Water Supply and Water Purification in Tourism Areas

Lebanon scale

ENI CBCMED
Cooperating across borders in the Mediterranean

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REGIONE AUTÒNOMA DE SARDIGNA
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Co-Evolve4BG

Analysis of Threats and Enabling Factors for Sustainable Tourism at Pilot Scale

Water supply and water purification in tourism areas

Lebanon scale

Union for the Mediterranean
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OVERVIEW

The present document was produced in the framework of **Co-Evolve4BG** project "*Co-evolution of coastal human activities & Med natural systems for sustainable tourism & Blue Growth in the Mediterranean*" in relation to Threats and Enabling Factors for maritime and coastal tourism development on a national scale" Co-funded by ENI CBC Med Program (Grant Agreement A_B.4.4_0075).

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REVIEW

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List of abbreviations

CAS	Central Administration of Statistics
ESCWA	United Nations Economic and Social Commission of Western Asia
FAO	Food and Agriculture Organization
ICZM	Integrated Coastal Zone Management
MEW	Ministry of Electricity and Water
MoE	Ministry of Environment
MoPH	Ministry of Public Health
MoT	Ministry of Tourism
MSP	Maritime Spatial Planning
NIS	Network Information Services
NWSS	National Water Sector Strategy
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNEP	United Nations Environment Program
WB	World Bank

I. Introduction

Co-Evolve4BG, an EU-funded project within ENI-CBC-MED Program, aims at analyzing and promoting the co-evolution of human activities and natural systems in touristic coastal areas, promoting sustainable development of touristic activities based on the principles of Integrated Coastal Zone Management (ICZM)/ Maritime Spatial Planning (MSP) and promoting Blue Growth in the Mediterranean. It is a part of the program's priority on Blue Economy and is a regional project gathering partners from Tunisia, Italy, Spain, Greece, and Lebanon. Currently, Co-Evolve4BG team is working on a national study of coastal touristic areas in Lebanon from the South to the North. Different topics are tackled such as climate change, pollution, safety and security, coastal protection measures, protection of ecosystems, water supply and purification, littoralization and urbanization, well- being of tourists, transport, governance, and coastal tourism. The national report will be part of a Mediterranean one and will give opportunities for better management of our Mediterranean basin.

II. Geographical framework

Lebanon is an Arab country bounded by Syria from the North and East, Palestine from the South, and by the Mediterranean Sea from the West.

Lebanon is characterized by its land variations despite the small surface. Its physical geography is extremely complex and diverse. It has four recognizable physio geographic regions: a narrow coastal plain along the Mediterranean Sea, the Lebanon Mountains (Jabal Lubnan), Beqaa valley, and the anti-Lebanon and Hermon range running parallel to the Lebanese mountains. These distinct regions create some keen and noticeable variations in this country's landforms, climate, soils, and vegetation.

The coastal plain is narrow and disconnected, almost invisible in some places. It results from alluvial soil and marine sediments, which alternate with rocky beaches and sandy bays. In the North of the country, it expands to create the Akkar plain.

Lebanon's snow-covered Mountains are considered one of the most prominent features of the country's landscape. Limestone and sandstone cover the ridge created from the range in the coast, cut by valleys. The mountain's highest point is Qurnat al-Sawda (3,088 m) in the North, where you can find the renowned cedars of Lebanon followed by a second peak, Jabal Sannin (2,695 m), in the Northeast of Beirut.

A fertile valley called Al-Beqaa valley lies between the Lebanon Mountains in the West and Anti-Lebanon Mountains in the east. This valley is home to several agricultural practices and is considered an important area for the economic income for Lebanon.

As for the Lebanese rivers, they are mainly created from winter overflow, draining the western slopes of the Lebanon Mountains. Tremendous water resources enrich Lebanon, and this has been usually viewed from a significant variety of rivers (*i.e.*, fourteen rivers). Minor catchments and short length characterize these rivers (Shaban, 2021).

Lebanon is characterized by a continental slope that is a seaward border of the continental shelf reaching approximately 1600 - 1700 m before the seafloor stretches into the deep-sea plain with approximate depth ranges from 1600 m to 2100 m (Folgado-Fernández *et al.*, 2021).

This continental slope is significant for marine ecosystems and helps the light penetrate deeper into the water creating a safer habitat for marine organisms (Britannica, 2018).

III. The influence of human geography

III.1. Population

The total number of the resident population in Lebanon is estimated at around 4,546,618 (MoPH and CAS, 2019) excluding the Palestinian camps and Syrian refugees, which increase the total to around 6,770,666. Lebanon occupies around 10,452 km^2 of area in western Asia along the Mediterranean Sea and is wedged between Syria and Palestine, which earns this tiny country as the 10th most densely populated country with 582 people per square kilometers (Figure 1).

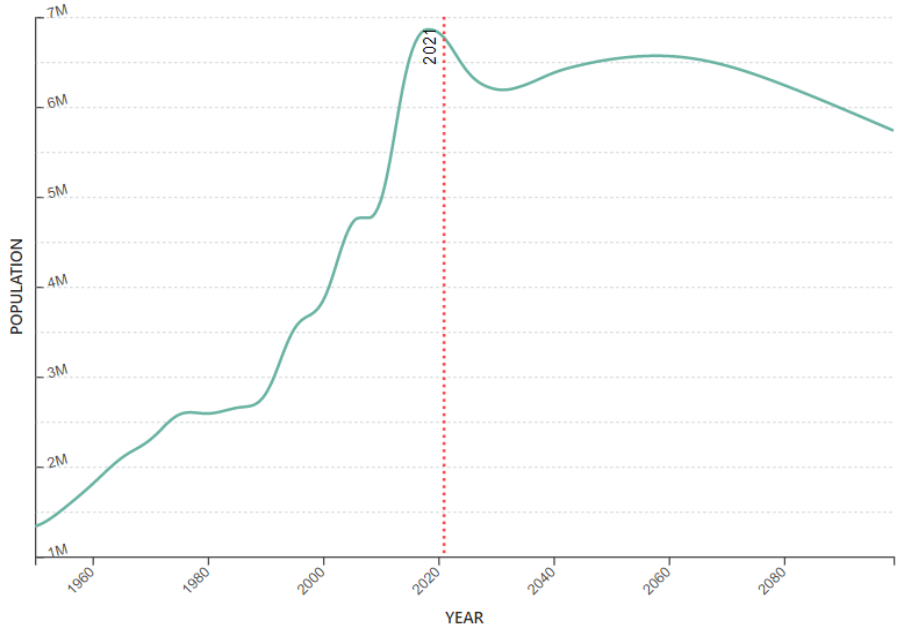

Figure 1. The current population of Lebanon based on projections of the latest United Nations data per year (World population review, 2021).

III.2. Environmental footprint

Marine habitats in the Lebanese Republic do not seem well outlined or mapped for fauna and flora associations. Studies surveyed specific coastal and sea sites for conservation wants, whereas others surveyed deep-sea habitats inside the context of the rising oil and gas sector. The Lebanese marine and coastal environment host a good sort of ecosystems that vary from shallow options reminiscent of vermetid reefs, coralligenous habitats, seaweed meadows and seagrass beds, rhodolite/maerl beds, to marine systems such as underwater canyons and ocean bottom muds (Kouyoumjian and Hamze, 2012; Bitar *et al.*, 2018a). The "National Program for Marine variety in

Lebanon" report delineates 20 benthic biocenoses of laborious substrata (littoral rock, infralittoral rock, and higher circalittoral rock) and soft substrata (infralittoral soft bottoms and upper circalittoral). The bound characteristics of Lebanon's benthic habitats are peculiar, making difficulties for the employment of the Mediterranean habitat/biocenosis classifications. Among these limitations:

- The inadequacy of analysis on marine habitats.
- The specificity and distinction of specific habitats from alternative components of the Mediterranean Sea.
- The relative homogeneity of the infralittoral fauna and flora (late summer thermocline at 40-50 m depth).
- The result of some NIS on habitats.
- The pronounced seasonal changes in fauna/flora composition.

Lebanese marine water temperatures follow a diurnal cycle and are subject to increase or decrease according to the alternation of seasons. Two annual thermohaline parts characterize marine waters: a cold-water winter phase dominates between December and March, whereas a warm-water phase is known between June and November (Hassoun, 2019). discovered that temperature ranged between a minimum of 17°C and a maximum of 31.5 °C with a mean of 22.8 ± 4°C. Freshwater flooding from rivers during the cold phase keeps salinity low in coastal waters and moderate offshore (Hassoun, 2019).

High population density on the coastal zone negatively impacts coastal and marine ecosystems as people, through their multiple activities, tend to exploit existing natural resources and economic sectors, and cause the degradation of its biodiversity (El Khoury *et al.*, 2020).

The notable increase in population number is one of the main reasons for this deterioration: marine ecosystems are mainly harmed by industry and urbanization activities. Every year, the number of resident people in Lebanon, either Lebanese or refugees, is causing a severe effect on Lebanon's resources. In addition to the main activities such as agricultural runoff and visual and noise pollution, the lack of proper infrastructure and weak institutional framework protecting the maritime domain play an essential role.

III.3. The environmental pressure caused by tourism

Lebanon's tourism industry is booming. Over half a million tourists visited Lebanon in 2019, 12 percent more than in 2018 (Figure 2).

Due to its warm summer and cold winter, Lebanon is an essential attractive country to all tourists worldwide. Holiday activities come along with pollutants emission, especially the activities related to traffic (land pollution), helicopter tours (air pollution), and jet-

skiing (water pollution). The degradation of natural resources is accelerating the climate change effects which are subtitled by degradation of beaches, increasing desertification, water scarcity, risk of fire, drought, and loss of some ecosystems. Therefore, tourism is an economic booster for the country, but it is also a booster for accelerating climate change effects.

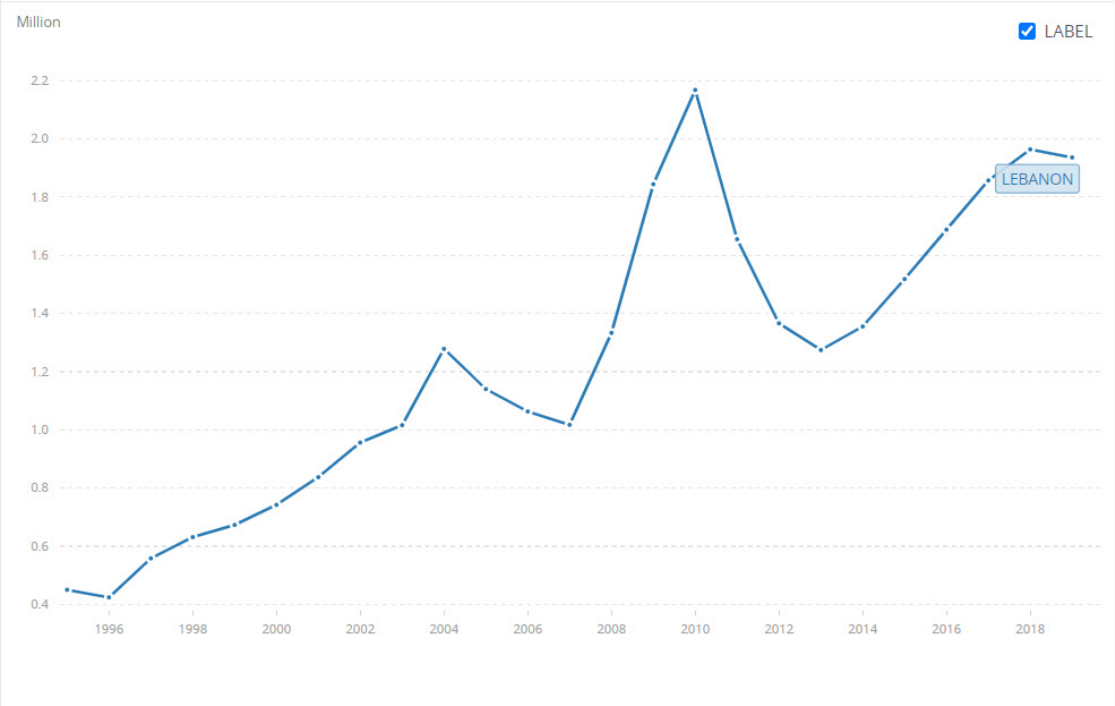

Figure 2. The number of tourists visiting Lebanon between 1996 and 2019 (World population review, 2021)

IV. Primary and industrial activities

The coastal zone stretches over 240 km from north to south; with an average dimension of less than 500 m. Lands placed on this zone are in very high demand thanks to their commercial enterprise potential and proximity to the ocean, and a booming property sector. This pressure has a crystal rectifier to implement large-scale reclamation (public and private), the development of dozens of marinas (for leisure boats and fisheries), and rampant urbanization stretching on large coastal areas. Violations of the public maritime domain are significant.

The Lebanese shoreline hosts more than 70% of the human populace with the very best awareness in Beirut and the encompassing Mount Lebanon location. This location accounted for ninety-seven million people, or 44% of the overall resident populace. Such excessive populace density is central to intense artificialization and privatization of the coast. Economic sectors also are positioned in this skinny strip ensuing in huge land-primarily based assets of pollutants (Municipal effluents & strong waste, commercial effluents, agricultural runoff, oil pollutants, noise, and visible pollutants, *etc.*). Wastewater is launched untreated in coastal environments; landfills are created at the coastline through sea-filling activities and strong waste from rivers washes into coastal waters for the duration of wintry weather storms. In addition, preservation of fishing and leisure boats need oversight (oils and paints and its by-merchandise are launched immediately into the sea). Hence, all lead to a cumulative and bad effect on marine habitats and species alike (MoE/UNDP/ECODIT, 2011; Badreddine, 2018a). The excessive artificialization charge alongside the coast altered cutting-edge and wave regimes inflicting excessive sedimentation in ports and harbors and depriving different places of desired sand. Exposed sandy seashores are eroding, and soft, shallow habitats are being lost (Mitri *et al.*, 2020). Currents and waves are shipping chemical and natural pollution alongside the coast, subjecting all marine ecosystems to many dangers, from bioaccumulation to the direct ingestion of macro and microplastics. Such factors can seriously degrade and damage faunal and floral species in shallow waters through:

- Destruction of the fragile vermetid platforms.
- Depriving species of essential oxygen.
- Increase in water turbidity that damages respiratory and other organs.
- Sedimentation negatively affects benthic species (seagrass meadows, benthic sessile species, macrophytes, *etc.*)
- Transmission of microbes to dwelling species along the shore (MoE/UNEP/UNDP, 2013a).

IV.1. Agriculture, fertilizers, and pesticides

Agriculture is a key to the economic growth of different countries. Many practices were used to enhance this culture, whether it is wrong or good practices. Misuse of pesticide is one of the most damaging activities. It is applied to protect crops from pests, weeds, fungi, and insects, plus it enhances yield production, which increases yearly economic income from the agriculture sector. However, its excessive use is harmful due to the transportation of the residues (nitrates and phosphates) by the rainfall and irrigation. Pesticides have a negative impact on the environment such as groundwater contamination affecting different ecosystems over a large geographical area (Figure 3).

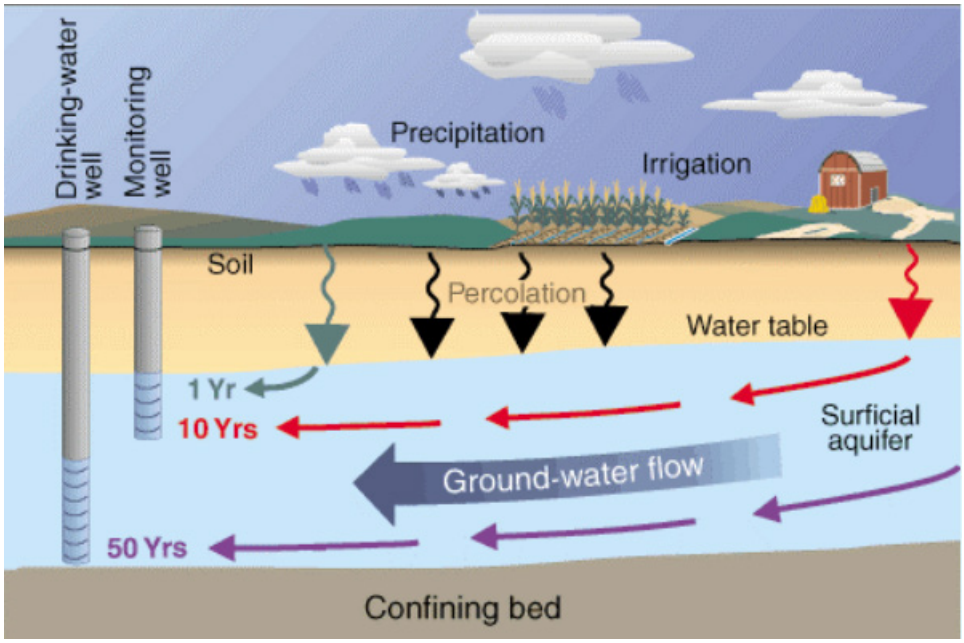

Figure 3. The water drainage in the different levels of the soil (FAO, 2021)

IV.2. Aquaculture

Aquaculture is a technology created to meet the high demand for seafood. Therefore, it is used to produce food and other commercial products, restore habitat, replenish wild stocks, and rebuild threatened and endangered species. Sadly, this method with an environmental approach damages the ecosystems by using the most common chemical contaminant in the world's groundwater aquifers: nitrates. Not only nitrate residues but also the uneaten feeds and the fish excreta diminish water quality.

IV.3. Industry

Industrial waste is one of the significant problems of water pollution. Mainly small-scale industries, which cannot afford pollution control equipment, increase water pollution. Their water waste contains chemicals, toxic contaminants, and organic pollutants. Polluted water is unsuitable for drinking, agriculture practices, industrial activities, in addition to its enormous effect on the deterioration of the ecosystem (MoE).

IV.4. Shipping traffic

Considering reducing the global impact of transport, marine transportation is one of the most common ways of global trading. Moving more than 10 billion tons of containers, solid, and liquid bulk cargo across the world's seas annually. Moreover, ship activities are the solution for solution for land traffic (Walker *et al.*, 2019). Consequently, marine transportation is causing a lot of negative impact on the marine environment, such as (Trozzi, 2003):

- the oil of bilge and motor fuel leakage from ships,
- accidental leakage of oil and chemical substances in loading and unloading of products,
- pollution from slop,
- leaching of antifouling paints,
- air pollution,
- greenhouse gas emissions,
- releases of ballast water containing aquatic invasive species,
- historical use of antifoulants,
- oil and chemical spills,
- dry bulk cargo releases,
- garbage,
- underwater noise pollution,
- ship-strikes on marine megafauna,
- risk of ship grounding or sinking.

IV.5. Offshore drilling

Coasts are home to stunning wildlife and incredible beaches. On the other hand, offshore drilling is an essential economic income for several countries. Unfortunately, this technique is putting the natural heritage and marine life at risk. Indirect and direct physical disturbance affect marine wildlife such as sound, traffic, anchor chains, drill

cuttings, and drilling fluids (Figure 4). Lights, burning flares, and human food attract seabirds to the offshore drilling platforms. Birds are mainly affected by the oil. In fact, once their feathers are coated with oil, they will be prevented from repelling water and will be insulated from the cold water, which will minimize their ability to float and increase the risk of their death. Oil and related chemicals also affect the immune and reproductive systems of exposed fish and shellfish, reducing the number of populations and retracting food from the predators that depend on them.

Mammals can also be trapped by offshore drilling impacts such as dolphins and whales can inhale the oil, harming their lungs, immune function, and reproduction. Moreover, many birds and animals also ingest oil trying to clean themselves, but they get poisoned (Spade, 2015).

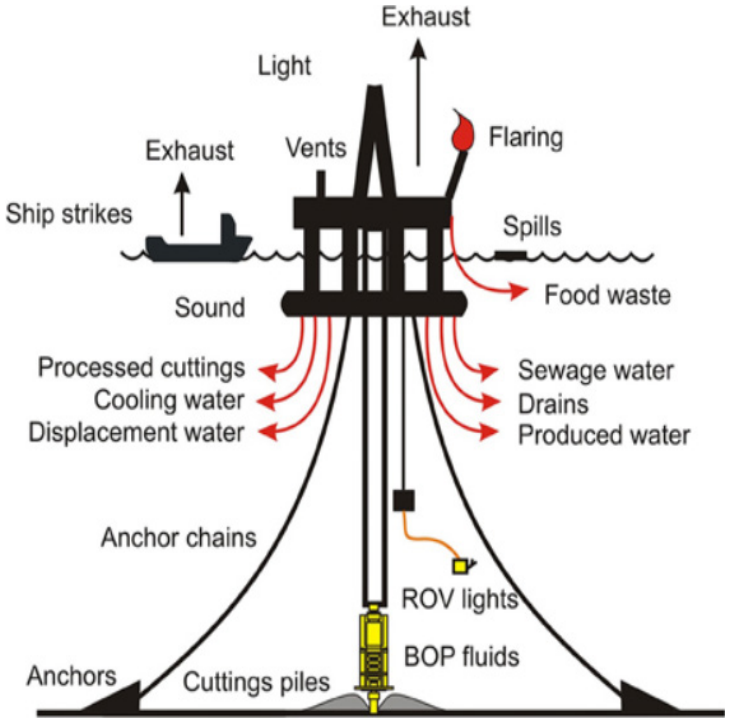

Figure 4. Diagram of impacts from typical deep-sea drilling activity (Cordes *et al.*, 2016)

V. Water and its uses

V.1. Water resources

In the air, on the surface, below the ground, and in the oceans, the water naturally exists. Here are some sources of water (World Water Assessment Program, 2006; Figures 5 and 6):

- Precipitation (rain, snow, dew, *etc.*) plays the key role in renewing water resources,
- Glaciers store water as snow and ice, releasing varying amounts of water into local streams depending on the season,
- Wetlands (including swamps, bogs, marshes, and lagoons) cover 6% of the world's land surface and play a key role in local ecosystems,
- River basins are a useful "natural unit" for the management of water resources and many of them are shared by more than one country,
- Freshwater, which is not frozen, is almost found below the surface as groundwater. Groundwater is generally of high quality and is being abstracted mostly to supply drinking water and support farming in dry climates.

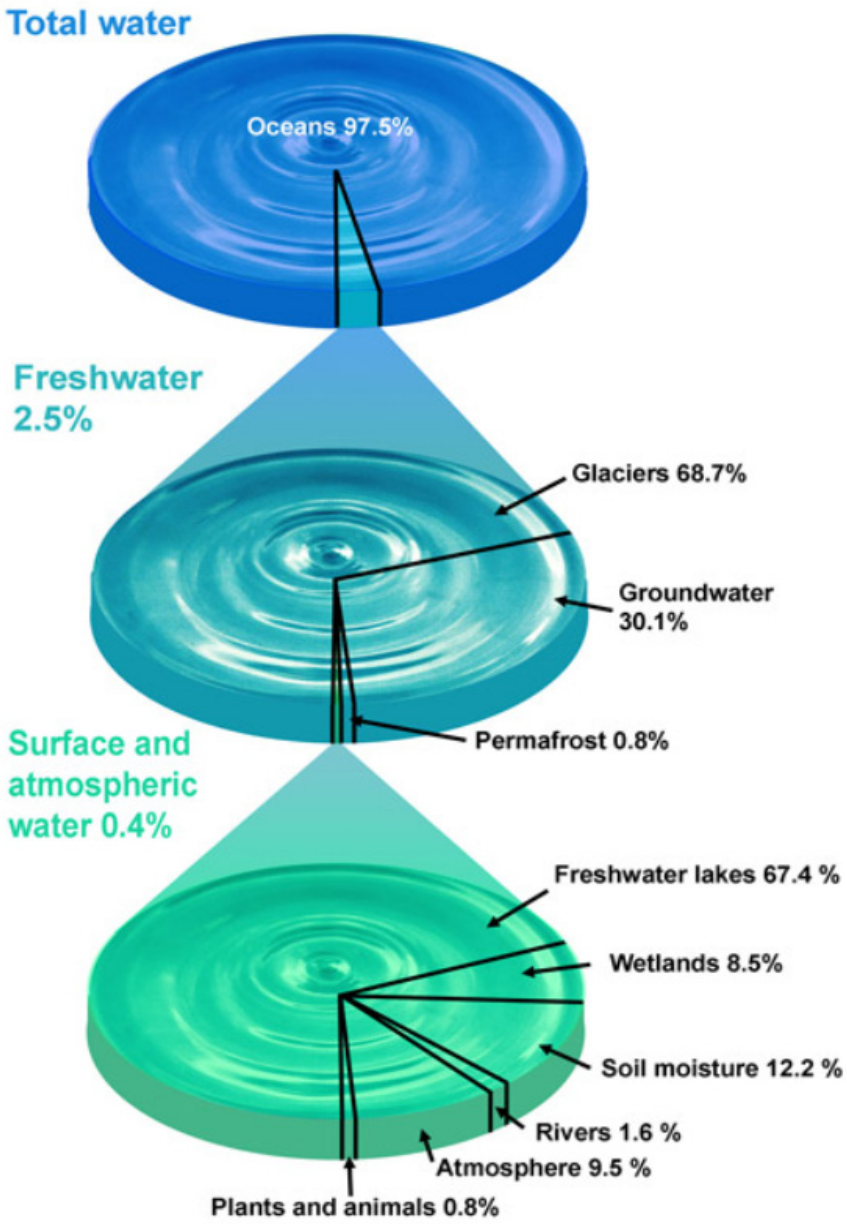

Figure 5. Water resources (World Water Assessment Program, 2006)

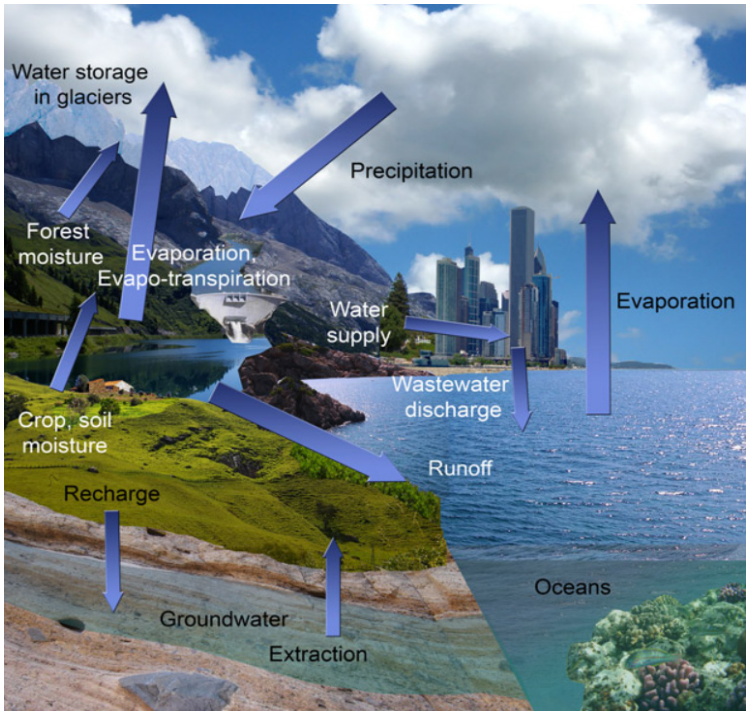

Figure 6. Water cycle (World Water Assessment Program, 2006)

V.2. Water loss

Not only climate change but also population growth is putting uncommon pressure on water. These practices lead to water scarcity by 40% between forecast demand and available supply of water by 2030 (World Bank, 2017). Thus, these are the main consequences for the loss of water (Figure 7):

- Precipitation pattern shifts
- Diminished water quality
- Algal blooms
- Declines in drinking water
- Disruptions to power supplies
- Stronger hurricanes
- Heat waves

Floods and droughts are considered among the biggest threats to global prosperity and stability, making it more difficult to access safe drinking water, especially for the most vulnerable populations. An increase in temperature will lead first to higher evaporation and plant transpiration rates, which will decrease the quantity of water in

the soil, and second will cause freshwater to become salty due to the rise of sea levels. In addition, warmer temperatures and increasing acidity make life difficult for sea creatures in the oceans, leading to the transformation of the food chain.

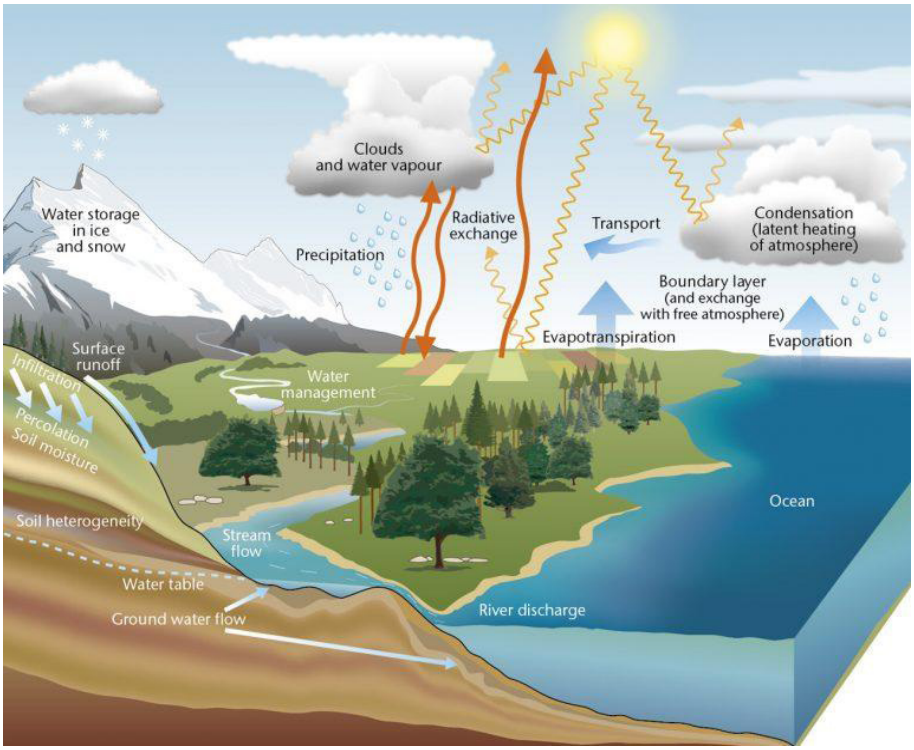

Figure 7. The effect of global warming on the different stages of water cycle (Fetch, 2019).

V.3. Water demand per sector

Four sectors rely on water availability (MoA, FAO Aquastat, UNESCO, WB, ESCWA, MEW, 1996, 1999; National Water Sector Strategy, 2010):

1. Domestic sector:

   a) Rural areas: Drinking and cooking, Personal use (bath, washing, *etc.*), Laundry, dishwashing, Cleaning, Gardening, Limited commercial use (~3% of demand),

   b) Urban areas: Same as rural area's needs, large scale gardening, Public Gardens, Commercial use (5-10 % of demand),

2. Industrial sector: Mainly small-scale industries: 99% of industries have less than 50 employees, average of 6.5 m^3/day per small establishment; can reach up to 600 m^3/day for large establishments. So, 11% of water use goes to industry,

3. Tourism sector: Consumption-based on benchmarks of similar countries in the region, average consumption in Mediterranean countries: 440 L/tourist/day

4. Irrigation sector: Including losses in transmission and distribution networks, 63,400 ha (70.4%) furrow irrigation, 21,100 ha (23.4%) sprinkler irrigation, and 5,500 ha (6.2%) drip irrigation.

Therefore, water demand is 160 and 180 liquid crystal display (LCD) for domestic in rural and urban areas respectively, 30% of domestic demand and the industrial demand, 440l/tourist/day for the tourism sector, and 9,000 m^3/ha/year in 2010 for the agricultural sector.

V.4. Strategies to mitigate the consequences of water scarcity

The Ministry of Energy and Water has developed the National Water Sector Strategy (NWSS), with the participation of national stakeholders and international donors to highlight the demand and supply forecasts create a sector-enabling environment, put an investment plan and strategic road plan.

Many practices could be achieved to mitigate water scarcity (NWSS report, 2010):

1. Perform all priority actions required to complete the restructuring of water enterprises and address potential limitations,

2. Improve the operating model between Water enterprises and Ministry of Electricity and Water,

3. Improve the performance efficiency of Water enterprises,

4. Restructure Ministry of Electricity and Water organization in line with the requirements of laws 221 and 247

5. Develop the process of the performance monitoring and evaluation of Water enterprises,

6. Provide the required manpower levels and capabilities to ensure an appropriate operation and maintenance of assets and the delivery of water at optimal service levels,

7. Enforce planning and capital spending responsibilities and coordination among various players in the water sector with a clear delineation of authorities,

8. Involve stakeholders participation in the design and management of irrigation projects according to best practices,

9. Improve irrigation water demand management and cost recovery and sustainability of irrigation schemes,

10. Water Supply Tariff: Implement a new consumption-based tariff which includes fixed and variable (volumetric) charges for connections equipped with customer water meters,

11. Irrigation Tariff: Design and implement alternative irrigation tariff structures based on the specificities of existing and anticipated irrigation schemes,

12. Wastewater Tariff: Apply a new wastewater tariff to customers connected to a sewer network and to a Wastewater Treatment Plant,

13. Provide support in developing the adequate legal institutional and regulatory setting to promote PSP, in a way to ensure the interests of the Government and the Lebanese population, and provide an attractive environment to the private sector,

14. Ensure the readiness of the water sector from all aspects (*e.g.*, institutional, organizational, financial, legal, and regulatory) to guarantee the success of future payment service provider transactions,

15. Strengthen the legal framework to improve the performance of the delivery of water and wastewater services and support the implementation of the proposed strategic initiatives,

16. Improve / refine climate change knowledge, and particularly its implications on the water sector and its vulnerability,

17. Improve water quality and protection of recharge zones,

18. Develop flood mitigation arrangements,

19. Improve wastewater quality,

20. Evaluate environmental consequences of the proposed NWSS (Strategic Environmental Assessment),

21. Conservation Initiatives on Domestic and Industrial Demand,

22. Conservation Initiatives on Irrigation Water.

VI. Water and tourism in the Mediterranean

VI.1. Tourism impact on the environment

Tourism has characteristics similar to industry and urbanization. It has negative impacts on the environment, causing the over-consumption of local natural resources, leading to the depletion of these areas. However, it can be restrained if the environment is appropriately managed, and water and energy conservation are taken care of (UNEP, 2001).

VI.2. Water and tourism, key issues

Beyond its energy and industrial uses, water can also be used for various recreational and tourist activities. This concept is often overlooked due to its scarcity. Tourists often need water for various purposes such as swimming, drinking, and cooking. Overuse of water can lead to the depletion of water supplies and generates a higher volume of wastewater. Due to water scarcity in some Mediterranean regions, such as Spain, tourists must conserve their consumption. The maintenance of golf courses, for example, can also deplete freshwater sources. In recent years' golf tourism has increased in popularity, and the number of golf courses has overgrown. An average golf course in a tropical country uses as much water as 60,000 rural villagers. It also uses 1,500 kg of chemical fertilizers, pesticides, and herbicides per year. Plus, the tourism industry tends to have high levels of energy consumption. Most hotels have star ratings and are usually responsible for high energy consumption (Cabie, 2014).

VI.3. Water and tourism: future trends: Effects of Climate change

Despite this, various initiatives can help develop water-based tourism. From an environmental perspective, those kinds of tourism provide essential possibilities for improving and implementing the latest sustainable fashions for the control of water resources, which have an advantageous effect on conserving the environment, biodiversity, and nearby ecosystems. Thus, water-primarily based tourism tasks can show this aid into a sustainable financial and social asset. Furthermore, via tourism, water may be used as an engine for local improvement, the safety of specific ecosystems, and the development of the best of existence for travelers and nearby communities (Folgado-Fernández, 2021).

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