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Proper technologies for reuse water for irrigation and agriculture sector in the area of Latakia, Syria

BACHELOR'S THESIS

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Declaration

I hereby declare that I have done this thesis entitled Proper technologies for reuse water for irrigation and agriculture sector in the area of Latakia, Syria independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague 10/ 04/ 2022

Abdul Hamid Fandi

Acknowledgement

I would like to thank my family for their continuous support throughout the years in all stages of my life.

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Abstract

The thesis was elaborated as a literature review, where in the first part general information was provided about Syria and the Latakia Governorate in particular in terms of climate, water resources and agriculture.

Then it was talked about reused wastewater for agricultural purposes in Syria and the criteria that determine the water quality and the reality of using this water and the health effects that arise from the use of this water for agricultural purposes. The three wastewater treatment methods were presented: Mechanical, Aquatic and Terrestrial Treatment Technologies.

Then the results presented and the recommendations were presented to the government authorities responsible for managing reused of wastewater.

Key word: wastewater, water purification technologies, Latakia, Syria

Table of Content

Table of Figures

1. Introduction

The recycling process is one of the important processes to protect the environment, as the use of recycling is not limited to plastic, paper, cardboard and metals, but also includes water recycling and reclamation by finding many sources of water before treating it and using it again in industry, irrigation and other processes. (Bunzel, et al., 2013)

It must be ensured before the process of using the treated water for specific purposes that this water is suitable for the place where it will be used. The processes of using used water after treatment may be planned, such as reuse in industries and irrigation, or unplanned, such as reuse through rivers and streams that pump the used water after treatment. (Dumont, et al., 2015)

Water resources in Syria face many challenges. First, sharing all of the country's major rivers with neighboring countries, Syria is largely dependent on the flow of water from Turkey through the Euphrates and its tributaries. Second, the high rate of population growth and urbanization increases pressure on water resources, resulting in local groundwater depletion and pollution, for example in Ghouta near Damascus. Third, there is no legal framework for the integrated management of water resources. Finally, the institutions responsible for managing water resources are weak, each being highly centralized and fragmented between sectors, and often lacking the ability to enforce regulations. Water resource policies have centered on dam construction, development of irrigated agriculture and occasional interbasin diversions, such as a pipeline to provide potable water to the city of Aleppo from the Euphrates. There are 165 dams in Syria with a total storage capacity of 19.6 km3. Managing demand through metering, higher tariffs, more efficient irrigation technologies and reducing non-revenue water in drinking water supply has received less emphasis than supply management. The government is implementing a major program for the construction of wastewater treatment plants including the use of reclaimed water for irrigation. (Mahmoud & Sayegh, 2017)

Since rain is the main water resource in Syria, which affects the availability of all other water resources. The average annual rainwater resource is estimated at 46 billion cubic metres. In drought years, this number drops significantly. Moreover, precipitation is distributed unevenly in space and time. It rains, and sometimes snow, between October and May, especially in the mountains. Since our focus is on the Latakia region as the most important agricultural region in Syria, the Syrian coastal region, including Latakia, covers about 1.3 million hectares, and the average annual rainfall is between 300 and 400 mm. (Mahmoud & Sayegh, 2017)

As a result of the war, which has been going on for more than ten years, it has greatly hampered access to basic services in Syria, including access to potable water or wasting irrigation water. Prior to 2010, 98% of urban residents and 92% in rural communities had reliable access to safe water. Today, the situation is vastly different from before: only 50% of water and sanitation systems are functioning properly across Syria. For example, the wastewater treatment plants serving the cities of Damascus and Aleppo were out of service in 2012, after they were directly destroyed. As a result, untreated wastewater seeps into the natural environment, posing a serious threat to public health and severely polluting groundwater resources. (Wahoud, 2019)

Hence, our study aims to show and study technologies of utilizing the reused wastewater in the field of irrigation and agriculture, and how useful for using it in the Latakia governorate.

2. The aim of thesis

The aim of the study is to show and study technologies of utilizing the reused wastewater in the field of irrigation and agriculture, and how useful for using it in the Latakia governorate.

3. Methodology

The information to this bachelor thesis was be collected from relevant and published scientific articles, periodicals and papers in English and analyzing what can be learned through the collection of data. The used internet databases are – Web of Science, Science Direct, Google Scholar…etc. Also, relevant and published books related to the topic will be worked.

4. Literature review

4.1. Background of Syrian Arab Republic

4.1.1. Location and terrain

Syria is located in the southwestern part of the continent of Asia; Syria overlooks the Mediterranean Sea. The length of the coastal strip is 193 km. The total general border is 2,253 km. It is distributed between Turkey in the north, Iraq in the east and south, and Jordan in the south. On the west side, beside the Mediterranean, Syria is bordered by Lebanon and Israel. (Jamal, 2017), all the Syrian topography can be seen on figure 1

The country's topography is diverse:

- in the south lies the volcanic Golan Heights and the fertile Hauran Plain, followed by Jabal al-Arab, which is composed mainly of basalt rocks; (Jamal, 2017)
- To the north, there is the West Lebanon mountain range on the border with Lebanon, which contains the highest point in the country, which is Jabal al-Sheikh or Hermon. From it, fertile plains form Ghouta of Damascus, before turning into barren, barren mountainous lands in the Qalamoun and al-Nabk mountain ranges to the north of Damascus countryside; Before it unfolds again in the Al-Ghab Plain and the plains of the Syrian coast, which is divided longitudinally by the Sahel mountain range extending from the Turkish border to Lebanon, and Jabal Al-Zawiya is its parallel. In the far north of Syria, Aleppo is located on a plateau surrounding fertile plains with some mountains such as Jabal Semaan; It meets with the Euphrates Valley, which has fertile soil, which extends to the Iraqi border; It is located in the far northeast of the island region, which got its name from the large number of rivers in it, which is also considered one of the most fertile regions of the country. Between the Euphrates Valley and the Al-Ghab Plain lies the desert of the Levant, sandy and arid, interspersed with a few mountains like the Palmyra mountain range. (Jamal, 2017)

In Syria, there is one island opposite Tartous, which is Arwad Island, and a number of valleys such as Wadi al-Nasara and Wadi Barada. (Jamal, 2017)

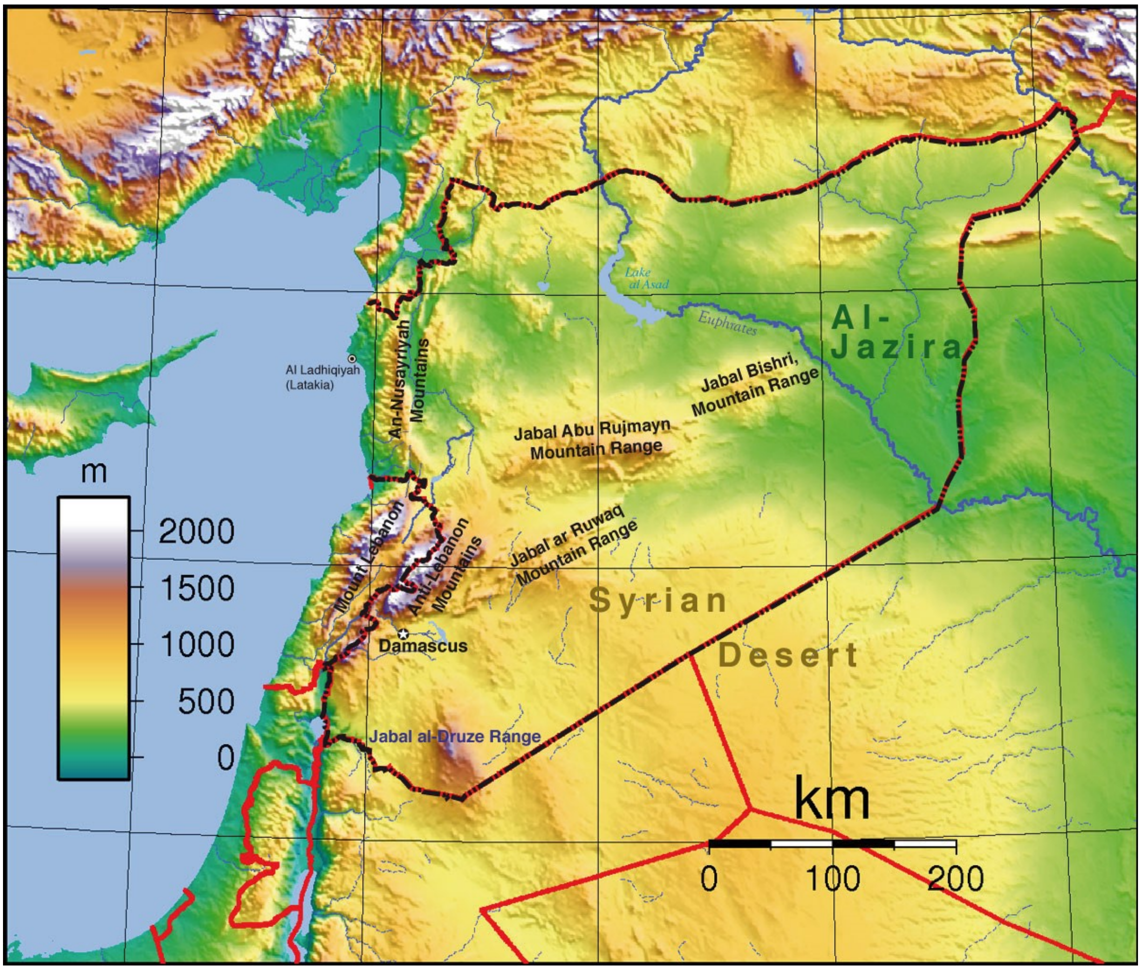

Figure 1 Syrian Topography Map

Source: (Jamal, 2017)

4.1.2. Climate

The climate in Syria is classified into two major divisions: (Salman, 2018)

The Mediterranean climate in the coastal region and the nearby areas, and the dry climate in all other regions.

The Mediterranean climate is characterized by hot, dry summers and cold and rainy winters with two transitional seasons, autumn and spring.

Figure 2 shows the climate classification map for Syria

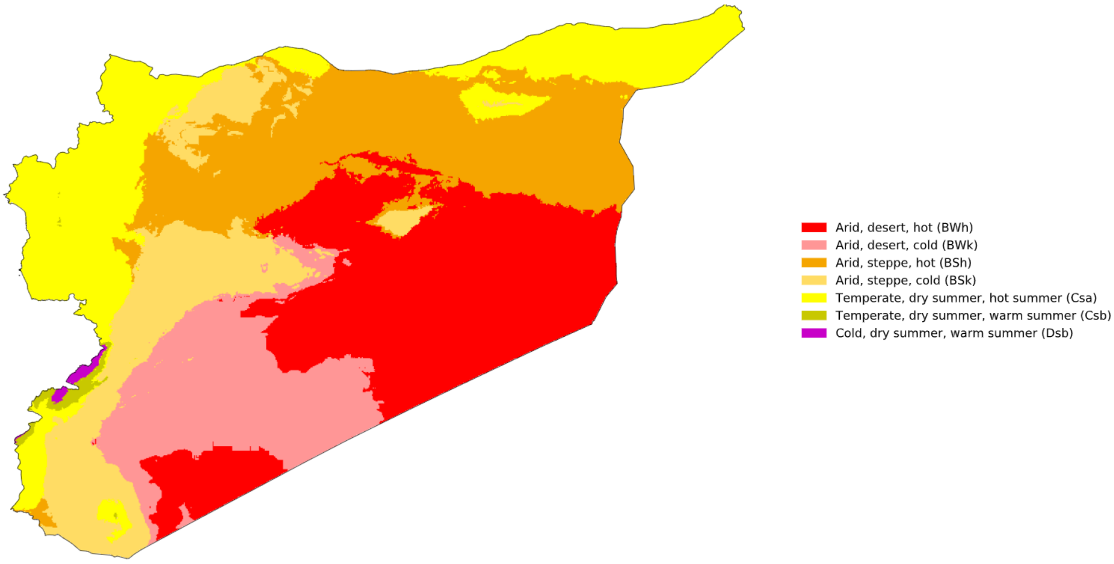

Figure 2 Syria's climate

Source: (Koppen-Geiger, 2016)

The dry climate is characterized by little rain, very cold in winter, where temperatures drop below zero degrees Celsius and very hot in summer, while in mountainous areas and highlands, moderate temperatures prevail in summer. Due to the elevated position. Precipitation is usually between September and May each year; Snow falls on the western highlands and the maximum precipitation is usually in the month of January. It is characterized by the heterogeneity in the distribution of rain between the coast and the interior, as well as the different rates of annual rainfall on the lands. (Faour & Meslmani, 2018)

Three areas can be distinguished which figure 3 shows: Coastal areas with high rainfall, up to about 1200 mm/year; and inland areas adjacent to the coastal area, where precipitation decreases to about 250 mm/year, and rises to 550 mm/year in the northern and northeastern regions; And the Badia regions, which constitute about 60% of the country's area, where the precipitation rate does not exceed 150 mm/year. Regarding humidity, the atmosphere in all parts of Syria except for the coastal areas is characterized by a high rate of relative humidity during the winter and a decrease in the summer; As for the coastal area, it has a high relative humidity during the summer due to the influence of the sea; The desert and semi-desert regions are the least humid regions; The average humidity during the summer ranges from 20-50% in the interior areas and from 70-80% in the coastal areas, while in the winter the rate ranges between 60-80% in the interior areas and between 60-70% in the coastal areas. As for the winds, they are moderate, with the exception of the Badia winds blowing over Damascus and the Euphrates Valley regions in the summer. (Faour & Fayad, 2018)

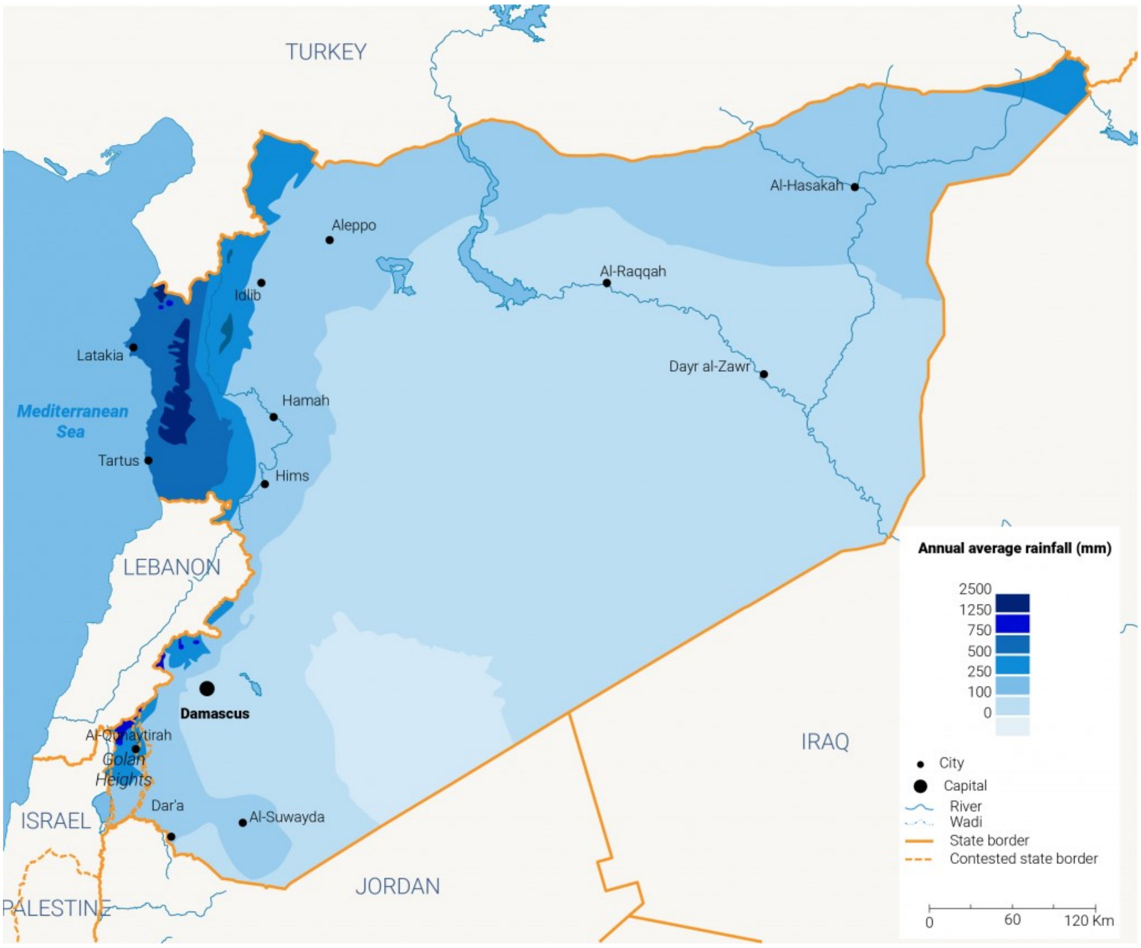

Figure 3 Syrian Annual Average rainfall

Source: (fanack, 2016)

4.1.3. Water Resources

Syria is rich in water resources, whether they are rivers, lakes, or underground springs. The largest river passing through Syria is the Euphrates River, which enters Syria from Turkey and crosses its eastern region towards Iraq. The length of its course in the territory of the Republic is 675 km, in addition to a number of basic tributaries, most notably the Balikh River with a length of 460 km and the Khabur River. The Tigris River, 50 km long, passes in Syria in the far north-east, adjacent to the Iraqi border. The third Syrian river in terms of length is the Orontes River, which enters Syria from Lebanon with a length of 325 km and forms the main nerve for the agricultural areas in the Al-Ghab Plain; (Kelley & Colin , 2015) and the figure 4 shows the official hydrological basin in Syria

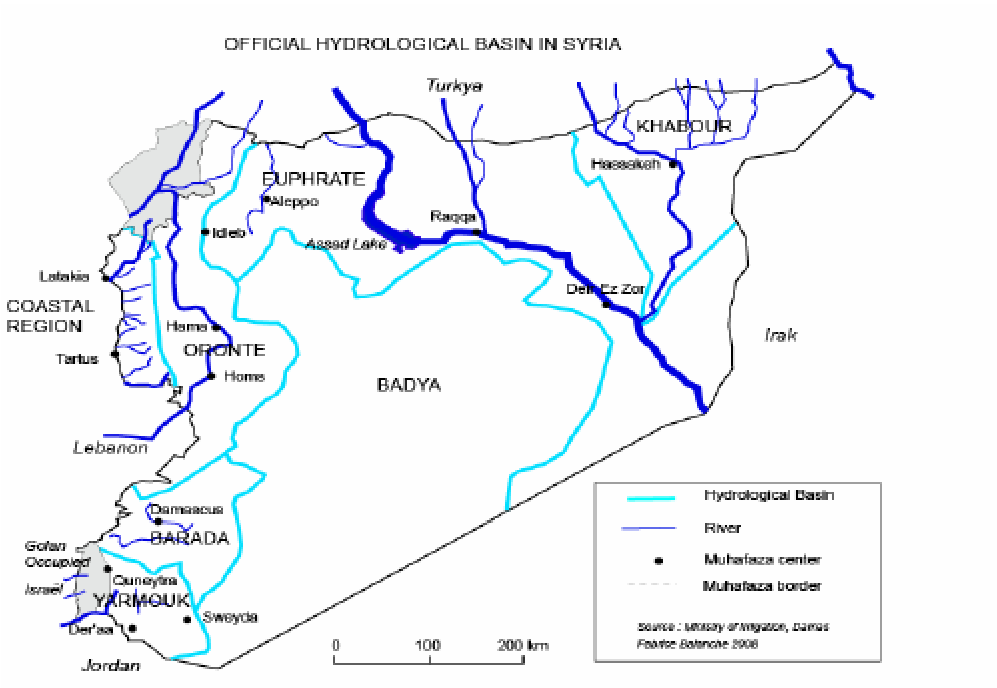

Figure 4 Official hydrological basin in Syria

Source: (Balanche, 2019)

The coastal region is also characterized by short mountain rivers, most notably the Al-Sin River and the Great North River. There is also the Barada River, which originates in the eastern Lebanon mountain range, passes through Damascus and Ghouta before flowing into Lake Al-Otaiba in the Badia, and forms the water portfolio for the city of Damascus and its countryside. As for the south, the most important of its rivers is the Yarmouk River, which continues on its way west, meeting the Jordan River before emptying into the Dead Sea. The state has built a large number of dams on the various rivers passing through the country, the most important of which is the Euphrates Dam, which forms behind it an artificial lake with a capacity of 14.1 billion cubic meters of water; Other important dams include the Al-Rastan Dam on the Orontes River, and the Tishreen 16 Dam on Great North River. (Faour & Fayad, 2018)

Syria contains a number of natural and artificial lakes formed behind dams, the largest of which is Lake Al-Assad, the Seven Lakes near Latakia, Lake 17 April on the Afrin River and Lake Rastan on the Orontes River, which was established in 1960; As for the natural lakes in Syria, the most prominent of them are Lake Qatina near Homs, Lake Zarzar near Zabadani, and Lake Masada in the Golan, which is characterized by its sulfur water. (Faour & Fayad, 2018)

The vegetation cover in Syria is varied in the central and western regions, and this contrasts in the regions of Badia al-Sham and the entire eastern region. Syria contains thirty nature reserves; Latakia Governorate is considered the richest Syrian governorate in terms of forests and vegetation cover with 31% of the total forests of the Republic, followed by the Al-Ghab Plain area with about 12%. About 3,500 species of plants and trees live in Syria. (Faour & Fayad, 2018).

4.2. Background of Latakia city

4.2.1. Latakia City

Latakia is one of 14 Syrian governorates, located on the eastern coast of the Mediterranean Sea, about 385 km from the northeast of the capital Damascus. It is the largest and most important port of the country on the Mediterranean Sea, which has given it a unique trade location. Also appeared in it the first alphabet in history (the Ugarit alphabet). The area of Latakia Governorate is 2,300 km2 and its population is more than one million (2018). (Abahussain, et al., 2012) (Faour & Fayad, 2018)

4.2.2. Geography of Latakia

Latakia Governorate is located in the west of Syria and bordered from the west by the Mediterranean Sea, from the north by Turkey, from the east by Hama Governorate, and from the south by Tartous Governorate. (Jamal, 2017)

The Governorate is divided administratively into four areas: Latakia, Haffa, Jabla and Qurdaha like map shown in Figure 5.

Figure 5 Latakia Governate

Source: (Koppen-Geiger, 2016)

4.2.3. Climate

The climate in Latakia Governorate is very humid in the mountains, especially in the coastal mountains, which extend for a distance of 170 km and a width of about 25 km, and there is a lot of rain in the winter, which is approximately 1000 mm, and it is known for its moderate temperatures, which range between 12 degrees Celsius in winter And 27 degrees Celsius in summer, which increases the amount of rainfall over the amount of evaporation, which results in an increase in humidity. (Parolari, et al., 2016)

The number of hours of sunshine is about 3000 hours annually, and the average of snowy days is about 4 days per year. These areas are concentrated in the Mediterranean depressions. Most of the paths to these depressions are on the southern coast of Europe and sometimes on the Mediterranean Sea itself and least on the northern coast of Africa, and usually during its course thermal depressions from the south in the foreground and cold highlands from the north in its rear, and is often accompanied by medium or heavy rains on the areas it passes through. (Terink, et al., 2013)

4.2.4. Soil in Latakia Governorate

Soil is second only to the climate in terms of importance to agriculture, each soil has its natural, chemical and organic properties, which in one way or another affect agricultural production. There is a mutual and close relationship between the soil and plant, where the cultivation of crops differs between one soil and another. The soil in Latakia is the cornerstone in the diversity of agricultural production, due to the abundance of rainwater on the governorate's lands, all the soils are suitable for agriculture, with the exception of areas where the unfolding solid rock, where spreads in latakia the red soil which characterizes the Mediterranean climate, interspersed with some lateral soil on the sides of the valleys and wells, the soils in latakia can be divided to: (Salman, 2018)

Coastal plain soils: It is located in the Jableh and Latakia plains, where the red Mediterranean soil appears on the calcareous sea formations near the shore. These soils are characterized by high fertility, while the black clay soil, which is a heavy soil with a depth of 50 cm spreads in the southern part of Jableh plain. Mud river soils are also of the coastal plain soils, it is located in the floodplains of coastal waterways. It is a high-fertility soils with a depth of more than 100 cm. (Salman, 2018)

Mountain highlands and slopes soil: Mountain soils are the least fertile soils in Latakia, in general, the thickness of the soil differs from one location to another depending on the shape of the geographical location. (Jamal, 2017)

Slope soil is rapidly drying out due to drainage caused by the tendency and the permeability of its granules. The eruption rocks prevail in the soil of Al-Bassit constituting more than 60% of it, and It is free of lime. (Jamal, 2017)

Highlands soils (Ein- al baida, Al Bahlolia, ALbaier): They are poor soils that depend on rainwater or on small springs in the area. (Salman, 2018)

4.2.5. Agriculture

The agricultural sector in Latakia along with the tourism sector is the cornerstone to ensure balanced and sustainable development, in other words, the agriculture sector is the main productive component of the governorate and it receives increasing attention because agriculture is still the main component of the economic structure and will continue to be in the future especially at a time when the problem of food security is one of the most important problems facing the developing countries, including the Syrian Arab Republic, especially in light of the current crisis that it suffers from, knowing that agriculture in Syria before 2011 was able to cover the needs resulting from the population increase fourfold, which improved the degree of self-sufficiency of the bulk of the main food items. Therefore, we will attempt to shed light on the reality of agricultural activity in Latakia Governorate, and to indicate the availability of the necessary ingredients to increase plant and animal production. (Jamal, 2017)

Intensive agricultural activity along the coast, including 70,000 plastic greenhouses, has led to excessive and uncontrolled use of fertilizers and pesticides. The main crops in Latakia are olives and citrus (1.2 million tons/year of citrus and 160,000 tons of olive oil from 87 million trees). Growing large citrus orchards requires the use of pesticides to prevent pest infestation, which requires significant agricultural investment. (Salman, 2018)

4.3. Hydrology and water situation in Latakia

4.3.1. Water resources

From a hydrological point of view, the area is located within a coastal basin, which is rich in water due to high rainfall (800-1,600 mm/year). Precipitation is the main source of surface water in the Syrian coastal basin area, which is located on the east coast of the Mediterranean Sea, with an area of about 5,048 square kilometers and a width of 30-40 kilometers. The water basin between the Rontes Basin, the northern boundary and the Iskenderun Brigade in southern Lebanon, a mountainous region with diverse topography, altitudes from 0 to 1500 m, the rainy season is usually September-May, with annual rainfall from the coast 800mm in the plains to 1600mm in the highlands. The largest river basin that flows into the southern city of Latakia. (Bunzel, et al., 2013)

The Studies found that there are about 20 dams on many of these rivers, the dams have a water storage capacity of about 600 million cubic meters, these dams are mainly used for irrigation and Troy 56,000 hectares, and the upcoming project team is used to build water storage A dam with a volume of 305 million cubic meters and is expected to irrigate about 16,500 hectares. (Parolari, et al., 2016).

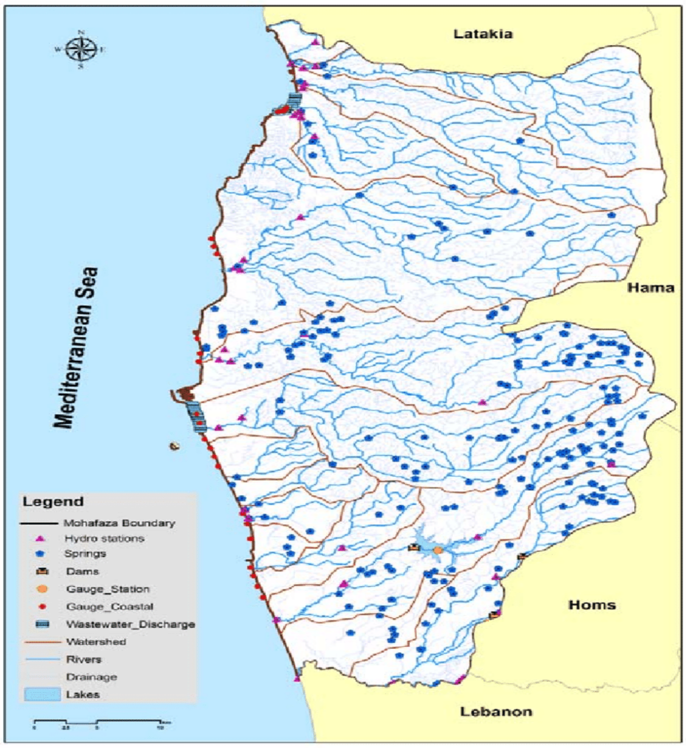

Figure 6 Hydrology Map of Latakia Region

Source: (Roman & Kosmo, 2016)

4.3.2. Surface water

Latakia contains many surface water sources about 14 springs, 15 marshes, and 14 rivers, It has built about 20 dams on it with a storage capacity of about 600 million m3, and the most important sources are: (Abahussain, et al., 2012)

- Great North River:

The river originates from the mountains of Latakia and empties into the Mediterranean Sea with a length of 96 km. It is considered one of the largest and longest rivers in the coastal region, and the maximum flow of the river reaches about 40 m3 / sec. (Roman & Kosmo, 2016)

- Al-Sin river:

This is the primary wellspring of savoring water beach front watersheds. It covers 70% of the area's water utilization. The stream is around 6 kilometers in length and is one of the briefest significant waterways in Syria. It is situated in the southern boundary area of Latakia, 14 springs and two little streams are the fundamental feeders of the waterway, and obviously precipitation. The Al-Sina River is situated in the southern locale of Latakia and covers an area of 92 square kilometers. Arsina, Greece is 6 km long and has two fundamental feeders and numerous little nearby occasional streams that bring precipitation, surface water and spring water into the waterway. It is a significant wellspring of new water for Syria. (Roman & Kosmo, 2016)

- Lake 16 of October:

It is located behind the Tishreen dam, the storage capacity is about 210 million cubic meters, and it is the third largest lake in Syria. (Jamal, 2017)

4.4. The real situation of reused wastewater for agricultural purposes in Syria

The area of the Syrian Arab Republic is 185,180 km2 and it has a desert or semi-desert environment, with the exception for the coastal region which is green, and includes two governorates Latakia and Tartous. (Jamal, 2017)

Agriculture is the main tributary of the economy in Syria, where the agricultural sector constitutes 32% of the total area of the country, equivalent to 5.91 million hectares, of which 25% is irrigated and contributes 22% to the Gross Domestic Product (GDP). (Faour & Fayad, 2018)

The Euphrates Valley basin is the main area of agriculture, especially grain and cotton cultivation. (Jamal, 2017)

While growing fruits is mainly typical in the coastal and southern regions.

Surface water represented by rivers and lakes is the main source of irrigation in Syria, in addition using the groundwater in some areas. The agricultural sector consumes about 88% of the total water supply. The water used for irrigation is 3% for treated and industrial wastewater, 13% for agricultural drainage water and 84% for fresh water. (Kelley & Colin , 2015)

It is assessed that ventures and homegrown families produce around 1,200 Mm³ of wastewater, of which on normal 75% is gathered. Figures for the wastewater area are not reliable. How much treated wastewater fluctuates somewhere in the range of 273 and 550 Mm³ relating to a treatment rate somewhere in the range of 23 and 46% of produced homegrown and modern wastewater. Syria has at present 40 wastewater treatment plants (WWTP), yet there are just three enormous scope WWTPs in metropolitan regions. It is assessed that one fourth of wastewater is neither treated nor utilized for water system and is released into surface water bodies or the ocean (AGRG/2008-01/FTF).

A new gauge expresses that 473 Mm³ or 3% of the water system water request is fulfilled by treated wastewater. Furthermore, 416 Mm³ of untreated wastewater are applied. Altogether 6% of the water system water request is provided by the two sorts of wastewater. (Directorate of Agriculture, 2006)

The obligations in the water area for wastewater reuse are divided between 4 services: Ministry of Irrigation, Ministry of Housing and Construction, Ministry of Local

Administration and Environment, and Ministry of Agriculture and Agrarian Reform. Syria has wastewater explicit regulations and guidelines. By and large, the reuse of wastewater in agribusiness is allowed with explicit limitations. The Syrian norms accommodate three classes of wastewater quality deciding the yields to be inundated. These principles are generally high and in one case much more severe than who rules: vegetables that are uncooked are rejected from water system with contaminated water sources. (Kelley & Colin , 2015)

4.5. Types of Reuse

Because of insufficient water resources for domestic and agricultural consumption, some farmers use all water sources for irrigation without regard to its quality, including sewage, whether treated or untreated, which causes the spread of diseases to the population who consume irrigated crops from this water, especially vegetables that are considered consumption daily for Syrians. (Directorate of Agriculture, 2006)

Studies and estimates indicate that 889 million cubic meters of wastewater are used for irrigation, and 473 million cubic meters of it are treated. 311 million cubic meters are discharged without treated to the surface water or into the sea. (Jamal, 2017)

Water reuse depends on the capacity of the treatment plants to improve the quality of the incoming wastewater and taking it out as appropriate form for irrigation, agricultural requirements and public health so that it reduces the use of fresh water for agricultural purposes. (Bunzel, et al., 2013)

The government is building a system of sewage pipes and treatment plants to protect the environment and provide safe use for water in agriculture. (Directorate of Agriculture, 2006)

4.6. Reusing Treated Sewage Water for irrigation

It is important and necessary for a country like Syria that relies on large areas in agriculture to take advantage of all available water resources, including water from treated wastewater, especially as it has a dry summer and thus the demand for water increases and the flow of rivers decreases so it is better for the government. To develop technology to use treated wastewater to secure an additional source to face the increasing needs, by building treatment plants and expanding awareness among farmers of the need to use this water to irrigate trees and to avoid using them to irrigate vegetables because it contains germs and bacteria despite its chloride disinfection. (Faour & Meslmani, 2018)

The Syrian government should treat the causes that affect the process of reusing water, including administrative problems between the four ministries concerned with this process, and increase cooperation among them in addition to improving the quality of the collection of incoming water to treatment plants located in the governorates and working to separate between domestic sewage and the water which coming from factories. (Salman, 2018)

4.7. Health Effects of Reusing Treated Sewage Water for Irrigation

An integrated approach to WASH planning can identify opportunities that are not clear when developing separate strategies for each service; The result is more integrated and more sustainable solutions, significant cost savings for local communities, and water conservation and water recycling actions are key components of integrated urban water planning. (Williams, 2019)

Water reclamation or recycling primarily makes wastewater (non-potable) useful; Thus, saving the economic and environmental costs of establishing new water supplies. Water recycling and reuse is the process of collecting, treating and using wastewater, especially from municipalities, industrial and agricultural areas.

Good institutional procedures are fundamental to effective water recycling projects, as they ensure a coordinated approach among the institutions responsible for water treatment and reuse. Awareness-raising campaigns on water recycling and reuse often play an important role; To ensure public participation from those who may initially be skeptical about the use of recycled “waste” water. (US EPA, 2016)

Among the most prominent benefits of water recycling are the following: (Tang, et al., 2019)

- It keeps wastewater for reuse, rather than discharging it in a way that may cause pollution.
- Provides the energy needed to extract fresh water or transport it to the region.

- Recharges groundwater and avoids deterioration and salinization of fresh water resources.
- Increases water supply to arid regions.
- Provides an easily accessible source of water for the economic, industrial, and agricultural sectors, and promotes economic development and food production.
- Improving the quality of agriculture through the use of valuable nutrients extracted from wastewater.
- There are a number of opportunities that can be taken advantage of:
- Adaptation to climate change.
- Relatively low cost technology compared to alternatives such as extraction and transportation. Successful water reuse projects have been established in both developed and developing countries, including extremely arid regions.

4.8. Laboratory Water Parameter in Latakia

- In previous studies, Laboratory results showed significant increase in the parameters of bacterial and chemical contamination values. And to increase the proportion of observed turbidity, low dissolved oxygen and high values of the water hardness values in addition to the presence of industrial pollution indicators (Sewerage network of a few houses,oil-press). (Hassan, 2015)
- A number of 7 sewage lines were observed ending the river without treatment.
- It was noticed that there are 10 industrial workshops on both sides of the river, without any treatment plant that reduces pollution from the great northern river.

4.9. Latakia Health Directorate Report

The annual reports to the Directorate of Health in Latakia confirmed the following facts: (El-Jardali, 2010)

- Increase in the number of cholera infections in certain seasons.
- Increase in cases of diarrhea, and intestinal diseases in recent times.
- A change in the taste of drinking water.
- Increase in the number of heart attack deaths.
- A Rise in the proportion of cancer disease.
- Death of freshwater fish on the tributaries of dams alsenn.
- The spread of landfills in agricultural areas and near sources of drinking water, does not have any evidence to show that they were built to fit the required environmental conditions.
- The increase in the number of sewage points poured into streams and rivers, brings about the spread of odors.

4.10. Waste Water Treatment Technologies

4.10.1. Mechanical Treatment Technologies

Mechanical treatment technology involves waste-water treatment of a physical and mechanical nature that results in decanted effluents and separate sludge. Mechanical processes are also used in combination with biological and advanced unit operations. Mechanical treatment includes processes such as sedimentation and flotation. (United Nations, New York, 1997)

Mechanical frameworks use a mix of physical, organic, and compound cycles to accomplish the treatment targets. Utilizing basically regular cycles inside a climate, mechanical treatment advancements utilize a progression of tanks, alongside siphons, blowers, screens, processors, and other mechanical parts, to treat wastewaters. Stream of wastewater in the framework is constrained by different kinds of instrumentation. Sequencing clump reactors (SBR), oxidation discard, and broadened air circulation (EA) frameworks are generally varieties of the initiated ooze process, which is a suspended-development framework. The trickling filter solids contact process (TF-SCP), conversely, is a connected development framework. These treatment frameworks are successful where land is at a higher cost than expected. (Williams, 2019)

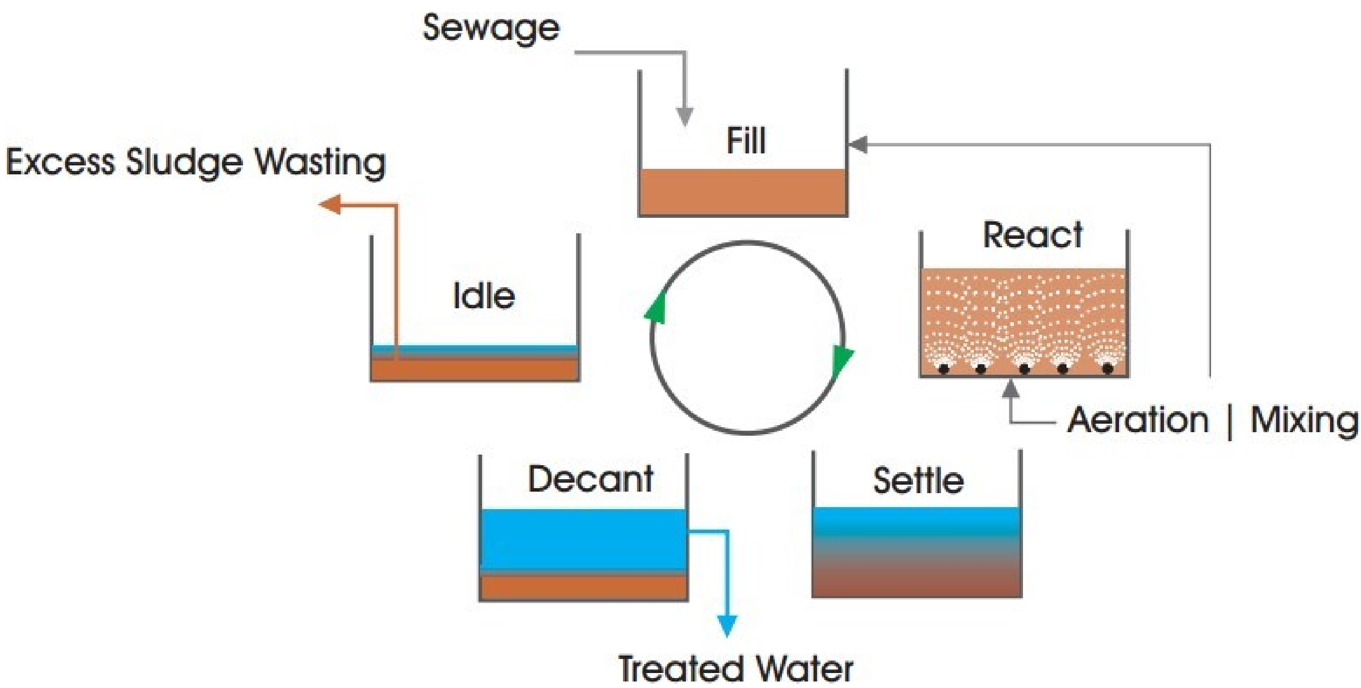

Figure 7 Sequencing batch reactors (SBR)

Source: (Williams, 2019)

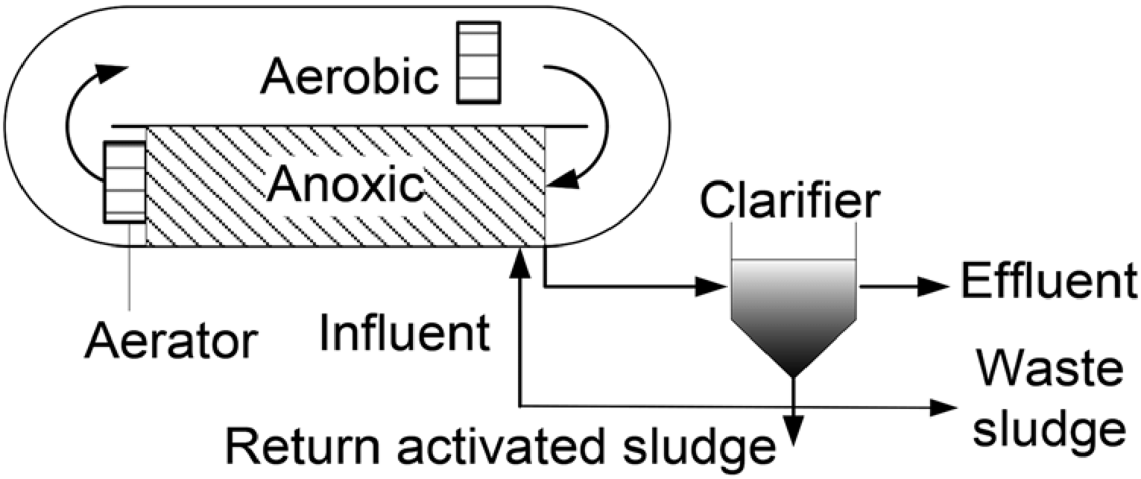

Figure 8 Diagram of an oxidation ditch

Source: (Williams, 2019)

Figure 9 Oxidation ditch

Source: Oxidation ditch Experience in Serbia

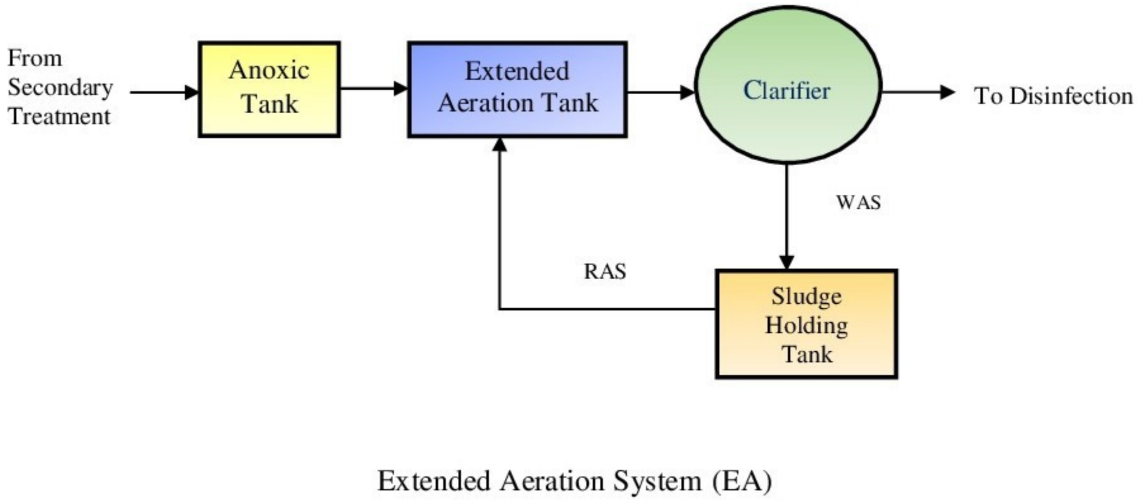

Figure 10 Extended aeration system (EA)

Source: (Williams, 2019)

4.10.2. Aquatic Treatment Technologies

Aquatic systems are represented by lagoons; facultative, aerated, and hydrograph-controlled release (HCR) lagoons are variations of this technology.

Facultative lagoons are the most common form of aquatic treatment-lagoon technology currently in use. The water layer near the surface is aerobic while the bottom layer, which

includes sludge deposits, is anaerobic. The intermediate layer is aerobic near the top and anaerobic near the bottom and constitutes the facultative zone. Aerated lagoons are smaller

and deeper than facultative lagoons. The main disadvantage of lagoons is high effluent solids content, which can exceed 100 mg/l. (WNOFNS 4, 2016)

An assortment of water treatment advances are expected to cooperate, in arrangement, to clean crude water before it tends to be conveyed. Here is a rundown of fundamental innovations frequently utilized in water treatment works. (Lakren, 2019)

1. Screens

Screens are utilized on many surface water admissions to eliminate particulate material and garbage from crude water. Weeds and flotsam and jetsam can be eliminated utilizing coarse screens, though more modest particles including fish can be taken out utilizing band screens and microstrainers. In front of coagulation or ensuing filtration, microstrainers are utilized as a pre-treatment to lessen solids stacking. (Lakren, 2019)

2. Gravel filters

Turbidity and green growth can be taken out utilizing rock channels, which comprise of a rectangular channel or a tank partitioned into a few areas and loaded up with evaluated rock (size range 4 to 30mm). A gulf dispersion chamber permits the crude water to enter through and stream on a level plane through the tank, experiencing first the coarse and afterward the better rock. An outlet chamber gathers the sifted water with solids being eliminated from the crude water collect on the floor of the channel. (Lakren, 2019)

3. Slow sand channels

Turbidity, green growth and microorganisms can likewise be eliminated utilizing slow sand channels. A straightforward and solid cycle, slow sand filtration is frequently reasonable for the treatment of little supplies given that adequate land is accessible. Slow sand channels generally comprise of tanks containing sharp sand (size range 0.15-0.30mm) to a profundity of between 0.5 to 1.5m. (Lakren, 2019)

4. Enacted carbon

Utilizing actual adsorption, pollutants can be taken out utilizing initiated carbon. This will be impacted by the sum and kind of the carbon, the nature and grouping of the impurity, maintenance season of water in the unit and general water quality (temperature, pH, and so on.). (Lakren, 2019)

One of the mocst normal mediums is granular enacted carbon (GAC), albeit powdered initiated carbon (PAC) and square carbon are likewise at times utilized. Channel media is contained in replaceable cartridges and a particulate channel at the power source of the cartridge is utilized to eliminate carbon fines from the treated water. (Lakren, 2019)

5. Air circulation

Air circulation is intended to move oxygen into water and eliminate gases and unpredictable mixtures via air stripping. A typical strategy is stuffed pinnacle aerators because of their reduced plan and high energy productivity. To accomplish air stripping different methods can be involved remembering counter current outpouring air circulation for stuffed towers, diffused air circulation in bowls and shower air circulation. (Lakren, 2019)

6. Film processes

Reverse osmosis (RO), ultrafiltration (UF), microfiltration (MF) and nanofiltration (NF) are the most generally involved layers for water treatment processes. Recently applied to the creation of water for modern or drug applications, films are being applied to the treatment of drinking water. Film cycles can give sufficient evacuations of pathogenic microorganisms, Cryptosporidium, Giardia, and possibly, human infections and bacteriophages. In a prominent contextual analysis, organizations from the Netherlands and Denmark are dealing with incorporating proteins into film innovation for the evacuation of pesticides and drug deposits from drinking water. (Lakren, 2019)

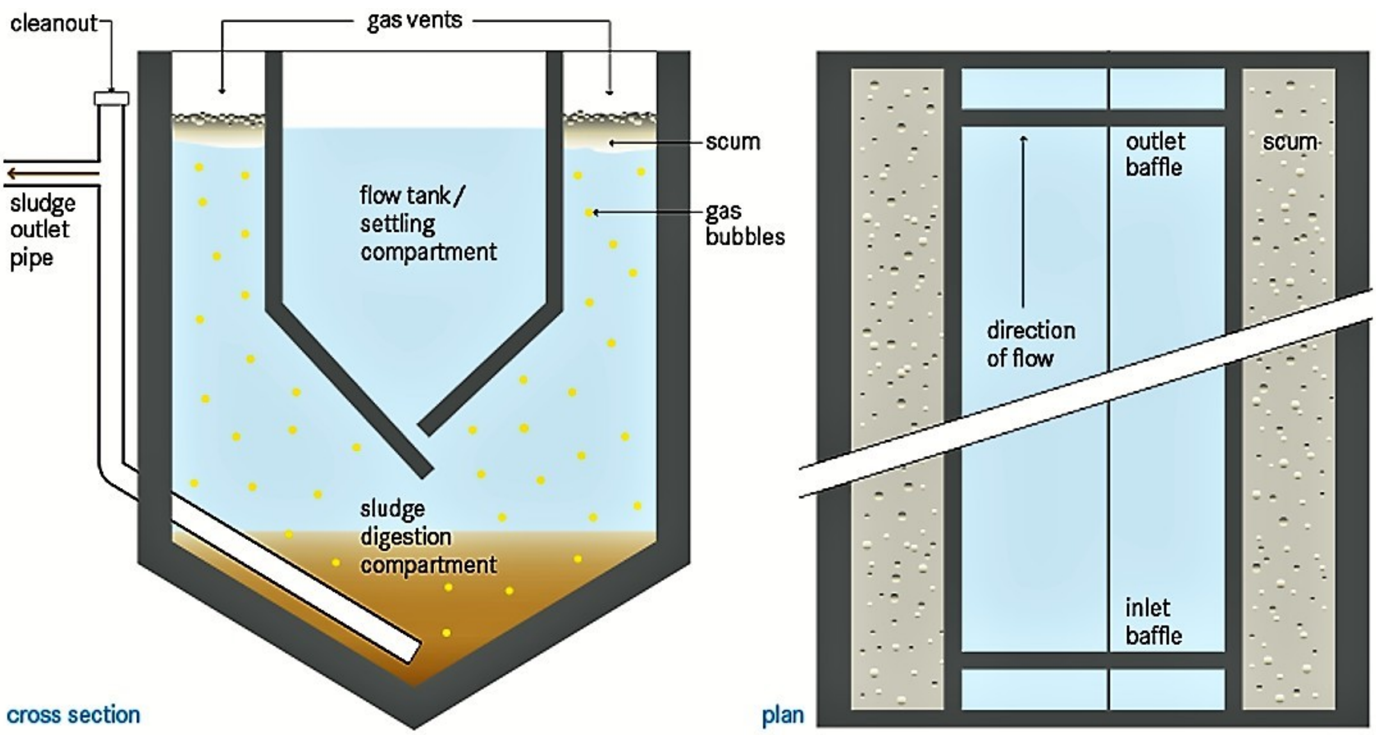

Figure 11 Schematic of an imhoff tank, Reverse osmosis (RO),

Source: (Lakren, 2019)

4.10.3. Terrestrial Treatment Technologies

Terrestrial treatment systems include slow-rate overland flow, slow-rate subsurface infiltration, and rapid infiltration methods. In addition to wastewater treatment and low maintenance costs, these systems may yield additional benefits by providing water for groundwater recharge, reforestation, agriculture, and/or livestock pasturage. They depend upon physical, chemical, and biological reactions on and within the soil. Slow-rate overland flow systems require vegetation, both to take up nutrients and other contaminants and to slow the passage of the effluent across the land surface to ensure maximum contact times between the effluents and the plants/soils. Slow-rate subsurface infiltration systems and rapid infiltration systems are "zero discharge" systems that rarely discharge effluents directly to streams or other surface waters. Each system has different constraints regarding soil permeability.

Although slow-rate overland flow systems are the most costly of the natural systems to implement, their advantage is their positive impact on sustainable development practices.

In addition to treating wastewater, they provide an economic return from the reuse of water and nutrients to produce marketable crops or other agriculture products and/or water and fodder for livestock. The water may also be used to support reforestation projects in water-poor areas. In slow-rate systems, either primary or secondary wastewater is applied at a controlled rate, either by sprinklers or by flooding of furrows, to a vegetated land surface of moderate to low permeability. The wastewater is treated as it passes through the soil by filtration, adsorption, ion exchange, precipitation, microbial action, and plant uptake. Vegetation is a critical component of the process and serves to extract nutrients, reduce erosion, and maintain soil permeability.

Overland flow systems are a land application treatment method in which treated effluents are eventually discharged to surface water. The main benefits of these systems are their low maintenance and low technical manpower requirements. Wastewater is applied intermittently across the tops of terraces constructed on soils of very low permeability and allowed to sheet-flow across the vegetated surface to the runoff collection channel. Treatment, including nitrogen removal, is achieved primarily through sedimentation, filtration, and biochemical activity as the wastewater flows across the vegetated surface of the terraced slope. Loading rates and application cycles are designed to maintain active microorganism growth in the soil. The rate and length of application are controlled to minimize the occurrence of severe anaerobic conditions, and a rest period between applications is needed.

The rest period should be long enough to prevent surface ponding, yet short enough to keep the microorganisms active.(WNOFNS 4, 2016)

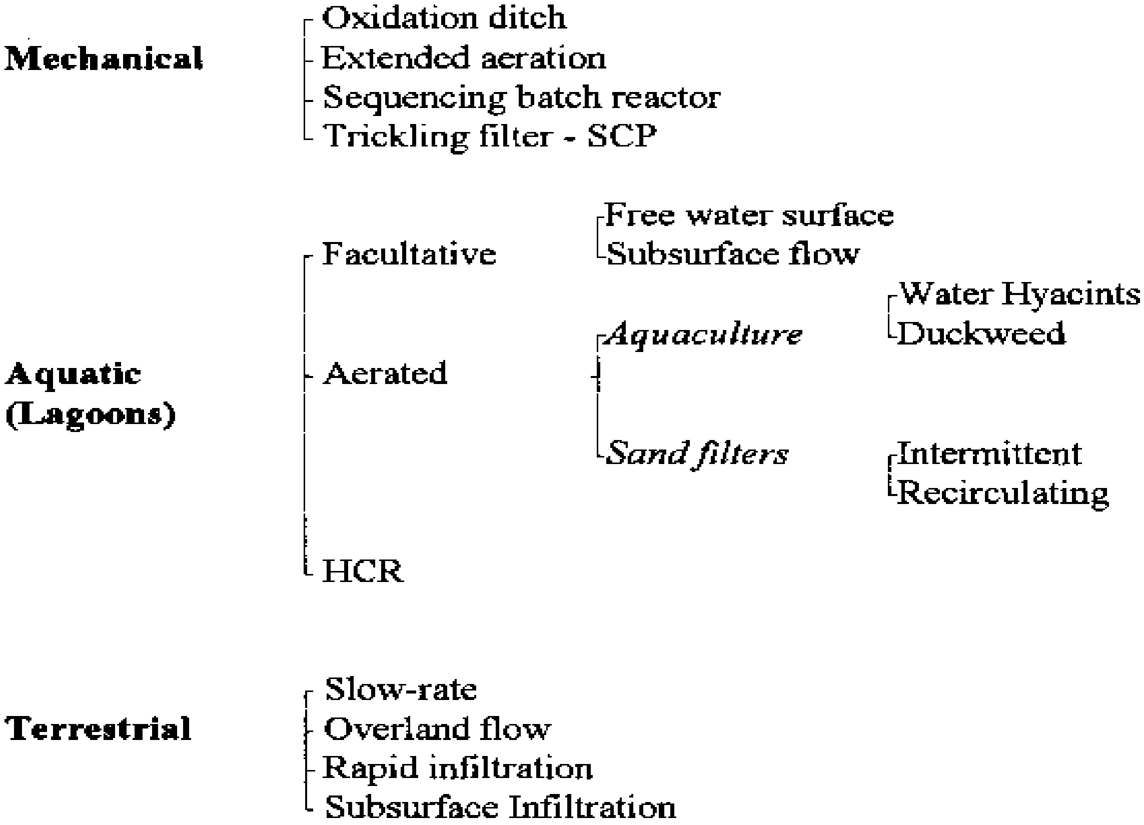

Figure 12 Summary of Wastewater Treatment Technologies.

Source: (USEPA, 2016)

4.11. Recommendation and selected waste water treatment technology

Depending on the previously collected data and results from the theoretical section of the literature review, there it was found that each method has its advantages and disadvantages. On the one side, the advantages of the Aquatic Systems are Low capital cost, low operation cost, low maintenance costs, and low technical manpower requirement. On the opposite side, this technology required a large area of land and may produce undesirable odors.

The Terrestrial Systems, this technology is convenient to be used by individual households, easy to operate and maintain, and can be built in rural areas.

On the opposite side provides a low treatment efficiency, must be pumped occasionally, and requires a landfill for periodic disposal of sludge and septage.

The Mechanical Systems has minimal land requirements; can be used for household-scale treatment, is relatively low cost and easy to operate but requires mechanical devices. The vertical biological reactor, High cost, Complex technology, requires technically skilled manpower for operation and maintenance, needs spare-parts-availability and has a high energy requirement. (Hassan, 2015)

Based on this data, the following solution is proposed:

Given the reality of water in Latakia Governorate, and through studies, it was found that there are serious pollutants and that the rainfall rate is relatively high.

The situation in Syria does not allow the establishment of water treatment plants fact that the cost of establishing them is large, in addition to the fact that there are no electric power stations to operate them.

It is proposed to establish Terrestrial Treatment Technologies in Syria and start constructing this type starting from the mountain villages the fact as they do not need energy.

This technology can reduce water pollution, even partially.

It is possible considering this technology as a start of a program of purification of water in Syria that we can reach water treatment for all of Syria according to international standards.

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