

Dhayan water supply

Dhayan

The town is located at about 22 km North-West of Saada town, the capital of the district. It has been affected by the conflict and damage has been quite important. Its location is shown in the next figure where remarkable features like IDP camps and villages particularly affected by the January June 2007 conflict are also shown.

Location of Dhayan, Saada and affected villages

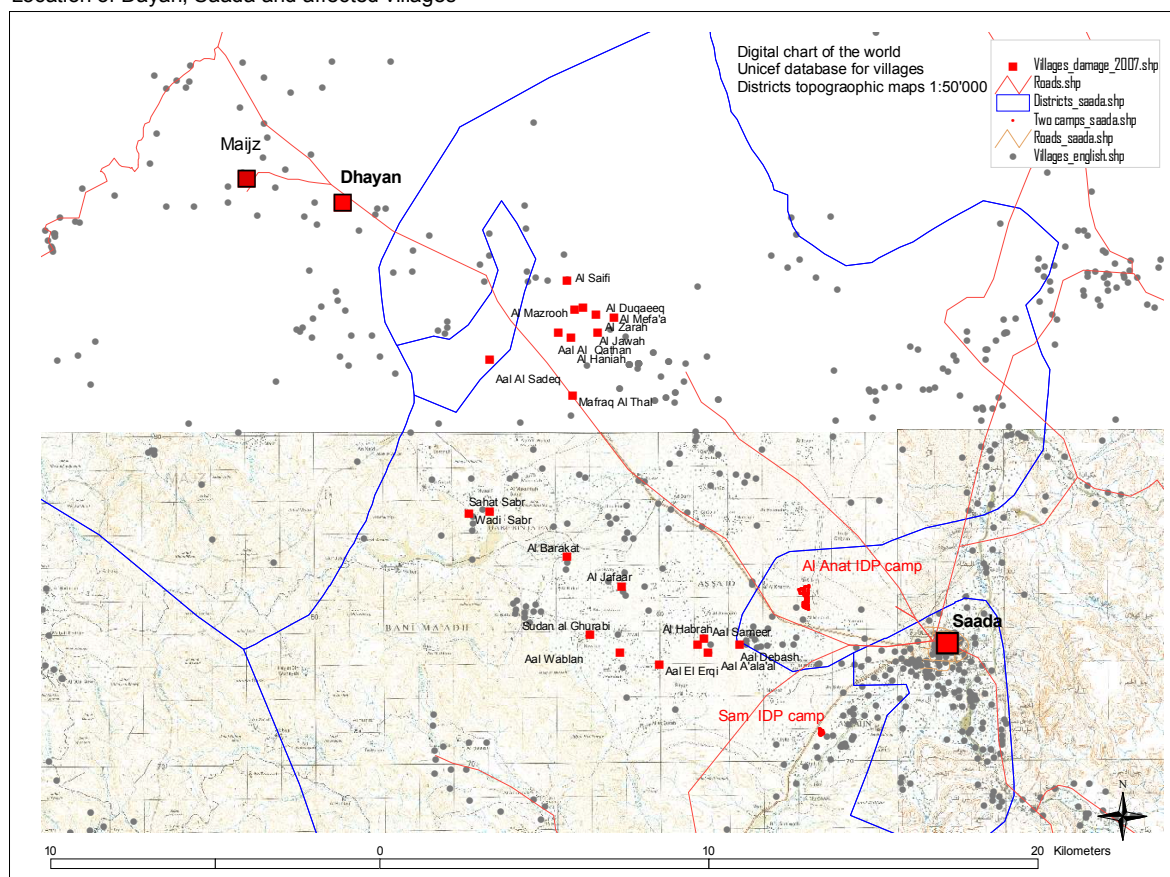


Figure 1 General location of Dhayan, Majz and Saada.

The population of Dhayan is estimated to be over 15'000 inhabitants and is on increase, according to the authorities. Initial assessments have been carried out at irregular pace due to the prevailing situation. Information on the situation of the town has been relatively scanty and difficult to compile. The possibility to get access to high resolution satellite images has made the understanding of the town slightly better and has allowed to position geographically most of the important features, mainly with the assistance of the managers of the Dhayan water supply board, in Saada and in Dhayan, during specific field trips.

This paper is essentially reporting on the situation of the town water supply by end of April 2008.

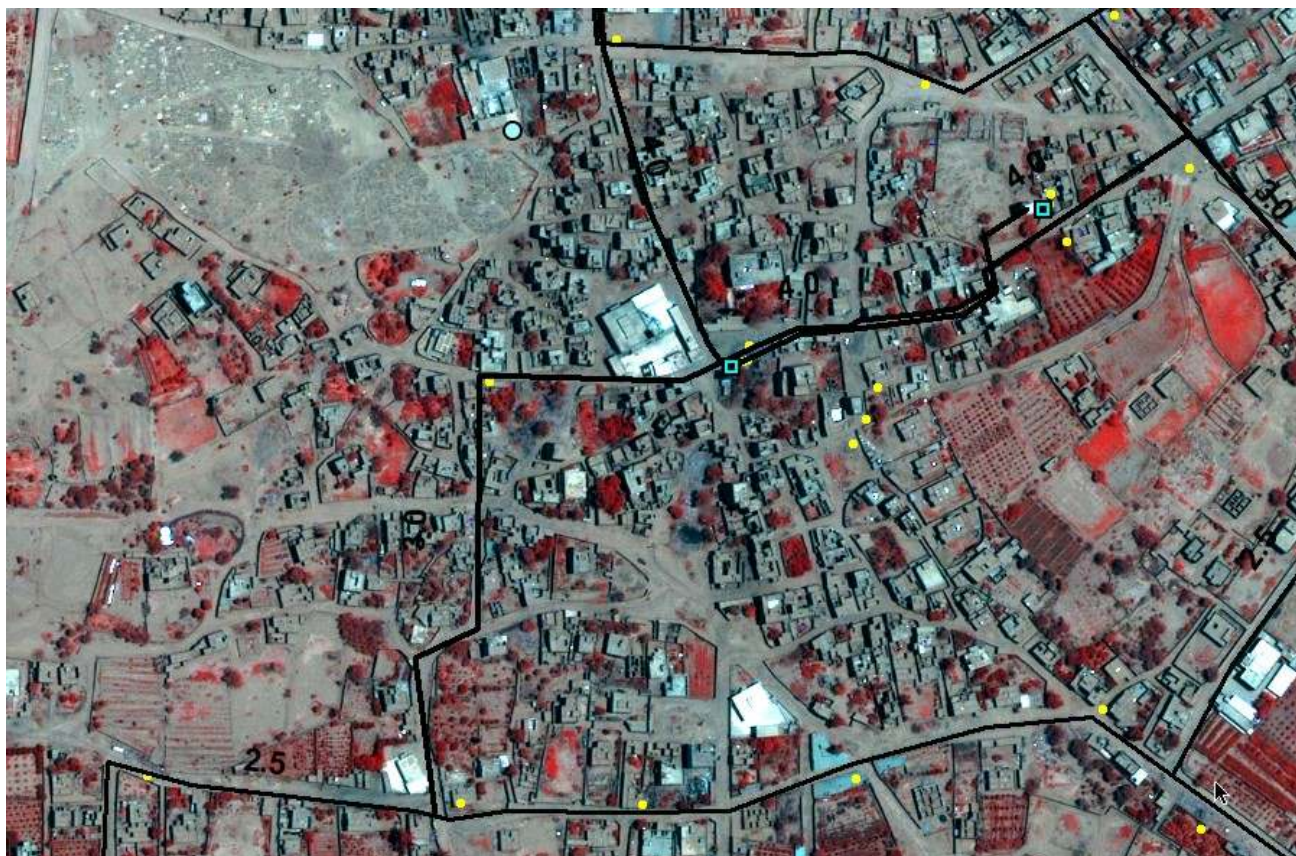


Figure 2

Dhayan town centre, showing the great mosque, two boreholes and the layout of the network. High resolution satellite image, Quickbird[®]. Cropped from 4:2:1: image, 7th of May 2007. Network: black lines. GPS positions in yellow. Boreholes: pale blue squares with dot. Emergency storage tanks: pale yellow circles.

For easier use, specific features can be vectorised, like built up structures, cultivated land, compounds, streets, etc. and used for planning and modelling purposes. A lighter image can be obtained and features can be chosen according to any particular purpose, particularly if network extensions are due to be planned. Measurements of distances are made easy as the image is geo-referenced. A total of 1419 built up structures have been recognised from the HR sat image and digitized, representing probably 95% of the built-up structures of the area of interest, the town. The presence of water reservoirs on the roofs of the built-up structures and the lengths of the shadows have helped to identify houses. Cultivated land has also been vectorised but attempts to identify specific crop have not been made. No specific ground recognition has been carried out, with the exception for the water network and for the specific structures like reservoirs and boreholes.

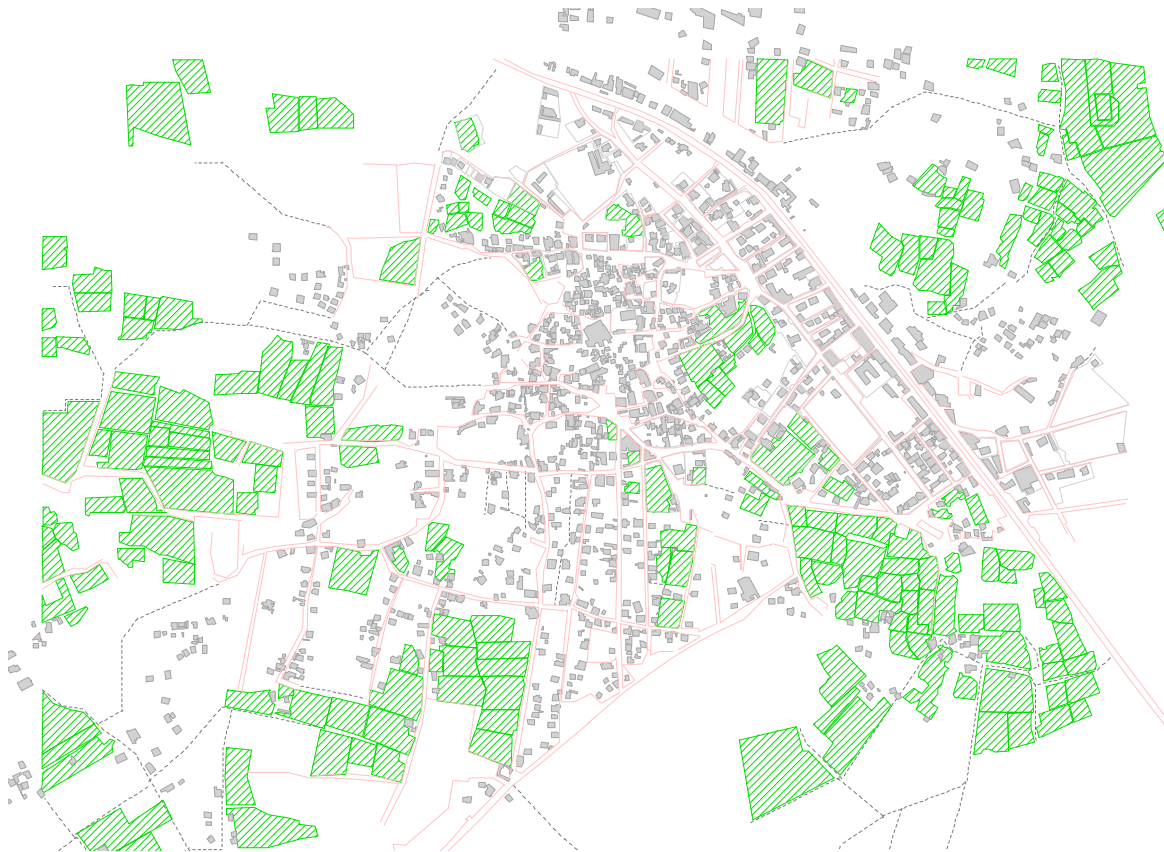


Figure 3 Vectorised features from the Quickbird^R image (roads, built-up surfaces, crops, tracks)

Dhayan water supply system

The town of Dhayan is built on a flat area and water is pumped from the underground aquifer. Four boreholes were operational before the conflict. All were equipped and were pumping water into two elevated tanks of different capacities. As the structures of the elevated tanks have been hit during the conflict, water is no more pumped into them. The boreholes are equipped with axial-vertical pumps powered by diesel engines. Some information could be obtained or collected.

Mosque BH	Q = 216 l/min	Total depth: 250 m	static water level: 73 m	Dynamic water level: 110 m
Al Rodwan	Q = 180 l/min		assumed to be identical or close.	
Al Zeelah	Q =		assumed to be identical or close	
Japanese	not in use			

The al Zeelah borehole, located in the western side of the town, is presently equipped with a Nemitsas Pump (Cyprus) which characteristics are not known. According to the manager the main purpose of operating it is to avoid clogging. Is this borehole that has been chosen for equipment.

The Mosque borehole is equipped with a Caprari pump and powered by a Daewoo diesel engine:
The characteristics are the following:

Pump Caprari Type R 25/5/24 1: 1:5 Lineshaft LA5/24 no 25
Bow ass. Type P8G/5/24 /5° 8 inches
Q 350 USG /min 311,68 ft
N 44.6 n= 2900 RPM

Diesel engine: DAEWOO 87 PS/ 1800 RPM ;odel DP Boo DAEWOO 2004
Consumption 6 litres/hour.

The location of the elevated tanks as well as the location of the boreholes is shown in the next figure.
The Mosque tank has been damaged but it is difficult to evaluate how badly. The Japanese elevated

tank is built in steel elements and is located closer to the main tarmac road, on the western side of the town. It has been hit during the conflict and a large hole can be seen on its western side. All the internal reinforcing beams have been disrupted.

Tank 1	close to the Great mosque	concrete	22 m3 (partial use)
Tank 2	japanese tanks	steel structure, steel elements	120m3



Figure 4 a, b

Concrete elevated tank (Mosque and Japanese). Above: the pumping/distribution station at the Mosque. The main hole in the Japanese tank is on its Western side. The distribution of water is controlled from this location, manually. Wires are for the electricity distribution, also controlled from this location.

The two elevated tanks have been considered difficult to repair. Water could not be pumped in any more and they had to be bypassed. After the conflict the two main pumps were linked directly to the network with the exception of the one supplying the Japanese tank, out of order. The third pump has been connected to the network end of March, pumping from the al Zeelah borehole. The main purpose of this operation was to supply several household in the neighbourhood but also to avoid clogging of the well. The equipment is however in poor condition and in need to be replaced.



Figure 5
Pumping assembly at the al Rodwan station and at the Al Zeelah borehole.

Network and water distribution

The total length of the primary network, shown in the different figures is of 8680 m, with diameter sizes varying from 4 inches to 2 inches. The supply of the distribution boxes is with 2 inches GI pipelines and from the boxes to the houses the connection are in 1 inch. Some sections of the network have been laid in 4 inches PVC pipe.

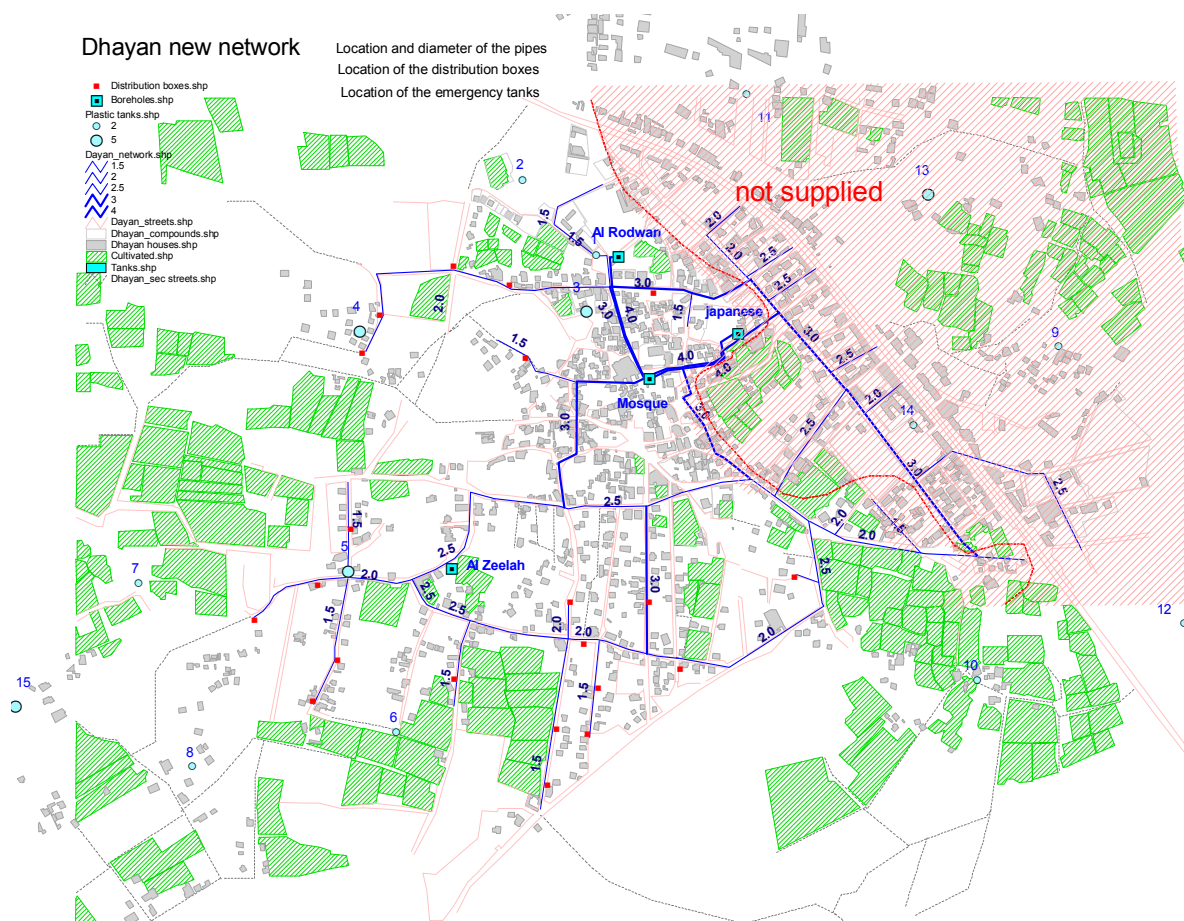


Figure 6 *Dhayan network: location of the boreholes and diameter of the pipeline. The location of the emergency storage reservoirs is also shown.*

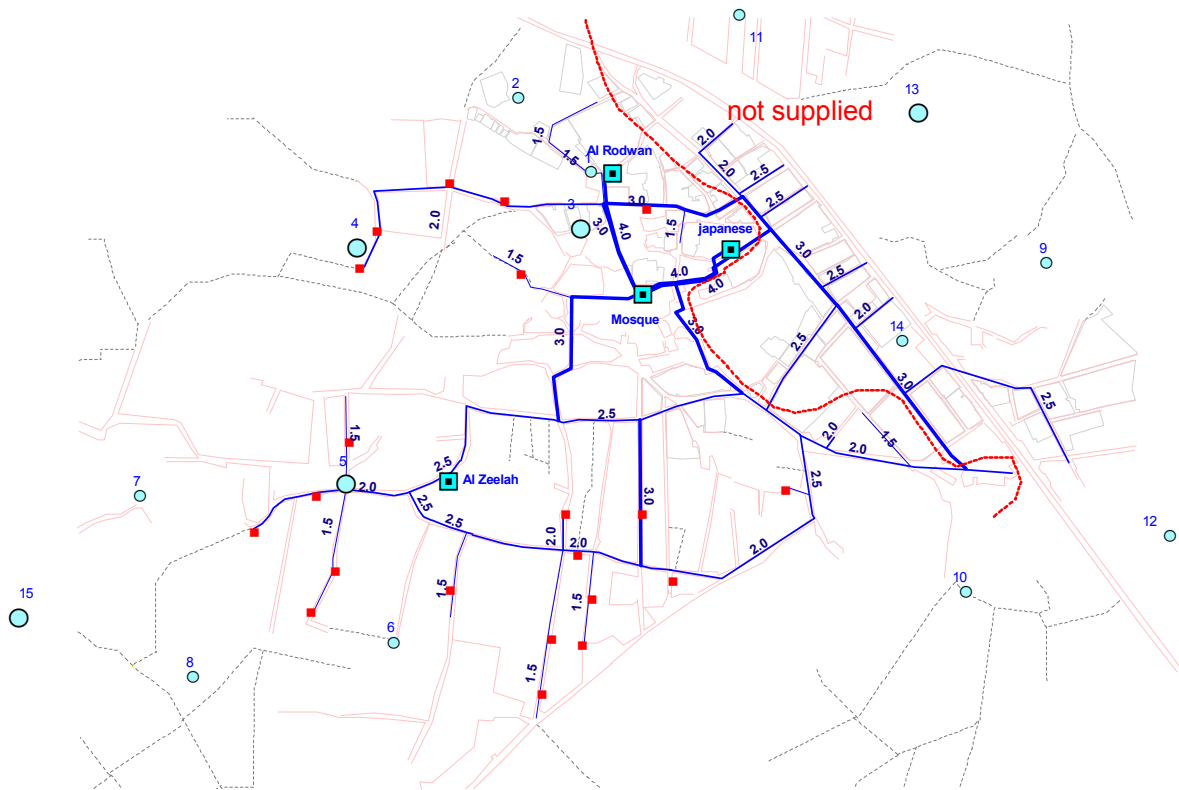


Figure 7 a New network and location of the distribution boxes (red squares).

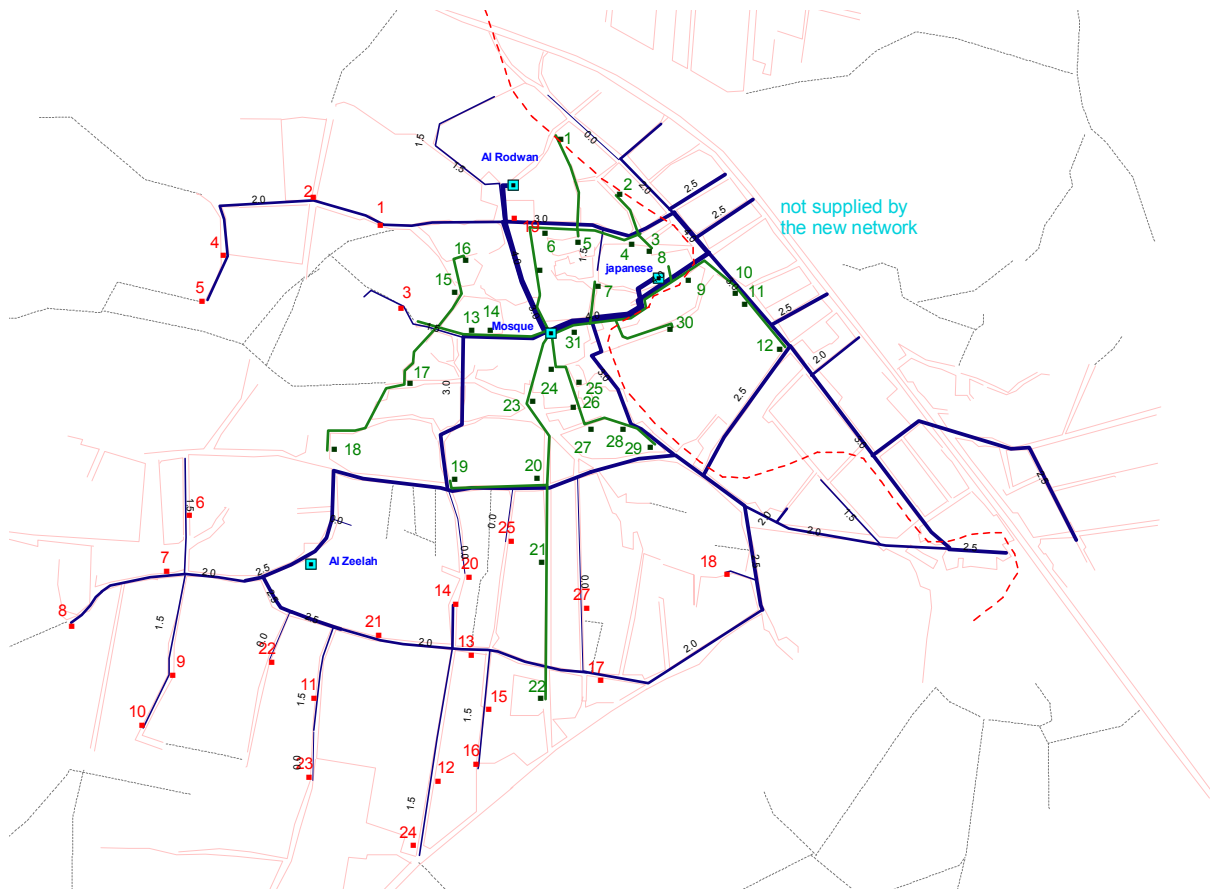


Figure 7 b New network and old one and respective distribution boxes.

If information on the characteristics of the boreholes have been difficult to gather and are still scanty, on the contrary, the layout of the network has been relatively easy to position on the satellite image, with the assistance of the Dhayan water supply manager, who has a sketch of the network. He will also compute the “nodal” consumption by adding the individual consumption of the meters of each distribution box. The total number of connection is 630. 21 of these boxes are scattered throughout the new primary network and are mapped on the image. The total number is 58. In general there are 10 meters per boxes but some have less, 6 or 7. According to the manager they can repair and re-calibrate the meters on the spot. In fact there are two networks, the old one and the new one. Only part of the new network can be supplied with the present pump capacity. The whole eastern side, close to the main road, is cut-off, as it is shown in figure 7. Every third day, the old network is also supplied. Everything is controlled manually from the “distribution” room, at the Mosque pumping station.

During the dry season, from December to the beginning of the rains, the two pumps are operated from 0400 h to 23.00 h for a total of 19 hours. At the onset of rainy season the pumps are operated only 14 hours /day. A total of 5864 units (1 unit = 1000 litres) have been metered during the month of December.



Figure 8 Distribution box and meters ready to be repaired.

The consumption of these boxes can be considered as nodal consumptions if one attempts to model the network using EPANET 2.0 or any other software available.

The lengths, the diameter and the type (PVC or GI) of the different sections are known and can also be measured from the GIS view, shown above, after verification of the exact position of the junctions, which has to be done on the spot.

A block tariff structure is used to collect the consumption fees:

From	0 - 10	80 YR / unit	of 1000 litres
	10 - 20	100	
	20 - 30 and more	200	

17 mosques are also supplied with water for free. At the mosques people can collect water for free provided that the jerry-cans are not bigger than 20 litres. Houses of the person who made the funds available for the construction of the network are not metered and not charged.

The consumption of one mosque is equivalent of the consumption of 15 houses, that is 85 m³/day. For instance, water is pumped 3 ½ h/ week to the grand mosque.

Water distribution by tankers

As the network does not cover all the areas 15 emergency storage tanks have been installed on the outskirts of the urbanised areas. Their location and capacity is shown in the previous figures. 5 x 5000 litres and 3 x 2000 litres are filled up by tanker, twice a day, and the remaining seven of 2000 litres are filled up once a day. The total volume distributed daily by tankers is close to 40'000 litres.

This water distribution is carried out by the water board and is only partially supported by the ICRC.

Extensions of the network and modelling.



The intention of the Water board is to extend the network to reach the newly populated areas. The proposed new pipelines have been reported into the different figures. What is not known is the capacity of the system to deliver water to these extensions and which ones have to be considered as a priority.

To allow for a proper planning all the important characteristics of the network have been defined and reported into a simulation programme, EPANET 2.0. Modelling will give the distribution of the pressure at any location at a given time of the day and will give us some hints on the choice of the pipes and of their lengths.

Data on Dhayan water supply.

The present output of the 2 boreholes is of about 400 l/min each, or slightly less. In January the 2 pumps at the Mosque and at Al Rodwan were operated for 19 hours.

We can assume that 24 m³/h can be pumped into the elevated tank, if the boreholes are connected directly to it. This means that the maximum production is close to a total of 700 m³/day if the pumps are operated 24/24 h. This is not the case presently as only 2 pumps are operated for about 19 h a day, for a total production of about 456 m³. If all the water is consumed, the amount corresponds to an average of 30 l/p/d for a population of 15'000 people.

Two networks are supplied presently: the old one and the new one. In principle the new one is supplied for 2 days and then the old one for the following day and so on. The total number of distributions boxes is of 58, with 27 in the new network and 31 in the old one. The consumption per box can be computed from the sum of the consumption of the meters of a specific box. For January 2008 the caretaker has given us a total consumption of 4299 units or m³, just slightly higher than the consumption for February 2008, metered at 5864 m³ (196 m³/day).

For January we were able to obtain the individual metered consumptions of every distribution box, computed by the caretaker by adding the individual consumption of every meter in a given box. According our calculations, the total amount metered is close to that value, at 4262 units/ month, which represent a total of about 142 m³/day. We will use the January figures to carry out our basic calculations in order to begin to understand the behaviour of the network.

Other consumptions

To the metered amount we have to add what is used by the tankers to fill up our reservoirs, estimated to be close to 41 m³/day. Moreover there are about 17 mosques which will receive water for free and where people can collect water for free too, if their jerry-cans are not too big. This consumption is estimated to be close to 85 m³/day. There are some houses, namely those used by the donor of the whole system, which are not included here and will be part of the unaccounted for water (UFW), like the losses, the possible eventual connections, the under metering and any other not accounted use of water.

The total measurable consumption is of 268 m³/day, with about 188 m³/day as unaccounted for water (UFW). Losses can be estimated to be close to 40 %, which is normal in such situations. These are due to not accounted draws, to poor metering, to poor estimated volumes used and most probably to overrated pumping and true losses. It is also most likely that these losses are higher in the old network than in the new one but needs to be confirmed.

According to the caretaker the daily amount available per person is around 10 l/p/d, which is half what is computed if we take into account the water trucking and the water to the mosques. Most probably the figure given to us was not taking into account these amounts and in this case our calculation is close to 10 l/p/d which is in line with what has been told to us. These data and the number of potential users projected for the near future, can be used to compute the size of the elevated tank.

To compute the size of the reservoir the following assumptions will have to be made:

A. the network will also supply the eastern part of the town, presently cut off.

To the actual population of 15'000 people we will have to add the people living on the eastern side of the main road, presently not supplied. The total number of **20'000** people will be used for the calculation. The average individual consumption has been increased to 30 l/p/day

B. The consumption in litres/p/day has been fixed to **30 l/p/d**, which is higher than what is computed presently, but closer to what is assumed to be considered in an urban environment. The average consumption per hour is then of 25 m³/h. The output of the each pump, estimated to be 12 m³/h is in principle matching the consumption. With a third pump installed at al Zeelah borehole, assumed to have a similar flow rate, the amount which can be pumped per day, for 19 hours of pumping, is close to 700 m³/, that is an average of 29 m³/h, therefore slightly higher than the set value of 25 m³/h chosen for this particular example.

C. We do not know the consumptions patterns of the Dhayan population, but the usual bimodal curve has been used until better information can be gathered. A data logger linked to an electronic flow meter may be installed to get more information on the patterns of consumption, as it has been done in other towns by the ICRC wathab teams..

D. A buffer safety volume of 100 m³ has been chosen. This choice can of course be discussed, as it implies higher costs of construction, but it also allows maintaining the distribution for the few hours necessary to carry out any intervention on the system.

A size of 160 m³ has been obtained using the excel file at our disposal. The size is slightly higher than the volume of the Japanese tank, designed at 120 m³, presently damaged beyond any repair.

Financial support

The decision to support the Dhayan water board has been taken during the very first field trips to Dhayan. It has allowed the Dhayan water board (in fact Mohammed Kassim and his son) to resume water pumping and distribution for the people returning to the town. The support was mainly to allow the caretaker to purchase the necessary diesel to operate the diesel engines powering the pumps. We can now compute the cost of such a support and adapt it to the present situation.

The consumption of the pumps is estimated to be close to 6 litres/hour, that means about 50 USD per day for a 19 hours operation of two pumps and a small one (total equal to 15 litres of diesel /h during 19 hours a day, with a mean cost of diesel of 0.175 USD/litre (35 YR/l). The total cost per month for this support is of 1500 USD and it is this amount which has been put at the disposal of the caretaker since August 2007 (150'000 YR/15 days). This is not including the support we give for the water trucking.

Without doubts, this initial support has allowed the inhabitants of Dhayan, estimated to be close to 15'000, to get a better access to water. As outlined above, the caretaker has started to collect the meter consumptions and he is certainly collecting some fees, based on the block tariff system also

outlined above. We can estimate that the majority of the meters do not measure more than 10 m³ and therefore the tariff applied is the minimum one, 80 YR/m³.

However, nothing is known about the collection rate. It is believed that at the beginning of the support of the ICRC, the amounts collected must have been very low, if any, the population being aware of such support mainly for the purchase of diesel, the main cost of the whole business.

We have extended this support for the next three months but as information is getting more and more precise we may also gain better data on this activity. It is now necessary to dig into the matter and get the relevant information about the collection rate. If a unit is billed 80 YR, and the collection rate is, let's say, 25 %, the metered units of January 2008 (4299) represent an income of 430 USD/month and those of February (5864) 586 USD. But if the collection rate is 50% the gross income is double and is approaching the running costs of the utility.

It is of paramount importance to get these data in order to begin to scale down any involvement, according to the evolution of the financial situation of the Dhayan water board. It may take a few months but things must be clarified before any further extension of the support, which will last at least until end of June.

Conclusions

Considerable knowledge has been collected during several interviews with the caretaker of the Dhayan Water Board in Saada and during a field trip to Dhayan. This has allowed us to understand a bit better the problems the undertaker is facing there to maintain a regular distribution to the population. Despite the difficulties he is able to supply regularly the users, with the assistance of the ICRC, who is providing the necessary fuel to operate the pumps and who is also partially supporting the water distribution to the emergency water storage tanks.

The financial support allowing the caretaker to purchase the diesel necessary to operate the pumps has been extended until end of June but will have to be reviewed before any further one will be granted.

It is likely that the present population is going to increase and it has been estimated that 20'000 people will be in need to be supplied in the near future. The installation of a new pump, the construction of a new elevated water tank and any possible extension will allow cover the needs of the town's population. With an increased collection rate it is foreseen that the support of the ICRC will gradually reduce.