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THE INFLUENCE OF EUROPEAN CLIMATE VARIABILITY MECHANISM ON AIR TEMPERATURES IN ROMANIA

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Key words: European climate variability, EOF analysis, non-parametric tests, maximum and minimum air-temperatures, Romania.

Abstract. The present paper investigates on the spatial and temporal variability of maximum and minimum air-temperatures in Romania and their connection to the European climate variability. The European climate variability is expressed by large scale parameters, which are roughly represented by the geopotential height at 500 hPa (H500) and air temperature at 850 hPa (T850). The Romanian data are represented by the time series at 22 weather stations, evenly distributed over the entire country's territory. The period that was taken into account was 1961-2010, for the summer and winter seasons. The method of empirical orthogonal functions (EOF) has been used, in order to analyze the connection between the temperature variability in Romania and the same variability at a larger scale, by taking into consideration the atmosphere circulation. The time series associated to the first two EOF patterns of local temperatures and large-scale anomalies were considered with regard to trends and shifts in their mean values. The non- Mann-Kendall and Pettitt parametric tests were used in this respect. The results showed a strong correlation between T850 parameter and minimum and maximum air temperatures in Romania. Also, the ample variance expressed by the first EOF configurations suggests a connection between local and large scale climate variability.

Introduction

To understand the mechanisms and physical processes that determine the global and regional climate and its variations, it is necessary to analyze the main characteristic structures of the climate system components. In this respect, it is noteworthy to mention the importance of conducting studies on climate variability analysis in order to identify the large scale mechanisms that may influence the

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regional or local climate. When it comes to presenting the climate variability based on observational data, the studies focus mainly on the analysis of temperature and precipitation variables, which are very important for human activities. As regards the Romanian territory, various studies were conducted, by using different methods or different number of meteorological stations and time periods (Busuioc and von Storch 1996; Boroneant et al., 2000; Busuioc et al., 2001). Generally, the main impact of climate change is related to the increase of mean air temperature values over land surfaces. From this point of view, the analysis of temperature variability is important to evaluate its growth rate for different time periods. Another important aspect is also related to the investigation of the frequency and magnitude of extreme events. For this, the present day weather conditions must be well understood both in terms of their common seasonal phenomena and extreme variations.

This study focuses on the spatial and temporal variability of maximum and minimum air-temperatures in Romania and their connections to the European climate variability. As it was already pointed out in the study conducted by Tomozeiu et al. (2002) it seems that the maximum air temperature in Romania is seasonally dependent on the various large-scale patterns of atmospheric circulations at European level. An analysis to detect the trend and shift points is therefore carried out by examining the data provided by 22 weather stations distributed all over Romania, over the 1961-2010.

The paper is structured as follows: section 1 describes the data and the methods that were used, while section 2 outlines the results. Section 3 summarizes the conclusions.

1. Data and methods

The observational data used in the present paper are represented by the 50 years' time series (1961-2010) of the seasonal means of maximum and minimum air temperatures during winter (December-February, DJF) and summer (June-August, JJA), at 22 weather stations evenly distributed all over the Romanian territory (Figure 1).

In order to analyze the spatial and temporal variability of observational data used in the study, two non-parametric tests were used. The trend of each time series was detected by applying the Mann–Kendall test (Sneyers, 1975), while the changes of the seasonal mean values of maximum and minimum air temperature were detected by means of the Pettitt test (Pettitt, 1979). These non-parametric tests have been used to verify the statistical assumptions in terms of the null hypothesis which does not depend on the distribution form. In practical examples, the positive values of the Mann-Kendall trend test greater than 1.97 shows an increasing trend, while the negative values lower than -1.97 reveal a decreasing trend. In both cases, the level of significance of 5% (0.05) is considered as being reasonable to obtain meaningful conclusions from a scientifically point of view (Busuioc et al., 2010). The Pettitt test detects the change points in the data series, by reporting the changes in time series average (Tomozeiu et al., 2000). More information about these tests can be found in Busuioc and von Storch (1996) and Busuioc et al. (2001).

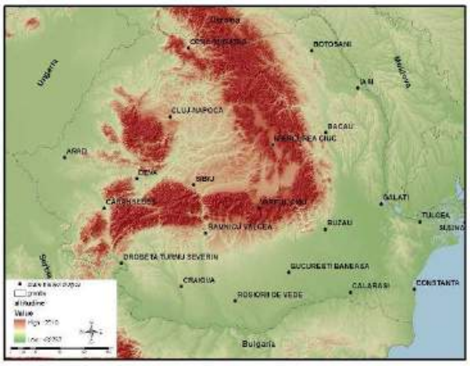


Fig. 1 – Geographical location of the weather stations used in the study

The EOF analysis (von Storch, 1995 and Wilks, 1995) has been used to investigate the spatial and temporal variability of the parameters under consideration. The analysis aims at finding possible relations between changes in large scale atmospheric circulation and seasonal mean values of air temperatures in Romania. For this, the first step of the EOF analysis is to split the temporal variance of original data sets into empirical eigenvectors (EOF's), associated with time series coefficients (PC's) which describe the evolution in time, of the spatial modes (Tomozeiu et al., 2002). It must also be pointed out that the EOF technique is applied to the anomalies calculated from the long-term mean of the data series. The Mann-Kendall and Pettitt tests are also applied to the PC series obtained in order to detect the possible reasons which could lead to changes in the seasonal mean of maximum and minimum air temperature values in Romania.

2. Results

2.1 The temporal and spatial variability of seasonal air temperatures in Romania

Below, we present the linear trends and the statistical significance for the seasonal mean values of maximum and minimum air-temperatures in Romania, as resulting from the non-parametric tests described above. Thus, Figure 2 show the linear trend for maximum air temperatures in the summer and winter seasons. The value distribution in the summer season reveals a significant warming at most of the stations, the highest values being recorded in the extra-Carpathian regions. Also, excepting the Sulina station, statistical significant trends were detected. Furthermore, the change point analysis performed by means of the Pettitt test revealed an upward shift in 1986, at most of the stations. In the winter season, significant values were detected at only 8 stations, the most pronounced values being identified in the South and South-East. The change point analysis shows an upward shift in the winter 1986/1987.

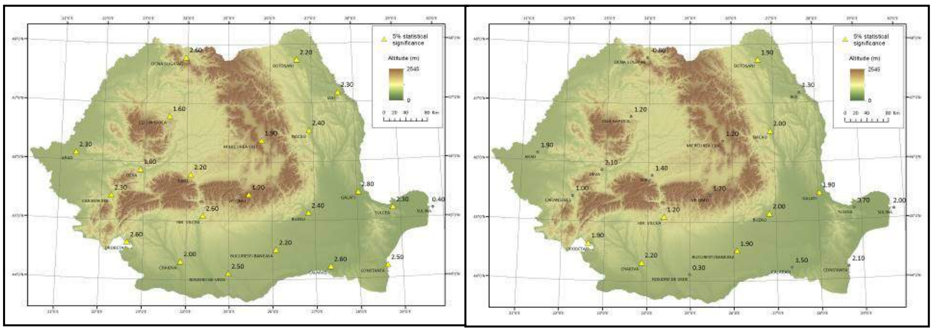


Fig. 2 - Linear trend (°C) of summer (left) and winter (right) maximum air temperature. Triangles mark the significant trends of 5%.

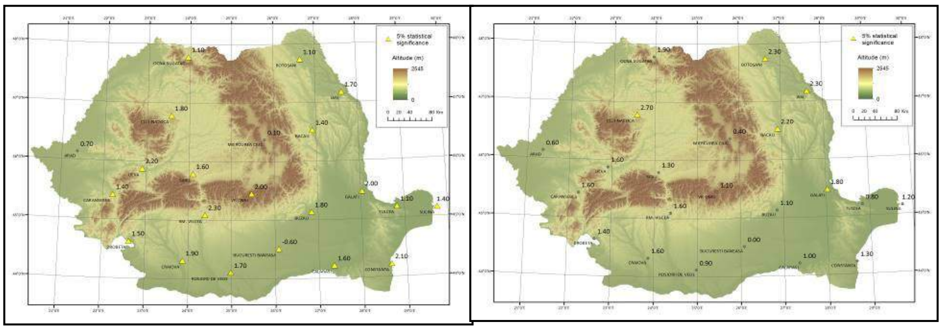
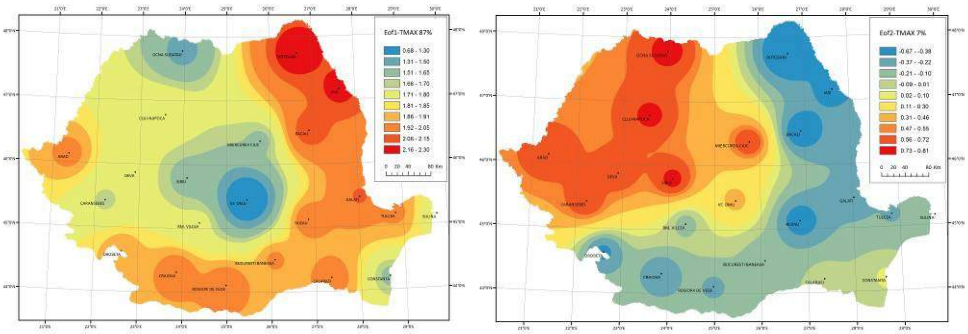


Fig. 3 - Linear trend (°C) of summer (left) and winter (right) minimum air temperature. Triangles mark the significant trends of 5%.

Concerning the analysis of the minimum air-temperature values, the results are shown in Figure 3. In summer, excepting the Arad and Miercurea Ciuc stations, statistical significant trends are detected, while in winter the signal is lower, a significant trend being detected only for Cluj Napoca, Bacau, Botosani, Iasi and Galati stations. The change point analysis revealed 1991 as a change point for the summer season at most of the stations, while the winter of 1986/1987 was pointed as an upward shift.

In order to identify the main characteristics of the spatial variability of seasonal mean maximum and minimum air temperatures in Romania, the EOF analysis was applied, by using the anomalies of summer and winter temperatures, as computed by subtracting the long-term means from the original values. In this respect, Figure 4 presents the first two EOF configurations for the **maximum air temperature** during the winter season. The first EOF configuration, with 87% explained variance, presents the same sign over the entire country, which may indicate that the temporal variability can be associated with a large-scale variability mechanism. As regards the spatial distribution of the displayed anomalies, maximum values can be found in the north and northeast part of the country. The second EOF pattern, with an explained variance of 7%, presents a dipolar structure, showing the influence of the Carpathian Mountains on the maximum air-temperature values distribution. Thus, the inner and outer Carpathian regions present opposite signs of variability.

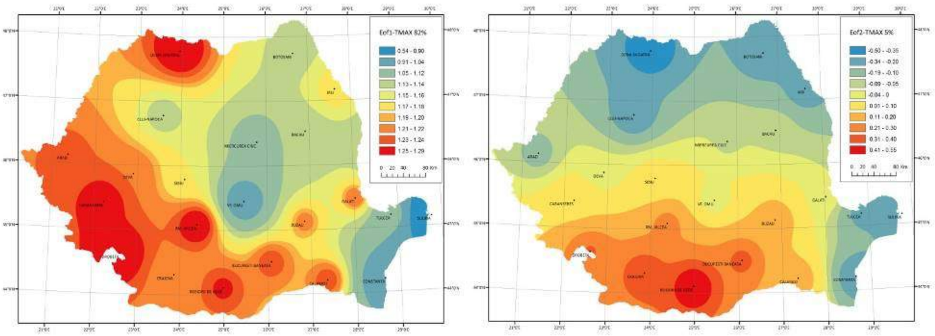


a. 87 % variance b. 7% variance

Fig. 4 - The first two EOF patterns of the mean maximum air temperature values during the winter season, in Romania

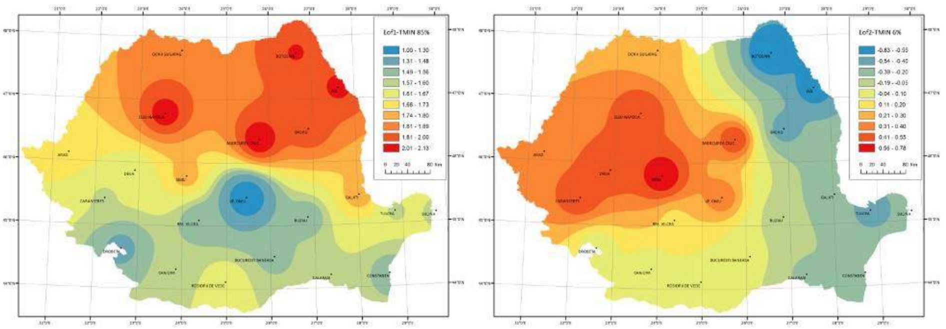
During the summer season, the first EOF analysis results for the mean maximum air temperature values are displayed in Figure 5. As in the case of the first EOF pattern for the winter season, the explained variance presents a high value (82%) in this case. The highest values (higher variability) are visible in the South and South-western parts of the country, while the lowest values are identified in the South-East.

The second EOF configuration shows a rather small explained variance (5%) and presents a dipolar structure between the inner and outer Carpathian regions, with different signs of variability.



a. 82 % variance b. 5% variance

Fig. 5 - The first two EOF patterns of the mean maximum air temperature during the summer season, in Romania

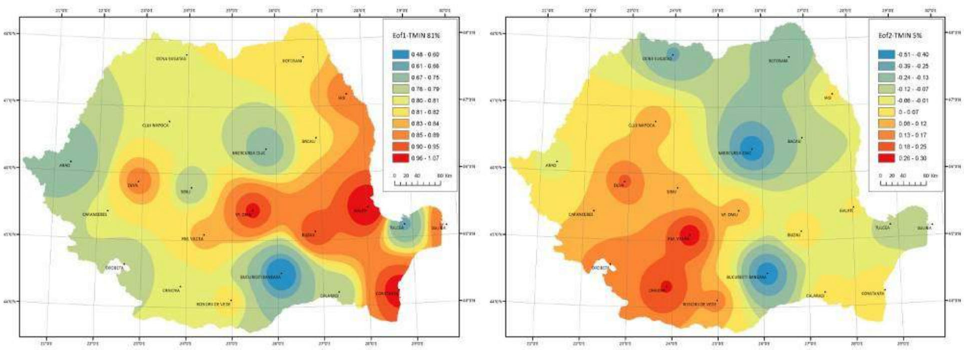


a. 85% variance. b. 6% variance

Fig. 6 - The first two EOF patterns of the mean minimum air temperature values during the winter season, in Romania

The EOF analysis performed for the **minimum air temperature** values in the winter season is presented in Figure 6. The first EOF configuration, with an explained variance of 85%, shows the same sign throughout the country, although higher anomaly values being recorded in the central Northern and North-eastern parts of the country. In case of the second EOF pattern, where the anomalies of opposite sign are shown, one may notice positive anomalies in the central and Western parts of the country, but with only 6% explained variance. Regarding the summer season, the EOF1 pattern shows an explained variance of

81% (Figure 7) and presents the most pronounced anomalies in the South-Eastern parts of Romania, whilst the EOF2 pattern (of 5% explained variance) reveals the most pronounced anomalies in the South-West. The Pettitt test applied to the PC series corresponding to the EOF analyses performed, shows shift points that are similar to those detected in the time series of each individual station.



a. 81% variance. b. 5% variance

Fig. 7 - The first two EOF patterns of the mean minimum air temperature values during the summer season, in Romania

2.2 Connection between Romanian air-temperatures and European large scale parameters

In order to find a physical mechanism that controls the climate variability in Romania, the large-scale climate variability was investigated by using the same method. Consequently, the EOF analysis was applied for both European H500 and T850 parameters in the winter and summer seasons, finally retaining the first two EOF configurations which explain more than 50% of the total variance. The first two wintertime EOF patterns over the 1961–2010 time periods for H500 parameter are presented in Figure 8. The first EOF model, which explains 34% of the total variance, exhibits a pronounced positive anomaly in central and western Europe, while the second EOF configuration (of 29% explained variance) shows a dipolar pattern, oriented from NW to the SE, composed of two structures: a structure centered in the North of the Atlantic Ocean, and another one, of opposite sign, centered in the Mediterranean Sea. For the first EOF configuration, the shift point detected was the winter of 1981/1982.

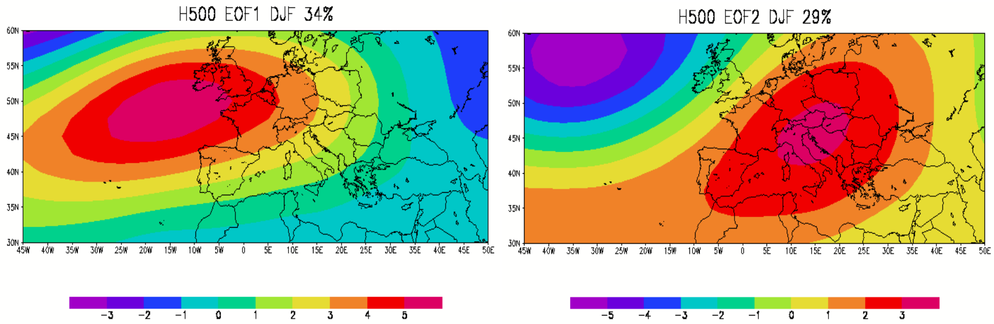


Fig. 8 - The pattern of the first and second H500 EOF configurations for the winter season

Figure 9 shows the first two EOF patterns for H500 in summer, featuring an explained variance of 31% (EOF1) and 19% (EOF2), respectively.

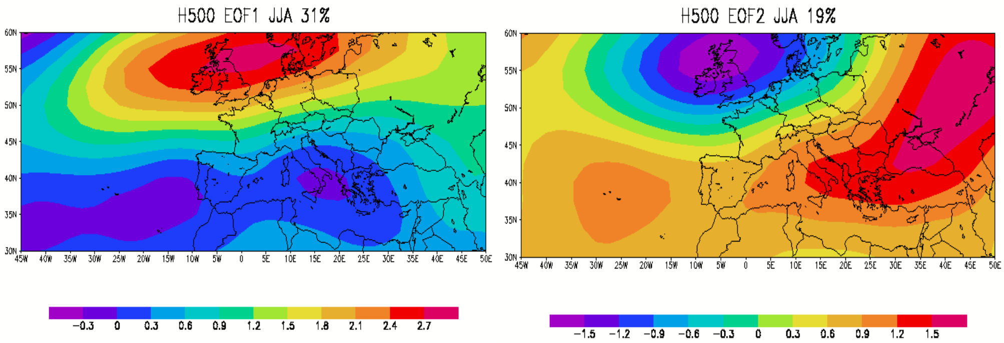


Fig. 9 - The pattern of the first and second H500 EOF configurations for the summer season

For the EOF1 structure, positive anomalies can be observed in north-western Europe, while the EOF2 configuration has a structure with three centers: a center of negative/positive anomalies centered in north-western Europe and two centers with opposite signs of anomalies (positive/negative) with the nucleus located in NE Europe and central North Atlantic. The Pettitt test revealed an upward shift of 1983 for the first EOF spatial pattern.

Regarding the EOF analysis for the T850 parameter during the winter season, the EOF1 configuration (Figure 10) shows a 47% explained variance, with pronounced anomalies in north-western Europe, while the EOF2 pattern reveals pronounced anomalies in Eastern Europe. The deviation from normal’s for the Romanian territory is between 0.6-1.2 hPa, (EOF1) and 0.7-1.1 hPa, respectively (EOF2). In the summer season (Figure 11), the EOF1 configuration (of 39%

explained variance) shows the same variability in all the analyzed area, with a nucleus centered in north-eastern Europe. For Romania, there is a deviation from normal between 0.5 and 1 hPa. The EOF2 configuration (of 16% explained variance) presents a dipolar structure with the nucleus centered in north-eastern Europe and south-western Europe, respectively. The change point detected for the first EOF's are: 1989 (winter) and 1983 (summer).

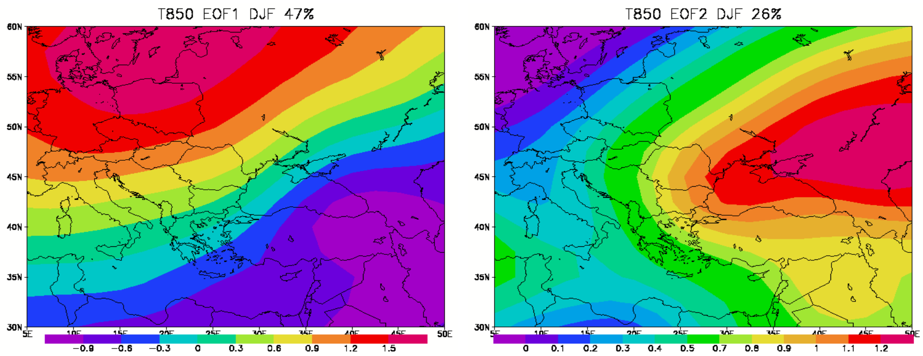


Fig. 10 - The pattern of the first (EOF1) and second (EOF2) T850 EOF configurationsfor the winter season

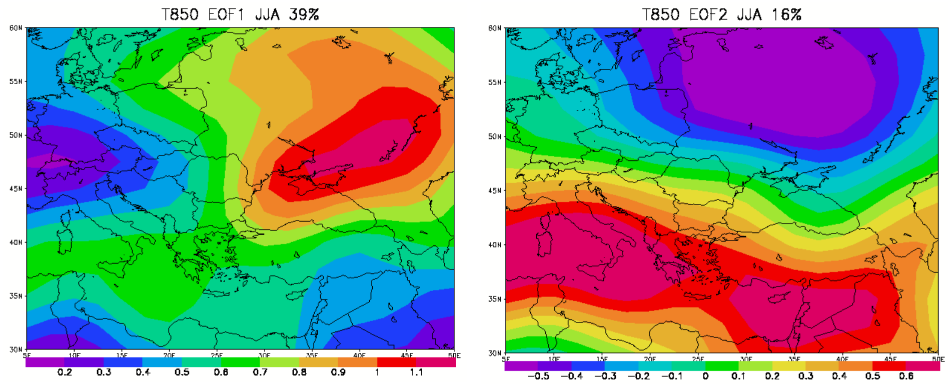


Fig. 11 - The pattern of the first (EOF1) and second (EOF2) T850 EOF configurations for the summer season

By taking into account the large explained variance of the first EOF configurations of the maximum and minimum air temperatures in Romania, below we also present the temporal series of the detected spatial variability. The changes in seasonal mean maximum and minimum temperature values in Romania can be explained by the changes in the first mode of the atmospheric circulation variability at European scale.

In this respect, Figure 12 presents the main component series of summer mean maximum temperatures in Romania, on one side, and the H500/T850 parameters in the same season, on the other side. One can notice that the positive anomalies of maximum air temperature can be associated to positive anomalies of the H500 and T850 parameters. On the other hand, the PC series of winter mean minimum temperatures in Romania and the H500/T850 time series are displayed in Figure 13. One may also notice that the influence of large scale parameters on the Romanian minimum air temperature regime is largely attenuated as compared to the summer season. As it was previously explained in various studies (Ion-Bordei, 2009, Busuioc et al., 2010), during the winter season, the temperature regime in Romania is much more influenced by the air circulation at surface level.

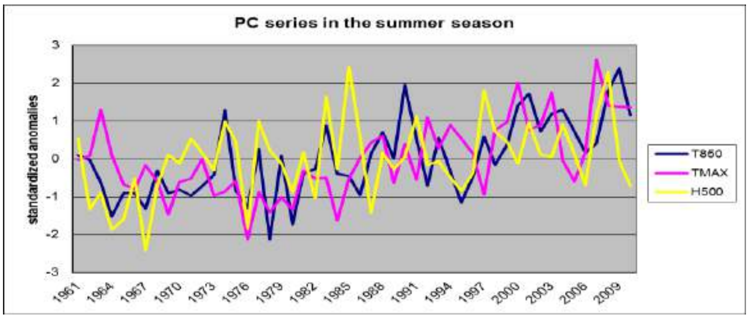


Fig. 12 - Temporal coefficients associated to the main modes of variability of H500/T850 anomalies and maximum air temperature anomalies in Romania

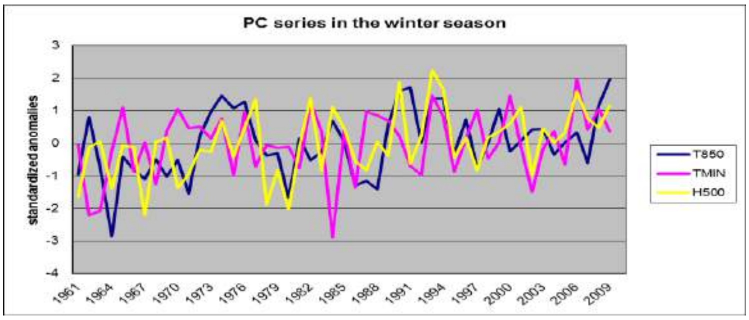


Fig. 13 - Temporal coefficients associated to the main modes of variability of H500/T850 anomalies and minimum air temperature anomalies in Romania

4. Conclusions

We may draw some interesting conclusions from this study with respect to the large scale mechanisms which control the changes in the seasonal mean maximum and minimum air-temperatures in Romania.

Primarily, the linear trend analysis performed for both maximum and minimum air-temperatures revealed positive trends both in summer and winter seasons. In the case of summer maximum temperatures, the highest values were identified in the South and South-East parts of the country. Regarding the analysis made for minimum air-temperatures in summer, a statistically significant trend was detected at most stations, while in winter, at only five stations.

The main characteristics of the spatial and temporal variability of the Romanian mean maximum and minimum air-temperatures were revealed by means of the EOF technique. The main modes of European climatic variability were also analyzed by applying the same method. Therefore, the PC series associated to the first EOF pattern of the H500 and T850 parameters and mean maximum and minimum temperature in Romania were analyzed by using the Pettitt and Mann–Kendall tests respectively, in order to detect their linear trend and shift points. The explained variance of the first EOF configurations for seasonal maximum and minimum temperature can lead us to the idea that the large scale mechanism is mainly responsible for the detected increasing trend. Also, the role of the Carpathian chain is revealed by the second EOF configuration, thus explaining the opposite variability between the inner and the outer Carpathian regions.

A significant warming trend was mostly detected in the summer season, while in winter the signal is lower. Regarding the EOF analysis performed for some European large scale parameters, in case of the geopotential height at 500 hPa, positive anomalies in both seasons were detected. Air-temperature at 850 hPa presents a much higher explained variance, with pronounced anomalies recorded above Romania. The analysis performed for the main component series of the EOF configurations also reveals the same linear trend mainly in the summer season. In other words, pronounced positive anomalies detected for maximum and minimum air temperatures in the summer season, can be associated to structures of positive anomalies for H500 and T850 parameters. In the winter season, it seems that the most pronounced influences are most probably related to other factors, like the intensification of the westerlies which is associated to the positive phase of the North Atlantic Oscillation (Busuioc et al., 2010, Dima and Stefan, 2008).

The temporal coefficients associated to the EOF technique performed for air-temperatures in Romania are in accordance with the trend analysis made for each station. The same situation is detected in the summer season but with different shift points detected (1986 for maximum temperature and 1991 for minimum temperature).

The results presented in this paper are in agreement with those presented by Tomozeiu et al., 2002, Busuioc and von Storch, 1996 and Busuioc et al., 2010, which analyzed the changes of the winter and summer precipitations in Romania and their relationship to the large scale circulation. This can lead to the idea that the large scale mechanism actually controls the temperature regime in Romania.

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STRUCTURAL DYNAMICS OF ROMANIAN FORESTS AFTER 1990

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Key words: forest, biodiversity, regeneration.

Abstract. The Romanian forest area in 2010 was 6,515 million ha, which represents approx. 27.3 % of the national territory. At European level, Romania is ranked 13 in the areas occupied by forests, but below the average forest coverage of 32 %. After a decline in forested areas recorded between 1990 and 2000 there was a slight rebound in the last decade, with an FAO estimated growth of over 30 000 ha per year between 2005 and 2011. This growth is primarily attributed to natural regenerations. If the production function is intrinsically provided in different proportions by all the functional categories, the protective function has a special attention, having clear typological distinctions, based on well-established natural or social components. Only maintenance work is allowed in protection forests. The total volume of timber harvested in Romania in 2010 was about 17 million m3, according to NFA upon reading the regeneration cuts of an area of over 99 hectares, 5000 ha of which by cuttings Compared to 2000, when they harvested less than 14 million m^3, one can see a substantial increase of approx. 20 %. In the same period, in 2010, the total area of artificial regenerations was about 10 000 ha, which represents a tenth of the cutting surface, the remaining land being regenerated naturally.

Introduction

It is estimated that at the beginning of the humanization of the territory, Romania was 80% covered by forests (Giurgiu, 2004). Apart from the Carpathian forests, large areas of hilly plaINS and even forests were occupied by the ancient and medieval West. Wooded areas were continually reduced by deforestation to obtain timber, in search of seeking new land for cultivation or

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grazing and by expanding settlements or means of communication. Currently, only about 27% of Romania's surfaces are still forested.

The reduction of forest areas of Romania continued after the political changes of 1989, due to irrational and sometimes illegal mining, which were practiced amid crumbling forestlands through partial repayment of former private property and the lack of enforcement authority and tolerance massive felling of forests. Giurgiu, 2010, states that the restitution is not over, because the state still owns 3.3 million hectares of forests in other forms of property and in opposition to optimistic reports, Romanian forest area will decrease further, as in recent years, because people and private entities will exploit wood resources.

Material and methods

The real appreciation of the difficulties of incomplete statistical data or the ones that do not reflect the real structural dynamics of the forests of Romania was the starting point of the study. The NFA advanced reports or the ministries to which the forests were attached sequentially are not truthful, because in some cases, the statistical data are indentical every four successive biannual evaluations. It is impossible for certain indicators not to suffer any changes of the surface or the percentage share for a period of six years. The data sources that were used are those provided by the NIS, NFA, EFM, Corine Land Cover and refers to the period after 1990 particularly and in particular quantitative assessments for 2005, 2007, 2009 and 2011. Inconsistencies between data and reality were raised primarily by comparative analysis method.

Results and Discussion

According to the report published by the NFA, SILV1, Romanian forest area in 2010 was 6,515 million ha, which represents approx. 27.3 % of the national territory. At European level, Romania is ranked 13 in the areas occupied by forests, but below the average forest coverage of 32 %. The highest percentages of afforestation are found in Finland, holding 73%, Sweden 69%, Slovenia 62% and Russia 49%. The forest area per capita in Romania is 0.33 ha, far below the average well wooded countires: Russia 5.7 ha / person, Finland with 4.4 ha/inhabitant, Sweden with 3.1 ha/person and Norway with 2.5 ha/person. It is likely for this indicator to exceed the European value in the near future, given the downward trend in the number of inhabitants of Romania. The forest area occupied only by forests was 6.354 million ha in 2010, the remaining 161 000 ha, representing other areas belonging to the national forest fund. After a decline in forested areas recorded between 1990 and 2000 there followed a slight rebound in the last decade, with a growth of over 30 000 ha per year between 2005 and 2011, estimated by FAO. This growth is primarily attributed to natural regenerations.

Table 1 The evolution of the total area of forests in Romania after 1990 (million ha) Source NFA

	1990	1995	2000	2005	2011
România	6,371	6,282	6,366	6,391	6,515

In 2011, the situation in the counties reveals major differences in the areas occupied by forests. The largest areas (over 250 000 ha) in counties are: Suceava, Caras-Severin, Hunedoara, Arges, Bacau and Neamt Valcea. On the opposite side there are a number of counties with very small areas of forest (below 40 000 ha): Călărași, Ilfov, Ilfov, Teleorman, Constanța, Brăila and Galați. If one takes the percentage into account, Suceava is still the most wooded county, having 51% of the territory covered by forests, followed by other counties, with percentages of 40%, which have an important mountain element surface (Vâlcea, Caras-Severin, Gorj, Neamt Covasna, Hunedoara).

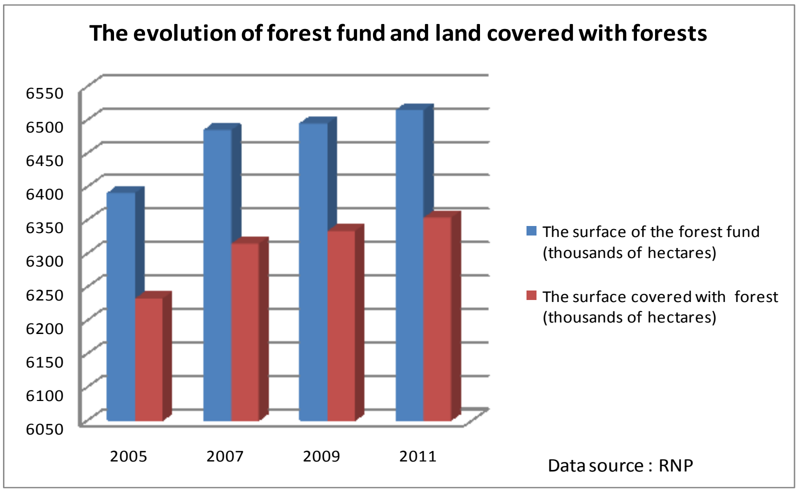

Fig.1.

Romania provides optimal conditions for the development of temperate forest types in different types of brushes. Climatic conditions differ very little from the latitude point of view, but they change in altitude, creating differences that reflect the natural setting of various types of wood. Only in southwestern Romania there are some thermophilic species of trees and shrubs installed in an environment with warmer climate, having Mediterranean influences.

Table 2. The counties with the largest forest areas (thousand ha, 2011). Source: EFM

	SV	CS	HD	AG	BC	VL	MM
Thousand ha	435	389	309	276	271	268	263

Table 3. The counties with the lowest forest areas (thousand ha, 2011). Source: EFM

	CL	IF	IL	BR	TR	GL	CT
Thousand ha	21	25	25	27	28	36	39

Table 4. The counties with the largest forest areas (%, 2011). Source: EFM

	SV	VL	CS	GJ	NT	CV	HD
%	51	47	46	44	44	43	43

Table 5. The counties with the lowest forest areas (%, 2011). Source: EFM

	CL	CT	TR	BR	IL	GL	OT
%	4,2	5	5	5,4	5,8	8,1	9,5

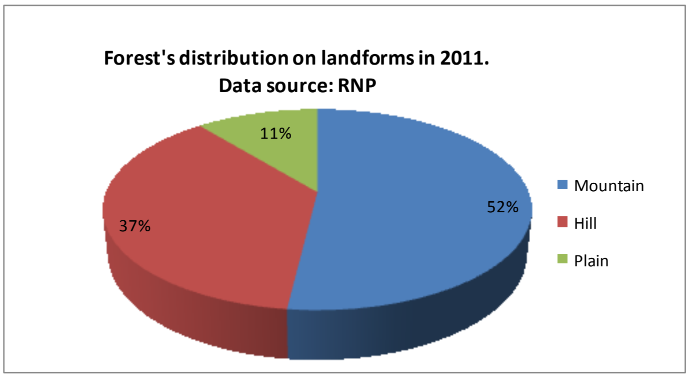

Fig. 2.

The analysis of the current level of afforestation of the country shows that Romania is underforested compared with other European countries showing morpho - pedo - climatic conditions like (Slovenia 62%, Austria 47%, Slovakia 41%). A 2010 European Union report states that forest area of 176 million ha exceeded union, which represents 32% of the territory of this organization.

Romania is far below the European average and much below the optimum afforestation level of 45% (Giurgiu, 2010), as stated by foresters.

Wide variations of forest areas occur among major relief units. More than half of the country's forests, about 52% of the total are located in the mountains and it represents 3.418 million ha. The considerable expansion of the forests in the mountainous regions of Romania was favored by several factors. The Romanian Carpathians occupy an area of 66300 km², 28% of Romanian territory being represented by mountains of medium height, bordered almost entirely in the boreal forest and nemoral from 400 - 500m in 1600 - 1800m altitude.

It is remarkable that about. 90% of the surface of the Carpathians is below the altitude of 1500m, in forest areas. Coniferous forests are present mainly in the Eastern Carpathians and the deciduous occupy larger territories in the Western Carpathians and the Southern Carpathians. Large areas of coniferous forests are situated in the upper forest floor, between 1500 and 1800m altitude. However, there are differences regarding the upper limit of forest between the north and the south. In mordor this limit is approximately 1600m, while in the south it is up to 1800m on the slopes with southern exposition. In the classification on phytoclimatic floors, the sub-alpine floor, situated between 1800 and 2200m, is included in the forestry and represents 1.2% of the total. Only peaks and the highest peaks that include meadows and alpine gaps are excluded from forest classification.

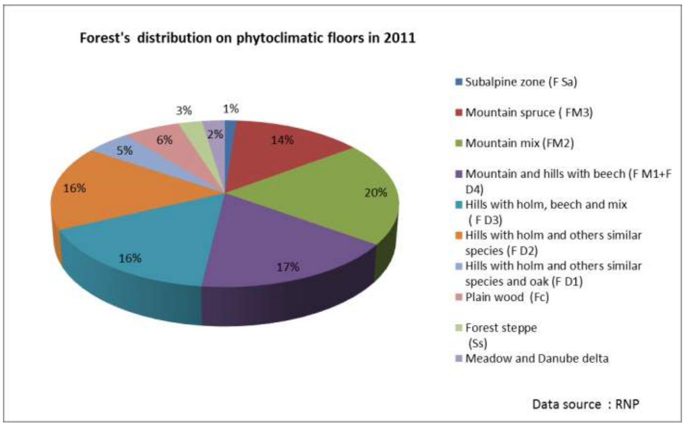

Fig. 3.

The hilly and plateau area include approx. 37.2% of the country's forests, ie 2.432 million ha and it falls almost exclusively in nemoral deciduous forest.

The altitudinal spread development of these forests is between 200 - 300m and 500 - 600m, in favorable climatic and edaphic conditions.

The deforestations in hilly area were more intense than in the mountains and were mainly made for new grazing land, for plantations of vines and fruit trees and for habitat expansion. Agrarian reforms of 1864 and 1920 affected the most forests in the hilly area, especially following the allotment and communal pastures extension deforestation.

The plains are the most deficient in forested areas. At low altitudes only thermophilic species resist, widespread in the forests and high plains of the steppe. The lowland forests were cleared for farmland expansion, especially for arable crops, currently reaching only 10.9 % of the forests of the country, accounting for 0.723 million ha. The current afforestation percentages are very low in some sectors: 4.1% in the Moldavian Plain, 3.5% and only 3.2% in Bărăgan.

The structure of forests Romania depending on species shows that the deciduous species, extended to all major steps relief in accordance with the thermal and rainfall temperate continental moderate climate.

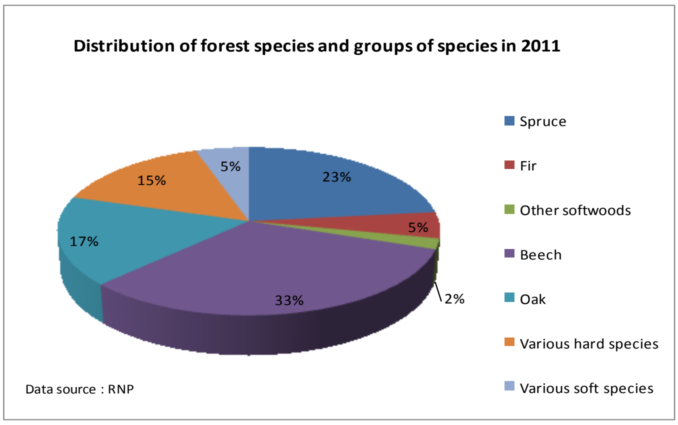

Fig. 4.

The resinous hold approx. 31% of all tree species and are confined mostly in the mountainous regions, mainly in the Eastern Carpathians. The spruce species is the dominant one (about 23%) that stands nearly in pure form from the top of the stage associated with tree boreal and the bottom of the floor. The second species, depending on percentage, the fir tree (5%), is a species more sensitive to the quality of the environment. Its percentage declined in recent decades and is found mainly in the lower boreal floor, but is also present at lower altitudes, mixed with beech and other hardwood. Along with the dominant species, with much lower effective, there is the pine (3 %) present in low mountain areas and even in hilly areas of the south - west. Other species of coniferous forests of Romania, the larch, yew and *Pinus cembra* have become rare and are protected in reserves and national parks (the larch in Ceahlău, the *Pinus cembra* in PN Călimani), or they are disseminated among conifers.

The deciduous trees have a share of approx. 69% of all species of trees and a range of wider spread of plain or delta lowlands until the Carpathian forest floor below. According to the NFA, the phage has the largest share with 32% of all forest species in Romania, followed by the oak 17%, various species of hardwood with 15 % and various species of soft wood 5%.

The distribution of forests in age classes indicates a relatively balanced structure, with young reserves for future operating availability as well as resrves of tree cutting for the ones that have reached the optimal age.

The young, under 20 years, occupy large areas, representing 23% of the Romanian forests and they were planted or they are the result of natural regeneration in the period leading to the post-revolutionary period. Forest areas aged 21-40 and 41-60 years (19% and 18%) means 37% of the total, and they were reclaimed within communist programs.

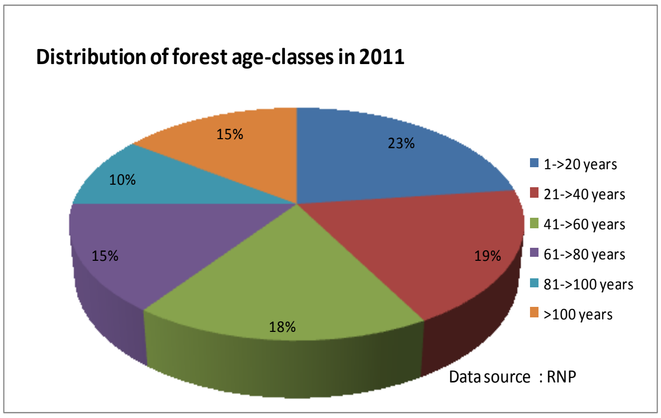

Fig. 5.

The stands operating at optimal age, the class age 61-80 (15%), 81 - 100 (10%), and 100 years (15%), together totaling 40% of the forest area of the country and support exploitation, development and export of wood and non-wood. The age that is optimal for operation varies depending on the species, the stationary conditions and woods. Species of soft wood and the ones that grow fast are exploited at a younger age (the willow, the poplar, the locust 20-35 years), the lime from 50-100 years, while resinous and beech reach optimal cutting age after 100 - 120 years. The longest to live species are the oak, whose optimum cutting age exceeds 120 years (ONF). Some aged stands as reservoirs of biodiversity are preserved and protected in national parks and numerous natural reserves of historical, ecological and scientific importance.

The current trend is of growing the surfaces driven and regenerated naturally, and to increase the area planted to ensure the future vitality and balance in the age class structure of the forests.

The distribution of forests in functional groups indicate the Romanian foresters' concerns about ensuring and sustaining vital functions of forests, protection and production. Romania is currently falling within EU standards and the FAO on forest classification by functional groups, but with some small differences imposed by the tradition in the operation and management of forests and national specificities. If the production function is provided in different proportions in all categories intrinsically functional, the protective function has a special attention, with clear typological distinctions, depending on well-established natural o social components. In the protection forests only allowed maintenance work is permitted.

The functional classification of Romanian forests comprises two functional groups. Grupa I comprises special protection forests and production forests and functional Group II includes production function and protection forests. This classification was carried out following the principle of multiple functional areas of forest, according to which any forest has a protective function and a production one, but the classification was customized by assigning a priority function, depending on the location of forests and the protection needs.

The functional Group I, including special protection forests, has as a priority the component of environmental protection of natural elements (air, climate, landscape, water, soil and biodiversity), but it also carries out a task of social protection and scientific interest. Areas having this function represent 53.3% of the Romanian forests (ie 3,503 million ha) and are broken down into categories based on the location of protective forests, the intensity of natural processes, the presence of areas intensely humanized, the forest age, the social and scientific interest.

The concerns about the importance and support of the forest protection functions have become increasingly evident in recent decades in Romania.

Areas aimed at protecting land and soil surfaces have a share of 43% of the functional category, ie 1.228 million ha, and they are located mainly in mountainous and hilly areas, where due to the brittleness geological substratum, the instability and erosion land suitability is the highest.

In the mountains, there came into this category forests of the Eastern Carpathians flysch area (pools Moldova, Bistrita and Trotuş, Vrancea region), petrographic mosaic areas in the Apuseni Mountains and Banat Mountains, and the hilly regions affected by landslides and gully processes (Plateau of Moldavia, Transylvania, the Sub-Carpathians, Western Hills). The vulnerability of these areas is given by the presence of surface deposits consistent quilts, but also brittle and vulnerable lithological constitution slope processes. If in the mountain areas the country, the forests are present in high proportions, and they offer protection to the lands, the hills and plateaus areas are more vulnerable because the forests protection is carried out in a much lesser extent because they were cleared in bulk and create intense discontinuities with current processes. There are well known cases of exacerbation of landslides and frequency of gully processes in Tutovei Hills, Central Moldavian Plateau, Curvature Sub-Carpathians, or Transylvanian Plain, the Somes Plateau region of forests have disappeared mostly in historical times. The restricted forest areas remaining in these regions are particularly effective against erosion.

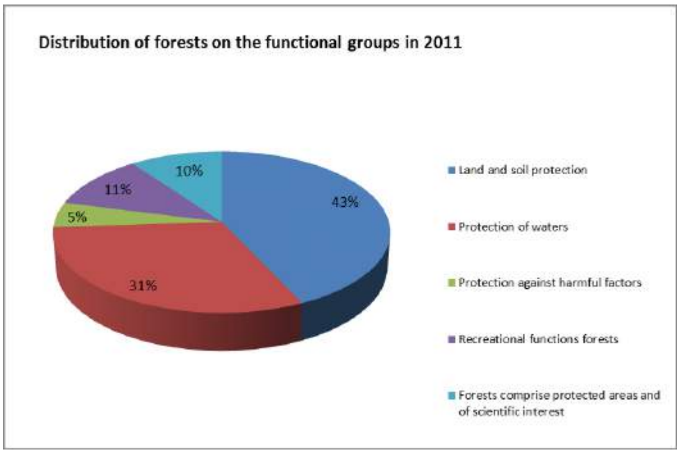

Fig. 6.

Recreation forests cover a total of 11% of the functional category (0.385 million ha) and they are intended for social and cultural activities. Forests are highly attractive and accessible, and in some sectors they are especially arranged for such purposes. All mountain resorts are surrounded by forests having a recreation function in the high traffic tourist activities. Borsa, Durău, Lacu Roșu, Sovata, Slănic Moldova, Stana de Vale, Sinaia, Baile Herculane are just a few examples of the resorts that benefit from the curative effect of the surrounding forests. Weekend tourism has acquired a new dimension and new importance and by this the forests near towns are invaded by urban dwellers who try a change of scenery and recreation in nature. However, it is often the case of this type of tourism to bear the mark of voluntarism and it may harm the forest landscape.

Other woods are intended for educational or cultural heritage of the country. Slătioara secular woods, the Silver Forest and the Copper Forests near monasteries Agapia and Văratec, the Cernica Forest and Letea, etc., are just some examples of forests maintained as elements of historical and cultural heritage of the country.

The protection against pests is ensured by only 5% of the forests of Romania (about 0.175 million ha) and it refers to the protection of forest areas and industrial harmful climatic factors. Pre-existing forests that can perform this function or plantations that were made for this purpose were included in this category.

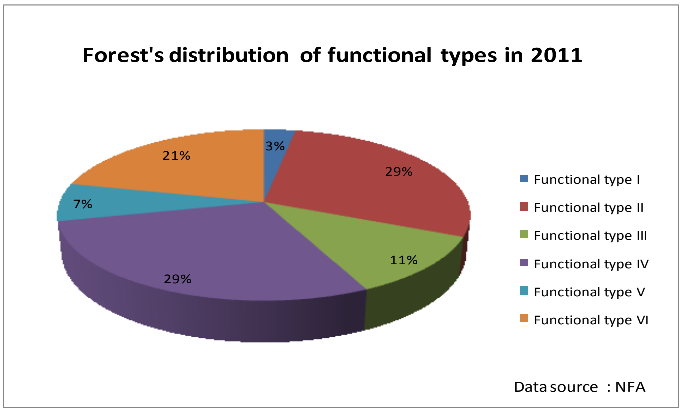

Fig. 7.

Few compact forests are designated to act as protection against harmful factors. The main tasks are fulfilled by outskirts and specific plantations. They are present around the city for retention of toxic dust released by industrial units polluting or toxic retention of combustion engine components autovehiculelor. Numerous shelterbelts and skirts were planted along railways and roads in order to prevent difficulties created by blizzards. Such facilities are present on sections of communication paths Romanian Plain, Plateau Moldova and Siret, areas exposed to winds in winter.

Under current guidelines in the European and global forestry, the biodiversity conservation function has become extremely important in the context in which this feature is threatened by the expansion of vital forest habitat and human activities. In Romania this function is performed by "forests and protected areas and the ones that bear scientific interest" in Group I function. These forest areas occupy 10% of this group (0.350 million ha) and are spread all over the country.

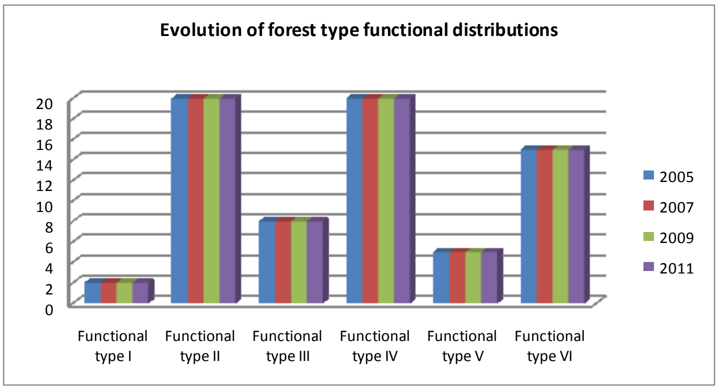

Fig. 8.

Located in the temperate continental moderate interference of various types of climates, Romania conserved different elements of flora and fauna: boreal, Ponto - Caspian, Mediterranean and Western Europe, which gives it a higher biodiversity than in European regions influenced by typical climates. The territory diversity in the delta and steppe, nemoral forests, boreal and alpine meadows Carpathian Romanian space favors the presence of many elements of biodiversity, some endemic.

The biodiversity protection and conservation is achieved primarily in protected territories legislative national parks, natural parks, protected areas and natural reservations. This function is fulfilled in the secondary forests and other forests that belong to functional group I.

In Romania there have been established over 20 national and natural parks and over 1000 nature reservations that are protected areas, some of which being of world importance, included in UNESCO heritage. All these areas of protection also include forest areas of great scientific importance for biodiversity conservation.

The production and protection function is ensured by 46.7% of the forests of Romania in the functional group II. In accordance with NFA within this group there were established six functional types with different degrees of restriction of silvicultural treatments:

- Functional type I includes forests where silvicultural treatments are not allowed, only exceptionally, in agreement with the Romanian Academy.
- Functional Type II includes forests where only conservation works are allowed.
- Functional types III and IV where only natural regeneration treatments are allowed and exceptional cuttings are allowed in the case of certain species.
- Functional types V and VI where all forest treatments are allowed.

The production function provides requirements for industrial wood and firewood processing and mproduces. According to the principles of sustainable forestry products, it is necessary to ensure continuity of production of timber, exploited when they have reached harvestable age, usually over 100 years in the case of species that have high economic value.

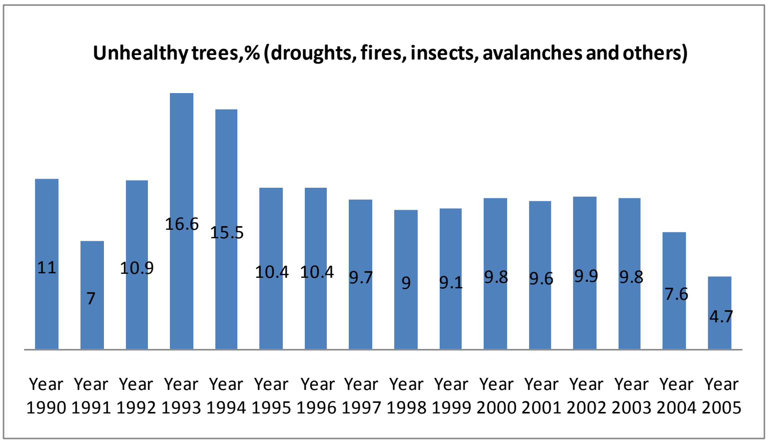

Fig. 9.

Age class structure analysis indicates a lack of exploitable trees (over 100 years), and pre-exploitable (80-100 years), caused by the massive exploitation of previous decades. The real share of exploitable trees is reduced because they contain mostly old forests having protective function and are included in protected areas. Exploitations in the past concentrated mainly in forests that were accessible overstrained the exploitable stands and at present, the low density of forest roads in areas that are difficult to access, make the capitalization of harvested forests difficult.

According to the report SILV1, 2010, the total volume of standing timber of Romania, or production fund is estimated at approx. 1413 million m^3, with an annual opportunity (availability of wood for exploited) approx. 22.3 million m^3. In particular, there are slight differences between the occupied area and the volume of standing timber. Even though the resinous occupies an area smaller than a phage, the foot volume is slightly higher because of the higher density of the shaft. The volume of standing timber species was represented in 2007, by 39% coniferous, 37% beech, 13% oak and 11% various other species or soft ones.

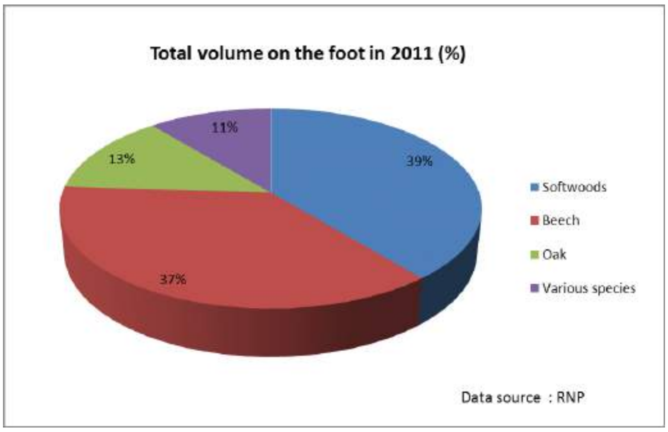

Fig. 10.

The average volume per hectare in the forests of Romania is about 218 m^3, exceeding the European average amounts to approx. 147 m^3/ha, due to good stationary conditions and the species diversity in the forest land. For the same reasons the annual growth of 5.6 m^3/ha exceeds the European average of 4.4 m^3/ha. Species and large groups of species, increasing the average current is 6.5 m^3/ha resin, 5.5 m^3/ha in beech, the oaks 4.7 m^3/ha; 4.7 m^3/ha in hardwood and 7.4 m^3/ ha soft leaved species (species that have rapid growth).

The capitalization of wood and forest is also based on availability, ie access roads network density within the forest. Biriş (2007) estimated that the total length of the access network in Romania totalling approx. 42,000 km, was made up of 32,000 km of forest roads and railways, public roads and adjacent industrial or cross forested areas.

The index density was estimated at 6.5m/ha, far behind other European countries with similar land topography: 45 m/ha in Germany, 28 m/ha in Switzerland and 26 m/ha, France.

In these conditions, about 2 million ha of forests are totally or partially inaccessible in Romania and timber harvest and silvicultural works execution are obstructed by topography or accomplished with difficulty.

Due to the high values of some morphometric characteristics of the relief (altitude, slope, depth and drainage density), the mountain is the most deficient in roadways, especially forest roads. To this other factors are added, such as the high density of river network, the brittle geological substrate and the slopes, overwetting of the slopes by precipitation and gravitational processes favoring the phenomenon of freezing - thawing, which creates problems of construction and especially railway maintenance access.

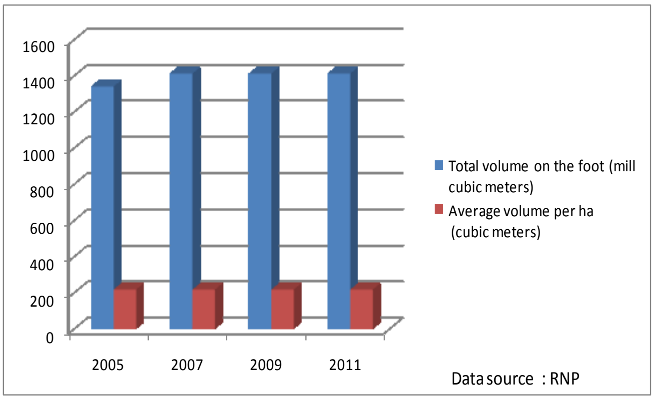

Fig. 11.

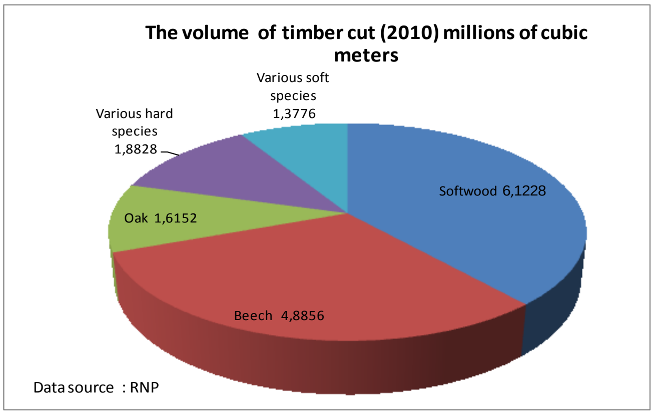

Fig. 12.

Table 6. The volume of timber harvested by region (% 2010). Source: NIS

Nord-Est	Centru	Vest	Nord-Vest	Sud	Sud-Vest	Sud-Est	B- Ilfov
29,3	23,0	12,3	12,1	9,2	7,2	6,5	0,4

Table 7. Artificial regenerations area by region (%, 2010). Source: NIS

Nord Est	Centru	Sud-Est	Nord-Vest	Sud	Sud-Vest	Vest	B-Ilfov
26,1	19,7	12,9	12,1	11,3	9,9	7,3	0,3

Table 8. Forest regeneration work in 2010.

Year	Natural regenerations	Artficial regenerations	Total
2006	12.021	15.544	27.554
2007	12.026	10.716	22.742
2008	11.940	11.244	23.184
2009	11.891	10.962	22.853
2010	13.628	10.106	23.734

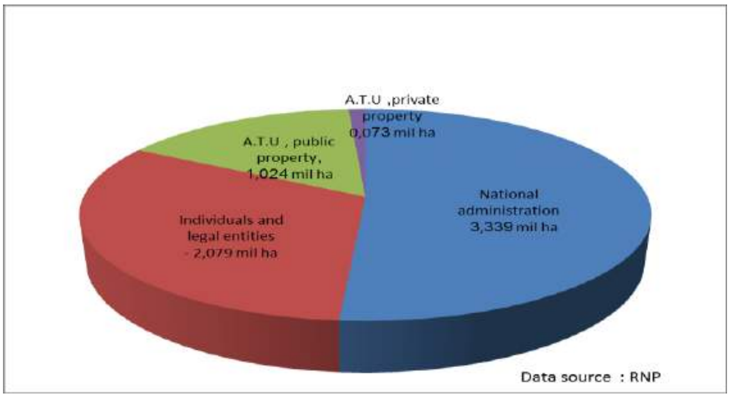

Fig. 13.

The total volume of timber harvested in Romania in 2010 was about 17 million m^3, according to NFA upon reading the regeneration cuts area of over 99 hectares year, 5000 ha of which by cuttings. Compared to 2000, when they harvested less than 14 million m^3, one can see a substantial increase of approx. 20%. The wood was extracted mainly in mountainous regions, the largest share being in the counties of Suceava and Neamt, which have had significant increases compared to 2000. These increases were primarily due to the accelerated pace of cutting in private onwed forests. However, there are counties with large areas of forests that reported they had significant reductions of the quantities of timber extracted in the period 2000 - 2010: Mehedinti, Harghita, Cluj, Hunedoara. In the same period in 2010, the total area of artificial regenerations was about 10 000 ha, which represents a tenth of the cutting surface, the remaining land being regenerated naturally.

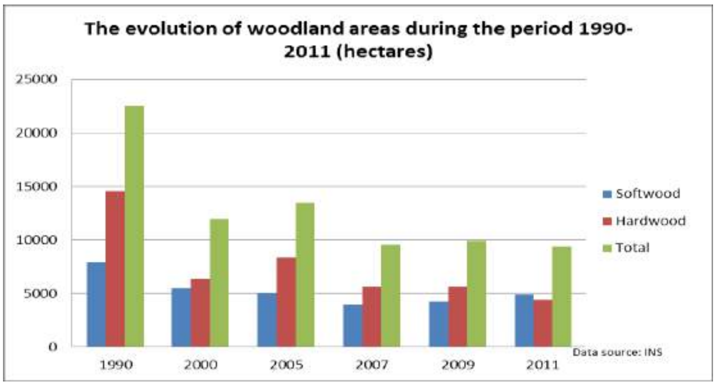

Fig. 14.

Table 9. The evolution of the timber extracted between 2000 and 2010 (thousand m^3). Source: Econtext

No	County	Year 2000	Year 2010	Variation %
1	Suceava	1576,7	2299,6	46
2	Neamţ	957,4	1253,1	31
3	Harghita	1131,5	999,8	-12
4	Bacău	696,7	869,6	25
5	Braşov	500,2	815,7	63
6	Caraş-Severin	511,5	767,1	50
7	Maramureş	475	639,8	35
8	Argeş	474,9	593,4	25
9	Arad	451	587,2	30
10	Mureş	570,7	554,5	-3
11	Alba	361	526,3	46
12	Covasna	466,7	511,6	10
13	Sibiu	377,8	503,9	33
14	Bistriţa-Năsăsud	439,8	476,6	8
15	Gorj	303,3	434,7	43
16	Hunedoara	459,7	438	-5
17	Bihor	269,5	426,6	58
18	Vrancea	387,7	392,6	1
19	Vâlcea	372,2	379,2	2
20	Prahova	328,2	373,7	14
21	Buzău	305,9	354,9	16

22	Timiş	251,5	295,8	18
23	Iaşi	249,5	271,3	9
24	Cluj	253,4	233,8	-8
25	Dâmboviţa	221,2	229,7	4
26	Tulcea	179,5	183,3	2
27	Dolj	190,8	164,1	-14
28	Mehedinţi	222,5	159	-29
29	Vaslui	172	152,4	-11
30	Sălaj	99,3	144,6	62
31	Botoşani	119	131,8	11
32	SatuMare	143	132,6	-7
33	Giurgiu	77,5	111,6	34
34	Călăraşi	112,9	110,6	-2
35	Ialomiţa	88,2	92,8	5
36	Olt	101,6	81,2	-20
37	Ilfov	91,9	70,8	-23
38	Brăila	79,9	60,9	-24
39	Galaţi	70,2	61,6	-12
40	Constanţa	77	52,9	-31
41	Teleorman	76,4	52,4	-31
42	Bucureşti	-	0,5	
43	Total Romania	14284,7	16991,6	18

Conclusions

According to the report published by the NFA, SILV1, the Romanian forest area in 2010 was 6,515 million ha, which represents approx. 27.3 % of the national territory. At European level, Romania is ranked 13 in the areas occupied by forests, but below the average forest coverage of 32 %. After a decline in forested areas recorded between 1990 and 2000 there was a slight rebound in the last decade, with an FAO estimated growth of over 30 000 ha per year between 2005 and 2011. This growth is primarily attributed to natural regenerations. The distribution of forests by functional groups indicates the Romanian foresters concerns about ensuring and sustaining the vital functions of forests, which are of protection and production. Romania currently meets the EU standards and the FAO ones on forest classification by functional groups, but with some small differences imposed by tradition in the operation and management of forests and the national specificities. If the production function is intrinsically provided in different proportions by all the functional categories, the protective function has a special attention, having clear typological distinctions, based on well-established natural or social components. Only maintenance work is allowed in protection forests.

The total volume of timber harvested in Romania in 2010 was about 17 million m3, according to NFA upon reading the regeneration cuts of an area of over 99 hectares, 5000 ha of which by cuttings Compared to 2000, when they harvested less than 14 million m^3, one can see a substantial increase of approx. 20 %. The wood was extracted mainly in mountainous regions, the largest share in the counties of Suceava and Neamt, which have seen important increases compared to 2000. These increases were due primarily to the accelerated pace of cutting private forests. There are, however, counties having large areas of forests, which have reported significant reductions in the quantities of timber extracted in the period 2000 - 2010: Mehedinti, Harghita, Cluj, Hunedoara. In the same period, in 2010, the total area of artificial regenerations was about 10 000 ha, which represents a tenth of the cutting surface, the remaining land being regenerated naturally.

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WWF – *Păduri şi arii protejate din Carpaţi* - Raport anual 2010, WWF Romania

Abbreviations:
FAO – Food and Agriculture Organisation
IUCN – International Union for Conservation of Nature
EFM – Environment and Forest Ministry (Ministerul Mediului și al Pădurilor – MMP)
NFA – National Forests Administration (Regia Națională a Pădurilor – RNP)
WWF - World wildlife Fund
NIS – National Institute of Statistics (Institutul Național de Statistică – INS)

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EXPERIMENTAL RESEARCH REGARDING THE APPLICATION OF ELECTRO-FLUSHING METHOD ON DIESEL CONTAMINATED SOILS

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Key words : decontamination, electroremediation, diesel fuel, soil, soil flushing

Abstract. In 2011, as a result of the inventory conducted at the national level, The Ministry Of Environment concluded that the largest number of contaminated sites with hydrocarbons are due to the petroleum products distribution (nearly 400 sites), followed by the hydrocarbons extraction (about 310 sites). So, soil contamination with liquid petroleum products resulting from many industrial activities became an important issue of environment protection. Unfortunately not all local governments have provided a list of contaminated sites, which means that there is a possibility to have a bigger problem at the national level. All these surfaces are in a continuous growth due to industrial and social development and that is why it is necessary to study and improve decontamination methods of contaminated sites in order to regain one of our most important resources - the soil. In this paper, the main results obtained during a research that aimed to study two different treatment methods of contaminated soil in a combined solution, are presented. The newly developed method is called electro-flushing. Results proved that combining the two nominated methods could be a viable solution for treating diesel polluted soil with better performances comparing with using them separately. Concerning the electrochemical treatment of diesel contaminated soils an efficiency of 35-40 % could be obtained after 28 days; while using the flushing method up to 15-20% efficiency could be reached. On the other hand, if we combine these two methods, we can reach remediation efficiency up to 50%. So, the main interesting results of the present research is given by the fact that combining two known remediation methods, better performances could be achieved.

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Introduction

The issue of contaminated soils with liquid petroleum products is one of the most complex challenges in the field of environmental protection, from the theoretical and economic point of view and in terms of the implementation of remediation methods. In the case of a surface discharge with petroleum products such as, crude oil or fuel oil, the negative effects extend into short time from the initial contamination especially in the upper soil profile, due to a high viscosity of the products, and in the atmosphere by evaporation of slightly volatile compounds. In the case of gasoline or diesel, the pollution can affect both the soil, subsoil and could reach even to the groundwater aquifers. Diesel fuel is a product obtained by petroleum distillation and it is composed of 75% saturated hydrocarbons and 25% polycyclic aromatic hydrocarbons (PAH).

Of the medium products obtained through oil distillation, products that are used in terrestrial situations, diesel oil has the highest content of PAHs (Wang et al., 1990) which makes it more difficult to remediate.

Polycyclic aromatic hydrocarbons, like any other aromatic compounds, represent a real danger for human health and vegetation, because of their powerful mutagenic and carcinogenic character.

Diesel pollution can cause changes in biochemical and chemical processes for plants and soil, causing ecological imbalances in chain, with bad consequences on the stability, vitality and regeneration capacity of terrestrial ecosystems. It was proven that at relatively low levels of diesel fuel contamination, delayed seed emergence and reduced percentage germination for the majority of plant species. In addition, the remaining diesel fuel in the soil added to this inhibitory effect on germination by physically impeding water and oxygen transfer between the seed and the surrounding soil environment, thus hindering the germination response (Gillian et al, 2002).

This paper is illustrating a combined a solution for the above problems: reducing the concentration of diesel in the soil by chemical and physical methods such as electro-flushing.

2. Remediation treatment of soils

Electrokinetic remediation methods may destroy, carry and concentrate a diverse range of organic pollutants that can be found in different types of soil, except in those with an increased hydraulic permeability (sandy). This method involves the use of electrodes placed in the ground in various configurations and the application of potential differences at their ends. The established current produces in soil various physical and chemical phenomena, underlying technologies for continuous current (DCT), like: electrolysis, electrophoresis, electro-osmotic flow, etc.

Electrolysis is the phenomenon that involves electrolyte decomposition in the presence of electric current through the migration of electrolyte ions to electrodes where a potential difference was applied. Electromigration represents ions transport under the electric field influence, the positive ions move towards the cathode and the negative ions move towards the anode. Electroosmosis is the process by which under the influence of electric current the water present in soil is moving from the anode to the cathode, creating this way an electro-osmotic flow. Electrophoresis is the motion of the charged particles under the influence of electric field (Acar et al, 1995).

In the present work, for soil decontamination two different methods were combined: electro-remediation and "soil flushing". This is the reason for which the authors named the process as electro-flushing. Soil flushing is a method that involves pollutant concentration for the extraction or isolation using a natural pressure gradient or a created one, by injecting the flushing liquid with pumps. This technique has good results in soils with high permeability, but in clay soils (particles smaller than 0.02 mm) cannot be applied. A major disadvantage of this process is that the liquid volume is disperses in all directions and cannot be directed entirely towards the extraction points (EPA, 1993).

Instead, through electro-flushing there is a guarantee to concentrate the entire volume of fluid that can be found in the treated soil mass towards the electrodes area through the above-mentioned transport processes. So, combining these two methods can lead to the possibility of an in-situ application with good results.

3. Experimental tests

The soil used during the experiment is identified as Luvisols with characteristics as shown in Tab. 1. Also the granulometry of the soil was determinate and the results are presented in Tab. 2. The experiment carried out consisted of the artificial contamination of 6 kg soil with an amount of 10% diesel. Initial soil moisture was 3.69%. In order to stimulate the electrochemical processes, it was necessary to add an additional quantity of 1.2 l of distilled water and so the final moisture reached 20.18%. The obtained mix was introduced in an electrochemical cell where a current density of 1mA/cm^2 was applied. The electrochemical cell has the next characteristics: 300x150x150 mm (Fig. 1).

The experimental setup used to apply the electro-flushing treatment was developed in the framework of a research project, co-financed by the Sectorial

Operational Programme " Increasing Economic Competitiveness " POSCCE-A2-O2.1.2.-2009-2, project called RECOLAND (ID519 , SMIS-CSNR: 11982 (2010-2013)).

The stainless steel electrodes placed in the soil have the dimensions of 145x130 mm and their body is a network of longitudinal slits 3 mm. Also the body of the electrochemical cell provided a cross-section of 3 mm slits that will allow passing the effluent (water and diesel) that will be stored in two tanks located on each side of the installation. At a distance of 50 mm from the anode 3 cylindrical metal sieve tubes of diameter 10 mm at equal distances from each other were introduced. The three sites were introduced in 3 wells with a depth of 100 mm in soil. These shafts were fed regularly with distilled water 20 g on average 10 hours.

Fig. 1 - Experimental installation of electro-flushing (top view)

Tab. 1. Properties of diesel contaminated soil used for the experimental tests

Soil characteristics	PH	Nt	Humus	P_{AL}	K_{AL}	The mobile forms of microelements				The total soluble salts content
						Zn	Cu	Fe	Mn	
units of measurement	-	%		mg kg^{-1}						mg/100 g sol
identified values	6,97	0,149	3,18	110	364	6,54	4,78	12,9	51,1	16

Tab. 2. The grain size analysis

Particle size	**Percentage**
[mm]	**[%]**
4	0,615
2	6,365
0,8	25,589
<0,8	67,431

4. Results

The initial parameters of the experiment that was conducted were: the electric voltage 30 V, while the intensity of electric current was 30 mA. During the experiment, an attempt was made in order to maintain the same intensities of electric current. With this aim it was necessary to vary the electrical tension between 30 V to 90 V.

The PH curve evolution (Fig. 1) shows a pH decrease in the anode area and an increase in the cathode are due to the water hydrolysis, which leads to the creation of an acid front at the anode moving towards the cathode, and a front base at cathode that moves towards the anode.

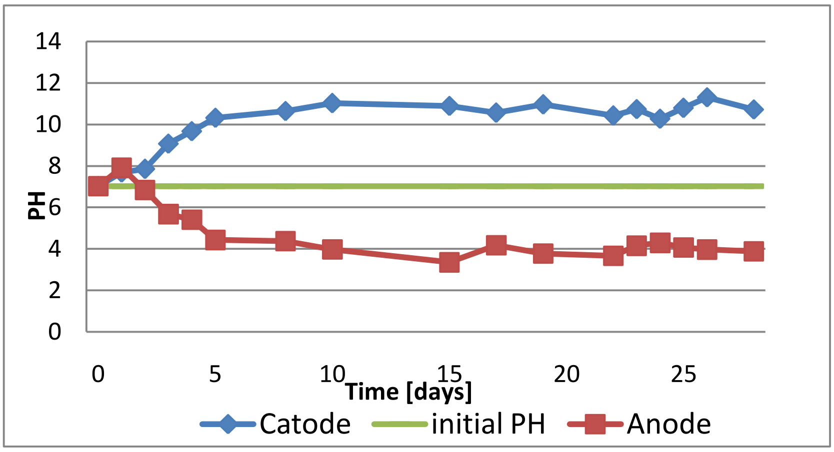

Fig. 2 – The trend of the PH variation during the treatment period

During the experiment, diesel in soil initial concentration was identified, but also after 15 and 30 days in order to identify changes of diesel concentration in time (Tab. 3.) All these analyses of the soil samples were made according to the Romanian analytical methods (SR 13511).

Tab. 3. The evolution of diesel concentration in soil

Analysis period / Type electrode	Initial analysis [g/kg s.u.]	Analysis after 15 days [g/kg s.u.]	Analysis after 30 days [g/kg s.u.]
Anode	106	61	55
Cathode	106	44	37

The total quantity of diesel collected and then extracted from the process of electro-flushing was 38%. The difference corresponding to the maximum remediation percentage is due to the electro-oxidation processes.

As a result, after the application of electro-flushing treatment conducted to a remediation percentages up to 42% after 15 days, and up to 65% after 30 days (Fig. 3).

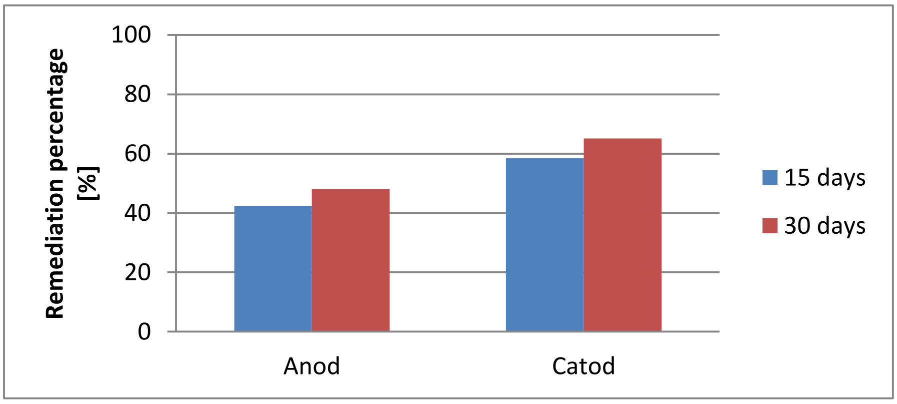

Fig. 3 – The evolution of the remediation process in time

In order to assess the combined method of electro-flushing also from the energy consumption point of view, the specific energy consumption was calculated using the following equation (Reddy and Chinthamreddy, 2003):

$$E = \frac{1}{Vs}\int VIdt \ ;$$

where:

E is the specific energy consumption [kWh/m^3],
V_s is the treated soil volume [m^3],
I is the current that was considered constant for al treatment [A],
V is the electrical current voltage during the experiment [V].

Consequently, for a treatment that has been applied for a period of 30 days and with a constant current of density of 1mA/cm^2, a specific energy consumption of 16 kwh/m^3 of treated soil was obtained.

Conclusions

By combining the two methods (the electroremediation and soil flushing), it was proved that using the electro-flushing method it can be obtained good removal percentages for diesel polluted soil: an average efficiency of about 46% for a treatment period of 30 days, comparing with 30% for flushing and 35-40% for electroremediation if the remediation methods are separately used. More than that, through this method, the pollutant destruction can be achieved and a recovery up to 30% from the initial quantity (Beckett et al, 1997) could be done. As results showed, it can be noticed the fact that, the final remediation rate increases with increasing the treatment period. The same tendency was observed also at the tests performed only with electroremediation. Energy consumption associated with electro-flushing method is lowest compared to other remedial methods.

According to data from literature (USEPA, 1993), an increase in diesel mobility in soil can be achieved by using cleaning liquid water in combination with different surfactants, thus realizing higher remediation percentages. This type of approach of the electro-flushing method is the subject for further research.

Acknowledgements

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THE LAND'S SUSCEPTIBILITY, DUE TO ATMOSPHERIC PRECIPITATIONS, WITHIN THE CATCHMENT AREA OF CÂLNĂU

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Key words: precipitation, impact, Angot parameter, modelling processes, Câlnău River

Abstract. The climatic factors, generally, and the precipitation amounts recorded, especially, constitute some of the factors which condition the development and intensity of actual geomorphologic processes. One of the most employed climatic parameters for determining the land's susceptibility to atmospheric precipitations, with real and concrete applications into the dynamic geomorphology, is the Angot factor.

The precipitations represent a crucial meteorological element in initiating, sustaining and reactivating some geomorphologic processes, acting as a modelling agent for every type of landscape. This influence can be highlighted by quantifying the values of some characteristic variables (length, frequency and intensity), as well as temporally confining individual and successive sequences, which present a certain degree of susceptibility.

The general objective of this research, through the analysis of precipitations and the Angot parameter, is to identify, on one hand, the months, seasons or years with a very high or very low susceptibility to the occurrence of bank erosion phenomena, and on the other, to examine the value variations of this parameter across the year. The purpose is to recognize a cumulative of pluviometric conditions which could contribute to inducing, in general, the modelling processes.

The study of land's susceptibility to atmospheric precipitations was conducted within the morpho-hydrographic drainage system of Câlnău.

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Introduction

The atmospheric precipitations are being produced in different quantities and discontinuously throughout time, having as a principal characteristic the dissimilarity between space and time. The general circulation of the atmosphere, the thermodynamic convection and the particularities of the underlying surface specific to the physical-geographic space of the morpho-hydrografic system Câlnău are all factors which influence the occurrence of precipitations.

The most common used parameter in determining the topographic surface's susceptibility to erosion from atmospheric precipitations is the Angot factor. This coefficient is used in the dynamic geomorphology of drainage basins.

Since the theme of this article represents the analysis of the relationship between precipitations and land degradation, henceforth we will depict the atmospheric precipitations through monthly and annual registered means, as maximum fallen quantities in 24 hours and as the determined monthly pluviometric parameter Angot, applied in the study of annual variations of atmospheric precipitations.

The data base utilized for this particular precipitation research and for establishing the Angot monthly pluviometric parameter, is comprised from meteorological observations carried out by the weather station Buzău (alt. 97 m, 45˚ 09′ lat. N, 25˚ 5′ long E.) for the time frame 1980 – 2012.

The evaluation of atmospheric precipitations, but most importantly the role played, as impact factor in the land's subsidence, is performed for Câlnău's catchment basin.

1. Geographic features of Câlnău's catchment area

The drainage basin of Câlnău is located in the south-eastern part of Romania and the arch of Outer-Carpathians, composing some of Buzău's catchment area, being the last major sub-basin of this system, before joining waters with Siret, as it can be seen in Figure 1.

The actual geographic landscape of Câlnău's basin reflects modifications along the lines of north-south and west-est, generally as a result of its geographic position. Therefore in the nordic and central parts it can be distinguished a hilly scenery, whilst the south is characterised by a mountain glacier environment.

Câlnău River originates from Costomirului Hills, at an altitude of 730 m, whereas the confluence with Buzău River occurs at 92 de m, near Buzău municipality, within its alluvial cone.

The landscape actively influences the intensity of current developing processes through its fragmentation grade, Câlnău's basin, being affected by landslides and the presence of torrential valleys. The predominant hypsometric level reads between 350 – 550 m, characterized by powerful fragmentation, due to an intermittent hydrologic chain, with a degree of one and two.

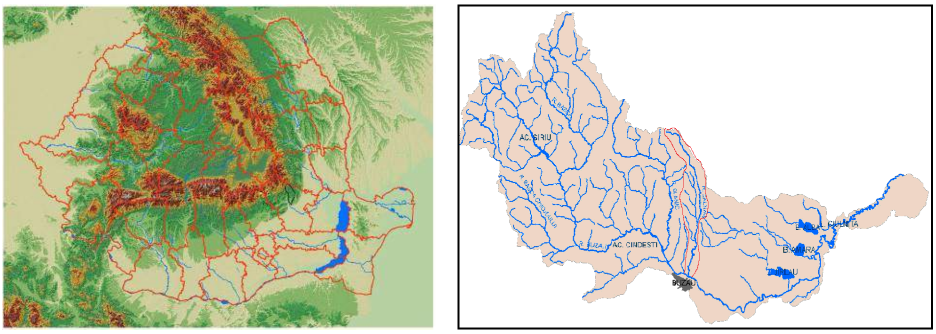


Fig. 1 The location of Câlnău's sub-basin within Romania and Buzau's watershed

From the biogeography standpoint, within this watershed occurs the transition among forest and forest-steppe ecoregions, allowing the expansion of deciduous forest region. The vegetation diminishes the impact of precipitations on soil, retaining a portion of fallen rainfall and adjusting the watercourse on slopes and in riverbeds, consequently attenuating soil erosion.

The soil, in the central and southern parts, is categorized as levigated chernozems, whilst in the north the soils are classified as alluvial-clay and pseudo-rendzina levigated. In the formation process of artificial discharge these soils constitute a major influence, acting as an interface between precipitations and discharge.

Presently, the anthropogenic pressure is not manifested through the rising number of population, but through neglecting requirements of sustainable development, as a result of unawareness or indifference.

2. Morphometric features of Câlnău's basin

Câlnău's watershed (Figure 2) is catalogued as a small drainage basin, as it is regarded a unit of the largest catchment area in the country, Siret's basin. With a surface of 209 km², it represents 3.8 % of the total drainage area of Buză and 0.08 % of the total area of Romania, and its drainage system is viewed as a fusiform, elongated shape, Câlnău River has a length of 62 Km and a medium debit of 0.45 m³/s. On Câlnău's channel there are no body of water accumulations, however along its length have been built 30 dams, in the time spam 1972 – 1982, which allowed for a while the retention of small masses of water, influencing positively both liquid and solid discharges.

Fig. 2 – Câlnău’s River valley. Source: personal archive

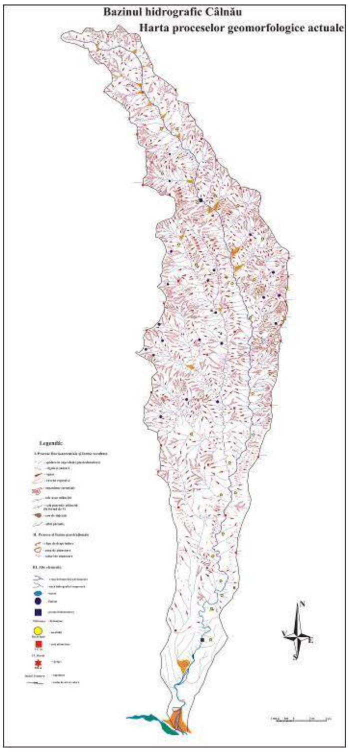


Fig. 3 – Map of actual geomorphologic processes in the drainage area of CâlnăuSource: adaptation of a topographic map 1: 50 000

Câlnău River holds the record, nationally, for the level of water turbidity (at PH Potâtnichești – 72 500 mg/l), an aspect which is reflected in the origin of the word ”Câlnău”, translating to ”muddy water”. After the arrangements to combat erosion have begun to yield results, the level of turbidity started recording a significant decline.

The general inclination of the thalweg is approximately 17 ‰, and after it enters the area of the sub-Carpathian glacis the slope becomes ~ 4 ‰ stretching to the section of the meander course, and under 2 ‰ downwards from that sector.

The surface waters grid consists of semi permanent rivers, temporary rivulets, lakes and wetlands reduced in size. The system features 16 important affluent streams, of which 11 are on the left, and the rest on right, therefore attributing an asymmetric layout (Figure 3), specific to subsequent valleys, with arrangements and confluence angles characteristic to every sector.

The hydrographical network of Câlnău receives an input both from surface waters (rainfall and snow), which represent the predominant means of supplementation and amounts to 60 % of the annual volume (55 – 65% rainfall and 35 – 45% snow), and from subterranean sources. The discharge regime can be characterized through a period of high flood, during spring, and series of outrushes, throughout the year.

3. Atmospheric precipitations in the catchment area of Câlnău

Atmospheric precipitations have a major component, from the regime point of view and the space – time repartition, great variability and discontinuity in time and space.

The precipitation regime is the result of interactions amongst general genetic factors and local factors.

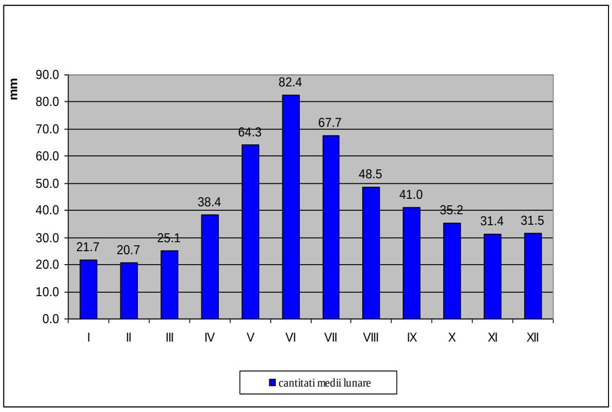


Fig. 4 – Mean values (mm) of monthly multiannual precipitations, at Buzău weather station, during 1980 – 2012. Data ANM processed

From the analysis of multiannual monthly precipitation values (1980 – 2012), supplied by Buzău's weather station, overall it is evidently a rise in values from February, with a recorded value of 20.7 mm, until June (82.4 mm), after which towards the end of the year and in January (21.7 mm), these gradually decline, as it can be observed in Figure 4.

The pluviometric minimum, recorded in February, is due to the higher frequency of continental air mass from winter months, while the pluviometric maxima is the consequence of local processes intensifying thermal and dynamic convection which generates cumulonimbus clouds. Amid these extreme values, the range of mean monthly multiannual data also registers between 25 and 65 mm, from March to May, and between 68 and 31 mm, from July to December.

In general the average multiannual quantity, for Buzău meteorological data, in the time period 1980 – 2012, is of 507.8 mm.

The annual behaviour of solar radiation, determines in its interaction with the active-underlying surface periodic developments of atmospheric circulation, which in its turn adjusts the method, amount, duration and frequency of precipitations across the seasons. Researching the amount of mean precipitations from the whole year it can be acknowledged a variation of data from month to month and from a season to another imposed by the general atmospheric circulation and the intensity of thermal convection.

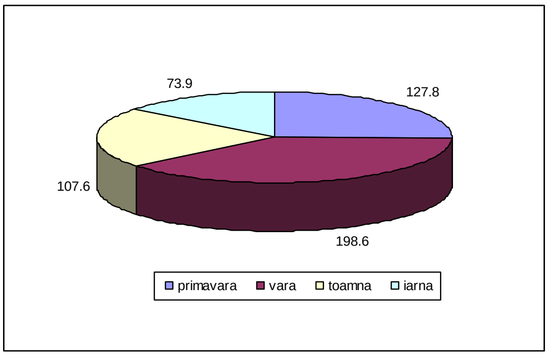


Fig. 5 – Mean values (mm) of multiannual season precipitations, at Buzău weather station, during 1980 – 2012. Data ANM processed

According to season data it is observed that the maximum value is recorded in the summer, of 198.6 mm, while the minimum value occurs in the winter, of 73.9 mm. For the transition seasons, registered data within the time period 1980 – 2012, at Buzău weather station, are: 127.8 mm – spring and 107.6 mm – fall. We recognize that during summer, medium amounts of rainfall are recorded, being 2.6

times bigger that those during winter while the difference between the sums of spring and fall is of 20.2 mm, in the favour of spring rain events, as depicted in Figure 5.

The maximum amount of precipitations fallen in 24 hour are either determined by a powerful local convection, or by the passing of a cold front. It accounts as a great vulnerability which affects the water volume registered in 24 hours, as it can sometime exceed the medium quantity from the respective month, detailed in Figure 6.

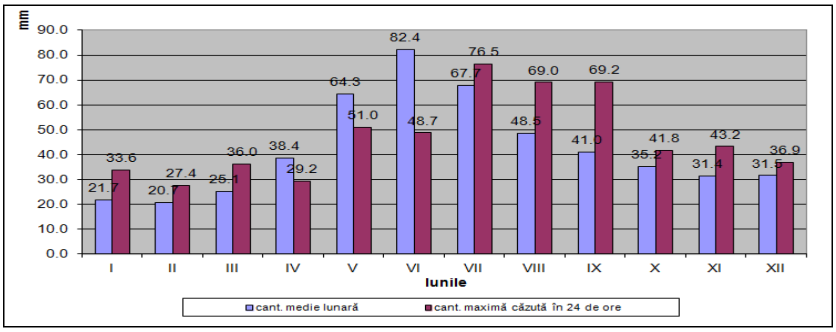


Fig. 6 – Mean values (mm) of monthly multiannual and fallen amounts in 24 hours of rainfall, at Buzău weather station, during 1980 – 2012.Data ANM processed

The maximum volume of precipitations fallen in 24 hours registers the biggest values during summertime, of 76.5 mm in July and 69.0 mm in August, whilst in wintertime the maximum diurnal amount of water are generally small due to the reduced content of water vapour, resulted from cold air masses, measuring 36.9 mm in December and 33.6 mm in January.

Values of maximum volume of precipitation surpassing the mean monthly quantities are detected both in the months of September and May, counting 69.2 mm and 51.0 mm, respectively. Only in the following months: April, May and June, the values of maximum precipitation quantities dropped in 24 hours are lower than the mean monthly multiannual.

In the yearly warm period, these recorded volumes of rainfall in 24 hours present a downpour aspect and can be categorized as a climatic hazard.

Another parameter employed in the methodical interpolation of data regarding atmospheric precipitations, is represented by the variability of monthly and annual precipitation amounts. Consequently, it can be highlighted the infrequent variations of precipitations from year to year. In general, the largest amounts of precipitation fall during years when cyclonic activity is very intense and persistent, and at a monthly level, the biggest quantities of recorded rainfall arise in the summer months. The reduced volume of precipitations occurs during the years and months with frequent and persistent anticyclone conditions, characterized through a considerable prevail of polar continental air masses, with a deficiency in water vapour. Predominantly, droughty years or with scarce precipitations are found clustered, in groups of 2 – 3 years.

In Figure 7, it can be asserted that the largest annual precipitations were recorded in the years: 1980 with 680.7 mm, 1984 with 618.6 mm, 1991 with 717.3 mm, 1997 with 729.3 mm, 1999 with 671.4 mm, 2005 with 753.7 mm and 2012 with 598.9 mm. Moreover, it can be observed that the highest value was measured in 2005, exceeding by 48.2 % the mean multiannual quantity.

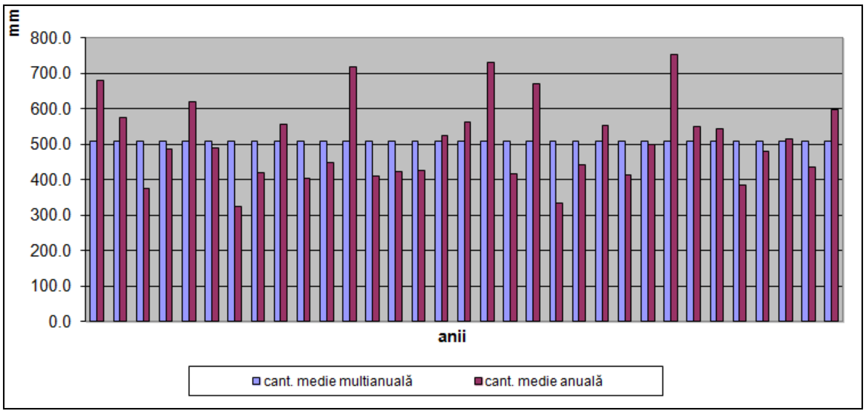


Fig. 7 – Variability of annual precipitation amounts at Buzău weather station, during the period 1980 – 2012. Data ANM processed

Similarly, the lowest amounts of annual precipitations were produced in the following years: 1982 with 375.2 mm, 1986 with 323.7 mm, which is also the minimum value for the investigated period, smaller by 36.3 % than the mean multiannual quantity, 1989 with 403.3 mm, 2000 with 333.3 mm and 2008 with 386.2 mm. In these precipitation scarce years, were even noted the presence of the most months with pluviometric deficiency.

Throughout the seasons of winter, spring and summer for the periods of 1992 – 1994, 2000 – 2001 and 2008 – 2009, across the whole country, and implicitly for the catchment area of Câlnău, were registered a deficit of 20 –30 % than the normal. Within the 1980 – 2012 time frame was counted a number of 18 negative deflections and 15 positive deviations. The greatest negative fluctuation is documented in 1986 of 184.1 mm, followed by the one from 2000 of 174.5mm, beside the mean multiannual volume of 507.8 mm; on the other hand the record positive anomaly is produced in 2005 of 245.9 mm, pursued by the value from 1997 of 221.5 mm.

Furthermore, great fluctuations are represented even at the level of monthly mean precipitation amounts, as it appears in Figure 8.

The greatest amounts of monthly precipitations occur especially in the summer and least during winter, the maximum value being recorded in May 2012 as 213.0 mm, with 148.7 mm more than multiannual monthly average. The smallest value among the biggest volumes of monthly rainfalls is the one registered in January 1998 de 50.2 mm, with additional 28.5 mm than the multiannual monthly mean.

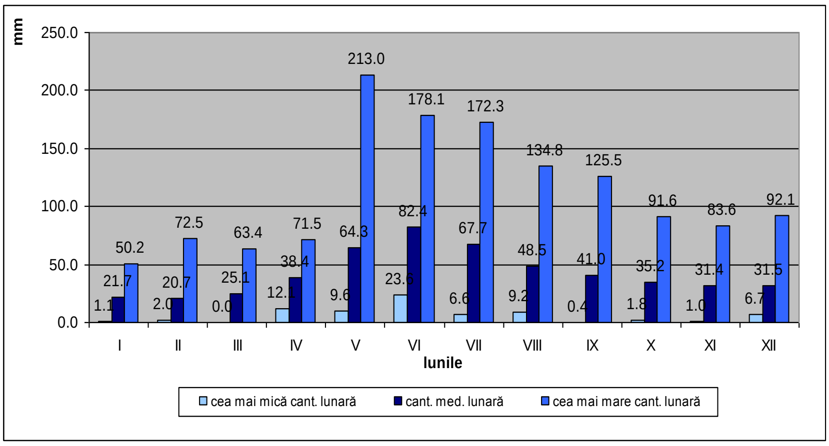


Fig. 8 – Variability of monthly precipitation amounts, at Buzău weather station, during the period 1980 – 2012. Data ANM processed

Contrary, the minimum amounts of monthly precipitations vary between 0.0 mm, for March, and 23.6 mm, for June, being with 25.1 mm and 58.8 mm, correspondingly, lesser than the multiannual monthly average value.

On the account of the above chart, we observe that the quantitative positive deviations are more numerous than the negative ones and act in accordance with the annual regime evolution of monthly mean multiannual.

The rain events generating hydrologic hazards are the torrential types supplied by summer months, short and swift, delivering a large volume of water in record time. Even the fall rainfalls with slightly reduced maximum can yield major destructive effects.

4. The pluviometric factor Angot

The equation introduced by Angot can characterize any month of the year from the pluviometric standpoint without being conditioned or influenced by the number of days in a month. With the aid of this parameter it is possible to evaluate and determine the pluviometric features for each month across the year. If the value is subunitary (smaller than 1) the respective month displays a pluviometric deficit. If the obtained value, from calculus, equals 1 subsequently the month is regarded normal from the pluviometric factor point of view. Finally, if the value is over-unitary (greater than 1) it results that the respective month produced a pluviometric surplus.

Amongst the most important applications of this parameter are: establishing the monthly pluviometric character, comparing precipitation amounts from different time frames and throughout the whole basin, evaluating the relief's susceptibility to erosion and landslides according to the pluviometric regime particularities and annual pluviometric characteristics for a catchment basin.

Regarding the drainage area of Câlnău the data interpolated was provided by weather station Buzău. This parameter was applied for monthly average amounts of precipitation recorded at this meteorology institution, within the 1980 – 2012 time frame. Table nr 1 displays that, within the Câlnău's catchment basin, in all 31 years of observations 8 months are generally rainy, whilst June and July are heavily abundant (over 2). Also, it is evidently that the draughtiest months are January, February, March and December, since the Angot factor value decreases under 1.

Table no. 1 – Monthly average value of pluviometric coefficient Angot at Buzău weather station, during the 1980 – 2012 period.

luna	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
I.A.	0.6	0.7	0.8	1.2	1.8	2.6	2.0	1.5	1.3	1.1	1.0	0.9

The Angot coefficient, through its prime component allows the distinction from the range of values of data base employed from arid or wet time sections, from the array of analyzed data. According to acquired results can be determined the susceptibility classes of landscape to geomorphologic processes of interest, depending on fallen amounts of precipitation. For values of **K** over-unitary, the susceptibility rises directly proportional with its size, as depicted in Figure 9.

From the analysis of tables 2 and 3, below, in which are computed precipitation quantities on susceptibility classes according to Angot parameter, it is discovered:

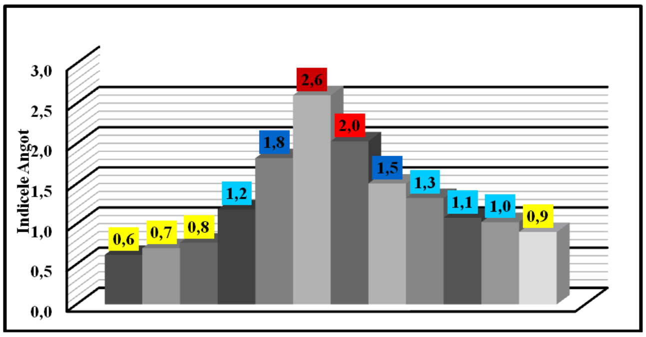
- in the case of class I, which designates draughty months (January, February, March, October, November and December), fallen precipitations meet on average

20 cases/month, respectively over 75% scarce amounts, presenting (according to Angot coefficient K **< 0.99)** a very small susceptibility of the land;

- susceptibility class II (small) is poorly represented assembling under 10 cases a month in all 31 years of precipitation measurements. Only April and June reach 10 in this time period. The probability of land erosion generation is under 15 % for the entire basin, and over 15% is registered in the two months mentioned above;

- the classes with medium susceptibility (III and IV) are the lowest occurring, these do not exceed 10 cases a month. The probability is small, generally under 15%. Only for June in susceptibility class III the likelihood of development barely reaches 9 cases, while for the IV class, only May achieves 9 cases;

- the large susceptibility class V is depicted across the June interval, with a number of 15 cases in every month from all 31 years. More elevated quantitative values appear in May, July and August when it is overreached a rate of 5 cases per month.



Clase de susceptibilitate	f.mică	mică	medie	mare	f. mare
valoare indice Angot	<0.99	1.00 – 1.49	1.50 – 1.99	2.00 - 2.49	> 2.50

Fig. 9 – Susceptibility classes of land for geomorphologic processes, according to precipitation quantities, after Angot parameter, for Buzău weather station, during the 1980 – 2012 period.

Table no. 2 **–** The probability of geomorphologic processes occurrence (%), according to precipitation quantities, on susceptibility classes, within the drainage basin of Câlnău

class	**ian**	**feb**	**mar**	**apr**	**may**	**iun**	**iul**	**aug**	**sept**	**oct**	**nov**	**dec**
I	23	24	19	11	6	1	2	11	11	16	17	19
II	6	2	7	10	4	0	10	8	8	3	5	6
III	2	2	4	4	4	9	5	5	6	5	7	3
IV	0	2	1	6	9	6	6	0	3	5	2	2
V	0	1	0	0	8	15	8	7	3	2	0	1

The occurrence probability of several extreme geomorphologic processes during the months of May – June – July– August, within the catchment area of Câlnău, exceeds 20 – 30%.

Table no. 3 – Precipitation amounts on susceptibility classes according to Angot factor, at weather station Buzău, between 1980 –2012.

Year /month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	sum year	mean year
1980	1,6	0,1	1,5	1,8	4,9	1,5	3,5	1,6	1,2	0,7	1,5	2,3	22,1	1,9
1981	0,9	0,9	1,9	1,9	2,7	1,6	1,0	1,6	0,8	1,5	2,2	1,9	18,9	1,6
1982	0,1	0,5	0,3	2,1	0,7	1,9	2,4	1,9	0,1	0,4	0,6	1,3	12,3	1,0
1983	0,1	0,7	0,3	0,7	1,3	4,8	2,0	3,9	0,2	0,7	1,1	0,3	16,0	1,3
1984	1,4	2,1	1,8	2,1	2,1	3,5	3,0	0,8	0,8	0,3	1,9	0,7	20,4	1,7
1985	1,5	0,9	0,2	0,5	2,0	5,9	1,7	1,1	0,3	0,2	1,6	0,3	16,1	1,3
1986	0,9	2,6	0,5	0,4	0,3	1,7	1,7	0,4	0,4	1,0	0,3	0,6	10,8	0,9
1987	0,5	1,0	0,3	1,0	2,1	2,1	1,3	0,8	0,5	0,7	2,8	0,8	13,9	1,2
1988	0,8	2,1	2,0	1,8	2,0	3,6	1,2	0,4	2,4	0,9	0,5	0,8	18,4	1,5
1989	0,1	0,4	0,4	1,0	0,9	4,6	0,5	1,7	1,7	0,9	0,9	0,2	13,3	1,1
1990	0,1	0,9	0,0	2,2	2,6	2,1	1,2	0,6	1,1	1,2	0,1	2,7	14,7	1,2
1991	0,2	0,9	0,3	1,4	5,6	3,9	5,3	1,8	0,6	1,7	1,3	0,5	23,5	2,0
1992	0,0	0,4	1,1	0,7	2,0	3,9	2,2	0,9	0,3	1,3	0,2	0,5	13,5	1,1
1993	0,0	0,6	1,3	0,7	2,4	2,0	2,2	0,9	1,0	0,2	1,9	0,7	13,8	1,2
1994	0,4	0,2	0,4	0,7	0,9	2,4	2,9	1,1	1,4	2,3	0,1	1,2	13,9	1,2
1995	1,0	0,1	0,6	0,8	1,9	3,3	1,4	1,3	4,2	0,3	1,8	0,9	17,4	1,4
1996	1,4	0,8	0,9	1,4	3,2	1,7	1,5	1,0	2,2	0,4	2,1	1,8	18,4	1,5
1997	0,3	0,1	1,1	2,4	2,4	2,8	4,7	3,0	0,6	2,2	2,3	2,1	23,8	2,0
1998	1,6	0,3	0,9	1,0	1,5	1,9	0,2	1,1	1,5	2,3	1,0	0,4	13,6	1,1
1999	0,7	0,2	0,8	2,0	1,1	5,0	1,0	3,2	4,2	2,2	0,3	1,3	22,1	1,8
2000	0,6	1,2	0,6	1,1	0,6	2,2	1,4	0,6	2,0	0,1	0,4	0,4	11,3	0,9
2001	0,4	0,9	0,6	1,4	1,2	2,3	1,9	0,3	3,7	0,3	0,3	0,4	13,6	1,2
2002	0,5	0,1	0,4	0,9	0,6	2,5	5,2	1,3	1,3	3,0	1,2	1,0	18,0	1,5
2003	1,2	0,5	0,4	1,0	0,4	0,8	3,0	1,1	1,6	2,5	0,6	0,4	13,5	1,1
2004	1,1	0,6	1,0	0,5	1,4	1,8	2,1	3,8	1,9	0,6	1,1	0,6	16,3	1,4
2005	0,5	1,6	1,0	1,0	3,0	3,6	5,6	4,0	1,8	0,2	1,6	1,0	24,7	2,1
2006	1,3	0,2	1,1	2,2	2,6	3,7	2,2	3,1	0,5	0,5	0,2	0,5	17,9	1,5
2007	0,6	0,3	1,5	0,6	1,5	1,5	1,3	4,4	1,3	2,3	1,5	1,0	17,7	1,5
2008	0,1	0,1	0,3	1,9	2,3	1,8	1,1	0,3	1,2	1,7	1,1	0,9	12,6	1,1
2009	0,1	0,4	1,4	0,9	1,7	3,0	1,1	1,2	1,1	1,7	0,9	0,9	14,3	1,3
2010	0,8	1,9	0,9	1,2	2,1	2,7	1,5	0,7	1,6	1,5	0,4	1,6	17,0	1,4
mean	0,6	0,7	0,8	1,2	1,8	2,6	2,0	1,5	1,3	1,1	1,0	0,9	15,6	

Conclusions

Precipitations have a direct impact on the landscape through pluvial denudation, installation of channels and trenches, ditches apparition, gorges and torrential organisms. Furthermore, as a major and direct impact, we are reminding the pluvial factor as an active part for the onset of landslides.

Even more, precipitations have an indirect impact on relief erosion through the rise and fall of liquid and solid debits of rivers within a catchment basin, rivers playing an important role in permanent erosion of the land.

The turbidity is determined by the presence of colloidal suspensions and gatherings of organic and inorganic nature, which rise quantitatively in the direction upstream **-** downstream. They register great abundances in the spring and after the downpours in summer.

Regarding the drainage area of Câlnău, the average specific discharge of alluviums in suspension is of 54t/ha/an, the largest multiannual mean in the country. Câlnău's river basin is included on the map of average discharge specific (after I.M.H., 1988) to the most afflicted zones by erosion.

As a result of the mentioned processes an intense accumulation of sediments take place near the mouth of confluent rivers and torrential organisms allowing the formation large alluvial fans. These microstructures have resulted due to exerted intense erosion, especially in the summer months, according to Angot parameter, which measures the land's susceptibility to erosion wielded by atmospheric precipitations. During the more arid months or with scarce precipitations the terrain is prepared to be eroded, through the drying of sediment deposits from banks and versants which do not present a band of protective forests.

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CLIMATE CHANGE AND ANOMALIES ASOCIATED IN THE REPUBLIC OF MOLDOVA

Maria Nedealcov [1]

Key words: Climate change, temperature, precipitation, anomalies, impact

Abstract. In the Republic of Moldova, regardless the limited area, regional climate change represents one of the major threats for sustainable development and is one of the biggest environmental problems, with negative consequences for the national economy. Displacement function analysis of the climate rules distribution which is characterizing mean annual temperature at different times in the Republic of Moldova shows that the last decade of the twentieth century (1989-1999) was the warmest decade of the century. At the same time, the first decade (2000-2012) of XXI century is the warmest decade of instrumental observations series (1887-2013). Measurement of the extreme values modification in the Moldova's climate evolution indicates that absolute maximum of temperatures and deficit (excess) of precipitation have a regular manifestation on the last period (2000-2012).

Introduction

According to the latest evaluation report on the climate change, issued under auspice of the Intergovernmental Panel on Climate Change [1], „Current climate change already have a significant impact on the natural ecosystems." In the Republic of Moldova, regardless of the limited area (33,3 square kilometers), regional climate change represents one of the major threats to sustainable development and is one of the biggest environmental problems, with negative consequences for the national economy.

1. Investigation materials and methods

Estimations are based on highlighting the trend for the average air temperature and annual amount of atmospheric precipitation, sorting the "dry-wet" and the "cold-warm" years during the history of instrumental observations - recorded data at Chisinau station, concerning thermal regime 1887-2010, and

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precipitation regime from 1891 to 2010. Taking into account the extremely pronounced variability of hydrothermal regime of the past 13 years (2000-2012) anomalies were estimated from the calculated multiannual average for the contemporary period 1960-2012, a period when it is felt the fastest rhythm of regional climate change.

2. Obtained results analysis

Thus, the average annual air temperature (fig. 1) in the Republic of Moldova had been registered an increase by 0.01 ºC/year during the years 1887-2010.

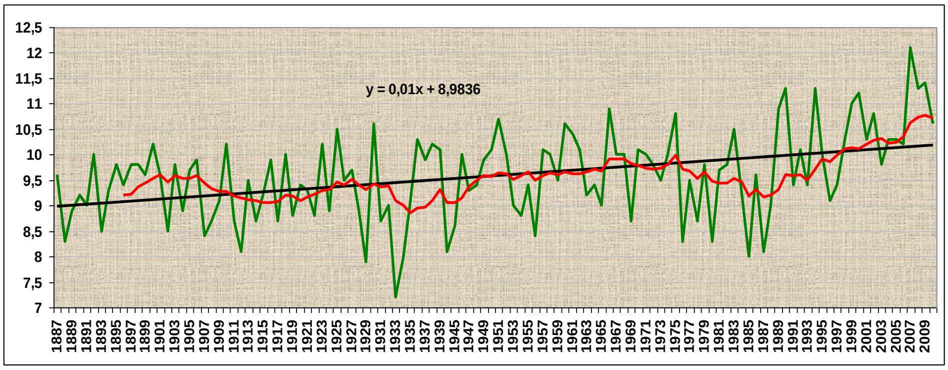

Fig. 1. The change tendency of annual average temperature (1887-2010

Analysis of annual thermal deviation denotes that they are characterized by the predominance of positive anomalies, especially at the end of 90s of XX century and beginning of XXI century (fig. 2).

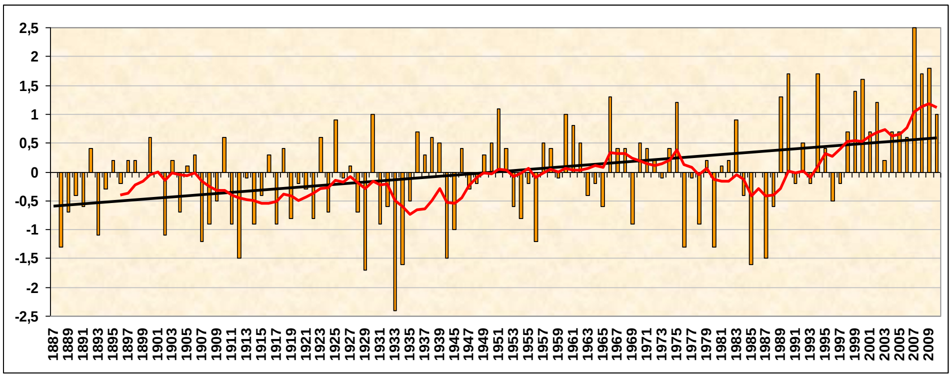

Figure 2. Evolution of annual thermal anomalies reported to the baseline period 1961- 1990

The 2007 year is the warmest year in the series of instrumental observations, average annual temperature exceeding the climatic norm with 2.5 ºC. The years 2009, 1990, 1994, 2008, 2000, 1999, 1966, 1989 and 2002 were extremely warm years, average annual temperature exceeded the value of 10.8 ºC and more (the climatic norm is equal to 9.6 ºC).

In the last two decades the manifestation of extremely warm years had repeatability once in 2 years (tab. 1). The lowest values of thermal were recorded in 1933 and 1929 when the average annual temperature was 7.2 – 7.9 ºC. Likewise with low values by 8-8.3 ºC is characterized the cold years: 1934, 1985, 1912, 1940, 1987, 1888, 1976, and 1980.

Tab. 1. Top of the coldest and warmest years recorded
in the period 1887-2010

Coldest years (T, 0^0C)		**Warmest years** (T, 0^0C)	
1933	7,2	2007	12,1
1929	7,9	2009	11,4
1934	8	1990	11,3
1985	8	1994	11,3
1912	8,1	2008	11,3
1940	8,1	2000	11,2
1987	8,1	1999	11
1888	8,3	1966	10,9
1976	8,3	1989	10,9
1980	8,3	2002	10,8

Amount of precipitation in annual aspect (fig.3) in the Republic of Moldova had been registered an increase with 0.719 mm/year during the years 1891-2010.

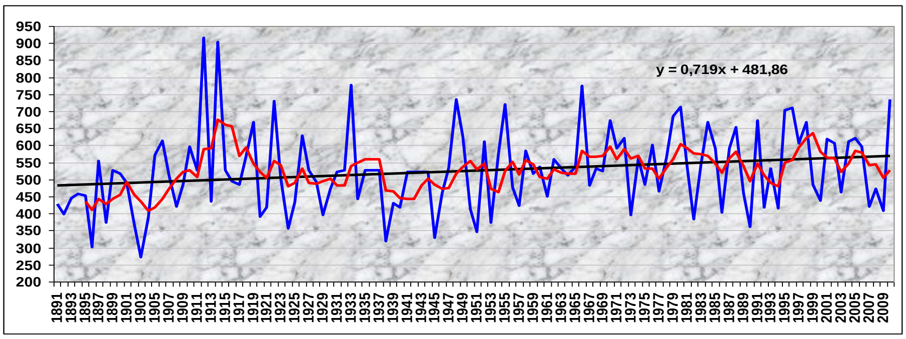

Fig. 3. The change tendency of average amount of annual precipitation (1887 - 2010)

In the last decades there are observed a frequent alternation of positive and negative anomalies, which demonstrates the highly variable character of both events years with precipitation excess as well as with precipitation deficit (fig. 4).

In 1903 the annual amount of precipitation was only 271.8 mm, and in 1912 were recorded the most significant values of 915 mm (tab.2).

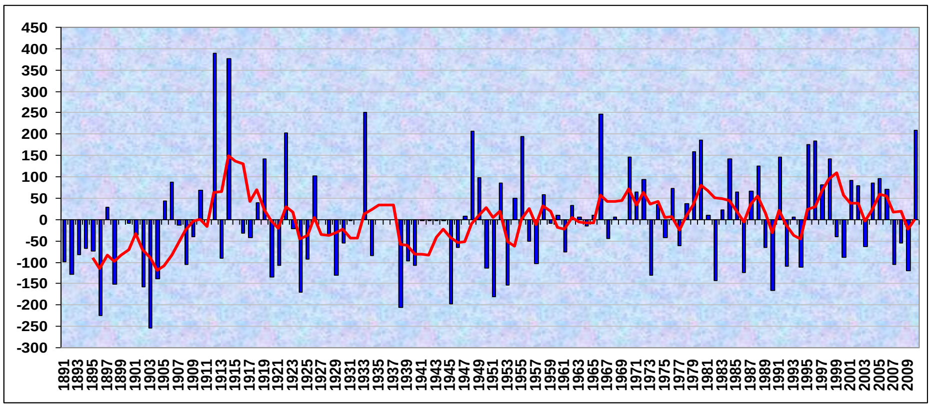

Fig. 4. Evolution of annual precipitation anomalies reported to the reference period 1961 – 1990

But, as previously was mentioned, in the past years (2000-2012), both the thermal as well as hydric extremes are to be the most significant.

Tab. 2. Top of years with pluviometric excess and deficit in the period 1891 - 2010

Dry years (mm)		**Rainy years** (mm)	
1903	271,8	1912	915
1896	301	1914	903
1938	320	1933	777
1945	329	1966	774
1951	345	2010	735
1924	357	1948	734
1990	361	1922	729
1902	368	1955	721
1953	373	1980	712
1898	374	1996	711

In the north of the country the significant values were recorded in 2012, followed by the 2007. In the central and southern part, contrary, thermal maximum in 2007 was the most significant followed by the 2012 (tab.3).

Thereby, calculation of absolute maximum temperature anomalies for the period 2000-2012 to their annual average for the period 1960-2012 reveals, different distribution in time from north to south, in most cases there is not respected the principle of zonality.

Tab.3. The anomalies of absolute maximum temperature from the period 2000-2012 compared to the multiannual average of absolute maximum temperature from the period 1960-2012

Briceni		Falesti		Chişinau		Cahul	
Years	Anomalies	Years	Anomalies	Years	Anomalies	Years	Anomalies
2000	3,9	2000	5,3	2000	4,1	2000	4,6
2001	0,7	2001	3,3	2001	2,2	2001	1,3
2002	1,6	2002	1,8	2002	2,8	2002	0,9
2003	0,8	2003	1,5	2003	1,3	2003	1,8
2004	-0,5	2004	0,3	2004	-1,4	2004	0,7
2005	1,4	2005	1,3	2005	1,2	2005	0,9
2006	-1,8	2006	-0,4	2006	-0,1	2006	1,6
2007	2,7	2007	5,7	2007	5,1	2007	4,8
2008	1,1	2008	3,2	2008	3,1	2008	3,3
2009	0,6	2009	4	2009	1,9	2009	3,3
2010	2,4	2010	2,7	2010	2,2	2010	2,2
2011	0,4	2011	1	2011	-0,8	2011	0,2
2012	4,5	2012	7,7	2012	4,8	2012	4,7

At the same time, we mention that in 2004 and 2006, in central and northern part of the country, thermal anomalies were lower compared to the multiannual average. The achieved results will serve as reference to highlight the influence of climate change on the autumn wheat productivity.

Comparative analysis (fig.5) of absolute maximum temperature anomalies from 2012 and 2007 reveal that the positive extremes in 2012 were above those recorded in 2007, mainly in the north of the country. Thermal maximum recorded at Falesti became absolute throughout the country. At the same time in the central and southern part absolute maximum reached the highest values in 2007.

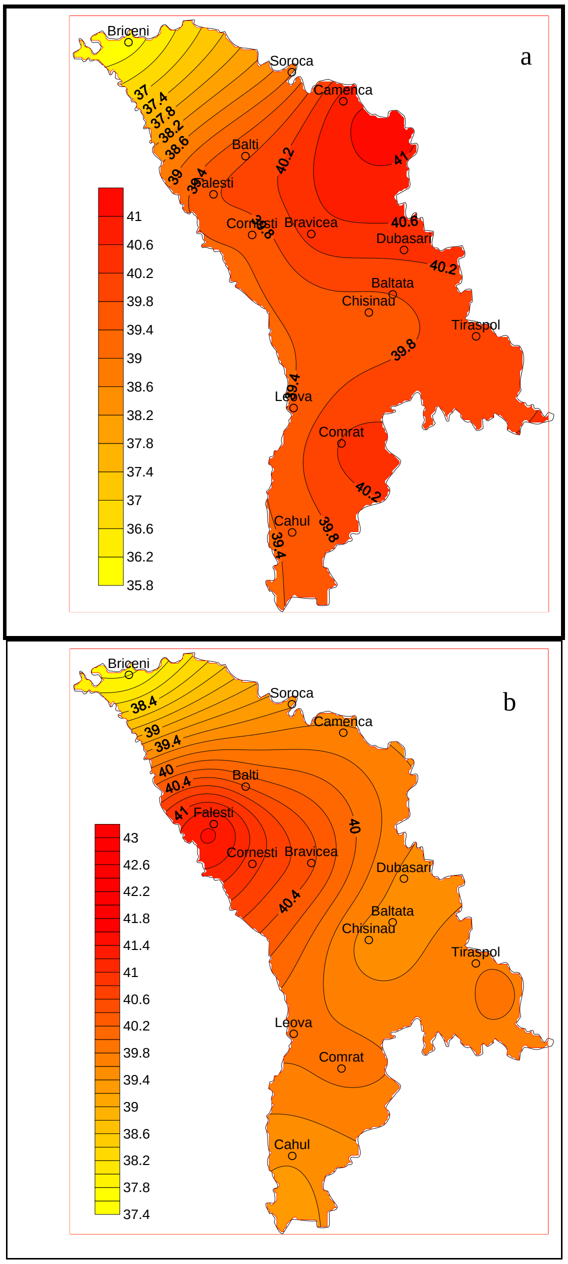

Fig 5. The distribution of absolute maximum temperature on the Republic of Moldova territory (a- 2007, b-2012)

Thus, the above mentioned results indicate, that the last 12 years are characterized by substantial variability in terms of maximum temperature manifestation both in time and in space.
In the last time a significant distribution records and absolute minimum. Although until recently it was thought that [2] the background of winters warming, absolute minimum in winter 2006 has a repeatability once in 24 years, climate variability in recent years shows that the winter from 2012, for example, differs only by 0.3 ºC in the north, compared to the winter of 2006 (tab. 4). In the top of cold winters, joined and winter of 2010, which essentially influenced multiannual crops wintering conditions in the Republic of Moldova.

Tab. 4. Consecutive arrangement of most significant absolute minimum (1960-2012) on the Republic of Moldova territory

Briceni		Chişinau		Cahul	
1963	-33,8	1963	-28,4	1963	-24,9
2006	-28	2006	-24,2	2006	-22,7
2012	-27,7	1967	-23,5	1996	-21,7
1996	-27,5	1961	-23	1976	-21,2
2010	-27,4	1987	-22,8	2010	-21,2
1987	-27,1	2012	-22,2	2012	-21,1
1966	-26	2010	-21,8	1972	-20,9
1972	-26	1972	-21,5	1961	-20,7
1976	-26	1996	-21,1	1964	-20,7
1985	-25	1994	-20,9	1985	-20,5

Calculation of absolute minimum temperature anomalies from the period 2000-2012 compared to the multiannual average of the absolute minimum from the period 1960-2012, reveal that these three winters registered the most essential thermal anomalies reported to the multiannual average. Thus, in the north of the country they constituted -6.1 ... -6.7 ºC, -4.4 ... -6.8 ºC in the center and in the south ... -4.3 -5.9 ºC. In the south there also are the winters of 2002, 2003 that compromised essential the autumn wheat crop in the region (tab.5).

Significant variability of the thermal regime in recent years requires highlighting the trends of change in this period of time (2000-2012) and in the atmospheric precipitation regime.

Table 5. Absolute minimum temperature anomalies from the period 2000-2012 compared the multiannual average absolute maximum temperature from the period 1960-2012

Briceni		Chisinau		Cahul	
2000	2,3	2000	1,8	2000	0,3
2001	1,8	2001	1,7	2001	0,6
2002	2,3	2002	0,9	2002	-1,8
2003	0,4	2003	0	2003	-1,1
2004	6,3	2004	4,3	2004	2,7
2005	-0,5	2005	1,9	2005	0,2
2006	-6,7	2006	-6,8	2006	-5,9
2007	3,2	2007	1,4	2007	0,9
2008	2,7	2008	2,1	2008	-0,2
2009	1,6	2009	0,6	2009	0,1
2010	-6,1	2010	-4,4	2010	-4,4
2011	3,6	2011	1,4	2011	1,7
2012	-6,4	2012	-4,8	2012	-4,3

Table 6. Annual pluviometric anomalies from the period 2000-2012 compared to the multiannual average from 1960-2012

Briceni		Chişinau		Cahul	
2000	-172,6	2000	-113,6	2000	-194
2001	87,4	2001	67,4	2001	64
2002	-44,6	2002	54,4	2002	34
2003	-5,6	2003	-91,6	2003	-229
2004	-108,6	2004	40,4	2004	-66
2005	176,4	2005	86,4	2005	-23
2006	52,4	2006	13,2	2006	-170
2007	-10,6	2007	-69,6	2007	-19
2008	149,4	2008	-85,6	2008	-92
2009	-182,6	2009	-103,6	2009	-131
2010	328,5	2010	184,1	2010	162,4
2011	-188,5	2011	-122,9	2011	-165,5
2012	-75,7	2012	-27,8	2012	58,4

The analysis of annual pluviometric anomalies from the period 2000-2012 calculated from the multiannual average from 1960-2012 (tab.6) reveal that they register a great variability in time and space. Thereby, in the southern part of the country were reached the most significant pluviometric anomalies (-229 mm) reported to the climatic norm during the period taken under study. Significant pluviometric anomalies throughout the country were registered in 2000, 2009, 2011. The year 2004 in the northern part (-108.6 mm) and 2006, in the southern part (-170.0 mm) registered the same substantial negative pluviometric anomalies. Among the significant positive pluviometric anomalies recorded throughout the country, it is highlighted 2010 while in the north of the country they were highest in the period taken under the study (328.5 mm). Also, in the north of the country, during 2005, 2008, as well, registered significant positive pluviometric anomalies.

a b

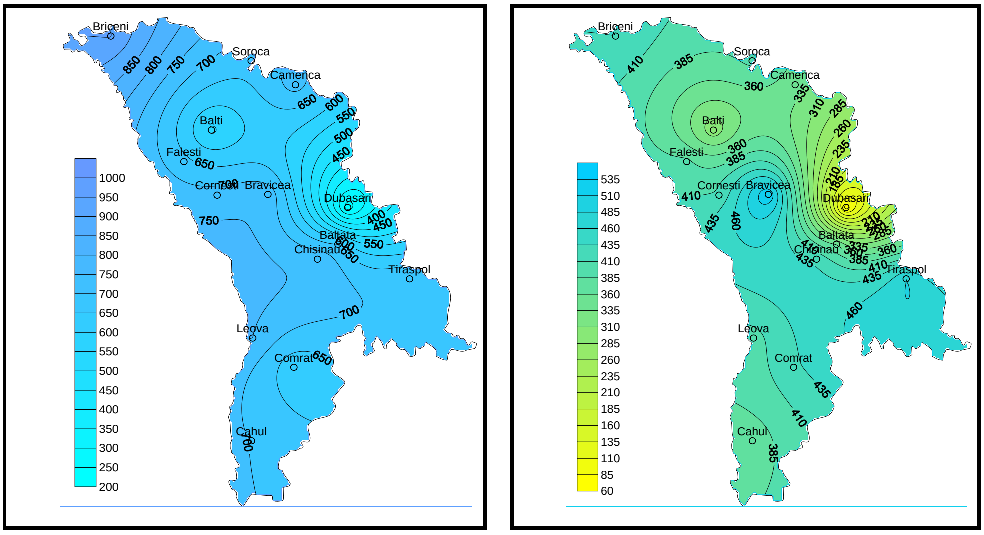

Figure 6. Cartographic modeling of annual precipitation (mm) in extreme years in terms of pluviometric regime (a -2010 - rainy year; b -2011 - dry year)

Cartographic Modeling (using Kriging interpolation program) allowed delimitation of “exposed” territories to excesses and, on the other hand, territories with insufficient regime of atmospheric precipitation (fig.6). Thus, in 2010 – a very rainy year, the highest values of atmospheric precipitation were recorded in the north-west in the center and at altitudes, values being within the limits 720-950 mm (fig.6a). In 2011 - an extremely dry year, the lowest values varied within 100mm in the middle Dniester Plain (mainly at Dubasari) followed by Balti Steppe - with values up to 290-300 mm (fig.6 b).

The results will be the basis for assessments with prognostic character in order to take appropriate measures for adaptation to new climatic conditions in the Republic of Moldova.

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CLIMATIC AND HYDROLOGICAL HAZARDS IN JUNE 26-27, 2010 IN THE UPPER BASIN OF TROTUȘ. CASE STUDY: BETWEEN THE PROPOSED PREPARATION AND THE EFFECTS AT AGĂȘ (COUNTY OF BACĂU)

Viorel Paraschiv[1], Ovidiu-Miron Machidon[2] Doina Capsa[3], Judit Găină[4]

Key words: hazards, water, climatic, flood, Trotuș

Abstract. The water catchment area of the Trotuş river lies on about 4340 square kilometers of which 66% are in the mountain area of the Central Group of the Eastern Carpathians (Moldo-Transilvans). In recent years the manifestation of natural hazards aggressiveness multiplied. In 2005 (12-13 July) and 2010 (26-27 June) Trotuş Valley was affected by strong floods that have produced great material damage. Hydro-technical works carried out after the 2005 summer hazard were swept away by the 2010 hazard, when were affected about 3,000 households in the upper *course* of the Trotus, most of the damage being recorded on the Agăş Creek Valley to the confluence with the Trotuş, the administrative territory of the commune Agăș, where about 2000 household suffered. The late melting snow on the Ciuc and Tarcău Mountains peaks mixed with summer rains determined total isolation of the Cotumba, Sulța, Goioasa and Coșnea hamlets. Provisory bridges realized on the main roads on the side valleys, where are many hamlets, renewed in 2009 summer, were quickly clogged and then swept away by the rough waters of the Trotus and its tributaries. In the upper basin of the Trotus. Over the past 20 years have been recorded up phenomena of paroxysm of the climatic and hydrologic hazards among which the creeks Grohotiş and Sulţa flooded the villages Goioasa and Sulţa. On the 12-13 July, 2005 the Creek Agăş flooded a part of the Agăş village, about 2 kilometers, in line, of households. Drăcoiu creek broke the wall of channeled flood reached exceptional values, the maximum flow at Vrânceni hydrometric station being of 2800 cubic meters/s (probability of overflow 0,5%) and the flood volume here was the biggest of all the existing measurements.

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1. Research methodology

• Analysis of weather characteristics overview for the area;

Correlation between temporal evolution of the use of the land and the construction of logging roads and of the mountain access, based on analysis of forestry cartographic materials (research projects, maps);

• Bibliographical study of the diagnosis drawn up by the institutions concerned about the structural analysis of the emergency situation;

• Identification of potential causes which can determine in the future similar hazards;

• Elementary impact study and the watershed more planning in the Trotus side.

2. Analysis of meteorological phenomena produced in the Trotus river basin (upstream from Comaneşti), 25-26 June 2010

At ground level in 25-26 June, 2010 UTC, the synoptic situation is the one on the synoptic map presented in pictures 1, 2. Romania was under a low pressure area which lies like a belt, from the South to the north-Eastern side of the continent with the main centers of low pressure disposed, one in the Northern side of the Black Sea, the other in the Scandinavian Peninsula.

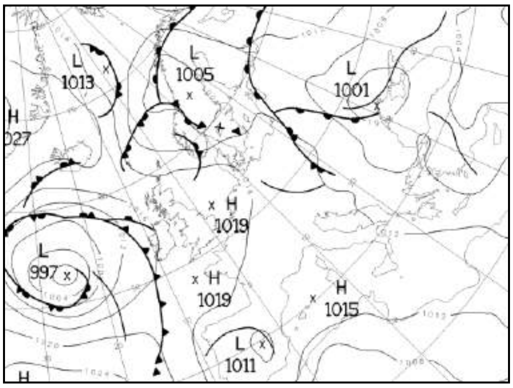


Fig. 1. The frontal ground analysis in June 25, 2010 UTC, h12.00 (source: www.wetter3.de).

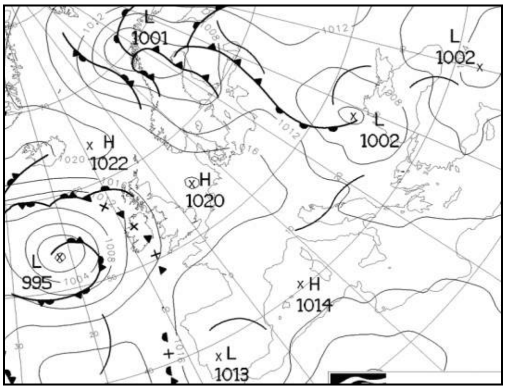
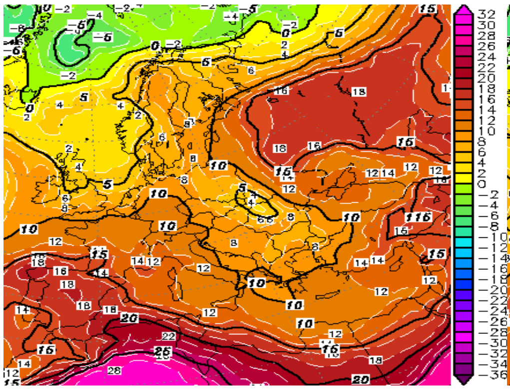


Fig. 2. The frontal ground analysis in June 26, 2010 UTC h6.00 (source: www.wetter3.de)

In the temperature land al the level 850 h Pa, our country is under the influence of an air mass of polar maritime origin, the whole territory of Moldavia being situated between 8-10^{o} (fig 3,4).

CAPE provides a good measure of the degree of instability, representing the amount of potential energy for a high particle at the level of neutral buoyancy. This item depends on the initial conditions of the particle and of the thermo-dynamic procedures used to raise the particle, the unit of measurement being J/kg (Jouli per kilogram).



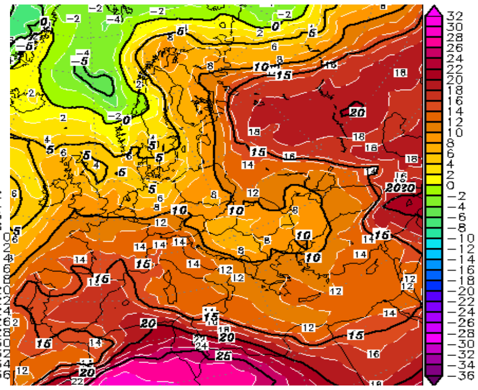


Fig. 3. The surface-level air isobaric temperature of 850 hPa on June 25, 2010, h00.00 UTC

Fig. 4. The surface-level air isobaric temperature of 850 hPa on June 26, 2010, h6.00 UTC

(source: http://www.wetter3.de/Archiv/)

CAPE values for convective storms are about 1000 – 2000 J/kg. Sometimes the values could be more then 5000 J/kg.

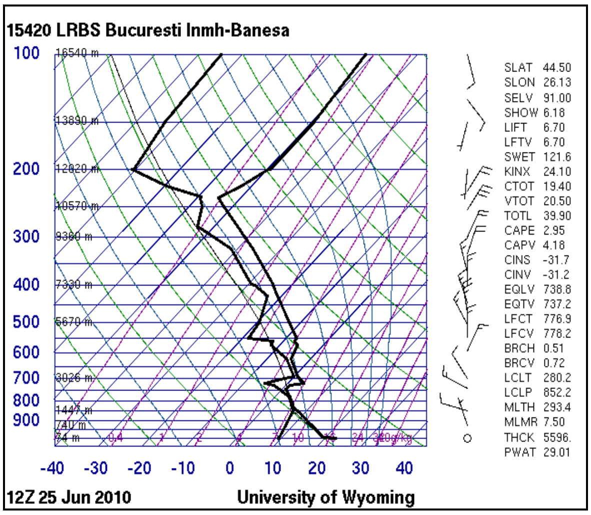
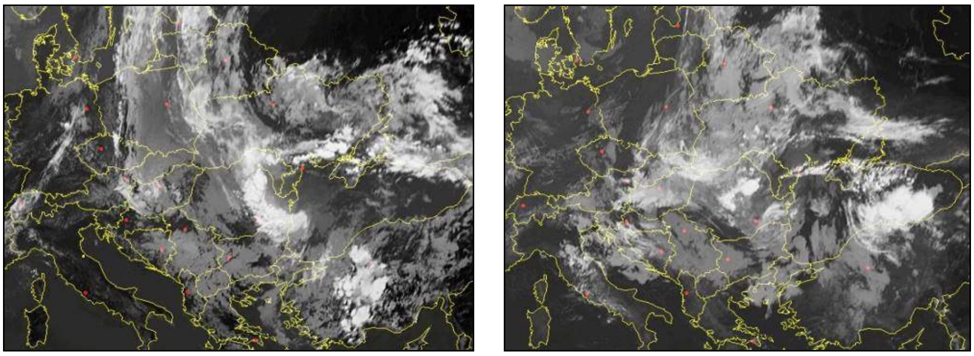


Fig. 5 - Diagram Skew-T from June 25,2010 h 12 UTC
(sursa:http://weather.uwyo.edu/upperair/europe.html)

The diagram (fig.5) where is the vertical profile of the atmosphere and assesses the stability of the atmosphere in Bucharest on June 25, 2010 h 12.00 UTC, indicates: K-INDEX= 24 (chances to develop clouds Cb); CAPE= 295 J/kg; Total Index = 40 (probability to appear clouds Cb).

Abundant rainfall during the day of June 25, 2010 had front causes (picture 1) accompanied by the instability level during the afternoon (picture 5).

In the first part of the day of June 26, 2010 were met conditions by the occurrence of precipitation due to the hot thermal convection. All these happened as in the pictures from the satellite (fig. 6).



a) *b)*

Fig. 6 a,b From satellite, in infrared, on June 25, 2010 h 12.00 UTC (a) and June 26, 2010 h 7.00 UTC (b) (source: http://www.sat24.com/history.aspx)

Tab. 1. The quantities of precipitation (l/m^2) confirmed by gauging stations situated in Trotus river basin (upstream from Comanesti)

Gauging stations	**The quantities of precipitation**	
	Between June 25, 2010 h 3.00 and June 26, 2010 h 3.00	*Between June 26, 2010 h 3.00 and June 27, 2010 h 3.00*
Lunca de Sus	24,5	41,1
Ghimeş-Făget	16,9	39,5
Goioasa	29,6	44,1
Ciobănuş	15,9	45,9

The rainy events from June 25-26, 2010 went to the accumulation of large quantities of atmospheric precipitations (>55 l/m^2) in Trotus basin (upstream from Comanesti) – tab. 1. This way the level of Trotus river and its affluent have increased significantly being exceeded, local shares and flood attention (tab. 2).

Tab. 2. The registered shares confirmed by gauging stations situated in Trotus river basin (upstream from Comanesti)

Gauging stations	Attention share (m)	Flood share (m)	Danger share (m)	H (cm)		
				25 June 2010	*26 June 2010*	*26 June 2010*
Lunca de Sus	100	120	200	65	175	125
Ghimeş-Făget	150	250	300	110	174	168
Goioasa	150	200	300	88	238	175
Ciobănuş	130	200	250	100	136	109

2. Overall space requirements

In the middle and upper basin of Trotus river (upstream from Comanesti) there are 61% forestry, 34% agricultural lands (95% pastures and hayfields and 5% arable land), the other 5 % being used for other reasons (Dumitriu, 2006), meaning buildings, roads or unused lands. About the forestry it could be seen that near Trotus river it is less, comparing with other basins of the rivers. Here , in the Oriental Carpathians, the forestry lies on important areas (Văcărașu, 1984). After the river springs, going to the middle stream, the surface of the forestry increases. So, from the springs to the confluence with Ciughes the forestry is 30%. In the basins of Cold Valley, Tărhăuş and Ciugheş the forestry is over 40 % and in those of Sulta and Camenca arrives to 60-70%. Over 80% are in the basins of Ciobanus and Asau streams. Beside this situation arrives another strange situation! Even if there were massive deforestations in the upper basin, at the beginning of the XX century, the damages were less regarding the soil from the middle basin. The maps and the documents prove this situation. The degradation of slopes is due to the fragmentation and of the slow slopes from the upper basin (Văcărașu, 1984). Another reason it could be the incorrect use of the pastures and hayfields comparing with the middle basin.

In the basins of Uz, Dofteana, Slănic, Oituz, Caşin the forestry increases from the springs to the lower basin. So, if in the upper and middle basin the forestry is over 70%, in the lower basin arrives to 30-40% (Uz, Oituz, Cașin). There is another situation in the upper basin of Uz(with the affluent Apa Lina and Rosu) and Oituz where the pastures and hayfields hold the main share. An increase of the process of erosion could be seen starting from the middle basin of Trotus river due to the pressure of humanity and fragmentation. These are determined by the lithological structure with effect in the dynamics of processes of beds from the major secondary valleys which empties into Trotus river.

3. Overall geographical conditions of Agas commune

The forestry is, statistically, about 60% from the surface of the commune (tab. 3) but the reality is different.

Tab. 3. Land structure

Agricultural land	**Arable**	240	0,1
	Pastures	4629	22,2
	Hayfields	3667	17,4
Non-agricultural land	**Forests**	12504	59,4
	Rivers	121	0,05
	Roads	254	0,1
	Built-up area	182	0,08
	Unused	50	0,02
Total		21040	100%

In Agas work about 400 persons the exploitation and processing of wood (2010, source: *The Mayor of the commune*): 200 on UFET Society and the others at private sawmills. The anthropic pressure on the forestry is overwhelmed and it seems that there is a big difference between the statistics and the reality. The forestry economy and agro-pastoral have 99% from the administrative surface of the commune. The arable lands are in built-up areas having soils of low fertility, especially podzols.

Analysis of geologic bibliography shows that in Panza of Audia (Brusturoasa-Agăş), because of the clay, which is the main, and the irrational use of the land, go to intense erosion in surface, especially on the right slope of the valley, between the confluence of Trotus with Popoi and Ciugheș. Other intense erosion areas were signed on left slope until the confluence with Cuchiniș. A proof of the irrational use of the lands could be seen on the left slope of Trotus valley, between the confluence with Cuchiniș and Camenca (Dumitriu, 2008), where appeared local badlands. The transit of silt in Agas is determined by the deep erosion , the torrentiality having the biggest contribution in forming silt (about 35%) thinking at the geological structure. Associated with the bank erosion and the massive landslides in the omonime valley, in the bed of the river appears accumulation of blocks. The roads for forestry exploition have a contribution of 20-30% (Dumitriu, 2008) in forming badlands on important surfaces.

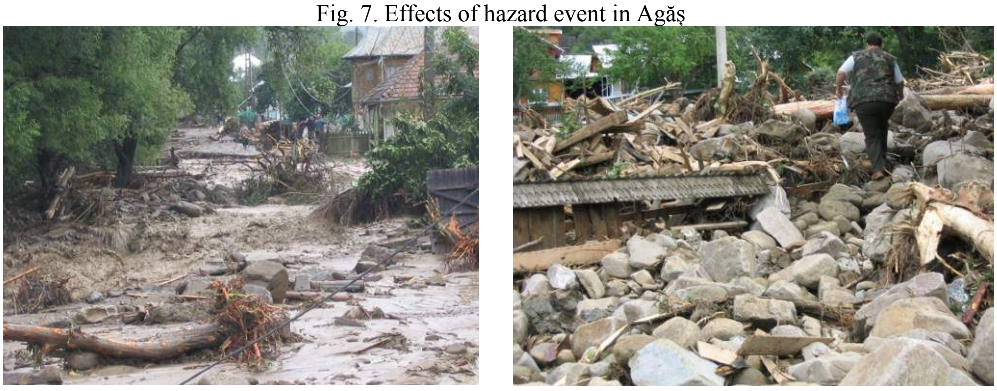
General conclusions

The main reasons which determined the floods in the last 10 years, with a maximum in 2005 and 2010, are:

- Important precipitations (over 130 l/mp) beside the water from the land, in spring, which comers from the snow
- The damage of the embankments because of to much water and the long period (ove
- r 20 days when appeared infiltrations – fig. 7. a, b)

a) b)

Fig. 7. Effects of hazard event in Agăș



a) b)

Fig. 8. Effects of hazard event in Agăș

- massive deforestation and unsuited agrotechnical works which help the erosion and lead to a bigger flow and important quantities of silt (fig. 7. a, b)
- The gullies and ditches are not enough, and the ones that exist in the rural area are not well used and kept (fig. 7. b)
- The clogging and the bad keeping of the gullies and ditches, which are not enough and properly for floods (fig. 8. a, b)
- Unauthorized buildings that appear in the flood areas

- Poverty, unauthorized buildings, bad projects, low quality materials and the lack of administrative rules for buildings (fig. 8. a, b)
- Overloaded transports on bridges and waste products which ruin the channels, already too few. Illegal deposits of sawdust from the major basins of Trotus and affluent are big pollutants
- The works around the bridges are not made according the legal notices
- The lack of enough materials and means of the local administration in case of floods

The ignorance of the people and the local administration how to interfere in case of climatic and hydrological hazards(to announce, to alarm the people).

Acknowledgments

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* * * Date pluviometrice masurate in intervalul 25 – 27.06.2010 de statiile hidrometrice din cadrul Directiei de Ape Siret – S.G.A. Bacau;

* * * www.sat24.com/history.aspx

* * * http://weather.uwyo.edu/upperair/europe.html

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THE COMPARATIVE ANALYSIS OF THE THERMAL REGIME IN THE RUCĂR-BRAN CORRIDOR AND THE PRAHOVA-TIMIŞ CORRIDOR

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Keywords: vertical thermal gradient, air temperature, Rucăr-Bran Corridor, Prahova-Timiş Corridor.

Abstract. Comparative analysis of thermal regime in the Rucăr-Bran Corridor and the Prahova-Timiş Corridor. The authors analyze the thermal regime of two close corridors – one in the mountains and one in a valley; the first one – the Rucar-Bran Corridor is situated in the east of the Southern Carpathians e separates the Bucegi group from the Fagaras group; the second – the Prahova Timis Corridor is situated at the contact between the Southern and the Eastern Carpathians, between the Bucegi-Postavaru Mountains and Teleajenului Mountains. In order to determine from a thermal point of view the similarities and the differences between the two negative landforms, the authors used the vertical temperature gradients on the northern, southern, eastern and western slopes, based on the annual average temperatures and of the two characteristic months of the year (January/February and July/August) from seven weather stations installed in the region, at altitudes between 461 and 2504 meters, for a 47 year period (1961-2007). This way, they discussed the temperature differences in winter and summer between the mountain peaks and the depression areas, as well as the thermal anomalies caused by the geographic location: the position of the corridors' regions with regard to the main atmospheric circulation and the exposure of the slopes to the sun, as well as the landform, which can alter the general distribution of the air temperature on the vertical.

Introduction

Knowing varriation of climatic elements such as the air temperature is of great importance in solving some issues raised by the various fields of national economy, especially tourism. This is because Rucăr-Bran and Prahova-Timiş Corridors are first rank tourist regions in Romania, with old traditions in this regard. About

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climate of two corridors so far a number of climate studies have been developed (see bibliography), among which two PhD theses (Teodoreanu, yet 1980; Mic, 2012) which allowed the possibility of comparing from a geographical mostly climatic standpoint the two nearby mountain regions, attempting in this way to emphasize the similarities and differences between them.

1. Study area

The two negative forms of relief, or the so-called „geographical discontinuity areas" (Mihăilescu, 1963), bound the Bucegi Massif being located on it's both sides (Fig. 1).

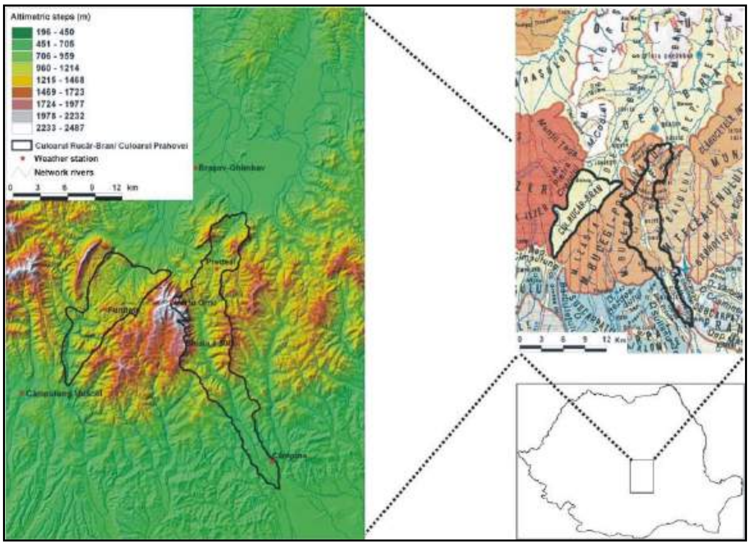

Fig. 1 - Location of meteorological stations and study area

Located in the western part of the Bucegi Massif, the Rucăr-Bran Corridor, compared to the highest altitudes in this massif (Omu Peak, 2504 m altitude) enhances the topoclimatic features which are different from those of the Prahova Corridor. Being a transverse mountain corridor, with an opening to the northeast and southwest respectively behind and in front of the orographic dam of Carpathians, Rucăr-Bran links the Bârsa Depression (Braşov Depression), north of the Carpathians, and the Câmpulung Depression (Muscelele Argeşului), south of them, therefore it is wide open for air masses from the north and northwest respectively south and southwest. Inside there are relatively small depressions (Dâmbovicioara, Podul Dâmboviţei and Rucăr) that differentiates between them by climate characteristics topoclimatic under the direct influence of the mountain

(Teodoreanu, 1980). Same as Rucăr-Bran Corridor, the Prahova-Timiş Corridor is bound at both ends by two well-developed depressions (Braşov Depression, on north side and Câmpina, on its southern side), so that north – south is the predominant movement direction of air masses.

Also within the Prahova-Timiş Corridor there are few generally small depressions (Săcele Piedmont, Timiş Depression, Sinaia Depression, Comarnic-Breaza Depression, Brebu and Câmpina) whose topoclimatic and climate characteristics are still under the influence of the mountain, but also of the surrounding hills, slightly tinted by the foehn effects from the Curvature region (Prahova Corridor being at the west end of it), occurring on the southern slopes, crossing the masses of wet and unstable air from the north and northwest.

Therefore, the presence mountain and hill peaks with different orientations and altitudes, which bound depression areas, have a significant influence on the climate of the valley and the mountain corridor.

2. Data and methods

The comparative analysis of the thermal regime in the Rucăr-Bran Corridor and the Prahova-Timiş Corridor was based on monthly and annual data recorded at 7 meteorological stations (located between about 400 and >2500 m) (Fig. 1), during the period 1961-2007.

To have a clear picture of the variation of air temperature with altitude, mainly ***the vertical thermal gradient values both at year level and thermally characteristic month level*** were looked at.

The temperature differences obtained (Δtº C) for meteorological stations located on the northern, southern, eastern or western slopes, but also on the Prahova slope or the one between the stations Sinaia 1500 and Predeal (table 1) were the data used or the comparative analysis of the vertical thermal gradients in the two mountain corridors. At the same time, the statistical significance of the trends of variation of air temperature was determined through the Mann-Kendall test (Sneyers, 1975; Salmi et. al., 2002; Tomozeiu et. al., 2005), setting as statistical significance threshold level of ≥ 90% (Micu, 2007-2008).

3. Results

A number of climate parameters highlight the local heat potential of the two mountain corridors.

3.1. The average annual temperature

Based on analyzed meteorological stations one can conclude that, on similar morphological conditions, the temperature variation has similar features (Fig. 2). A summary analysis of the ***distribution map of annual average temperatures*** for a period of 47 years (1961-2007) reveals that the highest values of te isotherms (7-9ºC) characterizes the southern extremity of Prahova Corridor, southern outskirts

Tab. 1 - Vertical thermal gradients in the Rucăr-Bran and Prahova-Timiş Corridors

Slopes types	Weather station	Δ h m	Δ t (ºC) Med. t. an	ºC/100 m	Δ t (ºC) Average temperature of the coldest month	ºC/100 m	Δ t (ºC) Average temperature of the hottest month	ºC/100 m
North slope	Omu Peak – Braşov-Ghimbav	1970	10.0	0.51	5.9	0.30	12.3	0.62
	Predeal – Braşov-Ghimbav	556	2.6	0.47	0.5	0.09	3.4	0.61
	Fundata – Braşov-Ghimbav	850	3.2	0.38	0.8	0.10	4.3	0.51
North slope average				0.45		0.16		0.58
South slope	Omu Peak – Câmpina	2043	11.4	0.56	10.0	0.42	13.9	0.68
	Omu Peak – Câmpulung	1923	10.5	0.51	12.4	0.40	12.5	0.61
	Predeal – Câmpina	629	4.0	0.64	3.1	0.48	4.9	0.78
	Fundata – Câmpulung	703	3.7	0.52	3.0	0.43	4.4	0.62
South slope average				0.56		0.43		0.67
Eastern slope	Omu Peak – Fundata	1120	6.8	0.61	5.1	0.46	8.0	0.71
Western slope	Omu Peak – Predeal	1414	7.4	0.52	5.8	0.41	8.9	0.63
Prahovean slope	Omu Peak – Sinaia 1500	994	6.2	0.62	5.5	0.55	7.0	0.71
	Sinaia 1 500 – Predeal	420	1.2	0.29	0.3	0.07	1.9	0.44
General average				0.52		0.30		0.63

** Source: Calculated data based on the ANM Archive.*

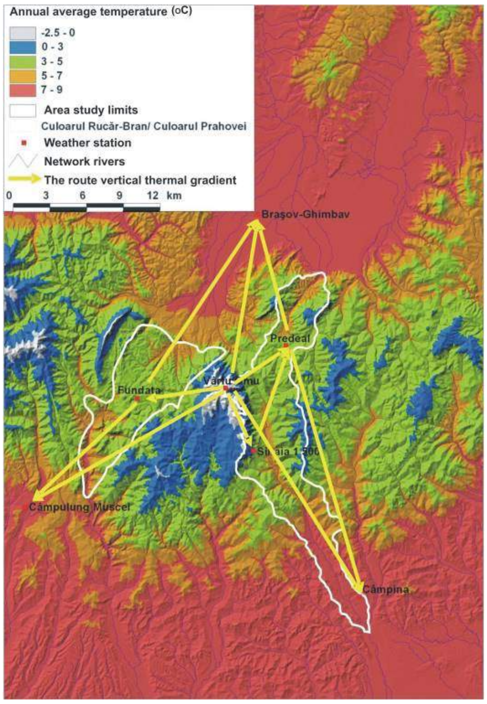

Fig. 2 - The territorial distribution of annual averages air temperature and vertical temperature gradients route

Rucăr-Bran and the northern one of the entire territory, so in general, the regions located at altitudes <800 m. Average annual values of the isotherms decrease as the altitude increases to about 2500 m. Thus, in both mountain corridors, between 800 and 1000 m altitude, they vary between 5º-7ºC.

3.2. Vertical thermal gradients

Instead, isotherms at between 3º-5ºC characterizes most of the Rucăr-Bran Corridor and only the Carpathian sector of the Prahova-Timiş Corridor with altitudes between 1 000 and 1 600 m. Between 1 600 and 2 000 m, isotherms have values between 0º-3ºC, and at over 2 000 m altitude, they have the lowest values (-2.5º…0ºC). Interesting aspects arise and if we look at average annual vertical thermal gradients route and from the thermal characteristics months (Tab.1, Fig. 2).

Since we aim to show, first the role of atmosphere general circulation and then of local geographical features, we chose six cross sections (Figure 3-8), which crosses the western slopes of the exhibition, eastern, northern and southern, and prahovean or the slope of Sinaia 1500 and Predeal. Sinaia 1500 sation, located 75 m above the bottom of the Prahova Valley has a typical geographical position, being located on a spur of storeyed ground (Stoenescu, 1951). However, a prolonged period of meteorological observations for over 40 years has allowed its thermal data comparison (synchronous intervals) with the meteorological station of Predeal, located in different conditions of relief. The Rucăr-Bran and the Prahova Corridors are characterized by considerable variations in vertical temperature gradients due to local morphological conditions, differences in altitude and especially the dominant pattern of air circulation, so that in the table above, which show the vertical thermal gradients, the ***average level differences (Δhm)*** for slopes with different exhibitions were included.

Fig. 3 - Profile I – western slope

Annually, ***the temperature difference (ΔtºC)*** between the highest peaks of the Bucegi Massif and the surrounding lowlands ranges between 10.0º…10.5ºC (Omu Peak –Braşov-Ghimbav respectively Omu Peak-Câmpulung Muscel) and 11.4ºC (Omu Peak and Câmpina). The eastern and western slope, and the slope of

Prahova, this difference varies between 6º-7ºC, while on the north side and south, it is equal to or below 4ºC (Table 1).

The overall average values of annual average vertical thermal gradient in the entire analyzed area is 0.52ºC; in ***summer***, increases to 0.63ºC, but in ***winter*** drops to 0.30ºC. It maintains its value and on the western slope (between Omu Peak and Predeal) (Figure 3) at both annually and in the hottest month of the year, but in winter, compared to the overall average of the region, it increases by up to 0.41°C/100 m.

For the ***Eastern slope (between Omu Peak and Fundata)*** (Fig. 4) vertical thermal gradient values are comparable to those recorded on the ***Prahova slope*** (***between Omu Peak and Sinaia 1500***) (Fig. 5), meaning that for every hundred meters, the temperature decreases in ***summer*** also by 0.71ºC, and the ***annual level*** of 0.1ºC higher, up to the value of 0.61°C/100 m. Larger differences are during the winter, when in January, the values of thermal gradient vertical fall to 0.46ºC/100 m, by aprox. <0.10ºC higher.

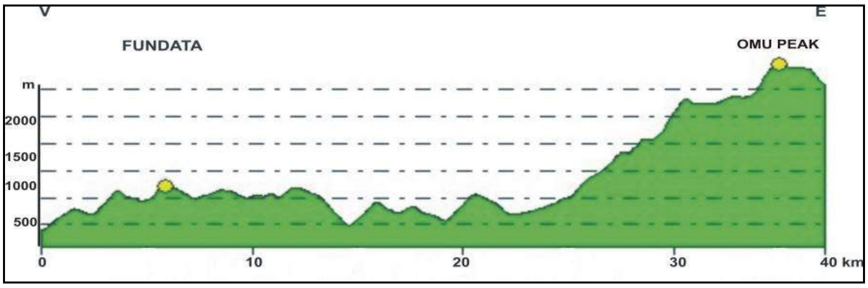

Fig. 4 - Profile II – Eastern slope

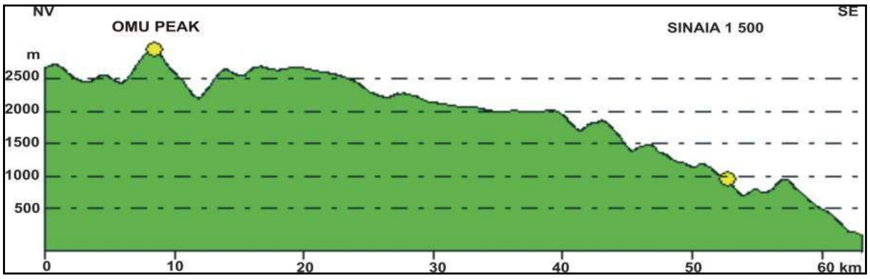

Fig. 5 - Profile III – Prahova slope

If we follow ***the variation of vertical thermal gradients on the northern and southern slopes*** of the analyzed area (Table 1, Fig. 2, Fig. 6), except that the ***annual temperature gradient route*** of Omu Peak-Braşov stations on the northern slope (Fig. 6) have equal values (0.52°C/100 m) with those of Omu Peak-Câmpulung Muscel meteorological stations on the southern slope (Fig. 7) – generally, the thermal gradients established using the meteorological stations ***are lower on the northern slope than on the southern one due to the temperature inversions during the winter.*** In this case, the differences can reach up to 0.17-0.18ºC/100 m in average.

Fig. 6 - Profile IV – north side

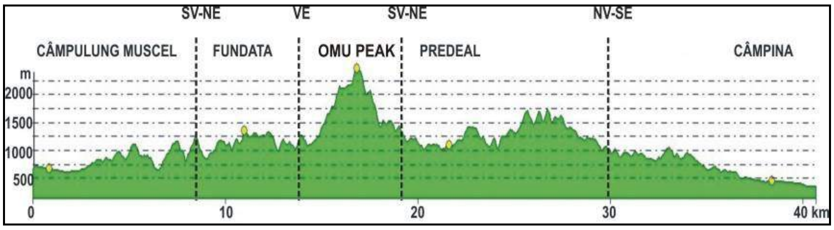

Fig. 7 - Profile V – southern slope

During ***the coldest month of the year***, more than the annual values, differences in temperature distribution on the northern slope and the southern one are noted (Table 1). The thermal gradients are very low in the first case i.e. 0.09-0.10ºC/100 m between Predeal and Braşov-Ghimbav and between Fundata and Braşov-Ghimbav, which highlights the intense and persistent inversions in this part of the analysed area and the relatively high, in the second case, 0.40-0.48ºC/100 m, slightly lower than the annual ones, as a result of weaker and shorter inversions (Teodoreanu, 1980).

The vertical gradients of the hottest month on two types of slopes range between 0.51ºC/100 m ***on the northern slope*** and 0.68ºC/100 m ***on the southern one***, showing a more obvious warming of the southern slopes and a deep cooling as the altitude increases, and on the other hand, favorable conditions for the existence of thermal inversions towards Brasov Depression, even during the warm season. Very pronounced is the thermal gradient between Predeal and Câmpina namely

0.78ºC/100 m, highlighting a more rapid cooling as the altitude increases (Teodoreanu, 1980).

Between Sinaia 1500 and Predeal stations (Fig. 8) vertical thermal gradient values (Table 1) decrease on average per year by 0.29º-0.44ºC/100 m – during the summer and during the winter by only 0.07°C/100 m whereas in Predeal, the horizon is cleared towards west and the morphological opening between Bucegi and Postăvaru through Râşnoavei Valley makes the overall direction given by the upper Prahova Valley in the region of origin to shape the route of the vertical thermal gradients in this part of the analysed area.

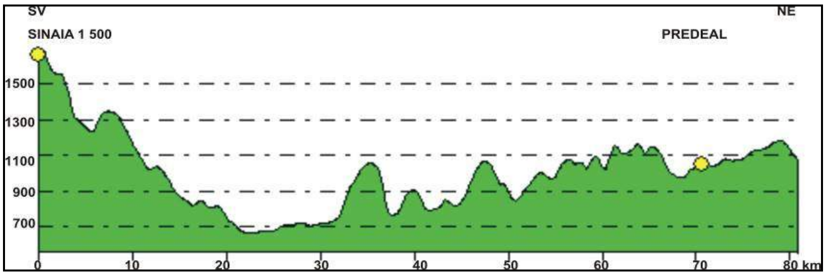

Fig. 8 - Profile IV – Sinaia1 500-Predeal

3.3. The average monthly air temperatures

From ***the territorial distribution of the average annual values of air temperature in the coldest month of the year***, it appears that in most of the analyzed territory with altitudes <1200 m, the isotherms have values >-5ºC (Fig. 9). On a small portion of the Rucăr-Bran and only in the Prahova-Timiş Carpathian Corridor at altitudes between 1 200 and 1 800 m, the values fall to-10ºC. Between 1 800 and 2 000 m, isotherms have values between-10.1...-10.5°C and at over 2 000 m altitude, the values drop to about -11ºC.

If we analyze ***the vertical thermal gradients*' *route*** (Table 1, Fig. 9), it appears that in winter in the coldest month of the year, large temperature differences occur only on the southern slope between stations Câmpina and Omu Peak respectively between Omu Peak and Câmpulung when ranges from 10-12ºC; otherwise they remain below 6ºC or even having below par values.

The average temperature of the warmest month shows a spatial distribution as varied as that of the coldest month of the year, but the temperature difference between high mountain peaks and surrounding lower regions increases substantially (Table 1).

The multi-annual variation of air temperature in the warmest month of the year at different altitudes is not the same. Thus, out of the territorial distribution of the climatic parameter (Fig. 10) results that the July isotherms' values >18°C are characteristic for both mountain corridors and their surrounding regions in the south and north, with altitudes <800 m.

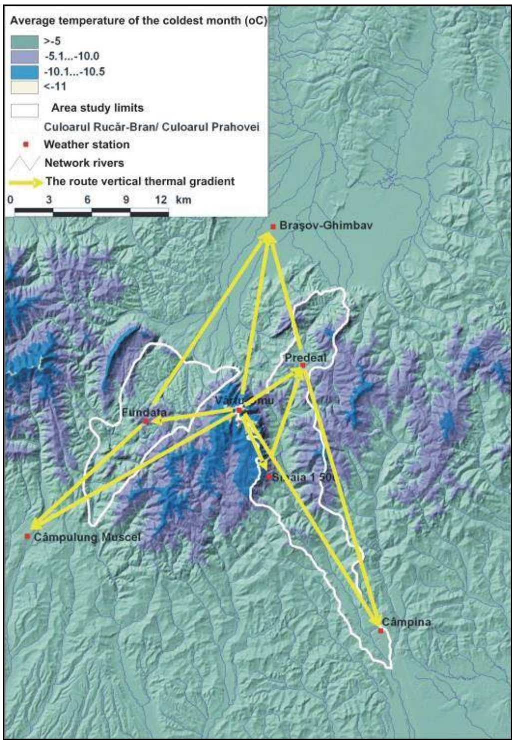

Fig. 9 - The territorial distribution of mean air temperature in thecoldest month of the year and the vertical temperature gradient route

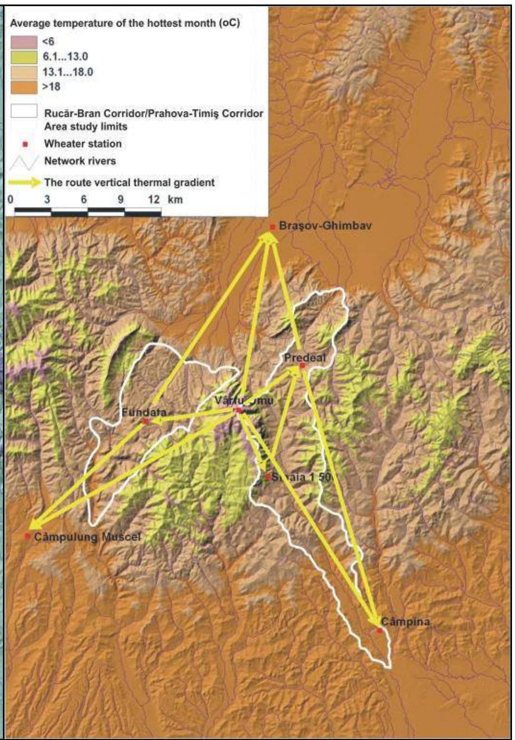

Fig. 10 - The territorial distribution of mean air temperature of the warmest month of the year and the vertical thermal gradients' route

Average annual values of the isotherms decreases as the altitude increase, so most of the two mountain corridors, with altitudes between 800 and 1 600 m, are characterized by values of isotherms between 13º-18ºC.

Then, the values drop further so that isotherms with values between 6º-13ºC are characteristic only for the Carpathian sector of the Prahova-Timiş Corridor and only to very specific areas of Rucăr-Bran. Meanwhile, the high atop of Bucegi Mountains appears to be a real cold climate island, as compared with the sorrounding warmer regions, where isothermal values <6ºC is typical.

3.4. Variability of annual mean air temperature

By reference to the length of data series and to the scale of the entire analysed region, ***the most obvious increases*** (>99% significance level) were recorded in Câmpulung Muscel station in the southern extremity of ***Rucăr-Bran Corridor*** but also on it's territory, at Fundata station (>95% significance level), where the variation rate of average annual temperatures range between +0.78°C/ year, respectively +0.65°C/year (Table 2).

Compared to this region, located west of the Bucegi Mountains, ***in the Carpathian sector of the Prahova Corridor***, ***and the surrounding region in the north*** (Braşov Depression), even if the average annual temperatures are increasing, ***the trends indicate an insignificant increase*** (Omu Peak, Sinaia 1500, Predeal and Braşov-Ghimbav). For these four meteorological stations, the variation rates of annual average temperatures range between +0.29°C/year (Predeal) +0.41...+0.42°C/year (Omu Peak and Braşov-Ghimbav) and can reach up to +0.49°C/year Sinaia 1500. According to the non-parametric Mann-Kendall test it was established as representativity threshold from statistical standpoint, a significance level ≥90%, so that, ***in the Prahova-Timis corridor one may note a significant air temperatures increase trend only in its sub-carpathian sector***, ***at Campina station***, where the variation rate of this climatic parameter is +0.56°C/year (Table 2). ***It results that, annually, the most sustained upward trends of the air temperature are specific to the Rucăr-Bran Corridor and Campulung Muscel Depression (located in Muscelele Argeşului)***, ***but also to the sub-carpathian sector of the Prahova-Timiş Corridor.***

Tab. 2 - Trends in averrage annual temperature variation during 1961-2007

Weather station	Annual average (1961-2007)	General variation rate (°C/year)[1]	Floor vegetation
Omu Peak	-2.4°C	0.41 (-)	Alpine
Sinaia 1500	3.8°C	0.49 (-)	Forest
Fundata	4.4°C	0.65 (*)	
Predeal	5.0°C	0.29 (-)	
Câmpulung Muscel	8.1°C	0.78 (**)	
Braşov-Ghimbav	7.6°C	0.42 (-)	
Câmpina	9.0°C	0.56 (+)	

[3] Mann-Kendall Test (Salmi et. al., 2002)

*** α = 0.001 significance level (99.99%); ** α = 0.01 significance level (99%);

* α = 0.05 significance level (95%); + α = 0.1 significance level (90%);

- = no statistical significance.

3.5. Air temperature variability during specific months

Except the coldest month of the year, at altitudes > 2500 m, the air temperature trends by specific month, show the same variation sign (Table 3).

During the coldest month of the year, the variation the positive range of the air temperature is ***insignificant*** in the Prahova-Timis corridor, ***at altitudes >1500 m*** (Sinaia 1500 and Omu Peak); ***less significant for its Subcarpathian sector*** (+2.3ºC/month Câmpina) ***and for Rucăr-Bran Corridor*** (+2.4ºC/month at Fundata), yet ***a significant increase trend*** (≥ +2.5ºC/month) ***in the south and north surrounding region*** (Câmpulung respectively Braşov-Ghimbav stations) and ***also Prahova-Timiş Corridor***, ***at altitudes of about 1 000 m (Predeal)***.

During the warmest month of the year, there is a significant increasing trend of air temperature for all seven analyzed meteorological stations, having a variation rate between +1.8 ... +2.0°C/month, ***more obvious in case of Rucăr-Bran Corridor***, where the variation rate of air temperature reaches up to +2.3°C/month at Fundata. It results that, at the level of the of thermally specific months, the increasing air temperature trends are more pronounced during the warmest months (July/ August); the most affected is Rucăr-Bran Corridor (especially Fundata station). In the coldest months (January/February), the air temperature increase rates are moderate, with statistical significance only at altitudes <1500 m.

Tab. 3 - The variation trends of the air temperature on specific months during 1961-2007

Weather station	The coldest month	Annual average (1961-2007)	Variation rate (°C/month)[1]	The hottest month	Annual average (1961-2007)	Variation rate (°C/month)
Omu Peak	February	-10.6	- 0.2 (-)	August	5.7	+ 2.1 (**)
Sinaia 1500	January	-5.1	+ 1.8 (-)	July	12.8	+ 2.1 (**)
Fundata	January	-5.2	+ 2.4 (+)	July	13.7	+ 2.3 (***)
Predeal	January	-4.8	+ 2.5 (*)	July	14.6	+ 2.0 (**)
Câmpulung Muscel	January	-2.1	+ 2.7 (*)	July	18.1	+ 1.9 (**)
Braşov-Ghimbav	January	-4.3	+ 3.0 (*)	July	18.0	+ 2.0 (**)
Câmpina	January	-1.7	+ 2.3 (+)	July	19.5	+ 1.8 (**)

[3] Mann-Kendall Test (Salmi et. al., 2002)

*** α = 0.001 significance level (99.99%); ** α = 0.01 significance level (99%);

* α = 0.05 significance level (95%); + α = 0.1 significance level (90%);

- = no statistical significance.

Conclusions

If in the regions with altitudes <1 800 m, within both mountain corridors, the thermal conditions are very similar, the specific thermal regime is better highlighted in the regions higher than 1 800 m, where, depending on altitude, differences are landscape more clear.

Emphasizing the thermal regime comparative analysis is meant to highlight not only the similarities and the differences between the two corridors, but also the influence of the thermal regime on the turist activity in their mountain resorts. There are practised many forms of tourism: rural and agrotourism, religious and/or cultural with etno-folk valences, scientific and eco-tourism etc.

The most important remain the mountain tourism, practised mainly in the resorts specially set-up for winter sports on the Prahova Valley: Sinaia, Buşteni, Azuga and Predeal. In the same time, such type of tourism is vulnerable to the climate changes experienced during the last decades on the grounds of general warming of the mountain climate, as the majority of the ski slopes unfold between 800 and 1 500 m altitude (Bogdan, Mic, 2011).

Nevertheless, presently, in both mountain corridors there are favourableclimate conditions for practising all forms of specific tourism: backpacking, rest, game sports, winter sports etc.

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STUDIES REGARDING THE SAFETY IN OPERATION OF EZER RESERVOIR

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Key words: dam failure, hydrostatic level, drainage system, behaviour monitoring

Abstract. The dam of the non-permanent reservoir Ezer, located on Jijia river is an earth dam with a maximum height of 6.18 m, which provides a global retention to the canopy of 10.330 million cubic meters. The dam founded on weak, muddy soils suffered in the years 1989 and 1992 downstream slope failures of the fillings. It was found that hydrostatic levels were high in the piezometric wells and that consolidation of the foundation soil was reduced. This paper presents a brief history of the dam and aspects regarding the behaviour monitoring of Ezer non-permanent reservoir during the years 2000-2012.

1. Brief overview of the reservoir

1.1. General data

Ezer non-permanent reservoir, operated by Prut-Bârlad Water Basinal Administration, is located on Jijia river (national cadastral code XIII.1.15), 16.2 km downstream of spring river, in Hilişeu–Horia village, upstream of Dorohoi city, in Botoșani county. The reservoir commissioned in November 1996, is mainly aimed to temporary withhold and mitigate flood waves, increase flood defense for the objectives located downstream of the dam.

The retention in Ezer reservoir is made by a frontal, homogeneous earth dam with a canopy length of 750 m, with a double trapezoidal cross section, between the surface outlet and the right bank embedding, and a trapezoidal cross section, between the surface outlet and the left bank embedding. The dam body has a canopy width of 5.0 m. The section between the surface outlet and the right bank embedding has upstream and downstream embankment slope of 1:4 and includes upstream and downstream 27 m width berms.

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The site was chosen taking in consideration the geomorphological and geotechnical features of the section and the nature and properties of the building material, data provided by the geological study prepared by the Research and Design in Water Management Institute – Iasi Branch. The geotechnical studies revealed unfavorable characteristics of the foundation soil and proposed measures to consolidate it in the meadow area and to waterproof the bank embeddings.

In order to descend the seepage curve through the dam a draining ballast mattress was placed on a 0.6 m width and 471 m long geotextile layer at the foundation soil. The consolidation of the foundation soil was accelerated by a system of 310 draining wells, arranged in 4 rows in the middle of the meadow, where muddy clay layer is thicker then 20 m. The 16″ nominal diameter wells filled with ballast have an 8.0 m depth. The top of the wells is placed, on a 0.6 m depth, in contact with the draining mattress by a network of draining ditches filled with ballast.

Collecting and dripping water from the wells and the draining mattress is achieved through 2 parallel 300 mm nominal diameter culverts. Between these culverts, on the foundation soil of the downstream berm, 0.7 m width and 0.5 m high ballast straps were placed. The connection of the culvert with the draining mattres is made through a a ballast prism with 0,5 m low base width, 0,5 m height and 1: 1 downstream slope thus ensuring the continuity of the draining mattress with the ballast straps drainage. (Fig. 1).

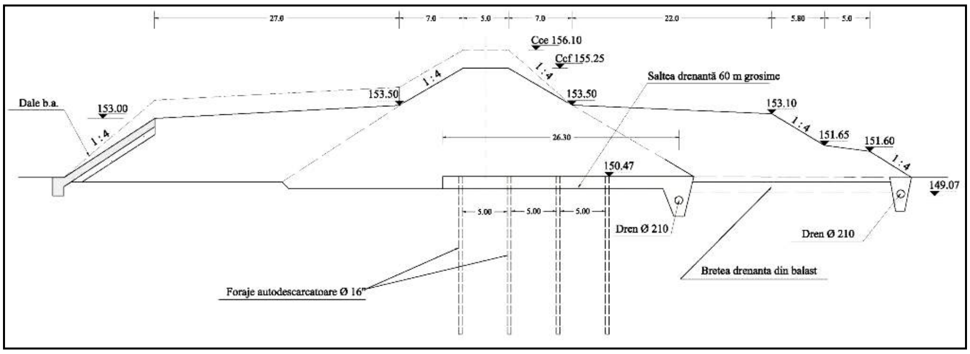

Fig. 1 – Cross section of the dam body – design phase

The downstream drain collector has a reverse filter made of 30 mm diameter refusal screen. Concrete 1000 mm diameter manholes are located on the trail of the draining culvert, with a 50 m distance between them. The water from precipitation that drains on the downstream embankment slope and banks is collected through a trench located at the downstream base of the berm dam. The trench discharges in Jijia's old riverbed through an earth canal.

1.2. Hidrological data

The reservoir in question falls in the **II^nd^** class of importance and **B** category of importance. According to the Romanian STAS 4068/2-62, Ezer reservoir was sized using the flow with the probability of exceedance of 1% and was verified using the flow with the probability of exceedance of 0.1% with a 20% increase safety.

Jijia river has the following features (Ministerul Mediului, Atlasul cadastrului apelor din România):

- catchment area in Ezer sealing section F = 116 km^2;
- average altitude 186 m
- river length from spring to dam L = 16.2 km;
- natural annual average flow Q_{mm} = 0.320 m^3/s

Characteristics of flood waves from design phase and updated in 2010 are presented in Table 1.

Tab. 1 - Characteristics of flood waves

Characteristics of flood waves	Design phase	Updated 2010
1,2x0,1% probability flow – cubic meters per second	-	354
0,1% probability flow - cubic meters per second	300	295
1% probability flow - cubic meters per second	160	170
Total time – hours	49	40
Increase time - hours	9.5	10
Form factor γ	0.3	0.35
1,2x0,1% probability volume – million cubic meters	-	17.842
0,1% probability volume – million cubic meters	16.850	14.860
1% probability volume – million cubic meters	8.980	8.568

1.3. Geological characteristics of the site

From geomorphological point of view the area occupied by Ezer non-permanent reservoir belongs to Moldavian Plateau, subland structural plateaux, subunit Moldavian Plain. Jijia river floodplain width is relatively large, between 300 and 600 m and has a longitudinal slope of 1‰.

In the damming sections of Jijia river, the slopes aren't affected by landslides. The analyzed valley presents a relatively large major bed with a width of 550-600 m. Its surface is generally smooth, uniform and shows a clear gradient, low slope, from the right side to the left. Existing land rates in the floodplain are higher by 2-4 m than those at a few hundred meters upstream. This situation is caused by Pârâul Întors river, which filled the confluence with Jijia river with a considerable amount of silt. The floodplain is affected by light marsh processes due to low flow springs coastal. Jijia riverbed, with a width of 8-10 m and a depth of 1.2-1.5 m, is shifted to the left slope, due to the cone of dejection of Pârâul Întors.

The floodplain alluvial deposits, which extend over a thickness of about 28 m, have the following limits of variation for land features:

- plasticity index	53 – 99 %
- consistency index	0.21 - 0.71
- humidity	48 – 99 %
- volumetric weight	12.4 -17.0 KN/mc
- porosity	58 - 82 %
- specific settlement	6 - 22 cm/m
- internal friction angle	6 - 22 grade
- cohesion	0.1 - 0.13 daN/cm^2

1.4. Component works of Ezer reservoir

a) The dam

The dam is homogeneous type, but has specific sealing constructions of the dam body in the embeddings with bentonite mud screen.

b) The surface outlet, a block called "Weir Crocodile", has incorporated an operation tower, also attached to the dam body.

➢ Structural elements: "crocodile weir" type overflow, frontal, with 2 discharge thresholds, energy disipator, gravel channel, connecting earth channel;

Surface outlet dimensions: total length 151 m, Ist threshold discharge front length=32.0 m, IInd threshold discharge front length=8.0 m (Fig. 2).

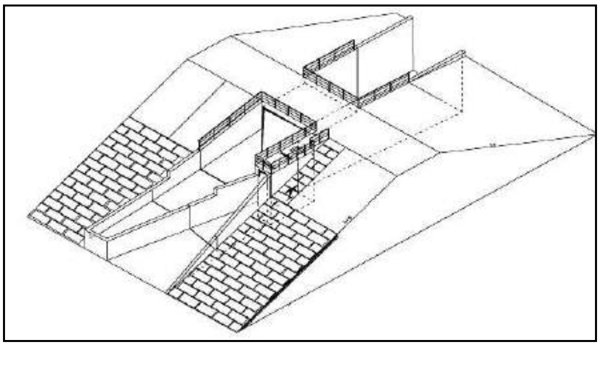

Fig. 2 – Axonometric view of the surface outlet

c) Bottom outlet has an acces channel to the operation tower and a 1.0 x 1.0 m orifice placed in the joint wall of the weir and the body dam. The water is released directly into the evacuation weir channel. Hydraulic equipment for the bottom outlet consists of fixed parts (guides and actuator) and mobile parts:

- metalic grid: 1000x1260 mm pannel manually operated by dragging the hoist
- cofferdam with guide wheels manually operated operation by dragging the hoist
- flat slide gate for draining the lake with dimensions of 1340x1100 mm, operated manually with normal position **open**.

1.5. Characteristic levels and volumes

The land rates reference plan is Black Sea 1975 and were updated by topographic measurements performed by specialized staff from the Prut-Barlad Water Basinal Administration on the lake basin, dam body and related constructions in 2010 (Tab. 2).

Tab. 2 – Characteristic levels and volumes

Parameters	Characteristic levels	maBS
Parameters determined by structural characteristics	- bottom outlet sill	149.40
	- surface outlet - Ist threshold weir	152.63
	- surface outlet - IInd threshold weir	153.16
	- dam canopy	154.38
Parameters determined by the operating conditions	- 1% probability of exceedance	153.27
	- 0.1% probability of exceedance	154.10
	- 1.2x0.1% probability of exceedance	154.41
Parameters	Volumes	mil cm
Parameters determined by structural characteristics	- global (at dam canopy)	10.33
	- at high waters weir - Ist threshold	5.967
	- at high waters weir - IInd threshold	7.243
Parameters determined by the operating conditions	- total (at 1.2x0.1% probability of exceedance level)	9.602
	- atennuation till high waters weir - Ist threshold	5.967
	- saftey (between the 1.2x0.1% probability of exceedance level and dam canopy)	0.727

2. Component elements of the behaviour monitoring system for ezer non-permanent reservoir

According to the current Romanian legislation (NTLH–021/2002) Ezer dam has a 0.34 risk index (established in the Evaluation of Ezer reservoir safety in exploitation and the Authorization number 566/25.07.2008), that fits the reservoir in „**B- special**”, category of importance. Monitoring behaviour is done accordingly to the „Project of special monitoring”.

2.1. Measuring installations for external stresses

- 2 vertical hydrometric stations are used to monitor hydrological parameters for Ezer reservoir:

- upstream dam slope for tracking the evolution of the levels/volumes in the lake;
- in the joint channel of the bottom outlet channel and the surface outlet, for tracking discharged flows;

- 1 rain gauge to measure rainfalls in the catchment of the reservoir;
- 10 landmarks are placed on the lake contour for tracking the evolution of lake basin warping.

2.2. Measuring installations of the dam response to stress

The measuring installations of the dam and its foundation are mainly distributed in 4 major characteristic sections, marked with I-I.....IV– IV.

- For tracking the evolution of vertical deformations are used:

- 40 vertical axis landmarks on the dam, of which 14 on the canopy and 26 on the 2 berms (upstream and downstream slope);
- 6 fixed landmarks;
- 4 landmarks on the operation tower;
- 4 inclinometer columns;

- For tracking the evolution of body dam seepage, 8 piezometric wells are used;
- To measure the interstitial pressures in the foundation soil 14 piezometers are used. They are placed in 8 wells, each of them containing 1 or 3 thin tubes (Fig. 3).

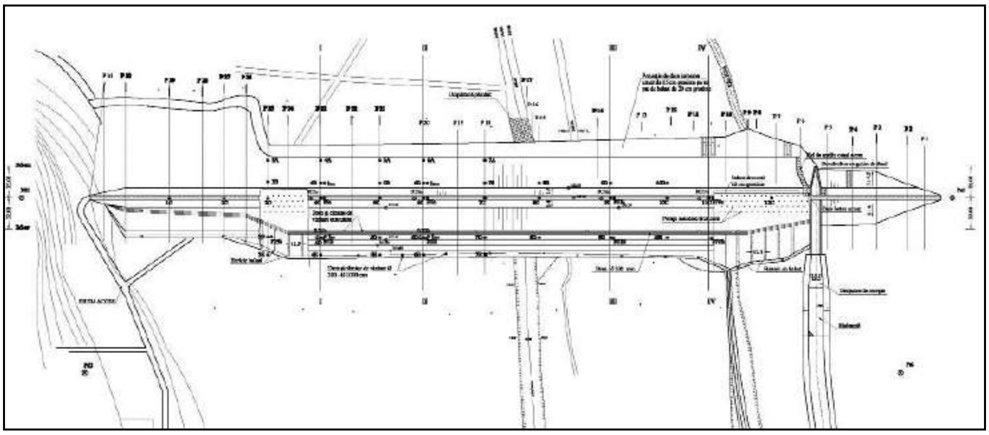

Fig. 3 – Dam body plan view with the location of the measuring installations

3. Recording and analysis of special events in ezer reservoir behaviour

3.1 Special events recorded during the execution of the dam

Given the unfavorable conditions of the foundation soil of the dam, the design phase documentation stipulated the execution of an experimental embankment equipped with measuring installations for the interstitial pressures and the vertical deformations in the foundation soil. This embankment was aimed to specify characteristic elements regarding the stability and behavior of the dam, in line with the development of the foundation soil consolidation. Thus, thin piezometric wells and columns with settlement landmarks were installed.

- In the fall of 1989, there was a failure on the downstream slope of the dam, in the experimental embankment area, on a 3.50 m height of the dam body fillings.
- The construction of the dam was resumed in the year 1992. In may 1992 a new dam failure occured in the area between the experimental embankment and the right slope. This new dam fillings failure, towards the downstream side of the dam, was similar to the one that occured in 1989.

The behavior monitoring of the dam and the foundation soil in the characteristic sections equipped with measuring installations revealed during the years 1989-1992:

- Decrease of the interstitial pressures is insignificant in this time interval. During dam failure in October 1989, pore water pressures in the foundation soil were at the fillings level, exceeding it in some cases, with 0.50-1.00 m. Two years after cessation of construction works, no significant reductions in water level in piezometers were observed. It was found that the consolidation of the foundation soil is reduced.
- The compaction measurements reveal the presence of a weak layer in the dam foundation soil, comprised approximately between 4 and 8 m depth. In this layer the compaction were bigger than the adjacent layers. It was found that the effects of the dam failure extended about 7 m below the dam foundation.

In order to continue the construction works of the dam, the The National Institute for Research and Development in Environmental Protection (former I.C.I.M.) performed stability calculations for a new cross section design of the dam. During the period August 1995 - April 1996 several series of measurements in columns with compaction landmarks, inclinometer and piezometric wells were conducted.

- In 8 months of measurements, settlements of 3-9 cm were recorded.
- It was found that the horizontal displacements were small (maximum 20-25 mm).

The technical regulations require that stability tracking methods of the embankments placed on weak, muddy foundation soils to be based on the study of maximum settlements measured in the central area of the fillings and of horizontal deformations of the foundation soil measured at the base of the slope. The ratio of horizontal and vertical deformation should be less than 1, preferably 0.5. The measured deformations satisfy the above conditions of stability.

- The highest interstitial pressures were registered in the I^{st} characteristic section. The low depth piezometric wells with the upper land rate of 140.00 maBS have shown high hydrostatic levels corresponding to canopy level and the downstream berm. Other piezometric wells in the I^{st} and the II^{nd} characteristic sections have also indicated relatively high interstitial pressures, the hydrostatic levels exceeded foundation level and water level in the lake. In the III^{rd} and IV^{th} characteristic section, the hydrostatic levels were lower, compared to the I^{st} and the II^{nd} characteristic sections.

In terms of general stability, the measurements showed that general stability is ensured and that the critical period "end of the construction" has been exceeded.

3.2. Special events recorded during operation

Starting with the year 2002, 5 periods of floods were recorded in Ezer reservoir. The exceedance of the characteristic defense thresholds is shown below:

- 152.66 maBS, 0.16 m above the **II^{nd} Defense Phase** (152.50 maBS) in 03/28/2002
- 153.09 maBS , +0.09 m above the **III^{rd} Defense Phase** (153.00 maBS – I^{st} threshold weir of the surface outlet) in 08/21/2005
- 152.54 maBS , +0.04 m above the **II^{nd} Defense Phase** (152.50 maBS) in 04/04/2006
- 153.13 maBS, +0.13 m above the **III^{rd} Defense Phase** (153.00 maBS I^{st} threshold weir of the surface outlet) in 06/06/2006
- 153.93 maBS, +0.43 m above the **II^{nd} threshold weir of the surface outlet** in 06/29/2010

On 06/28/2010 due to the rainfalls registered at Pădureni rain gauge (42.2 liters per square meter), there was a flash flood on Buhai river, in addition with the one formed on Pârâul Întors river, which inundated the Dorohoi city lower area and caused the accumulation of large volumes of water downstream Ezer reservoir's embankment. The backwater, formed on Jijia river, caused significant increases of water levels in Ezer reservoir, starting 06/28/2010 - 18^{00} hour.

Starting 06/29/2010-01^{00} hour, in the artificially created reservoir downstream of the dam, the water level exceeded the I^{st} threshold weir of the surface outlet (153.00 maBS) and on the downstream to upstream direction, an overflow spillway occurred, until 07/01/2010 – 12^{00} hour. The maximum height of the spill over the I^{st} threshold weir of the surface outlet (153.00 maBS) was 93 cm and the maximum height of the spill over the II^{nd} threshold weir of the surface outlet (153.50 maBS) was 43 cm. The maximum water level in the reservoir of 153.93 maBS was maintained for a gap of 2 hours, from 06/29/2010 - 05^{00} hour. The water level of Buhai river and the water volume accumulated downstream of the dam began to decrease gradually, and so on the date of 07/12/2010 – 18^{00} hour, the water level in Ezer reservoir decrease below the **Ist Defense Phase** (152.30 maBS).

The piezometric wells, located on the downstream berm of the dam, and also the inclinometer wells and the columns with compaction landmarks located on the upstream berm were flooded. Between the years 2000-2010, the culvert from the draining mattress worked under pressure, due to the clogging of the culvert draining channel and the operation personnel was unable to carry out measurements of flow seepage.

After the flood that occurred during June-July 2010, the following repairs and maintenance works were carried out in August 2010:

-unclogging the trench located downstream of the dam

-unclogging the seepage discharge channel to its confluence with Jijia river

-unclogging the regulated section of Jijia river downstream of the reservoir

-unclogging the manholes from the drainage system

-sediment exclusion of the piezometric wells, inclinometer wells and the columns with compaction landmarks, located on the upstream berm.

4. Analysis of the safety in operation of the reservoir and results

4.1. External stresses recorded during the years 2000 - 2012

The database containing water levels in reservoir, rainfalls, temperatures, floods recorded between the years 2000-2012, provided by the Prut-Barlad Water

Tab. 3 – External stresses between the years 2000 and 2012

Year	Water level (maBS)			Level diff. (m)	Precipitations (mm)			Average temperature ^{0}C	Floods
	Max level	Min level	Average level		Year Total	Maximmum monthly	Maximmum daily		
2000	150.92	149.75	149.97	1.17	299.4	118.4	62.4	10.82	
2001	151.06	149.88	150.28	1.18	533.3	145.3	56	9.63	
2002	152.66	150.87	151.57	1.79	549.9	186.6	44	9.98	+0.16mIInd DP
2003	151.79	150.26	150.50	1.53	329.8	95.4	28.8	8.22	
2004	150.92	150.00	150.49	0.92	325.2	70.7	23	9.95	
2005	153.09	149.86	150.30	3.23	761.8	304.1	57.9	9.22	+0.09m Ist Weir
2006	153.13	149.84	150.65	3.29	679.6	194.8	51.8	9.15	+0.13m Ist Weir
2007	150.70	149.83	150.02	0.87	597.2	106.8	38.3	10.78	
2008	150.70	149.83	150.02	0.87	669.5	153.7	51.1	10.77	
2009	150.96	149.70	149.98	1.26	445.9	87	38.2	10.80	
2010	153.93	149.71	150.11	4.22	811.8	208.5	67.3	9.65	+0.43m IInd Weir
2011	150.36	149.60	149.77	0.76	339.9	111.7	21.9	9.86	
2012	149.89	149.60	149.68	0.29	432.5	101.2	34.2	12.95	

Basinal Adminstration, was used for the interpretation of the reservoir behaviour (Tab. - 3).

4.2. Visual observations

a) Integrity of the structure, including the foundation and the embankments

The visual observations made by the operations personnel didn't reveal any structural changes of the dam's body and foundation or of the embankments.

b) Reservoir and embankments

No changes in embankments or lake bordeline geometry were reported and no ravines, landslides or leakings were revealed.

c). Outlets

During the floods that occurred during 06/29-07/12/2010, the degradation of concrete slabs pitching near the left wall of the overflow spillway has produced. Remediation works were applied.

d) Status of the upstream and downstream channels

From visual observations made post-event (june-july 2010 flood) by the operation personnel at the downstream riverbed, the silting of river Jija was revealed on the rectified section downstream Ezer reservoir, on a length of 1 km, with a 1 m thick alluvial deposit.During the year 2011, unclogging works were carried out.

e) Acces ways

The access ways to the dam haven't suffered incidents affecting their use.

f) Hydromechanical equipments

The hydromechanical equipments have a good operation status.

4.3. Evolution of monitored parameters

Geotechnical studies drawn during the design phase for Ezer reservoir revealed unfavorable characteristics of the foundation soil, which is characterized by high values of clay fraction and plasticity. Up to a maximum depth of 25 m, the foundation soil consists of gray to black greasy clays. Improvement of the dam stability and acceleration the consolidation of the muddy clays in site and foundation soil was achieved with the construction of the drainage system that has the role of direct dissipation of excess interstitial pressures.

Given the incident that occurred during the execution of the hydrotechnical work, the dam was equipped with relatively simple behaviour monitoring installations, that includes piezometric thin tubes with porous ceramic cell, columns with compaction landmarks, inclinometers, vertical axis landmarks placed on the dam canopy and on the upstream and downstream berms.

a) Seepage regime

Hydrostatic levels in the piezometric wells were the first response of dam body to the external stresses: reservoir water level variations, rainfalls and temperatures. The seepage regime through dams' body and foundation soil was also influenced.

The measuring installations were distributed on the dam mainly in 4 characteristic sections as noted I-I. ....IV-IV. The piezometric wells marked with Pic1, PIIc1, PIIIc1, PIVc1 - c4, located on the dam canopy and PIb1, PIIb1, PIVb1 located on the downstream berm, were designed to capture the seepage regime through the dam body. Piezometric wells of different depths PIc2 – 3, PIb2 - 3 PIIc2 - c3, PII b2 - 3 PIIIc2 - c3, PIIIb2 - b3, PIVc2-3 enter in the foundation soil and are designed to dissipate interstitial pressures in the foundations' muddy soil.

Primary processing of recorded data, revealed increases and decreases of the hydrostatic levels in the foundation soil in the canopy piezometric wells noted with c2, c3 and also in the piezometric wells noted with b2, b3 placed on the berm. These variations represent the response in time, mainly of dissipation of the interstitial pressures in the foundation soil and less the response in time of the variations of water level in the reservoir, which is operated as a non-permanent reservoir.

Hydrostatic levels in PIb1, PIc4, PIIb1, PIIIb3 piezometric wells were strongly influenced by the rainfalls produced in June 2010. Differences of over 0.5 m from the previous readings of the hydrostatic levels were highlighted. Measurements were performed at increased frequency in these piezometric wells and it was found that the storm water infiltration near the tube had caused high hydrostatic level. It can be concluded that the interstitial pressures in the foundation soil is consistently higher for the deepest piezometric wells located on the downstream berm (PIIb3 - 14.25 m depth, PIb3 - 8.5 m depth, PIb2 - 6.98 m depth).

The depression curves close in the downstream area of the dam, in the draining straps.

We believe that the consolidation of the foundation (poor, muddy soil) is still in progress. This phenomenon may extend for periods of tens of years, resulting in vertical deformations in the deep muddy layers of foundation soil and hence centimeters deep settlements of the dam body.

Buhai creek repeated overflows contributed to the clogging of drainage channel of Ezer reservoir, because it confluences with Jijia river in the immediate downstream vicinity of the dam. During the years 2000-2010, the culvert of the draining mattress has worked under presssure and the operation personnel was unable to carry out measurements of flow seepage. Since August 2010 measurements of seepage flow were carried out, the extreme values being 0.0283 m/s and 0.0783 m/s.

b) Compactions

On the dam canopy, 38 landmarks were planted in the year 1996 and the reference series "0" was carried out on 02/11/1997. In the period of 02/11/1997 - 10/29/2011, 32 cycles of observation were carried out. Analyzing the latest data, we have concluded that the relative values of the settlements were almost constant compared to the previous measurements. The maximum and minimum absolute values of vertical deformations indicate that the dam has not yet reached its maximum degree of compaction, this phenomenon is far more active in comparison with other dams, in which compaction has decreased.

Conclusions

The special events recorded during the execution of the dam and during its operation have imposed the implementation of a systematic behaviour monitoring of the hydrotechnic constructions at Ezer reservoir.

The behaviour monitoring performed by interpreting the visual observations and the measurement data from gauges, in relation to external stresses on the dam, allowed rapid reporting of exceedances of critical thresholds at monitored elements and of a typical behaviours of the dam.

The operation personnel intervened with remediation works on the faults that endangered the safe operation of the dam.

The behaviour monitoring of Ezer reservoir is recommended to continue accordingly to the "Project of special monitoring", with the same meticulosity as before.

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OPTIMIZATION PROBLEMS AND SOLUTIONS OF FOREST RESOURCES MANAGEMENT IN MOLDOVA

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Key words: forest, management, functions, efficiency.

Abstract: The main problems of forest management in Moldova are: consumerist approach of the forest fund; the superficial management of indirect economic functions and ecological functions; illegal logging, overgrazing, massive pollution with domestic waste; the closed character of decision making in the forestry sector; the limitation of population's access to forest lease land and the abuses in this field; cumulating and duplication of management functions; the inefficient realization of evaluation and integrated monitoring of forest fund, especially in the communal forests.

Introduction

Exploitation of wood products was always one of the basic traditional occupations of indigenous people, who inhabited predominantly to the peaks and slopes of the hills, including for the benefit of the products and services of the forest complex. Manufacturing value of wood between the Prut and Dniester was highly appreciated since Greek merchants, particularly for shipbuilding and manufacturing various quality tools. Special qualities of local wood are mentioned by Dimitrie Cantemir in the "Descriptio Moldavie", such as in the reports of Russian imperial authorities in the nineteenth century. Despite these claims, the local importance of wood was much higher. For most people the forests were used primarily as an energy source. In the villages of yeomen with massive compact areas valuable species, especially oak, woodworking crafts were well developed, some of which are renovated today.

Massive reduction of forest areas during the nineteenth century and the first half of the twentieth century were caused by increasing population and demand for firewood. In the interwar period, a large proportion of the consumption of urban centers and Southern Bessarabia was assured by transportation, by rail, of wood

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from the Pre-Carpathians areas rich with forest resources. In the Soviet period has passed massively to alternative energy sources and building materials and the consumption of work wood and firewood was assured of its bringing from other regions of the USSR. In the 90s, massive impoverishment of the population and multiple increases of import prices for coal, gas and wood was conditioned intensified exploitation of local wood and alarming increase of illegal logging, especially in the communal forests and forest protection belts.

1. Consumerist approach of the forest fund.

Overall, the management of forest resources in Moldova bears the imprint of the Soviet period, was strongly influenced by difficulties of the long period of transition. The current mechanism for management of the national forest fund had suffered insignificant changes. Despite legal provisions, which are declared priority of social utility and protection functions of national forests, management and exploitation of national forest fund is based on clearly the consumerist approach products and services generated by forest ecosystems. The majority of forest management actions are designed to achieve direct economic functions: reproduction and harvest of timber, hunting objects and accessories products that can be easily marketed. Delivery of wood products and accessories generates over 90% of revenues to forestry enterprises. Status of special regime of exploitation and protection of the national forest fund and the need for ecological reconstruction works are sometimes a front for hiding the primary interest of the manager of state forest fund − simultaneously obtaining of substantial budgetary allocations and maximum income (declared and undeclared) from the exploitation of wood products. To these products is a growing demand from the rural population, for which wood is the main energy source. Thus, it is found very sharp contradiction between the needs and the main directions of use of woody mass and the priority ecological destination of forests. At the same time, the indirect use value and the conservation value of forest is neglected.

The necessary work of rebuilding, refurbishing and expansion of forests are provided only at the rate of 65-70% [2, p. 19], and the amounts of tax exemptions for carrying out such work and of the revenue from tax on standing timber are very modest (about 500 thousands lei MDA). In the case of the reduction of budgetary allocations this is reflected directly upon the reduction of the volume and quality of the works mentioned. Despite these problems, is observed the expansion of evaluation and exploitation fields of forest ecosystem services. The annual revenues of payments for rental of state forest fund for recreational purposes is approximately 11.4 million lei MDA and of commercialization of carbon storing's (reducing emissions) in community forests - 9 million lei MDA. Significant added value can generated to achievement of the National Programme for the restoration of degraded lands and improve of soil fertility, given the fact that the soils are the most precious natural resources of the Republic, subject to one major destructive impact. Just because to erosion is lost annually 26 million tons of soil. Area of eroded land increases by 7-8 thousand ha and annual losses estimated are about 3 billion lei. Agro-forestry measures can reduce induced losses by soil erosion by 8% or 7.8 USD per ha of agricultural land. Implementation of the project "The conservation of soils in Moldova" will absorb 20 million USD (for the first 20 years), and the surface of the forest fund will expand by 20 thousand hectares, which will generate external benefits to agriculture and other related activities. Without neglecting the importance of the main and accessory forest products, which have direct use value, should be given priority to those categories of use that have indirect use value and conservation value [3, p. 42]. If wood and accessories products, we can replace it with others with similar usage or import at a reasonable price from other countries with rich forest resources, then the indirect economic or the ecological services we cannot substitute or import, because they are generated only in the presence of forested areas, especially in the proximity of settlements, agricultural land, transport highway, tourist and recreational infrastructure.

2. The phenomenon of illegal logging.

After the collapse of the USSR, the deep social and economic crisis accompanied by multiple prices increased of imported energy resources has generated massive impoverishment of the population, especially in rural areas, increasing the demand of local wood products and the anthropogenic pressure on forest ecosystems. Due to maintaining guard services of state forest fund, illegal loggings have not significantly affected the reproductive basis of national forest fund. However, the communal forests, green spaces, forest belts for protection of water objects and agriculture land, which are managed by municipalities and designed to achieve ecological and social functions do not have Guard services, do not dispose by cadastral evaluation and by necessary management system and it are in a grave state. The majority of forest belts protection of agricultural fields. Although their communal forests 2/3 of the volume of illegal logging, such data are not reflected in the actions brought for the recovery of damages and fines. With regard to grazing or mowing, the situation is very critical in most communal forests.

According to Table 1, in recent years the volume of illegal logging in state forest fund is about 4000 m^3, or approximately 1/3 of the total volume of illegal logging (12 000 m^3). The increase of cuts is explained by increasing the detection of these offenses in the state forest fund and implementation of the new Code Offences. Moreover, official data do not sufficiently reflect reality. Much of illegal logging are not registered or concealed by forestry staff. Out of over 650 thousand m3 of wood used comes from unidentified sources a great part is extracted from the forest fund. Thus, an amount that exceeds the official annual extraction of wood (450 000 m3) is not declared and official revenue missed of forestry enterprises would exceed 200 million lei MDA. Moreover, despite the optimistic official demarches of the Moldsilva, the actual extraction of wood mass is to limit of the capacity of forest regeneration, which requires taking of operative and effective measures in this regard [6, p. 36].

Table 1. The caused damage to state forest fund

The name of indicators	**The unit of measure**	**Years**						
		2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
1. The ilegal logging								
The total volume of illegal logging	thousands m3	2,3	1,7	1,7	2,2	3,9	4,8	4,2
The volume of illegal logging to 1000 ha surface covered with forests	m3/1000 ha	6,5	4,9	4,9	6,1	12,7	16,0	13,9
The detection of illegal logging	%	45,5	42	50,4	49,6	57	74	87
The sum of caused damage	thousands lei	401	281	271	377	675	821	675
2. Unauthorized grazing								
The sum of caused damage	thousands lei	590			214	147	119	272
The sum of caused damage	thousands lei	164	136	159	167	289	1265	230

Source: www.moldsilva.gov.md/Activitati/Paza-fondului-forestier

3. Application of administrative sanctions and actions for recovery of damages

Financial shortages and institutional disorder in rural areas makes the illicit exploitation of forest and green areas. More severely are affected ecotourism and recreational objectives outside of the State Forest Fund. Moreover, multiple functions of forests, their deficit and alarming phenomenon of illegal logging requires the adequate application of administrative sanctions and actions to recover damages caused by forest resources.

In the new Code of Administrative Offences (in force from 31 May 2009) were introduced new sanctions for breaching health's rules (art. 136) and protected rules of forests, green spaces and protected areas (and 141.2), for circulation and parking of vehicles on forest land, green spaces and in forbidden places (art. 135), for injury or unauthorized cutting of trees and shrubs in the green spaces (art. 122.2) (table 2). Was increased more than 10 times the amount of fines for: causing fires (art. 137); waste disposal in forests, green spaces and protected areas (art.

141.3); injury or unauthorized cutting of plants from the green spaces (art. 182 and 122.2); hunting in forbidden areas and prohibited seasons (art. 128.2); violating the rules of use and protected of the animal kingdom in the natural protected areas (art. 139); deliberate destruction or damage of dens, mounds and nests of birds in

Table 2. The amount of fines for offenses committed in the forest fund

	Art. Nr of OC	**The amounts of fines**, in conventional units	
		fizical persons	**legal persons**
Injury or unauthorized cutting of trees and shrubs in the states forest fund, inclusive by forestry staff or with their permission	122.1-122.3	40-50	400-500 50-100
Injury or unauthorized cutting of plant in the green spaces and failure to take measures established to protect green spaces;	122.2, 182	40-50 50-100	400-500
Authorization by the forest authorities harvested mass wood with violation of the regulatory provisions;	122.4	-	100-200
Degradation of pastures and hayfields, drainage systems and roads on the land of the forest fund;	126	10-20	100-200
Ilegal mowing and grazing in the forest lands and green spaces	127.1	5-10	-
Unauthorized harvesting wild fruits and berries, nuts, fungi, medicinal plants in areas where this is prohibited;	127.2	5-10	100-200
Intentional damage to panels, barriers, indicators of forest arrangement, and the fencing surrounding of restricted in the recreational places;	132	-	30-50
Unauthorized use of state forest land and of gren spaces, for deforestation, construction of administrative buildings and warehouses;	134	30-40	300-400
Circulation and parking of vehicles on forest land, green spaces and in forbidden places;	135	5-10	5-10
Violation of sanitary regulations in forests, green areas and reserves;	136	10-20	10-20
Violating the rules of fire security in forests, green areas and nature reserves;	137.1	10-20	10-20
Arson of forests, green areas and nature reserves;	137.2	100-200	100-200
Collection and destruction of plants and animals listed in the Red Book of the Republic of Moldova and the CITES Appendices;	140.1	50-100	50-100
Violating of protection rules of objects and complexes in the state natural protected areas;	141.1	30-50	200-300
Violations of use and protection rules of soils, water resources, flora and fauna in the state natural protected areas;	141.2	40-50	200-300
Violations of the prohibition of placement, processing and discharge rules of industrial and householde waste;	141.3	40-50	200-300
Infringement of procedures for exploitation fund, harvesting, transporting and exporting wood and wood products;	142.1	10-30	100-300
Circulation of wood without legal acts of provenance;	142.2	10-30	200-400
Unauthorized hunting and violation of the laws on the use and protection of the hunting fund;	128.1	20-50	200-400
Hunting in forbidden areas and prohibited seasons;	128.2	50-100	200-400
Deliberate destruction or damage of dens, mounds and nests of birds in the forest found;	129	20-50	20-50
Violating the rules of use and protected of the animal kingdom in the natural protected areas;	139	40-50	40-50

the forest found (art. 129). An insignificant increase (2-5 times) of fines amount is found for: injury and illegal cutting of trees and shrubs in the state forest fund (art. 122.1); illegal mowing and grazing in the forest lands and green spaces (art. 127.1); collection and destruction of plants and animals listed in the Red Book (art. 140.1).

For most offenses are provided for 20-60 hours of unpaid community work, but rarely apply. Also, in the case of payment for a period of 72 hours from the time of initiating the protocol shall be paid only 50% of the amount of the fine [4]. This stipulation significantly increased collected fines. We also consider the need to cancel this provision for environmental offenses.

The majority of fines are applied for injury or unauthorized cutting of trees and shrubs in the states forest fund, Infringement of procedures for exploitation fund, harvesting, transporting and exporting of wood, for violating of hunting rules (table 3). Maximum number of fines, applied for these offenses, is found in districts with a higher degree of forestations or where are located the forest headquarters households: Glodeni, Soroca, Orhei, Călăraşi, Hânceşti, Criuleni, Ungheni, Căuşeni. In the last years, a relatively large number of fines are applied for violating sanitary rules in the forests, green spaces and protected areas (art. 136), for unauthorized circulation and parking of vehicles in this spaces (art. 135) and for illegal cutting of trees and shrubs by forestry staff or with their permission (art. 122.3) and for illegal mowing and grazing in the forest lands and green spaces (art. 127). However, despite the fact that such offences are being committed very often, especially in recreational and ecotourism attractions nearby settlements, these violations are adequate detected and adequate sanctioned only in a few districts [5], as Ocniţa, Dondușeni, Glodeni, Rezina, Teleneşti, Nisporeni, Căuşeni (art. 136), Ungheni and Străşeni (art. 122.3), în the Bălţi and Chișinău municipalities (art. 135). Also, the amount of fines for violating sanitary rules in the forested, green areas and nature reserves (art. 136) is two times lower than in the localities (art. 181) – 200-400 lei against 400-800 lei.

There is a very low number of fines applied for: capture and destruction of plants and animals listed in the Red Book (art. 140.1); violating the rules of use and protected of the animal kingdom in the natural protected areas (art. 139); deliberate destruction or damage of dens, mounds and nests of birds in the forest found (art. 129); destroying young stands (art. 123); degradation of pastures and hayfields (art. 126); injury or unauthorized cutting of plants from the green spaces (art. 182); unauthorized use of state forest land (art. 134). However, such violations are committed more frequently and the amount of fines is significantly lower than the cost of restoration. Moreover, for waste disposal in forests, green spaces and protected areas (art. 141.3) were not applied fines. A critical situation is found in applying the fines for breach of the protection regime in the perimeter of the state protected natural areas. For example, in 2012, for violating of protection rules of objects and complexes in the state natural protected areas (art. 141. 1), have been applied only 33 fines and all in Edineţ district.

Table 3. Fines for violation of forestry legislation in Moldova

The number of articles of the Offences Code	**The number of apllied fines**				**The sum of applied fines**, in thousands lei				**The amount of collected fines**, in thousands lei			
	2009	**2010**	**2011**	**2012**	**2009**	**2010**	**2011**	**2012**	**2009**	**2010**	**2011**	**2012**
122.1	*156*	*634*	*852*	*939*	*124*	*537*	*774*	*795*	*65,9*	*295*	*379*	*378*
122.2	9	44	94	51	8,4	36,8	81,4	45,8	3,8	18,6	36,2	20,9
122.3	5	20	141	15	5,7	27,6	152	22,7	2,7	11,2	74,6	10,4
122.4	3	7	24	6	10,3	23,6	67,8	13,4	4,4	2,5	22,2	6,7
126	1	8	7	11	1	4,6	2,8	2,8	0	1,8	1,4	0,9
127.1	*67*	*143*	*141*	*198*	*9,1*	*19,4*	*20,7*	*29,2*	*6,1*	*10,6*	*11,3*	*19,2*
127.2	1	4	1	9	1100	400	100	2500	700	200	50	1250
132	2	8	17	10	0,4	1,5	2,9	2,4	0,2	0,9	1,45	1,2
135	*11*	*125*	*157*	*92*	*1,3*	*13,3*	*20,6*	*11*	*0,65*	*6,9*	*10,0*	*6,1*
136	*13*	*176*	*282*	*323*	*2,6*	*40,7*	*61,5*	*67,8*	*1,4*	*21,3*	*28,3*	*34,1*
137.1	*14*	*19*	*38*	*42*	*2,8*	*4,1*	*8,2*	*10,6*	*1,7*	*1,7*	*3,9*	*5,4*
137.2	1	0	4	4	4	0	8	9,2	0	0	2	3,1
140.1	1	2	10	5	1	2	10	5	0,5	0	1	1,5
141.1	0	3	18	33	0	2,2	12,2	29,8	0	1,1	6,4	15,3
141.2	0	0	5	3	0	0	4,4	3	0	0	2,2	1,5
141.3	0	0	0	0	0	0	0	0	0	0	0	0
142.1	*30*	*62*	*106*	*127*	*7,8*	*26,1*	*35,3*	*48,6*	*4,1*	*15,7*	*19,1*	*22,4*
142.2	*11*	*49*	*88*	*90*	*3,7*	*20*	*25,1*	*21,4*	*2*	*10,7*	*13,2*	*10,6*
182	2	20	23	20	1	24	25,6	25,1	2	10	12,8	12
Flora	**479**	**1657**	**2120**	**2387**	**216**	**843**	**1341**	**1246**	**110**	**436**	**644**	**597**
128.1	*41*	*38*	*56*	*88*	*28*	*22,4*	*38,3*	*54,8*	*13,9*	*13,2*	*19,0*	*27,2*
128.2	*32*	*34*	*71*	*87*	*36,8*	*38,9*	*91,6*	*110*	*19,8*	*24,0*	*47*	*50*
129	0	0	1	1	0	0	0,4	0,4	0	0	0,2	0,2
139	1	0	1	0	1	0	0,8	0	0,5	0	0,4	0
fauna	**626**	**1525**	**1700**	**1785**	**231**	**481**	**540**	**505**	**105**	**192**	**240**	**246**
Total	**1105**	**3183**	**3820**	**4172**	**447**	**1323**	**1882**	**1750**	**215**	**628**	**884**	**843**

According to the Annexes Forest Code, the amount of actual damage caused to vegetal resources reflect direct revenues missed by forestry enterprises by removing the wood from the production cycle. The amount of establismented damage differs depending by volume of timber, by size of felled trees, number of specimens collected or damages, by industrial, environmental and scientific value of species, by injury extending area, forest functional class of perimeter and the degree of species rarity and ecosystems affected. The compensation charges for violation of the Rules for the release of wood on the forestry beneficiaries varies depending on the volume of logs of the affected trees, the number of violations and the extent of damage restoration. The amount of forests damage should include factors such as the degree of actual clearing planning and its difference with respect to the area normative, emissions volume, ecosystems restoration costs and anti-erosion works costs [1, p. 148].

Most fines and actions to recover damages for illegal cuttings are applied to lands of forest state fund, but most of these offenses are committed in communal forests. Despite the shortcomings mentioned, actions brought to wrongdoers for compensation of the injury caused to plant resources are more frequent and their amount is much greater. Also, compared to other categories of natural resources, illicit action on biological resources is penalized, usually, not just as a warning or fine, but by actions for damages recovering. Although there is some disagreement between environmental and forestry authorities, coordinate implementation of economic sanctions and other common problems solving, are made at a higher level than the subdivisions of government responsible for managing the impact on air, water or soil.

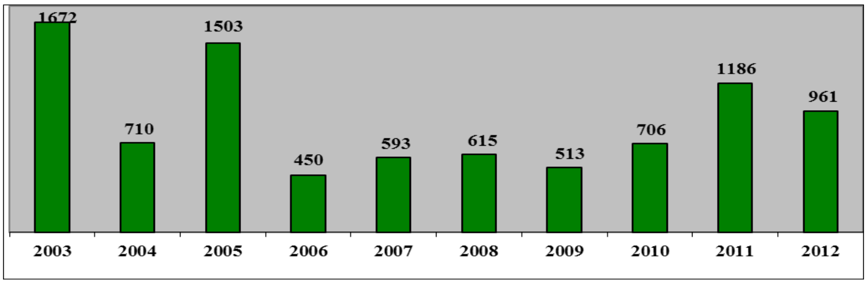

Figure 1. The amount of damages actions for vegetal kingdom

According to the State Environmental Yearbooks, the calculated amount of actions for compensation damage to the animal world was in the 2007-2009 years 350 thousands lei, while in 2010-2012 − only 46 thousands lei. We believe that these data are incomplete because the number of fines imposed for infringement of the fauna legislation increased approximately three times (from 626 in 2009 to 1758 in 2012) and the amounts of intended actions were to grow to over 1 million lei. Similar fines imposed, by an absolute majority of the actions for damage caused to forest fund is brought in more forested regions. Episodic are initiated actions for recover the damages caused by illegal hunting. Very rarely are brought the actions for damage caused for cruelty to animals, including from birds, reptiles and amphibians, to rare species. This situation is due, especially to reduced capacity of local environmental authorities needed to full detect of these offences and for adequate evaluation of the derived damage. Thus, despite an adequate methodology for evaluation damage to the animal kingdom, their practical application is very superficial. Therefore, for adequate exercise of environmental evaluation and control functions is necessary to ensure sufficient human, technical and financial resources. It is also necessary to stimulate and enhance collaboration of ecological authorities with forest authorities, with science centers, hunting associations as well as local authorities and population. It is welcome the application of financial incentives to people who help detecting offences and of full and timely evaluation of these damages.

4. Problems of forest fund rent:

Methodology to estimate the value of forest land transmitted on lease for hunting purposes and recreation is focused on direct missed incomes of forestry enterprises and on expenses to ensure reproduction of wood and hunting resources, and accessories products. Thus, this methodology is based on estimating the individual benefits and costs of forest-hunting works. We believe that this method of evaluation has a wrong approach because forest areas are exclusively public goods. In addition, the methodology adopted refers to the assessment of income and losses for a short period, of only one year, is not focused on the reproductive rate of the main tree species and wildlife species.

The methodology of calculating the lease payments for state forests for recreational purposes does not take into account the position of the land towards large urban centers, especially to Chisinau, towards driveways and their status, the development level of infrastructure [3, p. 51]. Moreover, much of the forest land tenants for recreation purposes only aim to obtain direct profits and are awaiting the real estate boom in these lands. Often tenants' contribution is limited only to leased perimeter, construction of several recreational objectives and their transformation into holiday homes for tenants, their close people, for political and economic elite etc. Thus significantly limited access of the population, including local people, which should be the main beneficiaries of forest areas. Even and the few existing tourist complexes based on receiving a small flow of visitors, especially with high-incomes. Therefore, most of the potential tourists cannot benefit from the services of these resort complexes, preferring attractive unspoiled areas, often unsanitary. Forestry and environmental authorities are limited more to episodic detection and sanction of the offenders, and sanitation works are ignored (planning and garbage disposal, picnic places). In addition, the existing mechanism to lease the forest fund land only based on a Decision of the Government has not a legal basis.

During the years 2008-2012 were leased 750 ha of land into recreational purposes, with a summary area by 2338 ha or 2.5% of the total recreational forest area by 94 000 ha. Overall, there is a very small percentage of leased land for recreation purposes and great potential by its growth. From the 750 land only about 30 are operational in accordance with the establisment requirements. At the same time, by an absolute majority of the lands leased for recreational use are located in the proximity of the Chisinau municipality and nearby access roads from the capital. Only in Chisinau and in forestry departments from the districts Străşeni Ialoveni Criuleni and Orhei, which are located at a distance by 50 km from the capital were allocated 634 plots (85%) with an area by 2172 ha (93%). This demonstrates about overconcentration of respective lands in the proximity capital, increased demand for them and a higher rent of the respective area, which is not reflected in the calculation methodology of payment for lease of these land, but will appear as individual benefits (of leaseholders) or illicit income of people who coordinate the lease process of respective land. Moreover, it generates a very high recreational pressing in proximity to the capital and is limited free access for citizens to the main and secondary products and services of the forest, especially for the local population very dependent on them. As an example in this sense we serve and massive grievances of the local population in the vicinity of leased forest areas.

Also, there is insufficient scientific basis on standards and criteria for the award of forest land for tourism purposes and measures necessary for supervision and reducing the recreational pressure. There is not a recreational zoning of the forest fund, according to the needs of major cities and recreational capacities of existing forests in their proximity.

5. The problems of optimization of the management functions of the forest fund

Cumulating of functions is one of the main impediments to the difficult process of forest management optimizing. Simultaneous pursuit of exploitation and control functions by the Agency Mold Silva substantially limit the public control on the process of decision making in the forestry and its efficiency, stimulates corruption and illicit income, concealing of information about real exploitation work of forests and its status. Management functions and financial autonomy statute applied to forestry enterprises bring to the foreground the economic and commercial interests of their activity, which reduces the importance and effectiveness of ensuring the environmental and social functions of national forest fund, including the perimeter of protected areas covered with forest vegetation. In the context of decentralization of management functions is expected transmission of control functions to the Ecological Inspectorate (Environmental Guard) and of exploitation functions - to private economic agents. Delimitation and transmission of management functions to local authorities, environmental authorities and to the private sector do not have to do in detrimental to the integrated management of the forestry sector, reduction in the effectiveness of the exercise of public functions of planning, coordination and control of the recovery and protection of forest ecosystems.

Another problem is the duplication of management functions by the central forest authority (Moldsilva Agency) and the central environmental authority (Ministry of Environment), including the evaluation, monitoring and control of the forest fund [3, p. 62-68]. This situation, especially the doubling control feed conflict of interest between these two public authorities and increases budgetary spending in this area. Conflict situation is specific, especially in scientific reserves. The forestry authorities ignores the status of scientific reserves established by the Law on Natural Areas Fund Protected by State. The forestry enterprises from scientific reserves exercising functions and exploitation management of these objectives similar with the other forest areas managed by the Moldsilva having as highest interest accumulation and increasing incomes from harvesting wood and accessories forest products. At the same time, missing the mechanism of support and funding of necessary activities in the protected natural areas.

Forest monitoring is carried out insufficiently and includes only representative areas of forest perimeters with high environmental and forest-hunting value. At low levels are carried out research on the optimal degree of forestation of the country, including in the territorial-administrative units and phytogeographical zones. It is necessary to carry out the integrated monitoring of forests and lands covered with forest vegetation managed by the local authorities and other holders, developing of the national system of public information on the state of forests and his participation in the decision-making process.

State Forest Cadaster is still in the long elaborating stage. Some functions of Forest Cadaster are carried out by the Forest Arrangement, including spatial and functional delimitation on forest household and districts, established volume of timber harvested and the rate of regeneration in these sectors, number of trees by representative species, and their phytosanitary status. Also, were adopted Regulations of Animal and Vegetable Regnum Cadasters and the models for their completion. Accumulated materials are systematized and processed by authorized institutes of the Academy of Sciences. It is not clear the subordination and collaboration modality of the mentioned institutes and Ministry of Environment, with holders of forest land to achieve the set objectives. These works, must be included in the strategic and current plans of the Ministry of Environment, Academy of Sciences, forest authorities, university research centers, assured with adequate human, financial and logistical support, so as to be reflected in the decision-making process in this field. In addition, complete information stipulated in these regulations, it is absolutely necessary for forest plantations outside of the State Forest Fund, which ensures the functional ecological connections between compact forest areas managed by the forest authorities.

In most cases, administration and exploitation of communal forests managed by local public authorities is not based on the forest cadastral evaluation. Forest arrangement works are carried out chaotically without an appropriate forest technology. However, Ecological Inspectorate authorizes annual fellings in those forests on appreciable surfaces and in big volume. Also, guarding the communal forests and forest belts for the protection of agricultural land is only 33 foresters and real necessities are over 300 foresters. For this reason, the mentioned vegetation is subject to alarming illegal logging, abusive grazing, to pollution with household waste and to massive recreational pressure. In addition the majority communal forests occupy heavily fragmented areas, predominantly composed of acacia plantations.

6. The problems of extending of national forest fund

The identification and allocation of degraded land for afforestation has a chaotic character and be conducted with great delays. This fact has negative impact on the rhythms and quality of afforestation works and on expected protective effect. The extension of forest areas have a populist character and, in reality, do not pursue to create the functional ecological network. Although the surface of ravines, landslides, land heavily eroded presents a real ecological and economic danger, most of the local councils are not sufficiently involved in the procurement process for the afforestation of degraded lands. Also very slow is conducted the process of evaluation cadastral of land, which had already attributed for afforestation and included in the annual action plans derived from the National Programme for the restoration of degraded land. Role by the main financial source of Fund of the State Agency for Land Relations and Cadaster considerably delayed carrying out the Program within the terms and volumes determined. In the recent years,bbecause multiple reduction of budget allocations, forestry enterprises have similarly reduced the volume of seedlings and works for these purposes, which had a direct impact on slowing rates of extension of the forests. Therefore, expansion of national forest fund with about 16 000 ha per year (130 000 ha by 2020) is impossible.

Concluzions and recomandetaions:

1. Most of the actions of exploitation and managing of forest fund is focused to forest products that have direct economic value and generate profits to forestry enterprises. This finding is also valid in case of application of fines and initiating the actions for damage caused forest resources.

2. The communal forests, forest belts for protection of agriculture land, which are managed by public local authorities and farms do not have Guard services, do not dispose by cadastral evaluation, not operated under Forest Arrangements and it are in a grave state.

3. The priority protection functions cannot be performed adequately by current forest plantations. It is necessary to increase their share to over 15% (over 100 000 ha) of the land fund surface and to eliminate the mentioned constraints of enlargement of the forest fund from account of degraded lands. It is necessary cconsequent measures are needed to improve the forest areas, especially in the communal forests, creating forest functional components of the National Ecological Network.

4. It attests extending of application area and multiple increasing of fines for forest offenses. Is it really necessary to apply frequent application of unpaid work in the benefit of community for offences committed in green spaces and communal forests.

5. The methodology of calculating the lease payments of state forests land for recreational purposes does not take into account the position of the land towards large urban centers and driveways and the absolute majority of the rent lands are not functional. There is not a recreational zoning of the forest fund, according to the needs of major cities and recreational capacity of the existing forests.

6. Cumulating and duplication of management functions, excessive centralization and reduced transparency of the decision-making process are the main impediments to reform forest management. It is necessary to delimit clearly the management functions exercised by the forestry and environmental authorities, their active collaboration with local public authorities, scientific centers, NGOs, etc.

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PRELIMINARY ASSESSMENTS OF THE RELATION: PRECIPITATIONS – WATER – SEDIMENTS WITH REGARD TO SOME ANTHROPIC ACCUMULATIONS IN THE RIVER BASIN OF BAHLUI

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Key words: statistical correlations, determination reports, reservoirs, effects on silting processes.

Abstract. An important aspect of the statistical assessment of the correlation between precipitations – water and sediments is the way these parameters are assessed by means of statistical correlations of the type Q=f(Pp), R=f(Q) or R=f(Pp). Following the analysis of the three types of correlations the conclusion that water and sediment flows depend much on the quantity of water that falls may be reached. The accumulations however introduce some modifications of the water run-offs depending on the intended use. In order to carry out detailed analyses of some processes related to the evolution of channel bed or reservoirs silting, the equations may be extrapolated to the entire river basin.

Introduction

While in the case of the water run-off, the water resources management enables the existence of a relative balance between the water volume entering the reservoir by means of the tributaries and the water flowing out of the reservoir by means of the natural drainage channel, the situation is different with the sediments run-off. Most of the solid run-off (suspended particles and carried bed load) is

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“abstracted” during accumulation and silts progressively throughout time (Ichim, Rădoane, 1986, Giurmă, 1997, Rădoane, 2005).

An important aspect of the statistical assessment of the correlation between precipitations-water-sediments is the way these parameters are assessed by means of the monitoring systems (meteorological stations or rain gauges and hydrometers, respectively). Taking into account that starting with the 50’s various water projects in the Bahlui river basin have been carried out, many stations have also undergone alterations of the observation and location. In this case certain parameters shall be assessed on the basis of the data collected from certain points located outside the water areas in order to integrate the findings in our study. In so far the relation precipitations-water-sediments has been analyzed for two accumulations: Pârcovaci located in the Northwest side of the basin which is almost entirely covered by forests, and Ciurbești, located at 20 km South from the city of Iași and where the drainage basin is seriously affected by the current geo-morphological processes (surface and bulk erosion, landslides, etc).

Database and methodology

The correlations are assessed on the basis of the data collected, in the case of Pârcovaci, from the hydrometers Vama cu Tablă (located upstream from the accumulation) and Cârjoaia (located in the basin of Măgura river in similar geographic conditions), and in the case of Ciurbești, on the basis of the data collected from the Ciurbești hydrometer. Moreover the impact of the accumulations on the water flow shall also be taken into account and assessed based on the relation:

$$Qnat = Qmas \pm \Delta Qamonte,$$

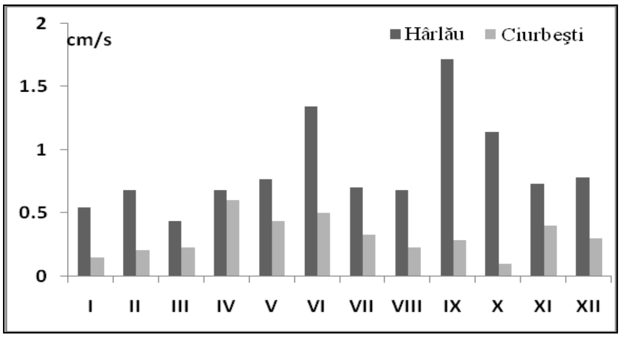

Fig. 1 Relation Qmăs/ Qnat in the case of the hydrometers concerned (average monthly values for 1950-2012)

In the case of Pârcovaci accumulation, Qmăs/Qnat exceeds the average of 0.44 m^3/s, and in the case of Ciurbeşti accumulation, 0.30 m^3/s (Fig. 1).

Statistical correlations such as Q = f(Pp), R=f (Q) or R = f (Pp) have been carried out for each and every accumulation to identify the connection between these hydrologic parameters in order to perform detailed analyses for some processes related to the evolution of the river bed or the reservoirs silting.

Correlation water – atmospheric precipitations Q = f(Pp)

Generally this correlation is showed by analyzing the data collected from the points monitoring the climatic and hydrologic parameters in the same area. Therefore in the case of Ciurbeşti accumulation for which there are common data strings related to precipitations and water flows measured within 1978 – 2011, the direct correlation between the parameters (r^2=0.63) is quite strong, provided the years with maximum and minimum quantities of precipitations, are excluded (Fig. 2).

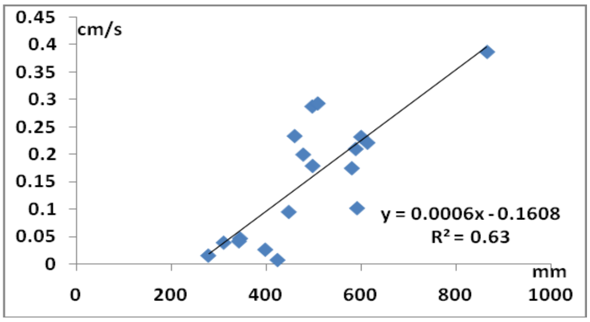

Fig. 2.Correlation Q = f(Pp) for Ciurbeşti accumulation (period 1978-2011)

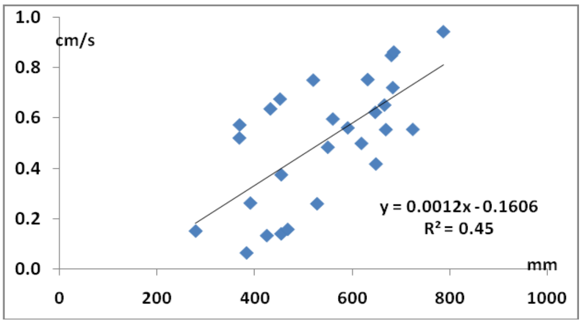

Fig. 3.Correlation Q =f (Pp) for Pârcovaci accumulation (period 1978-2011)

In the case of Pârcovaci accumulation the data string is slightly longer (from 1971 to 2011). Therefore the values of the correlation coefficient r^2 are lower (0.45, provided the years with maximum and minimum quantities of precipitations are excluded) due to local variations in elevation (higher altitude) and vegetation (wooded upstream basin) (Fig. 3).

By analyzing the values that result from the correlation Q = f(Pp) the conclusion that water flows depend much on the quantity of water that falls may be reached. However the accumulations introduce some modifications of the water run-offs depending on the intended use (volume of water abstracted for various usages, especially in the case of Pârcovaci accumulation).

Correlation sediment – water R = f(Q)

For what concerns the connection between the suspended load (R, kg/s) and water (Q, m^3/s), the hydrologic measures have been found to be relatively proportional in the case of Bahlui river basin also. Particularly interesting is the fact that for the same water flows, the sediments vary from one month to another or between floods depending on the geo-morphological evolution of the bed channel which is either in the phase of aggradation or silting. In our country a direct correlation between the water and sediment has been highlighted as:

$\log R = 1.25 \log Q$ (Diaconu, 1971),

and has been subsequently extrapolated to:

$R = AQ^n$,

(where A and n are coefficients specific to each river basin) (Diaconu, Şerban, 1994). Concerning the Bahlui river basin the following relation has been obtained by correlating the water and sediments from the hydrometers which reported significant databases (Fig.4) (Minea, 2012):

$\log R = 1.47 \log Q$,

Since there are only 3 points of monitoring the sediments in the Bahlui river basin: Cârjoaia (on Măgura river), Târgu Frumos (on Bahlueț river) and Iași (on Bahlui river), we will focus in our analysis on the data collected from the first monitoring point and extrapolate our conclusions to Pârcovaci accumulation area which is located in similar geographic conditions.

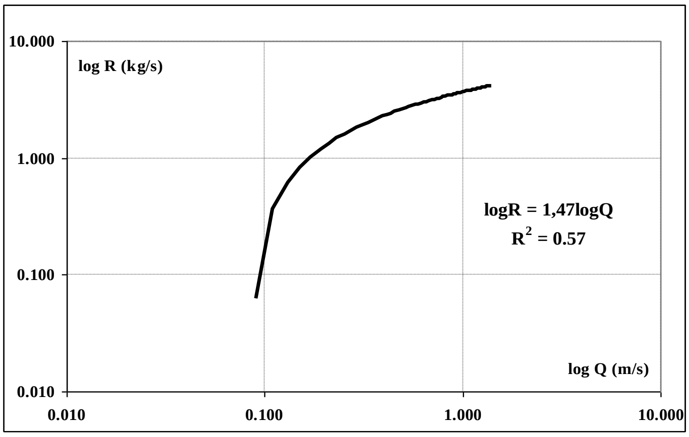

Fig.4 Connection between the average suspended load (R) and water (Q) in the case of Bahlui river basin (Minea, 2012)

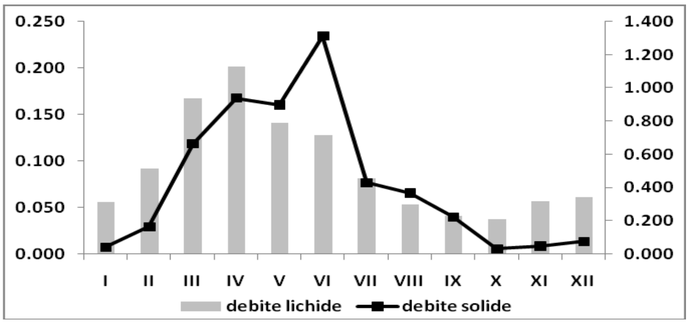

Fig. 5 Water and sediment annual regime for Cârjoaia hydrometer

In terms of flow regime showed in Fig 5 a certain gap between maximum monthly water and sediment flows is to be noticed. The gap results from the different carrying capacities recorded in March-April which is conditional on the bed load from the catchment area.

The highest values of sediments are recorded in May amid increasing bed load carrying capacity by the rapid floods occurring in this month due to significant precipitation falls (sometimes exceeding 100 l/m^2 in less than 24 hours). The multi-annual variation of the water and sediment flows indicates a decreasing trend for both parameters which is stronger in the case of sediments and weaker in terms of gradient in the case of water.

Concerning the statistical correlation between the above mentioned parameters the following relation has been obtained according to the methodology described (Fig. 6):

logR = 1.57log Q

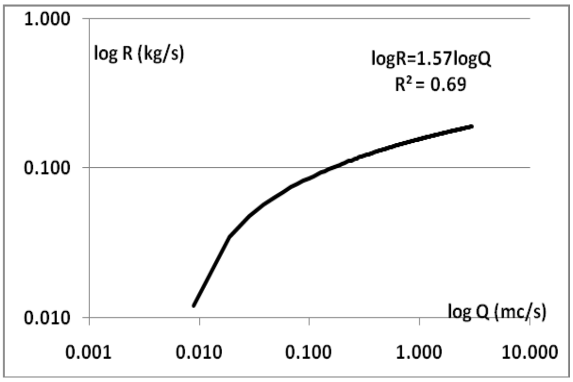

Fig. 6 Connection between the average suspended load (R) and water (Q) in the case of Cârjoaia river basin

The relation may be used to model the sediments of the rivers in the drainage basin of Bahlui river, including the rivers reaching the Pârcovaci accumulation. In the absence of data related to Ciurbești accumulation, the relation logR = 1.47log Q (Minea, 2012) may be used which is valid for the entire basin of the Bahlui river.

Correlation sediments – precipitations R=f(Pp)

The multi-annual variation of the suspended load is conditional on the water regime and atmospheric precipitations. Thus in the case of Cârjoaia hydrometer, within 1981-2005, in years 1988, 1991, 1996 the values of the annual average suspended loads are high (over 2 kg/s), and in years 1986, 1987, 1990, 2004 the values of the annual average suspended load are low (below 0.100 kg/s). Generally, the highest values correspond to years with large amounts of precipitations (e.g. in year 1991, the suspended bed load of 2,8 kg/s was recorded at Cârjoaia hydrometer and the amount of monthly precipitations in the case of Hârlău hydrometer was 825 mm), and the lowest values to the years with poor precipitations (Cârjoaia hydrometer, years 1986, 1987 and 1994, suspended bed loads records: 0.096 kg/s, 0.081 kg/s, 0.085 kg/s respectively, and the annual amounts of precipitations recorded at Hârlău rain gauge: 483.7 mm, 460.9 mm, 410.7 mm, respectively).

Generally there is a direct correlation between the annual amount of precipitations and the suspended bed loads carried by a river (Fig. 7). However the correlation is dependent on the degree of disaggregation of rocks and intensity of the geo-morphological processes taking place at the surface of the considered drainage basin.

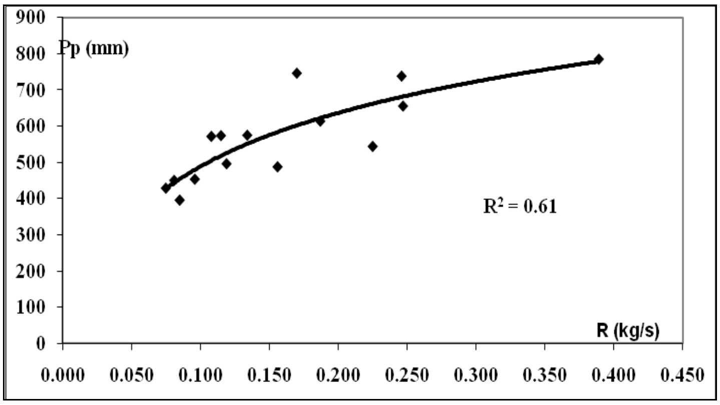

Fig. 7 Connection between the annual amount of precipitations and suspended bed loads recorded at Târgu Frumos hydrometer (Bahlueţ river)

Conclusions

Following the analysis of the three types of correlations the conclusion that water and sediment flows depend much on the quantity of water that falls may be reached. The accumulations however introduce some modifications of the liquid run-offs depending on the intended use (volume of water abstracted for various usages, especially in the case of Pârcovaci accumulation).

Although the value of the specific annual average suspended bed loads is close to the country average value (2.06 t/ha.year) and with the view to maintain a moderate erosion and a low bed load as reasonably possible in this basin, it is necessary to commence adequate arrangement programs for lands, including increasing the forestry plantation on ploughed flanks and inter-rivers with slopes greater than 10-20%.

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ENDOSULFAN RESISTANCE PROFILE OF SOIL BACTERIA AND POTENTIAL APPLICATION OF RESISTANT STRAINS IN BIOREMEDIATION

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Key-words: Soil, pesticide, endosulfan, socio-economic impacts, bacterial resistance, Bioremediation

Abstract. In the present study, bacterial strains were isolated from the soils of Wayanad District, Kerala, India and the isolates were tested for their tolerance to endosulfan and potential in bioremediation technology. Pesticide contamination in the soils, soil physico-chemical characteristics and socio-economic impacts of pesticide application were also analyzed. 28 pesticide compounds in the soil samples were analyzed and the results revealed that there was no pesticide residues in the soils. As per the survey conducted the pesticide application is very high in the study area and the level of awareness among the farmers was very poor regarding the method of application and its socio-economic and ecological impacts. A total of 9 bacterial strains were isolated with 50µg/ml of endosulfan in the isolating media and the results showed that most of the bacterial strains were highly resistance to endosulfan. Out of the 9 strains isolated 6 were highly resistant to endosulfan (500-700µg/ml) and the other 3 isolates showed the resistance of 250-500µg/ml. From the studied isolate, isolate 9 demonstrating prolific growth and high resistance was selected to check their capability to degrade endosulfan over time. Identification of the selected strain reveals that it belongs to the genus *Bacillus.* Results of endosulfan removal studies showed that with increase in time, the biomass of the bacterial strains increased. The complete disappearance of endosulfan from the spiked and inoculated broth during the first day of incubation (24 hour interval) was observed. While the control flask showed the presence of endosulfan during the experimental period. Pesticide resistant bacteria are widely distributed in the soils of selected study area and the tolerance varied between bacteria even though they were isolated

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from the soils of the same area. The selected *Bacillus* species carry the ability to degrade endosulfan at accelerated rates and it could be useful in framing a bioremediation strategy for pesticide contaminated soil and water environments.

Introduction

Plants on which we depend for food are under attack from insects, fungi, bacteria, viruses, rodents and other animals, and must compete with weeds for nutrients. To destroy unwanted populations living in or on their crops, farmers use pesticides. The first widespread insecticide use began at the end of World War II and included DDT (dichlorodiphenyltrichloroethane) and gammaxene. Insects soon became resistant to DDT and as the chemical did not decompose readily, it persisted in the environment. Since it was soluble in fat rather than water, it also biomagnified up the food chain. The most important pesticides are DDT, BHC, chlorinated hydrocarbons, organophosphates, aldrin, malathion, dieldrin, furdan etc. The remnants of such pesticides used on pests may get adsorbed by the soil particles, which then contaminate crops grown in that soil. The consumption of such crops causes the pesticides remnants to enter human biological systems, affecting them adversely. Pesticides not only bring toxic effect on human and animals but also decrease the fertility of the soil. Some of the pesticides are quite stable and their bio-degradation may take weeks and even months.

Endosulfan (6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,3,4-benzo(e) dioxathiepin-3-oxide) is a chlorinated compound, widely employed as pesticide in world farming. Technical preparation of endosulfan consists of a- and b-isomers (70:30). Endosulfan contamination has been detected in soils, water, air and foods because of its profuse practice and possible for environmental transport. It is extremely toxic to fishes and aquatic invertebrates (Verschueren, 1983; Sunderam et al. 1992) and is classified as a priority pollutant by international environmental agencies (Keith and Telliard, 1979). The persistence of endosulfan in agricultural soils has been studied in many laboratories. Its life in soils has been estimated to be from 100 to 120 days (Rao and Murty 1980; Kathpal et al. 1997) to several months (Stewart and Cairns 1974).

Accessibility of different pesticides in field provides contact of several different kinds of microorganisms to pesticides. Majority of them die under lethal effect of pesticides but only some of them advance in different ways and utilize pesticide compounds in metabolism. Numerous studies are available indicating degradation of different pesticides (Hussain et al. 2007; Lakshmi et. al. 2009). Successful removal of pesticides by the addition of bacteria had been reported earlier for many compounds, including chlorpyrifos, endosulfan, parathion, coumaphos, ethoprop, and atrazine (Singh et. al. 2004). Therefore in the present study aims to evaluate the endosulfan resistance profile of the bacterial isolates and bioremediation potential of highly resistant isolate. Pesticide contamination in the soils and socio-economic impacts of pesticide application were also analysed.

1. Materials and methods

1.1 Study Area: Wayanad, the agro based district of Kerala, South India is noted for its natural beauty, pleasant climate and the fertile soil. As the farmers of this area primarily depend on agriculture for their living, there is a necessity for the proper control of pests to make the cultivation economically a success. Reports say that the unscientific and indiscriminate use of pesticides by the farmers in this region has caused severe environmental pollution. Most of the paddy fields are extensively converted to banana plantations and extensively use inorganic fertilizers and pesticides. For the present study we selected banana and paddy fields of Padinjarathara and Kottathara Panchayaths of Wayanad district, Kerala, India.

1.2 Socio-economic and health impact survey: Wayanad being a zero industrial zone totally depended on agriculture for income. The present survey was conducted to get an idea on the consumption and use of fertilizers and pesticides in their crops and to what extent they are affected by its use. Interview method was used for the Socio-economic survey. The list of banana cultivators and rice cultivators were collected from the respective Agricultural department. Random sampling was done to select 62 farmers from the selected Panchayats. In view of the objectives a structural questioner was developed for collecting information.

1.3 Soil sampling: Soil samples were collected at a depth of 15 to 20 cm from the surface. For each of the sampling sites, 30 sub-samples of soil were collected from different locations, pooled together and homogenized so as to obtain representative sample. Samples were collected using a spade that is thoroughly cleaned and disinfected between sampling so as to prevent cross-contamination. Soil samples were packed in sterilized polythene bags and transferred to an ice box and transported to the laboratory.

1.4 Physicochemical characteristics of soil: Temperature was determined *in situ* with the help of mercury bulb thermometer. Soil moisture content was determined by gravimetric method. pH of soil samples were determined potentiometrically using pH meter. Available nitrogen in the soil samples was determined by Microkjeldahl method and the available phosphorus by Bray and Kurtz method (Jackson 1973). The available potassium was extracted using neutral normal ammonium acetate as extractant and determined by using flame photometer (Morgan 1941). The organic carbon was determined by Walkey and Black Method (Jackson 1973). Conductivity of the soil samples was determined by conductivity meter. Soil moisture content was measured by gravimetric method.

1.5 Pesticide analysis: The soil samples were extracted and analyzed using Gas chromatographic techniques (Shimadzu) coupled to an Electron capture detector.

1.6 Isolation enumeration and identification total heterotrophic bacteria: Isolation of bacteria was carried out by standard serial dilution plate technique. 10 g of soil samples were transferred into 90 ml sterile distilled water and agitated vigorously. Serially diluted samples were sow in Nutrient Agar supplemented with 50µg/ml of endosulfan and incubated at 37°C for 24-48 hours. After incubation, morphologically distinct colonies were picked and purified. Pure cultures of bacterial colonies were prepared and persevered as slant cultures for further analysis. The bacterial isolate exhibiting maximum resistance against endosulfan was identified by standard protocol (Holt et al. 1994).

1.7 Endosulfan resistance test: Resistance of the bacterial isolates to varying concentrations of endosulfan was determined by agar dilution method (Luli et al. 1983). Fresh overnight cultures of the isolates grown in peptone water were aseptically inoculated into nutrient agar plates, which were supplemented with increasing concentration of the endosulfan (100µg/ml to 800µg/ml). The plates were incubated at room temperature and observed for bacterial growth. The lowest concentration of pesticide at which no growth occurred was considered as the Minimal Inhibitory Concentration (MIC). Endosulfan was added to the medium after autoclaving and cooling to 45-50^{o}C, from filter sterilized stock solutions.

1.8 Bioremediation of endosulfan: The isolate (isolate 9) demonstrating prolific growth was investigated for their capability to degrade endosulfan over time. Endosulfan technical preparation consists of a- and b-isomers (70:30) was used for removal studies. For this purpose, 100 ml of autoclaved medium (Nutrient agar) were put into 250ml flask. These flasks were spiked with endosulfan already dissolved in acetone to attain a final concentration of 100µg/ml in a laminar flow hood for 10 minutes to allow acetone to evaporate. The flasks were inoculated with 1ml of 10^9 bacterial inocula. These inoculated flasks were incubated at room temperature on an orbital shaker at 150rpm. Uninoculated flasks (control) were also prepared to check the abiotic degradation under the same conditions. An aliquot of 5mL sample was taken during 3 day intervals from each flask. Samples were centrifuged to remove suspended bacterial biomass and presence of endosulfan was examined using gas chromatography.

2. Results and discussion

2.1 Socio-economic and health impact survey: From the survey it was observed that 92% of the people in Wayand district depend up on farming for their livelihood. About 31% people are illiterate, 34% having middle school education and remaining has primary education. Most of the people have annually income according to their annual yield from their farm. 80% of people are fully depending on rain for their irrigation; Wayand district got an average rainfall of 25,00 millimeters per year. The major pesticides used in Wayanad ditricts are Ecalux (quinalphos), sevin, bavestin, emisan etc. mostly against the attack of *Odoiporous longicollis* (Pseudo stem weevil), *Cosmopolites sordidus* (Rhizome weevil) and *Spodoptera litura* (Leaf eating caterpillars). But they use the pesticides without any gloves and also they didn't get any classes from Agriculture department for how to use pesticides, so they use pesticide according to the recommendations of shop keepers. All the farmers are opting branded pesticides only and also about 70% farmers are workers in their own farm. There is no mass fish kill report on their water resources.

The problem of pesticide exercise in farming is of particular importance as it has a significant negative impact on farmer's health (Antle et al. 1998; Ajayi 2000). In the present study 16% people suffer health problems during the application of pesticides such as head ache, burning effect, dinginess etc. 100% farmers adopt blanket spray for the application of pesticides. Many researchers reported the health problems during pesticide application such as headache, dizziness, muscular twitching, skin irritation and respiratory discomfort (Yassin et al. 2002; Maumbe and Swinton 2003; Mancini et al. 2005).

Pesticide not only affects human health, but also affects other environmental factors, for example soil, surface and ground water, crop productivity, microand macroflora and fauna, etc. (Pimentel 2005). Regardless of such environmental and health effects, farm workers in developing countries keep on to use pesticides in increasing quantities (Wilson, 2000; Wilson and Tisdell, 2001). Murphy et al. (1999) reported considerably more signs and symptoms in pesticide sprayers compared to the control people. Over half of the total respondents experienced skin irritations, more than a quarter experienced eye irritations and 7–12% experienced stomach poisoning in Zimbabwe (Maumbe and Swinton 2003).

2.2 Physicochemical characteristics of soil: Various physico-chemical properties of the soil such as temperature, Moisture content, pH, conductivity, organic carbon, organic matter has been studied and the results are presented in Table 1 and 2. Available nitrogen, available phosphorous and available potassium were also studied (Table 3). Soil temperature ranged between 20^{o}C and 27^{o}C during the study period and the maximum temperature of 27^{o}C was recorded from Padinjarathara Banana field and the minimum of 20^{o}C was recorded from Kottathara paddy field. The pH values ranged from 4.08 to 6.25 and the highest pH recorded from Kottathara Banana field and lowest pH recorded from Padinjarathara paddy field. Soil conductivity ranged between 0.07 and 1.22mS

In the present study highest organic carbon of 1.714% recorded from Kottathara paddy field and lowest organic carbon of 0.852% from Padinjarathara and Kottathara Banana fields. Available nitrogen ranged from 378 - 1890Kg/ha. Highest available potassium of 5.510 kg/ha was recorded from Kottathar paddy field and the least available potassium of 2.912 kg/ha recorded from Padinjarathara banana. The highest value of available phosphorous of 14.55 kg/ha recorded from Padinjarathara paddyfield and the least value 8.80 kg/ha from Padinjarathara banana field. Highest organic matter of 2.95% recorded from Kottathara paddy field and lowest organic matter of 1.4 % from Padinjarathara and Kottathara Banana fields.

Table No. 1 Physico-chemical characteristics of the soil

SamplingSites	**Soil Temperature (^oC)**	**Moisture Content (%)**	**pH**	**Conductivity (mS)**
KPF	20	42	5.09	1.22
PBF	27	16.37	4.28	0.77
PPF	21	40	4.08	0.23
KBF	26	24.11	6.25	0.07

Kottathara paddy field - KPF, Padinjarathara Banana field- PBF, Padinjarathara paddy field - PPF, Kottathara Banana field- KBF

Table No. 2 Soil organic carbon and organic matter content of the study area

SamplingSites	**Organic carbon (%)**	**Organic matter (%)**
KPF	1.714	2.95
PBF	0.852	1.4
PPF	1.701	2.92
KBF	0.852	1.4

Kottathara paddy field - KPF, Padinjarathara Banana field- PBF, Padinjarathara paddy field - PPF, Kottathara Banana field- KBF

Soils of selected study area are feebly acidic and the pH ranged from 4.08 to 6.25. Physicochemical characteristics of soil showed spatial variation. Spatial variations of soil characteristics are mainly due to the topography of the study area. A number of studies have exposed that even minute scale topographical landforms can change environmental conditions (Scowcroft et al. 2000). The same results were observed by different researchers; Miller et al. (1998) observed that organic carbon showed to vary with slope position and variation of soil properties within a distinct climatic area may also result from topographic heterogeneity (Brubaker et al. 1993). Another important reason for the spatial variation may be the vegetation cover. The difference in vegetation should affect the soil environment in many ways, including changing light intensity, wind, temperature, and soil moisture and nutrients; these should lead to remarkable changes in soil microbial diversity and structure (Greipsson 1995; Greipsson and El-Mayas 1999). In the present work vegetation differs considerably between the sampling locations because of samples were collected from different types of agriculture systems.

Table No. 3 Nutrient content of the soils

Sampling sites	**Available Nitrogen (Kg/ha)**	**Available Phosphorous (Kg/ha)**	**Available Potassium (Kg/ha)**
KPF	1890	15.50	5.510
PBF	378	8.80	2.912
KBF	630	13.98	4.625
PPF	1764	14.55	4.816

Kottathara paddy field - KPF, Padinjarathara Banana field- PBF, Padinjarathara paddy field - PPF, Kottathara Banana field- KBF

2.3 Load of Total heterotrophic bacteria: In the present study total heterotrophic bacterial (THB) load ranged from 32×10^5 to 260×10^5CFU/g; highest count recorded from Kottathara paddy field and the lowest count recorded from Kottathara banana field (Table No.4). Spatial variation of the microbial load attribute to variation of the soil characteristics and vegetation structure due to the difference in terrine of the study area. A number of studies have shown that even small scale topographical landforms can alter environmental conditions, which in turn retard or accelerate the activity of organisms (Scowcroft et al. 2000). The effects of topographical landforms on species composition, productivity, environmental conditions, and soil characteristics have been well investigated (Barnes et al. 1998).

Table No. 4 Load of total heterotrophic bacteria (THB) in the soils of selected study area

Sampling sites	**THB Count (CFU/g)**
KBF	32×10^5
KPF	300×10^5
PBF	76×10^5
PPF	270×10^5

Kottathara paddy field - KPF, Padinjarathara Banana field- PBF, Padinjarathara paddy field - PPF,Kottathara Banana field- KBF

2.4 Pesticide residues in the soil: 28 pesticide compounds in the soil samples were analyzed and the results revealed that there were no pesticide residues in the soils. Fate of pesticides in soil is controlled by chemical, biological and physical dynamics of this matrix (Sparks 2003). Above processes can be grouped into those that affect persistence, including chemical and microbial degradation, and those that affect mobility, involving sorption, plant uptake, volatilization, wind erosion, run-off and leaching (Andreu and Pico 2004). Chemical degradation occurs during process such as photolysis, hydrolysis, oxidation and reduction (Bavcon et al. 2002). Biological degradation takes place when soil microorganisms consume or break down pesticides (Sassman et al. 2004).

One thing that has been shown to boost the rate of microbial degradation of pesticides in soil is one or more previous applications of the same pesticide or another pesticide with a similar chemical structure. This phenomenon is known as accelerated or enhanced degradation (Racke 1990). In the present study we noted high number of pesticide resistant bacteria in the soils of selected study area that may be the major reason for the absence of pesticide residues. Wayand district got average rainfall of 25,00 millimeters per year, these also leads high run-off and leaching of pesticides. Chemical degradation and the other factors like plant uptake, volatilization and wind erosion studies etc. are needed to finalise the fate of pesticide in the selected study area.

2.5 Bacterial Endosulfan resistance: A total of 9 bacterial strains were (with 50µg/ml of endosulfan in isolating media) isolated from the soils of banana and paddy fields of selected study area. The results revealed that most of the bacterial strains were resistant to endosulfan. Out of the 9 strains isolated 6 were highly resistant to endosulfan (500-700µg/ml) and the other 3 isolates showed the resistance of 250-500µg/ml (Table 1). Findings of the present study are almost similar to those reported by Sahin et al. (2003), reported that many bacterial strains

Table No. 5 Endosulfan resistance patterns of bacterial strains

Isolates	MIC to Endosulfan (µg/ml)
1	500 - 700
2	500 - 700
3	250 - 500
4	500 - 700
5	500 - 700
6	250 - 500
7	500 - 700
8	250 - 500
9	500 – 700

tolerated concentrations up to 800µg of endosulfan/ml. Findings are almost similar to those reported by Ferrer et al. (1986), reported that 100, 200, 300, 400 and 500 µg/ml of 2,3,6-TBA (2,3,6- trichlorobenzoic acid) caused 28.0, 47.8, 54.5, 61.2 and 95.6% inhibition respectively. The elevated levels of resistance was originate among the isolates is probably attributed to the endosulfan usage in the study area in the past or present time.

2.6 Bioremediation of Endosulfan: Biodegradation of persistent compounds is an important mechanism for their dissemination in the environment (Marcae 1990). In predicting the persistence of synthetic chemicals in soil, sediment and natural water, it is necessary to determine the role of endogenous microorganisms in the overall degradation process. In the present study, isolate 9 demonstrating prolific growth and high resistance was selected to check their capability to degrade endosulfan over time. Identification of the selected strain reveals that it belongs to the genus *Bacillus.* Results of endosulfan removal studies showed that with increase in time, the biomass of the bacterial strains increased. The complete disappearance of endosulfan from the spiked and inoculated broth during the 3rd day of incubation was observed. While the control flask showed the presence of endosulfan during the experimental period. Bacteria and fungi, which degrade endosulfan isomers in liquid culture have been isolated and characterized in many laboratories (Kullman and Matsumura 1996; Awasthi et al. 1997). Endosulfan diol, endosulfan sulfate, endosulfan aldehyde, endosulfan ether and endosulfan lactone have been demonstrated as the major metabolites formed during its degradation.

Conclusion

Pesticide resistant bacteria are widely distributed in the soils of selected study area and the tolerance varied between bacteria even though they were isolated from the soils of the same area. The selected *Bacillus* species carry the ability to degrade endosulfan at accelerated rates and it could be useful in framing a bioremediation strategy for pesticide contaminated soil and water environments. The use of microorganism for bioremediation requires better and more understanding of all the physiological and biochemical aspects involved in chemical transformations of the pesticide. Thus further studies are needed prior to start any applied bioremediation process using the isolate.

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LITTLE ICE AGE IN ROMANIA IN THE VISION OF A SYRIAN TRAVELER

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Key words: Little Ice Age, Paul of Aleppo, climate information, Romania

Abstract. Archdeacon Paul of Aleppo of Damascus accompanied the Patriarch Macarios of Antioch, in Moldavia, Wallachia, Dobrogea for nearly seven years (1652-1659), just in time considered one of the coldest during the Little Ice Age, Maunder Minimum namely (1645-1715). His journey is recorded in his travel diary, written in Arabic and translated into Romanian in 1900. Romanian historians were particularly concerned with the information provided by the passenger about the towns, monasteries, and farmhouses, aspects of daily life, customs, habits and Romanian economy countries. But Paul of Aleppo describe and climate issues, particularly cold winters with frost Danube, snowy, storm at sea, rain, floods, etc. It is a very rich source of information in this area, so far little taken into consideration, showing that the Little Ice Age was also evident in Eastern Europe.

Introduction

During the Middle Ages, cold period called the Little Ice Age (ca. 1200 or 1300 to 1850) has been studied by specialists in western Europe based on data from "natural archives" (terrestrial and marine sediments, tree rings, pollen analysis), and the data in "archive society" (archaeological data, or notations in parish registers, monastic, chronicles, letters, travel journals and so on, about the phases of vegetation, flood or drought, frost river or sea layer snow, etc.). (Pfister, 1999)

On the territory of Romania, historical conditions were unfavorable for a normal life: invasions of migratory populations, wars between neighboring countries often went on these lands, attempts Ottoman Empire, Russian, Austro-Hungarian Empire to seize our lands. Because of these conditions, we have enough little information and studies about the climate of the period.

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The voyage of Archdeacon Paul of Aleppo[2] that accompanied the Patriarch Macarius of Antioch, in Moldavia, Wallachia, Dobrogea (and in Russia) for nearly seven years (July 9, 1652 - April 21, 1659) is recorded in his travel diary, writing in Arabic and translated into English, French, Russian and Romanian then in 1900.

In his diary the traveler describes settlements, towns and palaces of the princes and especially churches and monasteries, tell legends and myths, shows the many aspects of everyday life of Romanians, exterior and interior of peasant houses, Romanian economy countries, collecting information about customs and habits from weddings, funerals or celebrations of Christmas, Epiphany and Easter. He also gives data about extraction techniques copper mines at Baia de Arama or Romanian salt mines and deplores the loss of wealth by the Tatar invasion which ravaged settlements and taking thousands of slaves. Paul of Aleppo recounts numerous historical facts (e.g. end of the reign of Vasile Lupu and Matei Basarab's death). His diary has aroused interest Romanian and foreign historians and ethnographers.

Instead, climate issues were never considered by the researchers, although we consider that are very important, especially since this trip took place for several years, just at the beginning of the period considered one of coldest during the Little Ice Age, i.e. the Maunder minimum. The descriptions are rich, picturesque, typical oriental style, especially in the harsh winters of the Danube countries. Of course we could interpret these reports and the fact that these travelers came from a Mediterranean country where, even in this cold period, we can assume that the winters were milder and less snow.
However the details (freezing rivers and especially freezing food, suffering travelers) are particularly credible reports may encounter other travelers in the seventeenth century.

1. How were the winters during his travel.

The travelers have left Aleppo, crossed the Anatolian Plateau, and then entered the Black Sea through the Bosporus and reach Dobrogea in early 1652. One of the first impressions is storm at sea: *"January 7 to 9, 1652 - We started Friday night with outstretched sails, floating led by favorable wind from the south. But the wind has escalated so much that was to sink, but with God's help we*

[2] Paul of Aleppo (1627 - 1669, Tiflis) clergyman, traveler and chronicler, son of the Syrian Orthodox priest Macarius Zaim (patriarch of Antioch in the years 1648-1672), author of historical works and translations of Greek Oriental (Orthodox) Church History, accompanied his father as secretary of the patriarch, several times in his travels from Damascus, through Anatolia, Istanbul, Wallachia, Moldavia, Ukraine and Moscow, trying to raise funds and support for their church.

arrived midday Sunday after Epiphany, the port named in the Greek Konstanz and in the Turkish Kostendju ... We stayed there two days, dizzy by the great waves witch penetrate even into the ship, and we descended like a valley, and even as we ascended a mountain top. "

On the way to Moscow, travelers stopped longer in Moldova: *"On Tuesday morning February 8, Feast of St. Theodore Stratilat, the governor came to him with a carriage without wheels, called in their language" sanie" (sledge), as much snow had fallen and frozen. While wheeled carriages could not go, it took us quickly, without shaking… On the eve of Sunday Carnival, the abbot of Galata, famous monastery, came invited there the Lord Patriarch went up in a sleigh pulled by four black horses, as much snow had fallen and it was very cold, that it seemed that we fall nails."*

Next winter is not milder, but travelers are acquainted with a fast heat wave that turns winter into an early spring, full of unexpected inconvenience of climate: *"January 22, 1653 - "From this place (Vaslui to Skentai-Sparks) we left Tuesday morning. The previous night the wind blowing violently, with exceedingly cold, frozen mud, earth was hard, swamps in our way were now compact. At the same time it snowed a lot... In the afternoon, just leaving the snow perspiration, suddenly the atmosphere has warmed, snow melt and we sunk in the mud up to the horse's belly, on a yellow earth and glue... After unimaginable fatigue, we arrived at nightfall the proximity of a large lake, which they call pond (khalistao) digging by the ruler for fishing...at Bârnova (Bonoska) ".*

Next winter travelers are in Wallachia, where attending Epiphany ritual and they are amazed by the fact that it takes place in a frozen river. Paul of Aleppo notes (and other passengers later) that people rubbed their children with snow, to empower them: *"January 6, 1654 - Targoviste, Abbey Stelea. When our Lord patriarch came to the river bank, with cross in hand, the water was still frozen, because that day had been a hard frost ... priests baptized many children in the river, they broke some ice… Heads were discovered. We stayed for days with pain …"This year, the early Canon II (January) until the end of Adar (March) very much snow fell, covering the ground constantly, until Easter. As blizzards and frost, wet and cold I've never seen before, even oil and wine butter froze in pots... To be seen hanging from rooftops around some long sticks ice crystal. This happens when the heat inside the house, the snow melted and then every drop that fell by the action of cold, frost and ice turned into long sticks, unusual thing for the people of our country. ... "*

On his return from Russia inconveniences of climate continues and Paul of Aleppo notes something about human suffering related to the rigors of winter: 1656-1657 - *"... the evening we arrived at Targoviste. This winter was terrible and hard for farmers and livestock. Snow has continued to fall until the first day of Lent* *which was on 9 February and many cattle perished for lack of fodder, and the Danube River froze three times, the first time the ice with a thickness of three inches. (about 75 cm) then follow a thaw and melt some of it, then froze and then a second time because of snow, the third time, until the ice reached a thickness of nine hands (2, 25 m). That can take water from the river; its inhabitants had to dig a way through the ice layer. It is said that no such thing had happened thirty years. "*

January 1657 - *"With the army he (Gheorghe Rakoczy) started in the middle of winter, the weather is great snowstorm and frost; therefore many people have drowned or died of cold waves ..."*

November 8, Arges Monastery - *Campulung* - *"On Saturday morning when we got up to leave, he was a terrible cold, almost unbearable. How rivers here are very fast, the middle remained unfrozen so that when the carriage passed over them, water gets inside. God knows how cold it was! The Carpets were stuck to each other sleds and sled, ice forming a compact mass. Horses become unable really to walk due to frost..."*

Finally, the following year, 1658 begins early winter, with frost and heavy snow, killing the animals, followed by a heat wave, knew the people who called the late autumn "old woman Summer ":

"By the end of Teshrin Alarval (October), about ten days, a lot of snow fell with a severe cold, then changed and followed a second spring, sun, warmth, flowers and greenery, after it was destroyed by harsh cold ..... shepherds returned immediately with horses and cattle to pasture for the second time after before they put in their pens at the shelter. For this frost large numbers of sheep and oxen and other beasts of burden perished, so fierce was unexpected cold, and now after the fire burned day and night, I felt again a muggy oppressive heat ..."

Remarks about the warm seasons.

During the Little Ice Age, travelers found that summers were pretty cold, rainy and many storms, accompanied by thunderstorms and hail events, followed by increased water flow, producing disasters. Paul of Aleppo writes: July 1653 - *"Nights latter were all thunder and lightning, torrents of rain and stone with such great force, that we say, 'Of course arrived last hour!' Lightning fell on the huge wooden dome of the church of the Monastery of St. Panteleimon, which is in the possession of the monks of Sinai, and throws down the top cross, and put deep into the ground. Another lightning fell on the famous stables of the palace. They burned a lot of houses. Lightning flashed like swords in the sky and saw clouds shaped fortresses and battles. All this foretold the second conquest of Basil (battle of Vasile Lupu from Dry Valley, near Bacau) "*

May 22, 1654 - *"On the same day at noon we left Targoviste ... we came to a mountain and a forest which passed with difficulty because of the many and powerful rain that had fallen in those days and had many rivers to rise ..."*

July 1658 - *"On the night of 27 Tammuz (July) and the next was a terrible storm, with thunder and lightning that shook the earth, that I thought it was time Resurrection ..."*

September Slobozia monastery - "*We stayed here until the day of the Cross, because the emergencies rain that had fallen in the month of September, accompanied by violent storms, thunder,* lightning *and hail. Then we left forward through a vast plain in the middle of all the pleasures and beauty of the season.* "

After such harsh winters and storms descriptions of the Romanian countries, here are finally some notations about the beauty of the landscape. Then we find that Paul of Aleppo is impressed by the wealth of fruit in the Prince orchards:

June 5, 1653. *"Feast of Pentecost in Iasi. - Let it be known that in this country the first cucumbers ripen the feast of the Holy Apostles (June 29), are small and without gravy. And plum called "*pigeon *heart" is so much that resembles a large flows; plums are different varieties and colors white, yellow, red, rust and very tasty cherry (with* fruit) *are both red many that look like forests,* they *are* and *wonderful varieties of pears. "*

He also notes that there are local exotic fruits grown in pots: "*In the garden of the Prince I saw many mulberry and apricot sweet fruit, almonds, I saw a small pomegranate tree, planted in a barrel and sweet lemons, grown on the bucket ...*

About Moldovan wheat he notes, in an imaginative oriental style that is characterized by a long wire that exceeds the human height: "*Merchants and other Greek and Cossack soldiers had fled ... is thrown into a wheat field, which in this country usually surpasses the height stature of a man."*

The traveler is struck by the multitude of domestic animals grown on estates Preda Brâncoveanu and then gives unique details about the sturgeon fishing of the Danube. Is interested how to preserve vegetables the winter in monasteries and homes noblemen: *"As for vegetables, such as beets, parsley, onion and garlic, they do not grow until Easter, because during fasting always snowing day and night and in the morning the ground is rock hard, and especially rivers are frozen. When the sun warms and the days is longer, the snow melts and changes into a thick mud up to his knees. In monasteries and in the rich peoples' homes they are deep vaulted stone cellars "pivniţe" called in their language, which make wine barrels, there are and places for keeping vegetables. Before winter and snow fall they pluck from the ground parsley and onion to put them in the cellar. Leek is found in abundance and is very sweet. They keep vegetables in the holes we spoke to, thanks to the coolness that reigns there, they are kept. When needed, take them there and* *eat them, especially during fasting. In monasteries, after dinner Wednesday evening is fasting until Friday night "*

2. Weather Forecast for Romanians

With curiosity and interest in all the news that he finds in a country so different from his own, Paul of Aleppo noted concern of inhabitant for the weather forecast, a natural thing, if we consider the fact that food and their welfare depended largely (except historical events), of the weather in future:

"I noticed the Romanian excellent method to predict by certain signs, weather will be good or not. In August Teshrin Essani (November) is a commemoration of St. Plato, the festivity is celebrated by all with great sacrifices, gifts and services. For them this day shows the time that has to be the year, what happens when it's safe and clear indication. If it's snowy and cold, they say that the coming year will be great frost. But if rain and sun, they predict that next winter will be not an intense cold, but slowly. Such was the case this year: rain, alternating with beautiful sunshine, until 9 December when starting cold and snow. "

Conclusions.

Journal Archdeacon Paul of Aleppo shows that in the Roman countries in this period winters were harsh, snowy and cold, and the summers were cool, rainy storms and floods. Travelers have borne with difficulty in these conditions, and inhabitants have endured famines, diseases and deaths.

Some of these weather events were noted by Romanian chroniclers Miron Costin and Radu Popescu (1653), by the Swedish baron Clas Brorsson Ralamb, apostolic administrator in Moldova (1657) and by the Turkish chroniclers Mehmed Halifa and Evlia Celebi (1658).

If we look at Western and Central Europe, we find similarities in climate over the period. Thus in 1653, 1654, 1655, were harsh winters with frost river, followed by large floods in central Europe. In 1656 in France and Germany froze rivers, in Scotland fell very much snow, and froze people on the roads. In 1658 was one of the harshest winter in that period, from Denmark to Italy, where Rome fell very much snow, perished olive trees in Provence and died many travelers.

Besides the climate data, we find notes about the life of the inhabitants in these weather conditions: travel by "carriage without wheels" infant baptism in rivers frozen, summer storms, and the richness and variety of the fruits of the earth, and the interest of inhabitants for next weather.

It is a very rich and interesting source of climate information, which added to the information collected from other sources to the surrounding Carpathian territories or neighboring countries, we will enable a better understanding of the climate over the centuries in the Romanian countries.

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ROADS REHABILITATION AND ENVIRONMENT IN MOLDOVA: SOME LEGAL AND NORMATIVE HARMONIZATION ASPECTS

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Key words: road, environment, legislation, solutions.

Abstract: This paper analyzes the environmental regulatory reforms of the Republic of Moldova to restore roads and problems over time. Goals and objectives are the analysis of the current situation on road rehabilitation and environmental assessments in this area, as well as issues that require in rehabilitation and maintenance of roads in the Republic of Moldova.Are described briefly: general aspects of road rehabilitation issues; legislation and environmental regulations in the road; differences between Moldova and procedures of the World Bank's environmental assessment in the construction and rehabilitation of roads; problem of national legislative and normative acts harmonization to international requirements.The paper discusses specific environmental to appear on completion of the rehabilitation of roads in the Republic of Moldova. In the final part of the paper presents the conclusions and some suggestions on how to facilitate the rehabilitation of roads in accordance with Agenda 21 of the country and European and international requirements.

Introduction

It is known that Moldova make greater efforts in reforming all areas of the national economy, to overcome existing difficulties, which have a complex connotations - political, economic and social and related to global and regional economic crisis. Reform of all sectors of the national economy determined the need to change attitudes towards the use of natural resources, promote economic and social development compatible with the environment.

In this context the Republic of Moldova has to implement the National Strategy "Agenda 21" (2000), Republic of Moldova - European Union, 2005 –

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Achieving these goals requires action and great efforts to reinvigorate the national economy branches, which in turn requires updating existing normative legislative base, the development of new laws and regulations and/or amend those existing, national standards and norms adaptation to the international ones, and/or taking in force the international standards of ISO and EN series, etc.

The paper discusses specific environmental aspects to appear on completion of the rehabilitation of roads in the Republic of Moldova. Given the fact that the information gained may serve to comparative analysis of national acts with the international ones, in particular the European and can be used to develop concrete recommendations on the harmonization of environmental legislation, norms and standards.

1. Objects and methods of research

Objects of research were: the environmental legislative and normative-methodical acts of United Nations, European Union, Republic of Moldova and Russia, Agenda 21 of the Republic of Moldova, national environmental policy, strategies and programs of the Republic of Moldova and those international: "Republic of Moldova - European Union, 2005 - 2008", Programul de activitate al Guvernului Republicii Moldova „Integrarea Europeană: Libertate, Democraţie, Bunăstare” 2011-2014 and others.

It have been studied and the methodical recommendations concerned international (Handbook on the implementation of EC environmental legislation, 2008) and the national ones: Regulation on the harmonization of Moldovan legislation with Community laws (2006), Guide to the preparation of Tables of Concordance (2010), Methodology of law approximation in the Republic of Moldova (2010, Environmental protection laws and policy. Law approximation to EU standards in the Republic of Moldova (Breda Howard, Ludmila Gofman, 2010) and others.

Methods of research were:

1. *Study* the information on the environmental and legislative-normative acts. It was conducted by analyzing of the official materials of international (1999, 2013), European (2013) and national organizations (2007, 2008, 2013) existing in period of independence of the Republic of Moldova (1991 – present) and others.

2. *Collection and processing* of documents materials was carried out under official publications (in written or electronic forms) and existing data bases at international, European and national level.

3. Comparative analyzes of the acts in view elaboration of recommendations and proposals for harmonization of national legislative-normative acts to European and international ones.

2. Results and discussions

2.1. Assessment and developmaent of a database of environmental documents in road rehabilitation

In accordance with the recommendations of the European Union, Republic of Moldova has approved the programme to implement the majority of legislative and normative acts, which are part of Environmental Acquis and must be transposed into national law.

Republic of Moldova. Legislative and normative documents used in road rehabilitation.

Analyzing the legislative and normative acts and some publications used in the Repuiblic of Moldova on compartments "Rehabilitation of roads and environment" at the current stage of development, we highlight some specific materials, reflecting the complex legal and normative problems regarding roads, namely:

1. Laws - Law of Roads, no. 509-XIII of 22.06.1995; Road Fund Act, no. 720-XIII of 02.02.1996; Auto Transport Code, no.116-XIV of 29.07.98.

2. Bylaws - Regulation on Construction: Roads and bridges, no. D.02.01-96 (1996); Road Traffic Regulation, no 357 of 13.05.2009; List of public roads (Government Decision on the approval of national and local lists of public roads, nr.1323 of 29.12.2000 (2013).

3. Programs on road infrastructure (2013): Budget Investment Program 2011; Foreign Investment Program 2011; Program of works for rehabilitate of roads from external funds in years 2011 – 2015; National roads selected for rehabilitation and repair in years 2011-2014

4. Others.

Analysis of legislative and normative materials in domein of roads showed that the documental base is not optimal developed and existing documents in mostly are outdated. For legal drafting as used the Regulation on Construction: Roads and bridges no. D.02.01-96 (1996) in which are recommended using of several old regulatory acts (regulations fron the years 1974-1989 and standards from the years 1977-1986). It appears that the harmonization of national provisions to the European and international requirements is not visible, and most of national companies and businesses activities are conducted in accordance with the old legislation and rules that do not allow quality work in this area.

Similar problems have been highlighted in the process of drafting of the feasibility studies and technical projects on rehabilitation of roads. It is known that on this phase is given a special attention to the environmental impact assessment in accordance with the following basic environmental acts:

1. Laws (2013)- Law on Environmental Protection, no. 1515-XII (1993) with ulterior amendemends; Law on Ecological Expertise and Environmental Impact Assessment, no. 851 (1996).

2. Bylaws (2013)- Regulation on Environmental audits of companies (1998); Regulation on public participation in environmental decision-making (2000); Instruction on organization and implementation of the State Ecological Expertise (2003);

3. Others.

Therefore, planning new objects and activities that can radically affect the environment shall be based on documentation of the environmental impact assessment (EIA) which is necessarily subject to state ecological expertise. Under environmental legislation, in particular Law no. 851, the negative effects of human activity on natural elements and factors, ecosystems, human health and safety, as well as on material goods reprezents impact upon environment.

2. Environmental procedures and requirements in the rehabilitation of roads

In the Republic of Moldova legal and regulatory requirements for promotion of road rehabilitation requires modification and harmonizing with those european and international.

The EIA system is focused on the basic requirements and criteria checks of the state ecological expertise, developed since the Soviet period. In general aspects they are similar in most countries of the former USSR - now, Eastern Europe and Central Asia countries. Meanwhile, in several countries (including Republic of Moldova) the requirements EIAare proposed only to projects with major impact on the environment, which are acording cryteria stipulated in the Law no. 851 criteria (Box 1).

Country's projects requiring EIA are subject to the some stages of development. According to the Regulation on Environmental Impact Assessment (Annex to Law no. 851), in art. 9 indicates a string of measures need to be taken into account for the decrease environmental impact (Box 2.)

Box 1. Republic of Moldova. According to the Law on Ecological Expertise and Environmental Impact Assessment no. 851 all projects fall into three main categories:

• ***The first category*** - projects requiring full EIA before designing and could be developed further (detailed design) only with the positive approval of the EIA findings by State Ecological Expertize (SEE);

• ***The second category*** - projects require environmental approval of the project activities and to include of a special chapter on the environment in the design documents, and then, respectively, a positive approval from SEE prior to construction; and

• ***The third category*** - the other projects, which do not need to go through all official procedures EIA and SEE.

Box 2. Measures need to be taken into account for the decrease environmental impact (Annex to Law no. 851, art.9).

9.3.4. Description of actions proposed for averting, liquidation, minimize and offset of any environmental impact. A. Plans territorial nature protection. B. Technical Solutions for: decontamination, recycling of waste, protection of architectural and archeological monuments, etc. C. Measures of compensation. D. Other actions.

9.3.5. Description of operative measures for risk of any posible damage and unforeseen impact to the environment.

9.3.6. Scheme monitoring and environmental quality management, operating period of the object and of their activity achievment.

9.3.7. Description of the forecasting methods used, of the main principles used to assess the impact and of the ways of obtaining real indicators and forecasting of the quality of the environment in the district where the project is to be implemented.

9.3.8. Evaluation of uncertainty of the key findings.

Develop document EIA is a complex and includes:

• Analysis of project activities in combination with the base state of the environment;

• Comparative analysis of cumulative concentrations of pollutants with the maximum permisible concentrations (MPC) (eg: air pollution);

• Computer modeling (mostly produced in Russia) environmental impact by possible activities that are typically used directly without being translated or adapted to climate Moldova. Some models are developed by State Hydrometeorological Service in the Republic of Moldova.

From those mentioned in Box 2 it is clear that environmental protection plan is part of project documentation (project execution) and usually includes the chapter "Protection of the environment" or "Book of the environment".

However, the project selection procedures are arbitrary and have some gaps because of lacking the clear criteria that has specify which projects fall under the state ecological expertise. Moreover, final and complete environmental assessment is only accessible at the end of the design. In consequence, almost all types of activities fall under this practice, even those with minor impact on the environment.

In general, all activities resulting in the formation of a series of principles and tasks that need to be followed to promote the projects can be demonstrated in a scheme (Figure 1).

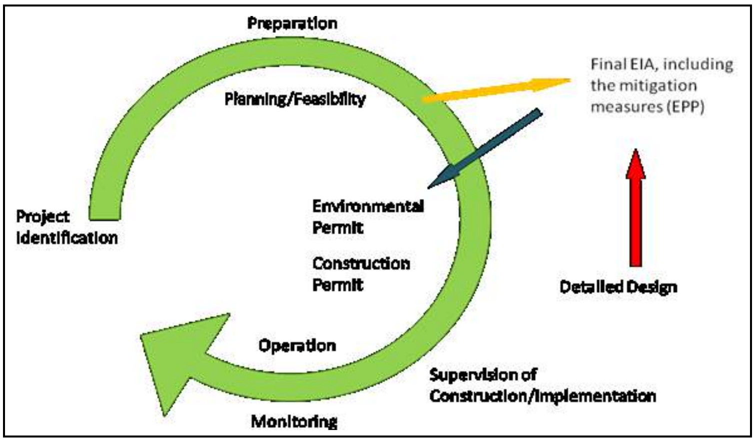

Fig. 1

Approval of project documentation, especially in the "Environment" is performed by the State Ecological Expertise, which often approve the same material twice: the *first time* at the feasibility study phase and the *second* - at the conceptual design phase.

But during training young Moldovan state issues related to infrastructure development, quality and sustainability of roads, many years have not been raised at their fair value, causes the poor economic situation and the poor legislation base.

Therefore, this important economic sector was hard hit by deteriorating its infrastructure and capabilities: some subdivisions have disappeared, and the number of specialized companies and enterprises decreased. In addition, it appears private interprises and companies operating large profile which, however, after weak legislation, old style and normative, as well as with a little experience created difficulties in projects implementation in roads branch.

In recent years, foreign assistance related to growth in Moldova is a redoubled effort in road rehabilitation projects, in which participat many specialized companies from abroad. Participation of foreign companies allows rehabilitation of roads with a high quality because they use international laws and regulations.

Article I. Analysis of documentation used by companies and businesses in the country and abroad in the field of roads has shown that in the development and implementation of projects reveals more differences in

Box 3. Case Study 1. Deference of requirements of the World Bank and of the Republic of Moldova into the development and implementation of an environmental management plan.	
Requirements of the World Bank (Operational manual. OP 4.01 - Environmental Assessment)	**Requirements of the Republic of Moldova** (Law on Ecological Expertise and Environmental Impact Assessment, no. 851 (1996).
Legal Status: EMP requested by WB is legalized and applied. The need for environmental assessment (EMP) is stipulated in the agreement lending / borrowing (also is provide money to implement the Environmental Monitoring Plan).	The legal framework in Moldova does not require developing and implementing of an environmental protection plan. The Law 1515-XII on Environmental Protection has'nt stipulates requirements for it.
Approaches to mitigation measures of the environmental impact	
EMPs requirements of WB derived from the EIA study.	Environmental protection plans which are required by national laws are also based on EIA documentation, but provide a list of specific impact mitigation measures.
WB usually require EIA / EMP at a very early stage (at feasibility level, or even before deciding to grant funding). This is done for dissemination / publishing / consulting better and better.	Law no. 851 (Article 17) requires: ... 1) Organization and EIA at all stages of planning and design objects, funding the development of EIA documentation, organizing public debates on the proposed activity and the presentation of the EIA documentation, with necessary approvals for to carry out the state ecological expertise; … ... 4) The positive advise of the state ecological expertise serves as the basis for the chapter "Environmental Protection" in the project and planning documentation.

Box 3 continued

1	2
Environmental Management Plan includes: 1. A brief project description; 2. Mitigation or control of pollutions plan: including responsibilities and costs; 3. Monitoring requirements: Including responsibilities and costs; 4. Institutional arrangements to be used to implement the EMP including: Responsibilities; Institutional strengthening (training) arrangements; 5. Reporting requirements: Schedules; Public consultation summary (minutes of meetings with affected groups and stakeholders, etc.).	**Environmental Plan includes:** 1. Description of the project; 2. Mitigation (or control) of the environmental impacts, including the responsibilities and costs. ***Or , The Moldovan EPP is mostly limited to this:*** **What are the implications?** 1. When the country has no provision for a legally binding EMP: Environmental mitigation measures are more difficult to enforce; 2. When monitoring plan is not included: The effectiveness of mitigation measures cannot be assessed; 3. When institutional responsibilities are not assigned: It is difficult to ensure accountability, monitor compliance, or reward good performance; 4. When costs are not estimated: It is less likely that the mitigation measures will be adequately financed; 5. When public consultation is not documented: It is less likely that consultation will be timely and adequate.

Article II. international, including the World Bank environmental policy document (OP 4.01 - Environmental Assessment (1999). Some of these differences, for example, the development and implementation of an Environmental Management Plan (EMP), are presented in Box 3. legislative and regulatory requirements of the Republic of Moldova and

However in the development of projects also must be considered some particularities of the existed roads of the rehabilitation conditions thereof in the Republic of Moldova, which may be:

Distance between localities (villages, towns) is relatively small, so it can be avoided the placing of the training camps for workers in construction sites, although workers transportation at the end of the working day to the premises leased necessary is less expensive.

The consequences are features, such as:

1.There is no need for field workers preparing food;

- No sleeping facilities are required;
- No need to shower facilities, washing clothes etc.

2.Most road rehabilitation projects are for the existing road, so:

- Not required detalied studies;
- Environmental impact is more significant during the implementation (execution of projects in the field);
- The terms and costs can be reduced and the reasons that the roads are of short length.

Conclusions

A. Updating existing normative legislative base require more effort, given the possibilities for their practical implementation in terms of co-participation of companies and foreign companies;

B. Adapting national norms and standards to those European and international and / or to receive international standards of ISO and EN series and to create conditions for their implementation, etc..

C. Creating favorable conditions for the implementation of the road rehabilitation projects by manz national companies and interprises, ensuring sustainable development in this branch and Agenda 21 of the Republic of Moldova.

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INTERPOLATION GRID FOR LOCAL AREA OF IASI CITY

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Key words: quasigeoid, interpolation, height, anomalies, precision.,

Abstract. Definitive transition to GNSS technology of achieving geodetic networks for cadastre implementation in cities and municipalities, enforce establishing a unique way of linking between current measurements and existing geodetic data, with a sufficient accuracy proper to urban cadastre standards. Regarding city of Iasi, is presented a different method of transformation which consist in an interpolation grid for heights system. The Romanian national height system is „Black Sea-1975" normal heights system. Founded in 1945 by Molodenski, this system uses the quasigeoid as reference surface, being in relation with the ellipsoid through the height anomalies sizes in each point. The unitary transformation between the ETRS-89 ellipsoidal height system and the normal one, at national level is provided through the „TransdatRo" program developed by NACLR (National Agency for Cadastre and Land Registration).

Introduction

The adoption in 2000 of the ITRS89 (International Terrestrial Reference System), was probably one of the most important achievements of geodesy of all time, because it provided a tool with which users can control both the positions of the points on the surface land and how these positions over time. This is geocentric reference system and its geometrical and physical parameters are the result of observation campaigns, extensive research and analysis on more than 30 years.

Regarding systems altitudes, the situation is unusual, being used practically all altitudes systems designed throughout history geodesy.

The trend of using satellite positioning systems and global satellite mapping systems may introduce serious practical difficulties if the results must be reported to the old maps or digital data. Consequently, it not only requires the data transfer between geodetic reference systems but also between cartographic projection systems referred to different reference systems.

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Regarding Iaşi city, it has been designed and built a geodetic network through GNSS technology, consisting of a total of 84 points evenly distributed across the entire city. They have been designed under the form of a support base for the development of further closed traverses and they are located two by two at close distances up to 200 meters. In 2005, the network was determined using the WGS-84 system. In 2010, some of the basic network points have been determined again in the ETRS-89 system, which became official in Romania since 2009, so that all network coordinates were transformed into the European datum under the centimeter precision (Chirila, C., Mihalache, Raluca Maria, 2011). Through this transformation, a data set containing the ellipsoidal heights of the network points known in ETRS-89 system was obtained. Due to the network relatively small surface of about 600 square kilometers, the initial precision for the ellipsoidal heights determination falls, generally, in the range of 2-3 cm (Chirila, C., Manuta, A., 2006).

After the closed traverses execution, a precise levelling network was design, containing horizontal network points and, implicitly, those of the geospatial network from Iasi city. The measurements have had on basic the class one landmarks from the national levelling network there for after geodetic processing, normal heights were obtained in ”Black Sea-1975” national system. Following measurements campaigns have resulted a number of 37 polygons, which totalled 145 Km, statistics highlighting a superior precision, in the range of few millimeters, obtained than GNSS technology. (Salceanu, G., 2009).

Given the existence of two data sets for a significant number of points, it is possible to apply a transformation model for the differences of the ellipsoidal heights, obtained with a millimeters precision on short distance, by GNSS technology, in normal heights system required in current practice. Through these, normal heights for the new points are resulted with a centimeters precision, avoiding the long-time execution need it for this kind of works.

Methods and algorithm

1.Theoretical review

A consistent technique for converting data from one datum to another shall maintain integrity and topology of existing data set and to ensure identical processing results regardless of who performs this transformation.

A model for transforming coordinates from one datum to another, adopted as an international standard, it must meet four criteria:

- Simplicity- to facilitate understanding and adoption by users;
- Efficiency-to minimize the time and computational requirements;
- Uniqueness-to ensure that a single solution;

• Rigor-to provide the best possible outcome of transformation.

Making a complex model transformation based on interpolation regular network (grid) is a convenient and widely accepted practice that meets the first three criteria.

Original method implemented in modelling surface for the heights transformation is based on polynomial functions. For monitoring precision variations it has been developed three different algorithms for the transformation by polynomial degrees, making the correlation between horizontal positioning points and height anomalies (Bofu, C., Chirila, C. , 2007):

- $\zeta = a_{00} + a_{10} x + a_{01} y$ (1st degree)
- $\zeta = b_{00} + (b_{10} x + b_{01} y) + (b_{20} x^2 + b_{11} xy + b_{02} y^2) + (b_{30} x^3 + b_{21} x^2y + b_{12} xy^2 + b_{03}y^3)$ (3rd degree)
- $\zeta = c_{00} + (c_{10}x + c_{01}y) + (c_{20}x^2 + c_{11}xy + c_{02}y^2) + (c_{30}x^3 + c_{21}x^2y + c_{12}xy^2 + c_{03}y^3) + (c_{40}x^4 + c_{31}x^3y + c_{22}x^2y^2 + c_{13}xy^3 + c_{04}y^4) + (c_{50}x^5 + c_{41}x^4y + c_{32}x^3y^2 + c_{23}x^2y^3 + c_{14}xy^4 + c_{05}y^5) + (c_{60}x^6 + c_{51}x^5y + c_{42}x^4y^2 + c_{33}x^3y^3 + c_{24}x^2y^4 + c_{15}xy^5 + c_{06} y^6)$ (6th degree)

where:

- $\zeta = (H^E – H^n)$ = height anomaly in point, calculated as the difference between ellipsoidal height (H^E) and normal height (H^n);
- (x,y) = the horizontal rectangular coordinates in the national map projection (Stereographic-1970);
- a_{ij}, b_{ij}, c_{ij} = the transformation coefficients, which are determined by the adjustment.

Solving the above equations, lies to the applying the principle of least squares, based on the excess points to the minimum necessary, obtaining the unknown parameters represented by the transformation coefficients. For the precision evaluation of the results, was retained for statistical analysis, the mean square error transformation for height anomaly of a point:

$$s_0 = \sqrt{[vv]/(r-n)}$$

where **r** represent the number of common points and **n** the number of unknown parameters.

2. Algorithm

Of the 84 points of Iasi city geospatial network, only 71 points were selected in processing algorithm. These have heights determined in both systems, ellipsoidal and normal, with no errors outstanding in terms of the anomalies values.

Further was continuing a data filter through comparing height anomalies to a smooth surface, by “v4” method of Matlab software, using a grid interval of 300 m (Figure 1).

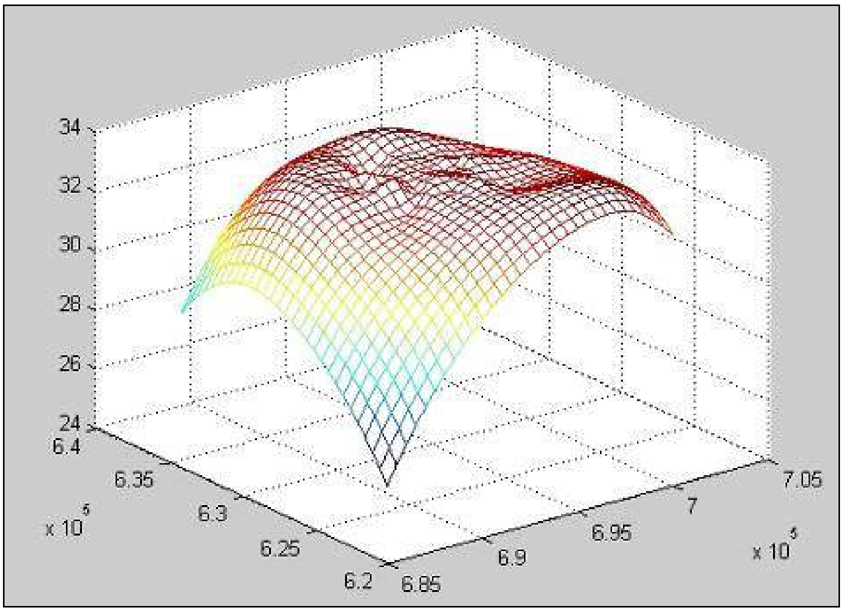

Fig. 1: Interpolated surface height anomalies by the "v4" method of Matlab software

Over 5 cm above a limit set for the differences between the known height anomalies and the ones, produced by the interpolation, have been removed from the adjustment model. Therefore, a total of 63 points were accepted according with the interpolation surface development.

Additionally, a graphics survey was conducted over the isolines generated by the height anomalies variation. It was observed the continuity of the model, without eliminating other points further processing (Dumitru, P.D. , 2011).

For other height anomalies interpolations testing were performed, in Matlab software, using several variants of spacing grid, with methods for linear interpolation, nearest neighbor, cubic and "v4" (www.mathwork.com).

3. Results and discussion

Obtained results for the three variants of polynomial interpolations are shown in **table 1**. It is noted that through the application of a polynomial function of 6th degree, the smaller mean square error is obtained with the best results for the control point. The latter was chosen on GNSS reference station site of the Hydrotechnics, Geodesy and Environmental Engineering Faculty of Iasi, with ETRS-89 geodetic coordinates and normal height determined with precision:

B = 47°09'20.19756"N; L = 27°35'55.55345"E; H^E = 89.985 m; H^n = 57.643 m

In the case of interpolation in Matlab using the four methods mentioned above, it is presented in the Table 2, standard deviation variation in height anomalies of common points for increasing the grid interval with 100m.

Table 1: Polynomial interpolation results for height anomalies

Polynomial transformation algorithm	The number of coefficients	The number of degree of freedom	Mean square error transformation s_0 (cm)	Deviation in the control point (cm)
1st degree	3	60	20.2	8.6
3rd degree	10	53	19.7	11.6
6st degree	28	35	16.1	6.6

Table 2:Statistical analysis of data set for interpolation in Matlab

Grid	The standard deviation of height anomalies in common points used in interpolation (cm)			
	Linear	Nearest neighbor	Cubic	“v4”
100 m	1.78	0.00	0.46	-
200 m	3.27	0.67	0.79	0.62
300 m	5.09	0.68	2.35	1.45
400 m	6.17	5.28	3.52	2.52

It is observed that as the grid interval increases the standard deviation also increases, so it is recommended that an interval as small, but not consume too much of computing resources (100 m - 200 m). For example, the statistics obtained at the interval grid of 200 m, in the four interpolation methods and the testing performed in the control point, are shown in Table 3.

Table 3: The results of interpolation by Matlab methods (200m)

Interpolation method	Mean deviation of transformation (cm)	Maximum value of deviation (cm)	Average deviation in absolute value from the mean (cm)	Deviation in the control point (cm)
Linear	3.27	9.04	2.24	8.7
Nearest neighbor	0.68	5.40	0.17	9.1
Cubic	0.79	3.13	0.44	7.9
"v4"	0.62	1.80	0.47	5.8

The graphic representations of surfaces thus obtained are presented in Figure 2, where the chosen grid interval is 500 meters, for better image quality.

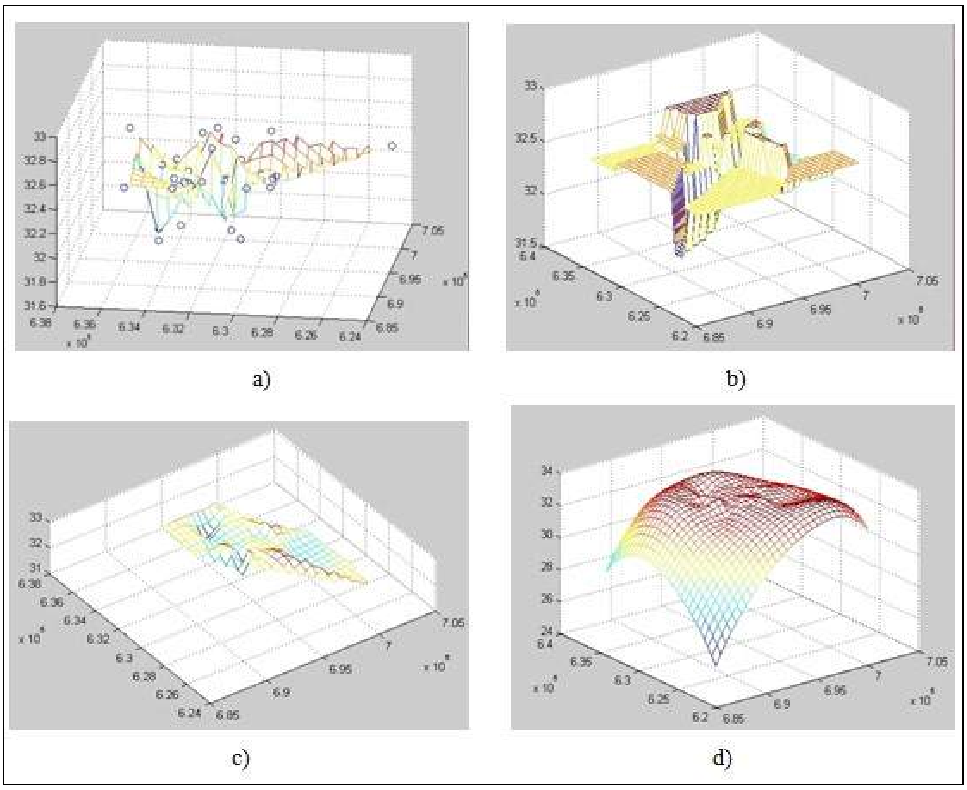

Figure 2: Interpolated surface for height anomalies by linear (a), nearest neighbor (b), cubic (c) and „v4" (d) method, for the 500 m grid interval

In Table 4 is presented statistical analysis of the data set, represented by the height anomalies in the common points, to highlight the variants of works, with improvements in relation with national TransdatRO application for the transformation of geodetic coordinates ETRS-89 in the national system (stereographic - 1970 projection and the heights system of "Black Sea – 1975").

Table 4: Statistical analysis of the differences between height anomalies obtained from GNSS measurements and levelling, respectively by application TransdatRO

Data set	Absolute average value	Absolute maximum value	Absolute minimum value	Standard deviation in data set s_o
63 points	17.60 cm	65.56 cm	0.77 cm	23.41 cm

There is to be seen an improvement in the results, for the common points, of the interpolated surface by applying local modelling for the heights transformation, at centimeter level.

Conclusions

Determining an accurate model of quasigeoid in Romania is a current concern in the domain of geodetic surveying. Due to insufficient data in the gravimetric measurements, the model developed nationally by National Agency for Cadastre and Land Registration (TransdatRO), requires further improvements for filling with new data from measurements and tests on multiple checkpoints.

In this context, the paper addresses a practical problem of modelling by geometric methods of interpolation for small areas at the local level. The available measurements consist of two data sets resulting from local GNSS and levelling network measurements of the municipality.

The data set was analysed statistically by the correlation between horizontal positioning points and height anomalies calculated at each point. The average height anomaly is 32.247 m. The maximum value is 3.632 m, the minimum is 31.734 m and standard deviation of about 20 cm.

Data filtering was performed by a method compared to a smooth surface obtained in "v4" interpolation method of Matlab and observing graphically the isolines of the height anomalies. It must be considered that this filter does not exclude some points that could reveal anomalies variation in land elevation.

When applying the selected methods of interpolation in Matlab software, it is recommend choosing a grid interval as small, but not consume too much of computing resources. A grid interval of 100 - 200 m is sufficient for a small stretch zone. Although the standard deviation of transformation can be very good for the common points, it is necessary that testing be performed on control points. Results on the checkpoint between the four methods discussed (linear, nearest neighbor, cubic and "v4") lead to results close to each other and to higher order polynomial transformation.

Choosing a method of the set is recommended to be taken after testing a sufficient number of control points distributed uniformly across the area. Also, combining geometric model derived from GNSS and levelling measurements with European regional gravity model can provide better results in correcting height anomalies and could provide the basis for accuracy in geodetic works.

Acknowledgments
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AN EPISODE OF LATE BLIZZARD, 25-26 MARCH 2013

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Key words: blizzard, climatic risk, North Atlantic Oscillation climatological and synoptic analyses, socio-economical impacts

Abstract. Climatologically speaking, March is a month of transition, from the cold season to a less cold season, and, therefore, weather phenomena occur in a different way from how they usually do during the cold season. The transition between seasons or a late winter can sometimes cause phenomena that usually happened in January or February, at the end of March. Such a case was the snowstorm occurred in two episodes (22nd – 24th and 25th – 27th of March 2013) in Romania in March 2013. In this paper is analyzed the first episode which affected southeastern Romania from different points of view: climatologically, synoptically, economically and social. It was used climatologically data over a period of 112 years, as well as a data for the first 3 month of 2013 which were provided by the National Meteorological Administration (NMA). It has been used synoptic maps, different pressure levels maps, and satellite data, radar data, soundings, all provided by the National Center of Weather Forecast of the NMA. Other type of information from the General Inspectorate for Emergency Situation (IGSU) or other ministries and media were also taken into consideration.

Introduction

In mid latitude, adverse weather can sometimes be very severe, being classified by some authors as “extreme weather events” (Moldovan, 2003) or as “climate risk phenomena” (Ciulache and Ionac, 1995). Blizzard is classified as a weather risk phenomenon typical for the cold season, but sometimes it may also occur in the transition seasons, in late fall or early spring in the third decade of March (e.g. the blizzards in two episodes: 22 –24 and 25–27 March 2013).

The climate of the south-east Europe region exhibits a marked variability, which has an enormous impact on people and their life.

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Due to intensity and associated phenomena (high wind velocity, significant snow falls, reduced horizontal and vertical visibility, large air temperature), such snowstorms can be very dangerous to the human society activities, often putting human lives in danger. Transports, agriculture and energetic industry are most frequently and severely affected.

In winter of the 2012–2013, a severe snowstorm occurred in December 2012 in a few episodes (6-10, 12-15 and 18-22). January and February 2013 are characterized as "mild" mounts. Therefore, the blizzards in the third decade of March are astonishment in the weather forecast.

The purpose of this paper is to describe a detailed observational weather risk phenomenon as blizzard using the architecture of weather data.

1. Data and methods

The weather data used in this paper were provided by the NMA, the main source of data. In order to analyze the occurrence of the phenomenon were used data from a period of 113 years (1900-2013), for the months March and April. The analysis of the snowstorm episode from 25th – 27th of March 2013 is based on hourly sea level pressure maps, weather reports and warnings issued by the NMA in the period of reference. Were also used some observational data as air temperature, pressure, rainfall, wind, other associated weather phenomena, etc. The synoptic analysis was based on the topography of sea level pressure and altitude maps, radar and satellite imageries provided by some open-access specialized sites such as: www.wetter3.de; http://weather.uwyo.edu/; www.nooa.gov, as well as soundings provided by the NMA. To roughly asses the damages we used releases from various ministries, the IGSU and information media.

2. Climatological state

Using the climatologically aspects were detected 42 episodes of blizzard, summing 104 days with blizzard. 1958 was the year when the biggest number days with blizzard were recorded in March (12). The latest date of when blizzard happened in a less cold season was 8th – 9th of April 1911, besides that, in April only two episodes of blizzard were registered during all the 113 years analyzed.

A climatological research over the entire analyzed period of 113 years reveals that 40 cases of blizzard happened during the March, the latest of them on the 27th – 31st of March 1907

In general blizzard occurred in Romania in a specific cut-off configuration due to the North Atlantic Oscillation (NAO) negative phase, and for this reason an analysis of the NAO Index was also used.

Using the NCEP/NCAR data was plotted the NAO index for the period between 1950 and 2013 (Fig.1). Therefore, 6 cases of March blizzards were happened when NAO was on the positive phase and 16 cases of March blizzards were on the NAO negative phase, with a lowest value in 17–18 March 1962 (-2.99)

Table 1.1 Number of cases with blizzard for March and April 1900–2013

Year	March	April	Year	March	April	Year	March	April	Year	March
1900	1		1940	2		1968	2		1987	1
1904		1	1949	1		1969	2		1988	1
1907	3		1952	1		1971	1		1992	1
1911	1	1	1955	4		1972	1		1993	2
1915	1		1958	1		1973	1		1995	1
1917	1		1962	1		1974	1		2006	1
1928	2		1963	1		1981	1		2010	1
1931	1		1964	1		1983	1		2013	2

(Source: NMA, 2013)

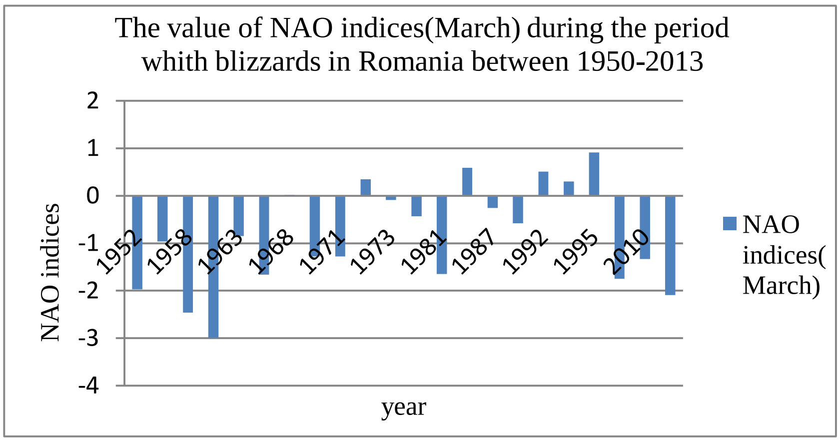
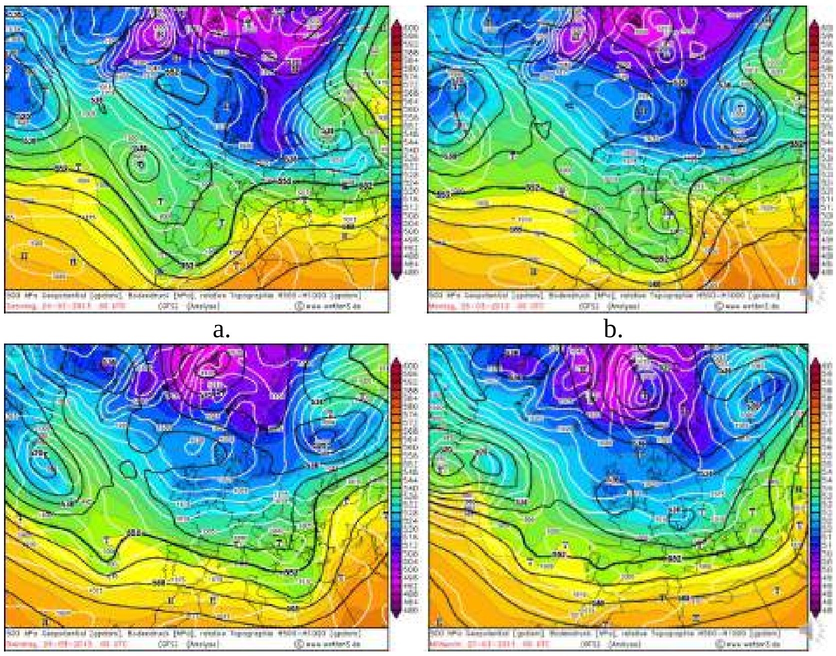


Fig.1 NAO index value for March in Romania, (Source: http://www.cpc.ncep.noaa.gov)

3. Case study: 25–26 March 2013

As an example, it is taken into consideration the event occurred from the 25th until the 26th of March. The synoptic overview of the blizzard episode is characterized by the analysis of the sea level pressure and altitude maps during the period between 24th to the 27th March that can be seen in the next charts.

The GFS model 500 hPa level map (Fig.2) describes the outbreak of the phenomenon in our country, in Europe, the synoptic configuration was the following**:** on the 24th of March 2013, the northern half of the continent was under the influence of the northern European anticyclone joining with the Scandinavian one, on the back of which the Icelandic cyclone was positioned, with N → S orientation, extending to the Mediterranean Sea basin, with a well-defined nucleus in the western British Isles, but advancing rapidly towards the Mediterranean basin, where we find it on 25th of March with a well developed nucleus in the Gulf of Genoa, displaying a S → E trajectory and , reaching on 26th of March over the Balkans and the southern part of our country.



a. b. c. d.

Figure 2. GFS numerical model analysis – synoptic maps 500 hPa at 00:00 UTC for March 24th (a), 25th (b), 26th (c) and 27th (d), (Source:www.wetter3.de)

The GFS model sea level pressure map (Fig.3) describes that on March the 24th, Europe was dominated by an anticyclone belt positioned in northern Greenland, and extending over the British Islands up to Central Europe, along NV→SE direction; behind it lying a low pressure field which originated in Iceland and extended from the eastern part of the Atlantic basin, up to the Mediterranean basin. The front line was stretching from the south of the British Islands to Western

Europe. On the 25th of March, the anticyclone belt changed its direction, placing itself over the continent, on a V→E direction, and reaching up to south-eastern Europe, where lies until the next day. The cyclonic field, at its back, develops over the Gulf of Genoa, and from there, it advances on V → E direction, over the Balkan Peninsula, where it reaches the southern part our country on the 26th of March.

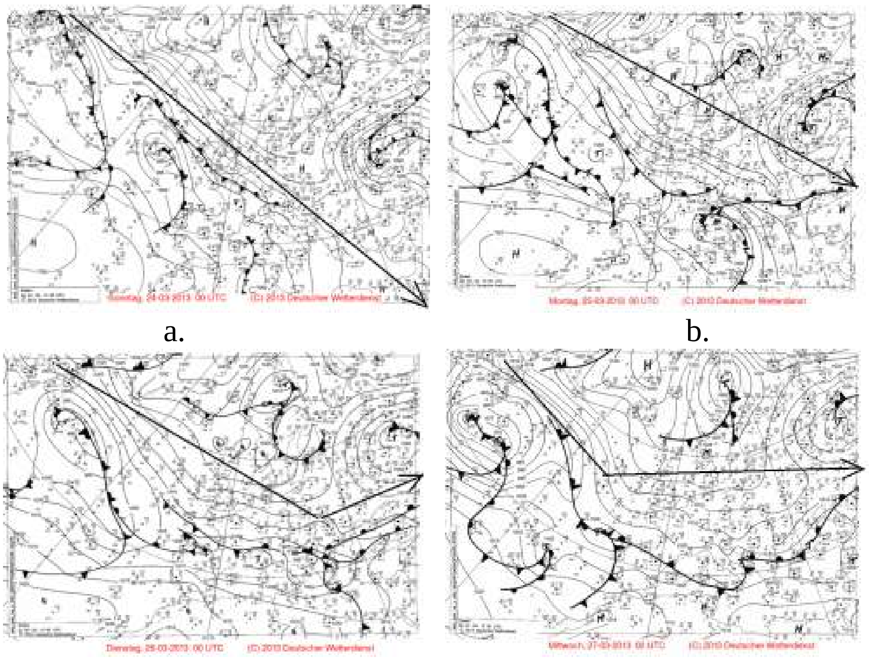
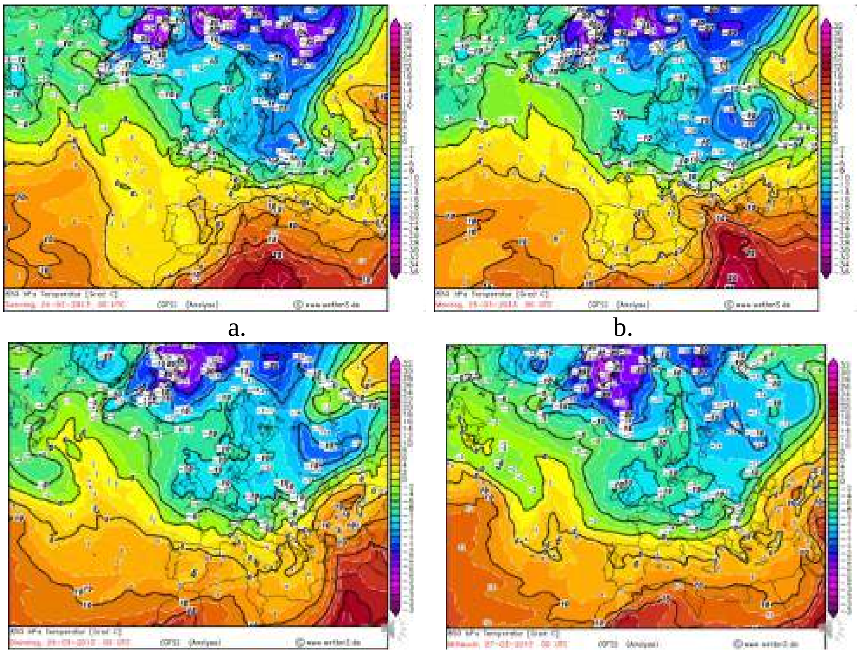


Figure 3. GFS numerical model analysis – sea level pressure at 00:00 UTC for March 24th (a), 25th (b), 26th (c) and 27th (d), (Source: www.wetter3.de)

The thermally according to the 850 hPa synoptic maps (Fig.4), GFS analysis model, on the 24th of March at 00 TMG, the northern part of the continent was under the influence of cold air masses of Arctic origins, 0 ° C isotherm crossing the continent on a NW → SE direction, and orienting to, the southern parts of the country, along the Southern Subcarpathian Hills while to the south a mass of Mediterranean warm and humid air mass was pretty active. On the 25th of March, the 0°C isotherm is shifts to the south, following the Danube basin, this situation remaining also unchanged on March the 26th. Due to the violent interaction between the two air masses on the 26th of March a snowstorm phenomenon therefore developed affecting Romania's SE regions for about 11 hours.

A "cross section" of temperature in the March 26th shows that in Sibiu (central part of Romania) was measured the highest value and one day before, same location had the lowest temperature value. One day later, the temperatures values suffered a slight drop, especially at Sighetu Marmaţiei and Bistriţa (7 degree Celsius), lowest absolute temperature being recorded at Miercurea Ciuc(-11 degree Celsius).



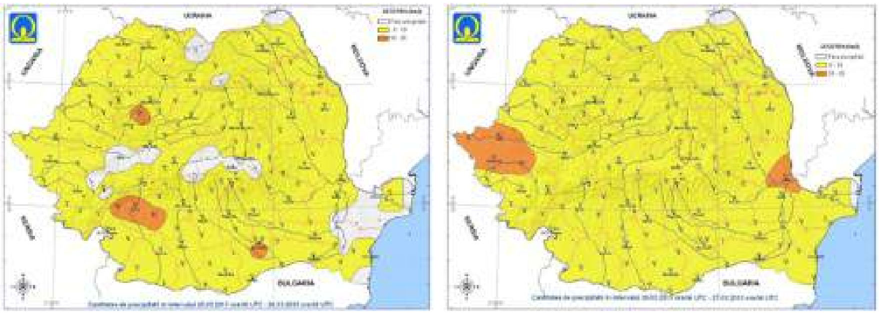
a. b.

c d

Fig. 4 Temperature maps at 850 hPa, 00:00 UTC, GFS analysis modelMarch 24th (a), 25th (b), 26th (c) and 27th (d), (Source:www.wetter3.de, 2013)

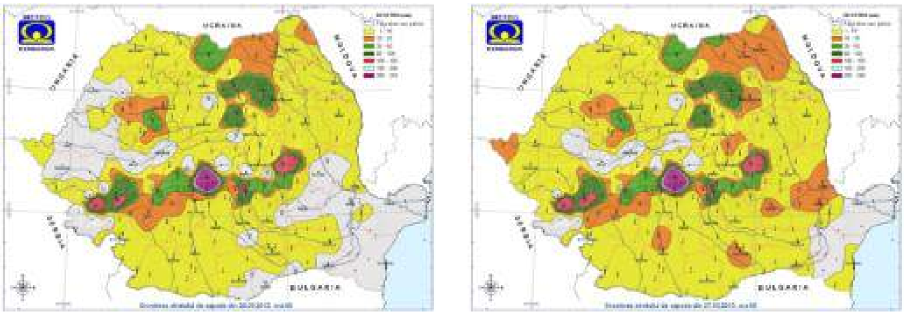
Synoptically overview of the meteorological phenomena from 24th -27th of March showed negative trend in their succession from rainfall at the start of the period, to snowfall and blizzard on the 25th and 26th of March especially in Southern and South-Eastern areas, highest blizzard intensity being situated in Bãrãgan (Fig.5), in the same areas atmospheric precipitation also being recorded was of 17.6 l/m³ at Galaţi on the 26th of March.

On the 25th of March there was snow in Crişana, Transylvania and Moldova, on the 26th of March, the snow covered most of the country, except Dobrogea, where snow was recorded only on the 27th of March as the rest of the country was already covered by it (Fig. 6).



a. b.

Fig.5 Rainfall amounts recorded in 24 hours: March , 25th (a), 26th (b), (Source: NMA, 2013)



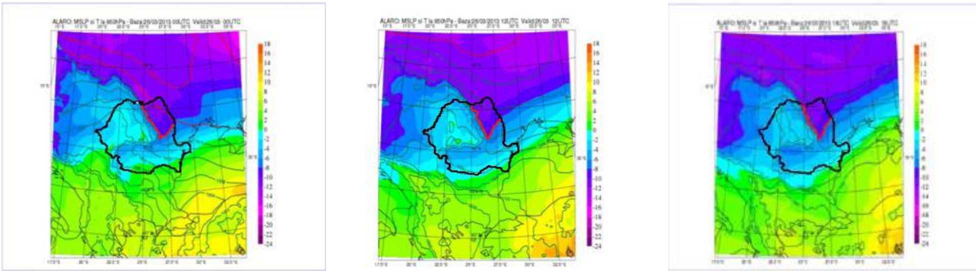
a. b.

Fig.6 Snow covers depths: : March , 25th (a), 26th (b), (Source: NMA, 2013)

4. Results

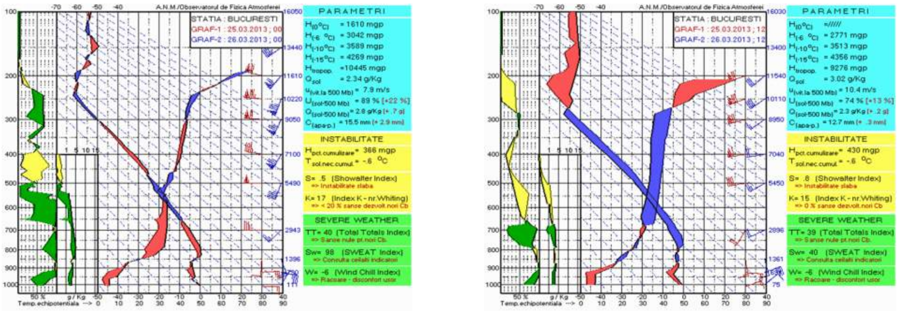
Using the ALARO numerical model data – the sea level pressure and 850 hPa temperature maps (Fig. 7) – denote that the polar air mass has a greatest influence over the northern part of Moldova extended along the Curvature Carpathians to the Bãrãgan area, pushing the warmer air mass generating the blizzard phenomenon. This fact it can be seen on the sounding diagrams for Bucharest.

The Bucharest soundings on the 26th of March, at 00:00 and 12:00 GMT (Fig. 8), show the existence in the lower troposphere of a warm air mass, which is then pushed up to higher levels once that the cold air mass sinks down, the thermal inversion occurring below 900 hPa, at a height of approximately 700-800 m, knowing that the blizzard mainly occurs in the lower troposphere. The soundings also show a wind shear at the sea level pressure from the NE which is increasing in upper levels. The warmer air mass was over the SW Romania.



a. b. c.

Fig.7 Sea level pressure and 850 hPa air temperature maps of 26 March 2013 ALARO model reconsidered, a) 00:00 UTC time; b) 12:00 UTC time; c) 18:00 UTC time, (Source: ANM, 2013)

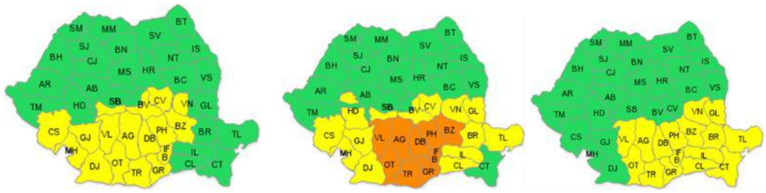


a. b.

Fig.8 Aerologic diagram in Bucharest on March 26, 2013: a) 00:00 UTC time; b) 12:00 UTC time, (Source:NMA, 2013)

4.1 Weather warnings

National Meteorological Administration first issued a yellow code, then an orange one and again a yellow code (Fig. 9).



a. b. c.

Fig. 9 a) Yellow code alert since 20 o'clock 25.03 - 26.03 at 4; b) Orange code warning at 26.03 04 - 26.03 14 hours; c) Yellow code warning on 26 March at 20, (Source: NMA, 2013)

4.2. Consequences

On the 26^{th} and the 27^{th} of March 2013, 600 schools and high schools were closed in Bucharest and Buzău county, A1 and A2 highways have been completely closed down to traffic because of the drifting snow piling on the road(Fig. 10)

Fig. 10 Images from Bucharest capital-city during the blizzard of March 26, 2013, (Source: http://www.click.ro/news/national/)

Sumary

The blizzard phenomenon from the 24^{th} until the 26^{th} of March 2013:

1. was a classic episode of blizzard produced by the violent clash between a Mediterranean cyclone and a Greenland anticyclone;

2. such phenomena usually occur on cut-off synoptic conditions in specific to the negative phase of the North Atlantic Oscillation favoring blizzards in mid latitude implicit regions;

3. the phenomenon was severe because of the great air-pressure horizontal lopes rates;

4. a cold air mass of polar origins stagnate over the northern parts of the Moldova province, extending towards the SE, along the Curvature Carpathian foothills and pushing the warmer air mass aloft

5. from a synoptic point of view, according to Bălescu and Beşleagă's classification(1962), this blizzard episode falls into the type III category;

6. the blizzard episode lasted for about 11 hours and centered over the Griviţa (Ialomiţa) locality;

7. the most intensely affected areas were: Bucharest, Ialomiţa, Buzău and Galaţi counties;

8. the climatologic analysis over a period of 113 years (1900-2013) revealed that in total there were 42 episodes of blizzard (40 in March and two in April), with a total duration of 102 days (98 March and 4 April);

9. the latest date on which blizzard conditions occurred was, from the 8th until the 9th of April 1911.

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25 YEARS OF SUSTAINABILITY. A CRITICAL ASSESSMENT

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Key words: development, economy, ecology, society, territory

Abstract. 25 years have passed since the 'Brundtland Report' defined sustainability as a possibility to equally meet current and future needs. 15 years later, the author of the definition stated that despite of the fact that the definition does not need to be changed, its understanding bettered off during the interval. 25 years later, the present paper takes an in-depth look at the concept and its practical implications. One of the issues being addressed refers to the pillars of sustainability; their number increased by 25% to include the cultural pillar in addition to the economic, social, and cultural one. Spatial thinking added a new dimension, translating into concepts like 'sustainable communities' or 'self standing village' at the local level, and 'polycentricity' and 'cohesion' at the regional one. Furthermore, practical implications include environmental impact assessment (evolving towards strategic impact assessment), internalization of externalities, ecological restoration, and a new view on conservation, different from the one addressed by the 'Zero Growth Strategy'. In addition, the paper discusses several criticism addressed to the concept and its implementation, attempting to reveal their underlying causes. Overall, the critical analysis shows that the attempts to achieve sustainability did not change the concept as much as its understanding.

Introduction

Twenty five years had passed since WCED published the report titled "Our common future", but referred later as the Brundtland report, after its author (Brundtland, 1987). Approximately fifteen years after, Dr. Gro Harlem Brundtland stated in an interview that her definition of sustainability should not change (Bugge and Watters, 2003). However, less than five year later, summing up an international view of development strategies, Steve Bass (2007) concluded that the

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evidence indicated that development did not turn sustainable. Nevertheless, from a theoretical viewpoint, Dr. Angheluţă Vădineanu (2009) refers to a certain theory of sustainability as a stage in the evolution of systemic ecology.

Taking into account these milestones, the present research aims at seeing whether there is any progress in understanding sustainability and what is needed for its implementation. We are merely asking questions rather than answering them. Issues of interest include the pillars and dimensions of sustainability; how did they change over the last quarter of century? What are the new concepts developed in relationship to them? Other questions regard sustainability itself; did its definition change, or at least the understanding of its definition? What is actually needed to achieve sustainable development? What are the driving forces that oppose sustainability?

1. Sustainability: the Concept

According to what Dr. Gro Harlem Brundtland wrote, sustainability is the "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (Brundtland, 1987). According to what she said fifteen years later, the same definition is still valid today (Bugge and Watters, 2003), even though many authors attempted to redefine it; as a matter of fact, the website at http://www.reds.msh-paris.fr/communication/textes/devdur.htm collects some of the significantly different definitions proposed in the meantime. Their analysis reveals three trends; one is mathematical, suggesting the maintenance of specific indicators below or above some threshold value (Lester and Becky, 1987) or securing their monotonic growth (Beaud, 1994). The second addresses the wellbeing issue (Barbier, 1987), and the last one deals with the resilience of systems (Conway and Barbier, 1986). In addition to the author's understanding, other researchers propose different meanings of sustainability or emphasize some particular sides of it.

If the definition did not change, then what else changed? According to Dr. Gro Harlem Brundtland, the understanding of sustainability bettered off. The question is, 'What particular aspect of sustainability needs to be better understood'? The definition focuses on human needs (Norton, 1992); as a matter of fact, the first principle of Rio de Janeiro Declaration stresses out this particular aspect, stating that "*human beings are at the centre of concerns for sustainable development*" (United Nations, 1992c).

Dr. Gro Harlem Brundtland is underlining two issues which are now better understood; one is the nature of the pillars and dimensions of sustainability, and the other is their integration. The first issue is discussed extensively in the next chapter, and their integration in the following one.

2. Sustainability: Pillars and Dimensions

Many authors consider that sustainability has three traditional pillars – economic, social, and environmental (Basiago, 1999; OECD, 2004; Littig and Grießler, 2005; Gibson, 2006; Murphy, 2012). Nevertheless, other authors consider a fourth cultural one, acknowledging its potential for economic growth (Hawkes, 2001). Its recognition was the result of an intense lobby by the United Cities and Local Governments, who officially recognized it in 2010 (United Cities and Local Governments, 2010). Nevertheless, it has addressed been earlier; the Convention on Biological Conservation (United Nations, 1992b) acknowledges the role of traditional cultural practices, by recognizing "*traditional knowledge, innovations and practices relevant to the conservation of biological diversity and the sustainable use of its components*". Elaborated descriptions are provided by Agenda 21: these people "d*eveloped over many generations a holistic traditional scientific knowledge of their lands, natural resources and environment*" (United Nations, 1992a). In a more generalizing way, the 2000 CEMAT "Guiding Principles for Sustainable Spatial Development of the European Continent" recognize "*cultural heritage as a factor for development*" (CEMAT, 2000). For this reason, it needs to be stressed out that the cultural pillar is considered equally important to the traditional ones, even though it has been added later (United Cities and Local Governments, 2010).

Some of the dimensions of sustainability overlap with its, economic, social, environmental, and cultural pillars. Nevertheless, a fifth dimension, of equal importance, was added to acknowledge the fact that sustainability occurs in territories of different sizes, corresponding to different administrative divisions (Bottero and Peretti, 2010; Péti, 2012). Because of its importance and relative novelty, spatial sustainability is discussed in a separate chapter.

Other dimensions are sub- or cross-sectors of the main ones; their interference is discussed in the next chapter. Examples include transportation, energy, housing, infrastructure, education, science, ethics, and management. Essentially, the guiding principle is the same, *i.e*. includes the ability of a system to self-sustain (autarky) after starting up by its own means, but evidence of (sustainable) growth is required in addition to it (Daly, 1990; Tofan, 1999; Curtis, 2003; Müller *et al*., 2011; McLellan *et al*., 2012).

To simply enumerate few approaches, the Club de la Budapest, founded in 1993, focused on a change of conscience and ethics (László, 2004; Ianoş *et al*., 2009); others looked for technological solutions (such as the ones promoted by the 1996 issue of *Daedalus*), considered the environmental impact of megalopolises (Dansereau and Weadock, 1970), or proposed economic, social or political issues or mixed strategies (Petrişor, 2011b).

3. Spatial Sustainability

A 2008 proposed definition of spatial sustainability is "*development providing for a territorial balance of satisfying at the same rate the economic, social and environmental needs of present and future generations*" (Petrişor, 2009). According to Collignon (2009), its aim is to "*ensure the coherence of socio-economic objectives in relationship with the territory and its ecological and cultural functions, aiming to enhance the quality of present and future generations' life by creating sustainable communities able to manage and use resources efficiently, exploiting the innovative ecological and social potential of the economy and guaranteeing the welfare, environmental protection and social cohesion*".

The spatial dimension has two important functions: (1) balances at different territorial levels cohesion and polycentricity, and (2) results into local 'sustainable communities'; at the same time, it is related to 'urban regeneration'. In the first case, **territorial cohesion** is defined as a "*balanced distribution of human activities in a territory*" (DG Regional Policy, 2004:3). The balance is reached by reducing existing gaps (for example, between urban networks), prevention of territorial imbalances (for example, between regions), through sectoral policies with spatial impact and more coherent regional policies. The active process leading to cohesion is called convergence (van Well, 2006:4). **Polycentricity**, a "*spatial organization of cities characterized by a functional division of labor, economic and institutional integration, and political co-operation*" (Nordic Centre for Spatial Development, 2003:3), is given by the *morphology* of a territory (number of human settlements, their hierarchy and distribution) and *relationships* (fluxes and cooperation) of these elements (Nordic Centre for Spatial Development, 2005:3). The second report cited distinguishes three levels of *polycentricity*: *macro* – the European alternative to the "Pentagonal", *mezzo* – regional, two or more cities are complementary, providing to the people and companies from the common areas access to urban functions that normally can appear only in higher ranked cities, and *micro* – intra-regional, complementary urban and economic functions are strengthened by the grouping of settlements (Nordic Centre for Spatial Development, 2005). Furthermore, the scale can move down to the city level, as the multiple development nuclei of a city can be seen as a form of polycentricity (McMillen and Smith, 2003).

The two concepts act together like the drivers of stability in an ecosystem: polycentricity provides for diversity, boosting the development of new centers, even of local importance, while cohesion gives coherence to the entire system, intervening when polycentricity results into serious imbalances with negative consequences; *e.g.*, a center that develops at the expense of stopping the development of all surrounding ones (Peters, 2003; Waterhout *et al*., 2005; Meijers, 2008). The ecological consequence of the two is that polycentricty disperses the impacts – particularly pollution – generated by the development of single centers (Coffey and Shearmur, 2002; Peptenatu *et al*., 2011, 2012), while cohesion allows for developing coherent environmental policies for the entire territorial system.

Sustainable communities were defined by the 2005 Bristol Accord as "*places where people want to live and work, now and in the future*" (Office of the Deputy Prime Minister, 2006). Even though the report refers to 'communities', the eight characteristics making a community sustainable point to urban areas:

- **Active, inclusive and safe**: fair, tolerant and cohesive with a strong local culture and other shared community activities;
- **Well run**: with effective and inclusive participation, representation and leadership;
- **Well connected**: with good transport services and communication linking people to jobs, schools, health and other services;
- **Well served**: with public, private, community and voluntary services that are appropriate to people's needs and accessible to all;
- **Environmentally sensitive**: providing places for people to live that are considerate of the environment;
- **Thriving**: with a flourishing, diverse and innovative local economy;
- **Well designed and built**: featuring quality built and natural environment;
- **Fair for everyone**: including those in other communities, now and in the future (Office of the Deputy Prime Minister, 2006).

A similar concept has been developed for rural communities; the '*self-standing village*', developed by Mihail Eminescu Trust, is "*an original concept promoting the sustainable development of rural communities by valorizing their unique heritage – monuments, vernacular architecture, landscape and biodiversity*" (Fernolend, 2010).

New socioeconomic constraints and people needs impose to human settlements a need for change (Turok, 1992; Bassett, 1993; Loftman şi Nevin, 1995; Healey, 2004; Ng, 2005); under this framework, urban regeneration is the "*adjustment and re-modeling process oriented to improving urban living conditions*" (Petrişor, 2012b).

4. Integrating the Pillars and Dimensions of Sustainability

The inter-relations of the pillars and dimensions of sustainability have been widely discussed. Some scientists applied the taxonomical principles to label each possible intersection. The image displayed in Fig. 1 has been quoted and used by numerous studies, since it is distributed under the Creative Commons Attribution-Share Alike 2.0 France license; it has been originally published by Jacobs and Sadler (1989).

The particular relationship between the economic and environmental pillars, perceived through the economic perspective as two types of capitals, has been analyzed by Vădineanu (2008) based on the assumptions of classical economy (where the natural capital is used disregarding its diminishing to increase the created one), ‘zero growth strategy’ (stopping the development and creation of capital, and consequently the reduction of natural capital), environmental economy (understanding that the decrease of the natural capital results into a reduction of the created one too), and sustainability (implying ecological restoration, which increases the natural capital, while the integration of environmental policies in socioeconomic strategies accounts for no longer depleting the resources of the natural capital while the created one is increased).

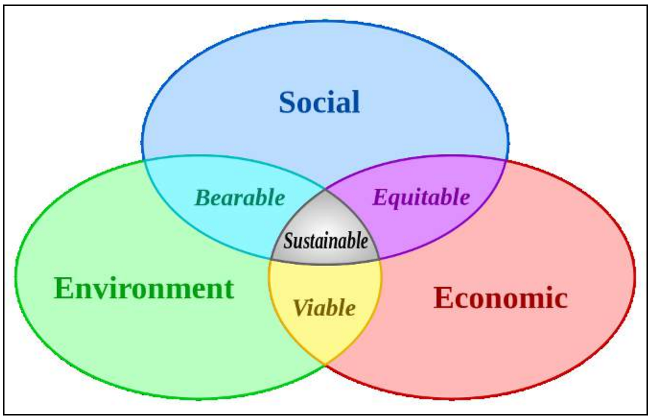
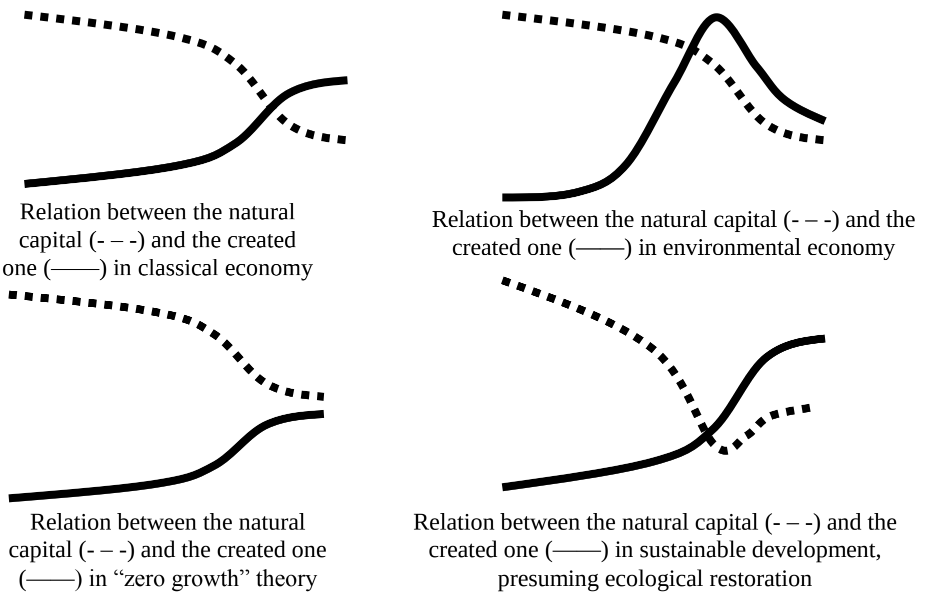


Fig. 1. Three-pillars view on sustainability. Image freely distributed under the Creative Commons Attribution-Share Alike 2.0 France license at http://en.wikipedia.org/wiki/File:Sustainable_development.svg

A similar theory is proposed by Petrişor and Sârbu (2010): the creation of capital leads to an increased complexity of territorial systems and growth of geodiversity; if natural resources are managed in an environmental-friendly manner based on a holistic managerial approach, biodiversity is “amplified” through the human contribution and geodiversity increases. An important conclusion of these findings is that sustainability implies a co-development of the natural and man-made capital, also underlined by Vădineanu (2004).

The integration is manifested and achieved through the recognition of all pillars and their equal consideration when designing the sectoral strategies of development at all administrative levels (Pope *et al*., 2004; Gibson, 2006; Fisher *et al*., 2008), as stated also in the title of the 8th chapter of Agenda 21: “integrating environment and development in decision-making” (United Nations, 1992a), and the integration of the policies of development for all administrative and territorial levels – international, national, regional, and local, accounting for the principles described in the previous chapter (aiming for a balance between polycentricity and cohesion). This issue is particularly important, as there is often a biased perception of sustainability addressing only or especially environmental issues (Smyth, 2011).



Relation between the natural capital (- – -) and the created one (——) in classical economy

Relation between the natural capital (- – -) and the created one (——) in environmental economy

Relation between the natural capital (- – -) and the created one (——) in "zero growth" theory

Relation between the natural capital (- – -) and the created one (——) in sustainable development, presuming ecological restoration

Fig. 2. Relationship between natural and created capital under different economic theories (Vădineanu, 2008)

5. Basic Assumptions of Sustainability

The theory of sustainability is based on a conceptual framework analyzing the evolution and underlying theoretical background of all implicit or explicit models of development, according to their consequences over the environment and response of the natural capital, presented in *Table 1*. Sustainability relies on a holistic and systemic understanding of the environment as a hierarchy of functional structures, regardless of their natural or socioeconomic nature, replacing the anthropocentric one (Vădineanu, 1998; Ungureanu *et al*., 2011). Ecological systems are the support of life and constitute the ecological foundation (Pawlowski and Auslander, 2000; Vădineanu, 2007; Haberl *et al*., 2009).

This theory is based on understanding the environment, from a trans-disciplinary perspective, as a sum of capitals; the first one is the natural capital, represented by the natural, life-supporting systems, constituting the ecological foundation, and composed of environmental goods and services, and the second, representing the anthropic environment or anthroposphere (Vădineanu, 1998), has three components: (1) the economic capital, composed by built infrastructure (physical capital), the technosphere (technological environment), (2) the social capital, consisting of institutional/administrative capital, and of all relations among humans, regulated (by juridical and socio-economic constraints) or not, and (3) the cultural capital, consisting of a traditional set of perceptions and practices, and human knowledge and abilities (Vădineanu, 1998; Petrişor, 2011b).

Tab. 1. A timeline of the relationships between human society and natural systems

Moment	***Early history***	***Industrial revolution***	***Oil Crisis, Club of Rome (1970's)***	***Brundtland Report, 1988; Rio de Janeiro, 1992***
Model	No model	No model	"Zero growth" strategy	Sustainable development
Action	Life in harmony with nature	Degradation of the natural capital	Strict conservation (preservation) of biodiversity	Conservation, impact assessment, ecological restoration, internalization of externalities
Consequence / reaction of environment	Low impact	Reduction of environmental goods & services	Development would stop	Co-development of natural systems & human society
Ecological approach	None	Anthropocentric	Anthropocentric	Holistic

It is obvious that the main barrier that sustainability must pass is the competition between the natural and anthropic capital (Mazilu and Giurgea, 2011). On the one hand, man-dominated systems are strictly dependent on goods and services provided by the natural ones (Sârbu, 1999, 2006), but they are also competing for space (Peptenatu *et al*., 2011, 2012; Petrişor, 2012a). The drivers of environmental change are political (Peptenatu *et al*., 2010), social and economic (Petrişor *et al*., 2010). More important than the drivers themselves is their interaction, due to synergistic effects. The term "global change" was introduced to encompass all man-generated impacts affecting the ecosphere: land use changes, climate change, and energy use (Dale *et al*., 2011).

Another important point that needs to be stressed out here, even though it will be discussed in the next chapter, is that the principles of sustainability do not apply only to concrete and ongoing activities, but also to plans, projects, programs, and to support activities, such as management, legislation etc. (Owens, 1994; Judge and

Douglas, 1998); this is, in fact, an illustration of the international precautionary principle of environmental law (Trouwborst, 2009).

Last but not least, scale is a crucial issue in sustainability. It has been shown above that the key to sustainability is integration, which needs to be manifested, from a spatial perspective, at all administrative and territorial levels. More exactly, according to Dr. Angheluţă Vădineanu (2004, 2007, 2009) and Dr. Radu Ştefan Vădineanu (2008), the key to sustainability is balancing socio-ecological complexes at all hierarchical levels.

6. Practical Implications of Sustainability

Previous discussions have attempted to analyze the theoretical framework of sustainability, addressing issue related to what needs to be known and what the appropriate approaches to achieving a sustainable development are. In the next paragraphs, the discussion focuses on the concrete means to turn development sustainable in practice.

Essentially, there are three issues needed to account for; (1) ecological restoration, (2) environmental impact aimed at internalizing externalities (accounting for the "polluter pays" principle) and avoiding further degradation (the precautionary principle, mentioned in the previous section), and (3) conservation of biodiversity.

With respect to the first one, sustainability must account for the mistakes made in the past through the ecological restoration of degraded systems, in order to offer future generations an unaltered part of today's natural capital; the ecological engineering techniques are an important instrument. This goal is connected to the third one, as safeguarding for the future generation an unaltered part of present environment requires bringing it to almost pristine conditions (Aronson *et al*., 2006; Choi *et al*., 2008).

Sustainability must look at all present activities and assess their impact (economic, social, environmental, and cultural) from a triple perspective: (1) ensure that all activities are designed for a long term; (2) assess the consumption of resources and generation of waste or pollution in order to hold the polluter responsible and prevent further degradation (Clive, 1999); and (3) provide mechanisms for the internalization of externalities (Pretty *et al*., 2001), putting into practice the "polluter pays" principle. At the same time, benefits must be returned to those who give up over some benefits in order to help the future generations (such as the indigenous communities or companies likely to adopt an environmentally-friendly behavior etc.). Based on these principles, the new integrated approach, called Strategic Environmental Assessment, tends to replace the Environmental Impact Assessment. The main difference between the two is that "*the object of assessment generates different methodological requirements related to the scale of assessment and to the decision-making process*" (Partidário, 2007). The new approach integrates better the pillars of sustainability (Abaza *et al*., 2004) and is particularly useful to solve specific issues of transition countries, such as the consequences of industrialization (Alshuwaikhat, 2005).

Finally, sustainability must safeguard for the future generations an important part of today's biodiversity, through the declaration of natural protected areas (Hoag and Skold, 1996; Holling, 2000). The design of such areas must take into account several principles: (1) conservation must not be understood as strict preservation, in an unaltered state, but as maintenance of systems within the carrying capacity limits, ensuring the structural and functional integrity of life-supporting systems, (2) conservation must reflect the international, national, regional, and local representativeness of chosen areas for the biogeographical space, ecological zoning, or spatial other form of diversity, (3) conservation implies an active management, requiring the existence of a plan and a structure responsible for its implementation, (4) within the protected areas, zoning must allow for a differentiated management; the core areas must be buffered gradually, ensuring the transition of practices to "no restriction" regions such that the core areas are not affected; (5) local populations must be attracted in drafting the plan of management, ensuring their support for its implementation, including a correct redistribution of benefits, and (6) multi-sectoral, regional, national, and international cooperation is very important for making all protected areas working together as a global network (Petrişor, 2011a).

7. Criticisms addressed to Sustainability

While it seemed that sustainability could solve all environmental issues, many authors started criticizing it. Criticisms ranged gradually from addressing the inability of putting it into practice to dealing with its means and finally denying its very essence; on a gradual scale, Steve Bass (2007), researcher at the International Institute for the Environment and Development and former advisor on environmental issues to the UK Department of International Development, showed that "*three UN-commissioned reports from 2005 show clearly that development has not yet become sustainable*". Serge Latouche (1994) criticized the means stating that "*sustainable development is like the road to hell, paved with good intentions*". Finally, Nicholas Georgescu-Roegen (1991:53) addressed the core saying that "*there is not the slightest doubt that sustainable development is one of the most destructive concepts*".

Analyzing the nature of criticisms, Sneddon *et al*. (2006) mention fundamental contradictions between the economic growth in developing countries and conservation, and the omission of power relations among the local-to-global actors and institutions supporting unsustainable development. Smyth (2011) resumes criticisms concerning the institutionalization of sustainability, as well as its programmatic implementation resulting into a precedence of the interests of donors over those of recipient communities.

Conclusions

This research attempted to summarize the changes occurred during a quarter of century since the concept of sustainability was defined. The analysis was focused on theoretical and practical issues. The results revealed that the definition did not change, but its understanding was enriched substantially. The number of pillars increased by 25% and many dimensions were addressed; for each of them theories were elaborated, turning sustainability into a science. However, little progress was made with respect to its practical implementation, resulting into numerous criticisms, addressing its means and even its core. Even though humanity seems to understand better what needs to be done for achieving sustainability, these requirements seem to be hard to put into practice. It can be only hoped for the concept to become operational in a degree commensurate with its improved understanding.

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OSCILLATIONS AND CYCLES OF AIR TEMPERATURE IN RUSSIA

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Key words: Oscillations of air temperature, cycles of air temperature, Laplace zonal spherical function, tidal potential, Rossby waves.

Abstract. This paper proposes to demonstrate that in Russia there are air temperature oscillations which produce almost perfect cycles. These are the same cycles previously described in Romania, North America, New Zealand and South America. The large latitude and longitude extent of the territory of Russia determines very different thermal oscillations from one region to another. The Arctic Ocean has a special influence in the evolution of air temperature in Russia, but so does the Pacific Ocean, through the cold "Oya Shivo" current. The warm ocean current "Kuro Shivo" has a reduced influence, only through one of its branches which enters the Sea of Japan from the south.

Introduction

Like in other regions on Terra, there are daily cycles of maximum and minimum temperature on the territory of Russia which are explained through cycles of the atmospheric tides, generated by the attraction of the moon and sun. Some air temperature oscillations from Moscow and Krasnodar are similar to the ones in Winnipeg (Canada) and, respectively, Minneapolis (the USA). Similar to other regions on Terra, there are air temperature cycles on the territory of Russia that can be explained through the zonal spherical Laplace function. This represents another argument that allows us to admit that this function can be applied in meteorology on the territory of Russia as well.

In order to describe air temperature oscillations and cycles, meteorological data from Moscow (accentuated temperate continental climate), Tomsk and Surgut (for the climate of Western Siberia), Oimiakon and Verhoiansk (for the climate of

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Eastern Siberia), Vladivostok (for the climate of the Far East, situated under the influence of the warm ocean current “Kuro Shivo”) and Krasnodar (for the temperate continental climate) have been used.

On Russian territory, all air temperature cycles previously described exist both those that last under a year and those whose duration is longer than a year.

1. Air temperature cycles lasting less than a year

On Russian territory, the most frequent cycles from this category are the following:

1.1. The 14-day cycle

This cycle of daily maximum and minimum temperature is attributed to the period of 14 days (more exactly 13.66 days), half of the tropical period of the Moon, which is 27.32 days. The tropical period of the Moon represents the cycle of its declination which determinates a tidal cycle with the same duration.

This period of 14 days is described by the zonal spherical Laplace function(y = 3sin2 x-1) and it is applied to the entire surface of the Earth, having the largest atmospheric tidal oscillations at 35° 16' *North and South latitude.*

The graphics from figure 1 presents air temperature cycles (daily maximum and minimum) in points of different climatic characteristics from the Russian territory. From the analysis of these graphics it can be stated that the largest amplitude of thermic oscillations is registered in Siberia and Far East.

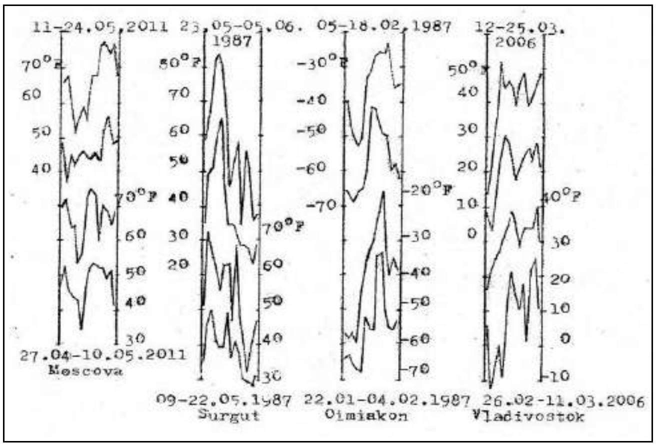

Fig. 1. The 14-day cycles of daily maximum and minimum temperatures in air in Russia.

1.2. The cycle of six calendar months (about 183 days)

This cycle is due to the period of six calendar months (half of the period of the tropic year = 365.24 days) in the evolution of the Sun, the celestial body that causes athmospheric tides with the same duration (fig. 2). This cycle is another application of the zonal spherical Laplace function in meteorology.

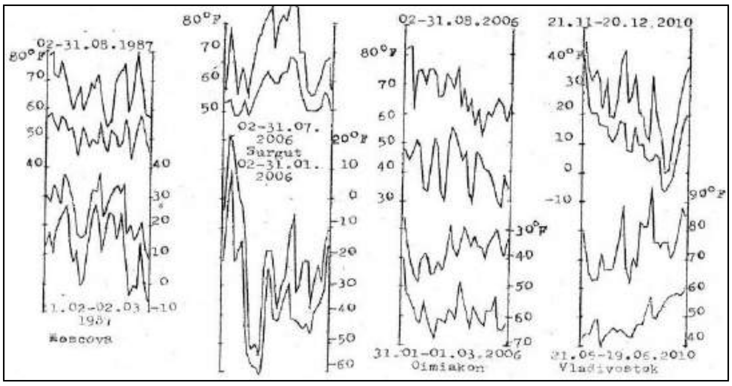

Fig 2. The six-month cycles of daily maximum and minimum temperatures in Russia

The graphics from figure 2 presents the six-month cycle (about 183 days) in the evolution of the daily maximum and minimum temperatures in air in Russia.

From the analysis of the graphics, it can be noted that the highest amplitudes of the air temperature are recorded in Surgut (West Siberia)

1.3. The 246-day cycles (about eight months)

The occurrence of this cycle is due to the fact that, in 246 days (about eight months) there are nine tropics periods of the Moon, according to the following calculation: 246 days: 27.32 days (the tropics period of the Moon) =9.00. It is understood that there is a cycle in the declination of the Moon, which determines a tidal cycle of the atmosphere with the same duration. This, in turn, is reflected in the daily motion of the minimum and maximum temperatures in air.

In figure 3 it is presented, by the graphics, the cycles of daily minimum and maximum temperatures in air lasting 246 days in Russia, in points with different climate conditions.

An analysis of the graphics from figure 3 shows us that the highest thermal amplitudes occur in Eastern Siberia (Verhoiansk), between 0°F and 70°F, from 11.05 to 09.06.2011.

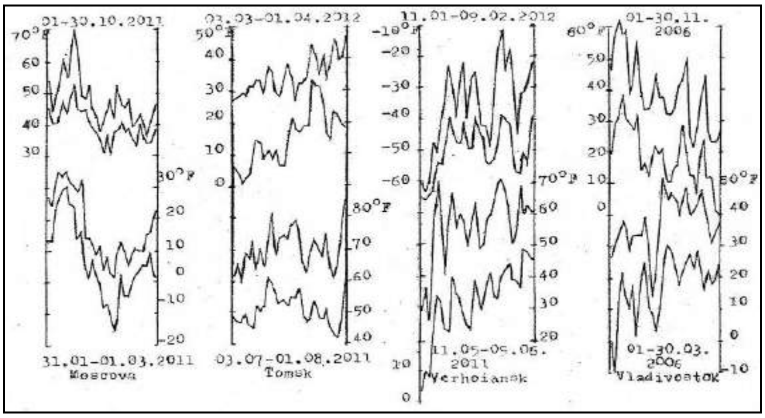

Fig. 3. The 246-day cycles of daily maximum and minimum air temperature in Russia.

In Russia there are other air temperature cycles with less than one year duration (of 28, 55, 82, 110, 137, 164, 192, 220, 274, 301, 328 and 355 days).

2. Air temperature cycles with more than one year duration

These cycles of the daily maximum and minimum air temperatures have a better clarity, because they do not represent only cycles of the tropics of the Moon (27.32 days). At the same time, they are also cycles for the other periods of the Moon (the synodic period = 29.53 days and the anomalistic period = 27.55 days). It is obvious that these lunar cycles are also tidal cycles. From this category, the most important are the cycles that include an entire number of years, such as the ones with a duration of 4, 8, 11, 19, 23 and 27 years.

The better clarity of those cycles is due to the fact that these encompass an tire number of years, which means that the atmospheric tides generated by the Sun have a more precise periodicity.

2.1 The 4-year cycle (approximate 1461 days)

This cycle represents not only a solar cycle, but a cycle for these 3 phases of Moon, according to the following calculation: 1461 days: 27.32 days (the tropical period of Moon) = 53.5 ; 1461: 27.55 days (the anomalistic period of Moon) = 53,0 and 1461: 29.53 (the synodic period of Moon) = 49.5 . In case of the tropical period of Moon, the atmospheric tides happen identical, irrespective of the declination's mark (+ or -). In case of the synodic period, the atmospheric tides produced from Full Moon to New Moon are identical with those ones produced from New Moon to Full Moon. Thereby, these periods (53.5 and 49.5) represent cycles.

The charts from figure 4 represent cycles of daily maximum and minimal temperatures, in points on the territory of Russia with different climatic conditions, in a 4-year cycle.

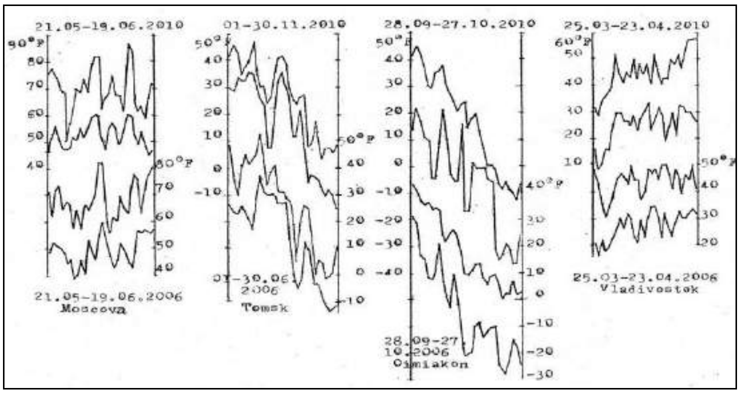

Fig. 4. Cycles of daily minimum and maximum temperatures in the air with the duration of four years, on the territory of Russia.

As in the case of other cycles, the largest thermal amplitude is recorded in Eastern Siberia.(Oimiakon from +40^{o}F to -30^{o}F)

2.2 The 11- year cycle (approximately 4018 days)

As it is known, in the Sun activity there are more cycles, the well-known being the 11-year one. The 11-year cycle is, at the same time, a tidal cycle which, through the Rossby waves (planetary), is reflected in the daily course of daily maximum and minimum temperatures. In 11 years it is produced an entire number of tropical periods of the Moon, according to the following calculation: 4018 days (11 years): 27. 32 days (the tropical period of the Moon) = 147.0, but it takes place an entire number of synodic periods of the Moon, namely 4018:29.53 (the syndical period of the Moon)=136.0.

The graphs from figure 5 represent the daily course of daily minimum and maximum temperatures in an 11-year cycle on the territory of Russia.

It is observable that, from the analysis of the charts in figure 5, the biggest thermal amplitude is recorded in West Siberia (Surgut between +20°F and -60°F).

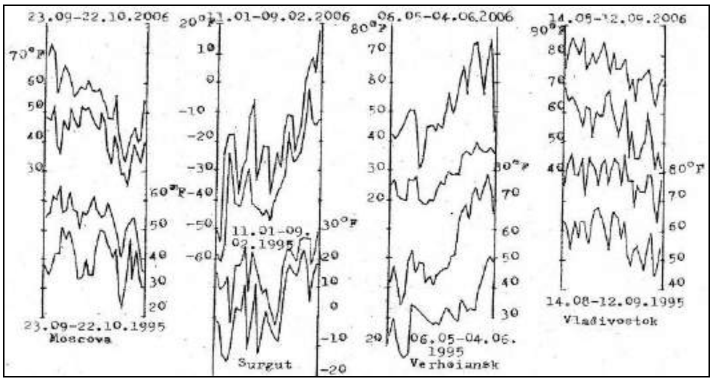

Fig. 5. Cycles with the duration of 11-years in the evolution of daily maximum and minimum temperatures in the air, on the territory of Russia.

2.3. Meton's cycle (19 years, about 6940 days).

The well-known astronomical metonian cycle (19 years) is also found in meteorology, especially in the daily course of maximum and minimum temperatures in the air. In a 19-year cycle it happens 254 tropical lunar periods and 235 synodic periods, according to the next calculation: 6940 days: 27.32 days (the tropical period of the Moon) = 254.0 and 6940: 29.53 days (the synodic period of the Moon) = 235.0 (fig. 6). The astronomical metonian cycle is actually a tidal cycle which reflects through the Rossby waves in the daily course of maximum and minimum temperatures in the air too.

In fig. 6, it is presented, by charts, Meton's cycle in the evolution of daily maximum and minimum temperatures in different points on Russia's territory, in which climatic conditions are different.

The analysis of the charts in fig. 6 points out the fact that the biggest thermal amplitude is recorded in Siberia (Tomsk and Oimiakon), over 60°F. At Vladivostok it is recorded the smallest thermal amplitude, about 30°F, because of the influence of the waters of Japan's Sea, where a branch of the Kuro Shivo stream permanently penetrates and brings warmer waters from the Pacific Ocean.

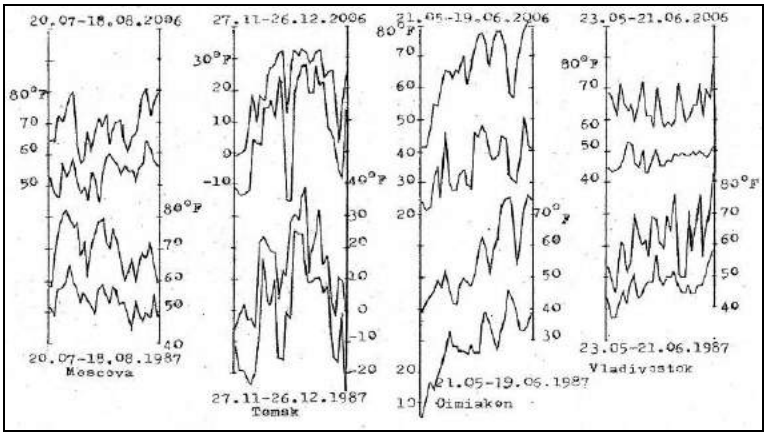

Fig. 6. The Metonic Cycle (approximately 6940 days) in the evolution of the daily maximum and minimum temperatures in the air, on the Russia's territory.

2.4. The 8-year cycle (approximately 2922 days)

As you can see, the 8-year cycle represents the difference between the Metonic Cycle (6940 days) and the 11-year cycle (4018 days). This cycle has the doubled duration of the 4-year cycle. The 8-year cycle is also a lunar phase, because in 2922 days it is completed Moon's 107 tropical periods and 99 synodic periods. The 8-year tidal cycle is both lunar and solar and it is reflected on the daily changes of the maximum and minimum temperatures in the air. The graphics from figure 7 demonstrate its existence on Russia's territory, during different climatic conditions.

After analyzing the graphics from figure 7, you can see that the highest thermal amplitude is found in Western Siberia (in Surgut) with over 70^{o}F (between +30^{o}F and -40^{o}F), during the period 22.11-21.12.1987.

After the completed research it has come to the conclusion that on the Russia's territory it is also registered the other cycles which last a whole number of years. We are talking about the 23-year cycle(approximately 8401 days) and the 27 year cycle(approximately 9861 days).

After analyzing the available meteorological data, on Russia's territory, as well as in other regions on Earth, there is an important category of cycles of the air temperature that last longer than a year and are based on cycles from the progress of the Lunar Perigee. As it is known, while revolving around the Earth, at a certain point, the Moon is nearest to the Earth. The point is called the Perigee. When the Moon is farthest from Earth, the point is called Apogee. The distance between the Moon and the Earth is determined by the lunar parallax, which represents the angle from which you can see, from the Moon, Earth's equatorial radius horizontal parallax. When the angle (the parallax) is bigger, the distance is smaller and vice versa. With small angles, the distance is bigger.

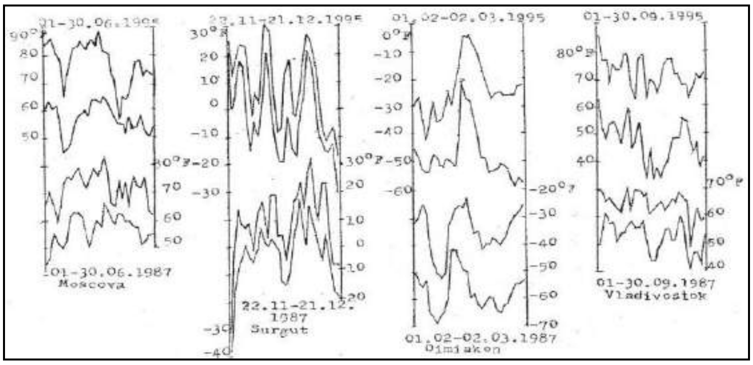

Fig. 7. Cycles of 8 years in the evolution of daily maximum and minimum temperatures in the air, on the territory of Russia

In case of the Climax, the lunar parallax varies very little, between 53'57" and 54'18". Because the Perigee executes a sidereal revolution, with de duration of 3232.6 days, the lunar parallax of this point varies very much, between 59'15" and 61'27". There is a circularity of the Perigee of about 412 days, which means that this period underlies other lunar circles with the duration longer than a year. This category includes more lunar circles, but more important due to their clarity are those with the duration of 18 years and 11 days (The Circle of Saros = 6585 days); 31 years and 2 days (11324 days); 44 years and 7 days (16064 days). All of these lunar circles are also tidal circles, because the tidal potential of the atmosphere depends mostly on the distance variation Earth-Moon. At the Perigee, the atmospheric tides have greater amplitude, in comparison with the situation at the Climax.

2.5 The Cycle of Saros (18 years and 11 days = 6585 days)

This cycle is a selenary one, because in this time period it happens 241 tropical revolutions; 293 anomalistic revolutions and 223 synodic revolutions of the Moon. Also, the Cycle of Saros contains 16 cycles of 412 days, the smallest cycle in the evolution of the Perigee.

On the territory of Russia this cycle has a very good clarity and we find it in all the regions, no matter what the climatic characteristics are.

In fig.8 it is shown, with graphics, the Cycle of Saros on the territory of Russia, in the evolution of the daily maximum and minimum temperatures in the air, in the most important regions.

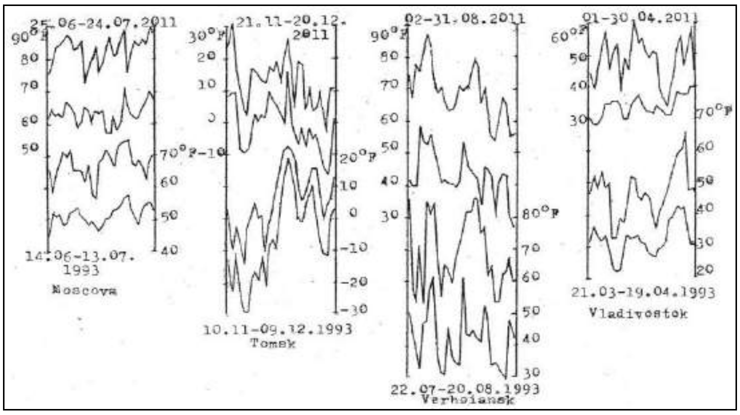

Fig. 8. The Saros cycle in the evolution of daily maximum air temperatures, in Russia

By analyzing the graphics in fig. 8 you can observe the clarity of this cycle in the evolution of the daily maximum and minimum temperatures in the air, especially in East Siberia (Verhoiansk) and in the Extreme Orient (Vladivostok). Also, you can notice that the highest thermal amplitude records at Verhoiansk (East Siberia), over 60 ^{o}F, in the period 02-31.08.2011, between +90 ^{o}F and +30 ^{o}F.

2.6. The cycle of 31 years + 2 days (about 11324 days)

This cycle represents half of the month cycle of 62 years + 4 days (about 22649 days) which includes 55 cycles of lunar Perigee, the period of 412 days. It was chosen cycle on half, because on the NOAA (SUA) weather database there aren't meteorological data for Russia earlier than 1960. In figure 9 it is represented, in graphs, the cycle of 31 years + 2 days (11324 days) in Russia, in different regions.

In the range of 11324 days it is produced 414.5 tropical revolutions; 411.0 anomalistic revolutions and 3835. synodic revolutions of the Moon. Also, it is produced 27.5 cycles of Lunar Perigee, which lasts for 412 days. Instead, double cycle, which lasts 62 years+4 days (about 22649) includes 829 tropic revolutions; 822 anomalistic revolutions; 767 synodic revolutions of the Moon and 55 cycles of Lunar Perigee, which lasts for 412 days. Both selenar cycles are also cycles of atmospheric tides which through the Rossby waves (planetary waves) are reflected in the evolution of the daily maximum and minimum daily temperatures in the air.

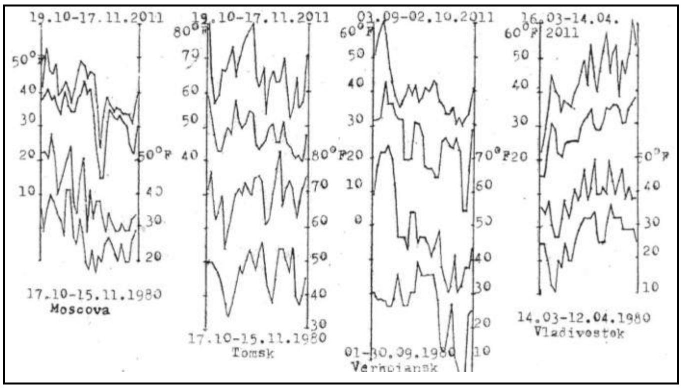

Fig. 9 The cycles of 31 years + 2 days (about 11324 days) of the daily maximum and minimum temperatures in the air in Russia

2.7 The 44 year -7 - day cycle (about 16064 days)

This cycle is a selenar one, because in this period 588 tropical revolutions; 583 anomalistic revolutions; 544 anomalistic revolutions of the Moon take place, as well as other 39 cycles of the Lunar Perigee, with a duration of 412 days. Obviously, this cycle is also a tidal cycle which is reflected in the daily course of daily maximum and minimum temperatures in the air. In figure 10 it is presented, by charts, the 44 year-7 day cycle in the evolution of the daily maximum and minimum temperatures in the air in Russia, in regions that have different climatic characteristics.

By analyzing the graphics in figure 10, it can be concluded that this cycle is the closest to perfection. This aspect is found in all regions of Russia, which were selected for demonstration, but especially in Moscow.

In many situations, the evolution of daily maximum and minimum temperatures in air in the European region of Russia, which has temperate continental climate, resembles to one in the temperate part of North America. In order to demonstrate this resemblance, there were chosen two points in each continent, which have approximately the same latitudes. For the European region of Russia, there were chosen the cities Moscow (about 56 degrees north latitude) and Krasnodar (45 degrees north latitude). From the North American continent, there were chosen Winnipeg (50 degrees north latitude) and Minneapolis (45 degrees north latitude).

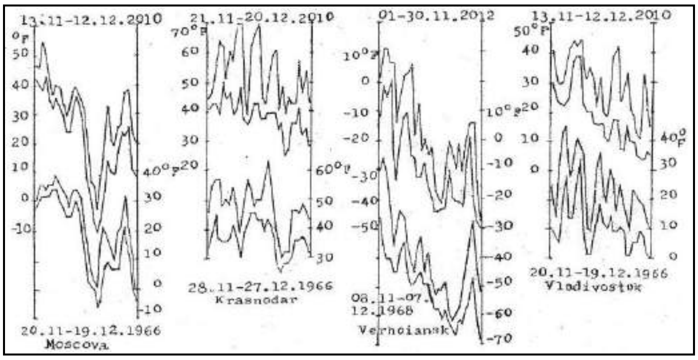

Fig. 10. Cycles of 44 year-7 day (16064 days) in the evolution of daily maximum and minimum temperatures in air, on Russia's territory.

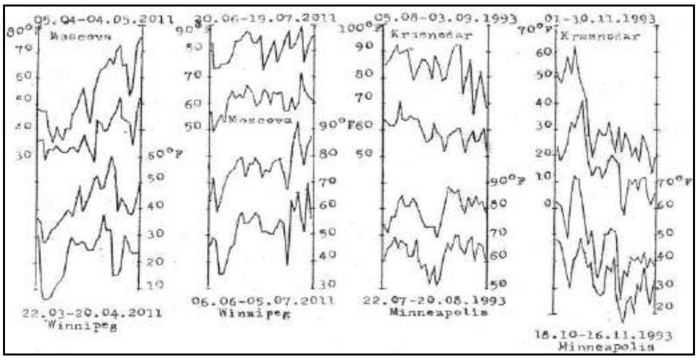

Fig. 11. Resemblances in the evolution of the daily maximum and minimum temperatures in air between Moscow and Winnipeg and between Krasnodar and Minneapolis, with a difference in time of 14 days.

In figure 11 it is presented, in form of graphics, the evolution of daily maximum and minimum temperatures in air in Moscow and Krasnodar, compared to one in Winnipeg and Minneapolis. From analyzing the graphics from fig.11, it is observed that the clearest resemblance (close to identical) is between Minneapolis (18.10-16.11.1993) and Krasnodar (01-30.11.1993), both points having 45 degrees north latitude.

The difference in time over 14 days between the points located in North America and those from the European side of Russia is explained by the time needed by the Rossby wave (planetary) to cover this distance. When the planetary waves have their wave length lower than 5400 km, their circulation is made from west to east, as it is also the general circulation of the atmosphere in the temperate zone of the Nordic hemisphere. When the Rossby waves have a length bigger than 5400 km, their circulation is made from east to west.

Conclusions

The analysis of the cycles and oscillations of the temperature of the air from the main regions of Russia allow us to draw the following conclusions:

- All the thermic cycles described in Romania, New Zeeland, The SUA and South America are also found on Russia's territory;
- On Russia's territory there are also cycles of tha air temperature based the 412 day cycle in the evolution of the selenic Periger;
- A great influence of the oscillations of the air temperature on Russia's territory has the Arctic and the Pacific Ocean;
- The biggest amplitudes of the thermic oscillations are formed in Siberia;
- Some resemblances in the evolution of daily maximum and minimum temperature in air between Moscow and Winnipeg (Canada) as between Krasnodar and Minneapolis (The SUA) can be explained through the circulation of the Rossby waves (planetary);
- Knowing these thermic cycles, there can be elaborated meteorological prognosis for a long time (10 days), for different regions of Russia.

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DATA-MINING – A VALUABLE MANAGERIAL TOOL FOR IMPROVING POWER PLANTS EFFICIENCY

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Keywords: data-mining, mathematical modelling, power production, environmental protection.

Abstract. Energy and environment are top priorities for the EU's Europe 2020 Strategy. Both fields imply complex approaches and consistent investment. The paper presents an alternative to large investments to improve the efficiencies of existing (outdated) power installations: namely the use of data-mining techniques for analysing existing operational data. Data-mining is based upon exhaustive analysis of operational records, inferring high-value information by simply processing records with advanced mathematical / statistical tools. Results can be: assessment of the consistency of measurements, identification of new hardware needed for improving the quality of data, deducing the most efficinet level for operation (internal benchmarking), correlation of consumptions with power/ heat production, of technical parameters with environmental impact, scheduling the optimal maintenance time, fuel stock optimization, simulating scenarios for equipment operation, anticipating periods of maximal stress of equipment, identification of medium and long term trends, planning and decision support for new investment, etc. The paper presents a data mining process carried out at the TERMICA – Suceava power plant. The analysis calls for a multidisciplinary approach, a complex team (experts in power&heat production, mechanics, environmental protection, economists, and last but not least IT experts) and can be carried out with lower expenses than an investment in new equipment. Involvement of top management of the company is essential, being the driving force and motivation source for the data-mining team. The approch presented is self learning as once established, the data-mining analytical, modelling and simulation procedures and associated parameter databases can adjust themselves by absorbing and processing new relevant information and can be used on a long term basis for

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monitoring the performance of the installation, certifying the soundness of managerial measures taken and suggesting further adjustments.

1. Data-mining – an overview

The knowledge discovery in databases (KDD) has emerged as a fundamental research area with important applications to science, engineering, medicine, business, and education. It aims to formulate, analyze and implement basic induction processes that facilitate the extraction of meaningful information and knowledge from structured and unstructured data. An important issue regarding this field is the understanding of KDD as a "nontrivial process of identifying valid, novel, potentially useful, and ultimately understandable patterns in data" (Fayyad et. al., 1996). From this point of view, pattern is meant in a very general way. A pattern is whatever an algorithm may find or generate from the data, like a model than scores customers based on a decision tree, on a neural network, or based a regression function, a clustering of the data, or a set of association rules.

The experience of the last years showed that discovering knowledge from huge databases involves a complex process. Over time, several models for KDD process have been proposed. Although are several different between these models, the key message is the same: data mining is just one of several steps in a KDD process. Corresponding to the CRISP-DM model (Wirth and Hipp, 2000), we distinguish the following six tasks:

- business (or problem) understanding - focuses on understanding the project objectives and requirements from a business perspective, and developing initial technical problem definition and a project plan;
- data understanding - based on the results from the business point of view the second step is to get familiar with the available data.
- data preparation - the next step is to construct the dataset where the mining algorithm is to be run on.
- modelling - various modelling techniques are selected, applied, and fine-tuned. In this phase the actual data mining takes place. Based on the identified business goal and the assessment of the available data an appropriate mining algorithm is chosen and run on the prepared data.
- evaluation - at this stage there are good models (from a technical point of view). Here we thoroughly evaluate the model, and review the steps executed to construct the model, to check if we did not miss an important business issue and achieves the desired business objectives
- deployment - can be as simple as generating a report or as complex as implementing a repeatable data mining process.

The analysis of these phases shows us that the KDD process no means only a "push button technology". On the contrary, knowledge discovery is complex, iterative and highly interactive. In each of the above phases it is the analyst as a human being who decides whether to proceed to the next phase, to redo the current phase or even to step back to one of the earlier phases.

Fig. 1 presents these phases and the most important interdepencies between them.

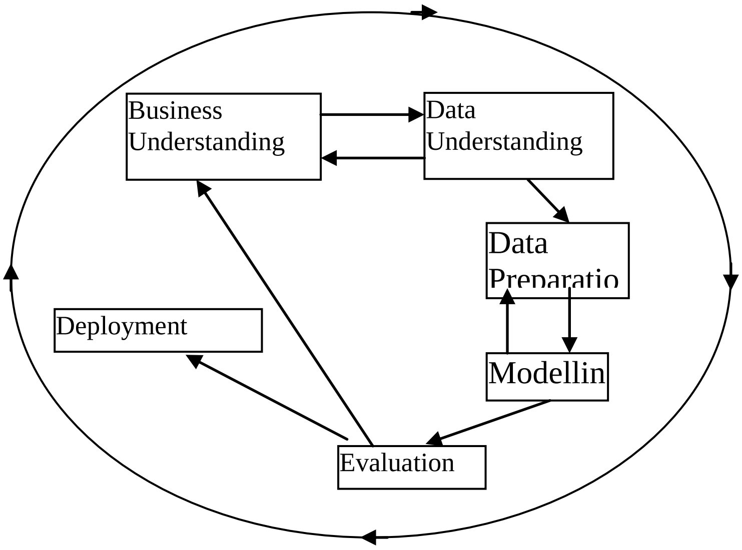

Fig 1. The crisp-DM model for KDD

Data mining involves the application of analysis on large volumes of data using algorithms which produce a particular enumeration of patterns from such data, and it may facilitate the discovery from apparently unrelated data, relationships that can anticipate future problems or might solve the studied problems. On may define data mining as the operation of extracting the interesting and previously unknown information from huge volumes of data.

It is able to solve problems which can be divided into two general categories: prediction and knowledge discovery (or description). Even prediction is the main goal of data mining, often it is preceeded by description. Each of these two problems has some associated methods. For prediction we can use classification or regression while for knowledge discovery we can use deviation detection, clustering, association rules, database segmentation or visualization.

Classification is a supervised learning method which consists in a two-step process. First, by analyzing database tuples described by attributes a model is built. It describes a predetermined set of data classes or concepts. Each tuple is assumed to belong to a predefined class, as determined by one of the attributes, called the class label attribute. The data set analyzed to build the model form the training data set. In the second step, the model is used for classification. Before that, it is necessary to estimate the predictive accuracy. The accuracy of the model on a data test set is calculated as the percentage of test set sample that are correct classified by the model previously build. To find this percentage, for each test sample, the known class is compared with the model's class prediction for that sample. If the accuracy is acceptable the model can be used for classifying future data tuples for which the class label is not known.

Whereas classification determines the set membership of the samples, the prediction of continuous values can be modeled by *regression.* In this case model design consists on finding a structure for it, on computing optimal value for its parameters and assessing the model quality. The model structure relates the type of mathematical formula that describes the system behavior. Depending on the model structure, regression models may be categorized like: simple linear regression, multiple linear regression, polynomial regression, logistic regression or nonlinear regression. We can also distinguish static and dynamic models. Static models produce outcomes based only on the current input, whereas dynamic models produce outcomes based on the current input and the past history of the model behavior.

Clustering, often referred as unsupervised learning, involve a process that discovers structures in data without any supervision. As the name clustering implies, unsupervised algorithm is capable of discovering structures on its own by exploiting similarities or differences between individual data points on a data set.

Association rules mining is also an important data mining method that aims to find interesting dependencies in large sets of data items. Often these items are stored in transactional databases that must have specific format. This format can be generated by an external process or can be extracted from relational databases or data warehouses. Interesting associations between data items can often lead to information used for decision making.

The algorithms used in data mining are often well-known mathematical algorithms, but in this case they are applied to large volumes of data and to general business problems. The most used are: statistical algorithms, neural networks, decision trees, genetic algorithms, nearest neighbor methods, rule induction and data visualization.

2. Starting the data-mining project

Having the approval and support of the TERMICA power plant top management, a Data-Mining Team (DMT) was established. It included the technical director, the mechanics-energy chief engineer, the chief accounting officer, the heads of the quality and environmental compartments and two junior members that took care of the IT infrastructure and of uploading data in the Project databases. The team included also two experts from outside TERMICA, namely a software professor and an energy and environment consultant, both with experience in data-mining, mathematical and statistical modelling, with good knowledge of the EU BAT (best available techniques) documents related to power production and its environmental impact. The DMT reported to the TERMICA top management on a daily basis so that the Data-Mining Project (DMP) went smoothly and access to all records and data existing at TERMICA was permitted to all DMT members after the signing of a Confidentiality Agreement.

The main objectives for the DMP were established once the team was constituted. These objectives were designed with respect of CRISP-DM steps. There are:

- Establishing the technological, economic and environmental parameters to be analyzed;
- Identifying sources of data, evaluating their coherence and establishing the databases of the DMP
- Assessing the need for supplementary hardware for measuring and monitoring, in order to increase the quality of data; in the first phase, the DMP worked only with existing data, even if their quality could be improved;
- Use of environmental accounting principles and procedures (EMA, 2001; ISO 14051, 2011) for an objective, unbiased analysis of environmental costs;
- Correlation analysis
- Internal Benchmarking (when, how and why have been attained the best operational and environmental performances of the TERMICA power plant)
- Comparison to best available techniques (LCP, 2006)
- Trend identification by regression analysis
- Devising an eco-efficiency index, together with its dynamic evolution, for the TERMICA power plant.

As a working procedure, the TERMICA top management expressly requested that:

- the DMP should use software familiar to local experts, or easy to learn and use by these experts (the Microsoft EXCEL and RapidMiner 5 was subsequently used);
- the DMP procedure and databases will be active, upgradable and at hand even after the Projects ends. Measures were taken to train TERMICA people with the use of the DMP procedures.

Data used in the DMP covered the period 2007-2011.

Existing technical parameters of the installations (specific consumptions, power and heat produced and delivered, excess air to burners, wastewater and ash generated, together with their characteristic parameters, costs and other economic parameters, etc.) were collected and uploaded in an agreed format in the DMP databases.

Assessing the normal (Gaussian) distribution of data was carried out using

- descriptive statistics for each data set (skewness and kurtosis moments of the data distribution were inferred and they are near zero value in almost all cases – indicating a distribution near to normal);
- Histograms and frequency tables showing graphically if the set of data fits the Gaussian case);
- 3 statistical tests specific for testing normality, built up in EXCEL worksheet: Jarque-Bera and Shapiro-Wilk tests. All calculate a *p*-value that is compared to and should be larger than the α-value chosen. All sets of parameter data passed the Jarque-Bera test and most of them the Doornick-Hansen (χ^2) test. Only a few passed the Shapiro-Wilk test.

It was assumed that the data are normally distributed and recommendations were made for installing more performant measuring and monitoring devices to increase in future the quality of acquired operational data.

3. Deriving environmental costs

In order to have a comprehensive image of the technology, economic and environment performance of TERMICA power plant, a detailed environmental cost accounting procedure was developed in order to associate costs to any material and energy flow in the power plant.

Recommendations of UN (EMA, 2001) and ISO (ISO14051, 2011) documents have been used to obtain environmental costs like those exemplified in Table 1.

Table 1. Examples of environmental costs evaluated at TERMICA.

Negative Flux Cost Index (2007=100)	**2007**	**2008**	**2009**	**2010**	**2011**
Electric energy internal consumptions	100	105.6	165.1	114.7	129.0
Thermal Energy not delivered	100	133.5	183.1	135.7	133.3
Ash management costs	100	121.6	221.6	157.1	178.5
Carbon Dioxide associated costs	100	80.4	95.8	88.7	91.4
Cost of flue gases at 140^{o}C	100	109.2	145.3	102.8	102.4
Cost of water / wastewater	100	128.3	144.5	168.2	172.6
Share in total costs (%)	31.1	18.2	19.8	18.9	19.1

Negative flows is the terminology used by ISO 14025 (equivalent to “non-product outputs” of the UN methodology (EMA, 2001) to denominate material and energy flows unintended, that can be reduced but cannot be avoided (losses, by-products, etc.). Table 1 shows an important share of environmental costs associated to power and heat production (up to 31.1% in 2007), yet declining and stabilizing at around 19%.

The structure of these costs, in 2011 is presented in Fig.2 indicating interesting conclusions for the TERMICA management. Examples:

- the larger share of negative costs is due to internal consumptions and losses of electric energy. Reducing these costs means investment in refurbishing existing installations, verifying constantly the state of electric energy consuming, transforming and transporting equipment, good maintenance policies;
- the cost associated to flue gases comes second. In principle, it can be reduced by lowering the gas exhaust temperature (currently 140^{o}C)but this cannot be achieved without risking water condensation and ensueing corrosion problems. Replacing the steel pipes conveying flue gases to stack with pipes made from corrosion resistant materials could be a solution but the investment should follow a detailed cost-benefit analysis;
- costs associated to carbon dioxide emitted can be evaluated once Romania has a market for this substance (CO_2 credits). Indeed TERMICA has managed to reduce costs with CO_2 by trading some of the associated credits allowed to the company. This is why the cost of carbon dioxide emitted has constantly declined to less than 20% of the 2007 value. Not only is this a very favourable environmental issue but TERMICA managed to turn a waste (CO_2) into a source of income.

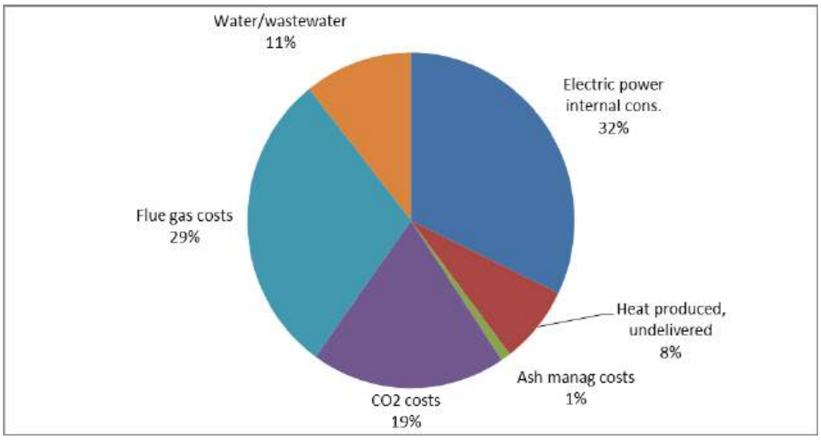

Fig. 2. Structure of negative costs at TERMICA in 2011.

A first glimpse in the operational data recorded at TERMICA has in this way indicated the hot points where managerial action is needed most, presenting objective quantification of spending and taking costs out of overheads.

3. Data correlation

A detailed correlation analysis has been carried out by the DMT with many parameters available in the records kept at TERMICA.

Pearson correlation coefficients were derived and some of them are presented in Table 2.

Some conclusions emerge:

- the ash management costs does not correlate, as expected, with the amount of power / heat produced or with other consumptions (e.g., water). This was explained by the variations of ash content of various solid or liquid fuels used at TERMICA in the period of time analysed;
- the ash and flue gas to stack associated costs correlate best, as expected, as do water and wastewater management costs with the same flue gas costs.

By acting upon, for example, flue gas temperature, practically all other costs (that correlate strongly with this parameter) will also decrease. This points out again on a further detailed analysis of the opportunity of decreasing flue gas temperature.

Table 2. Examples of Pearson Correlation coefficients calculated at TERMICA.

Parameter	**Electric energy internal consumption**	**Heat not delivered**	**Ash Manag.**	**CO_2 emitted**	**Flue gas costs**	**Water / wastewater**
Electric Energy internal consumption	1.00					
Heat not delivered	0.70	1.00				
Ash Manag.	-0.11	-0.01	1.00			
CO_2 emitted	0.36	0.62	-0.76	1.00		
Flue gas costs	0.80	0.78	0.91	0.82	1.00	
Water/wastewater	0.58	0.45	-0.86	0.87	0.88	1.00

4. Internal benchmarking and comparison to BAT

Benchmarking is used in most instances to assess the performances of a given industrial facility to similar installations operated elsewhere (domestic or abroad). The DMP carried out a detailed benchmarking analysis in order to:

- identify the best performances ever attained by the TERMICA installations in the period 2007-2011;
- asking the managers and technical staff to further evaluate how these performances have been attained and what can be done to reproduce them.

Internal benchmarking is, therefore, an approach that shows to operators how well their installations can perform and that ask them to maintain the conditions that enabled such performance. Important improvements can be achieved, in this way, by carefully operating existing equipment, respecting procedures, maintenance periods, etc. Practically no investment is needed but a training and motivation of the personnel.

From the best ever achieved level of performance, the installations should be aligned, by refurbishing and investing in replacing existing, outdated equipment, to BAT reference level of performance (LCP, 2006).

For the case of TERMICA, Table 3 illustrates the dynamics of various parameters in time and their level when compared to BAT documents.

As shown by Table 3, all current performances at TERMICA are well off the level required by best available techniques at hand.

Table 3. Data for internal benchmarking and comparison to BAT.

	BAT	**2007**	**2008**	**2009**	**2010**	**2011**	**%min of max**
Fuel specific consumption for power production	1	1.21	1.16	1.24	1.24	1.20	93.5
Fuel specific consumption for heat generation	1	1.17	1.14	1.22	1.21	1.21	93.4
CO_2/MWh	1	1.78	1.62	1.84	1.79	1.8	88.0
Water m3/MWh	1	1.21	1.14	1.28	1.24	1.21	89.0
Boiler efficiency	1	1.05	1.05	1.05	1.05	1.05	100
Electric energy internal consumption	1	1.21	1.13	1.16	1.17	1.18	93.3

5. Regression analysis and trend identification

Data from the 2007-2011 period can be used to identify current trends in TERMICA performances and evaluates the period of time until best available technology efficiencies are attained (Fig.3).

Fig. 3 indicates that continuing the current operational set-up and efforts to improve at the current pace (small investments in burning hardware, in water and ash management, etc.), TERMICA will reach the BAT level for water consumption in 2017, the BAT level for specific fuel consumption per 1 MWH in 2022 and the same consumption per 1 Gkal in 2040! All these identified trends are correct (as they indicate a progress towards BAT level) but the period of attaining this BAT level is far too long. The level of electric energy internal consumption is increasing instead of decreasing and aligning to the BAT value (here represented by unity). This is a hot point that must be addressed with priority by managers and engineers.

While the lag for attaining BAT consumptions in the case of water maybe acceptable, the other trends are barely so and the management must take decisions to refurbish the equipment and/or change the technology in order to align to BAT as soon as possible.

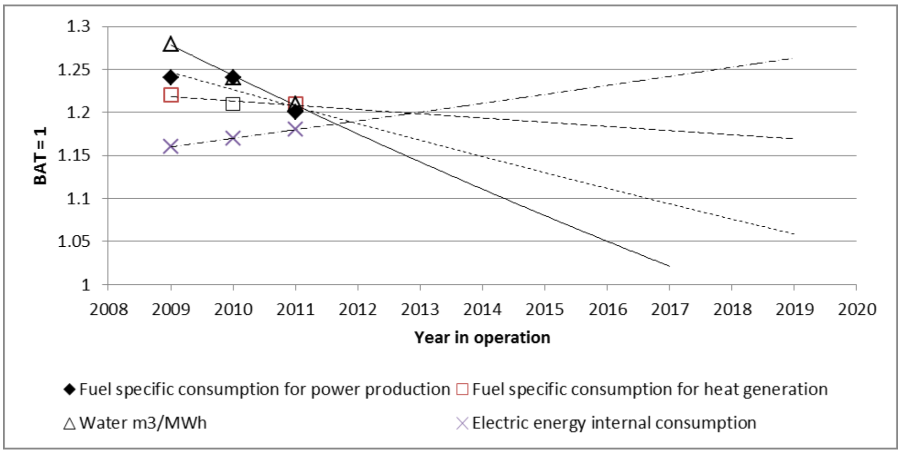

Fig. 3. Trends in TERMICA operational parameters based upon current set-up.

Conclusions

The paper presented an overview of the data-mining analysis that exploit the vast amount of data recorded by industrial installations during their years of operation in view of identifying hot points, trends, best efficiencies ever attained, etc.

With a dedicated team of engineers, economists, environmentalists, external consultants and having the full support of the top management at TERMICA power plant in Suceava (Romania, 450km N of Bucharest), the data mining-project carried out by the team led to the following findings:

a. there is a good amount of relevant data at TERMICA that allow a sound data-mining analysis; further updating of the created databases, in the format agreed during the Project will enable the data-mining procedure to absorb extra information and produce updated conclusions aout TERMICA process efficiencies and environmental footprint;

b. procedures for testing the coherence of recorded data, evaluate their Gaussian distribution were implemented in EXCEL and recommendations for further improve the quality of data by investing in new monitoring equipment for data acquisition were made to the Company management;

c. the Project Team helped local specialists to derive more objective estimates for their environmental costs by implementing procedures recommended by UN and ISO standards; it showed that these environmental costs amount to 18-31% of total Company expenses, in the period of time analysed (2007-2011);

d. the structure of these costs showed that the hot points, where costs are the higher, are the internal consumption of electric power generated and the costs associated to flue gas. The environmental cost accounting procedure should remain in place as it ascertain best what the environmental foot print of TERMICA is and how it evaluates. Managers should reduce this footprint by acting where the environmental costs are the;

e. correlation analysis enabled the parameters that correlates best. Acting upon one of them will result in a corresponding improvement in all other correlated parameters;

f. a benchmarking analysis was carried out having at hand the operational data included in the data mining project. The external, classical, benchmarking was carried out using best available techniques documents as reference. The internal benchmarking indicated the year 2008 as the best on in the recent history of the power plant. By simply reproducing the conditions valid in 2008, TERMICA could improve by 6-12% level of efficiency, without any investment;

g. regression analysis pointed out that, with the notable exception of internal electric energy consumptions, all other important operational parameters tend to approach the levels specified by the best available techniques documents, though the period in which those levels will be attained is considerable. This constitutes an objective assessment of the current and long-term performances at TERMICA and will help managers to decide where to act in the first place in order to improve. First the must reverse the increasing tendency in internal electric energy consumption, Then consumptions of fuel for 1MWh and 1 Gkal must be addressed.

The Project showed the importance of using every source of information and treats it using state-of-the-art methods in order to get the most out of such information. It should remain as a basic tool for local managers and specialists.

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EROSION ASSESSMENT MODELING USING THE SATEEC GIS MODEL ON THE PRISLOP CATCHMENT

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Key words: erosion, soil, GIS, SATEEC, Prislop, catchment.

Abstract. The Sediment Assessment Tool for Effective Erosion Control (SATEEC) acts as an extension for ArcView GIS 3, with easy to use commands. The erosion assessment is divided into two modules that consist of Universal Soil Loss Equation (USLE) for sheet/rill erosion and the nLS/USPED modeling for gully head erosion. The SATEEC erosion modules can be successfully implemented for areas where sheet, rill and gully erosion occurs, such as the Prislop Catchment. The enhanced SATEEC system does not require experienced GIS users to operate the system therefore it is suitable for local authorities and/or students not so familiar with erosion modeling.

Introduction

Accelerated soil erosion is a serious concern worldwide, and it is difficult to assess its economic and environmental impacts accurately because of its extent, magnitude, rate, and complex processes associated with it. Many human-induced activities, such as mining, construction, and agricultural activities, disturb land surfaces, resulting in accelerated erosion.

To estimate soil erosion and to develop optimal soil erosion management plans, many erosion models, such as Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1978), Water Erosion Prediction Project (WEPP) (Flanagan and Nearing, 1995), Soil and Water Assessment Tool (SWAT) (Arnold et al., 1998), and European Soil Erosion Model (EUROSEM) (Morgan et al., 1998), have been developed and used over the years.

The Sediment Assessment Tool for Effective Erosion Control (SATEEC) system was developed in 2003 (Lim et al., 2003) and has been upgraded with various enhanced modules incorporated into the system (Lim et al., 2005; Park et

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al., 2010). The system requiring only USLE inputs was developed with the philosophy of “very limited dataset for reasonable soil erosion estimation accuracy with commonly available GIS interface” and “easy-to-use”.

1. Study site

The Prislop Valley Catchment is located north of the Somesan Plateau (fig. 1). Over 60% of its surface is characterized by steep slopes covered with forest, while less than 40% is given by gentle slopes covered by arable land, orchards and meadows.

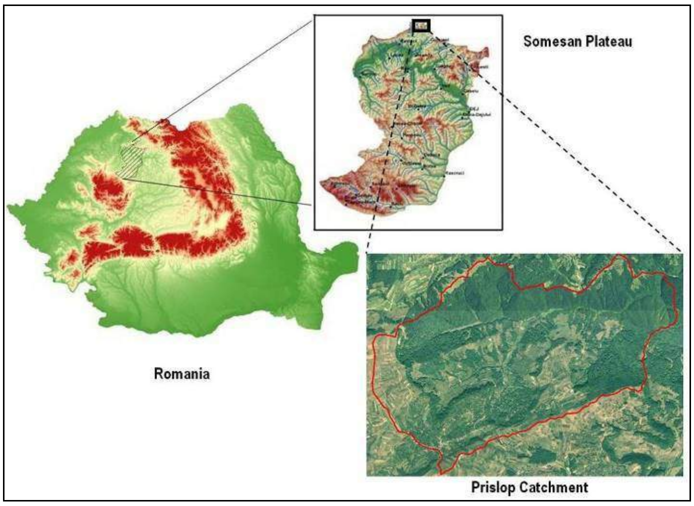

Fig. 1 Location of the Prislop Valley Catchment

The catchment has an area of 15 square kilometers, with altitudes varying between 240 m and 608 m.

The GIS database was made by digitizing the 1:5.000 scale topographic maps, the 1:5.000 aerial photographs, and by collecting and analyzing 14 soil samples.

All the resulting maps have a 10 meter resolution, for a high accuracy modeling.

2. USLE input data & maps

The USLE equation factors are generated by the digital elevation model – (fig. 2) which gives the LS factor (fig. 3), the soil texture (Table 1) which gives the K factor (fig. 4), the land use map (Table 2) for C factor (fig. 5), the precipitation distribution map (R factor) and the erosion management practices map (P factor).

Because of its constancy, the R factor has a value of 100 MJ.mm/ha.hr.year, while the lack of erosion management practices gives the P factor a value of 1.

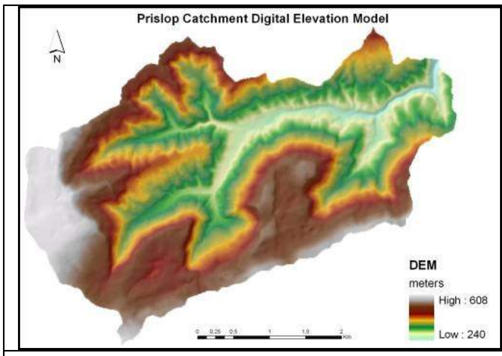

Fig. 2 The Digital Elevation Model

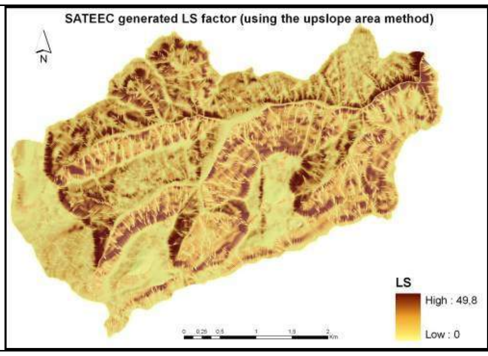

Fig. 3 The LS Factor

Table 1 – Soil texture

Soil texture	USLE K factor
Sand	0.02
Sandy loam	0.13
Silty clay	0.26
Silty clay loam	0.3
Loam	0.3

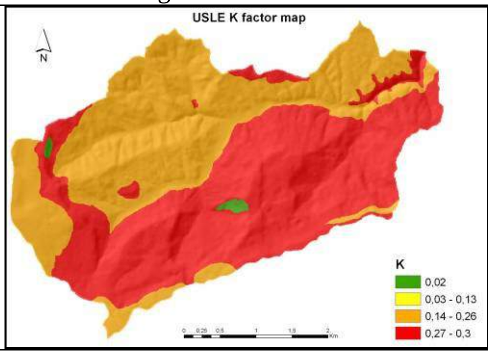

Fig. 4 The K factor

Table 2 – Land use

Land Use	USLE C factor
Urbanization	0
Bare rock	0.02
Pasture	0.02
Orchard	0.1
Forest	0.2
Bare ground	0.5
Agriculture	0.5

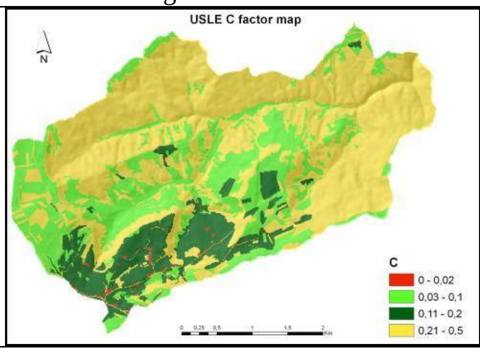

Fig. 5 The C factor

3. Running the SATEEC erosion modules

The SATEEC system acts as an extension for ArcView GIS 3, with easy to use commands. The two erosion modules consist of SATEEC_Soil Loss (fig. 6) and the nLS - Gully head detection (fig. 7). All the procedures are fully automated with Avenue, CGI, and database programming; thus the enhanced SATEEC system does not require experienced GIS users to operate the system.

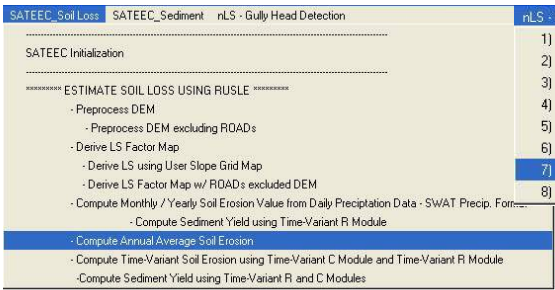

Fig. 6 SATEEC_Soil Loss

Fig. 7 nLS / Gully Head Detection

The SATEEC_Soil Loss generates the Universal Soil Loss Equation, with the following formula (1):

$$E = R * K * LS * C * P \quad (1)$$

E [*ton/(ha.year)*] is the average soil loss,

R [*MJ.mm/ha.hr.year*] is the rainfall intensity factor,

K [*tons per ha per unit R]* = is the soil factor,

LS [*dimensionless*] is the topographic (length-slope) factor,

C [*dimensionless*] is the cover factor

P [*dimensionless*] is the prevention practices factor.

Only 3 steps are required for running the USLE model: DEM preprocessing, LS Factor generation and Soil Erosion computing. After running the model, the Annual Average Soil erosion map was generated (fig. 8)

The modeling results show an average annual soil loss less than 3 tons / ha / year for less than forty percent of the catchment's surface while sixty percent is affected by higher values.

USLE is a field-scale model to estimate soil erosion by sheet and rill erosion, therefore excluding gully erosion which is the main form of soil erosion occurring in this watershed.

To estimate soil erosion containing all of the erosion stated above, nLS model (McCuen & Spiess, 1995) for gully head detection and Unit Stream Power-based

Erosion/Deposition (USPED, Mitas, L. & Mitasova, 1998; Mitasova et al., 1996) model for gully erosion was integrated with the SATEEC system. Kang et al. (2010) applied the SATEEC with nLS and USPED to estimate sheet/rill and gully erosion.

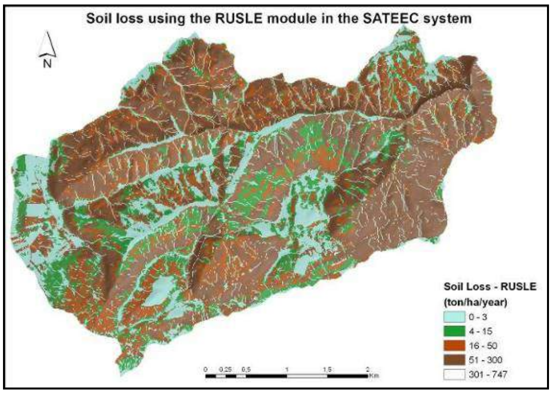

Fig. 8 Annual Average Soil erosion map

The nLS model detects gully head location based on the estimated nLS values, it requires Manning's n coefficient (fig. 9), length of overland flow, and slope for gully head detection as described below (2).

$$Gullyhead = \frac{3{,}3 * n * L}{\sqrt{S}} \quad (2)$$

Where, n is Manning's n coefficient, L is the length of overland flow, and S is slope (m/m).

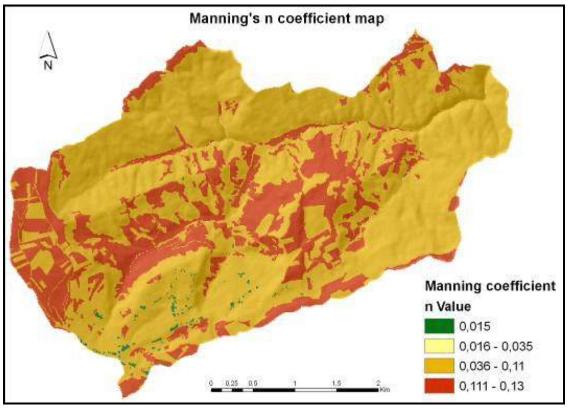

Fig. 9 Manning's n coefficient map

The nLS model (fig. 10) detects the gully locations based on the equation and the user chosen value inputs.

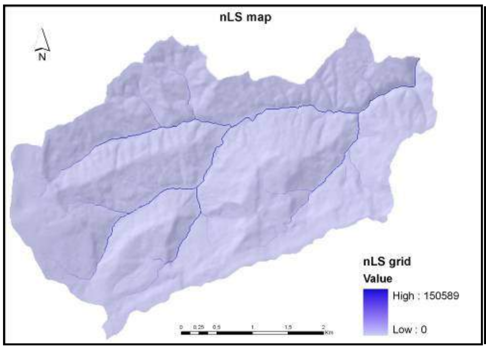

Fig. 10 The nLS map

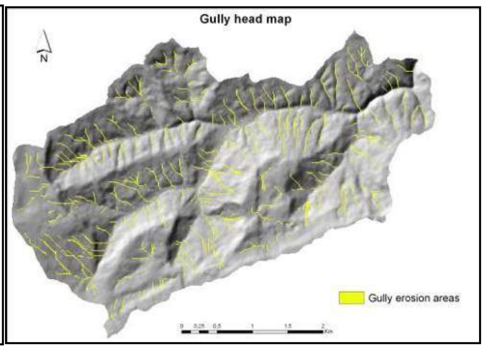

Fig. 11 The gully head map

The gully head map was derived from nLS map of which cell values are greater than 100m but less than 1000m, which indicates potential gully head location (fig. 11).

The USPED model (fig. 12) estimates soil erosion considering erosion and deposition based on tractive force (3) (Mitas, L. & Mitasova, 1998; Mitasova et al., 1996), most parameters are available to be defined with USLE input parameters.

$$T = R \times K \times C \times P \times A^{m} \times (\sin b)^{n} \quad (3)$$

Where, T is tractive force, A is area in square kilometer, and both m and b are coefficient for types of soil erosion.

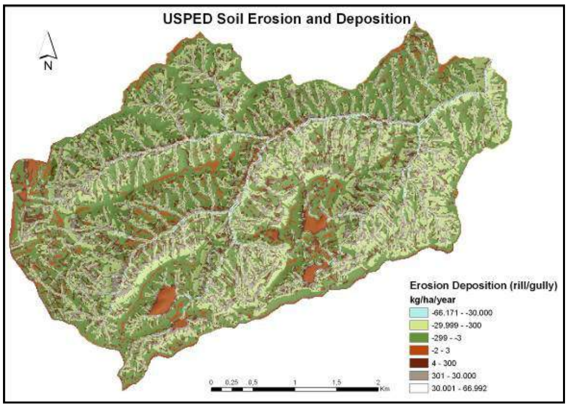

Fig. 12 USPED soil erosion and deposition

The negative values in the map indicate deposition, and positive values indicate erosion.

Using the Gully head map and soil erosion map by USPED, the map representing only gully erosion was derived (fig. 13).

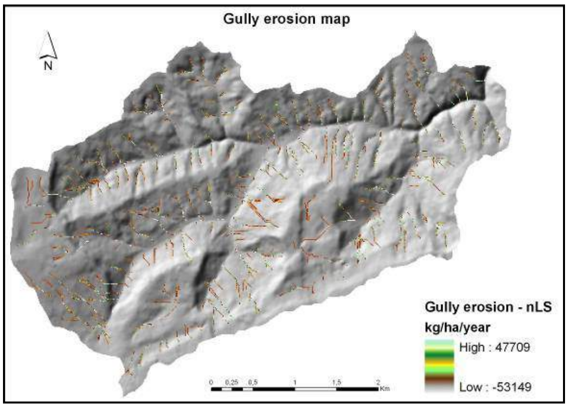

Fig. 13 The gully erosion map

The soil erosion map considering sheet/rill and gully erosion map was derived by combining the gully erosion map with the USLE erosion map. (fig. 14) The negative values in the maps indicate deposition, and positive values indicate erosion.

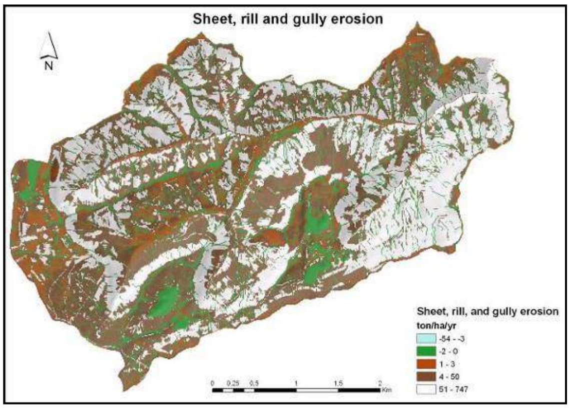

Fig. 14 The sheet, rill and gully erosion map

The total soil erosion map does not show significant differences from the USLE soil loss map, but marks the rill/gully influence in the catchment.

The map comprising all the erosion types is very suitable for those catchments where gully erosion is prevailing.

Conclusions

The SATEEC erosion modules can be successfully implemented for areas where sheet, rill and gully erosion occurs. The enhanced SATEEC system does not require experienced GIS users to operate the system therefore it is suitable for local authorities and/or students not so familiar with erosion modeling.

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MANAGEMENT OF ANTHROPOGENIC FACTOR IN MUREŞ COUNTY FORESTS

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Keywords: anthropogenic influence, illegal felling, forest planning

Abstract: The analysis and drafting of a conclusion regarding the current state of the anthropogenic influence on the forests were conducted by the study of forest planning and other documents that serve the purpose of the research. By following the paths in the forests of Mureş county, several remarks were noted on the state of private and state-owned forest areas: the forester's intervention in the woods, in terms of the application of silvicultural treatments and forest regeneration and promotion of the basic natural type of forest, the mapping of anthropogenically damaged areas, remarks on the planning of guarding activities and preventing illegal actions in the woods. The actions that cause damage to the forest and the general stock of wood are identified especially in terms of illegal felling. The damages caused though illegal felling during the analyzed period (1970 – 2013), enable us to assert that this kind of damages were recorded throughout the entire analyzed interval. The causes determining a high anthropogenic pressure on the forests are easily identified by the legislative gaps, social poverty of the Romanian society, the influence of the political factor on the national forest strategy, impairment of the forester's authority in the forests, the dependence of local communities to the forests etc. All these require identification of immediate solutions for the recovery of the anthropogenically damaged areas by afforestation, provision of a sole, coherent and efficient legislative framework, approach of a new concept in terms of supervision and control in the forests.

Introduction

The current economic and social situation requires the timely solution, respectively theoretical and practical clarification of the shortcomings generated by the anthropogenic impact on the natural ecosystems, especially on the forest ecosystems [3,4,5,6].

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Of all the disturbing factors, one concludes that the human factor, by his activities and measures, induces effects on the forest ecosystems both at local, regional, national and global level [4,5,6,7,8,9].

There is an objective, direct relation between the economic and ecological processes [1,2,4,5,7,8,9]. The relation between the economic processes and wise management of ecosystems' natural resources should be in a permanent balance [5,6,7]. The identification of the carrying limit of the natural forest ecosystems with the economic and social ones determines the needs – resources balance [5,7,8,9].

The natural ecosystems, especially the forest ecosystems create the necessary conditions for the social system development. Human society in relation with the social system as a whole may sometimes irreversibly affect and alter the forest systems self-regulation [3,5,6,7,8,9].

The analysis of anthropogenic factor management is relevant at administrative unit level, relatively homogenous in terms of geographical characteristics, tree structure, wood products demand, forest-dependent local communities, level of local economic and social development and the comparison with those at national level [5,7,8,9].

The purpose of the research is to contribute with scientifically-substantiated original elements to the general knowledge of the anthropogenic impact on the forest vegetation in Mureş county and to bring both theoretical and practical contributions for the prevention and control of illegal activities in the forests, as well as proposal of measures regarding the rehabilitation of anthropogenically damaged forest ecosystems.

The main objective of this research paper is to assess the consequences of the anthropogenic factor impact and the disturbances caused by this factor in the forest ecosystems from Mureş county.

The specific objectives include: identification and mapping of anthropogenically damaged areas; the inventory of resources and data regarding the current situation of the studied area, types of brush, development conditions, types of property and administration; determination of the work method, materials and necessary equipment; analysis of all elements and data regarding the resources; proposal of measures regarding the human action impact mitigation; monitoring and assessment of the measures proposed for the remediation of anthropogenic effects.

1. Materials and methods

In order to identify and characterize the current situation regarding the quantitative assessment of anthropogenic influence, relevant findings were considered in terms of the damages generated by the creation of structural imbalances of brushes, both vertically and horizontally, damages caused by illegal felling, seeding and soil, as well as the disturbances produced to forest biocenose and biodiversity conservation.

In order to conduct the researches, the following targets were set:

- identification and assessment of the disruptive and damaging impact on the forests in the entire research area (within the forest district, but also in the forest areas which are not managed, passed on by property restitution), according to the illegal felling and wood theft criteria;

- identification and recording of all changes inferred to forest ecosystems;

- conduct of dendrometric measurements in order to quantify the damages caused to forests in terms of illegally cut volumes and to compare the resulting volumes to the provisions of the previous planning activities;

The data included in the paper originate from documents drafted by the authors and by the staff of the forest districts, measured in the field, but also by comparing the data with the provisions of the previous planning activities regarding the clear-cut areas, cleared of timber from the private not managed forests by forest structures, both regarding the assessment of the total wood volume, species and wood varieties.

2. Results and discussions

The area covered by the forest vegetation in the Mureş county, in 2012 totals 217,679 hectares. Forest management is conducted by the Mureş Forestry Department Tg. Mureş through 10 forest districts, managing 105.4 thousand hectares of state-owned forests and 70.4 thousand hectares of private forests, representing 80% of the forest area of the county.

Another 38.5 thousand hectares forest area is managed by 4 forest districts representing 17.6%. One may thus notice that the 3.3 thousand hectares area extended throughout the county are not managed by an authorized forest structure, especially the areas retroceded as per Law 18/1991.

Of all the factors causing the disturbance of the forest ecosystem (which led invariably to the increase of anthropogenic impact), illegal felling especially in private forest is the most severe and disturbing.

The mapping of brushes exposed to the anthropogenic factor was developed depending on the consistence parameter. There were identified some lands severely damaged by the anthropogenic factor, by the incorrect implementation of silvicultural treatments, application of shallow inaccurate studies regarding the forests (age, composition, and consistence), and increase of selective illegal felling.

The brushes cleared of timber with a 0.1-0.4 consistence were also included in the category of severely damaged lands.

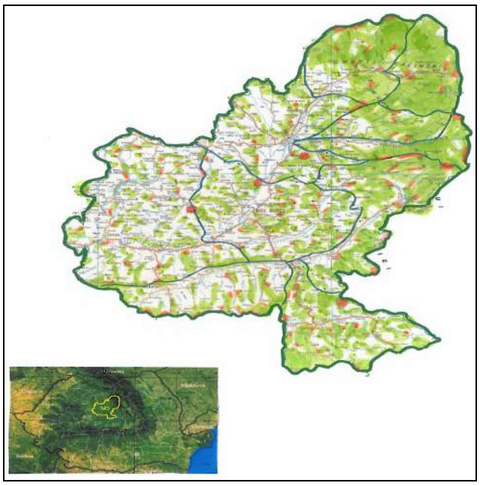

Fig.1 Location and mapping of risk areas anthropogenically affected in the study area, Mureş county, Romania (Source: ro.wikipedia.org, Mures Forestry Department, private forest districts)

As one may notice in figure 1, during the 1990 – 2012 period, the mountainous area was damaged by the anthropogenic factor in the localities Stânceni, Lunca Bradului and Răstoliţa. The hill and plain area is mainly affected near the localities where numerous unemployed rroma citizens live, in the following localities: Petelea, Tonci, Glodeni, Band, Tg. Mureş, Boiu, etc.

Fig. 2 Deforestation of private forest areas –Stânceni- Zebrac in 2012

The state-owned forest areas and those managed by authorized forest structures were affected by illegal felling below the disrupting level of tree stability, included in the slightly damaged category, although in time there were numerous variations caused mainly by the social factors.

Fig. 3 Deforestation of private forest areas –Petelea in 2009

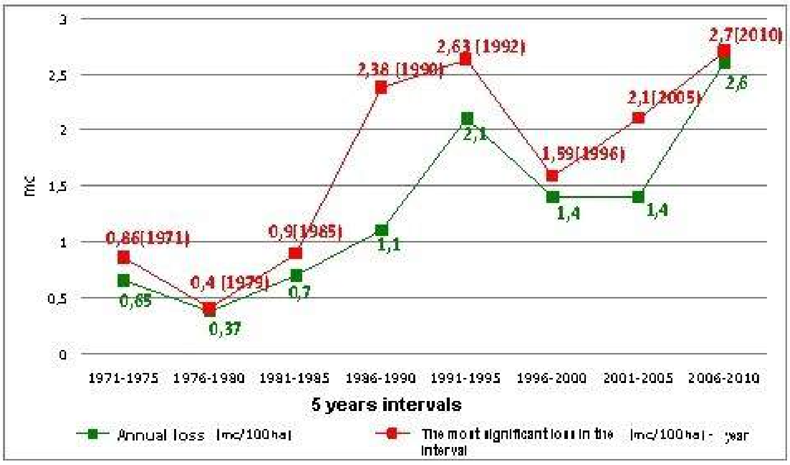

Fig. 4 Dynamics of damages found in illegal cutting of trees in state-owned and private property forests, managed by state forest structures (volume/ 100 ha), 1970 – 2010 (Source: Mures Forestry Department, private forest districts)

The analysis of the results achieved after conducting the research, as illustrated in figure 4, identifies the evolution of damages since the foundation of Mureş county. The damages caused to the forest by illegal felling during the analyzed time interval enable us to claim that the damages were recorded throughout the entire period.

The damages have been analyzed on five years intervals expressed in m^3/100 ha, enabling us to conduct a careful and accurate analysis of the damages caused before and after 1990, until 2010. The control interval considered in this paper was the 1970 – 1990 period, since the founding of the Mureş county until 1990, when the forests were entirely state-owned, with administration and guard provided by the forest department staff.

One could notice that during the 1970 – 1990 period, the wood volume of illegal felling reached the maximum value in the 1986 – 1990 interval, i.e. 1.1 m^3/ 100 ha, followed by the 1981 - 1985 interval, i.e. 0.7 m^3/100 ha, the 1970 - 1975 interval with 0.65 m^3/100 ha, respectively, the 1976 - 1980 interval with 0.37 m^3/ 100 ha.

The highest damage during this period was recorded in the year 1990, i.e. 2.38 m^3/ 100 ha.

The 1991 – 2010 interval has a special characteristic. As a result of property restitution, large damages were noticed especially during the 1991 – 1995 period, when the loss reached 2.1 m^3/100 ha, followed by a decrease to 1.4 m^3/100 ha during the 1996 – 2000 period.

After a period of apparent stability and damage mitigation in 2000- 2005, starting with the year 2006 the property restitution process continued, which resulted again in the increase of damages to 2.6 m^3/ 100 ha throughout the entire period, until 2010, inclusively.

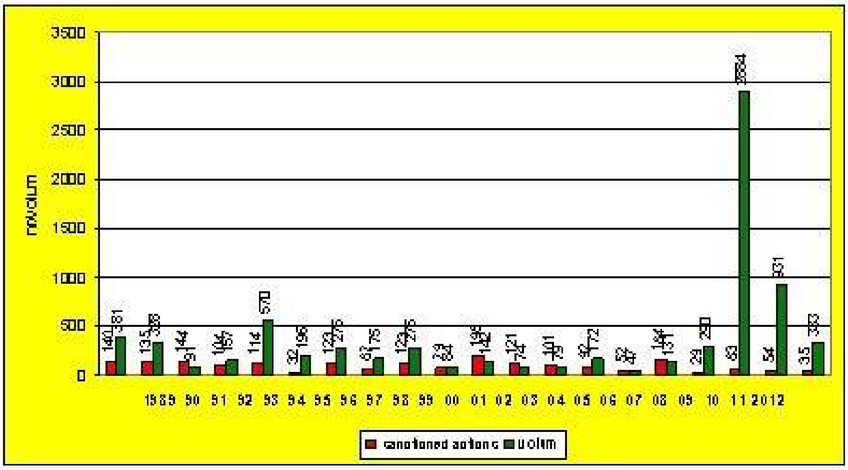

Fig. 5 Situation of findings and damages to exploitation irregularities – state-owned forests, managed by state forest structures 1989 - 2012(Source: Mures Forestry Department, private forest districts)

Referring to the years when the highest damages were caused, after 1990, the year 1992 stands out with 2.63 mc / 100 ha, followed by the year 2010 – 2.7 m^3/ 100 ha.

At the same time, the lowest damages were noticed during the 1971 – 1975 interval with 0.65 m^3/100 ha, the 1976 – 1980 interval with 0.37 m^3/ 100 ha and the 1981 - 1985 interval with 0.7 m^3/ 100 ha. The lowest damage was recorded in 1980, with a volume of 0.3 m^3/ 100 ha.

Considering the statistic data on the standard of living in Romania, one may conclude that there is a close connection between poverty, dependence on forests and anthropogenic pressure.

The highest damages were recorded in the 1991-1995 (2.1 m^3/100 ha) and 2006 – 2010 (2.6 m^3/100 ha) intervals, explained by the poor legislation regarding forest management, and by the illegal felling from private forests, retroceded as a result of property restitution on the forest lands and on the areas that were not managed in terms of forest, as well as by the non-observance of the forest exploitation regulation (by the access the economic operators in the forests).

After 1990, the damages identified are significantly higher than the average value of the 1970-1990 interval and are rather constant and ascendant during the entire 2006 – 2010 period, explained especially by the irregularities identified in wood exploitation from authorized felling areas (fig.5).

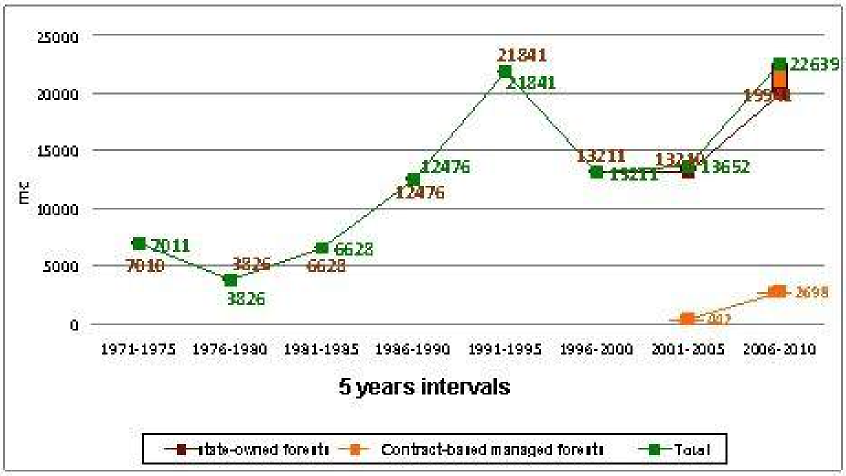

Fig. 6 Dynamics of illegal felling of timber from state-owned and private forests, managed by state forest structures (thousand m^3), 1970 – 2010 (Source: Mures Forestry Department, private forest districts)

The detailed analysis on the illegally cut wood volume (thousand of cubic meters during the five years interval) enables the identification of some relevant aspects in the analysis of this phenomenon.

Certainly, illegal felling existed during the entire time period considered, but their intensity obviously differs, from a five years period to another fig.6.

The comparative data analysis regarding the 1970 – 1990 control interval characterised by the centralized communist economic system, all the other options, with few exceptions, present significant to very significant diversions. After 1970, during a five years interval, 1986 – 1990, illegal felling was significantly higher than that of the control period. The other five years intervals are either identical with the control period in terms of illegal felling volume, or significantly lower than the control value.

One remark is necessary for the intervals after 1990 when all the five years intervals record significant differences higher than the 1970 – 1990 interval, considered as a control interval. It is obvious that at least the first five years interval (1991 – 1995) presented a unique increase of the illegal felling volume, reaching 21,841 m^3, with 15,213 m^3 more than in the 1985 – 1990 interval. Although during the 1996- 2005 period, the illegally felling wood volume has decreased, it remained relatively constant at 13,211 m^3, respectively 13,656 m^3 similar to the 1986-1990 interval. It is worth noting that during the last five years analyzed interval (2006 – 2010), a significant increase of the illegal felling wood material was recorded, reaching 22,639 m^3, above the differences significance limit.

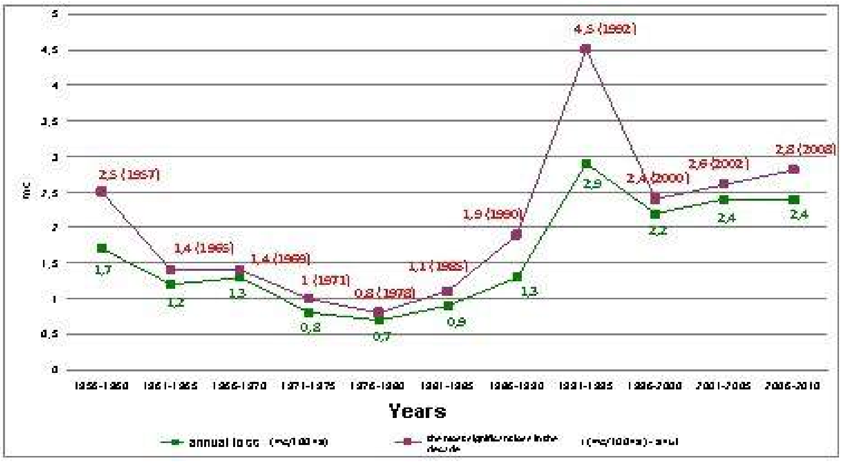

Fig. 7 Dynamics of loss caused by illegal felling in state-owned and private forests, managed by state forest structures (volume/100 ha), in Romania, 1956- 2010 [7]

The effects analysis of the anthropogenic factor in Mureş county is similar to the national state of things, according to Figs. 7 and 8, by comparison, with few exceptions.

One may conclude that the measures applied lately in the management of state-owned and private forests do not meet the current requirements in terms of prevention of criminal activities in the forest and cease of illegal felling.

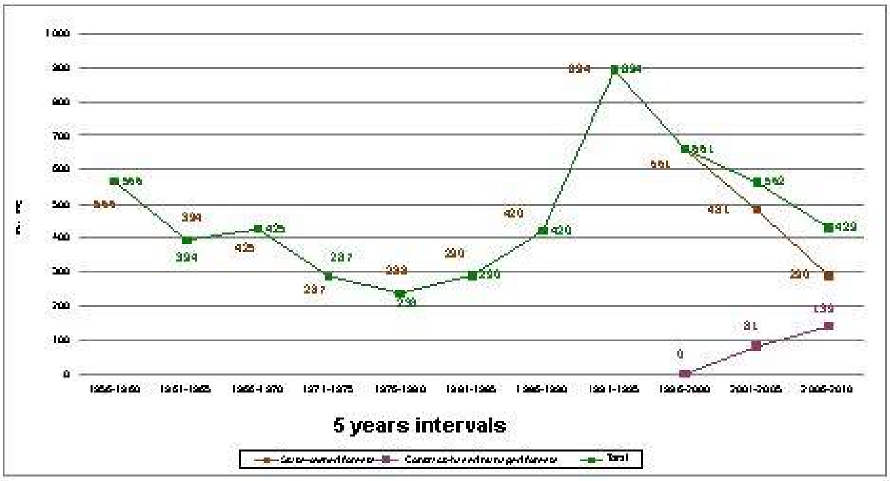

Fig. 8 Dynamics of illegal felling of wood material from state-owned and private forests, managed by state forest structures (thousand m^3), in Romania, 1956- 2010 [7]

The reality regarding the anthropogenic impact in Mureş county does not include all the damages in the forests, because there is a large illegally cut and stolen wood volume in the private forests not managed in terms of forest planning, where the control of national forest authorities was not performed.

Another aspect that should not be neglected is the deforestation of the forest vegetation from the pasture areas that were afforested after 1990, much of these in an advanced degree of degradation.

Although the animal stock did not spectacularly grow, in order to benefit of the amounts allotted by the state and the European Union as subsidies by the APIA programme, numerous owners lease the lands to *"support themselves"*, thus deforesting the vegetation installed in 20 years. In most of the cases, the composition and consistence of the forest is brush, which can be included from the pastures category of use to that of forests.

Conclusions

The assessment of the damages caused to forests by the increase of the anthropogenic factor intensity is materialized by the social and economic pressure of the forest-dependent local communities.

Of all the analyzed factors regarding the anthropogenic impact on the forest ecosystem, the illegal felling in private forests not managed in terms of forest planning was considered to be the most disturbing.

The significant anthropogenic impact identified by illegal felling in the research areas were favoured also by accessibility, the relatively short distances to the chipping machines, the gaps of the legislative framework, the fact that in the respective areas the forests were not properly managed.

The large wood volume identified as illegally cut in the currently exploited felling areas was determined as a result of the multinational corporation that buy good quality wood, the pine wood low quantity, the high standing timber price, and the reduced economic power of local economic operators.

The repeated anthropogenic intervention in the forest areas impacted by illegal felling prevents natural regeneration and restoration of forest ecosystems.

Recommendations

Considering the results of the paper and the conclusions drawn above, the following recommendations can be drafted:

- reduction of the cutting rate in the bordering anthropogenically affected areas;
- rehabilitation of the forest ecosystems by the afforestation of the clear-cut areas, rehabilitation of the brushes by the promotion of the natural basic type of forest;
- reconsideration and division of the respective brush in special protection functional groups;
- the correct assessment and quantification of the social and economic function of the forest;
- identification of solutions regarding the promotion of a new Forest Code - *Lex ferenda*, developed by forest and juridical specialists, which will include new solutions regarding all the aspects related to the forest domain, including clearly drafted norms and technical guidance, etc., to consider among others:
- comprehension of European provisions in the national regulations, applying the *sustainable forest management* concept;
- disambiguation of responsibilities and implementation of the forest district territoriality principle in developing the forest department;

- unitary management of all forest areas regardless of the property structure by means of the forest districts;
- unitary management of all forest areas in production units;
- initiation of regulations in application of silvicultural treatments to pursue mainly what remains in the forest (the trees) plus / minus what leaves the forest;
- the implementation of law on the afforested pasture areas and their inclusion in the national forest fund, as well as the interdiction to deforest them under the pretext of clearing the pasture;
- reconsideration of the surveillance and guard activity in the forest by specialized personnel, adoption of a new concept regarding the guard activity based on the personnel training and responsibility;
- drafting of a control regulation of the wood material traffic, provision of marked company cars and equipped with acoustic and green light signals, etc;
- identification of infringement solutions related to the provisions of the Criminal Code regarding illegal felling activities and wood theft from national forests;
- initiation of an efficient system for the assessment, use and rigorous management of the wood resources by the forest administrator;
- identification of solutions regarding the protection of the foresters for the sustainable development of forests.

The paper represents a benchmark for the state institutions designated to manage the forests, respectively to determine a more realistic actions on the forest conducted to an equal extent by forest administrators, technical experts and owners.

However, the results of this paper are extremely useful to the scientific community regarding the consequence analysis of the irresponsible human action on the forests.

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