

# Activating an Adequate Management & Effective Emergency Unit for The Water Supply in The Armed Conflicts Zones

T M Alnajar<sup>1</sup>, A Fitri<sup>2</sup>, W Almadhoun<sup>3</sup>, M S N Hadie<sup>4</sup>, F C Ros<sup>5</sup>, A E Kabeel<sup>6</sup>, and S Z H Shah<sup>7</sup>

<sup>1</sup>Faculty of Engineering, Islamic University of Gaza, P.O. Box 108 Gaza Strip

<sup>2</sup>Faculty of Engineering and Computer Science, Universitas Teknokrat Indonesia, Indonesia

<sup>3</sup>Dean of The Faculty of Engineering, Gaza University, Gaza

<sup>4</sup>Civil Engineering Department, Universitas Andalas, Indonesia

<sup>5</sup>Malaysia-Japan International Institute of Technology (MJIIT), Universiti Teknologi Malaysia, 54100 UTM Kuala Lumpur, Malaysia

<sup>6</sup>Faculty of Engineering, Tanta university, Egypt

<sup>7</sup>GAZIOSMANPAŞA University, Tokat, Turkey.

E-mail: tamernon7@gmail.com

**Abstract.** This study examined Gaza Strip water management after Israeli raids. This research is directly relevant to the Gaza Strip's water emergency plan. Taking immediate action helps prepare for shocks before, during, or after an emergency. This project aims to establish an updated emergency strategy for water sector emergencies. Considering Israel's Gaza raid This study is important because it addresses a vital issue that saves lives and sustains a vital industry (the water sector). In addition to other factors that support the management process, the study offers a basic method for controlling water supplies in an emergency (the Israeli aggression on the Gaza Strip). This solution is titled (decentralized supplies). This report updates a plan for managing Gaza's water supply during Israeli invasion. The report will enable decision-makers direct international organizations to improve and develop Gaza's water condition using scientific approach. The findings will benefit water experts and emergency managers.

## 1. Introduction

One of the greatest instances of a recent conflict zone is the Gaza Strip, where water service providers have developed on their own without the guidance of a strategy or master plan. Direct rainwater that seeps into the sands replenishes the aquifer. The overall water budget of the aquifer is also increasingly influenced by return flows from leaky supply networks, agricultural irrigation flows, and home or industrial sewage. The quantity and quality of its groundwater are significantly impacted by lateral subsurface groundwater inflows from nearby aquifers [1].



One of the most significant aspects of the environment that is regularly researched and examined as part of evaluating the state of the environment is the water sector [2,3,4]. The water problem, including the quantity and quality of the water accessible, as well as the methods for developing water work in the sector, are just a few of the significant issues that this title is related to within the context of the current study [5,6,7]. In addition to the most significant relevant institutions, civil organizations and bodies play an essential role in safeguarding water sources, enhancing their quality, and enhancing its output.

No matter how many families live there, a lot of residential structures just have one meter and one connection. There is about one meter for every 17–20 people in Gaza. Additionally, despite extensive network coverage, service delivery is inconsistent and there are significant differences in per-person supply between localities. In Gaza, just 30% of homes have access to 24-hour network water service. A little more than 15 percent of Gaza's residents have access to piped water for fewer than 10 days a month [8].

The water and sewage infrastructure in the Gaza Strip is being targeted by Israel's military operations, which result in the destruction of desalination plants for drinking water, public water supply networks, pumping and sewage treatment stations, as well as sewage and rainwater drainage networks. The effects of the invasions on Gaza extended to the water infrastructure, the most crucial of which are surface water and groundwater. The main electrical transformers that contain dangerous oils that could spill into surface or underground water and cause an environmental and health catastrophe were targeted. Additionally, the aquifer, where significant amounts of wastewater and sewage flow into the groundwater, is significantly impacted by direct targeting of sewage lines and extensions in the main and secondary streets [9]. As a result, there is an unequal distribution of water throughout much of the Strip. The owners of homes close to municipal wells or homes on the ground level receive municipal water sooner and in greater quantities than people living in remote places or on upper floors, particularly in tall buildings and towers. The projected 16 hours per day of electricity outages have a severe impact on water production and distribution, as well as restricting inhabitants' access to water. Furthermore, in some parts of the Gaza Strip, water is only provided to residents once or twice each week [10]. Additionally, the Gaza Strip has been deprived of numerous important strategic initiatives in a variety of environmental sectors due to Israel's siege. Along with restricting access to numerous pieces of machinery, tools, and apparatus necessary to improve the Strip's environmental performance [11].

The widespread violent bombing and targeting of electricity columns and lines has caused power outages, which has made all the environmental information pertaining to water more complex (resources and supplies). The shutdown of water resources, supplies, and desalination facilities, along with other significant environmental problems that will only get worse as time goes on, will have an adverse effect on people's health, the environment, as well as their economic, social, and even security situations. All prior development and enhancement plans will be scrapped or delayed as a result of the ongoing attacks, and their place will be taken by plans for relief, repair, and reconstruction. Considering the population is growing quickly and unabatedly, this indicates a significant fall and slowdown in development [11].

The research will reveal very useful guidelines for decision makers to guide international organizations to conduct better interventions to improve and develop the water situation according to appropriate scientific methodologies. In addition, the research will be of value to researchers in water topics as well as those working in the field of emergency.

## **2. Methodology and data collection**

By developing the existing emergency plans, this study aims to find a clear approach for optimal management of water supplies in light of the Israeli aggression on the Gaza Strip. Which can move towards better management in the event of dividing the Gaza Strip into zones that are managed separately, so that the network does not stop working or the water floods in the event that the main distribution network is bombed, as well as to ensure the minimum water interruption in the event that one of the areas is bombed.

Also, this process which is called (Decentralization), greatly enhances the concept of (community participation), so that the community is one of the main elements in its management in cooperation with the concerned authorities.

The decentralization process combines with the elements of existing plans at several important points but in a somewhat different order, which will be clarified later. It is also characterized as being applied without the need for major changes on the ground.

### 3. Analyses and discussion

Emergency planning is the methodical process of preparing for potential occurrences, such as large crises and disasters. The plan is typically a shared document that outlines the roles and responsibilities that each participant and stakeholder will play in the multi-agency disaster response. It is a guide for organizing events, so it must take management requirements into account. In other words, it is the framework for emergency response and should outline the principles of action, collaboration, command, and communication during a civil exigency like a tragedy or significant event.

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#### 3.1 Emergency plan frameworks

The fundamental goal of the emergency plan is to be able to maintain the bare minimum of services needed by the populace to carry out infrastructure restoration during a conflict. A movement coordination request will be made to the military forces to ensure the access to the ground for technical teams so that service providers may maintain the water and wastewater systems in working order (truce on the intervention area, avoid targeting the employees). It's also crucial to keep in mind that this approach focuses mostly on interventions for which movement coordination is necessary [12].

During war times, service providers are operating the network on a daily basis in non-military active areas and military active areas without going through this process. It is proposed that:

- In non-military active areas, the service provider acts as usual to ensure that basic services are provided to the population.
- In military active areas, a list of pre-ready coordination shall be prepared for the routine operation.
- In military active areas, coordination shall be requested to armed forces as described below to intervene in case of damages to a wash infrastructure.

#### 3.2 Emergency procedures

It is necessary to conduct extensive national public awareness campaigns about the precautions that citizens must take in emergency situations to provide water at a minimum, without causing a state of social panic, as the concerned authorities are under a constant state of pressure and depletion that is difficult to live with in some circumstances, such as times of armed conflict. The following actions and precautions should be done in case of an emergency (water sector):

- Activating the system of communication through the various communication channels available between the various operational areas of water sector in the municipalities, the Coastal Municipalities Water Utility, the concerned parties and their working teams, and finding the appropriate tools at various levels.

- Securing the minimum and acceptable number of spare parts necessary for the maintenance and operation of water lines, wells, pumping stations and various facilities. This includes spare parts for networks and electromechanical spare parts.
- Providing all water wells and water pumping stations with a chlorine solution for water sterilization, in order to prevent pollution, which is sufficient for a period of no less than a month, and to keep chlorine tanks in a state of fullness in various areas. As well as distributing protective clothing to various areas in the Gaza Strip to be used by workers in the water sector.
- Set a station for storing chemicals needed for water wells and desalination plants.
- Urgent and comprehensive follow-up of all water well facilities, pumping stations, desalination stations, and pumping stations through contracts for maintenance services for pumps, generators and electrical systems, which are managed and implemented by engineering teams, which helps to create a state of continuous operational and functional readiness around the clock, at a rate exceeding 95%.
- Securing the readiness of water tankers, to transport water to areas where water systems may be damaged.

### 3.3 Proper Management

Regarding the direct Israeli attacks on infrastructure mentioned at the beginning of this study (especially during the most recent armed conflict in 2021), the aggression on infrastructure directly resulted in the destruction of a significant portion of the public water supply network in addition to desalination plants, pumping stations, wells, and water tanks as well as the primary and subsidiary water distribution network.

Operation and upkeep of several water, wastewater, and storm water facilities make up the RWU's primary activity. These facilities can be found all over the Gaza Strip. In most facilities, the daily operation of the wash facilities requires the physical presence of the operators in addition to the swift movement of the repair teams. It is suggested that regional offices (RO), which are geographically dispersed throughout the Gaza Strip, handle the daily operation and maintenance in order to ensure effective management, efficiency, and retaining the organizational structure's decentralization philosophy. The cost-effectiveness, which will be evident in reducing the number of high-level management staff, as well as the geographic dispersion and integration between the WASH facilities and networks, will decide the number of these RO.

## 4. Decentralization approach

Decentralized supply systems offer the possibility to provide water where centralized supply systems are not feasible due to abnormal conditions. Small-scale systems (SSS) which is one of decentralizing supply systems types, is the most typical application of small-scale systems is for community water supply. However, they have also had important applications in emergency water supply. Because emergency situations necessitate provision of clean water with limited time and resources, SSS are one of the best options to quickly provide safe water for community and camp water supply.

Piratla and Goverdhanam [13] reported that according to the comparative reliability analysis, the decentralized scenario's reliability outperformed the centralized-only scenario by an absolute margin of 5.83%. The ability of the system to meet demands under various potential hydraulic and mechanical uncertainties is referred to as reliability. For instance, in a centralized scenario, 100% reliability refers to a system that can function fully even when demand increases (up to 25%) and every pipeline in the network fails. These results clearly show that, in terms of the system's ability to meet needs under various uncertainty, decentralized supply complements conventional water supply.

The study seeks to determine an appropriate strategy for managing water supply in light of emergencies and disasters, as well as with reference to the regional water utility plan that is currently under development, through this method (decentralized water supply), in accordance with the study's objectives. In order to make the current public network the one that is primarily relied upon and with a separate management system in cases of emergency and aggression, taking into account the anticipated situation of regional water

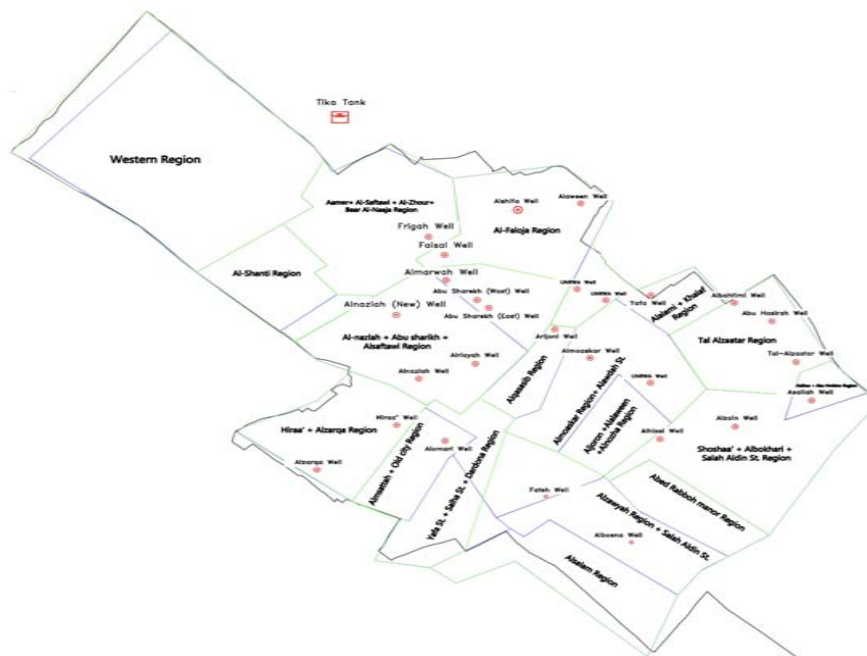
utility and its management process, the study involves a number of steps centered around the concept of decentralized water supply and its management process.

The process of decentralizing water supply covers several concepts, for example, through which it is possible to work on integrating the community within the water resources management plans and the process of implementing emergency plans, in addition to enhancing community participation in the management of water supplies during the emergency phase. It also contributes to the development of the administrative process of the water sector in the Gaza Strip from several aspects (economic, technical, environmental and operational), which makes it a strong preference for the concerned authorities to adopt and work on developing it to be the most reliable tool.

In order to clarify the steps that the study concluded within the emergency plans to manage the water sector in light of the armed conflict on the Gaza Strip under the title Decentralization Approach, a case study will be worked on, which was selected within the Jabalia Municipality authority, in the northern Gaza Strip.

#### 4.1 Decentralization (case study)

The study proposes a solution that can be applied to be a basic system for managing water supplies in the event of an emergency, which is represented in a basic title, which is (decentralized supplies) in addition to other elements that support the management process, those elements of which part that agrees with the existing plans, This confirms the results of the study tools used (questionnaires), as it turns out that there are effective emergency plans with moderate rates that can rise to a higher and more effective level through working on the development of water supply management. The study will examine the area of influence of the Jabalia municipality in the northern Gaza Strip as a case study, so that the policy of decentralization supplies and the development of an updated emergency plan that can be extend and applied effectively during the emergency phase for whole Gaza Strip. Jabalia city is one of the most important cities in the Gaza Strip figure 1. It is a 1.5 km away from the city center. The area of Jabalia is about 18 km<sup>2</sup>.



**Figure 1.** Jabalia Municipality Regions

Jabalia municipality services cover 25 official registered wells, benefiting 275,050 people living within the municipality's influence. Work will be done on dividing and developing the decentralized water supply management process based on a number of these wells so that the rest of the wells work as standby wells within the emergency plan.

Within the strategy of working with the emergency plan by adopting a schema of decentralized supply, water is distributed at the minimum limit in emergency and war situations, which is 15 l/c/d [14], which we often do not reach except in cases of complete interruption of water supply, and for which many interventions are prepared to compensate for any loss or interruption according to the supporting steps that are consistent with many points in the existing emergency plans, as follows:

- Securing the minimum and acceptable number of spare parts necessary for the maintenance and operation of water lines, wells, pumping stations and various facilities. This includes spare parts for networks and electromechanical spare parts.
- Securing the readiness of number of water tankers, with a capacity of 5-10 cubic meters each, to transport water to areas where water systems may be damaged.
- Providing the necessary fuel to operate the electricity generators in the various water facilities.
- Supplying electricity to water utilities by means of standby diesel generators.
- Distributing water through fixed/mobile water tanks, containers, and faucets, and this is supported by the provision of water bottles and bags.
- The residents are responsible for reaching the water distribution points and for bringing containers of the appropriate size for the family's daily allowance, through prior public awareness.
- Preparing the locations of the distribution stations as follows:
  - In each targeted area, water distribution stations are set up - next to a public facility, for example: a water well, a main square, a clinic, a school or other.
  - In the event of an emergency that necessitates distributing water by distribution stations, the stations are allocated to the affected areas.
  - The empty containers are distributed at the stations designated for this in the neighborhoods, and they are filled by tanks, the size of 5 cups, that move alternately.
- Water is distributed to all residents by means of mobile or fixed tanks, etc., water gallons, water bags, soft drinks, etc.
- Prepare to supply water according to the amount of 4 liters per person per day.
- Residents are responsible for accessing water distribution points and for bringing containers of adequate size for the family's daily allowance.

The following table 1 and figure 2 showing the division and distribution of zones according to the decentralized water supply system, which includes 11 zones depending on several determinants which are: the number and location of wells, the beneficiary population, the pumping rate for each well, the number of pumping hours, achieving the minimum amount of water needed in case of emergency and war, In addition to the main determinant, which is to identify the main resource and the supporting resources in the event that it stops working as a result of targeting or destroying the network. The study proposes a number of sequential steps to achieve optimal management of water supplies in light of the armed conflict on the Gaza Strip, which come in the following order: decentralized water supplies, supporting lines, water tanks, water distribution tankers. which are clarified during this part of the study.

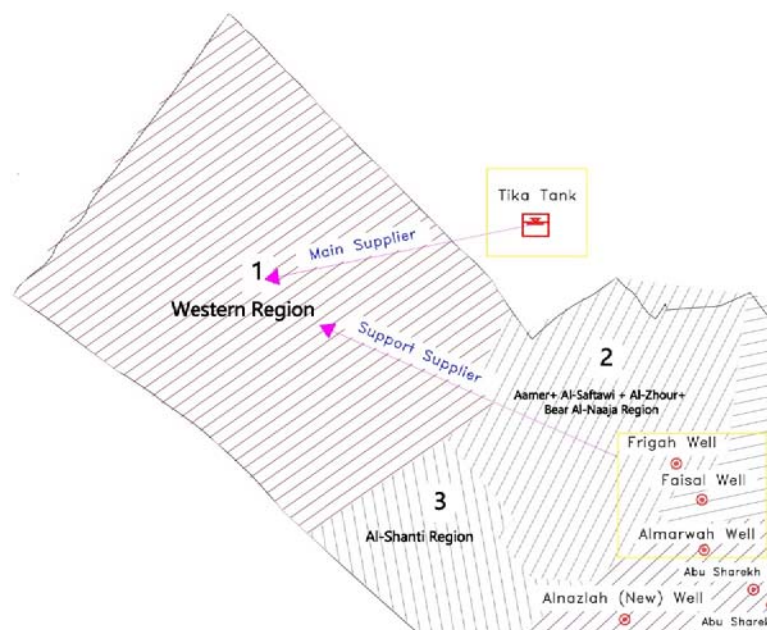
**Table 1.** Decentralized Water Supply Zones.

No. of D.P	Name of Well	Beneficiary population	Pumping Rate	Operating hours/day	L/C/d
D.P.1	Tika Tank	30000	700	4	93
	Faisal Frigah Al-Marwah	Support Supplier			
D.P.2	Faisal Frigah	31500	150	4	19
	Al-Shifa Al-Alaween Al-Marwah	Support Supplier			
D.P.3	Al-Nazlah (New)	13300	100	4	30
	Abu Sharekh (West) Abu Sharekh (East)	Support Supplier			
D.P.4	Al-Shifa Al-Alaween	16000	230	4	57
D.P.5	Abu Sharekh (Wast) Abu Sharekh (East)	22350	250	4	44
	Al-Nazlah Al-Marwah Al-Reayah	Support Supplier			
D.P.6	Hiraa' (New)	17500	140	4	32
	Al-Zarqa	Support Supplier			
D.P.7	Abu-Hasirah Al-Bahtimi Tal Al-Zaatar	19400	120	4	24
D.P.8	Al-Moaskar	55000	380	4	27
	UNRWA Wells Yafa Arijoni	Support Supplier			
D.P.9	Al-Omari	22000	110	4	20
D.P.10	Al-Hissi	33000	150	4	18
	Al-Zain Aslia	Support Supplier			
D.P.11	Al-Fateh Al-Bosna	20000	200	4	40
	Al-Hissi	Support Supplier			





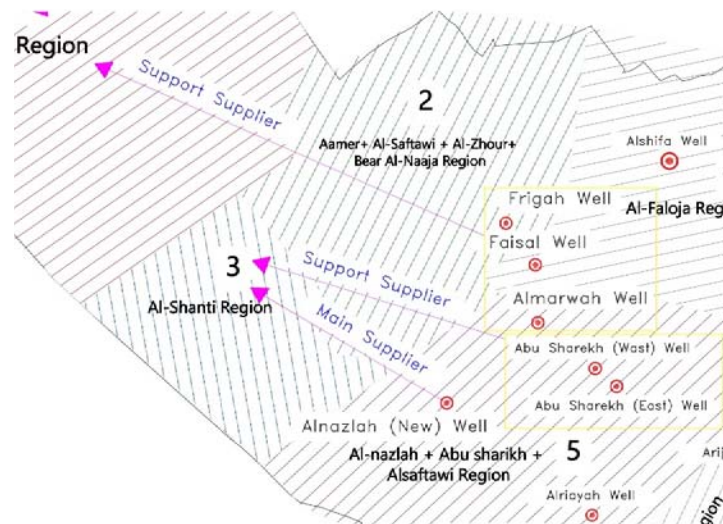
occurs in the network or the pump used, the water supply will stop completely in that area, which gets worse in the event of an emergency and aggression, in the event that the network, the pump, or the tank is bombed or destroyed, an entire area with a population of about 30,000 people will not have access to water, which may cause a mass displacement of the population with the aim of reaching areas where they can obtain water. In addition to these reasons, the western region may be a place for the displaced from the eastern regions, as a result of the land invasion in the event that it occurs, so it is necessary to provide adequate quantities of water within the framework of emergency plans. According to the foregoing, the study proposes to supply the western region with a transmission line from Frigah, Faisal and Al-Marwah wells to be used as a support line in the event of a failure or targeting of the main line (Tika reservoir, Fig.3). In addition, linking the wells and alternative line through the Supervisory control and data acquisition (SCADA) system to ensure remote monitoring and controlling, which contributes to improving the emergency period management process.



**Figure 3.** Zone 1 (Western Region)

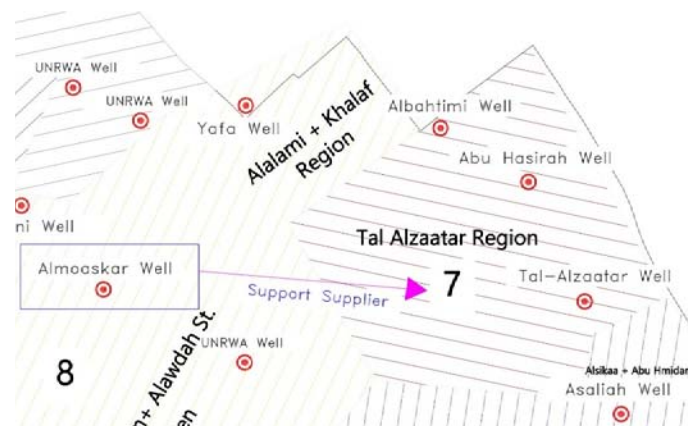
**4.2.2 Zone 3 (al-shanti region).** Al-Shanti zone also considered as one of the critical zones, as this area is supplied through the new Al-Nazla well alone without the presence of any alternative sources. In the normal case, if any failure occurs in the network or the pump used, the water supply will stop completely in the area, which is worsening in the State of emergency and aggression. If the network, pump, or tank is bombed and destroyed, an entire area with a population of about 13,300 people will not have access to water, which may cause a mass displacement of residents with the aim of reaching areas where they can obtain water. In addition to these reasons, Al-Shanti area may be a place for displaced people from the eastern, western and northern regions, as a result of the Israeli invasion in the event that it occurs, so it is necessary to provide adequate quantities of water within the framework of emergency plans. According to the above, the study proposes to supply the Shanti zone with a transmission line from the eastern and western Abu Sharekh wells

to be used as a support line in the event of a defect or targeting of the main line (the new Nazla well) as shown in figure 4.



**Figure 4.** Zone 3 (Al-Shanti Region)

4.2.3 Zone 7. With regard to the Tal Al-Zaatar zone, this area is considered to have a large population of about 20,000 people and may double, especially in emergency cases due to the large displacement cases from the border areas, so the study suggests the presence of a support line within the decentralized water supply so that the area is provided with a transmission line that connects it to the Al-Moaskar well as shown in figure 5.



**Figure 5.** Zone 7 (Tal Alzaatar Region)

4.2.4 Zone 10+11. The eastern areas of Jabalia city suffer from several problems that emerge clearly during the aggression against the Gaza Strip, the most important of which is the inaccessibility of these areas as they are dangerous and militarily active areas, in addition to the presence of a large number of factories and farms that require a continuous and sufficient water supply. Zone 11 depends on Al-Fateh and Bosna wells, So the study suggests supplying Zone 11 with a transmission line from the Al-Hissi well as part of

emergency plans, as well as providing Zone 10, specifically Salah El-Din Street, with a direct transmission line to ensure that water reaches the eastern border areas, as shown in figure 6. In addition, linking the wells and alternative line through the Supervisory control and data acquisition (SCADA) system to ensure remote monitoring and controlling, which contributes to improving the emergency period management process.

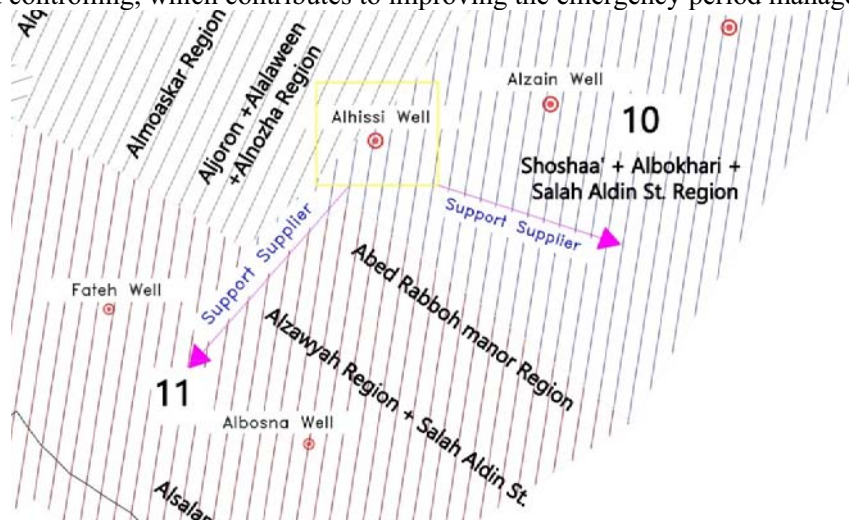


Figure 6. Zone 10+11 (Abed Rabboh manor and Salah Aldin St.)

4.3 Emergency stores

Within the preparedness stage, which is one of the most important elements and components of emergency plans, the study suggests establishing two emergency storages to be in easily accessible areas (the Alriayah and Amer region) as shown in the attached drawing see figure 7.

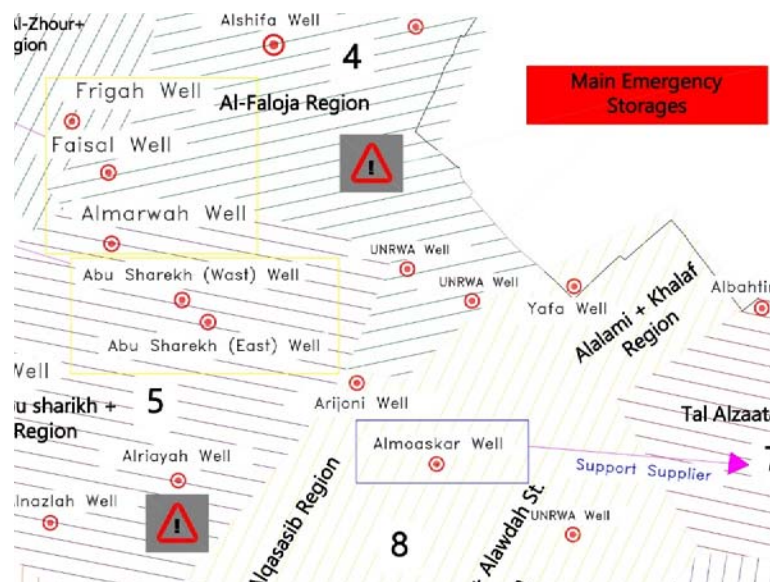
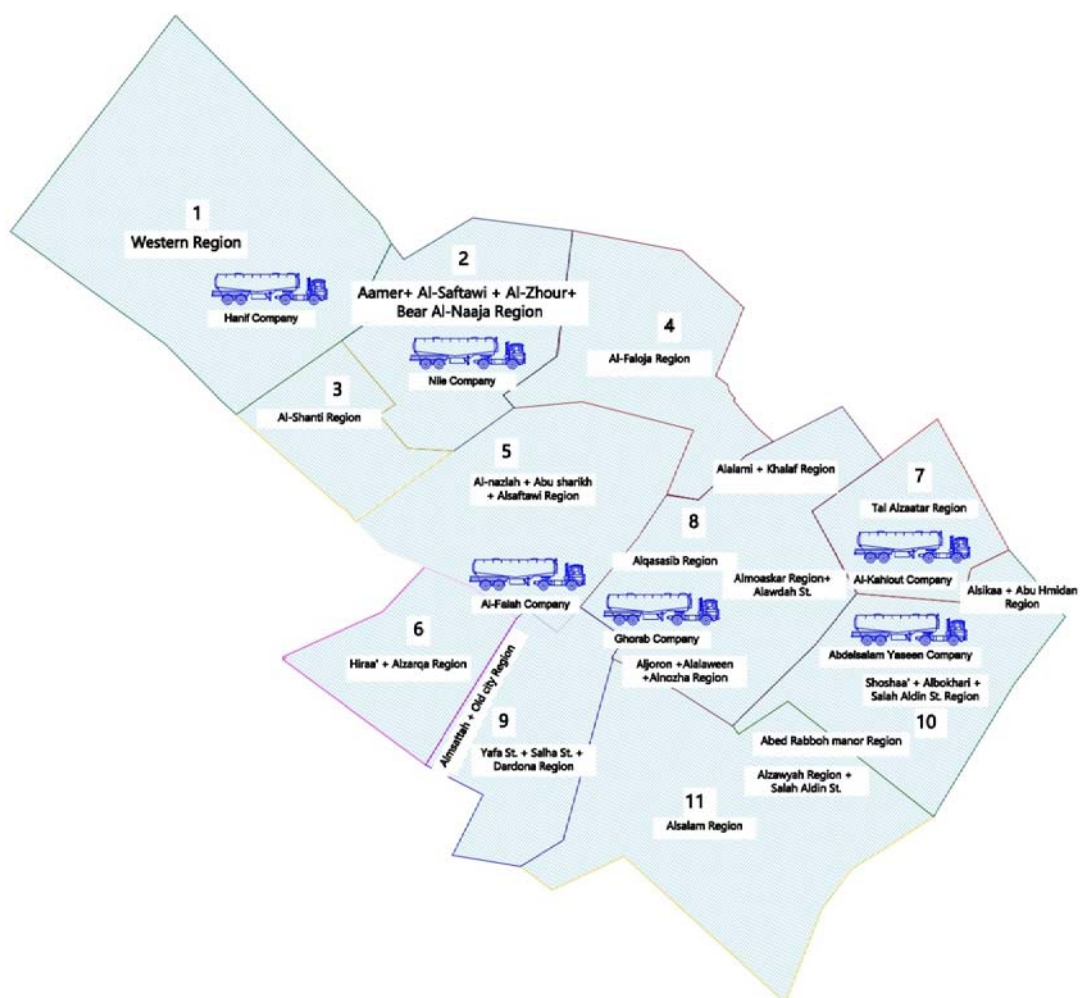


Figure 7. Emergency Storages for Jabalia City.

#### 4.4 Water tankers distribution

Within the state of readiness tools, the drinking water distribution companies operating within the influence of Jabalia Municipality, which can be contracted directly during the period of aggression (emergency) or in advance to provide citizens with water in the targeted areas in the event of the destruction of the main lines and alternative lines and the lack of availability stations or water tanks in that area. Which is distributed as follows: Hanif Company (Western Region), Nile Company (Amer area), Al Falah Company (Abu Iskandar area), Abdel-Salam Yassin Company (Al Zain area - east of Jabalia) and Al Kahlout Company (Tal Al-Zaatar area) as shown in figure 8.



**Figure 8.** Water Tankers Distribution.

#### 5. Conclusion

Based on results above, this study can conclude that:

1. The decentralization process combines with the elements of existing plans at several important points but in a different organize. It is also characterized as being applied without the need for major changes



on the ground, which will be clarified in two points: Regional Water Utility plan (RWU), and that this process depends primarily on effective management rather than a change in the network and its components.

2. Decentralized supply systems offer the possibility to provide water where centralized supply systems are not feasible due to abnormal conditions.
3. The study entails a number of steps centered around the concept of decentralized water supply and its management process, so that the current public network is the one that is basically relied upon and with a separate management system in cases of emergency and aggression, taking into account the expected situation of regional water utility and its management process.
4. The process of decentralizing water supply covers several concepts, for example, through which it is possible to work on integrating the community within the water resources management plans and the process of implementing emergency plans, in addition to enhancing community participation in the management of water supplies during the emergency phase. It also contributes to the development of the administrative process of the water sector from several aspects (economic, technical, environmental and operational), which makes it a strong preference for the concerned authorities to adopt and work on developing it to be the most reliable tool.
5. The study proposes a number of sequential steps to achieve optimal management of water supplies in light of the aggression on the Gaza Strip, which come in the following order: decentralized water supplies, supporting lines, water tanks, water distribution tankers. which are clarified during this part of the study.

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