Spatial analysis of potential evapotranspiration in Danube Delta

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Abstract. This article aims to highlight the many features related to the development of potential evapotranspiration space for the Danube Delta. This determination was based on the average monthly values and annual potential evapotranspiration in the period 2000 - 2009 and in the 1961 - 1990 period as a reference method using Thorntwaite. This material is an analysis of seasonal and interannual variability of potential evapotranspiration. The spatial variability of the potential evapotranspiration is presented as a map, using ArcObjects VBA 6.0 development resources, which allow the creation of GIS processes such as: drafting and editing data, navigation, object selection, operations and geoprocessing. Also, we propose a model interannual distribution of values of potential evapotranspiration. The frequency of the distributions of potential steps evapotraspirației values and curves corresponding probability density function. Regarding potential evapotranspiration regime , there is interannual and seasonal features important for the study period considered.

1. Introduction

Currently, there are a number of global environmental changes that occur in the whole Earth system, being a consequence of anthropogenic activity on biotic and abiotic components of the environment. Global climate change are included in these global environmental changes.

Identifying, assessing and managing the impact of climate change on biotic components is extremely important. In this effort, environmental managers will systematically assess the negative impact of climate change on ecosystems and identify the best strategies for adapting them for harm reduction [1,2]. This involves an assessment of the current state of the ecosystem, a realization of scenarios for climate change impact assessment on ecosystems and also to identify the best strategies for adaptation of ecosystems and their mitigation on these scenarios the impact.

Scenarios are expressed through interannual and seasonal variations in temperature, precipitation and evapotranspiration. This is actually the conceptual framework that allows environmental managers to monitor the impact of climate change and adapt existing strategies appropriate changes taking place.

Evapotranspiration represents a main link in the water cycle and the heat exchange factor affecting ecosystems. Potential evapotranspiration is the maximum quantity of water capable of being produced by a soil evaporation and transpiration of plants in a climate [3].

The objectives of this study are to identify the spatial and temporal evolution for the potential evapotranspiration in recent years in the Delta region and establish a model of development for this parameter hydrothermal important

2. Material and method

The area studied is the Danube Delta, which fall in semiarid temperate climate specific area Pontic steppes. Located in the northwestern part of the Black Sea basin, between lat 44º46'00" N, 45º40'00" wide 28º40'24" N and long. E, 29º40'50" long. E. (Fig. 1). Spaces and very large flat water, covered in varying degrees of vegetation, interrupted by fields of marine sandy islands make up the active area of the Delta and adjacent lagoons, quite different from the Pontic steppes [4]. The active surface reacts to the total solar radiation received and the general circulation of the atmosphere, resulting in a mosaic of microclimates.

The specific climate of the Danube Delta is influenced by proximity to the Black Sea and terrain, water and vegetation deltaic area.

Fig. 1. Location of study area

In order to achieve its purpose in this paper were determined intraanuale values and annual potential evapotranspiration (PET) after Thornthwaite's method, both for the period 1961 to 1990, taken as the reference period and the period analyzed from 2000 to 2009 taken as study period [5]. The data analyzed were from three meteorological stations Sulina,Tulcea and Sfantu Gheorghe [6].

The values for potential evapotranspiration (PET) were seasonal and spatial distribution maps constructed multi-annual average for the study area between 2000 - 2009 and 1961 - 1990.

3. Results and discussion

The results are summarized in several important directions the potential evapotranspiration variability characteristics of the delta, the spatial variability of hydrothermal parameter analyzed interannual evolution model for PET.

The analysis performed on the interval 2000 - 2009, there was a significant increase in potential evapotranspiration for the site studied in the range 6,25 ... 10,73 % compared to the reference period 1961-1990 (Fig. 2). There is significant seasonal differences. The winter is an increase of 9,5 ... 145 % of potential evapotranspiration values due to increased winter temperature for the last year analyzed by 20 ... 53,8 % (Fig. 3).

Autumn is characterized by lower growth, in the range 2,5 ... 6,6 %. They are related to the thermal variability of the season, in the sense that the period 2000 - 2009, the temperature rise was only 4.6 % from the average of the reference interval (Fig. 4). For spring and summer seasons, increases ranged from 8 to 11,25 %. It appears that, in the spring season, the increases are higher than in summer (Fig. 3 and Fig.4).

The analysis of the recorded values, there is an increasing trend for different extreme thermal indices. The duration of heat waves rising propensity manifested at both annually and seasonally. The analyzed area is characterized by an increase in the threshold process very hot days with a longer period of the year and a downward trend in the annual values of the cold wave.

To analyze the inter-annual variation in values was performed and frequency distribution of values of potential evapotranspiration values and determined steps distribution that characterizes the best string values for all three stations analyzed in the Danube Delta (Fig. 5).

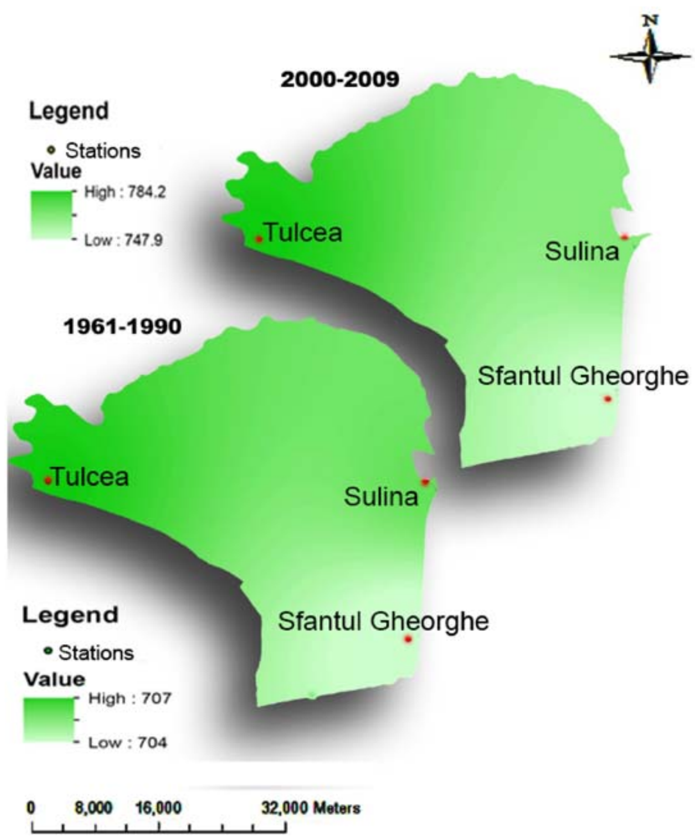

Fig. 2. Spatial distribution of potential evapotranspiration in the Danube Delta for the reference period 1961 - 1990 and for the period 2000 – 2009

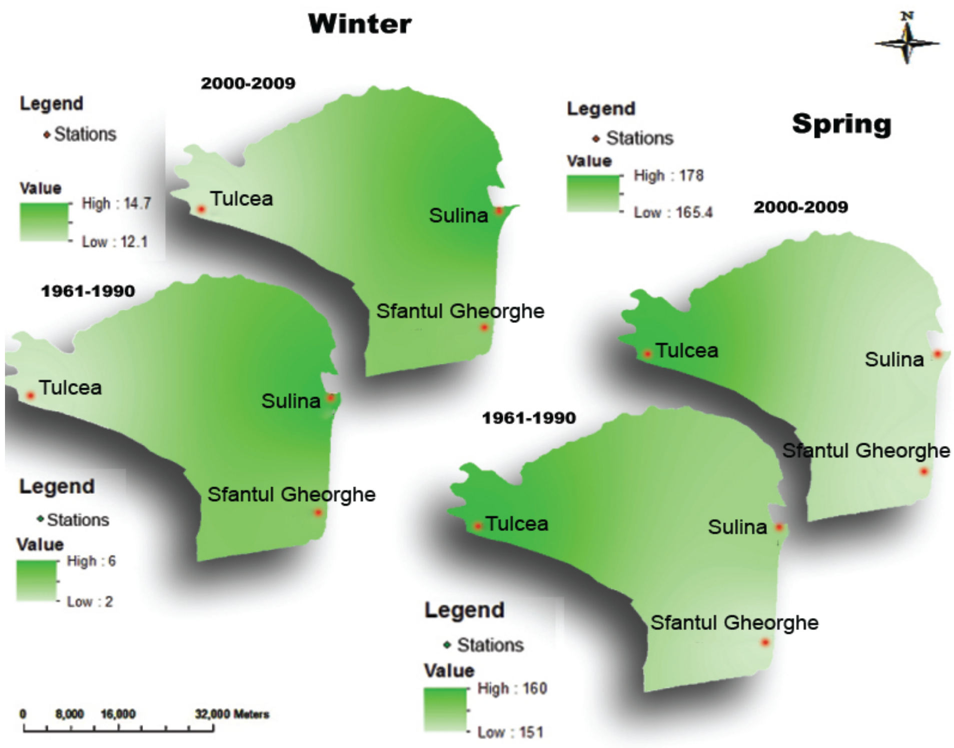

Fig. 3. Spatial distribution in winter and spring of potential evapotranspiration in Danube Delta between 2000 – 2009

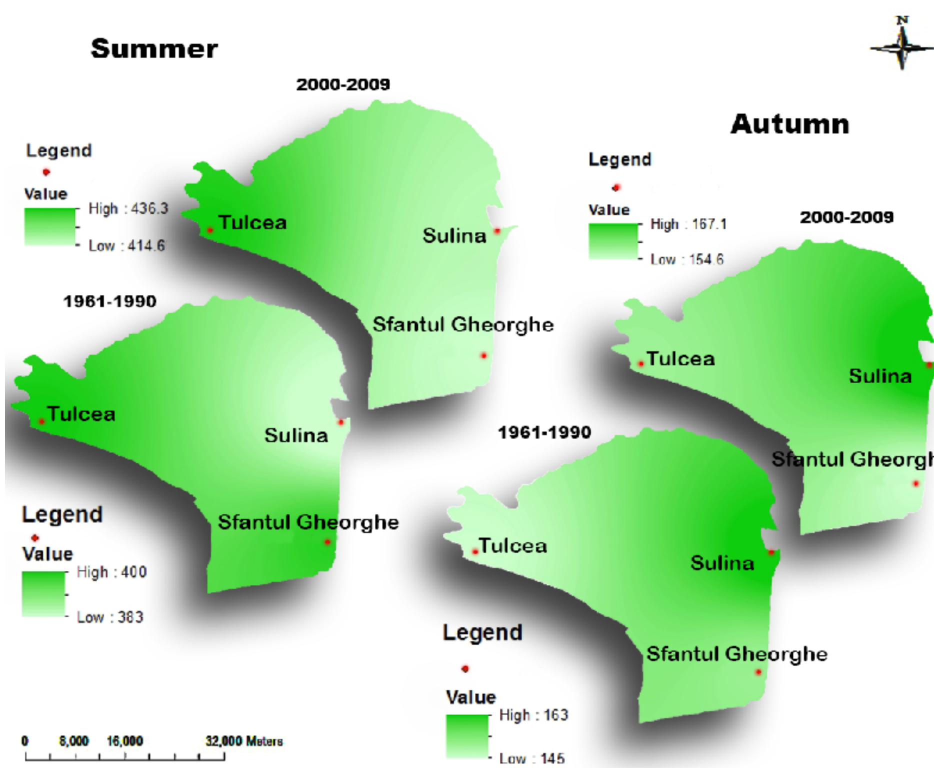

Fig. 4. Spatial distribution in summer and autumn of potential evapotranspiration in Danube Delta between 2000 – 2009

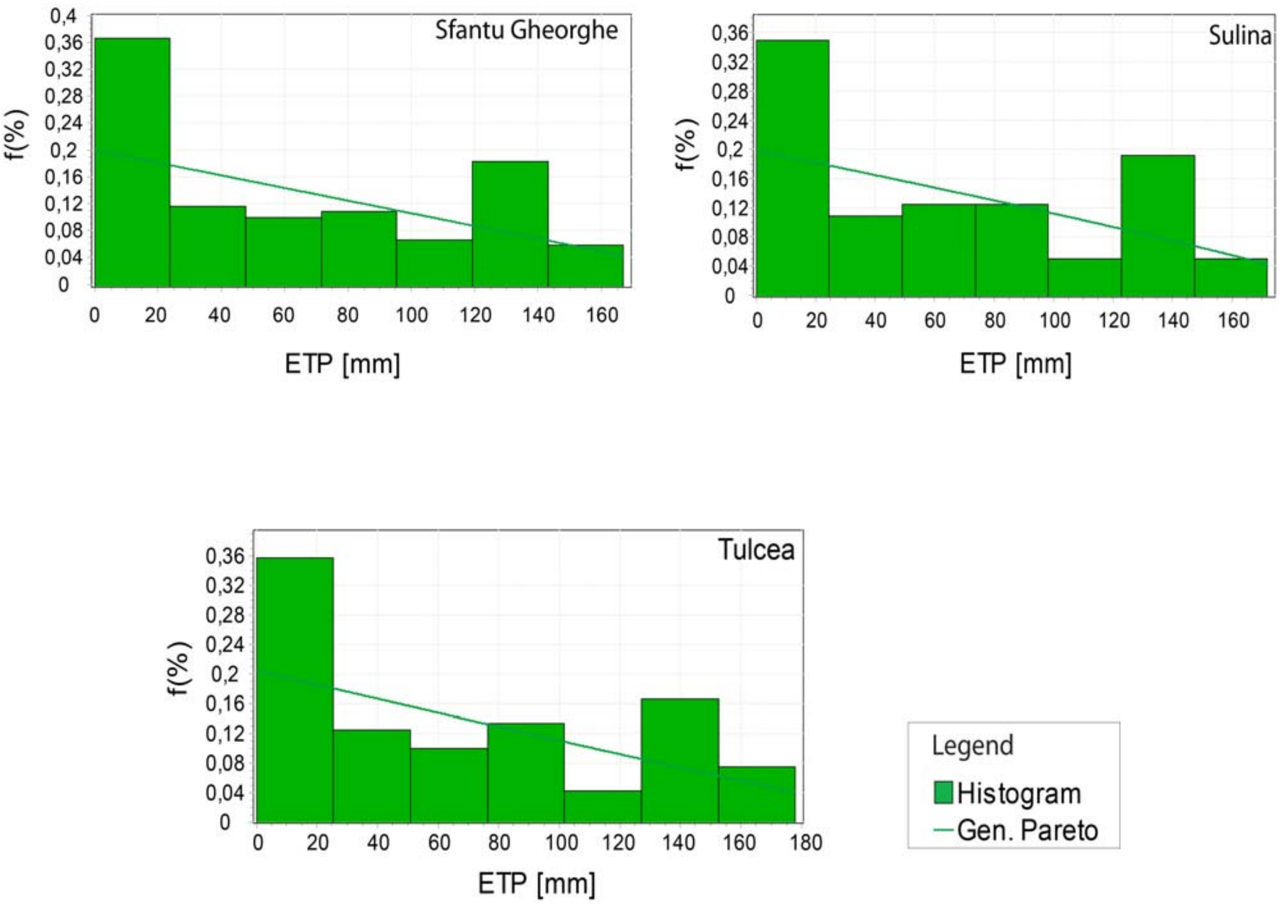

Fig. 5. Distribution frequency of average monthly of potential evapotranspiration values and graph corresponding steps Gen.Pareto distribution between 2000 – 2009

The model considered suitable for interannual distributions of potential evapotranspiration values in the range 2000 - 2009 is Gen. Pareto distribution (Fig. 5).

4. Conclusion

The research presented in this article revealed significant changes in potential evapotranspiration correlated with climatic variations for the study period 2000 - 2009, the area of the Danube Delta, the upside potential evapotranspiration both seasonally and annually to the reference period 1961 - 1990. This leads to increased aridity climate. The method used in this paper to determine the potential evapotranspiration was based on the values of air temperature and Thornthwaite 's nomogram and tables. In this way, we could achieve an overall picture for a time variation of PET for deltaic area.

Summarize the advantages of the indirect methods that do not require a large number of weather parameters measured by the fact that it can be applied easily obtaining good estimates.

No doubt climate change is underway affecting Earth's biodiversity. The greatest challenge in this regard is related to the coastal area, but it is not clear whether these climatic changes will affect ecosystems. What is known is that the steadily increasing temperatures and more frequent extreme weather events are those that have influence on migrating wildlife and also causes invasive species.

Ecosystems are affected by other forms of global change, such as changes in land use associated with habitat fragmentation, which causes a decrease in the viability of species populations.

The importance of this approach derives from the fact that the life cycles of various species will be modified so that there will be a lag between species phenological links.

All aspects of adaptation include differential responses of species and ecosystems to altered environmental conditions. For example, some ecosystems, such as those in coastal regions and in the semi-arid regions are particularly vulnerable aquatic and prospects are complex consequences of global warming [8,9].

5. Acknowledgement

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