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CUPRINS

PREFACE

Professor Lucica Tofan, PhD
Ovidius University of Constanta, RO

Evolution of the world climate and the dangers arising from global warming concern all socio-economic and political environments. Thus, representatives from 195 countries met in Paris in November 2015, during the United Nations Conference – COP 21 and adopted a global agreement on the reduction of climate change. The agreement set out a global action plan in order to limit global warming to well below 2°C, and will enter into force in 2020.

Before and during the Paris conference, countries submitted comprehensive **national climate action plans.**

As a preamble to the COP21 Summit, the Climatology International Symposium was held in Constanta, and organized by Ovidius University, in August 2015.

The Climatology International Symposium was dedicated to the memory of Professor Ion Florin Mihailescu, as a sign of recognition and appreciation for his activity and promotion of geography and climatology in the 90's, at Ovidius University, Constanta. After a few years, the symposium has become international with the participation of academics from Croatia, Germany, Greece, Moldova and Ukraine.

This event enjoys the presence of Romanian specialists from governmental institutions, research institutes and academics, specialised in environmental studies who are concerned about the impact of pollution, and whose purpose is to limit those pollutants that lead to climate change.

Another aim of the symposium is to create a connection with the young generation of future specialists. Only with good education, knowledge transfer and international experience, can our students become specialists with the ability to develop a better environmental policy in the future.

The papers presented in this volume address current issues related to balneo-climatology, agro-climatology, historical climatology, tourism climatology, micro-climatology, topo-climatology, climatology, forestry, resources and risks of climate variability and climate change, and the impact of climate on the environment dynamics.

FOG, A RISK PHENOMENON FOR THE RIVER TRAFFIC ON THE DANUBE-BLACK SEA CANAL

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Abstract

Fog is a meteorological process quite frequent along, the Danube- Black Sea Canal, the average number of fog days being 45-48 days a year. In the lower layers of the atmosphere, entering in contact with the active underlying surface, after clear warm days during which intensive processes of evaporation occur, often the fog phenomenon arises, due to the droplets of water or ice crystals which are in suspension. The average number of fog days occurs differently from one season to another, the highest frequency being encountered during winter and autumn. Fog is most frequent at night, especially during the first hours after sunset and before sunrise. We may say that fog is a phenomenon which arises partly because of the water and because the region has an aisle character. During foggy days the river traffic on the Danube- Black Sea Canal is hindered or even stopped when the fog is very dense.

Key words: radiative - advection fog, thermal inversion, upwelling phenomenon

Introduction

The main purpose of the present paper is to synthesize the knowledge acquired during specialized field training and after data gathering from the meteorological stations from the area. This analysis intends to became a synthesis of the fog problem, presenting the causes of its formation, the types of genetic fog which arises alongside the Danube- Black Sea Canal and the monthly and annual variation of this risk phenomenon. Also, the author proposes to present the impact of this meteorological risk phenomenon onto the river traffic.

Materials and methods

For this analysis, the fog periods between 2000 and 2010 were firstly established using the daily climate data base from the Meteorological Weather Stations in Cernavodă, Medgidia, Constanța and Valu lui Traian. This article endeavors to materialize observation data about fog from 2000 to 2010 and to synthesize these data, highlighting the average number of foggy days, the monthly and annual maximum number of foggy days and the evolution of this phenomenon in 24 hours as well as its duration. To complete this material, besides direct observation data, other bibliographic sources with general character were used.

Results

1. Conditions of fog production and types of fog

Fog is a complex of droplets of water, resulted from vapour condensation near the surface. The appearance of fog reduces visibility under 1 km. Fog is a meteorological phenomenon quite frequent in the Danube- Black Sea Canal area, the average number of foggy days being approximately 45 to 48.4 days a year (Iliescu, 1983).

In the lower layers of the atmosphere, at the contact with the active underlying surface, after clear and warm days in which intense processes of evaporation occur, the fog phenomenon arises because of the droplets of water or the ice crystals which are in suspension.

The following conditions are necessary to produce fog:
- to have sources of evaporation;
- the air humidity to overcome the state of saturation;
- a cool air advection to be produced on a warmer active surface;
- to produce a mixture of cool air and warm air;
- the temperature to drop below the value of the dew point.

In the case of positive temperatures, the relative air humidity is close to 100% (usually 95-100%) and in the case of negative temperatures this is usually lower than 100%.

Genetically, the most frequent types of fog are:
- advection fog;
- radiation fog;
- radiative- advection fog;
- mixture fog (coastal fog);
- urban or industrial fog, formed by increasing the condensation cores (Văduva, 2002).

Advection fog. It is produced because of the movement of warm and humid air masses above cooler regions. When the hot air enters cooler regions, the thermal inversion phenomenon is produced, which favors the condensation process of water vapours, right at the level of the land area.

The most important conditions in which advection fog is formed are:

- the relative humidity arisen in the air mass which will travel on the cooler underlying surface;
- the great difference of temperature between the air mass which moves forward and the underlying surface on which the movement is made;
- the average speed of the wind, 8 m/s at most.

When the wind speed is higher, the turbulent exchange is intensified and the production of fog is prevented.

Evaporation fog results because of the movement of a cool air mass over a warmer water surface (rivers, lakes, swamps) over which there are water vapours resulted from the evaporation processes. This situation is encountered during autumn mornings when cooled air above the dry land moves along these water surfaces. Sometimes, over the Dobrogea area, fog is due to the advection of hotter and more humid air, arrived from the Black Sea during the cool season, over a cooler surface of the dry land or because of the cooler air flow from the shore onto a warmer water surface of the Danube- Black Sea Canal and the Black Sea. In summer, given hot air advection from the shore to the sea, fog is formed only above the Black Sea basin. Also, it appears over the canal and the aquatic surfaces, by increasing the air humidity after water evaporation from the sea surface, from the Danube, from the Danube-Black Sea Canal, from the surface of the lakes. It is possible that fog may appears after the evaporation of the water from the soil moistened by rain.

Radiation fog. It is formed during clear and relatively calm nights, when the wind speed does not exceed 2m/s (a situation which usually occurs during anticyclone regime). The main cause of air cooling from the vicinity of the soil and of radiation fog formation is the loss of the nearby heat, from the land area through nocturnal radiation. The more pronounced cooling of the air from the vicinity of the land area generates the thermal inversion phenomenon. This plays a decisive role in the way fog is produced and the way fog acts. According to the position of the inversion layer, two types of radiation fog are distinguished: low and high (Bogdan, Mihai, 1972).

A special type of fog, genetically seen, is that which appears together with the upwelling phenomenon, alongside the Romanian coast (Văduva, 2002).

The cool air masses raised through this process produce a drop in air temperature, enough to get to a foggy air and sometimes even to fog. Some of the foggy air days which occur in summer are due to this process. All these types of fog have a common feature- they reduce horizontal visibility to less than 1 km, which causes great difficulties in the activity of river and marine transport.

2. Te average number of foggy days

The average number of foggy days is unevenly distributed, being influenced by the local processes caused by the mountainous region and the presence of water basins (theBlack Sea, the Danube, the Danube- Black Sea Canal).

Annually, the average number of foggy days ranges from 57.9 days in Constanța, 52.6 days in Valu lui Traian, 51,1 days in Medgidia and 48.4 days at in Cernavodă (Table 1).

Table 1. The monthly and annually average number of foggy days in the Danube-Black Sea Canal area (2000-2010).

Weather Stations	Months												Annually
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Cernavodă	8,8	5,3	2,8	3,1	2,6	0,6	0,8	1,4	2,1	4,5	7,3	9,1	48,4
Medgidia	7,8	5,8	5,1	3,1	2,7	1,7	1,2	2,2	2,7	3,7	6,9	8,2	51,1
Constanța	9	7,2	7,9	5,7	3,7	1,6	1,4	1,1	1,6	2,8	7,2	8,7	57,9
Valu lui Traian	6,7	5	3,7	4,2	2,3	1,1	0,8	1,3	2,2	3,9	6.7	7,6	52,6

(S*ource. The archive of the National Meteorology Administration.*)

We can observe that the fog phenomenon is more frequent from November till February.

Table 2. The seasonal frequency of the number of foggy days in the Danube- Black Sea Canal area (2000-2010).

Weather station	winter		spring		summer		autumn	
	no. days	frequency (%)	no. days	frequency (%)	no. days	frequency (%)	no. days	frequency (%)
Cernavodă	23,2	25,7	8,5	9,2	2,8	3	13,9	15,2
Medgidia	21,8	24,2	10,9	11,8	5,1	5,5	13,3	14,6
Constanța	24,9	27,6	17,3	18,8	4,1	4,4	11,6	12,7
Valu lui Traian	19,3	21,4	10,2	11,1	3,2	3,4	12,8	14,7

(*Source. The archive of the National Meteorology Administration.*)

Generally, the physical processes which lead to fog production in the Danube-Black Sea Canal area are more frequent in the cold semester of the year, this being reflected in the higher monthly average number of foggy days from this period and in its persistence during winter. Thus, starting with October, the monthly average number of foggy days suddenly increases (4.5 days in October, to 2.1 days in September in Cernavodă; 2.8 days to 1.6 days in Constanța), reaching in December the highest frequency of foggy days. In December we record, on average, over 7.5 foggy days, ranging from 7.6 days in Valu lui Traian and 8.7 days in Constanța. A slightly reduced, but appreciable frequency, is shown by this phenomenon in January when we can record 6.7 foggy days in Valu lui Traian and 7.8 days in Medgidia. Only at the Constanța station the frequency is higher in January.

The frequency of this phenomenon is greatly reduced in April- May, when the average number of foggy days ranges from 2.3 to 5.7 days. In summer, especially in June and July, when the fog producing conditions appear rarely, this phenomenon has the lowest frequency. Thus, in Valu lui Traian, the monthly average number ranges between 0.8- 1.1 days and in Constanța, from 1.4 to 1.6 days. Once the air temperature drops in autumn, the fog frequency rises, reaching in November, on average, 6.9 and 7.2 foggy days in Medgidia, respectively in Constanța.

From the compared analyses of recorded data in the four observation points results as an essential conclusion the fact that during the October–February period, in Cernavodă and Constanța the frequency of the fog phenomenon is higher (23%) than in Medgidia (20.9%) and in Valu lui Traian (19.8%). This is explained by the movement of cooler air over the surface of the Danube and Black Sea, which is hotter and more humid, thus creating conditions of producing evaporation fog.

During the period March-September, the fog frequency is higher in Constanța (10.7%) and in Medgidia (8.7%) than Cernavodă (6.2%) and Valu lui Traian (7.2%).

The phenomenon is explained by the presence in the local atmosphere of an impressive number of solid cores of condensation (caused by “Lafarge-Romcim” Medgidia and the Factory of precast concrete and lime from Constanța) which favour fog production even when the wet conditions are relatively lower than 90-100% (www.lagarge.com).

The seasonal average number of foggy days appear differentially from one season to another (Table 2).

Winter is the season in which fog is produced with a higher frequency in a big number of days. Thus, in Constanța, more than 24 foggy days occur (which constitutes almost 1/3 (27%) of the total number of days of this season); in Cernavodă, 23.2 days (about 26% totally); Medgidia , 21.8 days (24.4%) and Valu lui Traian , 19.3 (21.6%).

In summer, about 2.8-5.1 foggy days are recorded.

The fog is formed by water vapour condensation at temperatures between -5 and 5° Centigrade, relative humidity over 100% and light wind (below 4m/s) or at relative humidity of 80-100%, when there are numerous cores of condensation or by the sublimation of water vapours at temperatures of -30° and relative humidity lower than 80%. Fog frequency is higher at night, especially in the first hours after sunset and before sunrise. It appears rarely during afternoon hours and in summer (Măhăra, 2001).

3. The monthly and annually maximum number of foggy days

These constitutes an essential element is characterizing the fog regime along the Danube-Black Sea Canal. Over the years, the annual maximum number of foggy days oscillated between 109 in Cernavodă and 128 in Constanța.

The situation of the number of foggy days at the weather stations from the Danube-Black Sea Canal area is presented below.

Table 3. The average of the maximum number of foggy days at the weather stations from the Danube-Black Sea Canal area (2000-2010).

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annually
Cernavodă	14	19	9	7	7	2	2	4	7	10	14	14	109
Medgidia	15	15	12	9	7	6	5	6	8	8	14	14	119
Constanța	16	16	13	10	8	6	6	5	7	7	14	14	128
Valu lui Traian	16	15	12	9	8	6	6	5	7	7	14	14	119

(*Source. The archive of the National Meteorology Administration.*)

In the course of the year, the monthly maximum number of foggy days is recorded in winter, when 16 foggy days occurred in Constanța in January and February, and 19 days occurred in Cernavodă, in February. In spring and autumn, the monthly maximum number of foggy days is reduced, ranging from 7 to 12 days in Medgidia and 7 to 10 days in Cernavodă. In summer, the monthly maximum number of foggy days is larger in Constanța than the one in Cernavodă and Medgidia (Table 3, Figure 1).

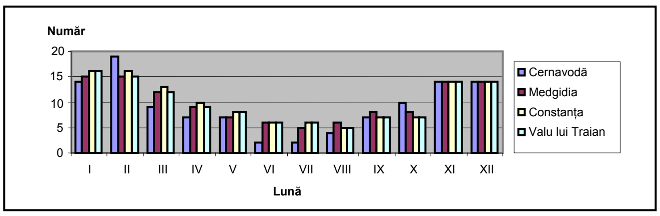

Figure 1. The average of the maximum number of foggy days at the weather stations from the Danube-Black Sea Canal area (2000-2010).

4. The evolution of the fog phenomenon in the course of 24 hours

Whatever the season of the year and the thermal threshold analyzed, the largest frequency of the fog phenomenon, at the four observation points is recorded at 7 in th morning. At this hour, the average frequency of foggy days varies according to the thermal threshold and the weather station analyzed between maximum one day during the summer months, and 2.1-2.2 days, during autumn and the winter months. In winter, a higher frequency of fog occurrence is recorded during the night (1.1-1.7 days at 1 o'clock). Between April-September, during the night, the fog frequency drops significantly (0.1-0.2 days), and during the day, especially in Cernavodă, appears only incidentally.

5. Fog duration

It is the time period calculated between the beginning and the end of the phenomenon visually reported in the area where the station is located, expressed in hours and tenths of hours. Data originated from observations referring to fog, made at the weather stations from the studied region in the period between 2000 and 2010 were used.

The monthly average of fog duration in the area of the Danube-Black Sea Canal totals over 250 hours (representing about 3% from the number of hours from a year). The maximum values of the annual fog duration are about 400 hours even higher, revealing the irregular character of this phenomenon procedure in different years.

In the course of the year, the fog duration varies from one month to another, presenting mean values, the highest ones, in the cold period, when over 20 hours of fog are monthly recorded. The biggest month duration appears in January or December (over 45-50 hours), and the smallest one in July (less than 5 hours). A higher duration of fog is noticed in April and May, on the seaside and a smaller duration in October, as a result of the thermal regime in the Black Sea basin.

The monthly maximum duration displays considerable values, at least double from the average ones. Thus during the cold period more than 50-60 monthly hours were recorded, and during the hot one, over 15-20 monthly hours. The maximum fog duration in 24 hours indicates the possibility of its persistence in some cases the whole day from November to February. The possible maximum duration in 24 hours drops a lot in the hot season of the year, recording only 10-15 hours. Because the fog can extend appreciably over the course of 2-3 days, the maximum duration of a fog case was analyzed. From the whole period of the years studied in the investigated region, there were cases when the fog lasted over 60 even 100 hours, without interruption. The longest durations being reached in the cold period October-March, when fog can last for 28 hours consecutively. In the hot period, April-October, the maximum duration of a fog case lasts, generally, under 20 hours.

6. The daily evolution of fog production

In the course of 24 hours, a considerable growth of fog duration is noticed, especially during the morning hours, approximately between 5 a.m. and 10 a.m., followed by its reduction during the afternoon hours, with a minimum between 2 p.m. and 10 p.m. . Of course, the time periods of fog production vary more frequently from one month to another. Thus, in the cold period of the year the maximum fog duration appears between 7 a.m. and 10 a.m., and between 5 a.m. and 8 a.m. in the hot season. During the afternoon hours and at the beginning of the night, the fog frequency is reduced, and the phenomenon is missing in the hot season of the year.

7. The monthly and annually frequency of foggy days with different durations

In general, the fog formed in the studied region has most frequently, a daily duration of 2 to 4 hours, with extended cases of up to 10 - 15 hours and rarely up to 24 hours. Fog existence is noticed lasting up to 24 hours during the cold season and reducing during the hot season, when practically there is no fog event lasting over 14-15 hours. There are situations when, in the course of one day, many cases of fog with different durations may appear. It is noticed that fogs lasting up to 6 hours (over 40-50% monthly) and those lasting up to 12 hours are predominant.

The cases of fog extension over 12 hours are relatively rare and are encountered, especially, during the cold period of the year. Also during the winter months it is possible, exceptionally, to have fog extending over 60 hours (Constanța: 61.4 hours).

In the Danube-Black Sea Canal area the fog phenomenon is frequent especially in winter, when it has negative repercussions on the navigation.

Case study

The fog on the Canal and its impact on the navigation

Days with dense fog were recorded on April, 3. 2008 (Figure 2), on December, 20. 2008, April, 19. 2010, February, 18. 2010. For the date of Aprilie, 3. 2008, starting with 5.30 a.m., the maneuvers in Constanța South and North ports, marine an river, were suspended, due to low visibility, which was under a half of nautical mile (www.ziare.ro).

Figure 2. The fog on the Danube- Black Sea Canal (*photo: Claudia Ilie*).

Also, for of the same reason the traffic on the Danube- Black Sea Canal was blocked by the shuttle from Agigea. Alongside the Canal the river and road traffic were greatly hindered. The activity was resumed at 7.30 a.m. in the Constanța South river port and the maneuvers at Constanța North and South maritime ports were resumed at 8 a.m. , the barge traffic by Agigea shuttle was also resumed (Ilie, 2012).

Conclusions

We can conclude the fact that the fog is a risk phenomenon which influences greatly the river activity on the Danube- Black Sea Cannal. The fog is intense over the canal and in its vicinity, due to the presence of the water and due to the aisle character of the region. The fog phenomenon recorded especially during the cold periods of the year entails the impairing or blocking of the traffic when the visibility is very reduced. This fact leads to economic losses.

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SUMMER TEMPERATURE EXTREMES AND THEIR INFLUENCE ON THE SOUTH-EAST DEVELOPMENT REGION

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Abstract

The particularly complex natural background of the South-East Development Region accounts for the varied climate influences, with excessive or maritime shades. The description of the positive thermal regime with its temperature extremes, based on characteristic summer thresholds (tropical and canicular days) is aimed at highlighting the frequency, duration and intensity of exceptional situations. We processed the daily maximum temperature data-rows recorded by the region's weather stations (Buzău, Galați, Călăraşi, Tulcea and Constanța) over a period of 54 years (1961-2014). The finality of our endeavour has been to present some examples for these extreme phenomena, their synoptic causes, and specific elements of exceptional manifestation, the effect of longer canicular periods finally impacting the whole social-economic life.

Key words: temperature extremes, canicular days, case-study, consequences.

Introduction

The present study discusses the manifestation of some extreme temperature thresholds specific to the summer season, as well as the negative effects of these special situations and their possible threats to people's health, to the environment and to socio-economic activities.

The particularly complex natural background of the six counties that make up the South-East Development Region consists of distinct altitude steps, starting from the orographic barrier of the Curvature Carpathians in the north-west, followed by the mosaic of summits and depression of the Subcarpathian Curvature, the vast lower plain and tableland areas and finally the neighbouring water bodies – the Black Sea in the south-east and the Danube Delta in the east. This territorial complexity accounts for the varied temperate-continental influences, with excessive or maritime shades (Figure 1) (Geografia României, 1983).

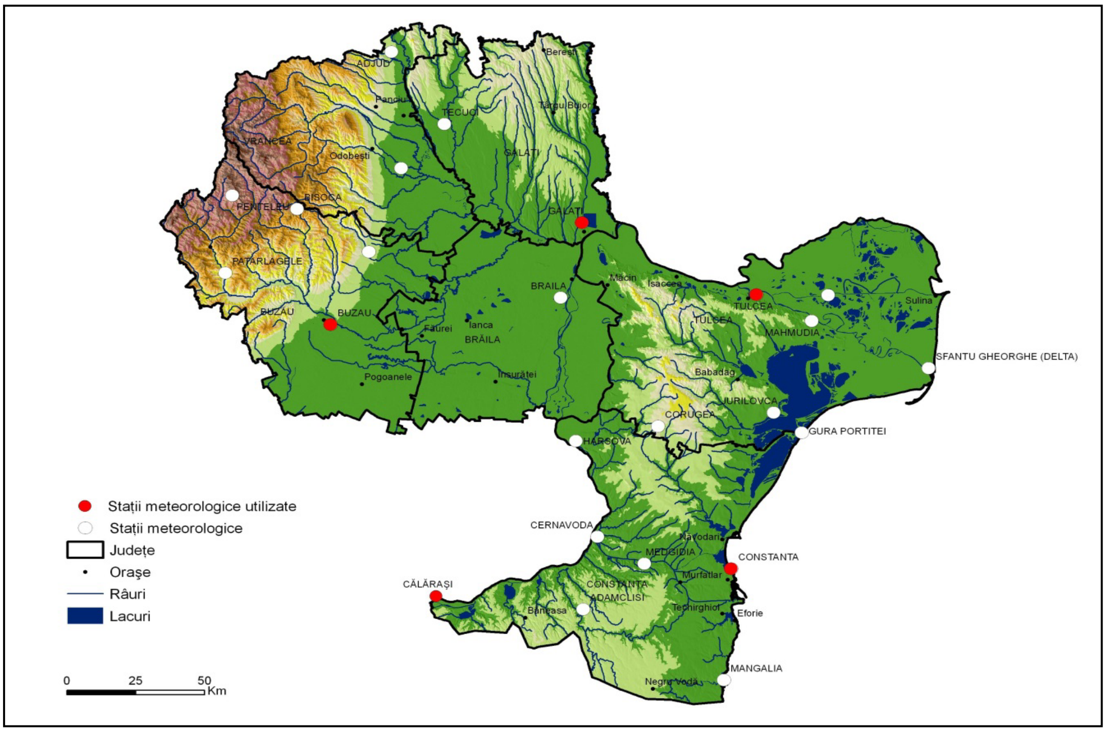

Figure 1. Physical-geographical background of the South-East Development Region.

Data and methods

A description of the positive thermal regime with its temperature extremes, based on characteristic summer thresholds (tropical and canicular days) is aimed at highlighting the frequency, duration and intensity of exceptional situations.

A first step in this was the processing of the daily maximum temperature data-rows recorded by the region's weather stations (Buzău, Galați, Călăraşi, Tulcea and Constanța) over a period of 54 years (1961-2014), registered by the National Meteorological Administration (NMA) and included in the international data-flow (ECAD, http:\\knmi.eca.nl).

Our analysis pointed out the annual values of specific temperature days and the intervals of consecutive days for the respective thresholds, as well as evolution trends. By highlighting some cases of exceptional temperature frequency, duration and intensity, we intended to outline a few thermal hazard situations in the South-East Development Region.

The finality of our endeavour was to present some examples for these extreme phenomena, their synoptic causes, and specific elements of exceptional manifestation.

Results

The characteristic summer temperature thresholds presented in this paper regard at least two successive tropical days (max. temp. ≥30˚C), and two successive canicular days (max. temp. ≥35˚C).

The graph of numerical variation in the annual days with tropical temperatures reveals the coincidence of years with higher or lower values recorded at all the stations. Also, a distinct evolution was found at Constanța station, where the far lower values resulted from the moderating effect of the vast Black Sea water-body. Outstanding for the highest number of tropical days was Călăraşi station, the consequence of its southern geographical location. The data-rows found at Galați and Tulcea stations indicate a significantly similar development, but the values are lower, being also influenced by the neighbouring water-bodies (Figure 2).

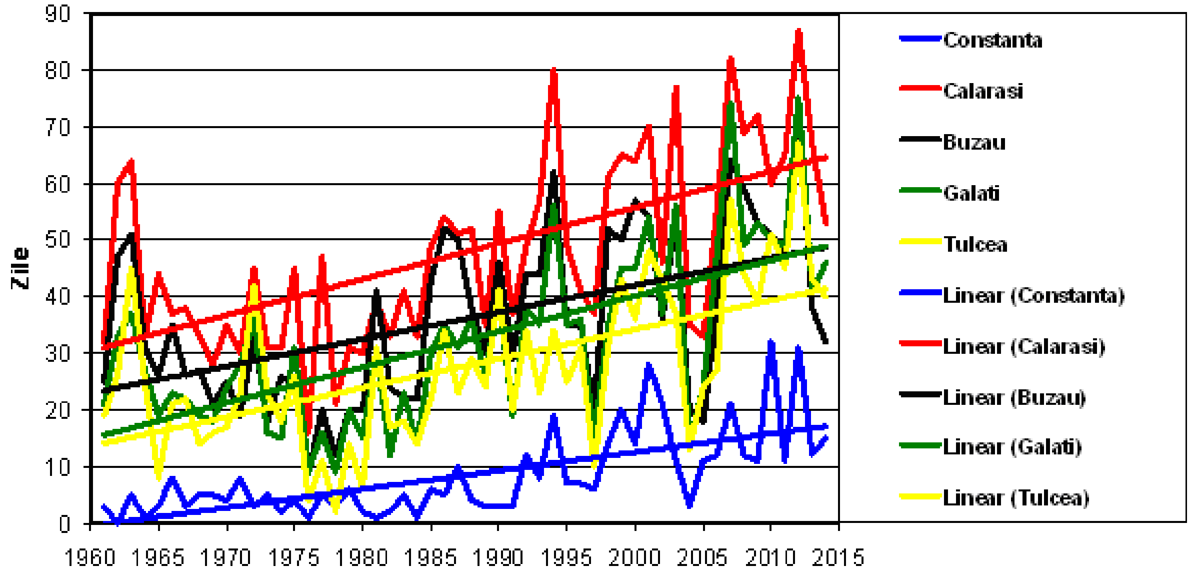

Figure 2. The annual number of tropical days (max. temp. ≥30˚C).

The linear evolution trend of this variable at all the five stations suggests rather more moderate increases at Constanța and Buzău, and somewhat higher at Călăraşi, Galați and Tulcea (Figure 2).

Major implications for human life, and the environment in general, have temperatures of 35˚C and higher, which the longer they last, the greater their threat and impact. In view of their particular dangerous effects, the exceptionally hot-weather cases were studied in detail, e.g. the calculation of the total number of canicular days/year, their evolutions by the year, the periods of successive canicular days and their lengths, and frequency over the studied period, the identification of maximum length of intervals/year and evolution trends.

The annual numerical variability of canicular days (max. temp. ≥35°C) (Figure 3) shows the highest values in the last years of the studied period (2000, 2007 and 2012), with absolute maxima over the 1961-2014 interval, the year 2012 being a record high at almost all the weather stations taken into consideration: Călăraşi 34 days/year, Galați and Buzău 26 days/year, Tulcea 14 days/year.

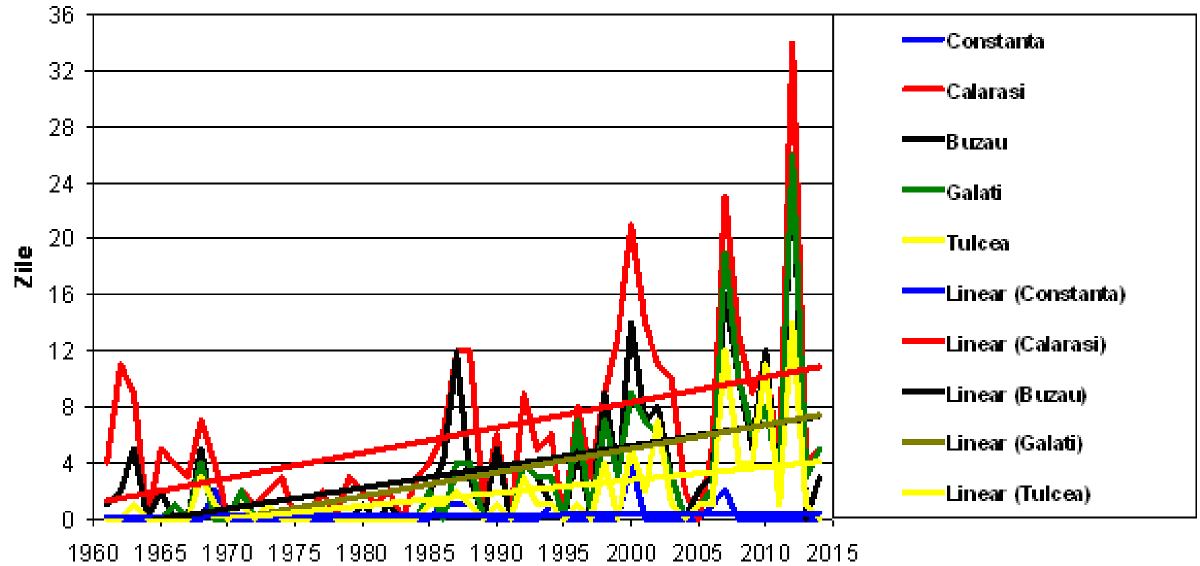

Figure 3. The annual number of canicular days (max. temp. ≥35˚C).

These values were twice and even thrice those summated in other extremely hot years (1987, 1998) of the last 20th-century decades, an indication of the accelerated linear increase trends of this variable, particularly at Călăraşi and Galați stations.

At Constanța station, canicular days were a rarity, being registered only occasionally in some years (4 days in 2000, 2 days in 2007, etc.), due to the more moderate littoral climate (Figure 3).

The absolute frequency of the length of intervals with canicular temperatures by value classes (Fig. 4) shows this variable in the lower classes, all the stations having recorded only two or three consecutive canicular days, that is, two-thirds of the total. The lowest succession of canicular days was registered at Tulcea station (15 cases throughout the studied period) and no such cases in the upper classes at all. The explanation could be the climatic regime with Black Sea influences. Galați station records contain 26 cases of 2-3 cannicular days in a row; one or two cases in the moderate value classes, and an extreme case alone of 10 consecutive days with canicular temperatures. A higher incidence of this variable was found at Buzău station, where climatic influences contain excessive shades, and although the cumulated share of the first two lower classes represents about three quarters of all cases, their absolute value-sum is of over 34 cases, and only incidentally nine days in a row with canicular temperatures. Exceptionally hot days, especially at Călăraşi station, appear also on the graph, their values being the highest absolute ones not only for the two lower value classes (53 cases), but also for the moderate classes, and one single case of 10 successive canicular days on the last value threshold (Figure 4).

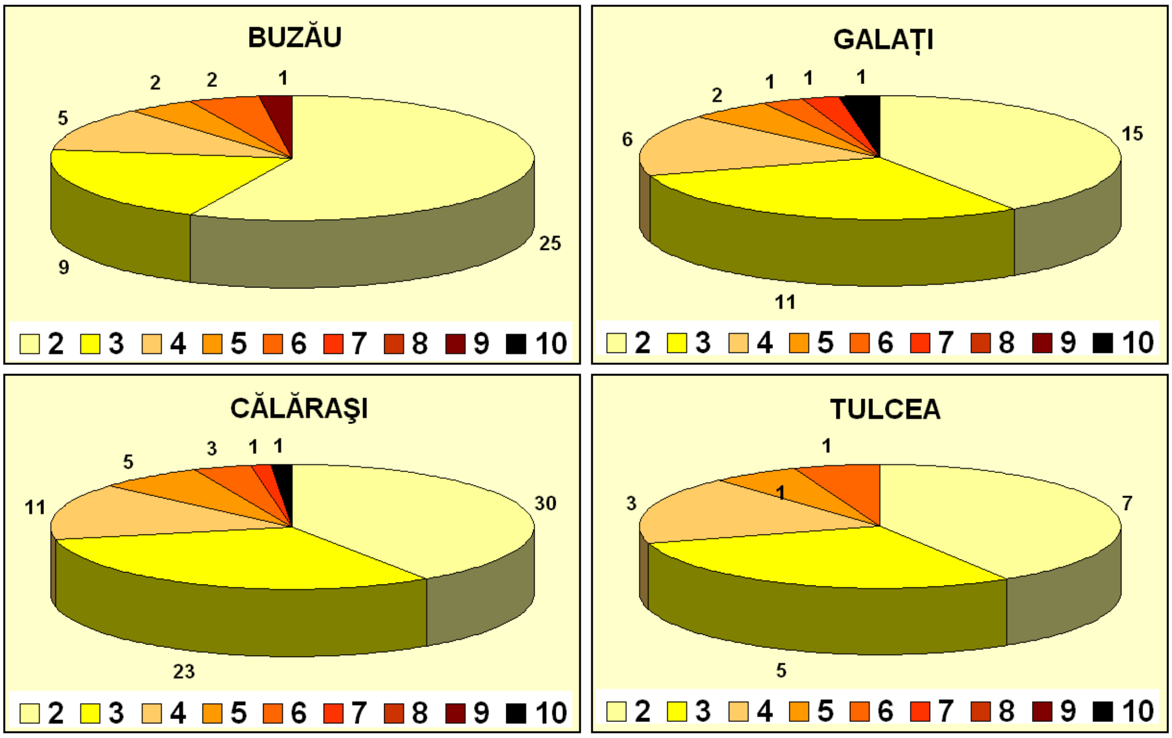

Figure 4. The absolute frequency of the length of intervals with canicular temperatures by value classes.

The graph of variation interval of consecutive canicular days shows the total number of canicular intervals by the year versus the maximum duration of intervals of consecutive days with such temperatures (Figure 5). Although the value evolution differs with the station (highest at Călăraşi and lowest at Tulcea), as far as the years with a maximum value record are concerned, all the four stations display similitudes. Along the 54 years analysed, 2007 stands out by record long intervals of consecutive canicular days: 10 at Călăraşi and Galați, and 9 at Buzău station, the hottest year being 2012 in terms of record sums of canicular intervals (Figure 5). The warming process registered in the last years of the studied period is also indicated by the aspect of linear evolution trends of maximum canicular intervals duration, the highest increasing tendencies being registered at Galați and Buzău stations.

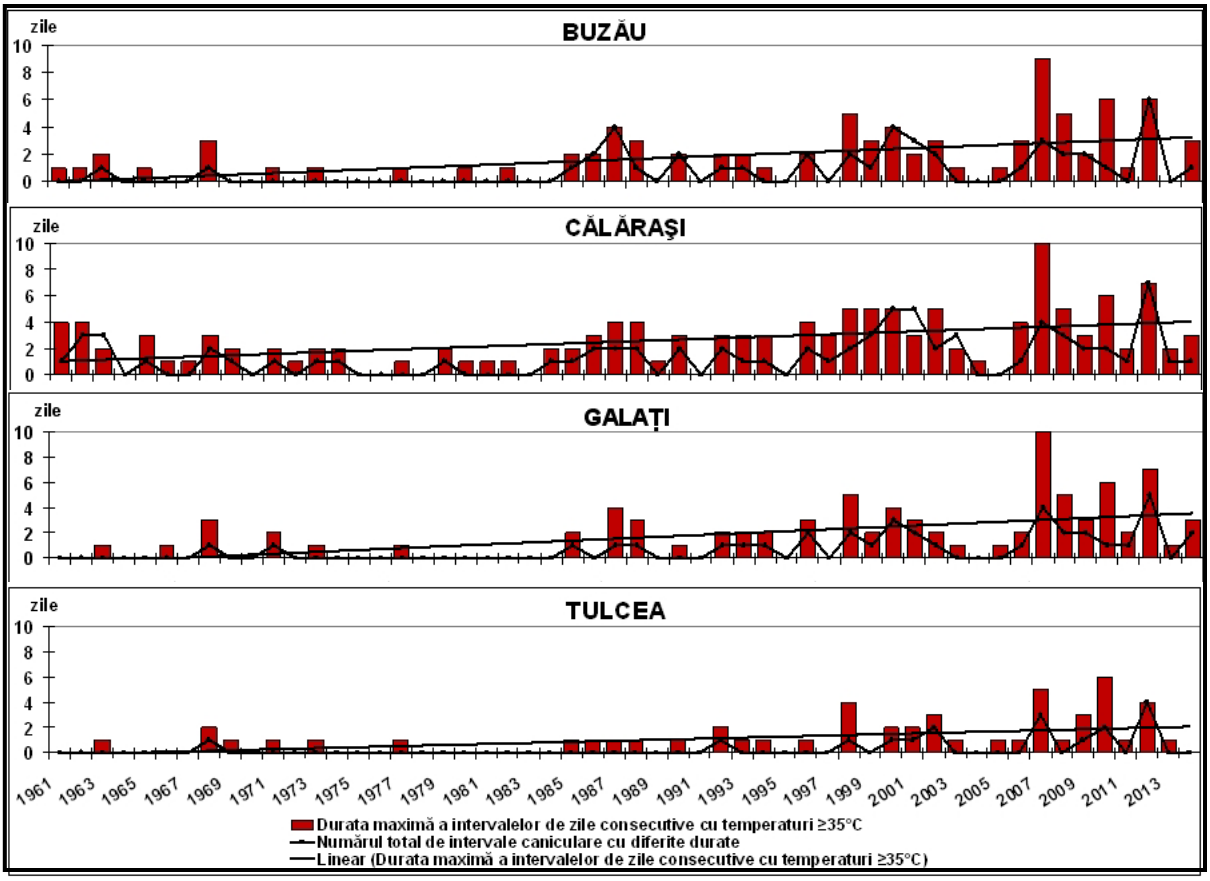

Figure 5. Variation interval of consecutive canicular days.

Record high canicular episodes. The succession of canicular episodes in 2007 and 2012 are actual climate records that indicate climate change in temperate-continental regions manifest against the background of climate warming with excessive shades and a higher frequency of extreme phenomena.

Positive temperature extremes have rather a greater incidence in the South-East Development Region, where the low-altitude relief favours the penetration of the hot tropical air from the south and east, followed by enhanced insolation-induced local warming associated with the Föehn effects felt at the periphery of the Curvature Subcarpathians (Bogdan, 1980, Bogdan; Niculescu, 1990).

Massive advections of very warm air over vast territories at temperate latitude are driven by continental anticyclones originating from South-East Europe, South-East Asia, the Black Sea Basin, the Balkan Peninsula, North-West Africa, etc. (Milea et al., 1971).

The severest warming is the result of the cumulated effect of warm, dry advections and excessive local warming under conditions of reduced humidity and a clear sky specific to persistent anticyclonic activity (Mărculeț, 2014).

Against the synoptic background of a high-pressure ridge coming from Asia Minor and the east of the Mediterranean Sea, most of Europe is affected, but especially its eastern and south-eastern parts, where, as tropical-continental air advections develop, they generate a warm weather, canicular in summer, and generally without precipitation.

A rare situation occurred in July 2007, when the North-African upper-level ridge went beyond the Baltic Sea. At soil level, what mattered in this configuration was not so much the latitudinal extension of the Azore Anticyclone, as the position of the secondary maximum pressure field from the north-west of the Black Sea which would be maintained active by the Arabian low (Mărăşoiu, 2008).

The extremely elevated temperatures registered in the Extracarpathian regions were triggered by a south-west high-altitude circulation and a high pressure field on soil (1015-1020 hPa), facilitating, the advection of a hot Saharian air. The high pressure field on soil, and throughout the tropospheric column, occurred on the geopotential surfaces as a high pressure ridge, advancing from the north of Africa towards the Mediterranean Sea, the Balkan Peninsula and the neighbouring countries (Figure 6, 7). Hovering for days in the plains and lower hills, and associated with the intensification of local insolation processes, it produced excessive and persistent canicular weather.

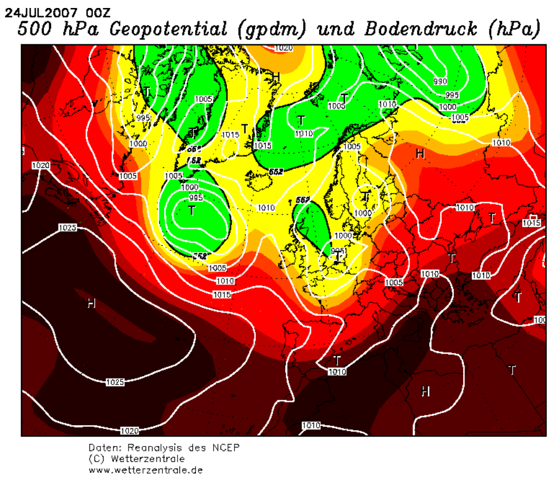

Figure 6. Atmospheric pressure field on the ground and a geopotential field at 500 hPa, July 24, 2007,00 hr GMT (*Karten Archive, Germany*).

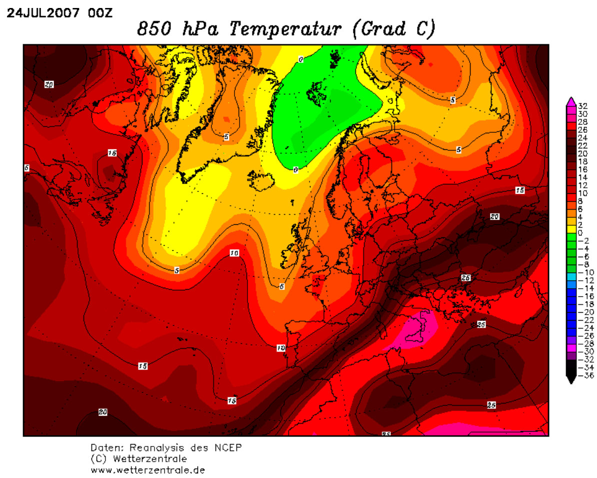

Figure 7. Temperature (°C) at 850 hPa July 24, 2007, 00 hr GMT (*Karten Archive, Germany*).

The whole summer of 2007 was extremely hot, the average temperature in the country (22.6°C) being comparable with that of summer 1946, this time, however, with new monthly absolute maxima registered at 53 weather stations in June, 94 in July and 17 in August, with a record high number of cases (149) in July, and daily maxima of over 40°C, as well as daily records of consecutive canicular days, among which the 10 days previously mentioned at Călăraşi station (Mărăşoiu, 2015).

In the studied region, it was July 2007 when maximum intervals of successive canicular days were registered: 9 at Buzău (17-25 interval), 10 at Călăraşi and Galați (16-25 interval) and a secondary maximum of 5 days at Tulcea station (21-25 interval). Overheatings during that canicular episode topped 40°C on July 23 at Călăraşi (42.1°C) and 40.3°C at Buzău stations, but only 39.9°C at Tulcea station; on July 22, Galați station registered 40.5°C.

Throughout July 2012, canicular intervals were signalled by 5 yellow meteorological code warnings of canicular weather and thermal discomfort and 5 orange codes of canicular persistence with over 40°C; there were 124 new record days with maximum values and 74 new records of highest minima throughout the observation series for the respective dates.

Thus, July 2012 was a record month, the hottest July since 1961, with an average temperature of 23.8°C. Although temperatures did not reach the July 2007 level, there were more time-intervals of over 35°C, the highest number of canicular days in the 1961-2014 period being also registered at the stations in the studied region: Călăraşi 20, Buzău 15 and Galați 14.

Consequences of the positive temperature extremes. The impact of consecutive days with extreme air temperatures are detrimental to people's health in the first place, but they also have major consequences for the environment and the economy.

The impact of excessively hot periods of time is particularly severe for the townspeople of big cities, where green areas have been drastically reduced to the benefit of a highly anthropized environment. Temperatures of over 35°C are a threat to human health, and if they persisted for several days, society as large would be in real difficulty. People's depleted capacity to work eventually impacts the economy by diminishing the outputs (WMO, 2006). In cases of excessive canicular weather, pre-school children, the elderly, people with chronic and neurological diseases, or the homeless, as well as those who fail to protect themselves when working in the open, run high risks, even loss of life (Patz et al., 2005; Teodoreanu, 2007; Bogdan, 2008).

Among the threats to human and animal health we would recall that the highest temperatures are propitious to the spread of infections, by reproducing some pathogens both inside one's body and outside it. Global warming facilitates the dissemination of tropical diseases through various factors (West Nile virus, tick-borne encephalitis virus, etc.). For example, a greater risk of the Lyme disease is caused by the tick *Ixodes scapularis* expanding its area, and transmitting the disease through the agency of *Borrelia burgeroferi,* the process being accelerated by climate warming (Ogden et al., 2009).

In Romania, the higher incidence of confirmed cases is an indication of the dissemination of this tick to new geographical areas, among which some localities in Tulcea and Constanța counties (Paşcalău et al., 2012).

Temperature extremes prove particularly detrimental to agriculture, jeopardising crops, which are partially or totally compromised, also affecting the animals. A negative effect on the transport sector, mostly the railway transport, is the danger of derailment through expansion of the rails, which increases the risk of accidents. The energy sector is directly affected, greater use of air-conditioned devices may produce fault of current in urban agglomerations (Constanța, Galați, etc.) (Bojariu et al., 2015). The indirect effect of the longer canicular periods are the severe droughts which diminish the water amounts of rivers, lakes and the phreatic level, finally impacting the whole social-economic life.

Conclusion

We would say that the warming trend is particularly visible in the studied region, irrespective of the climatic influences and shades locally felt.

The greatest danger is posed by the exacerbation and lasting presence of the upper thermal threshold, canicular weather representing a major thermal stress for the South-East Development Region. In view of the above, taking preventive measures, educating and raising people's awareness, as well as implementing these measures in developing a disaster management system is an imperative necessity.

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THE MANAGING OF THE WASTE WATER IMPACT IN THE PRUT RIVER BASIN (THE REPUBLIC OF MOLDOVA SECTOR)

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Abstract

The purpose of this research consists in the elucidation of spatial and economic aspects of the water use in the Prut river basin. The main topics presented in this paper are: 1) the dynamics of volume of wastewater discharged into the river Dniester basin and its sections; 2) wastewater discharge by the degree of treatment; 3) spatial and branch profile of wastewater discharged; 4) existing problems in the evaluation and monitoring of waste water; 5) efficiency of the implementation of economic and administrative instruments of wastewaters management. In order to achieve these objectives, traditional methods of geographical and economic research were used. Also, the content of the present study is focused on the methodology to elaborate the management plans of hydrographical basins and their chapters on the status of water resources and water bodies and on the economic analysis of water use.

Key words: wastewater, management, Dniester, tariffs, efficiency.

Introduction

The study area – the Prut River Basin within the limits of the Republic of Moldova – has a total area of 8226 km^2 which is ≈ 30% of the total area of the basin respectively. Also basin that holds ≈ ¼ of the area and the total population of Moldova. However, the Prut River basin has a very pronounced rural and agrarian character. Thus, about ¾ of the total population (800,000 inhabitants) is established in rural areas and to agriculture water use captured over 70% of the perimeter of the basin. In addition, only in Cahul and Ungheni prevailing urban infrastructure and non-agricultural occupations, and most other cities have poor access to urban services and modern facilities.

The volume of wastewater disposal in the area mostly reflects the volume of water consumption. It depends on the demographic characteristics of the territorial entities (Ungheni and Cahul districts) and the presence of large industrial enterprises (e.g. sugar factories) (Glodeni, Făleşti and other districts).

A lot of farms do not use sewage disposal systems. In most cases the discharge of insufficiently treated and untreated water was provided by the livestock breeding complexes, many of which are located in the water conservation areas around the river. The discharge of the untreated municipal wastes remains a topical issue. In some cases, water pipelines are built without construction of sewage facilities and sewage treatment plants. In addition, most rural households are not connected to centralized sewerage and effluents are not evaluated. Thus, the river basin is used primarily for water supply. However, in the last two decades, large quantities of untreated waste water and chaotic waste disposed over the area of the basin, turned the water of one "of the cleanest rivers of Europe" into one moderately and heavily polluted.

The managing of the wastewater is focused on some basic principles, such as: a) the polluter pays; b) full recovery of costs for wastewater services and of damaged caused on the environment and human body; c) optimize economic performance of the wastewater facilities and services; d) decentralization and local financial autonomy; e) norming of wastewater discharge; f) to prevent accidental situations.

The economic and financial instruments regulating the wastewater discharges are: 1) tariffs for the provision of sanitation services applied to secondary water users; 2) pollution charges applied to primary water users; 3) fines for infringements of water protection regulation; 5) damage caused on water sources and sewerage installations; 6) grants for the expansion and modernization of the sanitation network.

Theory and methodology:

The present research is based on recent analytical studies on the implementation of the Management Plan of River Basin, which is stipulated in the EU Directive (2000/60 / EC) on integrated water management (*Directive 2000/60/EC of the European Parliament*). For this study, the author has focused on management plans which are being implemented, such as the Danube River Basin Management Plan (*Danube River Basin Management Plan*) and the Management Plan of the River Space Prut-Bârlad (*Planul de management al spațiului hidrografic Prut Bârlad*). Very valuable, in particular for determining the status and economic analysis of water use are the research methodology and study of transboundary rivers in the Black Sea Region and Belarus (*EPIRB Program*).

The main methods used in this study are: statistical, analytical, comparative, analogical, as well as consultation with competent authorities in the field of assessing and managing water resources. The statistical method was widely used in the processing of the statistical information on the capture and use of water in all the administrative-territorial units from the Dniester basin. The analytical method was used a) to identify qualitative aspects of the sanitation system; b) for the diagnosis of a situation in this space; c) for the establishment of problematic situations in regulating system; c) for the elaboration of recommendations to prevent problematic situations; d) for the definition of priority directions of activity optimization of water resources management in the Prut basin. The comparative method was applied to establish the trends in the branch and spatial aspects of the use of water resources, the dynamics of tariffs for sanitation services.

The main informational and statistical support that formed the basis of this study included: 1) Generalized Annual Reports on Water Management Indicators elaborated by the Basins Department of Agency "Apele Moldovei" (*Rapoartele anuale generalizate privind Indicii de gospodărire a apelor în Republica Moldova*); 2) Annual Reports of Ecological Agencies and Inspection (*Rapoartele anuale privind calitatea factorilor de mediu şi activitatea Agențiilor şi Inspecțiilor Ecologice*); 4) The Reports of water supply and sewage companies of Association "Moldova Apa-Canal" (*Planul de management al spațiului hidrografic Prut Bârlad*); 5) analytical studies in this field (*Danube River Basin Management Plan; EPIRB; Planul de management al spațiului hidrografic Prut Bârlad*), including by the author of this article (Bacal, 2010). The study comprised mostly the years 2007-2014. The results of this study were used by the author in preparing Chapter 6 (economic analysis of water use) of the Management Plan of the Prut River Basin in 2014-2015.

Table 1. Discharged wastewater volume and weight per river basins (average in 2007-2014).

River Basin	Total		In natural water receivers									In retention basins
			Total	Without treatment		Insufficiently treated		Conventio-nally pure		Sufficiently treated		
	mln m³	%	mln m³	mln.m³	%	mln m³	%	mlnm³	%	Mln m³	%	mln m³
Prut	80	1.2/10[1]	6.5	0	0	1.4	17	3.7	46	1.4	18	1.4
Prut river bed	2.0	0.3/2.6	1.8	0	0	1.0	49	0.01	0.6	0.8	40	0.2
Dniester	674	98	669	0.84	0.1	6.6	1.0	547	81	113	17	4.7
Totally, RM	683	100	677	1.0	0.16	8.8	1.3	551	81	115	17	6.8
Left bank of Dniester river	79	12	75.2	0.94	1.2	6.0	7.6	5.7	7.2	61.5	78	4.7

***Source**. Table and figure are elaborated by the author according to data from Generalized Annual Reports (2007-2014) regarding the Indices of Water Management in Moldova. Bazine Department of the Agency "Apele Moldovei".*

Results and discussions

Waste water discharge

An amount of 8,0 mln m^3 of wastewater is discharged in the Prut river basin, which represents 1.2% total discharged waste water of the country (Table 1) and 10% on the Dniester right bank.

In the last 25 years (1990-2014), the total volume of wastewater discharged in the Prut river basin decreased about 14 times, from 97 million m^3 to 7 million m^3 (*Rapoartele anuale generalizate privind Indicii de gospodărire a apelor în Republica Moldova)*. The main causes are: the drastic reduction of the volume of industrial and agricultural production and services; the deplorable status and stopping of the operation of several sewage treatment plants in the household sector, industry and services; the partial presentation of data about wastewater discharge; the application of the "guillotine law" in environmental control; the massive negligence of environmental requirements etc. Since 2007, its found a oscillating evolution on the background of slow reduction a trend and the average is 8,0 mln m^3.

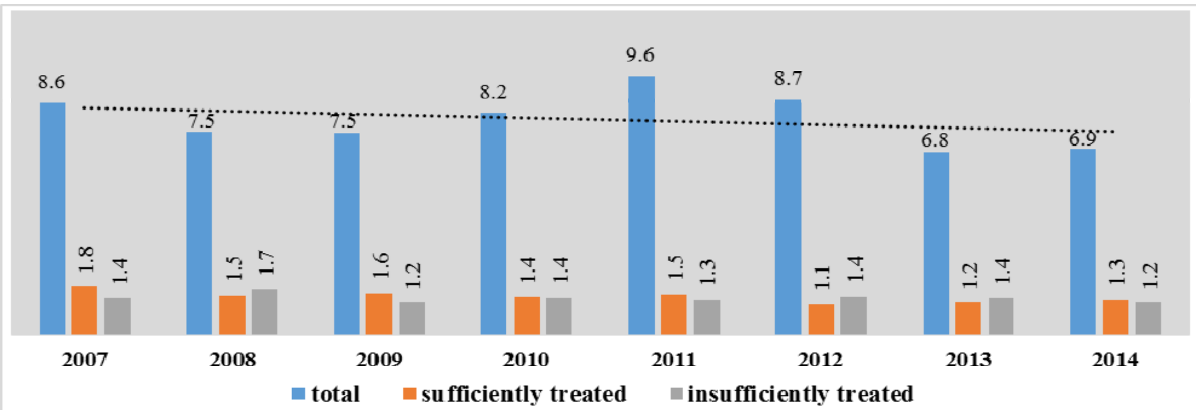

Figure 1. Dynamics of volume of wastewater discharges.

In natural waters an average of 6.5 mln m^3 are discharged (75%) of waste water, including 1.8 mln m^3 in the Prut river bed. In the retention basins 1.4 million m^3 were evacuated. Nearly 50% (3.7 mln m^3) of the waste water discharged into natural water basins is

[1] on the right bank of the Dniester river

assigned to conventional pure water and 16-17% (1.4 mln m^3) for each of the two, sufficiently and insufficiently purified waste water, while sewage discharged without treatment is almost missing.

At the same time, according to the ecologic and medical authority reports (*Rapoartele anuale privind calitatea factorilor de mediu şi activitatea Agenţiilor şi Inspecţiilor Ecologice*), these figures do not correspond to reality. More than this, most treatment plants are worn and damaged, and some do not work. Also, reports of the Agency "Apele Moldovei" contain inaccurate information (mln m^3), which may not be subject to appropriate spatial or branch review, and in many districts the use and disposal of sewage include only data from the urban areas served by the municipal enterprises of the Association "Apă-Canal".

According to local environmental authorities' annual reports for the years 2003-2014, about 46% of the discharged waste water was insufficiently treated, and 28% untreated, which is much closer to reality than the data provided by the Agency "Apele Moldovei". The volume of discharged wastewater indicated in the regional environmental authorities' reports constitutes about 70% of that indicated in the reports of the Agency "Apele Moldovei" and includes only a part of the agricultural enterprises, which are attributed to pure conventional category. In addition, the environmental reports in some districts (eg. Râşcani, Hânceşti) include a larger number of public utility enterprises.

The production indices of sewerage and wastewater treatment services

Within the Prut river basin work 43 centralized waste water discharge systems or 3 times less than the water supply systems (Figure 2). The total length of the sewerage network is 389 km (table 2), and 279 km or 13% of all network belongs to the Association "Apă-Canal". The length of the sewerage networks is conditioned by the size of the served urban centers. Thus, the maximum length is registered in the districts of Ungheni (86 km), Edineț (57 km), Cahul (66 km), and the minimum (<10 km) in Ocnița, Nisporeni and Cantemir districts.

Table 2. The sewerage and wastewater treatment services at the enterprises of the Association "Moldova Apă-Canal" located in the Prut river basin (2013).

No.	TAU	Number of sewerage systems		Length of sewerage network, km		Number of pumping stations		Treatment stations		
								Capacity, thousand m^3/day		Usage degree, %
		Total	Apă-Canal	Total	Apă-Canal	Total	Apă-Canal	Total	Apă-Canal	Apă-Canal
1	Ocnița	3	3	12.5	4.1	3	1	3	1.2	37
2	Briceni	3	2	33.1	30.1	3	2	11.4	10	2.2
3	Edineț	5	2	56.6	52.7	9	7	5.8	5.5	18.3
4	Râşcani	3		17.1		4	3	1.2		
5	Glodeni	9	1	35.1	18.2	10	3	11.2		
6	Făleşti	2	1	43	31	5	3	12.1	10	4.1
7	Ungheni	6	1	85.6	63.2	7	3	18.3	15.0	16.1
8	Nisporeni	2	1	8.5	6.8	*2*	3	1.5	1.5	23.4
9	Hânceşti	4		10		4		2		
10	Leova	1	1	12.6	12.6	3	3	4.7	4.7	4.3
11	Cantemir	1	1	8.9	8.9	0	0	3.5	3.5	4.9
12	Cahul	4	1	65.6	51.6	5	3	14.3	13.7	15
	Totally Prut	**43**	**14**	**389**	**279**	**55**	**31**	**89**	**65.1**	**12.5**
	Totally RM	**156**	**48**	**2663**	**2187**	**209**	**125**	**687**	**649**	**27**

Sources. *Elaborated by the author on the basis of the NBS Reports on the water supply and sewerage systems, amac.md.*

Unlike the water supply systems, the sewerage and treatment systems do not register high growth rates (Figure 2). Overall, according to the National Bureau of Statistics, the number and length of sewerage networks in the years 2007-2013 remained practically unchanged (+ 2%) and, in the districts Râşcani, Nisporeni and Leova they showed a negative trend. Moreover, the coverage of water supply and sewerage networks decreased during the period by ≈ 2 times (from 36% to 20% reported to their length). And even more, decommissioning and abandonment of sewerage networks is mostly observed in rural areas and mono-specialized and intensive ruralized small towns in the last 2 decades.

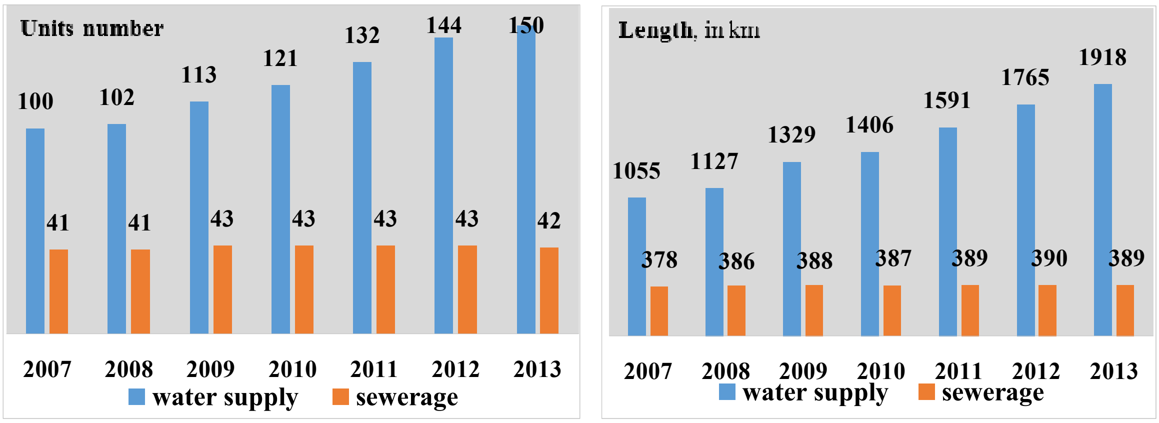

Figure 2. Dynamics of water supply and sewerage systems in the Prut river Basin.
Source. *Elaborated by author based on the NBS Reports on water supply and sewerage systems (Activitatea sistemelor de alimentare cu apă şi de canalizare în anii 2006-2013).*

The extension of the water supply infrastructure requires it to be accompanied by a similar expansion of the sewerage network. These requirements have recently been included both in the legislative acts regulating this field and regulations of water supply business, and environmental and regional funds, which also finance such projects. In spite of their mandatory character, these requirements are often not respected.

The total capacity of the waste water treatment systems is over 90,000 m^3/day and only 12% of it are used. That is conditioned by the economic and demographic decline of the served towns, as well as very high (over 50%) of the wear and tear sewerage and waste water treatment installations. Disastrous technical conditions and a superficial control of the sources of pollution, water pollution, very low payments and episodic offenders' punishing generate, on the whole, a great impact on the water and the human body.

The total volume of wastewater discharged through the sewerage network is 3.1mln m^3, out of which 2.7 mln m^3 by the enterprises "Apa-Canal" (Table 3). The amount of discharged wastewater is subject to the urban and industrial center size. The maximum volume of discharged wastewater is found in the districts of Ungheni, Cahul and Eirdeţ and the minimal one in the districts of Ocniţa, Cantemir and Leova (*Activitatea sistemelor de alimentare cu apă şi de canalizare în anii 2006-2013*). Also, the minimum values in the Hânceşti and Râşcani districts is conditioned by the location of these district centers outside of the Prut river basin.

On average, ≈ 60% of the discharged wastewater comes from households, and 30% from economic agents. Lately, the share of industrial enterprises decreased significantly, but the share of budgetary organizations, commercial and service centers increased. Over half of the discharged wastewater is insufficiently treated as confirmed by local environmental authorities.

Table 3. Wastewater discharged into the Prut river basin per categories of users.

No.	TAU	Total		Population			Economic agents			Insufficiently purified	
		Total	Apă-Canal	Total	Apă-Canal	Total	Total	Apă-Canal	Total	Apă-Canal	
		thousand m^3		thousand m^3		%	thousand m^3		%	thousand m^3	%
1	Ocniţa	56.8	56.8	38.5	38.5	68	2.5	2.5	4	56.8	100
2	Briceni	121	106	81.3	77	68	5.4	5.4	4	106	100
3	Edineţ	468	367	157	154	34	200	200	43	15.8	4.3
4	Râşcani	17		16		94	1		6		
5	Glodeni	298	80.5	59.2	59.1	20	218	6.0	73	148	100
6	Făleşti	178	148	122	106	74	33.2	30.4	20	881	100
7	Ungheni	884	881	581	581	66	183	183	21		0
8	Nisporeni	135	128.1	41.7	41.7	59	10.1	10.1	14	73.7	100
9	Hânceşti	20		10		63	6.0		38	62.5	100
10	Leova	73.7	73.7	40.9	40.9	55	4,.0	4.0	5		0
11	Cantemir	62.5	62.5	53.3	53.3	85	3.6	3.6	6		
12	Cahul	752	749	473	469	63	229	229	30		
	Total Prut	**3066**	**2653**	**1674**	**1621**	**56**	**896**	**674**	**30**	**1343**	**51**
	Total R M	**65942**	**63977**	**38754**	**38275**	**60**	**9825**	**9170**	**20**	**4534**	**7**

Source. *Elaborated by the author based on the Reports of the NBS and of Association „Apele Moldovei" on sewerage systems.*

Tariffs for sewerage and waste water treatment

Tariffs for public water supply, sewerage and wastewater treatment are applied to secondary users which are supplied by public or private enterprises authorized to provide these services. They are intended for 3 main categories of consumers, which are assigned separate tariff quotas: 1) population and households, including nutrition and sanitation, irrigation of the lots nearby the house, and maintaining livestock; 2) budgetary organizations; 3) economic agents performing various entrepreneurial activities and request the purchase of such services.

The amount and procedure of charging for public water supply, sewage and treatment are set out in Decision no.164. of National Agency for Energy Regulation (NAER) of *29.11.2004* on "Methodology Determination, Approval and Application of Tariffs for Public Water Supply, Sewerage and Waste Water Treatment" (*Hotărârea nr. 164 a Agenției Naționale pentru Reglementare Energetică din 29.11.2004 privind Metodologia determinării, aprobării şi aplicării tarifelor pentru serviciile publice de alimentare cu apă, de canalizare şi epurare a apelor uzate)*. This methodology is developed in accordance with the provisions of the Law on Public Utility Service no. 1402-XV of 24.10.2002, on the Drinking Water Act no.272-XIV of 10.02.1999, Law no. 303 of 12.13.2013 on public water supply and sewerage and Law no. 397 of 16.10.2003 on local public finance.

Also, recent methodology amendments are adjusted to Article 9 of the Water Framework Directive 2060/EC and focus on the "beneficiary and polluter pays" and water supply and sewerage cost recovery from the service tariffs. Meanwhile, tariff shares for water supply and sewerage services are set only on categories of users and their ability to pay, but not on the complex value (economic, recreational and ecological) of the water objectives and sources, the cost – efficiency analysis in accordance with the WATECO Guidelines on the methodology of economic evaluation of water use and restoration and the ecological status of water sources.

Tariffs are calculated separately for the services of drinking water supply, technological (industrial) water supply, and sewage and waste water treatment starting from consumption and expenditures determined according to this Methodology. Their quotas are approved by local public authorities and the public service tariffs for technological (industrial) water supply provided centralized by city and district are approved by the Board of Directors of NAER, in coordination with local public authorities. Enterprises calculate the tariffs according to the present methodology and submit them for approval to the authorities entitled to approve these rates (NAER, LPA). Under the new legislative provisions, *if the local council approves tariffs at a lower level than those provided in The Opinion delivered by the The Agency, it is obliged to establish in its decision of tariff approval the source and specific amount to be allocated to the operators to cover their lost incomes due to low tariffs.*

The average amount of general tariff for sewerage service in the enterprises of the Association "Moldova Apă-Canal" in the Prut river basin is 12.0 MDL/m^3 or 1.3 MDL/m^3 lower than the general tariff for water supply (*Indicii financiari şi de producţie ai activităţii întreprinderilor de alimentare cu apă şi canalizare ale Asociaţiei „Moldova Apă-Canal”).* Also, the average quota in the Prut river basin exceeds the average quota of tariffs in the Dniester river basin.

In the period under review, the general tariff increasing rate for sewerage is, on average, 78% (Table 4) and significantly exceeds the growth rate of the water supply tariffs in the basin. Also, there is a more rapid increase in these tariffs compared to the Dniester river basin and the Republic. In the Prut river basin the highest growth (2.5-3 times) of the general tariff is recorded in Leova, Nisporeni and Ocniţa and the lowest (up to 30%) in Glodeni, Cahul and Briceni.

In 2014, the average quota of the general tariff was 15.25 MDL/m^3. Despite the unique methodology for calculating the tariff, large differences are observed (5-6 times) between the maximum and minimum quotas approved by local councils, denoting subjectivity in the procedure for establishing and approving the tariff. Thus, the maximum quotas (> 20 lei/m^3) of the general tariff are set in Glodeni and Leova and the minimum in Cahul (4.57 MDL/m^3) and Ungheni (8.58 MDL/m^3) due to "economies of scale", as well as in Cantemir (6.48 MDL/m^3). In most of the sewerage networks and wastewater treatment plants an infrasture with a high degree of wear (about 60%) predominates, which considerably reduces the profitability of these services and imposes tariff increases.

Table 4. Tariff for public sewerage services for the enterprises of the Association "Moldova Apă-Canal" in the Prut river basin per consumer categories, MDL/m^3 (without VAT).

Category	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**average**	**growth**, %
Average tariff	8.57	8.61	10.41	11.45	13.00	13.28	15.25	15.25	12.0	178
Population	6.05	6.17	7.02	8.02	8.94	9.11	9.97	9.97	8.1	173
Budgetary organizations	17.58	17.58	19.14	18.81	21.10	21.68	23.94	23.94	20.2	143
Economic agents	17.97	17.97	20.60	20.90	22.51	23.63	25.84	25.84	21.7	150

Tariffs for sewerage services to the population register an increase of 73% or 20% more than the increase in these tariffs for budgetary organizations and for economic agents (fig. 3). Thus, unlike the case of water supply service, the sewerage service records decreasing of tariff cross-subsidization, but tariffs for the population remain ≈3 times lower than for the other two categories of consumers.

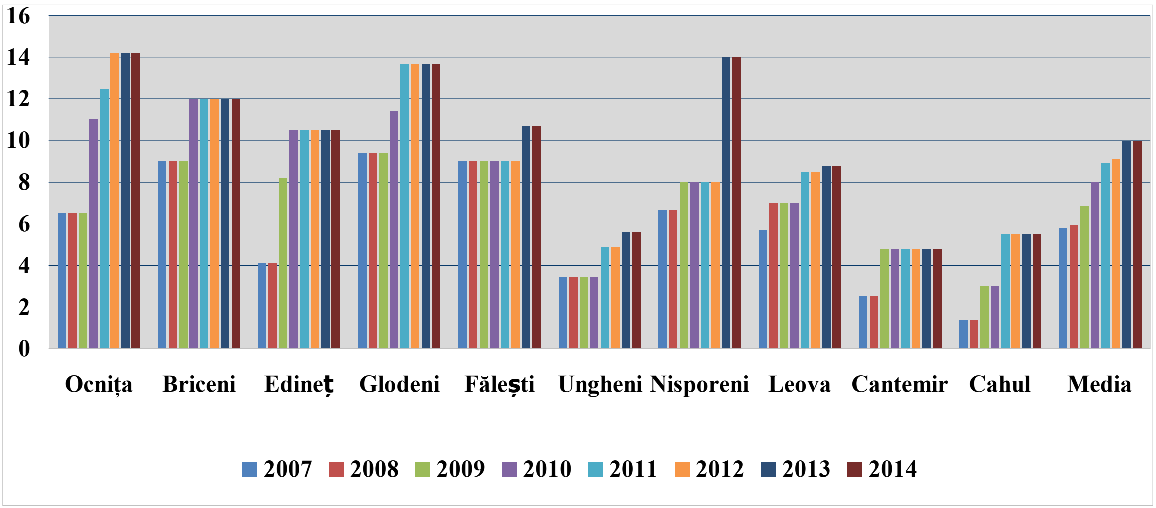

Figure 3. Tariff dynamics for sewerage service provided to population, MDL/m^3.

The average amount of current sewerage tariffs provided to population is ≈10 MDL/m^3. The minimal quota (<5 lei/m^3) is established in Cahul and Cantemir, and the maximum (14 MDL/m^3) in the small towns Ocnița, Nisporeni and Glodeni. Also, differences between minimum and maximum quotas are much lower than other consumer categories and continue to decrease.

Tariffs for sewerage service provision to economic agents were increased, on average, by 50% (Table 4) or much slower than the tariffs for the population. The fastest increasing (>2 times) is found in Edinet, Nisporeni and Ocnița and the minimal increase (<20%) in Glodeni, Cahul and Făleşti (Figure 4). A similar dynamics, but slower, is stated in the water supply tariffs for budgetary organizations.

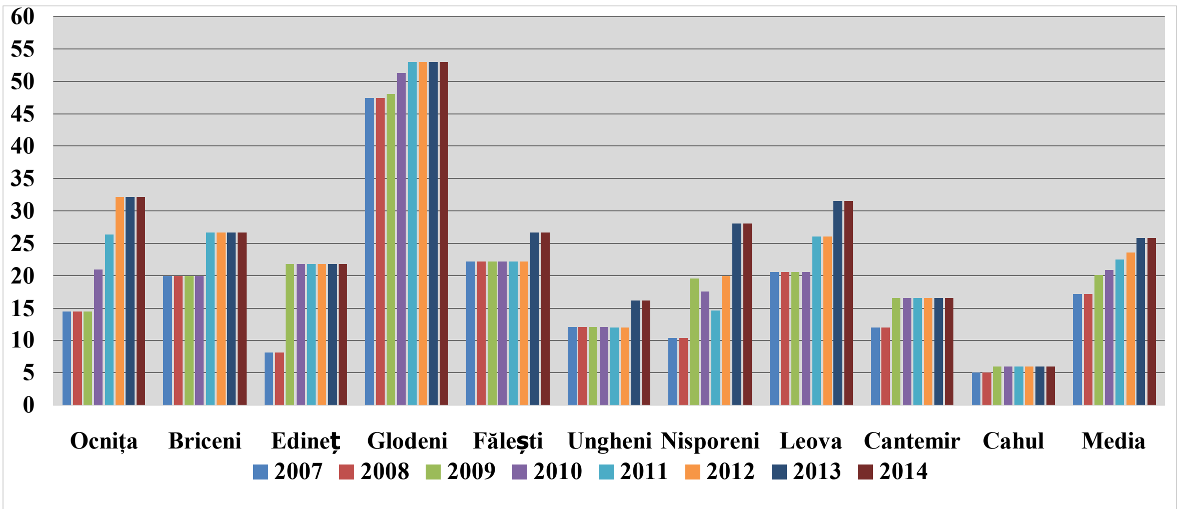

Figure 4. Tariff dynamics for sewerage service provided to economic agents, MDL/ m^3.

Average quota for economic agents' tariff is ≈ 26 MDL/m^3 and of the tariffs for budgetary organizations is ≈ 24 MDL/m^3. For both categories of consumers, the maximum tariffs of over 40 lei/m^3 are set out in Glodeni and the minimum in Ungheni and Cahul. Despite the existent large differences, there is a tendency to level the tariffs.

Unlike the water supply service, the difference between the tariff and the prime-cost for sewerage service is positive (0.95 MDL) and determines the overall positive difference between tariffs and prime-costs in the enterprises of "Apă-Canal" in the Prut river basin. Also, the average difference in the Prut river basin exceeds with over 2 lei the national average, which is negative (-1.13 MDL). This fact is due, in particular, to a higher growth (20%) of the tariff for sewerage services in that basin. In 2013, tariffs for sewerage services were lower than prime-costs only in 4 of the 10 enterprises of "Apă-Canal" in the Prut river basin due to minimal tariffs in Cahul (-4.3 lei MDL) and smaller capacity enterprises in Cantemir (-3.1 MDL), Ocniţa (-1.2 MDL) and Briceni (-0.56 MDL). Also, as mentioned above, obtaining and increasing positive difference was possible not only due to the increase in tariffs for sewerage, but also to the more efficient use of production factors and the optimization of the strategic and operational management.

Charges for water pollution

According to Article 9 and Annex 5 of Law on Environmental Pollution [8], water pollution payment shall be applied for: 1) discharges of waste water pollutants into water bodies and sewerage systems; 2) discharges of pollutants into receiver-tanks, fields of filtration, drainage collectors; 3) water discharges from fishery ponds; 4) the rain leaks from the territory of enterprises; 5) the heat exchange water release. These payments are charged from polluters for the normative and over-normative discharges.

Table 5. Dynamics payments for water pollutants in the Prut river basin (thousand MDL).

No.	TAU	Years								
		2007	2008	2009	2010	2011	2012	2013	average	growth, %
1	Briceni	101	193	238	153	294	152	173	186	171
2	Ocniţa	40.4	77	95.2	61	118	60.9	69.2	74.5	171
3	Edineţ	64.1	87.9	109	104	181	101	140	112	219
4	Râşcani	36.8	60.1	76.3	63.4	102	68.9	90.3	71.2	245
5	Glodeni	38.9	32.8	71.5	56.1	101	80.7	51.1	61.7	131
6	Făleşti	70.9	67.6	109	124	141	78.4	102	99	144
7	Nisporeni	23.3	33	43.6	56.3	128	82.7	125	70.2	536
8	Ungheni		9.5	3.4	12.7	15.1	44	20.1	17.5	212
9	Hânceşti	52.9	51.9	59.2	41.4	57.2	39	42.9	49.2	81
10	Leova	56.8	58.7	65.4	68.7	78.1	67.5	94.0	69.9	165
11	Cantemir	23.6	48.9	39	45.1	58.9	34.5	97.4	49.6	413
12	Cahul	27.8	36.5	44.7	51.3	65.7	60.2	54.8	48.7	197
	Prut bazin	**537**	**757**	**954**	**836**	**1339**	**870**	**1060**	**907**	**198**
	Total RM	**4033**	**3978**	**5056**	**4726**	**6551**	**4896**	**5467**	**4958**	**136**

Sources. *Elaborated by the author according to the data of the Annual Reports of Ecologic Agencies and Inspections (Activitatea sistemelor de alimentare cu apă şi de canalizare în anii 2006-2013).*

The calculation formula includes the produce of: a) payment normative; b) aggression coefficient; c) the actual mass of discharges. Payment for the discharge of pollutants is mandatory for all water consumers. At the same time, according to Article 2 of this law, payments for discharges of pollutants are collected only from the water supply beneficiaries who carry on an economic activity that generates pollutants. Usually, this payment shall be paid only by big enterprises and the majority of budgetary organizations are not included in the list of payers. These categories of polluters and the households that use the centralized wastewater discharge network have to pay for the sewerage and treatment services.

Frequently, no discharge payments are applied for the manures pollutants from animal breeding complexes, especially from the sheep ones, many of which being located in the immediate proximity of rural settlements and do not meet environmental and sanitary norms.

The amount of payment for the discharge of pollutants is conditioned by the number and size of the monitored polluting enterprises, the volume of discharged wastewater and its toxicity, as well as the volume of pollutants leaking with rainwater from their territory. The last index is conditioned both by enterprise drainage area and the rainfall amount in that period. Moreover, the payment for pollutants leaking with rainwater shall be paid only in the case of exceeding the established norms, and applying the multiplication coefficient. This explains the higher discharge payment amounts for pollutants in 2011 and 2013 (Table 5), when a greater amount of precipitation fell. The maximum amount of payments for discharging pollutants is collected in Briceni, Edineț, Falesti, and Nisporeni.

Also, the paid amount depends not only on the amount of pollution, but also on the activity and efficiency of regional environmental authorities, which explains some large amounts in some districts with fewer and smaller production capacity of the industrial enterprises such as Nisporeni, Leova and Cantemir.

Overall, in the Prut river basin, the amount of payments calculated for the discharge of waste water pollutants is about 1 mln MDL or 20% of the total country amount (Table 5). In the period under review, there is a variable evolution of the amounts paid for the Prut river basin water pollution. At the same time, this variable evolution is marked by an overall positive trend in most of its districts. On the whole, there was a doubling of the amount of those payments, and the highest increase is observed in Nisporeni, Cantemir and Râşcani. About half of the amount of payments for pollution originates from the enterprises in agriculture and food industry, followed by fuel marketing, and service and transport companies. In the northern districts of the basin the mining industry lies among the top positions.

Payments for the discharge of pollutants have a significant contribution to the National Environmental Fund's income. These are collected from local environmental funds and 30% of them transferred to NEF. Regional environmental authorities, who are responsible for implementing environmental payments, lack qualified staff and technical equipment necessary for the effective monitoring of pollution sources. As a result, much of the pollution sources, especially of small and medium impact, and public institutions are not monitored and do not pay for pollution. More than half of the amount of payments received during the current year represents the calculated payments for previous years, and creates large distortions in planning local environmental fund income and transfers to NEF.

Conclusions

Due to its pronounced agrarian and rural characteristic, the Prut River basin has a reduced share of only 1.2% of the total volume of wastewater discharged and 10% on the Dniester right bank.

In most rural localities, the extension of the water supply network was not accompanied by the necessary work of sewage and wastewater purification, which increased significantly the impact on water and human health in these areas. The very low coverage of sewage network stimulates massive depopulation of the rural space in Moldova and significantly limits the local development.

There are major gaps in the monitoring of wastewater discharges, official statistics provided by the Agency „Apele Moldovei" are incomplete and the actual harmfulness of wastewater evacuated is greater.

Tariff quotas are set only on categories of users and their ability to pay, but not on the complex value of water resources and cost-effectiveness analysis and on the restoration of the ecological status of water sources.

Despite the significant growth of tariffs, in the majority of enterprises "Apa-Canal" the expenses related to sewerage services exceed these incomes. However, despite the unfavourable situation, it is found there is a faster increase of income over expenditure. This fact proves the start of a trend to increase the efficiency of the "Apa-Canal" enterprises after nearly two decades of decline and ruin.

It is necessary that the tariffs increase and the difference between them and prime-costs not only to contribute to increased corporate profitability and optimized ratio between quality and price, but also to a more economical use, reduced harmful impact and improved quality of water.

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CLIMATE CHANGE AND TOURISM. BETWEEN OPPORTUNITY AND UNPREDICTABILITY

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Abstract

The 4th IPCC Report (2007) states that global change is unquestionably underway, affecting all environmental components, as well as the economy and human society at large. This ongoing process, started in 1980, is mainly the consequence of gas-induced greenhouse air pollution. The Expert Group for Climate Change devised a number of scenarios of a global rise of the air temperature mean values by 1.8-4.0˚C at the end of the 21st century compared to the 1980-1990 interval. According to B1 scenario, the temperature in Europe is expected to increase by 2.0-2.5˚C (Sandu et al., 2010, p. 21), while B2 scenario forecasts 4.0-5.0˚C if the gas-induced greenhouse air pollution is not stopped. The latest estimations contained in the 5th IPCC Report (2013) suggest that, by the end of the 21st century, the mean global temperature could be higher by 1.5˚C than in the years 1850-1900, other scenarios indicating 2.0˚C and over (Bojariu et al., 2015, pp. 88-89). The specialist literature considers that among the numerous and unpredictable consequences of this process, tourism will be the most affected by climate warming, basically by its meteo-climatic and hydrological hazards of great destructive potential, e.g. higher incidence of meteo-climatic risks, especially thermal-pluviometric contrasts, canicular temperatures, the melting of mountain and ice-cap glaciers, greater concentration of gases with greenhouse effect, disturbance of tourists' health condition, etc. All these situations might destabilise the local and regional climate, disturb the translation of climatic zones and seasons, induce abnormal psychic and social behaviour, all with obvious impact on tourism. As indicated in the STERN Report (2007), two measures should necessarily be taken: adjusting to the new climatic conditions and undertaking a new type of tourism management in line with European and international norms, in order to ensure the profitable and sustainable development of this domain.

Key words: climate change, global warming, meteo-climatic and hydrological hazards, tourism adjustment and management.

Introduction

The contemporary society is being faced with a global risk phenomenon, that is climate warming, which impacts all environmental components (Ciulache, Ionac, 2002; Bălteanu, Şerban, 2003; Cuculeanu – coordinator, 2003; IPCC, 2007; Bogdan, Marinică, 2007; Busuioc et al., 2010; Sandu et al., 2010; IPCC, 2013; Bojariu et al., 2015, etc.).

That is why many scientists consider climate warming to be an ongoing "planetary cataclism", some perceiving it as the greatest risk, greater even than geological disasters (earthquakes, which though catastrophic, occur locally, whereas climate change affects the whole planet (Bogdan, Marinică, 2007).

The arguments sustaining this view:

- Scientific research has shown that between 1860 (when weather observations began) and 1990 the hottest year was 1860;
- Within a lapse of 100 years (1906-2005), temperature values were higher by 0.74˚C, while in the interval between 1901 and 2000 the increase was of 0.6˚C; from 1880 to 2012, the average global temperature rose by 0.85˚C and by nearly 1˚C in Europe (5th IPCC Report, 2013);
- From 1950 to 2014, out of the warmest 15 years, 14 occurred in the 21st century (IPCC, 2014).

- Within a ten-year interval (1991 and 2000), temperatures were higher by 1˚C/decade (1998 being the warmest of the last 11 years (1989-1998) and also since weather observations exist, an important role being played by the ENSO positive phase – IPCC, 2013). These findings indicate an alarming global warming trend since 1998.

The question is: what has triggered this global warming process?

Answers are controversial, but three variants are worth-considering.

- Some researchers view *atmospheric pollution* to be the main triggering factor (Elsom, 1987, 2000; Engardt, 1997; Busuioc et al., 2003; Cuculeanu et al, 2003; Fărcaş, Croitoru, 2003; Bălteanu, Şerban, 2005, etc.)*;*
- The 5th IPCC Report, 2013 (cited by Bojariu et al., 2015) incriminates CO_2 atmospheric pollution that increased by >40% compared to pre-industrial times, and CH_4 amounts that doubled, thereby enhancing the greenhouse effect;
- Other researchers maintain that global warming is inherent of climate variability, which is induced both by natural factors (astronomic, telluric, geographic) and anthropic factors (atmospheric pollution) (Mihăilescu, 2004; Bogdan, 2005; Bogdan, Marinică, 2006, Măhăra, 2006; Teodoreanu, 2006; IPCC 2007, 2013, Busuioc et al., 2010; Sandu et al., 2010; Bojariu et al., 2015).
- Others still, analysing global climate change and *climate variability* current short-time warming, forecast long-time cooling, basically a new glaciation (Bogdan, Marinică, 2007).

So far, what started fast-going warming has not been fully elucidated, but the environmental consequences of this process are quite obvious in the great many extreme climatic phenomena.

Here are some examples:

The year 2003 was considered to be the third hottest year on the Globe (after 1998 and 2002) since weather observations were in place, warming being particularly severe in the sub-tropical countries, but felt intensely in the temperate and sub-polar regions, too, yet in a distinctively different way in each country. Thus, in France, Germany, Portugal, Spain, Italy, The Netherlands, Great Britain etc., values over 40°C were registered (with 40.6°C in Germany, surpassing that country's absolute record), 32°C offshore in the Mediterranean Sea, that is higher by 5°C than the average summer value.

As a result, Mediterranean countries had to cope with numerous forest fires that destroyed over 160,000 ha, the damage being of 9,900 million Euro, and caused more than 70,000 casualties in 16 European countries (WHO, 2007). Therefore, the summer of 2003 was nicknamed "killer summer".

A WHO report mentions four heat waves that year: in June, the first wave hit Portugal, Italy, Spain and the south of France, leaving 10,000 people dead; in mid-July, a second wave reached Great Britain, northern France and Germany, adding 10,000 human casualties; the third wave moved from Spain towards western and northern Europe, the toll being of 45,000; the fourth wave came in September and left 5,000 dead.

The most affected countries were Luxembourg, Belgium and France.

That summer France and Italy reported the greatest number of heat-induced deaths: 19,490 and 20,089, respectively (events reported by Jean-Marie Robine, Director of the National Health and Medical Research Institute of France, 2007).

By contrast, the frosty *winter of 2000-2001* began when a cold wave, started from Central Siberia and the extreme north of Russia, brought temperatures of ... -60 ... -70°C, and 160 people died from hypothermia.

In the *winter of 2002-2003*, a cold wave with temperatures of ... 45°C, started in the East of the Russian Federation, made 20,000 casualties in India (a much warmer country).

Also in Romania, some extreme situations were recorded in the first ten years of the 21st century:

- *The summer of 2000* was the driest in this country, after the one of 1945-1946, with heat waves of ≥40°C at 42 weather stations and ≥42°C at 18 stations; in 2000, values of 43.5°C (July 5) were reached in Giurgiu City, a national thermal record for that month (only by 1°C below Romania's absolute record of 44.5°C registered on August 10, 1951 at Ion Sion's farm in Brăila County, simultaneously with 44°C at Amara-Slobozia and Valea Argovei settlements).
- *Summer 2007*: six heat waves, the most extended and hot ones in the history of Romanian meteorology. Temperatures of ≥40°C had 48 stations, with ≥44°C at five of them (Moldova Nouă, Moldova Veche and Băileşti, 44.0°C; Bechet 44.2°C and Calafat 44.3°C) only by 0.2°C lower than the previously mentioned national thermal record in this country (July 24, 2007). The toll was of over 30 dead in July alone, while stubbles and woods took fire (more than 100 ha); top temperatures were recorded especially in the south-western counties (Timiş, Mehedinți, Dolj, Gorj and Olt), in the Carpathian Curvature area (Buzău), and in the central part of Romania (Harghita) (Tudose, Moldovan, 2007).

Speaking of wintertime we would recall several warm winter years, almost without any snowfall and snow layer at all. In 2006-2007, January (the coldest winter month), registered average temperature deviations of 9.7°C at Calafat, the highest in this country; +9.5°C at Joseni and +9.2°C at Miercurea Ciuc weather stations situated in the Giurgeu – Ciuc – Braşov groove, the pole of cold in Romania (<-38.5°C), and in mountain regions at over 1,000 m alt.: Păltiniş +3.5°C, Lăcăuți +3.2°C, Vârfu Omu (Omu Peak) +2.2°C (Bogdan et al., 2007).

After 1991, the incidence of warm winters increased very much, from 1/10-15 years in the 1901-1990 period to 1-2 years as the warming process got momentum. Thus, in the 1999-2000 – 2008-2009 decade, the occurrence frequency was of 50% in the south-west of Romania (Oltenia region), of which 10% were warm winters and 10% exceptionally warm winters; in addition, there was one normal winter weather year, one cold year and three years with monthly frequencies equal to warm, normal and cold winter weather (Helmann-type Criterion proposed by Bogdan, Marinică, 2010).

- *The 2005 warm semester* featured six waves of rain throughout the south of Romania, with historical quantities of precipitation. Moving from west (Banat) to east (Southern Moldavia) they triggered huge flood waves at the Siret/Danube junction, covering much of the Subcarpathian Curvature area, forming a kind of 'inland sea' and making impracticable several localities in the counties of Galați, Brăila and Vrancea.

These were but a few examples of climatic anomalies in the world and in this country. They are by far more numerous and diverse, see the special volume on meteo-climatic hazards in the temperate zone (Bogdan, Marinică, 2007).

Current climate warming affects all environmental components (air, water, relief, vegetation, soils, the economy and society, that is, all of the environment, whether natural or anthropic), which, failing to adapt themselves to the new climatic conditions might be destroyed.

Climate warming and pollution itself may do it. If, for all its unpredictability, this process goes on, and the increasing atmospheric pollution (from 280 ppm in the pre-industrial period to 379 ppm in 2005 – IPCC, 2007) is not stopped, then the air temperature will continue to rise.

Using various IPCC – SERIES-type scenarios based on a linear projection of climate scenarios (Bojariu et al., 2015) the Expert Group for Climate Change forecast a global average temperature increase of 1.8-4.0°C at the end of the 21st century compared to year 2000 levels (IPCC, 2007).

In Europe, a rise of 1.0-1.5°C is expected in 2020-2029 as against the 1980-1990 interval. B1 scenario values of 2.0°-2.5°C and 4.0°-5.0°C would be recorded by 2090-2099, respectively (IPCC, 2007, quoted by Sandu et al., 2010, p.21). On the other hand, constantly lower precipitation amounts versus the 1980-1990 interval are considered for the last decade of the 21st century, when richer snowfall in winter (by 5-10%) and poor rainfall (by 10-30%) in summer are foreseen especially for the south of Europe (op. cit. 21).

The 5th IPCC-SERIES Report (2013) includes the latest situations (periodically re-modelled) of the Climate Change Intergovernment Commission using RCP scenarios which, unlike the IPCC-SERIES scenarios, no longer proceed from the socio-economic scenarios responsible for future concentrations of greenhouse-induced gas emissions (EES) released by all socio-economic units e.g. demographic, technological, energy and land-use changes (Moss & al., 2008 quoted by Bojariu et al., 2015 p. 88). The results suggest that, by the end of the 21st century, the average global temperature might increase by >1.5°C, and occasionally by over 2°C.

At global level, *precipitation* will record great regional variations, enhancing the contrasts between wet and arid zones. In terms of the scenarios used, the Planetary Ocean might rise by 0.2 m – 0.82 m, possibly even more, because the mechanisms affecting Greenland and the Antarctic ice cover are unpredictable (*op. cit*., p. 89).

The 5th IPCC Report (2013) cited by Bojariu et al., 2015, suggests also global change consequences, e.g. *intensification of the hydrological cycle*, which might increase the intensity/frequency of some extreme events (droughts, floods, cyclones at medium altitude and tropical storms) in various regions of the Earth. Also heat waves might become more frequent, intense and lasting, especially on the continents (p. 89).

The impact of climate warming on the tourism industry could mean the impairment of tourist sites (possibly their degradation), adjustment of tourists to the new climatic conditions, and adaptation of the *tourist infrastructure* to the new requirements, the profitable management of tourism requiring huge costs.

Noteworthy, the impact is twofold: direct/higher temperature and indirect/the positive feedback it generates is cascading regional hazards and risks.

These phenomena are triggered by climate warming-induced vaporisation and intensification of the air circulation in the troposphere, which are involved in climate system variability, and unleash extreme phenomena that might induce global, regional and local climate change.

The greatest impact on tourism will have the highly destructive meteo-climatic and hydrological hazards and risks.

1. ***More frequent meteo-climatic hazards/risks and thermal-pluviometric contrasts***

The 4th IPCC Report (2007), discussing the conclusions of the *STERN Report* (2007), considers that although climate warming is labelled 'global', because it affects all of the Planet's environmental components, its manifestations do not occur simultaneously on the Globe. They have regional and counter time occurrences, in other words, some areas are affected while others are not. So, as shown in the previous examples, a higher incidence of temperature and precipitation contrasts is likely to be seen.

An illustrative example are the *warm winters,* without cold weather, snow-layer, or substantial snowpacks either, an obvious drawback for tourism.

Because of climate-induced warm winters, there will be no snow-layer in the mountain region and even if it were, it would be thin and ephemeral.

Also, the tourism industry will suffer, because winter sports are impracticable if the snow-layer is not at least 20cm thick; neither can national or international competitions be organised, so fewer incomes will be generated for the profile industry.

There are countries in the world where the mountain catena is at altitudes of 2,500-3,000 m and even higher, and though the permanent snow limit might decrease, a new snow-layer may cover the previous one, which has not fully melted. So, tourists may choose those countries where conditions are favourable to practicing winter sports.

- *Cold winters* are usually associated with *snow-layer*, which is the thicker, the more intense the air circulation in the troposphere. In this case, there is the risk of:

- avalanches and accidents;
- skin and eye cancers produced by strong snow albedo if tourists stay unprotected.

Low temperatures associated with *much humidity* and *windy weather* may induce:

- cold stress (get a cold, chilblains, etc.);
- respiratory affections (sinusitis, laryngitis, pharyngitis, rhinitis, or rhino-pharyngitis, etc.);
- lung diseases;
- chilblains of peripheral organs (nose, ears, lower and upper limbs etc.);

Atmospheric pressure-induced affections:

- breathing difficulties;
- heart diseases and strokes, etc.

2. ***Higher incidence of canicular temperatures***

Summer is the season of canicular temperatures at temperate latitudes, but with increasing climate warming, they have become more frequent, last longer and have greater intensity.

For example, in the first two decades of the 21st century, thermal-pluviometric contrasts materialised in warm, canicular summers which culminated in 2007 (record-high values since meteorological observations started in Romania: values of 44.3°C/July 24, 2007 at Calafat coming very close to the highest absolute temperature of 44.5°C/August 10, 1951 registered at Sion's farm in Brăila County); also the cold winter of 2011-2012, with thick snow-layer, big snowpacks and especially low temperatures of -25˚C, came very close to the 20^{th}-century record harsh winter of 1953-1954. However, the winter of 2011-2012 was quite singular among the warm or relatively cold winters preceding it after 2000.

At the same time, increasing canicular summer temperatures (max. ≥33˚C and 35˚C) after 1990 (2000, 2002, 2003 and 2007), but also in later years, registered the longest canicular intervals.

The adverse effects of canicular temperatures will influence weather-sensitive tourists, in particular, through:

- heat-induced stress
- insolation – risk of skin cancer, headaches, vomiting, excess transpiration, etc.

Low atmospheric pressure and reduced air moisture produce:

- oxygen deficiency
- breathing difficulties

- altitude sickness
- lower heart-rate, fatigue;
- articular pains

Canicular temperatures will entail additional costs for:

- hot water, accommodation; energy;
- air-conditioning equipment in accommodation units, public catering units (restaurants, canteens), shops, cars and buses;
- juice, beverage and ice-cream producing industries will flourish;
- higher costs for tourism.

3. ***Glacier melting in permafrost and snow-covered high-mountain regions***

The impact of cold snow-rich winters on tourism has been previously discussed. Furthermore, we shall dwell on the effects of mountain glacier melting.

In the Romanian Carpathian Mountains, with altitudes of some 2500 m in the Southern range (Moldoveanu Peak, 2544 m), Quaternary glaciers no longer exist, as they melted in the Postglacial period, when the climate started warming up.

Yet, depending on the meteo-climatic conditions, a snow-layer may, or may not, form annually. However, observations have revealed that its duration and depth are shorter by the year, with obvious negative effects on winter sports.

It is the case of the mountain glaciers in the permanent snow-covered high regions of Europe (the Alps, Mont Blank Peak, 4807 m), Asia (the Caucasus, Cazbec Peak, 5047 m; Pamir, Pamir Peak 7845; the Himalayas, Chomolungma Peak, 8848 m), of the Andes Cordilleras, 3,500-5,000 m in North America and >6,000 in South America (Aconcagua, Peak, 6960 m), of Africa (Kenya, 5199 and Kilimanjaro, 5895 m) etc.

Climate warming, though with local differences, affects all climatic zones, both on the horizontal (from the Equator to the Poles) and on the vertical (with the increase of altitude) and, as known, tourism is a world practice.

Therefore, climate warming will impact the permafrost and the snow layer, as well as rivers, lakes, people, etc.

Possible consequences:

- As the glacier and permanent snow-line is rising, permafrost and the permanent ice layer withdraw upstream to the mountain catenae at over 2500-3000 m altitude;
- Higher risk of avalanches;
- Numerical increase of glacial lakes and of their water volume flooding the lower limitrophe areas (e.g. vulnerable territories at the southern foot of the Himalayas in Nepal);
- Expanding drainage-basin areas through backward erosion, affecting forest roads, paths and tourist marks, alpine chalets and refuges, etc.

All these situations imply new costs for maintenance, rehabilitation and reconstruction, as well as new tourist amenities.

As mountain glaciers are melting, the level of discharge on watercourses will increase, intense erosion processes will develop, too, destroying:

- the roads lining watercourses;
- tourist bases, health resorts, and human settlements situated alongside watercourses used for farming and tourism;
- natural and man-made tourist sites.

All flooding episodes might affect vegetal ecosystems and animals, monuments of nature, floodplains located in nature reserves, pools and limitrophe areas, sporting fishing and hunting, causing huge losses.

4. *The melting of ice-cap glaciers in polar regions*

This is already a fast-going process in polar regions. As reported in the specialist literature, satellite images showed significant ice-cap melting, the glacial field decreasing by 20% in 2007 alone. A major consequence would be level elevation of the Planetary Ocean and expansion of water surfaces, affecting both tourist activities and climatic variability.

At the same time, it might have a greater impact on the land-governed Northern hemisphere, which is the most populated zone, particularly in the littoral areas. The phenomenon is caused both by higher quantities of fresh-water released by glaciers and by the bigger ocean-water volumes, the result of warming-induced water expansion.

Possible risks of the Planetary Ocean rising level:

- flooded coastal regions and beaches;
- destroyed infrastructure of ports and health resorts;
- no more water connections between ports;
- no more tourist flows and access routes between continents to the sea-side regions;
- no longer spa-cures;
- huge economic losses, great maintenance and economic recovery costs, long-time needed for rehabilitation and reconstruction, etc.

The expansion of water surfaces might influence the evolution of the climate towards cooling, kind of feed-back of evaporation and nebulosity, having a negative impact on tourism. Also, evaporation and mist formation might get momentum. Hence, greater sea-side nebulosity diminished sun brightness and visibility. The consequence would be shorter sun-bathing time, while photographic and filming would become impossible.

Were total nebulosity to increase, air temperature would decrease, liquid and solid precipitation would occur more frequently.

In these conditions polar-ice areas in polar and mountain regions might recover and even expand, provided weather cooling goes on.

If this phenomenon were to persist, the climate system might evolve in a different direction, as some specialists say, namely towards cooling, associated with meteo-climatic winter risks and weather-induced health problems specific to the cold season.

Practicing winter tourism is climate-dependent.

What is greatly unpredictable is whether the climate will evolve towards warming or cooling and, connected with it, the question is whether some meteo-climatic phenomena liable to influencing life on Earth will, or not, develop.

5. *Expansion of aridization in the extra-tropical regions*

As known, arid regions on Earth lie in the tropical and sub-tropical zones, the hardcore of tropical anticyclones and of the hottest areas on the Planet. Climate warming goes from the Equator to the poles, and the risk is for its aridization to expand to the generally land-covered Northern Hemisphere. This situation might create a new type of land use and a change of the Terra albedo, influencing the landscape, crops and food products, surface and ground-water resources, leading to water shortage, hence involving great energy and irrigation costs, and not least, trade and supply difficulties.

Climate aridization might enhance fire risks, degrade landscapes, forests, the natural and anthropic environment in general, all tourism activities, protected natural areas, etc. and might also affect the habitats of birds – areas that are protected and also open to tourism.

Climate aridization will stimulate soil erosion by increasing potential evapo-transpiration, expanding diversification, and dust storms (cohesionless particles of dust and sand), associated with new states of discomfort, unknown diseases induced by heat, hardly controllable strains, influencing tourist activities as well.

6. ***Growing concentration of greenhouse gases and water vapours***

Failing to stop pollution, while climate warming will continue to increase, the risk of ever higher concentrations of greenhouse gases and of water vapours contributing to this effect, is a real threat; likewise pollution, the feedback response will intensify the warming process.

In these conditions, the O_3 layer risks to be reduced or altogether destroyed, O_3 holes being likely to develop, as demonstrated in the specialist literature. This is a huge threat to life, and implicitly to tourism, and to spa-and-health resort tourism, in particular.

The absence of an O_3 life-protecting layer will augment UV radiation-induced chemical impairment of human skin. Sun-bathing tourists at the sea-side, or itinerant mountain tourists in winter or summer should have protection equipment lest they might get burns and develop skin or eye cancers.

In view of it, beach programmes and excursions routes in summer or winter should necessarily be reconsidered.

It is not unlikely for tourist flows to diminish, hence fewer incomes for fresh investments.

7. ***The climate warming impact on tourists and tourism management***

As shown in the 4th and 5th IPCC Reports (2007, 2013), if the warming process continues, the general health condition of tourists might suffer, nor is tourism management spared either, a topic partly discussed in this paper.

One of the consequences would be the destabilisation of the climate, the translation of seasons and of climate zones, with effects on the general state of health of tourists and of the general population; climate warming might enhance social stress by rising upkeep costs (rent, taxes, foodstuff, health insurance, etc.).

On the other hand, climate warming might prove beneficial to tourists by reducing stress to cold and health risks (strokes, lung diseases, respiratory diseases, chilblains and other affections typical of this season caused by the contraction of the blood vessels) generated by winter-summer contrasts, especially in the high mountain regions.

However, far more likely is a higher heat stress in summer and the health problems attached to it, e.g. dilatation of the blood vessels, more cases of breathing difficulties and heart failure, insolation, etc.) (Topor, 1957; Teodoreanu, 2004).

People unable to adapt to the new climatic conditions might develop abnormal psychic behaviours, even suicidal manifestations, hence a higher morbidity and mortality risk.

Since climate warming will influence all environmental components, causing deep changes and even mutations in their characteristic features, as well as all types of human activity, including tourism, some general measures are imperative.

The main measure stated in the IPCCC Report 2007, STERN Report, 2007, and the 5th IPCC Report, 2014 is adaptation to the new environmental and climatic conditions.

Attaining sustainable tourism development requires a new type of management capable to reorganise tourist activities, find more profitable forms of tourism, protection of tourist sites, through a sustained activity of educating people in the spirit of ecotourism, develop an adequate infrastructure and create the necessary thermal comfort in accommodation units, canteens, restaurants, cars, buses etc.; arrange new tourist zones and routes less prone to meteo-climatic and hydrological risks, make advantageous tourist and agro-tourist offers (while market prices are high), profitable for both the workforce and for new investments; create a modern tourism in line with European and world standards, and make it attractive for foreign tourists.

As climate change prediction relies on models and scenarios subject to periodical improvement, we may as well suppose that the consequences themselves are very much unpredictable. Even if pollution is stopped at the level of the year 2000, atmospheric greenhouse gases would still be active for some time, but climate warming would stay around 0.6°C (Sandu et al., 2010, p. 19). It follows that unpredictabilities still remain.

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MARINE METEOROLOGY AND MARITIME NAVIGATION

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Abstract

Marine meteorology as the specialized, applied part of meteorology uses general meteorology and physical oceanography data, so as to provide weather and hydro-logical forecasting necessary for safe maritime activities (shipping and maritime transport, ocean fishing, maritime industry, marine sports and leisure).

Keywords: marine meteorology; marine environmental conditions; maritime navigation

Introduction

Marine environmental conditions have a particular impact on navigation, life and daily activities on board ships. A navigator would not show so much interest in meteorology or oceanography, if they were to navigate only on calm seas and nice weather.

But the sea would never forgive an incompetent sailor. Therefore, throughout the history of navigation, sailors were interested in knowing both the sea and the surrounding natural phenomena, be them hospitable or hostile. On rough sea, or in difficult areas, the life of the crew can be very tough and the ship and her cargo may be endangered.

Winds, waves, fog, rain, storms have all been observed and recorded, becoming the objects of study for marine meteorology and oceanography. They have been introduced into the curriculum of marine education worldwide.

Today there are worldwide precise rules on Marine Meteorological Services, which operate on the basis of four principles2:

1. marine weather services are provided in order to meet the information requirements established by national practice and international conventions, about environmental conditions and meteorological phenomena;

2. marine weather services contribute to the safety, efficiency and economy of marine environmental activities;

3. marine weather services include the guidance on the interpretation of meteorological and oceanographic information;

4. marine weather services assist the users in obtaining high standard information.

Now, following the example of maritime navigation, defined in the recent past as both art and science, marine meteorology has shifted from the stage of art to that of independent science, with laws, principles and specific methods, using modern tools and equipment, along with specialized computer programs capable of providing the navigator with knowledge about the evolution of weather at sea, at high accuracy and for fairly long periods of time, for ensuring the ship's safe voyage.

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[2] World Meteorological Organization, *Manual on Marine Meteorological Services*, Volume I – Global Aspects, WMO-No.558, 2012 edition

At sea, ships are subjected to the action of meteo-oceanographical factors, which can generate different dangerous phenomena that make navigation difficult, worsen the storage conditions of goods on board, increase the voyage execution time, increase fuel consumption and ship's wear, or affect her stability, thus creating stressful living conditions for the crew members, to say nothing about the threats upon navigation and ship's safety.

In bad weather conditions, loading and unloading port and fishing operations are stopped, vessels go to shelter in the inner or exterior roadsteads, sail in high seas or lie ahull.

Given that any vessel, regardless of her robustness and propulsion, is not guaranteed against loss or damage caused by severe weather phenomena, it is necessary to have thorough knowledge of the influence of meteorological parameters on navigation.

The analysis of a vessel's cargo and crew safety is closely related to the economic factor, to the profitability of the voyage. It is necessary to choose the safest route, the one that fulfills the best economic performance criteria, so as to be able to prepare the ship and crew for navigation in bad weather.

Applied Meteorology includes meteorology those components with immediate application in practice, i.e. agriculture, forestry, land, sea and air transport, medicine, tourism etc3. Marine Meteorology is a scientific and technical applied discipline that uses data from general meteorology and physical oceanography, with the purpose of producing meteorological and hydrological forecasts, which are necessary and useful for conducting maritime activities: navigation and shipping, ocean fishing, maritime industry, marine sports and leisure etc.

Marine Meteorology provides specific and accurate information about the status and evolution of weather in some areas, in time and space, further used to increase the safety of passengers and crew, of ship and her cargo.

Brief history of marine meteorology

The first international meteorological conference took place in August 1853, in Brussels. It was attended by major maritime countries. Here, the American lieutenant Matthew Maury, who was already known for his studies on ocean winds and currents, coordinated the works of the conference, exchanging multiannual meteorological information with the other participants. Therefore, he is considered the founder of marine meteorology and operational oceanography. He initiated the international cooperation, which further led to the establishment of the World Meteorological Organization and of the Intergovernmental Oceanographic Commission, belonging to UNESCO (Intergovernmental Oceanographic Commission-IOC)4.

During this conference, a few directions regarding the watch of world weather were set, i.e. the standardization, the instructions for completing the meteorological journals, and also the measured and calculated parameters (atmospheric pressure, humidity, wind, cloudiness, clouds, sea surface temperature, water temperature and depth). All the above were considered as a beginning for the current World Weather Watch5.

Beginning with 1855, as a result of losses of ships and human lives in the Crimean War, during the storm in the night of November 14, 1854, action was taken to organize a system for collecting, interpreting and transmitting meteorological information to ships.

[3] Shearman,R.,J., *The growth of marine meteorology - a major support programme for the World Weather Watch,* WMO Bulletin, ian. 2003
[3] Ibidem
[5] Ibidem

In 1905, the International Meteorological Organization is formally created. Since 1907, when the Technical Commission for Maritime Meteorology was created, it became compulsory for all ships to be equipped with a telegraph, by which meteorological information could be transmitted to shore.

Starting with the 30s, with the development of overseas aviation and navigation, and also with the events and circumstances generated by the Second World War, there emerged a network of meteorological ships which provided meteo-oceanographic information necessary for the safety of navigation, and which lasted until the early 80s[6].

In 1952 the World Meteorological Organization (WMO) was founded. Under its auspices the members of the Commission for Maritime Meteorology (later called the Commission for Marine Meteorology – CMM) meet. This commission had regular meetings for 45 years, having been entrusted with the mission of regulating the activity of meteorology for the benefit of seafarers.

Since 1980, the Commission for Marine Meteorology has known two main directions of development: the oceanographic meteorology and the costal meteorology, the two, equally serving both navigation and maritime coastal industry. Towards the end of the twentieth century the necessity of cooperation between marine meteorologists and oceanographers becomes almost mandatory, so that, in 1999 the WMO Congress and the IOC Assembly decided to create the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology - JCOMM, whose first session was held in 2001. On this occasion, the development and action directions were settled.

The World Meteorological Organization (WMO), http://www.wmo.int, is the United Nations specialized agency for conducting, coordinating, harmonizing and improving the world meteorological activities and for achieving the specialized collaboration among states.

Beginning with 2007 the WMO has developed an integrated concept on meteorological observations, i.e. WMO Integrated Global Observing Systems –WIGOS, that ensures a complex network of meteorological observations, in space, on land and at sea. Today, this network consists of over 10,000 classical and automated weather stations on land, more than 1,000 stations in the atmosphere, over 7000 stations on maritime vessels, over 3000 meteorological stations on board civil aircraft, over 100 anchored meteo-buoys, over 1,000 drifting meteo-buoys, hundreds of weather radars, weather satellites etc.

Currently there are meteorological observation systems, such as global observation system (Global Observing System - GOS) of the World Weather Watch - WWW), the Global Ocean Observing system - GOOS), the Global Hydrological Networks – WHYCOS, operating at national and regional level, the Global Atmosphere Watch - GAW which provides information for scientific research, and also warning regarding changes in the chemical composition of the atmosphere, or in the atmospheric physics with serious consequences on the environment.

Marine meteorology in Romania

In Romania the marine meteorological activity is related to the foundation, in 1926, of the Maritime Hydrographic Service. Beginning with 1955, the Maritime Hydrographic Direction has provided the hydrographic and hydrometeorological information for the Romanian Navy. Through Law 395, of 2004, the Maritime Hydrographic Direction – DHM has become the national authority in the field of marine hydrography. The Marine

[6] Ibidem

Meteorology Department of DHM has a permanent role in weather watch and weather forecasting in areas of responsibility and interest of the Romanian Navy, for safe navigation.

Also, this unit functions as a forecasting center within the Integrated Meteorological System of Romania-SIMIN. The Marine Meteorology Department operates, maintains and develops the National Integrated Meteorological System of the Navy (SIMIN-FN) and the Navy Meteorological Maritime Surveillance Network (RSMM-FN), composed of coastal and marine automatic weather stations7.

Romania is a founding member of the World Meteorological Organization (WMO) and has a total number of 170 meteorological stations, of which five are located on the Romanian Black Sea coast, i.e. Sulina, St. George, Gura Portiței, Constanta and Mangalia (Figure 1).

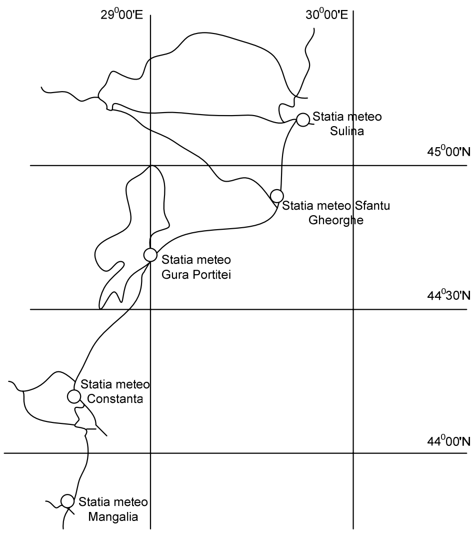

Figure 1. Romanian Black Sea coast meteorological stations.

Among the outstanding Romanian authors who have contributed to the development of the Romanian marine meteorology, through their significant activity and important papers in the domain, the following are worth mentioning: Constantin Bondar, PhD - Black Sea-hydrological monograph, 1971; sea captain Liviu Neguț - Maritime Meteorology-1981; assistant professor Octavian Mircea Selariu, PhD, with numerous studies and marine meteorology; assistant professor Brândușa Chiotoroiu, PhD – River Hydrometeorology, 2001; Cornelia Pescaru, PhD - Marine Meteorology, 2005; assistant professor Romeo Boşneagu, PhD - Marine Meteorology. Meteorological Navigation, 2014.

Meteomarine information

The main meteorological parameters which are used in the maritime activities are: solar radiation; sunshine duration; temperature; water temperature; salinity; air moisture; atmospheric pressure; nebulosity; rainfall; the wind, and weather phenomena.

For the vessel voyage planning and for the preparation of a maritime technological activity in a sea area or ocean basin it is necessary to thoroughly study the meteorological and oceanographic documentation, both from the hydrographic point of view (bathymetry, bottom

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[7] www.dhmfn.ro

nature, dangerous depths) and also in terms of marine meteorology and hydrology (medium waves, variation limits, physical processes and dangerous phenomena).

The meteo-oceanographic information for the navy can be twofold: direct meteo-information, and encoded meteo-oceanographic information.

The direct meteo-information refers to transmitting and receiving weather bulletins and gale warning on board vessels. Such messages inform on the meteorological situation in the area of navigation, or in the surrounding areas, being used for more accurate interpretation of synoptic charts.

They contain the following information:

1. presence or absence of storm in the area;

2. the general meteo-synoptic context: the presence and development of maximum pressure centers, and of low pressure disturbances, and also some information on the weather conditions when crossing the atmospheric fronts related to extratropical depressions;

3. meteorological forecast for a certain period of time (degree of cloudiness, visibility, dangerous phenomena at sea, sea state). The weather bulletins/notices are received by radio or NAVTEX.

The encoded information is done by using multiple specialized codes among which the most important are SYNOP and SHIP codes. These encoded messages contain meteorological and hydrological information organized in a logical order, so as to be easily decoded and understood. These data are contained in the basics of meteo and hydrosynoptic charts, while a part of it used in support of meteorological and oceanographic maritime navigation.

Conclusions

Now, the influence of weather conditions on maritime navigation can be quantified by:

Navigation and visibility

For maritime navigation it is important to define and know some specific situations related to visibility, such as: good visibility; poor visibility; no visibility.

Good visibility is manifested in nice weather and ensures the observation of the various ships, boats, objects etc., at sea at long and very long distances.

Poor visibility generally is generated by covered skies, and is usually accompanied by moderate weather events. Observation in poor visibility is done on short distances, which directly affects the safety of ship and navigation. Additional watching measures are required.

No visibility or "zero visibility" is generated by dense fog and rainfall. Special measures should be taken in such cases, both during watches and during ship maneuvering so as to minimize the occurrence of navigation accidents.

Reduced visibility at sea may also be caused by a number of meteorological phenomena such as fog, snow, heavy rains etc. In compliance with the international regulations regarding safety of navigation in poor visibility, a vessel’s speed must be reduced to a value that would allow avoidance of any hazards.

At the first signs of low visibility the navigator must determine the fix, and also record the ship’s course and speed. The officer on watch (OOW) and all members of the crew should engage both visual and auditory senses so as to prevent or avoid accidents. Fog signals are issued, and also particular attention is given to the radar information and to the data existing on the navigation charts (depths, navigational hazards etc.).

Also, the navigator needs to take into account that sound is deflected both horizontally and vertically, in the air, thus making it difficult to determine the position of the source of noise (ship, aids to navigation, be it afloat, or on land).

At sea visibility is paramount. Low visibility, even in the current technical conditions, is still a great danger to navigation. Visibility depends on a number of factors: atmospheric transparency, brightness and colors of objects, land-marks or background, etc. The main cause for poor visibility is the existence of water vapor in the air, which, under certain environmental conditions, merges into liquid or solid form. Fog could decrease visibility to zero, at sea.

Most often, the fog occurs due to the advection of warm and moist air on the relatively cool surface of seawater (advection fog). This is characterized by large vertical thickness, extension on large areas, duration and mobility. The intensity of advection fog depends on the difference in temperature between the mass of air and sea water (the greater the difference, the greater the intensity and density of fog). Due to the aforementioned characteristics, the advection fog may occur unexpectedly.

The advection fog's density decreases when hot air comes over, or when the wind changes its direction, in which case it is possible that it bring cooler and less humid air.

In winter, the evaporation fog occurs over maritime areas due to the access of cold air masses over warmer waters. The evaporation fog occurs at low air temperatures, and high water temperatures (higher than at least 100C).

In winter, worsening visibility warm front occurs before a slow-moving or while driving an occluded front after a warm one. It is caused by the evaporation of warmer droplets of rain or frost in cold air. In winter fog can appear after a cold front, if it rains in the area with cold air, or evaporation comes over from a surface which is warmer than the air. Frontal type fog can formed both within the cold front, and outside it, in the narrow coastal areas, due to the mixing of warm and humid air with cold air. As a practical conclusion, in winter the crossing should be done by taking a perpendicular course.

Influence of air temperature on navigation

Air temperature has a great influence on navigation, ship, cargo and crew.

The optimum temperature for work on board ships is 180 to 250C. Temperatures higher than these, accompanied by excessive humidity, or low temperatures create a specific discomfort (for lower temperature variation), or influence the activity of the crew in a negative way.

Excessive dampness or moisture can deteriorate the cargo stored on deck or in cargo holds. Deposits of ice on the deck and superstructure could be dangerous for the ship and crew. Moving ice drifting at mid-latitudes hinder navigation and become extremely dangerous.

The influence of air humidity on maritime navigation

The amount of atmospheric moisture has a great influence on people, on physiological processes, especially on thermoregulation processes.

The thermal comfort index has a special influence on those who work on deck.

Weather associated with cloud types

The stratus clouds do not have a special significance for the weather condition analysis. If the stratus clouds are very low they may affect visibility. They indicate a stable air mass if the convection is low. They may produce drizzle.

The nimbostratus clouds are rain clouds. Generally, these clouds announce bad weather, possibly with rain. In some cases rain does not reach the ground.

The stratocumulus clouds have special significance for weather analysis. Overall, they are not bad weather clouds. They indicate stable weather. Sometimes they are accompanied by light rain or drizzle.

The small Cumulus clouds generally indicate good weather. The big Cumulus clouds indicate instability with possible showers caused by the strong convection phenomenon. They may indicate rain when they are spread by the wind.

The Altocumulus does not have a special significance for weather analysis. Overall they are not bad weather clouds. They indicate rain when they are spread by wind.

The Altostratus clouds announce the advance of a baric depression if they derive from Cirrostratus clouds and the atmospheric pressure is dropping.

The Cirrus clouds in development generally indicate the proximity of bad weather with rain.

The Cirrocumulus clouds are associated with fair weather with light wind.

The Cirrostratus clouds indicate proximity of rain. If Cirrus follows, chances are for a tropical storm to approach.

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PHYSICAL – GEOGRAPHICAL CONDITIONS INFLUENCE ON THE BLACK SEA CLIMATIC FACTORS EVOLUTION

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Abstract

Climate is the weather multiannual regime resulting from the interaction between radiative factors, general circulation of the atmosphere and the complex physical and geographical condition for a 30 year period. The Black Sea climate is strongly influenced by the physical-geographical characteristics of its basin. This study presents the specific Black Sea shorelines climatic factors over a long period of time in relation to their geography.

Key words: Black Sea; physical-geographical conditions; climatic factors

Introduction

Climatology is the branch of meteorology that studies weather multiannual regime depending on the locality, zone, country, region, continent specific geographical or even the world. Climatology is the science that deals with climate study (Romanian ANM, 2015).

In accordance with WMO-100/2011 climatology is the study of climate, its variations and extremes, and its influences on a variety of activities including (but far from limited to) human health, safety and welfare. Climate, in a narrow sense, can be defined as the average weather conditions for a particular location and period of time. Climate can be described in terms of statistical descriptions of the central tendencies and variability of relevant elements such as temperature, precipitation, atmospheric pressure, humidity and winds, or through combinations of elements, such as weather types and phenomena, that are typical of a location or region, or of the world as a whole, for any time period (WMO-100/2011).

Climate is the weather multiannual regime resulting from the interaction between radiative factors, general circulation of the atmosphere and the complex physical and geographical conditions. Studies usually used an average of 30 years (1961-1990, reference recommended by the World Meteorological Organization) or more recently, the period from 1971 to 2000, to define a normal climate for the region. The aim of these studies was to identify the impact of climate change on human activities and society in general. Climatic data is used to analyze the tendency of the time, at a time. Climate is defined as multiannual meteorological parameters generated by radiative, dynamic, physical-geographic, anthropic factors action, etc.

According to *dexonline.ro*, climate is defined as the annual average regime and meteorological phenomena processes (characteristic of a certain region), caused by solar radiation and the general circulation of air masses that vary with position relative to Earth, with absolute altitude and relief configuration region, having as main components: mean air temperature, cloud cover, precipitation and wind. Maritime climate is characteristic of the oceans, seas and continental regions under the direct influence of marine air masses, wet climate, with annual and diurnal thermal small variations.

Also in dexonline.ro, climate is defined as all the processes and meteorological phenomena characteristic of a geographical area.

The main genetic factor for climate is the astronomical one (shape and movements of the Earth, depending on distance from the Sun, the tilt poles axis to the plane of the ecliptic) that influenced the radiative conditions (change in the angle of incidence of sunlight causes unequal distribution of radiant energy on land area, reflected in the geographical latitude depending on the height of the Sun, the length of day and night, radiative - caloric balance of the earth's surface).

Depending on geographic latitude, and the amount of heat received by the Earth from the Sun there are three major climatic zones: hot, temperate and cold. In this climate zones there are several specific types, mainly determined by physical-geographical factors, but also the atmospheric dynamics at the regional level, with different characteristics, influenced by the nature of the active surface (land and water), the geographical position region (within continents or near oceans and seas), air supply, and the presence of various major forms of relief. This paper is interested in the Black Sea climate.

Data and methods

The Black Sea, the third largest European sea, although a semi-enclosed sea, is regarded as the biggest of the big components of the Mediterranean Sea basin and has developed both continental crust and the oceanic crust. The Black Sea basin morphology is similar to a continental bordered basin and also, to abyssal oceanic plains.

The Black Sea is situated in the eastern part of the south-east, between $40^0$55'N and $46^0$32'N parallels and between $27^0$27'E and $41^0$42'E meridians. By its latitudinal placing the Black Sea is in the central temperate zone and by its longitudinal placing the Black Sea is affected by the main air masses barometric centers (Azores anticyclone, Eurasian anticyclone, North Atlantic cyclones and the Mediterranean ones. The Black Sea is a deep tectonic depression divided into two compartments (basins): western and eastern.

The Black Sea is connected to the Atlantic Ocean by the Bosporus (which emerges from the sea’s southwestern corner), the Sea of Marmara, the Dardanelles, the Aegean Sea, and the Mediterranean Sea. The Crimean Peninsula thrusts into the Black Sea from the north, and just to its east the narrow Kerch Strait links to the Sea of Azov. The Black Sea coastline is otherwise fairly regular. The maximum east-west extent of the sea is about 730 miles (1,175 km), and the shortest distance between the tip of Crimea and Cape Kerempe to the south is about 160 miles (260 km). The surface area, excluding the Sea of Marmara but including the Sea of Azov, is about 461,000 square km. The Black Sea proper occupies about 422,000 square km. A maximum depth of more than 2,210 meters is reached in the south-central sector of the sea (Britanica, 1996).

The coastline of the Black Sea (4340 km) is only mildly indented, except for the northwestern and northern shores, which are low and furrowed by numerous ravines, valleys, and rivers, the mouths of which are often impeded by sandy spits. The mountains of southern Crimea form the only precipitous cliff areas. In the east and south, the coasts are steep and mountainous. Spurs of the Greater and Lesser Caucasus ranges, separated by the Kolkhida lowland, confine the Black Sea in the east, while the Pontic Mountains run along the southern coast. Near the Bosporus outlet, the shoreline relief is moderate though still steep. Farther north, in the Burgaski Bay area, low mountains emerge where the Balkan Mountains of Bulgaria extend eastward. Continuing northward along the western shore, a flatter plateau region gives way to the great Danube River delta, which thrusts its mass out into the sea (Britanica, 1996).

The Black Sea climate is influenced by the geographical position of the sea, the movement of air masses, the wind regime etc. During the cold season are highlighted in the northern sector winds, very strong along the coast, weaker at large. The prevailing summer winds are the northwest, west and southwest, in the west of the Black Sea and from the sea to coast, in other parts of the sea. As regards the distribution of wind speeds, 40-50% of the speeds are between 1 and 5 m/s.

The types of wind Black Sea wind movement, according to wind directions (determined based on the baric field distribution on the sea and surroundings) are: northeast, east, southeast, southwest, west, northwest, north and week movement. The most probable average length for these types of movement is 6 ... 24 hours at a rate of 67% of cases (for cyclonic circulation the interval of 6 .. 12 hours represents 77% of all cases).

The Black Sea Basin is located in the temperate zone, so the development of its maritime climatic factors is influenced decisively by the main barometric centers that govern the general atmospheric circulation in southeastern Europe.

The climate of the Black Sea are, for the most part of his basin, a semiarid character, evaporation is greater than precipitation. The appearance continental of the landscape shores of the Black Sea causes very uneven distribution of dynamic factors of climate over the entire basin. Black Sea position has a large opening on the largest part of the northern side, to the Pontic steppes where easily penetrate dry and cold continental air masses. Carpathian Mountains greatly reduce the penetration of oceanic influences from the west and the Caucasus creates an effective shelter to excessive continental influences in the Northeast. The Pontic Mountains and southern Anatolia Plateau determine a specific model of spatial distribution of climatic parameters.

Depending on the specific geography of the area (spatial distribution of openings and continental barriers), according to references, there are three different climate zones differentiated in the Black Sea: the western, eastern and central.

The Western Basin is wide open to the north and northeast, where they come from excessive continental influences specific to Pontic steppes. The northern section of this area is characterized by cold and dry winters, with strong winds. The average yearly temperature of January increases from -0.6^0 to -0.7^0 C in the Gulf, 3^0 C, near the Bosphorus. Winter precipitation has monthly averages between 38 and 50 mm and between 30 and 80 mm evaporation. Summers are moderately warm. In July, the temperature is distributed more evenly, with a temperature gradient of only 0.5^0 ... 0.6^0 C. Summer rainfall moderate values, monthly averages ranging between 25 and 35 mm, evaporation showing values between 80 and 130 mm. Average annual rainfall varies between 350 and 600 mm, and evaporation of between 800 and 975 mm.

The Eastern Basin, located in the Caucasus Mountains shelter, has a specific climate with average annual temperatures of 14^0...15^0C, with warm winters and relatively mild summers and wet wipes. This section is more homogeneous in terms of distribution of temperatures, but well differentiated in relation to the distribution of precipitation and evaporation. Thus, in the north of this area, monthly average rainfall recorded between 25 and 100 mm and 200 mm evaporation and 35, whereas in the southern area, the average monthly rainfall values are between 80 and 200 mm and evaporation between 70 and 110 mm. The annual precipitation average is 600 mm in the northern area and 1700 mm in the south area. The annual evaporation average is 1290 mm and 785 mm from the north to the south. Local there is subtropical climatic conditions similar to those due solely shelter of the Caucasus, as well as relief with deep valleys oriented southwest and depressions housed.

Central Basin reveals transition climate aspects. The most significant differences are registered in precipitation in the northwest and the southeast, which expresses the essential role of the Caucasus barrier. The annual precipitation average is 370-380 mm in the north-east (46º28 'N, 30º10' E), 340-350 mm in the central part of the Black Sea (43º50 'N, 33º27' E), and 1700-1900 mm in the southeast (41º55'N, 41º15'E).

Results

The climatic factors variation in the Black Sea basin is analyzed for the period 1968-2000, on the basis of meteorological data processed from several reliable sources for a period of over 30 years. 1968 .. 2010.

Air temperature regime is as follows: the average annual temperature is set on the Black Sea from 10,0^0C to 15,2^0 C, with very hot summers and poor rainfall, and relatively warm and humid winters, except for the southeast area with a near subtropical climate.

The lowest air temperatures at sea are between January and February, and the highest are in July and August.

Atmospheric humidity follows the variation in air temperature. The thermo-hygrometric regime causes atmospheric instability, decreased visibility and a wide range of weather phenomena. The hygrometric regime is determined by the sea's own evaporation and by the Mediterranean and oceanic air advection. The annual value of atmospheric circulation over the sea basin is about 3,600 km^3 of water.

The relative humidity average has an inverse variation like temperature variation. The nebulosity annual average in the Black Sea basin is about 5.6 tenths.

The presence and wind speed (Figure 1) and storms (average annual number of days with thunderstorm is 20-40.

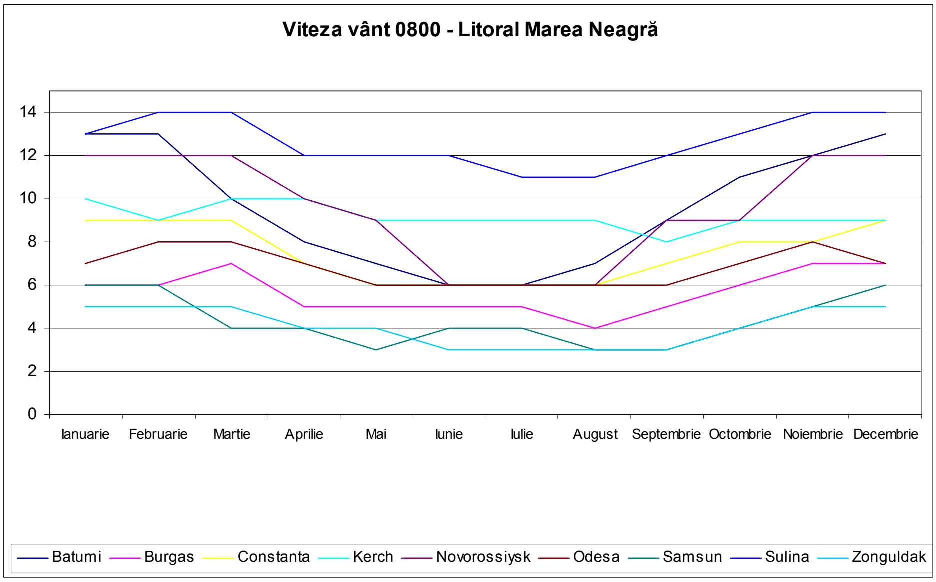

Figure 1. The presence and speed of wind on the Black Sea coasts.

Air temperature

In winter, the average temperature ranges between -2^0 in north and 9^0 in south, in summer, between 20^0 to 24^0 in the whole basin of the Black Sea (maximum monthly average - figure 2 and minimum monthly average - figure 3);

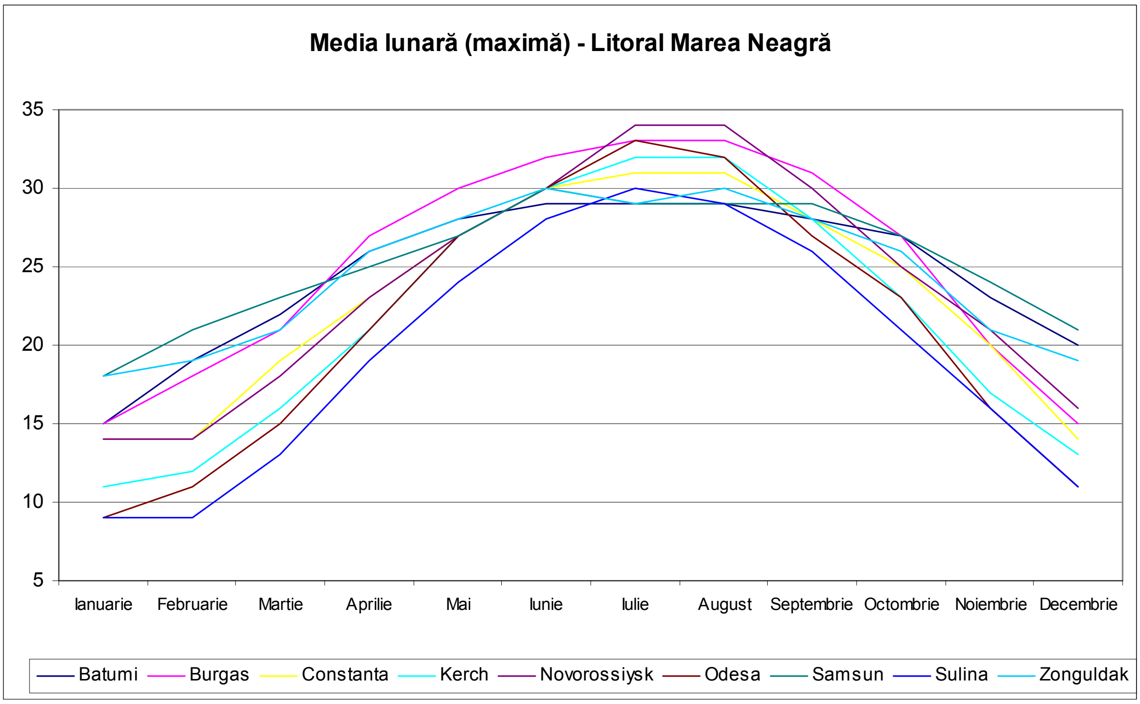

Figure 2. Air temperature on the Black Sea coasts - maximum monthly average.

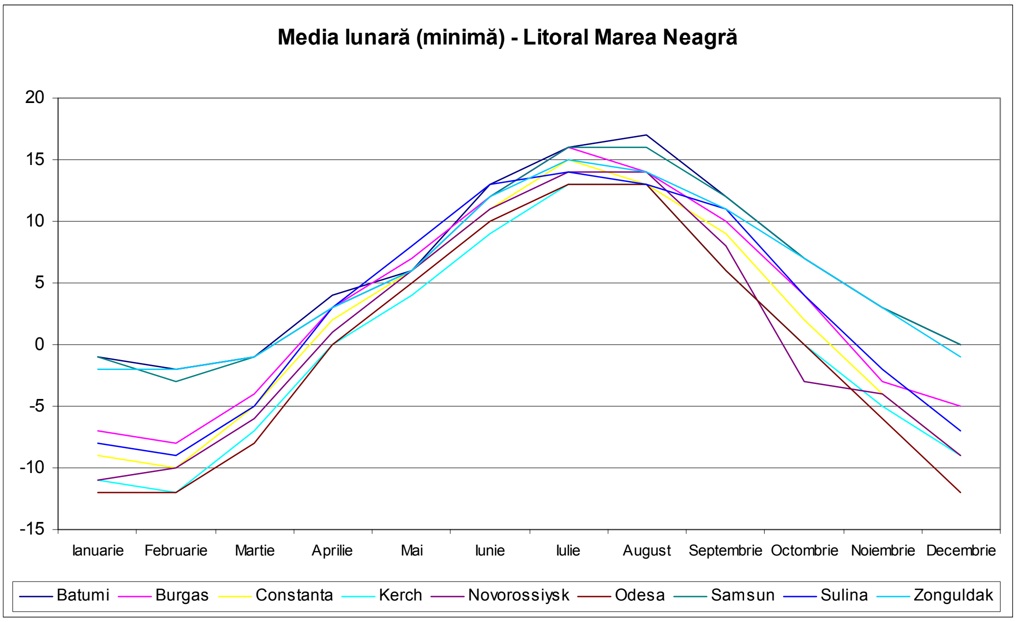

Figure 3. Air temperature on the Black Sea coasts - minimum monthly average.

Humidity

Relative humidity varies between 70-85%, rarely exceeding the limit of thermal comfort.

Visibility

Visibility is lower in transitional seasons (average of days with zero visibility is 7 to 10 days on the Romanian seaside).

Nebulosity

Nebulosity is higher in winter (average of days with maximum cloudiness on the Romanian coastline is 10 to 15 days per year).

Fog

Foggy days average is 30 in the west (Figure 4).

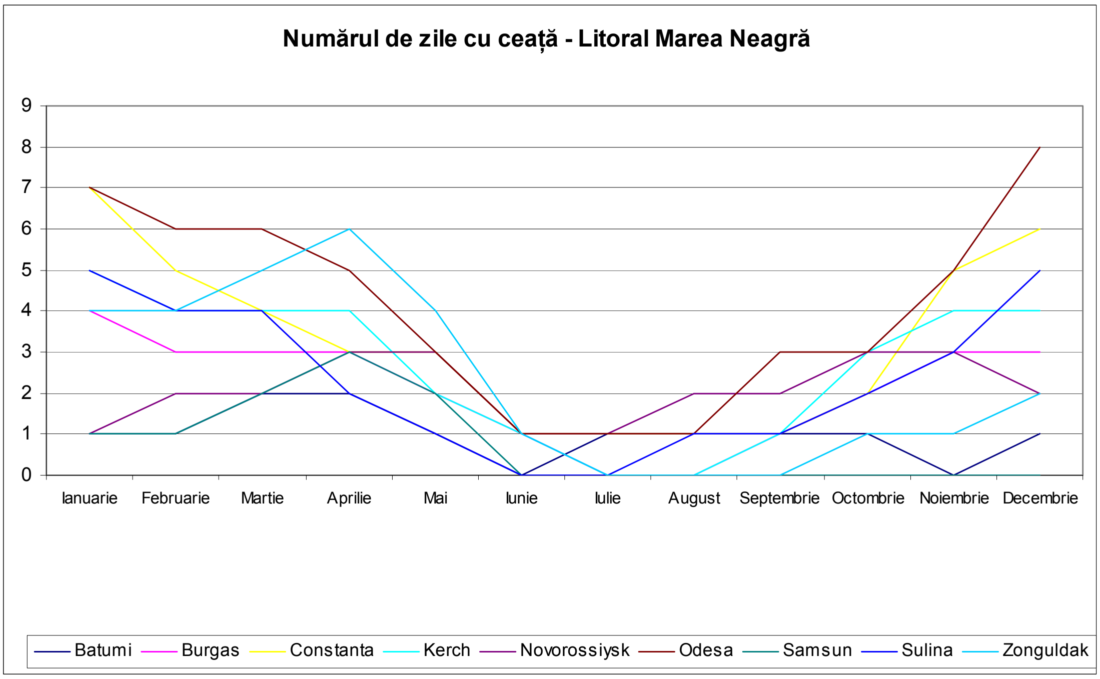

Figure 4. The number of days with fog on the Black Sea coasts.

Precipitation

Precipitation is moderate, with an annual average of 300-500 mm **(Figure 5).**

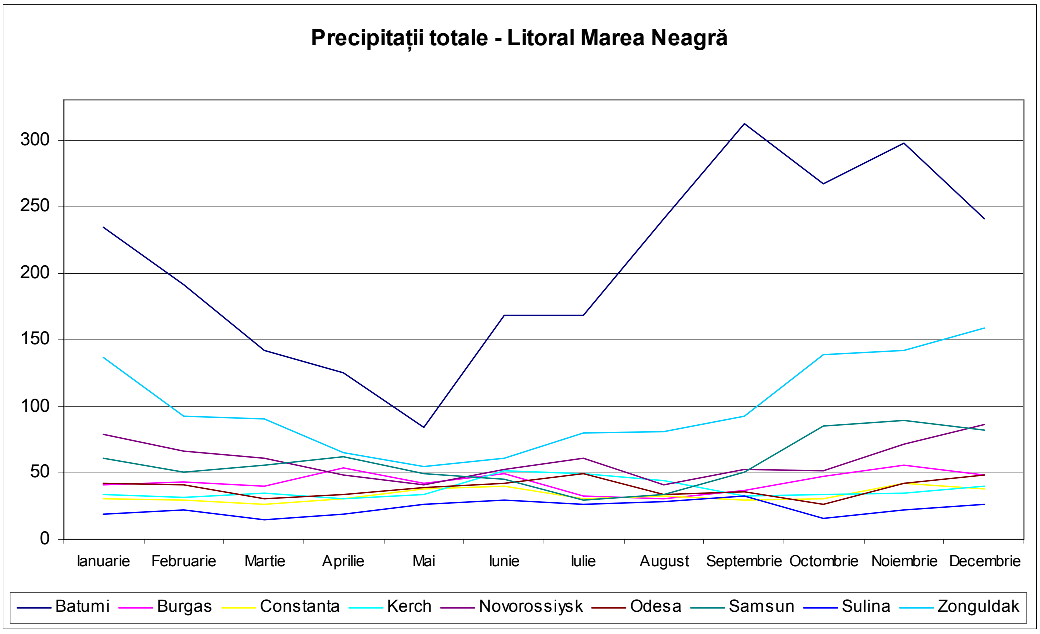

Figure 5. Total precipitations on the Black Sea coasts.

Conclusions

Climatology has become a dynamic branch of science with a broad range of functions and applications. New techniques are being developed and investigations are being undertaken to study the application of climate in many fields, including agriculture, forestry, ecosystems, energy, industry, production and distribution of goods, engineering design and construction, human well-being, transportation, tourism, insurance, water resources and disaster management, fisheries, and coastal development.

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ANALYZING CLIMATE-TOURISM POTENTIAL IN MAMAIA RESORT AREA USING TOURISM-CLIMATE INDEX (TCI)

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Abstract

From the perspective of tourism supply, climate has been identified as an important natural resource for the tourism sector. Some of the key characteristics of climate as a tourism resource include: it is free, renewable and non-degradable, as well as cannot be transported or stored. Using climate-tourism indices, such as the one developed by Mieczkowski in 1985, we can assess a destination`s favourability for touristic activities, taking into account its main climate characteristics relevant for these activities, such as thermal comfort, sunshine, precipitation and wind speed. The main objectives of this study are to use the Mieczkowski tourism-climate index (TCI) in order to identify the year period which is best suited for outdoor activities in the are of Mamaia resort. It was found that the most suitable months for touristic activities are June, July and August, which are regarded as excellent in Mieczkowski`s classification. Also, the touristic season can be extended through the months of May and September, classified with good and very good conditions for outdoor activities.

Key words: tourism, climate, tourism-climate index (TCI), Mamaia resort.

Introduction

Climate attractiveness for tourists has been highlighted in many studies (Gearing et al., 1974; Ritchie, Zin, 1978; Hu and Ritchie, 1993; Lohmann and Kaim, 1999; Kozak, 2002 and Moreno, 2010). Some studies concluded that climate is an important characteristic of a certain area regarding its attractiveness for tourists (Mayo, 1973; Gearing et al., 1974; Hu and Ritchie, 1993; Lohmann and Kaim, 1999), while other studies went even further and stated that climate is the most important factor in determining destination attractiveness (Ritchie, Zin, 1978; Wall, Badke, 1994; Kozak, 2002; Moreno, 2010). Other authors (Dann, 1981) regarded only sunshine and air temperature as the most important climatic features for attracting tourists in certain places.

Knowing the climatic favourability for tourism activities is important both for tourists and tourism service providers. In consequence, several climatic indices were developed, in order to assess the suitability of climate characteristics for tourism activities and to present the information in a more easily interpretable way, both by tourists and stakeholders in the tourism industry.

Method

The Tourism-Climate Index (TCI) was designed by Mieczkowski (1985) as a method to quantitatively evaluate a specific location's climate suitability for general tourism activities. The TCI has been applied in studies to assess a place's climate suitability for tourism on a global (Amelung et al., 2007), regional (Scott et al., 2004) and country/destination scale (Roshan et al., 2009).

The TCI assesses a location's climate suitability for tourism by grouping seven climatic variables relevant to tourism (maximum air temperature, mean air temperature, minimum relative humidity, mean relative humidity, amount of precipitation, hours of sunshine and average wind speed) into five sub-indices (*Table 1*).

Table 1. Components of Tourism-Climate Index.

Sub-index	**Climatic variable**	**Influence on the TCI**	**Weighting (%)**
Daytime Comfort Index (CID)	Maximum daily air temperature (°C) Minimum daily relative humidity (%)	Thermal comfort when maximum tourist activity occurs	40
Daily Comfort Index (CIA)	Mean daily air temperature (°C) Mean daily relative humidity (%)	Thermal comfort over 24 hours period including night time	10
Precipitation (R)	Total precipitation (mm)	A negative factor on overall experience	20
Sunshine (S)	Total hours of sunshine (hours)	A positive factor on overall experience	20
Wind (W)	Wind speed (km/h or m/s)	Highly depends on air temperature (evaporative cooling effect in hot climates rated positively, while 'wind chill' in cold climates rated negatively)	10

The TCI is calculated as follows: **TCI = 2*(4CID + CIA + 2R + 2S + W).**

The **Daytime Comfort Index** (CID) is a combination of maximum daily temperature and minimum daily relative humidity to assess the level of daytime climate conditions when maximum tourists' activities occur.

The **Daily Comfort Index** (CIA) is a combination of mean daily temperature and mean daily relative humidity to assess the thermal comfort over the 24 hours.

The highest weight is given to the Daytime Comfort Index (CID) (40%) to reflect the fact that tourists are most active during the day. The variables of sunshine and precipitation are given the second highest weight (20% each), followed by the Daily Comfort Index (CIA) (10%) and wind speed (10%).

As for the original TCI design, each of the sub-indices was assigned a highest rating score of 5.0 to make the maximum TCI score 100 while the minimum score is -30 (when both CID and CIA were rated a score of -3). The rating scheme of the TCI climatic variables are outlined in *Table 2*.

Table 2. TCI`s rating scheme.

Rating	**Effective temperature (°C)**	**Mean monthly precipitation (mm)**	**Mean monthly sunshine (h)**	**Wind speed (km/h)**		
				Normal	Trade wind	Hot climate
5.0	20-26	0.0-14.9	≥10	<2.88	12.24-19.97	
4.5	19; 7	15.0-29.9	9-10	2.88-5.75		
4.0	18; 28	30.0-44.9	8-9	5.76-9.03	9.04-12.23 19.80-24.29	
3.5	17; 29	45.0-59.9	7-8	9.04-12.23		
3.0	16; 30	60.0-74.9	6-7	12.24-19.79	5.76-9.03 24.30-28.79	
2.5	10-15; 31	75.0-89.9	5-6	19.8-24.29	2.88-5.75	
2.0	5-9; 32	90.0-104.9	4-5	24.30-28.79	<2.88 28.80-38.52	<2.88
1.5	0-4; 33	105.0-119.9	3-4	28.80-38.52		2.88-5.75
1.0	-5 - -1; 34	120.0-134.9	2-3			5.76-9.03
0.5	35	135.0-149.9	1-2			9.04-12.23
0	>36; -10 - -6	>150.0	0-1	>38.52	>38.52	>12.24

The index score calculated according to the TCI formula was then adapted to the classification scheme designed by Mieczkowski (1985) to describe a location's climate suitability for tourism (Table 3). There are eleven categories in the TCI's scheme, ranging from "ideal" (90 – 100) to "impossible" (-30 – +9).

Table 3. Rating categories of Tourism-Climate Index.

TCI score	Descriptive category	TCI score	Descriptive category
90-100	Ideal	40-49	Marginal
80-89	Excellent	30-39	Unfavourable
70-79	Very good	20-29	Very unfavourable
60-69	Good	10-19	Extremely unfavourable
50-59	Acceptable	9 - -9	Impossible

Results

Data from the Constanța meteorological station were used (1961-2005). According to the values of the TCI obtained by applying Mieczkowski`s formula, the favorability of climatic conditions for tourism in the Mamaia resort area vary from *marginal* to *ideal*, as shown in Table 4 and Figure 2.

Table 4. Calculated values for the five sub-indices and for the TCI.

	Tmed (°C)	Umed (%)	CID	Tmax (°C)	Umin (%)	CIA	Pp (mm)	R	Sunshine	S	Wind speed	W	TCI
I	0.6	85	**1.5**	4	82	**1.5**	29.7	**4.5**	2.66	**1**	18.5	**3**	**43**
F	1.8	83	**1.5**	5.3	72	**2**	26	**4.5**	3.5	**1.5**	15.9	**3**	**46**
M	4.7	83	**1.5**	8.3	55	**2**	28.2	**4.5**	4.28	**2**	15.5	**3**	**48**
A	10	82	**2.5**	13.9	55	**2.5**	29.2	**4.5**	6.06	**3**	14.06	**3**	**61**
M	15.6	79	**3**	19.5	48	**4.5**	34.7	**4**	8.5	**4**	13.32	**3**	**71**
I	20.2	75	**5**	24.	46	**5**	43	**4**	9.55	**5**	12.95	**5**	**96**
I	22.4	75	**5**	26.3	42	**5**	34.8	**4**	10.5	**5**	11.1	**4**	**94**
A	22.1	76	**5**	26	44	**5**	30	**4**	9.85	**5**	12.95	**5**	**96**
S	18.1	78	**4.5**	22.3	50	**5**	29.5	**4.5**	7.95	**3.5**	13.32	**3**	**84**
O	13.2	81	**2.5**	17.1	63	**3.5**	34.3	**4**	5.74	**2.5**	14.43	**3**	**59**
N	7.8	85	**2**	11.3	79	**2.5**	38.3	**4**	3.34	**1.5**	15.54	**3**	**49**
D	3	86	**1.5**	6.3	80	**2**	34.2	**4**	2.48	**1**	15.91	**3**	**42**

The lowest values of the TCI, and, thus, the least favourable conditions for touristic activities are recorded in the winter months (January, February and December), with the lowest value recorded in December, of 42.

Also, at the beginning of spring and at the end of autumn, in the months of March and November, there are *marginal* conditions for touristic activities, with TCI values of 48 and 49, respectively.

Acceptable conditions are recorded in the month of October, with a TCI value of 59, while *good* conditions are recorded in April, with a TCI value of 61.

Very good conditions are recorded in the month of May, with a TCI value of 71, while *excellent* conditions can be found in September, with a TCI value reaching 84 units.

The best conditions for touristic activities in the area of Mamaia resort are recorded in the summer months, and are categorized as *ideal*, according to the Mieczkowski classification. The TCI values vary from 94 in July to 96 in June and August. The high values of the TCI in the summer months are the result of the sunshine duration, which is maximum in the summer time, and also of the moderate high air temperature, which creates nearly perfect conditions for touristic activities, especially for leisure and sea-side related activities, such as heliotherapy.

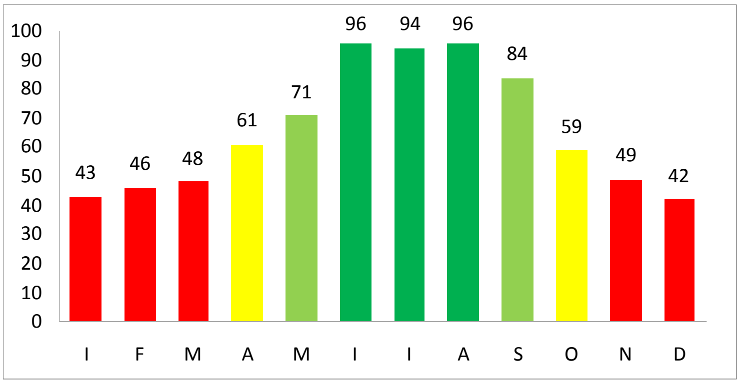

Figure 1. Monthly variation of the five sub-indices and of the TCI.

Conclusions

After analyzing the climate potential for tourism using the TCI, some conclusions can be drawn:

- The least favorable months for tourist activities are winter months and the most favorable are the summer months. This situation generates the biggest tourists flows in the summer months, Mamaia being in the top Romanian resorts in terms of the number of tourists visiting it every year.
- The touristic season can be extended through the months of May and September, both having good and very good conditions, respectively.
- Although the TCI was designed nearly three decades ago, it is still one of the most widely used climate index in assessing a destination's climatic suitability.

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ASSESSMENT OF CLIMATIC RESOURCES FOR THE ESTABLISHMENT AND DEVELOPMENT OF TOURISM IN CHERNIVTSI REGION

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Abstract

The effect of climatic resources is reviewed: of the average July temperature, of the duration of periods with temperature above +10°C and of the annual amount of precipitation on the establishment and development of tourism in Chernivtsi region of Ukraine. The score system of assessment was taken as the basis for the calculation. The assessment is provided by three climatic zones of the region.

Key words: climatic resources, Chernivtsi region, score assessment, duration of the period, climatic zone, climate, air temperature, amount of precipitation.

Relevance of the research topic

Climate is one of the main recreational resources, since its peculiarities facilitate the organization of sanatorium and resort treatment and other kinds of recreational activity. The climatic conditions for recreation are studied from the viewpoint of weather and climate comfort for the organism of a healthy adult who rests. The thermal state of a human is an appropriate response for a complex effect of the weather. Daily, a human organism reacts not only to the changes of air temperature, fluctuations of atmospheric pressure, but also to constant changes of oxygen amount in the atmosphere. In terms of climatic conditions, two recreational activity periods are differentiated: a cold one (November – March) and a warm one (April – October).

Being in close interconnection with all nature components, the climate in the same time affects them significantly, including through weather indicators at the well-being of a human, turning into an important touristic resource. Touristic climatic resources are first of all comfortable weather conditions, availability of sunshine, ultraviolet radiation, clean air saturated with phytoncids and ions, etc, which in total facilitates the conduction of different touristic activities. The studying of the effect of climatic resources on the establishment and development of tourism in the region is important and relevant.

Presentation of main material. Climatic resources, according to the methods of O.O. Beidyk, are assessed by such indicators as (Beidyk, 2001):

- average July temperature;
- duration of the period with temperatures above +10°C;
- annual amount of precipitation.

It is worth noting that for assessing the climatic resources, the score assessments receives a broader application. However, in the scientific literature, not only the means of their use, but also the very possibility of their use is debatable.

The climate of Chernivtsi region is conditioned by its location in the moderate latitudes and the influence of the Carpathians system. Generally, it is quite mild and humid, but the complex relief causes some climatic differences in different areas. For example, the climate is more continental in the east, while becoming harsher in the foothill and the mountains due to the cold and short summer.

In general, in Chernivtsi region the spatial differences of climatic resources are considered in the context of natural zones – flat, foothill and mountains. The climatic zones correspond to these natural zones and they differ by temperature, amount of precipitation, dominating winds, snow cover depth and duration, and other climatic characteristics.

The touristic assessment of the climatic potential of Chernivtsi region is integrated in itself in some way by the air temperature indicator because the temperature reflects a synthesized effect of solar radiation, atmospheric circulation and underlying surface, but does not exclude the effect of strong wind, direct solar radiation, increased air humidity, and adverse atmospheric phenomena. The data on the duration of the period with temperatures above +10°C and other climatic indicators were taken from (Herenchuk, 1978).

When the average July temperature in Chernivtsi region is taken into account, the score was taken in the following way: 1 point - +16.0…+16.9; 2 - +17.0…+17.9; 3 - +18.0…+18.9 and so on. (Table 1).

Table 1. Assessment of average July temperature.

Climatic area of the region	Average July temperature, °C	Assessment of average July temperature, points
Mountain zone	+16.0	1
Foothill zone	+17.4	2
Flat zone	+20.0	4

July is the warmest month of the year. The highest air temperatures in summer are related to eastern winds which bring the very heated masses of continental air. Due to this, a noticeable increase of air temperature is observed in the valleys of Dniester, Prut and partially Siret, the directions of which are favorable for infiltration of eastern and south-eastern winds. For example, in the Dniester valley in the east of the region, the average July air temperature is 19.6 - 20°C. In the mountains, the distribution of air temperature in summer largely depends on height. Here, in Suceava valley, in Selyatyn, it reaches 16°C, while in the foothills (Storozhynets, Vyzhnytsya and partially Hlyboka districts) the average July temperature reaches 17.4°C. The review of table 1 reveals generally favorable temperature indicators for summer recreation (the multiyear average July temperature is within +16.0...20.0°C). However the flat area of Chernivtsi region is characterized by the most favorable July air temperatures.

For summer recreation types, according to specialists' assessments, the most favorable are the conditions with average daily temperatures of more than +10°C for no less than 100 days per year; for winter ones – accordingly, with the temperature lower than 0°C no more than 110 days.

In addition, the mandatory condition is the presence of a snow cover of no less than 10 cm and no more than 30-40 cm. It is also necessary to note that the discomfort zone starts with the temperature of -10°C. At low temperatures the wind increases the heat irradiation of the organism, which can lead to supercooling. Moreover, a strong wind wearies and irritates the nervous system, and obstructs breathing, especially in the mountains.

The duration of the period with temperatures above +10°C in Chernivtsi region is the smallest in the Carpathians mountain area (up to 99 days at the height of 1100 m), and the greatest in the flat area in Novoselytsya, Sokyryany, and Kelmentsi districts. Here, this period lasts between 149 and 162 days. In the foothills the period with temperatures above +10°C lasts 124-140 days (Herenchuk, 1978).

The received values were assessed by the 7-point system: 1 point – 90-100 days; 2 – 100-110; 3 – 110-120; 4 – 120-130; 5 – 130-140; 6 – 140-150; 7 – 150-160 (Table 2).

Table 2. Assessment of duration of the period with temperatures above +10°C.

Climatic area of the region	Duration of the period with temperatures above +10°C, days	Assessment of duration of the period with the temperature above +10°C, points
Mountain zone	99-110	1
Foothill zone	124-140	4
Flat zone	149-162	6

The duration of the period with minus temperatures fluctuates annually from 100 days at the flatland to 130 days in the mountains.

As demonstrated by the data in table 2, the territory of Chernivtsi region should be considered favorable for summer recreation, treatment, tourism. It is especially worth distinguishing the foothills and flat areas, with temperatures above +10°C lasting for 124-162 days.

In assessing the annual amount of precipitation only the maximal (right) ones were taken into consideration, as they were regarded more significant than minimal indicators (left ones), the limit of comfort, its lowest level (1 point). The arguments are as follows:

a) the overcast days are more "depressive" (according to the data of psychologists, psychoanalysts, and physicians);

b) cloudless weather provides more opportunities for picture and video taking, and it is considered to be safer and more favorable for recreation and other activities.

Generally, it is traditionally explained by a more positive attitude of the population towards the sunny (in this context, "rainless") days, than towards rainy ones. Therefore, 1 point – 1000-1500 mm; 2 – 700-1000 mm; 3 – 600-700 mm; 4 – 500-600; 5 – less than 500 mm.

Table 3. Assessment of the annual amount of precipitation.

Climatic area of the region	Annual amount of precipitation, mm	Assessment of the annual amount of precipitation, points
Mountain zone	1000 mm	1
Foothill zone	700 mm	3
Flat zone	about 550 mm	4

The lowest annual amount of precipitation in Chernivtsi region, about 550 mm (4 points), is observed in the extreme east of the region in the Dniester valley, namely on the flatland. Towards the southern-west, their amount increases up to 700 mm (3 points) in the Storozhynets district in the foothills. In the mountains, the precipitation increases sharply with height, reaching 1000 mm per year (1 point) on the highest ridges.

The result of the assessment of climatic resources of the administrative-territorial subjects of Chernivtsi region is the sum of the points of assessment of the average July temperature, the annual amount of precipitation, and the duration of the period with temperatures above +10°C.

As the integrated assessments of climatic resources suggest, the highest score has been received by the flat part of Chernivtsi region (14 points); the second position with 9 points is occupied by the foothills area, and the mountain area has earned only 3 points.

Quite interesting from the point of view of cognitive tourism is being in places related to extreme phenomena, including the climatic ones. For the territory of Chernivtsi region, some negative hydrometeorologic phenomena are characteristic as well: fog, glaze ice, blizzard, thunderstorm, hail, and dry winds; in the rural localities the snow avalanches, mud flows and other are possible. But their frequency is insignificant, and it cannot impede the development of the tourism sector in any area of the region. The parameters of climatic conditions are within the optimal limits for the development of all main types of recreational activity.

Conclusions

The most favorable area for development of recreation in Chernivtsi region is the flatland. Here the climatic resorts facilitate the recovery and treatment of diseases of the respiratory, nervous and cardiovascular systems etc. However, the foothill and mountain areas are favorable for the development of other kinds of tourism, in particular the mountain and ski ones. The important advantage for the development of tourism in Chernivtsi region is the absence of the period of acclimatization for inhabitants of the major part of Europe, who are the potential consumers of the Ukrainian touristic product. The climate of Chernivtsi region is not an extreme one from the point of view of adaptation, but the requirements to it increase with the change of climatic zone (especially in the off-season) and altitude belts.

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THE INFLUENCE OF CLIMATIC CONDITIONS ON SHEEP MILK PRODUCTION

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Abstract

Important climatic factors, temperature and humidity, are acting complexly and cumulatively on the sheep body, on fodder crops and pastures, in terms of quantity and quality production. The research in this paper aims at the influence of the climatic conditions on the Palas Merino sheep breed and on the Dairy Palas sheep breed productivity. The experiments were conducted at the Palas Research Institute for Sheep and Goat Breeding Constanta. From the thermal point of view, the annual average temperature over the ten years studied was between 11°C and 4°C, which shows the studied area is one of the hottest in the country. Humidity acts in close contact with temperature. From one year to another the milk production in the two sheep breeds had variations and was significantly influenced by climate variability and particularly by the occurrence of climate events. In 2014, the highest milk production was obtained in the Palas Merino breed: total milk production 97.46 ± 2.54 liters, 42.66 liters of milked milk in 92.8 days of lactation, with 5.79±0.10% protein and 6.32±0.14% milk fat. In the Dairy Palas breed: total milk production 227.46±2.54 liters, 142.66 liters of milked milk in 232 days of lactation, with 5.89±0.10% protein and 6.12 ± 0.14% fat.

Key words: climatic, condition, influence, milk, production.

Introduction

The paper aims at the knowledge of how the climatic factors (temperature and humidity) influence the sheep organism, and the variation in the quantity and quality of milk production. The indirect influence of climate changes on the livestock is known, as it is manifested in the quantitative and qualitative effect on forage plants and pastures and by their action on animal systems and metabolic processes, as well as their influence on productions.

Humidity acts in close contact with temperature. Under low humidity conditions, the animal's resistance is higher, regardless of the temperature value. Humidity greatly affects the health of animals and their productions. At the ovine species, which, due to the farming methods is most of the time under the influence of climatic factors, it is important to know the influences of climatic factors on production, in order to prevent and reduce the consequences on them.

In the current national and international economic context which is aimed at developing sheep rearing, their production must increase in order to enhance the profitability of the agricultural farms and their contributions to the food production.

Dobrogea, by the geographical position that it occupies in south-eastern Romania, between the Black Sea (east) and the Danube Valley (west and north), is characterized by the typical temperate continental climate in Romania (Bogdan, 2001), individualized as the hottest, driest and most windy region of the country. We aimed to study how climate variability affects milk production in the Palas Merino sheep breed and in the Dairy Palas sheep breed, from ICDCOC Palas Constanta.

Material and Methods

To achieve the objectives of this paper, we used existing climatological data from the ANM archive (the National Meteorology Administration) and daily weather bulletins (Ciulache, Ionac, 2001). For the conditions of ICDCOC Palas Constanta, the variation of monthly and annual temperatures are recorded at the agro-meteorological station Valu lui Traian.

The sheep of the two breeds, which are lactating, were followed individually, registering data regarding the quantitative milk production control based on the Romanian ”coefficient control” method (Nica-Dermengi). The method is based on the ratio of the daily milk production and the quantity of milk obtained in one milking on the same day (Taftă, 1998).

During lactation, sheep from the experimental and control lots received the same feed ration (Burlacu, 1998): 1.68 SU, 1.62 UNL, 118 g PDIN, 147g PDIE, 14.8 g calcium and 7 g phosphorus.

Results and discussions

The variation of monthly and annual average temperatures during the 2005-2014 period in the area where ICDCOC Palas Constanta is placed it is shown in Table 1.

In terms of thermal values, the multi-annual average temperature of the ten years studied was 11.4^{0}C, which shows that ICDCOC Palas Constanta is in one of the hottest areas of Romania.

Table 1. The average air temperature - **˚C.**

Year/ month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
2005	-3.5	2.7	4.7	11.9	15.9	19.8	24	21.6	16.7	11.9	10.2	4.3	11.7
2006	2.7	-0.6	4.1	9.7	16.5	19.3	22.5	22.5	18.4	11.9	6.3	3.8	11.4
2007	-3.5	2.7	4.2	9 .9	15.8	17.1	21.5	20.2	18.5	12.9	6.2	4.1	10.8
2008	-2.7	2.9	2.1	7.9	17.8	17.4	21.4	22.4	18.4	10.9	7.1	1.2	10.6
2009	-1.9	2.7	4.7	9.8	16.5	19.3	22.5	21.7	17.8	10.5	8.9	-2.4	10.8
2010	2.7	3	8.5	9.8	15	19.3	24.8	23.2	18.5	12.9	4.9	-3.1	11.6
2011	-1	5.9	7	9.4	16.4	20.7	24.2	23.3	18.6	12.1	8.9	2.4	12.1
2012	0.1	4	2.1	7.9	17.8	21.5	22.6	23.2	15.9	10.9	7.9	1.8	11.7
2013	-1.9	4.4	6.6	10.4	14.7	19.5	21.9	22.7	17.8	14	7.7	3.8	11.8
2014	-1	5.9	7	9.4	16.4	19.3	22.5	22.5	15.9	11.9	6.3	1.8	11.5
The multi-annual average	-0.15	1.4	5.45	9.85	16.05	20.02	23.33	22.25	17.48	12.28	7.65	0.88	11.4

An important feature for the climate area is determined by the influence of the immediate proximity of the Black Sea, namely the frequent movements of low temperatures from winter to spring and from spring to summer, which causes springs delay, long and warm autumns, and the usually sudden transition from spring to summer, with an accentuated warm weather in June (Lungu, 2009).

The absence of precipitation in this period increases the dry nature of the area. The constant high temperatures in July and August associated with hot winds adversely affect plant vegetation (evapotranspiration is increased and plant water supply is reduced which causes the twisting and wilting of their leaves if there is no rainfall or irrigation).

At ICDCOC Palas Constanta, the highest average temperatures of over 20^0C are recorded in July and August, with limits between 20.2^0C and 24.8^0C.

Also, for 2005-2014 periods, the annual regime of average monthly precipitation amounts are shown in Table 2 and the monthly and annual averages of relative humidity are shown in Table 3.

The regime's annual average monthly precipitation amounts show a rainy period in late spring and early summer, driven by the intensification of front (while stepping up cyclone activity) and thermal convection (due to higher radiative balance sheet values).

Table 2: The amount of precipitation (mm).

Year/ month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Anual Average
2005	37.3	28.9	26.1	16.8	12.6	45.5	9	0	23.9	8.4	23.2	7.1	238.8
2006	3.9	40.1	40.8	36.7	23.3	27.4	25.5	3.6	29	2.5	45.5	33.4	311.7
2007	18.4	3.1	83.8	10.7	8.1	27.1	171.9	38.1	80.4	65	25.3	30.7	550.5
2008	39.5	20.4	21	21	7.4	28.1	39.8	42	136.9	74.3	21.5	6.1	458
2009	44.6	23.8	24.3	11.4	129.9	75.4	40.9	204.6	25	11.5	13.7	83.3	688.4
2010	56.4	65.4	41.9	33	27.9	24.8	13.8	39.2	14.3	49.2	31	28.5	425.4
2011	18.9	33.5	22.5	36.7	22.8	28.1	39.8	22.8	13.9	74.3	44	33.4	390.7
2012	19.4	44.6	77.2	10.7	129.9	75.4	40.9	40.2	136.9	74.3	29.7	30.7	709.9
2013	24.5	22.8	52.1	21	129.9	129.9	75.4	40.9	45.5	62	52	48.9	704.9
2014	44.7	43.8	44.3	41.4	47.9	112.5	66.5	40.9	136.1	74.3	61.3	51.3	765
The multi-annual average	30.76	32.64	43.4	23.94	53.97	57.42	48.75	47.23	64.19	49.58	34.72	35.34	524.33

Dobrogea is considered a dry area, due to the small amounts of precipitation and their uneven distribution during the year. The action of sea breezes front on land is mitigated and if accompanied by thermal inversions, it prevents cloudiness and thermal convection intense rains. Water from rainfall in this area is not an important reserve to the soil, which is why irrigation is required.

The largest amounts of water fall in early summer. The rains have a torrential character, which makes Dobrogea a region with one of the highest amounts of water from rainfall in a day. During crops vegetation, droughts are frequent, sometimes lasting 2-3 months, causing an atmospheric drought with significant influence on soil moisture and on agricultural production.

From Table 2, concerning monthly and annual rainfall averages in the last decade, the year 2014 shows the highest amount of rainfall (765 mm), followed by 2012 (709.9 mm) and 2013 (704.9 mm). The average amount of precipitation in the last ten years was 524.33 mm.

In Dobrogea, the relative air humidity is characterized by distinct features, determined by the proximity of large water surfaces in the eastern region. The existence of these important and stable sources of water vapors causes a relative air humidity which is distinguished by high values, determined on the background of the maximum frequency of droughts of Romania. A major role in the distribution of relative humidity rests on the local regular air circulation, in the form of breezes.

Table 3. The relative air humidity (%).

Year/ month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2005	90	87	83	80	68	70	67	73	88	84	90	84
2006	83	82	81	84	77	74	62	61	77	75	80	88
2007	84	69	80	75	65	73	71	78	76	79	86	93
2008	93	84	73	72	61	73	72	71	78	86	90	88
2009	87	76	74	73	81	75	80	80	72	88	81	74
2010	71	79	63	60	61	71	78	71	76	87	97	75
2011	84	69	81	75	65	73	71	78	76	79	86	82
2012	81	72	81	68	70	67	73	85	84	90	84	79
2013	84	69	79	75	65	73	71	78	72	79	85	83
2014	79	75	85	68	70	67	73	71	84	90	84	77
The multi-annual average	83.6	76.2	78	73	68.3	71.6	71.8	74.6	78.3	83.7	86.3	82.3

Monthly and annual humidity averages are shown in Table 3. In 2005 the highest value of relative humidity were recorded, and the months with the highest values throughout the studied period of ten years were January (83.6%), August (83.7%), November (86.3%) and December (82.3%).

To follow the influence of climatic conditions on sheep milk, production was controlled for the Palas Merino sheep breed and for the Dairy Palas sheep breed. From one year to another, milk production had variations, being significantly influenced by climate variability and particularly by climate events.

It is known that animal production decreases when the outside temperature exceeds, for a period of time, critical limits specific to each species and animal category. In the case of sheep, prolonged temperatures of over 32°C in temperate conditions, reduce the rhythm of wool growth (Mireşan, 2001).

Humidity is often closely related to temperature. In conditions of low humidity the environmental resistance of the animal is higher both at high and low temperature, the air humidity greatly influencing not only the animal health but also their productions.

In the ovine specie, which, due to the farming methods practiced mostly under the influence of climatic factors, it was found that, in temperate areas with relative high humidity, the best adapted breeds are sheep with thick wool (Ţurcană breed for example) (Pădeanu, 2000). Tables 4 and 5 show the milk production in the Palas Merino sheep breed and the Dairy Palas sheep breed.

In 2014, when precipitations had the highest value of 765 mm, the average temperature in July and August was 22.5°C and the relative humidity in July and August had values of 73% and 71%, the highest milk production was achieved in the Palas Merino breed: a total milk production of 97.46 ± 2.54 liters, with 42.66 liters of milk milked in 92.8 days of lactation, with 5.79 ± 0.10% protein and 6.32 ± 0.14% fat.

Table 4. Palas Merino sheep breed milk production.

Year	Palas Merino sheep breed (n=15)				
	Total milk production (l)	Milking dairy production (l)	Days of lactation	Fat (%)	Proteins (%)
	X ±Sx Cv%	X ±Sx Cv%	X ±Sx Cv%	X ±Sx Cv%	X ±Sx Cv%
2005	79.02±2.91 14.24	36.12±1.3 13.94	88.2±0.9 3.95	6.07±0.16 9.93	5.46±0.10 6.79
2006	81.27±4.17 19.20	37.85±1.2 12.28	89.6±1.2 5.19	6.07±0.17 10.18	5.51±0.14 8.98
2007	87.74±3.36 14.83	39.24±1.6 15.79	87.3±1.2 5.32	6.13±0.12 8.54	5.69±0.08 6.30
2008	86.45±3.93 17.01	38.14±2.1 21.32	90.2±2.1 9.02	6.22±0.18 10.96	5.64±0.09 6.13
2009	88.75±3.07 14.68	40.2±1.3 12.52	89.5±2.4 10.39	6.20±0.14 8.98	5.79±0.11 7.80
2010	83.46±3.37 17.13	41.5±2.1 16.60	89.2±2.1 9.12	6.13±0.12 8.54	5.79±0.11 7.80
2011	81.61±2.06 10.68	39.7±1.8 17.56	88.2±1.5 6.59	6.04±0.13 8.44	5.59±0.09 6.25
2012	91.38±3.54 14.98	40.22±1.9 18.30	90.2±1.2 5.15	6.20±0.14 8.98	5.77±0.11 6.81
2013	91.94±2.69 12.43	41.1±1.5 14.13	93.2±0.9 3.74	6.39±0.19 11.39	5.85±0.08 5.81
2014	97.46±2.54 11.07	42.66±1.6 14.53	92.8±1.2 5.01	6.32±0.14 9.42	5.79±0.10 7.63

Of course, not only the influence of climatic conditions contributed to these productions, but also the enhanced nutritional value of green mass grazed by dairy sheep, pasture vegetation in these favorable climatic conditions having a high nutrient content and a high degree of palatability (Taftă, 2008).

Table 5. Dairy Palas sheep breed milk production.

Year	Dairy Palas sheep breed (n=25)				
	Total milk production (l)	Milking dairy production (l)	Days of lactation	Fat (%)	Proteins (%)
	X ±Sx Cv%	X ±Sx Cv%	X ±Sx Cv%	X ±Sx Cv%	X ±Sx Cv%
2005	211.02±2.91 6.90	130.20±1.21 4.65	229.3±1.8 3.92	6.05±0.16 13.22	5.44±0.10 9.19
2006	215.27±4.17 9.65	132.50±1.23 4.64	227.3±1.5 3.30	6.07±0.17 14.01	5.51±0.14 12.70
2007	219.74±3.36 7.65	134.80±1.39 5.16	229.2±1.8 3.93	6.08±0.12 9.87	5.67±0.08 7.05
2008	222.45±3.93 8.83	137.30±2.10 7.65	226.3±1.5 3.31	6.09±0.18 14.78	5.61±0.09 8.02
2009	221.75±3.07 6.92	135.60±1.81 6.67	228.2±1.2 2.63	6.08±0.14 11.51	5.78±0.11 9.52
2010	218.46±3.37 7.71	133.61±1.21 4.53	225.5±1.6 3.55	6.10±0.12 9.84	5.79±0.11 9.50
2011	219.61±2.06 4.69	136.22±1.35 4.96	231.5±1.9 4.10	6.09±0.13 10.67	5.61±0.09 8.02
2012	225.38±3.54 7.85	138.42±2.10 7.59	229.3±2.1 4.58	6.11±0.14 11.46	5.77±0.11 9.53
2013	224.94±2.69 5.98	140.24±1.28 4.56	230.7±2.5 5.42	6.10±0.11 9.02	5.85±0.08 6.84
2014	227.46±2.545.58	142.66 ±1.20 4.21	232.2±1.2 2.58	6.12±0.14 11.44	5.89±0.10 8.45

The qualitative and quantitative determinations of milk production in the Dairy Palas sheep breed in 2014 achieved the highest yields: 227.46 ± 2.54 liters of total milk with 142.66 liters of milking milk in 232 days of lactation, with 5.89 ± 0.10% protein and 6.12±0.14% fat.

Conclusion

ICDCOC Palas Constanta is located in one of the hottest areas of Romania, the multiannual average temperature was 11.4^{0}C between 2005-2014.

Determining the monthly and annual averages of the past ten years, 2014 shows the highest amount of rainfall (765 mm), followed by 2012 (709.9 mm) and 2013 (704.9 mm). The average amount of precipitation in the last ten years was 524.33 mm.

The average monthly and annual relative humidity shows that the highest value of relative humidity was recorded in 2005, and the months with the highest values for the entire period of the ten years were January (83.6%), August (83.7%), November (86.3%) and December (82.3%).

In 2014, when precipitations had the highest value (765 mm), the average temperature in July and August was 22.5°C and the relative humidity in the same month had values of 73% and 71%. That year, the Palas Merino sheep breed achieved the highest milk production, a total of 97.46 ± 2.54 liters, with 42.66 liters of milk milked in 92.8 days of lactation, 5.79 6.32 ± 0.10% protein and 6.32 ± 0.14% fat; the Dairy Palas sheep breed obtained the highest total milk production throughout the year 2014: 227.46 ± 2.54 liters, 142.66 liters of milking milk in 232 days of lactation, with 5.89 ± 0.10% protein and 6.12 ± 0.14% fat.

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THE IMPACT OF WASTE AND SANITATION IN THE LOCALITIES ON THE LOWER COURSE OF THE DNIESTER

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Abstract

This study introduces the main waste and the actions that are taken in order to stock and remove it, actions that have a direct influence upon the development of tourism in the lower course of the riverDniester. The basin of the Dniester has a patrimony of special value which is insufficiently exploited. This situation is conditioned by the insufficiency and the poor state of the garbage dumps and of the spaces allotted for garbage collection, by the absence of trash bins in locations for balneary recreation and ecotourism of the described region, by the problems of the farmsteads on the one hand, and the ones of the town halls on the other. Despite the cuts in the number and surface of the unauthorized landfills reported by the environmental authorities, the situation of the communal waste management remains tense, and in many localities critical. According to the number of existing landfills, especially unauthorized ones, just as the number of illicit garbage dumps of big and medium size, the most critical situation is recorded in the districts of Anenii Noi, Căuşeni, Ştefan Vodă. These districts must be declared priority to the financing of sanitation.

Key words: waste, Dniester, difficulties, storages, sanitation.

Introduction

This study and the variety of the proposed objectives have determined the application of a range of various methods and techniques, and was developed in consultation with several bibliographical sources (geographical, historical, statistical),and by processing a certain number of data, meant to familiarize with the impact of waste and sanitation that serve as difficulties standing at the basis of the tourism development in the given region. As a result of inefficient public policies on regional and zonal management of the communal landfills, we can find the overcharging of landfills in some localities (particularly in the proximity of big urban centers) and the very poor exploitation of some landfills in other localities, included those that have been built or rebuilt with substantial financial contributions from environmental funds. The absolute majority of landfills of municipal solid waste (MSW) do not have methane capture plants.

Theory and methodology

For the development of this study I used such *methods* as: description, synthesis, analysis, comparison etc. *The relevance of the topic* of study is determined by the fact that tourism is a very dynamic element, the changes occurring in the evolution of economic, demographic, and natural phenomena standing as an argument. Taking into consideration that the given region is poor in exploitable mineral resources, and the primary and secondary sectors of the economy decline, the development of tourism is needed as an alternative livelihood resource for the population, and for the conservation of natural and human geographical environment.

The goal of the study is the emphasis of the impact of waste and sanitation upon the development of tourism in the lower course of the river Dniester.

Localization of the study area

The Lower Dniester region indwells the S-E region of the Republic of Moldova within the plain with the same name, and the eastern sector of the South Moldova Plateau from the lower sectors of river's Bîc and Botna basins. The conventional border from the S-W of the given region passes over the river Ceaga, on the Taraclia-Chircăetii Noi – Cărbuna – Țîpala line from the confluence of the Căușeni and Ialoveni districts. The conventional N-W border crosses the Criuleni and Dubăsari districts. An the one from the North, starting from the left affluent of the Dniester, the Iagorlîc stream, and the southern part of the artificial storage lake Dubăsari. The eastern border traverses the Transnistria Autonomous Territorial Unit and its border with Ukraine. Thus, we can say this region includes territories from the districts of Ștefan-Vodă, Căușeni, Anenii Noi, Criuleni, a big part from the district of Ialoveni and Dubăsari, as well as a lot of the Chișinău municipality and the Transnistria Autonomous Territorial Unit (Dubasari, Grigoriopol, Slobozia).

Results and discussions

The impact of waste on the environment

The increasing production and expenditure of natural and material goods was followed, continuously, by a similar increase of the waste stocks and the amplification of the their management problems. The waste generates, not just the squandering of raw materials, but, also a multitude of economical, environmental, and social problems. In the post-war period, the problems with management of the production, and, especially with the household waste existed in almost every locality of our Republic. Nevertheless, the problem was insufficiently tackled with in the geographical studies at that time(Bacal, 2010).

Actually, the waste represents a reflection of the economic and environmental reality, especially in the rural areas of the region. The most stringent problems in the management of waste are: the presence of unusable and illicit pesticide stocks; the inefficient centralized evacuation, and the non-performance of separate collection and processing of solid waste; the liquidation of illicit garbage dumps; the storing of manure in town; the excessive accumulation and insufficient treatment of organic waste from biological treatment plants; the stocks of toxic industrial waste, especially from the wine industry; the superficial exploitation of vegetable waste (Bacal, 2007; *HG nr. 606 din 28.06.2000 privind aprobarea Programului Național de Valorificare a Deşeurilor de Producție şi Menajere*).

Waste of persistent organic pollutants (POPs) do massively pollute the soil and the drinkable water sources, and gravely affect public health, especially in rural areas. They can remain for a long time in the environment, possesse a varied toxic action and can be easily transported over long distances (Garaba, Pleşca, Isac, 2005). Accumulating in the tissues of plants and animals, many of them multiply their toxic effect in the human body. Excessive concentration of POPs cause increased incidence of liver disease, cancer, immune and nervous system disorders (Duca, Cazac, Galcă). The geo-ecological geo-medical studies conducted in the late 1980s within these areas, note the increased presence of trace concentrations of harmful substances in soil, groundwater and water bodies, and very high incidences of cancer diseases and, in particular, a considerable number of children with physical and intellectual disabilities. The effects are felt acutely by the impact of these stocks today, but due to the lack of recent studies, we cannot speak with certainty about the risks and actual harm of these wastes (Bacal, 2007).

The adoption, in 2004, of the National Strategy and of the Stockholm Convention on POPs reduction and elimination signified a new stage in achieving these goals. The implementation of the Strategy was based on financial assistance, information and external management, and the allocation of sufficient financial, operational, and domestic human resources (Bacal, 2007).

In recent years, to address this problem, the project "Management and destruction of persistent organic pollutants" is being implemented successfully. It is a pioneering project in Central and Eastern Europe. Under the agreement between the Government of the Republic of Moldova and the NSPA - NATO Support and Procurement Agency, the absolute majority of obsolete pesticides and capacitors were collected, repackaged and stored.

The impact of household wast

For Moldova, like other countries with low financial provisions and inefficient institutional structures, the most serious problem is not the very large stocks of such waste, but their location in chaotic and unacceptable places in terms of environmental safety and sanitary hygiene. The impact of household waste has increased alarmingly and inefficient management of the communal landfills leads to the contamination of soil, the water pollution and toxic gas emissions (*Anuarul privind calitatea factorilor de mediu şi activitatea Inspectoratului Ecologic de Stat in anul 2007*). However, about 40% of the solid waste components are recyclable waste (paper, cardboard, plastic, glass, metal) (*Anuarul privind calitatea factorilor de mediu şi activitatea Inspectoratului Ecologic de Stat in anul 2005*).

Very alarming is the situation of illegal dumps in and near rural areas. Annually, virtually innumerable big, medium and small illegal dumps are detected. Most of these dumps are located on the banks of ravines, small rivers and around wells and springs. Although in recent years, about 70% of dumps were liquidated, they reappear in most localities. This critical situation is conditioned by the perfunctory sanctioning of these activities, by the careless attitude of the population and the local administration, by insufficient technical, economical and human resources, necessary to prevent and solve this problem. Endless piles of rubbish not only affect the environment and human health in this space, they also transform our villages' attractive sights in garbage fields and huge pits. In 2009, the maximum number of detected illegal dumps was recorded in Căuşeni (180) and Stefan Vodă. The minimum weight of liquidated garbage dumps is found in Anenii Noi (23%).

The number of dumps discovered and liquidated not only depends on the size of the settlements, financial and technical assistance and effectiveness of sanitation measures, but also on the frequency, scope and effectiveness of the measures for tracking and monitoring these dumps. Of the total volume of this mandatory waste management only waste collection and disposal in municipal landfills is usually performed. The most common method of waste management is its storage on the ground with serious risks of polluting the soil and water. Separate collection and processing of household solid waste, especially plastic, is made only in certain neighborhoods in the city.

The nonperformance of necessary drainage works at landfills substantially reduces communal waste management efficiency and increases the risk upon soil and water in the adjacent area. Moreover, the majority of authorized landfills do not meet sanitary-hygienic and ecological requirements, lack dam embankments, landscaped platforms, fence protection, security service, the tracking and monitoring of waste stored and respective ramps; also the burial works are not done on time and according to technology (*Anuarul privind calitatea factorilor de mediu şi activitatea Inspectoratului Ecologic de Stat in anul 2005*).

Due to the overloaded landfills, as well as the high consumption, the area of ramps and the volume of communal deposited waste registers a slight increase. The ascending evolution in the total area is observed in most districts.

Excessive growth in waste volumes was seen between 2001-2009, in the Anenii Noi district. About 40% of the area and the number of municipal landfills are unauthorized. As a result of the persistent efforts of the ecological authorities, the surface of unauthorized landfills decreased in percentage from 61% in 2001 to only 27% in 2014. The maximum area of unauthorized dumps documented is in Anenii Noi district (29.2 ha) and Căuşeni (20 ha). The minimum weight (under 10%) is observed in Dubăsari district.

The maximum weight of spectered garbage dumps is found in Anenii Noi, Căuşeni și Ştefan-Vodă (table 1).

Table 1. Detection and liquidation of illegal waste dumps

No	Districts	**Number of illegal waste dumps**				**The surface of illegal waste dumps**, in ha			
		trace		**liquidated**		**trace**		**liquidated**	
		2013	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
1	Anenii Noi	44	46	20	36	2,91	2,52	1,23	1,9
2	Causeni	167	105	146	96	12,66	4,12	11,91	3,78
3	Criuleni	81	93	75	74	8,97	8,1	7,70	6,5
4	Dubasari	17	13	9	6	1,9	1,74	0,78	0,64
5	Stefan Voda	106	118	101	105	8,07	10,97	8,05	9,65

According to the Regional Development Strategy, waste disposal polygons were placed in some localities, one of which is located at Opaci, Căuşeni.

The location of the landfill in the town hall perimeter, which calls for the implementation of the project, is facilitating the application of public private partnership (PPP), since the private investor is interested in its presence in good condition, in order to have lower operational, and particularly environmental costs and risks. Most forms of concession in waste management and sanitation look for construction, reconstruction, ownership and operation of the respective ramps.

In this region, there is not a shortage of municipal landfills, on the contrary. In Soviet times, they were built by one or several ramps, including authorized ones, in most of the localities. After independence, the situation and attitude remained the same. In the 1990s, due to the lack of funds, the condition of many ramps worsened considerably and their impact on the natural and social environment increased. In the last decade, with the support of the National Environmental Fund (NEF) and other institutions providing such assistance, they were modernized and a large number of such locations were built.

However, as mentioned above, a large part of the existing ramps are used at very low capacity, and people continue to throw garbage in landfills and unauthorized spectered dumps in and near the cities, in rivers and groundwater, seriously affecting the health of people in the area. Therefore, it is not the extension in the number of the ramps that is the priority, but their reduction, modernization, adequate construction of selected sites, and their effective management.

Waste management is one of the important problems faced by this region. It concerns the activities of collection, transportation, treatment, recovery and disposal of waste. The main way is the household waste's treatment by means of recycling, of which three methods are currently used: composting, incineration, and landfilling. Waste transported to polygons are not subject to composting and burial as required, but are stored erratically throughout the perimeter, including roadways in the given area. The technology designed for the execution of composting is not working.

The main forms of impact and risk on the development of tourism caused by the waste in the region are:

- changes of landscape and visual discomfort;
- air pollution with odors, suspensions driven by wind and emission of greenhouse gases;
- pollution of surface and groundwater, especially in the result of the formation of the filtrate from washing waste deposited by rainwater;
- Changes of biocoenoses on the polluted fields and the ones neighboring them, so the ruderal plant associations become dominant species specific to polluted areas, and some mammals, birds, insects leave the area for the benefit of those who feed on refuse (rats, crows, stray dogs).

Lately, the amount of animal waste has reduced significantly. The maximum amount of this waste is found in Anenii Noi district (28 000 t). However, most districts do not show the full information about this waste. To improve that situation, several joint platforms for storing manure were appointed in Anenii Noi şi Căuşeni districts. It is necessary to impose severe restrictions on the evacuation of pig manure from sheepfold locations.

The amount of **communal household waste** is the solid waste and the remaining waste from the water treatment stations. Currently, most of the treatment plants lack modern technologies for dehydration and processing of such waste, usually, calling on the services of nature. Processed organic sludges and solids collected from sewage are transported to filtration fields that often are not arranged according to respective regulations. Because of the direct contact with the natural environment, atmospheric air, groundwater and surface water are heavily polluted.

A particularly alarming situation is found in **toxic waste** management resulting from individual consumption, such as polyethylene bags, plastic and aluminum dishes, or waste tires. They are bypassed by centralized management records and statistics, but are found in abundance in all ramps and dumps in ravines and small rivers.

Conclusions and recommendations:

1. The Lower course of the Dniester River has a great tourism heritage varied and rich, but because of the particularly strong rural and agrarian character, tourism activities are underdeveloped.

2. Despite the high value of the tourism sites, a good part of the natural geological monuments are transformed into unauthorized dumps and quarries while landscape reservations are subjected to massive illegal deforestation, overgrazing, landslides and other forms of degradation.

3. In the '90s, due to the decline of the industrial and agricultural production, substantial reduction in emissions (8 times) was registered, as well as reductions in water consumption and discharges (4 times), followed, in 2000, by the fluctuation amid a slow trend of overall increase. About 90% of the total weight of the emissions is generated by mobile sources.

4. Overall, remarkable results are attested in solving the problem of banned pesticides and industrial toxic waste, modest in utility ramps and unsatisfying in unauthorized dumps, livestock waste and the separate collection of municipal waste. The amount of obsolete pesticides, cyanide from wineries and the share of communal unauthorized ramps dropped by 30%. In a few localities the following were initiated: the separate collection of communal waste, landscaping livestock for biogas production platforms, treatment and incineration of municipal waste, including waste water treatment plants. The following are required: a) proper implementation of environmental initiation and education; b) mandatory provision of data by environmental authorities on waste general production and harsh sanctions for the failure; c) adequate monitoring and enforcement of mandatory drainage works at communal waste storage ramps; d) adequate involvement of branch subdivisions of central and local public authorities in order to achieve the National Program waste recovery; e) implementation of the Urban Plans of localities that include specific technical projects for waste management.

5. Tourism capitalization of the region is conditioned by economic underdevelopment and the predominantly agrarian and rural character of the region, the poor state of access roads, insufficient sanitation, unauthorized settlements and waste areas. At the same time, regulating the Transnistrian problem and implementing the Association Agreement with the EU will enhance the attractiveness of the territory, and tourism will become one of the main areas of attraction for foreign investments and overall economic recovery in Moldova.

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