed wastewater storages next to family households. In order to improve long-term sustainability in all aspects: equitable water and sanitation access, public health risks and environmental impact and operational costs, water and sewage systems with household connections are being implemented. In this shift from emergency to sustainable phase, urban infrastructure selection and design methods were found to be beneficial and adapted for the situation. Aspects such as stakeholder management and project management, throughout design and implementation phases, are vital and similar to the planning processes of urban water utilities. Potential for further sustainability lies in the development of operation and maintenance and administrative strategy to reflect and maximise the significant investment. Therefore, a shift is necessary from a humanitarian approach toward a more structured vision based on master planning. Quality control of the entire process and outputs requires a project management unit. The long term master planning perspective of urban development and urban utility perspective of operational sustainability is determined to be essential in the conception of water and sanitation schemes in Zaatari refugee camp.

Keywords: cost effectiveness; drinking water; infrastructure; public health; refugee camp; sanitation; sustainability; wastewater.

Introduction

Zaatari camp in the Hashemite Kingdom of Jordan, opened on the 29th of July, 2012 and was initially designed to host approximately 22,000 Syrian refugees. The influx of refugees far exceeded the planned number almost immediately. Zaatari camp is one of the largest refugee camps in the world hosting around 82,000 Syrian refugees, now with a maximum hosting capacity of up to 100,000. In Figure 1 the spatial development of Zaatari camp is shown. The development of adequate water and sanitation systems that take into consideration humanitarian needs as well as environmental concerns is crucial in the camp. It is situated in one of the most water scarce areas on earth and above the Amman-Zarqa groundwater basin with an abstraction of 156.3 Mm^3/y in 2013, which is almost 30% of the total groundwater abstraction in Jordan (MWI, 2015).

From 2012 to 2013, UNICEF and humanitarian partners constructed 417 communal water, sanitation and hygiene (WASH) blocks spread out evenly across the camp as it grew. A complete gender segregation with privacy distances were incorporated, to take into account cultural practices and ensure protection (Sphere, 2011). Despite respecting minimum humanitarian standards, refugees' concerns around their personal safety and privacy hindered the use of the communal WASH blocks. As they were used to in their place of origin, inhabitants of the camp demonstrated a strong desire for family water and sanitation facilities.

Syrian refugees almost immediately started to construct private showers at household level. As humanitarian funds became available to improve living conditions and tents were replaced with better shelters (caravans), refugees used savings, income and resourcefulness to build toilets and showers adjacent to their caravans. Significant damage has been done to communal WASH blocks as refugees recovered construction materials to reinforce shelters and private WASH facilities, resulting in the loss of 14% of WASH blocks by February 2015. Significant humanitarian resources are continuously required to maintain the WASH blocks to a minimum standard, as the most vulnerable refugees in the camp are dependent on the use of the communal facilities. With the construction of private sanitation facilities, naturally, increased needs in water appeared. Unregulated water supply systems were developed, leading to inequitable water access, water losses and unregulated wastewater disposal by 93% of the households (REACH-UNICEF 2014), increasing the risks of communicable diseases spread and groundwater contamination.

Fig. 1 Spatial development of Zaatari camp from September 2012 to March 2013.

Inequity, health and environmental risks, increasing operation and maintenance resource needs, resulted from a combination of rapid expansion of the camp, fast self-development by refugees and variable and high population density. These conditions expedited the need to consider an integrated approach for service provision similar to urban utility water and sanitation. The objectives for the development of utility infrastructure for Zaatari camp are comparable to urban development, but the organisational context differs greatly. No plan exists for infrastructure or resource management departments, administrative functions, customer revenue sources, well-defined annual balanced budgets, nor contracts between service providers and users which determine service levels, rights and responsibilities. The fast conception of a refugee camp as an urban setting, with an integrated sustainable development approach within 2 years after opening, is novel. With the support from available funds, relevant government authorities and humanitarian partners, the development of sustainable water and sanitation infrastructure was started. The objective of this paper is to describe the development of the water and sanitation infrastructures in Zaatari refugee camp, from the emergency phase towards an integrated sustainable solution that is currently under design and moving to implementation.

Camp development

Since its establishment in 1950 the Office of the United Nations High Commissioner for Refugees is mandated to lead and co-ordinate international action to protect refugees and resolve refugee problems worldwide. Due to the large vital needs of refugees, UNHCR works with UN sister agencies and partners to try and satisfy them. UNICEF has been upfront in assisting refugees in the WASH sector, among others.

UNHCR considers the establishment of formal settlements as the last resort option and (whenever possible) prefers alternatives to camps, provided these protect and assist people of concern effectively (UNHCR, 2015a). However, the construction of refugee camps cannot always be avoided. When a camp is initially constructed, two phases are distinguished: the emergency phase and the post-emergency phase. The emergency phase is characterised by the sudden appearance of large groups of people in despair that can continue for months or longer if causal factors persist. Provision of essential services such as food, shelter, public health, water and sanitation need to be available immediately and contribute to protection and security. In protracted situations, refugee camps, planned as temporary by definition, may develop into permanent settlements defining the post-emergency phase. The facilities then need to serve the population for years ahead, as the average life of a refugee camp is 17 years (based on data from refugee camps under UNHCR mandate). In the post-emergency phase, services and facilities need to be developed sustainably with a view of the longer-term. In practice, the transition between phases is gradual and the conflict with maintaining services and facilities characterises the Zaatari camp experience.

Regardless of the period of displacement out of their country of origins, refugees naturally develop their own coping mechanisms, which strongly influence camp development and may or may not coincide with humanitarian plans.

Population development and density

The trend of population figures for Zaatari camp has been highly variable, resulting from the specific circumstances linked to refugees' movements, see Figure 2. Based on registration data from UNHCR, the cumulative figure of Syrian refugees passing through the camp is 430,000 (as of May 2014). Fluctuating population has led to changing camp design capacity and difficult planning of facilities based on users' ratio.

The size of a camp and area per capita is critical in the planning of camps as large number of persons in crowded conditions lead to increased morbidity, competition over limited resources, stress and ultimately protection issues. In Table 1 the emergency standard and ranges for the average camp area per person (UNHCR, 2015a), and corresponding population density are shown. The residential surface area of Zaatari camp is approximately 4.7 km^2, meaning the current population, and the design capacity, comply with the emergency standard for the average area per person. The standard camp population density falls within the lower range of the world's 50 most dense cities ranging from around 17.000 persons per km^2 to

43.000 persons per km^2 (Wikipedia, 2015). Although what may be deemed adequate during an emergency, in terms of shelter and space, cannot be regarded as adequate in a protracted situation (UNHCR, 2015a), it is not always possible to decrease density. Therefore, sustainable services should be appropriately planned in comparison with dense urban settings. It should be noted, that within the camp, density is not distributed evenly as can be seen in Figure 3, family density for Zaatari camp in February/March 2014.

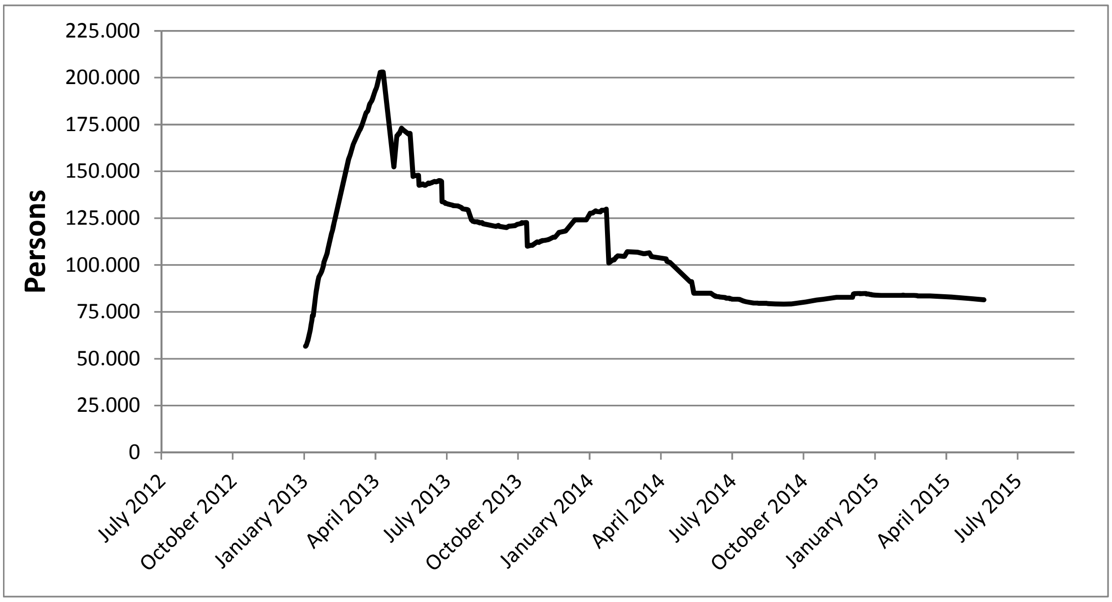

Fig. 2 Registered refugee population in Zaatari camp (UNHCR, 2015b)

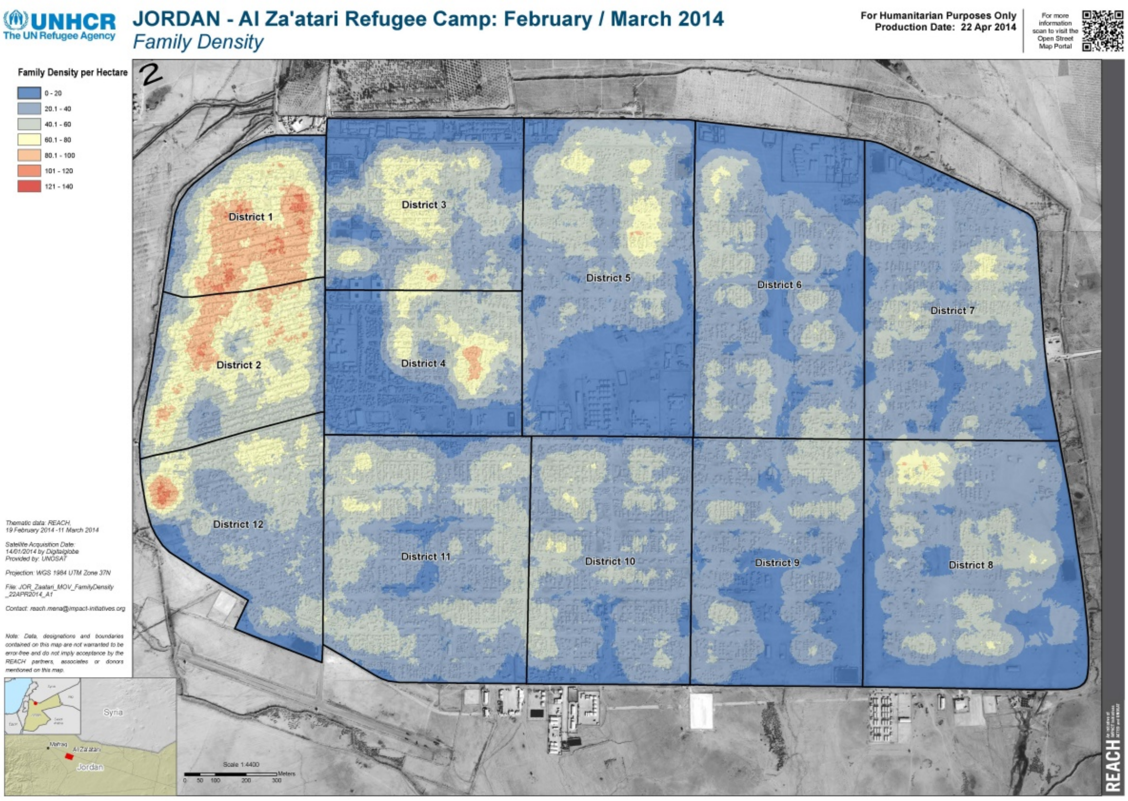

Fig. 3 Zaatari camp family density February/March 2014 (Reach, 2014)

Table 1 Standard for average camp area per person and population density and for Zaatari camp

	Average camp area (m^2/p)	Population density (p/km^2)
Standard	45	22.222
Acceptable range	>= 35	<= 28.571
Unacceptable range	34-30	29.412-33.3333
Critical range	<= 29	>= 34.483
Zaatari camp		
Currently (ca. 85.000 cap)	55,3	18.085
Capacity (100.000 cap)	47,0	21.277

Water and sanitation services development

Standards

For water and sanitation, the minimum standards defined by the 'Sphere project' on water quality and access, endorsed by UNHCR, are leading. The standards are considered minimums and context specific indicators are critical to ensure expected health benefits and cultural situation. For example, in some countries water for anal cleansing and pour-flush toilets is essential, otherwise altered behaviour is more likely to result in adverse protection, hygiene and health outcomes. Service provision is also influenced by physical constraints, funding, host country requirements and the level of the local water and sanitation services in the host country. WASH emergency service provision is focused on health outcomes and cannot always address all cultural aspects such as ideal privacy arrangements. Table 2 presents a selection of water and sanitation standards and indicators for camps (UNHCR, 2015a) comparing emergency and post-emergency with those adapted for Zaatari camp.

Table 2 Selection of water and sanitation indicators with standards for refugee camps including Zaatari refugee camp (UNHCR, 2015a)

Indicator for water	Unit	Emergency	Post Emergency	Zaatari
Litres/person/day	l/p/d	>=15	>=20	35
Number of persons per tap	p/tap	=<250	Max 80-100	1 tap/HH
Distance from dwellings to taps / water collection locations	meters	=<500	=<200	0
Households with sufficient daily water storage capacity (50 litres for 5 family members average)	%	>=80	>=80	100
Indicator for sanitation				
Persons per communal toilet/latrines	# of p	=<50	=<20 (aim=1 lat/HH)	1 toilet/HH
Households with access to latrines	%	>=60	>=85	100

Drivers for adaptation of water and sanitation service level

The drivers for adaptation for integrated sustainable development of water and sanitation services result from observing stakeholder's perspectives and actions, and political, physical and economic constraints. Major drivers for Zaatari camp are summarised as follows:

- Refugees: development of individualised coping mechanisms conflicting with humanitarian service mechanisms resulting in inequity, health and environmental risks, and unsustainable O&M costs. Figure 4 presents the coverage of private toilets in 40.4% of the households in February/March 2014.

- Humanitarian organisations: risks to sustainable management of competing aspects such as health, environment, finance and peaceful coexistence.
- Local authorities: risks to political and socioeconomic stability and sustainable national resource and infrastructure management. Jordan Ministry of Water and Irrigation indicated that unregulated wastewater disposal to the ground by more than 90% of households in the camp poses an unacceptable contamination risk to the Amman-Zarqa groundwater basin. Also, continued use of the Jordanian wastewater treatment plant for up to 100,000 population in the camp would displace the ability to treat wastewater from approximately 35,000 Jordanians impacting municipal infrastructure operation and master planning.
- Donors: risks to funding uncertain and changing (increasing) O&M budget forecasts, expenditure deadlines, ability to respond to new emergencies, and type of funding that is accessible and available (emergency or development) at any particular time.

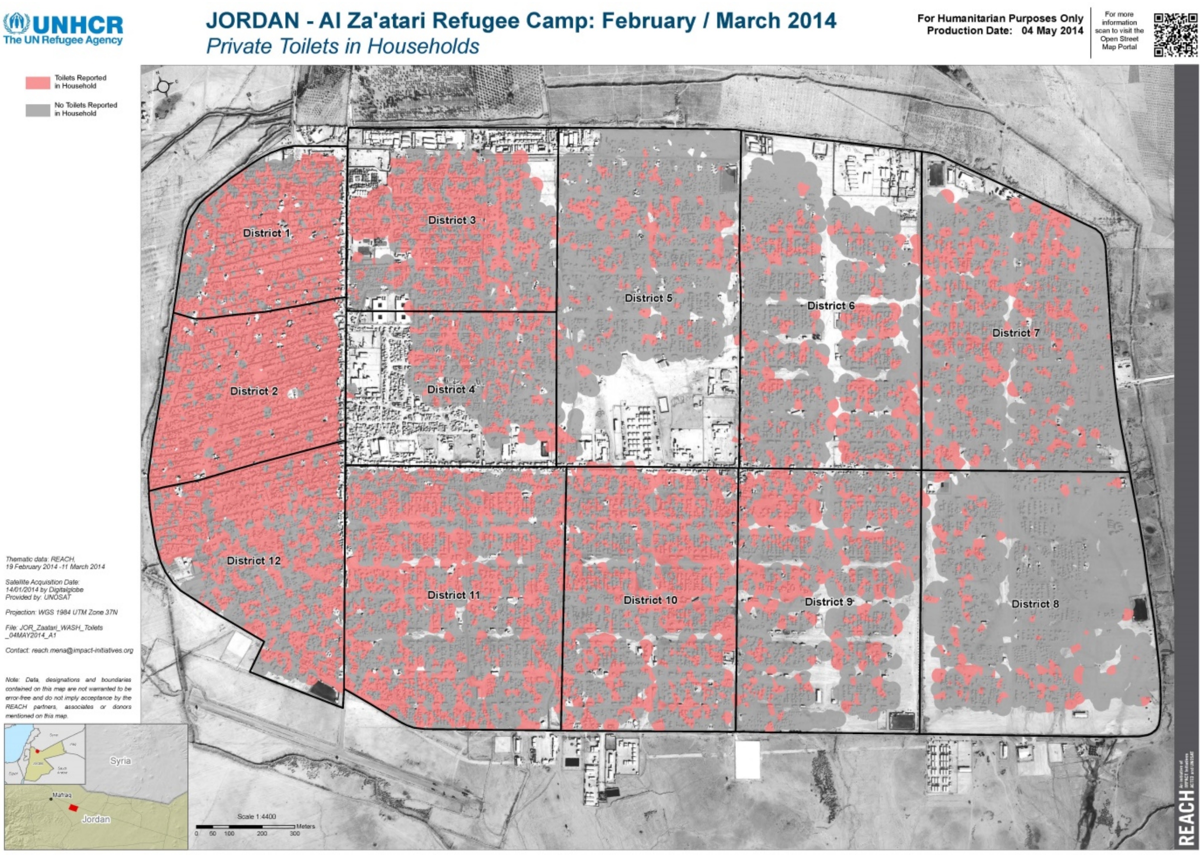

Fig. 4 Zaatari camp private toilets in households February/March 2014 (REACH, 2014)

Development of water services

Humanitarian organisations are currently providing refugees with water delivered to communal WASH blocks, communal water tap points and private tanks. The amount delivered by humanitarian organisations is an average of 35 l/p/d (UNHCR, 2015c), which is the minimum standard set for the camp. With the proliferation of private water storages and private water vendors in the camp, it is expected that the average daily water availability is higher than this. The water is produced at external and internal boreholes. Water quality testing takes place at the boreholes in the camp and at the entry of the camp for tankers delivering water from external boreholes.

Based on the drivers identified above, the humanitarian organisations, with support from all major stakeholders, have sought to maximise the opportunities and overcome constraints in development of sustainable services. Discussions and concept options (centralised versus decentralised) for sustainable water supply solutions began in late 2012. A milestone on the timeline was the decision in May 2014 to aim for realisation of a camp-wide drinking water network with household connections for a design population of 100,000 persons. The decision was taken based on a conceptual and feasibility study with an options analysis comparing three network variants with different levels of water service: piped delivery to communal facilities; piped delivery to communal facilities and additional distributed water points; piped delivery to individual households. To ensure the most sustainable infrastructure decision, a multi-criteria comparison of the three options in terms of various social and technical (implementation and O&M) aspects was undertaken with participation/representation of all stakeholders. Net present cost analysis for each option (including sensitivity analysis) was undertaken to determine the financial value of each. The development of water services in Zaatari camp is outlined in the timeline in Figure 5.

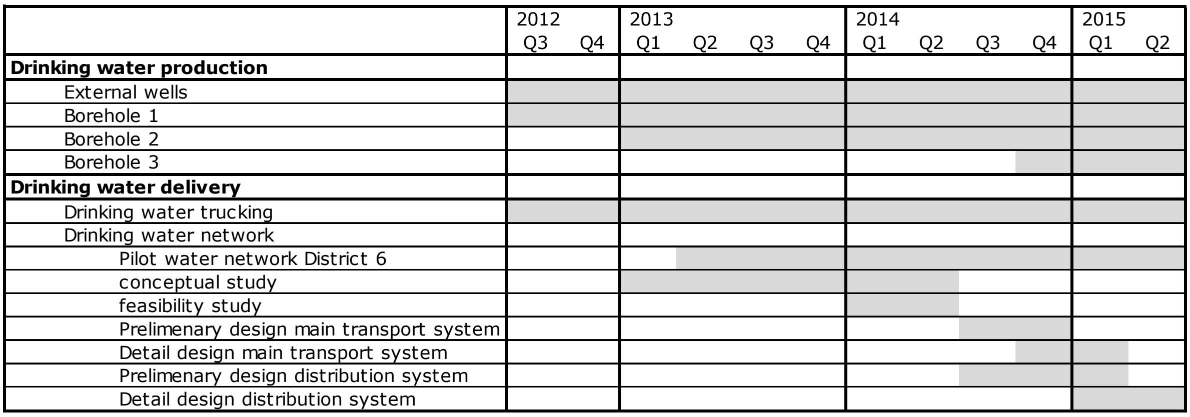

Fig. 5 Timeline for water service development in Zaatari camp

Development of sanitation services

Humanitarian organisations are currently providing refugees with communal WASH blocks including toilets, showers and laundries at the ratio of approximately 42 persons per communal toilet (REACH, UNICEF 2015). Besides the communal facilities, 84.6% of the refugee households have installed private toilets and showers in their shelters in March 2015 (UNICEF, 2015) up from 40.4% in February 2014 (REACH, UNICEF 2014). Some of the private facilities are connected to wastewater collection tanks of communal facilities, some to private pits next to their shelters and some to storm water drains with the potential to overflow into surface water ways in wet weather. Wastewater is collected from the communal wastewater storages, from private pits and from the endpoint of the storm water drains by tankers and taken to a municipal wastewater treatment plant (WWTP) and a recently commissioned containerised on-site WWTP.

As for water, humanitarian organisations sought stakeholder's support, understand the drivers, maximise opportunities and overcome constraints. Discussions for sustainable WWTP solutions began in September 2012 due to municipal WWTP nearing design capacity. A milestone was a tender by the Ministry of Water and Irrigation/Water Authority of Jordan (MWI/WAJ) in September 2013 for mobile, containerised trickling filter and membrane bioreactor WWTP specified to produce irrigation water according to Jordanian standards.

For collection networks, comparison of options through multi-criteria analysis began in early 2013 with a milestone in September 2014 when stakeholders agreed on the conditions that household WASH facilities would need to be made safe and hygienic and all wastewater produced around the camp to be collected and transported to the camp WWTP. This resulted in existing funds immediately directed to commence design and implementation of an interim wastewater management solution that could integrate with a comprehensive camp network design in the future. Almost simultaneously, it was agreed that ‘simplified sewer’ design guidelines (Bakalian, 1994) would be adopted for the comprehensive camp network. Design commenced parallel to the interim wastewater management solution. Both designs are completed and integrated and implementation of infrastructure commenced. The development of sanitation services in Zaatari camp is outlined in the timeline Figure 6.

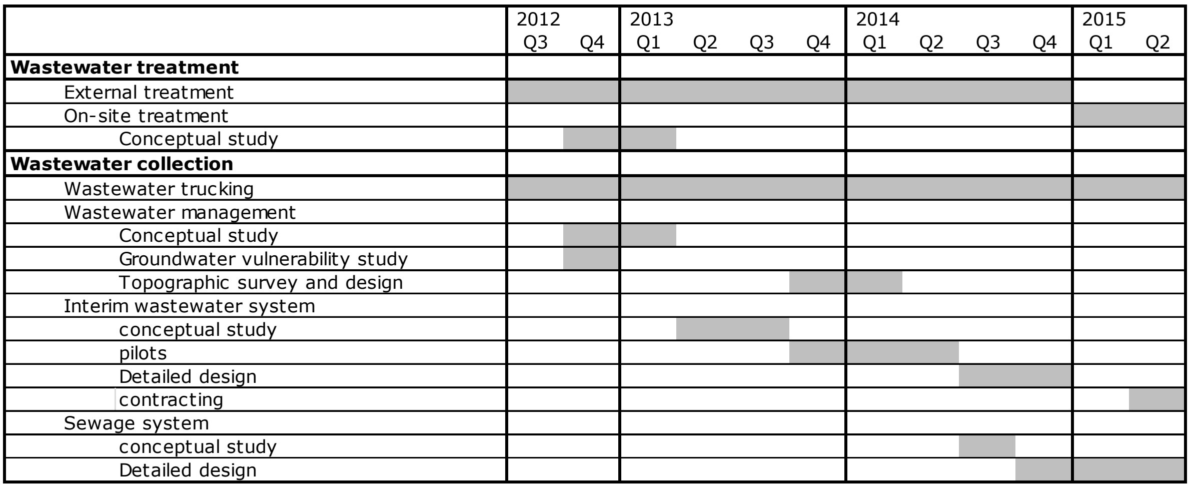

Fig. 6 Timeline sanitation development in Zaatari camp

Discussion

Integrating services

For truly sustainable infrastructure, ideally all physical planning sectors would simultaneously and cooperatively develop sustainable solutions and designs to be integrated as would be undertaken in urban master planning, and as recommended in the UNHCR Global Strategy for Settlement and Shelter (UNHCR, 2014).

Without integrated master planning, each sector’s infrastructure design objectives cannot be well defined and optimised. Further, there is a risk that redesign is required later to accommodate a change in another sector’s objectives with resulting change in resource implications. This risk permeates not only the design and capital works, but flows into whether a particular infrastructure design can be operated and maintained as designed, and directly impacts the expected return on investment.

Although concepts of integrated sustainable infrastructure were developed for the camp, the rapidly changing situation highlighted the difficulty of integrating all sector’s technical design objectives and implementation schedules. However, some camp master planning objectives were agreed as necessary regardless of the situation, which provided the foundations for technical design of water and wastewater infrastructure as part of the camp water cycle. The Zaatari water cycle as of January 2015 and planned long-term are summarised in figures 7 and 8 respectively.

Design paradigms and end value

Initial cost-benefit analysis, indicated a camp lifespan exceeding 5 years results in benefits from drinking water and wastewater infrastructure far greater than the costs and impacts of construction and O&M, due to savings of current operational expenditure alone. For Zaatari, the designed life expectancy of infrastructure is stated to be greater than 5 years, and from experience the usual life span of water infrastructure can vary, but is at least 15 to 20 years (USEPA, 2015) if designed to minimum standards. Therefore, regardless of whether the camp is needed for refugee accommodation or not in the long-term, the infrastructure remains as a legacy for the benefit of local communities for a variety of possible land uses. The end value will be predominantly determined by the actual use after refugees have left, regardless it will be a worthwhile investment with benefits extending past the refugee crisis.

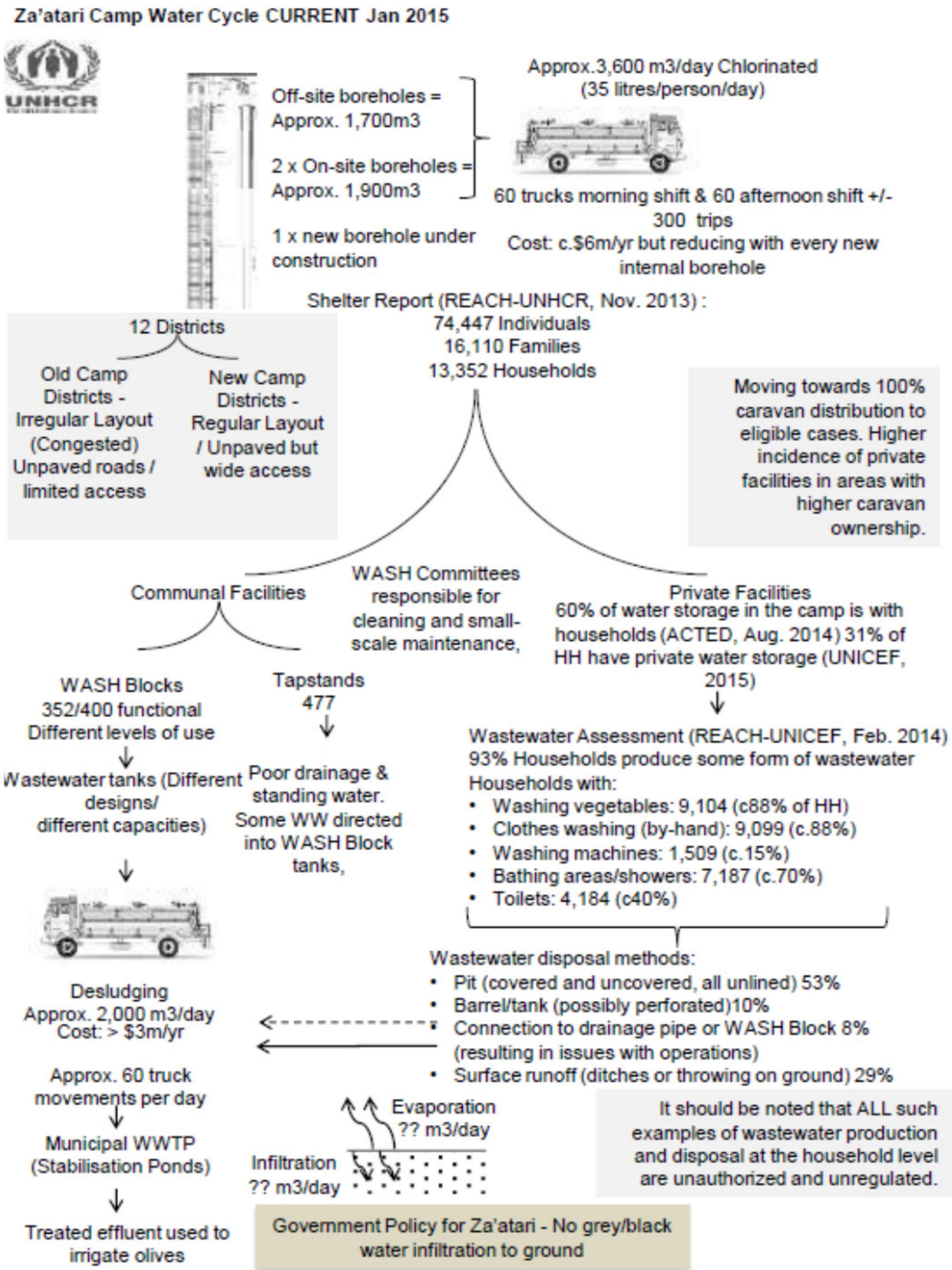

Fig. 7 Water cycle of Zaatari camp as of January 2015

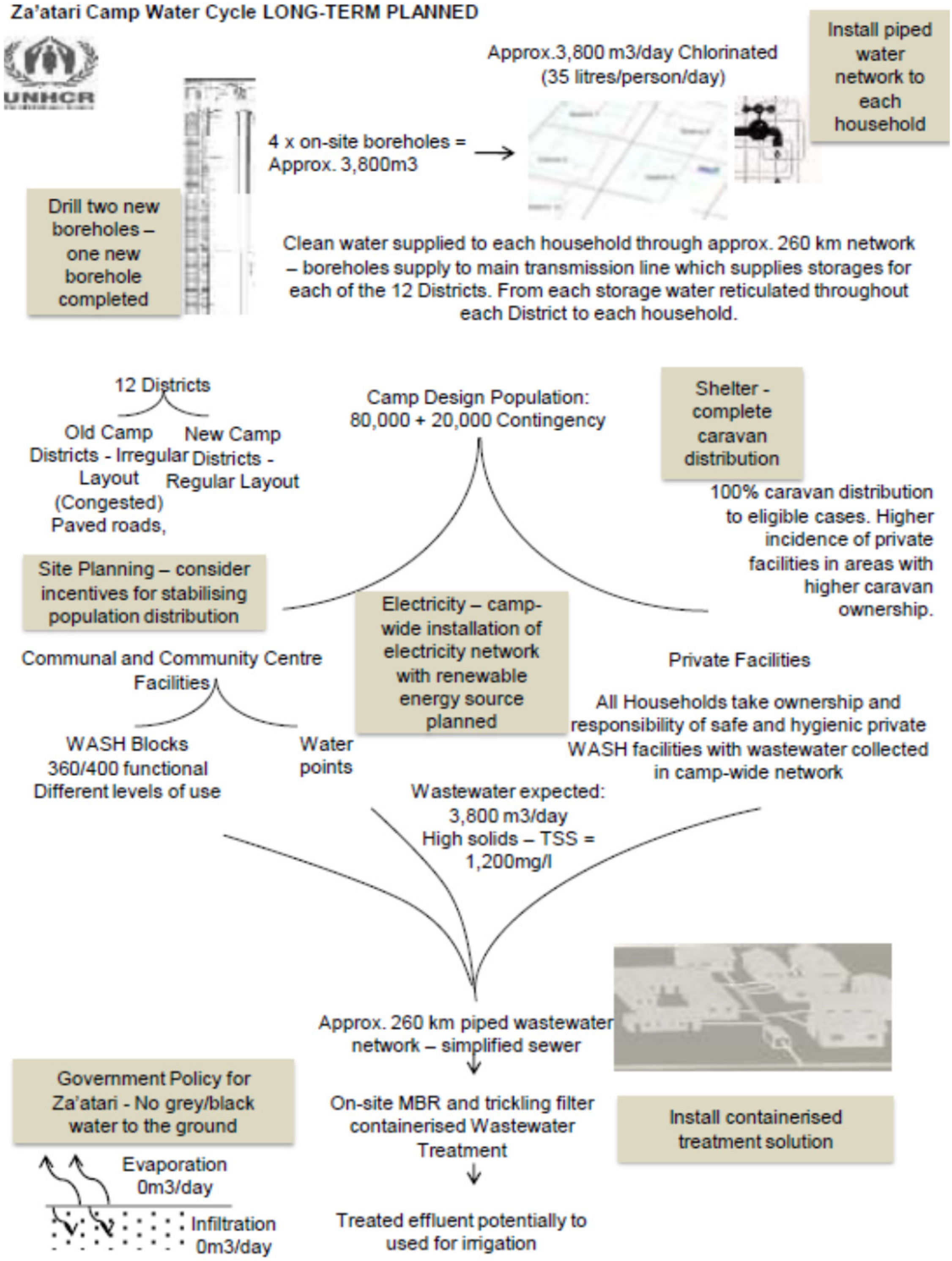

Fig. 8 Water cycle of Zaatari camp planned for the longer-term

Jordanian standards for urban infrastructure were referenced and considered for design of all aspects of the long-term camp infrastructure. Urban standards usually contain a high factor of safety to ensure meeting legal service level agreements with paying customers and minimise risk of legal liability and insurance premiums associated with failing. However, it was necessary to justify deviating from these standards considering the constraints of the situation in Zaatari. For example, the expected high solids wastewater, space constraints, depth of rock, distances to span, lack of legal customer contracts or cost recovery , and expected limited O&M resources, resulted in agreement to adopt the World Bank-UNDP simplified sewer guidelines (Bakalian, 1994). Simplified sewers have been implemented in dense, low income areas around the world for much greater design life and design capacities than Zaatari. They provide significantly more degrees of flexibility in design than conventional urban sewer design resulting in significantly reduced capital costs, implementation time and O&M resource requirements.

Urban infrastructure master planning usually includes development of a legally binding service level agreement with responsibilities on the service provider and the customer, and clear distinctions in asset ownership. Further, there are significant resources dedicated to continuous monitoring and reviewing of the relationship between service providers and customers but also the wider factors that affect infrastructure planning and operation. Stakeholder, community and customer engagement is important for effective management of urban water and wastewater systems and will likewise be critical in Zaatari.

Through design process, most physical and technical constraints can be addressed for a least-cost solution considering limited and uncertain resources i.e. a minimal acceptable service level with minimal capital costs. However, there is still the need to address the technical, social and financial interactions envisaged once the systems become operational to ensure the benefits of the massive infrastructure investment are realised and maximised. Understanding these interactions provides certainty and predictability of service level and operational resource management. The Zaatari design process stipulates the need to develop technical operation and maintenance manuals with consideration of both technical and behavioural scenarios, including, minimising operational conflict between residents, all being served by centrally connected and operated infrastructure. The status of both refugees and humanitarian organisations in a hosting country means conventional legal contracts are not possible. This makes the need for community and stakeholder engagement to explore social contracts/agreements critical. Ongoing phased approach to engaging and consulting refugees needs to commence in the design stage. The critical component of this engagement will be scenario analysis and forecasting of various technical, social and financial aspects including (but not limited to) needs/service level, awareness/knowledge/skills level, shared responsibilities, conflict minimisation and resolution mechanisms which are critical to establishing mutually beneficial agreements. This engagement should also include experienced exploration of mechanisms for relationship administration, incentives/penalties, cost-recovery, service level options similar to telecom and electricity networks being implemented in Zaatari, and other comparable settlements around the world (Mara, D. and Alabaster, G. (2008).

Synchronising construction

Synchronizing construction of centralised water and sanitation infrastructure is important in densely populated areas such as Zaatari camp. Options for location of infrastructure in the horizontal and vertical plane are limited and can be assessed during design. Footprint and geological constraints require water and wastewater collection systems to be laid in close proximity especially at local street level. This requires detailed consideration of standards of design and construction to minimise risks such as wastewater contaminating intermittently pressurised drinking water; providing maintenance access; minimising construction impact on inhabitants and existing service delivery, and maximising construction efficiencies. At the street and household connection level, the pressurized water network has a degree of location flexibility, whereas the gravity wastewater network has less location flexibility. Planning prior to commencing construction, would ideally result in synchronised construction to minimise conflicts but maximise synergies and efficiencies. Synchronising both networks will be difficult in Zaatari camp due to different starting times and starting points resulting from funding conditions. The possibilities for synchronising works will require experienced project management.

Project management

Project management in the context of quickly developing refugee camps is even more critical considering, unlike established urban utilities, implementation and performance standards are not readily available and need to be adapted. Development towards urban infrastructure in refugee camps can be focused and optimised through a project management structure similar to that used in urban planning. The project management unit can also monitor information within and external to the camp to further improve sustainability of any aspect. For example, operational quality management frameworks usually used in urban planning such as Water Safety Plans (WSPs) and HACCP analysis were identified. They will generate operational strategies and action plans critical for monitoring and responding to ensure system performance, and establishing operational resource requirements.

The project management roles include stakeholder and information management and quality control of all phases from design through implementation, handover and development of an optimised operational strategy. For example, with many implementing organisations in Zaatari, without a project management structure design and as-built documents as well as operational manuals would not be automatically directed to a centralised document management system for future reference.

Opportunities for further sustainability and integration

Considering the depth of water source, length of water network and electro-mechanical WWTP in Zaatari camp, the energy requirements are expected to be a large component of operational costs and environmental impact, although significant improvement on current water tankering. Increased operational, financial and environmental sustainability will add further value to this significant capital investment. As with the initial cost-benefit analysis resulting in justification of infrastructure for Zaatari camp, detailed design could be followed by holistic investigation of satisfying energy needs sustainably in the long-term.

A socioeconomic and financial analysis of the water cycle nexus between the camp and the surrounding Jordanian community could be undertaken to explore long-term impacts and undertake SWOT analysis of options for integration with Jordan infrastructure master plans.

For integrated development of water and sanitation services in refugee camps the following roles have been proposed as essential from an early stage:

- Development expert to further explore sustainability and integration options;
- Public engagement, social assessment, stakeholder management and communications expert to facilitate trust and goodwill in the process of developing service level and shared responsibility agreements;
- Infrastructure finance analyst to formulate budget forecasts for water and sewerage system development and operations into the future.

Conclusions

The perspective of urban development on water and sanitation is essential for an integrated transition from emergency phase to sustainability, while mitigating potential health, environmental and financial risks. Therefore, situational factors should be closely monitored and humanitarian agencies should budget for technical studies to assess the opportunity for, and prepare master plans, even though resources for projects may not be available immediately. Cost-benefit and sensitivity analysis should be undertaken as early as possible. A comprehensive socioeconomic and financial concept and feasibility analysis of the impacts, costs and benefits of integrating informal settlement infrastructure and local community infrastructure should be undertaken.

Donor's involvement is essential for them to understand the complexity of the situation to manage the risks contributing to and resulting from uncertain funds and expenditure timelines. For water and sanitation, the engagement of local, national and international water utilities and governments on water infrastructure development and operation and maintenance is beneficial in the transition from emergency water and wastewater trucking to operating and maintaining water and wastewater systems. As refugees' situation and humanitarian organisations called in to respond to their needs suffer from limited and uncertain resources and unknown timeframe, it is important that urban infrastructure planning tools are adapted for application to the informal settlement to ensure technically, socially, economically and financially optimised solutions. Engagement and consultation with all stakeholders to build trust, goodwill and develop social contracts throughout all stages of planning and implementation can build certainty, predictability, flexibility and minimise multiple risks once infrastructure becomes operational, especially in a resource limited situation. There are significant aspects of urban infrastructure selection, design, implementation and operation that can be transferred through adaptation to informal settlements with a prolonged expected lifespan. Blending the experience, functions and organisational structures of humanitarian organisations with urban infrastructural organisations is an asset in transition from emergency phase toward sustainable solutions.

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