Forest Fire Resources and Services
Case study: In Saida, Tyre and Bint-Jbiel Cazas

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□ ABSTRACT □

INTRODUCTION:

- **OVERVIEW** : The forest fire problem has been a long-standing issue in Lebanon, posing a significant hazard and causing environmental damage. It is critical for the Lebanese environment to plan for control. Fire control services are important services in any community that strive to safeguard life and property.
- **Objective of the project:**

1. General Objective : We propose to unleash a forest fire Resources Plan which put us all on the same track whenever a fire crisis occurs. Furthering from our resources and equipment also learning from our mistakes we are capable of making a change.
2. **Specific Objectives:**

- To document how fire services are provided and the shortage in its resources in Saida, Tyre and Bint-Jbiel Cazas.
- Identify the water outlets in Saida, Tyre and Bint-Jbiel Cazas.
- To Identify fire frequencies that occurred in Saida, Tyre and Bint-Jbiel.

Keywords: Forest- Fire Resources - Services

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موارد وخدمات حرائق الغابات دراسة حالة: في صيدا وصور وقضاء بنت جبيل

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(تاريخ الإيداع 12 / 1 / 2023. قُبِل للنشر في 1/ 3 / 2023)

□ ملخّص □

نظرة عامة: مشكلة حرائق الغابات مشكلة طويلة الأمد في لبنان ، وتشكل خطرا كبيرا وتسبب أضرارا بيئية .من الأهمية بمكان أن تخطط البيئة اللبنانية للسيطرة .تعد خدمات مكافحة الحرائق خدمات مهمة في أي مجتمع يسعى إلى حماية الأرواح والممتلكات .الهدف من المشروع .1 :الهدف العام: نقترح إطلاق خطة موارد حرائق الغابات التي تضعنا جميعًا على المسار نفسه كلما حدثت أزمة حريق .بناءً على مواردنا ومعداتنا ، نتعلم أيضًا من أخطائنا ، فنحن قادرون على إجراء تغيير .2 .أهداف محددة • :توثيق كيفية تقديم خدمات الإطفاء ونقص مواردها في صيدا وصور وقضاء بنت جبيل • .تحديد منافذ المياه في صيدا وصور وقضاء بنت جبيل تحديد ترددات الحرائق التي حدثت في صيدا وصور وبنت جبيل.

الكلمات المفتاحية: موارد –خدمات حرائق – الغابات

* **ماجستير– كلية الهندسة المدنية– جامعة تشرين– اللاذقية– سورية.**

LITERATURE:

- **FIRE SITUATION IN LEBANON :**

1. Forest fire strikes Lebanon every year leaving behind catastrophic irreparable damage to forests that could take up to 20-30 years to disengage.
2. Lebanon loses up to 1,200-1,500 Ha a year from forest fire and several more from urbanization
3. Causes of Fires:
   - Fireworks in celebrations and events.
   - High voltage power lines that are implemented above forest areas.
   - Reckless agronomists.
4. Rules and regulations:
   - Article 593: "Whoever causes his negligence, lack of caution, or non-observance of the laws or regulations to burn something owned by others, he shall be punished with imprisonment for one year at most. If the offense is trivial, the penalty shall not exceed three months."

- **Overview of the Civil Defense :**

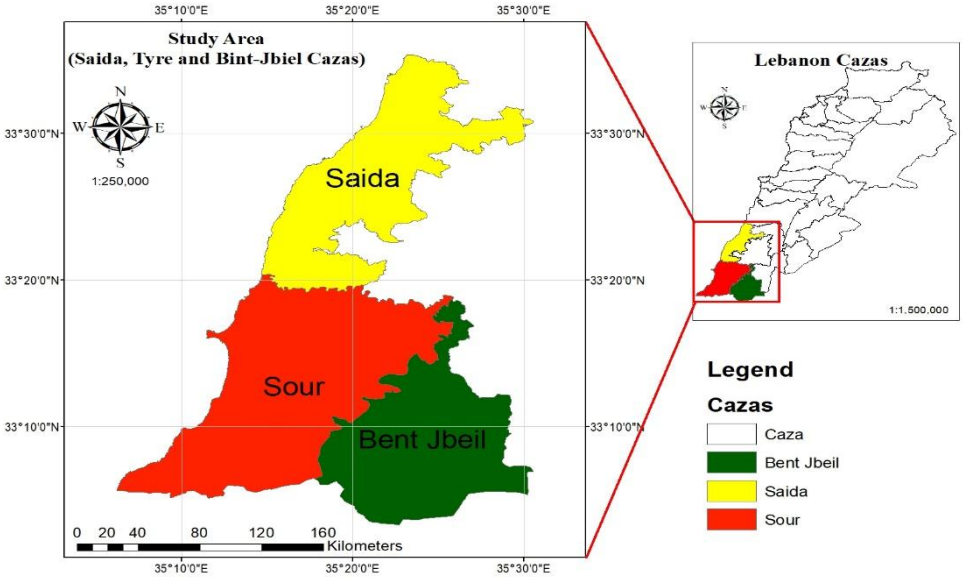
1. Some of Lebanese Civil Defense Responsibilities:
   - Securing civil protection for people, property and the environment.
   - Desolation of buildings subject to collapse.
2. Pre-Disaster Structure and Functions:
   - Identify and purchase supplies needed by the rescue team.
   - Create an operational primacy to control the units.
   - Understand the onslaught of the disaster.
3. During and Post-Disaster Structure and Functions:
   - Warning.
   - Coordination between other authorities.
   - Emergency communication.

- **METHODOLOGY:**

Study Area: Southern Lebanon consists of two governorates, South and El Nabatiyeh; the area spans over 3,000 square km, with 264 municipalities and 12 unions of municipalities.
The South Lebanon Governorate includes 178 cities and villages, of which 133 have municipal councils. While the governorate of Nabatiyeh is found in the eastern and central sector of the southern Lebanon. It is separated from the Mediterranean by the South Governorate. The Nabatiyeh governorate Includes 129 cities and villages, Bint-Jbiel is the second largest town within it. The study area includes three districts (Saida ,Tyre and Bint-Jbiel).

- **Research Strategy:**

1. The project started by acquiring qualitative and quantitative data which may contribute in a better response whenever a wildfire strikes.



Map 1 Study Area

2. Locate all the Lebanese Civil Defense stations in the study area as well as Non-Governmental Organization (Al-Resala Scouts and the Islamic Health Authority).
3. A questionnaire was created to collect information related to the readiness of the volunteers, in addition to everything related to logistical matters.
4. To identify the fire frequency in the study area, the indices were taken into account before and after the fire incident, taking advantage of the data gathered and manipulated, we'll be able to identify areas suffering from shortage in resources and to generate a forest fire frequency map

which in return will come in handy in snowballing the response for wildfires.

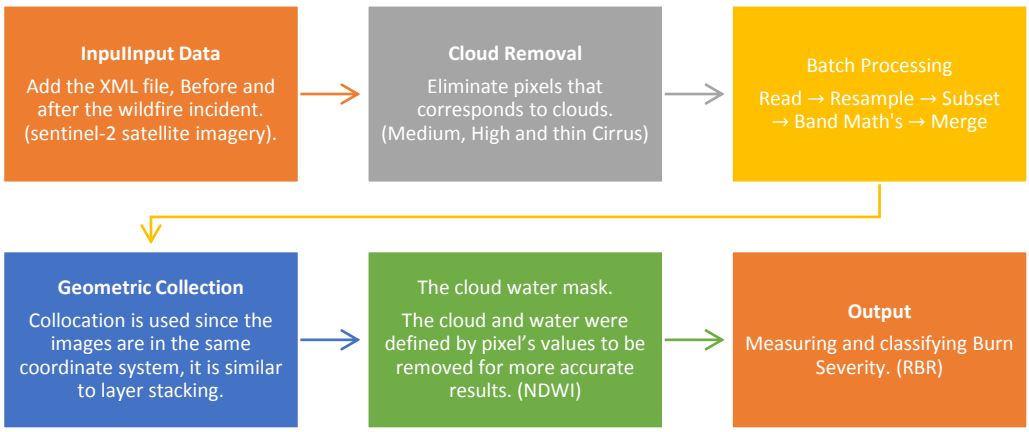
- **Questionnaire:**

To seek and explain how fire services are provided in Saida , Tyre and Bint-Jbiel a questionnaire was conducted

Some of the Interview questions:

1. General information (Date, Station , Caza and Governate).
2. Human Resources (The total number of employees in the center, Volunteers number , no. of males , females …)
3. Types and number of vehicles and equipment's in each center ?
4. Water resources (water tanks, other outlets and water intakes) location and capacity?
5. The source of electricity in the Stations?
6. What are the communication network used in the center? number?
7. How many incidents of fire breakouts do you attend to in a month?
8. How do you get informed of fire incidents when they occur?

- **WORK FLOW USING SNAP:**



The indices were taken into account before and after the fire incident. Furthermore, NDVI will be used to detect the status of the vegetation cover, the pixel value shifts toward 1 when there's a dense vegetation cover and vice versa (Tucker, 1979). On the other hand, NDWI will be used to eliminate any water content. Nevertheless, the outcome of the RBR band will be categorized as follow:

Table 1 Spectral Indices

Spectral Indices	Formula description	Values
NDVI	(NIR - RED) / (NIR + RED)	0 and 1
NBR	(NIR - SWIR) / (NIR + SWIR)	
NDWI	(GREEN – NIR) / (GREEN + NIR)	
dNBR	($NBR_{PRE-FIRE}$ – $NBR_{POST-FIRE}$)	-1 and +1
RBR	(dNBR) / ($NBR_{PRE-FIRE}$ + 1.001)	-2 and +2

Table 2 Burn Severity Categories

Severity Level	dNBR range (not scaled)	Color Ramp
Enhanced Regrowth, High (post-fire)	-0.500 to -0.251	
Enhanced Regrowth, Low (post-fire)	-0.250 to -0.101	
Unburned	-0.100 to +0.099	
Low Severity	+0.100 to +0.269	
Moderate-low Severity	+0.270 to +0.439	
Moderate-high Severity	+0.440 to +0.659	
High Severity	+0.660 to +1.300	

■ WORK FLOW USING ARCGIS ONLINE:

1. Drive times areas: Use the Create Drive-Time Places tool in ArcGIS Online to determine areas within the following time interval: 5-10-15-20-25-30 minutes of a fire station. Live traffic and Friday afternoon rush-hour traffic were evaluated to prepare for the worst-case situation. To build a simple coverage from a more complicated one, a dissolve option was employed.
2. Summarize Nearby: Using a line distance, the Summarize Nearby tool discovers features that are within a defined distance of features in the input layer. The statistics for the neighboring features are then computed. In our case, the analysis was made to determine the reachable tanks by stations within a distance of 1 to 2 km.
3. Web AppBuilder for ArcGIS:

Step One: Choose a web map and turn on Web AppBuilder for ArcGIS.

Step Two: Configure the look for the web app.

Step Three: Customize map display of the web app.

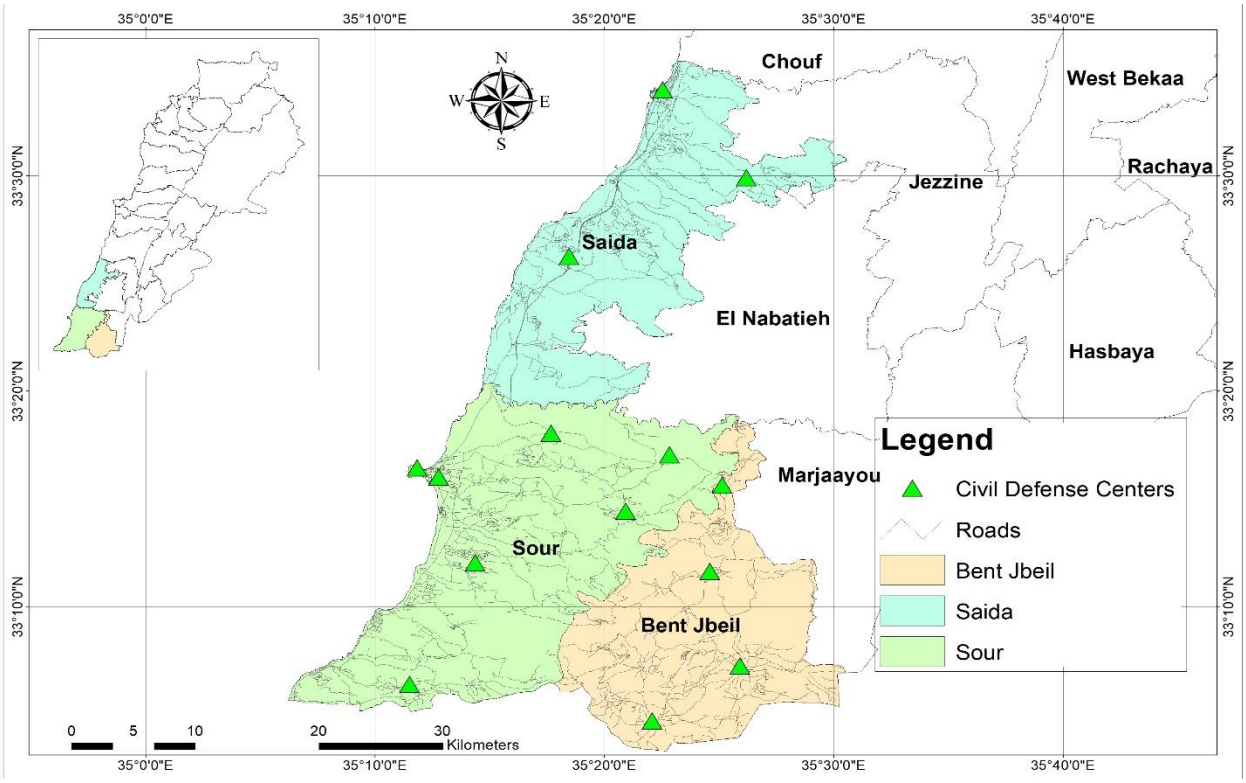
Step Four: Configure the web app's functionality.

■ RESULTS AND ANALYSIS:

DISTRIBUTION OF THE LEBANESE CIVIL DEFENSE STATIONS

According to Map 2, 3 and 4, the total number of stations distributed in the study area are 53, 14 of these stations belongs to the Lebanese Civil Defense (table 4), while 19 for the Islamic Health Authority (table 5) and 20 for Resala Civil Defense. (table 6).

1. Civil Defense stations

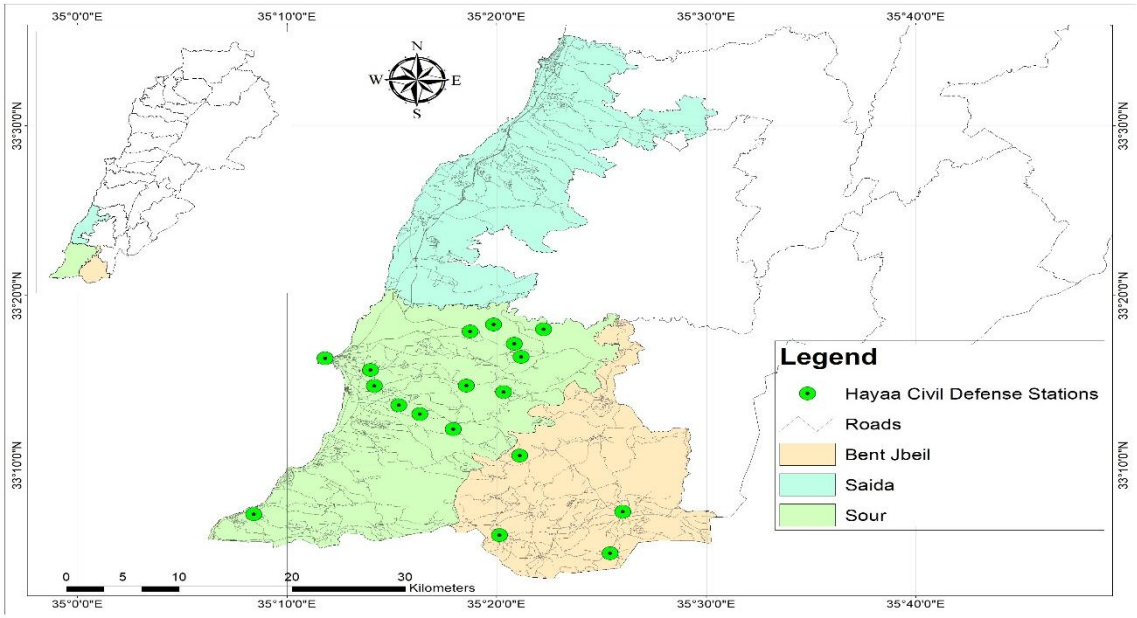


Map 1 Distribution of the Lebanese Civil Defense Stations

Table 3 Lebanese Civil Defense Station

Stations	Governorate	District	x	y
Foune	Nabatiyeh	Bint Jbeil	35.41894	33.26036
Tebnine	Nabatiyeh	Bint Jbeil	35.40975	33.19392
Bent Jbayl	Nabatiyeh	Bint Jbeil	35.43169	33.12072
Rmaich	Nabatiyeh	Bint Jbeil	35.36785	33.07811
Aabbassiyet	South	Tyre	35.29439	33.30083
Tyre	South	Tyre	35.21263	33.26674
Jouaiya	South	Tyre	35.34856	33.24056
Kleile	South	Tyre	35.23930	33.20030
Aalma Ech Chaab	South	Tyre	35.19152	33.10630
Derdaghaya	South	Tyre	35.38055	33.28412
Sea Rescue Tyre	South	Tyre	35.19700	33.27400
Saida	South	Saida	35.37539	33.56639
Aanqoun	South	Saida	35.43644	33.49842
Sarafand	South	Saida	35.30764	33.43761

2. Islamic Health Authority

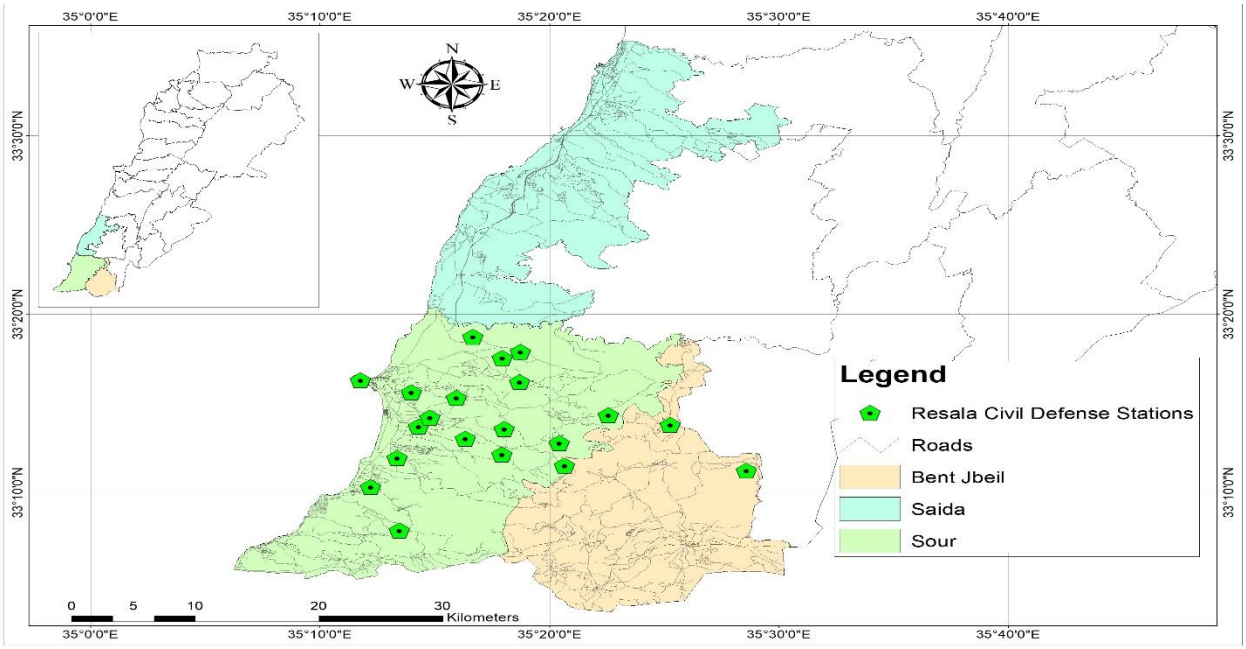


Map 2 Distribution of the Islamic Health Authority Stations

Table 4 Islamic Health Authority Stations

Station	Governorate	District	x	y
Al-Naqoura	South	Tyre	35.13983	33.11850
Tyre City	South	Tyre	35.19680	33.27172
Batolay	South	Tyre	35.25531	33.22564
Bourj Al-shemali	South	Tyre	35.23283	33.26016
Al-Housh Ainbaal	South	Tyre	35.23594	33.24468
Wadi jelo	South	Tyre	35.30899	33.24496
Hanaway	South	Tyre	35.27209	33.21685
Maaroub	South	Tyre	35.34731	33.28600
Derqanoun al naher	South	Tyre	35.31218	33.29803
Barich	South	Tyre	35.35267	33.27311
Hallousiyyeh El Faouqa	South	Tyre	35.33078	33.30493
Jouaiyya	South	Tyre	35.33864	33.23848
Chehour	South	Tyre	35.3704	33.30028
qana	South	Tyre	35.29863	33.20199
Kafra	Nabatiyeh	Bint Jbeil	35.3516	33.17608
Ayta ash Shab	Nabatiyeh	Bint Jbeil	35.3353	33.09802

1. Resala Civil Defense Stations



Map 3 Distribution of the Resala Civil Defense Stations

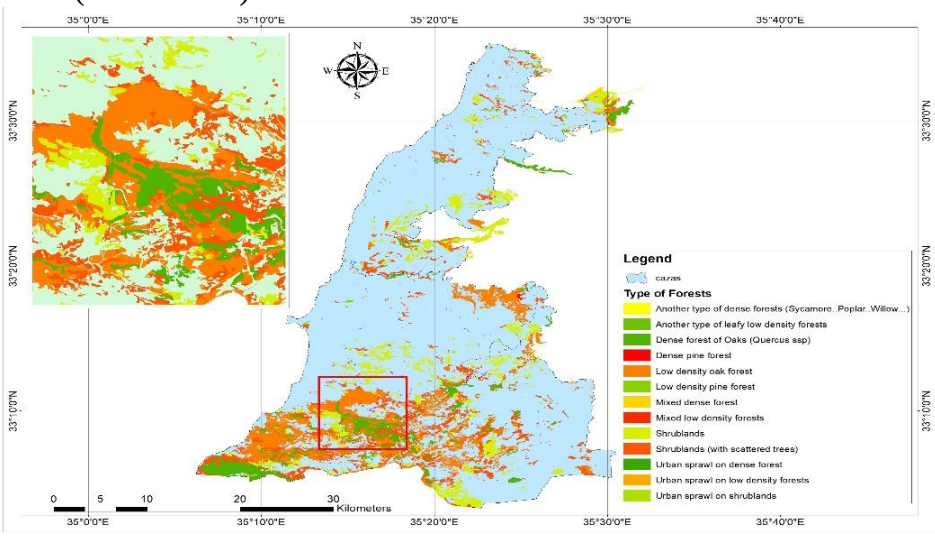
Table 5 Resala Civil Defense Stations

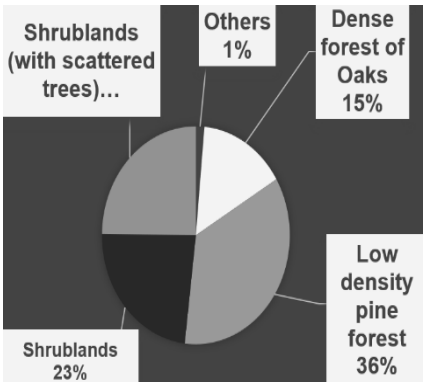
Station	Governorate	District	x	y
Tyre (Imam El-Saddek)	South	Tyre	35.19594	33.27134
Bazouriye	South	Tyre	35.26542	33.25492
Maarakeh	South	Tyre	35.31159	33.26967
Chehabiyeh	South	Tyre	35.37606	33.23877
Deir Qanoun En Nahr	South	Tyre	35.31217	33.29802
Batouliyeh	South	Tyre	35.23796	33.22803
Ain Baal	South	Tyre	35.24629	33.23660
Hanouiyeh	South	Tyre	35.27209	33.21685
Qana	South	Tyre	35.29863	33.20198
Aaitit	South	Tyre	35.30016	33.22589
Deir Aames	South	Tyre	35.34420	33.19157
Mazraat Mechref	South	Tyre	35.34038	33.21256
Qlaileh	South	Tyre	35.22238	33.19864
Mansouri	South	Tyre	35.20334	33.17158
Toura	South	Tyre	35.29889	33.29221
Borj El Chmali	South	Tyre	35.23283	33.26015
Borj Rahhal	South	Tyre	35.27747	33.31198
Tayr Harfa	South	Tyre	35.22416	33.13083
Kherbet Selem	Nabatiyeh	Bint Jbeil	35.42083	33.22953

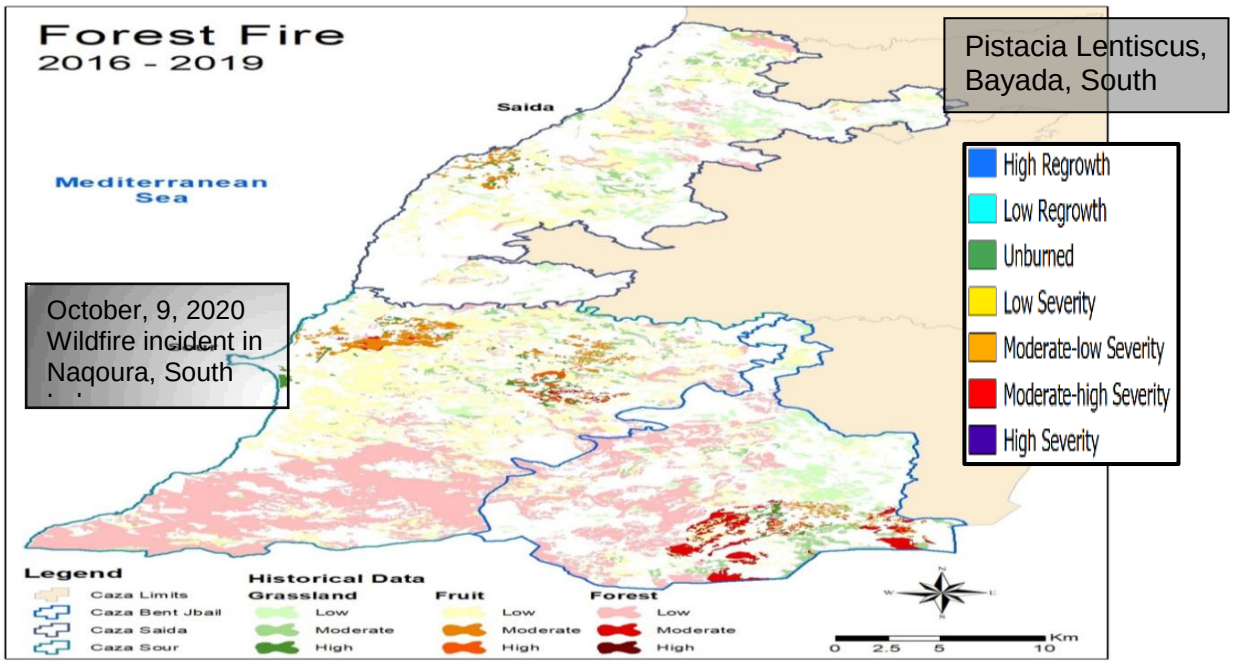
- **FOREST COVER 2010:**

Forest cover occupies 25.86% of the total study area. Among the forest cover system mapped at level 4, Low density pine forest occupies 36% of forest area followed by shrublands (with scattered trees) (25%), shrublands (23%) and dense forest of oaks (15%) respectively. The rest occupy insignificant area and represent approximately 1% of the forest cover.

- **Forest fire frequency:** Map shows fire frequencies occurred in the years of (2016 - 2019).

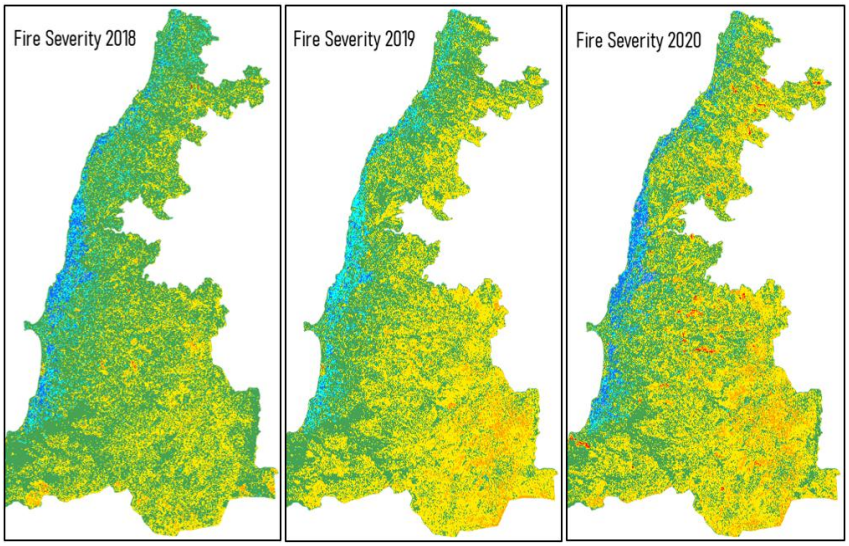


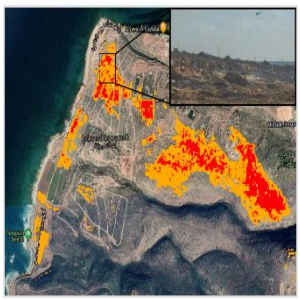




Fire Trench, Naqoura, South

Ceratonia Siliqua, Bayada, South





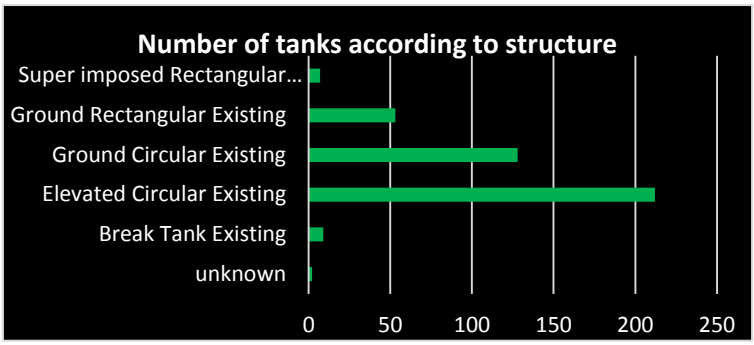
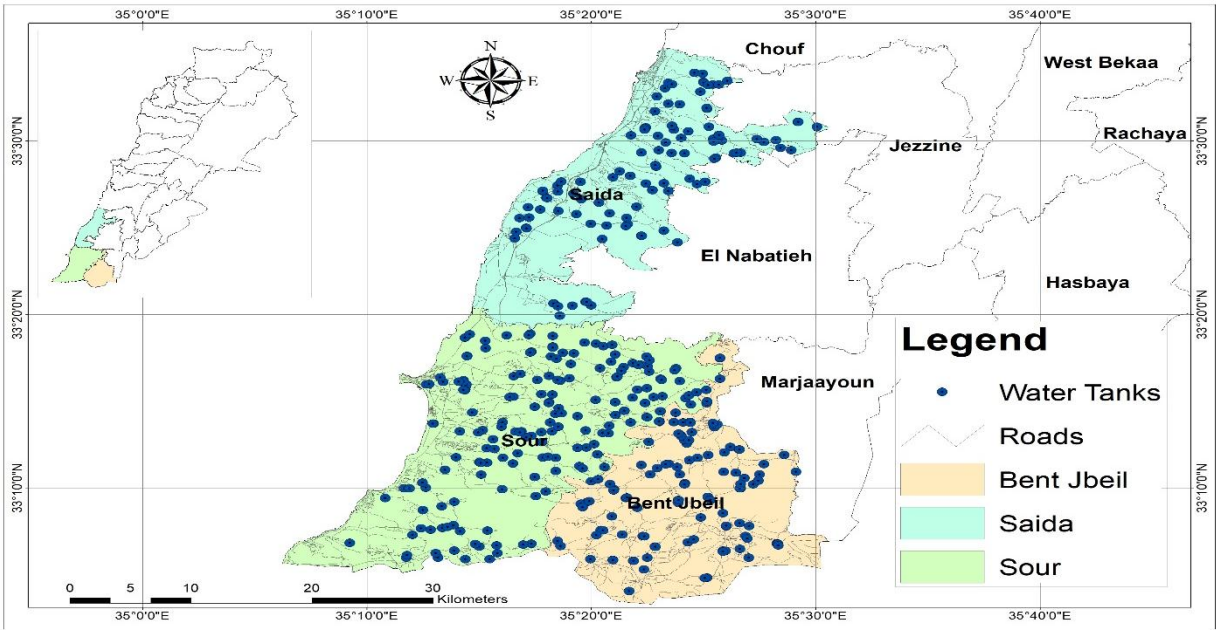


Figure 1 Tank structures

DISTRIBUTION OF WATER TANKS ALONG THE STUDY AREA: Water tanks distribution along the study area will come in handy in extinguishing fire. The data were brought from South Lebanon Water Establishment (SLWE, 2021).



Map 5 Distribution of water tanks along the study area

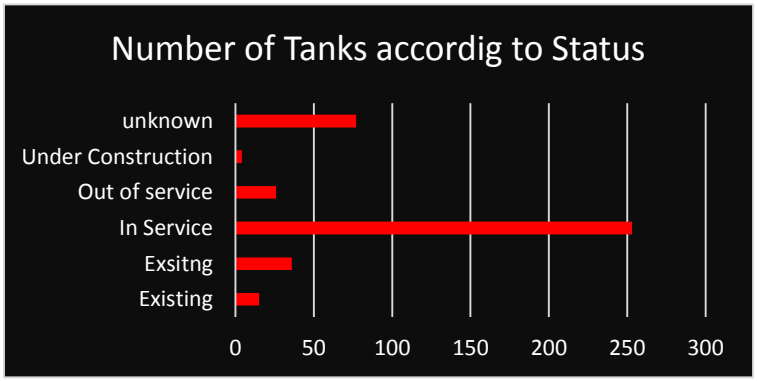
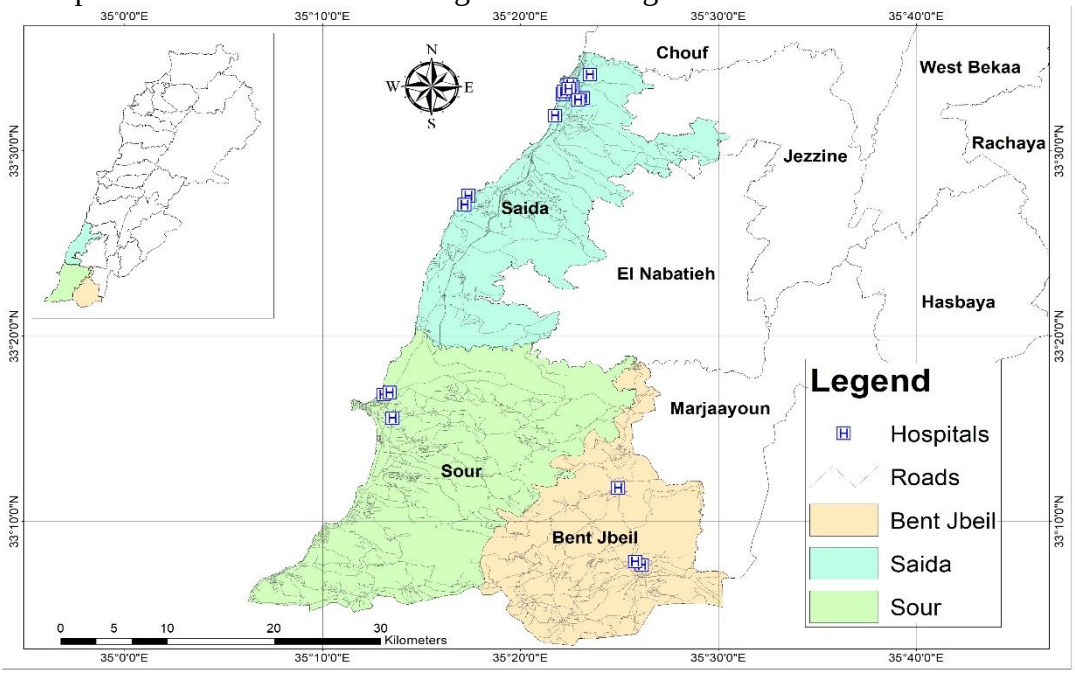


Figure 2 Tank status

DISTRIBUTION OF HOSPITALS IN THE STUDY AREA

The hospitals along the region enables the teams to save lives, especially when fire extinguishers arrive within a short period of time. Injured individuals are taken to nearby hospitals. As shown in map 10, there are 19 major and minor hospitals. As shown in figure 9, the hospitals are distributed according to cazas and governorate.



Map 6 Distribution of hospitals in the study area

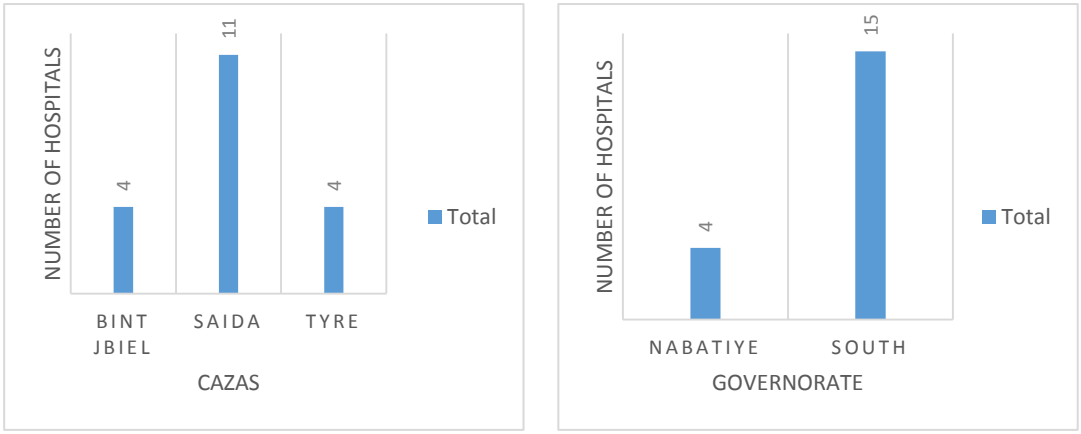
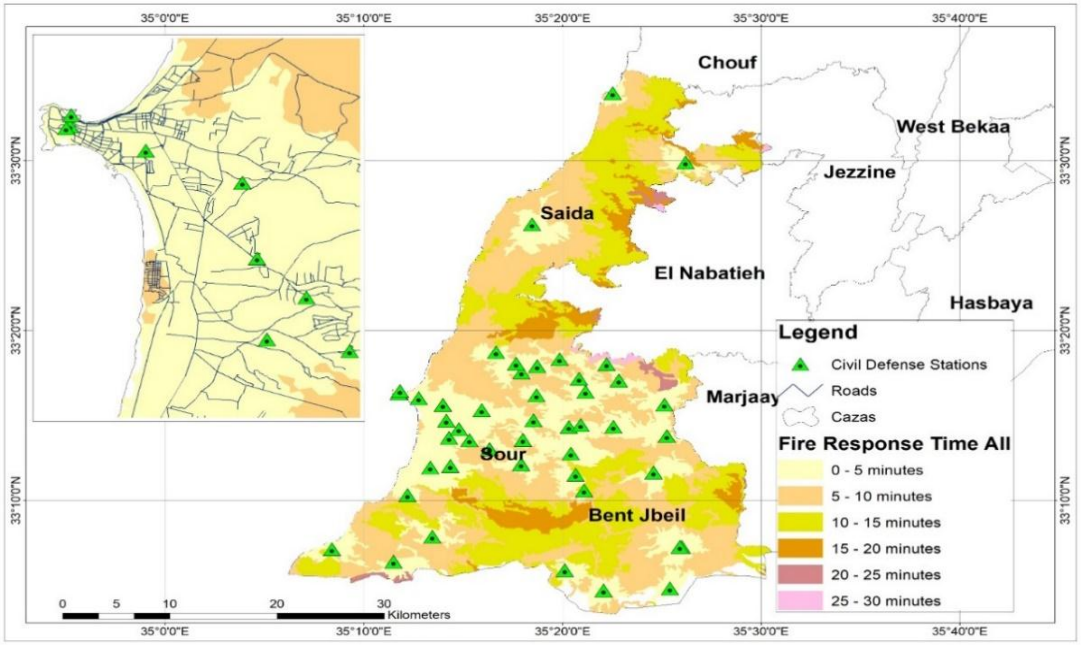


Figure 3 Distribution of hospitals according to Governorate and Cazas

FIRE RESPONSE TIME BY ALL CIVIL DEFENSE SERVICES :

The fire Response time option determine which regions in a city are within a given driving time (5, 10, 15, 20, 25, and 30 minutes) of a fire station. While the data is true, the scenario, analysis, and conclusions that follow are all fictitious. The goal of this research is to show the types of problems that can be solved using drive-time areas. The majority of

the city, including all of the heavily populated regions, is within a 5-10 minutes driving time of a fire station, and practically all of the city is within eight minutes. However, amid rush-hour traffic, a few streets in the city's easternmost reaches are more than 15-20 minutes away from a fire station. Nevertheless, those areas can be reached by Marjaayoun and Nabatieh stations. The main concern lies within the Zebqine valley since it is unreachable by most of the stations due to absence of roads.



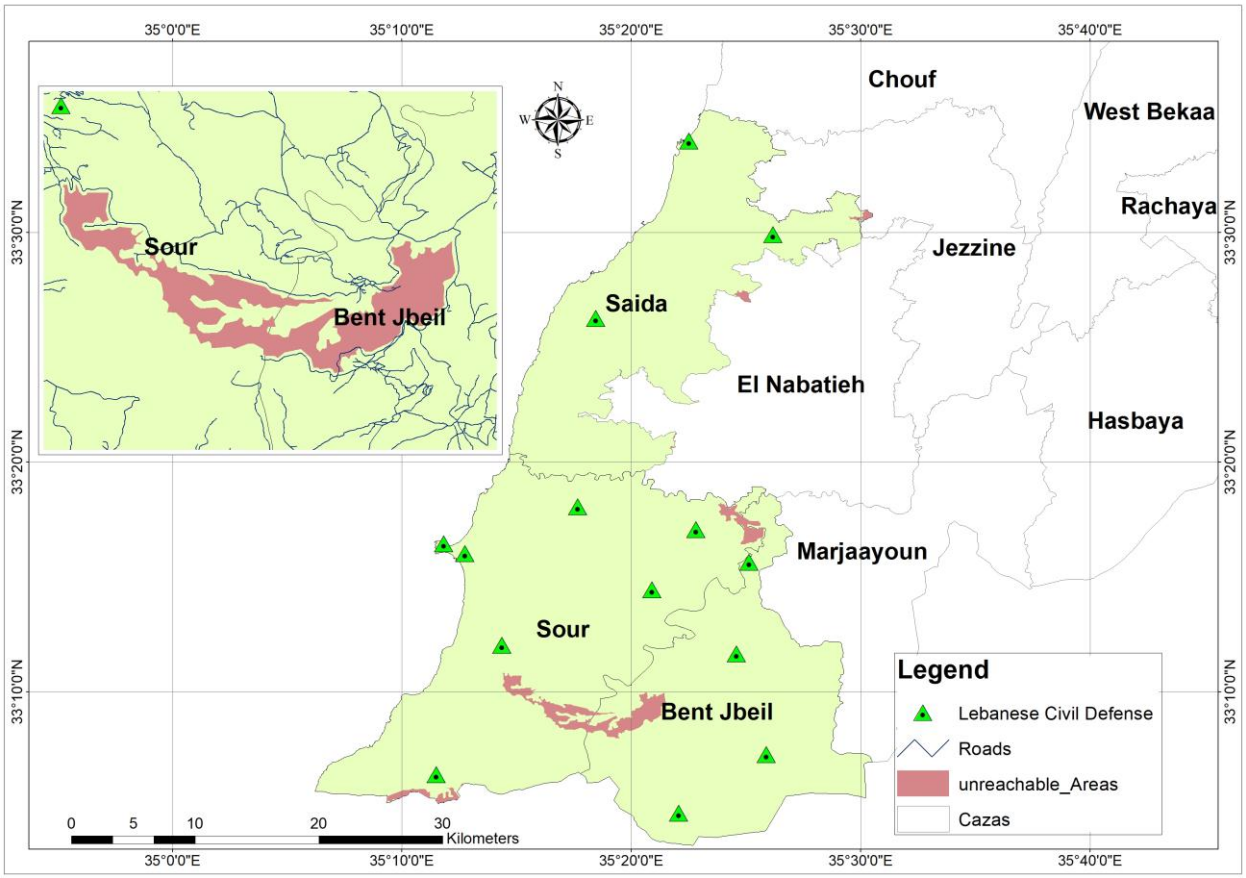
Map 7 Fire Response by all stations

Table 1 Areas covered according to fire response time

Travel Time By All (Features: 6, Selected: 1)

Name and Size	Travel Time Start (Minutes)	Travel Time End (Minutes)	Area (Square Kilometers)
5 - 10	5.00	10.00	389.85
10 - 15	10.00	15.00	340.62
0 - 5	0.00	5.00	259.97
15 - 20	15.00	20.00	215.41
20 - 25	20.00	25.00	214.31
25 - 30	25.00	30.00	172.93

UNREACHABLE AREAS BY LEBANESE CIVIL DEFENS



Map 8 Unreachable Areas

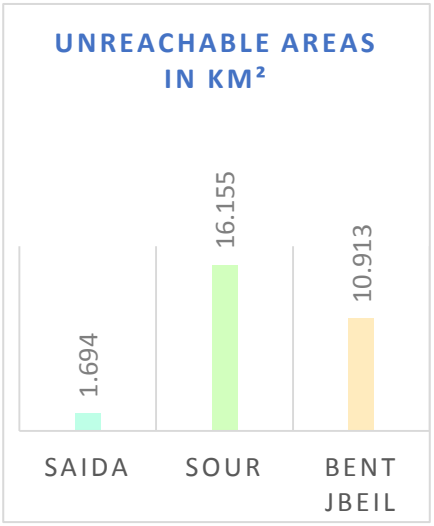
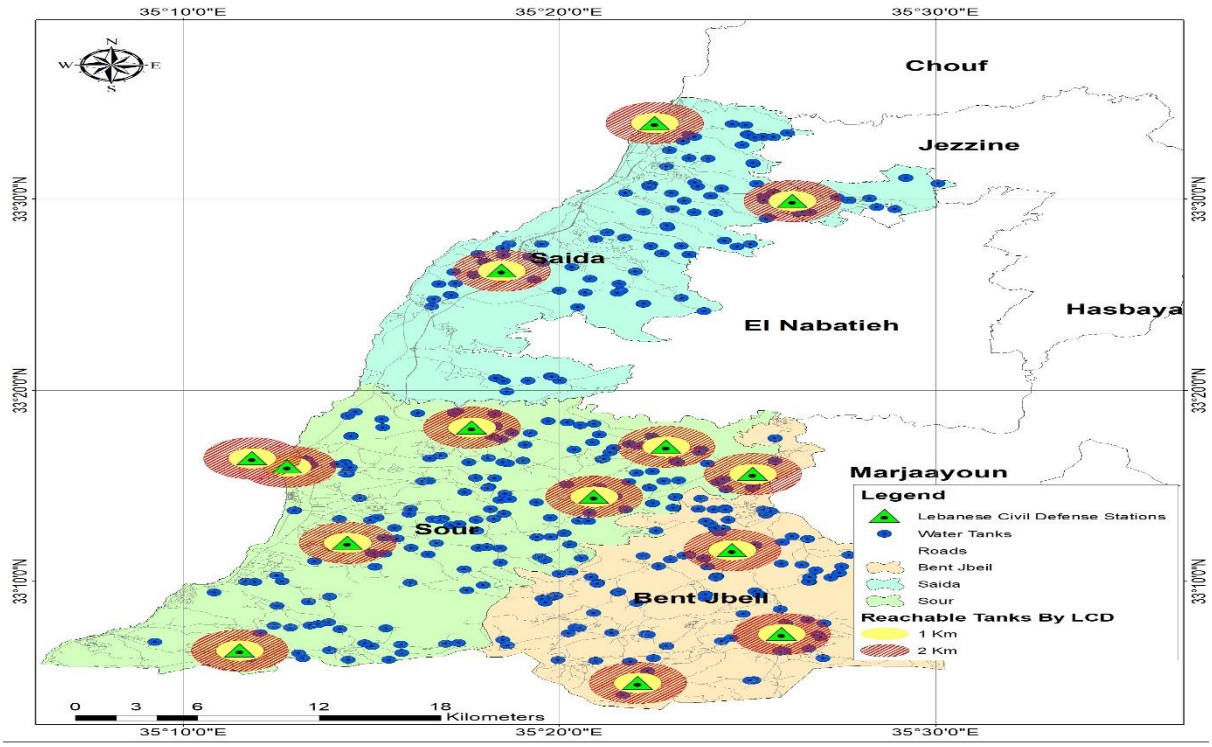


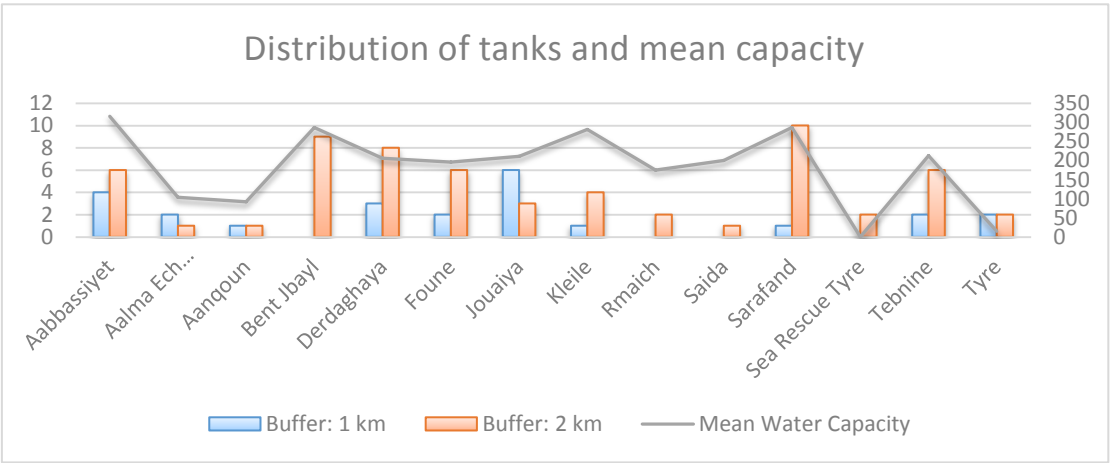
Figure 4 Unreachable area's cover

REACHABLE TANKS BY THE LEBANESE CIVIL DEFENSE

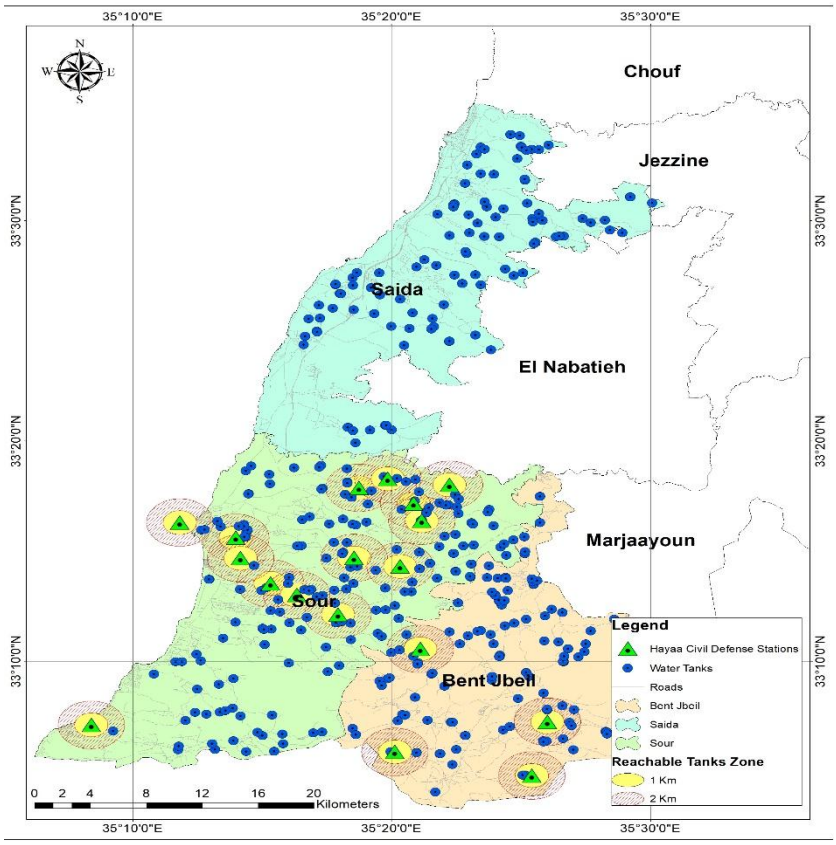


Map 9 Reachable Tanks by the Lebanese Civil Defense

Figure5Tanks and water capacity near LCD



REACHABLE TANKS BY THE HAYAA CIVIL DEFENSE



Map 10 Reachable Tanks by the Hayaa Civil Defense

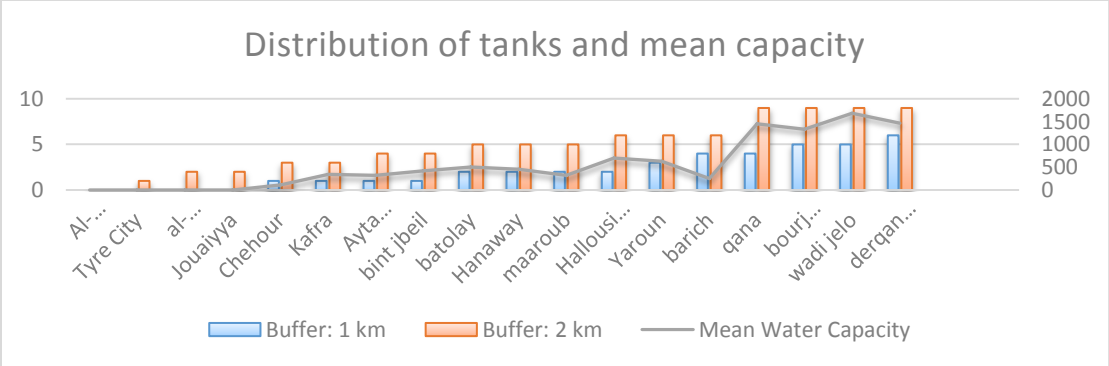
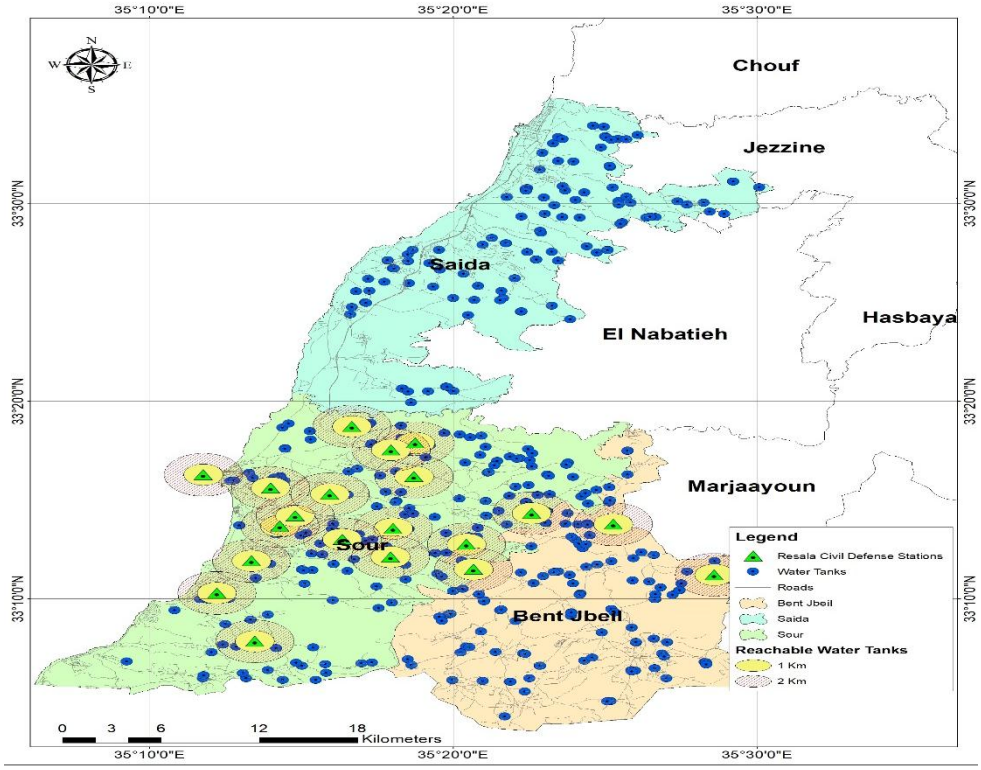


Figure 6 Tanks and water capacity near Hayaa

REACHABLE TANKS BY THE RESALA CIVIL DEFENSE



Map 11 Reachable Tanks by the Resala Civil Defense

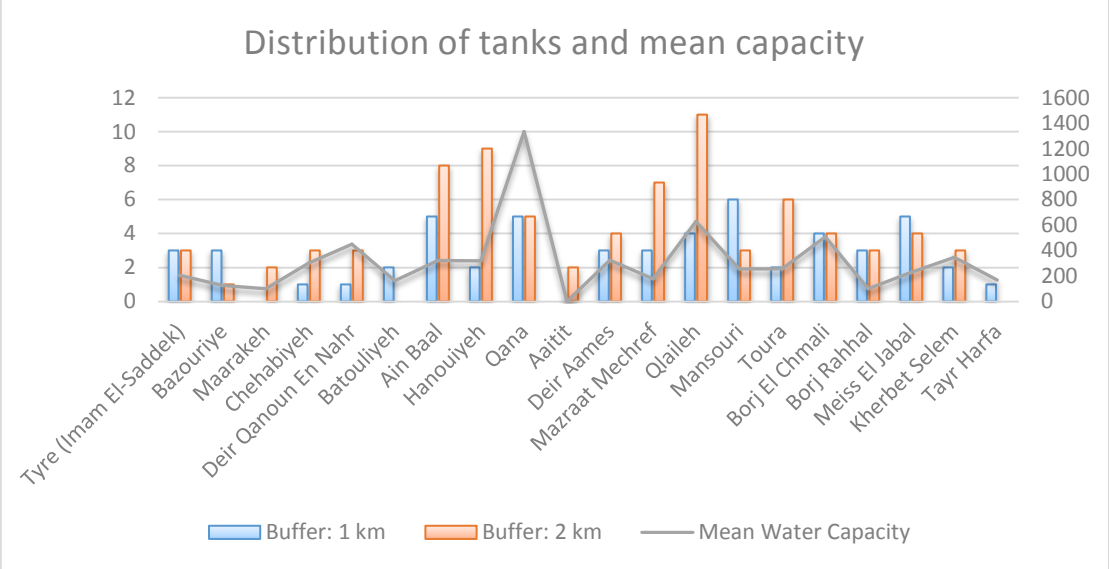


Figure 7 Tanks and water capacity near Resala

■ CONCLUSIONS and RECOMMENDATIONS:

Conclusions:

For any society to grow both in development and population, measures should be undertaken to minimize loss of lives and destruction of property. Fire as a threat ought to be controlled at all cost. In this age of computer technology, the GIS technology has been proved to be a tool for enhancing efficiency in fire control services across the globe.

It is clear that fire stations are sufficient, water tanks are dispersed, and there is a lack of prior awareness of the event site. Furthermore, much of the work is done by hand. Based

on the study area existing growth conditions, this study may be utilized to locate fire stations as a fast win in the first instance.

Recommendations

1. Additional fire stations, fully equipped with contemporary tools and equipment, are required. Although the road network is adequate, traffic bottlenecks continue to be a problem. As a result, improved digital traffic control systems should be used.
2. The majority of the tasks are completed manually, and fire outbreak alerts are obtained by phone calls. Hence there's a need for the automation of fire department operations, allowing for the development of a fire information system and the capacity to make real-time judgments.
3. Some areas are within a 30 minutes response time. The fire engine should be at the incident area within 8 minutes, according to the National Fire Protection Association (NFPA) of the United States. The usage of a traffic control station, a global positioning system, and fire detectors to alert firemen when a fire breaks out should all be used.
4. An effective examination of the position of fire stations and water tanks will be established using the GIS application, as will shorter routing and land uses for the incident site regions. The study area's most pressing requirement at the time is the installation of new fire hydrants.

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