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Option: Environmental risks

Presented By

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Evaluation of the ecological quality of the Al-Ostuan River and statistical study of the socio-economic status

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Résumé

Comme la plupart des rivières libanaises, la rivière Al-Ostuan à Akkar souffre de nombreux problèmes environnementaux. Les plus importants d'entre eux sont le rejet des eaux usées dans la rivière, le rejet de déchets dans la rivière, la négligence et le manque de collaboration entre les institutions de l'État. Ce travail a été fait avec le support d'ACTED, il présente une étude statistique permettant de faire le bilan économique et social du Bassin versant de l'Ostuan à travers une enquête réalisée auprès des chefs des municipalités (40 villages) du bassin de l'Ostuan concernant la pollution de la rivière. Cette évaluation a révélé que la situation écologique de la rivière est très catastrophique, des manques d'informations concernant les activités polluants l'eau et des impacts économiques importants. En vue des résultats, l'État doit intervenir pour arrêter les empiètements pratiqués sur la rivière par les citoyens, et les exhorter à prendre soin des sources d'eau comme une ressource naturelle de base pour eux et pour les générations suivantes.

Mots clés : Al-Ostuan, environnement, qualité ecologique, Economie, Social., Eaux-usées

Abstract

Like most Lebanese rivers, the Al-Ostuan River in Akkar suffers from many environmental problems. The most important of these are the discharge of sewage into the river, the discharge of waste into the river, negligence and lack of collaboration between state institutions. This work was done with the support of ACTED, it presents a statistical study to have an economic and social assessment of the Ostuan River Basin through a survey conducted among the municipalities (40 villages) of the Ostuan River Basin regarding the river's pollution. This assessment showed that the ecological situation of the river is very catastrophic, lack of information about water polluting activities and important economic impacts. In view of the results, the state must stop the encroachment of citizens on the river, and push them to take care of the water sources as a basic natural resource for themselves and for the following generations.

Keywords: Al-Ostuan, environment Economic, Social. Ecological quality, Wastewater

List of tables

List of figures

Introduction

The water policy in Lebanon and its multiple attempts at reform are part of a long historical and legal depth. It has strong links with the land issue and, beyond, with the social, political and economic organization of the country.

The Lebanese ecosystem is paying a heavy price because of the easy solutions and the lack of involvement of a government that is still unstable, more concerned about its own survival and security issues than about sustainable development, which is an integral part of human security. Lebanon, unlike its neighbors, has abundant water resources. Its rivers reflect the many paradoxes of our country.

Al-Ostuan River is one of the most important rivers in Lebanon, based in Akkar in the North of the country. The Al Ostuan River has its source in the Akkar Mountains and flows through villages to reach the Akkar plain and finally the Mediterranean Sea, with an annual flow of 67 mm3. This river constitutes a main resource of water for multiple uses mainly in the irrigation of crops in the district of Akkar, domestic use, and many other activities (Tourist, economic,), previous is considered a source of food (fishing activities) and drinking water.

Currently, the river has become extremely polluted due to decades of neglect and exploitation. Several toxic pollutants reach the river, mainly untreated sewage, municipal solid waste discharges, agricultural activities (excessive use of fertilizers and pesticides), industrial activities (vehicle maintenance garage, washing and emptying station...), and the food industry (dairies, olive mills, butcheries...), farms....

The lack of sewage treatment plants (STPs) and the direct discharge of untreated urban sewage into the river, along with uncontrolled agricultural runoff and the dampening of solid waste have led to high levels of pollution in the Al Ostuan River and caused severe environmental damage. The pollution has reached a catastrophic level where it is damaging the aquatic life in the river. It also causes serious problems for human health due to the contamination of irrigated crops by the polluted river water.

This pollution also reaches the groundwater of the Akkar plain and makes it polluted due to the infiltration of contaminated water during irrigation.

Within this framework, this study was conducted in collaboration with the international organization ACTED and had the general objective of analyzing the socio-economic and natural situation and the environmental impacts of the pollution of Al Ostuan in its watershed.

Specifically, it will: - describe the initial situation of the project sites in economic, social and environmental terms, as well as the project activities; - analyze the potential social and environmental impacts of the river pollution

-To obtain real data on the population, activities (quality and quantity), wastewater networks, waste disposal technique in all the villages that affect the Al Ostuan River.

These data are considered the first step in any solution plan to address the catastrophic state of the river and push the local authorities and government to decide to stop all activities that affect the river and put in place a plan for the proper management of the river.

This study focused on the villages around the Al Ostuan River (Akkar Al Atika, Dawra, Mejdel, Senn, Qoubayat, Deir Janine, Al Hedd, Mazraat Baldeh, Kafar Harra, Hayzouk, Machha, Al Souyseh, Al Khraybeh, Al Kwaykhat, Tal Abbas Al Charki, Tal Abbas Al Gharbi, Al Hisa, Massoudye, Al Knayse, Cheikh Znad, Tall Keri. The population of Akkar was estimated at 389,899 in 2015 (UNHCR). By including the refugees, this project focuses directly on the inhabitants of the villages around the river, and indirectly on all the inhabitants of Akkar district.

This thesis is divided into four chapters. First, a bibliographic part explaining the history of pollution in this watershed. Secondly, chapter II presents the study area and explains the methodology used to conduct the statistical study. Chapter III treats the data with the discussion of the results to finish in last chapter with the conclusions and the perspectives.

I. MATERIALS AND METHODS

I.1 Description of the study site

The governorate of Akkar is the northernmost governorate of Lebanon. It comprises the district of Akkar, which is divided into 121 municipalities. The capital of the governorate is located in Halba. The governorate of Akkar covers an area of 788 km2. The Office of the United Nations High Commissioner for Refugees (UNHCR) estimated the population of the governorate at 389,899 in 2015, including 106,935 Syrian refugees registered as a result of the Syrian war and 19,404 Palestinian refugees[1].

Akkar district has four major perennial rivers: Nahr Al Kabeer Al Janoubi, Nahr Al-Ostuan, Nahr Arqa and Nahr El Bared. But the state of surface water in Akkar can only be described as very bad, despite the enormous wealth of water, it has a national status, threatening, especially since there is no serious attempt to stop this deterioration in the level of water security.

The Al-Ostuan River had an importance after the Al Kabir Al Janoubi River. It flows from the East, where it originates from Akkar Al-Atikar and Qubayat, to the Mediterranean Sea at the Lebanese coast. The length of the river is estimated at about 44 km and the flow rate is about 2.28 m2/second near the river mouth, which is equivalent to 5.90 million m3/month. The Al-Ostuan River rises to about 510 km above sea level, and the river and its tributaries drain about 145 km2 with an annual volume of 47 million m3[2].

The main crops are terraced crops (vegetables), fruit trees and olive trees. The percentage of irrigated areas is currently about 27% of the total agricultural areas in the western and northeastern parts of the basin currently managed by NLWE[2].

Water pollution is also a major threat to the freshwater ecosystem in the region and the Mediterranean. The main sources of pollution are wastewater (untreated) and runoff (pesticides and nutrients). Al-Ostuan is polluted by sewage, direct discharges along the river that contribute to the modification of the water quality and its organic content.

The Al-Ostuan River Basin includes 51 villages, located entirely or partially within the river basin. The largest villages in terms of population are Akkar Al-Atika, Al-Qubayyat, Al-Dousa and Baghdadi, Tal Qari, Kafr Al-Fotouh and Al-Suwaisah. The average densityThe population density is about 1079 persons/km2. A maximum of 6,339 persons/km2 is observed while the minimum population density is observed in Al Hedd area, 8 persons/km2[2].

In terms of land use, agriculture dominates in this basin, accounting for about 37% of the basin area, while forests make up about 25%, followed by grasslands 16%, urban areas 12%, abandoned land accounts for 8% and wetlands and water bodies account for only 0.8% of the basin area[2].

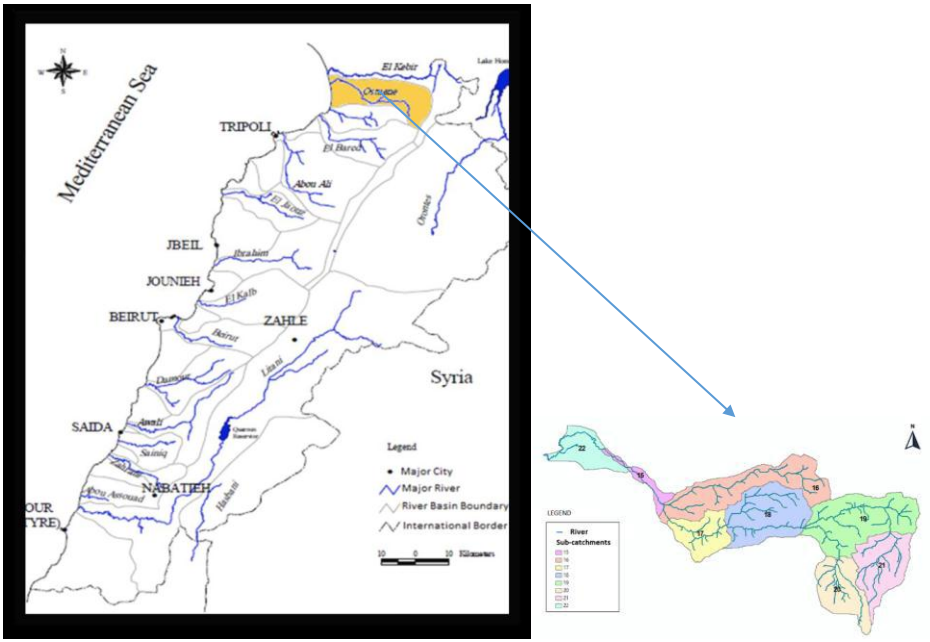

Figure 1: Geographical map of the Lebanese rivers[2]

I.2 Socio-economic context

The Al-Ostuan basin comprises 51 villages. Rapid urban growth is one of the major factors affecting living conditions and the environment in the Ostuan basin. The table below shows the villages located in the river basin and their respective areas and populations.

Table 1: Villages located in the Al Ostuan river basin and their respective areas and populations[2]

Village Name	Village area within the Al Ostuan RB (Km^2)	% of the village area that falls within ORB	Total population of the village (inhabitants)
El-Koubayet	27.39	89%	13000

Akkar El-Atika	24.99	89%	17000
Deir-janine	5.84	100%	1400
Charbila	5.18	100%	400
Tal Kerri	4.54	63%	7000
Al-Khraibe	4.25	88%	1018
Majdel	4.02	100%	3200
Beino	3.94	41%	5000
Daoura	3.29	47%	3500
El-Msalle	3.28	100%	1600
Cheikh Zennad Tal Bibe	3.15	35%	2544
Machha	3.14	55%	10000
Sindianet Zeidan	3.08	96%	776
Hayzouk	3.00	100%	2000
Al-Rihanie	2.94	99%	1800
Katte	2.53	100%	1050
Andeket	2.53	9%	6000
El-Kouachra	2.45	44%	2500
Daouce et Baghdadi	2.20	55%	25448
Mazraat Balde	1.81	100%	2800
Sfeinite El-Dreibe	1.81	100%	670
Al-Kneisse	1.74	100%	205
Hmais	1.71	100%	1200
Kfar Harra	1.65	100%	270
Ain El-zeit	1.61	100%	3000
Ain Tanta	1.52	100%	2000
Kherbet Daoud	1.42	100%	2500
Dahr el-kneisse	1.36	100%	602
Fseikine et Ain Achma	1.31	100%	1303
El-Hed	1.23	100%	10
Al-Souaisse	1.22	100%	3500
Barbara	1.15	100%	550
Tal Abbas El-gharbi	1.06	21%	3594
El-Daghle	1.01	100%	700
Kefr El-Ftouh	0.97	100%	5276

Al-Massoudie	0.91	18%	6000
Al-Kleiat	0.89	14%	6000
El-Tleil	0.83	27%	1800
Tal Abbas El-Charkie	0.82	22%	650
Denke et El-Amriyeh	0.80	25%	1600
Kherbet Char	0.74	100%	1500
Dahr-Leycine	0.73	24%	509
Saidnaya	0.66	79%	2150
Douair Adouiye	0.60	100%	1200
Al Moghrak	0.52	100%	150
Koueikhat	0.50	43%	30000
El-Bire	0.28	8%	2500
Omar el-Beikate	0.19	5%	2000
El-Haouchab	0.09	6%	400
Al-Hissa	0.07	3%	6000
Halba	0.00	0.06%	12000

I.3 Ecological state of the river

There are several sources of water pollution in the Al-Ostuan River basin. Direct discharge of untreated wastewater from municipal and domestic areas has been identified as one of the main causes of environmental pollution. In addition, runoff from agricultural soils into the Ostuan or its tributaries may also be directly related to heavy metal contamination of the water. The absence of public sanitary collection networks and wastewater treatment plants promotes contamination in the Ostuan basin since untreated wastewater is discharged directly into the river.

ACTED had finished research work regarding the water quality of Al-Ostuan River. Two water sampling campaigns were conducted in October 2019 (dry season) and February 2021 (wet season), where samples from 17 sites (figure) were collected and analyzed. These sites were selected to cover the upper river area (upstream), the middle of the river -primarily populated-, as well as the downstream area near the outlet, or untreated water[2].

This study showed that the physical parameters (temperature, PH, electrical conductivity, etc.) were at acceptable levels (below the Libnor Water Standards). As for the chemical parameters, the values related to the basic water quality, such as anions and cations, were all below the national

standards, except for nitrate and nitrite (which exceeded the standard values). Regarding the analysis of heavy metals, all results obtained showed higher than standard values in the 17 sampling sites along the river. This can be directly linked to fertilizers and industrial effluents that discharge heavy metals directly into the aquatic environment. Finally, microbiological parameters (fecal coliforms and E coli) exceeded acceptable limits, due to the fact that sewage effluents are discharged into the river, as well as uncontrolled agricultural runoff[2].

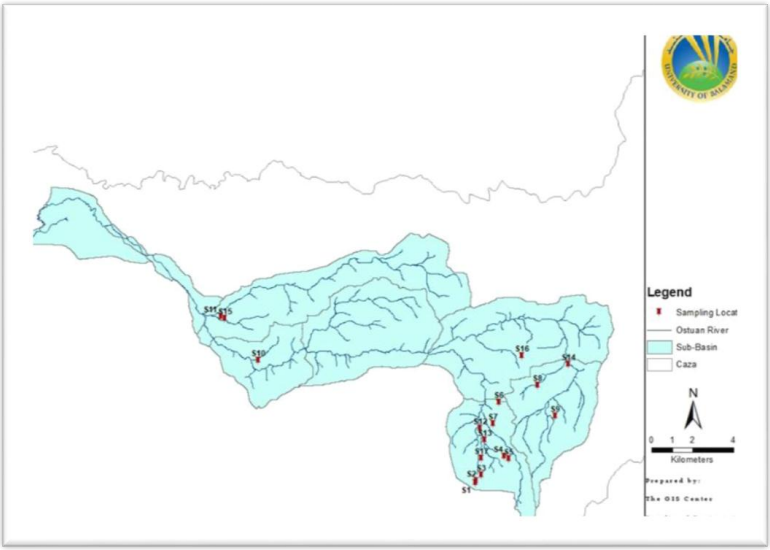

Table 2: Location of the sampling points[2]

Table 3: Results of the physical parameters of the dry sampling campaign[2]

	Temperature °C	**Conductivity µS/cm**	**Salinity %**	**TDS ppm**
Maximum	30.79	772	0.04	1001
Minimum	10.57	391	0.01	255
Average	15.94	566.88	0.03	397.06

Table 4: Results of the microbiological parameters of the dry sampling campaign[2]

	Ecoli MPN	Fecal MPN	DBO mg/L
Maximum	352	212	68
Minimum	64	0	10
Moyenne	178.65	83.59	27.47

Table 5: the results of water quality analyses and possible sources of pollution[2]

Sampling sites	Parameters above the Maximum Contaminant Level	Possible Souce of pollution
S1 to S17	DO, Nitrite, Hg, Pb	▪ Discharge of untreated wastewater ▪ Open dumping ▪ Animal waste ▪ Use of fertilizers and chemicals
S13	TDS	▪ Leaching of soil ▪ Agricultural and urban runoff ▪ Discharge of untreated sewage
S10	DBO5	▪ Untreated municipal and domestic waste open dumping
S15	E coli, Température	
S14, S16, S17	DBO5, Taux élevée Ecoli, Température	

I.4 Statistical study

This study aims to investigate the socio-economic and environmental interaction between the populations of the Al Ostuan river basin and the river itself for this purpose statistical studies were carried out with the heads of the municipalities of the villages of the AL Ostuan basin. The survey was divided into five parts of which the first part is devoted to the environmental sector such as the different sources of water in the region for domestic and drinking purposes, water discharge technique and their treatment, in addition it deals with the method of waste management in the villages of Al Ostuan basin.

The second part was reserved for agricultural activities such as the space of active agricultural lands, source and means of irrigation water, percentage of irrigated water....

The third part is devoted to the economic and tourist activities in Al-Ostuan basin area where the number of industrial and agro-food enterprises as well as tourist enterprises and their effect on Al-Ostuan River as well as the fishing activities in the river are estimated.

The fourth part estimates the effect of pollution in the Al-Ostuan basin on human health, especially infectious diseases.

The last part estimates the role of municipalities in addressing environmental problems that directly or indirectly affect the Al Ostuan River.

Before the implementation, the audit stage was important to modify the survey, some things were reworded and introductions were added, or rearranged, and some questions were omitted to get a final ready-to-use copy of this questionnaire with maximum clarity, usability and understanding.

The survey was organized with the approval of which is considered an introduction explaining who is the creator of this survey, the name of the university collecting the data, and the coordinates of the heads of the municipalities of the villages in the basin of AL Ostuan were obtained by the site Localiban.

The survey consisted of a telephone call with the heads of the municipalities in the AL Ostuan basin, the duration of the telephone call was about half an hour, sometimes the survey was done by personal interviews.

90% of the villages of the basin have participated in this study where after the collection of data they are well processed first by the Excel software then we study the correlations between the results obtained in this study with the results of analysis of physico-chemical and microbiological parameters of a recent study carried out by Hasan Selman under the direction of Dr. Moumen Baroudi on the river Al Ostuan for this we have divided the villages and towns into different areas in order to compare the data obtained with the data of Hassan.

I.5 surveys

1. Name of the area

2. What percentage of your dependence on water from the Al-Ostuan River is for domestic use?

[0% - 20%] [20% - 40%] [40% - 60%] [60% - 80%] [80% - 100%]

3. What is the percentage of bottled water consumption of displaced Syrians compared to the total population consumption?

[0% - 20%] [20% - 40%] [40% - 60%] [60% - 80%] [80% - 100%]

4. Did the pollution of the river lead people to draw water from the springs that feed the river or to dig artesian wells?

No

Yes

How many springs are pulled?

How many new wells?

5. Is there a public drinking water system in the area? Yes No

6. Does the state allocate any of this system's budget to treat wastewater? Yes No

7. What is the coverage rate of the sewerage system in the municipality?

0% [1% - 30%] [30% - 60%] [60%- 100%]

8. How do unsewered neighborhoods dispose of wastewater?

- industrial throat
- aspiration directly into the river
- septic systems

9. Is the sewage system connected to a wastewater treatment plant? Yes No

10. If yes, what is the percentage of wastewater treatment?

[0% - 20%] [20% - 40%] [40% - 60%] [60% - 80%] [80% - 100%]

11. Are there polluted water sources that feed the river?

No

1-2

2-4

4-6

12. Is there a landfill or garbage collection point near the river? Yes No

13. If yes, how far is the landfill or waste collection point from the river?

14. What percentage of the population litters the river banks?

[0% - 20%] [20% - 40%] [40% - 60%] [60% - 80%] [80% - 100%]

15. What are the reasons why people throw garbage into the river?

- Lack of environmental awareness
- Irregular collection of waste by the waste collection agency
- Considering that these wastes are not dangerous

16. What is the smell of the river?

***Table 6**: smell of the river in winter and summer*

	slight odor	**Medium odor**	**strong odor**	**very strong smell**
Winter				
summer				

17. What color is the water in the river?

***Table 7**; Color of the river in winter and summer*

	Blue	**Grey**	**Dark grey**	**Green**	**Black**
Winter					
summer					

18. How long have you considered this river to be polluted?

- [0-5] years
- [5-10] years
- [10-20] years
- +20 years

19. How much of the total area of the municipality is agricultural land?

20. What is the source of irrigation water for crops?

- artesian wells
- Springs and artificial ponds
- Al-Ostuan River

- other sources

21. How much agricultural land is irrigated by Al-Ostuan water?

22. How many tourist facilities (restaurants and swimming pools) are located on the banks of Ostuan?

23. To what extent do the economic and tourism activities built on the shores of Ostuan constitute a percentage of the economic activity of the region?

24. How do these parks dispose of wastewater?

- Connect it to the sewer system
- Convert it into the Al-Ostuan River Pipes

25. How do these facilities dispose of solid waste?

- Discharge
- Burning
- Tracking
- throw at random

26. Among these economic facilities, which are located in the commune, especially on the banks of the river

***Table 8**: Different economic activities in the Al-Ostuan basin*

	yes	No	at the river's edge
Cheese and dairy factories			
Auto mechanics, laundries and blacksmith shops			
Poultry and livestock farms			
olive oil press			

27. How is the waste generated by these economic establishments disposed of?

***Table 9**: Methods of disposal of industrial waste in the Al-Ostuan basin*

	connected to the sewer system	Connected to natural channels	Connected to River	Independent treatment system
Cheese and dairy factories				
Auto mechanics, laundries and blacksmith shops				
Poultry and livestock farms				
olive oil press				

28. Do you catch fish from the river? Yes No

29. If the answer is no, does the pollution of the Al-Ostuan River cause fishing from the river to stop?

30. Is river pollution causing the decline, increase or extinction of fish in the Al-Ostuan River? Yes No

31. - Are there any artificial fish farms on the banks of the Ostuan River? Yes No

32. What is the rate of decline of active agricultural land as a result of the pollution of the Al-Ostuan River?

[0% - 20%] [20% - 40%] [40% - 60%] [60% - 80%] [80% - 100%]

34. What is the percentage of the region's working population in these economic and tourist establishments?

35. has the accumulation of waste and fill in the river caused flooding and damage to agricultural and residential land? Yes No

36. If the answer is yes, what percentage of the land is affected by this flood?

37. - Has the smell from the river caused respiratory problems for residents in the area?

No

Yes - how many of these cases

38. Have cases of poisoning been recorded among the inhabitants of the region following their consumption of vegetables and fruits irrigated with water from the Ostuan?

No

Yes - the number of these cases

39. Were there any cases of skin diseases recorded after residents bathed in the Al-Ostuan River?

No

Yes - the number of such cases

40. - Have you, as a municipality, developed a plan to reduce pollution in the river? Yes No

41. Did you place it in coordination with neighboring municipalities or individually?

42. How many municipalities participated with you in developing this plan?

43. What is the success rate of this device?

[0% - 20%] [20% - 40%] [40% - 60%] [60% - 80%] [80% - 100%]

44. What obstacles have you encountered in implementing the solution plan?

45. Have you, as a municipality, taken legal action against people who have committed encroachments (dumping garbage in the river, dumping olive dung, car oil...) on the river? Yes No

46. - If the answer is yes, what actions are taken?

47. Is there a project to build a dam on the Al-Ostuan River? Yes No

48. If the answer is yes, what is the proposed geographic area for the construction of the Ostuan Dam?

49. Is there a geographic area of approximately 1000 cubic meters, 100 meters from residential communities, on which a refinery plant can be built in the area? Yes No

50. Can the municipality allocate a portion of its budget to help secure the cost of operating the wastewater treatment plant? Yes No

51. Are you willing to treat wastewater from nearby areas if the refinery exists or is located? Yes No

52. With respect to adjacent areas, is there an encroachment between these areas and the Al-Ostuan River?

No

Yes

- Disposal of household waste
- Disposal of construction, industrial and agricultural waste
- Disposal of dead animals (chickens, birds)
- Throwing away other waste

53. With respect to neighboring areas, is there any encroachment between these areas on the waters of the Al-Ostuan River? Yes No

54. As a result of these encroachments, have there been cases of conflict between regions? Yes No

55. - Are you willing to join an environmental organization to protect the river from pollution sources and prevent encroachment? Yes No

56. Are you willing to participate in a campaign to clean up the river and support it? Yes No.

II. RESULTS AND DISCUSSION

II.1 Geo-demographic characteristics of the Al-Ostuan basin

The study included 40 villages in the Al-Ostuan basin, which is made up of 51 villages. This is equivalent to 78% of the area of the basin. The villages and areas in the study are: Hayzouk, Machha, Khreibet El-Jundi, Tal Kerri, Tal Abbas El-Charki, Daher leycine, Ain El-Zeit, Daouce and Baghdadi, El-Tleil, Tal Abbas El-Gharbi, Kherbet Daoud, Ain Tanta, Koueikhat, Sindianet Zeidan, Akkar El-Atika, Deir Janine, Beyt al Haj, Daoura, Al-Kleiat, El-Bire, Sfeinite El-Dreibe, El-Daghle, El-Haouchab, Kherbet-Char, Douair Adouiye, El-Kouachra, Barbara, Al-Rihanie, Al-Kneisse, Al-Souaisse, Charbila, Cheikh Znade, Halba, Koucha, Kfar Harra, El Koubayet, Omar El-Beikate, Beino, Mazraat Balde, Al Massoudie.

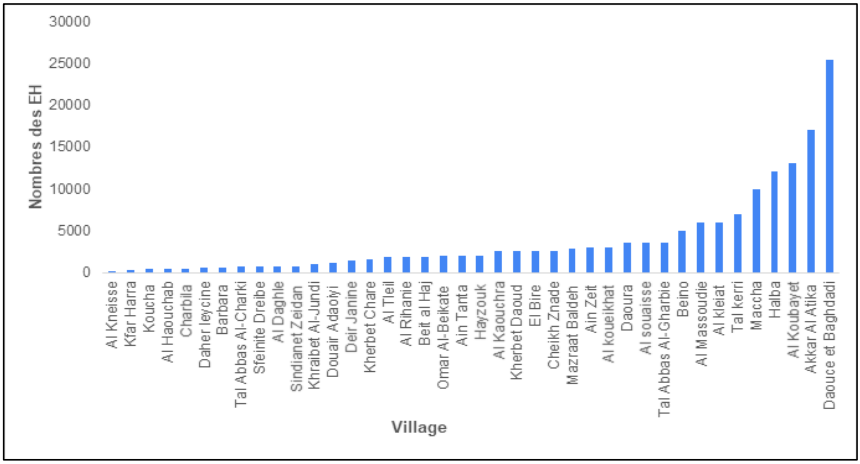

***Figure 2**: Number of Population Equivalents in the villages of Al-Ostuan Basin*

The total surface of the basin is 146.67 km2. This basin is subdivided into 8 sub-basins, the first of which has a surface area of 15.63 km2, the second 18.44 km2, the third 30.01 km2, the fourth 24.68 km2, the fifth 28.55 km2, the sixth 12.11 km2, the seventh 4.19 km2, and finally the eighth 11.96 km2.

The largest village in terms of population equivalent is Daouceh and Baghdadi (25448 PE) while the smallest village in terms of population is Al-Kneisse (205 PE). In addition, the largest village in terms of area in this study is El Koubayet (3092 hectares) while the smallest village is Douair Adouiye (60 hectares).

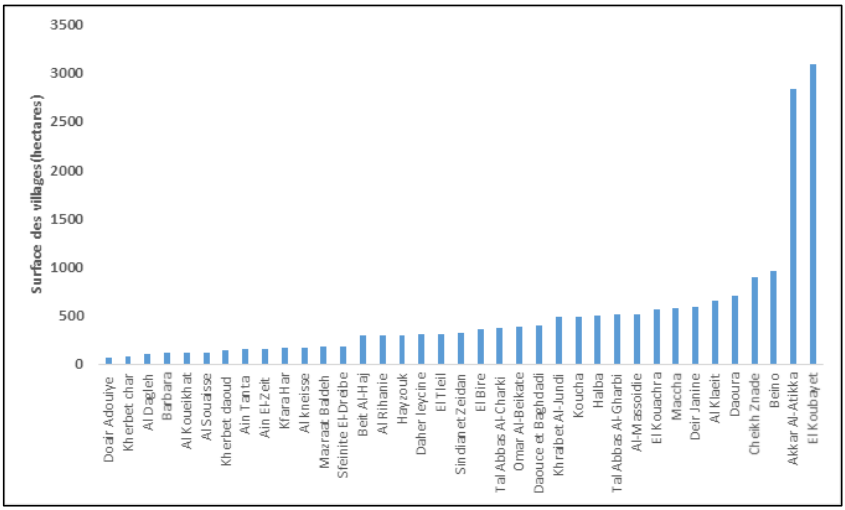

***Figure 3**: Surfaces of the villages of Al-Ostuan basin*

II.2 Characteristics of the Water Sector in the Ostuan Watershed

Domestic water sources

The statistical study carried out showed that most of the inhabitants (Lebanese and Syrian) of the villages studied (82%) use the water distributed by the North Lebanon Water Agency (Halba network, El-Koubayet network) to ensure their domestic water needs, while 5% of the villages use the water of Al Oustouene river (El-Koubayet and Khraibet El-Jundi) and 13% use other sources to ensure their domestic needs.

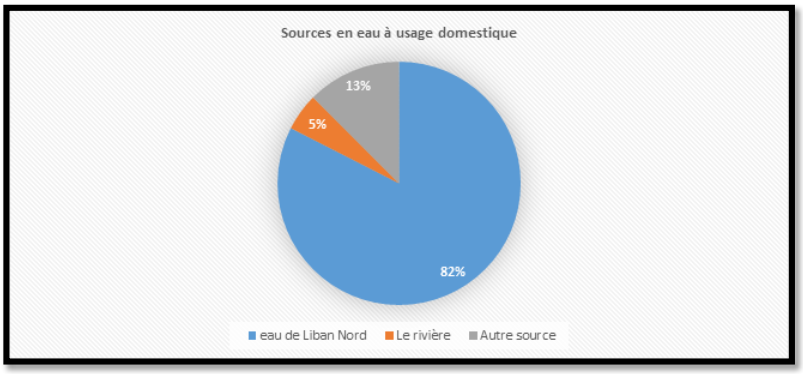

***Figure 4**: the different sources of water for domestic use.*

Effect of river water pollution on pumping and use of natural water sources

The study showed that artesian wells were dug in 47.5% (19/40) of the villages to provide water needs, where 737 wells were drilled. The village that recorded the highest number of drilled wells is Al-Rihanie (150 wells), while the village that recorded the lowest number of drilled wells is Beit Al-Hajj (5 wells). In addition, 15% of the villages in Al Ustouene watershed to resort to natural water sources due to the pollution of the river in order to ensure their water needs with a number that varies between 10 (Akkar El-Atikkka) and 1 (Daoura and Beyt Al-Hajj).

***Table 10**: Number of sources of water used following the pollution of the Ostuan*

Nombre des villages	1	1	1	1	2	34
Nombre des sources pompés	2	5	6	10	1	0

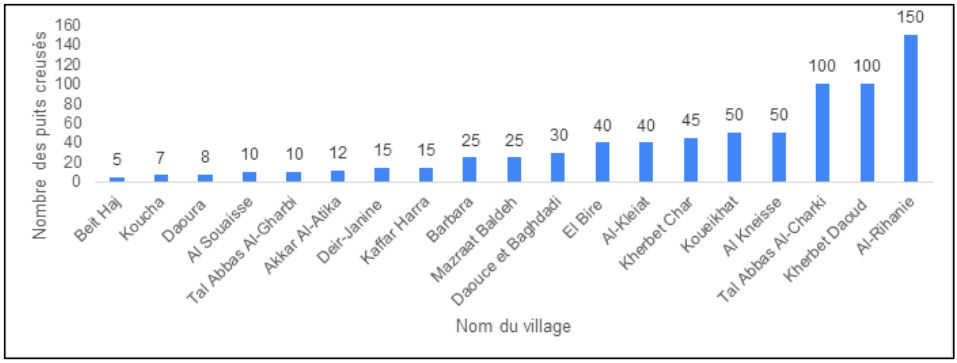

Figure 5: Number of wells drilled in the watershed

Collection networks and wastewater disposal methods

The study showed that 53% (21/40) of the Al-Ostuan villages where the percentage of coverage of the village sewerage system varied between 60% and 100%.

100%, in addition 15% (6/40) where the coverage rate varied between 60 and 30%, while 27% are

Coverage varied between 60 and 30%, while 27% are in absence of connection to a sewerage network in the

Sewerage system in the village. In addition, the study showed that the neighborhoods that are not connected to

Connection to a sewerage system to collect wastewater dispose of this water in several ways

65% of the villages dig natural channels, while 22% direct the wastewater directly to the river and 13% to the

22% direct wastewater directly to the river and 13% dispose of wastewater in streams.

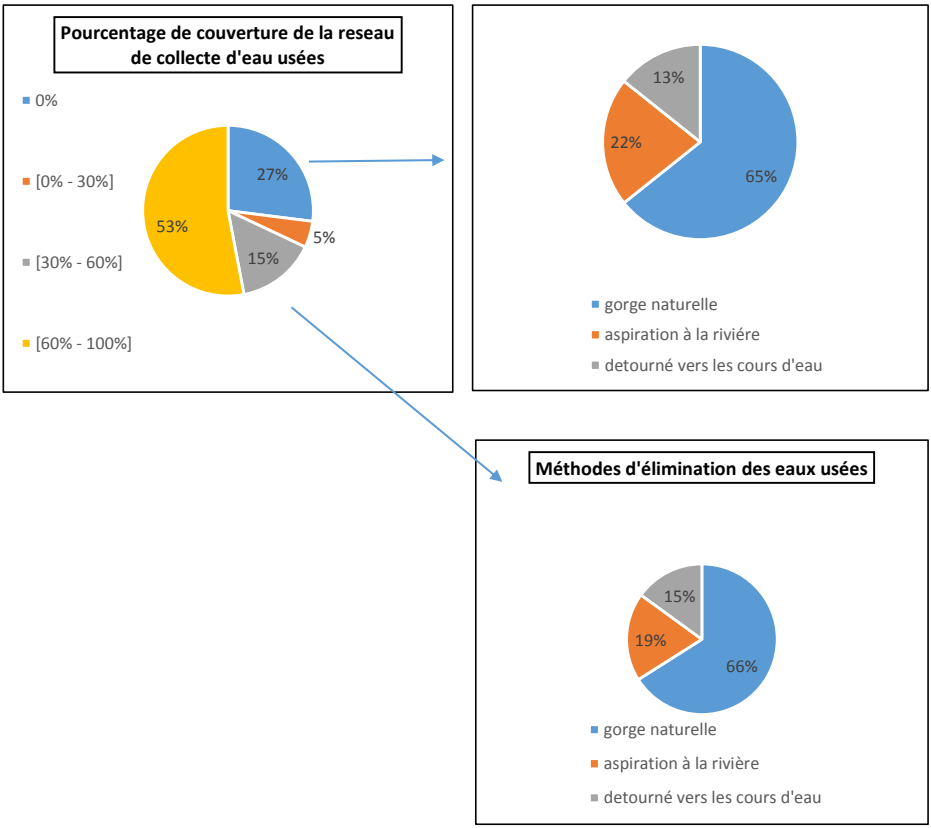

***Figure 6**: The percentage of coverage of the village's sewage systems and their method of disposal*

The results indicate that 20% of the villages (8) are connected to wastewater treatment plants of which 37.5% provide a treatment of 20 to 40% of the total amount of wastewater discharged, in addition 25% of the villages (2) provide a treatment of 60 to 80% and only 12.5% provide a treatment of 80 to 100%.

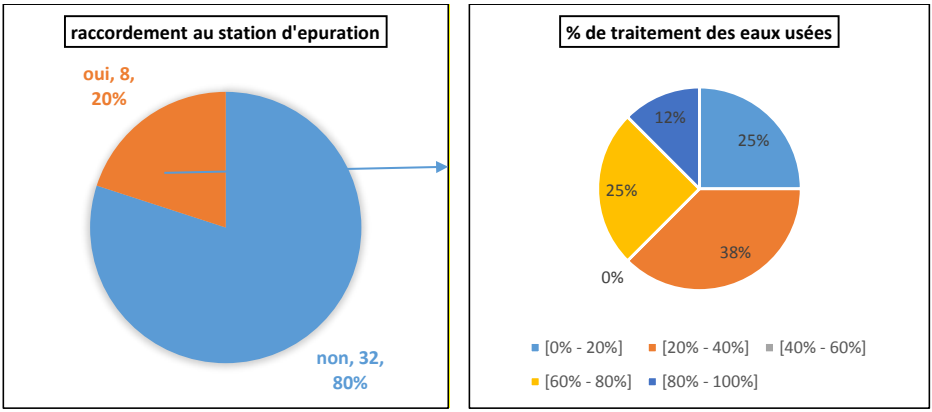

***Figure 7**: Sewage collection network and treatment plant*

In accordance with the law on the collection of taxes and fees, stipulated by the Ministry of Energy and Water. The citizens participating in the North Lebanon Water Establishment must pay a fee to participate in the water which is divided as follows: Basic amount: 228,000 L.L. (~151 USD), Maintenance fee: 24,000 L.L. (~16 USD), Wastewater treatment fee: 20,000 L.L. (~13 USD), Taxes: 10% VAT. However, the survey showed that all villages (40/40) report that the water facility in North Lebanon does not allocate any budget amount for wastewater treatment[2].

II.3 Collection and Quantity of waste produced

The histogram below shows the quantities of domestic waste produced per day in the villages of Al-Ostuan basin. The town that recorded the highest amount of waste produced is Daouce and Baghdadi (29265.2kg/Day), while the village that recorded the lowest amount of waste is Al Kneisse (236 Kg/Day) with an average rate of about 4397 Kg/Day.

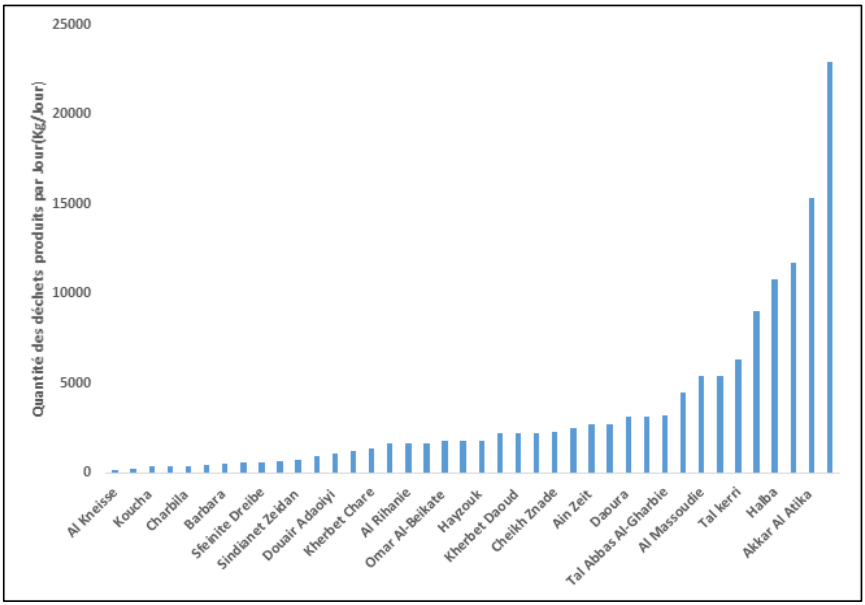

***Figure 8**: Quantities of domestic waste produced by the villages of Al-Ostuan basin (Kg/Days)*

The study showed that most of the villages and communes whose household waste is taken to the landfill of Srar, Akkar by the Arab Safety Company. While some villages throw their waste into the river directly.

Water quality of Al-Ostuan River

Regarding the smell of the river in winter, the study showed that 78% (31/40) of the villages said that the smell of the river is light in winter and this is related to the strong flow of the river, while 10% (4/40) of the villages said that the smell of the river is strong, especially during the first rains in winter.

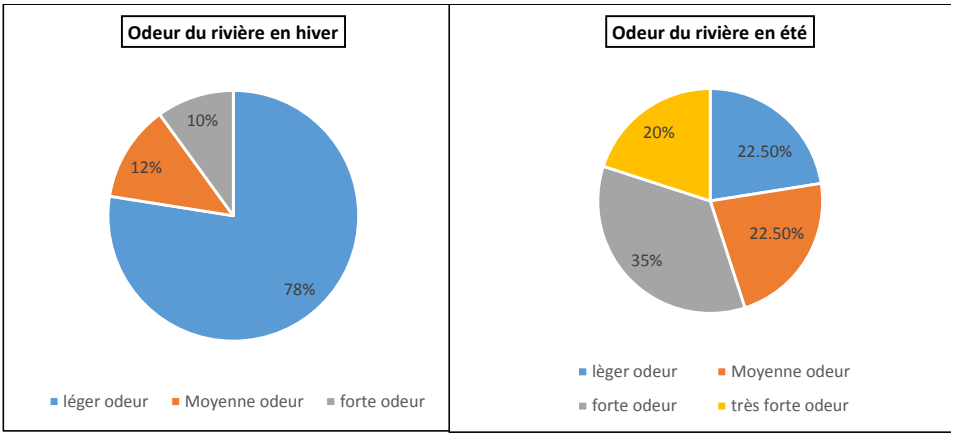

***Figure 9**: Smell of the river in winter and summer*

Regarding the smell of the river in summer, the study showed that 35% (14/40) of the villages and towns reported that the smell was strong in summer, and also 20% (8/40) of the villages reported that the smell was very strong, and this is mainly due to the fact that the sewage from the villages is discharged directly into the river, and in the summer and with the rise in temperature, the biological activity in the river increases.

Table 11: color of the river in winter and summer

Water color	Blue	Grey	Dark grey	Green	Black
Winter	13/40 (32.5%)	20/40 (50%)	2/40 (5%)	4/40 (10%)	1/40 (2.5%)
Summer	4/40 (10%)	5/40 (12.5%)	0/40 (0%)	23/40 (57.5%)	9/40 (22.5%)

The table above, shows the colors of the river water in winter and summer. The study showed that in winter 50% (20/40) of the villages and towns said that the color of the river water is gray, while in summer 57.5% (23/40) the color of the river water is green and this is due to the wastewater discharged into the river and eutrophication phenomena.

The villages and municipalities were asked about the history of pollution of the Al-Ostuan River, and the study showed that about 45% (18/40) consider that the river has been polluted for more than twenty years.

II.4 Agricultural activities in the Al-Ostuan basin

The main water demands in the Al-Ostuan basin are for irrigation purposes, and represent about 62% of the total water demand. In addition, the demand for irrigation water is highly dependent on rainfall and therefore varies from year to year from 8 to 13 million m3/year. The agricultural areas where the demand is the most important are located in the northern part of the Al-Ostuan basin.

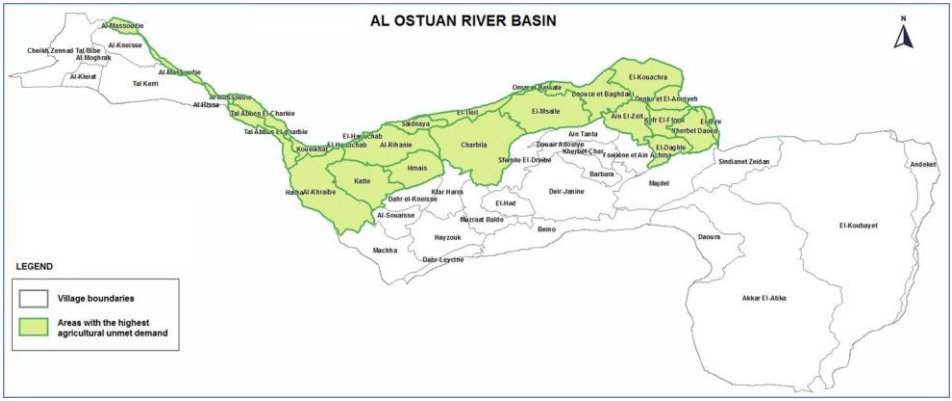

***Figure 10**: Villages with the highest unsufficient agricultural water demand (million m3) per year (from 2003-2018) in the Al-Ostuan basin [2]*

Irrigation water sources

The study showed that 77.5% (31/40) of the villages and towns in Al-Ostuan, where farmers use groundwater in irrigation, while there are 35% (14/40) of the villages in which agricultural activities depend on Al-Ostuan River. The histogram below shows the different sources of water for crop irrigation in Al-Ostuan basin.

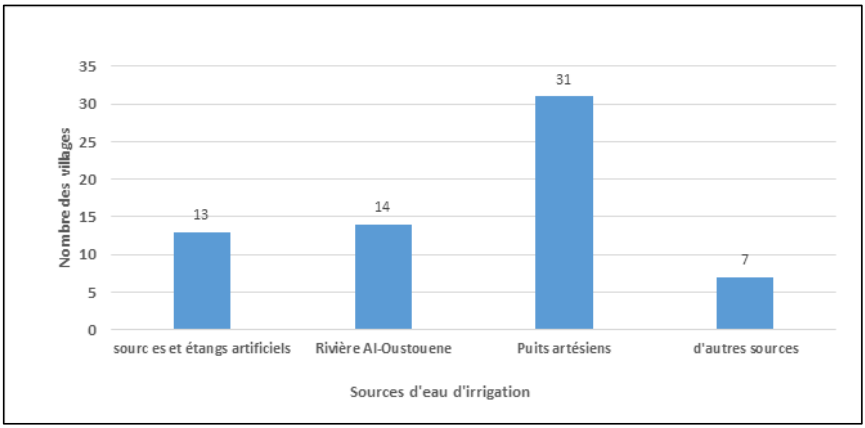

Figure 11: the different sources of irrigation water in Al-Ostuan basin

Regarding the area of agricultural land irrigated by Ostuan water, the study showed that, 27.5% said they originated from Ostuan water in different proportions. The village that Recorded the highest irrigated area of the river is Mazraat al-Baldah (570 hectares), while The village that recorded the lowest irrigated area is Khraibet al-Jundi (15 hectares).

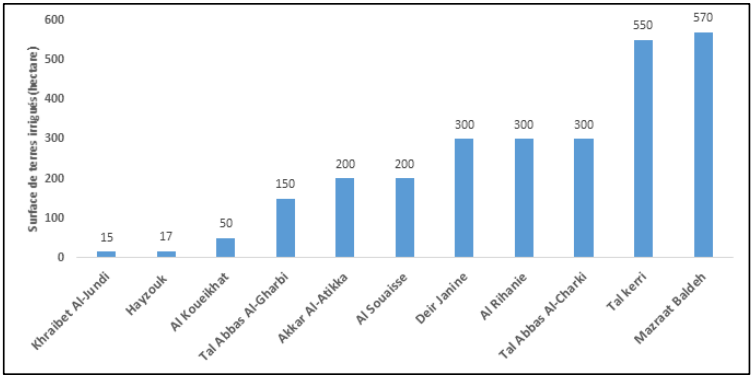

Figure 12*: The surfaces of the areas irrigated by the Al-Ostuan River*

Effects of the pollution of the Ostuan on agriculture

The histograms below show the percentage decline in active agricultural land and the percentage increase in of the increase in rain-fed agriculture at the expense of irrigated agriculture as a result

of the pollution of the Al Ostuan River. 20% (8/40) of the villages in the basin reported that active land had been reduced by active land has been decreased by about 0-20%.

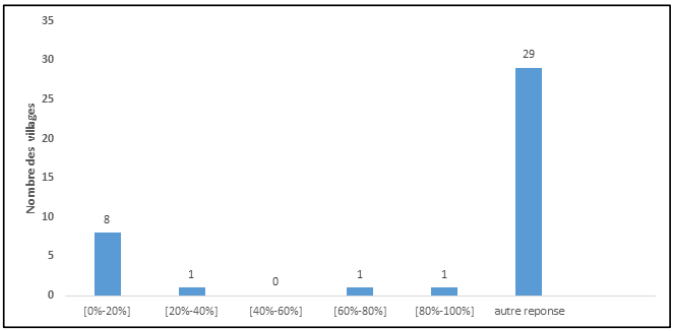

Figure 13: The percentage decline in agricultural land as a result of the pollution of the Al-Ostuan River

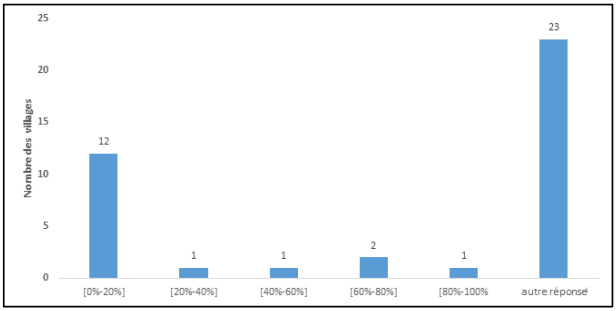

***Figure 14**: the percentage increase in rainfed crops as a result of the pollution of the Al-Ostuan River*

As for the rate of increase in rainfed crops, 30% (12/40) said that rainfed crops have been increased by about 0-20% due to several reasons, either because of water pollution, or because of the worsening economic crisis in the country, or as a result of the near failure of electricity in the country and thus farmers are unable to take water from wells to irrigate crops.

Economic and tourist activities in the Al-Ostuan basin

Tourist activities along the river

The study showed that the number of villages that have cafes and restaurants located by the river represents only 22.5% (9/40) of the villages in the basin (Table 10). The village that recorded the

highest number of restaurants and cafes is Mazraat al-Baldah (14), while the village that recorded the lowest number of restaurants and cafes is Deir Jenin and Khraibet al-Jundi (1).

***Table 12**: Number of cafes and restaurants located along the river*

Number of villages	1	1	2	2	3	31
Number of restaurants and cafes	4	14	1	3	2	0

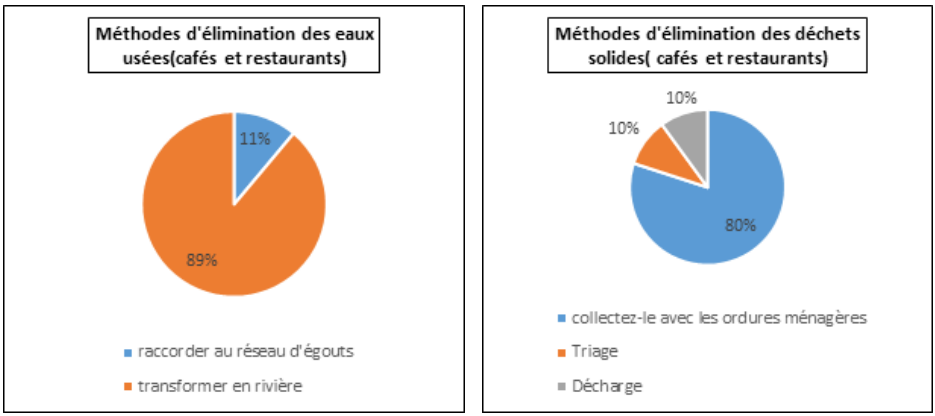

***Figure 15:** disposal routes for sewage and solid waste from restaurants and cafes along Al-Ostuan*

The study showed that 8/9 (89%) of the villages that have cafes and restaurants by the river are diverting wastewater to the divert wastewater to the Al-Ostuan River courses (Figure15), while

Only 1/9 (11%) discharge this water into the public sewage system of the area. In addition, with regard to solid waste, 80% of the solid waste80% collect it with household waste, while 10% dispose of it in landfills and 10% dispose of it by sorting.

Economic activities

Table 11 below presents the different economic activities that exist in the municipality, particularly on the banks of the Ostuan River.

***Table 13**: Industrial facilities in the Al-Ostuan basin*

	Presence	**Absence**	**at the river's edge**
Cheese and dairy factories	9/40	31/40	1/9

Auto mechanics, laundries and blacksmith shops	21/40	19/40	1/21
Poultry and livestock farms	28/40	12/40	1/28
olive oil press	13/40	25/40	0/13

The study showed that poultry farms (28/40) come first in terms of importance and presence, followed by mechanical workshops (21/40), then olive presses (13/40), then dairy industries (cheese factories and dairies 9/40).

The table above shows that there are different ways to dispose of waste from economic facilities.

***Table 14**: Different ways of disposal of waste from economic activities in the Al-Ostuan basin.*

	connected to the sewer system	**Connected to natural channels**	**Connected to River**	**Independent treatment system**
Cheese and dairy factories	7/9	1/9	1/9	0/9
Auto mechanics, laundries and blacksmith shops	7/21	4/21	2/21	8/21
Poultry and livestock farms	4/28	10/28	2/28	12/28
olive oil press	4/13	7/13	1/13	1/13

For example, the most important waste in the auto mechanic and forge shops is hydraulic oil. The study showed that some mechanic and car forge shops throw the oil into the public sewage system, and most of the stores sell burnt oil, and this business has increased, especially after the suffocating economic crisis.

Regarding the waste from the farms, a large part of the farmers depend on the integration of the liquid waste with the solid waste and their contribution in fertilizer for the agricultural land. And the others, they dump the waste in the natural channels, and in the sewerage systems.

Fishing activities in the river

The table shows the fishing activity in Al-Ostuan River. Only 30% (12/40) of the villages and towns in the basin fish in the river.

Table 15: Characteristics related to the fishing activity in the Al-Ostuan River

Questions	Yes %	No%
Do you catch fish from the river?	30	70
If not, does the pollution cause the fishery to stop?	67.5	32.5
Is pollution causing the decline, increase or extinction of fish in the river?	60	17.5 (22.5)
Are there artificial farms on the banks of the Ostuan?	7.5	92.5

We also investigated whether the pollution of the river caused the cessation of fishing. The study showed that 67.5% (27/40) of the villages and towns in the basin have taken the pollution problem into consideration. Moreover, also a decrease in the number of fish had been noticed and even the extinction of some species. 60% (24/40) stated that the numbers had decreased.

Effects of pollution of the Ostuan on the health of the inhabitants

The study showed that 12.5% (5/40) of the villages reported that there were respiratory problems among the inhabitants.

***Table 16**: Number of people suffering from respiratory diseases due to the pollution of the Ostuan*

Number of villages	35	2	1	1	1
Number of people suffering from respiratory diseases	**0**	**15**	**60**	**70**	**450**

***Table 17**: Number of people suffering from infectious diseases due to the pollution of the Ostuan River*

Number of villages	36	1	1	1
Number of people suffering from infectious diseases	**0**	**10**	**20**	**400**

***Table 18**: Number of people suffering from skin diseases due to the pollution of the Ostuan*

Number of villages	33	1	1	1	1	2	1
Number of people suffering from skin diseases	**0**	**3**	**4**	**5**	**10**	**20**	**45**

The village that recorded the highest number of sick is Al-Daghle (450 Cases), and the two villages that recorded the lowest number of sick are Ain Tanta and Khraibet Al-Jundi (15 Cases). In addition 10% (4/40) of the villages report infectious diseases, the village that recorded the highest number of sick is Khraibet Al-Jundi (400 cases), while the village that recorded the lowest number of diseases is Al Massoudie (10 cases). Thus, 17.5% (7/40) reported that there were skin diseases among the population. The village that recorded the highest number of cases is Al-Kneisse (45 cases), while the village that recorded the lowest number of cases is Barbara (3 cases).

Socio-political status of the study population

The study showed that only 20% (8/40) developed a plan either individually (4/8) or in cooperation with neighboring municipalities (4/8). As for the success of the program, the program failed for many reasons, including lack of funding, lack of cooperation between municipalities, and the complete absence of the state.

- **Construction of a dam and a wastewater treatment plant**

The table above shows the opinions of the residents of Al-Ostuan basin regarding the construction of a dam to store wastewater.

***Table 19**: Residents' opinions regarding the construction of a dam to store water and the establishment of a water treatment plant.*

Questions	Yes%	No%
Is there a project to build a dam?	40	60
Is there a geographical area where a wastewater treatment plant can be built?	87.5	12.5
Are the municipalities able to ensure the operation of wastewater treatment plants?	32.5	67.5
Are you prepared to treat wastewater from neighboring areas	65	35

According to table 17 we can see that 40% (16/40) of the villages and municipalities in the basin have a project to build a dam on the river in different geographical areas, such as the area between Kfar Harra and Mazraat Baldeh, as well as in the Al Sad region under the former Akkar region, in Deir janine and in Kherbet Daoud, the Sherchar spring. In addition, 87.5% (35/40) declare that they have a geographical area on which the wastewater treatment plant can be built, while only 32.5% (13/40) are able to afford the cost of operating the treatment plant, and more 65% (26/40) of the villages and municipalities in the basin are willing to treat wastewater from neighboring regions in case a treatment plant will be established in the region.

- **Encroachments on the Al-Ostuan River**

The pie charts in Figure 27 show the encroachments that have occurred in the Al-Ostuan River between neighboring areas. The study confirmed that 35% of the villages in the basin had committed violations, including the discharge of solid waste into the river 33% (6/40), sewage 23% (4/40) and the discharge of slaughterhouse waste and dead animals 44% (8/40), in addition no conflicts or disagreements were recorded between the areas as a result of these encroachments.

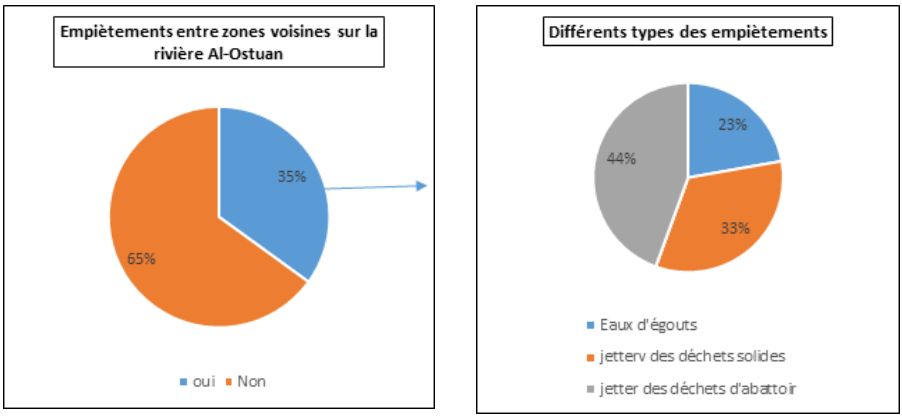

***Table 20**: Types of encroachments between neighboring areas on the Al-Ostuan River*

- **River flooding and its effects on agricultural land**

17% of the villages and basins of Al-Ostuan have been damaged by the river floods due to

Accumulation of solid waste. The village that recorded the highest damage rate is Tel Abbas

Abbas Al-Charki, where the area of damaged land reached about 25 /100, while the two Villages that recorded the lowest damage rate are Al-Rihanie and Al-Daghla (5/100).

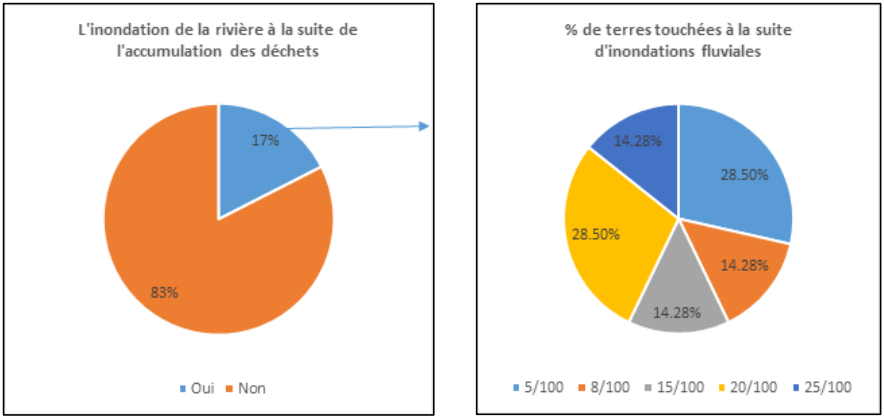

***Figure 16**: River flooding and its effects on the agricultural area*

- Proposed activities to protect the Al-Ostuan River

According to Figure 29, 80% of villages and towns in Al-Ostuan are willing to join an environmental organization to protect the river from pollution sources and prevent any encroachment on it. In addition, 85% are willing to participate in a compaign to clean the river and support it according to the capacity of each municipality.

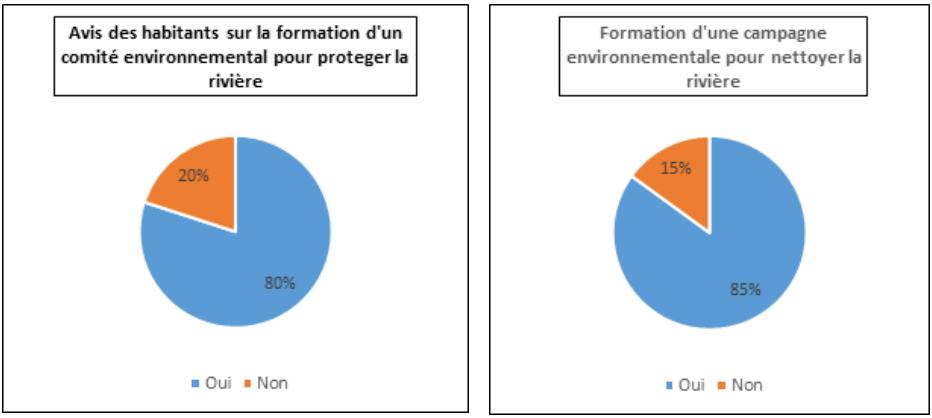

Figure 17: Residents' opinions on the formation of a committee and an environmental campaign

Discussion

1 Correlation between agricultural land area and nitrate concentration in the River:

Nitrate is an essential nutrient for agriculture. In addition, the presence of nitrate in watercourses streams is generally due to leaching from agricultural soils or oxidation reactions between ammonia nitrogen and nitrite. Nitrates also have other sources, silage through the drainage system, water and air, and the drainage system, runoff, sewage, industrial effluents and human and animal waste[2].

A positive correlation occurred between the area of agricultural land Al Ostuan basin and the concentration of nitrates (r=0.64) in the river water. The larger the area of agricultural land in the basin, the greater the density of nitrate in the river, which means that the amount of fertilizer (KNO3, NH4NO3) and chemical fertilizers used on crops has increased, and the agricultural residues will be discharged into the river.

High nitrate levels in the presence of bacterial contamination can lead to cyanosis or blue baby syndrome in bottle-fed infants (WHO, 2011), therefore nitrate levels above 100 mg/l are not recommended for infants[3].

2 Correlation between wastewater system coverage rate and fecal coliform bacteria

It is well known that bacteria play an important role in maintaining the balance of the hydrodynamic environment with respect to the self-purification capacity of a river, unless certain anthropogenic microorganisms are released into the environment and thus disturb this water balance. These microorganisms can cause disease and be harmful to public health by colonizing epi-lithic biofilms. As the detection of these pathogens is difficult, indicators of fecal contamination have been chosen to assess water quality, such as fecal coliforms and Escherichia coli (ISO / LIBNOR)[4]. Our study indicates that there is a positive correlation between the coverage of the village sewage system and the quantity of fecal coliforms (r=0.50) in the river. This is evidence that wastewater is discharged directly into the river, without any treatment in the sewage treatment plants.

3 Correlation between summer river odor and total coliform levels

Microbial contamination of aquatic ecosystems has serious consequences for human health[5]. It has been associated with various waterborne diseases and periodic epidemics in Lebanon[6],[7]. Fecal pollution of water can introduce a variety of intestinal pathogens that can cause disease, ranging from mild gastroenteritis to dysentery, diarrhea, cholera, typhoid, hepatitis, giardiasis, etc[3].

The adsorption of bacteria onto waterborne particles and their sedimentation forming biofilm are factors that may contribute to the apparent disappearance of pathogenic microorganisms from the water column[8] and thus, to their persistence in the aquatic ecosystem. A positive correlation occurred between residents' opinions on the odor of the river in summer and the amount of total coliform (r=0.57) in the river. In general, bacterial detection is higher in summer than in spring and winter. This could be related to the dilution effect due to snowmelt and more rain in spring and the concentration effect in summer due to dryness and high temperature (30^0C).

We note here that the coliforms total and fecal classify the river in the poor to very poor water quality zone, excluding their use for drinking water production[4].

4 Correlation between fish stop and chloride ions:

The chloride ion is one of the main anions in water. It is usually associated with sodium. In addition, an excessive concentration of chloride ion increases the corrosion rate of metals. A high level of chloride ion can give an unpleasant salty taste[9].In our study a positive correlation took place between the cessation of fish fishing in the river and the concentration of chloride ions (r=0.705). High concentrations of chloride ions may indicate pollution by sewage, industrial waste, seawater intrusion, in addition the presence of this ion in natural waters is due either to the leaching of rocks and sedimentary soils, or to the disinfection of domestic water[10].

5 Correlation between the cessation of fish harvesting and Cadmium

The direct discharge of fertilizers and industrial effluents into water bodies results in the contamination of the ecosystem with heavy metals. These compounds are considered dangerous for the ecosystem and human health because they tend to accumulate in the environment[2]. A positive correlation occurred between the cessation of fish fishing in the river and the concentration

of Cadmium (r=0.53). The main source of exposure is the ingestion of food of aquatic origin. In addition, cadmium is transported through the blood by binding to hemoglobin in red blood cells. Cadmium is then accumulated mainly in the kidneys and liver. Excretion is a very slow process[10].

6 Correlation between artesian well drilling in the basin and ammonium concentration in the river

A positive correlation took place between the digging of artesian wells in the Al-Ostuan basin, with the concentration of ammonium (r=0.58) in the river. The high values of ammonium in the water could be due to the discharge of domestic waste and sewage. In addition to the high concentrations of NH_4^+ indicates the presence of NH_4Cl of anthropogenic origin, and other NH_4NO_3 of agricultural origin (chemical fertilizers).

Conclusion and perspectives

Currently, collective and non-collective sanitation are almost absent in the Ustuan watershed located in Akkar in Northern Lebanon. The settlements in this catchment area do not have wastewater treatment plants despite the fact that there are sewage networks in most of the neighborhoods and wastewater is discharged either into septic tanks or directly into the river without any prior treatment. Approximately 1079 inhabitants/km2 live in the catchment area of the Al-Ostuan River. Industrial activities are limited to small industries (poultry and livestock farms, cheese and dairy factories, repair shops, various factories, etc.) Agriculture is the largest consumer of water in this area. Agricultural activity is dominated by fruit trees at high altitudes. The use of fertilizers rich in nitrogen and pesticides is important. In addition to poor water management, solid waste dumps are scattered throughout the area, especially along rivers in inaccessible areas, with no consideration for environmental impacts.

This study conducted in this area loaded with environmental pollution problems was specifically based on data collection from areas along the river.

The investigations carried out have shown a lack of information among the inhabitants concerning the actions leading to this huge form of pollution of the river, in addition this pollution has well affected the agricultural activities, the fishing activities and the tourist quality of the region. In addition, conflicts concerning water policy are starting to emerge in some neighboring villages.

More than one third of the villages discharge their sewage directly into the water environment, and dispose of solid waste on the banks of the river. About three quarters of the villages or farmers use groundwater in irrigation, while one quarter use Ostuan water. In addition, almost all the cafes and restaurants along the river divert wastewater to the Al-Ostuan River. This pollution of the river has led to 20% of the villages in the basin having non-active land and consequently increased rainfed cultivation. Also this pollution of the river has greatly decreased the fishing activity, and increased the respiratory and skin diseases.

According to this study 80% of the villages and towns in Al-Ostuan are ready to join an environmental organization to protect the river from pollution sources and prevent any encroachment on it and they are ready to participate in a campaign to clean the river and support it according to the capacity of each municipality.

All these results allow us to conclude that the situation in this watershed is serious and it is absolutely necessary to continue the research and treatment of water and waste.

As perspectives we can propose:

- Find solutions for the treatment of wastewater before it reaches the aquifer and soil, and the use of treated water in the irrigation of agricultural land.
- Conduct analysis and monitoring of drinking water and groundwater through biological and chemical analysis in special laboratories to ensure water quality and non-contamination.
- Valorize industrial waste by recycling it and not throwing it down the drain and polluting the groundwater.
- Train the inhabitants to preserve clean water sources from pollution and not to pollute them with solid waste or sewage, etc.
- Water resources such as rivers, springs and lakes must be monitored and managed by the government.
- To organize days and seminars at the municipal level to inform and train the public on environmental and aquatic problems.
- Use media, social media, and advertisements to educate residents about the importance of saving water and the aquatic ecosystem.
- Strengthening the actions of the environmental program in primary education
- Develop tourism through the extension of green spaces, which will limit desertification and improve the natural landscape.
- The conservation of the river's water quality provides a better source for the domestic water needs of the local people and preserves the quality of crops and groundwater in the Akkar region in order to increase the economic income of farmers. In addition, it encourages ecotourism activities around the river, which represents an employment opportunity for the unemployed youth of the villages. The preservation of the river prevents many bacterial diseases.
- Link all the local authorities of the villages around the river to make a global solution plan and take advantage of the experience and capacities of each (Union).
- Analysis of pesticides in water and sediment in all river courses.

- Analysis of heavy metals in sediments in all river courses.

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Annexes

1- التأثيرالمائي:

اسم المنطقة:

ما هي نسبة إعتمادكم على مياه نهر الإسطوان المعدة للاستعمالات المنزلية؟
[0%-20%] [20%-40%] [40%-60%] [60%-80%] [80%-100%]
ما هي نسبة استهلاك النازحين السوريين لمياه الإسطوان من نسبة استهلاك الإجمالية للسكان؟

[0%-20%] [20%-40%] [40%-60%] [60%-80%] [80%-100%]
هل أدى تلوث النهر إلى توجه الناس لجر مياه الينابيع التي تغذي النهر او حفرآبار ارتوازية

كلا

نعم

عدد الينابيع التي سحبت؟

عدد الابار الجديدة؟

هل يوجد شبكة مياه شفة تابعة للدولة في المنطقة؟ نعم كلا

هل تخصص الدولة مبلغ من ميزانية هذه الشبكة لمعالجة المياه المبتذلة؟ نعم كلا

2 – التأثير البيئي:

1- ما هي نسبة تغطية شبكة الصرف الصحي من البلدة ؟

0% [1%- 30%] [30%-60%] [60%-100%]

2- كيف تتخلص الأحياء الغير الموصولة بشبكة الصرف من المياه المبتذلة؟

- جورطبيعية
- جور صناعية
- مجاري المياه
- شفط الجور مباشرة إلى النهر

3- هل شبكة مياه الصرف الصحي موصولة بمحطة لمعالجة المياه المبتذلة؟ نعم كلا

4- إذا كان الجواب نعم ما هي نسبة معالجة المياه المبتذلة؟

[0%-20%] [20%-40%] [40%-60%] [60%-80%] [80%-100%]

5- هل هناك عيون ملوثة تغذي النهر ؟

كلا

2-1

4-2

6-4

6- هل يوجد مطمر للنفايات أو نقطة تجميع للنفايات قريبة من النهر؟ نعم كلا

7- إذا كان الجواب نعم ما هي المسافة التي يبعد المطمر أو نقطة تجمع النفايات عن النهر؟

8- كم تبلغ نسبة السكان التي ترمي النفايات على ضفاف النهر؟

9-

10- ما هي الأسباب التي تدفع السكان إلى رمي النفايات في النهر؟

- قلة الوعي البيئي
- عدم الإنتظام بجمع النفايات من قبل الجهة التي تجمع النفايات
- باعتبار أن هذه النفايات غير خطرة

11- كيف تبدو رائحة النهر ؟

	خفيفة	متوسطة	قوية	قوية جدا
الشتاء				
الصيف				

12- كيف يبدو لون مياه النهر ؟

	أزرق	رمادي	رمادي داكن	أسود
الشتاء				
الصيف				

13- منذ متى تعتبرون هذا النهر ملوث؟

4 – التأثيرالزراعي:

14- كم تمثل الأراضي الزراعية من المساحة الإجمالية للبلدة؟

15- ما هو مصدر مياه ري المزروعات؟

- آبار ارتوازية

- ينابيع وبرك اصطناعية
- نهر الإسطوان
- مصادر أخرى

16- كم تبلغ مساحة الأراضي الزراعية التي تروى من مياه الإسطوان؟

5- التأثير الإقتصادي والسياحي:

17- ما هوعدد المنشآت السياحية (مطاعم ومسابح) الموجودة على ضفاف الإسطوان؟

18- كم تشكل الأنشطة الإقتصادية والسياحية المبنية على ضفاف الإسطوان نسبة من النشاط الإقتصادي للمنطقة؟

19- كيف تتخلص هذه المنتزهات من المياه المبتذلة؟

- ربطها بشبكة الصرف صحي
- تحويلها إلى مجاري الاسطوان

20- كيف تتخلص هذه المنشآت من النفèايات الصلبة؟

- الطمر
- الحرق
- الفرز
- الرمي العشوائي

21- أي من هذه المنشآت الإقتصادية متواجدة في البلدة وخصوصا على ضفاف النهر:

	نعم	كلا	عددها	على ضفاف النهر
مصانع أجبان وألبان				
محلات ميكانيك ومغاسل وحدادة السيارات				
مزارع للدواجن والمواشي				
معاصر للزيتون				
اخرى				

22- كيف يتم التخلص من النفايات التي تنتج عن هذه المنشآت الإقتصادية؟

	موصولة بالصرف الصحي	موصولة بالقنوات الطبيعية	موصولة بنهر الإسطوان	نظام معالجة مستقل
مصانع أجبان وألبان				
محلات ميكانيك ومغاسل وحدادة السيارات				
مزارع للدواجن والمواشي				
معاصر للزيتون				
اخرى				

23- هل تصطادون الأسماك من النهر؟ نعم كلا

24- إذا كان الجواب كلا هل لتلوث نهر الإسطوان سبب في توقف ممارسة الصيد من النهر؟

25- هل لتلوث النهرسبب في تراجع أو تزايد او انقراض للأسماك الموجودة في نهر الإسطوان؟ نعم كلا

26- هل يوجد مزارع اصطناعية لتربية الأسماك على ضفاف الإسطوان؟ نعم كلا

27- كم تبلغ نسبة تراجع الأراضي الزراعية النشطة نتيجة تلوث نهر الإسطوان؟

[0%-20%] [20%-40%] [40%-60%] [60%-80%] [80%-100%]

28- كم تبلغ نسبة زيادة المزروعات البعلية على حساب المزروعات المروية نتيجة تلوث الإسطوان؟

[0%-20%] [20%-40%] [40%-60%] [60%-80%] [80%-100%]

29- كم تبلغ نسبة اليد العاملة من أهالي المنطقة في هذه المنشآت الإقتصادية والسياحية؟

[0%-20%] [20%-40%] [40%-60%] [60%-80%] [80%-100%]

30- هل أدى تراكم النفايات والردميات في النهر إلى فيضانه وإلحاق ضرر بالأراضي الزراعية والسكنية؟ نعم كلا

31- إذا كان الجواب نعم ما هي نسبة الأراضي المتضررة من هذا الفيضان؟

6- التأثير الصحي:

32- هل تسببت رائحة النهر بمشاكل تنفسية لسكان المنطقة؟
كلا
نعم -عدد هذه الحالات

33- هل سجلت حالات تسمم لسكان المنطقة جراء تناولهم الخضار والفاكهة المروية بمياه الإسطوان؟
كلا
نعم -عدد هذه الحالات

34- هل تم تسجيل اصابات بأمراض جلدية بعد سباحة السكان في نهر الإسطوان؟
كلا
نعم -عدد هذه الحالات

7-التفاعل الإجتماعي:

35- هل قمتم كبلدية بوضع مخطط للحد من تلوث النهر؟ نعم كلا

36- هل قمتم بوضعه بالتنسيق مع البلدات المجاورة أو منفردين؟

37- ما هو عدد البلديات التي شاركت معكم في إعداد هذا المخطط؟

38- ما هي نسبة نجاح هذا المخطط؟
[0%-20%] [20%-40%] [40%-60%] [60%-80%] [80%-100%]

39- ما هي العوائق التي واجهتكم خلال تنفيذ مخطط الحل ؟

40- هل أتخذتم كبلديات اجراءات قانونية بحق الأشخاص الذين مارسوا تعديات (رمي نفايات في النهر، ردميات، زبار الزيتون، زيوت السيارات...) على النهر؟
نعم كلا

41- إذا كان الجواب نعم ما هي الإجراءات المتخذة؟

42- هل هناك مخطط لإنشاء سد على نهر الإسطوان؟ نعم كلا

43- إذا كان الجواب نعم ما هي المنطقة الجغرافية المقترحة لإنشاء سد الإسطوان فيها؟

44- هل يوجد مساحة جغرافية بحدود 1000متر مكعب وتبعد 100 متر عن التجمعات السكنية يمكن بناء محطة تكرير عليها في المنطقة؟ نعم كلا

45- هل بإستطاعة البلدية أن تخصص جزء من ميزانيتها للمساهمة بتأمين الكلفة التشغيلية لمحطة معالجة الصرف الصحي ؟ نعم كلا

46- هل أنتم مستعدون لمعالجة المياه المبتذلة للمناطق المجاورة في حال وجود محطة التكرير أو في حال إنشائها؟ نعم كلا

47- بالنسبة للمناطق المجاورة هل يوجد تعدي بين هذه المناطق على نهرالإسطوان؟ كلا

نعم:

رمي نفايات منزلية

رمي مخلفات البناء والصناعة والزراعة

رمي حيوانات نافقة (دجاج طيور)

رمي مخلفات أخرى

48- بالنسبة للمناطق المجاورة هل يوجد تعدي بين هذه المناطق على مياه نهر الإسطوان؟ نعم كلا

49- نتيجة هذا التعديات هل سجلت حالات نزاع بين المناطق؟ نعم كلا

50- هل لديكم استعداد للإنضمام لهيئة بيئية لحماية النهر من مصادر التلوث ومنع التعدي عليه ؟ نعم كلا

51- هل لديكم استعداد للمشاركة بحملة لتنظيف النهر ودعمها؟ نعم كلا

Annexes

***Table 21**: Characteristics of the samples[11]*

Numéro d'échantillon	Localisation	Altitude en m	Longitude	Latitude
S1	Akkar al Atika-source	1350	36.233E	34.502 N
S2	Akkar al Atika- le pont d'Antaya	684	36.236 E	34.525 N
S3	Akkar al Atika- le quartier de Mrahat	550	36.238 E	34.543 N
S4	Kobayat	486	36.260 E	34.575 N
S5	Seindianet Zeidan	469	36.246 E	34.574 N
S6	Al-Rihanie	108	36.108 E	34.582 N
S7	Deir-Janine	252	36.168 E	34.557 N
S8	Al Salsabil	107	36.111 E	34.554 N
S9	Khreibet Al-Jundi	78	36.093 E	34.563 N
S10	Al Koueikhat	73	36.088 E	34.573 N
S11	Tal Abbas Al-Charki	44	36.073 E	34.591 N
S12	Al Hissa	30	36.063 E	34.596 N
S13	Al Massoudie	13	36.051 E	34.603 N
S14	Kneisse	9	36.003 E	34.604 N
S15	Cheikh Znade	0	35.986 E	34.605 N

***Table 22**: Comparison of study areas with Hassan's sample[11]*

Zones d'études	Sites d'échantillonage
Zone 1: Akkar Al Atika, Dawra	S1,S2,S3
Zone 2: El -Koubayet	S4
Zone 3: Baghdadi, Kouachra, Ain el zeit, El Bire, El Daghle, Kherbet Daoud, Kherbet Char, Douair adawiyi, Sindianet Zeidan	S5
Zone 4: Barbara, Deir-Janine, Beino, Mazraat Balde	S7
Zone 5: Al Rihanie, El Tleil, Omar El Beikate, Charbila, Ain Tanta, sfeinite dreibe	S6
Zone 6 :Halba, Al Khraibe, Al Souaisse, Machha, Hayzouk, Daher leycine, Beyt haj, Koucha	S8,S9
Zone 7: Koueikhat, El-Haouchab	S10
Zone 8: Tal Abbas Al-Charki, Tal Abbas Al-Gharbi, El Hissa	S11,S12
Zone 9: Tal kerri, Al Massoudie	S13
Zone 10: Al Kneisse	S14
Zone 11: Cheikh Znade, Al Kleiat	S15

***Table 23**: Results of the physicochemical parameters of the samples[11]*

Numéro du zone	pH	Conductivité en µs/cm	Dureté totale	Alcalinité	Somme des ions (mg/l)
Zone 1	8.426666667	454	15.2	10.33333333	96
Zone 2	8.56	538	19.8	12	124
Zone 3	8.23	828	22.6	16.5	195
Zone 4	8.59	472	13.2	9.5	105
Zone 5	8.53	572	17.6	12.5	119
Zone 6	8.715	592.5	18.45	12.25	125
Zone 7	8.75	568	18	11.5	132
Zone 8	8.535	577.5	19.75	14	137
Zone 9	8.32	654	19.9	13	145
Zone 10	8.56	627	20.2	13	159
Zone 11	8.59	816	21.9	14.5	204

***Table 24**: The contents of dissolved ions in the samples[11]*

Numéro du zone	ion Calcium mg/l	ion Magnesium mg/l	ion potassium mg/l	ion Chlorure mg/l	ion nitrites mg/l	ion Nitrates mg/l	ion Phosphates mg/l	ion ammonium mg/l
Zone 1	56.9	23.26666667	0.456666667	11	0.09	4.7	0.066666667	0.99
Zone 2	63.3	36.4	0.49	21	0.09	3.5	0	<0.01
Zone 3	92.1	29.6	0.01	40.1	0.19	29.6	1	2.52
Zone 4	44.8	22.8	0.95	33.1	0.09	4.3	0.25	0.99
Zone 5	74.5	21.3	0.8	18	0.09	4.7	0.17	<0.01
Zone 6	60.5	33	0.935	19.5	0.09	11.8	0.24	0.235
Zone 7	83.3	17.4	0.9	21	0.09	10.8	0.35	0.09
Zone 8	60.9	37.65	1.175	20.5	0.205	17.65	0.33	0.115
Zone 9	84.9	23.8	1.42	22	0.25	14.8	0.48	0.12
Zone 10	64.1	37.4	1.1	23	0.22	24.5	0.35	0.17
Zone 11	63.3	44.7	1.39	73.2	0.21	22	0.23	0.06

***Table 25**: Results of heavy metal analysis[11]*

Numéro de l'échantillon	plomb ppm	cuivre ppm	zinc ppm	fer ppm	Nickel ppm	cadmium ppm	Manganese ppm
Zone 1	**0**	**0**	**0.038**	**0.048**	**0.071**	**0.071**	**0.001766667**
Zone 2	**0**	**0**	**0.04**	**0.073**	**0.103**	**0.086**	**0.001**
Zone 3	**0**	**0**	**0.056**	**0.188**	**0.181**	**0.057**	**0.0009**
Zone 4	**0**	**0**	**0.046**	**0.111**	**0.123**	**0.086**	**0.0016**
Zone 5	**0**	**0**	**0.053**	**0.13**	**0.142**	**0.043**	**0.0005**
Zone 6	**0**	**0**	**0.052**	**0.064**	**0.1715**	**0.0465**	**0.0007**
Zone 7	**0**	**0**	**0.024**	**0.054**	**0.065**	**0.05**	**0.0005**
Zone 8	**0**	**0**	**0.04**	**0.092**	**0.1325**	**0.064**	**0.00085**
Zone 9	**0**	**0**	**0.06**	**0.073**	**0.221**	**0.057**	**0.0004**
Zone 10	**0**	**0**	**0.046**	**0.111**	**0.142**	**0.086**	**0.0014**
Zone 11	**0**	**0**	**0.04**	**0.092**	**0.123**	**0.071**	**0.0003**

***Table 26**: Results of bacteriological analysis[11]*

Numéro du zone	Coliforms totaux (UFC/100ml)	Coliforme fecaux (UFC/100ml)	Streptocoques fecaux (UFC/100ml)	CF/SF
Zone 1	**82.66666667**	**40**	**73.66666667**	**0.5**
Zone 2	**100**	**20**	**8**	**2.5**
Zone 3	**400**	**200**	**300**	**0.66**
Zone 4	**300**	**100**	**50**	**2**
Zone 5	**200**	**100**	**100**	**1**
Zone 6	**100**	**100**	**85**	**1.21**
Zone 7	**>1000 indénombrables**	**>1000 indénombrables**	**300**	**>3.34**
Zone 8	**>1000 indénombrables**	**>1000 indénombrables**	**350**	**>4**
Zone 9	**700**	**600**	**200**	**3**
Zone 10	**600**	**500**	**100**	**5**
Zone 11	**>1000 indénombrables**	**>1000 indénombrables**	**400**	**>2.5**