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ECOLOGICAL ASPECTS OF DATA SERIES COMPUTER ANALYSIS CONCERNING QUANTITIES OF SEA FISH CATCHES IN GREECE BY PRINCIPAL SPECIES AND FISHING AREAS

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Abstract. Data concerning quantities of sea fish catches in Greece by principal species and fishing areas are extracted from database of the National Statistical Service (NSS) in Athens. Data series from 1990 to 2000 are set up and organised in hierarchical structure in Excel tables. An algorithm for the distribution of areas and fish species by groups according to the types of the curves of fish catches is created. After data processing an analysis of the groups is carried out. The analysis of the information concerning the variation of sea fish catches by areas and species gives opportunities for important ecological studies. They are related to phenomena such as decreasing population of some fish species, changes in quantities of fish landed in the regional wharves and inevitable pollution of the environment around them. The main practical issue of this research is of meaning for well-grounded decision-making related to the ecological measures of the fishery projects on regional and national level.

Keywords: algorithm, data series, trend evaluation, fish catches, ecology.

AIMS AND BACKGROUND

The most common aspects of sea fishery scientific publications are in Biology, Ecology, Geography, Management and Economics. The ecological aspects of sea fishery have been discussed over the last decades. The influence of the fish catching to the ecosystems is researched in the works cited in Refs 1-3. The problems of the fish population are investigated as cited in Refs 4-6. Most of the researches of the authors mentioned above as well as othes not mentioned here, are referred to both limited number of fish species (one or several ones) and geographical regions (one region or gulf). Only several researches[7-9] comprise a remarkable exception. In Ref. 7 the authors have used the data from NSS for the period 1964-1989 and in Refs 8 and 9 the author refers to 83 and 61 fish species (respectively) regarding their size, weight and catching tools. An aspect that has

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been slightly researched in Greek sea fishery is the economics. No references concerning trend of sea fish catching in Greece based on existing big amount of data for the recent years has been found. The purposes of the present paper are:

- To structure the information concerning quantities of sea fish catches in Greece by all regions and all species for the time period 1990-2000, reported by National Statistical Service in Athens.
- To create the algorithm for the distribution of the regions and fish species in groups according to the type of the curves of fish catches.
- To analyse the trend characteristics of data series related to ecology.

EXPERIMENTAL

The basic data source for the present work is National Statistical Service (NSS) in Athens. Data on fishing production are collected every month for each fishing vessel separately, through the local customs authorities. For each vessel a statistical questionnaire is answered. Due to the exceptional difficulties involved in the collection of the statistical returns from all fishing vessels, the NSS adopted the sampling method for the process of the collection returns assuming that the latter constitute a random sample of all returns. Thus, the method of stratified random sampling was finally applied. The resulting estimates of totals are considered satisfactory[10].

For the present research the basic data about the 18 regions and 71 fish species for the time period 1990-2000 are used. This data have been extracted from the database of NSS–Athens in a standard TXT-format. User-oriented program for the input, control, saving, generalising, structuring of this data (Fig. 1) on the PC was developed. The fact that the number of the records per year varies between 9000 and 14 500 proves the huge amount of information. Data series are formed regarding fish catching by fish species and regions for the investigated period 1990-2000 and have been saved in hierarchically structured Excel tables following the principle: Month–Year–Data series.

The basic idea of the suggested algorithm is trend evaluation and modelling of quantities of fish catches by statistical approaches for the distribution of fish species and regions by groups according to their curves. The flowchart of the algorithm is presented in Fig. 2.

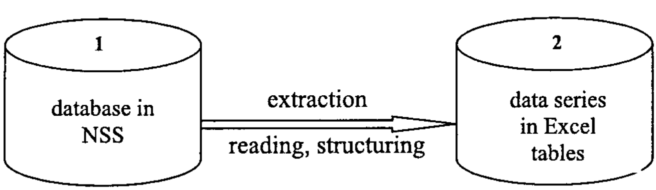

Fig 1. Extraction and organisation of data series

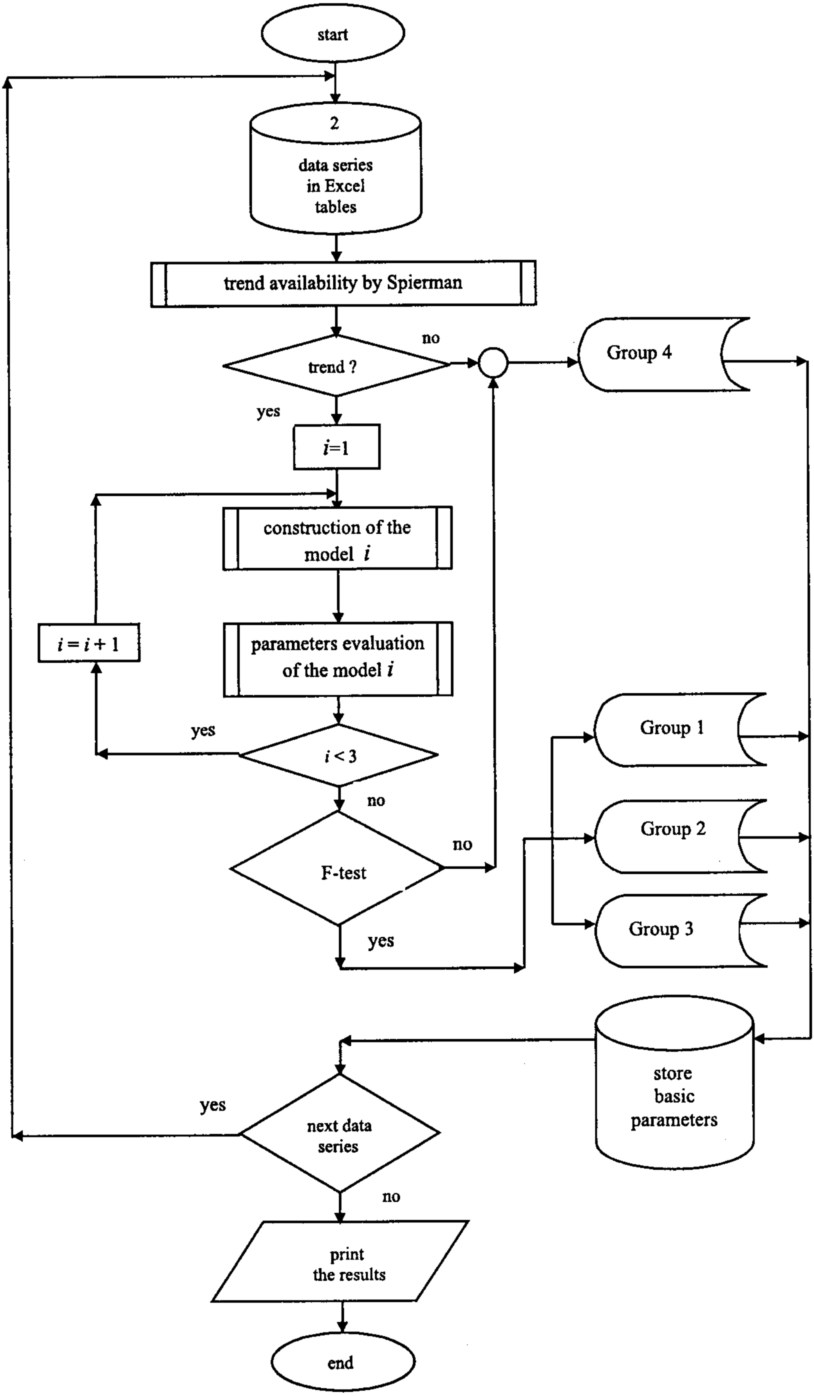

Fig. 2. Flowchart of the algorithm

Algorithm can be described by the next basic steps:

Step 1. Data series is read from the Excel tables.

Step 2. The procedure for the trend availability by the method of Spierman[11,12] is created. In the case of no trend availability, the corresponding data series (region or fish species) are placed in the Group 4.

Step 3. Procedure for the construction of the models is used. This procedure is oriented to the trend modelling. For each data series 3 polynomial models are constructed. The polynomial type of models can cover the characteristic changes in the quantities of fish landed over the researched period of time. Presenting the models through the corresponding curves suggests an easy interpretation of the results.

The groups are defined according to the order of the discussed polynomial models:

Group 1 – Linear model – $Q = A_0 + A_1t$

Group 2 – Polynomial model in order 2 – $Q = A_0 + A_1t + A_2t^2$

Group 3 – Polynomial model in order 3 – $Q = A_0 + A_1t + A_2t^2 + A_3t^3$

where Q – quantity of fish landed by regions or by fish species (metric tons); t – time (years).

Step 4. Procedure for evaluation of the parameters of each model is prepared. The method of the least square means is applied. The standard deviations between real values and corresponding model values are computed. The minimum deviation is used for assigning the data series into the corresponding group.

Step 5. F-test is applied for evaluation of model adequacy. Data series with no model adequacy are assigned to Group 4.

The parameters of the obtained mathematical models and the corresponding graphic charts are saved on files. The user is offered the opportunity to have these formed groups of fish species and regions printed. The present algorithm was applied in the processing of data series either by regions or fish species.

RESULTS AND DISCUSSION

In an overall scale the change in the quantity of fish landed in Greece over the researched period of time is divided into 2 stages – increasing stage from 1990 till 1995 and decreasing one from 1996 till 2000. Naturally all fish species and regions may not have the same trend as the general one. The sense of the practical application of the algorithm described above is to assign fish species and regions having similar trend to the same group.

Regions and fish species with linear trend – Group 1 (Tables 1 and 2) are an exception to the general trend. The feature of the fish species placed in this group, e.g. sole (Fig. 3), black bream, crayfish, warty venus appears as an decreas-

Table 1. Fish regions in the groups

Group	Number of regions in the group	Regions
1	1	gulf of Lakonia
2	4	Atlantic ocean; Thermaikos gulf and gulf of Chalkidiki; islands of Lesvos, Chios Samos and Ikaria; Kriti
3	3	coasts of Kefalonia, Zakynhos and gulf of Patra ; gulf of Korinthia; gulf of Southern and Northern Evia, gulf of Lamia
4	8+1	coasts of Ipiros and Kerkyra; gulf of Kyparissia and gulf of Messinia; gulf of Argolida and Saronikos gulf; Pagassitikos gulf; Eastern coasts of Evia and Sporades islands; Strymonikos gulf, gulf of Kavala-Thassos and sea of Thraki; Dodekanissos; Kyklades + Amvrakikos gulf and coasts of Lefkada island

Table 2. Fish species in the groups

Group	Number of fish species in the group	Most significant species
1	9	sole, black bream, common prawn, shrimp, crayfish, warty venus, etc.
2	6	goatfish, couch's whiting, mackerel, cuttlefish, etc.
3	14	bogue, red bream, red mullet, horse mackerel, common sea bream, gilt sardine, common squid
4	38+4	hake, anchovy, swordfish, pilchard, tune fish, octopus, mussel+ common gray mullet, pickerel, etc.

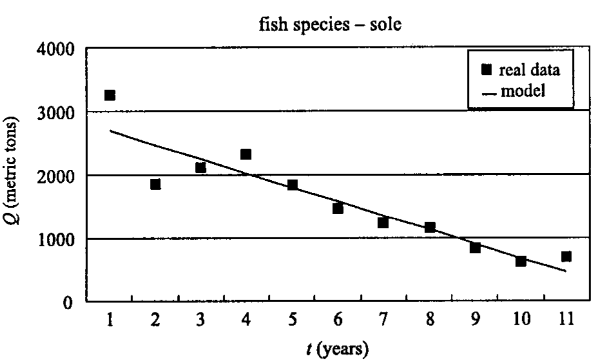

Fig. 3. Linear model for the sole fish species

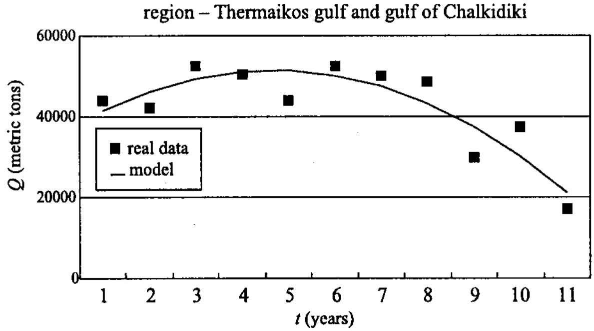

Fig. 4. Second order polynomial model for the region Thermaikos gulf and gulf of Chalkidiki

ing linear trend over the investigated period of 11 years. The contradiction with the general trend from the period 1990-1995 can be explained from the abrupt decrease of the population of this fish as a result of inappropriate climatic or ecological conditions. There is an increasing trend only for common prawn.

The second order polynomial model is appropriate to fit the fish catches by regions and species in the cases of trends close to the general one. Some large fishing regions like Thermaikos gulf and gulf of Chalkidiki (the corresponding curve is presented in Fig. 4) and some fish species with a significant quantity of fish catches like goatfish, mackerel and cuttlefish are assigned to this group.

The greatest number of regions and fish species for which a trend is available is assigned to Group 3. In general, the change in the fish catches is of a more complicated character. In some regions certain stabilisation or fish catch increase is observed (1998-2000). Modifications of such type require the more complicated polynomial model of the third order. Curves of this type can be used to characterise the fish catches in the regions coasts of Kefalonia (Fig. 5), Zakynhos and gulf of Patra and gulf of Korinthia. Increase in fish catches,

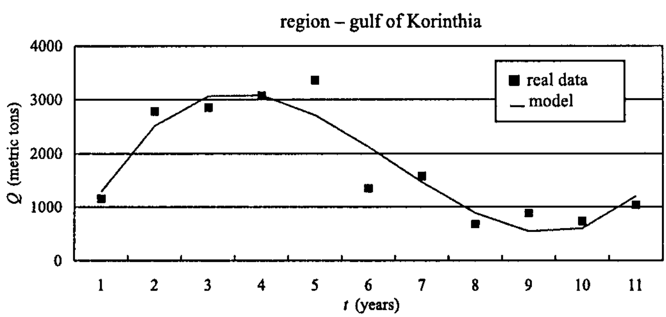

Fig. 5. Third order polynomial model for the region – gulf of Korinthia

though slight, is also observed with some fish species in this group like red bream and common sea bream.

Group 4 covers regions and fish species for which there is lack of trend or no adequate model can be found. The higher value of variation of the quantities of fish catches is the basic statistical feature for the fish species and regions in this group. The existence of a number of factors such as ecological, climatic, socio-economic, etc., affects the quantity of fish landed. These factors can induce different impacts on the fish catches even in two consequent years. They can also interact one another. There should have been indicated the availability of the fish species and fishing areas in this group – 1 region and 4 fish species (Tables 1 and 2) for which there is a trend availability by Spierman but none of the suggested model is adequate. It can be explained by the following two reasons. The first of them is that the corresponding Spierman coefficients of corre-

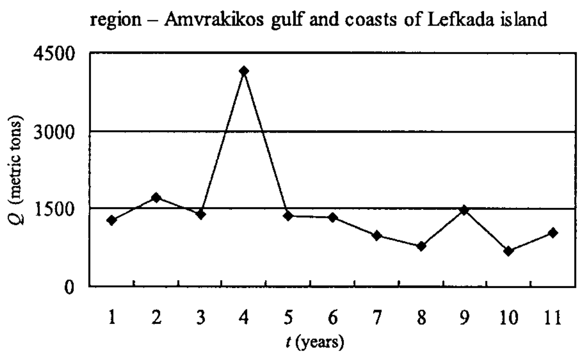

Fig. 6. Fish catches for the region Amvrakikos gulf and coasts of Lefkada island

lation are close to the theoretical value (0.56), while the second one is that these data series have highly expressed pick values for fish catches (Fig. 6).

The obtained results give the opportunity to find out some ecological aspects of fish catches in Greece. The results in the present paper are prerequisite for taking justified decisions with the perspective of applying some ecological measures:

– analysing the factors (part of them on ecological bases), that have a significant impact in the regions where there is not trend availability;

– the large fishing ports in Greece are distributed according to a regional feature. Investigating the trend of fish landings by regions a necessity for the correct distribution of the financial funds for storage, renovation, restoration of ports, creating better labour conditions for the employees in the branch, building new fishing markets under higher hygiene requirements appears;

– artificial breeding of important fish species in order to enrich the regions where the phenomena of decreasing of fish population is obvious. That must be connected with storage of the fishing resources and ecological balance.

CONCLUSIONS

The creation of the algorithm and computer programs in order to save, structure and process the data series have given opportunities for the distribution of fish species and regions by groups according to the types of the curves of fish catches. This approach can be applied to other significant factors concerning sea fishery – value of fish catches by regions and species, employment, etc. This algorithm could be improved in the following directions: using autocorrelation coefficient and wider opportunities for trend modelling including multiple regression analysis.

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