Fishery potential of Lakes in Macedonia, North Greece

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FISHERY POTENTIAL OF LAKES IN MACEDONIA, NORTH GREECE

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Abstract: The fishery potential of lakes in Macedonia, North Greece, have been elaborated according to their morphometrical features and to their water quality conditions applying various formulae. Lakes Zazari, Doirani, Kastoria, Ioannina and Koronia show high productivity indices and satisfactory conditions for their annual fish yield improvement. Lakes Volvi, Vistonis, Petron and Chimaditis appeared medium productivity indices, while lower indices were calculated for the lakes Vegoritis and Megali Prespa. Most of the studied lakes seemed to have a rather high fishery potential but the optimum productivity yield could be reached if some basic logistic obstacles and environmental alterations withdrawn.

Introduction

The morphometrical features, the geology of catchment areas and the length of the productive period seem to be favourable for most of Greek inland water fishery [1]. On the contrary enviromental alterations, institutional constrains as well as local peculiarities, pose a negative factor for fishery development in the lakes [2]. Greece is now facing the increasing competition and conflicts between water uses and thefore assessment of inland water fishery is of considerable economic, social and ecological importance to Greece and will become more so.

Material and Methods

Simple and multiple regression was used in the present study for the result presentation, because logistic as well other local factors are interfering giving inaccurate results of the maximum fishery production capacity of each lake. The regression was based on the following indices:

- the calculated productivity index and the relative factor of the food chain length and fishing effort [3],
- the mean depth (Z, in m) and the annual theroetical forecast of the fishery production (P, in kg/ha): $\log 10\ (P - 0.5) = 1.4806 - 0.7029[\log 10\ (Z)]$ [4]
- the morphoedaphic index (MEI) and the annual theoretical fishery production (P, in kg/ha):

$$p = 0.966 \sqrt{(MEI)} \quad [5]$$

Additionally, the theoretical fishery production which can be achieved according Oglesby's formula [6] as well as the productivity index of each lake (YPI), were calculated:

$$YPI = -0.236 + 2.26\ 10\text{-}4(105/area) - 0.643[\log 10(Z)] + 0.196\log(Alkalinity) \quad [7]$$

With all the above calculations and indices evaluation, the fishery production dynamic efficiency of each lake can be estimated. The raw data of the period 1960-1987 were kept and updated from local officials and fishing organizations. Lake's morphometry and other relevant data were obtained from area maps (Scale 1:50.000) as well as field studies [1].

Results and Discussion

The classification of the lakes according to their morphoedaphic data and their fishery production is presented in Fig. 1. Interpreting the position of the lakes during the period 1960-1970 and 1971-

1987, can be pointed out the following:
- only the lakes named Petron and Megali Prespa have improved their yield at about 50% and 20% respectively during the recent years while, the rest of the lakes showed a decrease in their yield ranging from 6% (lake Chimaditis) to 60% (lake Vistonis).

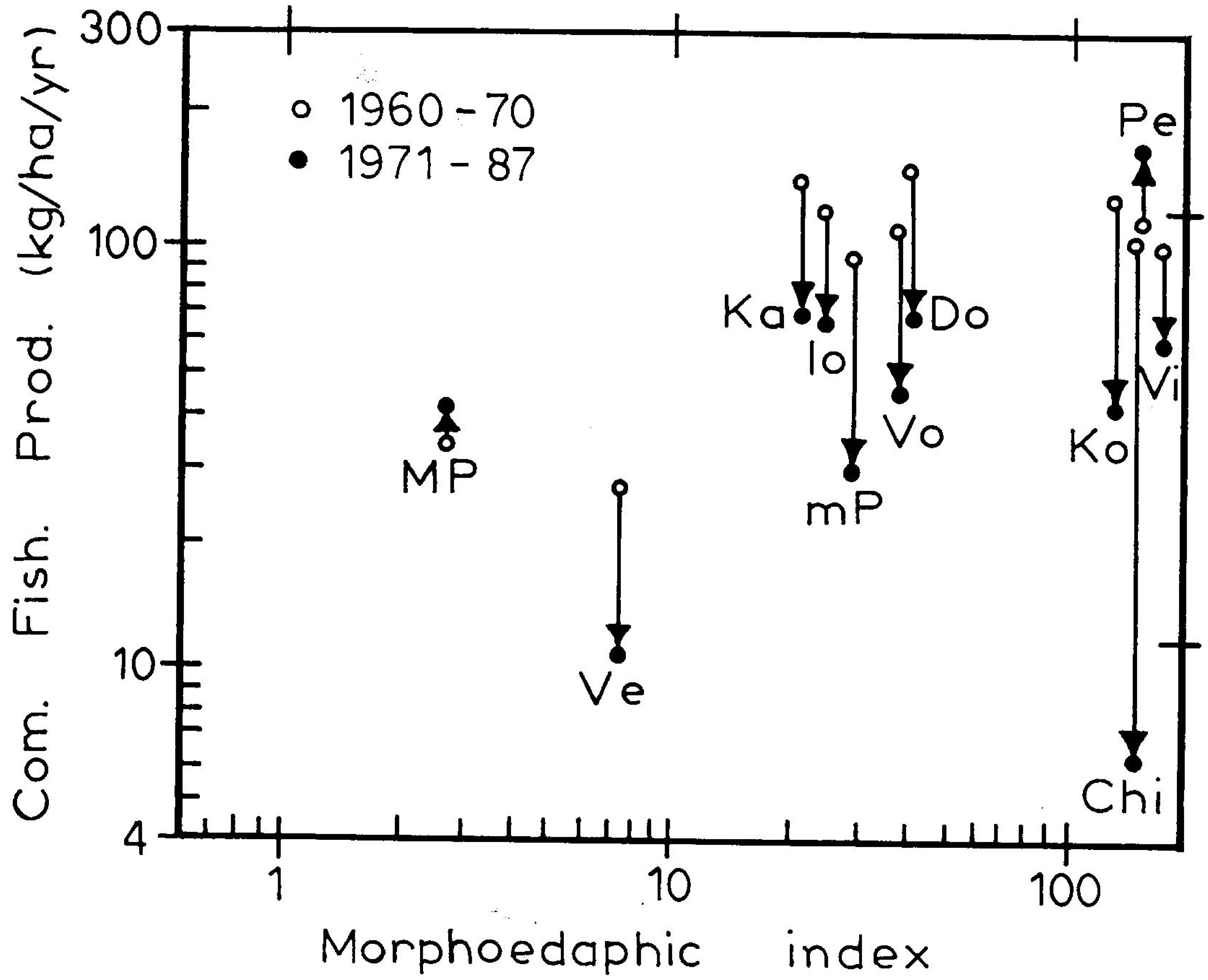

Figure 1. Illustration of the fishery production shift in the examined lakes according to the catch data of the periods 1960-1970 and 1971-1987 as affected by the morphoedaphic index (MEI). MP-Megali Prespa, mP-Mikri Prespa, Ve-Vegoritis, Ka-Kastoria, Do-Doirani, Vo-Volvi, Ko-Koronia, Pe-Petron, Vi-Vistonis, Chi-Chimaditis, Io-Ioannina.

According to the fishery potential point of view and morphoedaphic index previously described [6], the studied lakes have shown the following (Table 1):
- Lake Vegoritis is exploited less or more but close to its theoretical capacity. Its actual annual efficiency is around 20 Kg/ha, while its calculated mean annual fishery production is 56 Kg/ha according to productivity index, 39 Kg/ha according to lake's mean depth and 22 Kg/ha in relation to the morphoedaphic index.
- The lakes Koronia and Mikri Prespa seem to be exploited sufficiently, while during several periods overfished as stated in recent paper [8]. These two lakes appeared mean annual fishery efficiency 83 Kg/ha (lake Koronia) and 61 Kg/ha (lake Mikri Prespa). Meanwhile, the calculated production for lake Koronia is 224 Kg/ha, the productivity index 46 Kg/l and according to lake's mean depth 46 Kg/ha.
- Lake Petron can improve it's yield at least 2 times, while lake Chimaditis up to 6 times considering the observed fishery production and the calculated indices of productivity, mean depth and its morphoedaphic features.

The above, of course, are credible as long as the raw data that were collected are sufficient statistically for each lake and that fishery production is not affected by other man-held factors. According to the fisheries statistics for each lake (Table 2) for the period 1960-1970, the lakes Zazari, Doirani, Kastoria, Ioannina and Koronia have shown high productivity index, the lakes Volvi, Vistonis, Petron, Chimaditis and Mikri Prespa medium productivity index while the lower was estimated for the lakes Vegoritis and Megali Prespa.

Table 1. The calculated productivity index (YPI) for the major North Greek lakes according to the Hayes and Anthony equation [7], the relationship between observed and calculated productivity index (PI/YPI), the mean annual fishery production (MAFP, in kg/ha) according the YPI, mean depth (Z, m) and morphoedaphic index (MEI) and the observed mean annual productivity (MAP) for the period 1960-1987

LAKES	YPI	PI/YPI	MAFP			MAP
			YPI	Z	MEI	
Volvi	0.7	0.71	98	41	75	73
Koronia	1.6	0.37	224	46	123	83
Doirani	1.1	0.72	154	45	49	111
Vegoritis	0.4	0.25	56	39	22	20
Kastoria	1.1	0.72	154	45	58	108
m.Prespa	1.1	0.36	154	46	65	61
M.Prespa	0.4	0.75	56	40	26	38
Vistonis	1.5	0.40	210	48	198	78
Ioannina	0.9	0.77	126	45	59	97
Petron	1.1	0.81	154	48	156	121
Chimaditis	1.6	0.25	224	89	170	51
Zazari	1.4	0.78	196	49	154	150

During the period 1971-1987, the highest index was estimated for lake Petron, medium for Ioannina, Kastoria, Doirani, Vistonis, Zazari, Mikri Prespa while the lowest was calculated for the lakes Megali Prespa, Vegoritis and Chimaditis.

Considering the period 1960-1987 with all data pooled, the highest index was estimated for lakes Zazari, Petron, Kastoria, Doirani and Ioannina while the lowest for lakes Chimaditis, Megali and Mikri Prespa, and Vegoritis. The relevant position of each lake is also presented according to their morphoedaphic features and their water quality parameters (Fig.2.) in the wellknown Ryder's diagram [9]. According to that, the following can be pointed out in order to let the studied lakes obtain their highest possible yield:

- The lakes Koronia, Mikri Prespa, Kastoria and Petron show to be close to the optimum conditions in relation with depth.
- Lake's Chimadidis environment is very close to the optimum nutrient concentration.
- Lake Doirani has morphoedaphic and water quality factors near both optimum depth and nutrient conditions.
- Lake's Volvi position is within the limits of morphometric oligotrophy, but away from optimum depth's and nutrient's conditions.
- Lake Vegoritis is further than the above limits of oligotrophy, but in the optimum level of lake's nutrient.

According the Hayes-Anthony equations [7] with which the fishing prouctivity can be estimated, the raw data from each lake were analyzed and summarized in Table 2. From Table 2 can be seen that the highest productivity index is estimated for the lakes Koronia, Chimaditis, Vistonis and Zazari, medium values for Petron, Mikri Prespa, Kastoria, Doirani, Ioannina and Volvi while the lowest for the lakes Vegoritis and Megali Prespa.

Table 2. Mean annual fishery production (kg/ha) of the major North Greek lakes during 1960-1987 with the observed productivity index (PI) and the Percentage Productivity difference (PD).

	1960-1970		1971-1987		PD	1960-1987	
LAKES	kg/ha	PI	kg/ha	PI	%	kg/ha	PI
Volvi	103	0.7	43	0.3	-41.7	73	0.5
Koronia	127	0.9	39	0.3	-30.7	83	0.6
Doirani	157	1.1	64	0.4	-40.7	111	0.8
Vegoritis	28	0.2	11	0.08	-39.3	20	0.1
Kastoria	150	1.1	65	0.5	-43.3	108	0.8
m.Prespa	92	0.6	29	0.2	-31.5	61	0.4
M.Prespa	34	0.2	41	0.3	+20.6	38	0.3
Vistonis	96	0.7	59	0.4	-61.4	78	0.6
Ioannina	129	0.9	65	0.5	-50.4	97	0.7
Petron	97	0.7	145	1.0	+49.5	121	0.9
Chimaditis	95	0.6	6	0.04	-6.0	51	0.4
Zazari	250	1.8	50	0.3	-20.0	150	1.1

Taking under consideration the relationship PI=MAP/F [3] where PI stands for the observed productivity index and F, the coefficient according the food chain length for each fish species and fishing effort, then the observed productivity index (MAP) combined with the data presented in Table 2 is estimated as follows:
- 1.1-0.7 for lakes Zazari, Petron, Kastoria, Doirani and Ioannina,
- 0.6-0.4 for lakes Vistonis, Koronia, Volvi, Mikri Prespa and Chimaditis and
- 0.3-0.1 for the lakes Vegoritis and Megali Prespa.

From the above and applying the relationship PI/YPI (Table 1), it can be assumed that the differences between the observed and the calculated productivity index can be attributed to ecological stress as well as insuffcent samples. The method of estimating the fishery production of a lake in combination with the mean depth gives low values (Table 1), thus it must be abandoned, while the method of the calculated productivity index gives better and more reliable results (Table 1) and for each lake we have the following:
- the lakes Chimaditis and Koronia yield about 220 kg/ha. The corresponding observed values are 170 and 123 kg/ha respectively,
- lakes Vistonis and Zazari have a theoretical yield of around 200 kg/ha. Lake Vistonis shows a high value of variation as it gives an observed yield of 150 kg/ha,
- lakes Doirani, Kastoria, Mikri Prespa and Petron give theoretical yield of 150 kg/ha. The actual yield of Mikri Prespa, Kastoria and Doirani differs significantly from the calculated one. This discrepancy for Mikri Prespa can be attributed to mass fish mortality and low MEI index.
- lake Ioannina shows a theoretical yield of 120 kg/ha,
- lake Volvi gives a value of 100 kg/ha without significant difference from the actual yield recorded,
- the lakes Vegoritis and Megali Prespa do not show differences from the actual yields.

From these data we can point out the following:
- the lakes Doirani, Kastoria and Mikri Prespa give a difference between theoretical and actual yield of 150 kg/ha. In particular, for Mikri Prespa, the discrepancy can be attributed to the mass mortality observed during past years as well as to environmental pressure as indicated from MEI index.

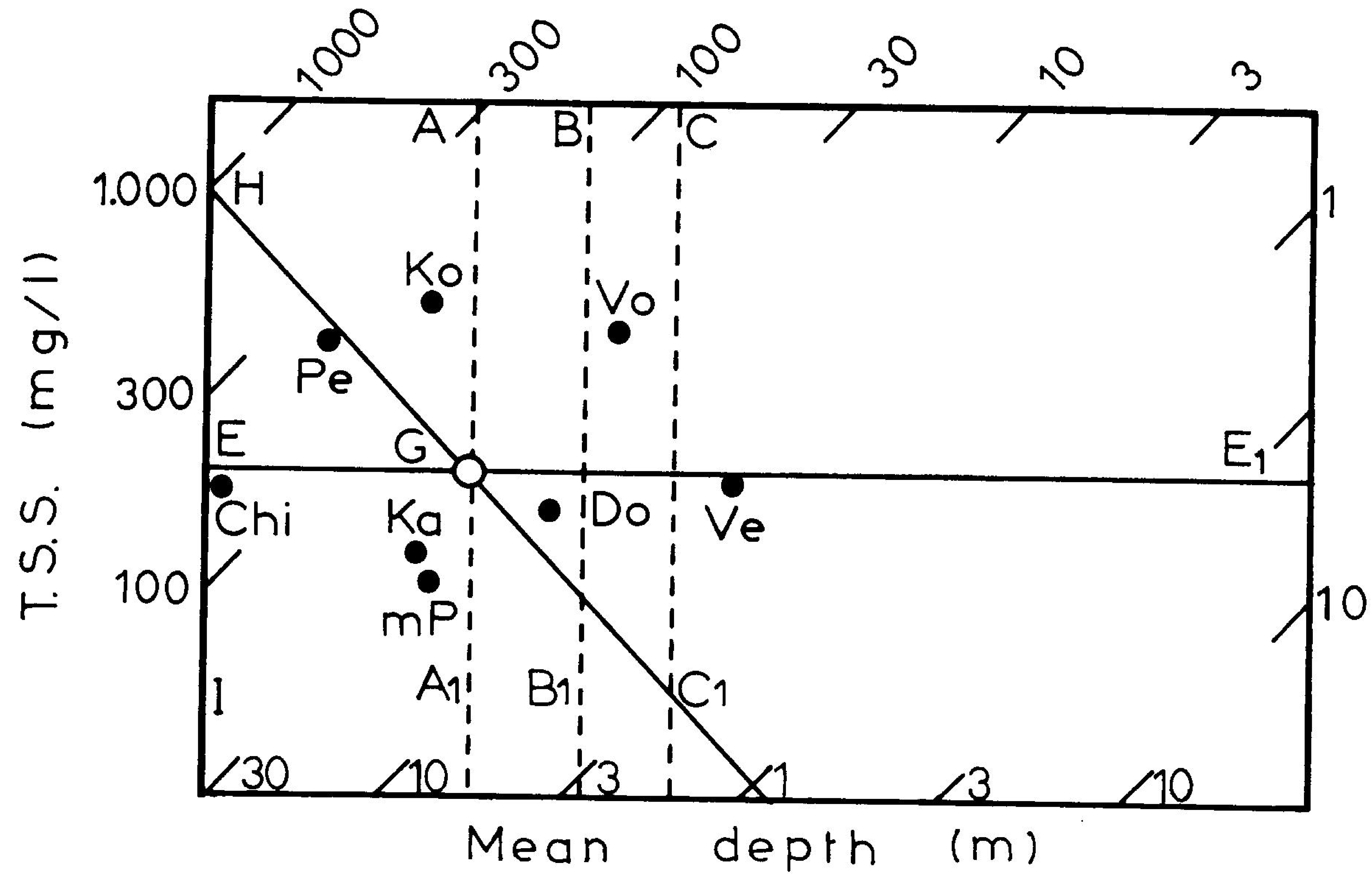

Figure 2. Illustration of the relative position of the lakes in Ryder's diagram [9] and according the dissolved solids (1-1000 mg/l), mean depth (1-1000 m) and morphoedaphic index (1-1000). MP-Megali Prespa, mP-Mikri Prespa, Ve-Vegoritis, Ka-Kastoria, Do-Doirani, Vo-Volvi, Ko-Koronia, Pe-Petron, Vi-Vistonis, Chi-Chimaditis, Io-Ioannina.
G = point of maximum fishery catches
E-E1 = optimum line of nutrient concentration for the maximum fishery yield
A-A1 = optimum depth values
B-B1 = optimum conditions of mean depth
C-C1 = limit of morphometric oligotrophy
F-F1 = minimum limit for osmoregulatory functions
H-H1 = maximum value of morphoedaphic index in accordance with its contribution to the fish productivity.

Also, significant differences are shown for the lakes Kastoria and Doirani.
- lake Ioannina shows a small difference while significant for the MEI index,
- lakes Volvi, Vegoritis and Megali Prespa shows small difference both from the actual yield as well as the MEI index.

In conclusion we have to point out that Macedonias lakes in Northern Greece stand in rather highfishery potential, but their optimum productivity yield is blocked by constitutional constraints, local environmental alterations, commercial overfishing and enrichments with agricultural runoffs or urban untreated wastes.