

WATER CLASSIFICATION OF EL-BAHR EL-SAGHEIR

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تصنيف مياه البحر الصغير

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خلاصة

يتناول هذا البحث تصنيف مياه البحر الصغير بشرق محافظة الدقهلية أخذاً في الاعتبار الخواص الهامة مثل : درجة الحرارة ، ودرجة التوصيل للكهرباء ، ونسبة الاكسجين الذائب ، والاكسجين العيوى المتص ، والاكسجين الكيميائى المتص ، وشفى الكبريتات واللوسفات ، والامونيا والمواد الصلبة العالقة . وهذا التصنيف تم على الاسس التالية : الإستخدامات العامة للمجرى ، وأولويات هذه الإستخدامات ، ثم التصنيف على اساس الخواص الفعلية للمجرى بإستخدام دليل تلوث النهر ، ولقد إستخدم هذا الدليل لتحديد مستوى جودة المياه وتوزيعها في المناطق المختلفة من المجرى .

ABSTRACT

This paper is based on a study conducted to assess and classify the canal of EL-BAHR EL-SAGHEIR in eastern DAKAHLIA Province , taking into consideration several relevant parameters as : Temperature , electrical conductivity, DO , BOD₅ , COD , SO₄²⁻ , PO₄³⁻ , NH₃ - N , and SS. The classification was performed using: The current general uses of the canal , the priority of uses and existing water quality using an indexing approach (1) , specifically the River Pollution Index (RPI) . The index was used to determine the level of water quality at different regions of the canal .

1 . Introduction :

In order to determine and consequently protect the quality of a body of water for certain beneficial uses, classifying it on the basis of selected relevant parameters is one of the measures normally adopted. Generally , surface waters can be classified according to their existing water quality or their practical beneficial uses , or preferably both , and different water quality standards can be imposed for different bodies of water. In this study classification of EL-BAHR EL-SAGHEIR canal was made first on the basis of its present uses , and then on its existing water quality. Finally the stream was classified according to both its major uses and its existing water quality by means of an indexing approach (1).

2 . Description of Water Course :

EL-BAHR EL-SAGHEIR canal is located in the eastern part of DAKHLIA province (fig. 1) . It is one of the largest water streams in the province with a total length of about 65 Km , an average slope of about 1 : 25000 . Other details concerning its dimensions at different parts are given in Table (1) . The drainage basin of El BAHR EL - SAGHEIR is a flat area of about 602.53 Km² . Along the water stream four big towns are located : DIKERNIS , MENIET EL- NASR , EL - GAMALIA and EL-MANZALA . These towns and their satellite villages communities have a population of = 0.81 million , comprising 23% of the total population of DAKAHLIA province . By 2000 the population is expected to reach 1.06 million. Population density around the water course is not regular . Dense population is found near the big towns , where the water course is going through . Fig (2) , shows the distribution of population density along the stream .

3 . Sampling and Method of analysis :

In this study sampling stations with the time schedule of sampling are included in Table (2). The distances reported are measured from the stream mouth near EL-MANSOURA City , where its water is coming from EL-MANSOURIA Canal.

Analysis of the spot samples from each point were made in the field for the measurements of dissolved oxygen (DO) and temperature . DO and temperature were measured using a digital DO meter fitted with a display for temperature reading (SCHOTT GERÄTE , W.G. , MODEL CG 867) . Other characteristics were measured in the laboratory at the same day of collection , (Faculty of Engineering , Mansoura University) . Electrical conductivity was measured using a digital conductivity meter (AQUA SCIENTIFIC , ENGLAND , model PTI.18) . Ammonia and phosphate were measured colorimetrically using a comparator (Lovibond 2000 comparator , U . S . A .) . Chemical oxygen demand (COD) was determined using dichromate , whereas biochemical oxygen demand (BOD) was determined manometrically using a manometric BOD apparatus (HACH , U . S . A . , model 2173 B) suspended solids were measured gravimetrically. All these measurements were according to the procedure outlined in Standard Methods for Examination of Water and Wastewater (2).

4. Present Uses:

Some of the important uses of EL-BAHR EL-SAGHEIR canal at present are as follows :

4.1 Drinking water : The water course provides a potable water supply . Recently , The province has established small units for water treatment on the banks of EL-BAHR EL-SAGHEIR canal ; to support the main source of drinking water coming from the water treatment plant at BOUSAT, KAREIM EL-DEIN. The capacity of each unit is about 100 m³ /hour . The principal unit operations in these units are given elsewhere (3) . Locations of these units are shown in fig. (1).

4.2 Irrigation : EL-BAHR EL-SAGHEIR is the most important source for agricultural use in eastern DAKAHLIA . It provides 3340 million m³ of irrigation water per year . This quantity of water is utilized for irrigation of 143459 feddans.

4.3 Fishery : Game fishing is a popular activity in different places on the banks of EL-BAHR EL-SAGHEIR during spring and summer seasons . Rice farms are utilized as fish ponds . During the dry season , (in winter from 30 - 40 days) , fishing activity on large scale is observed along the whole length of the water course .

4.4 Industrial water supply : Surface water from EL-BAHR EL-SAGHEIR is utilized for manufacturing and cooling purposes by industrial establishments in the basin area . Locations of these establishments are shown in fig. (1).

4.5 Navigation : Till twenty years ago , EL-BAHR EL-SAGHEIR stream was utilized for navigation on a large scale . sailing boats were utilized for transportation of bricks , sand , cement , agglomerates and lime stone and other goods . Now , due to the existence of excellent and faster highway transportation systems , the use of EL-BAHR EL-SAGHEIR stream for navigation is minimal , if not non-existent.

4.6 Waste-disposal : Few domestic sewage and other waste loads from the villages along the banks of the water course , in addition to tankers loaded with raw sewage , taken from sewage trenches present in some places inside the towns . This occurs specifically near DIKERNS town as observed by the author many times . In addition to solid wastes collected are dumped near the banks of the water course as observed specifically near all the four towns

4.7 Classification based on present uses : From the above discussion , the major uses of EL-BAHR EL-SAGHEIR water course can now be classified according to their priorities by the stream areas as shown in table (3).

5. Existing Water Quality :

For this study , the level of water quality at different regions of the water course and the length of the stream applicable for specific uses were determined using a water quality indices . Specifically , the relatively simple index called the River Pollution Index (R P I) presented by Mc Duffie and Hany [1] . Although only eight pollutant variables are discussed in this paper , more than eight variables can be included in the index depending on the availability of data . The RPI functions applied here are given in Table (4) after Lohani and Maw-Sen [4] . The index is computed as the sum of sub indices times a scaling factor ($10/n$) . Thus :

$$RPI = (10/n) \sum_{i=1}^m I_i$$

Where

- n = number of pollutant variables ,
- I_i = subindex for the i th pollutant variable ,
- $m \leq n$
- RPI = River pollution Index .

The purpose of the scaling factor is to make the index , which has an increasing scale , vary from approximately 100 (" natural " level) to approximately 1000 (" high polluted " levels . However , the index can go below 100 and , theoretically , can approach zero . Thus, the range can be from 0 to above 100 [4].

The stream length of each zone of EL-BAHR EL-SAGHEIR is measured from the stream mouth , taking from EL-MANSOURRIA canal near EL-MANSOURA city , for the purpose of calculating the RPI . The RPI is computed for 25 , 50 , 75 , and 90 percentile values . These percentile values were statistically inferred elsewhere [5] , and are given in Table (5) . The calculated RPI values of each zone based on the different percentiles are given in Table (5) and plotted graphically in fig . (3) .

6. Classification of EL-BAHR EL-SAGHEIR based on existing water quality:

Based on the results of the surveying study given in table (5) , EL-BAHR EL-SAGHEIR canal can be divided into classes with varying levels of COD , BOD₅ ,etc. Appropriate stream standards are recommended for different water usage and are classified according to the priority of use Lohani and Maw-Sen [4] proposed different standards for each class of water . Values of cod for each class are predicted in the empirical relation ($BOD_5 / COD \approx 0.2$) [6] .

The RPIs for the different classes of water . based on eight pollutant variables are calculated via the subindex functions given in Table (4) . The results obtained are given in table (7) .

The observed level of RPI for EL-BAHR EL-SAGHEIR at different zones based on the four quantiles : 25 , 50 , 75 , 90 percentiles is roughly grouped into the last mentioned four classes in Table (6) .

7. Classification Based on Existing Water Quality with best uses specified :

The observed water quality in EL-BAHR EL-SAGHEIR and River Pollution Index indicate that the water quality of each region are different and vary significantly according to the quantile used for calculating RPI values . The best usages of water in order of priority according to the different classes are given in Table (8) (4) .

Investigating Tables (3) , (6) and (8) , it is obvious that the existing water quality could fulfil the requirements of the existing water uses , till the 50 percentile values only . To realize these requirements the class of water must not be less than class B at least with the 90 percentile values. These requirements may be attained easily if the COD values are reduced which is responsible for the very high values of the subindex of the organic refractory matter . This subindex has the preponderance part in the RPI values . The survey of the region illustrates that the important source of high refractory organic matter is coming from the solid waste dumped along the banks of the water course from the towns and villiages near by the water course , in addition to domestic sewage outfall into the stream directly.

8. Conclusion :

As can be seen from fig.(3) and the inevitable usages of EL-BAHR EL-SAGHEIR ; the attainment of the required quality could be achived by rationalization of community behaviors . The entire stream has been divided into four regions , each region has a class depending on the quantile used to express the pollutants . Along the whole stream-excepted the third region - the water stream may realize the requirements based on the 50 percentile values .

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Table (1) : Major Dimensions of El-bahr El-Sagheir *

Parameter	Region			
	I	II	III	IV
Bed width (meter)	22	20	15	8
Side Slope	3:2	3:2	3:2	3:2
Longitudinal Slop	1:25000	1:25000	1:25000	horizontal
High water level (meter)	beginning of region	4.8	3.7	1.45
	end of region	4.03	2.7	1.27
Low water level (meter)	beginning of region	3.7	2.55	1.45
	end of region	2.45	1.55	0.45

* Source : Irrigation Authority in Dakahlia Province (1956).

Table (2) : Location and date of sampling

Sampling point	distance from origin	Location	Date of sampling										
			April (1987)			June			July		Sept. (87)		
			20	26	29	23	26	30	4	7	5	9	
1	origin	EL Bahr El Sagheir	x	x	x	x							
2	2 Km	Meet Nazah					x					x	
3	4	El Redania							x				
4	5	Salmon El-Komash								x			x
5	7	Showra									x		x
6	8	Mahalt El Danana					x					x	
7	11	El Kebab El Kobra	x	x	x	x		x					
8	13	Demoh								x			x
9	15	El Kebab El Soghra					x		x	x	x	x	
10	18	Dekrins			x	x		x		x			x
11	22	Meet El Soudan	x	x			x		x			x	x
12	26	Meniat El Naser			x	x		x		x			x
13	30	Maushat Asem					x		x	x	x	x	x
14	32	Meet Asem						x	x	x			x
15	33	El Mezanja	x	x	x	x	x					x	x
16	38	El Reyad							x				
17	40	El Cordy						x		x			
18	44	Meet Salsyl								x			
19	47	El Kafr El Gedid		x	x	x	x					x	x
20	48	Meet Maraga Salsyl									x		
21	50	El Gamaleia	x		x	x		x				x	x
22	51	Hawes El Gamaleia						x					x
23	53	El Manzala							x				
24	60	Treit El Aasaphra	x	x	x	x							

Table (3) : Existing water uses in EL-BAHR EL-SAGHEIR water course.

Region and distance	Uses of water
(I) 0 - 15 Km	1- Irrigation 2- Potable water supply 3- Waste disposal 4- Fishing
(II) 15 - 30 Km	1- Irrigation 2- Potable water supply 3- Waste disposal 4- Fishing
(III) 30 - 45 Km	1- Potable water supply 2- Irrigation 3- Fishing 4- Waste disposal
(IV) 45 - 60 Km	1- Irrigation 2- Fishing 3- Potable water supply 4- Industrial water supply

Table (4) : Subindex functions for Mc Duffie's Index [1]

Indicator	Functions
Percent oxygen deficit	$I = 100 - X$, $X = DO (\%)$
Biodegradable organic matter	$I = 10 Y$, $Y = BOD (ppm)$
Refractory organic matter	$I = 5 (X - Y)$, $X = COD (ppm)$ $Y = BOD (ppm)$
Average nutrient excess	$I = 5 \left(\frac{X}{0.2} + \frac{Y}{0.1} \right)$, $X = \text{total N (ppm)}$ $Y = \text{total po (ppm)}$
Dissolved salts	$I = 0.25 X$, $X = \text{Specific conductance}$ ($\mu\text{mhos/cm}$)
Temperature (°C)	$I = \frac{X}{6} - 65$, $X = \text{temperature (°C)}$
Non volatile suspended solid	$I = X$, $X = \text{suspended solids}$ (mg/lit)

Table (15) : Percentile values
of the Surveyed Data **

Quantile		Do % satura- tion	BOD 5	CO ₂	NI 3	Cond (μ mhos/ Cm)	Temp (°C)	SS
REGION (I) 0 - 15 Km	X(0.25)	100	0.5	16	0.20	311.5	24.5	12
	X(0.50)	100	0.9	31.7	0.26	318	27.5	14
	X(0.75)	100	1.6	55	0.32	366	28.25	15
	X(0.90)	85	2.3	118.7	0.44	367.4	28.61	16
REGION (II) 15 - 30 Km	X(0.25)	100	0.50	21	0.2	308	27.20	10
	X(0.50)	100	1.50	31	0.26	313	28.4	13
	X(0.75)	96.25	1.80	58.9	0.39	364	28.8	15
	X(0.90)	83	2.50	88	0.43	365	29.5	17
REGION (III) 30 - 45 Km	X(0.25)	100	1.2	26.9	0.2	315	27.8	11
	X(0.50)	100	1.5	45.2	0.24	319	28.5	13
	X(0.75)	98.7	1.8	61.6	0.32	364	29.1	16
	X(0.90)	74.4	2.0	84.6	0.45	367	29.4	18
REGION (IV) 45 - 65 Km	X(0.25)	100	2	20.3	0.27	315	27.0	13
	X(0.50)	100	3	27.9	0.40	354	28.2	14
	X(0.75)	91	4.5	62.8	0.46	391	29.4	16
	X(0.90)	72.2	7	77.7	0.67	1166	30	20

** Phosphate were undected , all the values listed
are in mg/lit , otherwise stated .

Table (6): Classification of El-Bahr El-Sagheir according to existing water quality

Zone and Distance From mouth (km)	R P I	Classification	Condition
I: 0 - 15 Km X (0.25) X (0.50) X (0.75) X (0.90)	266 400 582 1012	A B C D	good fairly good polluted heavily polluted
II: 15 - 30 Km X (0.25) X (0.50) X (0.75) X (0.90)	319 411 587 830	B B C D	fairly good fairly good polluted heavily polluted
III: 30 - 45 Km X (0.25) X (0.50) X (0.75) X (0.90)	373 503 637 823	B C D D	fairly good polluted heavily polluted heavily polluted
IV: 45 - 60 Km X (0.25) X (0.50) X (0.75) X (0.90)	291 421 687 1080	A B D D	good fairly good heavily polluted heavily polluted

Table (7) : River pollution index of different water classification after setting recommended stream standards .

Indicator Class	Percent oxygen deficit	Biodeg- radable organic matter	Average nutrient excess	Dissolved solids	suspended solids	Tempe- rature	Refractory organic matter	RPI
A	10.4	20	22	50	25	65.7	40	291
B	36	30	22	100	30	65.7	60	430
C	61.6	50	22	150	50	65.7	100	624
D	87.2	80	22	250	100	65.7	160	956

Table (8): Best usage of water in order of priority according to water class [4]

Class	A	B	C	D
ORDER OF PRIORITY	1- Potable water supply 2- Irrigation 3- Industrial water supply 4- Fishing 5- Recreation	1- Irrigation 2- Potable water supply 3- Fishing 4- Industrial water supply	1- Industrial water supply (cooling or washing) 2- Wast disp- osal 3- Fishing	1- Waste disp- osal 2- Industrial water supply (Cooling or washing)

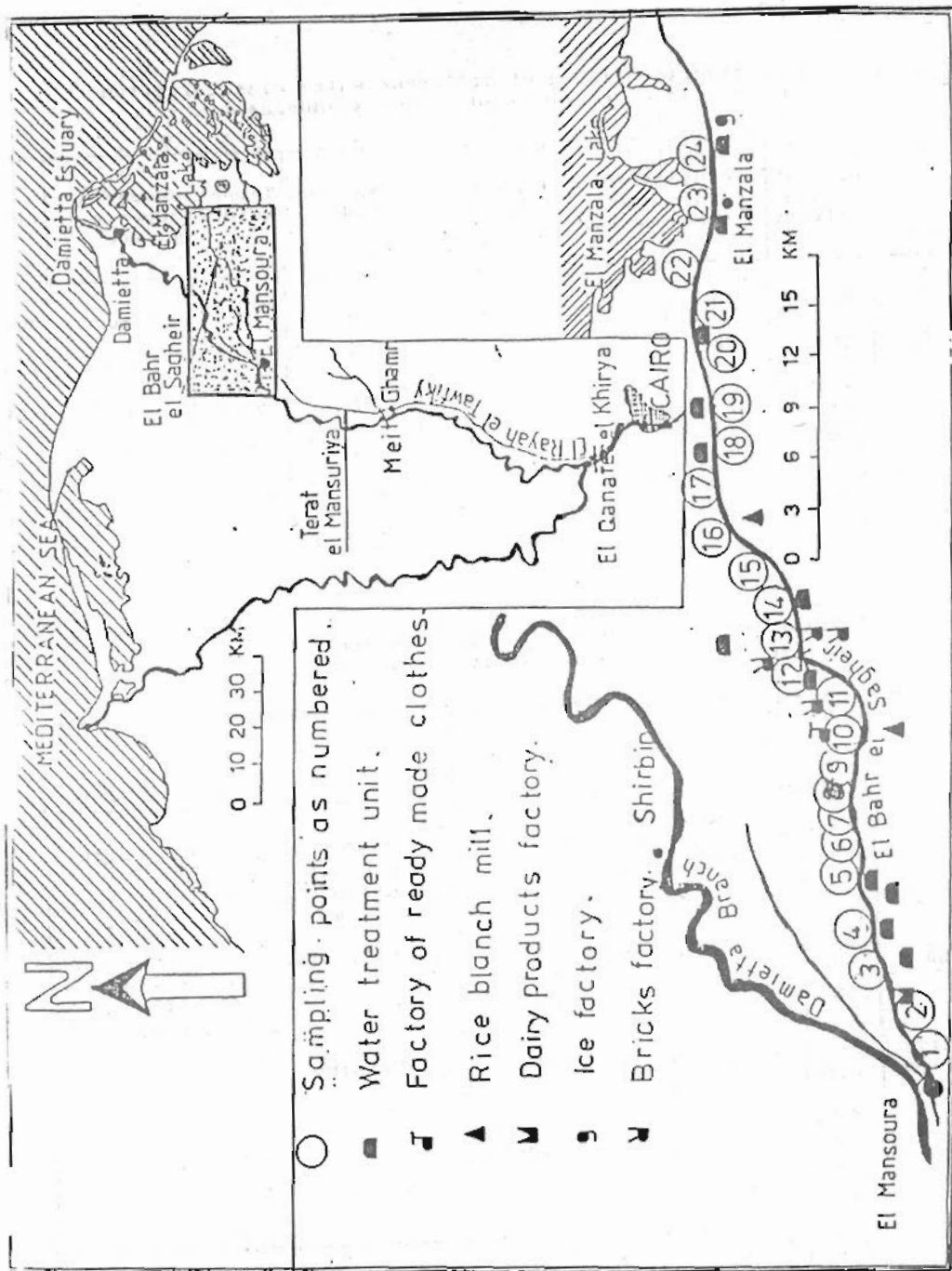


Fig.1 Sampling points and industrial activities along El Bahr el Sagheir.

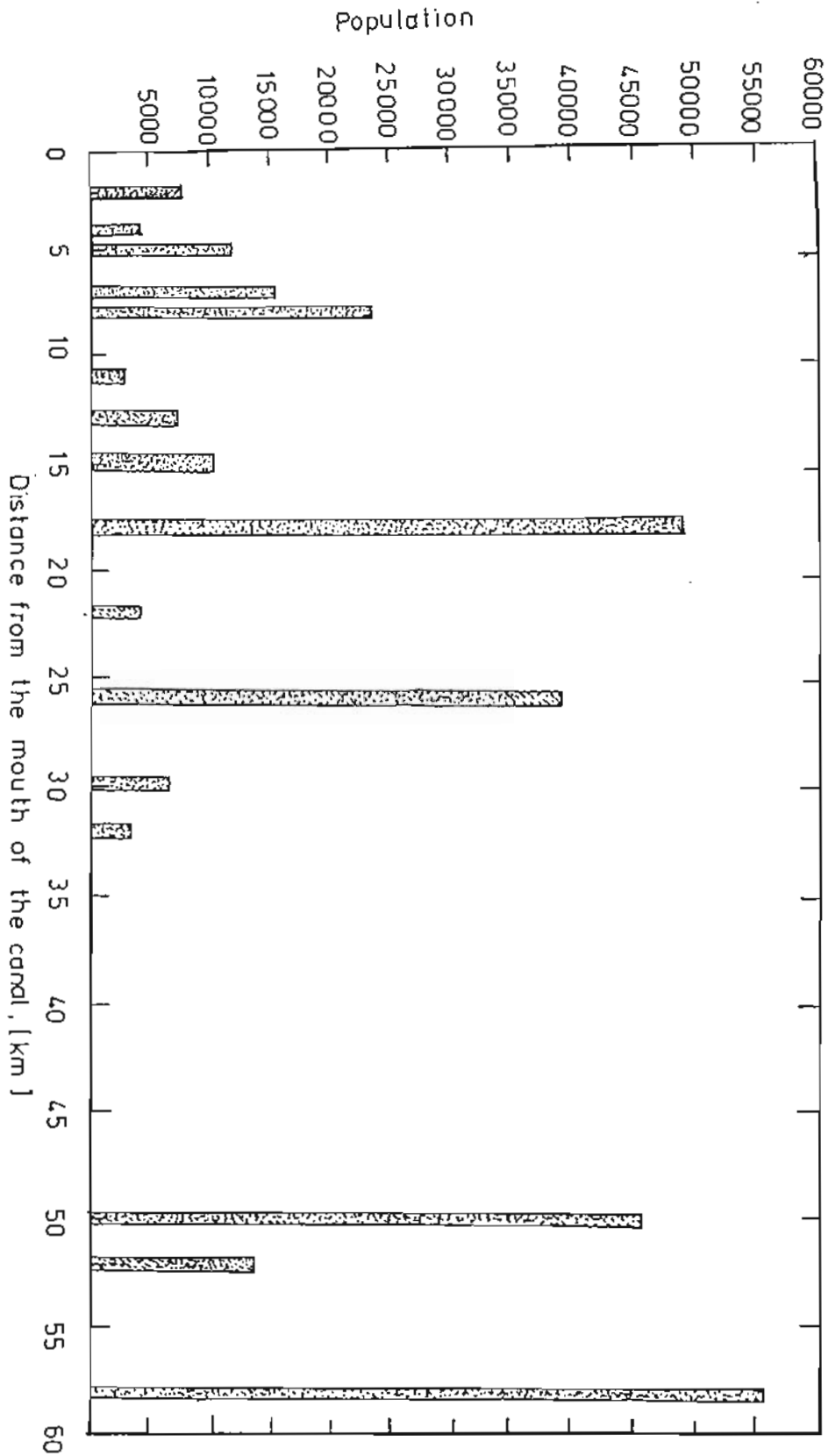


Fig.(2): Population density distribution along El Bahr el Sagheir, (1986).

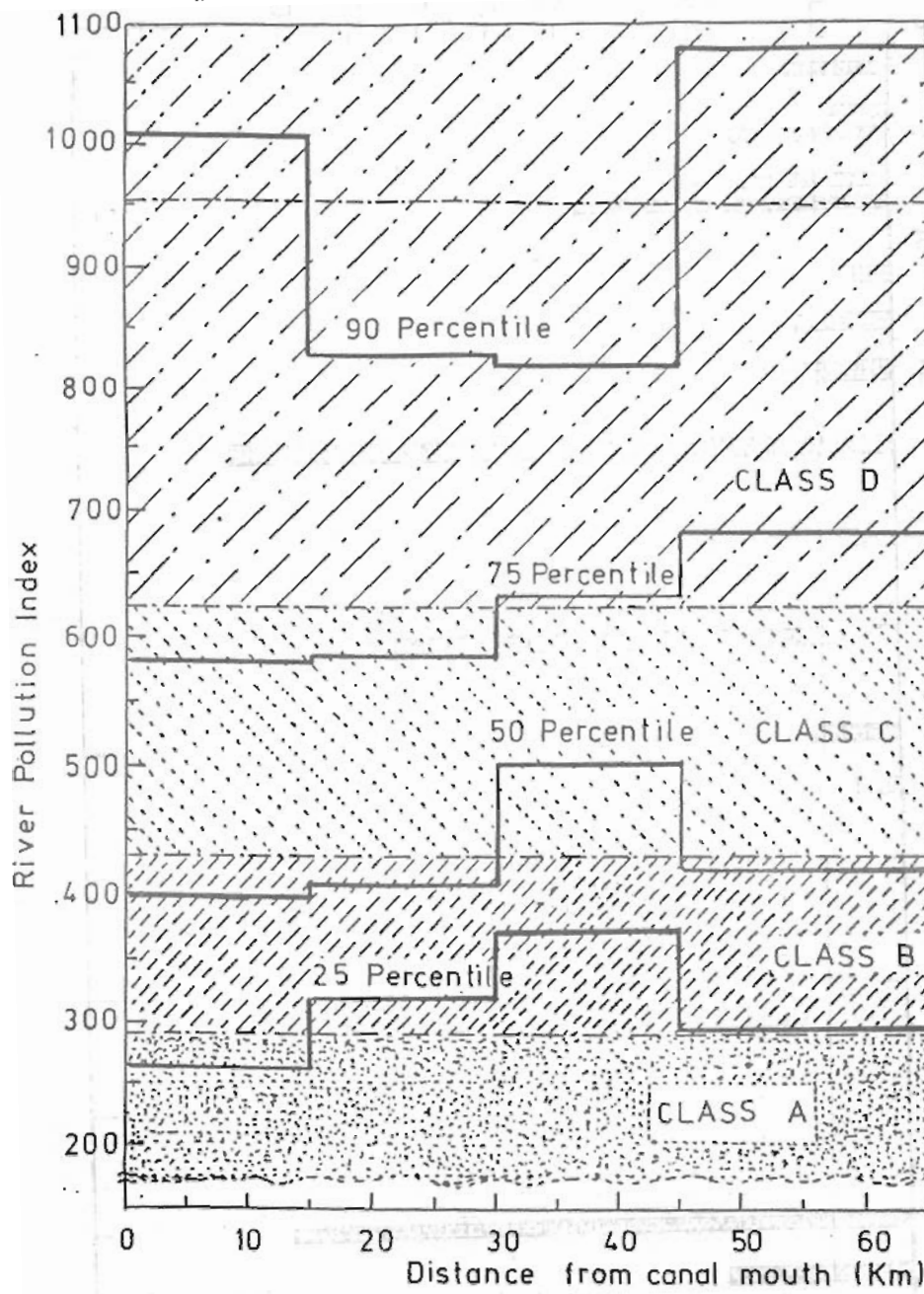


Fig.(3): River Pollution Index for El Bahr el Sagheir at various regions.