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9. Some climate parameters evolution within Danube Delta Biosphere Reserve territory for 1961-2013 period

MIERLĂ Marian

Danube Delta National Institute for Research and Development, Babadag Street No. 165, 820112, Tulcea, Romania, e-mail: marian.mierla@ddni.ro

Abstract: This study aims to study the climate change knowing the climate parameters as an important step to determine the changes and their meaning. Knowing that the meaning of the changes is valuable information for future actions to adapt to climate change. For a consistent study, ROCADA dataset was used for the evolution of climatic parameters in the Danube Delta Biosphere Reserve territory. This is a set of daily gridded data for the entire Romanian territory, covering data from 1961 to 2013 with values for weather variables. From the mentioned dataset there were extracted information for the Danube Delta Biosphere Reserve and a 20 km buffer zone. From the extracted data, it was taken into account a set of 16 points widely distributed in a manner to cover all the area in order to provide weather information as much as possible close to the reality from the field. Inside the expanded study area there were materialized the selected points (centred cell) in order to be relatively evenly distributed across it's the entire surface. In the point selection process there were taken into account the S-N and V-E directions. From the data the assessment of rainfall evolution for most points shows very little decrease which can be interpreted as a very slight increase of the dryness for the studied period. This very slight decrease in rainfall is supported by the low or very low negative correlation coefficients along the passing of the years. The area under research shows, in terms of climate, a trend toward aridity.

Keywords: Danube Delta Biosphere Reserve, climate change, precipitations, temperatures

INTRODUCTION

Climate change research comes amid frequent increasingly manifestations of extreme weather (maximum temperatures, minimum temperatures, heavy rains, extreme droughts etc.). At international level there is an intergovernmental organization on Climate Change (IPCC - Intergovernmental Panel on Climate Change) which envisages extensive research verifying global climate change and their impact on numerous areas related directly or indirectly to human activity.

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to offer the world a scientific clear perspective about the current state of knowledge on climate change and its potential impact on the environment and socio-economic issues. In the same year, the UN General Assembly approved the WMO and UNEP action in establishing joint IPCC. (http://www.ipcc.ch/organization/organization.shtml, august 2016)

As an intergovernmental body, the IPCC membership is open to all member states of the United Nations (UN) and the WMO. Currently, 195 countries are members of the IPCC. Governments participating in the review process and plenary sessions, in which cases are adopted major decisions on the work program of the IPCC and reports are accepted, adopted and approved. Bureau members, including IPCC Chairman, are also elected during plenary sessions. (http://www.ipcc.ch/organization/organization.shtml, august 2016)

Thousands of scientists from around the world contribute to the work of IPCC. The review is an essential part of the IPCC process, to ensure an objective and complete assessment of current information. IPCC aims to reflect a range of views and expertise. IPCC Secretariat coordinates all work and liaise with governments. This is established by WMO and UNEP and its location is at the WMO headquarters located in Geneva. IPCC is managed in accordance with rules and procedures UNEP, WMO and the UN, including codes of conduct and ethical principles (as outlined in Ethics UN function Ethics WMO Staff Regulations and the 2012/07-Retaliation). (http://www.ipcc.ch/organization/organization.shtml, august 2016)

The importance of climate change research is undertaken at national level, such was drafted Romania's National Strategy on Climate Change 2013-2020 by the Ministry of Environment and Climate Change (at that time MECC). Implementation of the proposed strategy is the responsibility of the Government, under the coordination of MECC. Strategy and its objectives reviewing and updating are recommended to be made in the first half of 2015 and during the period till 2020 (Table 1):

Table 1: Ministry of Environment and Climate Change plan (2013-2020)

Implementation	2013	2014	2015	2016	2017	2018	2019	2020
Action plan elaboration	■							
Evaluation of the objective accomplishing degree		■			■		■	
Strategy reviewing			■					■

For developing process of the National Action Plan on Climate Change it is necessary to include aspects of synergistic implementation of the three Rio Conventions, with reflection in legislative and institutional framework. (MECC, 2013)

This strategy includes two parts: the first one contains elements on greenhouse gas emissions reduction and increasing the natural capacity to absorb CO from the atmosphere, and the second part contains elements of Adaptation to climate change (MECC, 2013). The present work is a preliminary study that aims to research the climate change and its influence on the natural environment through changes in ecosystem types on the Danube Delta Biosphere Reserve (R.B.D.D.). Knowledge development is an important step for climatic parameters research in order to determine the changes and their meanings. Knowing the pattern of changes can provide valuable information for future actions to adapt to climate change.

Given the lack of concrete measures on adaptation to climate change at international level and the need to take urgent action, it was launched at European level, the first political initiative on adaptation to climate change through the adoption by the European Commission (EC) 29 June 2007 document "Green Paper on adaptation to climate change in Europe - options for EU action". Subsequently, the EC launched a public discussion document, consultative process with the participation of Romania. The Green Paper is based on results of research conducted under the European Climate Change Programme (ECCP). The document highlights the need to prepare a coherent framework on adaptation casement that will allow carrying out adaptation actions less expensive than unplanned response measures to climate change. The adaptation process requires action at all levels: local, regional, national and international. In May 2008, the EC held consultations with stakeholders to develop more urgent steps as a "White Book" on adaptation document that will contain concrete actions that will be implemented in each state (MECC, 2013).

Adapting to changing climate conditions is a key concept that stands above other concepts, which is the result of other concepts that were presented by the National Agency of Meteorology in the Guide on adaptation to climate change. Climate change impacts – the effects of climate change on natural and anthropogenic systems and the potential effects should be differentiated by the remanent ones for the case of adaptation measures implementation:
Potential impact - effects arising from climate change in the future without taking into account adaptation measures.
Residual impact - climate change effects that may arise after the adaptation measures.
Resilience - all the tools, resources and institutional structures needed to implement effectively adaptation measures.
Vulnerability - the negative impact of climate change, including climate variability and extreme weather events on the natural and anthropogenic systems. Vulnerability depends on the type,

magnitude and rate of climate variability to which a system is exposed, and the possibility of adaptation.
Adaptation - the ability of natural and anthropogenic systems, to respond to climate change, including climate variability and extreme weather events, to reduce potential damages, to take advantage of opportunities or face the consequences of climate change. One can distinguish several types of adaptation: anticipatory and reactive, private and public, autonomous and planned. (NMA, 2006)

MATERIAL AND METHOD

In the climate studies are used numerous climatic parameters and / or weather parameters that may be taken into account to an analysis more or less accurate. In the case of the present study was chosen five meteorological variables, namely: average, minimum and maximum air temperature, relative humidity and rainfall.

For the studying of the evolution of climate parameters was used ROCADA dataset (ROmanian Climate Data Set). This is a set of daily gridded data for the entire Romanian territory covering data from 1961 to 2013 for nine weather variable: air pressure, minimum, maximum and average air temperature, soil temperature, precipitation, hours of sunlight, cover cloud and relative humidity. ROCADA meteorological dataset provides daily recordings of new meteorological variables covering the period of years 1961-2013 and these values were used to create a homogenized climate dataset for all over Romania at a spatial resolution of 0.1 ° (Dumitrescu and Birsan, 2015).

All weather stations with complete data records and posts up to 30% missing data were used for the following variables: air pressure (150 stations); minimum, maximum and average temperature air (150 stations); soil temperature (127 stations); precipitation (188 stations); hours of sunshine (135 posts); cloudiness (104 stations); relative humidity (150 stations) (Dumitrescu and Birsan, 2015).

For each parameter, the data sets were first homogenized with software MASH (Multi Series Analysis for homogenization); then the data series were translated in grid format through software MISH (based on surface interpolation stirred Meteorological data) (Dumitrescu and Birsan, 2015). An overview of the dataset can be seen in the form of georeferenced grid (Figure 1).

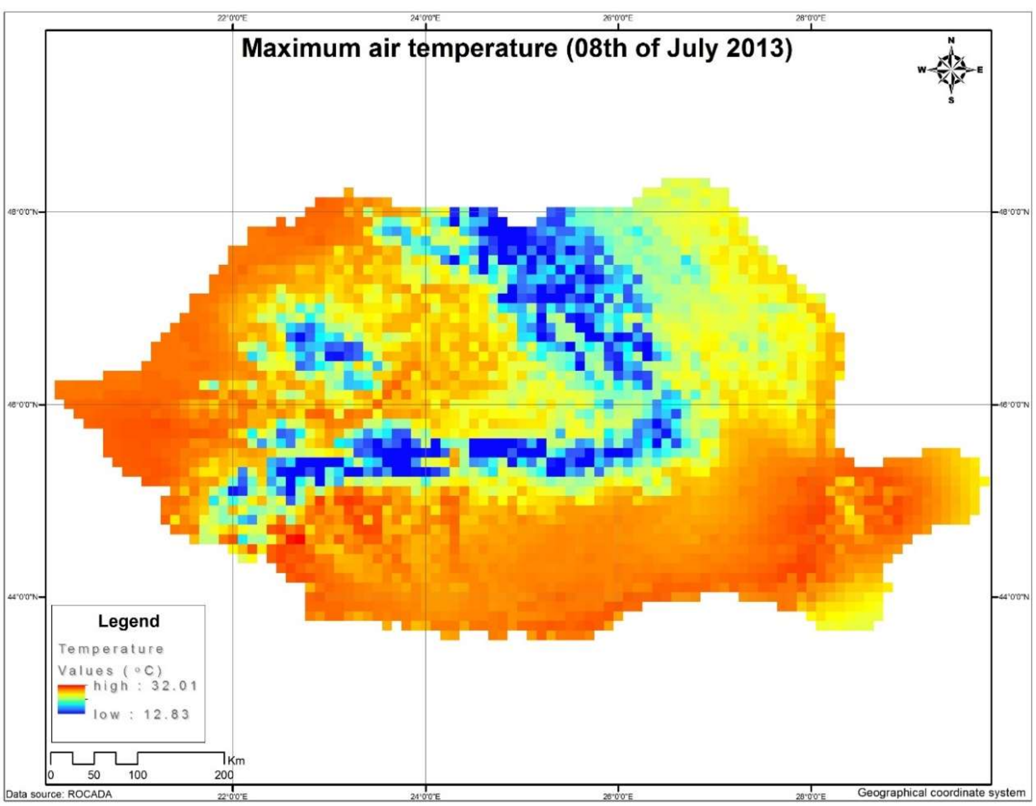

Figure 1 - Meteorological data as a grid for Romania (maximum temperature 2013)

Implementation of a data grid form allows estimating climatological characteristics for locations or areas where measurements are not available (SLUITER 2012). Gridded data are essential for assessing the performance of regional climate models and they serve as inputs for agro-meteorological and hydrological models spatially distributed (Tveito et al., 2006; Birsan, 2013).

The project CARPATCLIM funded by the Joint Research Centre of the EU national meteorological services in nine countries (Romania, Hungary, Ukraine, Slovakia, Serbia, Poland, Czech Republic, Croatia and Austria) joined efforts to build some daily climatological data grid for Carpathian Mountains region, where Romania is covered more than a third of the surface. The project was a good opportunity to update and inventor data (with their gaps, quality and homogeneity) usefulness to science has already been proven by several studies (Lakatos, 2013; Spinoni, 2014; Birsan et al., 2014; Cheval et al., 2014a).

It presents the implementation and evaluation of a set of climate daily data grid for Romania (ROCADA-ROmanian Climate Data Set). It applied the same package as the homogenization and gridding as it was used for CARPATCLIM project due to its performance, reliability and speed tested by comparison with E-OBS (Haylock, 2008) and APHRODITE (Yatagai, 2012), data sets and time series starting from some weather stations independent (ie, stations that have not been involved in creating one of the two data sets). Several recent studies have dealt with climate change on Romania, not only regarding increased extreme precipitation and air temperatures (Ionita, 2012; Busuioc et al., 2014; Rimbu et al., 2014; Stefanescu et al., 2014), but also with terrestrial attenuation (Birsan, 2013), seasonal changes or annual relative humidity, cloud cover, hours of sunshine (Dumitrescu et al., 2014; Marin et al., 2014), studying decreasing snow cover (Birsan et al., 2014; Micu, 2019) and changes in their regime (Birsan et al., 2012; Ionita et al., 2014; Ionita, 2015) of evapotranspiration (Croitoru et al., 2013) or drought (Cheval et al., 2014).

These studies demonstrate the importance of providing a quality controlled climate data set of "everyday" covering the whole of Romania and extending over a long period of time. (Dumitrescu and Birsan, 2015)

From the data set shown in Figure 1 data were extracted for the Danube Delta Biosphere Reserve and a buffer zone of 20 km. From these extracted data were taken into study a set of well distributed 16 points in order to provide weather information as close as it can to the reality on the ground. (Figure 2)

To extract the data as correct as it can be there was used the polygon contour of Danube Delta Biosphere Reserve (D.D.B.R.) projected in national coordinates system (Stereo 1970). This contour has been reprojected from the national coordinates system to geographic coordinate system (identical to the dataset used in this study, ROCADA) to make the overlay accurate. After reprojecting the R.B.D.D. contours it was created the 20 km buffer around the study area. This extensive area offers a very good meteorological context of the studied area. The R.B.D.D. contour and the buffer files are constituted as shp (vector format specific elements for geographic information systems (GIS)), polygon.

Inside the expanded area were materialized points (centred cell) in order to be relatively evenly distributed across the entire study surface. In the points selection process were taken into account both directions S-N and V-E. Materialized points are saved as a file shp (point) (Figure 2).

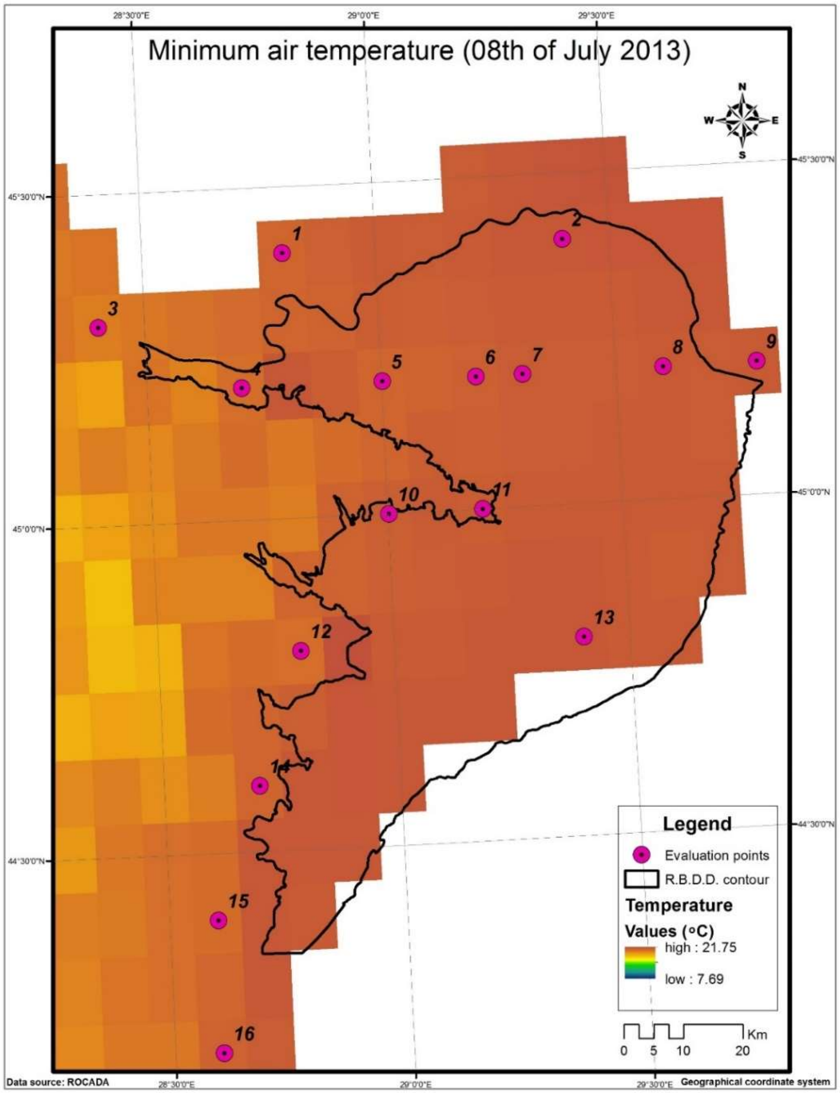

Figure 2 – Meteorological gridded data and evaluation points

The evaluating points (SHP format) were used in GIS to extract data from the meteorological ROCADA dataset focusing on each studied parameter separately, for each one a specific file.
Having all data in separate files there could be analysed each meteorological parameter separately along each year all the years within the period between 1961 and 2013. Thus for each variable mean values were made graphical representation of the entire years period with evolution lines and calculated correlation coefficients.

RESULTS AND DISCUSSIONS

All analysed data were those extracted by the 16 evaluating points mentioned above. All these analyses were performed using Excel spreadsheets. For better and more detailed approach will be presented each point for five meteorological variables.

Rainfall

Rainfall is a very important factor in the evolution of biodiversity in an area, it determines the vitality of plant species, number of individuals and also the number of species, indirectly. The evolution of rainfall for the evaluating point 1 has a very small slope which can be interpreted as a very slight decrease in rainfall for the period. This very slight decrease in rainfall is supported by the correlation coefficient of -0.09. For the evaluating point 2, the correlation coefficient calculated is -0.336. The correlation coefficient for the data in evaluating point 4 is approximately -0.049 which shows very little decrease in rainfall amount for the studied period. Regarding the evaluating point 5 it can be said that the slope of the trend line of rainfall is higher than the previous point evaluation. The correlation coefficient calculated for evaluating point 5 is -0.203, which shows a slight decrease in rainfall. The correlation coefficient calculated for precipitation data related evaluating point 6 is -0.367, which shows a slight decrease in rainfall amount for the period under study. Situation for the evaluating point 7 the rainfall for the period presents a situation worse than in the previous point, the correlation coefficient calculated for precipitation is -0.339. Data for the evaluating point 8 for the entire studied period presents a medium decrease (figure 3).

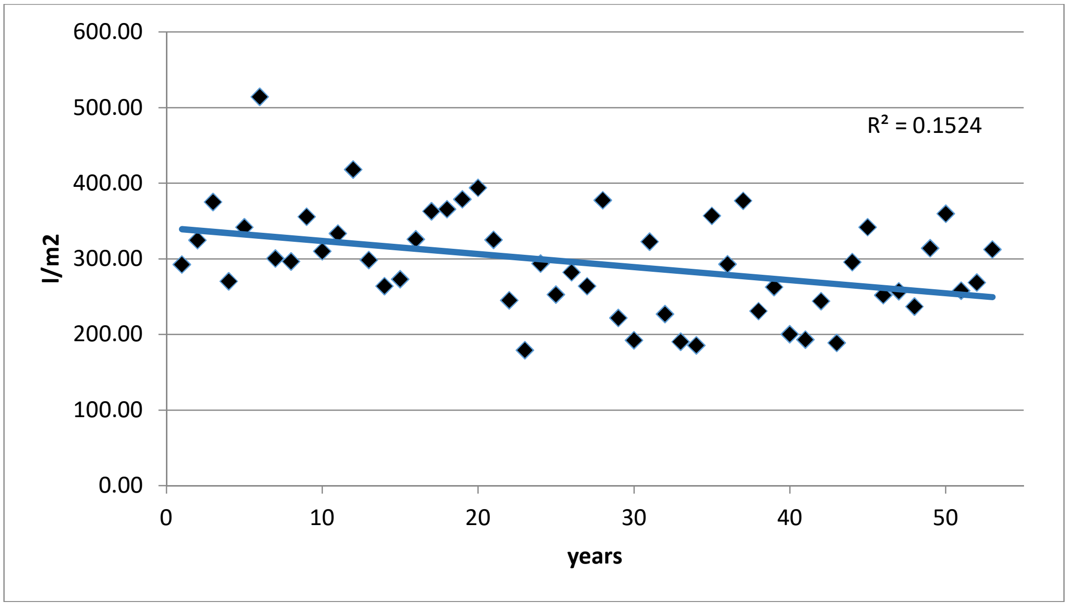

Figure 3 - The annual amount of precipitation and the trend line for the evaluating point 8

The correlation coefficient calculated for the evaluating point 8 is -0.39, which shows the most decreasing trend from all the 16 points. In the case of evaluating point 9 the rainfall evolution has a negative trend. The correlation coefficient calculated is about -0.378. The quantities of rainfall for the evaluating point 10 in the studied period is a slightly decreasing trend line. The correlation coefficient calculated for precipitation for the study period is approximately -0.23. A decreasing trend was calculated also for the evaluating point 11. The correlation coefficient calculated for the entire rainfall studied period is about -0.313. Precipitation for the evaluating point No.12 for the entire studied period shows a decreasing trend with a very slight slope. The correlation coefficient was calculated approximately -0.146, which certifies very slight slope of the line of rainfall amount evolution. The trend line for the evaluating point 13 is -0.332. For the evaluating point 14 for the entire studied period the trend line shows a very slight decrease and the correlation coefficient calculated was approximately -0.082. The correlation coefficients calculated for evaluating points 15 and 16 for all rainfall amount for studied period have positive values 0,021 and 0,162, fact that reveal an ascending trend of precipitations amount.

Relative humidity

Represents the relative concentration (percentage) of water vapours in the atmosphere. This variable is important because it provides information about loading the atmosphere with water vapours especially for the living beings.

For all measurement points relative air humidity evolution trend presents a decrease. The lower correlation coefficient (-0.429) was for evaluating point 12 which had the greatest negative slope. The higher correlation coefficient was calculated for the relative humidity for the evaluating point 3 (-0.176). The smallest slope of the trend line was calculated for evaluating point 3.

Average, minimum and maximum air temperatures

Temperature is the main factor which drives the other weather components (variables). The temperature differences are leading to differences in air pressure and to air movements either vertically, but the most important are those horizontally. Temperatures are causing climatic differences between different areas. In figure 4 is shown the evolution of maximum, medium and minimum air temperature for the entire studied period at the evaluating point 16. For each studied temperature type the evolution presents an increasing trend line and the respective correlation coefficients have the following values: 0.56; 0.49 and 0.52 respectively. In the case of evaluating point 16 has been calculated the highest correlation coefficient (figure 4).

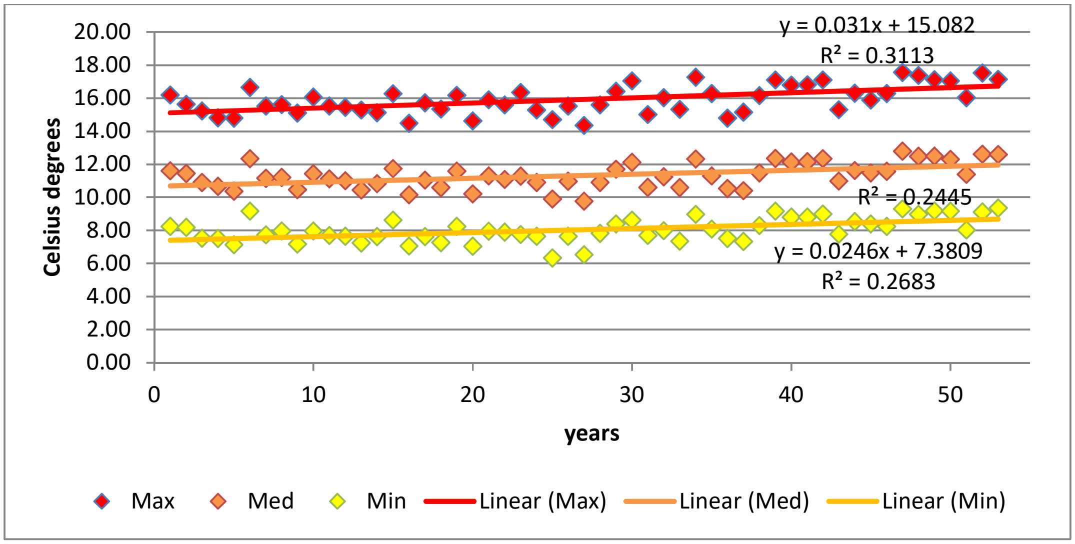

Figure 4 - Maximum, medium and minimum temperatures trend line for the evaluating point 16

A larger angle of divergence shows that temperatures were higher amplitude towards the end of the studied period. This shows that the more frequent are occurring the temperature extremes fact that could lead to the increase of the frequency of other climatic variables.

CONCLUSIONS

It is known that the Danube Delta is the driest region in terms of rainfalls. Carefully studying the charts of the evolution of rainfall it can be said that this region will be drier with regards to rainfalls; this is easily to see because for almost all evaluation points the trend lines present low to medium decreasing slope. Only for two evaluating points the trend lines were very slight ascending (negligible). Regarding relative humidity for all evaluating points, the evolution of air relative humidity values registered a decrease. The lowest correlation coefficient (-0.429) was calculated for the evaluating point 12 which had the greatest negative slope. The highest correlation coefficient calculated for the relative humidity was for the evaluating point 3 (-0.176). The negative but almost horizontal trend line was calculated for the evaluating point 3.
All studied temperature types were increases over the entire studied period, thus the slope of the trend lines registered increasing aspects and the correlation coefficients values registered positive small and medium values. The angle's value of divergence of the trend lines of the temperature values between the maximum and the minimum is not equal to 0 (zero) suggests an increase in the temperature amplitude. This means that temperature extremes frequency is increasing, having in mind a general increase of temperatures.

Decrease in precipitation clearly correlates with decreased relative air humidity making the air to be drier and unsuitable for many species that live in the studied area.
General rise in all temperatures types values in the study area while the decrease in precipitation, leads to the idea of increased aridity for study area, aridity that can affect various species of the Danube Delta Biosphere Reserve.

BIBLIOGRAPHY

Birsan M.V., 2013. Application of a distributed physically-based hydrological model on the upper river basin of Someşul Mare (Northern Romania). Rom. Rep Phys 65(4):1469–1478;
Birsan MV, Dumitrescu A, Micu DM, Cheval S., 2014. Changes in annual temperature extremes in the Carpathians since AD 1961. Nat Hazards. doi:10.1007/s11069-014-1290-5;
Birsan MV, Zaharia L, Chendes V, Branescu E., 2012. Recent trends in streamflow in Romania (1976–2005). Rom Rep Phys 64(1):275–280;

Busuioc A, Dobrinescu A, Birsan MV, Dumitrescu A, Orzan A., 2014. Spatial and temporal variability of climate extremes in Romania and associated large-scale mechanisms. Int J Climatol. doi:10.1002/joc.4054

Cheval S, Birsan MV, Dumitrescu A., 2014a. Climate variability in the Carpathian Mountains region over 1961-2010. Glob Planet Change 118:85–96. doi:10.1016/j.gloplacha.2014.04.005;

Cheval S, Busuioc A, Dumitrescu A, Birsan MV, 2014b. Spatio-temporal variability of the meteorological drought in Romania using the standardized precipitation index (SPI). Clim Res 60:235–348. doi:10.3354/cr01245;

Croitoru AE, Piticar A, Dragotă CS, Bursada DC, 2013. Recent changes in reference evapotranspiration in Romania. Glob Planet Change 111:127–136. doi:10.1016/j.gloplacha.2013.09.004;

Dumitrescu, A, Birsan, M-V, 2015. ROCADA: a gridded daily climatic dataset over Romania (1961–2013) for nine meteorological variables, în Revista Natural Hazards, Volume 78, Issue 2, pp 1045-1063

Dumitrescu A, Bojariu R, Birsan MV, Marin L, Manea A, 2014. Recent climatic changes in Romania from observational data (1961–2013). Theor Appl Climatol. doi:10.1007/s00704-014-1290-0;

Haylock MR, Hofstra N, Klein Tank AMG, Klok EJ, Jones PD, New M, 2008. A European daily high-resolution gridded dataset of surface temperature and precipitation. J Geophys Res (Atmos) 113:D20119. doi:10.1029/2008JD10201;

Ionita M, 2015. Interannual summer streamflow variability over Romania and its connection to large-scale atmospheric circulation. Int J Climatol. doi:10.1002/joc.4278;

Ionita M, Chelcea S, Rimbu N, Adler MJ, 2014. Spatial and temporal variability of winter streamflow over Romania and its relationship to large-scale atmospheric circulation. J Hydrol 519:1339–1349. doi:10.1016/j.jhydrol.2014.09.024;

Ionita M, Rimbu N, Chelcea S, Patrut S., 2012. Multidecadal variability of summer temperature over Romania and its relation with Atlantic multidecadal oscillation. Theor Appl Climatol 113(1–2):305–315. doi:10.1007/s00704-012-0786-8;

Lakatos M, Szentimrey T, Bihari Z, Szalai S., 2013. Creation of a homogenized climate database for the Carpathian region by applying the MASH procedure and the preliminary analysis of the data. Időjárás 117(1):143–158;

Marin L, Birsan MV, Bojariu R, Dumitrescu A, Micu DM, Manea A., 2014. An overview of annual climatic changes in Romania: trends in air temperature, precipitation, sunshine hours, cloud cover, relative humidity and wind speed during the 1961–2013 period. Carpath J Earth Env 9(4):253–258;

Micu D., 2009. Snow pack in the Romanian Carpathians under changing climatic conditions. Meteorol Atmos Phys 105(1–2):1–16. doi:10.1007/s00703-009-0035-6;

Rimbu N., Stefan S., Necula C., 2014. The variability of winter high temperature extremes in Romania and its relationship with large-scale atmospheric circulation. Theor Appl Climatol. doi:10.1007/s00704-014-1219-7;

Spinoni J, Szalai S, Lakatos M, Szentimrey T, Bihari Z, Mihic D, Antofie T, Vogt J, Auer I, Hiebl J, Milkovic J, Stepanek P, Tolasz R, Zahradníček P, Nagy A, Nemeth A, Kovacs T, Kilar P, Limanowka D, Pyrc R, Cheval S, Gyorgy D, Dumitrescu A, Matei M, Birsan MV, Dacic M, Petrovic P, Krzic A, Antolovic I, Nejedlik P, Statsny P, Kajaba P, Bochnicek O, Galo D, Mikulova K, Nabyvanets Y, Skrynyk O, Krakovska S, Gnatiuk N., 2014. Climate of the Carpathian Region in 1961–2010: climatologies and trends of ten variables. Int J Climatol. doi:10.1002/joc.4059;

Stefanescu V., Stefan S., Georgescu F., 2014. Spatial distribution of heavy precipitation in Romania between 1980 and 2009. Meteorol Appl 21:684–694. doi:10.1002/met.1391;

Tveito O.E., Wegehenkel M., van der Wel F., Dobesch H., 2006. The use of geographic information systems in climatology and meteorology. COST Action 719 Final Report. w3.cost.eu/fileadmin/domain_files/METEO/Action_719/final_report/final_report-719.pdf, august 2016;

Yatagai A., Kamiguchi K., Arakawa O., Hamada A., Yasutomi N., Kitoh A., 2012. APHRODITE: constructing a long-term daily gridded precipitation dataset for Asia based on a dense network of rain gauges. B Am Meteorol Soc 93:1401–1415. doi:10.1175/BAMS-D-11-00122.1;

Ministry of Environment and Climate Change, 2013. Strategia Națională a României privind Schimbările Climatice 2013-20120;

National Meteorological Administration, 2006. Ghid privind adaptarea la efectele schimbărilor climatice, ANEXĂ, http://www.meteoromania.ro/anm/images/clima/SSCGhidASC.pdf, august 2016

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