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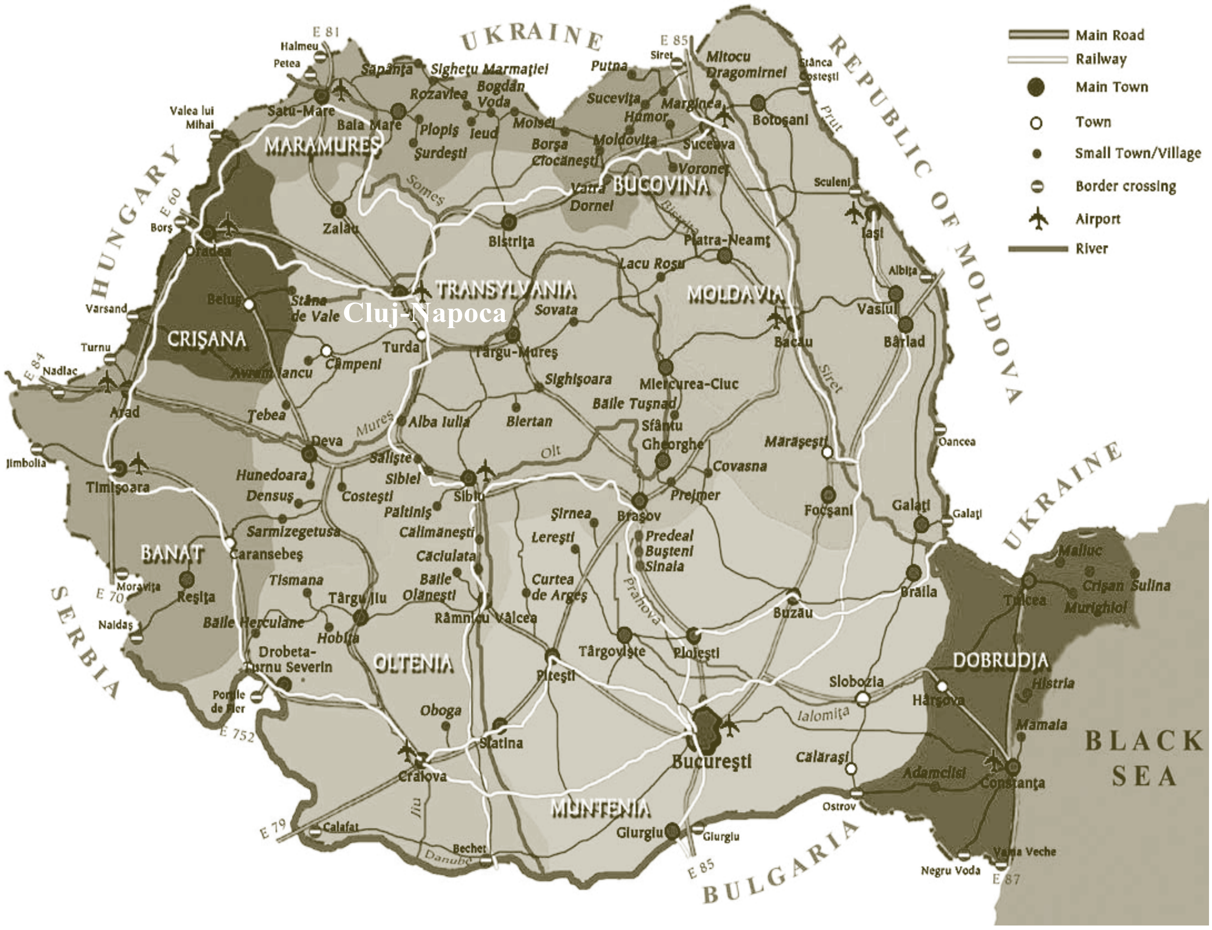

GEOGRAPHIA

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Dedicated Number of the Conference

"AIR AND WATER" COMPONENTS OF THE ENVIRONMENT

WORLD METEOROLOGICAL DAY

AND

WORLD WATER DAY

March 20-21. 2009
CLUJ NAPOCA
ROMANIA

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CUPRINS – CONTENT – SOMMAIRE – INHALT

III. Hydrological Environment

FOREWORD

United Nations Organization, the most representative organism of contemporary world, has recommended the celebration every year, in the same day, of some special moments, events, resources, actions etc.. For the two main components of the environment, air and water, by hazard or no, two consequent spring days has been established.

World Water Day has been celebrated, every year since 1993, on March 22nd, having as initial goal to draw attention on the fact that more than 1 billion people did not have access to clean water. The World Meteorological Day, has been celebrated each year on March, 23rd, since 1953, when World Meteorological Organization Convention was signed and stated its existence.

In time, the celebration of the two days has become a tradition in many countries. The fact is a normal consequence of the importance that the two subsystems of the environment have for human life and activity. Nowadays, among other problems, human society has preoccupations connected to the hydro-atmospheric environment: warning, mitigation and fighting against effects of the climatic and hydrologic hazards, improving air and water quality, a better management of water resources. One can say with no doubt that both air and water, represent nowadays very important problems for life and health of our planet, as a unique system, but also for component subsystems. Their importance increases considering climatic changes which influence, mainly, water resources of the Earth.

Hydrology and Meteorology team from Babes-Bolyai University of Cluj-Napoca, Faculty of Geography, working in Physical and Technical Chair, has considered very useful to promote the idea of celebrating the two days. First, we have thought to celebrate the two events by a symposium which could reunite people from research field, teaching activity and operational activity having as main aim a better knowledge of hydro-atmospheric environment. This is the reason that has led to organize the scientific conference “Air and Water – components of the Environment”. We have wished that our conference bring together people from all branches of the main fields, from internationally recognized researchers to people who are involved in the operational activity.

We are glad that our proposal has had a huge echo both in the universities and research institutes and meteorological, hydrological and environment networks from our country and from abroad.

Our goals could not become reality without the support of few companies in the field of monitoring and management of air and water resources in our city. That's why, we want to kindly say "thank you" to all those people and institutions which have given us important moral and financial support to get to the final points of the conference.

One of those points is the printing of scientific communications presented during the first edition of "Air and Water - components of the Environment" conference. The reviews published for this purpose, one special issue of Studia Universitatis Babes-Bolyai, Geographia, and a special issue of "Riscuri si catastrofe", are the main reason which proofs that our efforts have not been in vain. More than 60 relevant articles have been published in the two special issues. They cover both theoretical and practical aspects in the fields of meteorology, hydrology or environment pollution.

Finally, we want to say "thank you" to all those who have made us the honor to participate to this scientific conference and we promise that the meeting with spring in Cluj-Napoca will be repeated every year from now on.

Prof. Univ. Dr. Pandi Gavril

Conf. Univ. Dr. Florin Moldovan

I. Theoretical Approach

CLIMATIC CHANGE AND WATER RESOURCES

G. PANDI[1]

ABSTRACT. Climate Change and Water Recources. Water resource has a constant amount, but its spatial-temporal distribution on Earth's surface is highly modified by climatic changes. Genetic factors of water resources – the rainfall and temperature – have significatively been modified within last decades, and the phenomenon will not stop in the future. Consequently, water resources stocked as ice cap, glaciers and snow will be diminishing. Water on continents – running water, lakes and phreatic waters - would be changed from both as amount and quality. The level of Planetary Ocean will rise, and the characteristics of the seawater are changed. All those changes would be reflected by modification of average values, as well as frequency and amplitude of extreme hydrical phenomena. The landscape components – abiotic, biotic and anthropic would be affected by these changes.

Keywords: *climatic changes, water resources, continental waters, solid water, Planetary Ocean, extreme hydrical phenomena.*

1. INTRODUCTION

The Earth is the only planet of Solar System that has water resources capable to sustain the life. During planetary evolution history, the amount of water from Earth surface has been modified many times in accordance with major climatic changes.

If we take into account actual stage of evolution, shorter, water resource of the Earth might be considered relatively constant. Using this hypothesis, we can write the balance equations of ocean and continental environment, on the base of relation between evaporation, rainfall and surface flow.

$$E_o = P_o + R \qquad \text{and} \qquad E_c = P_c - R$$

Algebraic sum of two equations show equality between the amount of rainfall and evaporation, so the Earth's resource of water has a constant value.

$$E_o + E_c = P_o + P_c$$

Only a very small amount of water (around 500000 km^3) from the total volume of water on the Earth ($1,39 \times 10^9$ km^3) is involved in this hydrologic cycle.

The climate is responsible for genetic factors of water resources. The rainfall represents the main input of hydric system, then the temperature, which has a direct influence. Along with other factors, the role of human intervention is more and more important within hydrologic system. There are three ways through human factor influence hydrologic cycle:

-increase influenced area.

-there are more and more influenced phenomena.

-increase the influence degree.

Of course, the influence degree is stronger at micro scale level and it is reducing slowly for superior levels. Already we can identify other hydrologic cycle (influenced or even artificial) at different levels of analysis.

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No matter which factors natural or human lead to the climate changes, the spatial-temporal modification of climate elements have influence on hydrologic cycle, consequently water areas and water resources that exist under all three phases: liquid, ice and vapors.

2. THE GENETIC FACTORS CHANGES WITHIN LAST CENTURY

2.1. Rainfall

The amount of annual rainfall, related to the average value of several years, has been suffered important changes during time. The anomalies plotted for the last 100 years emphasis some characteristic periods and a sort of cyclicity.

The debut of the last century was a period characterized by a value of rainfall less with 15 mm. compare of nowadays. Starting with 1850 up to, 1940 it can be noticed a certain increase to average value, anomalies being slightly positive with a tendency for decrease. The next 10 years were dry or near the average value. Then a period with positive anomalies follows, on average over 20 mm. Exceptionally wet was the period 1955-1965, when the most years had the anomaly over 30 mm. During the period 1980-1995 the most years were characterized by the reduce amount of rainfall, sometimes having anomalies of 20 mm less. Within last years of the period, the amount of rainfall starts to rise but not significatively. Consequently, the decrease tendency of anomaly is very clear for 1075 and 1992, having maximum amplitude around 100 mm.

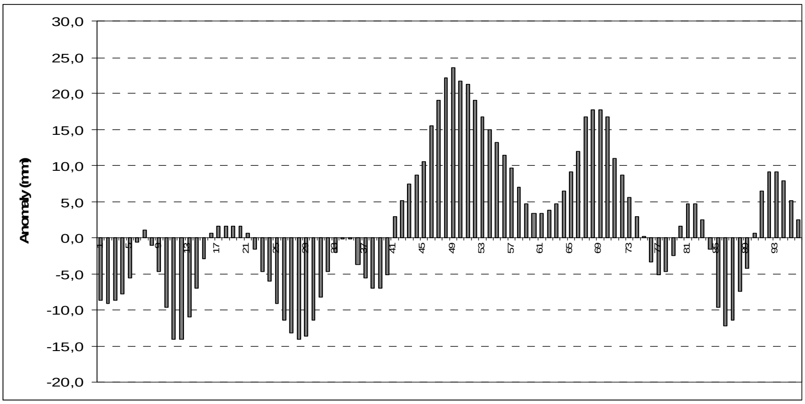

Fig. 1. Anomaly of annual rainfall (IPCC)

The variations of rainfall amount were significatively differentiated from geographical point of view. For the last century, Africa recorded the highest diminution of rainfall amount. At the same time for southern part of South America, west of Australia and east of North America was recorded slight positive anomaly.

For the last 25 years, positive anomalies are present for western part of Australia, southern part of South America, whilst african Sahel has recorded a slight surplus. In return, negative anomalies are extended in North America, Europe, south of Africa, south an east of Asia and southeast Australia.

2.2. The temperature

From reconstructing the evolution of solar radiation influencing factors for 2000 years, result changes of temperature. For last century it can be noticed an abrupt increase of greenhouse effect, the diminution of aerosols and volcanic activities as well as a very week intensity of solar radiation.

For the last 100 years, temperature has recorded a very clear increase tendency. If for the beginning of last century the anomaly was -0,4^{0}C compare with the average of interval 1961-1990, nowadays it is +0,4^{0}C. In absolute values, that means an increase in average temperature values on Earth from 13,5^{0}C to 14,5^{0}C. If the northern hemisphere is regarded the anomaly's amplitude is even bigger, around 1^{0}C. The warming climate tendency is going on. The shorter period of regression taking into analysis the bigger peak of the graphic.

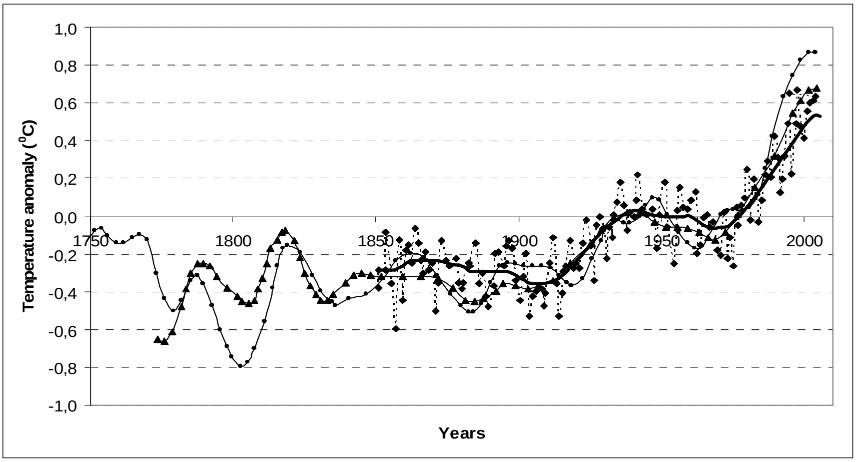

Fig. 2. Anomaly and the trend of annual average temperature (IPCC)

Geographical distribution of global warming shows maximum values within temperate zone of northern hemisphere, first in North America, northern part of Atlantic Ocean and Europe. In southern hemisphere south of Africa has become warmer. The polar zones from both hemispheres have become colder. Taking into analysis only last 50 years we have the image of a general warming, having as exception the two poles and southern band of Planetary Ocean.

3. FORECAST OF CLIMATE CHANGES

The forecast of genetic factors changes of water resources – rainfall and temperature –is not always straightforward. Global warming tendency of atmosphere is accepted but last of some information are indicating a potential start for a cold period. Significant differentiations show the quantitative evaluation of global warming. Different models realized for the next 100 years are indicating an increase of average temperature of the atmosphere between 0.5^0 – 3.5^{0}C.

There have been drawn up the maps of temperature changes areas for the next 20 years and up to the end of century. For both cases, it is foreseen that the hottest periods will affect northern areas of north hemisphere. In these regions temperature might increase with 2^0C for 20 years and with 7^0-8^0C up to the end of the century. The slightest warming will be recorded to the south of southern hemisphere, where within 20 years temperature will increase with $0,5^0$C and around 2100 year will increase with 1^0-2^0C.

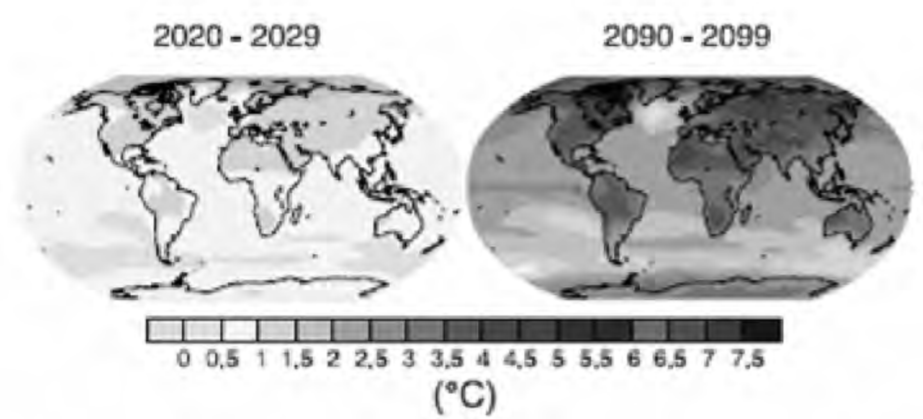

Fig. 3. Distribution of global warming in the 3rd decade and up to the last decade of XXI century (IPCC)

The evolution of rainfall amount will not be so one-sided. It can be foreseen both decline and increase, their distribution on Earth being very uneven. In general, it is foreseen an increase of the rainfall amounts over 20%, at higher latitude, especially in northern areas. Important increases will be the same in equatorial areas of Africa and south Asia. The most important decrease of rainfall amounts will be recorded in near area of Mediterranean Sea, on south-west of North America and southern Africa. Within these areas, the diminutions may exceed 20% in comparison with actual quantities. In accordance with these anticipations, the zones less affected by rainfall changes will be the equatorials ones and Australia.

4. THE CHANGES OF WATER RESOURCES

The most foreseen have the source the average values of the elements. Some of them are related to amplitude and frequency of extreme values. It has to be stressed that from point of view of hydric resources modification, along with average values of climate elements, the changes of extreme values will have a very important role.

4.1. Solid water resources

The direct effect of global warming is the melting of snow and ice both in polar zones and into the mountains areas. During the interval 1960-2005 the ice amount of Earth has decreased with 7 x 10^2Gt. Three characteristic intervals can be identified: 1960-1975 an average decline under $1x10^2$Gt, 1975-1993 average declines under $2x10^2$Gt, and the last interval when it was an abrupt decline from $2x10^2$Gt to $90x10^2$Gt.

Along with general thickness diminution of ice caps, it can be noticed an intense melting up to 50 cm/year for the seaside area of Greenland and Antarctica's seaside oriented to South America. The areas of ice-caps is permanently restraining for last ten years, reaching an anomaly of $0,8x10^6km^2$ in 2005, compare with the average of interval 1966-2005. The evolution of Arctic Ocean ice-cap show an upward trend up to 1965, a relative steady state up to 1988 and a rapid decrease afterwards that year. Within last interval the anomaly decrease from +0,2m to -0,6m compare with average value of interval 1950-2000. Up to 2050, it is foreseen that the surface of ocean covered by ice will diminish to halve.

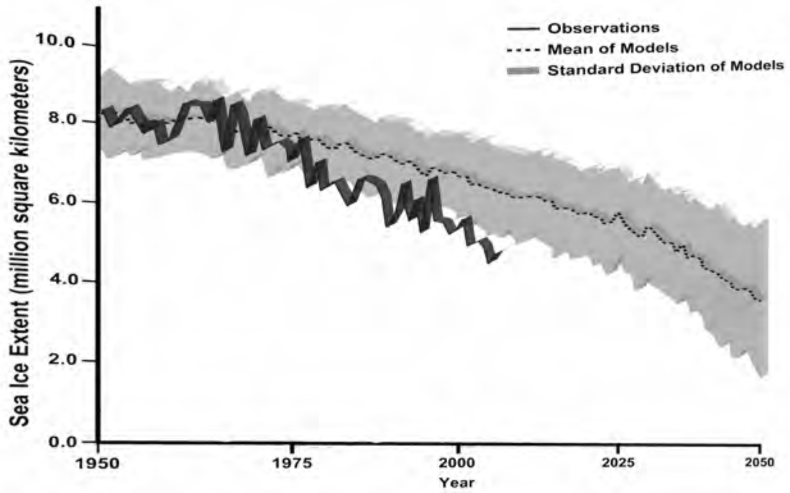

Fig. 4. Forecast of ice area diminution of Antarctica (IPCC)

The continental areas covered by snow were diminishing especially within decade 1980-1990, but today it shows some stabilization. Had it taken into account the evolution of ice sheets of tropical mountains (Kenya, Kilimanjaro, Ruwenzori, Irian Jaya), for the last 100 years it was noticed a dramatically decrease of the surfaces.

The permafrost had a permanent diminish tendency. The area anomaly had been reduced from $+0,5x10^6$ km^2 for decade 1950-1960 to $-1,0x10^6$ km^2 for last decade, in comparison with the interval 1950-2005.

4.2. The Planetary Ocean

The ice and snow resources melting, in accordance with the change of rainfall distribution has direct implication on the level of Planetary Ocean. The general tendency is the uplift of Planetary Ocean. Plotting data allow us to differentiate an interval of stability for 1800-1870, a slight uplift of 40 mm. up to 1930, and then an intensification tendency with amplitude of 120mm. The forecast for next century show a great variation from 200mm. to 480mm. The minimum limit preserve actual gradient.

The uprising level amplitude is different in surface. For last 50 years, rates of maximum uprising, over 3mm/year have been recorded for the north –east part of Indian Ocean, for the middle and northeast part of Pacific Ocean, and for north part of Atlantic

Ocean. For the whole area of Atlantic Ocean, it can be notice a general uprising of water level. At the same time, there are areas where ocean level decreased for the same interval: the middle of Indian Ocean, equatorial band of Pacific Ocean and some regions of east Pacific Ocean.

The Black Sea level has the general tendency, but with a faster rhythm. The uprising tendencies for Constanta and Sulina are almost parallel. Average water level for last century was 25 cm.

The studies show that uprising of ocean level is due first to melting of Antarctic ice cap, then to melting of the snow and ice from the other continents and on the third place due to melting of Greenland, and finally follow thermic expansion of water.

The ocean water warming has not as main effect general uprising of level but modification of some qualitative states. Therefore, the uprising gradient of level has a longitudinal difference with a maximum in temperate zone. The salinity of water increase, especially within intertropical zone, but significantly even in temperate zone. The concentration of CO_2 increase and concentration of H^+ in water decrease. A general phenomena is the lowering of isotherm horizon and uplift to the surface of isodensity horizon. Only for cold climate zones, the rainfalls may bring the equilibrium of quality changes, refreshing water resources.

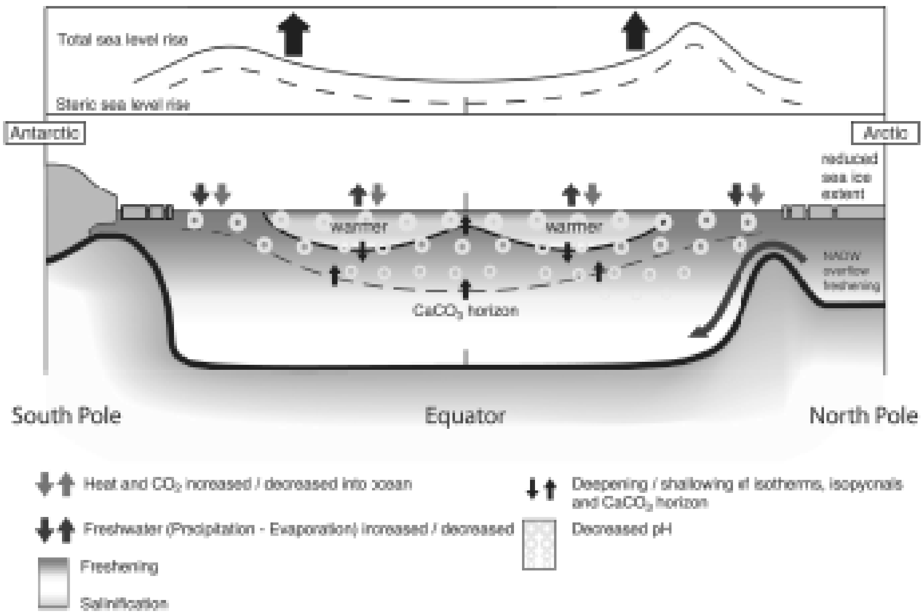

Fig. 5. Changes of ocean water state (IPCC)

4.3. The continental water

The change of climatic conditions is reflected on river flow and change resources of phreatic water.

Foreseen for the next 50 years shows a highly decline of annual average debits for hydrographic basins belonging of Mediterranean Sea, Black Sea, Caspian Sea, for central Asia up to China, for southern part of North America, for middle part of South America and for central part of Argentina.

Up to 2050, the capacity of phreatic water regeneration will be the highest for northern zone of Asia and North America, for south part of Australia and for some mountain zones. The lack of regeneration will be recorded for northern and southern Africa, and for northeast part of South America. From this point of view, Europe is placed into a neutral zone.

One of the main conditions for sustainable development of human society is the state of continental water resources. From this point of view there were differentiated some critical zones for the next period. Up to 2070 hydric potential used for electric energy, production for Europe will decrease with 25%.

Up to 2050 for northeast part of South America, phreatic water resources will decrease with 70%. After the year 2020 decreasment of river debits for southern part of North America and Central America will lead to the impossibility of providing enough water for society. The acid rain in east Africa will significatively diminish water resources in use. Starting with 2040-2080 for island from northeastern part of Indian Ocean the uprising of sea level will affect horizon of fresh water. The triggered flooding on big river in Bangladesh will increase around 25%.

5. THE EXTREME HYDROLOGIC PHENOMENAS

The first indications of the hydrologic consequences of climate change will be higher amplitude and frequency of risk hydrologic phenomena.

The affected areas by risk phenomena will be more extended in comparison with those affected by general lack of water. Major hydrological risk would be the consequence of extreme phenomena and not because of the lack of water resources.

For the last decade, there can be listed extreme phenomena due to changes of climatic elements.

- drought in central and southwestern part of Asia, 1998-2003;
- drought in western part of North America, 1999-2004;
- flooding in Europe, 2002;
- drought in Australia, 2002-2003;
- very hot days in Europe, 2003.

The increasement of very rainy days frequency will enhance not only rainfall amount but also the frequency and amplitude of flash flooding. In the temperate zone of northern hemisphere this tendency will be very strong and will increase up to 2030.

The very heavy rain have a contribution to extension and intensification of linear and area erosion processes. The torrential landforms are more frequent and the riverbeds are affected by a very intense dynamics. All these processes provoke the augmentation of alluvial transport and the acceleration of fluvial accumulation processes. The soil overmoisturing is a opportune condition for mass movement processes triggering. Consequently, the areas affected by bad-lands erosion type are extended.

The choking of lakes and intense evaporation of water, due to extended intervals with high temperatures are lead to diminution of lakes areas. In central Africa and Asia, the situation is very serious. Classical example for Africa is Ciad Lake that in 130 years has reduced ten times its area because of lowering the level with 6 m. Within 40 years lake Aral has reduced very much its surface and the water is altered form qualitative point of view. The level of Dead Sea lowered many meters and salt concentration has multiplied.

Extensive and frequent intervals without rainfall lead to hydrologic drought. If for intervals 1940-1980 the evolution of drought parameter has certain equilibrium for the whole planet, nowadays shows a rapid increasement. Extreme manifestations are common in African Sahel, southern part of Africa, eastern part of South America, and southeastern part of Europe.

The uplift of planetary ocean level will cause flooding on the shores and a high risk for Gulf of Mexico, Amazon's estuary, Gulf of Guineea, English Channel, the south part of Baltic Sea, southeastern part of Mediterranean Sea, east coast of India.

General tendency of quantitative water resources diminution, alteration of water qualities and extreme hydrologic phenomena more and more frequent have as consequences the impossibility to satisfy the needs of human society. For the most countries it is recorded a significant reducement of water resources per head, within a short interval 2000-2005.

Hard to believe for some areas the reducement of water resources is about 50%, as example in Madagascar, Mauritania, Senegal, Sudan and Nigeria.

6. CONCLUSIONS

The genetic factors modification of water resources lead to a wide range of dangerous hydric phenomena, which show a major risk. This will affect all type of aquatic areas having repercussions on all abiotic, biotic and human components of geographical landscape. The climate changes due to the natural evolution factors and/or the existence of human society, will affect the future evolution of the planet Earth overall. The assertion that "XXI century will be dedicated to the water resources protection" it is not exaggerated.

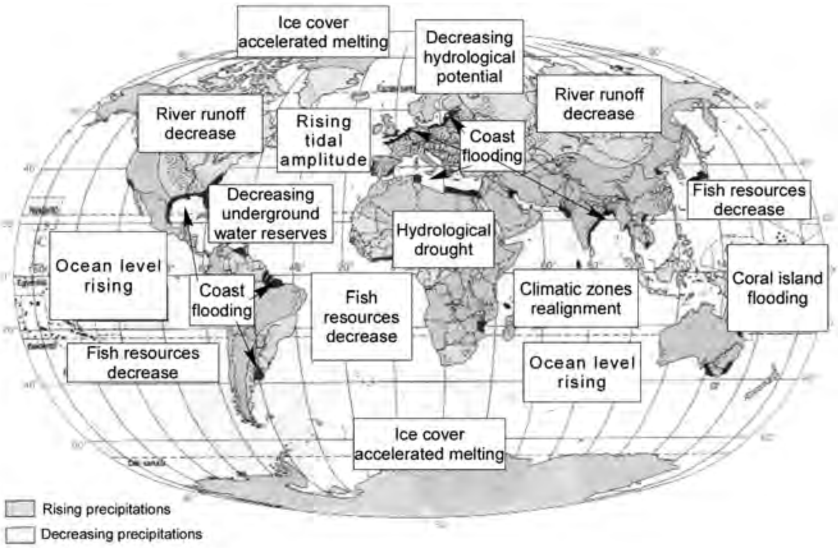

Fig. 6. Distribution of hydric phenomena having a major risk on Earth

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AIR AND WATER. PATHOLOGY AND THERAPY

ELENA TEODOREANU[1]

ABSTRACT. Air and Water. Pathology and Therapy. The paper makes an overview of the pathological aspects of air when limits of thermal comfort, high pressure variation, humidity, high winds or air pollution are surpassed. Various forms of naturistic treatments based on the qualities of air (aerotherapy, heliotherapy, mofette and saline cures) are also discussed. Some pathologies, pollution with heavy metals, pesticides and micro-biological agents can unleash water-related epidemics. Water-based cures (crenotherapy with mineral waters, hydro- and thalassotherapy) are also dealt with. Medical indications for prophylactic, treatment and rehabilitation cures are included.

Keywords: *climatic parameters, hydrographic conditions, naturistic treatment, pathology*

1. INTRODUCTION

As known, air and water are the two capital elements for life on Earth, forming its two covers: the atmosphere and the hydrosphere. In order to make the life of plants, animals and man possible, they should meet certain physical-chemical and biological conditions.

Man's life is intimately linked with the quality of these two elements.

If the limits of some of these two variables are surpassed, if their chemical composition is changed, vital elements are reduced, if they are chemically and biologically polluted, then a specific pathology sets in liable to increasing morbidity and even mortality in time and space.

On the other hand, if some of their health-stimulating features are judiciously used, a naturistic therapy could be developed capable to fight the negative effects of a less favourable environment, or of some unhealthy habits inherited or acquired in the course of one's life-time.

Zonal climates and local hydrographic conditions have in time engendered major economic and mental disparities in people's state of health or illness.

A characteristic of warm areas is the high caloric and radiative stress, with wet regions dominated by infectious diseases, e.g. endemics or epidemics maintained by infections agents (mainly viruses and bacteria, but also fungi, protozoans or metazoans), transmitting agents (arthropods – lice, fleas, etc.; insects – mosquitoes, flies, domestic or wild animals); in dry and desert zones the density of population being extremely low, the incidence of diseases is also very much reduced.

The temperate zone has a moderate climate with seasonal contrasts, more life-friendly, a better living standard and a more efficient health-care system. Diseases are rather anatomic, the consequence of nervous stress, sedentarism, irrational diets, air and water pollution, etc.

The cold zone exerts a high thermal and dynamic stress, the pathology being related to hypothermy, avitaminoses and anatomic diseases.

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2. AIR AND HUMAN PATHOLOGY

The relationship between the two is disturbed whenever certain limits, deemed to be life-friendly and comfortable, are surpassed. All the elements characteristic of a region's climate fall into this category.

A temperature above comfort limits (varying in terms of adaptation to the general climate) usually tops 30º-33ºC (average skin temperature) and, if it lasts, the human body undergoes a heat stress. Returning to normal values, the body must activate some mechanisms to deplete overheating, e.g. conduction (transfer of body heat to a colder substance or body), convection (substitution of the hot air layer close to the skin for a colder one), the body's heat radiation, kind of "black body" behaviour, and skin water evaporation mainly through perspiration. The last mechanism, entailing loss of salts and oligo-elements, causes fatigue, circulatory instability and loss of body water (especially if not permanently replaced by drinking), rises again the skin temperature, increasing the internal body temperature. Effects: heat oedema, spasms, exhaustion, congestion, and caloric syncope.

Whenever high temperature is associated with *lengthy sun exposure, especially to UV radiation*, insolation may set in, the symptoms being headache, sickness, dyspnaea, erythema, photo-thalassemia, cataract, caloric shock and particularly melanopathy (skin cancer frequently followed by metastases). At the other end of the spectrum, *lack of light* leads to rachitis, infectious diseases, depleted immunity, and tuberculosis. Temperature below comfort limits (also varying in terms of local climatic conditions) increases the internal heat output to rebalance heat values through some physiological processes: intenser metabolic combustion, shiver (involuntary contractions of the striated muscles), more blood flow to the skin and subcutaneous tissues, increase of secretions and arrest of perspiration, etc. Hypothermy entails peripheral vasoconstrictions, chilblains, neuritis, neuralgias and death if the body temperature falls below 24ºC.

High humidity or high winds, enhance cooling and if exposure is longer, clothes are not thermoisolated and the diet is poor in caloric input, effects are severer and set on faster. The symptoms of a weather-induced pathology are more obvious in rheumatic patients.

Noteworthy, high humidity creates discomfort also with elevated temperatures, enhancing the sensation of oppressive heat with pathological effects.

High atmospheric pressure variations over a short time span caused by an active atmospheric circulation, with rapid successions of air fronts, entails weather changes, inducing blood pressure variations and pathological effects in the circulatory, respiratory, endocrine and nervous systems due to swift thermal and hydric variations associated largely to rapid pressure falls.

Some negative symptoms may occur at high-altitude mountaineering (particularly if the pace is fast) because atmospheric pressure, basically partial oxygen pressure dropping, may entrain variations of blood pressure, of heart-beat, of cholesterol and glycemic metabolism, modifying the activity of the nervous and respiratory systems, sometimes falling under "mountain sickness" ailments.

Winds can change thermoregulation, and by exerting direct pressure on the body and stimulating skin nerves, may unleash angina attacks, negatively affecting the respiratory or nervous systems. Fast-blowing local winds (Föehn) increase the temperature, depress air humidity, cause irritability, fatigue, headaches, haemorrhages, venous stasis, water retention, painful scars, occasionally nervous disturbances, suicides, etc.

Hydrometeors (rain, sleet, snow and mist) exacerbate the symptoms caused by severe humidity and reduced insolation.

Wind-related phenomena may influence the nervous system triggering the symptoms common to the rapid passage of cold air fronts, and causing particularly heart pain, articular pain and attacks of asthma. People struck by thunder may die through hyperemia (congestion, accumulation of blood in a body organ or body part) and pulmonary oedema.

As a rule, meteo-sensitivity and the negative effects of atmospheric phenomena beyond comfort limits are visible especially in people suffering from various illnesses, in elderly with depleted thermoregulation capacity and in small children whose thermoregulation is not sufficiently consolidated. Young, healthy individuals and particularly trained people, put up more easily with the unusual manifestations of climate.

It should be remembered that occasional or permanent *air pollution* is a characteristic mainly of *large cities*, with great density of population, buildings, heating installations, and cars that modify air chemism by reducing the quantity of oxygen strictly necessary to breathing normally. At the same time, they increase the content of various oxides, particularly carbon oxides, petrol vapours, etc., especially in conditions of thermal inversions, atmospheric calm when pollutants hover over the city for a long period of time. One may truly speak of a pathology of large cities, of urban infections (frequent influenza epidemics, tuberculosis, syphilis) due to high population density, asthma attacks, deficiency of minerals and disturbances of the mineral metabolism caused by low UV radiations, urban fatigue, nervous disturbances, etc.

The air of *industrial zones* is polluted by the noxae released from manufacturing units (thermal power stations, non-ferrous metals, anorganic and organic chemical works and building materials). The effects on the population are either immediate (in case of accidents) or delayed: irritations, asphyxia, fibroses, cancers, anomalies and malformations, genetic mutations. Morbidity and mortality are on the increase through the aggravation of non-specific chronic broncho-pneumonias (chronic bronchitis, pulmonary emphysema, bronchial asthma, nervous, vascular and haematological disorders, lesions of the osteo-articular apparatus, etc.).

3. AIR AND THE NATURISTIC THERAPY

The same elements within convenient limits can be used both for prophylactic, therapeutic and rehabilitation purposes.

Aerotherapy means progressive exposure of part of the body, or of the whole body to the action of air. The techniques used are sedation, relaxation for neurotonic excitable patients, for sufferers from pain, and for frail ones, and stimulation for those with delayed organic responses.

The air cure acts upon the thermoregulation processes, improves blood circulation and influences nutrition. In terms of temperature, air baths are cold, moderately cold, cool, indifferent, warm and very warm, depending on the comfort-inducing temperature and on heat loss. In terms of aerodynamic action, air baths are static, slightly dynamic, moderately dynamic and highly dynamic, depending on wind velocity (above 4 m / sec aerotherapy is considered to be stress-inducing). In terms of hygrometric conditions, air baths are dry (under 55% relative humidity), moderately dry, moist and very dry (over 86%). Air bath may be associated with *aeroionotherapy* or *therapy with inhalations* of marine or forest aerosols, or with mineral waters and drug solutions. Aerotherapy may be associated with other naturistic cures, e.g. heliotherapy, hydrotherapy, kinetotherapy, etc. This type of therapy is administered mainly in spas and health resorts located in the mountains, hills, plains or at the seaside, according to medical indications and the combination with other forms of therapy. Air cure also means spending one’s leisure time and taking walks in green areas, in parks, in near-by forests or on lake shores and river banks.

Heliotherapy can be practiced in the mountains, hills, plains or at the seaside, depending on the patient's age and type of affection.

The general technique of a sun cure should be established by the doctor who doses it in terms of weather and hour of the day. Prophylactic indications for children: otorhynolaryngological ailments, trachaeo-bronchitis, rachitis and endocrine hypofunctions; for adults: allergic asthma, chronic gynaecological affections, and dermatological problems. Contraindications: cancer or precancerous conditions, evolutive pulmonary tuberculosis, gastro-duodenal ulcer, hyperthyroidism, asthenic neurosis, decompensated cardio-vascular affections.

An *in-door therapy* includes *mofette* and *solfatation*; whenever there is high CO_2 content with H_2S percentages, indications are for arterial, mainly cutaneous, circulation, hypotension, varicose ulcer, etc. *Spelaeotherapy* in s*alinas* rich in sodium, potassium, calcium and magnesium aerosols that are absorbed by the upper breathing pathways, is indicated in unspecific chronic respiratory diseases (bronchitis asthma, chronic bronchitis, etc.). Spelaeotherapy in *karst caverns*, where the concentration of calcium ions is recommended in hypocalcemia with manifestations of tetany, migraines, psychic and neurological manifestations, dental decay and cataract.

4. WATER AND HUMAN PATHOLOGY

Doctors say that man can live without food for up to 40 days, but no more than three days without water. For water to be fit for drinking it should correspond to legally established norms of taste, colour and smell, not health-impairing.

Each type of pollution produces a specific pathology. *Thermal pollution* produced by thermal power stations affects mainly water flora and fauna, and indirectly man. *Chemical pollution* (with oil, phenols, detergents, nitrates from the fertilization of soils with natural fertilizers) produces intoxications, particularly in sucklings ("blue disease"), headaches, diarrhea, and depletes natural immunity in adults. *Heavy metal pollutants*: lead causes hydric saturnism, anaemia, nephrites, etc.; cadmium is responsible for hypocalcemia and spontaneous bone fractures, while arsenic may develop skin cancer. *Pollution with pesticides* is lethal for fish, and if assimilated by the adipose tissue of man has long-term pathological effects. *Radioactive pollution* targets the sexual organs, the blood, the epidermis and the eyes.

Micro-biological pollution brings about microbial diseases: typhoid fever, dysinteria, cholera, enterocholitis, tularemia, carbuncle, etc. and viral diseases: respiratory, ocular, digestive, paralyses, encephalitis, hepatitis, etc. Diseases induced by protozoans (e.g. giardioses), by various species of worms (cestodes, trematodes, filariids) engender hydatic cyst taentasis, elephantiasis, etc.

There are situations when *water-induced epidemics*, usually explosive, occur as lots of people in a region drink contaminated water. As they stop drinking it, the number of cases suddenly drops.

The presence of *macro-and-micro-elements* in a region's waters may produce certain diseases, e.g. if water hardness is low (deficiency of calcium and magnesium salts) the incidence of cardio-vascular affections rises; the absence of chromium favours atherosclerosis-related morbidity. On the other hand, if water hardness is high, the incidence of kidney diseases is on the increase.

5. WATER AS THERAPEUTIC FACTOR

Crenotherapy. *Internal treatment* with mineral waters: carbogaseous in gastrites, enterocholites, biliary and renal dysfunctions; *alkaline* in chronic gastro-duodenites, ulcer, cholecistites, bile and kidney lithiases; *chlorinated-sodic* in stomack diseases and diabetis; *sulphattated* in constipation, and stimulate dieresis; *sulphorous* in gastrites and diabetis.

External treatment – baths with carbogaseous waters in cardio-vascular diseases, ovarian insufficiency and hyperthyroidism; with chloride-sodic and iodated waters in gynaecological, dermatological and rheumatic affections.

Aerosols with alkaline and sulphur waters in chronic rhinopharyngitides.

Just like the sea water, *therapeutic lakes* are rich in chlorinated-sodium, magnesium and sulphattated substances, being recommended in external cures for rheumatic, gynaecological, dermatological, neurological, post-traumatic and cardio-vascular diseases; warm baths and vagina irrigations are also indicated.

Hydrotherapy includes bathing in the sea (thalassotherapy), in rivers or lakes (especially salty), out-door or in-door pools, depending on season, water temperature, salinity, dynamics (waves or river currents), age, training and illness.

Baths have a stimulating and tonic effect if the water is ice-cold and rough, and sedative if the water is warm and calm, with relatively small thermal contrasts against the surrounding air.

In terms of temperature, *sea baths* are: very cold (8-13ºC), cold, cool, warm and very warm (> 27ºC); with regard to sea dynamics they are hydrostatic, slightly dynamic or dynamic, depending on sea roughness. Effects: on the peripheral circulation due to the contrast between the temperatures of water and of air, water dynamics makes continuous massages, while salinity stimulates the metabolism and the skin receptors.

Heliothermal lakes are sought for the temperature contrast between upper and bottom water layers.

Out-door hydrotherapy can be associated with or replaced by other forms of treatment: *hydrothermotherapy*: warm – over 35ºC, indifferent, cool and cold (18-20ºC), total or partial baths, compresses, wrappings, showers, and baths alternations. *Hydrokinetotherapy* and *hydrotherapy* with medical herbs, chemical and drug substances, as well as therapeutic gases are also used.

6. CONCLUSIONS

Maintaining the environment as clean as possible and using the natural cure factors for prophylactic, therapeutic or rehabilitation purposes whenever necessary, is an effective means, perhaps less costly, to preserve one's health, fight against all kind of diseases and, why not, spend the little leisure time modern man can spare as agreeably as possible.

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DEGRADATION THE AQUATIC ECOSYSTEMS AS CONSEQUENCE OF THE ANTHROPIC IMPACT

NINA LIOGCHII[1]

ABSTRACT. Degradation the Aquaric Ecosystems as Cosequence of the Anthropic Impact. Aquatic ecosystems with all their components (biotic and non-biotic), directly or indirectly, are under human influence. This is why corrective measures are necessary in order to improve their state and to ensure the preservation of biodiversity and natural habitats.

The object of our study was a like, situated between the Plopi and Maramanovca villages (in the northern region of the Republic of Moldova) and the surrounding region of about 10 hectares, represented by a flooded meadow with an abundant paludinous vegetation, dominated by *Cyperaceae, Thyphaceae, Poaceae.* Besides the registered fauna and flora species in this ecosystem, water and mud composition was researched. The results showed a high accumulation of stable chemical compounds and intensive consumption of N and P compounds. The obtained results represent a fact of the anthrop factor impact on the researched lake, witch persist during the last years.

Keywords: *Anthropic impact, aquatic ecosystem, ecoindicators species, biodiversity conservation.*

1. INTRODUCTION

The anthropic impact and the atmospheric processes persist on the environment, continuing to endanger the ecological equilibrium of natural ecosystems, simultaneously influencing the human life conditions. Among the three main natural factors of the environment: Atmosphere, soil, water, the last one is the most exposed to human action. Water passes through different usage places (technological processes, agricultural activities, domestic use) and captures much substances that worsen it qualities. Aquatic ecosystems with all their components (biotic and non-biotic), directly or indirectly, are under human influence. This is why corrective measures are necessary in order to improve their state and to ensure the preservation of biodiversity and natural habitats.

2. EXPERIMENTAL

The experimental research was conducted on the lake and the surrounding grounds situated between the Plopi and Maramonovca villages, (in the northern region of the Republic of Moldova). The lake is artificial, situated at an altitude of around 150 m next to a rive Cubolta.

Initially, some observations regarding the ecological state of the ecosystem were conducted, the next step being a phytocenotic description in different phenological stages (spring, summer, autumn), creating an inventory of the plants and animals living there, collecting algae, molluscs, water and mud samples for lab investigations. Classifying and systemizing the biotic species present there was an operation conducted using the MBS-10 and MBS-5 microscopes while their identification was realized using the identifiers approves for superior

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plants [2], algae [6] and molluscs [1]. The algae samples were taken from the aquatic basin, from those places that have the highest density of aquatic plants, filamentous algae - from the bottom of the aquatic basin, from the stones, mud and aquatic plants.

The material collected was conserved using formalin solution 4% and kept in the dark. The terrestrial gastropods were collected from the plants and soil near the pond, together with these. The bivalve molluscs were collected directly from the shore of the lake.

Establishing the value and the level of endangerment for the recorded species was conducted according to the categories UICN, Moldavian Red Book, Ukraine Red Book, Romanian Red Book, Bern Convention, Bonn Convention, Washington Convention [3]. The water collecting and analysis was conducted according to standards [4,7] conforming to the standard dishes, conservation conditions and the carrying-out of the analysis.

In order to determine the heavy metals content, the atomic absorption method was used - AAS and spectroscopy (XRS) [5].

3. RESULTS AND DISCUSSIONS

The observations regarding the ecological state of the lake and the nearing zone, that were taken into consideration for this study, are testimony to the influence of the anthropic factor on the researched lake. In the last few years, the ecosystem is subject to the impact of the irrational use of intensive agriculture, intensive use of the water in irrigations. In the nearing zone, the aquatic basin protection zone is missing. The lake is in very bad shape, with a very low water level, much mud and on its shores, gastropod shells were discovered, bivalve molluscs, remains of the river lobster, traces from a while back.

The nearing sector, with a surface of around 10 hectares, presents a flooded meadow zone with abundant palustral, mesophytic vegetation well developed, dominated by *Cyperaceae, Thyphaceae, Poaceae.*

Amongst the superior palustral plant species have been recorded as follws: *Calamagrostis epigeois, C. earundinacea, Carex brevicollis, Phragmites australis, Plantago maritima, Thypha latifolia, Th. angustifolia* and so on, and amongst the aquatic the species of chlorophyts, diatoms, cyanophytes, euglenophytes and rodophytes. Amongst the fauns species recorded, we mention: *Helix pomatia, Anodonta cygnaea, Astacus fluviatilis., Ardea cinerea, Oendatra zibetica* and so on.

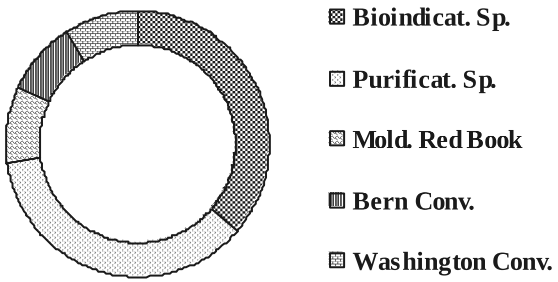

Figure 1. Categories of valuable species of flora and fauna

The value of the ecosystem comes from the importance of the species that purify water (g. *Phragmites*, *Thypha*, *Carex*), eco-indicators of the degree of pollution with organic and inorganic chemical compounds (g. *Scenedesmus, Trachelomonas*, *Anodonta*, *Astacus*) and the possibility of serving as habitat for the migrating and remaining birds, as well as for some species with a national and international level of protection (*Ondatra zibehtica* – 8^{th} category of protection in the UICN clasifier, *Ciconia ciconia* – endangered species, included in the appendix of the Berna convention, 1979, 8^{th} category of protection in the UICN clasifier, *Helix pomatia* - include in the appendix of the Washington convention, 1973) (Figure 1).

Some species, as *Trachelomonas hispida, Scenedesmus acumunatus***,** beside the fact that they take part in the biological water purification process, they also have the capacity to assimilate organic substances and are used as nutrition for invertebrate animals.

In the aquatic biocenoses, the molluscs represent the dominant group. Bivalve molluscs have their contribution in maintaining the quality of the water, having the capacity of accumulating intensively a lot of metals. In the water of the lake situated between the Plopi and Maramonovca villages, shells of the lake mollusc - *Anodonta cygnaea* (sometimes it has 160-180 mm in length), were found in abundance, this mollusc being considered as an indicator of good water quality. Thus we can conclude that pollution in this basin in minimum, fact confirmed also by the presence of the river lobster. The capacity of accumulating Cd, Pb, Zn, the vast spreading and the reduced migration make the *Anodonta* molluscs very good bio-indicators for the level of pollution with these metals [8]. Within this context, the analysis of heavy metals contents in the shells of the lake mollusc was conducted. The molluscs were of course collected from the researched lake. The results indicate an insignificant accumulation of heavy metals, especially of the most aggressive ones Cd and Pb, of which content proved to be of 0,31 and respectively 0,76 mg/kg. Thus, the weight of metal content raises as follows: Cd(II) < Pb(II) < Zn(II) < Cu(II) < Ni(II) (Figure 2).

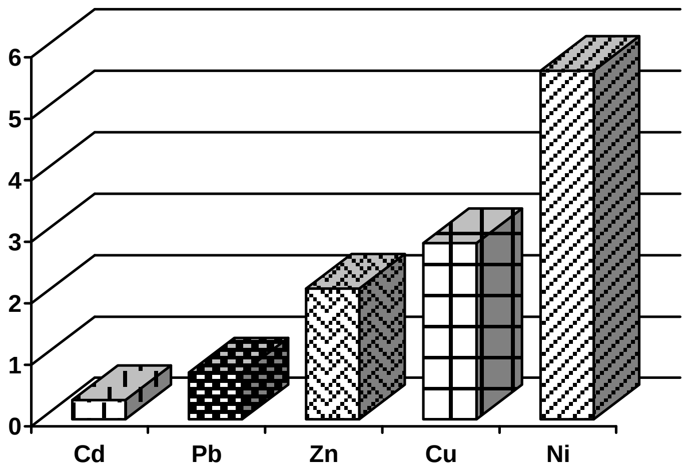

Figure 2. Heavy metals content (mg/kg) in the shells collected

Along with the heavy metal content of the shells, the composition of the water and mud were also analysed, the results indicating a high accumulation of stable chemical compounds, as well as an intense use of compounds that contain nitrogen and phosphorus. According to the ecological state index, the water quality in the lake researched falls within the quality classes II and III.

In order to maintain its value, are necessary suitable measures for diminuation the anthropic impact, fact that will contribute to the re-establishment of the ecological equilibrium, the preservation of bio-diversity and to the ecological education of the population.

4. CONCLUSIONS

The value of the ecosystem comes from the diversity of the species that purify water, eco-indicators of the degree of pollution with organic and inorganic chemical compounds and the possibility of serving as habitat for the migrating and remaining birds, as well as for some species with a national and international level of protection. CMA limits, as well as the parameters of the water in the lake, confirm a satisfying quality of this ecosystem.

The results of the study will serve as scientific argument for establish necessary suitable measures for diminuation the anthropic impact, fact that will contribute to the re-establishment of the ecological equilibrium of this aquatic basin, the preservation of bio-diversity and to the ecological education of the population.

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TEORETICAL ASPECTS ON THE USE OF GREEN TAXES

ADINA RUS[1]

ABSTRACT. Teoretical Aspects on the Use of Green Taxes. One of the central goals of a green economy would be to make prices reflect true costs. At present, prices place an artificially low value on non-renewable natural resources and completely ignore external costs – to the air, the water, the soil, to future generations, to workers' health. The whole economic system is geared to keeping these costs 'externalized'. A green economy would adjust prices to include real costs and would institute a system of 'green taxes' to drive this forward. Green taxes began with the simple aim of discouraging people from damaging the environment by making them pay for using natural resources. For example, burning fossil fuels in power stations causes acid rain; it damages the environment and should be taxed. Raising the tax on motor fuel would encourage people to use more energy-efficient cars or to use them less, or both. Taxing the dumping of waste in landfill sites would encourage recycling and alternative ways of dealing with waste and might help to reduce the total amount of waste we create.

Keywords: *air pollution, environmental taxes,environmental restoration, taxation.*

1. INTRODUCTION

Many serious threats to humanity's future – from climate change and ozone depletion to air pollution and toxic contamination – arise from the economy's failure to value and account for environmental damage. Because those causing the harm do not pay the full costs, unsuspecting portions of society end up bearing them, often in unanticipated ways. People from different countries, for example from United States, annually incur tens of billions of dollars in damages from unhealthy levels of air pollution, but car drivers doesn't pay anything at the gas pump for their part in this assault.

Taxation is an efficient way to correct this shortcoming, and a powerful instrument for steering economies toward better environmental health. By taxing products and activities that pollute, deplete, or otherwise degrade natural systems, governments can ensure that environmental costs are taken into account in private decisions. If income or other taxes are reduced to compensate, leaving the total tax burden the same, both economy and the environment can benefit.

2. THEORETICAL AND CONCEPTUAL ASPECTS

Opinion polls show that a good share of the public thinks that more should be spent on protecting the environment, but most people doesn't agree with the idea of higher taxes. By shifting the tax base away from income and toward environmentally damaging activities, governments can reflect new priorities without increasing taxes overall.

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So far, most governments trying to correct the market's failures have turned to regulations, dictating specifically what measures must be taken to meet environmental goals. This approach has improved the environment in many cases, and is especially important where there is little room for error, such as in disposing of high – level radioactive waste or safeguarding an endangered species. Taxes would be a complement to regulations, not a substitute.

Green taxes are now seen as part of a wider restructuring of taxation – eco-tax reform – which will encourage not just environmentally sustainable development but also better economic performance, more jobs and greater economic justice within and between nations. One reason green taxes make sense from an economic, social and environmental point of view is because they tax 'bads' instead of 'goods'.

Recent studies in Britain, the US and by the European Commission have found that replacing existing taxes on employment, incomes and profits ('goods') with taxes on energy use ('bad') can yield a threefold dividend: better overall national economic performance; higher levels of employment; and a cleaner environment. Their goal should be to shift the balance between the use of human resources (now under-employed) and natural resources (now over-employed).

However, critics charge that green taxes are regressive because they hit poorer people relatively harder than richer. For example, if a tax on household energy raised the cost of heating, cooking and lighting, poor people would find it harder to pay and harder to invest in energy efficiency to reduce the higher rates. The regressive effect would be all the greater if green taxes replaced taxes on incomes and profits – which many poorer people never had to pay in the first place.

Environmental taxes are appealing because they can meet many goals efficiently. Each individual producer or consumer decides how to adjust to the higher costs. A tax on air emissions, for instance, would lead some factories to add pollution controls, other to change their production processes, and still others to redesign products so as to generate less waste. In contrast to regulations, environmental taxes preserve the strengths of the market. Indeed, they are corrective taxes: they actually improve the functioning of the market by adjusting prices to better reflect an activity's true cost.

In a minor form, environmental or so-called green taxes already exist in many countries. A survey by OECD turned up more than 50 environmental charges among 14 of its members, including levies on air and water pollution, waste, noise as well as various product charges, such as fees on fertilizers and batteries. In most cases, however, these tariffs have been set too low to motivate major changes in behavior, and have been used instead to raise a modest amount of revenue for an environmental program or other specific purpose. Norway's charge on fertilizers and pesticides, for instance, raises funds for programs in sustainable agriculture – certainly a worthy cause – but is it too low to reduce greatly the amount of chemicals farmers use in the short term. Thus, some economists conclude that the main effect of green taxation is fiscal rather than environmental. For example, green taxation has been applied in relation to the reduction of carbon dioxide (CO_2) emissions in OECD countries. However, one may argue that even though CO_2 taxes are differentiated, they may lead to the required environmental results. A straightforward way of measuring these environmental results is simply to look at the nominal emission development in the five OECD countries where CO_2 taxes so far have been applied.

Table 1

	CO_2 tax, year	1990	1997	Increase 1990–1997
Denmark	1992 – 93	53	63	19%
Sweden	1990	55	57	4%
Norway	1991	35	41	17%
Finland	1990	73	77	5%
Netherlands	1990	160	179	12%

Note: Figures are rounded to the nearest million ton.
Source: Daugbjerg and Svendsen (2001) and Andersen, Dengsoe and Pedersen (2001).

In the table presented above are used nominal CO_2 emission figures and the year 1990 as reference year because these two criteria are used in the Kyoto Protocol which is an international agreement on national CO_2 target levels. Carbon taxes went into effect in Finland and the Netherlands in early 1990; Sweden began collecting carbon taxes in January 1991. Unfortunately, none of these levies seems high enough to spur major changes in energy use. In the case of Sweden, however, a hefty sulfur dioxide tax, which also went into effect in January 1991, combined with the small carbon tax, may encourage measurable reduction in fossil fuel burning. Table 1 shows that CO_2 emissions have increased significantly since 1990 for all 5 countries that have applied CO_2 taxation (the CO_2 taxes were all introduced in the beginning of the 1990's).

A comprehensive set of environmental taxes, designed as part of a broader restructuring of fiscal policy, could do much more to move economies quickly onto a sustainable path. Most governments raise the bulk of their revenues by taxing income, profits, and the value added to goods and services. These are convenient ways of collecting money, and ones that often serve an important redistributive function, but such taxes distort the economy by discouraging work, savings, and investment. Substituting taxes on pollution, waste, and resource depletion for a large portion of current levies could improve both the environment and the economy, and be done in a way that keeps the total tax structure equitable.

A comprehensive green tax code would alter economic activity in many areas. It would place fees on carbon emissions from burning of coal, oil, and natural gas, and thereby slow global warming. It would penalize the use of virgin materials, and thus encourage recycling and reuse. It might, among other things, charge for the generation of toxic waste, and so foster waste reduction and the development of safer products, and for the emissions of air pollutants, thus curbing acid rain and respiratory illness. And it might impose levies on the overpumping of groundwater, which would encourage more efficient water use.

Completely shifting the tax base away from income and toward environmental concerns would not be desirable. Income taxes are usually designed to make the wealthy pay proportionately more; green taxes, on balance, would not serve this equity goal. Hefty carbon charges would cause heating oil prices to rise, imposing a heavy burden on low-income households who spend a greater share of their income on this essential item. To offset this undesirable impact, income tax rates would need to be lowered even more for poorer people. Another reason to blend income and environmental taxes is that green tax revenues would diminish as production and consumption patterns shift away from taxed activities. Environmental levies would therefore not be as constant a source of revenue over time as income taxes are. Once producers and consumers have adjusted to the new tax scheme, revenues from green taxes and income taxes would strike a more stable balance.

Besides their help in reshaping national economies, green taxes can also raise funds for global initiatives that require transfers from rich countries to poorer ones, including slowing global warming, preserving tropical forests and biological diversity, and protecting the ozone shield. An extra tax of 10 $ per ton of carbon emitted in industrial countries would initially generate 25 billion $ per year for a global fund.

Reshaping fiscal policy to be an instrument of environmental restoration may be difficult at a time when policymakers are concerned with the economic slowdown and with revitalizing the flagging economies of the former soviet bloc. Yet nothing lasting will be gained by the continued pursuit of growth at the environment's expense.

3. CONCLUSIONS

Green taxes must be part of a larger package of taxes which will make people pay for using *common* resources. The most obvious of these taxes will be a tax (or a 'rent') on the value of land – proposed by the American economist Henry George a century ago and opposed by wealthy interests ever since. Among others could be taxes on the use of radio frequencies, space or the oceans. Because these taxes will hit rich people's incomes harder than poor people's (like an energy tax at source) they will not be regressive.

If green taxes are successful they will reduce the wholesale destruction of natural resources. And eventually this will mean less revenue from the tax. If government finances depend on green taxes this could be a serious problem. But it is a problem that must and can be avoided. Green taxes will need to be phased in at steadily rising rates over a period of 10 to 15 years, so the total revenue from them should rise for at least that long. Afterwards, human activities will still depend on using energy and other natural resources: even when their use has fallen to sustainable levels, people will continue to use them. Widening the principle of green taxes to include taxes on the use of all common resources like land, radio frequencies, the oceans and so on would result in a new tax base adequate for future needs, though very different from the present one.

For economists, the function of green taxes is to 'internalize' costs now 'externalized'. People and companies should be made to pay all the costs of their activities, instead of being allowed to impose them on other people, including other parts of the world and future generations. Ideally, green taxes should be set at rates that reflect these 'true' costs.

On the other hand, most people will benefit as eco-tax reform helps to shift the balance from resource-intensive, environmentally-damaging production to people-centred activities. 'Sunrise industries' will benefit, including electronic and environmental technologies and the intellectual 'know-how' and 'software' occupations that go with them. And so will the whole range of industries and occupations – including health, education, entertainment and the arts – that rely mainly on the skills of people to deliver personal services. As it becomes more widely understood that the issue is eco-tax reform, not just a particular green tax, political support will grow.

We also can't think about green taxes without looking at the international dimension. As the recent World Commission on Global Governance put it: 'The time has come when we must seriously consider levying charges on the use of common global resources to finance common global purposes.' International green taxes could be a much-needed source of revenue for the UN. They could also encourage globally-sustainable development and economic justice between nations.

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THE DETERMINATION OF AUTO TRANSPORT IMPACT ON URBAN AGGLOMERATIONS

V. PLÂNGĂU[1], D. BUBURUZ[1], REGINA FASOLĂ[1]

ABSTRACT. The Determination of Auto Transport Impact on Urban Agglomerations. Monitoring air quality in urban agglomerations of the Republic of Moldova shows an increased level of atmospheric air pollution in some areas exceeding several times the sanitary level. The air quality was determined by direct measurements of concentrations in air polluting substances, using standard methods, by calculating the quality and quantity of used fuels. To determine the contribution to the pollution sources of pollution and the assessment rate to the fund of transport auto pollution, the rate impact of motor transport, and from fixed sources of pollution in the investigated areas, were inventoried fixed sources of air pollution, determined the intensity of road traffic, and transport structure.

The emissions of polluting substances from fixed sources were determined by inventory. The evaluation of impact and pollution sources on atmospheric air quality was conducted on the basis of inventory data, LAE normatives (limited allowable emissions) and MAC (maximum allowable concentrations).

Keywords: *urban agglomerations, Republic of Moldova, polluting substances, atmospheric air quality*

1. INTRODUCTION

Republic of Moldova is situated in the Northern hemisphere, in the South-Eastern Europe, and includes the land in North latitude 45°26'-48°29', and east longitude 26°30'-30°05'. Territory stretching from north to south for a distance of 350 km, and from West to East over 150 km distance.The surface of Republic is 33.7 thousand km^2.

The territory of Republic of Moldova is a part of the Eastern Europe plain, and it's located in a proportion of 90% between Nistru and Prut rivers. 59% of territory in the basin of the Nistru, 23% in the Prut basin, 11% in small river basins, tributaries of the Danube, and 7% in small basins of rivers that flows into the Black Sea.

The relief of Moldova is a plain with an average altitude of 147 m. The highest part of the territory of the republic (Codrii), located in the central area, has a strong relief scraped with a maximum altitude of 429. 5 m, and occupies approximately 15% of the whole territory of the republic.

Moldova's climate is temperate continental. On average per year are 2060 hours in the sun in northern and 2350 hours in the southern regions of the republic. The average annual temperature of air in Moldova is positive and is 10°C. The annual quantity of atmospheric precipitation is 380 mm in the south and 560 mm in northern republic**[**1,7**]**.

The climate is determined by external barice centers. The atmospheric circulation is predominantly anticiclonal with relatively low atmospheric processes, expressed by a variety of changes in seasonal movement.

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Most of the cyclones cross the RM of West, South-West with an average speed of 20-30 km/hr, range 80-90 km/hr, prevailing winds directed from the West, North, North-West and with a lower frequency in South and South-West. The average speed of 2,5-4,5 m/sec.

Because fluid state of the object of study - the atmosphere, the ceaseless movement of air masses, the atmospheric air quality is in a permanent change, but at the same time stability and periodicity of physical processes in the atmosphere, allowing to develop some criteria for assessing which and ensure the state can assess the air quality as a result of scientific research and direct atmospheric measurements [2-7,9].

Air basin has a capacity of resistance to pollution (self-purification), which depends on the flow of pollutants into the atmosphere and the climatic conditions. To characterize the auto-purification level of atmosphere was introduced the concept of potential pollution of the atmosphere(PPA). PPA is classified: down (2.4), moderate (2.4-2.7), average(2.7-3.0), high (3.0-3.3) very high(3.3) [1,7,8]. The PPA average calculated for the air basin in the Republic of Moldova on the basis of geoclimatic,(the periodicity of temperature and ramp inversions, frequency of wind speed 0-1 m/s, frequency of days without wind, periodicity of mists) is 2.8-2.9, which shows that the atmosphere in the RM has a low potential for self-purification and natural complex is characterized as unreliable [1].

What makes the limitation of development areas with large industrial emission of pollutants.

Depending on weather conditions the atmosphere has a certain capacity for self-polluting substances. To characterize the stability of the atmosphere using the potential pollution of the atmosphere (PPA). PPA average calculated for the air basin in the Republic of Moldova on the basis of geoclimaticaly is 2.8-2.9, which shows that the atmosphere in the Republic has a low potential for self and natural complex is characterized as unreliable [1,4], which makes the limitation of industry development areas with high emission of pollutants.

Serious consequences of air pollution in Moldova are felt in all spheres of activity, as degradation of soil quality and agricultural products, initiating the process of desertification, decreasing productivity of crops, forest damage, changing composition of ecosystems at the micro and last increased morbidity and mortality population.

In the air basin of RM emit more than 130 substances unfit air, of which about 36 in considerable amounts. Atmospheric air pollution with chemicals lead to degradation of air quality, As a result of this growth factor we owe, population morbidity and mortality, degradation of forests, disappearance of many species of flora and fauna.

The biggest influence on air quality is dust, nitrogen oxides, oxides of sulfur, oxides of carbon, hydrocarbons, heavy metals **[7].**

Growth in the volume of auto transport leads to a pressure of increasing environmental, particularly in relation to climate change and diminishing biodiversity [2,6,7,10].

To study the processes leading to degradation of air quality have begun research to estimate the level of pollution of the atmosphere and assessment of anthropogenic impact on air quality caused by atmospheric emissions of polluting substances from auto transport.

2. OBJECT OF STUDY AND RESEARCH METHODS

The object of this research study is the impact on air quality exercised by atmospheric transport and trends of change during 1990-2008, the emission and concentration of polluting substances in atmospheric air of urban agglomerations, the areas with concentrations that exceed health standards and present danger to the environment and health.

The monitoring of concentrations of substances polluting the atmosphere is made by service Hidrometeorologic state stationary positions to 17, located in 5 industrial centers: Chisinau, Balti, Tiraspol, Ribnita, Tighina for basic pollutants (dust, sulfur oxide (IV) oxide carbon (II), nitrogen oxide (IV)) and specific (phenol, formaldehyde and soluble sulphates) [1].

Emissions of polluting substances were determined by inventory fleet and traffic, parallel computing based on the fuel consumed by the transport units and specific emission coefficients.

Air quality is expressed through the complex index of pollution of the atmosphere, which is calculated using the formula [1,2,7]:

$$I_{(m)} = \Sigma (q_i / CMA_i)\, C_i;$$

where m - the number of polluting substances monitored;

q_i - pollutant concentration in air;

CMA_i - the maximum concentration of the substance in air (mg/m^3) (full health),

C_i- dimensional constant, which depends on the class of dangerous and polluting substance is set: hazard class 1 -1.7, 2 -1.3, 3 -1.0, 4 -0. 9.

Using the index $I_{(m)}$ we appreciate the quality of the atmosphere. When $I_{(m)}$ air quality is considered acceptable, when $I_{(m)}> m$, the concentrations of some pollutants, all substances monitored is greater than the CMA and air quality does not meet health standards. $I_{(m)}$ is used for comparing air quality in cities for different time periods, which allow the trend to change the air quality in cities. $I_{(m)}$ allows the ranking of the cities according to air quality.

Air basin has a capacity of resistance to pollution. To characterize the atmosphere auto-purification we use the concept of potential pollution of the atmosphere (PPA). PPA is classified: down (2.4), moderate (2.4-2.7), average (2.7-3.0), high (3.0-3.3) and high (3.3) [1,2,4].

Based on data about the geoclimaticaly, (the periodicity of temperature and ground inversions, frequency wind speed 0-1 m/s, frequency of days without wind, periodicity of mists) PPA was calculated average for Moldova and he is 2. 8-2. 9, so it is considered high, indicating that the atmosphere in the RM has a small potential auto-purification and natural complex of the republic is characterized as unreliable [1,7].

To meet the proposed objectives have been achieved a series of tasks – inventory of auto-park - state and dynamic analysis in time of atmospheric air quality in urban agglomerations for the period 1990-2008 - the impact assessment of pollution sources on air quality in cities and atmospheric throughout the RM – the analysis of consequences caused by the pollution of the atmosphere.

3. RESEARCH RESULTS

To achieve the proposed objectives, was analyzed the auto road network , vehicle fleets inventoried, measured emissions from mobile sources of pollution into the atmosphere through the inventory forms in the air and 2TP statistical calculation based on the road traveled and fuel consumed, monitored the air in urban agglomerations of the main polluting substances in research, determined the quality and dynamics while air quality in cities for the years 1990-2008, carried out the modeling process of dispersion of the polluting substances into the atmosphere from mobile sources of air pollution, assessed the impact of pollution sources the atmospheric air quality

3.1. Structure and transport in the RM

In RM are working 566 power stations with oil and gas at the present, 24 bases for the storage and preservation of petroleum products and over 460,000 units of motor transport. Number and structure for the years 1990-2007 are shown in Figure 1 [10].

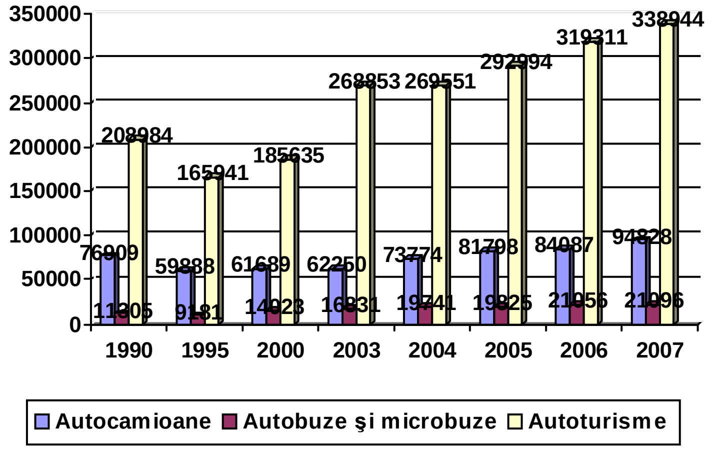

Fig. 1. Number and structure of the auto park in RM

The structure of auto park that we have now is after the age of about 30% of transport units with less than 10 years, otherwise vehicles aged over 10 years, practically worn with redundant emissions into the atmosphere, every third car and second truck involved in traffic does not meet the requirements of environmental and safety standards. Predominant tendency to import classes small tonnage automobiles, trucks, cars and small buses, endowed with body type pick-up. Increases the rate of non-soviet production cars, especially cars and small buses, which are used quite extensively.

The public network of roads in Moldova is 12 719 km, of which 87% paved surface. Of the total 3 669 km form the national roads, it would be 6 834 km local roads, quality, however, does not meet international standards [10]. The national standards meet the international rules only in relation to establishing the degree of fuming with exhaust gases of Diesel engines. Emissions standards for pollutants in the exhaust gas provided by the national standards for vehicles with engines based on gasoline, do not correspond to those laid down by the European Union (Euro-1, 2, 3 and 4).

Adjustment of national legislation with the EU Directives on the implementation of environmental norms Euro-2, Euro-3, Euro-4 for transportation, import cars would reduce waste and thus diminish the negative impact on quality of life.

3.2. Mobile sources of pollution

Mobile sources of pollution include road vehicles, agricultural and special aviation, rail transport, marine and inland waterway transport, which removes significant amounts of CO, NO_x, hydrocarbons, Pb. Of engines is deleted benz(a)pirenele, dioxins, hydrocarbons and volatile benzofurani.

In assessing the amount of polluting substances released into the air basin of the Republic of Moldova has made an inventory of sources of pollution of the atmosphere were determined from emission sources in the environment and passports by calculation based on the quantity and quality of fuel consumed (fig.1).

In the republic are located approximately 105 motor transport undertakings and industrial enterprises, households who own transport.

According to the National Bureau of Statistics the imported quantity of gasoline in the years 2000 - 2006 is characterized by a continuous growth, as in 2004 about 212.3 thousand tons, with 42. 5% increase compared to 2000. Maintain positive trend of increasing the share of gasoline containing lead reduced: from 121.7 thousand tons in 2000 to 212.2 tons in 2004, representing respectively 57.35% and 99.9% of total gasoline.

In assessing the amount of polluting substances released into the air basin of the Republic of Moldova has made an inventory of sources of pollution of the atmosphere were determined from emission sources in fixed and mobile source direct estimate, based on ecological and passports by calculation based on quantity and quality of fuel consumed (fig.2).

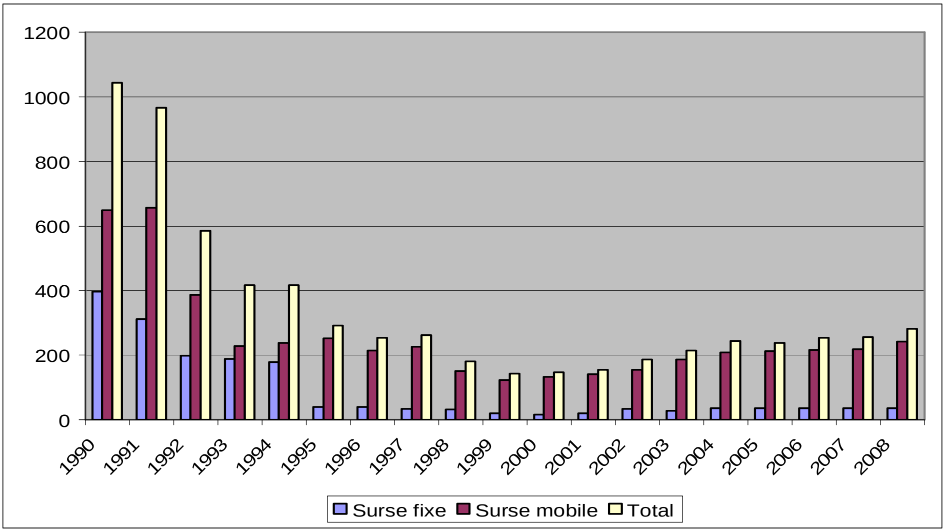

Fig. 2. Annual emissions of polluting substances from local sources

For the period 1990-2008 emissions from mobile sources decrease from about 650 kt per year in 1990 to around 250 kt in 1993, which is maintained with small variations until 1997, then nine in 1998 to decrease to about 150 kt and then start a slow increase until a value of about 240 thousand tons of polluting substances in 2008. Since 2000 is a slow but stable growth in emissions from transport, due to massive imports of cars from Western Europe.

Comparative analysis of total annual emissions of pollutants into the atmosphere from fixed and mobile sources of pollution during the years 1990-2008 shows that in 1990 the total mass of polluting substances released from fixed sources constituted about 40% of total emissions, which lowers gradually to 10.5% in 2000, then begin a slow growth rate reaching 15% in 2008. Share of transport in the basin air pollution in 1990 was about 60%, which rose to 89.50% in 2000 (of which 84% returned auto transport) and a small decrease to 85% in 2008 of total anthropogenic emissions.

Comparing emissions from fixed and mobile sources, we find that mobile sources have a decisive contribution to local air pollution. Emissions from fixed sources are held in height and up to the soil is diluted and moved considerable distances from the source, emissions from mobile sources occur at about 0.8 m from the surface and directly affect air quality and currently layer of earth in the troposphere. So auto transport is the main source of air pollution in cities.

Systematic observations of the level of air pollution in the republic is carried out in five cities - Chisinau, Balti, Bender, Tiraspol and Rabnița meteorological services by the state [2]. Air quality is expressed through the complex index of air pollution

The values of complex index of air pollution for the period 1993-2005 in the cities had: Chisinau I_5 = 4. 2 (1993); I_5 = 4. 2 (1995); I_6 = 4.3 (2000); I_8 = 4.77 (2005). Balti I_5 = 11.7 (1993); I_5 = 11.7 (1995); I_6 = 10.4 (2000) and I_5 = 6.74 (2005). Râbnița I_4 = 3. 1 (1993); I_4 = 3. 1 (1995); I_4 = 3. 1 (2000); I_4 = 1.86 (2005). Tiraspol I_5 = 12. 0 (1993); I_5 = 12. 0 (1995); I_6 = 12. 0 (2000); I_6 = 5.17 (2005). For Tighina I_4 = 3. 0 (1993); I_4 = 3.0 (1995); I_4 = 1.4 (1995); I_5 = 4.21 (2005). According to data presented air quality in cities Râbnița, Chisinau, Tighina is satisfactory, but in some periods, the index is greater than the CMA. The results show cities monitored an increase in the level of air pollution in 2005 compared with 2004. Analysis of data from past 5 years show a trend of reducing levels of pollution in min. Chisinau, Balti, Tiraspol and an upward trend in property Tighina and Rabnița.

Between 1990-2008 the level of background pollution of the atmosphere has not changed essentially, except the concentration of sulfur oxide(IV), which decreased, while clearing the atmosphere from sources of pollution for the same period have decreased essential (fig. 1).

3.3. Determining the impact on air quality

Emissions from sources are expressed in tons per year. Gross mass does not always show the real picture and the impact of pollutant on the environment and health, which depends on the class of dangerous substance. Substances polluting the level of danger to the environment are classified into four classes, which for most substances are determined.

To prioritize actions of environmental importance and the priority list was drawn up by the polluting substances impact achieved, depending on quantity and class of dangerous substance. Were cataloged the major sources of air pollution atmospheric sources priority established by their contribution to air pollution as the quantity of pollutants t/year. To determine the effect of toxic substances polluting pollutant mass was recalculated in tonnes conventional t - actual emission conventional formula [2,6,12]:

$$Q = L_i : CMA_i \times M_i$$

where M_i - the gross polluting substance in tons/year;

CMA_i - maximum allowable concentration, mg/m^3;

L_i - coefficient which takes into account the class of pollutants threatening(L_i hazard class 1 is equal to 1000; hazard class 2 to 100, for Class 3 with 10 and 4 with grade 1).

Results of investigations and calculations have shown that emission from mobile sources is higher than the state (Figure. 1). After the priority gross emissions from stationary sources of SO_2 held at the mobile - carbon oxide(II), the total emissions - carbon oxide(II). After conventional emission-effective first is nitrogen oxide(IV) in both types of sources and emissions.

So the first inning measures must be directed at reducing emissions to the atmosphere of nitrogen oxide(IV) with full priority after the amount of sulfur oxide(IV).

4. SUMMARY OF RESULTS

Results of research shows that:

- emissions from mobile sources of pollution have a tendency to decrease until 1999, after which begins a stable growth.
- emissions in the years 1990-2000 were a considerable decrease, but the background concentrations of the main pollutants in the cities atmosphere does not change.
- air quality in cities where atmospheric background concentrations is to limit the health rules, maximum concentrations exceeding several times the sanitary level.

5. CONCLUSIONS

1. Air quality in cities doesn't meet the health rules. After the index complex pollution cities are placed in order of increasing: Tighina, Rabnița, Chisinau, Tiraspol, Balti.
2. The main source of air pollution is atmospheric transport.
3. Organic primary task is to reduce emissions of nitrogen oxides.

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II. Air Environment

STUDIA UNIVERSITATIS BABEŞ-BOLYAI, GEOGRAPHIA, LIV, 3, 2009

THE DROUGHTS IN ROMANIA. CASE STUDY-OLTENIA

OCTAVIA BOGDAN[1], ION MARINICĂ[2]

ABSTRACT. The Droughts in Romania. Case Study-Oltenia. In the present paper we analyse the evolution of droughts in Romania, at the end of the 20th century and at the beginning of the 21st century. The analysis of an important number of documentary archive materials made obvious a growth in the area of Romania where phenomena of drought and dryness are encountered, a rise in the frequency and intensity of these phenomena, as well as an increasing aridization of the climate. An important feature of droughts in our country, beginning with the year 2000, was their association with intense heat waves, during which the maximum values of temperature exceeded greatly the climatic limits that were common for the 20th century. As a consequence of these evolutions, the losses in agriculture and the environmental damages were constantly growing and played an crucial role in the increase in the price of food, living expenses and the aggravating of social problems, in general.

Keywords: *drought, canicular days, phenomena of meteo-climatic risk, the aridization of the climate, the spatial extension of droughts, lack of precipitations.*

1. INTRODUCTION

In Romania, droughts are phenomena of climatic risk, that occur episodically regardless the season and the year. In the history of Romanian meteorology the numerous droughts have severely affected the population.

For the 20th century the peak of the drought was the drought of 1945-1946, which was a real disaster for agriculture (Gh. Ionescu Siseti, 1946), and a “national calamity” for the population (N. Al. Radulescu, 1964), and for the first years of the 21st century, the drought of 2000-that, despite its durration, 150 days in a row (from January to July) (Ion Marinica, 2006), did not surpass that of 1945-1946.

The highest frequency of the years with lack of precipitations and also of the longest periods of time with lack of precipitations were registered in the South-East of Romania. For example: in Baragan in Lehliu between 8 and 12 consecutive years that lacked in precipitations have been registered, in Braila-8 years (from 1944 to 1951), in Iazu-10 years (from 1923 to 1932), in Calarasi-12 years (from 1921-1932). Also, the minimum annual quantities of precipitations were registered in Baraganul (Cioara Doicesti)-131.6 mm in 1945 and in Braila-179.6 mm in 1951, these negative deviation of almost 300 mm from the normal value being resemblant to those in the regions of arid climate (Bogdan, 1980). In the South-East of Romania,more than 1/3 of the considered stations had annual quantities of precipitations that varied form 200 mm to 300 mm, emphasizing the excessively droughty character of this plain. For example, in 1945 when the most important drought of the 20th century was recorded, the annual quantities of precipitations were: 208.4 mm in Ciochina, 239.0 mm in Armăşeşti, 241.6 mm in Ianca, 249.5 mm in Griviţa, 258.7 mm in Lehliu, 272.0 in Răzvani etc., the least being the aforementioned value of 131.6 mm in Cioara Doiceşti.

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As we move to the East towards the Dobrogei Plateau, the littoral and the Danube Delta, the aridity of the climate grows due to the continentalization of the air masses on the one hand, and the downdrafts above the Moors of the Danube Delta and the marine aquatorium on the other hand (Geografia Romaniei, V, 2005). As a consequence, in this area, the minumum annual quantities of precipitations were less than 200 mm: 116.7 mm in 1984 in Adamclisi; 132.7 mm in 1920 in Sulina; 164.3 mm in 1896 in Mangalia; 176.9 mm in 1924 in Mihail Kogălniceanu etc.

2. THE EVOLUTION OF DROUGHTS IN ROMANIA

The drought is an extremely complex climatic phenomenon determined by four categories of factors (Figure No 1): meteo-climatic factors that define the time type and the topoclimatic characterstics; geographical factors that define the particularities of the active surface; biological factors which reflect the physiological particularities of plants and anthropical factors which show the anthropic impact on the environment.

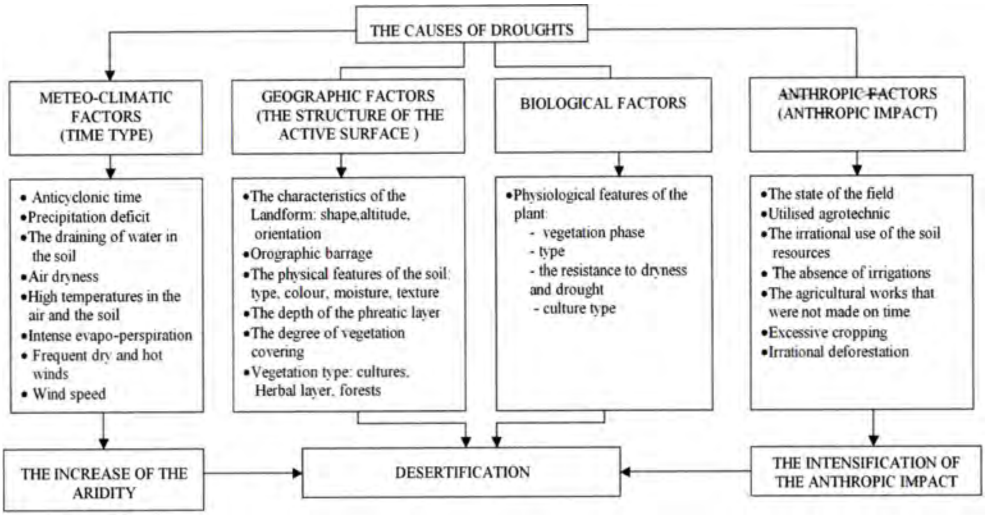

Figure No. 1. *The conceptual model regarding the causes of droughts*

If the aridisation of the climate and the anthropic impact increase, the territories affected by the drought might reach a new stage in their evolution, namely desertification.

Out of the four categories of factors that cause droughts, the most important role is played by the meteo-climatic factors that lead to this phenomena-as a consequence of the prevalence of stationary anticyclonic formations-while the other three categories are associated in order to permit the intensification of this phenomena.

The study of drought and dryness phenomena can be done using different methods. In order to highlight the areas with different degrees of vulnerability to droughts,we used the Walter-Lieth climatic diagrams-common in the specialised literature-in their analysis (Bogdan and Co., 1972, Bogdan, 1980; Bogdan, Niculescu, 1995, 1999, Teodoreanu, 1980; Erhan 1979, *Geografia României*, I, 1983; *Geografia României*, V, 2005; Mihăilă, 2006 etc.).

Using the 310 climatic diagrams for the regions of less than 700 m altitude,the average annual number of months in which drought and dryness phenomena occurred was calculated in order to create the map of their repetition (Bogdan, Niculescu, 1999).Relating to the exterior climatic influences and the landforms, we established the following:

- the drought and dryness phenomena are typical for the regions of plain and low hills, where agriculture is used.
- in the Western regions, where oceanic influences can be found, on average, only phenomena of dryness occur annually.These phenomena decrease in intensity with the latitude: in regions of plain-from West (3 months) to East (2 months)-and almost 1 month in the regions of hills.They also decrease with the longitude: from South (2-3 months) to North (less than half a month).
- in the Passage of the Mures and in the areas sheltered by the Apuseni Mountains, as a consequence of the tropical warm air of Mediterranean origin advection and the Foehn effects, 1-2 months - on average - of dryness phenomena occur annualy, while in the West of the Transylvanian Plateau these are replaced by excess of humidity phenomena.
- in the South of Romania phenomena of both drought and dryness occur,and by taking this into consideration we can distinguish two areas: the first in the Plain of Oltenia, where 3-4 months-out of which 1-2 months are droughty in the Southern region - of dryness phenomena which decrease in intensity from South to North are typical,while in the Getic Piedmont and the Getic Subcarpathians at less than 700 m altitude less than 1 month of dryness phenomena might occur.The second area is the Baraganului Plain, where, on average, 3-4 months of dryness phenomena-out of which 1-2 months are droughty-occur annually.
- in the Dobrogei Plateau on average, 4-5 months of dryness phenomena-out of which 2-3 months are droughty-occur annually.
- in the littoral zone more than 6 months of dryness phenomena-out of which more than 3 months are droughty-occur annually.

We remark the increase in the frequency of the drought and dryness phenomena, from West to East, proportionally with the increase of the degree of continentalism. The highest frequency of these phenomena is reached in the Danube Delta and in the littoral zone (Bogdan, Niculescu, 1995, 1999) due to the downdrafts of air masses which dissolve the cloud systems.

- in the Moldovei Plateau the frequency of dryness and drought phenomena is decreasing from South (3-5 months of dryness and almost 1 month and a half of drought) to North, where, due to the Scandinavo-Baltic influences, these phenomena are absent. The exception is the Moldovei Plain, where, on isolated areas, only dryness phenomena can occur for almost a month in the warm season (Mihaila, 2006).

A study of the unperiodic variations of the climate based on the annual climate diagrams would reveal that even in the Western regions where oceanic influences are encountered, as well as in the Northern of the Moldovei Plateau, dryness and drought phenomena might occur in certain years with persistent anticyclonic activity (Bogdan and Co., 1972, Bogdan, Niculescu, 1999a and b and Mihăilă 2006) - thing that is not revealed as possible when analysing the multi annual average values.

Vertically-excepting the very high altitude-at above 700 m, the excess of humidity, caused by the increasing quantities of precipitation proportionally with the altitude, replaces drought and dryness phenomena.

The analysis of the map of the repartition of the dryness and drought phenomena makes obvious an asymmetry in the occurrence of these. This wawe notice that the most frequent and intense such phenomena occur in the South-Eastern and Eastern regions of Romania, where continental and pontic influences are found. This repartition is determined by the role played by the Romanian Carpathians-that of orographic barrage which stops the East and South East continental air advection in the rest of the country-this is why drought has never covered the whole country. This fact allowed us to create the map of the areas vulnerable to dryness and drought phenomena *(*Bogdan, 1999; Bogdan, Marinică, 2007) (Figure No. 2).

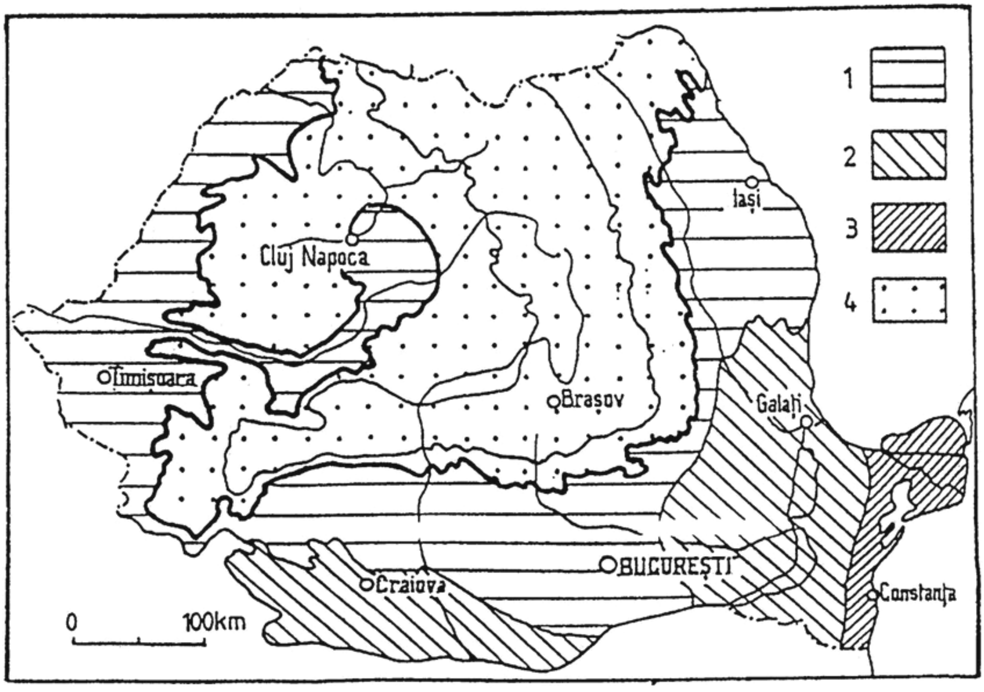

Figure No. 2. Areas vulnerable to dryness and drought phenomena: 1. Low vulnerability; 2. Medium vulnerability; 3. High vulnerability; 4. Regions with excessive humidity (Bogdan, 2002)

From this figure we notice that the most vulnerable areas to these phenomena are the South-Eastern (The Romanian Black Sea littoral, then the Dobrogei Plateau, and the Baraganului Plain) and the Southern (The Olteniei Plain), fact already shown by their geographic repartition.

The climate warming of the last two-three decades (and especially after 1980), led to the rising frequency of dryness and drought and an increase in the area affected by these from East to West (in the Dobrogei Plateau and the Baraganului Plain) and from South to North (especially in the Southern Oltenia). This fact is strongly supported by the analysis of statistic data in the 1980-2007 period .

3. THE EVOLUTION OF DROUGHTS IN OLTENIA

In Oltenia, the atmospheric precipitations vary-as in the whole country- from one place to another and from South to North-variation set by the landform classification.

The minumum annual quantities of precipitations were registered in different years and varied between 200 and 300 mm (l/m^2).

The minimum quantity of precipitations in the whole period of observations registered in Oltenia was 178.3 mm in Dragasani in 1907-representing a negative deviation of -401.7 mm and a pluviometric deficit of 70% in comparison with the multi annual average of 580 mm. Such a quantity of precipitations is actually lower than the aforementioned value of 176.9 mm registred in the littoral zone, in in 1924 in Mihail Kogălniceanu. As the multi annual average quantity of precipitations (considered normal) was small (451.0 mm), the negative deviation of –274.2 mm was also small, leading to an annual precipitations deficit of about 61% of the normal value.

The territorial variation of the quantities of precipitations from South to North in Oltenia, highlights negative deviations of crucial importance that go from –161.2 mm in 2000 in Bechet (the smallest) to –459.5 mm in 1925 in Rm.Valcea (the greatest), proving the great variability of precipitations in time and space.

Another conclusion is that droughts - despite not always covering the entire Oltenia simultaneously - can have the same or a higher intensity in the hilly regions than in the plain regions where the deviations in the quantity of precipitations are smaller than in the hills where the quantity of precipitations increases with the altitude.

The analysis of the succession of droughts in Romania between 1987 and 2007 (Figure No. 3) which were characterized by the presence of 2-4 warm seasons with pluviometric deficit, reveals that before 1987 the frequency of long lasting droughts was of 10-15 years and from 1987-2007 this frequency has radically increased,developing a annual tendency which seems to become permanent.

Moreover, during the year- from 1987-1993- the rate of droughty time in Oltenia has varied, in conformity with Hellmann`s Criterion, from 50.5% in 1987 to 83.3 in 1992,when the water deficit in the whole region reached its height, resulting in a 64.6% annual average.

The Droughty Period 1991-1993

In this period, the drought started in 1991, the lack of water in the soil reaching its maximum in 1992, while the most pronounced intensity and the greatest damages were registered in 1993, as a consequence of the succession of two very droughty years,from which 1992 most acutely lacked water.

In 1992 the excessively droughty time predominated. The annual deficit (representing the negative deviation in comparison with the normal value) exceeded in many places 40%: 46.5% in Calafat, 53.7% in Băileşti and 55.0% in Slatina in the plain regions and respectively, in the Oltului Pasage; 46.2% in Bâcleş, in the Getic Piedmont and 40.4% in Târgu Jiu, in the Gorjului Subcarpathians.

During the year, excepting June when some scanty rains had fallen, the drought was present in all the other months (Figure No 4).

Some of the most affected counties were: Mehedinți, Dolj, Olt, Teleorman; Dolj being the most gravely affected, as the corn, soy and beans harvest were 100% compromised.

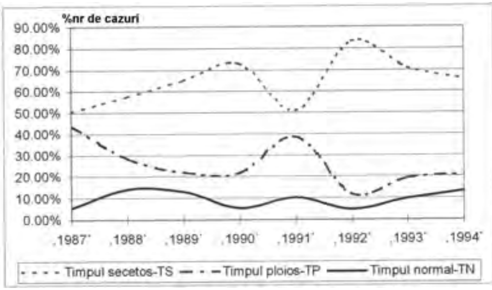

Figure No 3. The evolution of drought from 1987-1994 in rates of number of time type cases in months/ meteorological station in conformity with Hellmann's Criterion.

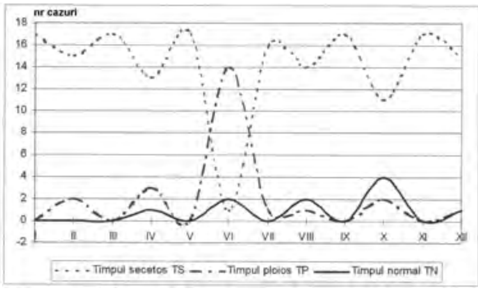

Figure No 4. The evolution of drought in 1992 in rates of number of cases on time types in conformity with Hellmann's Criterion.

Even though the droughty time continued in 1993 (Figure No. 5), the water deficit has lessened (between 22.4% in Apa Neagra and 43.6% in Caracal), but the effects of the drought were greater (the withering of harvests,pastures and even forests) because of the very droughty previous year (1992).

The Drought and Canicular Days of 2000

The beginning of the 20th century was marked by a new drought-that of 2000- which affected not only Romania,but also the countries in the Southern half of Europe. In Oltenia this drought lasted for 3 years (Figure No 6).

In 2000, 11-12 droughty months were recorded in the Subcarpathian depressions (12 months in Apa Neagra and 11 in Polovragi and Rm. Valcea) 10 months in Drobeta-Turnu Severin and Bechet on the Danube; 10 months in Caracal in Câmpia Olteniei and 9 months in Bâcleş and Drăgăşani in the Getic Piedmont, as well as in Petroşani Depression.

The rate of the droughty and excessively droughty time type in the year 2000 in conformity with Hellman's Criterion was of 80.4%, varying: 58.8 in Drobeta-Turnu Severin and 52.8% in Calafat over Dunăre; 52.2% in Băileşti in the Olteniei Plain and 53.7% in Slatina, in the Oltului Passage; 51.6% in Rm. Vâlcea, 56.3% in Târgu Jiu, 57.2% in Polovragi and 63.0% in Apa Neagră in the Subcarpathian depressions, being a little reduced in the mountain areas: 45.5% in Voineasa and 45.8% in Parâng.

In this period temperatures typical for canicular days were registered in the following periods: 6-10 and 21-25 June; 2-12 and 22-27 July; 3-7 and 17-24 August.

On July 5 2000, 42 meteorological stations from the South of Romania- out of which 17 stations in Oltenia (16 in July and 1 in August) recorded temperatures that became absolute maximum, the highest recorded value being of 43.2^{o}C on July 4, 2000.

Such temperatures led to aridization processes, especially in areas with sand dunes in the South of Oltenia, called „The Sahara of Oltenia".

In the summer of 2007, in Oltenia the weather was extremely changing. The summer months-June, July and to a smaller extent, August-were affected by drought and canicular days, which were, at least for July, the most intense in the history of meteorological observations.

Six heat waves took place in the following periods: 19-26 June, 2-4, 8-10, 15-24, 27-30 July and 22-25 August (Figure No. 7). From these, the most intense were those of 19-26 June and 15-24 July.

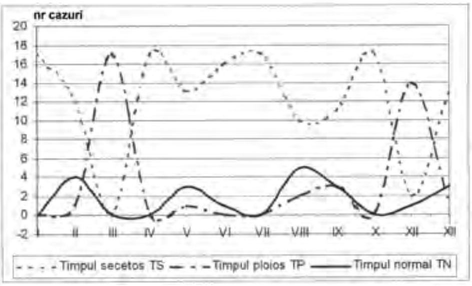

Figure No 7. The evolution of drought in 2007 in rates of number of cases on time types in conformity with Hellmann’s Criterion.

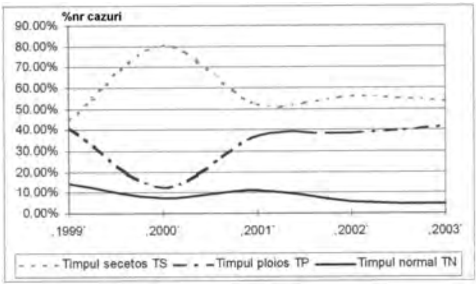

Figure No 6. The evolution of drought of 1999-2003 in Oltenia in number of cases on time types in conformity with Hellmann’s Criterion.

The Drought of 2007

We remark an increase in intensity towards the West of the heat waves for the 21st century. This phenomenon is highlit by the fact that in July 2007 the maximum temperature exceeded 44 °C at 5 meteorological stations: Băileşti, Moldova Nouă and Moldova Veche (44.0°C), Bechet 44.2°C and Calafat 44.3°C, only 0.2°C less then the absolute thermic record of 20th century, that of 44.5°C reached on 10.VIII.1951, causing various material damages through: -the harvests which were affected in important rates; - the draining of water reserves in phreatic layers, fountains, lakes and rivers; -numerous forest fires; as well as by the reduction of electric energy production in powerstations over Danube: from 17 000 MWh/day in 2006 to 11 000 Mwh/day in 2007.

The high temperatures affected gravely the health of people, as many health inconveniences even deaths were registered (Tudose, Moldovan, 2007).

4. CONCLUSIONS

From the presented material we can conclude that:

For Oltenia as well as for all the extracarpathic regions from the South and South-East of Romania, the drought is a common phenomenon, that can have a periodic character (a month, a semester, a year) but it can also last many years in a row.

After 1980 and especially 1990 the frequency and duration of the droughts have increased in Oltenia, as well as in the rest of Romania as there have been cases of 2-3 consecutive years of draught.

The analysis of different time types in conformity with Hellmann’s Criterion shows that the droughty weather (of pluviometric deficit) may vary between 20% and more than 80% in a year. Furthermore, starting with 2000, almost no year misses a drought period, hence, the tendency of this phenomenon to become permanent.

The drought phenomena are associated with very hot and dry periods that increased in durration from 2-3 days/month in the 20th century to 10-14 days in the canicular days of the summer of 2007, as we remark a transition of the intensity of the heat and drought waves from East (Baragan) to West (Oltenia).

The damages caused by the dryness, draught and the canicular days phenomena are huge and they require measures of monitorization and the diminution of consequences.

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STUDIA UNIVERSITATIS BABEŞ-BOLYAI, GEOGRAPHIA, LIV, 3, 2009

DIURNAL AND SEASONAL VARIATION OF CO_2 IN URBAN AREAS FROM CLUJ COUNTY

IOVANCA HAIDUC[1], M. S. BELDEAN GALEA[1], C. ROBA[1]

ABSTRACT. Diurnal and Seasonal Variation of CO_2 in Urban Areas from Cluj County. This study shows the influence of the anthropic factors (urban agglomeration, economical activities, traffic) and the ecosystems upon the urban CO_2 budget, during six months in 2008 (July-December). For this study, there were established three different locations from Cluj County: Cluj-Napoca, Turda and Huedin. In each of them, we chose city points with intense anthropic activities, and some reference points with a minor anthropic impact. The data show a significant variation for the CO_2 level from one area to other, depending on the size of the urban agglomeration. There were also observed diurnal variations of the CO_2 level, influenced by the ecosystem activity through photosynthesis.

Keywords: *CO_2, urban agglomeration, diurnal and seasonal variation*

1. INTRODUCTION

The presence into the atmosphere of carbon dioxide (CO_2), a gas with greenhouse effect, is a consequence of natural activities - the carbon cycle – and antropogenic factors, especially human activities such as the burning of fossil fuels.

Since the Industrial Revolution in the 1700's, the human activities, such as the burning of oil, coal and gases, and the deforestation, have increased CO_2 concentrations in the atmosphere. The CO_2 level increased from approximately 280 ppm in pre-industrial times to 382 ppm in 2006, according to the National Oceanic and Atmospheric Administration's (NOAA), a 36 percent increase. Almost all of the increase is due to human activities. The current rate of increase in CO_2 concentrations is about 1.9 ppmv/year. Present CO_2 concentrations are higher than any time in at least the last 650,000 years (IPCC, 2007).

In Romania, the main responsible institutions in controlling the air quality are the Ministry of Environment, the National Environmental Protection Agencies and their regional and local branches. In our country exits a Air Quality Monitoring Network which includes 117 automatic stations for the monitoring of air quality, and 17 mobile stations. These stations are monitoring the following pollutants: SO_2, NOx, CO, O_3, VOC and PM10.

Some studies recently, regarding the air quality in important Romanian urban areas, such as in the case of Timişoara (F. Popescu 2007) and Cluj-Napoca (Iv. Haiduc 2007) have been done.

2. MATERIALS AND METHODS

Three different locations from Cluj County (Cluj-Napoca, Turda and Huedin), situated in areas with intense anthropic activities (Cluj-Napoca and Turda) and minor anthropic activities (Huedin) were selected. To illustrate the influence of urban agglomeration upon the CO_2 budget, in each location some reference points situated out side of cities were choused (see figure 1).

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For the atmospheric CO_2 determination a non-dispersive IR analyzer (NDIR), model EMG-4 (figure 2) was used. This analyzer is able to identify variations that regard the gas concentration over a long period of time (that depends of hours) and it is sensitive enough to indicate variations of ppms level.

Fig. 1. The location of the determination points.

Fig. 2. The NDIR, used for the CO_2 determination.

Fig. 3. Weather shelter for the measurements.

The measurements were done at 2.0 m above the soil, during two seasons (summer and autumn), for 8 hours a day (9.30-16.30 OVR respectively 8.30-15.30 OIR) in each location (Cluj-Napoca, Turda, and Huedin).

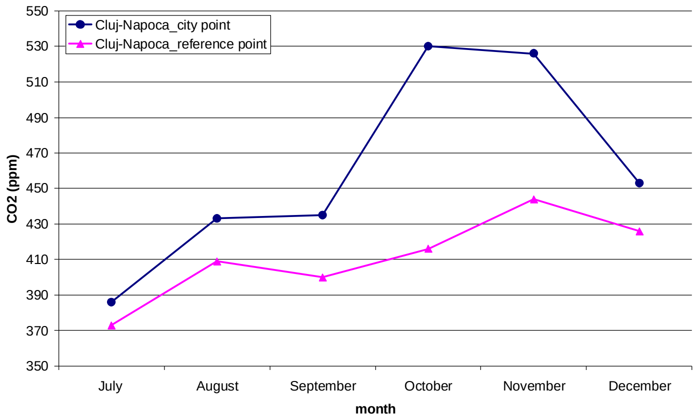
To prevent the impact of meteorological factors (wind, rain, solar radiation) on the data, the measurements were performed in a meteorological shelter, figure 3.

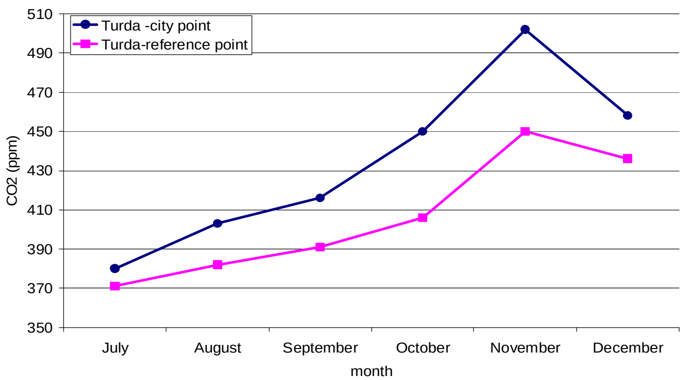
3. RESULTS AND DISCUSSIONS

The influence of the anthropogenic factor upon to the CO_2 budget was studied by simultaneous determination (at 12.30 OVR respectively 11.30 OIR) done in the selected city points and the reference points. The obtained values are shown in figure 4.

Comparing the measurements done simultaneously in each location we can conclude that in the selected city points the CO_2 concentrations (386-530 ppm for Cluj-Napoca, 380-502 ppm for Turda, and 376-433 ppm for Huedin) are higher, compared to those from the reference points (373-444 ppm for Cluj-Napoca, 371-450 ppm Turda and 376-389 ppm for Huedin).

It can be seen that the highest CO_2 level was registered in Cluj-Napoca both in the city point (460.5 ppm average value) and the reference point (411.3 ppm average value), compared to Turda, where the CO_2 average value from city point was 435 ppm and reference point 406 ppm. The lowest CO_2 average value was registered in Huedin, with 402.16 ppm in city point and 381 ppm in reference point. These differences of CO_2 levels are reflecting the impact of the urban agglomeration, intensity of the vehicle traffic and economical activities upon the CO_2 budget.





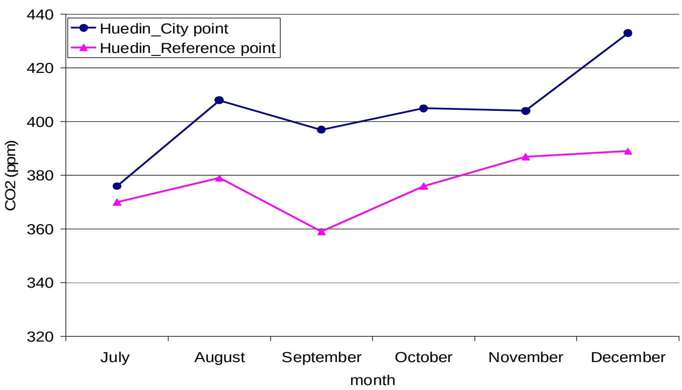


Fig. 4. The simultaneously determinations of CO_2 concentrations in city points and reference points.

Also in all cases, the difference between the CO_2 level from city points and reference points is higher during October and November, compared to July and August, because of the influence of the natural factor, see figure 5.

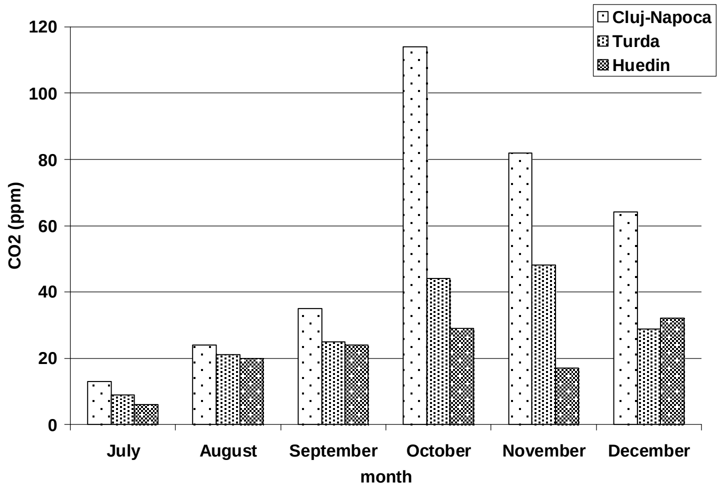


Fig. 5. The difference between the CO_2 level from city points and reference points, for each location.

Diurnal measurements were done each month, during 8 hours a day. In figure 6, the variation of CO_2 concentration is presented, during 8 hours, for the selected city points.

As it can be seen in figure 6 the highest concentrations were observed during 9.30-11.30 AM (536 ppm for Cluj-Napoca, 502 ppm for Turda and 453 ppm for Huedin), and the lowest concentrations were in the afternoon (390 ppm for Cluj-Napoca, 367 ppm for Turda and 369 ppm for Huedin). This fact can be explained by the influence of the process of photosynthesis and of the heat convection process, which determines the rise of the pollutants to the altitude. In the third place, the concentration during the morning hours may be due to the intensity of the auto traffic, which has a peak between 8.00-10.00 AM. During the afternoon hours, there is a traffic relaxation that together with the convection heat process and the photosynthesis, lead to the smallest concentrations (Mill´an M. M. 2005).

In all cases, the CO_2 level registered during October and November was higher comparing to the CO_2 level from July and August (figure 7). During the autumn months the differences between the CO_2 level from the city points and reference points (82 ppm for Cluj-Napoca, 48 ppm for Turda and 17 ppm for Huedin - in November) are higher compared to those registered during summer months (13 ppm for Cluj-Napoca, 9 ppm for Turda and 6 ppm for Huedin-in July). One of the reasons for this variation is the fact that during October and November, the photosynthesis processes are not so intense as in July and August, and the vegetation cannot absorb so much of the atmospheric CO_2.

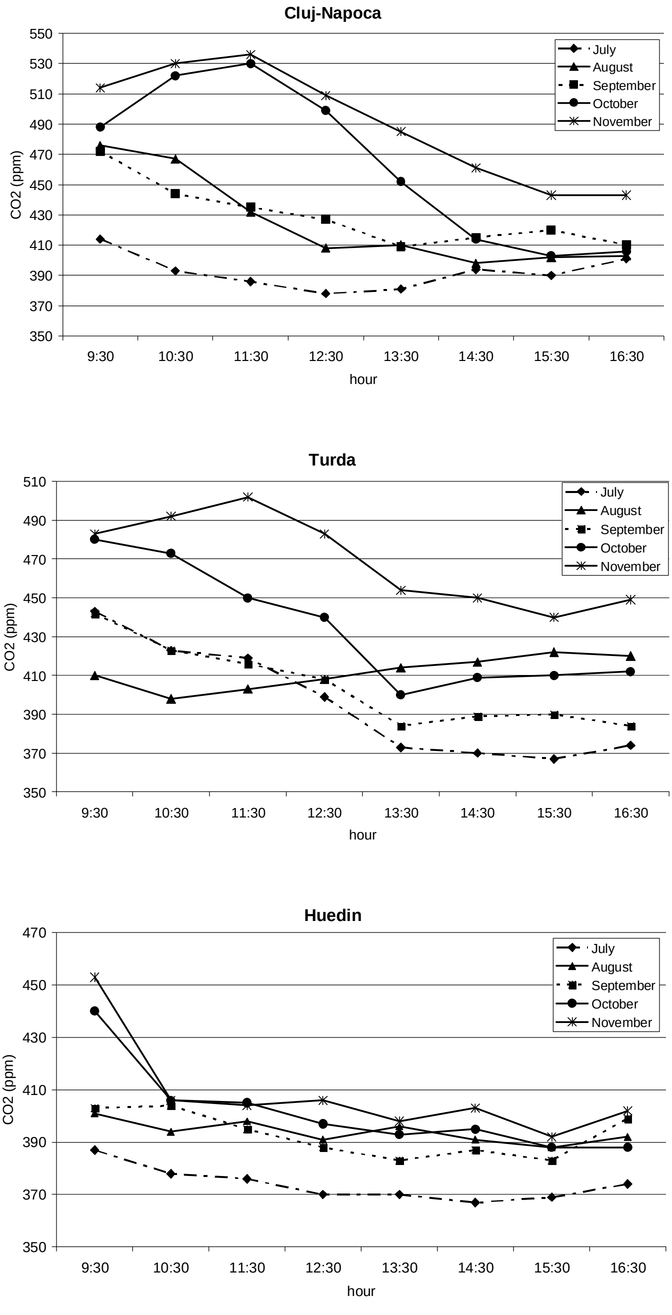


Fig. 6. 8 hour values of CO_2 recorded in all city points.

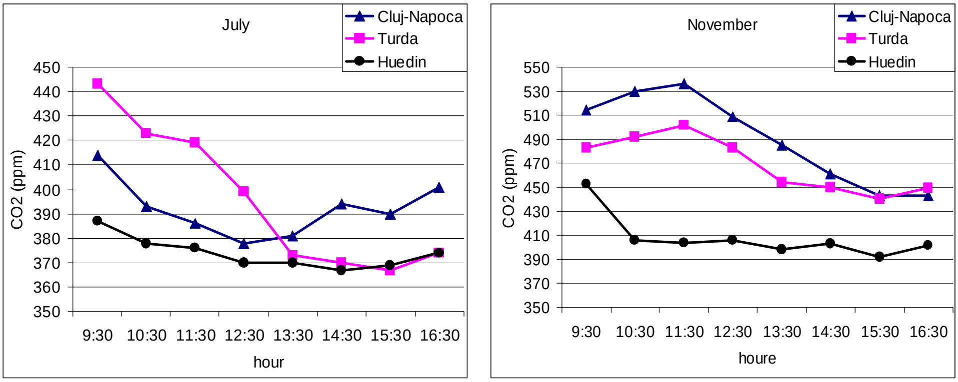


Fig. 7. Comparison between the diurnal variation of CO_2 in July and November**.**

4. CONCLUSIONS

The CO_2 concentration during July-December shows a daily variation, which depends on the location (urban agglomeration, anthropogenic activities) and natural factors (photosynthesis, temperature). The highest concentrations were observed during 9.30-11.30 AM (536 ppm for Cluj-Napoca, 502 ppm for Turda and 453 ppm for Huedin), and the lowest concentrations were in the afternoon during 3.30-4.30 PM (390 ppm for Cluj-Napoca, 367 ppm for Turda and 369 ppm for Huedin).

The highest CO_2 level was registered in Cluj-Napoca both in city point (460.5 ppm average value) and reference point (411.3 ppm average value), as a consequence of the urban agglomeration, intensity of the vehicle traffic and economical activities from the Cluj-Napoca city.

In Turda the CO_2 average value from city point was 435 ppm and 406 ppm in the reference point, and the lowest CO_2 average value was registered in Huedin, with 402.16 ppm in city point and 381 ppm in reference point.

Comparing the CO_2 values for the two seasons, in all the three studied areas, we can notice a significant increase of the concentration in autumn compared to summer. During summer months the differences between the CO_2 level from the city points and the reference points (13 ppm for Cluj-Napoca, 9 ppm for Turda and 6 ppm for Huedin-in July) are lower compared to those registered during the autumn months (82 ppm for Cluj-Napoca, 48 ppm for Turda and 17 ppm for Huedin- in November).

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STUDIA UNIVERSITATIS BABEŞ-BOLYAI, GEOGRAPHIA, LIV, 3, 2009

THE INTENSITY OF SIGNIFICANT RAINFALLS IN THE WARM SEASON, IN THE NORTH-WESTERN PART OF ROMANIA

T. TUDOSE[1], F. MOLDOVAN[2]

ABSTRACT. The Intensity of Significant Rainfalls in the Warm Season, in the North-Western Part of Romania. By using the climatic data provided by 11 weather stations in the North-Western part of Romania, measurements have been made regarding the average and maximum intensity of the significant rainfalls, recorded during the warm season of the year (April – October), within the 1975-2006 interval. In the case of the significant rainfalls that have an average intensity under 0.17 mm/min (10.2 mm/hr), amounting up to 93.1%, the highest frequencies of occurrence are during the afternoon and in the first part of the night. The main maximum occurs between 16 and 20 RST (Romanian Summer Time), fact which has been noticed especially in the mountainous and hill areas and in the Maramuresului Depression. The average intensities of 0.17-0.41 mm/min (10.2-24.6 mm/hr), amounting to 6 % can be observed between 14-22 RST. In this case, the highest percentage values occur in the hill areas, in Maramureş and in the plains. The rainfalls characterised by an average intensity of above 0.41 mm/min (above 24.6 mm/hr), effectively reaching the limit of heavy showers, occur at maximum frequency in the afternoon and are determined by the rainfalls which last less than an hour (0.8 %). The maximum intensity of the significant rainfalls occurs most frequently in the afternoon and evening (between 14-20 RST). The analysis of intensity thresholds indicates a decrease in their frequency in direct ratio with the increase of their maximum intensity, so that the rainfalls whose maximum intensity exceeds 1.0 mm/min show no uniform spatial disposition and represent rather random phenomena. In 22.8 % of the cases, the onset of the maximum intensity coincides with the beginning of the rainfall, while in 54.5 % of them the maximum intensity is recorded within the first 20 minutes after the inception of the rainfall.

Keywords: *average intensity, maximum intensity, significant rainfalls, North-Western part of Romania*

1. INTRODUCTION

In the specialised literature, the intensity of the rainfalls is a frequent subject for analysis, taking into account the practical relevance of the topic. Koji Dairaku and his team (2004), based on the data provided by 12 measurement locations situated at altitudes between 471 m and 2496 m and recorded in the June-October intervals of 1998 and 1999, study the relationship between the amount, intensity, duration and frequency of the rainfalls in the Mae Chaem region (North-Western Thailand). They point out that there is a solid relationship between altitude and the frequency of the rainfalls, highlighting the fact that the reduced intensity of the rainfalls is relative to altitude, whereas the high intensities are independent of it. In addition, they also note that the small average intensities of the rainfalls are the reason for the occurrence of the largest amounts of precipitation, and the analysis based on intensity thresholds reveals that the rainfalls whose intensity is between 1 – 5 mm/h represent a total of 54.1 – 58.0 % of all precipitations.

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Based on the data collected from 130 weather stations in Romania between 1961-1996, Carmen Sofia Dragotă (2006) conducts an analysis of the average of the highest 5 values of the mean and maximum intensities of rainfalls in the warm season. The author points out that, at the level of the entire country, the average intensity varies between 0.76 and 2.76 mm/min, the average maximum intensity being between 3.0 and 6.8 mm/min, while the absolute maximum intensity does not exceed 10.5 mm/min. Furthermore, the absolute amount corresponding to the absolute maximum intensity exceeded 30 mm only in a punctiform manner (37.5 mm at Câmpulung Moldovenesc), on the whole being below 20 mm.

Tudose and Moldovan (2008) study the diurnal variation and the duration of significant rainfalls in the warm season, at 11 weather stations in the North-Western part of Romania, in the 1975-2006 interval. The study shows that the significant rainfalls have the highest frequency of occurrence in June-July (41.7 %), the diurnal variation of their inception time being greater in the afternoon and evening (14-21 RST), with a main maximum between 17-20 RST. In terms of spatial disposition, the significant rainfaills in the North-West of Romania are more frequent in Maramureş, in the hill-areas and the mountains.

The present paper discusses the intensity of the significant rainfalls characteristic for the warm season, by analysing their average and maximum intensities, focusing on the spatial disposition and their modes of temporal manifestation.

2. DATA AND METHODS

The significant rainfalls are represented by those liquid precipitations recorded on the pluviogram in the warm season which fulfil the following conditions: their maximum intensity is > 0.04 mm/min and their average intensity > 0,02 mm/min, or the amount of water recorded is > 2.5 mm (Instructions for weather stations, 1995).

For the purposes of this study, we have used data on significant rainfalls recorded at 11 weather stations in the North-Western part of Romania: Satu Mare and Supuru de Jos (in the plain area), Baia Mare, Sighetu Marmației and Ocna Şugatag (the first one in the Baia Mare Depression, and the latter two in the Maramureş Depression), Cluj-Napoca and Dej (in the Someşul Mic corridor), Zalău and Bistrița (situated in the hill area of the Transylvanian Plateau), respectively, Vlădeasa 1800 (in the Apuseni Mountains) and Iezer (the Rodnei Mountains), in the mountainous area. The period for analysis spans between 1975 and 2006, an interval within which the significant waterfalls of the warm season (from April to October) have been taken into account. For the mountainous area, the period which is of interest spans between June and September, the other months being characterised mainly by the occurrence of solid precipitations.

The Method of analysis is the statistical one, through which we have determined the diurnal variation of the average and maximum intensities of the significant rainfalls - (I_{med}) and (I_{max}) – as well as the moment of the onset of the maximum intensity.

For the North-Western part of Romania, the absolute average annual intensities recorded per period of analysis are between 0.64 and 1.8 mm/min, fact which does not reveal a relevant spatial disposition. Nonetheless, the majority of rainfalls having such intensities were recorded in the months of July and August, and in terms of duration they all lasted under 1 hour, more than half of them lasting less than 15 minutes. The absolute values of the maximum intensity are situated between 5.0 and 10.1 mm/min, with almost half of them exceeding 9.0 mm/min. The duration of the maximum intensities of the rainfalls is less than 1 minute (82% of the cases), longer durations occurring only in the plain areas. The absolute maximum amounts recorded are between 54.0 and 82.4 mm, with an average around 61 mm. The high quantities of precipitations are associated with rainfalls of long duration, except for the plain areas, where such values were recorded with rainfalls lasting less than 3 hours.

3. RESULTS

The average intensity of the significant rainfalls displays wide variations in frequency, in function of their duration and the value of the analysed threshold (Table 1). The highest frequency of occurrence (93.1 % of all) is displayed by rainfalls of average intensity under 0.17 mm/min (respectively, under 10.2 mm/h). The disposition of these rainfalls relative to their duration indicates a prevalence of those lasting less than 1 hour (32.9 %), closely followed by those lasting more than 3 hours (31.4 %).

Tabel 1

The disposition of the average and maximum intensities of rainfalls by threshold, in function of the duration of the rainfall.

	Average intensity (mm/min.)			Maximum intensity (mm/min.)		
	< 0.17	0.17-0.41	> 0.41	< 0.5	0.5-1.0	> 1.0
< 1 hrs	32.9	4.5	0.83	30.0	5.4	2.7
1-2 hrs	16.9	1.1	0.05	12.3	3.7	2.2
2-3 hrs	11.9	0.3	0.01	8.7	2.1	1.3
> 3 hrs	31.4	0.1	0.01	25.7	3.9	2.0
Annual	93.1	6.0	0.9	76.7	15.1	8.2

The annual diurnal variation of the rainfalls that have an average intensity under 0.17 mm/min reveals that the highest frequencies occur in the afternoon and evening hours (14-22 RST), with a more prominent maximum reached in the Maramureş Depression (between 17-22 RST) and, respectively, in the hill and mountainous areas (between 16-21 RST). More reduced annual frequencies and an occurrence maximum delayed by 1 – 2 hours can be noticed in the valley corridors and the plain areas (Figure 1). In Maramureş, around 23-24 RST, there is a second maximum, though a less manifest one.

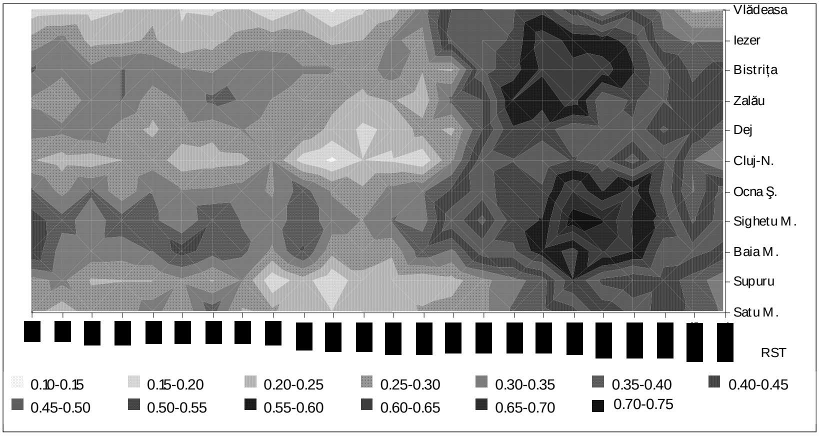

Fig. 1. The diurnal variation of the occurrence in time of rainfalls with I_{med} < 0.17 mm/min.

Regarding the significant rainfalls that have an average intensity between 0.17 and 0.41 mm/min (10.2-24.6 mm/h), reaching 6.0 % of the total amount of rainfalls, the highest frequencies of occurrence are in the afternoon and the evening (14-23 RST). In the mountainous regions and the hills the maximum of the frequency of occurrence is reached 3 or 4 hours earlier. In the hill areas there is a second maximum in the evening (20-22 RST), which is a consequence of the nebulous formations that develop during the afternoon (Figure 2). The frequencies decrease in direct ratio with the increase of the duration of the rainfalls, from 4.5 % in the case of those lasting less than 1 hour to almost 0.1 % in the case of those that span over 3 hours.

The significant rainfalls with I_{med} > 0.41 mm/min (over 24.6 mm/h, representing the limit of heavy showers), are characterised by lesser percentage values, amounting to only 0.9 % of the total number of rainfalls, out of which 92 % are rainfalls with a duration of less than 1 hour. The diurnal variation of their onset time displays highest frequencies in the afternoon and the first hours of evening, and it is possible to notice a non-homogeneous spatial distribution in their case (Figure 3), with the highest values attained in the plain areas and the Maramureş Depression (16-20 RST), in the hill areas (18-20 RST) and the valley corridors (18-19 RST). Their random spatial disposition shows that these rainfalls represent events whose occurrence is rather the consequence of the influence of local factors and not only of the existence of favourable mesoscalar conditions.

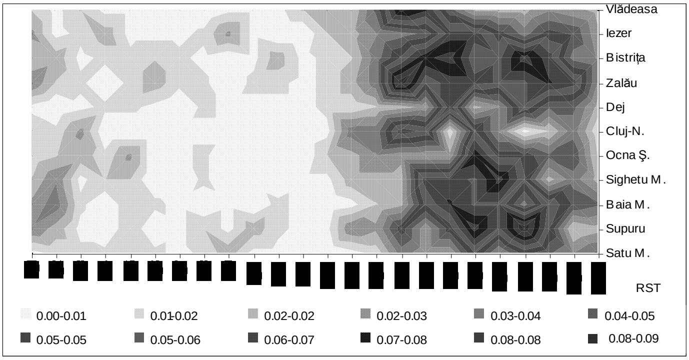

Fig. 2. The diurnal variation of the occurrence in time of rainfalls with I_{med} 0.17-0.41 mm/min.

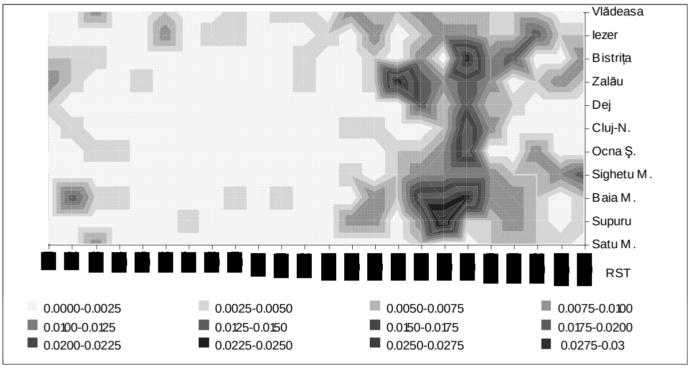

Fig. 3. The diurnal variation of the occurrence in time of rainfalls with I_{med} > 0.41 mm/min.

The maximum intensity of the significant rainfalls – an important segment in the evolution of a rainfall and one connected to the speed of precipitation – displays high variability in time and space. The analysis of the maximum intensity in function of the length of the rainfall, the time of recording and its very value shows a number of particular characteristics. The analysis of the intensity thresholds indicates that the rainfalls with $I_{max} < 0.5$ mm/min represent the largest segment (76.7 %), being followed by those with I_{max} values between 0.5 and 1.0 mm/min (15.1 %) and those above 1.0 mm/min (Table 1). It is possible to notice that the frequency decreases in direct ratio with the maximum intensity. At the same time, we can observe a decrease of the frequency of these rainfalls proportional with the increase of their duration, in the case of those lasting less than 3 hours and, respectively, a slight increase in the case of those with a duration of more than 3 hours.

The analysis of the diurnal variation of $I_{max} < 0.5$ mm/min (under 30 mm/h) reveals highest frequencies in the afternoon and the first part of the night (14-24 RST), with a well-defined maximum in the interval 15-20 RST, especially in Maramureş, in the hill areas and partly in the mountains, whereas in the plains the maximum is slightly delayed (Figure 4). High frequencies of the onset time of the maximum intensity are recorded in the Maramureş Depression and the hill areas, as well as during the night and the morning, fact noticed in the case of the rainfalls whose duration exceeds 3 hours.

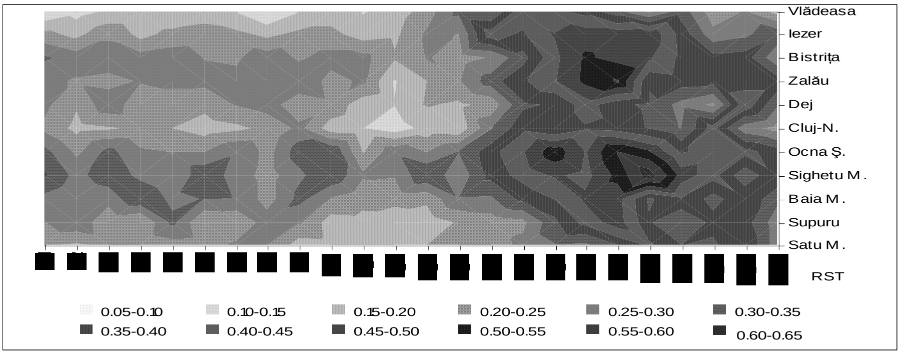

Fig. 4. The diurnal variation of the occurrence in time of rainfalls with $I_{max} < 0.5$ mm/min.

Relative to this average distribution, in the case of the rainfalls whose duration is less than one hour the highest frequencies occur in the afternoon and the evening (15-21 RST), a similar spatial distribution being displayed by those with a duration between 1 and 2 hours. The rainfalls with a duration of 2-3 hours have a non-uniform spatial and temporal distribution, and they mark the transition to the rainfalls that have a long duration (> 3 hours), with which the maximum of the frequency is recorded in the second part of the night and in the morning (02-10 RST).

In the case of the rainfalls with an I_{max} of 0.5-1.0 mm/min (30-60 mm/h), the diurnal variation is characterised by the highest occurrence frequencies in the late afternoon hours and in the evening (16-21 RST), the highest percentage values being recorded in Maramureş and in the hill areas of the surveyed unit (Figure 5). In the mountainous areas, the onset time of the maximum frequencies arrives earlier (15-16 RST), and in the valley corridors and the plains the onset is, on the other hand, slightly delayed (17-19 RST and the

19-20 RST, respectively). A secondary maximum, much lesser in value though, is recorded in Maramureş during the second part of the night and towards the morning and it is determined by the maximum intensities of the rainfalls with long duration. The analysis of the diurnal variation in function of the duration of the rainfall does not reveal noticeable differences, except in the case of the rainfalls exceeding 3 hours, with which the maximum frequencies are recorded in the afternoon and the second part of the night, but their ratio is rather small (3.9 %).

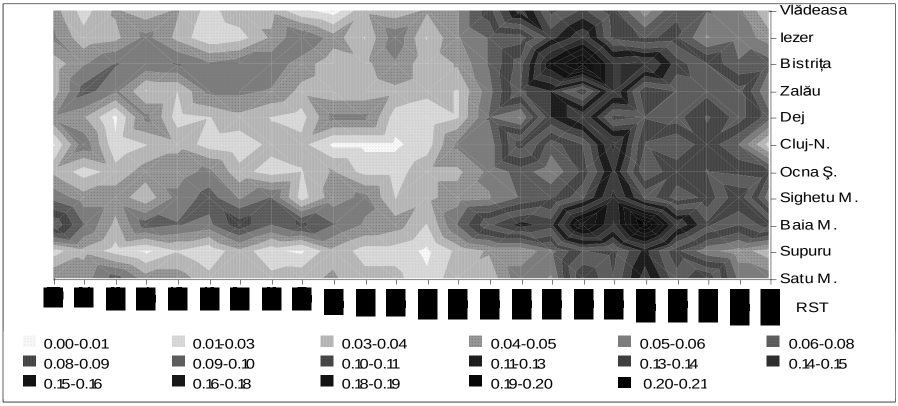

Fig. 5. The diurnal variation of the occurrence in time of rainfalls with I_{max} 0.5-1.0 mm/min.

The diurnal variation of the rainfalls with I_{max} > 1.0 mm/min (over 60 mm/h) has the highest frequencies of occurrence in the afternoon and evening over the entire area, the highest percentages being displayed in the valley corridors (Figure 6). The spatial structure is different relative to those analysed above, these rainfalls showing a spatial distribution that is non-homogeneous, being primarily influenced by the local factors, rather than the general ones. In addition, the structure of the diurnal variation in function of the length of the rainfall does not significantly differ from the general one, the highest probability of occurrence with these rainfalls being in the late afternoon hours and towards the evening, as a result of the convective developments during daytime.

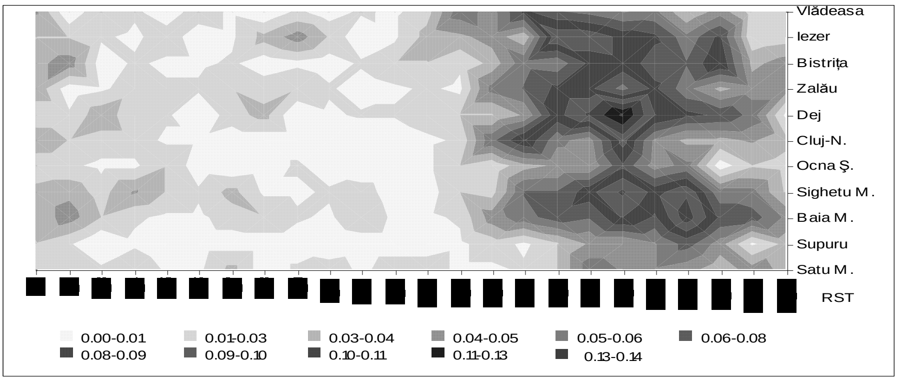

Fig. 6. The diurnal variation of the occurrence in time of rainfalls with I_{max} > 1.0 mm/min.

The onset time of the maximum intensity since the inception of the significant rainfall represents an important element in the immediate prognosis of the amount of precipitation determined by it, and especially so for surface level flows. The analysis of this moment, expressed in minutes, shows that in 28.2 % of the cases it coincides with the moment of inception of the significant rainfalls, where 10.7 % of rainfalls have their moment of inception of the maximum intensity in the first 5 to 10 minutes since the beginning of the rainfall, while in the case of 20.9 % of the rainfalls it is within the first 5 to 20 minutes. It is possible to notice a slight increase of the frequency of this moment in direct ratio with the duration of the rainfalls, in 15.1 % of the cases the maximum intensity being reached more than 120 minutes after the inception of the rainfall.

The analysis of the onset time of the maximum intensity relative to the duration time of the significant rainfalls indicates that 16.95 % of the rainfalls with a duration under one hour begin with their maximum intensity, and with 29.7 % of these the maximum intensity occurs within the first 10 minutes after the onset of the precipitation (Figure 7). In the case of the rainfalls whose duration is between 1 and 2 hours the structure is similar, 2.78 % of the rainfalls beginning with peak intensity. At the same time, it is possible to notice a slight increase of the threshold frequencies of 10-20 and 20-30 minutes, 4.8 % of the rainfalls reaching their maximum intensity within this interval. On the whole, the rainfalls that have a duration between 2 and 3 hours have their maximum intensity distributed in a relatively uniform way within the rainfall, with a slight prevalence of the 10-30 minutes threshold. In the case of the rainfalls whose duration exceeds 3 hours, the maximum intensities occur most frequently more than 120 minutes after the inception of the precipitation (5.99-8.44 %).

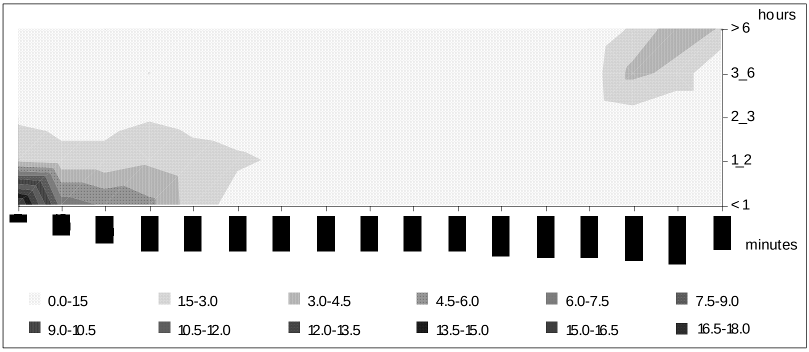

Fig. 7. The frequency (%) of the moment of occurrence of the maximum intensity after the inception of the rainfall (minutes), in function of the duration of the rainfall (hours).

The spatial distributon of the moment of the onset of the maximum intensity relative to the inception of the significant rainfalls reveals that the highest frequencies occur within the first 5 minutes in the depression areas in Maramaureş, in the plains and the hill areas, a situation which is primarily determined by the rainfalls whose duration is under 2 hours (22.5 % of the total number). A second maximum, well defined in Maramureş, in the hills areas and the plains, is attained more than 120 minutes after the inception of the rainfalls, being determined by the rainfalls whose duration exceeds 3 hours (14.4 %).

4. CONCLUSIONS

In the North-Western part of Romania, the distribution by threshold of the average and maximum intensities of the significant rainfalls reveals a high rate of small intensities (93.1 % with I_{med} < 0.17 mm/min, respectively 76.7 % with I_{max} < 0.5 mm/min), while the rainfalls that have medium and maximum intensities show a limited rate of occurrence, decreasing in direct ratio with the increase of the intensity and duration of the rainfalls.

The diurnal variation of the rainfalls with reduced average intensity displays a main maximum occurrence rate in the afternoon and the first hours of the evening and a secondary one, much less defined, during the night. The rainfalls with high average intensities have one single maximum, in the afternoon and the evening, which is a result of the intensifying of diurnal convection. As the value of the maximum intensity increases, the highest frequencies occur towards the evening, fact which is most evident in the valley corridors, the hill areas and in the mountains.

The moment of the onset of the maximum intensity drifts along with the increase of the duration of the rainfall, with those of a shorter duration reaching their maximum intensity at the beginning of the rainfall, while in the case of those lasting longer this is attained at least 2 hours after the inception of the rainfall.

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AIR QUALITY AND LEGAL MECHANISMS FOR THE QUALITY ASSURANCE IN THE RM

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ABSTRACT. **Air Quality and the Legal Mechanisms of the Quality of the RM**. Activity intensive environmental advanced industrial countries is not enough, the annual quantity of the polluting substances released into the atmosphere is growing steadily, is rising and the degradation of air quality status.

During the years 1990-1999 emissions from sources in Moldova have fallen by about six times, for the years 2000-2008 is a slight increase in emissions, but background concentrations in the atmosphere of the main cities polluting substances, except sulphur oxide (IV) for this period or remained virtually the same level, which shows that fund the creation of pollution of the atmosphere in part RM attend and other sources of pollution.

Analysis of annual emissions into the atmosphere by the type of source of pollution for the years 1990-2008 shows that in 1990 the total mass of polluting substances released from these sources was fixed about 40% of total emissions, which gradually decreases to 10.5% in 2000, then begin a slow growth rate reaching 15% in 2008.

Analyzing the average monthly concentrations of polluting substances into the atmosphere during winter was found that when increasing the number of sources of local pollution, they have a lower amount than the summer, which shows that air quality concentration of substance in Moldova is influenced of transboundary transfer of polluting substances.

Legal protection of atmospheric air quality in Moldova is virtually assured of legislation. Taking into consideration that air quality degradation is caused by transboundary air pollution in Moldova is a need to initiate international Conventions in the procedure for compensation of injury and product environmental health in the Republic.

Keywords: *Air pollution, air quality, auto purification process, atmosphere, source of pollution, anthropogenic emissions, pollutant substances, the complex index of air pollution, impact on the air quality, measures of edification, regime juridical.*

1. Introduction

Moldova is a part of the plain of Eastern Europe and is located in the proportion of 90% between the Prut and Nistru rivers. 59% of the territory is in the Nistru basin, 23% in the Prut basin, 11% in small basins of rivers, tributaries of the Danube and 7% in small basins of rivers flowing into the Black Sea.

Moldova is located geographically in the way of movement of air masses in front of the Atlantic, which by-the-European countries, strong and continuous source of pollution, incorporating harmful substances emitted into the atmosphere and air transport in the basin of RM.

Relief Moldova is a plain with an average elevation of 147 m. The highest part of the territory of the republic (Codrii), situated in the center, has a strong relief fragmented with a maximum altitude of 429.5 m and occupies about 15% of the whole territory of the republic.

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Moldova's climate is temperate continental. On average per year are 2060 hours in the sun in northern and 2350 hours in the southern regions of the republic. The average annual temperature of air in Moldova is positive and represents 10°C. The amount of annual rainfall is 380 mm weather in the South and 560 mm in northern Republic [2].

The weather is caused by external centers barice. The atmospheric circulation is predominantly anticyclone with relatively low atmospheric processes, expressed in a variety of changes in seasonal movement. The main climatic factor of movement of air masses are cyclone which facilitates the exchange of southern and advection.

Most cyclones crossing the territory of Moldova from the Western Balkans with an average speed of 20-30 km/hour, range 80-90 km/h. Prevailing winds directed Western, Northern, North-West and a lower frequency of the South and South-West. Average speed of 2,5-4,5 m/sec. In places higher maintain 4,0-4,5 m/sec [2].

The consequences of air pollution in Moldova are felt in all spheres of activity, the degradation of soil quality and agricultural products, taking up the desertification, decreasing productivity of crops, damage forests, changing the composition of ecosystems at the micro and not Finally increased morbidity and mortality and population required monitoring processes that occur in the atmosphere as consequences of pollution they anthropogenic substances, assess the impact of polluting substances atmospheric air quality [2-5].

2. OBJECT OF STUDY AND RESEARCH METHODS

The object is to study air quality and atmospheric trends of change during 1990-2008, the sources of air pollution and transboundary transfer, emission and concentration of polluting substances in atmospheric air, environmental impact assessment.

As the object of legal research support to ensure air quality served the legislative and normative-methodical Moldova, analyzed by comparison with the EU Directives, International Environmental Conventions, Environmental Policy Concept of the Republic, the Concept of Sustainable Development [7,8, 10, 11].

Emissions from sources were determined by the inventory, in parallel computing based on fuel consumed by branches of national economy and specific emission coefficients. Assessing the impact of pollution sources on atmospheric air quality was made based on inventory data and norms ELA (limited allowable emissions) [2-6,12].

The concentration of polluting substances into the atmosphere were determined by direct measurements in the atmosphere, according to normative document [1, 6] and mathematical modelling of the processes of dispersion of the polluting substances released into the atmosphere by sources of pollution [2-6]. In assessing the fields noxious concentrations in the atmosphere of earth layer applied method of calculation of the normative document OND-86 [6] algorithm developed software that is ' Ecolog '.

Air quality is expressed through the complex index of pollution of the atmosphere, which is calculated by formula [1,2-6, 9]: $I_{(m)} = \sum(q_i/CMA_i)\, C_i$; where m - the number of polluting substances monitored; q_i - pollutant concentration in the air; CMAi - the maximum concentration of the substance in air (mg/m^3) (full health), C_i- constant, which depends on the class of dangerous and polluting substance is set: hazard class 1 -1.7; 2 -1.3; 3 -1.0; 4 -0.9 [1,2].

Using the index $I_{(m)}$ appreciate the quality of the atmosphere. When $I_{(m)} > m$ concentrations of pollutants, or all substances monitored is greater than the CMA and air quality does not meet health standards. $I_{(m)}$ and is used to compare air quality in cities for different time periods, which allow the trend to change the air quality in cities. $I_{(m)}$ allows the ranking of cities where air pollution.

Air basin has a capacity of resistance to pollution (self), that depends on the flow of pollutants into the atmosphere and the weather conditions, which is expressed by the index, the potential for pollution of the atmosphere (PPA). PPA is classified: down (2. 4), moderate (2. 4 - 2. 7), high (2. 7-3. 0), high (3. 0-3. 3) and high (3. 3) [1., 2-6, 9]. PPA average calculated for the air basin in the Republic of Moldova on the basis of geoclimaticaly (periodicity inverse ground temperature, wind speed frequency 0-1 m/s, frequency of days without wind fogs frequency) is 2. 8-2. 9, which shows that the atmosphere in the Republic has a low potential for self and natural complex is characterized as unreliable [1.3], which makes the limitation of industry development areas with high emission of pollutants.

To support the basis of the quality of air in the Republic has been considered normative legal basis of the RM. In determining the level of harmonization of legislation and normative-methodical with the Republic of EU Directives has been used systemic comparative analysis methodology and Community harmonization of national legislation to the requirements of EU directives [6,7,10,11].

3. RESEARCH RESULTS

To accomplish goals was caused by local sources of air pollution through inventory and forms the basis of statistical 2TP air, monitored in the main air polluting substances in the research, determined the quality and dynamics while air quality in cities for 1990 -2008 made modelling processes dispersion of polluting substances into the atmosphere from sources of pollution of the atmosphere, assessed the impact of pollution sources on air quality atmospheric.

3. 1. Sources

Sources of pollution are classified as fixed and mobile [2-6]. Sources are fixed combustion plants and technological processes. Mobile sources include road vehicles, and special agricultural, aviation, railway transport, maritime and inland waterway transport. As pollution sources operate over 3706 industrial enterprises, 105 enterprises engaged in transportation, 3 - CTE, 40 boiler district, 28 boiler interregional, approximately 2112 boiler productivity and low average, 573 power stations with oil and gas, 24 bases petroleum and auto traffic by about 350 thousand units of transport.

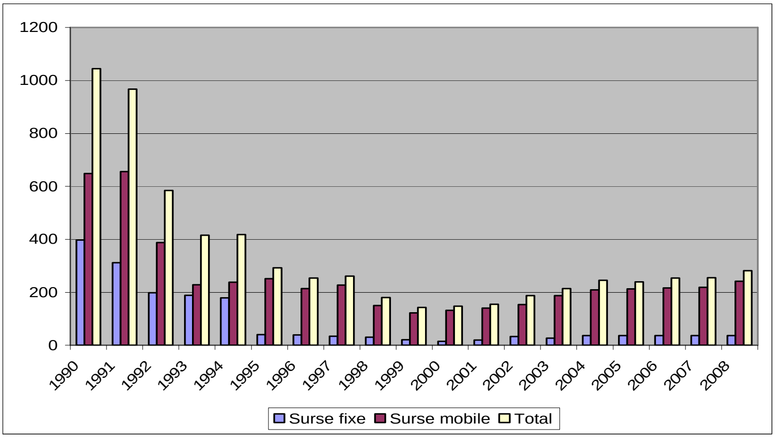

Fig. 1. Annual emissions of polluting substances from local sources

In assessing the amount of polluting substances released into the air basin of the Republic of Moldova has made an inventory of sources of pollution of the atmosphere, have caused emissions from sources in fixed and mobile source direct estimate, based on environmental and passports by calculation based on quantity and quality of fuel consumed (fig. 1).

3. 1. 1. Fixed sources of pollution

The biggest consumers of energy resources in the Republic are: Joint Stock Company "Central Thermal Power - I, Joint Stock Company "Central Thermal Power – 2" and JSC Termocom - mn. Chisinau "CTP- North - mn. Balti. Total emissions of pollutants into the atmosphere from the above in 2005 were 1969. 252 tonnes, including dust - 6.9 tons, sulphur oxide (IV) – 138. 599 tonnes of carbon oxide (II) - 208. 577 tonnes of nitrogen oxides - 1614. 252 tonnes, other - 1. 121tone electrical boilers using fuel gas - 56. 50% oil - 7. 90%, coal - 35. 60%.

On the RM currently operates 18 companies with annual emissions between 100-5000 tonnes and about 3700 enterprises with annual emissions by 100 t. Total annual emissions from fixed sources are shown in figure 1.

Objects thermal energy and heat of the republic during 1990 - 2000 have been major polluters of air, their emissions as 84% of the summary from fixed sources. In 2005 recorded an increase of emissions of pollutants into the atmosphere from industrial and constituted 49.91% of total emissions from fixed sources of pollution [2-6]

In 1994, the atmosphere in the republic was released by fixed sources 179.10 kt of pollutants. Compared with previous years the release of fixed sources of pollution continued to decrease from 396. 46 kt in 1990.

The volume of emissions of pollutants (without Central Thermal Power Cuciurgani) in atmospheric air from stationary sources of pollution in 2005 is indicative 17, 9 thousand tons, including: dust -3.98 tons, sulphur oxide (IV) - 1.98 thousands, carbon oxide (II) - 5. 34 thousand tonnes of nitrogen oxides – 2,9 thousand tons, oil - 1.5 thousand tons and more -2, 2 tons.

Annual emissions from fixed sources of pollution of the atmosphere during 1990-2008 decreased continuously around 20-25% annually until 2001, reaching the value of 19.20 tons of the value of 396.46 kt in 1990 then began a slow unstable growth of emissions by about 37 kt in 2008. In the period after 1990 have reduced the share of energy in industry, agriculture and transport are increasing the public sector.

3. 1. 2. Mobile sources of pollution

For the period 1990-2008 from mobile sources decrease from about 650 kt per year in 1990 to around 250 kt in 1993, which is maintained with slight variations until 1997, then nine in 1998 to decrease to about 150 kt after which begins a slow increase to a value of around 240 thousand tons of polluting substances in 2008.

3. 1. 3. Emissions

Comparative analysis of total annual emissions of pollutants into the atmosphere from fixed and mobile sources of pollution during the years 1990-2008 shows that in 1990 the total mass of polluting substances released from fixed sources constitute about 40% of total emissions, which decreases gradually to 10.5% in 2000, then begin a slow growth rate reaching 15% in 2008. Share transport basin air pollution in 1990 was about 60%, which rose to 89.50% in 2000 and a slight decrease to 85% in 2008 from the total anthropogenic emissions.

Comparing the rate of decrease in emissions from fixed and mobile sources, we find that mobile sources have a decisive contribution to local air pollution. Emissions from sources were fixed at a height until reaching the ground is heavily diluted and displaced at considerable distances from the source, emissions from mobile sources occur at about 0.8 m from the surface and directly affect the quality and currently air ground layer of the troposphere.

3. 2. Air quality trends and changing it

In the air basin is RM emit more than 130 improper substances air, of which about 36 in considerable quantities. The biggest influence on their air quality has particulate matter, nitrogen oxides, sulphur oxides, carbon oxides, persistent organic pollutants, heavy metals. Air quality monitoring is carried out in Moldova by Hydrometer Service, which has 17 jobs on site parking, located in 5 centres industrial: Chisinau, Balti, Tiraspol, Rabnita, Tighina [1].

Investigations conducted in 1993, the watershed in the pollution of the atmosphere in the Republic of decreasing the growth and stationary (on the mobile sources of pollution), showed a periodic overruns CMA (maximum allowable concentrations) for particulate Balti - 2.7 times, Chisinau - by 1.3 times, Rabnita and Tiraspol - 2 times. Overcome of CMA have been recorded in Chisinau over 71 days, in Rabnita - 74 days, Tiraspol - 127 days. Indices average SO_2 exceeded the CMA in Balti 1.3 times, and for NO_2 - 1.8 times. The maximum amounts of nitrogen oxides have been fixed in Chisinau CMA by 2.7, in Balti -3.5 CMA, in Tiraspol with 4.0 CMA, Rabnița with 1.5 CMA for the overrun of SO_2 were detected in Chisinau within 40 days, at Balti - 66 days, Rabnita and Tiraspol - 26 days. Indices average CO never exceeded CMA, maximal indices were registered in the city Balti 1.2 times (10 days) in mn. Chisinau - 2 times (6 days), in Tiraspol of 8.8 times [1].

In 1995 air quality is characterized by complex indicial pollution of the atmosphere ($I_{(m)}$)) values: Chisinau I_5 = 4. 2; Balti I_5 = 11. 7; Râbnița I_4 = 3. 1; Tiraspol I_5 = 12. 0; Tigina I_4 = 3. 0, which shows the serious air quality in cities of Balti and Tiraspol. In Rabnita, Chisinau Tighina quality is acceptable, but in some periods, the index is greater than the CMA [1].

In 2000 comprehensive pollution indices (I_6) ranged from 1.4 (min. Tighina) to 10.4 (m. Balti). Were overrun registration of CMA average Balti up to 2.3 for CMA powder 1.8 CMA for nitrogen oxide (IV) and 2.7 CMA for formaldehyde. Maximum concentrations were registered in Tiraspol for the nitrogen oxide (IV) - 6.6 CMA and phenol - 8.6 CMA. Analysis shows that concentrations exceeded the average were recorded for 3 of 6 pollutants in Chisinau and Balti. In Tiraspol have exceeded 5 CMA noxious of 6 investigated [1,3].

Air qualities in cities in 2005, expressed through complex index of pollution of the atmosphere were as follows: Chisinau I_7 = 4.77, = 6.74 Balti I_5= 6,74, Tiraspol I_6= 5.17, Ribnita I_4 = 1.86, Tighina I_5= 4.21. The average annual CMA expressed are suspended solid-0.5, sulphur dioxide - 0.2; monoxide carbon - 0.7, nitrogen dioxide 0.1-, 0.7-phenol, formaldehyde - 1.3; -0.2 soluble sulphates in Chisinau suspension and solid -2.0, sulphur dioxide - 0.6; monoxide carbon-0.4, nitrogen dioxide-0.8; formaldehyde - 2.3 in mn. Balti. Data analysis of the past 5 years shows a trend of reducing levels of pollution in Chisinau, Balti, Tiraspol and an upward trend in Tighina and Râbnița.

During the years 1990-2008 to fund the pollution of the atmosphere in cities has not changed essentially, with small fluctuations, with the exception of the concentration of sulphur oxide (IV), which dropped. Analyzing the monthly average concentrations in the atmosphere of polluting substances during winter has been found that when increasing the number of local sources of pollution and the average monthly should increase, they have a lower amount than the summer. Decisive factor in this problem are the climate. Summer priority direction of movement of masses are cyclonic front and direction of Western winter of NV through large spaces, least populated and a less polluted atmosphere, which shows that air quality concentration of substance in the Republic of Moldova influenced transboundary transfer of polluting substances [2-6].

Measurements conducted shows that air quality in cities is seriously affected. After background concentrations of air quality meets health standards, but in some periods actual concentrations in the atmosphere exceed the maximum allowable concentrations. After the complex index of air pollution cities republic placed in order of increasing: Rezina, Chisinau Tighina Rabnița, Tiraspol, Balti [1,3].

3. 3. Modelling of diffusion processes in terrestrial atmosphere

Air pollution in cities is caused by the quantities of pollutants released by sources of pollution and climatic conditions that favors or decreases in air diffusion noxious.

Diffusion of pollutants is subject to: a) the source of pollution parameters (height, diameter, gas temperature ^{o}C), b) the climate and the relief [2-6,9].

For assessing the actual air quality in cities was conducted mathematical modelling processes in air dispersion noxious issued by local pollution sources..

In assessing field noxious concentrations in the atmosphere of earth layer applied method of calculating the OND-86 algorithm which is built into the computerized 'ecolog'. Sources were classified, taking into account their parameters, the concentration and temperature gas output of trash, the type of source - mobile or fixed.

The calculations showed us that the source for mobile and fixed speed for maximum concentration noxious gets in to the atmosphere is 0. 62 m/sec (low and cold sources). Sources for high v = 7. 8 m/sec and the amount of the sources of low and cold climatic conditions unfavourable for v = 4. 35 m/sec.

For CO, volatile organic substances, size background concentration are lower than the CMA, and pollutants such as NOx, CO_2, dust were located a number of critical areas, where concentrations reach and exceed the actual CMA size from 5-10 units. Cities large basin affect air distances of up to 10 km.

4. LEGAL PROTECTION OF AIR QUALITY ATMOSPHEERE IN MOLDOVA

Legal protection of atmospheric air quality is through legislation regulating social relations in this field in order to preserve the purity and atmospheric air quality improvement, prevention and reducing the harmful effects of physical factors, chemical, biological, radioactive and other kind of atmosphere, the order of a right of emission rights and obligations of holders of fixed sources of pollution, the consequences of failure of operation, etc..

The legal regime for the protection of atmospheric air quality in Moldova is regulated by law 4, 53 standards, guidelines and regulations 6, 3 International Conventions and Protocols Additional Conventions 5 [6,7,10].

Currently legislation virtually ensures the legal protection of atmospheric air quality, but the legislative and regulatory acts do not always be met for technical and economic. Effectiveness depends on the standards of the real possibilities of the economic performance, especially during the economic crisis. To be effective and feasible, the requirements should have some flexibility. They must provide tougher for us or a new technologies but can be tolerant to the old strategic. Is important to provide a transition period until the new fully standards.

Comparative analysis of legislative and regulatory force in the Republic with the EU Directives showed that legislative acts, for the most part, are inconsistent with the aqius Community legislative acts in recent years have been approximated in the design.

Another aspect is that the background of the atmosphere in the Republic is determined to transboundary transfer of pollutants is a need to initiate international Conventions in the procedure for compensation of injury and product environmental health.

5. CONCLUSIONS

1. Air quality in cities is the health rules. After complex pollution index cities are placed in order of increasing: Tighina Rabnița, Chisinau, Tiraspol, Balti.

2. The main source of air pollution is atmospheric transport, the greatest environmental impact on air quality we have nitrogen oxides.

3. Background concentrations of major polluting substances in the air basin of Moldova consist of transboundary transfer.

4. Environmental legislation in Moldova to provide general legal protection of atmospheric air quality.

5. It is necessary to develop a mechanism to compensate the damage produced by environmental health and transboundary pollution.

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CLIMATIC CONDITIONS AND TOURISM DEVELOPMENT IN SOUTHERN CARPATHIANS. CASE STUDY - CINDREL MOUNTAINS

ADINA-ELIZA CROITORU[1], P. COCEAN[2], A. SUCIU[3]

ABSTRACT. Climatic Conditions and Tourism Development in Southern Carpathians. Case Study - Cindrel Mountains. Climatic conditions are very important in developing new or old tourism resorts in mountain regions. This study aims to identify whether, in the general context of global warming, Northern slopes of Southern Carpathians (Cindrel Mountains) are suitable for winter tourism, especially for winter sports from climatic poit of view. 47 years-long data series (1961-2007) were analyzed from Păltiniş Weather Station for air temperature, snow cover and wind speed. Main conclusions are: there are not statistically significant trends in air temperature, important increasing statisitcally significant trends in snow cover depth and statistically significant decreasing trends in wind speed. The last two conclusions are due also to the presence in the last 10-15 years of the fir forest around the measurement platform. The fact is a good indicator for location of the ski slopes.

Keywords: *climatic conditions, Southern Carpathians - Cindrel Mountains, trend, tourism development*

1. INTRODUCTION

Climatic conditions are very important in developing new or old tourism resorts in mountain regions. Recently, few studies were published in order to identify the climatic conditions of Romanian mountains areas and to map suitable locations for some new winter sports resorts. Trends in snow cover were computed for many locations in the Southern Carpathians (Dragne, 2008). Some other authors studied snow cover as climatic hazard in different regions from Romanian mountains (Bogdan, 2008, Gaceu, 2005)

This study aims to identify whether, in the general context of global warming, Northern slopes of Southern Carpathians (Cindrel Mountains) are suitable for winter tourism, especially, for winter sports from climatic point of view. The advantage of the analyzed area is that Păltiniş resort already exists in the area and is developing more and more. More, statistical climatic data are recorded very at the weather station located very close to the resort and thus data recorded can be considered as real data and no correction is necessary for the climate of the resort.

2. DATA AND METHOD

2.1. Data

We used homogenized monthly mean temperature, snow cover and wind speed data series both from Păltiniş Weather Station archive and other sources (Meteorological Yearbook, 1961-1973). In Romania, like in other regions, the most of the inhomogeneities

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in the series were found in the 19th century and in the first half of the 20th century (Rebetez and Reinhard 2008). Mean daily temperature is computed as average of four climatological values, measured at 00.00, 06.00, 12.00 and 18.00 UTC. Because the up-mentioned method of calculation mean daily temperature began on 1961, January, 1, we decided to take into account only data recorded after 1960, in order to maintain homogeneity of the data series. Then monthly mean temperatures were calculated. Thus, 47 years long-series covering the last part of the 20th century and the beginning of the 21st century were considered (1961-2007). Mean monthly data for October-May period were used in order to identify middle-term general trends in temperature, snow cover and wind speed data sets.

2.2. Method

To detect and estimate trends in the time series of monthly data, an Excel template – MAKESENS (Mann-Kendall test for trend and Sen's slope estimates) – developed by researchers of Finnish Meteorological Institute (Salmi et al., 2002) was used. The same method and software were also used with good results to identify trends in temperature and precipitations in Romania (Holobâcă et al., 2008) or in numbers of fog days in North-Western Romania (Mureşan and Croitoru, 2009).

The procedure is based on the nonparametric Mann-Kendall test for the trend and the nonparametric Sen's method for the magnitude of the trend. The Mann-Kendall test is applicable to the detection of a monotonic trend of a time series. The Sen's method uses a linear model to estimate the slope of the trend and the variance of the residuals should be constant in time. The MAKESENS soft performs two types of statistical analyses: first, the presence of a monotonic increasing or decreasing trend is tested with the nonparametric Mann-Kendall test and then the slope of a linear trend estimated with the nonparametric Sen's method is computed (Gilbert, 1987). In MAKESENS the tested significance levels α are 0.001, 0.01, 0.05 and 0.1. Both methods are here used in their basic forms. At the same time, they offer many advantages: missing values are allowed and the data needed are not comparable to any particular distribution; the Sen's method is not significantly affected by single data errors or outliers.

The Mann-Kendall test is applicable in cases when the data values x_i of a time series can be assumed to obey the model (Mann, 1945, Kendall, 1975):

$$x_i = f(t_i) + \varepsilon_i \,, \tag{1}$$

where:

- $f(t)$ is a continuous monotonic increasing or decreasing function of time;

- the residuals ε_i can be assumed to be from the same distribution with zero mean. It is therefore assumed that the variance of the distribution is constant in time.

Then the null hypothesis of no trend, H_0, is tested in order to accept or reject it. The observations x_i are randomly ordered chronologically, contrary the alternative hypothesis, H_1, where there is an increasing or decreasing monotonic trend.

Statistic test Z (normal approximation) is computed because all time series are longer than 10. To estimate the true slope of an existing trend (as change per year) the Sen's nonparametric method is used. The Sen's method can be used in cases where the trend can be assumed to be linear. This means that $f(t)$ in equation (7) is equal to:

$$f(t) = Qt + B \tag{2}$$

where:

- *Q* is the slope
- *B* is a constant.

3. RESULTS

3.1. Snow cover

Solid precipitations fallen during cold period of the year, usually in the mountain area, form the snow cover. Its importance is due to the fact that it influences more or less the socio-economic activities depending on its depth and persistence. In the analyzed area, the snow cover usually lasts from October till May. During May, the depth is the most probable less than 1 cm (table 1, figure 1). From December till April snow cover varies between 12 (April) and 37 cm (February) in depth. Compared to the average values, the maximum values of snow cover are considerably higher and, usually, overpass 40 cm from December till April. At the same time, in the mountain area the maximum depth of the snow cover increases from October till April because of successively snowfalls. The lowest values in snow cover are mostly less than 5 cm with the only exception in February. Sometimes it can miss. This fact could generate serious problems in tourism activities, especially in winter sports, if the special infrastructure is not available.

Table 1

Average depth in snow cover at Păltiniş (1961-2007) (cm)

Month	O	N	D	J	F	M	A	M
Maximum values	9.7	38.0	40.0	59.0	79.0	86.0	89.0	8.0
Average values	1.0	6.2	14.9	27.3	37.0	33.4	12.4	0.9
Minimum values	0.0	0.0	0.0	1.0	8.0	0.0	0.0	0.0

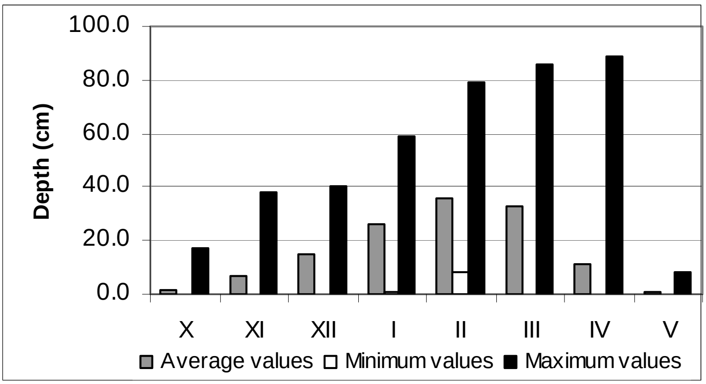

Fig. 1. Average depth in snow cover at Păltiniş (1961-2007)

In order to place the infrastructure for winter sports, data for snow cover were analyzed. Linear trend and Sen's slope were determined for the average values of snow cover for months from November till April. Results are presented in table 3. General trends are increasing with a significance level of 0.05 or 0.01 for each month. November is the only exception and no trend was identified for it. The increasing trends vary from 1.5 cm/decade, in April, till 7.38 cm/decade, in March.

Table 2

Trend in depth of snow cover at Păltiniş

Month	Trend	Significance level	Average slope cm/year	Average slope cm /decade
N	+0.54		0.000	0.00
D	+2.13	0.05	+0.250	+2.50
J	+2.38	0.05	+0.345	+3.45
F	+2.53	0.05	+0.566	+5.66
M	+2.61	0.01	+0.738	+7.38
A	+2.48	0.05	+0.148	+1.48

It is possible that the general trend in snow cover depth, analized for Păltiniş weather staion, to be influenced by the presence of the forest arround the measurement platform. The forest overpassed 2 m hieght 10-15 years ago (Suciu, oral information). This means that wind speed is diminished and, therefore, the snow cover is not anymore swept away.

Thus, tourism based on winter sports can be succesfully developed in the area for the next period. Of course, suplementary studies are necessary for forest influence on snow cover in the area. Those data can be used for the entire mountain area arround if consider the placement of ski slopes in the forest areas (up to 1800 m height).

To place ski slopes over this height, beyond the upper limit of the forest, the depth in snow cover due to altitude can replace the forest shelter effect.

3.2. Air temperature

Temperature data were also analyzed, in the context of global warming issue. For Păltiniş, temperature data series do not reveal important changes in trend. There are both months with negative trend, and months with positive trend (table 3).

Except November when the trend has a significance level of 0.1, for the other months, there is no statistical significance. Thus, they can not be considered as real and they can change from one year to another.

Table 3

Trend of air temperature at Păltiniş (1961-2007)

Month	Trend	Significance level	Average slope °C/year	Average slope °C /decade
O	-0.45		-0.012	-0.12
N	-1.92	0.1	-0.050	-0.50
D	-0.09		0.000	0.00
J	1.62		0.043	+0.43
F	0.31		0.011	+0.11
M	0.07		0.000	+0.00
A	-0.09		-0.004	-0.04
M	1.45		0.033	+0.33

3.3. Wind speed

Wind speed is a very important climatic parameter because of its major implication in the cable transport infrastructure for winter sports. Thus, trend in wind speed for October-May interval was analyzed and the results are presented in table 4. The data reveal important decreasing trends in wind speed for all these months with a significance level of 0.01 or 0.001.

Although for the eight months considered, important negative trends were identified, do not have to forget that in the last 15 years, wind speed diminished due to the forest nearby. The fact is very important because it provides important information about placement of ski slopes inside the wooded areas (up to 1800 m altitude).

Decreasing in wind speed is important not only for cable transport infrastructure, but also for calculating cooling index for human body together with air temperature.

Table 4

Trend in wind speed at Păltiniş (1961-2007)

Month	Trend	Significance level	Average slope (m/s/year)	Average slope (m/s/decade)
O	-3.27	0.01	-0.049	-0.49
N	-4.68	0.001	-0.091	-0.91
D	-4.68	0.001	-0.080	-0.80
J	-4.43	0.001	-0.069	-0.69
F	-4.77	0.001	-0.075	-0.75
M	-4.93	0.001	-0.062	-0.62
A	-5.24	0.001	-0.067	-0.67
M	-5.36	0.001	-0.071	-0.71

3.4. Ice depositions

This phenomenon is important, mainly, for cable transportation for electricity network, but also for tourist transportation infrastructure. Average number of days with ice depositions at Păltiniş varies from January (6.8 days/month) till October and May (less than 1 day/month) (table 5). The maximum values recorded from October till May was of 15 or more days/month. The most days with ice depositions are specific to November and December (figure 2).

Table 5

The average number in ice depositions at Păltiniş (1961-2007)

Month	O	N	D	J	F	M	A	M
Average values	0.9	3.2	4.9	6.8	4.9	3.2	1.4	0.8
Maximum values	18	22	18	20	22	18	15	12

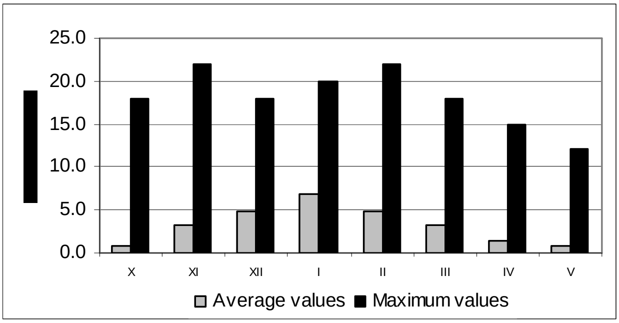

Fig. 2. Number of days with ice depositions from October till May

CONCLUSIONS

Considering the datasets analyzed for air temperature, depth in snow cover and wind speed, one can conclude that for Northern slopes of Cindrel Mountains, the climatic conditions are suitable for installing new infrastructure for winter sport, especially ski slopes. It is also recommended that ski slopes to be placed in the forest areas because of its important role in preserving the snow cover for longer period and with higher depth.

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STORM ON SEA CONCEPT. NAVIGATION SAFETY THRESHOLDS IN THE WESTERN PART OF THE BLACK SEA

BRÎNDUŞA CHIOTOROIU[1], LAURENȚIU CHIOTOROIU[2]

ABSTRACT. Storm on Sea Concept. Navigation Safety Thresholds in the Western Part of the Black Sea. Definition of storms produced in the western part of the Black Sea takes into account the navigation casualties' frequency, the peculiarities of the sea to run high simultaneously to wind intensification and the stresses acting on the ship's hull when is underway. All the sailing vessels record a natural speed reduction due to the added resistance caused by storm's wind and wave. Storm evolutions and speed-loss diagrams based on new meteorological information's may support the work of a routeing officer trying to find the best solution for the ship's safety and economy.

Keywords: *hydro meteorological parameters, incidents on sea, ship stability.*

1. INTRODUCTION

In order to define storms produced along the Romanian shore, two parameters have been used: wind speed of 12 m/s and sea state 4 near the coast. Using these thresholds, more than 180 storm situations have been identified in 20 years (Chiotoroiu B., 1998). One of the main characteristics of these extreme events is the strong winds, constantly blowing from North and favouring consequently the rapid increase of waves' height.

The main consequence represents the ship's speed reduction and increasing fuel consumption, but the ship stability may also be affected in a high sea.

The statistics for the incidents on sea, established for the ships underway or being at anchor in the Black Sea western part or the Romanian ports, emphasize their occurrence even during moderate storms.

Important damages were noticed as a consequence of the ship's dynamical behaviour, especially related to large heeling angles exceeding the weather criterion. International regulations have been consolidated into a few international codes on stability: the Code on Intact Stability (IMO regulation A.749 (18)), SOLAS (1974) or rule 25 of MARPOL 73/78 about damage stability of tankers. All these state clearly maximum allowed values to prevent the loss of stability and the ship's capsizing.

Moreover, the stresses on the ship hull acts on the bending moment's variations and leads to a natural speed reduction. Generally, the captain's decision to reduce voluntarily the speed is taken for a sea state 6. This judgement is also valid for a sea state 4 in certain visual conditions: decrease in propulsion efficiency and increase in added resistance (due to vertical coupled motions of the ship).

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2. STORMS' CHARACTERISTICS

2.1. Hydro meteorological thresholds

Storms in the western part of the Black sea have been already defined using two hydro meteorological parameters: *wind speed >12 m/s* (force 6 Beaufort) for at least 12 consecutive hours and *sea state 4 near the coast* (wave's height 1,25 m – 2,50 m), Chiotoroiu B., 1998. The correspondence is given by the nautical tables published by the Hydrographic Office of the Navy in Constanta (1990).

Storm situations have been considered when the above mentioned values were registered at a least one of the Romanian meteorological coastal stations, Sulina or Constanta. Sea state 4 near the coast generally corresponds to a sea state 5 offshore (at Gloria oil platform), figure 1. Usually, there is a concomitance of storm occurrences at Sulina (on the coast) and at Gloria (offshore).

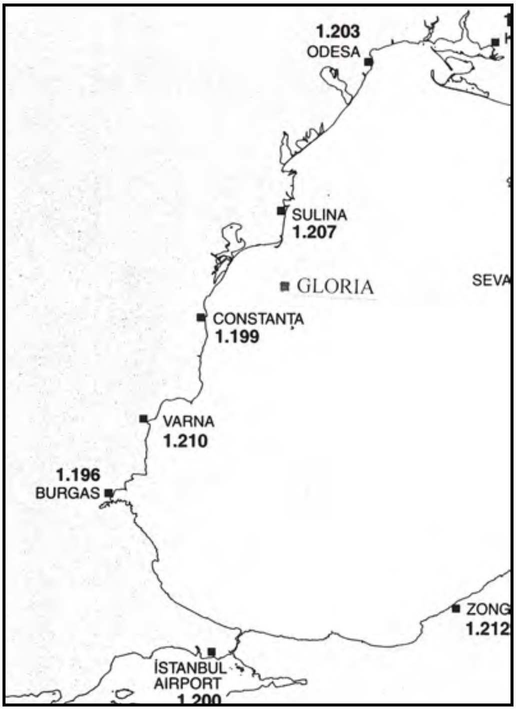

Fig. 1. Romanian meteorological stations

Previous studies on the waves' height evolution near the Romanian coast as a function of the wind speed for different wind directions emphasize the following peculiarities (Bondar coord., 1972): the highest waves form during eastern winds, no matter the wind speed (that includes also the moderate winds); during winds stronger than 10 m/s, Black sea waves exceed 1 m height (sea state 4) when the winds blow from North and 2 m height (sea state 5) if the winds blow from East, figure 2.

Other research papers on storms produced over the western part of the Black Sea has shown that they are more frequent during the cold season, from November to March (75% from all the storm situations in 20 years) and that the strongest winds direction is from North or North-North-East (Chiotoroiu B., 1998).

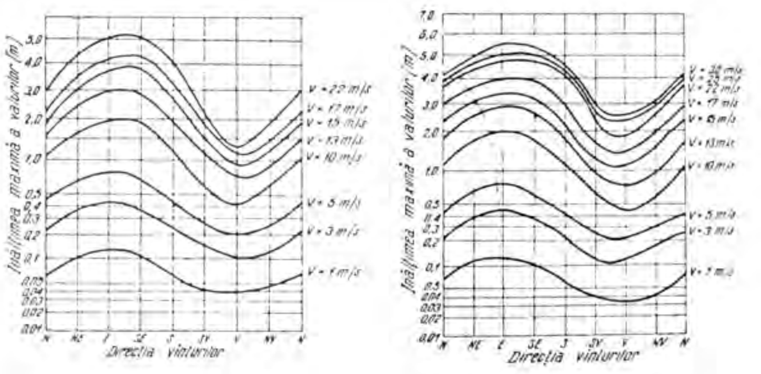

Fig. 2. Wave's height vs. wind speed and direction: Sulina, 15 m depth (on the left) and Constanta, 9 m depth (on the right), Bondar (coord.), 1972.

In most of the cases, during strong winds blowing constantly from a North direction an increase in the wave height almost simultaneously with the wind speed intensification was noticed (figure 3).

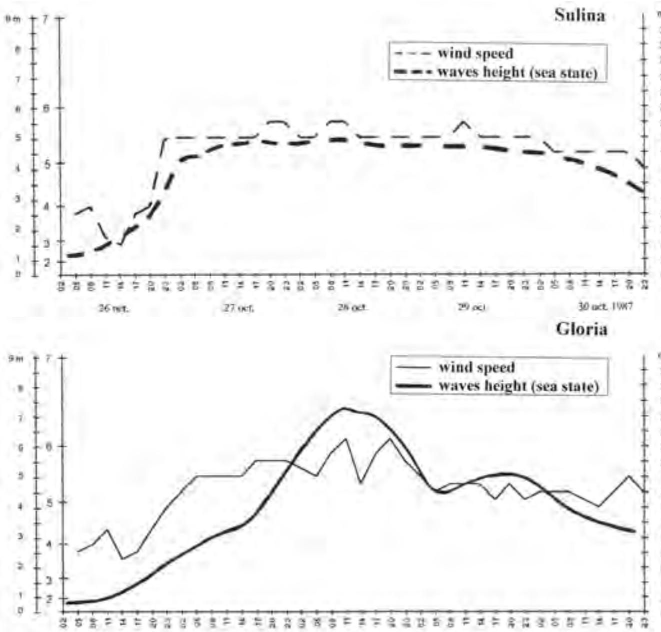

Fig. 3. Wind speed and sea state observed at Sulina and Gloria stations during the storm from 26-30 October 1987 (Chiotoroiu, 1998).

2.2. Navigation casualties

As a result of the Black Sea peculiarity to run high in a very short time, many incidents on sea occurred along the Romanian shore. Some incidents were followed by disasters, like the storm in January 1995. This is a typical example of a violent storm near the coast, which lasts a moderate period of time. As well as during the storm from October 1987 (figure 3), in January 1995 the sea was running high quickly, simultaneously with the wind intensification. The wave height at Gloria station exceeded 8 to 9 m in the evening/night of 4/5 January 1995. Despite of the warning messages sent in due time onboard ships and Constanta Port Control's recommendations, two ships (Paris and You Xiu) rode at anchor the 4th January 1995 until 6 p.m, being at 3,5 and respectively 1,9 miles distance from the Constanta port breakwater's north extremity. At 6 p.m the Port Control found out on the radar screen a change of the two ships' position as well as a drift towards the breakwater. The drift was produced in the dominant direction of winds and stormy waves, towards SW. After hitting the breakwater two gaps were formed and the two ships began to sink. The efforts made by the rescue crews were useless.

The storm in October 1987 have produced moderate to large hull damages to many ships: M/V (motor vessel) Lupeni being underway through the Black Sea and M/V Viseu in Constanta open roadstead (on 29th of October), the Ro/Ro ship Bazias (on 30th of October) etc.

The frequency as well as the intensity of the storms arising offshore the Romanian coasts has been correlated with the incidents on sea registered by the navigation registers of Constanta Harbour Master as a result of extreme weather events. The conclusions of this analysis highlights that over 180 vessels suffers different damages (losing the anchor, hull or deck machinery damages, damage stability due to cargo loss or grounding, ship wrecking etc.). The above damages were produced during the most violent storms, defined by rapid wave height increase and North winds direction.

3. NECESSITY OF A SHIP'S SPEED/ POWER PREDICTION METHOD

The speed of a ship in a heavy sea depends mainly on the ship's resistance and the behaviour of the ship in waves. The prediction method was created by the authors for regular head waves and presently, the program is in a developmental stage concerning the irregular head waves (Chiotoroiu L., 2004). The method will be suitable for all the liners (ships travelling same navigational route) crossing the Black Sea. Keeping in mind that the storm waves near the Romanian coast may have a North-East or East direction, there are few possible cases to be analysed from the ship power and speed point of view:

1). Ship in "following waves" - if the vessel is heading Varna port for example (it's well known that a ship in a following sea may capsize without any prior notice, thus is a very dangerous situation, which has to be avoided as soon as possible);

2). Ship in "head waves" - if the ship is leaving Constanta heading to Odessa or to Sevastopol for example, the ship may encounter a heading storm.

In both cases, the vessel will naturally decrease in power and speed. In the first case, the speed will decrease slightly (with a negative propeller slip), while in the second case, the speed and power will be reduced dramatically (figure 4).

No matter which case is analysed, in the event the ship encounters a severe storm on the service route through western Black Sea, the proper action is based on the personal judgment of the ship's operator. To prevent severe ship's motions, the ship's captain has to change the navigational route based on the new meteorological conditions. At this point, a diagram representing the loss of ship's speed will be helpful.

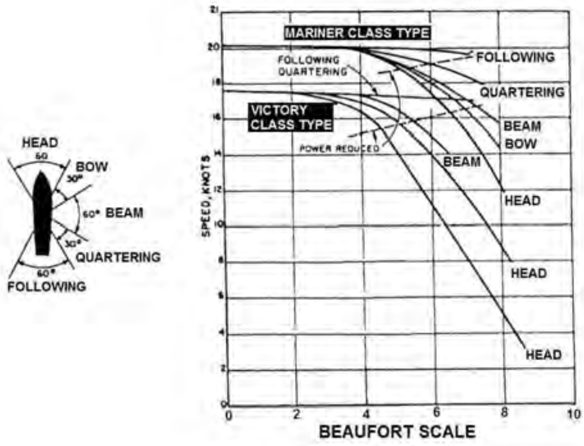

Fig. 4. Example of a speed - loss diagram for ships in rough sea (Ochi et al., 1974)

The aim of our prediction method is to create such a speed-loss diagram valid for the Black Sea for some certain type of cargo ships.

3.1. Prediction algorithm framework

In creating a power and speed prediction method, two factors have to be considered: the natural speed reduction due to added resistance (caused by the winds and waves) and the voluntary speed reduction by the ship's captain.

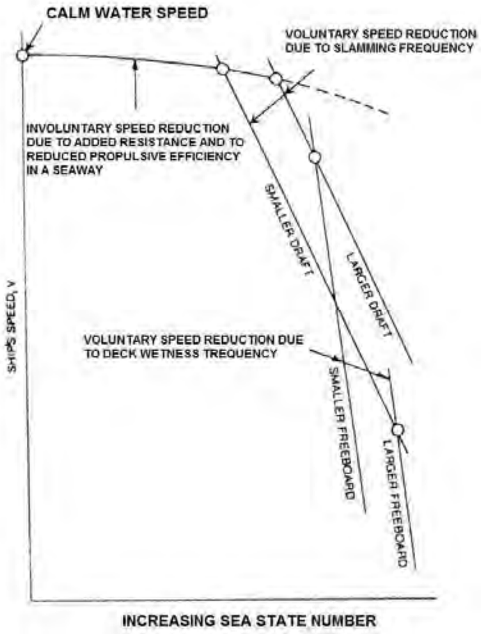

Fig. 5. Natural and voluntary speed reduction according to sea state (Journée, 2001).

To determine the ship service speed in a stormy weather within the prediction method, a computer program valid for regular head waves was developed (Chiotoroiu L., 2004). As a case study, a container vessel was analysed.

Furthermore, to compute the behaviour of this ship in waves, the Black Sea energetic spectrum was necessary to represent. This was done using meteorological and hydrological data concerning the wave parameters, recorded on two Romanian stations (Gloria oil-platform, in open sea and Constanta coastal station), the mean wave period and the average frequency (Novac I., Chiotoroiu, 2004).

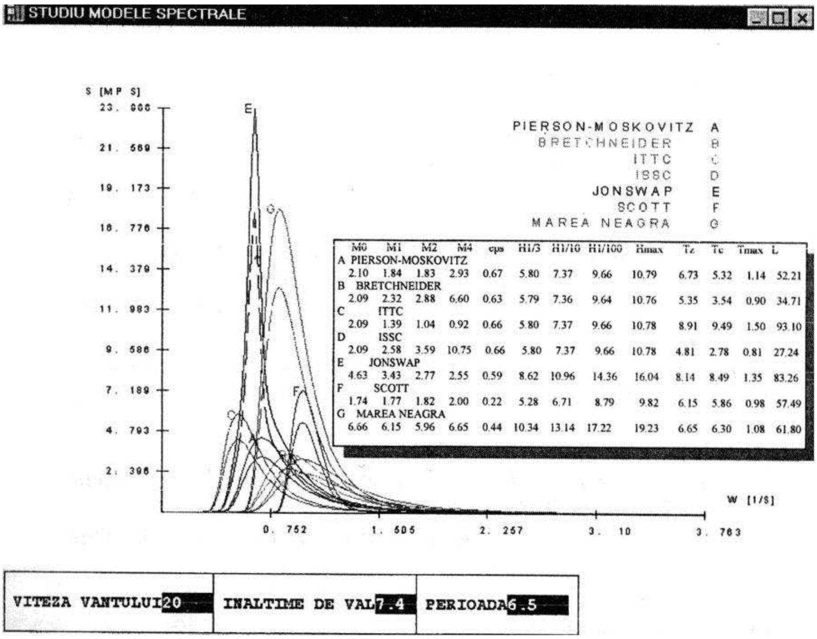

Fig. 6. The Black Sea wave spectrum in comparison with other sea spectrum (Novac et al., 2004)

3.2. Determination of ship's response characteristics

Based on the above data, the behaviour of any sailing ship in a Black Sea storm may be determined based on certain steps:

1. Determine Black Sea wave spectrum;
2. Encounter wave energy spectrum $S_{\zeta}(\omega_e)$, as experienced by vessel;
3. Determine the harmonic response in regular waves;
4. Calculate the Response Amplitude Operator (RAO);
5. Represent the response spectrum ($S_Z((\omega_e)$);
6. Find the system response.

In the present stage, the program is analysing step 3. When the transfer function will became a known quantity, it will be possible to calculate the behaviour of any ship or model in a Black Sea wave spectrum.

4. POSSIBLE STABILITY HAZARD DUE TO DEFINED BLACK SEA STORM

As mentioned before, wind speed of 12 m/s blowing constantly from same direction leads to a rapid increase in the wave height along the Romanian shore. Thus, if initially the wave height is 1,5 m, it may rapidly increase to 2,5 or 3 m. As a result, in addition to the ship's speed reduction and increasing fuel consumption, the ship stability may also be affected.

In this realistic scenario, to avoid incidents which may occur, the ship's captain or the deck officer in charge has to act in consequence. The recommended procedure is to change the route to diminish the effects of the beam and quartering winds (figure 4). In other words, to avoid stability hazards, the ship has to sail as much as possible in head and bow waves instead of beam or quartering winds and waves.

In the event of sailing in beam winds and waves, depending of the bulk cargo type (solid or liquid), the cargo surfaces will incline relatively to their original horizontal orientation. This effect of sliding cargo (or free surface effect accordingly) deteriorates stability significantly. The effect on the curve of statical stability of such shifts is obvious. The ship will navigate listed (approx. 11º in the figure 7 below); this could be a navigation condition but not a safe and not a recommended one. The figure 8 holds for a vessel of 40.000 tons displacement due to a heeling moment of 7875 [t·m].

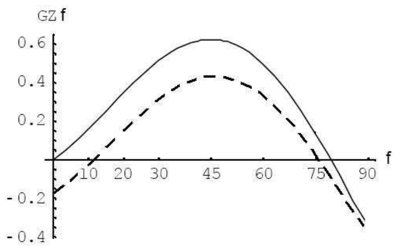

Fig. 7. Effect on the curve of statical stability of static list of approx. 11 º (Chiotoroiu L., 2007)

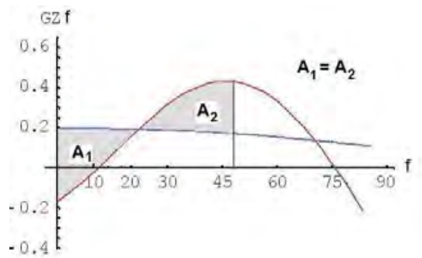

Fig. 8. Graphical estimation of the maximum dynamical heeling angle of approx. 47º (Chiotoroiu L., 2007)

The ship will not remain in this position due to the heeling moment created. Under the non-stationary winds and waves action, she will start to behave dynamically. This means that the inclining angle will increase more than 11º. The maximum dynamical heeling angle depends on ship's hull form and other parameters. The winds and waves transfer energy onto the ship and the ship will heel over to a maximum heeling angle before rolling back. This maximum heeling angle is larger (sometimes more than double) than the statical list angle.

However, as mentioned before, there are international regulations like the Intact Stability Code, regarding the maximum allowed dynamical angle and generally the ship ability to withstand the combined effects of beam winds and waves. For example, in a passenger ship case, the maximum heel angle is 10°; the list resulting from a beam wind pressure of 504 Pa must not exceed 16°, in the weather criterion of the same Code etc.

5. CONCLUSIONS

Research on extreme weather events characteristics and their consequences on navigation can lead to useful conclusions for plotting the meteorological routes through the western Black Sea. With a known rough weather pattern in the Black Sea, an optimum ship's route can be found with a minimum travelling time, fuel consumption or risk of damage stability. Up to now, the prediction of the behaviour of a vessel in a heavy sea is based on routeing experience.

Together with the meteorological information, accurate speed-loss diagrams help the routeing officer to give well-founded routeing advice to the ship's captain. This is not only of importance for the economy of the ship's operation but also for its safety.

This kind of calculation and diagrams we try to settle can also be used in developing operational performance systems on board ships. The calculated speed, power and motion data can be used in these systems with respect to decisions for course deviations or speed reductions. Calculated fuel consumption data can be added easily for minimum use of fuel, predictions of fuel consumptions etc.

ACKNOWLEDGEMENTS

The authors wish to thank the Constanta Harbour Master's representatives for their acceptance to consult the registers containing the navigational incidents in the Romanian Black Sea area.

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A PECULIAR CASE OF HAIL IN THE WEST OF ROMANIA: JULY 14TH, 2008

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ABSTRACT. A Peculiar Case of Hail in the West of Romania: July 14th, 2008. The work presents a case study with a view on the dangerous meteorological phenomena that took place in the evening of July 14th 2008, in the western regions of the country. In the interval 11th-13th July 2008, the central-eastern part of Europe was under the influence of a very hot, tropical air mass that determined the scorching days in our country. The northern and later the central regions of Europe were affected by a cold air mass, moist and unstable which gave precipitation. At the contact of two air masses with thermic differences of about 10°C, in the accentuated generated instability, dangerous meteorological phenomena have resulted. They manifested in the western and central regions of Romania by torrential sudden showers, hail, lightning, thunders and squalls. The effects produced by the dangerous meteorological phenomena were felt in many counties in the country, and in the western part they were most intense in Arad County. There, in some settlements the hail was as big as a hen's egg, generating massive destructions.

Key words: *hail, instability, dangerous meteorological phenomenon, warning, effect.*

1. INTRODUCTION

Hail is a climatic hazard typical for the warm semester of the year and which brings to important local damage in a short period of time, depending on the trajectory of the cloud that generated it. In general, in our country, hail falls as a result of high thermic differences (10-20°C) between the air masses over the country territory and the wet ones which replace them, situation that determines the occurrence of a great instability. In the West of the country, hail falls are more frequent than in other regions, because of the easiness with which wet, oceanic air masses penetrate, coming from the West or Northwest of Europe.

2. DATA AND METHODS

In the present work, meteorological data have been used, regarding air temperature, precipitation, wind speed, atmospheric pressure, during July 11th and 15th 2008, at the stations to the West of the country, coming from the Archive of the National Meteorology Administration (N.M.A.). Synoptic maps, radar maps and satellite images posted on official websites (Eumetsat, N.M.A., Karlsruhe Meteorology Center), have also been analyzed in order to extract the conclusions on the synoptic situation that favoured the occurrence of hail.

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3. RESULTS AND DISCUSSIONS

In the interval 11th-13th July 2008, the central-eastern part of Europe was under the influence of a very hot, tropical air mass that determined the scorching days in our country (temperatures rise to maximums of 35-36°C). On July 13th, the maximums of air temperature for the West part of the country were 34°C at Satu Mare and Oradea and 35°C at Timişoara. Beginning with July 14th, the hot air mass started to recede towards the East of the continent, determining a cooler weather in the West and central parts of Romania (fig.1). Thus the maximum temperatures were lower to the West of the country, 29°C at Satu Mare and Oradea and 31°C at Timişoara but kept at about 35-37°C to the Southwest and South of the country. On the contrary, the northern and later the central regions of Europe were affected by a cold air mass, moist and unstable which gave precipitation. Due to the dorsal of the Azores Anticyclone, the instability moved towards the East and Southeast of Europe, where it grew in intensity because of the high temperature and pressure differences between the two air masses (the thermic differences rise to about 10°C) (fig.2).

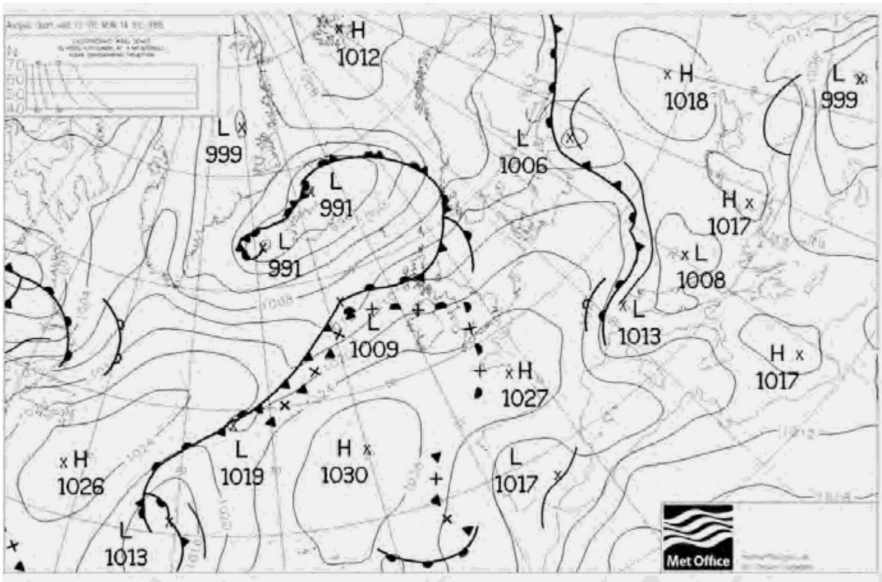

Fig. 1. Field of atmospheric pressure at ground level over Europe, on July 14th 2008, 12^{00} UTC (according to www.wetterzentrale.de).

As a result, in the contact region of the two air masses with different properties, in the circumstance of pronounced generated instability, dangerous meteorological phenomena arose and manifested in the western and central regions of Romania by torrential sudden showers, hail, lightning and thunders, strong winds, sometimes with the appearance of a squall. Those phenomena were recorded in the West of the country in the evening of July 14th (especially between 9,00 and 11,00 pm), but they continued in other regions of the country in the night of July 14th to July 15th (fig.3-4). During the whole interval, the N.M.A. issued through its stations in the country, 18 yellow code warnings on immediate dangerous meteorological phenomena: 9 warnings issued by SRPV Timişoara, 3 by Oradea Radar Observatory, 1 by SRPV Cluj, 2 by SRPV Craiova, 1 by SRPV Sibiu and 2 by SRPV Bacău.

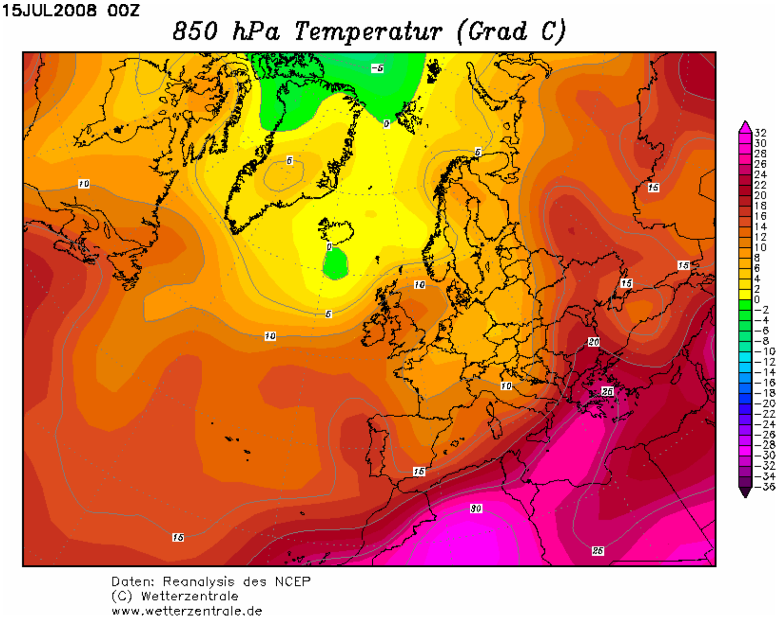

Fig. 2. Distribution of air temperature at isobaric surface level of 850 hPa over Europe, on July 15th 2008, 0^{00} GMT (according to www.wetterzentrale.de).

In the interval between July 14th, 9,00 am and July 15th, 6,00 am, the meteorological situation was as follows (according to the N.M.A.): during the day, the weather was extremely hot, with scorching temperatures especially to the West and South of the country. The sky was gradually clouding over in the West, North and center of the country. Sudden showers and lightning discharges were recorded in Banat, Crişana, Maramureş and later on in other regions of the country, towards the evening and during the night. The wind blew heavier during rainfalls and turned into a squall near Şiria. Locally, hail was recorded at Timişoara, at the localities Şiria, Pecica and Utviniş in Arad County, but also in some mountain regions. Precipitation rose above 15 l/m^2 in the West of the country (up to 44 l/m^2 at Dumbrăvița de Codru).

In the evening of July 14th 2008, 9,00 pm, in the Crişano-Someşană Plain – which was very much affected by those phenomena – the air temperature was between 25.3°C at Satu Mare and 31.5°C at Holod, and after an hour it was around 23-24°C (and 29.0°C at Holod). At 9,00 pm, the wind had a speed of 2-7 m/s on the entire plain, higher at Şiria (7 m/s) and Chişineu-Criş (6 m/s). The atmospheric pressure was around 991-999 mb over the entire plain and lower at Şiria (957.1 mb) (according to the N.M.A.).

The effects produced by the dangerous meteorological phenomena were felt in many counties in the country, and in the western part they were most intense in *Arad County*. So, because of the frequent and intense electric discharges and also the strong wind, there were power breakdowns in more than 12 localities in the county and 7 medium voltage power lines being partly affected, one totally, 80 power conversion stations and 9 power poles broken down in the area Petrol Turnu. There also appeared a lot of problems concerning low voltage lines in almost the entire county (source: Arad Online, www.aradon.ro/stiri).

Fig. 3. Radar map of Romania, July 14th 2008, 9³⁰ pm
(according to database of N.M.A.).

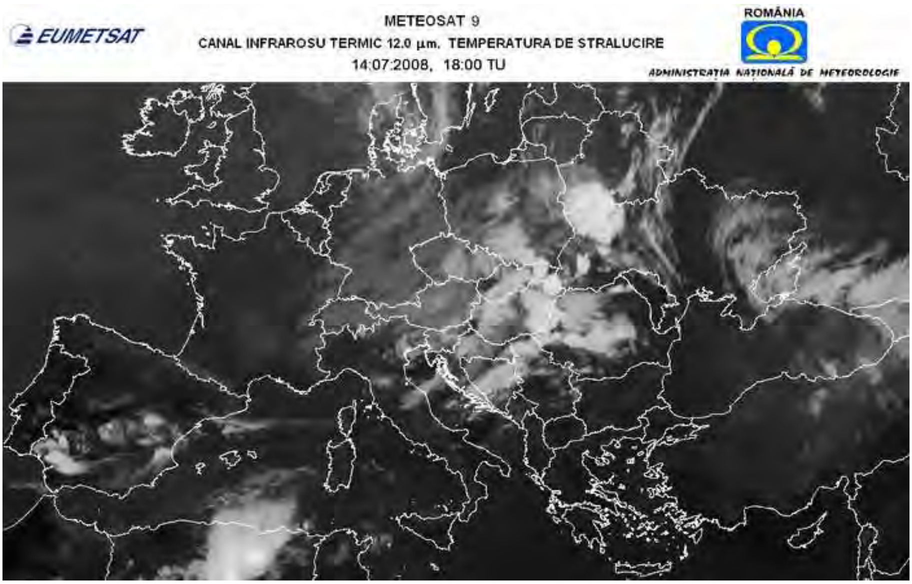

Fig. 4. Satellite image, July 14th 2008, 18⁰⁰ UTC
(according to database of Eumetsat and N.M.A.).

The strong wind and squall produced great damages: roofs were wrested away, cars were damaged, trees fell on the roadways and field crops were destroyed by wind and hail. Very large hail fell in some localities in the county (fig.5). In this respect, at Şofronea, *the lumps of ice were as large as a hen's egg,* but no great damage was done because of its very short lasting time. The same situation was at Nădlac, where only slight damages were done. On the other hand, the settlements Livada and Turnu recorded massive damages. At Livada people's gardens were heavily affected as well as field crops. PVC blinds at the windows were perforated through and even the windows behind the blinds were broken. Corrugated bituminous plates on the roofs were also pierced by hail. Near Pecica – where the most affected areas were Moara Mică and Turnu – hail broke easily through melons, ruining the crop. About 150 houses were affected by hail, ending with broken windows and roofs and tenths of cars were damaged (source: Arad Online, www.aradon.ro/stiri; ProTV News, www.protv.ro/stiri).

Fig. 5. Hail fallen in Arad County on July 14th 2008 (source: http://www.protv.ro/stiri).

However, the most affected area was Şiria-Pâncota, where the squall and hail produced great damages. At Şiria 300 households were damaged, as well as 20 cars. The metal roof of a department store was pulled off and also a part of the Greek-Catholic church roof. About 70-80% of the farm and vine crops were destroyed. A fallen tree smashed a car. At Pâncota, large ice lumps fell for around 5-10 minutes, destroying everything (according to locals testimonies, the ice lumps were as large as a fist). The damages were greater than at Şiria. Farm crops were affected – only corn stalks remained – buildings, cars. The buildings in the precincts of football field remained without roof. The blinds at the windows were pierced by hail, the windows (even vinyl ones) were broken and power and telephone lines broken and fallen to the ground (source: Arad Online, www.aradon.ro/stiri).

Tenths of trees fell of because of the strong wind, blocking the traffic on several roads in Arad County. That happened with the roads: DJ 709B between Şofronea and Arad; DJ 709 between Şiria and Horia; the road between Ceala and Nădlac (where 8 trees fell to the ground); DN 79 between Arad and Chişineu-Criş (where 5 trees fell) (source: Arad Online, www.aradon.ro/stiri).

Dangerous meteorological phenomena were also recorded during that night in other country counties. In Cluj, the electric discharges were very frequent and intense and there was a torrential rain. At Vultureşti, County of Argeş, a house took fire from a thunder-stroke. At Braşov hail was as large as a guinea fowl's egg and formed an ice layer on the ground. It was accompanied by heavy rain. Fallen ice lumps damaged several cars. Hail was present also in the County of Covasna, at the localities Boroşneul Mare and Doboly de Jos, where it destroyed the field crops (source: Ştiri ProTV, www.protv.ro/stiri).

On the afternoon of July 14th 2008, the road between Arad and Şiria was blocked for almost an hour, because of a serious fire that burned over 100 hectares of stubble field.

The two hours intervention of the fire brigade was needed to stabilize the situation (source: Press Online, www.presaonline.com). As a result, we consider that *the very large ice lumps in the area Şiria-Pâncota and the greatest damages which followed in this area were caused by the existence of a very hot air layer generated by the fire of that afternoon,* which produced a particularly intense thermic convection, given the background of the existent scorching temperatures. This convective movement superposed over the dynamic accentuated one, associated to the atmospheric front that crossed the western territory of country on Monday evening, July 14th.

Although in the area mentioned above hail was very large, at the weather station Şiria, the maximum size of the ice lumps was just 23.3 mm. That emphasizes once more the uneven territorial distribution of this dangerous hydrometeor.

4. CONCLUSIONS

The present study emphasized the intensity of dangerous meteorological phenomena produced in the western regions of Romania, where air masses with different properties penetrate easily, given that over the vast Pannonian Plain there are no orographic obstacles. When the thermic differences between the air masses which come into contact are over 10°C, particular phenomena may occur, as: large hail (as described above), intense lightning and thunders, torrential rains, squall. The effects of such phenomena are strongly felt by the population and local economy, by the massive damages that took place. Farm lands, orchards, vines, roads, power lines, communication networks, buildings are generally affected.

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THE VARIATION OF CH_4 IN THE URBAN AREAS FROM CLUJ COUNTY

G. CRISTEA[1], IOVANCA HAIDUC[2], S.M. BELDEAN GALEA[2], S. CUNA[1]

ABSTRACT. The Variation of CH_4 in the Urban Areas from Cluj County. The emission of methane in big urban areas is considered one of the sources that determine the creation of the methane nu inteleg in ce sens daca te referi la cantitate amount in the atmosphere e mai bun. In this study, we have investigated the variation of CH_4 level, in three urban areas from Cluj county: Cluj-Napoca, Turda and Huedin, for six months, since July-December, 2008. In each of these locations, we chose city points with intense anthropic activities, and some reference points with a minor anthropic impact. For the CH_4 determination, the air samples were collected in a special glass vials and analyzed by gas chromatography equipped with a packed column and FID detector. The results showed that the CH_4 concentration levels depend on the date and the place of determination. The concentrations of CH_4 in urban area are lower then in the reference points.

Keywords: *methane emissions, urban agglomeration, gas chromatography*

1. INTRODUCTION

The global community has begun to recognize that it is imperative to identify and to monitore greenhouse gases, including methane, in both industrialized and developing countries. Methane is a greenhouse gas, that is produced mostly (80%) of bacteria in anaerobic conditions, in wet environments (wetlands, marshes, tundra and crops of rice), in the intestines of ruminants and termite. Around 20% of the methane emissions result from coal sources, such as coal extraction, industrial waste, Fischer-Tropsch synthesis, exhaust gas of vehicles, volcanic emissions. (Hollander J. et al.1996)

Methane, has received an increasing amount of attention during the past few years. This attention has been caused by the relatively short lifetime of the gas, the rapid growth rate of ambient concentrations of about 0.8% per year and the relatively low reduction of emissions (about 10%) needed to stabilize atmospheric concentrations (IPCC, 1995). The radiative forcing of methane in the atmosphere is estimated to be 0.5 W m^{-2}, amounting to 20% of the total anthropogenic radiative forcing today. Methane's chemical lifetime in the atmosphere is approximately 12 years and is about 21 times more powerful at warming the atmosphere than carbon dioxide (CO_2) by weight. The global emission of methane of 535 Tg y^{-1}, based on estimates of source and sink strengths derived from atmospheric chemistry models (IPCC, 1995) is pretty constant. The annual increase in global averaged methane concentration is steadily declining during the last decade. (Jagovkina, S. et al. 1996)

The CH_4 lifetime was estimate at 6.2 years in 1850, 7.9 years in 1992 and will probably increase to 8.6 years in 2040.

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2. MATERIALS AND METHODS

For the determination of CH_4, level in the air samples a Gas-chromatograph GCL 90 equipped with a packed column (L=2 m, ID= 2.2 mm) containing 13X molecular siege (80-100 mesh) and FID detector was used. The instrument was operating in isotherm mode at 60° C and the flow rate of mobile phase (argon of 99.999% purity) was 30 cm^3/minuts. The temperature of injector and detector was 50°C. The air samples were injected in GC with a syringe of 0.25 ml. The quantification of methane in real samples was made by external standard method using a mixture containing 115 ppm CH_4 and 275 ppm CO_2 in nitrogen.

For the present study three different locations from Cluj County (Cluj-Napoca, Turda and Huedin) were chosen. To study the influence of urban agglomeration on CH_4 budget, in each location were selected the determination points with intense anthropic activities and minor anthropic activities. (Shorter, J.H. et al. 1996, Veenhuysen, D. et al. 1998)

3. RESULTS AND DISCUSSIONS

During the period of five months (July-November), the CH_4 concentrations from Cluj Napoca, Turda and Huedin city points from ranged between 3 ppm and 37.9 ppm, with lower values in August and higher values in October and November.

In Cluj-Napoca the seasonal variations of the CH_4 level presents an upward trend during the autumn months in Mărăşti and Reference point and a decrease trend in Grigorescu. (Figure 1)

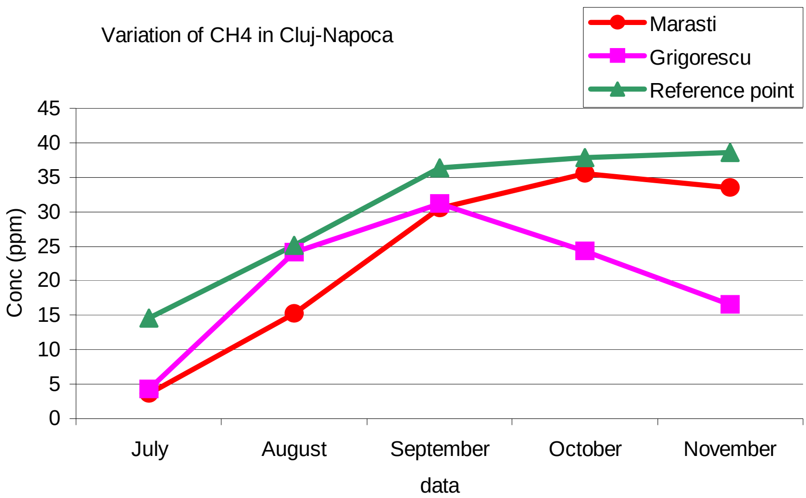

Fig. 1. The variation of methane concentration in Cluj-Napoca.

The CH_4 level registered in Turda (4-36.1 ppm) was a little bit lower comparing with Cluj-Napoca. The concentration was higher in the reference point (4-36.1 ppm) comparing to those from the city point (4-22 ppm). (Figure 2)

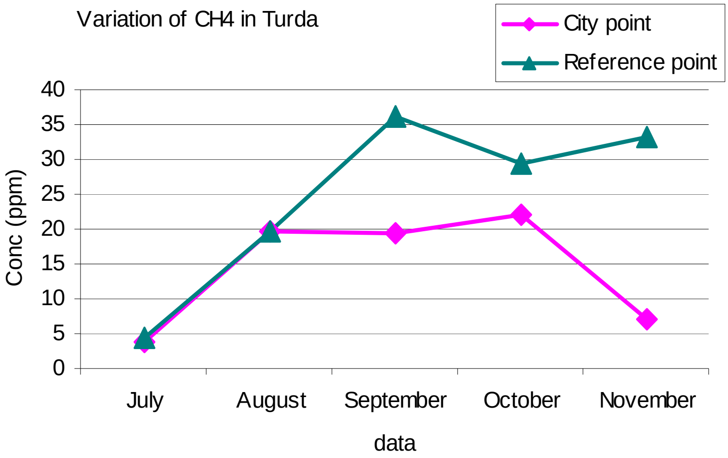

Fig. 2. The variation of methane concentration in Turda.

The CH_4 level registered in Huedin was very similar to Turda. Although the level of methane was higher in reference point (4-36 ppm) comparing with City point (3-35.2 ppm). (Figure 3)

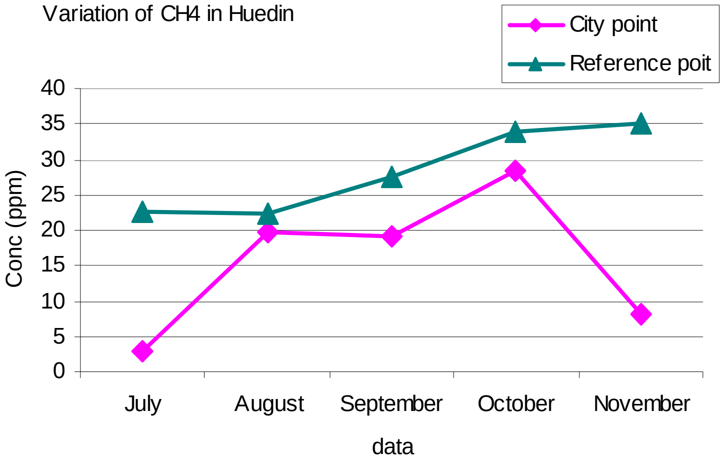

Fig. 3. The variation of methane concentration in Huedin.

The analysis of the CH_4 data shows that in all the three locations the CH_4 level is higher in the reference points compared to the city points. This indicates a greater influence of CH_4 natural sources in comparison with the anthropogenic sources.

In all selected locations, the CH_4 level from the reference point was higher in November compared to July. The increasing trend of methane in the autumn season in the reference points shows the acceleration of the processes of anaerobic degradation of the organic matter.

4. CONCLUSIONS

In all the three studied locations the values of methane concentrations are higher in the reference points (38.6 ppm Cluj-Napoca, 36.1 Turda, 35.2 Huedin) comparing to city points, which indicate a greater influence of natural sources of methane than anthropogenic sources.

The highest CH_4 level was registered in Cluj-Napoca both in City point and Reference point (ppm), compared to Turda and Huedin.

In all selected locations, the CH_4 level from the reference point was higher in November compared to July. The increasing trend of methane in the autumn season in the reference points shows the acceleration of the processes of anaerobic degradation of the organic matter.

The monitoring of methane for a long period could give information with regard to the influence of biological life cycle and the anaerobic degradation of organic matter on methane budget.

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THE ASSESSMENT OF AIR QUALITY THROUGH LICHEN INDICATION IN FOREST ECOSYSTEMS

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ABSTRACT. The Assessment of Air Quality Through Lichen Indication in Forest Ecosystems. The present paper proposes the Lichens Toxitoleration Scale (LTS) towards different concentration of SO_2 in atmosphere. Taking into account the specific diversity, abundance and indicator species toxitoleration there is proposed a scale with 6 gradations for assessing the air quality (further referred as AQGS), which was applied in 62 forest ecosystems. Typically, ecosystems with low polluted air are located at altitudes above 200 m, and those with polluted air – below 200 m. In fact there are exceptions as there are such important factors as distance from the pollution source and direction of prevailing winds. The following paper presents a comparative presentation regarding the application of AQGS and EMEP in the Republic of Moldova.

Keywords: *forest ecosystems, lichen indication, air pollution, SO_2 emissions, toxitoleration, abundance, evaluation criteria, environmental monitoring.*

1. INTRODUCTION

Given the fact that currently there is enough information on the most atmosphere toxic pollutants which causes disturbances in lichens vital cycle (DeSloover J., LeBlanc F., 1968; Atlas, Schofield, 1975; Burton, 1986, Richardson, Nieboer, 1980; Trass, 1977, 1984; Blum, 1986; Mihailova, Vorobeychik, 1995), some authors of the lichens toxitoleration scales specific gradations in SO_2 concentrations (Hawksworth, Rose, 1970; LeBlanc, Rao, 1972; Liyv, 1982, etc.). The indicated concentrations differ greatly from one author to another, probably because of the fact that some data was obtained in laboratory and other in field conditions; the emissions structure is different, climatic conditions, research methodology etc.

2. RESULTS

The analysis of the scales allowed us to see that at the most authors the concentration of SO_2 < 0,05 mg/m^3 air is indicated for the area with clean air and the harmful effects start at 0,1 to 0,3 mg/m^3 air, some indicating the stage > 0,3 mg/m^3 as very polluted air, others indicating that the fatal concentration as being SO_2 > 0,5 mg/m^3 air. Thus, based on analysis of data published by other authors and based on our tests performed in laboratory and field conditions, we propose the Lichens Toxitoleration Scale (LTS) towards different SO_2 concentrations (Table 1).

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Table 1

Lichens Toxitoleration Scale (LTS) towards different SO_2 concentrations in the air

Toxitoleration	Area particularities	SO_2 concentration in the air, mg/m^3 air	The presence of lichens with different degree of sensibility towards pollution
I	Non polluted	< 0,05	Highly sensible
II	Low polluted	0,05 – 0,1	Sensible
III	Moderate polluted	0,1 – 0,2	With moderate resistance
IV	Highly polluted	0,2 - 0,3	With increased resistance
V	Heavy polluted	0,3 – 0,5	With high resistance
VI	Critical polluted	> 0,5	Complete absence of lichens

Considering that any presence of lichens is an indication of the true criterion, as previously exposed to the higher plants (Viktorov, 1962), lichens appreciation will be truthful when the lichen indicator species coverage will be over 10% of substrate surface. This threshold is very important, especially for toxitoleration grades I and II since we cannot state that the air is clean when we have studied only one example of lichen indicator species (or even 2-3) very sensitive to pollution and which coverage of the substrate is minor or it has a pale aspect of development. Thus, proceeding from the eco bioindicators abundance there is proposed the following criteria for assessing the air quality (Table 2).

Table 2

Air Quality Graduations Scale (AQGS) in dependence on ecobioindicators abundance

Air quality	SO_2 content in the air, mg/m^3	Abundance of species with different toxitoleration degree, % of substrate surface
1.Clean	<0,05	I > 10 or I < 10 and II > 75
2.Low polluted	0,05-0,1	I – 0 -10 or II – 50-75
3.Moderate polluted	0,1-0,2	II - 10-50 or III > 50
4.Polluted	0,2-0,3	III - 10-50 or IV > 50
5.Haevy polluted	0,3-0,5	IV - 10-50 or V - 1-100
6.Critical polluted	>0,5	Complete absence of lichens

Evaluation of atmosphere air quality in 62 forest ecosystems throughout the Republic of Moldova has been developed taking into account the specific diversity, abundance and indicator species toxitoleration, applying the AQGS developed by us.

Based on the above mentioned, we can conclude that on the territory of our country there have been highlighted 3 forest ecosystems in which the air is considered as clean (Ocnița - Hădărăuți, Bahmut, Seliste - Leu) and one in Romania (Potoci), the rate of ecosystems with low polluted air reaches 11, moderate polluted - 31, polluted -13, heavy polluted - 3 (Criva, Saharna, Copanca) and those with critical polluted are missing (Table 3). The air quality from the ecosystems which were reported as clean is confirmed by the presence of lichens species very sensitive to pollution, the coverage of which was over 10% of substrate surface (i.e. *Usnea hirta* - in Ocnița-Hădărăuți, *Peltygera canina* - in Bahmut and *Ramalina fraxinea* - in Seliste-Leu) .

Ecosystems with low polluted air (SO_2 = 0,05 – 0,1 mg/m^3 air) are primarily located in the north part of the country (6 - Trebisăuți, Fetesti, La Castel, Zabriceni, Lipnic, Donduseni) and some of them in the central part - Codri area (3 - Bujor, Cimişeni, Loganesti) and 2 in the middle of the Dniester (Lopatna) and Prut (Cotul Morii).

Ecosystems with moderate polluted air (SO_2 = 0,1 – 0,2 mg/m^3 air) are more (31) and have a wide distribution throughout the country, often being subject to impact from local pollution sources (i.e. - Hâjdieni, Criva, Orhei, Seliste, Durlesti, Budeşti, Văleni, Giurgiulesti etc.) or from sources located at the border, particularly subjected to acid precipitations (i.e. - Balanesti, Cobac). Others are likely to be affected by both pollution sources (i.e. - Tețcani, Clocuşna, Rubleniţa, Stinca Mare, Sarata Galbena, Sarata Mereşeni, Cobac, etc.). The share of ecosystems with polluted air (SO_2 = 0,2 – 0,3 mg/m^3 air) is 13, prevailing in the pollution outbreaks vicinity such as Balti, Rezina-Râbnița, Chisinau, Tiraspol, Cuciurgan (i.e. - Trinca, Chetroşica Noua, Mândreştii Noi, Papauti, Şoldăneşti, Tohatin, Hârbovăț, Ciobruciu etc.). Heavy polluted air (SO_2 = 0,3 – 0,5 mg/m^3 air) is set for 3 ecosystems - Criva, Saharna, Copanca which have a location in immediate vicinity of pollution sources and are positioned in the path of the prevailing winds. Ecosystems with critical polluted air (SO_2 > 0,5 mg/m^3 air) were not recorded.

Table 3

The estimation of air quality in forest ecosystems according to Air Quality Gradations Scale (AQGS – Begu, 2008) and the Air Purity Index (API - DeSloover, 1968, with our adjustments)

Ecosystems	**Criva**	**Pererîta**	**Tețcani**	**Trebisăuți**	**Trinca**	**Fetești**	**La Castel**	**Zăbriceni**	**Clocuțna**	**Ocnița - Hădărăuți**	**Lipnic**	**Cernoleuca**	**Dondușani**	**Climăuți**	**Călărășauca Moșana**	**Chetroșica**
API (*DeSloover*, 1968)	**21**	**62**	**49**	**66**	**13**	**43**	**104**	**85**	**82**	**154**	**63**	**50**	**70**	**31**	**8**	**30**
AQGS (*Begu*)	**V**	**III**	**III**	**II**	**IV**	**II**	**II**	**II**	**III**	**I**	**II**	**III**	**II**	**III**	**IV**	**IV**
Altitude, m	**140**	**120**	**150**	**270**	**230**	**260**	**260**	**250**	**260**	**280**	**280**	**265**	**280**	**265**	**275**	**255**
Exposition	**SV**	**N**	**NV**	**SV**	**V**	**NE**	**V**	**N**	**SE**	**SE**	**NE**	**SW**	**NW**	**SW**	**NE**	**NE**
Pollution hotbed	**Edineț – Lipcani**								**Edineț – Mogilău**							

Ecosystems	**Rublenița**	**Rădulenii Vechi**	**Stănca Mare**	**Hâjdieni**	**Iabloana**	**Mândreștii Noi**	**Ciorna**	**Păpăuți**	**Șoldănești**	**Cuhureștii de Sus**	**Saharna**	**Pohribeni**	**Lopatna**	**Orhei**	**Seliște**	**Ivancea**
API	**23**	**48**	**14**	**13**	**70**	**36**	**72**	**26**	**32**	**49**	**8**	**65**	**131**	**29**	**39**	**38**
AQGS (*Begu*)	**III**	**III**	**III**	**III**	**III**	**IV**	**III**	**IV**	**IV**	**IV**	**V**	**III**	**II**	**III**	**III**	**III**
Altitude, m	**310**	**350**	**220**	**140**	**230**	**250**	**190**	**260**	**320**	**310**	**210**	**260**	**210**	**180**	**261**	**200**
Exposition	**NE**	**E**	**W**	**NW**	**S**	**NE**	**SW**	**E**	**E**	**NE**	**SW**	**E**	**E**	**N**	**NE**	**N**
Pollution hotbed	**Soroca-Iampol-Bălți**						**Rezina – Râbnița – Orhei**									

Ecosystem	Potoci	Valea Mare	Nemțeni	Cotul Morii	Cornești	Bahmut	Bălănești	Seliște-Leu	Cobac	Bujor	Căprian a	Durlești	Tohatin	Budești
API	**159**	**24**	**15**	**92**	**67**	**102**	**60**	**64**	**53**	**40**	**45**	**88**	**9**	**68**
AQGS (*Begu*)	**I**	**IV**	**IV**	**II**	**III**	**I**	**III**	**I**	**III**	**II**	**III**	**III**	**IV**	**III**
Altitude, m	**978**	**90**	**80**	**80**	**380**	**340**	**429**	**380**	**380**	**240**	**320**	**220**	**200**	**200**
Expos.	**W**	**-**	**-**	**-**	**W**	**NE**	**NW**	**SE**	**NE**	**SE**	**NE**	**NW**	**N**	**NW**
Pollut. hotbed	**Ungheni – Iaşi**							**Chişinău-Hânceşti**						

Ecosystem	Cimişeni	Logăneşti	Sărata-Mereşeni	Sărata-Galbenă	Hîrbovțăul-Nou -Balmaz	Copanca	Cioburciu – Răscăieți	Cărbuna	Vilcovo	Sărata-Nou ă	Codr. Tigheci	Crihana-Veche	Văleni	Giurgiuleşti	Congaz	Taraclia
API	**76**	**97**	**37**	**44**	**21**	**15**	**49**	**79**	**32**	**20**	**58**	**10**	**19**	**12**	**41**	**26**
AQGS (*Begu*)	**II**	**II**	**III**	**III**	**IV**	**V**	**IV**	**III**	**IV**	**III**	**III**	**V**	**III**	**III**	**III**	**III**
Altitude, m	**190**	**310**	**320**	**250**	**160**	**150**	**170**	**200**	**2**	**220**	**300**	**180**	**150**	**60**	**170**	**160**
Expos.	**W**	**E**	**SW**	**W**	**SE**	**NW**	**NE**	**NW**	**-**	**NE**	**SW**	**SW**	**SE**	**S**	**NW**	**NW**
Pollut. hotbed	**Chişinău**						**Tighina – Tiraspol – Cuciurgan**					**Tiraspol – Cuciurgan-Cahul**				

Typically, the ecosystems with low polluted air are located at altitudes above 200 m and those with polluted air - below 200 m, but there are exceptions, for example the distance from the pollution source and the direction of prevailing winds (for example - Trinca, Calaraseuca, Chetroşica Noua, Mândreştii Noi, Saharna - arranged at altitudes above 200 m, but rather polluted). Compared with the ecosystem Potoci (Romania) - mountain type, most forest ecosystems in the Republic of Moldova are hilly type (200-600 m), less flat (0 - 200m). Rather enhanced can be considered the effects of pollution in ecosystems located on plain areas for instance those around Valea Mare, Nemteni, Crihana Veche, Vilcovo (Ukraine), and for Criva, Hâjdieni, Orhei, Tohatin, Copanca, Harbovat, Cioburciu the determining role was played by the distance from the pollution source of and the direction of prevailing winds.

Thus most of SO_2 emissions from local sources in 2005 year were typical for the area of South East of the country with the focal point in Tighina - Tiraspol - Cuciurgan, exceeding at about 20 times in Chisinau, 100 times in Balti and more than 700 times in Cahul. This focal point or outbreak has led to pollution of ecosystems located in the SE rose due to prevailing winds from NW to SE, which were reported by us. The emissions of SO_2 from Soroca accounted - 154 tons/year and in Balti - 85t/year which led the Hâjdieni ecosystem degradation. The geological exploration of Criva and Trinca, the later being as well affected by unauthorized burning of tires in the lime production process, have placed these ecosystems in the category with highly polluted air. High emissions of SO_2 are characteristic for Hancesti (332 tons/year) who have left their prints on the state of bordering ecosystems atmosphere air - Sarata Galbena and Sarata-Mereşeni. Chisinau emissions have evidently contributed to the pollution of ecosystems Balmaz - Harbovat located in the South East and Tohatin - Budeşti located towards East. The effects of pollution from the outbreak Rezina - Rabnita were reported only in direct vicinity (Saharna, Ciorna, Popauti), due to the direction of winds from NW to SE, leaving unaffected the ecosystems Pohribeni and Lopatnic. The possible harmful effects, catastrophic for vegetation, from the outbreak Cuciurgan were more pronounced in Copanca and least in Cioburciu - Răscăieți again due to the direction of winds from the NW to SE.

The South part of the country is affected by transboundary pollution (Galati city, Romania), especially Crihana Veche, as well as Giugiuleşti and Văleni. The effects of pollution from the sources located in Iasi, inseparable from those of Ungheni, strengthen the pollution of ecosystems in the region around – Valea Mare, Nemteni, less Balanesti, Cobac, but fortunately not reaching Bahmut and Cornesti located in the NE from the pollution sources and as a result of being protected by the high relief of Codri forest reservation.

According to EMEP Report 1/2003 issued by the Meteorology Institute, Norway, transboundary pollution remains to be current for many countries in Europe, including Moldova, which is located in the area of annual SO_2 deposition equal to 700 - 1000 kg/km^2. Additionally, in the last 5 years there is a tendency in emissions incensement due to potential economic growth of the countries located in the in the SE of Europe.

The linkage of lichen indication applied in 62 ecosystems to EMEP network (50x50 km grid), according to the parameters which contain Moldova (Table 4), shows a hindering of the real environmental state, probably because pollution effects are more pronounced within the 25-30 km from the pollution source. In the case of EMEP network (50x50 km grid), the environmental situation is horizontal throughout the 50x50 km grid, which does not correspond to reality.

Table 4

Ecosystems EMEP networking distribution (32dials 50x50km grid)

North - South	**West – East Direction**					
	62	**63**	**64**	**65**	**66**	**Total**	**Ro, Ua**
85	**Ro**	**1**	**-**	**Ua**	**Ua**	**1**	
86	**Ro**	**2**	**11**	**1**	**Ua**	**14**	
87	**Ro**	**2**	**1**	**2**	**-**	**5**	
88	**Ro**		**2**	**1**	**4**	**7**	**1- Ro**
89	**Ro**	**3**	**6**	**4**	**1**	**14**	
90	**Ro**	**1**	**4**	**3**	**-**	**8**	
91		**2**	**1**	**3**	**-**	**6**	
92	**3**	**2**	**-**	**-**	**-**	**5**	
93	**-**	**Ua**	**Ua**	**Ua**	**Ua**	**-**	
94	**Ua**	**Ua**	**1- Ua**	**Ua**	**Ua**	**-**	**1- Ua**
Total	**3**	**13**	**25**	**14**	**5**	**60**	**2**

Note: Ro - Romania; Ua - Ukraine
low polluted air; moderate polluted air
polluted air; highly polluted

For example in the 86/64 parameters the 11 studied ecosystems showed the air as clean – i.e. Ocnita ecosystem, low polluted air – i.e. Fetesti, Trebisauti, Zabriceni ecosystems, La Castel, Lipnic, Donduseni, moderate polluted air - i.e. Clocusna, Cernoleuca and polluted air – i.e. Trinca and Chetrosica Noua. Thus the EMEP matrix characterizes the state of the air as polluted whereas our results as low polluted. The comparative analysis of our assessments and those made by EMEP coincided only in 2 cases (91x63 and 92x63 parameters).

Given the S and N content in atmosphere annual rainfall (kg/ha) under EMEP 50x50 km grid, 6 dials (parameters) (85 - 90/63) from N – CE have the air low polluted with *S*, 4 dials (91 - 92/62 - 63) - have moderate polluted air, 5 dials (85 - 87 / 6 - 65) - have polluted air, and 15 dials (88 - 92/64 - 66) - highly polluted. Assessing the same dials under lichen indication, we can state that it broadly confirms the basic theory, but it provides additional more precise information on each forest ecosystem, studied as individual or in a group of ecosystems compact located.

The 50x50 km grid is likely to be successful in extensive forest areas (for instance Taiga, Russia) or countries with a high degree of forestation and/or plain landscape (for instance Belarus, the Baltic Republics, Poland, Russia, etc.) and therefore not suitable for the Republic of Moldova fragmented and reduced in number forests, placed mainly on rough relief, which essentially redirection the harmful effect of pollution, both at local and cross-border level. Thus, at the national level is recommended the application of 25x25 km grid. The pollution of forest ecosystems with NO_x expresses the same regularity as in the case of SO_2. The prevailing emissions are from the outbreak Tighina - Tiraspol - Cuciugan (about 7300 tons/year), followed by Chisinau (1680 tons/year) with an apparent reduction in Rezina, Balti, Drochia - namely 260, 108 and 107 tons/year. Other outbreaks do not exceed 100 t/year each. According to EMEP grid the N content in annual rainfall (kg/ha) express the same regularity as in the case of S, except Soth-Est dials (91-92/64-66) with a triple reduction in regard to the North coterminous dials. The different content of N or NO_x in precipitation emitted to atmosphere by the pollution sources, has led to the increase of nitro file species in the Center - Center - East (Budesti, Cimiseni) and in the South - East (Balmaz-Harbovat, Cioburciu-Rascaeti, Vilcovo) and partial around the city Balti - Iabloana, Mandreatii Noi.

The evaluation of air quality based on integrated indices, allows us to see the following: the Poleotolerantion Index (PI) proposed by Trass (1985) for Estonia and Air Purity Index (API) proposed by DeSloover and Leblanc (1968) for Canada, are based on poleotoleration classes (indicator species toxic phobia) and the species coverage and frequency on substrate surface. The calculation of PI and API for all of the 62 studied forest ecosystems was conducted by taking as basis two formulas with some modifications: species toxic phobia proposed by the Canadians (between scales VI-I) was reduced to 5 levels, because I step mean critical pollution and thus lichens are missing completely; the 10 classes of poleotolerantion proposed by Trass were comprehended in 5 classes – from the most sensitive (I) to the toxitolerant species (V), because the specific lichen diversity of Moldova is inferior to those from Estonia and virtually does not have a sufficient number of veritable eco bioindicators for all 10 steps. In the case of both indices (API and PI) the coverage-abundance degree, proposed by the authors to be expressed by certain score, was expressed by us in the real value beginning from the point that the cover/abundance below 10% is not applicable and therefore based on the example of a single species cannot characterize the air quality.

Thus the API proposed by DeSloover and Leblanc (1968), with our adjustments reached the maximum values of 159,0 -153,8 (for Potoci and Ocnita-Hadarauti) and the minimum values of 8,1-9,1 (for Tohatin, and Saharna Calarasauca). This range shows that 5 ecosystems have the air clean (PIA> 100), 7 – low polluted (IPA = 100-75), 14 – moderate polluted (IPA = 70 -50), 20 – polluted air (IPA = 50-25), 16 ecosystems - highly polluted air (IPA = 25-5), and ecosystems with critical polluted air (IPA = <5) – were missing (Table 5). Analysis of PI by Trass (1985), with our adjustments showed the following: ecosystems with clean air (IP <1), low polluted (IP = 1-2) and those with critical polluted air (IP> 5) are generally missing. Thus among the 6 graduations of appreciation 3 are excluded and eventually the scale does not work. In addition, the category of those with polluted air (IP = 4-5) includes only 1 ecosystem**.**

Table 5

The appreciation of air quality using different methods

Air quality	**Evaluation method**			**Coincidence**	
	Begu, 2008, GECA	**DeSloover, 1968 - IPA**	**Trass, 1985 - IP**	**Begu-DeSloover**	**Begu-Trass**
I – clean air	4	5	-	3	-
II – low polluted air	11	7	-	4	-
III – moderate polluted air	30	14	23	10	11
IV – polluted air	13	20	38	7	12
V – highly polluted	4	16	1	4	-
VI – critical polluted air	-	-	-	-	-
Total	**62**	**62**	**62**	**28**	**23**

Among the three methods applied in the assessment of air quality (Begu, DeSloover, Trass) there is coincidence only in 10 cases (ecosystems). As for the correlation with the scales proposed by us the API overlap in 28 cases, and PI - in 23 cases, but the practical application of PI cannot be recommended because it comprises only 3 steps, as mentioned above. As a rule the API usually tends to increase the share of terrestrial ecosystems with clean air and PI - those with polluted air. Graphic interpretation of these results allows us to see that compared with the assessment of air quality done by us based on scales for assessing the air quality API correlates well in all categories (IV), while PI only in 2 categories (III-IV). Thus we can conclude that API proposed by DeSloover and Leblanc, with or adjustments can be applied under the conditions of the Republic of Moldova.

3. CONCLUSIONS

1. Application of Lichen indication in air pollution monitoring within forest ecosystems is a contemporary method offering reliable data with minimal cost;
2. The European Union program EMEP camouflage the air quality in the Republic of Moldova forest ecosystems as they are rather few and primarily placed on rough relief, thus a grid equal to 25x25km is recommended to be applied at national level;
3. The Air Quality Gradations Scale developed by us and the Air Purity Index (with some adjustments) are proposed to be implemented in the country forest ecosystems air quality monitoring.

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WINTER HYDRO-METEOROLOGICAL RISKS IN DOBROGEA

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ABSTRACT. **Winter Hydro-Meteorological Risks in Dobrogea.** The paper deals with the spatial distribution of some risk hydro-meteors (hoarfrost, white frost, glazed frost, fog) specific to the cold season in Dobrogea. Data were collected and analyzed from 12 weather stations during the 1961-1999 period and 48 rain gauge locations during 1964-1999. During the cold season, the highest frequency of the risk hydro-meteors analyzed was noted within the high land relief of Dobrogea, namely in the Macin Mountains, Casimcea Plateau, Cobadin Plateau, and in the extremely western part of this territory between towns Harsova and Cernavoda as well. Fog was registered over a large number of days, especially in the neighboring area of some towns (Constanta, Medgidia, and Negru Voda). The lowest parts of the valleys that are cooled through night radiation during clear-sky weather present a high frequency of hoarfrost. Here, the thermal inversion regime is often met. The largest area showing a minimum risk hydro-meteors duration for the cold season is located to the eastern part of Dobrogea, along the Danube Delta sea-coast, the big sea-coast lakes, and the Romanian southern coast of the Black Sea.

Keywords: *risk hydro-meteors, the hoar frost, white frost, glaze ice, mist*

INTRODUCTION

The analysis of the risk hydrometeors in Dobrogea is based on data obtained from observations at 48 pluviometric stations between 1966 and 1999 and 12 meteorological stations between 1961 and 1999; and aims at describing the climatic patterns, establishing its probability of appearance (in key-locations, with relatively complete registrations) and its regional distribution. Aspects regarding climatology of Dobrogea and, generally, risk hydrometeors, were approached in some paper works of D. Tâşlea and co. (1967), I.F. Mihăilescu (1986, 1999), S. Ciulache and Nicoleta Ionac (1995), Cr. Păltineanu and co. (2000).

The cold season between November and March is marked by high frequency of specific hydrometeors (hoar frost, white frost, glaze ice ice, mist), which could be a major risk for the geographic environment generally and for various human activities, in particular. In the thermal conditions of water within the Romanian part of the continental shelf of the Black Sea, this season coincides with the frost phenomenon.

The hoar frost

Early, fall and late (spring) hoar frost is an important risk factor for growing and flourishing plants. Spring hoar frost is particularly dangerous for blooming fruit trees, causing partial or total loss of the crop. Hoar frost is missing in the studied area only in the summer, reaching the maximum annual average term of over 40-50 days in west, in the Casimcea Plateau and in the higher terraces of Danube river (between Hârşova and Cernavodă), in western Danube Delta, Teliţa drainage basin and in the Măcin Range. Hoar frost centers, with a high annual average of over 50 days appear in the bottom of the valleys, because of

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thermic inversion (for example in the Carasu Valley, Valu lui Traian), even if they are situated near the coast, where this hydrometeor has a relatively short average duration, of about 20 days. Areas with low frequency of the hoar frost are nearby the coast, in the eastern half of Danube Delta, in southern and central Dobrogea and also in northern Dobrogea (in Taița, Slava, Pecineaga, Hamcearca drainage basins and in the north-western Măcin Range). Distribution of the hoar frost in winter is, generally, similar to the annual values, but the changing duration of this hydrometeor is largely produced, the lowest isoline being of 10-15 days.

Agriculturally, the winter months, when vegetation is usually active and subject to hoar frost, are November and March.

In November the average length of the hoar frost period is minimal, of 2-3 days in the eastern Danube Delta, on the southern coast, in central Southern Dobrogea, in the north-western and south-eastern Măcin Range. Areas with a maximum average duration of the hoar frost, of over 7-9 days, are subject to the annual emergence of this hydrometeor and are situated in west, in the Casimcea Plateau and high terraces of the Danube river (between Hârşova and Cernavodă) and in the Telița upper basin. In the rest of the Dobrogean territory, hoar frost in November oscillates between these extreme limits.

In March, the areas with ahigh average duration of the hoar frost, of over 6-8 days, are very extended in the central and southern Dobrogea, including the central part of the Casimcea Plateau, the high terraces of the Danube river (between Hârşova and Cernavodă) and centers with thermic inversions in the Carasu Valley. The hoar frost isoline of 6-8 days in March also crosses Taița and Telița basins and Măcin Range, but the most part of Dobrogea is comprised between 3 and 5 days isolines. Figure 1 and 2.

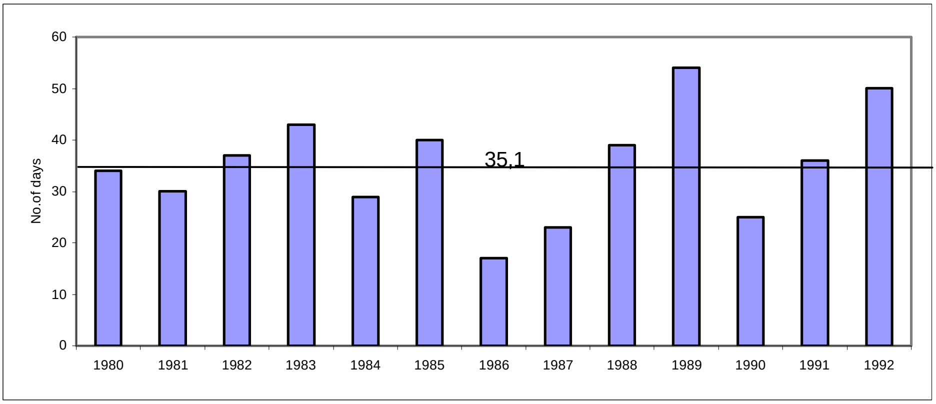

Figure 1. Multiannual variation of the average hoar frost days at Medgidia (1980-1992)

White frost is a solid deposition of ice which forms directly from mist, in anticyclone synoptic situations (when usually has a crystalline structure) or when warm and wet air mass rises (then, structure is often granular).

Massive white frost depositions (having a diameter of over 5 cm) are really dangerous, because they overload the electric energy and telecommunication networks. Strong winds, which have the highest frequency in Dobrogea during winter, multiply the damages caused by white frost. As for the electric energy network, the highest prejudices occur during maximum exploitation hours in the night and in the morning.

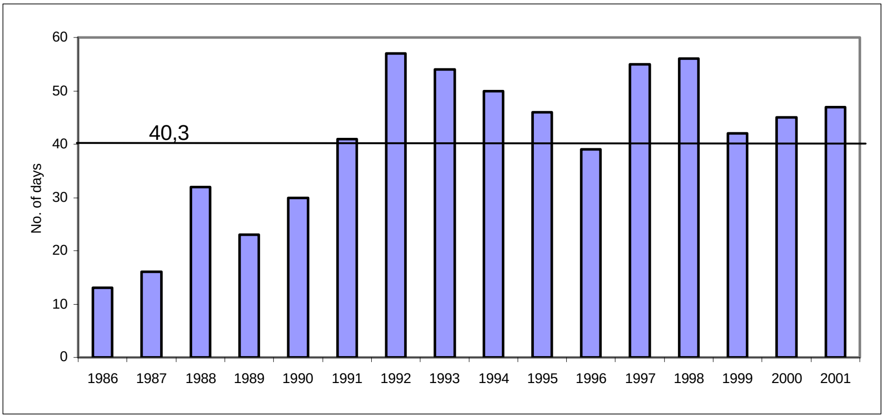

Figure 2. Multiannual variation of the average hoar frost days at Cernavodă (1986-2001)

The annual duration of the white frost oscillates between 1-2 days, on the largest part of Dobrogea, and its minimum frequency (less than a day) affects a large area along the great coastal lakes and southern coast of the Black Sea, to the Bulgarian frontier; and on smaller areas in south-eastern Danube Delta and also, in the extreme south-western and north-western Dobrogea.

The maximum annual average duration of the white frost, of over 8 days, is limited to the highest part of the Casimcea Plateau; a high frequency, of about 4 days, occurs in the Măcin Range, on the high terraces of the Danube river (at Hârşova) and in the Cobadin Plateau (at Adamclisi). In the cold season, the distribution of white frost is relatively identical with the annual distribution.

In November, the white frost has a short average duration which, on the most part of the analyzed area, oscillates between 0.1 - 0.2 days to about 0.4 – 0.6 days on smaller areas, in the Măcin Range and on the high plateaus of central and southern Dobrogea.

In December, the area with a minimum average duration of the white frost (less than 0.3 days) is obviously extended in the eastern Dobrogea, south to the parallel that crosses north to the great coastal lakes. The 0.6 days isoline borders the north-western half of the Danube Delta and the centers on higher plateaus where white frost forms and lasts, on average, 2-3 days in the Măcin Range, Casimcea Plateau and on the terraces of Danube river (at Hârşova).

In January is the maximum average duration of the white frost, at the majority of meteorological stations, but the highest frequency (2-3 days) is registered, like in December, on the peaks of Măcin Range and on the high Casimcea Plateau.

In January, Dobrogea is enclosed between the 0.3 and 0.6 isolines on its most part, and the minimum average duration of the white frost (less than 0.3 days) is registered on large areas in the eastern half of Danube Delta and nearby the southern coast of the Black Sea, south to Agigea.

In February, the average duration of the white frost decreases, oscillating between 0.1 – 0.3 days on the most part of the analyzed area. The low frequency areas (less than 0.1 days) are limited to a relatively narrow strip in the Danube Delta, next to the Black Sea coast, between Sulina and St. George branches – and become obviously larger in the south-eastern Dobrogea, west to the great coastal lakes, in the Taiţa, Slava and Casimcea basins. The centers where white frost has the highest frequency in February lie on the higher land, with 0.9 days in the Casimcea Plateau (at Corugea).

In March there are the last white frost days, which are missing in south-western Dobrogea, in the lower Slava, Casimcea and Carasu basins and still occur on large areas, west to the Black Sea coast, between southern Sinoe Lake and northern Mangalia.

In the Măcin Range, around Tulcea town and western Casimcea and Dorobanţu Plateaus, white frost registers the maximum average duration in March, of about 0.3 days. Figure 3 and 4.

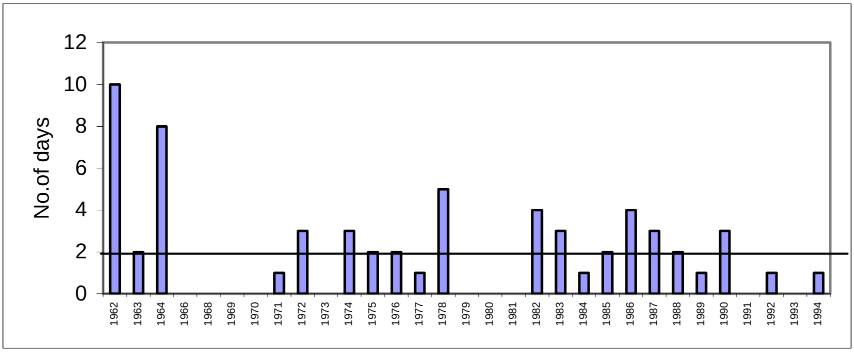

Figure 3. Multiannual variation of the average white frost days at Valu lui Traian (1962-1994)

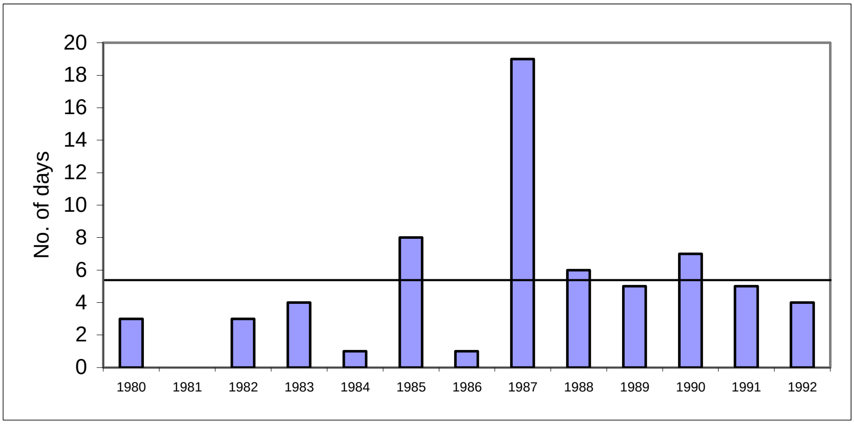

Figure 4. Multiannual variation of the average white frost days at Medgidia (1980-1992)

Glaze ice. The depositions of ice named glaze ice affect primarily transportation on the road systems, telecommunication and electric energy networks. On arable land, the glaze ice crust might be an important risk factor for the crops.

In winter, synoptic situations, along with depositions of glaze ice in Dobrogea are mainly advections of warm and humid air from the south-western outer limit of the eastern anticyclones (frequent from the Mediterranean Sea).

Duration of glaze ice rises from the Black Sea coast to the higher Dobrogean land, where the coldest areas are subject to the humid, warm air invasions. The highest annual average, of 4-6 days of glaze ice, is in the Măcin Range, Casimcea Plateau and Cobadin Plateau (at Adamclisi).

The lowest frequency of the glaze ice (less than a day) is registered on the one hand in the south-eastern region, nearby the Black Sea coast, where in winter the average monthly temperatures stay positive; and on the other hand in the Taița and Slava basins and also in the extreme north-western Dobrogea, on the landforms below the southerly winds.

A relatively high annual average number, of about 3 days of glaze ice, is registered in the eastern Danube Delta and great northern coastal lakes, which are usually covered by ice in winter. The annual and seasonal (winter) distribution of glaze ice is relatively the same in Dobrogea.

Frequency of the glaze ice rises constantly in winter, from November to January, when the maximum average number of days in winter is registered at the most of the pluviometric and meteorological stations. At some observation points, this maximum also occurs in December, mainly on high plateau land, where the intensity of glaze ice forming is the highest in Dobrogea (at Corugea).

In November, the duration of glaze ice is lower, of about 0.4 – 0.6 days on the high plateaus (at Corugea and Adamclisi) and around some local centres, where the occurrence of this hydrometeor is encouraged by the proximity of warm and humid surfaces, lakes or rivers (for example at Jurilovca, Tulcea, Hârşova etc.).

In December, occurrence of glaze ice – marked by a pronounced contrast – becomes more intense on the higher plateaus where, in specific conditions (the highest relative humidity of the year), can reach the maximum average duration of over 2 days. In south-eastern Danube Delta and Southern Dobrogea, in Taița and Slava basins as well as north-west to Măcin Range, the average duration of glaze ice in December is minimal (less than 0.3 days).

In January, the glaze ice has the maximum average duration at the majority of the observation points in Dobrogea, oscillating between 1 and 2 days on large areas, in Central Dobrogea, western Danube Delta and around the great coastal lakes. The largest areas where the frequency of glaze ice is minimal (less than a day) are in the eastern Danube Delta and in the Taița and Slava basins.

In February, The frequency of glaze ice reduces and registers the maximum average duration of about a day, in the upper Casimcea Plateau, at Corugea, but in the most part of Dobrogea it stays below 0.2 – 0.1 days.

The cold level of thermic inversions on the bottom of the valleys is the main origin of the glaze ice. In the Carasu Valley, at Valu lui Traian, the average duration of glaze ice in February, of 0.4 days, is typical for the regions with a high frequency of this hydrometeor in western Danube Delta and coastal lakes, Măcin Range and Southern Dobrogea Plateau.

In March, the largest area affected by glaze ice lies west to the analyzed territory; the 0.1 day isoline crosses Dobrogea from north to south near Tulcea, Medgidia and Negru Vodă. In the eastern Dobrogea isolated, very low duration centres (0.05 days) occur west to the great coastal lakes.

The area with the highest duration of the glaze ice, of over 0.3 days, lying in the north-western part of the territory, includes Măcin Range and Casimcea Plateau.

Mist is one of the hydrometeors which clearly influence differing parts of practical activity, by causing significant damage to road, water or air traffic, as well as to telecommunication network and electric energy transport system; it is often associated with intense air pollution moments and has a great importance in solving urban, health, industrial, agricultural and forestry issues.

Mist which forms in Dobrogea throughout the year has an inverse pattern comparing to the air temperature, its frequency rising from warmer to colder season, registering the minimum value in July or June (when it might be missing in some observation stations) and the maximum value in December or January.

The annual average duration of the mist is heterogeneously distributed in Dobrogea, oscillating between less than a decade – in north-western Dobrogea, between Danube river and Măcin Range and northern plateaus – and about 2 months or more – in the upper Casimcea Plateau (at Corugea) or within some urban centres (Constanța, Negru Vodă). Some mist centres, with a high annual average duration of over 50 days, lie in the higher part of Măcin Range and Cobadin Plateau (in north-west, at Adamclisi). But, generally, the most part of Southern Dobrogea, except the extreme south-west, is included within the limits of annual isolines of 30-40 mist days, and the Central and Northern Dobrogea and Danube Delta – between isolines of 20-30 mist days.

In winter, distribution of mist has a similar tendency of the annual pattern, but the values are lower, with centres of 30-40 days on the higher land (Măcin Range, Casimcea and Cobadin plateaus) and around and within urban centres (Constanța, Medgidia, Negru Vodă). The lowest average duration, of 5 – 10 days of mist, in winter, is between Danube river, Măcin Range and northern plateaus, as well as in the lower Telița and Taița basins, the most part of the Dobrogea being within isolines of 15-20 days of mist.

CONCLUSIONS

Territorial distribution of the analyzed risk hydrometeors in winter (hoar frost, white frost, glaze ice and mist) is characterized by high frequency on the higher land (Măcin Range, Casimcea and Cobadin plateaus) and in the extreme west – on the Danube's terraces between Cernavodă and Hârşova. Mist occurs for a longer period around and within some urban centres (Constanța, Medgidia, Negru Vodă). These centres and mainly the industrial towns/cities are known to form strong "fog centres"; this hydrometeor in their influence area lasts for longer than in the neighbouring regions. On the bottom of the valleys, which are intensely cold because of radiation, and where, in clear sky conditions, thermic inversion prevails, have a longer period of hoar frost.

The largest area with the shortest period of risk hydrometeors in winter is the eastern Dobrogea, along the Danube Delta coast, great coastal lakes and southern Romanian coast of the Black Sea.

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CHANGES IN WIND SPEED REGIME IN GIURGEU BASIN IN THE PAST DECADES

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ABSTRACT. Changes in Wind Speed Regime in Giurgeu Basin in the Past Decades. Changes in wind speed regime were observed in the Giurgeu Basin area after 1990. In this study we made a quantitative evaluation of wind speed in the region using basic statistical approach, trend evaluation, ranking system and frequency analysis. We succeeded to determine that a split year could be identified for both meteorological stations in the region, Joseni and Toplita. The wind speed regime shows a different evolution before and after these years enforcing that deforestation had an impact of this region. Using frequency analysis we could calculate the maximum wind speed values for different return periods. We also have the confirmation that a local microclimate exist in the basin existing a good correlation not only regarding the temperature, visibility, precipitation (revealed in other studies) but also in wind speed.

Keywords: *wind speed, frequency analysis, deforestation, trend, correlation*

1. INTRODUCTION

Based on media information and local observations during the past 10 year the material losses due to wind activity have increased in the neighborhood of Gheorgheni settlement. The civil society argued that this is the consequence heavy deforestation made after 1990. Our research wants to investigate this point of view based on quantitative methods regarding the evolution of maximum wind speed taking account also the forest losses after 1990.

We considered as the study area the Giurgeu Basin, where are two meteorological stations Joseni and Toplita. The data source regarding the wind speed was NCDC (National Climatic Data Center) where we used the daily maximum sustained wind speed considering that this can represent a real threat eventually producing material and human losses.

This research doesn't take account wind direction just want to investigate if there can be observed a change in wind speed evolution before and after 1990 at yearly and monthly scale. For evaluating the threat representing by different wind speed the Beaufort scale was used.

Strongly related to wind speed increase/decrease we also take account the land cover changes between 1990 and 2000, considering the CLC (Corine Land Cover) values for 1990 as characteristic for the period before 1990 and the CLC values for 2000 characteristic for the period after 1990.

2. STATISTICAL ANALYSIS

A first visual analysis of maximum yearly wind speed could show a slight incremental trend for Toplita but the year 2000 has a considerable fall of maximum sustained wind speed. This situation was verified based on local measurements which confirmed the presented situation.

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Fig. 1. Maximum wind speed evolution between 1982 and 2002.

If we consider some basic statistical indicators the maximum and also the mean value of maximum annual wind speed before 1990 has significantly lower values as the period after 1990, especially for Toplita station.

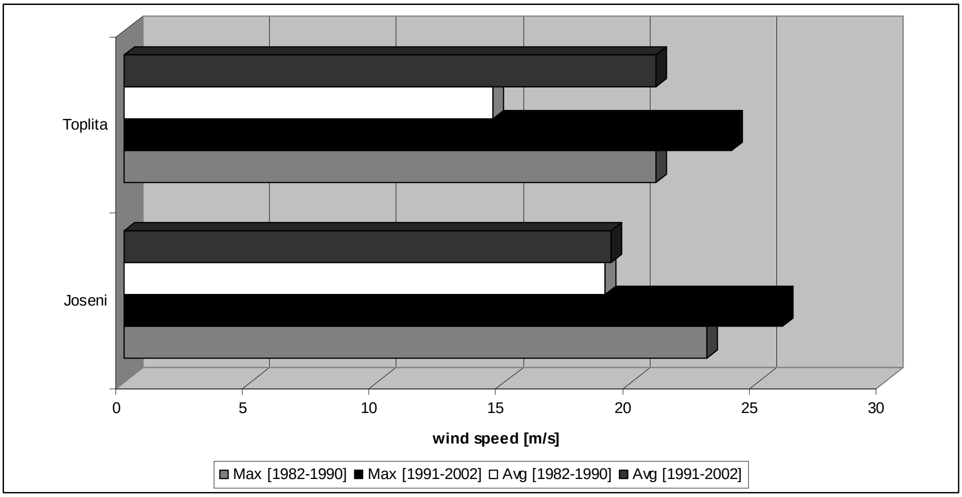

Fig. 2. Multiyear maximum and average wind speed before and after 1990.

For the beginning the year 1990 was considered the split year based on socio-political reason, but we supposed that the massive deforestation hasn't started obligatory with 1990. Even if the research period is relatively short we want to determine the most probable split year for wind speed changing. Thus we calculated the maximum absolute difference of successive 3 year periods for maximum and average yearly maximum wind speed. Excluding the terminal values the highest differences indicates that the split year is 1990 for Joseni and 1994 for Toplita station. This concludes that the possible change in wind speed regime was after 1990 so it can be related to deforestation.

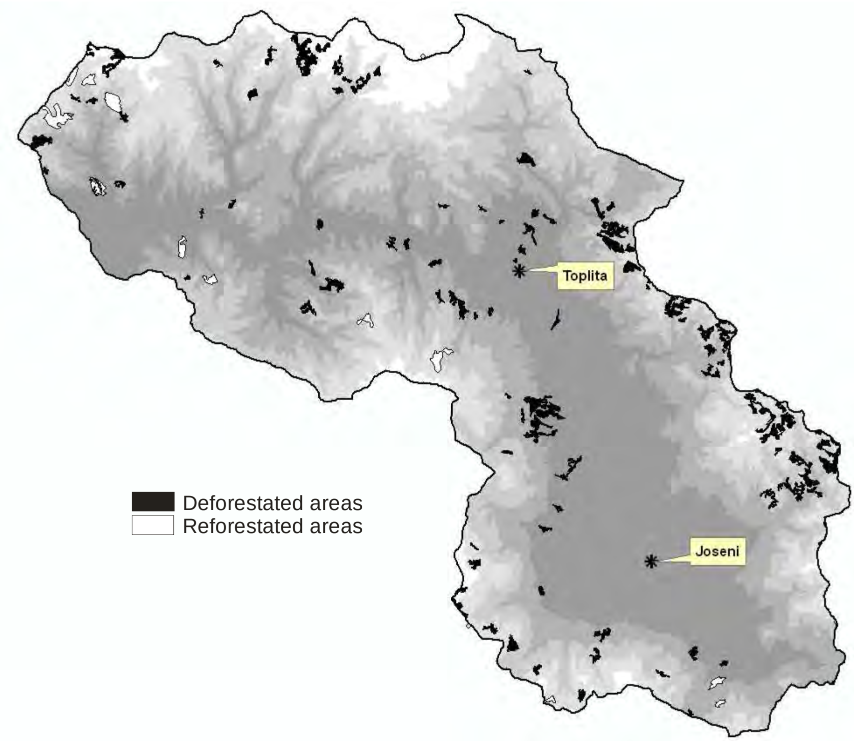

Fig. 3. Deforestation and reforestation in the study area between 1990 and 2000.

Studying the land cover changes between 1990 and 2000 we obtained the following values:

Table 1

Land cover changes over time in Giurgeu Basin

LAND COVER 1990	LAND COVER 2000	AREA (KM^2)
Pastures	Agricultural with natural vegetation	1.0
Complex cultivation patterns	Pastures	1.6
Broad leaved forest	Woodland shrubs	1.9
Coniferous forest	Woodland shrubs	38.8
Mixed forest	Woodland shrubs	11.4
Woodland shrubs	Broad leaved forest	5.9
Woodland shrubs	Coniferous forest	1.2
Woodland shrubs	Mixed forest	4.5

If we take only the forests the deforestation or natural forest loss is over 50 km^2, and the difference between forest loss and reforestation is 40.5 km^2, a significant value. Concerning the above map the forest loss affect especially Toplita while Joseni is more protected if we consider the appreciations of scientific literature where we found that the predominant wind speed direction is from west.

Based on the possible split years we continued the investigation regarding the monthly distribution of highest wind speeds. Using a ranking system we tried to identify the most dangerous month. For the ranking process the maximum wind speed for every month in a year was arranged in decreasing order and starting from 12 a rank value was selected. For two equal values equal rank points was calculated but the following value got a lower point with one unit. This modality was used starting not just from a methodological point of view but also trying to reflect the real situation due to measurement limitations, as wind speed measurements was done with certain precision (0.1 knot) and that's why equal values could appear even if the real wind speed was different.

The ranked values were cumulated for the periods before and after the split years and normalized with the year number for every station. The difference of these values before and after the split year shows the evolution of wind speed threat for every month.

Comparing the monthly normalized wind speed we can observe that before the split year at Joseni station the months with the highest wind speeds was November, December an January and after 1990 the threat dislocates to February, April and September. If we look at Toplita station the situation is more equilibrated the highest values before 1994 corresponds to March, May and September and after it April, May and September.

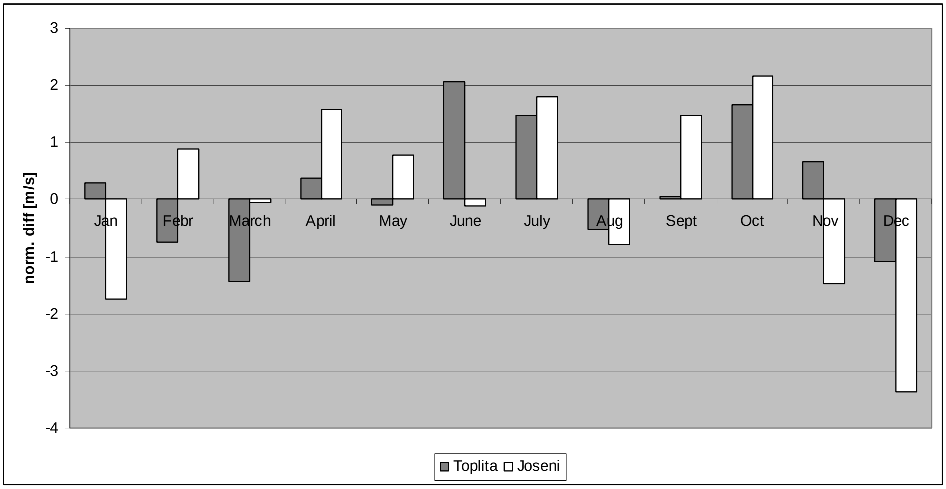

Fig. 4. Differences of multiyear monthly normalized rank values.

The Giurgeu Basin has a local microclimate existing high correlation between daily temperatures, fog apparition measured at Joseni and Toplita stations. It's normal to have a lower correlation between yearly maximum values, but also in this case the correlation coefficient is 0.56 for the whole study period. If we take account the two split years for the first period (1982-1990) we have a 0.74 correlation coefficient and for the second period

(1995-2002) this value is even higher 0.81. Between 1990 and 1995 the correlation coefficient is -0.47 showing that in this period local change affected the wind regime, reconfirming the correct split year selection.

3. FREQUENCY ANALYSIS

In our research we also want to make some estimation regarding the wind speed evolution using frequency analysis. Frequency analysis is a statistical prediction method which is based on the study of former events, not taking account the physical modeling of the phenomenon. In frequency analysis for every measurement characterizing the studied phenomenon a probability value is associated, and for every probability a return period is granted base don the following formulae:

$$T = \frac{1}{p}$$

where T is the return period and p the corresponding producing probability.

For frequency analysis we used our own developed software module for continuous space based on Borland Delphi and R System. For Joseni the independence, stationery and homogeneity test were all accepted with a significance of 95%. Using both the Anderson Darling and Kolmogorov Smirnov adequacy tests the most suitable frequency distribution was the Normal distribution. For different return periods the calculated most probable values (quintiles) shows that the absolute maximum value of wind speed in the study period (25.97 m/s in 1993) has a return period of 70 years, which corresponds to storm event on Beaufort scale. For a large return period of 500 years the maximum wind speed is 28.12 m/s, 101 km/h the higher part of storm conditions but can't be considered a violent storm. We can conclude that the Joseni surroundings will not be affected by major wind speed rising in the following year.

Regarding Toplita station we observed that the stationary and homogeneity tests failed. Because the homogeneity test could be accepted at 98% significance level we have focused on the trend of the wind speed evolution. We obtained the following regression formulae:

$$WS = 0.484Y - 945.86$$

where WS is the estimated wind speed in m/s any Y is the year.

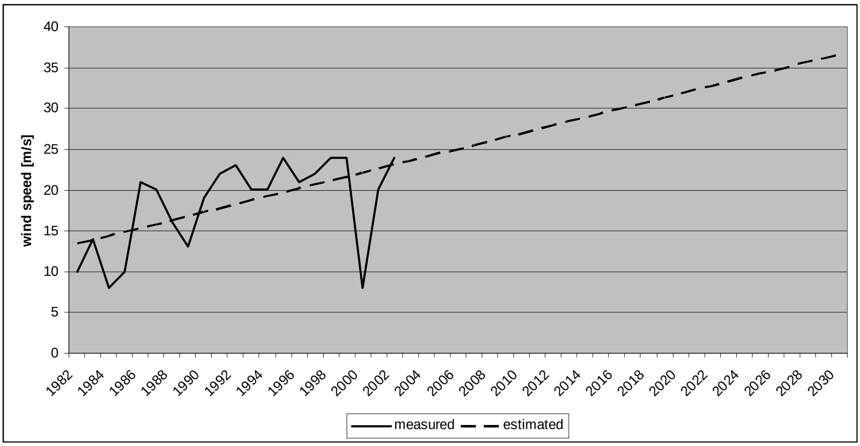

Fig. 5. Apparent trend of wind speeds at Toplita station.

If this trend is real than by 2030 we could take account wind speeds over 120 km/h. On Beaufort scale this corresponds to hurricane force which is clearly unrealistic. Knowing that in time series analysis even a couple of values could significantly change the results of an analysis we separately analyzed the trend before and after the split year and we found that in both cases before the split years a rising tendency could be observed but after it there's no trend. The overall trend for Toplita station is due to the fact that the tendency before 1995 is much stronger that in case of Joseni. These observations also reinforced that the deforestations causes disturbing effects in wind regime.

We continued with the recalculation of quintiles for different return periods based just on the trendless values at both station. For Joseni we obtained slightly higher values but both before and after 1990 the normal distribution is proved to be the most suitable. For Toplita station higher quintiles were obtained even if in year 2000 a significantly lower value was measured that the average multiyears wind speed. For Toplita station also the normal distribution was the adequate one, showing hurricane force storm possibility for the return period of 100 years. If we consider the initially higher wind speed values for this station an existing trend for the wind speed but also the deforested region of the west side of the settlement and the fact that the preponderantly wind direction is west side we could affirm that Toplita region is much more vulnerable to hazardous wind speeds than Joseni. We also have to take account to the fact that Toplita is situated at the eastern end of the Mures Defilee which can be considered as a west-east wind channel.

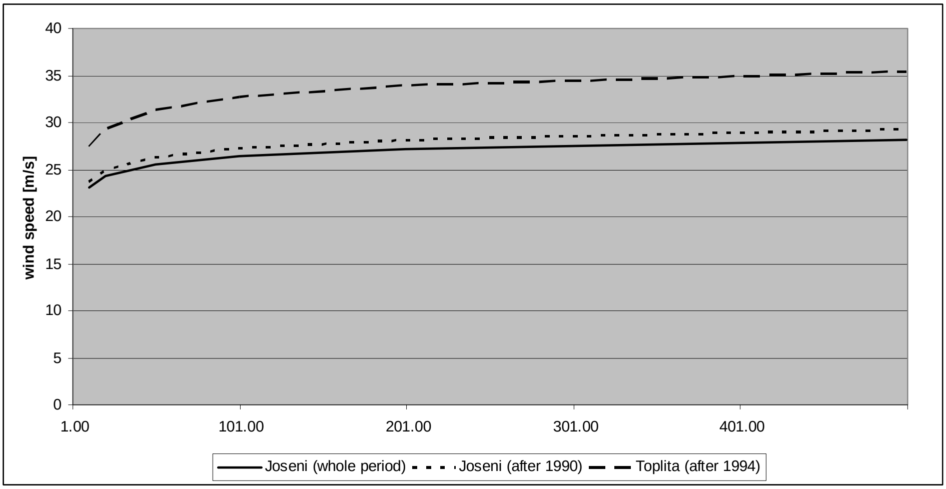

Fig. 6. Maximum wind speed obtained for different return periods.

4. CONCLUSIONS

With no doubt in Giurgeu Basin significant forest losses appeared after 1990 as results form Corine Land Cover database of 1990 and 2000 years. We observed that not considering only other climate factors but also in sustained wind speed there is a local microclimate in the region. Using more methods including descriptive statistical approach and frequency analysis we observed that after 1990 there were different split years in wind speed regime at Joseni and Toplita station respectively. At monthly scale in case of Toplita station is a clear evidence of rising wind speeds in spring and autumn while in case of Joseni this change cannot be confirmed.

The evolution of wind speed regime at the two meteorological station is seems to be different. Even if at Toplita the maximum wind speed values were lower before 1990 the latter values indicates a rising trend. The ascendance of threat represented by high wind speed at this station is confirmed also by the frequency analysis, while at Joseni nothing unusual was observed concerning the wind speed hazard evolution.

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VARIATION OF OUTDOOR RADON LEVELS IN URBAN AREAS OF CLUJ COUNTY

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ABSTRACT. Variation of Outdoor Radon Levels in Urban Areas of Cluj County. Some early work has considered the connection between atmospheric temperature differences, wind speed, relative humidity and radon concentration in outdoor air. A comprehensive evaluation of some possible environmental factors which could influence outdoor radon concentration is the subject of this study. Research is being conducted to measure outdoor radon concentrations in some urban areas of Cluj County and observe any correlations with atmospheric conditions. The outdoor radon measurements were performed using Radim 5 continuous radon monitor that allows the variation of radon concentrations based on air temperature. Monthly atmospheric temperature, humidity data and outdoor radon concentration are measured simultaneously in order to observe any cross correlations between variables with radon concentration. These results can be used by radon testers to determine when radon concentrations will be at their maximums or to help interpret data obtained under given conditions. A preliminary analysis of these results has shown that seasonal and diurnal variations, atmospheric temperature and relative humidity of outdoor air may bring some significance in the effects on radon concentration.

Keywords: *radon concentration, outdoor air, seasonal variations, diurnal variations, meteorological factors.*

1. INTRODUCTION

In several studies realized previously (C. Cosma, 1996) the main aspects related to the problem of radon was approached as regards the analysis of the radon concentration in various environmental factors, such as radon in atmosphere, indoor radon, radon in water and radon in soil.

The radon concentration in outdoor air is mainly related to atmospheric pressure, and (in case of non-perturbative weather) it shows a typical oscillating time pattern, with higher values during night. When radon surfaces in the open air, it is quickly diluted to harmless concentrations, but when it enters an enclosed space, such as a house or other building, it can sometimes accumulate to unacceptably high concentrations (EPA, 2003). In these conditions, if radon is accumulating inside the houses can be represent a risk to the exposed population. Recent researches have consistently demonstrated an increased risk of lung cancer for inhabitants (Field et al., 2006; Darby et al., 2006), even in the case of normal indoor concentrations ranging from 40 to 300 Bq/m^3.

Ambient air over oceans has very low values (- 0.1 Bq/m^3) of radon concentration, due to the minimum presence of radium in the sea water and the high solubility of radon in water at low temperatures. Therefore radon concentration in outdoor air of islands and coastal regions is generally lower than in continental countries, e.g. United Kingdom and Japan have an average outdoor air value of 4 Bq/m^3 (European Collaborative Action, 1995).

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Many continental countries have adopted National reference levels for outdoor radon concentration exposures from 5 to 10 Bq/m^3, as recommended by UNSCEAR in its last report (UNSCEAR, 2000).

A comprehensive evaluation of some possible environmental factors which could influence outdoor radon concentration is the subject of our research.

2. MATHERIALS AND METHODS

In order to evaluate the variation of radon levels in outdoor air, radon measurements were made in some urban areas of Cluj County using Radim 5 continuous radon monitor that allows the variation of radon concentrations based on air temperature.

Radon measurements in air were performed in the period July-December 2008, daily in Cluj-Napoca at 12.30 and monthly in Turda and Huedin (measuring 8 hours) respectively. A single point of measurement in each location (Grigorescu-Cluj-Napoca, Turda-Potaisa School, HighSchool "O. Goga"- Huedin) was chosen for measuring.

Monthly atmospheric temperature, humidity data and outdoor radon concentration are measured simultaneously in order to observe any cross correlations between variables with radon concentration.

2. 1. Concept of the Radim5 detector

The concentration of radon is determined by measuring the α-activity of the decay products of the conversion of radon, 218Po (RaA) and 214Po (RaC'), collected from the detection chamber on the surface of a semiconductor detector by an electric field. Half of the hemispherical chamber consists of a grid, covered with two layers of material. The material captures the radon products formed in the external space and protects the detector against light and dust. The dimensions of the Radim5 detection chamber are 140 ml. As the chamber dimensions are smaller, a source of 400 V is used in Radim5 (Radonlab, Radim5).

3. RESULTS AND DISCUSSIONS

Variation of radon concentration (July-December) in the outdoor air in Cluj-Napoca is between 0.98 and 28.95 Bq/m^3, as can be observed in the Fig. 1.

In terms of meteorological factors influencing radon concentration in the same location (apart from anthropogenic factors) the most important factors are (EPA, 2003):

-air temperature causes the formation or the inhibition of thermo convection/ dynamic;

-wind speed determines the movement of air particles and therefore the dispersion of all existing gas, including radon, in the air, respectively;

-soil temperature is directly proportional to the radon dispersion in the atmosphere: when the soil temperature is lower, the air mass situated above it has tended to cool from the base and, therefore, leads to a stable thermal bedding and a temperature inversion at low or very low levels (even only a few tens of cm from the ground), which prevents airborne vertically growth;

-soil state: a ground covered with snow or a frozen ground will cause a radon dispersion decrease to the atmosphere, and thus a radon concentration decrease.

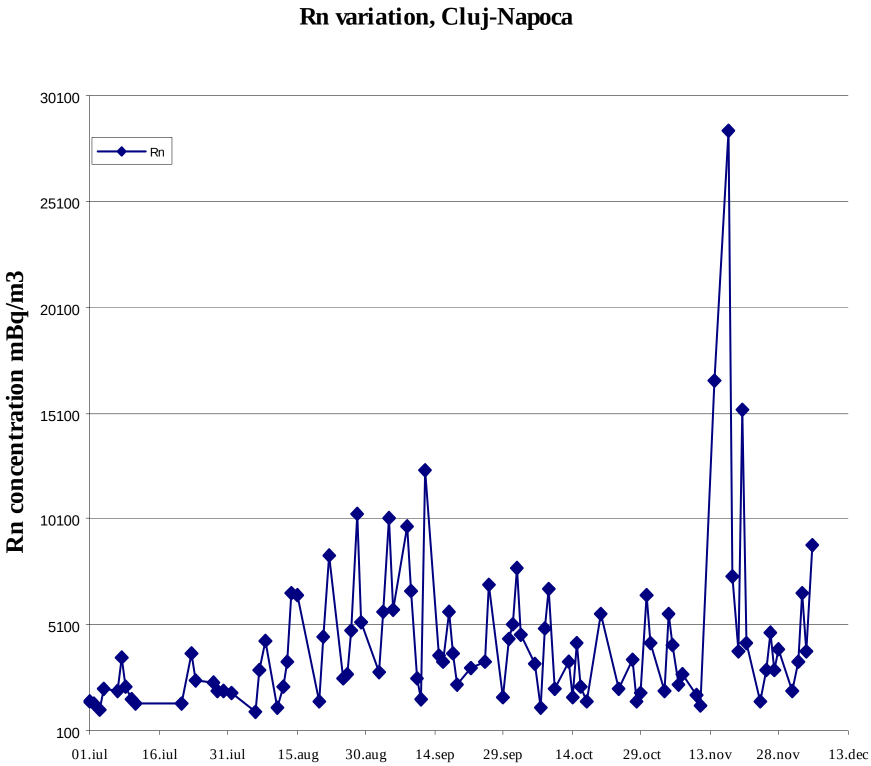

Fig. 1. Variation of radon concentration in the air in Cluj-Napoca.

The average values of radon measurements for 8 hours in the three areas varies from month to month and from city to city, the highest values recorded in Cluj-Napoca and the lowest in Huedin (Fig. 2), respectively.

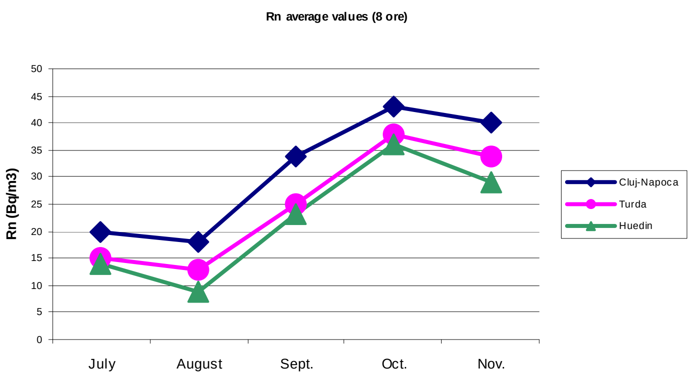

Fig. 2. Seasonal variation of outdoor radon concentration in the studied areas.

The lowest values were recorded in August (summer), as a result of the thermo-convection process that has a much greater intensity than in the winter, when the colder air stagnate in the vicinity of the soil where it was take the air samples. In addition, another meteorological factor influencing very much the radon concentration is considered to be the wind speed, which in summer months is higher and has minimum values in winter months. From the climatologically point of view, October is an autumn month with the highest atmospheric stability, and consequently the maximum of radon concentration recorded this month are fully explained.

Regarding the difference between radon concentrations in the three measured locations, it must be noted that this depends primarily on the type of soil and geologic substrate of the concerned area.

The highest diurnal variation for radon concentration in air is recorded at the midday (Fig. 3).

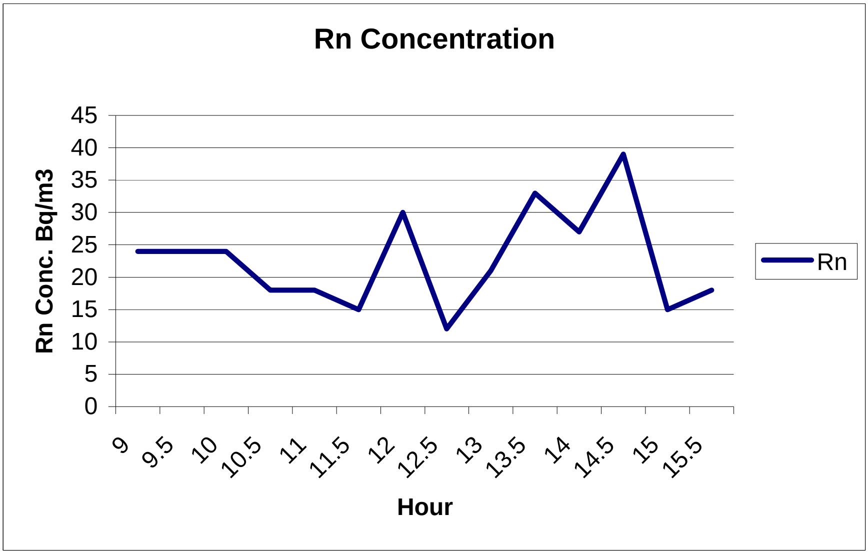

Fig. 3. Diurnal variation of radon concentration in the air in Cluj-Napoca.

Radon concentration in the three measured areas varies from month to month and from city to city, with the highest values recorded in Cluj-Napoca (43 Bq/m^3) and the lowest in Huedin (9 Bq/m^3), respectively.

The diagrammatic representation of radon variations and meteorological parameters clearly show a link between them (Fig. 4-5). However, if we calculate the correlation coefficients, we obtain the value of 0.14 for radon and temperature which indicates an inversely proportional relationship between these and a value of -0.075 for radon and relative humidity, which show a proportional relationship between the two variables.

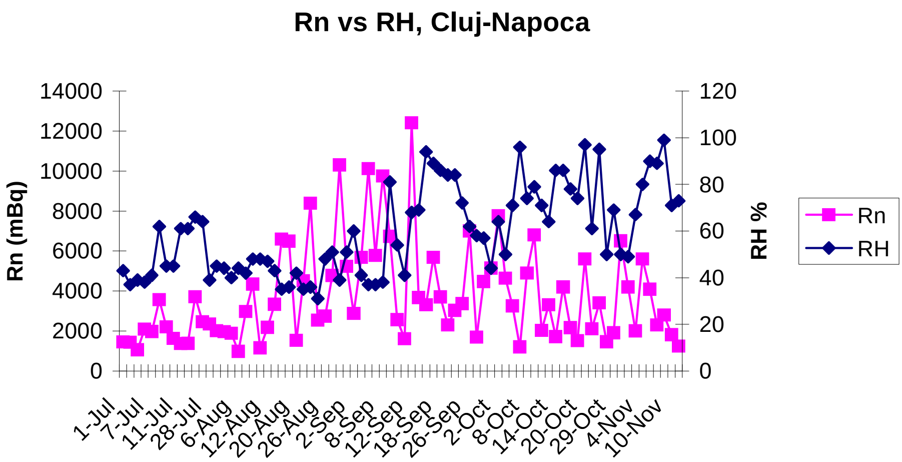

Fig. 4. Variation of radon and relative humidity in Cluj-Napoca (July-November 2008).

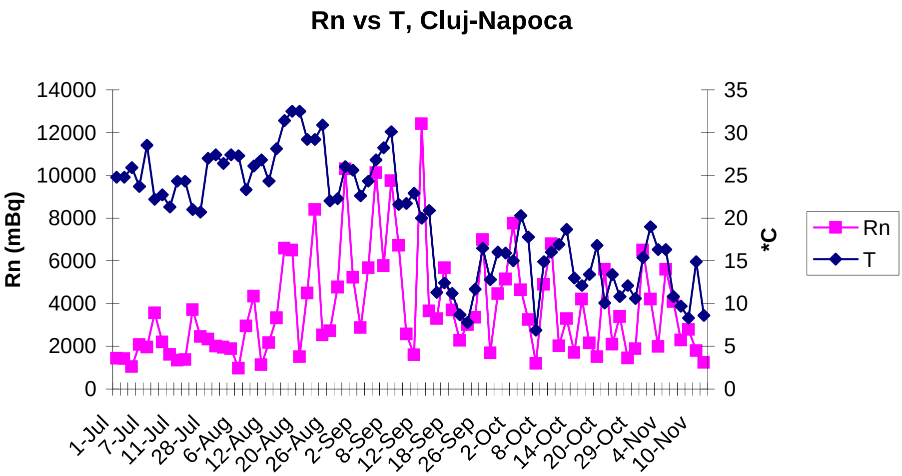

Fig. 5. Variation of radon and temperature in Cluj-Napoca (July-November 2008).

4. CONCLUSIONS

Our study is relevant for the main aspects related to the radon distribution in the atmosphere depending on seasonal variations, diurnal variations, atmospheric pressure and air temperature.

Radon concentration in the three measured areas varies from month to month and from city to city, with the highest values recorded in Cluj-Napoca (43 Bq/m^3) and the lowest in Huedin (9 Bq/m^3), respectively.

The lowest values were recorded in August (summer), as a result of the thermo-convection process that has a much greater intensity than in the winter. The highest diurnal variation for radon concentration in air is recorded at the midday.

A preliminary analysis of these results has shown that seasonal and diurnal variations, atmospheric temperature and relative humidity of outdoor air could bring some significance in the effects on radon concentration.

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STATISTICAL MODELLING OF MEAN ANNUAL TEMPERATURES AT IASI METEOROLOGICAL STATION SINCE 1894

C. V. PATRICHE[1]

ABSTRACT. Statistical Modelling of Mean Annual Temperatures at Iasi Meteorological Station since 1894. The scope of our paper resides within the context of the present global warming process. Our paper attempts to model the evolution of mean annual temperatures recorded at Iasi meteorological station during the 1984-2007 period, using statistical methods, namely the regression analysis, spectral density analysis and Fourier analysis. Three different models are compared, departing from different assumptions regarding the warming process: a regression models assuming that the atmospheric CO_2 increase is the main cause of the global warming, a Fourier model assuming that the warming process is part of a long period climatic cycle and a hybrid model, using both trend and cyclic components, assuming that the warming process is the result of a non-periodic disturbance of the climate system.

Keywords: *temperature time series, regression, spectral density, Fourier components.*

1. INTRODUCTION

The evolution of climate, in general and that of meteorological and climatological parameters, in particular, is the complex effect of the interaction of a large number of control factors such as the orbital variations of the Earth and the Moon, solar activity variations, qualitative and quantitative changes of the atmospheric composition, volcanic activity cycles etc. These factors act at different time scales resulting in complex variations of climate, composed by combinations of numerous quasi-cyclic components and marked here and there by qualitative transitions induced by a strong imprint of a non-periodical factor.

2. INPUT DATA

Our dependent variable is the mean annual temperature series recorded at Iasi meteorological station, situated in north-eastern Romania at 47.17^{o}N latitude, 27.60^{o}E latitude and 102m of altitude. We analyzed a period of 114 years, from 1894 up to 2007.

The predictors we used in order to explain the temperature's evolution are the solar activity variation, expressed by the annual number of sun spots (NCDC / World Data Center for Paleclimatology), the El Niño Southern Oscillation Index (SOI) NOAA / National Weather Service, Climate Prediction Center (http://www.cpc.ncep.noaa.gov/data/indices/) and the atmospheric CO_2 concentration at global level (Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends) and CO_2 recordings at Mauna Loa observatory (Hawaii) (C.D. Keeling, T.P. Whorf, and the Carbon Dioxide Research Group, Scripps Institution of Oceanography (SIO), University of California, La Jolla, California USA 92093-0444 (http://cdiac.ornl.gov/ftp/maunaloa-co2/maunaloa.co2). The CO_2 recordings from Mauna Loa observatory were taken into account because of the longer data series (1958-2004) as

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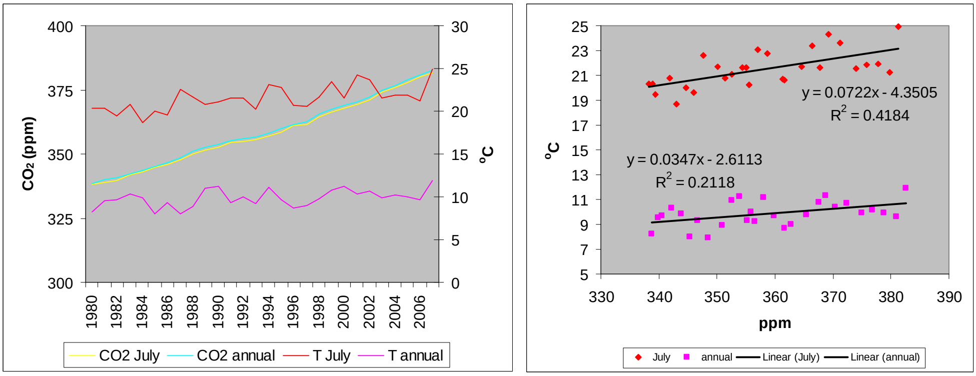
compared to the global CO_2 concentration series (1980-2007). Being almost perfectly correlated with the global CO_2 series, the Mauna Loa series was used to verify the results achieved by means of the shorter, global, series.

3. FACTORS CONTROLLING THE TEMPERATURE EVOLUTION

Our study attempts to statistically link the evolution of temperature parameters (mean monthly and annual values) recorded at Iasi meteorological station with some of the factors controlling this evolution, both periodic (solar activity, El Niňo Southern Oscillation Index) and non-periodic (the greenhouse effect induced by the growing trend of carbon dioxide concentration).

Figure 1 compares the general growing pattern of mean annual and mean July temperatures with the upward, better marked, evolution of global CO_2 concentration. The differences between the evolution rates may be explained by some of the inverse connections governing the atmosphere-ocean-land system, which reduce the effects of an internal or external perturbation, that is the effect of CO_2 rising in our case.



a b

Fig. 1. Comparative evolution of mean temperatures at Iasi station and global CO_2 concentration (1980-2007, a). Correlation between mean temperatures at Iasi station and global CO_2 concentration (1980-2007, b)

The lack of statistically significant correlations with the other two potential causes for temperature dynamics taken into account does not exclude the existence of real causal relationships. We should recall that a time series may be regarded as the complex outcome of numerous cyclic variations associated to a great number of factors. One of these factors, even though it is a real control factor, may have only a small contribution, statistically insignificant, to the formation of the real time series. This happens at least in the case of the solar activity, expressed by the monthly and annual sunspots number, as we shall see as it follows.

The spectral analysis offers the possibility of deciding whether a quasi-cyclic factor is a real control factor or not. The analysis identifies, within the time series, those significant cyclic fluctuations form the viewpoint of their contribution to the formation of the real series. If these fluctuations appear both within the control factor and the dependent variable and the oscillations are synchronous, then we may draw the conclusion that the control factor has a real influence upon the dependent variable through the effect of inducing these oscillations.

A problem related to spectral density analysis is the fact that a quasi-cyclic fluctuation is, most of the time, revealed on the periodogram not by a single peak, but by a series of peaks situated in a narrow interval of periods. Consequently, in this situation, we are unable to specify the exact period associated to the fluctuation. A solution to this problem is the filtering the periodogram in order to group the near peaks. Even so, the resulting peak is the expression of the most powerful cyclic signal from an interval of cycles, which together compose the real quasi-cycle variation. The main problem deriving from this situation is the difficulty of reconstructing the quasi-cyclic fluctuation, being necessary to sum up all the significant cyclic fluctuations composing the real fluctuation.

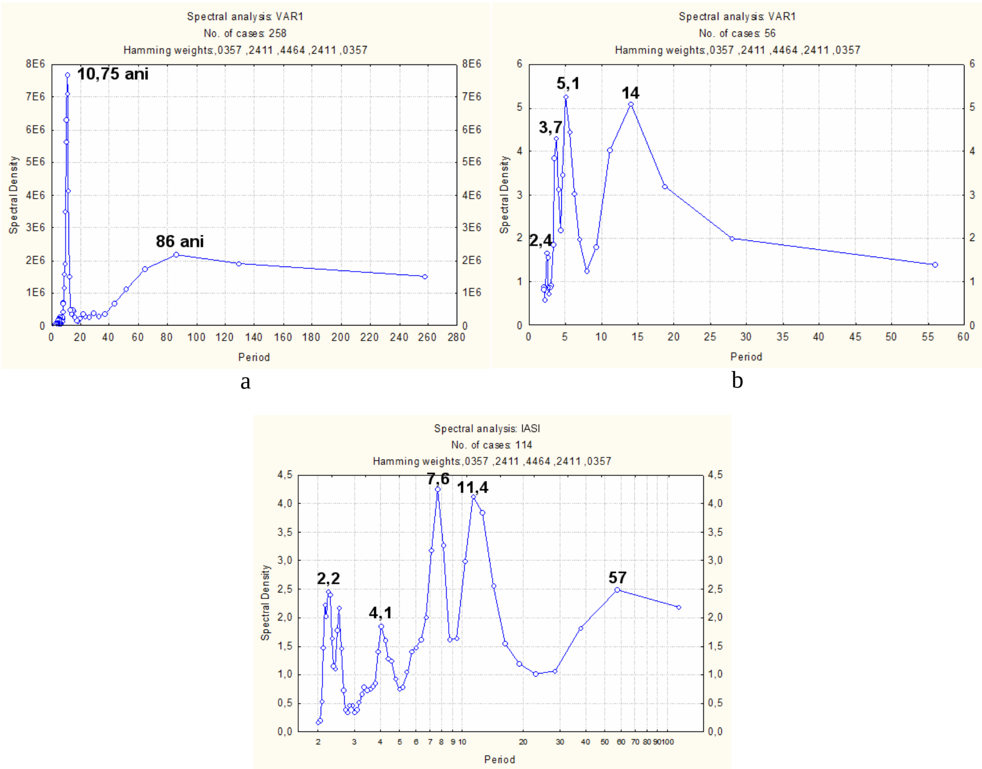


Fig. 2. Spectral density curves for mean annual sunspots number (1749-2007, a), Southern Oscillation Index – SOI (1951-2007, b) and mean annual temperatures at Iasi station (1894-2007)

The spectral analysis of the annual number of sunspots for a period of 258 years (1749-2007) (NCDC / World Data Center for Paleclimatology) reveals the presence of 2 main cycles, with periods of 10.75 years and 86 years respectively, explaining together 74% of the time series (figure 2a). As we mentioned before, the period of 10.75 years represents the most powerful signal from an interval of cycles situated between 9 and 11 years. We find these oscillations within the analyzed temperature series, the peak corresponding to a period of 11.4 years (figure 2c). Consequently, we may regard as real the influence of solar activity on air temperature, even though it has a small contribution to the explanation of the temperature series. Thereby, the 11.4 years cycle, identified at Iasi meteorological station in the case of mean annual temperature values, is characterized by an amplitude of 0.65°C, accounting for only 6% of the real series' variance.

If the atmospheric carbon dioxide variation and the 9-11 years solar activity fluctuations are real control factors, we may proceed to the estimation of the temperature values, using the regression analysis.

Because of the shorter interval of measurements for the global CO_2 concentration (1980-2007) and in order to achieve a more complete image, we elaborated two regression models, one using the global CO_2 values, the other the Hawaii CO_2 values. This is possible taking into account the very tight correlation between the 2 series (coefficient of correlation of 0.99).

The results achieved by means of the 2 stepwise regression models are given in tables 1 and 2 and figure 3. We notice important differences as far as the estimated gradients (B coefficients) are concerned, indicating a greater rate of mean annual temperature increase when using the global CO_2 data and a smaller increment when it comes to using the Mauna Loa CO_2 data, even though the 2 data series are practically identical. This situation is the effect of the change in the rate of temperature increase, which is significantly higher within the 1980-2007 interval, compared to the larger 1959-2004 interval. Both models have a fairly low capacity of explaining the temperature variations, which is better in the first case (29%) and poorer in the second case (15%). As a consequence, the prediction capacity associated to the models is reduced.

The differences between the 2 models may be explained either by the incapacity of the first model to quantify the CO_2 – temperature relationship due to the shorter analysis interval, or by the non-linearity of this relationship, meaning that a linear increase in CO_2 concentration induces a non-linear (exponential type) increase in temperature. We should mention that the CO_2 – temperature relationship operates non-linearity, from a certain threshold, acting like a direct connection type of relation. The temperature increase enhances the CO_2 transfer from the ocean waters into the atmosphere, while the atmospheric CO_2 increase increases further the air temperature through the greenhouse effect.

Our 10 years predictions (2008-2017) are given in table 2. The model based on the global CO_2 data predicts temperature values approximately 0.6-1°C higher than the model base on Mauna Loa series, the highest temperatures being placed, in both cases, within the 2012-2014 interval, which corresponds to a maximum of solar activity.

Table 1

Stepwise multiple regression parameters with global CO_2 data and sunspots number (left) and Mauna Loa CO_2 data and sunspots number (right).

	global CO_2 data, sunspots number		**Mauna Loa CO_2 data, sunspots number**	
	R^2 = 0.346, p<0.00498, standard error: 0.84402		R^2= 0.224, p<0.01256, standard error: 0.78353	
	B	**p**	**B**	**p**
Intercept	-6,67660	0,170968	4,259251	0,058749
CO_2	0,04449	0,002065	0,014562	0,027314
Sunspots	0,00064	0,032647	0,000436	0,042636

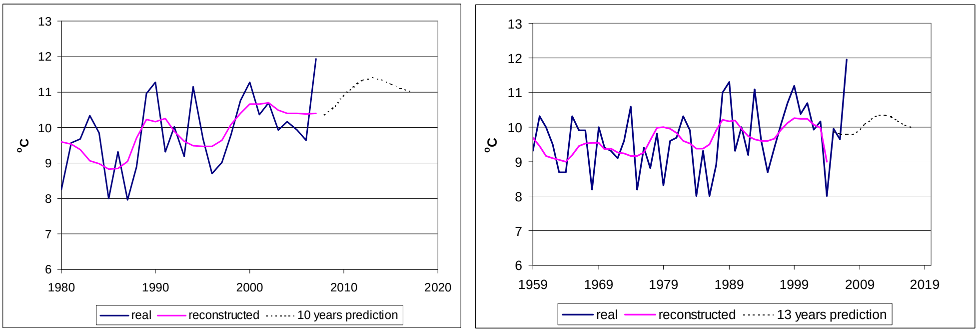


Fig. 3. Real and reconstructed mean annual temperature series at Iasi using regression models with global CO_2 data and sunspots number (a) and Mauna Loa CO_2 data and sunspots number (b).

4. PREDICTION OF TEMPERATURE EVOLUTION

The present global warming process cannot be contested. The uncertainty resides in the role played by the human activities, especially by the greenhouse effect, in explaining this warming process.

Two main categories of models can be used for the purpose of predicting the climate evolution: general circulation models (GCM), which are, in essence, conceptual models, and statistical models, based on time series modelling. The former generally produce long-term predictions (tens and hundreds of years), while the statistical models may produce variable predictions, according to the length of the analyzed time series. In our situation, having a data series of 114 years, we limited the extrapolation to a period of 10 years (2008-2017) for a better confidence upon the results.

Our study uses the statistical models in 3 ways:

- Using predictors (atmospheric CO_2, annual sunspots number). We have already presented the results achieved through this model.
- Using cyclic components identified by spectral density analysis (figure 4a). This type of modelling assumes that the trends identified within the time series are, in fact, components of some long-term quasi-cyclic variations. Precisely, the model assumes that the temperature increase trend, which began during the years ’70-’80, is in part of the upward segment of a long-term cycle.
- Using trends and cyclic components (figure 4b). This type of modelling associates the cyclic components to a general increasing / decreasing pattern of the analyzed parameters. Therefore, the model assumes that the present warming process is the result of a non-periodical perturbation within the climate system.

From the viewpoint of the correlations between real and estimated values (figure 5), we notice that the regression model using the global CO_2 data for the 1980-2007 period seems to perform the best, explaining 34.6% of the mean annual temperatures variance. Still, we should bear in mind the shorter period of analysis. The weakest model seems to be the regression model using the Mauna Loa CO_2 data. The models including cyclic components identified by spectral density analysis occupy an intermediate position, the one using the 2^{nd} degree polynomial trend being slightly superior. Even though it has a lower explanation capacity, this model has the advantage of being more stable due to the much longer period of analysis (114 years).

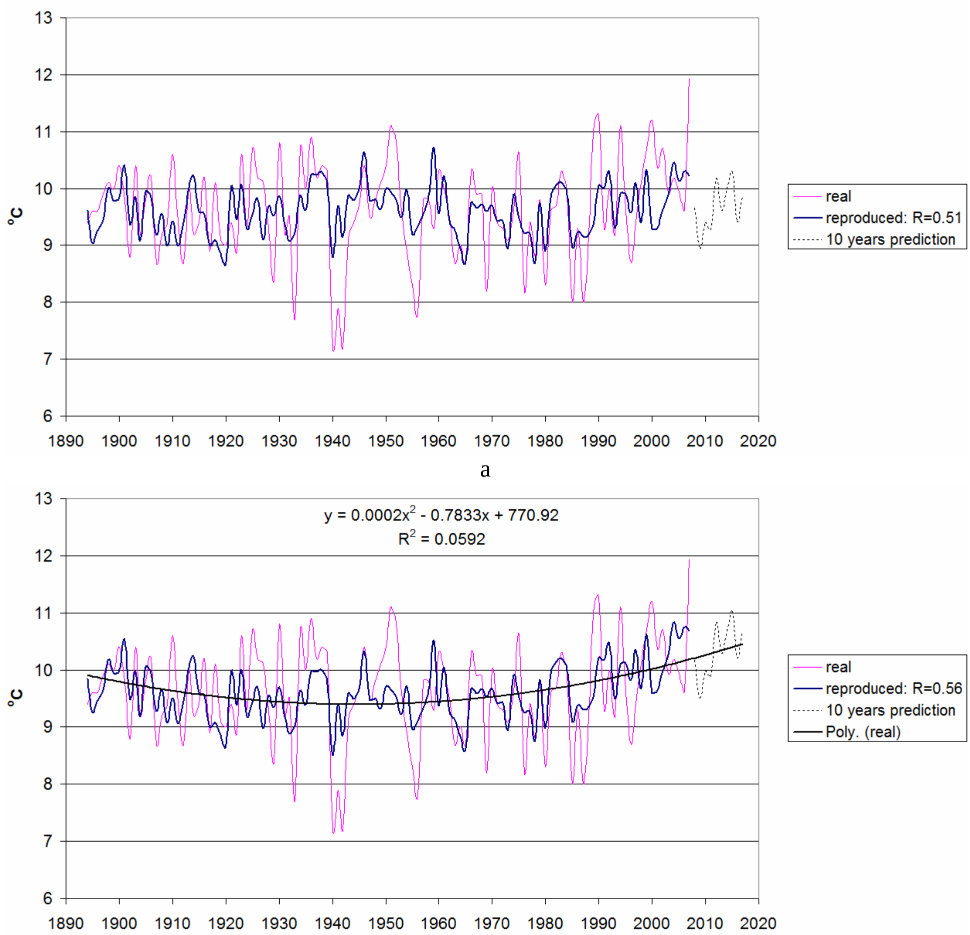
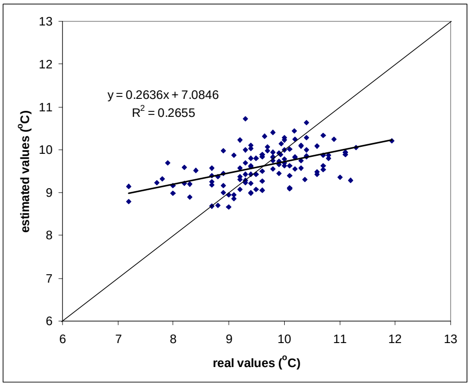


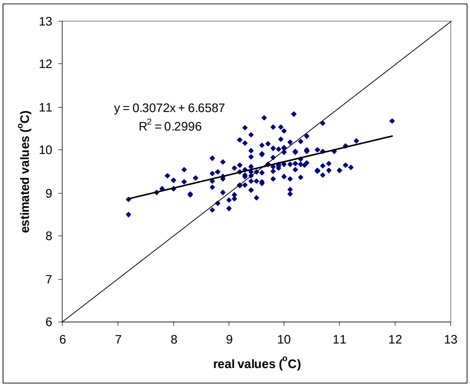
Fig. 4. Statistical modelling of mean annual temperature evolution at Iasi meteorological station (1894-2007) using cyclic components (a) and polynomial trend and cyclic components (b).

The overall prediction capacity of the models is fairly low, attested by the small values of the explained variance and by the orientation of the correlation line between real and estimated values, which should have a slope of 45^o in an ideal situation.

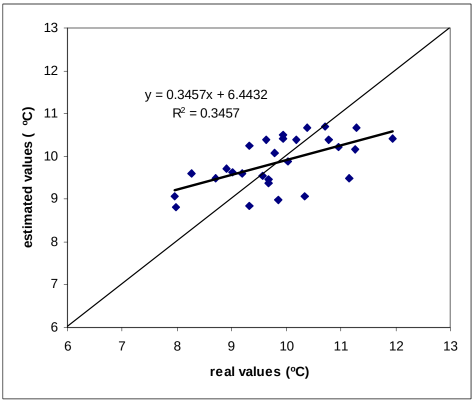
The estimations achieved by using the 4 models are given in table 2. As expected, the model based exclusively on cyclic components gives the lowest temperature estimates (8,9-10,3^{o}C), while the model based on the recent global CO_2 increase gives the highest temperature estimates (10,4-11,4^{o}C).



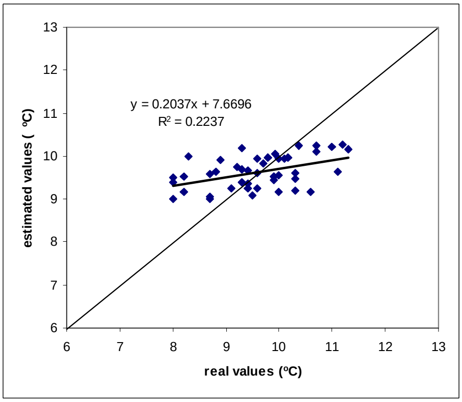
model using cyclic components



model using trend and cyclic components



regression model using global CO_2 data, number of sunspots (1980-2007)



regression model using Mauna Loa CO_2 data, number of sunspots (1959-2007)

Fig. 5. Correlations between real and estimated temperature values using the four statistical models.

Table 2

Estimated mean annual temperature values for the prediction interval using the four statistical models

Prediction interval	Estimated mean annual temperature - cycles -	Estimated mean annual temperature - trend, cycles -	Estimated mean annual temperature – predictors	
			global CO_2	Mauna Loa CO_2
2008	9,66	10,17	10,36	9,79
2009	8,96	9,50	10,60	9,92
2010	9,40	9,98	10,89	10,09
2011	9,28	9,89	11,16	10,25
2012	10,19	10,83	11,35	10,35
2013	9,61	10,29	11,42	10,37
2014	9,99	10,69	11,37	10,31
2015	10,29	11,03	11,24	10,19
2016	9,43	10,20	11,11	10,07
2017	9,85	10,67	11,04	10,00
Mean	**9,67**	**10,33**	**11,05**	**10,13**
Maximum	**10,29**	**11,03**	**11,42**	**10,37**
Minimum	**8,96**	**9,50**	**10,36**	**9,79**

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THE NUMBER OF EQUIVALENT DROUGHT DAYS AND THE SYNTHETIC INDEX OF DROUGHT INTENSITY

IULIAN CĂTĂLIN STÂNGĂ[1]

ABSTRACT. The Number of Equivalent Drought Days and the Synthetic Index of Drought Intensity. Using data from seven meteorological stations and 27 rainfall gauges from the eastern part of Romania, the present paper desires to evidence more clearly the real significance of drought phenomena. This was done with the help of two distinct expressions, resulted from the processing of daily values of the climatic parameters: equivalent drought and the synthetic index of drought intensity. Equivalent drought shows the length of the interval lacking precipitations, characterized by similar consequences in different temperature conditions, and it was computed by reporting water consumption (evapotranspiration) according to a series of elements standard considered. The synthetic index of drought intensity (severity) has been proposed taking into consideration both the length of the drought interval as well as its mean temperature (practically expressing water consumption), to which is added and the sum of precipitations from a previous interval (to approximate the easily and directly accessible crop water reserves).

Keywords: *climatic parameters, daily values, equivalent drought, drought intensity.*

1. INTRODUCTION

Defining drought is extremely difficult, this issue being approachable from different viewpoints, according to each of these, the term's understanding being slightly or very different. From a genetic point of view, droughts relate to the existence of periods lacking rainfall, long enough so as the hydric deficiency to be felt at the level of the natural and human systems or subsystems. Many times are being identified several drought types (atmospheric, hydrologic, soil-related, physiological, agricultural), essentially being the same phenomenon, that gradually evolves, modifying the ratio between the water reserves and the requirements of a certain system. If the atmospheric drought persists, long enough, the wind and temperature intensify the evapotranspiration and thus reduce the soil water reserve up to the pedologic drought: this reserve is gradually exhausted up to the wilting point, leading to the irreversible crop fading. This aspect is characteristic to all the droughts that occur during the vegetation period. In addition, in the case of the drought occurred outside this period it contributes to the decrease in the available water capacity, with negative consequences in the first part of the crops' vegetation period.

Evaluating drought as a climatic risk phenomenon implies some uncertainties. These are of objective (inherent to the natural variability of the weather states and of the climatic characteristics – stochastic uncertainties) – or subjective nature (due to the lack of a complete database, with information from meteorological stations that would cover the entire analyzed territory, or due to other aspects regarding strictly the scientific approach – epistemic uncertainties) (Stângă, 2007). In such situations, most of the times the study of droughts has

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a diagnosis character, but extremely important for the correct identification and evaluation of the maximum risk areas, where we must take into account an effective intervention, by prevention and negative effects' diminishment.

2. INDICES USED IN THE EVALUATION OF THE DRYNESS AND DROUGHT PHENOMENA

The practical utility of knowing, diagnosing, monitoring and predicting dryness and drought explains the special interest for a more precise evaluation of these risk phenomena. In our country, these phenomena were studied by different methods, among them rainfall or aridity indices, bioclimatic indexes, calculations of evapotranspiration and soil water balance for different crops, the use of rainfall and hydric balance indices (Stângă, Minea, 2004, 2005).

The very large number of drought evaluation indices and methods may be grouped in several categories, according to the methodology and spectrum of the used climatic parameters (uni- or multi criteria approaches):

- *rainfall indices and criteria:* the Hellman criterion, Topor rainfall index, deciles method, rainfall percentage index, Bhalme-Mooley drought index, standardized precipitation index, effective drought index, Gaussen xerothermal index, rainfall anomalies index, etc.;
- *hydric balance and complex indices*: de Martonne dryness index, Thornthwaite climatic characterization, Selianinov hydro-thermic index, Palfai drought index, Soroceanu humidity index, Palmer drought severity index, etc;
- *diagrams and climograms:* Walther-Lieth, Peguy, Gaussen ombrometric diagrams.
- *indices determined on the basis of satellite images:* normalized vegetation index, vegetation state index, normalized multispectral drought index, the drought index determined on the basis of the vegetation albedo etc.

The indices based on satellite images imply a distinct methodology, and the obtained results reflect an indirect evaluation of drought (through the effects it had at a certain moment), the technique having the indisputable advantage of offering in relatively short time a regional or even global scale image of the phenomenon. The first three categories of indices are based on direct determinations at rainfall stations and gauges, the relevance of the results depending on the time span of the data, the territory covered and the selection of parameters, to which are normally added the elements specific to each method. The length of the observations assures the statistical relevance; the density of the observation points offers the possibility of interpolating and the precision of the spatial representations, requisite for a geographical study, while the selection of the used climatic parameters gives consistency to the research method.

The preferential use of monthly average values for the calculation of the specific indicators is justified by practical reasons that have in view the access to direct data, as well as the difficulties of processing an over-dimensioned set of daily observations, which would be needed for large-scale studies. The average values evidently reflect the overall characteristics of the climate and its general evolution tendency, yet the analysis of the meteo-climatic risk phenomena recommends in such situations the use of the daily values of the climatic parameters, especially for a more accurate evaluation of the length and intensity of the dryness and drought phenomena.

The present study, that refers to the south-central part of the Moldavian Plateau – was conducted based on daily values and monthly average data (between 2002 and 2008) taken from several sources. First we have used the database (1963-1999) created by Tatiana Bradu (2004) for her PhD thesis (with her approval), later completed with data offered by the National Meteorology Administration, Bucharest (1961-2007), on the basis of a collaboration during the CEEX 756/2006 research grant. Equally, with the help of the Moldova Iaşi Regional Meteorology Center we have obtained daily data for rainfall and other meteorological phenomena from the rainfall measurement stations from the region. The most delicate problem was the selection of the most representative data, in the conditions of a variable observation period (mainly for the rainfall measurement stations).

The processing of the daily values and monthly means from seven meteorological stations and 27 rainfall measurement gauges allowed us to propose two new indicators used in the evaluation of the drought phenomena in Tutova Hills: the number of equivalent drought days and the synthetic index of drought intensity (severity).

3. THE NUMBER OF EQUIVALENT DROUGHT DAYS

According to the Hellmann criterion, the dryness and drought periods are determined based on the number of consecutive days with rainfall less than 0.1 mm. Thus the dryness periods are considered as intervals lacking rainfall of 5-9 days for April – September, ore 5-13 days for October – March. The drought periods are the intervals lacking rainfall in at least 10 days in the warm season and at least 14 days in the cold one. Based on this criterion and analyzing the data from the rainfall gauges in Tutova Hills for the 1980-2003 interval, we see that yearly are registered 10-13 dryness periods and 3-4 droughts.

Later, we attempted a more precise evaluation of the length and intensity of the droughts, having in mind the fact that they are the extreme climatic phenomena with the highest occurrence in the region. In this purpose, we have selected all the intervals ≥ 10 days in which were registered rainfall larger than 0.1 mm, the respective value not being taken into consideration as threshold because it does not have an agro-climatic significance. In a second stage, based on the information from the meteorological stations, we evaluated air temperature for each interval lacking precipitations. If daily temperature data are missing, we may use mean decadal values to approximate drought period temperature. Even if some errors occur, they are usually insignificant for later calculations, and some of them may be eliminated through mathematical and statistical corrections.

In Tutova Hills, from the 493 cases introduced in the analysis (Rădeni, Ghergheşti, Banca, Lipovăț, Puieşti, Cuibul Vulturilor, Coroieşti, Pogoneşti, Coloneşti) for the 1980-2003 interval, the drought length exceeded the threshold value of 30 days in 3.85% of the cases, entered the 20-29 days interval in 22.72% of the cases and the 10-19 days interval in 73.43% of them. Their distribution during the year is variable, the maximum values of drought length and frequency being registered during August – March. The longest period lacking precipitations summed 47 days at during August 24th – October 9th 1982, on the background of a maximum pressure baric field over east-central Europe. In fact, September 1982 (1-6 October) represented the longest drought period also for the Moldavian Plain, where were registered 36 consecutive days lacking precipitations (Mihăilă, 2006).

The significance of the drought intervals is different from a season to another, mainly according to temperature and water consumption. Thus, to be able to compare drought intervals from different periods of the year we computed **the number of equivalent drought days,** by applying a coefficient evaluated according to water consumption and strongly conditioned by temperature. The evaluation of water consumption was done by using the correlation between temperature and Penman-Monteith reference evapotranspiration (Păltineanu ş.a., 2007):

$$PM\text{-}ET_0 = 0.0048 \cdot T^2 + 0.0678 \cdot T + 0.4888.$$

To obtain the correction coefficient, we first computed reference evapotranspiration for each value of air temperature (between -10°C and +40°C). For simplification, we preferred using value classes for which we computed mean reference evapotranspiration (PM-ET). For the climatic conditions of low hills and plains regions, we consider as threshold the temperature span of 10-15°C, characterized by a mean reference evapotranspiration of 2,11 mm/day and an unitary calculation coefficient according to which all other corrections are made (table 1). For other climatic conditions (subcarpathian or mountainous area) would be recommended the use of another landmark temperature span, closer to the multiannual mean value of air temperature (5°-10°C) from that region.

Table 1

Parameters specific to equivalent drought

Temperature classes	$PM\text{-}ET_0$ (mm/day)	Coefficient equivalent drought	Equivalent drought for standard interval (ten days with 10-15ºC)
≤ 0°C	0.31	0.15	2
0-5°C	0.7	0.33	3
5-10°C	1.28	0.61	6
10-15°C	2.11	1.00	10
15-20°C	3.17	1.50	15
20-25°C	4.47	2.12	21
25-30°C	6.01	2.85	29
>30	7.79	3.69	37

The application of these coefficients allows the comparison of drought intervals for different values of air temperature, thus differently reflecting water consumption by evapotranspiration. Thus, ten days lacking precipitations have the significance of only two days of equivalent drought if air temperature does not exceed 0°C, 10 days of equivalent drought at air temperatures of 10-15°C and 37 days of equivalent drought if air temperature exceeds 30°C.

Evaluating droughts according to the number of equivalent drought days was later grouped in several classes: excessive: over 30 days of equivalent drought; very strong: 21-30 days of equivalent drought; strong: 11-20 days of equivalent drought; moderate: maximum 10 days of equivalent drought. Among the drought cases analyzed in Tutova Hills, we see that 14.68% enter the category of excessive droughts, summing up over 30 days of equivalent drought; 20.73% are very strong droughts; 29.37% are strong, while 35.22% are moderate droughts. The most severe are the ones from the first category, with a mean real length of 23 days, occurred in 79.71% of the cases during July - September, in the period of the maximum water consumption by crops. This implies severe losses, mainly if we have in mind the agricultural specific of the region, with a high dominance of arable terrains and long vegetation crops.

The number of equivalent drought days is in our opinion an indicator that allows a comparative analysis between periods or regions in which water consumption is different, and thus having an extremely important agro-climatic significance.

4. THE SYNTHETIC INDEX OD DROUGHT SEVERITY

To express and interpret the significance of each interval lacking precipitations, we wanted to take into account the easily accessible water reserve, evaluated by only taking into account two climatic parameters and no soil hydro-physical coefficients. In this purpose, we elaborated a multi-criteria synthetic index of drought intensity. The length of the interval lacking precipitations and its temperature are evaluated identically as in the case of equivalent drought. More, while extracting from the observation tables the intervals lacking precipitations ($\geq$ 10 days with less than 0.1 mm precipitations), are also extracted the sum of precipitations from the decade previous to the analyzed interval. Thus, **the synthetic index of drought intensity (severity) (Is)** is based on the length of the interval lacking precipitations (D_i), mean air temperature of the interval (T_i) and the sum of precipitations in the previous decade (P_{i-1}), the calculus formula being:

$$Is = D_i \cdot \frac{T_i + 10}{P_{i-1} + 1}.$$

Air temperature is reflected directly in water consumption by evapotranspiration. This is why we have considered it as directly proportional to drought intensity, the conventional plus of +10 being justified by the necessity of eliminating errors introduced by negative temperatures (as in the case of the „de Martonne" aridity index). The precipitations from the ten days previous to the analyzed period express in relative terms the available and easily accessible water reserve, being evaluated inversely proportional to the index value. If in the case of the minimum duration of the drought interval we departed from the Hellmann criterion, in the evaluation of the water reserve we choose the same interval (ten days). The choice of a variable interval would create over-lapses and would lead to an erroneous evaluation of the existing reserves (that would obvious accumulate as the interval increases). The adding of 1 for the denominator has the meaning of reducing the extremely large value span of the index, imposed sometimes by the existence of ten consecutive days with precipitations between 0.2 and 1.0 mm. The length of the interval lacking precipitations has the purpose of illustrating the cumulative effects of drought, as intense as it extends on a longer period.

In parallel, drought intensity may be computed with the help of the following formula: $Is = D_i \cdot (ET_i/P_{i-1})$. In this case the supplementary corrections (+10, +1) for the numerator and denominator are no longer needed. The results are clearly similar, being evidenced by a significant (0.91), but predictable (having in view the fact that evapotranspiration has been computed indirectly using air temperature) statistical correlation.

The variation of drought intensity (severity) according to the precipitation quantity from the previous decade in which mean air temperature is of 5ºC, 10ºC, 15ºC, 20ºC, 25ºC and respectively 30ºC is suggestively given in figure 1. For the standard interval (ten days) and the temperature thresholds taken into consideration, the graphic representation illustrates the increase in drought intensity (*IsTi* – drought intensity at temperature *i*) as the precipitation quantity measured in the previous decade decreases from 50 mm towards 0.5 mm.

In figure 2 is shown the variation in drought intensity according to temperature, for an interval lacking precipitations of ten days and a precipitation quantity in the previous decade of 5, 15, 25, 35, respectively 45 mm. For the standard interval and the mentioned precipitation quantities, the graphic representation is the expression of a linear function that illustrates drought intensification as temperatures rise from -5°C to 35°C (IsPi – drought intensity for a precipitation quantity in the previous decade of *i* mm).

The value span of the index is quite large, separated into four distinct significance classes: $\leq$ 20 – moderate drought; 21-50 – strong drought; 51-100 – very strong drought; > 100 – excessive drought. From the cases analyzed in Tutova Hills based on the drought intensity index, we see that 42.8% of the droughts have moderate character, 29.6% are strong, and 16.6% are very strong, while 11.0% have an excessive character. The analysis of the monthly distribution of droughts is not easy, since in over 35% of the cases the drought interval begins in a month and ends in the following one. We cannot consider the beginning of the drought interval as a criterion, since the real effects are felt most of the times in the second part of the interval.

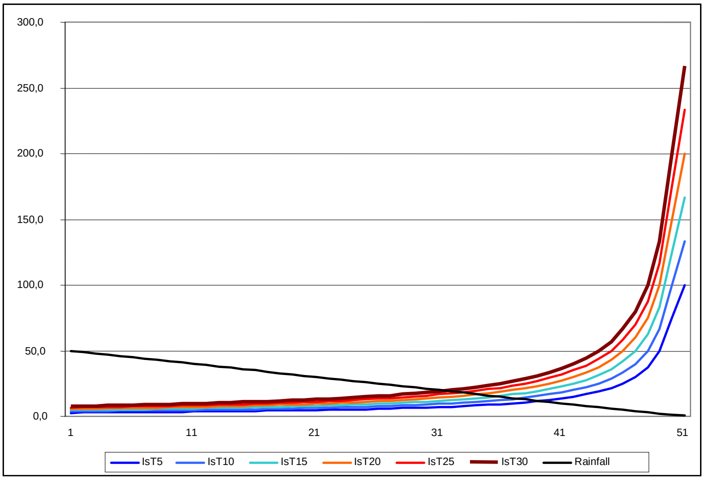

Fig. 1. Drought intensity according to the precipitation quantity from the previous decade (50-0.5 mm) for different temperature thresholds (IsTi)

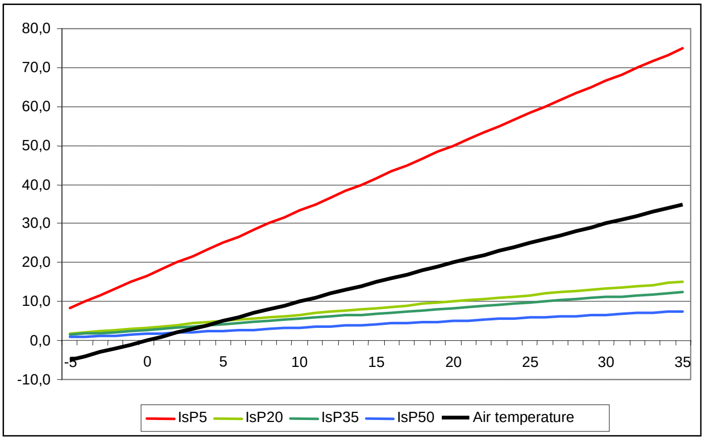

Fig. 2. The variation in intensity of a ten days interval lacking precipitations according to air temperature, in the conditions of standard precipitation values for the previous decade

Analyzing the data from table 2, we observe that the highest values of the synthetic index of drought intensity characterize the cold season, on the background of generally low precipitations (considered as available humidity). In this way, although the real water consume is reduced on the background of accumulations of insignificant reserves through precipitations, the values of the index seems exaggeratedly high, yet illustrating the features of atmospheric drought with a climatologically relevance. In the analysis of meteo-climatic risks we desire to apply corrections and a different percentage of the factors introduced in the equation, inclusively for the evidencing of the water reserve blocked by frost during winter. The results will be presented as they will be tested, validated and considered representative.

Table 2

The characteristics of the longest periods lacking precipitations in Tutova Hills (1980-2003)

Period i	Station	Di	Ti	PM-Et_0	PP_{i-1}	Equiv Days	Is
24.07-9.10.1982	Gherghești	47	20.4	181.9	19.2	99.6	70.7
15.01-21.02.1989	Pogonești	38	3.3	29.1	2	12.5	168.5
24.07-27.08.1993	Cuibul Vulturilor	35	19.9	130.9	25	52.5	40.3
20.07-22.08.1992	Puiești	34	20.9	136.1	9.8	72.1	97.3
16.01-17.02.1989	Cuibul Vulturilor	33	3.3	25.2	0.6	10.9	274.3
24.10-25.11.1991	Cuibul Vulturilor	33	9.9	53.8	26.3	20.1	24.1
1-31.01.1992	Cuibul Vulturilor	31	-2.5	10.8	6.4	4.7	31.4
1-30.01.1992	Pogonești	30	-2.5	10.5	0.8	4.5	125.0
7.11-6.12.1990	Cuibul Vulturilor	30	7.5	38.0	8.5	18.3	55.3
18.10-16.11.1982	Gherghești	30	10.1	49.9	14.8	30.0	38.2
19.07.-17.08.1988	Cuibul Vulturilor	30	22.4	132.5	46.3	63.6	20.5

4. CONCLUSIONS

In the attempt of a more precise evaluation of dryness and drought phenomena, the present paper proposes and describes two new indicators, elaborated based on daily values of climatic parameters: equivalent drought and the synthetic index of drought intensity. To catch the relevance of the proposed indices, we synthetically presented the characteristics of the longest periods lacking precipitations for different rainfall gauges from Tutova Hills. The significance of the two indicators is easily different. Thus, **the number of equivalent drought days** expresses more clearly the hydric stress from the warm period of the year, having special agro-climatic relevance. Meanwhile, **the synthetic drought intensity index** better reflects strictly climatic peculiarities, evidencing atmospheric drought.

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III. Hydrological Environment

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G.I.S. PROCEDURE FOR FLOOD-PRONE AREAS MAPPING BASED ON THE RESULTS OF THE FLOOD SIMULATION MODELS

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ABSTRACT. G.I.S. Procedure for Flood-Prone Areas Mapping Based on the Results of the Flood Simulation Models. The development and implementation of the procedures for flood-prone area rapid mapping in the operative activity of the hydrological forecast is an important step in providing real-time information to the institutions involved in the management of the affected areas. In order to know the potentially flooded areas, a series of software programs was developed, starting from inputs resulted from the hydrological models and hydraulic routing.

Representing the results of the flood simulation mathematical models, actually leads to the delimitation of the flood-prone areas. For their representation in GIS environment, it was developed a simplified procedure that uses in addition to D.T.M. only the river bed thalweg and the forecasted value of the water level in successive profiles.

This paper presents the work steps of the methodology, the GIS chart model made in ArcGIS 9.2, the Builder Model module, and also a case study for the Ialomita River, on a river branch with a length of about 110 km.

***Key words**: rapid mapping, flood-prone areas, flood simulation, GIS.*

1. INTRODUCTION

The use of Geographic Information Systems (GIS) in hydrology and water management is based on the idea that water, climate and society formed a whole system that could be studied using spatial modeling and analysis, GIS becoming a useful tool. The global changes leading to the intensification of extreme events and the increasing water demands require more detailed knowledge of this resource. The unequal distribution of water in space and time, due to hydrological cycle, makes the study of water through GIS very useful and practical.

Floods represent one of the main natural disasters, affecting many states over a year, endangering life, environment and natural resources, and leading to large economical losses and social and health problems, too.

In 1992, WMO has elaborated the following definition for floods: *"the submersible position of floodplain, caused by the river water that exceeds the river channel or by the accumulation of precipitation or snow-melting water in areas of insufficient natural drainage"*. A more recent definition is presented in the Directive of the European Parliament regarding the assessment and management of floods - Directive 2007/60/EC: *„flood' means the temporary covering by water of land not normally covered by water…"*.

The disasters produced by floods are favored by man, due to the fact that he exposes himself to risk through the development of the settlements, economic and agricultural activities, roads, bridges, etc., in the floodplains (Mustăţea, 2005) – fig. 1.

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Fig. 1. The economica effects of floods

Left) The collapse of a bridge at Bâsca Chiojdului during the flood in May 2005 (photo V. Chendes);
Right) The morphological change of Trotuş river bed and the collapse of the bridge downstream to Tg. Trotus during the floods in July 2005 (Source: ANAR)

In runoff assessment and modeling, especially in flood-prone assessment, the GIS and Remote Sensing methods are very important. The classical hydrological analyses are generally based on point data, not on spatial data. The modern methods of spatial analysis specific to these fields complete the hydrology, allowing, not only the spatial data organization, visualization and, especially, processing and analysis, but also the increasing of performances and efficiency of hydrologic and hydraulic models through the physico-geographical component of these technologies.

For the runoff forecasting in real time, a permanent data exchange is necessary between several components of an integrated hydrological system, including hydrologic, hydraulic and GIS-based models.

2. Hydrologic and hydraulic simulation models

The CONSUL – UNDAP software package, available within the NIHWM, was used for flood simulation.

CONSUL deterministic hydrologic model allows simulation of all phases of the runoff, both in the small and the large river basins, natural or hydrotechnically arranged. It is a conceptual model based on sem-distributed parameters depending on the physical characteristics of the river basin: topography, vegetation, and soil. The rainfall-runoff process modeling taking place in a watershed, by using CONSUL model, can be achieved following the main steps below (*Chow*, 1971; *Şerban*, 1984a, b; *Şerban* and *Corbuş*, 1987; *Şerban* and others, 1989):

- Determination of the snow-melt water, using the degree-day method;
- Calculation of the effective rainfall by extracting the infiltration and evapotranspiration loss from the average water inflow using PNET deterministic reservoir model;
- Effective rainfall integration on slopes and in the primary hydrographical network using the unit hydrograph method;
- The composition of flood waves and their routing along the river using Muskingum transfer function;
- Flood wave attenuation through reservoirs using Puls method;
- Forecasts updating using CORA procedure.

UNDAP hydraulic model simulates the one-dimensional, unsteady flows with free surface and it can treat one-string river bed and dendritically and rig-shaped river beds as well. It is based on the numerical integration of Saint-Venant equations with partial derivatives, according to a rectangular network in the plane (space, time), making use of the double scanning algorithm for a given time step, and offering the results needed to establish the flood risk. Although it is a one-dimensional model, due to its operative features and good performances in simulating the unsteady flow, it is one of the most used models.

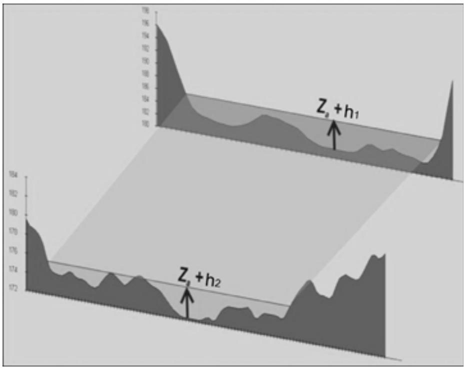

Fig. 2. The use of forecasted water level in successive profiles

The main input data are discharge hydrographs provided by the CONSUL program, rating curves in a single output cross section, geometric elements of the river bed in used cross sections (water level, width, depth, and roughness).

Coupling between CONSUL and UNDAP models was performed using the TRCONUND program which allows to transfer the forecasted hydrographs computed with CONSUL model from output file in the input file of the UNDAP model. UNDAP results are stored in an ASCII file type, consisting mainly in water levels, depths, widths in the mirror of water, drain sections, velocity and discharges in all computed cross sections.

3. Flood-prone areas representation in GIS environment

Nowadays, large efforts are focused on developing maps for flood-prone areas with different return periods, in order to use them in planning and managing different components of human society. They are maps of imaginary (theoretical) floods, not maps of flooding forecast for an approaching storm (Jones, 2004).

In this respect, a simplified GIS procedure has been developed, to translate the flood levels of the various events forecasted using CONSUL and UNDAP models. It uses, in addition to DTM only the river thalweg, and the forecasted water level in successive profiles (fig. 2).

Besides the mathematical model results of the flood routing, the precision and the quality of the DTM is another important element to obtain some flood-prone areas with a high accuracy. Unlike the DTM used for general purposes, accomplished only on the basis of the topographical information, having maps (contour level and elevation points) as source, the ones used in hydrologic (especially in the hydraulic) modeling involve a very accurate river channel drawing up, through field measurements (fig. 3).

DTM quality is very important in dikes areas, too. The relative small width of dikes (5 – 10 m generally) makes important not only the accuracy of the DTM, but also its resolution, especially when topographical maps are used as information source for elevation, or when field measurements are required. In these cases, a lower resolution averages a large range for altitudes, leading to distortions of real dike elevation.

DTM based on information from topo maps at the scale 1:25000 can be obtained at 15 - 30 m resolution, and could be reduced at 5 – 10 m by cross section integration. But small width of dikes requires a higher-resolution data (around 0.5 - 2 m), that could be obtained from LIDAR (Light Detection and Ranging) type DTM.

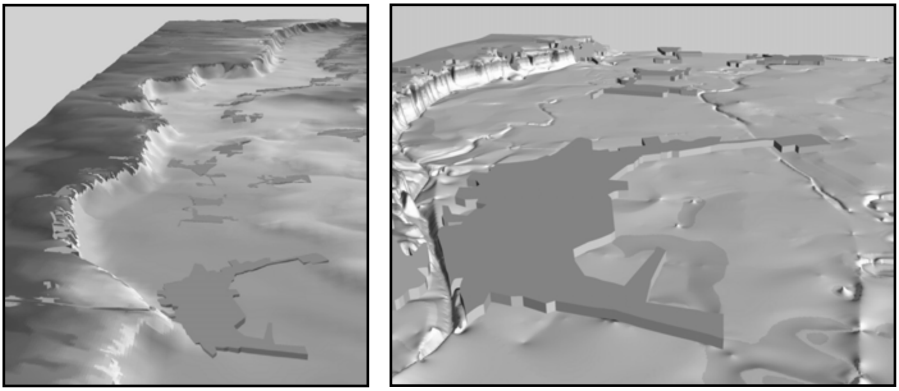

Fig. 3. Increasing DTM quality by field measurements integration, especially cross sections
Left) DTM accomplished on the basis of topographical maps; Right) Enhanced DTM to accomplish hydraulic modeling requirements

The lack of such DTMs leads to the need to enhance the information from topographical maps. The large differences between topo maps and the current state (new reservoirs, meanders rectification, etc.) impose the use of updating data sources: satellite images Landsat ETM+, orthophotomaps etc. The integration of the cross sections with initial topographical information has been done both by using the field measured points and by generating some lines characteristic for the river bed (thalweg, banks and dikes). The elevation of these lines is known for the cross sections, the next step being to extrapolate these values between profiles for detailing the geometry of the river bed.

For each forecasted value h a quasi-parallel plan to the river bed channel (of the thalweg) is generated. This plan has the Z_1+h_1 elevation in profile 1, Z_2+h_2 in profile 2, etc., where Z represents the thalweg altitude and h represents the increase of the level forecasted for each profile.

The main steps in the flooding areas representation are the following:

- discretizing the river thalweg to points – a simple GIS procedure to convert a line to points
- assigning to each point a value of altitude (z) on the DTM basis
- calculating the water level in each point of the river thalweg, taking into account the water levels in successive cross sections (MS Excel procedure)
- building a Thiessen polygons network corresponding to the thalweg points.
- transferring the "water level" values of each point to the associated polygon; this step is done by using an unique identifier, inside a JAVA procedure developed to couple the UNDAP and GIS models, in order to transfer the UNDAP results and water level data for the entire river thalweg in the GIS input files (Thiessen polygons).
- transforming the Thiessen polygons in grid [thiessen_w], using water level in that particular point as attribute (vector – raster conversion)
- comparing water level [thiessen_w] and DTM value through the difference between the two grids:
  - positive values: the submersible area (the flood-prone area)
  - 0 value: the flood-prone area limit
  - negative values: the immersible area (above the water)

- obtaining the flooded affected area by querying and selecting the pixels having positive values.
- separating flood-prone areas, located in the river neighbourhood, from other potential flood-prone areas, located behind the dikes and other obstacles, representing areas with lower altitude than the forecasted water level. This step is necessary only if the water level is lower than the dike elevation.

The most important problem is the difficulty to automate the whole GIS procedure, due to the lack of an adequate DTM to hydraulic modeling (a DTM LIDAR type or integrated cross sections). For the most part of it, a flow-chart using Model Builder module in ArcGIS 9.2 has been developed.

The procedure is designed to represent, using GIS techniques, 10 successive moments of the event (time step can be hourly or daily). This could be done by using number of 10 Thiessen polygons files containing level data obtained with JAVA procedure.

4. Runoff simulation in Ialomița River Basin

Considering CONSUL model for the simulation of flood, in view to divide the catchment in sub-basins and the river network in reaches, for the Ialomita River Basin 22 sub-basins and 13 river reaches resulted.

For model parameter calibration seven flood events have been selected: May 1973, July 1975, June 1979, July 1981, August 1982, November 1996 and February 1999.

The study of flood wave routing using the hydraulic model was made for Ialomita River, on the Cosereni – Slobozia sector. This river sector has a length of 110 km and a very large flood plain that overflows at rates of 350 – 450 m^3/s. The overflowed water is lost through infiltration and evaporation. For this reason there is significantly non-concordance in volume, especially for large high floods.

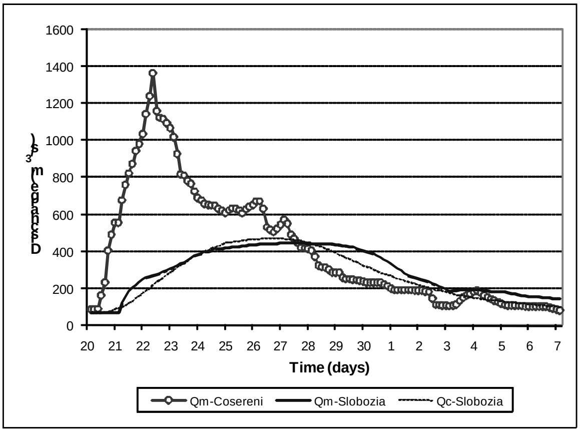

Fig. 4. Measured (Qm) and computed (Qc) hydrographs for flood in September 2005

Following the flood simulation in April 2000 and taking into account the morphometric characteristics of the river sector and the routing duration of the maximum flow, optimal values of the hydraulic model parameters have been obtained.

Figure 4 shows simulation results of the flood in September 2005 on the Ialomita River, sector Cosereni - Slobozia.

GIS modeling has been done for a 10 days period (20 - 29.09.2005). At Cosereni the maximum discharge was 1366 m^3/s, registered in September 22. The maximum level was 753 cm over “0” reference point of hydrometric station (846 cm over thalweg) – fig. 5. As a result of overflow phenomenon in the very large flood plain of Ialomita River, the discharge gradually decreased, reaching the value of 448 m^3/s at Slobozia in September 27. The level decreased to 664 cm over thalweg.

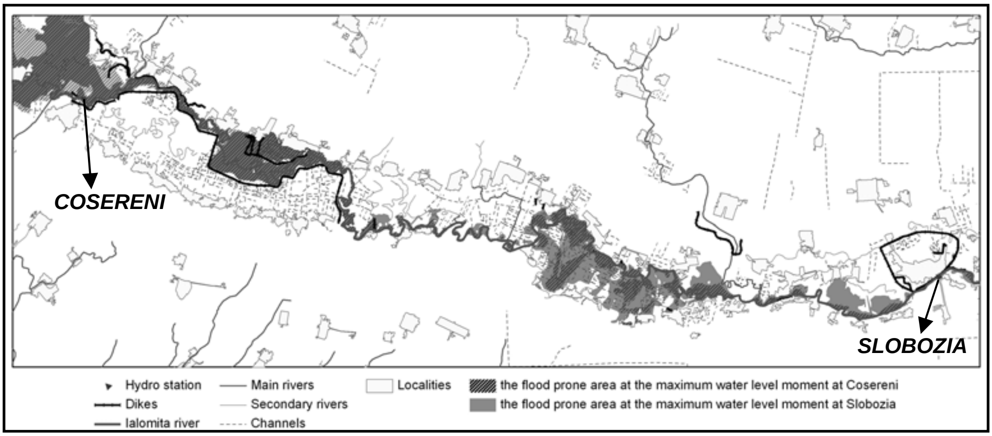

Fig. 5. The evolution of flood-prone areas at the moment of maximum level

In the vicinity of Slobozia, the flood-prone area has covered large surfaces downstream and upstream the town (fig. 6), but closely to the town, the dikes kept the flood in the narrow area of the river bed. It has to be highlighted the level difference between the two banks, the dikes being built-up on the left bank, lower than the right one with 20 – 30 m.

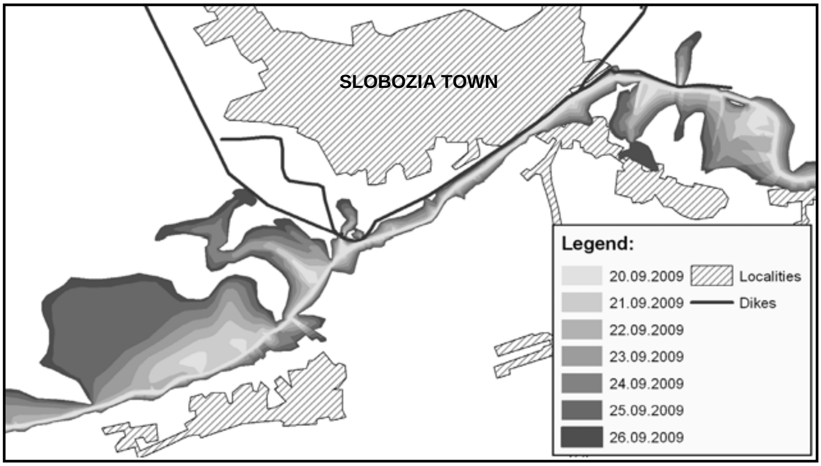

Fig. 6. The evolution of flood-prone areas during the increasing period

5. Conclusions

Flood mapping is a widely used tool in the assessment of the extent of flooding over floodplains and in the development of planning instruments. This phase is based on simulation model results: maps for flood extension, water depth, flood contours, flood hazard categorization, etc. for existing conditions, for proposed management scenarios and for a range of flood events.

Programs package allows providing information in real time to the institutions involved in the floods management. The knowledge of potential flood-prone areas in advance due to forecast models leads to the enhancement of the activities for floods effects diminishing.

Development of the operational version of the models and its application on river sectors having high quality DTMs lead to an increasing warning and decision time.

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GLACIER RISKS AND DISASTERS IN THE ALPS MOUNTAINS

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ABSTRACT. Glacier Risks and Disasters in the Alps Mountains. The present paper synthesizes and analyzes the main types of glacier hazards, both with rapid effects (glacier outburst floods, ice avalanches, rock falls, and landslides that affect glacial valley slopes), and with slow effects (glaciers fluctuations). The causes generating glacier hazards and the consequences they bring about are emphasized through theoretical considerations and are supported by examples. The analysis focuses on the Alps Mountains, where glaciers occupy considerable areas and where, over the time, many glacier hazards, some of them with catastrophic damages, have occurred. The capitalization of tourist and hydropower potential of mountain glaciers has increased the economic value of alpine area, but at the same time it enhanced its vulnerability to glacier-related risks.

Key words: *glaciers, risks, ice avalanches, glacial floods, tourism, Alps Mountains.*

1. INTRODUCTION

Glacier risks, as any other natural risk, are the resultant of the joining of two major components: the natural hazard and the vulnerability (Dauphiné, 2003). They constitute a category of hydrodynamic risks induced, directly or indirectly, by glaciers.

The present paper aims at making a synthetic presentation of glacier risks and disasters generated by mountain glaciers, aspects that have been slightly approached in the Romanian literature, especially because glaciers do not show up in the Romanian landscape. However, such a synthesis can add up to the existing information with regard to hydric risks, in order to better perceive their complexity and diversity. The paper focuses on the Alps Mountains, which over the years have been affected by several glacier disasters. More than that, the vulnerability of this area to glacier hazards has continuously increased as a result of its social and economic development, due, to a large extent, to the capitalization of the glaciers touristic potential, as well as to the water resources they posses. The paper relies on bibliographic information, as well as on personal observations undertaken during several trips in the alpine area.

2. GENERAL DATA REGARDING THE EXTENSION OF ALPINE GLACIERS

The Alps shelter more than 3,000 glaciers, totalizing an area of about 2,300 Km^2[2]. Specific for the region are the valley glaciers, with well-developed tongues. Alpine glaciers are scattered over six countries: Switzerland, Austria, France, Italy, Germany and Slovenia. The most numerous (1006) are on the Swiss territory, which holds nearly half of the total

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[2] According Francou & Vincent, 2007. Dolgușin & Osipova (1989), quoted by Grecu (1997), give like total area of glaciers in Alps Mountains, 2682 Km^2.

area covered by alpine glaciers. Austria and Italy shelter 800 glaciers each, with areas of 561 km^2 and 526 km^2 respectively, while in France there are 465 glaciers that hold an area of 369 km^2 (Dolguşin & Osipova, 1989, quoted by Grecu, 1997). The most widespread alpine glaciers are found in the Swiss and French Alps (Table 1).

Table 1.

Morphometric data on the major alpine glaciers

Glacier	Location/Country indicative	Area (Km^2)	Length (Km)	Max. altit. (m)	Min. altit. (m)
Aletschgletscher	Bernese Alps/CH	126,29	24,7	4160	1565
Gornergletscher	Valais Alps /CH	38,25	14,1	4610	2240
Fieschergletscher	Bernese Alps /CH	33,06	16	4180	1681
Mer de Glace	Mont Blanc Massif /F	33	12	3600	1480
Unteraargletscher	Bernese Alps /CH	22,7	13,5	4090	1930
Oberaletschgletscher	Bernese Alps /CH	21,7	9,1	3890	2144
Unterer Grindelwaldgletscher	Bernese Alps /CH	20,6	9	4100	1090
Pasterzen Kees	Austrian Alps/A	17,7	9,4	3700	2070
Rhonegletscher	Urner Alps/CH	17,38	10,2	3620	2208
Corbassière	Pennine Alps (CH)	16	9,8	4310	2219
Argentière	Mont Blanc Massif/F	15,6	9	3500	1500
Bossons	Mont Blanc Massif /F	10,53	7,2	4800	1190

Source: World Glacier Monitoring Service, http://www.geo.unizh.ch/wgms/fog.html

The main glaciers of the French Alps are in the Mont Blanc Massif. There are about 100 glaciers with a total area of 200 km^2, of which 125 km^2 in France, 42 km^2 in Italy and 33 km^2 on Swiss territory (Grecu, 1997). On the French side, the most important glaciers are Mer de Glace, Argentière, Bossons, Tour, Talefre, Taconnaz, Griaz, Bionnassay, Tré la Tête et al. On the Italian side the largest glaciers are Brenva and Miage, while on the Swiss side Trient and Saleina are the most significant. In the French Alps smaller-sized glaciers are to be found in the Grandes Rousses Massif of the Dauphiné Alps (Blanc, Noir, Saint Sorlin and Sarennes glaciers), as well as in the La Vanoise Massif of the Graian Alps (Gébroulaz and Chasseforêt glaciers).

3. DYNAMICS OF ALPINE GLACIERS – FACTOR OF GLACIAL RISK

One of the main causes that determines the occurrence of glacier hazards in mountain area is glacier dynamics, represented by the sliding and fluctuations of the ice mass. Glacier sliding is a consequence of the ice viscosity and plasticity. Under its own weight, the ice slides down on the bedrock with variable speeds, depending on several factors, such as: ice thickness, bedrock features (gradient, shape, rugosity), ice base features and the presence of sub-glacial water and sediments. Glaciers movement velocity grows in spring and summer, when melt water and sub-glacial sediments favor the sliding. In the presence of steeper slopes and thresholds the ice cracks. Thus, crevasses of variable depths (up to 25 – 30 m) arise, which may break up the glacier's tongue in huge ice blocks (*séracs*). In the sections where the gradient is higher the increasing ice velocity renders the ice blocks unstable and consequently they often fall with great force, endangering the downstream areas. The most spectacular ice blocks in the Alps are those belonging to Argentière (in Lognan zone), Géant (at the origin of the Mer de Glace glacier) and Bossons glaciers. In the Lognan zone of the Argentière glacier the ice speed may reach 500 m per year, while in the case of the Géant glacier it may increase even further, to 900 m per year (Moreau & Vivian, 2000), which enhances the risk of ice blocks falls with the associate negative effects.

Glaciers fluctuations are a consequence of climatic variability and they influence the lengths, areas and the thickness of ice masses. Over the time, alpine glaciers have known periods of advance and retreat, in accordance with global and regional climatic variations. During the last glacial maximum (Würm) alpine ice cap covered approximately 150,000 km^2 and the glacier equilibrium line altitude was as low as 1300 – 1400 m. In Holocene, as a result of less significant climatic variations, alpine glaciers advanced and retreated at lower rates. The Holocene glacial maximum was reached in the period 1820 – 1860, the so-called "Little Ice Age" (14th – 19th centuries), when alpine glaciers stretched out on 4,500 km^2 (Zryd, 2008).

Beginning with the 20th century, as a result of temperature increase, alpine glaciers have entered a recess period. In comparison with the year 1850 the present glaciers have lost 30 – 40% of their volume and decreased to about half the area (Francou & Vincent, 2007). From the end of the 19th century glaciers tongues retreated 1 – 2 km or even more. Thus, the main French glaciers, Mer de Glace, Argentière and Bossons, have grown shorter by 1,000 m, 1,150 m and 1,200 m respectively (*World Glacier Monitoring Service*). According to the Swiss Glacier Monitoring Network, Aletsch glacier receded by 2,875 m (1870 – 2007), Gorner by 2,118 m (1882 – 2007), Unteraar by 2,202 m (1876 – 2001) and the Rhône glacier (Rhonegletscher) by 1,225 m (1879 – 2007).

On the background of the general recession, however, some periods of advancement, like 1910 – 1930 and 1960 – 1990 existed. After 1990, alpine glaciers have entered a serious recession phase. From the perspective of global warming it is believed that alpine glaciers will continue to shrink (in some cases up to extinction), which will bring about important social and economic consequences. In the hypothesis of a "moderate" climatic scenario realized by IPCC, an increase of air temperature by 2 – 2.5^{0}C until the end of the 21st century, if precipitation remain the same, will have as result the rising of the equilibrium line altitude in the Alps, which today is at 2,900 – 3,000 m, by approximately 300 m (Francou & Vincent, 2007).

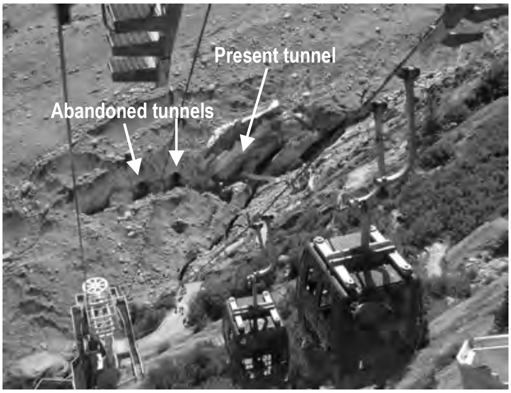
3. ECONOMIC IMPORTANCE OF ALPINE GLACIERS – ELEMENT OF VULNERABILITY TO GLACIER RISKS

Mountain glaciers are an important natural resource and consequently they have encouraged the development of economic activities in the alpine areas. Of these, the most significant are tourism and hydropower generation. The gradual increase of economic value of this mountain space has entailed however a higher vulnerability to glacier hazards.

Tourism. The value of the landscape and the diversity of leisure activities that may be practiced are major assets for touristic activities. In Switzerland, for instance, tourism contributes 5% of the GNP and in the mountain areas it absorbs up to 20% of the labor force (Zryd, 2008).

The capitalization of glaciers touristic potential has led to the appearance and development of many mountain resorts. Among the most famous in the world are Chamonix – Mont Blanc in France and Zeramtt in Switzerland. The development of transportation and services infrastructures has allowed an easy access to various parts of the massifs and encouraged the practicing of touristic activities and winter sports at elevations higher than 3,000 m. Thus, from the French resort of Chamonix (1035 m) one can reach by cable car, in less than 20 minutes, the Aiguilles du Midi peak (3,842 m), from where, also by cable car (telegondola), one can reach further, in 35 minutes, the Helbronner peak (3,466 m), passing above the supply area of the Mer de Glace glaciers (Géant glaciers). It is a trip that offers one of the most spectacular views of the Alps. The highest point that may be reached by cable car is the Klein Matterhorn peak (3,883 m). The access to it is very easy from the Swiss resort of Zermatt (1,620 m). Also from Zermatt, by means of a rack railway, one can reach in 30 minutes the Gornergrat station (3,089 m), from where tourists can get an impressive panoramic view of the many glaciers in the area, of which the most outstanding is the Gornergletscher. However, the highest rail station in Europe is Jungfraujoch (3,454 m), which can be accessed from Interlaken Swiss resort (570 m) after a spectacular journey by train that lasts about two hours and a half. Jungfraujoch station allows a grand view over the longest alpine glacier, the Aletschgletscher, which originates in this area. At Jungfraujoch is the headquarters of an environmental research center (*Sphynx Observatorium*). Another belvedere point offering a great view of the Aletschgletscher is Eggishorn (2,893 m), easily accessible by cable railway from the Swiss resort of Fiesh in the Rhône valley.

Beside the many and various touristic and sport activities carried out both in winter and summer, for which adequate transportation and services infrastructures exist, other elements of interest are the ice tunnels excavated inside the glaciers. Such tunnels may be seen in the Mer de Glace (at Montenvers), in the Rhonegletscher (at Furka), in the Aletsch (at Jungfraujoch), as well as in the ice mass lying on the slope of Klein Matterhorn (at Zermatt), to mention just a few. The maintenance of ice tunnels is very costly because ice sliding makes necessary that improvements be made every year (Photo 1). In addition, they pose a great threat in the event of an ice avalanche or a glacier's tongue break.



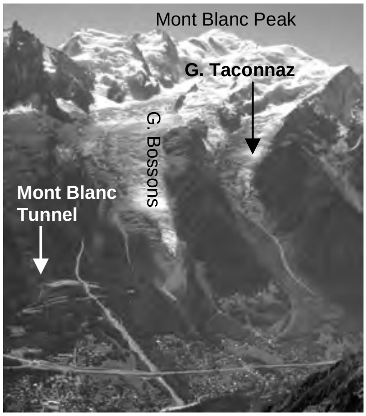


Photo 1. (left). The access by cable gondola inside the ice tunnel excavated in the tongue of the Mer de Glace glacier. One can notice the entrances in the previous tunnels, abandoned as a result of glacier's movement.

Photo 2. (right). The Chamonix valley (The Upper Arve) with the Bossons and Taconnaz glaciers with glacial torrents downstream. To the left, at the extremity of the Bossons glacier, is the access road to the Mont Blanc tunnel going to Italy.

Water resources capitalisation. Alpine glaciers make up important reservoirs of water in solid and liquid state. They are a major supply source for the rivers, which in their turn are used to cover the various social and economic demands. In the last four decades, sub-glacial water has also been used indirectly for hydropower generation. In order to accomplish this, complex improvement works have been undertaken with the purpose of collecting the subglacier water and bring it into the reservoirs. For instance, the Emosson Lake, lying at the French – Swiss border, is used to collect the sub-glacial waters coming from several glaciers stretching out on the northern side of the Mont Blanc Massif, some of which are situated in France (Argentière, Tour) and others in Switzerland (Trient, Saleina, Planereuses, et.al.). From here, water is guided to the hydropower plants at Vallorcine and Batiaz (Martigny). Some other alpine glaciers, like the Mer de Glace and Aletsch, are used not only for hydropower generation but also for water supply. A share of the Swiss glaciers water is used for irrigations in the Rhône valley.

4. GLACIER-INDUCED RISKS AND DISASTERS IN THE ALPS

The most frequent glacier hazards are outburst floods, ice avalanches, falls of rocks, and landslides. A major control in the occurrence of such phenomena, generally with immediate effects, is the glacier movement, which renders the ice and glacial valley slopes unstable. However, glaciers fluctuations may lead in time to serious economic losses, as various activities and infrastructures are gradually affected.

Within the framework of Glaciorisk European Project aiming at studying glacier hazards, 167 glaciers generating disasters have been identified since 1595 in the Alps Mountains area, half of which (84) are lying on the Swiss territory (Zryd, 2008).

Glacier outburst floods are determined by the presence on the surface, at the margins or inside the glaciers, of water accumulated in lakes or pockets, which are suddenly discharged. Such phenomena usually occur in summer-time. Due to the rapid occurrence, huge water volumes and important amounts of debris, they sometimes generate mudflows, which may have devastating effects.

Usually, the glacier lakes are formed in several ways: when a glacier tongue blocks a lateral valley (ice-dammed lake), behind a moraine dam in front of a receding glacier (moraine-dammed lake), at the junction of two glaciers and in the space between the glacier and the valley side. Most frequently, glacier outburst floods result from the failure of moraine-dammed and ice-dammed lakes. Among the glaciers that generated more or less catastrophic floods one can count Giétro (1595, 1818), Allalin (1633, 1680, 1770), Aletsch (1813, 1913, 1938) and Gorner, in Switzerland, as well as Tacul (1819), in France (Buisson, 1998).

The flood provoked by the Giétro glacier on May 25, 1595, following the failure of the ice-dammed lake, resulted in the killing of 150 people and the destruction of about 500 buildings, most of them in the Martigny City, situated downstream. On June 16, 1818, after the failure of an ice-dammed lakes, the same glacier was at the origin of another flood, which killed 44 people and wiped away 360 buildings. Although the catastrophe had been anticipated and engineering works to empty the lake were under way, it could not be avoided, however, inasmuch as the ice-dam was destabilized because of the works and it failed before the lake was completely drained (Buisson, 1998).

The ice-dammed lake of Märjelen (Märjelensee) formed through the barring of a lateral valley (Märjela) by the Aletsch glacier has been responsible for several floods that happened over the time. After 1895, the risk induced by the likelihood of its overflowing has diminished considerably once a tunnel was carved with the purpose of draining it to the Rhône valley (Zryd, 2008).

The Tacul Lake, formed at the junction of the Tacul and Leschaux glaciers, which continue downstream with the Mer de Glace glacier, has grown empty several times during the history, generating floods in the Chamonix valley, fortunately without serious consequences. Such an event was recorded on August 13, 1819. Later on, when the glacier lowered its level the lake became extinct and the risk of flooding disappeared (Buisson, 1998).

Glacier outburst floods may also be generated by the **break of intra-glacial or sub-glacial water pockets**. Apart from the floods triggered by the failure of moraine-dammed and ice-dammed lakes, these are more difficult to predict and their effects are more dangerous, because water may drive ice blocks, rocks and debris, often generating fast flowing mud-flows. The Tête-Rousse glacier on the French face of the Mont Blanc Massif provoked the most catastrophic phenomenon of this type that ever happened in the Alps. Thus, on July 11 – 12, 1892, the failure of a sub-glacial water pocket, lying behind a rock-bar at 3,150 m altitude, determined the rapid discharge of about 200,000 m^3 of water and 90,000 m^3 of ice, which drove 800,000 m^3 of eroded materials and generated a strong mudflow. The flood wave devastated everything in its way, as it was the case with the thermal establishment of Saint–Gervais–les–Bains resort, and killed 175 people (Zryd, 2008). In order to avoid the likelihood of occurrence of such a phenomenon, at the beginning of the 19^{th} century a tunnel was built to evacuate the water that accumulates behind the sub-glacial threshold.

The Trent glacier on the Swiss face of the Mont Blanc Massif contains a sub-glacial water pocket that empties periodically, every 3-5 years, leading to the increase of its emissary's discharge and sometimes to floods. More important such events took place in 1911, 1930, 1942 and 1960, but without serious consequences. The worst flood occurred on August 6, 1960. It destroyed bridges, railroads and dams (Buisson, 1998).

In summer-time, when melt water and heavy rainfall water combine, at the end of glaciers tongues torrents come into existence, generating rich discharges, as well as mudflows, which affect the downstream settlements and transportation infrastructure. Deposited materials may block the trunk valley leading thus to floods. It is the case of the Arve valley in the Chamonix area, which receives many glacial torrents from the northern face of the Mont Blanc Massif. Of these, the Griaz torrent has frequently affected (on an average every 2 – 3 years) by its rich debris flow the road and railway infrastructures. Of great economic importance in this area are the highway along the Arve valley, the road leading to Mont Blanc tunnel and the railway that goes to Chamonix resort (Photo 2). In order to lessen the risk induced by this torrent a suspended concrete canal was built in its lower course between 1986 and 1987. With an inner section of 9 x 9 m the canal crosses the highway and allows the accumulation of more than 100,000 m^3 of solid waste (Moreau & Vivian, 2000).

Ice avalanches represent rapid falls of ice blocks. Sometimes they can have large amounts of rocks in them. They may be triggered by many mechanisms: glacier sliding and *séracs* formation; peeling off of a block of ice from an unstable cliff; more deep-seated failure involving bedrock and overlying ice (Hambrey & Alean, 2004). An important part in the occurrence of ice avalanches is played by sub-glacial runoff, which in summer-time exerts a higher pressure and accelerates glacier sliding. Due to the important volumes of water ice avalanches often generate mudflows.

Ice avalanches occur very quickly, are usually unpredictable, and their consequences may be devastating. The oldest known catastrophe caused by an ice avalanche in the Alps Mountains occurred on August 31, 1957, when a mass of ice detached from the Balmengletscher, hanging on the western sides of the Breithorn and Monte Leone massifs, totally destroyed the Eggen village, situated near the Simplon pass (Switzerland), killing 81 people. The village no longer exist and later on, in the 20^{th} century, due to the effects of climatic warming, the glacier disappeared, too (Zryd, 2008; Hambrey & Alean, 2004).

On August 30, 1965, the detachment of the terminal part of the Allalingletscher (in Pennine Swiss Alps) triggered an ice avalanche of 1 – 2 million m^3, which in 30 seconds buried the camp of the workers to the Mattmark dam (in the Saas valley), killing 88 people. The avalanche was caused by the increase of glacier's sliding velocity under the lubricating action exerted by sub-glacial melt water and the infiltrated water from heavy rainfalls of that summer. On the night of July 30 – 31, 2000, another avalanche occurred, which drove more than 1 million m^3 of ice. Fortunately, the monitoring of glacier's dynamics and the early warnings made it possible to avoid the damage (Buisson, 1998).

In the period 1901 – 1997, ice avalanches in the Alps were responsible for 137 human deaths. The Chamonix valley, with an intense touristic activity and a valuable touristic and transportation infrastructure, is very much exposed to such phenomena, due to the numerous glacier tongues that flow on the northern face of the Mont Blanc Masif (Photo 2). In 1949, the detachment of the terminal part of the Tour glacier generated an ice avalanche that killed 6 persons. In 1994 and 1995, two ice avalanches caused by the famous Bossons glacier resulted in the death of 9 and 3 people respectively (Zryd, 2008).

Other risks induced by glaciers. Glacial outburst floods and overflowings, the mudflows, as well as ice avalanches represent direct glacier hazards that lead to immediate consequences. However, glaciers may also determine indirectly some dangerous phenomena with rapid or slow effects, which often result in material damage and human losses. Among the rapid phenomena one can count rock falls, land falls and landslides, which affect the glacial valley slopes (be them rocky or made up of moraine deposits) that become unstable when glaciers recede and the pressure exerted by the ice mass drops. Permafrost melting, waterlogging conditions created by precipitation and snow melting and the freeze-thaw action specific for the high mountain areas, are other control factors of gravitational processes, which may lead to more or less serious effects.

The existence of dams and reservoirs downstream the glaciers (especially the hanging ones) raises the risk of flooding in the train of ice or rock avalanches, which may either generate huge waves that overtop the dam or may lead to dam failure. Such a threat poses the lake and the dam at Mauvoisin in the Valois Swiss Alps, lying downstream the Giétro glacier. In a similar situation is the Lago de la Rossa, at the French – Italian border, found under the menace of the Croce Rossa glacier (Zryd, 2008). In order to prevent such risks, automatic monitoring devices keep the glaciers dynamics under close surveillance.

Glacier advancement and retreat, even though at a slowly pace, may bring about important economic losses when infrastructure elements and economic activities are affected. Thus, in 1990 the tongue of the Mer de Glace glacier grew thicker and thicker and damaged the cable cabin arrival station that used to take down the tourists to the ice tunnel. To avoid future destruction the station was subsequently re-built downstream the former location, on safer grounds (Photo 1). In 1982, the Argentière glacier had advanced 200 m as compared with 1972, which affected the running of the cable cabin belonging to the French company of electricity (EDF), which was used to access the sub-glacial water collecting tunnels (Moreau & Vivian, 2000).

The recession of glaciers as a result of climatic warming has negative economic effects, especially on touristic activities. If at present the glaciers allow ski practicing in both winter and summer, their recession will bring about the shortening of the skiing period, as well as the restriction of the skiing tracks. Likewise, the tunnels dug in the ice mass, which are great touristic sights, will gradually become impassable, requiring important investments for their relocation. Such is the case of the ice tunnels in the terminal parts of the Rhoneglestscher and Mer de Glace glacier (Photo 1).

5. CONCLUSIONS

Mountain glaciers are an important element of the natural capital. Their turning to account, especially for tourism and hydropower generation, has favored the social and economic development in the Alps. However, beside the economic advantages they offer, mountain glaciers are a permanent threat for mountain communities, as these are exposed to the risk of occurrence of glacier-induced natural phenomena (both direct and indirect), which result in social and economic damage, sometimes with catastrophic effects. The most frequent, dangerous and with immediate consequences are glacier outburst floods, ice avalanches, rock falls, land falls and landslides. Glaciers fluctuations, however slow it may be, can cause important damage by affecting economic activities and infrastructures.

The growth of population density and of the economic value of alpine mountain area has enhanced the vulnerability to glacier hazards. In order to diminish their negative effects, the countries concerned with such phenomena pay a special attention to preventing and protection measures, based on the cognition of glacial risks and on the understanding of their occurrence mechanisms. In this respect, numerous glaciers, especially those in the areas with high vulnerability to glacial hazards, are subjected to a close and permanent surveillance.

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SOMEŞAN PLATEAU RIVERS RUNOFF REGIME SEASONAL AND MONTHLY PARTICULARITIES

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ABSTRACT. Someşan Plateau Rivers Runoff Regime Seasonal and Monthly Particularities. The study is based on the processing and interpretation of seven hydrometrical stations on the autochthon rivers and two from the allochthons. The analyzed interval was between 1968-2005. The detailed analysis of the seasonal and monthly river water runoff regime evidences the geographical particularities of the five subdivisions of the Someşan Plateau, particularly the climatic and geomorphological ones. The essential feature in the yearly runoff repartition consists in the fact that on all the rivers the spring runoff is dominant and the autumn has the smallest weight in the multiannual average runoff volume. From the analysis of the monthly variation coefficients we observe that on the majority of the rivers the highest values correspond to the summer, and the smallest to the winter. At the majorities of the studied hydrometrical stations we observe a stationary or declining trend in all of the seasons.

Keywords: *Someşean Plateau, runoff regime, season, month, variation, trend.*

1. INTRODUCTION

Integrant part of Transylvanian Basin, the Someşean Platau represents the north-western compartment of it, being the most extended and complex unit from the three major subdivisions of the Transylvanian Plateau. In accordance with the morphological particularities of the relief, the climate and the biogeographical cover in the Someşean Plateau where separated more subdivisions: Clujului and Dejului Hills, Simişna-Surduc Hills, Purcareț-Boiu Mare Plateau and the Sălătrucului Hills.

Table 1

Base values of the multiannual average runoff (1968-2005)

River	Hydrometrical station	H (m)	F (km^2)	Q (m^3/s)	q ($l/s.km^2$)	Y (mm)	V ($mil.m^3$)
Nadăş	Aghireşu	579	46	0.208	4.518	137	6.307
Nadăş	Mera	510	273	0.895	3.280	115	31.378
Borşa	Borşa	452	182	0.645	3.545	112	20.340
Lonea	Luna de Sus	418	180	0.635	3.525	111	20.025
Olpret	Maia	394	101	0.384	3.802	114	11.510
Sălătruc	Căşei	463	149	1.033	6.934	218	32.576
Poiana	Poiana Blenchii	423	96	0.807	8.409	265	25.449
Someş	Dej	648	8 823	81.4	9.222	291	2567.030
Someş	Răstoci	623	9 704	87.6	9.029	285	2762.553

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In the study of the runoff regime we used data from seven hydrometrical stations on the autochthon rivers and two from the allochthons, the analyzed interval was between 1968-2005 (Table 1).

The runoff repartitions in the year determines in largely the economic value of the water. As balanced is the runoff regime the most efficient can the water be used. Also, the manner in which the main sources are combined is reflected in the yearly distribution of the transported water quantities.

2. SEASONAL RUNOFF REGIME

The seasonal runoff variation is determined by the characteristics of the base climatical elements and constitute de dominant feature of the runoff in the studied area, as mater of fact of all the rivers from Romania. The essential feature consists in the fact that in all rivers the spring runoff dominates and the smallest weight from the multiannual runoff volume is assigned to the autumn.

2.1. Spatial-temporal variation of the seasonal runoff

The territorial differences are determined by the river basins altitude and the exposure to the western humid air masses advection. In the *winter* (XII – II), the territorial repartition of the runoff is influenced mainly, besides the fallen precipitation (rarely in liquid state), by the temperatures regime.

Table 2

Seasonal runoff percentile values (1968 – 2005)

River	Hydrometrical station	% of the average multiannual runoff				Summer/ Winter
		Winter	Spring	Sum-mer	Autumn	
Nadăş	Aghireşu	20.2	32.2	32.1	15.4	1.63
Nadăş	Mera	21.3	35.2	28.8	14.7	1.35
Borşa	Borşa	23.4	44.7	21.3	10.6	0.91
Lonea	Luna de Jos	25.8	44.5	19.6	10.1	0.75
Olpret	Maia	29.5	42.1	19.1	9.3	0.65
Sălătruc	Căşei	29.4	42.9	17.5	10.2	0.59
Poiana	Poiana Blenchii	31.3	40.2	17.7	10.8	0.56
Someş	Dej	19.1	41.5	21.9	17.5	1.14
Someş	Răstoci	21.2	40.8	21.4	16.6	1.00

The air negative temperature conserves the snow cover, creates ice on the rivers and extract from the circuit a large quantity of water.

The winter seasons weight in the annual average runoff water volume differs by the altitude and the basins exposure to the dominant directions of the air masses movement. Therefore we observe an increase in the percentage values of the winter runoff from south to the north of the studied region, exposed to the western air masses advections.

On the rivers from Clujului Hills which are under the Apuseni Mountains shelter and have some higher altitudes, the percentile values of the winter runoff are smaller, representing 20% to 26 % from the average annual runoff volume. In exchange, on the rivers from Dejului Hills, Purcăreț - Boiu Mare Platou and the Sălătrucului Hills this represents between 29% and 32 % from the annual runoff volume (Fig. 1.). In these areas the snow quantities are higher and because of the warmer air masses invasion the possibilities of alimentation for the rivers from the melting snow are higher.

The snow cover instability, the positive temperature days frequency and the intercalation of rainy periods is greatly evidenced by the increase of the percentage values

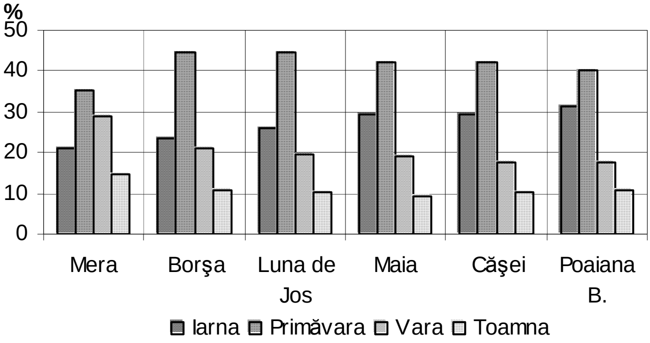

Fig. 1. Seasonal runoff percentage values at the Someşean Plateau autochthon rivers hydrometrical stations.

of the runoff from winter season, from the territories in the south of the studied area, under the shelter of the Apuseni Mountains, to the north, exposed to the western air advections over the Meseş Mountains lover sector named "Poarta Sălajului".

The highest runoff values were measured in the winter of 1978/1979 when there were favorable climatic conditions to feed the rivers from precipitations and particularly the successive melt of the snow cover. Similar conditions appeared in the winters of 1981/1982 on the Olpret, Luna, Borşa, in 1969/1970 on the Nadăş and in 2001/2002 on the Poiana and Sălătruc Rivers.

The smallest runoff values were observed in the winters of 1953/1954, 1963/1964, 1983/1984, characterized by a persistent anticyclone regime with reduced precipitations and low temperatures, determining in many cases the drying of the rivers by total freezing. Similar situations appeared but with less intensity in the winters of 1990/1991, 2000/2001, 1971/1972 etc.

Spring (III – V) represents the season with the richest runoff, conditioned by the melting of the snow, the relatively high precipitation amounts and the reduced evapotranspiration values. Together with the positive temperatures of the air, starts the gradual melting of the snow which is reflected in the runoff by the spring high waters. In accordance with the melting rhythm and the precipitation duration, intensity appear the spring floods generated by the snow melt or the high precipitations or the overlapping of the two phenomena.

In this season the average runoff volume is high, representing 32 % and 45 % from the multiannual average volume. The highest volumes are on Borşa and Luna Rivers (44,5 % - 45 %), and the smallest are on Nadăş (32 % -35.5 %). On the rivers from Dealurile Dejului, Platoul Purcăreț - Boiu Mare and Dealurile Sălătrucului from the annual runoff 40 to 43 % are realized in this season.

The highest values from spring were registered in the year 1970 in the rivers from Clujului, Dejului and Şimişna-Surduc Hills and in 2000 over the rivers from Purcăreț - Boiu Mare Plateau and Sălătrucului Hills. In the mentioned years the frontal, long and high intensity rains generated significant volumes of water which ran down in 80-85 % because of the high humidity of the substrate. In 1981 similar situations appeared in the whole studied area, and in 1985 just over the Dejului Hills and the Purcăreț - Boiu Mare Plateau.

The smallest values of the spring runoff ware measured in different years: 1995 on the Olpret, Borşa and Luna; 1974 on the Poiana and Căşei Rivers. In 1990 at all the studied hydrometrical stations were measured values similar with the mentioned ones.

Is mentionable, that in the studied period, the smallest values in spring runoff were measured in the first part of the VIII and X decade of the last century.

In the *summer* (VI – VIII) the air temperature growth and the development of the vegetal cover intensifies the evapotranspiration, phenomenon reflected in the significant diminish of the runoff from the precedent season. To the appearing of low waters in the summer contribute also the diminishing of the groundwater resources. Following the convective and rarely the frontal rains appear summer floods which can reach sometimes high amplitudes and create inundations like those from June 1970, June 1974, July 1980 etc.

In the summer 17.5 % to 32.1 % from the average annual runoff is accomplished, although the precipitation contribution is maxim. On the rivers from the south part of the Clujului Hills the summer contributions are higher than the winters, representing 28.2 % and 32.1 %. At the other rivers the summer contribution are more reduced than the winters (Table. 2.). The diminishing of the percentile values from the average annual runoff occurs inverse like in the winter. So, the percentile values diminish from 21.3 % at station Borşa on the River Borşa to 19,1 % at Maia on the Olpret, respectively 17,5 % at Căşei on the Sălătruc River.

From the presented average situations there were some extreme cases. So, the highest summer runoff was measured in different years on different rivers: 1970 on Borşa and Nadăş, 1974 on Luna, Sălătruc and Poiana and also in 1980 on the Olpret. This distribution proves the convective rains the important role in this season’s runoff formation.

The smallest summer runoff values were measured in the X decade of the last century and at the beginning of the XXI. Accordingly, the smallest values were registered in 1994 on Nadăş at Mera, on Borşa on Borşa and in 2003 on Olpret at Maia, on Luna at Luna de Jos, on Sălătruc at Căşei and on Poaina at Poiana Blenchii. In the mentioned summers there were over 20 succeeding days without precipitations causing the drying of several rivers with small drainage basins. Similar situations were observed on Nadăş, Olpret and Sălătruc in 1990, and in Luna and Borşa in 1995.

In the *autumn* (IX – XI), the evaporation diminishes and the autumn rains appear, the groundwater reserves are exhausted and so at the beginning of this season the low water period appears. At the end of autumn floods may appear after long rains.

The autumn has the weakest contribution to the average yearly volume (9 – 16%) even if the precipitation amounts are almost doubled like in the winter. In the distribution of the autumn runoff there are some evident contrasts. So, on the rivers in the south of the Clujului Hills the percentile values of the autumn runoff are higher (14.5-15.5 %) than in the rivers from Dejului Hills (9,2 %), Purcăreț – Boiu Mare Plateau and Sălătrucului Hills (10 % -11 %).

On most rivers, the peak autumn runoff was measured in 1974, when there were abundant precipitations on a longer period with significant hydrological effect. Exceptions are the rivers Poiana and Borşa where the autumn runoff maxims were measured in 1998, respectively in 1972. In the mentioned years there where high autumn runoffs on other rivers too: Olpret and Nadăş (1972), Sălătruc (1998) etc.

2. 2. Seasonal runoff oscillation and tendencies

The chronologic variation of the average seasonal runoff evidences year cycles with rich and pour runoff. As an example we remark a 5-6 year high summer runoff cycle.

Analyzing the seasonal variation coefficients we observe that in the case of most rivers the highest values are in the summer (0.93-1.51) and the lowest in the winter (0.41-0.84) (Table 3). In spring and winter the variation coefficient smaller values reflect the uniform distribution character of the runoff. In exchange, in the summer and autumn, when the variation coefficients are the highest, the territorial differences are more pronounced. So, some evident contrasts appear between the rivers from the south and those from the central and north part of the Someşean Plateau.

Table 3

Seasonal variation coefficient (C_v)

Hydro-metric station	Variation coefficient values			
	Winter	Spring	Summer	Autumn
Aghireşu	0.57	0.62	0.93	0.60
Mera	0.41	0.62	0.89	0.56
Borşa	0.64	0.69	0.97	0.88
Luna de Jos	0.67	0.74	1.25	0.96
Maia	0.84	0.83	1.51	1.43
Căşei	0.55	0.61	1.02	0.91
Poiana Blenchii	0.47	0.58	1.36	1.16
Dej	0.48	0.42	0.55	1.04
Răstoci	0.69	0.47	0.59	0.76

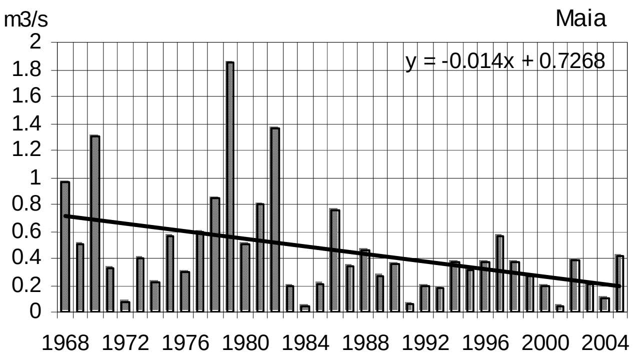

Fig. 2. Maia hydrometrical station winter runoff trend

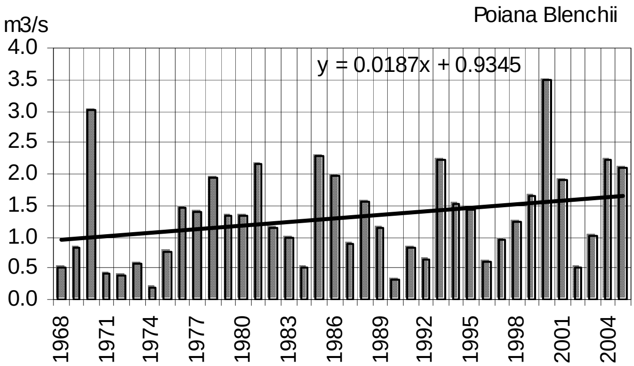

Fig. 3. Poiana Blenchii hydrometrical station spring runoff trend

Following the seasonal evolution of the runoff from the period of 1968-2005 we observe at the majority of the studied hydrometrical stations a stationary or diminishing trend of runoff in every season.

The same diminishing trend was observed in case of the annual precipitation amount fallen in the studied period.

In the winter the runoff trend is stationary at the stations Poiana Blenchii, Borşa, Aghireş and are in f diminishing trend at the stations Căşei, Luna and Maia where is the most accentuated (Fig. 2.).

In the spring at almost all the studied hydrometrical stations we observe that the runoff trend is stationary. Only at the hydrometrical stations which are on the rivers that control the runoff from the Purcareț-Boiu Mare Plateau and the Sălătrucului Hills manifest a growing runoff trend, most accentuated on the Poiana River (Fig. 3.).

In the summer at all the studied hydrometrical stations we observed a falling runoff trend (Fig. 4.). The only exception is the station from Poiana Blenchii where the trend is stationary.

This can be explained by the fact that the River Poiana goes through a calcareous region where the accumulated water over the spring ensures a constant alimentation to the summer runoff, which manifests as a stationary trend in the multiannual runoff profile.

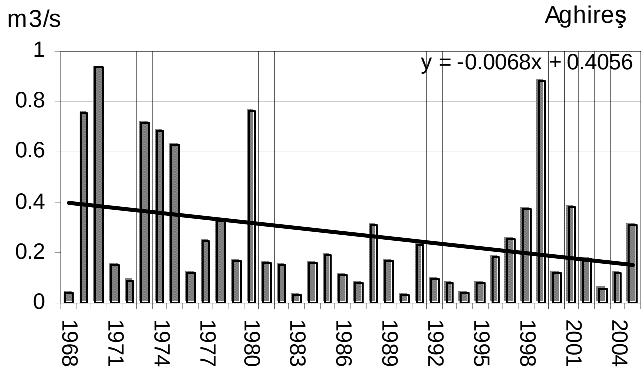

Fig. 4. Aghireş hydrometrical station summer runoff trend

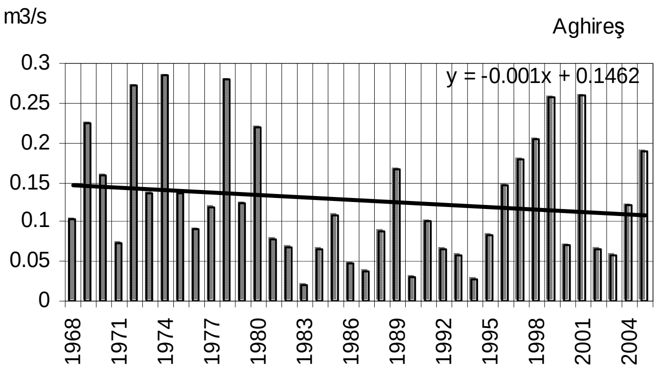

Fig. 5. Aghireş hydrometrical station autumn runoff trend

In the autumn on most of the rivers there is a light diminishing runoff trend (Fig. 5.). Exceptions are the rivers from Purcareț-Boiu Mare Plateau and Sălătrucului Hills, with a stationary trend at the Căşei hydrometrical station on Sălătruc and with a light ascendant trend at Poiana Blenchii station on the Poiana River.

This light ascendant trend of the autumn runoff and the stationary trend from the summer is maintained by the rich underground alimentation, ensured by the accumulated waters in the calcareous rocks of this part of the Someşean Plateau. Also, the rivers runoff seasonal evolution in this two regions is completely different from the rivers of the other regions.

3. MONTHLY RUNOFF REGIME

From the average monthly runoff of the year we observe significant territorial differences generated also by the climatical factors. So, on the rivers from the south of the Clujului and Dejului Hills is evidenced a maxima in June and a minima in October. In exchange on the other rivers the maxima appears in March and the minima in September (Table 4). On the Someş River the maxima appears in April and the minima in August.

Table 4

The monthly average runoff in the year (% from the average runoff 1968-2005)

Hydrological Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Aghireşu	6.24	8.35	11.4	9.80	10.6	13.1	12.4	7.34	5.45	4.72	5.06	5.47
Mera	5.90	9,00	13.3	9.06	12.8	13.6	9.53	5.61	4.82	4.40	5.45	6.56
Borșa	6.71	10.3	21.0	11.7	11.9	10.3	6.87	4.16	3.06	2.91	4.65	6.36
Luna de Jos	7.46	10.9	21.9	11.3	11.2	9.87	6.32	3.42	2.50	2.77	4.87	7.35
Maia	8.42	13.1	21.2	10.7	10.3	10,0	5.97	3.08	1.95	2.55	4.78	7.84
Căşei	8.25	12.8	21.0	12.4	9.58	9.03	5.58	2.92	2.47	2.58	5.16	8.20
Poiana Blenchii	8.56	14.6	19.9	12.2	8.11	9.89	5.22	2.6	2.24	3.13	5.44	8.02
Dej	5.37	7.32	13.2	15.2	13	9.52	7.66	4.73	4.69	7.07	5.75	6.40
Răstoci	5.59	9.06	12.5	14.9	13.4	9.12	7.68	4.66	6.07	4.65	5.84	6.51

The territorial differences are also evidenced by the monthly average runoff repartition. So, in January the precipitations fallen almost exclusively as snow and the unfavorable conditions for its melting determines reduced runoff values, which represent between 5 and 9 percent from the yearly average volume. The percentage values increase from the south to the north of the region, where the thermal instability is higher. In February we remark an increase of 2% - 6 % in the runoff volume, higher on the rivers from Purcareț-Boiu Mare Plateau and Sălătrucului Hills (4-6 %).

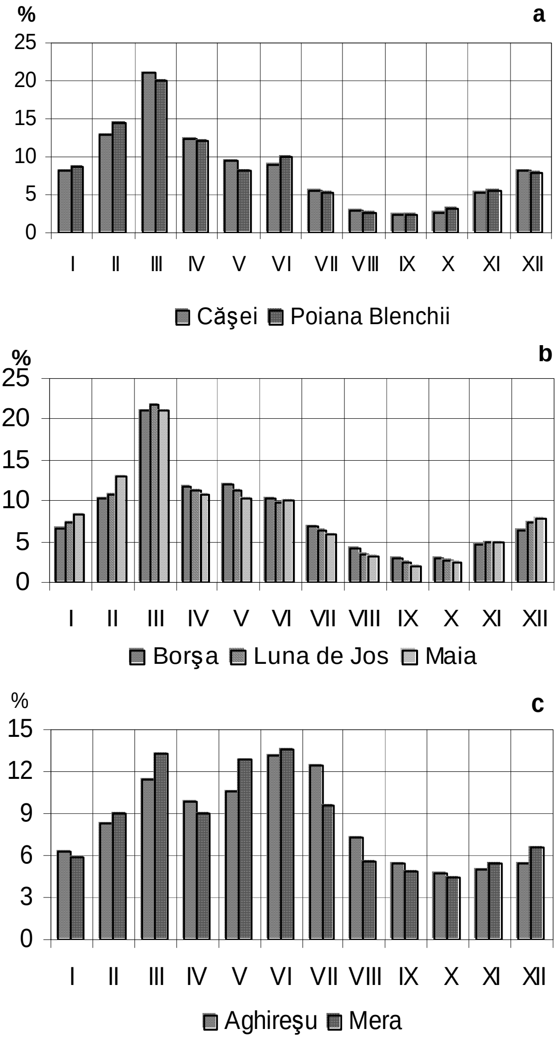

Fig. 6. Yearly average monthly runoff variation

On the rivers from Clujului and Dejului Hills, Purcareț-Boiu Mare Plateau and Sălătrucului Hills in March is the highest runoff amount from the year, representing 19.9-21.9 % from the average yearly volume. In April is a gradual decrease in the runoff volumes which becomes more accentuated in September and August, when we register the smallest values of monthly runoff, representing 1.9 and 2.5 % (Fig. 6. a. and b.).

On the rivers from the south of the Clujului and Dejului Hills from March, which has a smaller contribution to the average yearly volume (11-14%), comes a small decrease of runoff in April and then a gradual increase till June when it reaches the highest monthly average runoff value (Fig. 6. c.). The drastic reduction of the precipitation amounts, the exhaustion of the underground waters and the high evapotranspiration values lead to the decrease of the rivers runoff values.

As a result in the next months there is a decrease in the runoff amount till October, when are the smallest values from the year, representing between 4 % and 5% from the average yearly runoff volume (fig.6 c.).

From November there is an increase in the runoff volume, generated by the autumn rains. The average runoff from this month represents 4.5 % and 6 % from the yearly average runoff (fig. 6 a, b and c). In December we remark an increase in the runoff average values from the south (5,5 - 6,5 %) to the north (8 - 8,5 %) of the region.

The monthly average runoff variation was characterized with the help of the monthly coefficients. On the rivers from south and the center of the region the minimal values of the variation coefficients correspond to the winter months and in the north to the month April (Olpret and Căşei) and February (Poiana) (Table 5). On the Olpret, Luna and Borşa rivers are evident variations of the runoff in the winter months (December, January) which are generated by the frequent intercalation of rainy and warm periods contributing to the rapid melting of the snow cover an reintegrating the accumulated water reserves.

The highest monthly variation coefficients are recorded in the summer months (Table 5), when the frequent droughts and the short rains have reduced hydrologic effects.

Table 5

Monthly variation coefficient values (1968 – 2005)

Hydrol. St..	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Aghireşu	0.69	0.73	0.73	0.64	0.77	1.14	1.22	0.81	0.72	0.67	0.59	0.53
Mera	0.51	0.62	0.76	0.64	0.95	1.16	1.06	0.71	0.75	0.61	0.58	0.52
Borşa	0.98	0.74	0.87	0.88	1.26	1.30	1.12	1.50	1.17	1.08	1.03	1.07
Luna de Jos	0.92	0.76	0.94	0.78	1.46	1.71	1.39	1.67	1.19	1.06	1.14	1.19
Maia	1.07	0.99	0.99	0.83	1.66	1.70	2.08	1.70	1.40	1.91	1.57	1.51
Căşei	0.76	0.80	0.83	0.58	1.07	1.28	1.17	1.52	1.27	1.13	1.01	0.89
Poiana Blenchii	0.78	0.68	0.79	0.75	1.12	1.65	1.53	1.24	1.47	1.61	1.11	0.77
Dej	0.68	0.62	0.55	0.45	0.72	0.72	0.63	0.52	0.62	2.20	0.73	0.71
Răstoci	0.71	1.42	0.55	0.45	1.04	0.71	0.70	0.61	1.70	0.69	0.80	0.76

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FLOOD RISK ANALYSIS MODEL IN THE VILLAGE OF ST. GEORGE/DANUBE DELTA

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ABSTRACT. Flood Risk Analysis Model in the Village of St. George/Danube Delta. Although the natural hazards are currently a main subject of interest on a global scale, a unitary methodological approach has yet to be developed. In most cases, the risk analysis focuses only on an assessment of the probable material damage resulted from a specific risk scenario. Taking these matters into consideration, the aim of this study is to develop an efficient **flood risk assessment methodology** based on the example of the **village of St. George in the Danube Delta**. The study area is situated at the mouth of the St. George river branch, being part of the largest ecosystem of the European humid zones. As a complex hydrological process, the flooding of the delta space is very important within the dynamics and evolution of the natural system. The methodology was based on correlations between the flood risk maps resulted with satellite pictures, cadastral plans and field data by using GIS functions, this cartographic material playing an important part in the development of a proper public awareness strategy. In addition, the field investigations conducted in September 2008 focused on collecting the data necessary in the assessment of the buildings. The observations that synthesize the features of each construction included in the analysis were also stored in ArcGis in the shape of a table of attributes. The analysis revealed an increased degree of the area visibility, pointing out not only certain sectors affected by floods, but also the more detailed level of the residences. The flood risk damage assessment potential was also considered for the residences, the model revealing water depth maps. This cartographic material is essential in establishing a series of adequate strategies for the protection of the population and material goods.

Keywords: *flood risk analysis, St. George village, Danube Delta, risk assessment methodology*

1. INTRODUCTION

River deltas may have been cradles for prehistoric civilizations (Day et al. 2007) and still represent favoured areas for human habitats on the basis of their high productivity, biodiversity and favourable economical conditions for river transport (Giosan and Bhattacharya 2005). In the same time, these regions are defined through their high vulnerability to environmental changes, being extremely susceptible to natural disasters, especially to floods.

In the perspective of risk assessment research, every populated place faces a certain risk engaged by a disaster, the size of which depends on the specific location, existent hazards, vulnerability and the number of elements at risk.

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Although natural hazards are currently a main subject of interest on a global scale, a unitary methodological approach has yet to be developed. In the general context of hazard analysis, there is the need to put more emphasis on the problem of the risk analysis. In most cases, it focuses only on an assessment of the probable material damage resulted from a specific risk scenario. Taking these matters into consideration, the aim of this study is to develop an efficient flood risk assessment methodology based on the example of the village of St. George in the Danube Delta.

2. AREA OF STUDY

The Danube Delta, with an area of 5640 km^2, is the largest ecosystem of the European humid zones. Its state reflects environmental conditions at both local and regional levels via liquid and solid parameters and has to ensure the water supply for the local economy and communities. Flooding of the delta is important for the dynamics of the entire natural system. Floods sustain both alluvial processes and the water supply to deltaic lakes. In addition, flooding frequency is important in flushing the deltaic lake system water, ensuring a normal evolution of both terrestrial and aquatic ecosystems. For human communities, on the other hand, floods are perceived as a risk factor, entailing material damage, human victims and psychological stress.

The study area is situated at the mouth of the St. George river branch, which suffered a series of interventions resulting with the shortening of 31 km (period 1984-1988). As a direct result, the medium speed of the water grew along with the both liquid and solid flows. In fact, this is only an example of the human activity that took place in the Danube Delta starting with the second half of the last century that influenced the hydrological system for a better use of the natural resources offered by the delta.

3. METHODOLOGY

The study is structured in two stages: the analysis of the hydrological hazard together with the simulation of a series of scenarios concerning floods at various flows and the risk analysis, expressed in the shape of the calculus of the material damage.

In order to elaborate the maps concerning the flooding of St. George village and to improve the precision of the land model for the study area (the last 5 km of St. George branch) were used 1:25000 topo-hydrographic maps (Fig. 1(a), where the equidistance of the contour lines is 0.5 m. In addition, for the project CEEX DANUBERES, mixed groups from UB and UPB did topometric measurements in St. George by using the total station (Leica TPS 407, Fig. 1(b) and the GPS (Leica SR20). For the analysis of the flooding level of the area of study, bathymetric data were added from the investigations carried out in July 2005 and July 2006 by the team from UB, the Faculty of Geography, coordinated by lect. dr. Ştefan Constantinescu).

The numerical modeling of inundability was done by using the CCHE2D program (University of Mississippi), program based on the integration in finite differences of the flow equation (Navier-Stokes) mediated on depth (the 2D Saint-Venant equations).

1. in a permanent regime, at maximum water flows with insurances of 0.5%, 1% and 5%.
2. in non-permanent regime for the flood of 2006 (for which the maximum from the hydrograph of the St. George km 8 hydrometric station was considered, in the period 25 April 2006-6 May 2006). This period of time was chosen because on the 25, 26, 27, 30 April, 2 and 3 May satellite pictures of the area of study were available, emphasizing the flooded perimeters.

Fig. 1(a) and (**b).** Topo-hydrographic map from 1965 (a) and the total station Leica TPS 407 (b) used for the development of the land section of the topo-bathymetric model in the area of study

The maps resulted are the cartographic support for the risk analysis in various hazard scenarios. In the flood risk analysis at the level of St George village the information concerning the type, structure, price per property and building location was based on data resulted from cadastral plans and field data by using GIS functions, this cartographic material playing an important part in the development of a proper public awareness strategy. In addition, the field investigations conducted in the summer and autumn of 2008 focused on collecting the data necessary in the assessment of the buildings by a group of students from the Faculty of Geography, UB.

In the area of St. George village a number of 1152 residences and household annexes were identified and assessed, representing the subjects of the current study, 27 of the houses being built after 2001.

The information resulted from the digitization of the cadastral plans, satellite pictures and field investigations were inserted in ArcGIS in order to compile the data base. The field observations and the ones resulted from the analysis of ortophotoplans and cadastral maps were introduced in a table of attributes that synthesizes the features of each building analyzed: location, height, construction type, equipment and estimated price calculated based on the offers present on the market in the period of August-September 2008.

The risk maps resulted by applying a series of signification tests (by using SPSS) and also by processing the information from the database in ArcGIS.

The analysis revealed an increased degree of the area visibility, pointing out not only certain sectors affected by floods, but also the problems that occurred at the more detailed level of the residences. In addition, the cartographic material plays also an important part in the development of a proper public awareness strategy.

4. RESULTS AND CONCLUSIONS

Flooding in the Danube Delta occurs when the flow of the Danube upstream from Ceatal Izmail is higher than 10000 m^3/s. Statistical data from the last 161 years (1840-2000) show that at the apex of the delta over 89 similar events occurred. According to these datasets, events with flows between 10000 and 11000 m^3/s, along the inferior sector of the Danube, have an average probability of occurrence of 50% (once every two years).

The floods produced by the sea in the sector of the littoral sand barrier. The current sand barrier along the deltaic front is quite low (+0,7 reaching the limit of +1,5 m). Near the mouth of the St. George river branch it reaches approximately 1,4 m (reference Sulina-Iason Project, 2006).

Hydrographs were used in the mathematical modeling and recorded at the stations: St. George km 8 (of flow), km 4 (of level) and the hydrograph of flow calculated based on the correlations at km 4.

The mathematical hydrodynamic model was applied by taking into consideration:

The initial conditions:

1. the geometry of the model (the calculus space network resulted from the plane network interpolated with topo-bathymetric data) and
2. the level of the free surface of the water (chosen arbitrarily at 0 m)

The conditions at the limit:

1. on the entrance frontier. For the simulations in a permanent regime, on the upstream frontier the value of the flow was specified (according to the free calculation scenarios in a flooding regime used in the previous stage: Q0,5%, Q1% and Q5%. For the rolling in a non-permanent regime on the upstream frontier the main point of interest was the flow hydrograph from km 4.
2. on the exit frontier(s). For the downstream simulations in a permanent regime levels of the sea were identified known (with or without taking into consideration the influence of the waves) and also water levels and on the downstream frontier, a discharge curve, taking into consideration that the level of the Black Sea depends on the flow of the Danube (Fig.2).

Fig. 2. The conditions at the limit specified on the upstream and downstream frontiers of the hydrodynamic model for the calculations done in a permanent and non-permanent regime

The numerical calculations were done after establishing the time sequence $\Delta t = 20s$ and the total calculation time T (20 000s > T $_{physical}$ of going over the domain ($\frac{L}{V_{med}} = \frac{4500m}{0.5m/s} = 2h30'$), implicitly the total number of 2000 steps. In the same time, T was chosen with a higher value than the „warm up" time, so that the calculation instabilities could be attenuated. The minimum depth where a calculation element was considered „dry" was 4 cm and the sliding coefficient at the impermeable frontier was 0,5.

The visualization and interpretation of the results for the permanent flow simulations at the flows characteristic to the three calculation scenarios in a flooding regime consisted of a comparative analysis of the hydrodynamic parameters: the level of the water free surface, local speed (scalar units based on the two directions and the vector unit), specific flow (scalar and vector units), tangential effort of friction with the water bed (scalar and vector units), Froude number, turbulent viscosity etc. It was verified that the water flow that entered the domain to be equal to the one that left the domain, meaning no water deposits.

The roughness coefficients were calibrated in a permanent regime by comparing the measured levels of the free surface of the water at the gage from the harbour (km 4) with the ones calculated. For future analysis comparisons of the size and direction of the speed vectors will be used, resulted from the calculations with the ones from the measurements (with the ADCP or the ADV).

After the calibration, it was considered that the model reproduces the hydrodynamic behaviour of the St. George branch in the conditions of a stationary level of the Black Sea.

Images 3 (a) and (b) show two of the inundability maps resulted from the calculations done in a permanent regime with flow values of 823 m^3/s and 1517m^3/s and a downstream level of 61 cm and, respectively, 96 cm. The water mask was laid over the satellite picture and, thus, the areas and even the residences that could be flooded in that specific calculation scenario were identified.

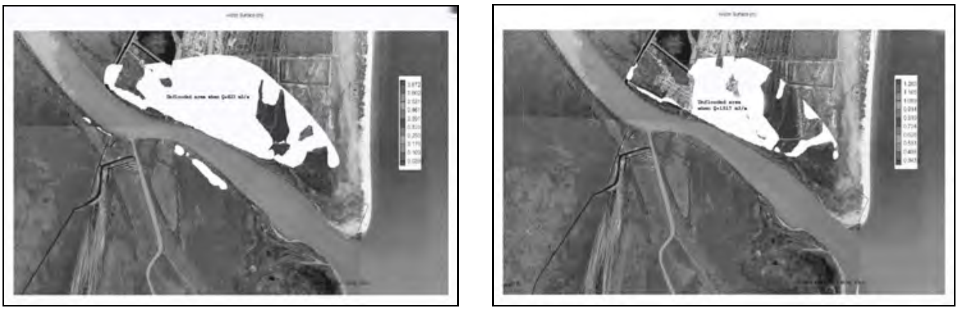

Fig. 3. Maps of the "dry" areas in the calculation domain at the flow of 823 m^3/s and downstream level of 0,61 m (a) and in the calculation domain at the flow of 1517 m^3/s (Q_{max} 0,5%) and downstream level of 0,97 m (b)

Image 4 illustrates the water mask resulted from the calculations done in a non-permanent regime for the flood in spring 2006. The results from the days when satellite pictures were available in the area of St. George village were noted. The figure also shows the flow and level hydrographs at km 4 for correlations between the results and the time of the flooding. In that period there was no wind activity, so that the flooding of the areas in the E, NE and NW of St. George village is noticeable, especially on the 30th of April and 2nd of May, when the flows were highest at km 4. These areas are visible on the satellite pictures and also on the images resulted from the calculations (the water mask laid over the ortophotoplan).

Based on the hazard scenarios, the risk analysis was done at the level of the building fund. The statistical descriptive analysis revealed that most of the buildings maintain their traditional features, with a low height (rarely reaching 1 floor and heights between 2,5-5 m), made out of clay, with a medium value of 20000 euro and supplying water from draw wells/wells.

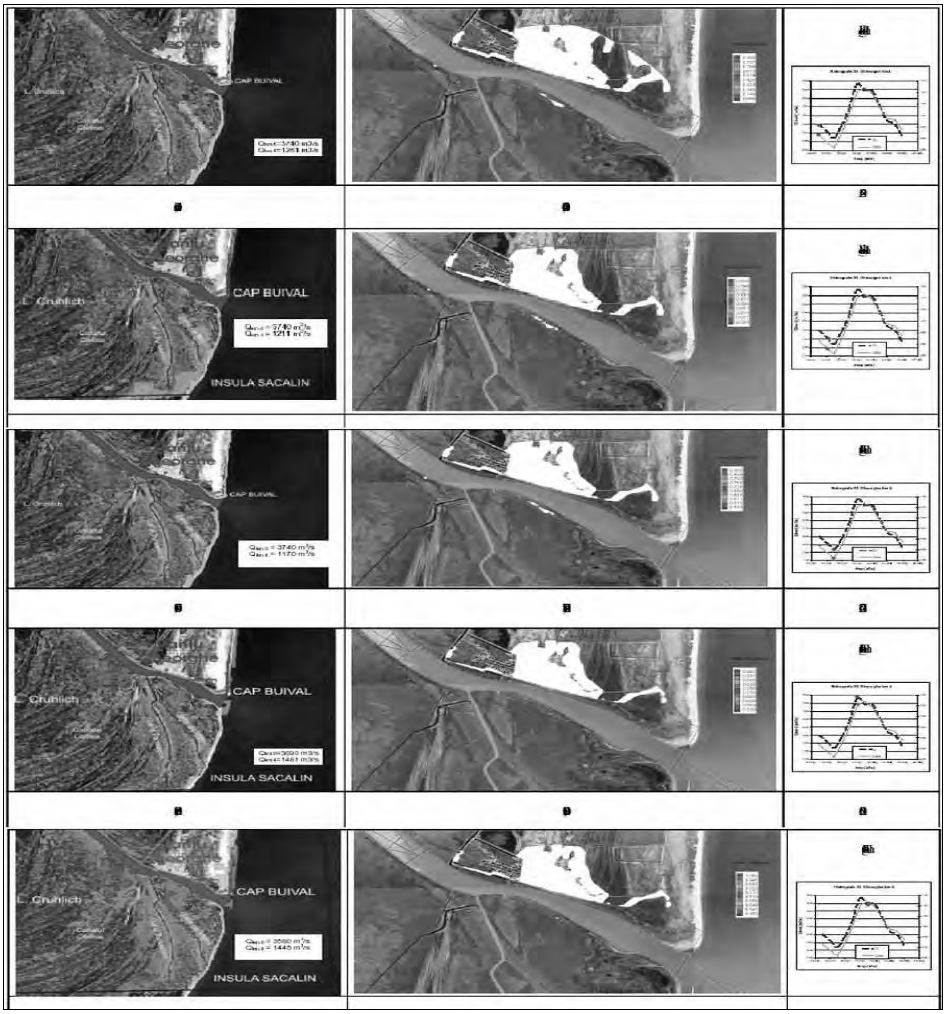

Fig. 4. The water mask for the flooding in 2006, St. George village

Image 5 illustrates the map of the flooded houses for a calculation flow 1517 m3/s and downstream level of 0,97 m. As a consequence of the price difference o the real estate market, the map shows only the recently built buildings (after 2001), distinguished by their constructive type, the old ones being dominantly made out of clay with just the ground floor. An exception makes is represented by the 4 floors apartment houses located in the proximity of the harbor.

According to the water depth and speed, the next step was provided through the calculation of the level of damage resulted, corresponding to the degree of destruction and value of the residences. In the case of the specific flooding scenario, the houses made out of clay will be completely destroyed and in the rest of the cases the damage being estimated at 40% of the value of the residence.

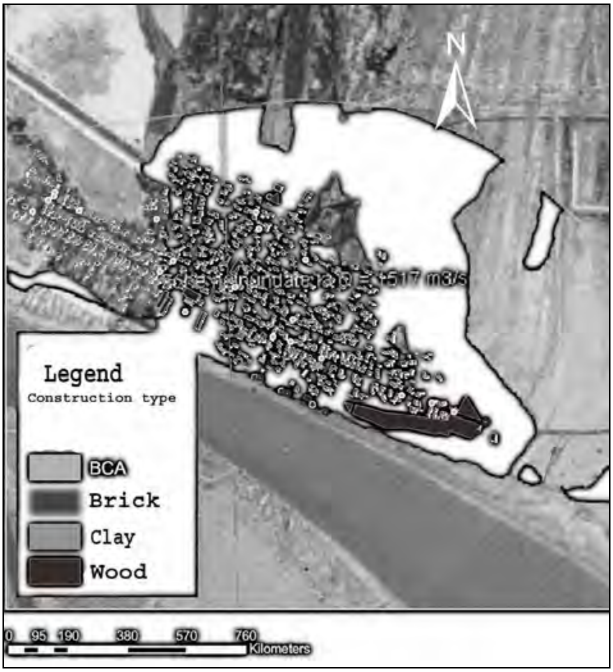

Fig. 5. Detail of the flooded/unflooded area for a calculation flow of 1517 m^3/s showing a classification of the houses according to height and price: the height is shown through proportional triangles and varies between 2,5 m and 10 m and the prices (in euro) are distinguished through colours, from 20000 euro to over 1 million euro (the Dolphin complex represented with the colour black in the image)

The risk analysis model presented in the study can become a useful tool for decision factors and local authorities by providing the necessary informational support in the implementation of physical planning and disaster management politics.

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THE SILTING OF THE RESERVOIRS FROM SOMEŞUL CALD VALLEY UNDER CONDITIONS OF THE IRREGULAR DISTRIBUTION OF THE FOREST AND OF THE ALLUVIAL FLOW

GH. ŞERBAN[1], H. CACOVEAN[2]

ABSTRACT. The Silting of the Reservoirs from Someşul Cald Valley under Conditions of the Irregular Distribution of the Forest and of the Alluvial Flow. After a general presentation of the drainage basin of the reservoirs from the Someşul Cald Valley, the authors proceed to a short analysis of the forest repartition in the drainage basin area and of the alluvial flows, which condition the reservoir sedimentations. There are put into evidence low values of this phenomenon, but also the existence of several spaces with anomaly character, respectively values among most erect, due to the presence of the friable sedimentary rocks and, also, of a poor forest coverage. This aspect is confirmed by the values measured at the hydrometric stations, included in text under tables and correlation charts form of the specific parameters, respectively, by the map and the table of forest repartition in the drainage basin area. In the second part of the study there are emphasized several aspects concerning the silting volumes degree and areas of high intensity of the silting phenomenon. In the four reservoirs the principal affluent outlets are characterized by important alluvial deposits, frequently organized under dejection cones form, or reefs and alluvial strings, depending on the volume and the dynamics of waters from retentions.

Keywords: *reservoirs, forest repartition, suspension flow, sedimentation, accumulation shapes.*

1. INTRODUCTION

The drainage basin of the reservoirs from the Someşul Cald Valley is situated in the north-eastern part of Apuseni Mountains (the massifs of Gilău, Muntele Mare and partly Bihor). The confluence of the Someşul Cald river with Someşul Rece river, downstream of the Someşu Rece-sat village, led to the Someşul Mic river forming, however, its source is considered to be the source of Someşul Cald river through of the superior length and debit (fig. 1).

In the studied space there are included the sub-basins of rivers Someşul Rece and Someşul Cald, and also the upper basin of Iara river (down to the Bondureasa dam) and its left tributaries Valea Calu, Şoimu and Lindrul. The changing of the natural system was made through the underground deviation of the waters into hydrotechnical system of Someşul Cald valley, although geographically it belongs to the Mureş basin *(Serban, 1999, 2007)*.

The favourable conditions (petrographic, morphological, climatic etc.) made possible a great hydrotechnic arrangement of the mountainous area, which capitalised the existing potential in the natural area. The 860 km^2 of the drainage basin afferents in the Gilău dam section (lower limit of the studied basin) were arranged since the end of '60 years, through the

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accomplishment of the four reservoirs in the Someşul Cald Valley (Fântânele, Tarniţa, Someşul Cald and Gilău) and several intakes in the Someşul Rece drainage basin intended to supplement the tributary debits in the four lakes *(Serban et al., 2003, Serban, 2007).*

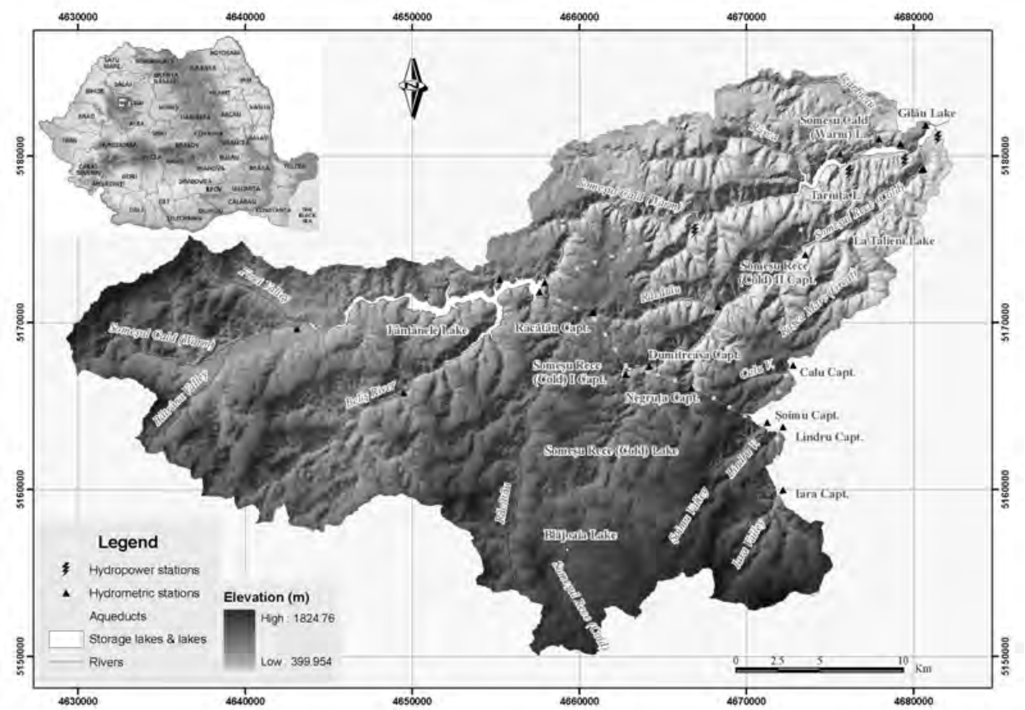

Fig. 1. General map of the drainage basin of the reservoirs of the Someşul Cald Valley.

2. METHODS

The documentation and the construction of digital media has been achieved by using cartographic information available to the faculty and other units of the endowment with which our institution has concluded cooperation agreements.

Recent technical equipment made by the institution and the team-working with the similarly or related profile units facilitated the measurement campaigns development designed to update existing databases and make additions in the areas where information is missing. Thus, for the topometric operations were used Trimble and Magellan GPS terminals doubled by the theodolite in the areas with consistent canopy of trees. To achieve the batimetric data were used PEL 4 and ADA 80 echosounders – for the most of the lake surfaces and simple sounders - for the lake difficult to reach areas and the least deep.

The centralization and the information processing were performed in digital version using the software of endowment of Hydrometry Laboratory of the faculty and collaborative units: Microsoft Office XP; The Scientific Software Group's: "Groundwater Modelling System-GMS"; "Watershed Modelling System-WMS"; "Surface-Water Modelling System-SMS"; ESRI ArcView 3.x; ESRI ArcGIS/ArcINFO 8.x.

3. RESULTS

3.1. Forest repartition in the reservoirs drainage basin

In the specific climatic conditions vegetable coating maintains a vertical storing depending on altitude.

Thus, **the foliated forests** include two major components. *Oak floor*, with expansion up to altitudes of 500 - 600 m, particularly prevalent in north-eastern and eastern basin, with many species including Quercus robur, Quercus sessiliflora. *Beech floor* is met by high altitudes (900 - 1000 m) occupying extensive areas in the central and the north-eastern part of the basin. It penetrates into the valleys mixed with other species, including the resinous and the highest area of the basin, without exceeding specified altitudes.

It appear other foliated species in combination with the beech: Carpinus betulus (hornbeam), Ulmus campestre (elm), Fraxinus excelsior (ash tree), Acer pseudoplatanus, oak and Tilia cordata (lime), Cornus sanguineea (horn), and in meadows meets Alunus icana and willow tree.

Following deforestation made in order recovery timber, floristic composition of this floor has altered the meaning of the occurrence of raspberry bushes, elderberry bushes or blackberry bushes.

Coniferous forests consist of Picea excelsa (spruce) and to a lesser Abies alba (tree), disseminated by willow, occupies significant space, to expand to highs of 1600 m. Along the valleys appear the birch, also present on some high plateaus (Râşca). They were cleared in the settlements neighbour and in the vertex spaces or height plates occupied by three large municipalities (Risca, and Marisel Maguri).

Alpine and subalpine floors extend to altitudes of over 1600 m and an island occurrence (Bihor Mountains, and especially Great Mountain), including herbs and inferior alpine bushes (Festuca pratensis - păiuşul, wind herb etc.) and meadows with alpine dwarf bushes upper (Festuca rubra, Agrostis tenuis, Juniperus communis, etc.).

Secondary meadows extended as a result of anthropogenic intervention, including several associations who certify their installation after coniferous deforestation. Several cenozes are prevalent in various pastoral values: Festucetum rubrae montanum, Agrostetum tenuis, Festucato - Nardetum montanum or Nardo Callunetum vulgaris, the very low economic value.

Around the reservoirs (less Fântânele and Tarnița) appears a hygrophile specific vegetation (reed, rush and sedge), and on the delta from upstream end of the Gilău lake extends rapidly the evolving vegetation (willow, wicker).

Anthropogenic factor induced *changes in the space occupied* by some plant systems by deforestation, or to exploit or to create space for settlements or pasture and meadows (fig. 2).

The most important cuts of trees, between 1978 and 2008, were made in the upper river basins of Iara, Someşul Rece and Racatau, followed by the basins of the rivers Beliş and Someşul Cald. The aggressive cuts were made at great distances from localities, in the neighbour of some dwellings located in areas of basin difficult to reach and harder to control. Reforestation was restricted to areas that call an emergency intervention due process very aggressive side (upper river basins of Râşca and Agârbiciu).

On the river basins, the forests occupy the largest area in the Someşul Rece basin (60% of area) compared with that of the Someşul Cald basin, where the percentage is only 41% (table 1).

The situation is obvious whereas areas cleared for settlements abode occupies a small space in the first case. On the sub-basins is remarkable high percentage of space occupied by forests in the upper basin of the Someşul Cald river and in the upper and middle basin of Someşul Rece river and in the basin of the Iara river, tributarry to the intakes.

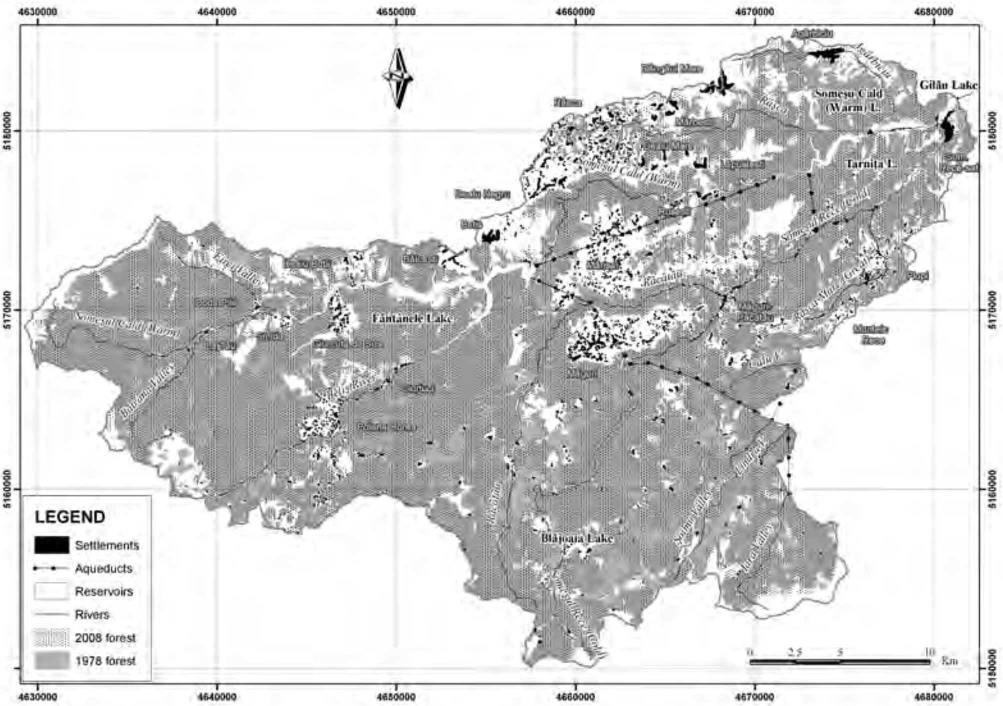

Fig. 2. Forest repartition in the Someşul Cald reservoirs drainage basin.

Development of the intensive agriculture and forestry, has ordered an intensive use of soil resources, which amended the coating plant and the soil. Anthropogenic interventions have the effect of flow changing, the deforestation leading to surface and deep progressive erosion, changing microclimate in the old forest areas, all with implications for the dynamics of hydrological elements (riverbeds sedimentation, lakes clogging etc.).

3.2. Suspensions flow which conditioning the reservoirs silting

Although the slopes are generally high, the low clogging phenomenon intensity of the reservoirs is explained by the particular rocks strength (peach-stones, granite, magmatic rocks), by the significant extending of the forest carpet and of the pasture in cleared areas, and by the anthropogenic interference still low in most of the basin *(Serban et al., 2003)*.

There are basin spaces that induce anomalies in this repartition, of natural or anthropogenic causes. Such areas occur in the lower basin of Someşul Rece river, due to the Muntele Mare's granite rocks alteration *(Mac, 1998)*, in the basin of Râşca and Agârbiciu rivers, where the sedimentary rocks in conjunction with a low density of the forest allow massive displacements in the periods with average and maximum flows.

To better illustrate the previous information's, several data were processed from four hydrometric stations, through which were monitored quantities of alluvial matter entered into the lakes (table 2). Period of observations taken into account corresponds to the interval 1981 - 1997 for three of the stations. Although the period of the fourth station (Someşul Cald on the

Agârbiciu river) was very short (1979 - 1982), the data obtained from observations were eloquent in explaining the process of Someşul Cald reservoir clogging phenomenon under the influence the most important specific input alluvial matter from the basin.

Table 1

Forest areas of the constitutive basins from the Someşul Cald reservoirs drainage basin (after Romanian Water Authority„Someş-Tisa" Cluj Subsidiary)

N°.	River	Drainage basin			
		Surface (km^2)	Average elevation (m)	Forest areas	
				(ha)	%
1	Ponor	16	1321	1213	76
2	Bătrâna	37	1326	2374	64
3	V. Firei	22	1394	902	41
4	Giurcuța	9	1296	260	29
5	Beliș	88	1240	6245	71
6	V. Leşu	12	941	178	15
7	Râşca	59	889	1768	30
8	Agârbiciu	26	677	995	38
I	**Someşul Cald***	**533**	**1135**	**22077**	**41**
1	Irişoara	20	1411	1400	70
2	Dumitreasa	13	1366	855	66
3	P. Negru	11	1227	814	74
4	Răcătău	101	1242	6008	59
5	Râşca Mare	18	1099	541	30
II	**Someşul Rece***	**327**	**1214**	**19865**	**61**
1	Iara	45	1653	2345	52
2	Lindrul	4	1410	268	67
3	Şoimul	23	1452	918	40
4	V. Calu	12	1405	980	82
III	**Iara**	**84**	**1480**	**4511**	**54**

* Values for fully basin
41 Values under 50% forest coverage

According to the obtained results, the highest rates of alluvial matter coming from the sedimentary area of north-east basin, carried by the left branch of the Someşul Cald river, Agârbiciu (R = 1034 kg/s).

High values have been determined in last years in the area during the campaigns of measurements and observations made in July of 2001 and 2003 on another river neighbour, Râşca Valley. During the campaign (4-10 July 2001) were measured high debits and, also, low debits, being very well correlated with the debits measured on the Căpuş river at Căpuşu Mare hydrometric station, located a bit of north. Average alluvial debit determined during observations was R = 0784 kg/s, very close to the value of the river Agârbiciu. It reported in the area of 59 km^2 of the basin, giving a specific average alluvial flow significantly, estimated at r = 4190 t/ha.yr.

Also, high values of average alluvial flow were registered on the Beliş river at Poiana Horea hydrometric station (R = 0548 kg/s) because of sedimentary rocks presents in the mid-upper basin and of the deforestation produced in last period of time.

Table 2

Main elements of the average suspensions flow to the hydrometric stations from the drainage basin (after Romanian Water Authority „Someş-Tisa" Cluj Subsidiary)

N°.	River	Hydrometric station	Surface (km²)	Average elevation (m)	Alluvial debit (kg/s)	Alluvial volume (t)	Specific alluvial debit (t/ha.yr)
1	Someşul Cald	Smida	110	1293	0,211	6664	0,606
2	Beliş	Poiana Horea	85	1259	0,548	17277	2,033
3	Agârbiciu	Someşul Cald	28	705	1,034	32609	11,857
4	Someşul Rece	Someşul Rece-sat	334	1218	0,050	1581	0,047

Someşul Rece river, at the entrance into the Gilău reservoir, is in "shadow of alluvial matter, under the effect of two upstream catchment. However, at the phase of maximum leakage, the alluvial flow is reactivated, reaching very high values (R = 54.5 kg/s at the flash-flood from December 1995), the prove being the progress of the Someşul Rece river delta.

Under these conditions, an increased sedimentation affects the two little reservoir basins (Someşul Cald and Gilău) where are directed the alluvial matter debits of the Agârbiciu and Someşul Rece rivers; such cases have been referred in literature *(Ichim et al., 1976, Giurma, 1997 etc.).*

4. DISCUSSIONS

Using GIS technology in information processing has made possible the realization of digital models of the lake basins, elements of great utility in the analysis of area alluvial matter dispersion *(Kondratyev et al., 1999, Touchart, 2002, Serban et al., 2005, Alexe et al., 2006, Serban, 2007).*

Generally, in the reservoirs cascade system of Someşul Cald river, the areas of maximum intensity of clogging correspond to the confluence of the main rivers and brooks, situation specific and other lake studied in Romania *(Bojoi et al., 1972, Ichim et al., 1976).*

The two large lakes in the upper and median drainage basin (*Fântânele and Tarniţa*) were not distinguished by the spectacular developments of the clogging phenomenon. *Clogging rates* and *the sediment distribution* on basin spaces fall into the normal pattern and, since the basins are developed on the crystalline and magmatic rocks (fig. 3).

Concerning the small reservoirs from the mid-lower basin, including the *Someşul Cald*, the sediment distribution across the basin area is different because of the depths and volumes much lower compared with the reservoirs of upstream and of a special water transit. Although there is a massive intake of alluvia they were reshuffling in a different way than natural because of the water currents very active, who coming from the Tarniţa hydropower station *(Serban et al., 2006).*

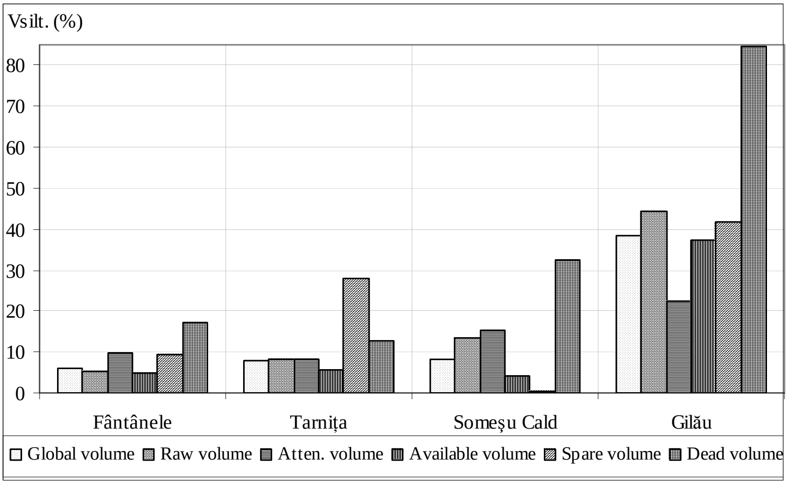

Fig. 3. The characteristic volumes reduction from the make in use of the reservoirs from the Someşul Mic upper basin. Fântânele, 1976-2000; Tarniţa, 1973-2001; Someşul Cald, 1983-1993; Gilău, 1972-2005.

Compared to the original state, the most clogged space of the lake basin is not to the Agârbiciu river outlet, where it should have under normal conditions of sedimentation to be a submerged dejection cone, but on the opposite slope of the lake basin. The character of buffer lake between the Tarniţa and Gilău lakes and the frequent discharges from the upstream hydropower station, made than the sediments to be diverted by the currents to the convex bank, opposite to the confluence with Agârbiciu river and reshuffling in the form of reefs or small longitudinal sand banks. A part of the deposit has been widespread also in the upper sector of the lake basin under the same forms, during the quiet periods between discharges.

The most aggressive evolution of the clogging phenomenon was observed in the Gilău reservoir where the geological factor influenced largely the sediment distribution on the lake basin surface (*Pandi, 1997, Pandi et al., 2005*). Thus, the cretaceous hones horizon who crossing the lake over the median basin zone, play the role of threshold and resulted in shrinking and compartmentalization of the basin in two sectors; each sector will have their particularly evolution of sedimentation under the influence of alluvial flow of the tributaries. In the upper compartment, the first phase was a shrinking of the old Someşul Mic meadows, under effect of bilateral alluvial transport of the Someşul Cald and Someşul Rece rivers. Later it disappears as morphological unit (1977) being substituted by a twining of alluvial cones of the two rivers (*Aniţan et al., 1977*).

After the Someşul Cald dam construction (1983), the alluvial intake from the primary tributary becomes almost null and, hence, their cone evolution ceased. Instead, the Someşul Rece alluvial cone start to configure more than one delta and the thalweg is pushed slightly to the left slope of the lake, such evolution being distinguishable in other field studies (*Romanescu, Gh, 2002*).

5. CONCLUSIONS

Forest carpet, irregular distributed in the Someşul Mic upper basin, induces more instability on the lower reservoirs from the lower arranged drainage basin part, by promoting of a consistent influx of alluvial matter, the more so as the cleared spaces pools overlap frecvet those with friable sedimentary substrate.

The tributary's outlets in reservoirs are characterized by large alluvial deposits, which most often take the form of dejection cones, of reefs or alluvial girdles. The particularly water transit, but, also, the laterally alluvial contribution distinguishable to the Someşul Cald and Gilău reservoirs, affect the distribution of sediments on the lake basin spaces, putting into evidence a rapidly and highly evolution of the evolved forms of sedimentation (lacustrine delta) and, also, thalweg deviations, submersible channels etc.

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ESTIMATION OF SOIL WATER INFILTRATION USING CN (CURVE NUMBER) INDEX AND G.I.S. TECHNIQUES - Application: Săcuieu Hydrographic Basin-

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ABSTRACT. The Estimation of Soil Water Infiltration Using CN Indices (Curve Number) and G.I.S. Techniques. The principal purpose of this paper is to establish a work methodology that can help to evaluate the quantity of soil infiltrated water in different pluviometrical conditions. Knowing this segment of rainfall-runoff system, could have an important role in anticipating a flood dimension. The beginning of surface runoff depends on the soil water saturation, and this depends, on its turn, on the antecedent precipitation characteristics as well as the soil physic characteristics (texture, structure, depth soil profile, permeability, capacity of soil infiltration and water retention etc.). Study algorithm provides the integration in G.I.S medium of an equation proposed by SCS (Soil Conservation Service) based on using Curve Number Index (CN). Determination of these indices it is realized, by USDA-SCS, depending on hydrological soil groups and land use. In the same time, these indices values depends on antecedent moisture conditions (AMC), determined by quantity of precipitation from last five days. The study surface is Săcuieu (Hent) Hydrographic Basin for which we intend, using G.I.S. functions, to represent infiltration values in space by emphasize the vulnerable areas to flood.

Key words: *infiltration, Curve Number, G.I.S, Săcuieu*

1. INTRODUCTION

The soil water infiltration, during a rainfall and analyzed as water infiltrated depth (mm) - *cumulative infiltration* or as infiltration speed (mm/min.;mm/h), represents an essential variable in surface runoff study. The starting of infiltration process and its intensity depends, principally, on the pedogeographical characteristics and on land use in the studied area. The antecedent moisture conditions also become important in decreasing or increasing of water accumulation time. If the pluviometric event is high, a soil that is closer of the superior saturation limit will have a low infiltration capacity and this fact can intensify the risk of a high flood.

During the time, in order to determine the infiltration, there had been elaborated a lot of models, some of them based on empiric relations, (Horton`s formula, 1940; Holtan`s formula, 1961; Kostiakov`s model, 1932 etc.), some of them have a physic base (Green Ampt model, 1911; Philip model, 1957 etc.).

In the beginning, the use of Curve Number indices in order to evaluate the hydrological balance parameters in a basin had ample applications, most of them in USA (*USDA 1972, 1997; Mishra S. K. and Singh V. P., 2003; Bernard E., 2005* etc.). After that, these indices had been successfully applied in some of the European researcher’s studies (Musy A., 1998; Luijten J. C., 2002; Baltas E. A., 2007; Man T. and Alexe M., 2006; Drobot R., 2007; Chendeş V., 2007 etc.).

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The main objectives of this study are:

— to present a spatial analysis methodology of infiltration process, focused on integration in G.I.S medium of a method developed by SCS (Soil Conservation Service);

— to apply the calculus algorithm in Săcuieu Basin for daily precipitations > 50 mm;

The studied area, Hydrographical Basin of Săcuieu (Hent), is situated in the north of Apuseni Mountains, between Drăgan Basin (in west), Someşul Cald Basin (in south), Călata Basin (in east) (**Fig. 1**). Having a 200 km^2 area, its biggest part is lied on the eastern side of Vlădeasa Massive, from here the Săcuieu Basin receives the most important tributaries (V. Stanciului, V. Cetății, V. Răcaş, V. Vişagului). From Gilău Massive, the principal stream receives the most important tributary– V.Mărgăuța. In an anterior study (Crăciun A. I., Haidu I., Bilaşco St., 2007) we have used de CN index for evaluate de hydric runoff in the Hydrographical Basin of Valea Mare (Clujului Hills).

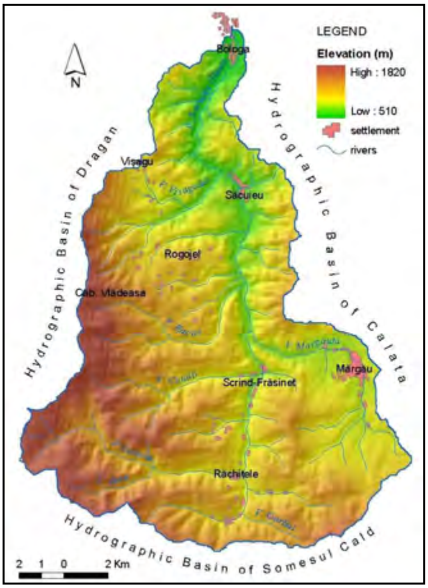

Fig. 1. Elements of studied area location

2. G.I.S METHODOLOGY

For estimating the infiltration – *cumulative infiltration* – (F) (*Musy A., 1998*), **SCS** (**S**oil **C**onservation **S**ervice) proposes an equation that depends on quantity of precipitation(P), initial loss – evapotranspiration, vegetation retention (I_a), maximum potential of retention (S):

$$F = \frac{S \cdot (P - I_a)}{P - I_a + S} \qquad (2.1)$$

In what concern the quantity of precipitations, for this study, there had been used daily data (NCDC source) which correspond to Vlădeasa Meteorological Station, the vales being considered medium on basin.

From this series of data, there had been chosen the pluviometrical events characterized by quantities > 50 mm: 29th of June 1986; 27th of August 1993; 24th of November 1993; 14th of July 1994; 06th August 1994; 21st of August 1994; 09th of June 1995; 26th of July 1998 (**Fig. 5**).

In order to estimate the initial loss (I_a), after many studies, SCS proposes an empiric relation such as:

$$I_a = 0,2 \cdot S \qquad (2.2)$$

If $P \le I_a$ infiltration is 0.

The calculus of maximum water retention potential (S) is realized by applying the next relation:

$$S = \frac{25.400}{CN} - 254 \qquad (2.3)$$

where: CN = f (soil, vegetation, soil conservation, land use, antecedent moisture conditions)

An alternative of estimating the <u>**C**N **I**ndex</u> (**C**urve **N**umber) is based on using the **L-THIA GIS** (**L**ong-**T**erm **H**ydrologic **I**mpact **A**ssessment) extension, developed by EPA (**U**nited **S**tates **E**nvironmental **P**rotection **A**gency) and Purdue University in U.S.A. The main steps that had to be followed for spatial representation of CN index assisted by L-THIA are:

a). generation of data referred by land use and hydrological soil groups (HSG) in raster format. The categories of land use must have the next structure: Water, Commercial, Agricultural, HD Residential, LD Residential, Grass/Pasture, Forest, Industrial (Bernard E., 2005). In function of water infiltration capacity, the soils can be classified in four groups: **A**- high capacity, specific to sandy or sandy-loam texture; **B –** medium capacity, specific to loam and loam-sandy texture; **C** – low capacity, specific to loam-clay texture; **D** – very low capacity, specific to loam-clay, clay-loam and clay texture;

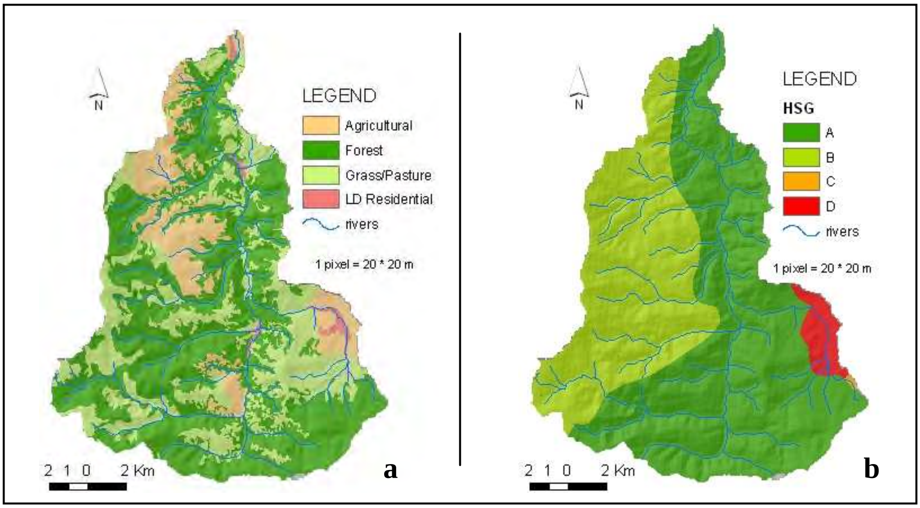

Fig. 2. Săcuieu Basin. Spatial distribution of land use (a) and hydrologic soil groups (b)

b). reclassification of both raster themes, in order to convert the qualitative information to a quantitative one, using the functions: <u>**L**and **U**se **C**lassification</u> and <u>**S**oil **C**lassification</u>. So, each category will be automatically coded according to **Table 1**.

c). determination of CN indices, for normal antecedent moisture conditions, using <u>**C**alculate CN</u> function;

The CN index resulted will be adjusted in rapport of antecedent moisture conditions (**AMC),** in function of precipitation quantity in last five days:

AMC_I – dry soil conditions, specific to precipitation < 12,7 mm, in period of pluviometric deficit, respective < 35,6 mm in rainy period;

AMC_{II} – normal soil moisture conditions, specific to precipitation values between 12,7 – 28 mm in period of pluviometric deficit, respective 35,6 – 53,4 mm in rainy period;

AMC_{III} – saturated soil conditions, specific to precipitation values > 28 mm in period of pluviometric deficit, respective > 53,4 mm in rainy period.

The equations used for adjusting are (Luijten J.C. et colab., 2002):

$$CN_I = \frac{(-75 \cdot CN_{II})}{(-175 + CN_{II})}; \quad CN_{III} = \frac{(175 \cdot CN_{II})}{(75 + CN_{II})} \qquad (2.4)$$

In Săcuieu Basin, for each selected pluviometric events was noticed normal antecedent moisture conditions (AMC_{II}).

The CN values obtained (Fig. 3) are classified between 30 (for afforested areas and characterized by sandy-loam soil textures) and 85 (for agricultural areas and characterized by clay-loam soil texture).

Table 1

The codes used by L-THIA GIS for reclassification land use and hydrologic soil group

Recls_land	Code
Water	1000
Commercial	2000
Agricultural	3000
HD Residential	4000
LD Residential	5000
Grass/Pasture	6000
Forest	7000
Industrial	8000
Recls_hsg	**Code**
A	1
B	2
C	3
D	4

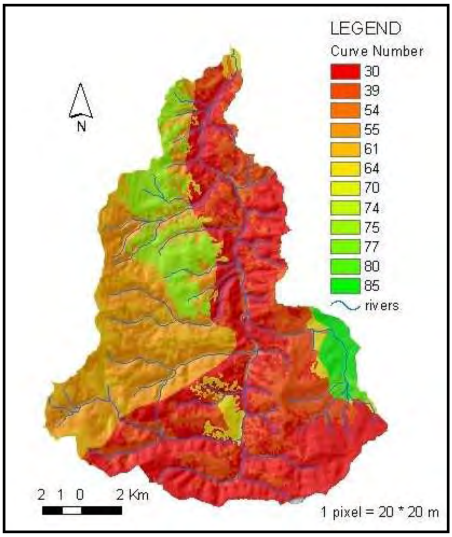

Fig. 3. Sacuieu Basin. Curve Number Distribution

The spatial representation of maximum retention potential (S) and initial loss (I_a) was realized by integration in G.I.S medium of equation 2.2 and 2.3, using Spatial Analyst extension. The maps obtained, show some areas characterized by a high water retention capacity, situated, principally, on right side of Săcuieu Basin (**Fig. 4**). These areas are afforested or covered with grass and pasture, overlapped to some sandy or sandy-loam soil texture (Chicera Hill, Răşinari Hill, Preluca Hill, Boroilasa Hill, Runcului Hill etc.).

3. RESULTS AND DISCUSSIONS

Once realized the data base that correspond to the parameters showed anterior, the next step was to apply the equation 2.1 for the calculus of infiltrations values for selected pluviometrical events In **Fig.5** we present the estimated infiltration for precipitations > 50 mm to Vlădeasa Station.

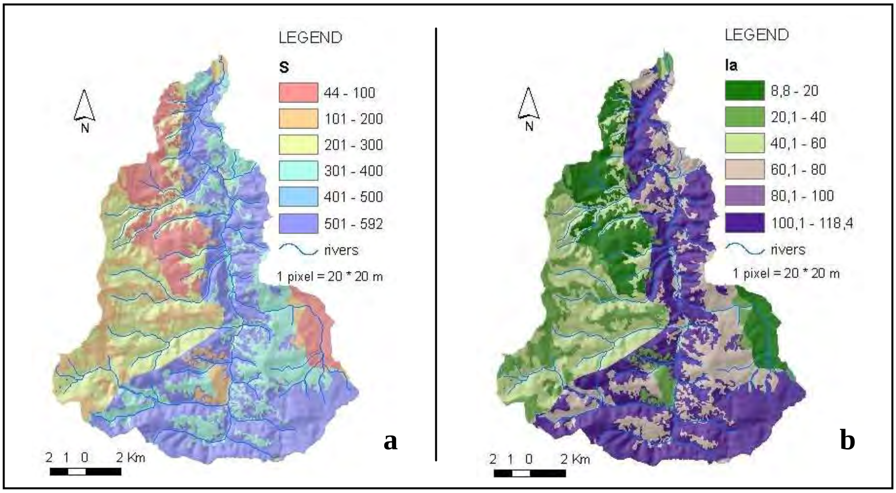

Fig. 4. Săcuieu Basin. Spatial distribution of maximum retention potential (a) and initial loss (b)

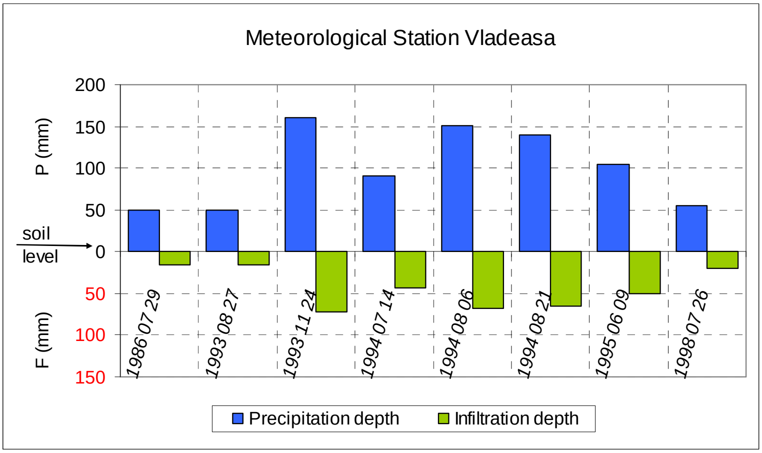

Fig. 5. Vlădeasa Station. Relation precipitation depth – infiltration depth for pluviometrical events > 50 mm

The clay and clay-sandy texture soils from Vlădeasa Station perimeter, placed in hydrological class B (medium infiltration capacity) and the fact that these soils are covered with grass and pasture, determined values situated between 20 and 40 mm in what it concerns the initial loss. In these conditions, the infiltrated water depth represent about 30% of the precipitated one, in the case of precipitations situated around the values of 50 mm. For precipitations higher, we can observe a percentage of infiltrated depth situated around 50%.

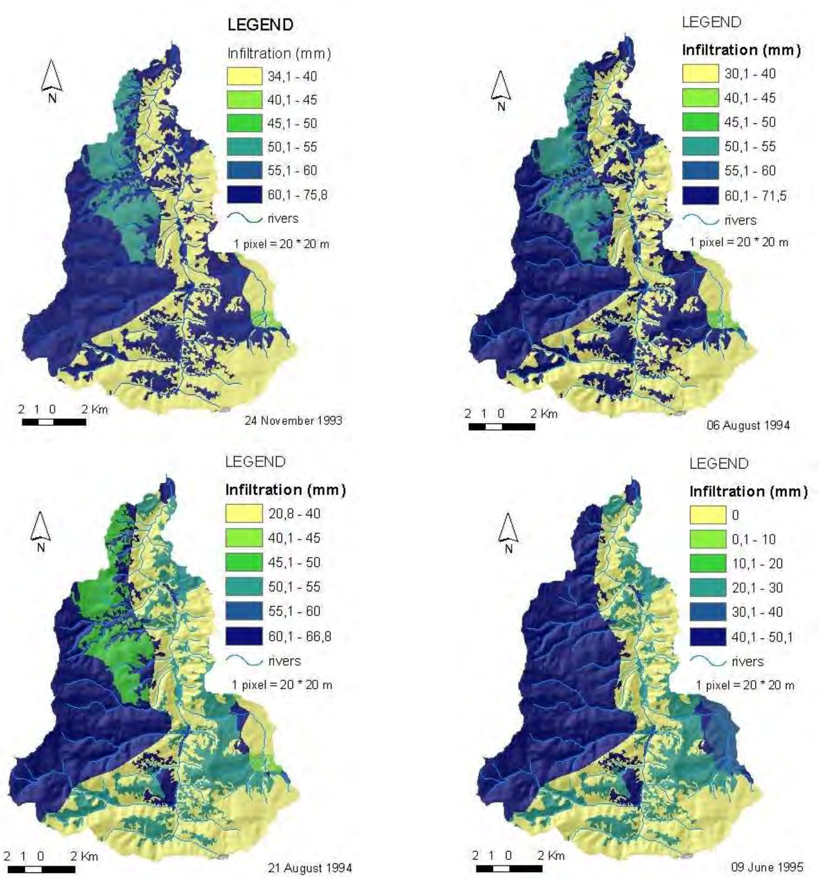

Fig. 6. Săcuieu Basin. The spatial representation of infiltration values for daily pluviometrical events > 100 mm

The obtaining the infiltration maps for rarely pluviometrical events (**Fig. 6**) could be possible by integration the relation 2.1 in G.I.S medium, using Cartographical Algebra techniques. It is talking about using **R**aster **C**alculator function, available in **S**patial **A**nalyst extension.

Analyzing the four maps, it can be observed the maximum infiltration values, especially on left side of the basin (even if it has a high afforesting level), due to loam and loamy-sand texture soils, that are characterized by a high water retention capacity. High values of infiltration are found in the pasture or grass areas and sandy-loam texture soils on the right side of the basin. The lowest values (< 40 mm) are found in the superior sector of the basin and on vast areas from the right side of middle sector. These values are explained by the high afforesting level, which determine the initial loss, by one side and by existence of some pedological entities with sandy and sand-loamy texture, which are characterized by a low water retention capacity, on the other side.

For a better detail description of the results, we realized an infiltration analysis for some fitopedological characteristics in daily precipitation conditions > 100 mm registered in the studied area (**Table 2**, **Fig. 7**). Generally, the results show an increase of infiltration values starting from the afforested areas to the agricultural ones, respective from clay-loam or clay soils texture to sandy texture ones.

Table 2

Values of SCS method parameters for different pedological characteristics and land use types of Săcuieu Basin

Land Use	**Soil Texture**	**HSG** (Hydrologic Soil Group)	**CN**	**S**	**I_a** (mm)	**F (mm)**			
						24. Nov. 1993	***06. Aug. 1994***	***21. Aug. 1994***	***09. Jun. 1995***
Forest	Sandy-loam	A	30	592,7	118,5	38,8	30,0	20,7	0,0
Forest	Loam-clay	C	70	108,9	21,8	60,9	58,9	56,7	47,1
Pasture	Sandy-loam	A	39	397,3	79,5	67,0	60,0	52,5	23,9
Agricultural	Sandy-loam	A	64	142,9	28,6	68,5	65,7	62,6	49,7
Agricultural	Loam	B	75	84,7	16,9	53,2	51,8	50,2	43,1
Agricultural	Clay-loam	D	85	44,8	9,0	34,6	34,0	33,4	30,5

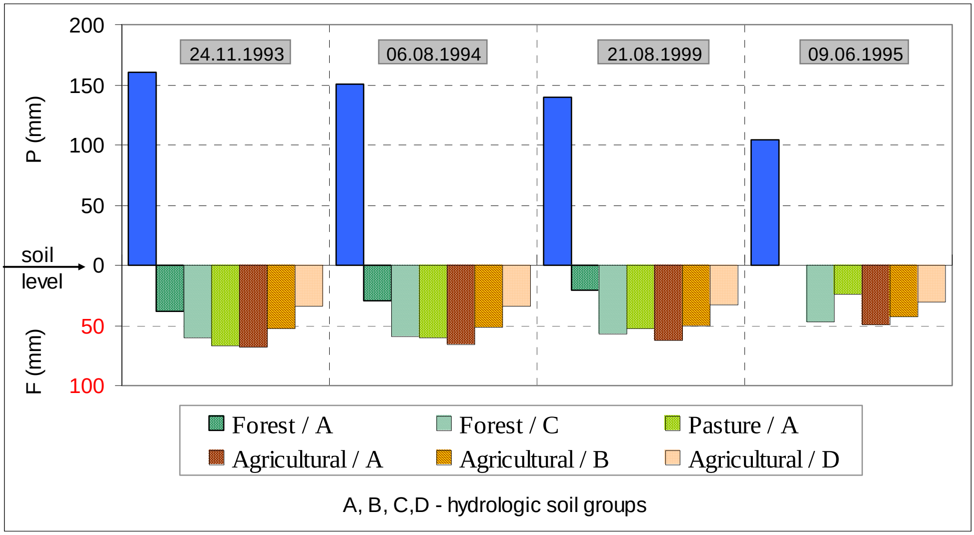

Fig. 7. Development of infiltration for different land use conditions and hydrological soil groups from Săcuieu Basin

In what it may concerns the risk of high flood generation, we consider that the most vulnerable areas are in three settlements: Rogojel, Vişagu şi Mărgău. The low values of maximum retention potential that characterized these areas determine fast saturation of soil profile, fact that goes to generating of a high surface runoff.

4. CONCLUSIONS

Using G.I.S technology for realizing the hydrological studies presents a big importance, principally, due to the analyze possibilities of the results from cartographical point of view. So, that can be emphasized those areas that had been affected or that present high vulnerability of extreme hydrological phenomenon.

In this study, the integration of a classical calculus infiltration method in G.I.S medium permitted an area analysis of the process, not just a punctual one.

In what it may concerns the method developed by SCS, based on using the CN index, we consider that, for the increasing of results accuracy, could be useful to take into account some index of land slope. In the same time, a coefficient that can illustrate the cranked level of geological substrate would be important, especially in the areas characterized by a very slim soil profile.

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CHEMICAL ANALYSIS OF WELL WATERS OF VILLAGE OF CÂMPENEŞTI, CLUJ COUNTY, ROMANIA

C. ROŞU[1], G.I. PESCAR[1] AND I.M. VARGA[1]

ABSTRACT. Chemical Analysis of Well Waters of Village of Câmpeneşti, Cluj County, Romania. The proposed study area of Câmpeneşti is located in Cluj County. Only 11% of the population in the rural zone in Romania has access to safe drinking water. Most of human population use wells or springs as the main source of drinking water. Wells are generally less than 20 meters deep and they are not properly sealed. The water samples were analysed for **pH**, Electrical Conductivity (**EC)**, Total Dissolved Solid (**TDS**), Oxi-Reduction Potential (**ORP**), Calcium ($\mathbf{Ca^{2+}}$), Magnesium ($\mathbf{Mg^{2+}}$), Total Hardness (**TH**), Sulfate ($\mathbf{SO_4^{2-}}$) and Nitrate ($\mathbf{NO_3^-}$) using standard techniques in laboratory. Total dissolved solids (**TDS**) vary between 835 mg/L and 1488 mg/L and well water **pH**s are slight basic (7..62 – 8.38). Nitrate concentrations monitored in Câmpeneşti groundwaters show that 80% of the well water samples exceed 50 mg/L (WHO guidelines value and Romanian value) and 100% exceed 13.5 mg/L (indicative value of human activities). The nitrate content ranges from 48.1 to 85.2 mg/L. Groundwater nitrate correlates positively with TDS.

Keywords: *well water, nitrate, ground-waters, water quality, hardness of water.*

1. INTRODUCTION

Water is nowdays considered as a precious resource since it is main source of life. However, it may also be a cause of lots troubles, which could affect to some extent human health. Therefore, there is an increasing concern on water pollution of both natural and human origin. Water quality assessment is now becoming a necessity. However, groundwater is highly vulnerable to contamination and no comprehensive studies have been completed on groundwater quality in the study zone. Wells are generally less than 20 meters deep and they are not properly protected from surfacial pollution.

The present report summarizes the water quality chemical parameters of well water samples during January-June 2008. Contaminants occuring in large concentrations are nitrate (NO_3^-) and mineralization (TDS).

2. REGIONAL AND HYDROGEOLOGICAL SETTING

The study site is located in Câmpeneşti, Cluj County. It stretches from 46^0 $85^{'}$ latitude to 23^0 $72^{'}$ longitude. The average annual rainfall is around 750 mm in the study area. The mean annual air temperature ranges from -25^0C to $+35^0$C. The zone is predominantly rural. Agricultural land uses and cattle breeding dominate the population activities.

The well depth ranges from 5 m to 20 m, depending on the sampling site topography.

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1:100 000 m

Fig. 1. The position of Câmpeneşti as part of Cluj County.

3. SAMPLING AND ANALYSIS

The sampling campaign was carried out in the area of Câmpeneşti in January – June 2008. There were a total of 120 water samples collected from 5 private wells (four samples / month / well). Temperature (^{0}C), pH, redox potential (ORP in mV), Electrical Conductivity (EC in µS/cm) and Total Dissolved Solids (TDS in mg/L) were measured in field using portable multiparameter WTW 720 Inolab. The Total Hardness (TH in mg $CaCO_3$/L) was also determined in-situ by EDTA titration. For the remaining analysis, samples were collected and passed through a 0.2 µS filter and the other elements in solution were determined in the laboratory using a RQ-flex 10 Merck.

Table 1

The parameters of Câmpeneşti well water samples during January-June 2008

No.	T (^{0}C)	pH	EC (µS/cm)	TDS (mg/L)	ORP (mV)	TH (mg/L)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)
1.	+13.8	8.15	2 980	1 488	+78.8	357	285.6	42.1	85.2	164.3
2.	+11.2	7.98	2 142	1 071	+53.4	256	181.9	9.8	61.5	97.8
3.	+12.1	7.62	2 420	1 206	+20.2	291	203.5	11.4	68.9	232.1
4.	+13.4	8.21	1 673	835	+18.2	199	34.2	3.6	48.1	187.2
5.	+14.6	8.38	2 474	1 237	+61.8	298	97.7	32.4	70.7	217.6
MCL		**< 8.5**	**2 500**	**500**		**360**	**100.0**	**50.0**	**50.0**	**250.0**
MV	**+13.02**	**8.07**	**2 338**	**1 167**	**+46.5**	**280**	**160.6**	**19.8**	**66.9**	**179.8**

MCL – Maximum contaminant level [1-2]; MV – Mean value

Measured well water temperature range from 11.2 to 14.6 ^{0}C and averaged 13.02 ^{0}C. Electrical Conductivity (EC) values varied from 1673 to 2980 μS/cm and an average value of 2338 μS/cm. The pH values were in range of 7.62 to 8.38 and averaged 8.07. Sampled water presented an ORP value ranging from +18.2 to +78.8 mV, indicating oxidizing conditions at the locations. The TDS values varied from 835 to 1488 mg/L and averaged 1167 mg/L. Total Hardness (TH) values varied from 199 to 357 mg $CaCO_3$/L and an average value of 280.2 mg $CaCO_3$/L. Well water samples had concentrations of calcium ranging from 34.2 to 285.6 mg/L with a mean value of 160.6 mg/L. The magnesium concentrations varied between 3.6 to 42.1 mg/L and averaged 19.86 mg/L. Sampled water contained nitrate in concentrations of 48.1 to 85.2 mg/L. The mean value of nitrate level was 66.88 mg/L. Only one of five wells analyzed for nitrate contain concentration below the maximum allowed value (50 mg/L) proposed by the drinking water quality standards. All of water samples had sulfate concentrations below the maximum allowed value.

4. DISUSSION

4.1. Primary Contaminants

Results of six month well water chemical analysis indicate that nitrate was the important primary contaminant found in Câmpeneşti well waters (fig.2).

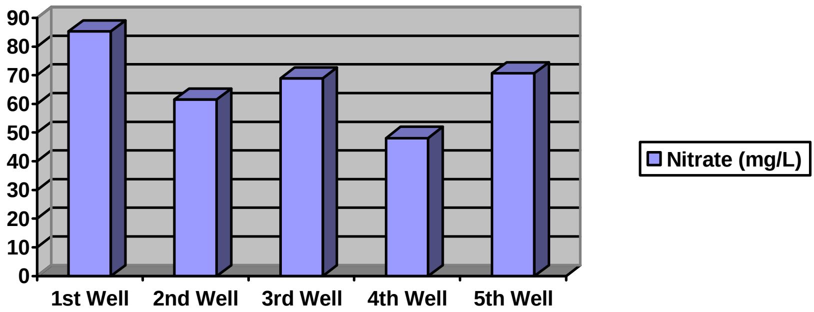

Fig. 2. The nitrate in well water collected in January – June 2008 in Campenesti.

Results show that100% of sampled well water were of nitrate level higher than 13.5 mg/L. Among them, 80% had nitrate concentration exceeding the maximum allowed value (50 mg /L). Therefore, most of well waters sampled in Câmpeneşti appear to be contaminated by human activities. With regards to the well localization, the nitrate contamination may be due to the infiltrations from latrines, storage of animal manure and storage of domestic rubbish [3-5].

4.2. Secondary Contaminants

100% of the samples collected from wells in Câmpeneşti area contain TDS higher than 500 mg/L. When water mineralization is high with a pH value higher than 7.62, water-rock interaction exert control on the TDS level. Figure 3 indicate the correlation between nitrate and TDS (the presence of nitrate at high concentration in well waters seems to correlate with the TDS value).

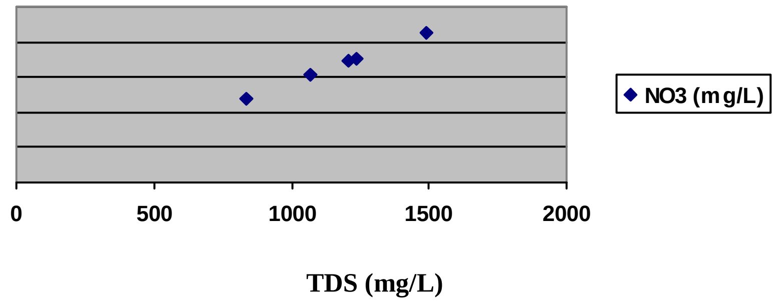

Fig. 3. Plot of nitrate versus TDS for all water sampled in Câmpeneşti

5. CONCLUSIONS

Groundwater quality was assessed in Câmpeneşti by assessing a total of 120 well water samples collected from 5 private wells (four samples / month / well). At the scale of this investigation, well waters were contaminated by nitrate. The pH values ranged from 7.62 to 8.38 and the redox potential (ORP) indicated oxidizing conditions (+18.2 mV< ORP < +78.8 mV). The TDS level varied between 835 mg/L and 1488 mg/L. All of the sampled well waters were highly mineralized (TDS > 500 mg/L). The correlation between nitrate concentrations and TDS suggested relatively high concentrations of nitrate in well water may be caused by human activities such as latrines, animal manure storage and domestic wastes stockpiling located near the wells. More detailed study would be necessary to identify the contaminant water source.

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WASTE WATER DISPOSAL IN BUCHAREST – RISKING DURABLE DEVELOPMENT ON RIVER ARGES'S INFERIOR BASIN

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ABSTRACT. Waste Water Disposal in Bucharest – Risking Durable Development on River Arges's Inferior Basin. The hydrographical basin of Arges is a relatively modest water source supporting great pressure due to several industrial centers located in the area, as well as due to 3 million inhabitants residing around Bucharest.

The disposal of municipal wastewater into the river Arges, without proper cleaning has unfortunately led and continues leading to permanent degradation of the basin's environmental factors and also jeopardizes socio-economical development, especially in the inferior area of the basin.

Physical and chemical analyses of the parameters conducted on different sections on river Arges and also on inferior courses of its main affluents show the evolution and also the extension of this phenomenon. The 2000/60/CE Framework Water Directive clearly presents the quality requirements regarding all water bodies in correlation with the measure programs that need to be taken in order to achieve good water environment.

Taking measures to improve over ground water quality and implicitly underground water quality are mandatory, especially when considering the possibility of extending the metropolitan area of Bucharest, which, in the southern part, would mean including Arges's inferior basin almost entirely.

Key words: *water quality, risk, durable development.*

1. INTRODUCTION

Water quality in Romania is being monitored by the National Administration of Romanian Waters according to the methodology of the Integrated Water Monitoring System.

Our country's joining the European Union has led to implementing of several directives and decisions regarding a new monitoring and evaluation strategy of over ground waters, being based on a new monitoring concept implying a triple integration:

- of the investigation areas of hydrographical basins (rivers, lakes etc.);
- of the investigation environments (water, sediments etc.);
- of the monitored elements and components (biological, hydro morphological etc.).

Characterization of running water quality represents the global evaluation of the analytical results obtained by measurements conducted monitored sections. The indicators enclosed in the 5 class normative (Order nr. 161/2006) have been classified as follows:

- "***oxygen regime***" group includes: dissolved oxygen, CBO_5, CCO-Mn, CCO-Cr ;
- "***nutrients***" group includes: ammonium, nitrite, nitrate, nitrogen, orthophosphate, phosphorus, chlorophyll;
- "***general ions, salinity***" group includes: filterable dry residue, sodium, calcium, magnesium, ferrum, manganese, chloride, sulfate;
- "***metals***" group includes: zinc, copper, chromium, arsenic. *Lead, cadmium, mercury, nickel* have been included in the **"proritary substances"** group;

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- "***organic and inorganic micro pollutants***" group includes: phenols, detergents, AOX, petroleum hydrocarbons. Other substances such as *PAHs, PCBs, lindane, DDT, atrazine, trichlormethane, tetrachlormehtane, trichlorethane, tetrachloretane, etc.* have been included in the ***prioritary substances*** group.

The quality indicator of the monitored sections is given by the most favorable indicators.

The water quality data being aleatory variables are affected by several causes, their processing is being made by statistical and mathematical methods. This way the water quality characterization of hydrographical basins is a result of numerical and procentual estimation of the registered cases, respectively on framing of the monitored sections and water partitions on quality categories.

2. QUALITATIVE CHARACTERISTICS OF OVERGROUND WATERS IN RIVER ARGES'S BASIN

On stretches of river ***Argeş*** characterized by the same quality category, the situation was the following: out of 2681 monitored kilometers in 2007, 323 km (12%) were classified in the 1st category, 1090 km (40.8 %) in the 2nd class, 977 km (36.4 %) in the 3rd class, 178 km (6.6 %) in the 4th class and 110 km (4.1 %) in the 5th class.

In case of Arges's basin the permitted limits were exceeded for the 5th class in the sections: *Clatesti* (**PAHs**) on River Arges; *Suseni* (**NH_4, PAHs**) on river Dâmbovnic; *Glambocata* (**Fix Residue**, **Cl**) on river Sabar; *Balaceanca* (**O_2, CBO_5**, **CCO-Mn**, **CCO-Cr**, **NH_4**, **Ntot, PO_4, Ptot**, **phenols, detergents, PAHs**) and *Budesti* (**O_2, CBO_5**, **CCO-Mn**, **CCO-Cr**, **NH_4**, **PO_4, Ptot**, **fenoli, detergenti, PAH-uri**) on river Dâmbovita; *am.confl.Arges* (**Cl**) on river Budisteanca.

Regarding the evaluation of heavy metals (Cu, Cr, Pb, Cd) included in the priority endangering substances, monitored in almost each of the 75 sections of Arges basin, water quality has been diagnosed as not corresponding in case of Cu in 30% of the monitored sections.

Regarding the evaluation of organic micro pollutants included in the group of priority endangering substances, monitored in almost each of the 75 sections of Arges's basin, the exceeding over the permitted limits, as diagnosed in 70% of the monitored sections in case of some indicators (hexachlorbenzene, DDT, endrin, aldrin, trifluralin etc.) must be looked at with flexibility due to the fact that the detection limits of the analysis devices are higher than the quality objectives set in the normative.

The main pollution factors are a result of the activities performed in the chemical industry (SNP Petrom SA Arpechim Pitesti), car manufacturing industry (Dacia Piteşti) or of domestic activities (Bucharest and Piteşti).

Obviously the main impact on the water quality of Arges's inferior basin is caused by the water disposal in Bucharest. The sewerage system of the city finds its origins in year 1828, later on, in 1847 the first underground sewers to discharge in Dâmbovița were built in.

100 years later there was a public announcement declaring that this river has become the city's sewer. In 1985 fitting out proceedings started on the river Dâmbovița, by building a partioning sewer under the riverbed to collect and transit Bucharest's wastewater to the Wastewater Cleaning Station Glina (SEAU). The cleaning station has experienced several project stages, building, interrupting development, reprojecting etc., as a conclusion, the station is practically in a non-functional state at the moment.

The space and time evolution of over ground water quality oscillates from one year to the other, according to the activities performed, but maintaining in the rates of quality classes 4 and 5 (Table 1).

Table 1

Evolution of certain quality indicators on river Dâmbovița in the period 2005-2007

Nr crt	Indicator (mg/l)	Arcuda			Bălăceanca			Budeşti		
		2005	2006	2007	2005	2006	2007	2005	2006	2007
1.	Fix residue	321	169	244	369	454	421	523	492	471
2.	CBO_5	5,6	5,4	3,2	44,2	33,2	68,5	49,5	42,3	62,5
3.	CCO – Mn	7,0	6,8	5,6	88	60	110	90	82	115
4.	NO_3	4,2	2,2	6,3	5,1	2,8	7,0	1,1	1,2	7,3
5.	NH_4	1,3	0,55	0,61	7,9	13,1	6,7	10,8	9,6	11,1
6.	Detergents	0,02	-	-	0,26	0,13	0,22	1,43	0,12	0,26

But the shocking elements are the colour, the odour and the turbidity caused by the substances floating above which make the water also unpleasant for the eye.

More relevant are the comparisons of the analyses conducted on the river Arges, on monitored sections upstream and downstream of the confluence with river Dâmbovița referring to the pollution phenomenon; the dilution phenomenon cannot decrease the negative characteristics (Table 2).

Table 2

Evolution of certain quality indicators on river Argeş, upstream and downstream of the confluence with river Dâmbovița in the period 2006-2007

Nr crt	Indicator (mg/l)	Malul Spart (upstream)		Clăveşti (downstream)	
		2006	2007	2006	2007
1.	Fix residue	206	247	653	502
2.	CBO_5	1,7	1,8	12,1	5,8
3.	CCO – Mn	5,0	4,8	52,1	20,7
4.	NO_3	3,6	2,1	13,7	2,7
5.	NH_4	0,5	1,9	2,6	5,8
6.	Detergenț	0,22	0,09	1,01	0,01

The following aspects are to be noticed: the relevant influences are of organic origin and ammonium ions, as well as the tendency of decreasing the pollution rate due to reduction of industrial activity in Bucharest.

A campaign was initiated in May 2008 in order to reveal the water quality parameters of Arges and Dâmbovița by collecting samples and analyzing water quality taking in consideration wave propagation patterns in the downstream. Seven sections were established this way and eight quality parameters have been monitored.

Analyzing the results (Table 3) the dissolved oxygen was rated as normal upstream, in the discharge section of Bucharest's waste water and respectively at Arges's confluence with river Dâmbovița, maximum of charge with organic substance was reached after Dâmbovița's confluence with Colentina (Budeşti section), floating polluting substances vary from 5 to 137 mg/l even though in the inferior basin no precipitations or flooding were registered that would lead to alluvia.

Table 3

Water quality parameters (mg/l)

Nr. crt.	Section	Temp. ^0C	pH	CCO-Cr	NO_2	P-PO_4	MTS	O_2	CBO_5
1.	R. Dâmbovița, cca. 1Km upstream Glina discharge	20	7,5	20,42	0,007	0,028	5	6,54	4,44
2.	Waste water cleaning partition station Glina	19	7,5	195	0,005	0,020	131	0,19	45,39
3.	Cassette discharge in river Dambovița	20	8,0	210,71	0,008	0,032	103	0,11	43,12
4.	R. Dâmbovita cca. 1Km Downstream discharge	20	7,5	199,47	0,005	0,040	116	0,08	47,98
5.	R. Dâmbovita Bridge Budeşti	21	8,0	264,84	0,007	0,028	137	1,74	52,2
6.	R. Argeş upstream confl. Dâmbovița	16	7,5	15,98	0,03	0,012	69	7,51	5,04
7.	R.Argeş Pod Șoldanu, downstream confluence	19	7,5	78,14	0,007	0,028	118	1,04	20,09

3. IMPACT OF WASTE WATER UPON UNDERGROUND PHREATIC WATERS IN ARGES INFERIOR BASIN

For the settlements in the inferior basin of river Arges phreatic water represents the only constant water source throughout the year. The precarious economical state of the countryside settlements, in the absence of a proper sewerage and water distribution means and utilizing wells leads to usage of lower quality water.

The water layer in this area has a specific debit of aprox. 5 l/s m, the piezometric level oscillates between 2-4 m in depth. Regarding the quality aspect, up until 1960, the aquifer in the area fulfilled the conditions to provide for feeding people and animals.

Starting with 1970 the mineralization level of the water has started to increase, which has led to total durity increase, exogene elements appearing in water composition clearly indicating aquifer pollution. Among these elements are NO^-_3, NO_2, PO_4, NH_4, heavy metals (Zn, Pb, Cd, Cu, Cr) but also pesticide.

In the last 15 years also a thermal pollution of the phreatic waters has been acknowledged, which is leading to an increase of dissolving capacity in case of some minerals contained in the rocks, process leading to a water mineralization increase.

Bacterial pollution was identified 20 years ago, analyses showing the presence of coliform and coliform – fecal bacteria, as well as of enteroviruses, as a result of domestic unclean water discharge from Bucharest.

This massive and constant pollution throughout the last 50 years has led to quality degrading of the aquifer but also causing serious damage of soil quality and vegetation in the regarded area.

Also noticeable is the fact that these waters have increased their aggression factor on concrete and metal, this way affecting the building foundations which come in contact with the underground waters, considering the Bucharest – Oltenita navigation system stretching on 73 km.

4. CONCLUSIONS

River Arges's waters on the inferior course range in moderate and satisfactory quality classes, and Dâmbovița's waters upstream from Bucharest are highly polluted and drastically limit their utility and increase the costs of their utilization.

Râul Dâmbovița Aval de SEAU Glina

Underground water influence from quality point of view due to discharge in over ground waters of unclean waste waters or insufficiently cleaned waste waters.

Soil reliability reduction and affecting agriculture in respective areas, as well as building degradation which come in contact with over ground and phreatic waters.

Acknowledging the relation between the water resource and the number of inhabitants, as well as the socio - economical effects that derive form reduction of used water quantities due to pollution and high treatment costs.

Most of the problems listed above can be solved by implementing proper measure programs for:

- Municipal water waste cleaning;
- Endangering substances discharge;
- Restoration of water bodies connectivity that have preliminary been identified as been modified.

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THE USE OF G.I.S. TECHNIQUES IN ESTIMATING THE FLOODABLE STRIPES IN RELATION WITH DISCHARGES VALUES WITH LOW PROBABILITIES OF OCCURRENCE. CASE STUDY: RIVER ARIES - TURDA CITY.

R. BĂTINAŞ[1], ŞT. BILAŞCO[2]

ABSTRACT. The Use of G.I.S. Techniques in Estimating the Floodable Stripes in Relation with Discharges Values with Low Probabilities of Occurrence. Case Study: River Aries - Turda City. To determine the floodable stripes must be followed a complex algorithm involving statistical operations, graphical representations, correlations and cartographic expressions. Each of the elements is supported by appropriate computer software that competes to a high degree of results accuracy. Validation methodology has been made on the case of Arieş River crossing the Turda city between hydrometric station profile and the corresponding area with buildings, with high vulnerability to floods. The final interpretations support the compliance of the buildings position in the floodable areas, which unfortunately is not respected in many cases.

Keywords: *floodable stripes, floods, probabilities of occurrence, GIS.*

1. INTRODUCTION

Defending people and goods against flooding events is a priority in the urban and rural settlements. In this respect, have been implemented a number of structural and non-structural measures to achieve the limits of safety to reduce the effects caused by floods. The most important legislative act in this sense refers to the regulation on emergencies situations management arising from floods, dangerous meteorological phenomena's, accidents at hydrotechnic constructions and accidental water pollution. This act stipulates among others, the establishment of floodable stripes with low probabilities of occurrence of 10%, 5% and 1%. Also are indicated the man-made objectives that can be affected: buildings, agricultural land, transport and communications networks.

The detailed rules on how to design risk maps related to floods, were also covered by legislation (H.G. 47/2003).

2. MEANS AND METHODS USED

The determination of floodable stripes is done in several stages of work, involving the pursuit of a specific algorithm. Thus, taking into account the maximum monthly and annual flow average values over a longer period (40 years, in this case), it can be obtained the occurrence probabilities of discharge with exceptional value, which are associated with

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floods and inundations. Thus are expressed the discharges with probability of occurrence of 10%, 5% and 1%. To complete the calculations the exceptional values associated with very low probabilities (0.5% and 0.1%) must be obtained too.

To determine these values we have used specialized software: HyranPlus (demo version), through which we have obtained the absolute values and percentile chart values.
Next step consists in preparing the base map to be used in the study. In this sense, we considered the topographical maps with 1:25.000 scales, the maps with 1:5.000 scales and the use of GPS points sampled from the field. It can also be used, satellite images, with high resolution.

Based on synthetic correlation between the two elements that describe the rivers liquid flow (discharge and level values) it can be made a correspondence of the values previously determined with the maximum probable levels, which could be achieved. These levels are then transposed on the cartographic material for achieving the flooded areas at different probabilities of occurrence for exceptional discharge values. These floodable stripes are evolving on each side of the river, occupying the river meadow up to the valley slopes. Spatial extension of these stripes is determined primarily by the configuration of the field through a transverse profile over the river flow direction. The biggest area will be associated with the discharge value with 0.1% probability of occurrence, respectively to the discharge values that can be achieved once a thousand years.

2. 1. Hydrological Analysis

In the present study, we took as the area of analysis, the Arieş River, which transit Turda city. We took into account the recorded discharged values at the hydrometric station and the limnimetric key that can be described by processing the values obtained from field measurements. We also processed the annual peak flows recorded at the station for a period of 40 years (1964-2003), obtaining the discharges values with low probabilities of occurrence of 10%, 5% and 1% respectively of those with very low probability, 0.5% and 0.1%. Confidence interval and the recurrence time are shown in the table below (Table 1).

Table 1

The non-exceedance probabilities and estimated discharges for Arieş River

Nr. Crt.	Time (years)	Non-exceedance probability	Estimated discharge (m^3/s)	Confidence interval (95%)
1	1000	0.999	1220	844 – 1600
2	500	0.998	1120	783 – 1460
3	200	0.995	988	699 - 1280
4	100	0.99	884	635 – 1130
5	50	0.98	779	568 – 989
6	20	0.95	636	476 - 797
7	10	0.9	525	402 - 649

By using the HyfranPlus software, we have represented the graphic correlation of Pearson type III curve, which indicates a good classification of the cloud of values in the confidence interval associated with each probability of non-exceedance (Figure 1).

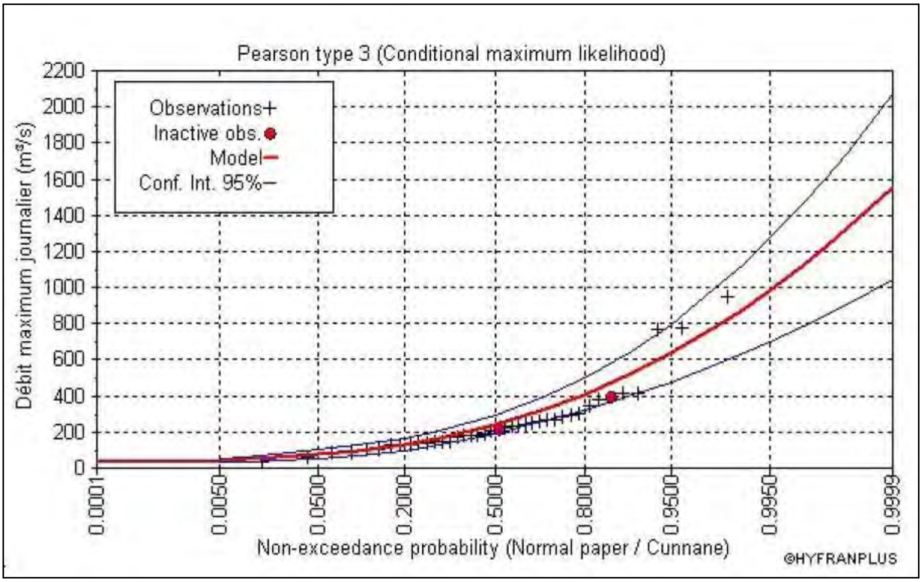

Fig. 1. The correlation diagram between maximum discharge and non-exceedance probabilities.

2. 2. G.I.S. Analysis

The identification and representation of floodable stripes is based on GIS spatial analysis, using numerical database obtained directly (discharge values, volumes, levels) and by analysis of the primary data (isohypses and satellite images). In the analysis process we have used as a primary data a structure represented by vector layers (Table 2) and alphanumeric data. The resulted derived database is the digital elevation model, mainly used as support for modeling floodable stripes.

Table 2

Data basis for the study of floodable stripes

Nr. Crt	Name	Type	Attribute	Sort
1	Map	Raster	-	1:25.000
		Raster	-	1:5.000
2	Maximum levels recorded	Numerical	-	-
3	Altitude points	Shape file	Altitude	GPS
4	Isohypses	Shape file	Altitude	Primary data base
5	Digital elevation model	Grid	Altitude	Derived data base
6	Floodable areas 1 %, 0,5 % and 0,1 %	Grid / vector	Surface	Modeled data base

An important step in achieving the spatial analysis was the making of digital elevation model, to meet the final shape. To reach this aim, we used the method of topogrid interpolation to achieve a correct elevation model from hydrologic point of view (no sink points with drainage forced on the river_elementary thalweg and interfluves outlined on the highest levels of the studied area), with a resolution of 0.1 m.

The mapping of floodable areas was done through GIS-GRID analysis, with the use of Spatial Analyst extension, respectively using the sub-menu Raster Calculator of the ArcGIS 9 software.

The modeling processes consist in identifying all cells with an altitudinal value lower than the calculated levels to the hydrometric leveling staff using the mathematical identifier ≤, using the spatial query as follows:

[grid] <= 320.47,

Where: [grid] - digital elevation model
<= - mathematical identifier
320.47 m - the maximum level associated with the discharge value of 1 %.

Such spatial queries were performed for each scenario in hand, resulting in what we called a modeled database representing areas affected by floods, at different probabilities of occurrence (Fig. 2-4).

From the values analysis and cartographic expression results, can be made very precise indications regarding the degree of vulnerability of the studied territory. Thus, we have made the correlations between discharge values with those of levels, respectively with the safety water levels of the studied area (Table 3 and 4).

Table 3

Safety water levels at Turda hydrometric station, on Arieş River

Nr. crt.	River	Hydrometric station	"0" level altitude (m)	Reference system	Levels at hydrometric staff (cm)		
					CA	CI	CP
1	Arieș	Turda	315,22	MN	250	350	450

Table 4

The tabelar limnimetric key associated with discharge values with low probabilities of occurrence

Nr. crt.	River	Hydrometric station	Probabilities of occurrence	Discharge (m^3/s)	Level (cm)
1	Arieș	Turda	1 %	884	525
2			0,5 %	988	553
3			0,2 %	1120	588
4			0,1 %	1220	612

The comparison of the values in the two tables may sustain that safety water levels are exceeded even from the value of 1% of exceptional flows.

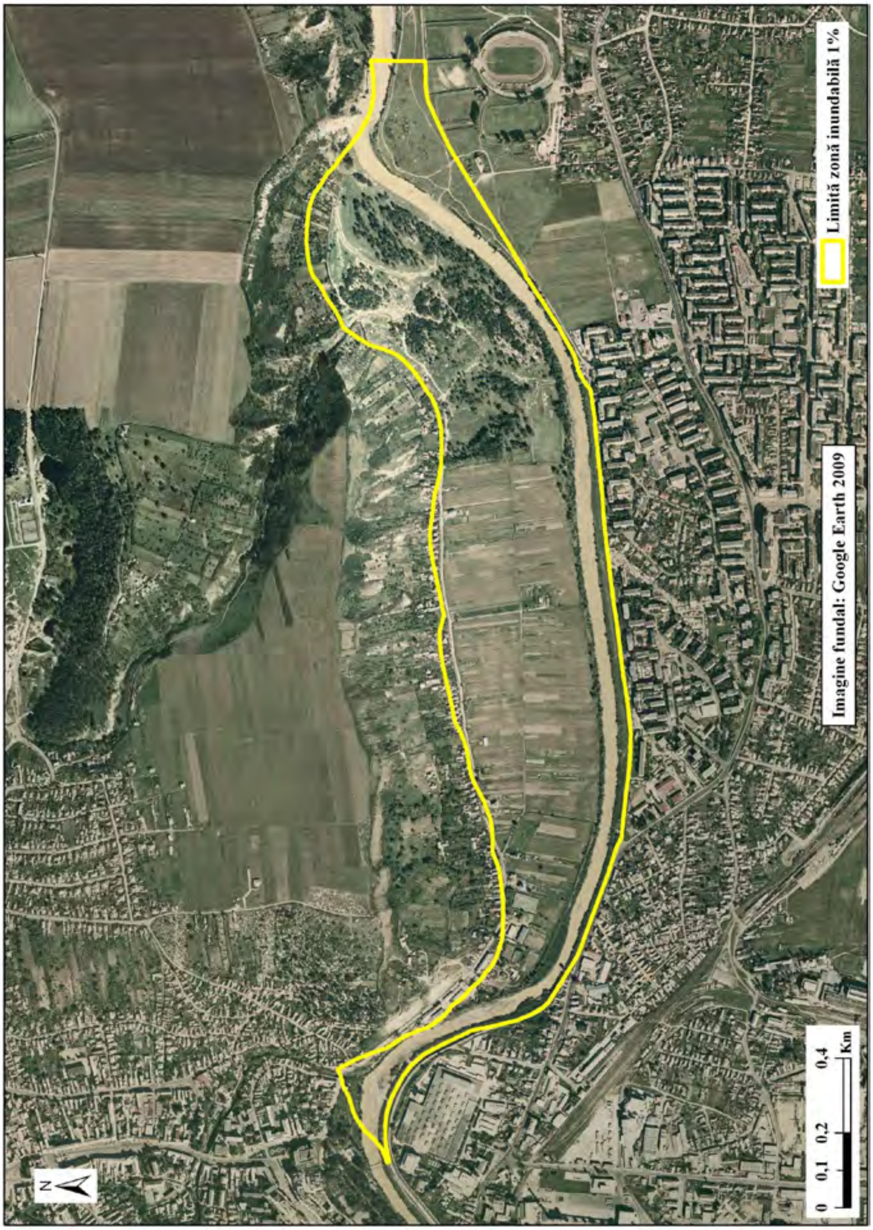

Fig. 2. The flooded area related to the non-exceedence probability of 1% on the Aries Valley at Turda

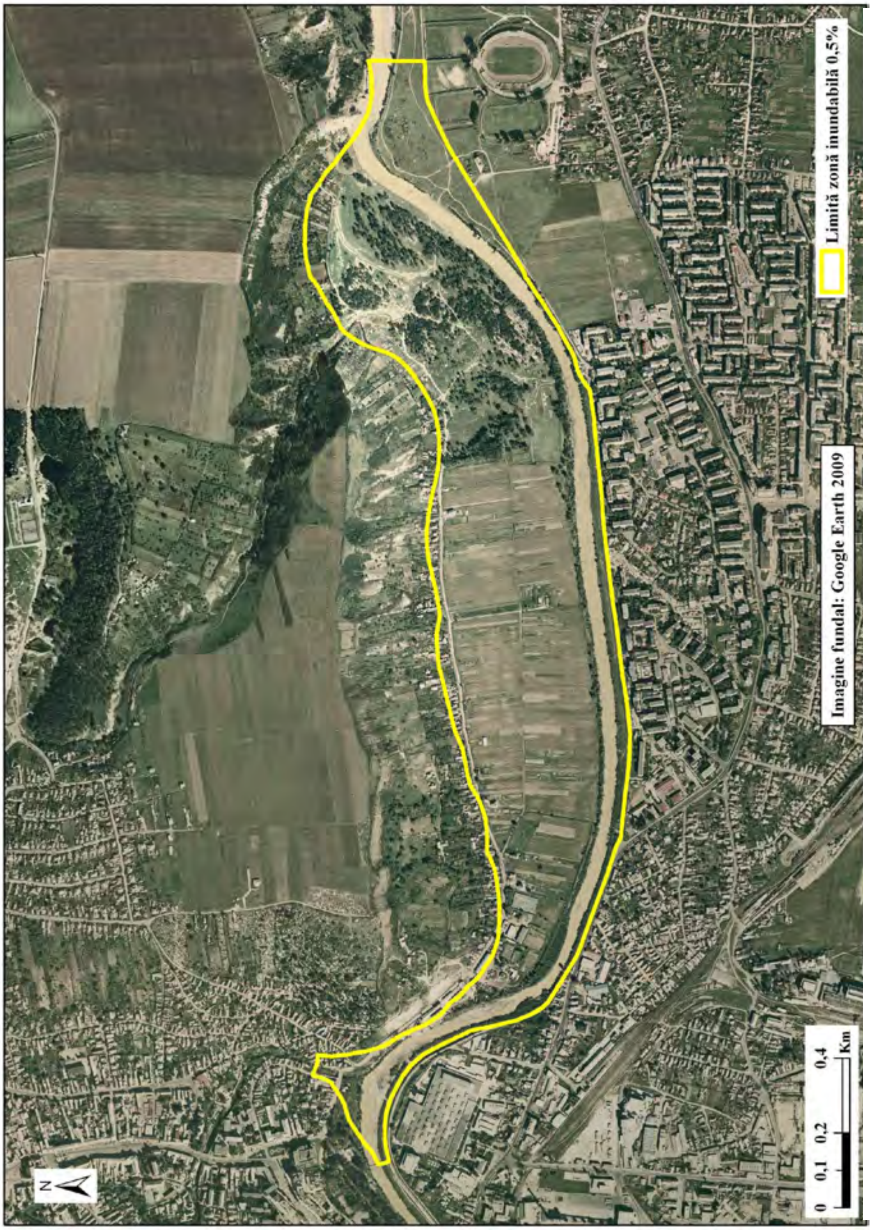

Fig. 3. The flooded area related to the non-exceedence probability of 0.5 % on the Arieș Valley at Turda

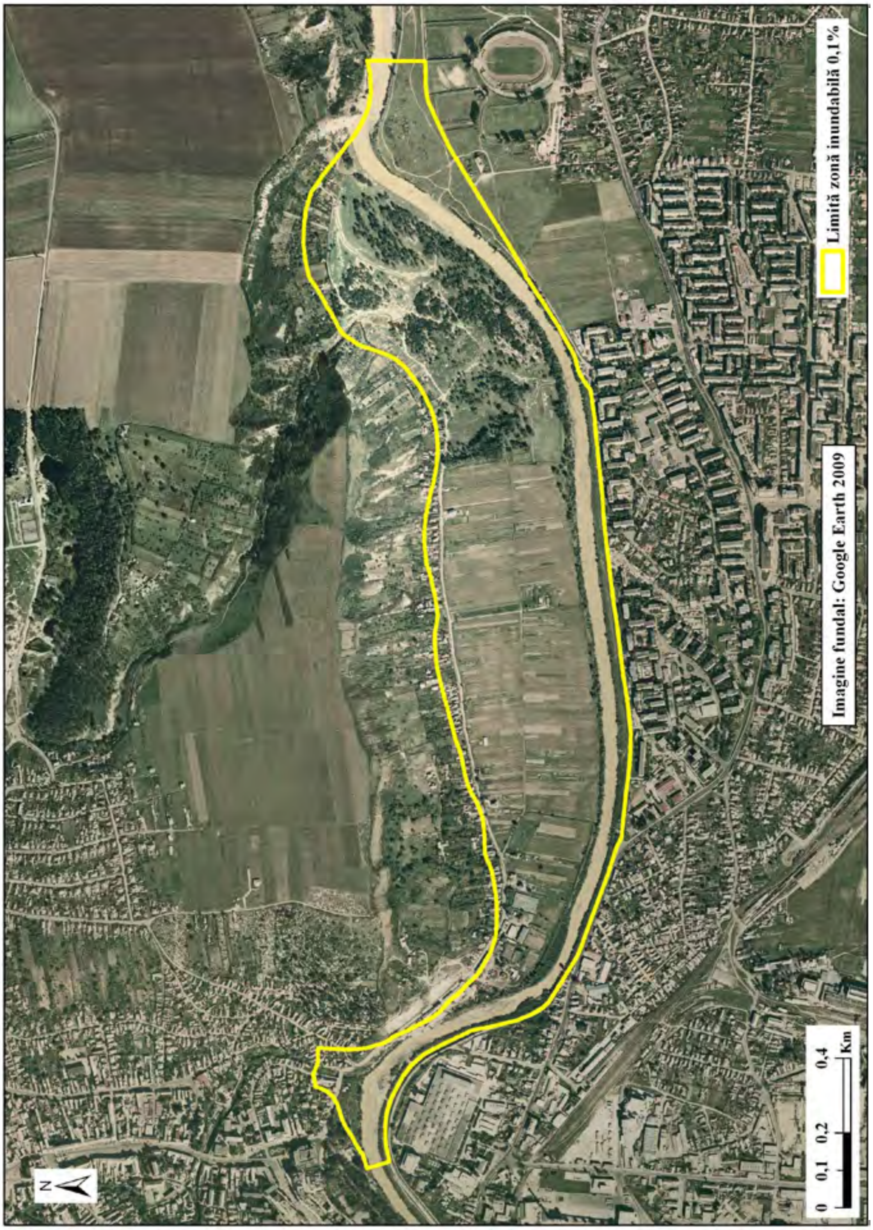

Fig. 4. The flooded area related to the non-exceedence probability of 0.1 % on the Arieș Valley at Turda

3. RESULTS

Analyzing the data's from the hydrological station and those calculated using the programs mentioned above, and also by the use of GIS modeled database, the following conclusions can be presented:

a. The Arieş River course arrangement, by asymmetric embankment of the right bank (to the city) plays an important role in the spatial extension of the floodable stripes.
b. Most of the territories affected by exceptional events (floods, inundations) are located on the left side of the river, having different size, depending on the calculated levels (Fig 2-4). The size degree of the affected areas is expressed in square kilometers and shows values that are almost identical, which is explained by the presence of a very steep cuesta front.
c. In terms of affected areas it can be distinguished the following conclusions:
   - For the probability of 1%, the affected area is about 1.05 km^2, for the value of 0.5%, an area of 1.08 km^2, and for the probability of occurrence of 0.1%, an affected area of 1.11 km^2.
   - Regarding the land use, in the affected areas are included: agricultural land, buildings (some of them built in recent years), road infrastructure (street Petru Maior) and transport of electricity and gas. Add some industrial (inside part of the sorting stations and the Public Turda Company), situated near the confluence with Racilor Valley.
d. The discharge values with low probabilities of occurrence (0.5% and 0.1%) can produce a backwater phenomenon onto Racilor Valley, which can lead to blocking access to two streets, a footbridge and a number of approximately 10 buildings.
e. GIS analysis reduces the establishment time for the areas affected with a minimum margin of error.

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CHARACTERISTICS OF THE ANNUAL- AND PEAK DISCHARGES OF THE UPPER MURES AND OLT RIVERS

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ABSTRACT. Characteristics of the Annual- and Peak Discharges of the Upper Mures and Olt Rivers. The Mures and the Olt rivers flow through a somehow uniformous but well delimited row of depressions on the Eastern ridge of the Transilvania Basin. The annual mean and the peak discharges have been analysed at seven hydrometric stations for the 1950-2006 and the 1992-2006 periods. The mean discharges of the Olt river have a better correlation with the height of the surface than those of the Mures river. Both rivers present a clearly detectable regularity in the 1950-2006 period and on the Olt even a periodicity can be noticed. The variability factor moves within large boundaries in the case of both rivers. The probability curves are different as a result of the different local alimentation. The time-space differences are an important factor to know, both in water-management and in flood prevention.

Key words. *mean-discharge, peak-discharge, variability factor, probability curve*

1. INTRODUCTION

The Neogene volcanic activity on the inner arch of the Carpathians closed in a series of small but well delimited depressions from the Transilvania Basin. Their relative closeness, their depth, compared to the surrounding mountains, and their perpendicular position to the western winds created a series of physico-geographical and social particularities. The climato-genetic processes of the hydrological phenomena are different from those of the Transilvania Basin. The mean temperatures are a few degrees lower, the amplitudes are higher, the minimum temperatures, due to thermal inversion, are powerful, the number of winter days is higher than in the Transilvania Basin. The precipitation pattern is also specific because of the horizontal and vertical differences of the air masses.

Among the volcanic and the crystalline ridges of the Eastern Carpathians there is a series of, naturally, socially and economically particular, depressions. From these the Giurgeu depression is drained by the Mureş river, flowing northwards, the Ciuc depression by the Olt river, flowing southwards.

In the depressions the upper sections of the Mureş and Olt rivers belong to the alimentation type from snow-melt, precipitation and rich underground supply. All these create high mean discharges on the upper sections of both rivers. From the point of view of the hydrological regime, characteristic are the nivo-pluvial floods in spring and the beginning of summer, the pluvial floods in summer and the long low-water periods in winter. Among these the risk of suddenly formed, torrential floods is always high.

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The flow of these rivers is monitored at three hydrometric stations in the Giurgeu depression, on the Mureş, and at four stations in the Ciuc and Braşov depressions on the Olt. This hydrometric net offers a proper follow-up of the flow. The used series of data starts in 1950, in the case of monthly mean discharges, but the series of the peak-discharges is significantly shorter.

The multiannual mean flow on both rivers is about 6-9 l/s.km^2. The surface flow is higher in the Giurgeu depression, where the water quantity coming from the mountains is bigger. This is mainly due to the Călimani mountains. This influence can be traced at the Stânceni station and also influences the correlation between the specific discharge and the average height of the watershed. The data from the Stânceni station do not follow the q = F (Hmed) function.

Along the Olt the changes in the specific discharge are better balanced, only the Micfalău station showing quicker growth than the other three stations. This offers the conclusion, that the alimentation in the Ciuc and the northern part of the Braşov basin is more uniformous.

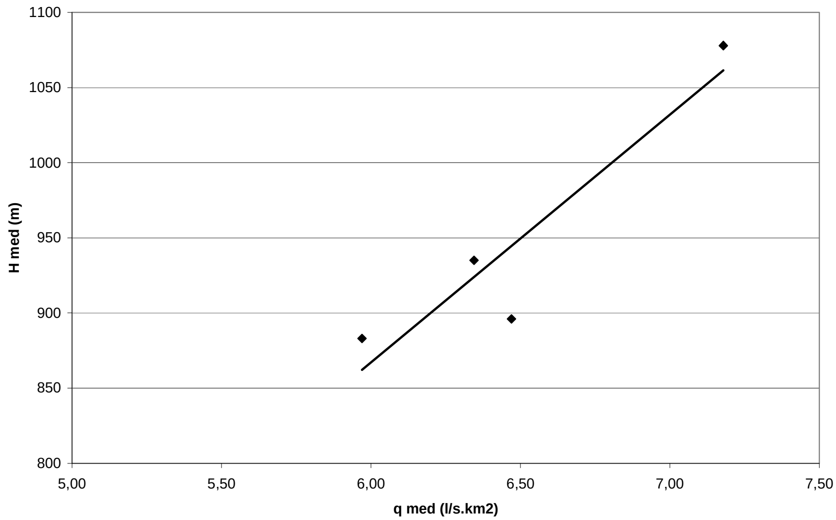

Fig. 1. The q = f (H med) function of the Olt

2. THE TIME VARIATION OF THE MEAN DISCHARGE

The annual mean discharges faithfully follow the changes of the genetic factors. The growing and decreasing periods can be well separated on both rivers. The fact that the changes on the cross sections of the Mureş are more divagant than on the Olt is also due to the position of the hydrometric stations.

On the upper Mureş the Suseni hydrometric station follows the flow from the middle Giurgeu basin, while the Toplița station from the homonymous microbasin. The Stânceni station reflects the influence of the Călimani mountains too. The multiannual mean discharge grows continually: 1,02 m^3/s at Suseni, 8,48 m^3/s at Toplița, 13,2 m^3/s at Stânceni. On each cross section the high flow periods of the mid 1950s, the beginning of the 1970s and 1980s are prominent. These are followed by a high amplitude flow period, mainly at the Suseni and Stânceni cross-sections. At Toplița the flow is better balanced. The characteristics of this last period determine the linear trend, which is growing at the Suseni and Stânceni cross-sections and is slightly decreasing at Toplița.

The variability factor moves within large boundaries at all three cross-sections: 0,27-1,14 at Suseni, 0,48-1,96 at Toplița, 0,43-1,78 at Stânceni. At the last two, the high-discharge tributaries coming from the neighboring mountains cause a strong factor-amplitude. The highest values are connected to the very high flows of 1970 while the smallest ones show the low-flow periods of the 1950s and 1990s.

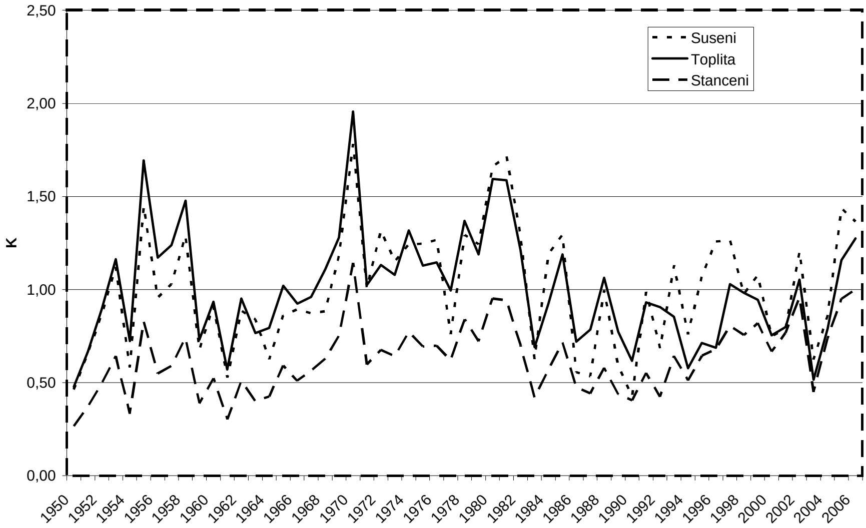

Fig. 2. The variability factors of the Mureş stations

Along the Olt river the flow from the Ciuc basin is followed at three hydrometric stations (Tomeşti, Sâncrăieni, Micfalău) while in the Braşov basin the discharges are measured at the Sfântu Gheorghe station, next to the Râul Negru. The annual flows are steadier than those of the Mureş. All four stations clearly show the high flow of the 1950s, followed by a low-flow period and the very high flows of the 1970s. Between 1988-1995 on the upper two cross-sections Giurgeu remain the relatively low flows, while at the two lower cross-sections a growth can be detected. For the entire period, at all four cross-sections of the Olt a growing linear trend is characteristic. A good, 15 years periodicity can also be detected.

The variability factors of the Olt strongly follow each other. Small deviations can be noticed only after 1990. The amplitude is 1,57, so the values of the coefficient is between 0,40 and 1,97. The highest values are connected also to the floods of the 1970s and are, starting from upstream, the following: 1,66, 1,97, 1,84, 1,85. The insufficient flow is shown by the small values of 1950, 1961, 1986 and 1990, of around 0,5.

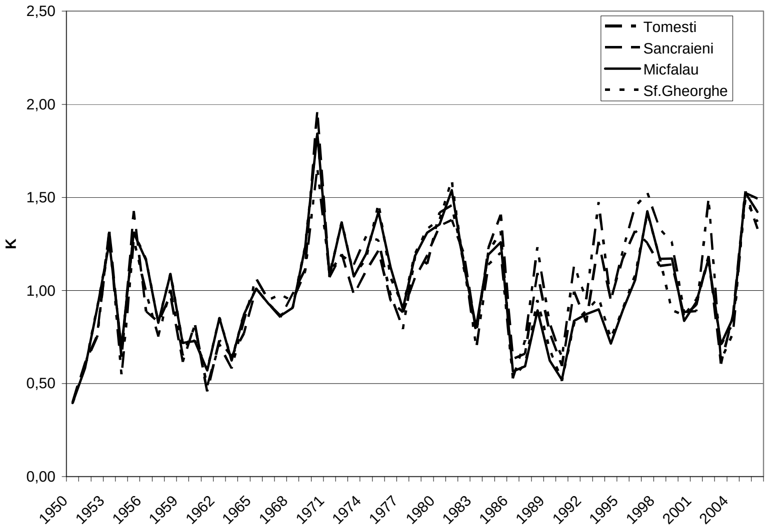

Fig. 3. The variability factors of the Olt stations

3. THE PROBABILITY CURVES

The risk assessment has to take into account several factors influencing the probability and the value of the damage. The most important are the following: the peak-discharge of the flood, the simultaneity of more, unfavorable phenomena, the extent of the flooded area, the stability parameters of the constructions, the value of the investments at risk and the loss of production caused by the flood.

The dominant factor of the risk analysis refers to the periodicity of the flood discharges. As a result of the meteorological conditions, the characteristics of the watershed and the laws of the flow, the peak-discharges are repeated from time to time. The probability of the occurrence is inversely related to the magnitude of the discharge. The higher the peak-discharge, the less frequently it occurs. Precise determinations can be done by probability distribution. The accuracy of the probability analysis depends on the fidelity of the data and the lengths of the data series.

3.1. The probability of the mean discharges

Using the values of the mean discharge good precision probability curves can be constructed at each hydrometric station. The standard deviation is growing only at high discharges but, even is these cases, the correlations can be cleared. The trend is best shown by the fifth degree polynomial curve. Using this, even the 1% probability discharges could have been well determined.

The growing trends of different probability mean discharges resemble well each other. The growth rates are almost similar at each station from Q med 50 % to Q med 1%. If we analyse separately the two rivers, it can be concluded that the discharges grow more quickly downstream on the Mureş river than on the Olt. This is valid for all probabilities.

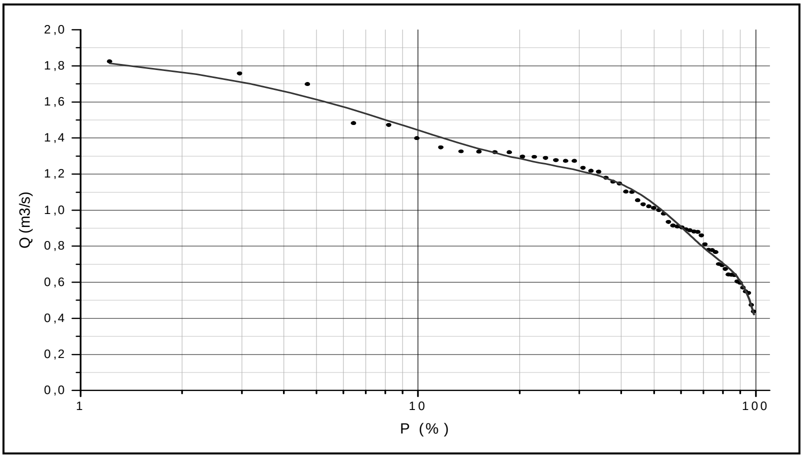

Fig. 4. The probability curve of the Suseni station

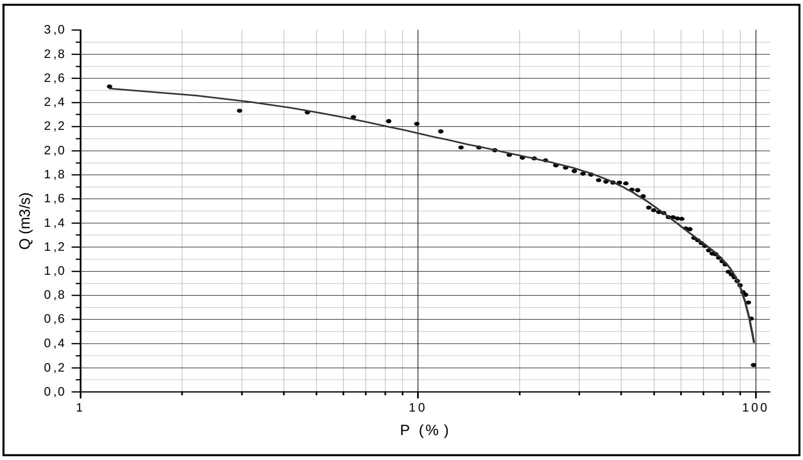

Fig. 5. The probability curve of the Tomești station

Tabel 1.

Different probability means discharges (m^3/s)

P	Suseni	Toplița	Stânceni	Tomești	Sâncrăieni	Micfalău	Sfântu Gheorghe
1%	1,8	16,1	23,3	2,5	10,3	15,9	17,4
5%	1,6	13,8	20,8	2,3	9,1	14,3	15,7
10%	1,4	10,7	17,2	2,1	8,0	13,0	14,3
20%	1,3	10,1	16,2	2,0	7,1	11,6	12,6
50%	1,0	8,4	13,1	1,5	5,8	9,1	9,9

3.2. The probability of the peak-discharges

The data series of the peak-discharges are significantly shorter: from 1992 to 2006. These were also suitable to construct good precision probability curves. The standard deviation in this case is also bigger at the lower probabilities. Because the data series were too short, the correlations had to be extended for the probabilities above 5%.

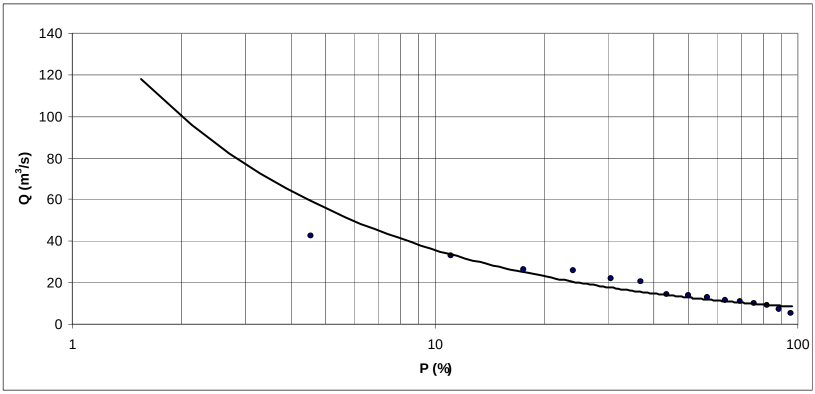

Fig. 6. The probability curve of Suseni station

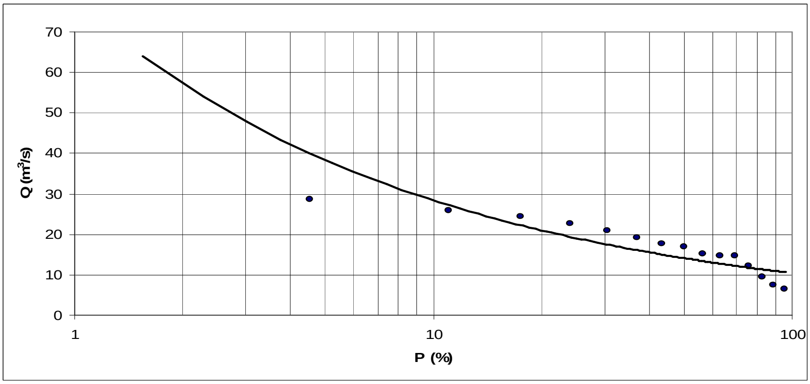

Fig. 7. The probability curve of Tomeşti station

If we take into account the probability curves of the first two stations, on both rivers, it can be seen that the trends are different. On the Mureş, at the Suseni station the growth of the discharge is much steeper than on the Olt at Tomeşti. At the 20% probability discharges there is no significant difference between the two stations. The 2% probabilities, on the other hand, are greatly different, the value at Suseni almost doubles that of the Tomeşti station. This is the result of the more torrential flow of the floods in the Giurgeu basin than in the Ciuc basin.

Tabel 2.

Different probability peak-discharges (m^3/s)

P%	Suseni	Tomeşti
2%	99,2	56,9
3%	77,0	47,9
5%	55,2	38,5
10%	35,5	28,5
20%	23,0	20,9

4. CONCLUSIONS

On the upper sections of the Mureş and Olt rivers there is a characteristically lawful flow. Even though both present the supply characteristics of the elongated row of depressions, time and space differences can be seen. The variability factors, the mean discharge and the peak discharges all show differences. According to these, the probability curves of the analyzed hydrometric stations are also slightly different. These time and space differences have to be taken into account in water management and flood control.

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THE REGIME OF OXYGEN AND NUTRIENTS IN ST. ANA LAKE

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ABSTRACT. The Regime of Oxygen and Nutrients in St. Ana Lake. St Ana Lake is located in Ciomad crater, the youngest formation of the volcanic chain that timbers the Carpathians. The lake is exclusively supplied with rainfall, as there are no flowing waters inside the crater. For this reason, the quantity of mineral substances dissolved in water is very small. All these characteristics influence the physical, chemical and biological parameters of the water. The temporal differentiations of the oxygen and nutrients' regime are small. The period of analysis extends between 2000-2004, and the control points are at northern and southern ends and in the centre. The analyses refer to dissolved oxygen, saturation in oxygen, the biochemical consumption of oxygen, the chemical consumption of oxygen, nitrate, nitrite, ammonium, total mineral nitrogen, phosphate, total phosphorus and phytoplankton.

Key words. *St. Ana Lake, physical, chemical and biological features, oxygen, nutrients, eutrophication, state of the water*

1. FACTORS THAT INFLUENCE THE WATER'S FEATURES IN ST. ANA'S LAKE

St. Ana Lake is the only volcanic lake in Romania, located in the crater of Ciomad Mountain Mass. The morph metrical sizes and the hydrologic parameters are not too high. The surface of the water brilliance is 189000 m^2, 610 m long, 150m wide, and with a maximal depth of 6 m. 580,000 m^3 water are found in this tank.

The effective denudation factors of the crater and the factors that influence the water's quality are limited to the concentrated drainage on the slope to which the anthropic influence is added. The ravine system is due to tourist pats and is the most important source of alluvium. During the tourist season various polluting materia get into the water.

The vegetation of deciduous forest diminishes a lot the effect of the rains. Due to the well developed litter the area washing is not very significant. At the same time, the foliage that reached the soil is a rich source of organic materia that gets into the lake's water.

The crater's substrate is formed of in situ or reshuffled pyroclastic rocks that develop a strong resistance to the action of denudation forces. The soil that developed in such vegetative conditions has limited podsol processes, with a well structured skeleton, which gives it resistance to the action of denudation agents.

The climatic elements influence the water's parameters by temporal variation, making themselves felt in the seasonal order first of all. The average values, specific to the temperate oceanic climate, rain, temperature, moisture have an influence on the physical and chemical parameters.

2. QUALITY PARAMETERS

The natural waters contain a varied range of substances, materia and organisms due to the exchanges with the environment. Their diversity is so much more as the exchanges of energy and materia are more intense. They all influence the physical, chemical and biological characteristics of the water and its quality parameters.

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The quality of a water body, according to the EU Directive, depends on the physical, chemical and biological characteristics, compared to a certain use. As for the environmental state of the water of the lakes, the European Union has not yet established a normative that imposes maximal accepted concentrations. The procedure of cataloguing the quality of the lakes' water is given by the biological elements, although the physical and chemical characteristics have their importance as well.

In view of the control and resolution of pollution problems and implicitly quality problems at regional level, the European Union adopted the "Framework Directive for Water". It introduces a whole series of new laws, regulations, measures that define the water's quality from the point of view of the effect of the living creatures in the water, both individually and in the direction of systemic associations.

The European Union has established new groups of general indicators of water quality depending on the influence of the chemical substances of the water on the ecosystems. In the present work we will analyze the oxygen regime and the nutrients that form subgroups in the new quality group. The directive states that these two subgroups are part of the group of physical and chemical indicators of water. These parameters have an important role in determining the water's composition and implicitly, its quality. In the conception of European Union, the water's composition is studied depending on the role if fulfils in an aquatic system.

2.1. Oxygen regime

The directive highlights that the oxygen is a dissolved gas that maintains life in natural waters, being the most important quality parameter of the water.

The regime expresses the quantity of oxygen that exists in water under various forms and its temporal and spatial variation. This subgroup includes four parameters:

- the concentration of saturated oxygen, expressed in percentages;
- dissolved oxygen defined by oxidizable substances and micro organisms;
- the biochemical consumption of oxygen (BCO), given by organic biodegradable substances;
- the chemical consumption of oxygen (CCO), which is obtained by two methods depending on the solution used, permanganate or potassium bicarbonate.

The last three methods of expression have the measurement unit mg/l.

2.2. Nutrients

In this case the Directive highlights the importance of nutritive or biogenic substances, especially for the eutrophication processes. The overproduction of the primary aquatic ecosystems leads to a more and more intense eutrophication. These substances are based on nitrogen and phosphorus, which form new compounds following different processes and reactions. In order to express the water's quality, the most frequently analyzed is the nitrite (NO_2), nitrate (NO_3), ammonium (NH_4), orthophosphate (PO_4) and total phosphorus (P). Apart from these nutrients, depending on necessity, we also determine the organic nitrogen and the total nitrogen. Their quantitative expression is in mg/l. The nitrogen compounds are formed directly or indirectly, and the phosphorus compounds have a multiple origin.

3. VARIATION OF OXYGEN AND NUTRIENTS IN TIME

The water's features do not remain constant over time, that is why they are characterized by a permanent variation that depends on both natural and artificial factors.

St. Ana Lake is a small aquatic unit, with relatively stable features. For this reason, the time unit for doing the analyses is the term. The period of study extends between 2000-2004. Every year we collected four samples allotted approximately in the same month. The cold season was deprived of observations, and in the spring they were rare. The sample collections were done at the surface of the lake in three control points (south, north and centre). By using the existing data, we could do an analysis regarding the average annual values and the comparison of the state of the water in summer and autumn.

Dissolved oxygen. The variation deviation of the annual average values during the analyzed period is small, the value ranging between 8-10 mg/l with a slight alternation. There is a single value below 8 mg/l, in 2002. The maximal value of 9,87 mg/l was recorded in 2000, which is confirmed by the lowest temperature of all the years.

The autumn values were always higher than the summer values, due to inverse proportionality with the water's temperature and the water's more intense dynamics. Apart from these natural factors, tourism contributed to the decrease in the summer values. The autumn minimal value of 8,3 mg/l was recorded in 2000, and the summer minimal value of 8, 1 mg/l was recorded in 2004. The autumn variation has a maximal value of 10,1 mg/l in 2002, and before and after the values are in a slow decreasing trend.

CBO_5. The highest value between the annual average values, of 4 3 mg/l, was recorded in 2001, which represents a rich charging of water with biodegradable organic substances. In the following two years the values dropped to 2 mg/l, due to the high consumption of oxygen. At the end of the period of analysis, the concentration of oxidizable substances starts to increase again. In the variation of CBO_5, apart from dissolved oxygen, the water's temperature has a significant role in the pace of biochemical oxidation of the organic materia.

In the first three years the autumn values (maximal value of 6 mg/l in 2001) are higher than the summer values (maximal value of 3,9 mg/l in 2002), which shows cool summers that inhibit the biodegradation processes. In the following years the situation returns to normal, the summer maximal values (5 mg/l in 2004) are higher than the autumn maximal values (1,2 mg/l in 2003). The highest variation deviation between summer and autumn was in 2004. Throughout the analyzed period the autumn minimal values of 1,2 mg/l were lower than the summer minimal values of 2 mg/l. from the analysis of this indicator we can see an alternation in the size of values as to summer variation. It shows the differentiation between the meteorological and hydric elements from one year to another.

CCO_{Mn}. The annual variation deviation is high, being 2,8 mg/l. the beginning and the end of the period are remarked by maximal values (4,5 mg/l and 4,07 mg/l), and the minimal value is very conspicuous around 1,9 mg/l of 2002 is due to a poor oxidation of organic substances. The small quantity of oxidizable substances of 2002 is due first of all to weather modifications and the changes of hydric conditions such as temperature, rainfall, wind, solar radiation, lake volume, dynamics of water, etc. The oxidation processes are stronger and need a longer time than the biodegradability of the organic materia, that is why the values of this indicator are higher than the value of CBO_5.

The seasonal evolution resembles the evolution of CBO_5, just the intensity of oxidation processes is higher, resulting in higher values. The summer maximal values (4,9 mg/l in 2004) are much lower than the autumn maximal values (8,8 mg/l in 2000). The summer minimal value of the analyzed period was recorded in 2001, and the autumn minimal value was recorded in 2003. The maximal difference between the two seasons was 5, 4 mg/l in the first year of study. For this indicator we notice the same alternation of values in the summer season. We can also notice the decreasing trend of the autumn values during the whole period of study.

Saturation in oxygen. This indicator represents a synthesis of the whole oxygen regime. By it we express the quantity of oxygen needed by the biotic associations in the water.

The variation deviation of the annual average values is high, the oscillation being between 97,3 - 88,4 %, with a maximal value in 2002. The trend of saturation has been on the increase until 2002, after which a new drop follows. The climax results from the optimal conditions of temperature, pressure, and atmospheric oxygen that privilege the changes of the organic materia. The minimal value of 88,4 % was recorded in 2003.

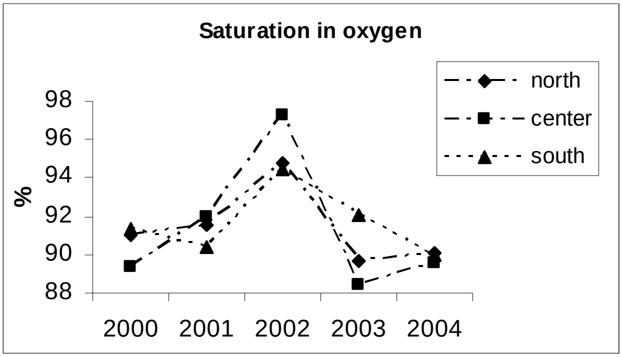

Fig. 1. Saturation in oxygen

The summer values are higher than the autumn values, with a maximal difference of 20 % in 2003, which is due to the summers dominated by a long calmness that facilitated the photosynthesis process. In the summer the maximal value (92,5 %) was recorded in 2002, and the previous and subsequent trends have smaller slopes. The summer minimal value was 92,5 % in 2002, and the autumn minimal value was 72,9 % in 2003.

Nitrate. The highest annual value is 0,8 mg/l, and is recorded in the first year of study. The following years are marked by a more or less accentuated decrease, almost reaching zero in 2004. This evolution shows a weaker and weaker decomposition of materia following biological processes, which means that the proteic compounds of water have smaller and smaller concentrations.

The seasonal evolution is very alternating, both in the same season and in the comparison between the two seasons. The both maximal values are reached in 2000, being 0, 96 mg/l in the summer and 0,798 mg/l in the autumn. As for the minimal values, they reached 0 mg/l in 2004 in the summer and, respectively in 2001 in the autumn.

Nitrite. The annual values have a slightly winding evolution, with a deviation between 0,012-0,002 mg/l. The maximal values are recorded in 2002 following a more favourable oxygenation that facilitated the decomposition processes. 2003 and 2004 are years when the concentration of the nitrite drops to the minimal values.

In the summer the values are higher (maximal value of 0,026 mg/l) or at most equal in 2002 and 2004, to the autumn values (maximal value of 0,005 mg/l). This difference is accounted for by the high summer temperatures and the hydric calmness that privileges the decomposition of the organic materia. There are two minimal autumn values that are very close to zero mg/l.

Ammonium. It reaches the maximal value of 0,4 mg/l in 2002. This year is preceded and followed by sudden decreases, reaching only 0,075 mg/l in 2000, respectively 0,022 mg/l in 2004. These values lead to the conclusion that the decomposition of organic substances has a slower and slower pace. The number of micro-organisms in the lake is decreasing, which leads to a depopulation of the lake.

The autumn evolves in a higher deviation ranging between 0,379-0,018 mg/l. In the summer the amplitude of variation is smaller, and the extremes are reached in the first year of study (maximal value) and the last year of study (minimal value).

Total phosphorus. The annual values reach the maximal value in 2002, recording 0,026 mg/l. This climax can be the result of contaminations or occasional accumulations of organic remains due to tourist activity. The previous and subsequent years are remarked by severe drops, reaching just 0,0061 mg/l in 2001, respectively 0,0087 mg/l in 2004.

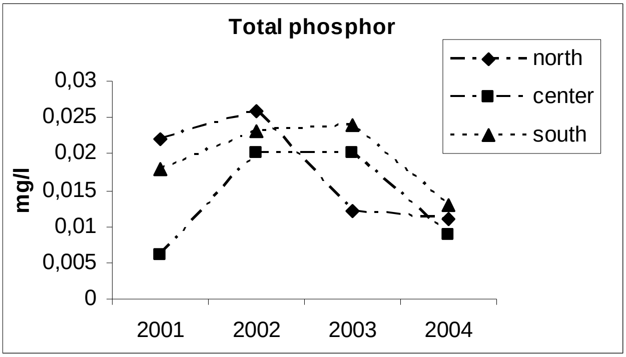

Fig. 2. Total phosphor

In general the summer values (maximal value of 0,032 mg/l) are higher than the autumn values (maximal value of 0,024 mg/l), as it is natural, because in the warm period the organic materia is in progress of development. The autumn evolution is marked by a continuous decrease, sudden in the first three years, and then the decreasing pace becomes very slow.

Phosphate. It evolves very chaotically, having a high variation deviation ranging between 0,015-0,045 mg/l. This lack of uniformity results from the multitude and diversity of sources of this element. Rainfalls play a significant role by their unequal quantities and charge. The minimal values are recorded in 2001 of 0,017 mg/l and 2004 of 0,015 mg/l, and the maximal value is recorded in 2003.

4. EUTROPHICATION

According to the EU Directive, the main biological elements of qualitative evaluation of lakes' water are total phosphorus, total mineral nitrogen, phytoplankton biomass and chlorophyll. These indicators express the degree of eutrophication of the lakes' water. The state of quality is expressed in five degrees: ultraoligotrophic, oligotrophic, mesotrophic, eutrophic and hypertrophic.

Since this new method of appreciation of water's quality came into force in Romania only in 2004, the data from previous years refers only to phytoplankton. During the last year of the analysis period we determined the parameters of biological quality, except for chlorophyll.

Phytoplankton. For this indicator of eutrophication degree the analyses were done during the period 2002-2004. During these years the tendency was to increase from 0,056 mg/l to 0,667 mg/l. These values prove that the quantity of biomass of the lake is increasing without exceeding the limit of the ultraoligotrophic class of 1 mg/l. the main component of the biomass if formed of Phyrrophyta and Chrisophyta that must be followed in order not to exceed the first degree of eutrophication.

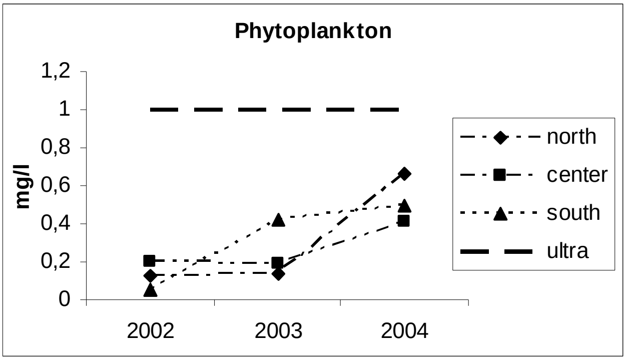

Fig. 3. Phytoplankton

From the seasonal point of view as well, the increasing tendency is maintained. The autumn values (maximal value of 0,8 mg/l) are higher than the summer values (maximal value of 0,3 mg/l), which indicates the influence of the anthropic factor. We must pay attention to the environmental state of the lake especially in the autumn for the degree of eutrophication not to increase.

Analysis of the state of the water in 2004

The average value of the total mineral nitrogen and the average value of phytoplankton range St. Ana Lake in the ultraoligotrophic class, which means that the lake's water from the biological point of view is clean. As for the situation of the total phosphorus, the situation worsens. The average value of 0,0109 mg/l is slightly higher than the limit value of the oligotrophic group (0,01 mg/l). From the point of view of this indicator the lake integrates in the mesotrophic group. In order to reduce the quantity of phosphorus in water, we must control the human activity in the area, and first of all, tourism.

Table 1

Indicators of biological quality

Control points	Total phosphorus	Total mineral nitrogen	Phytoplankton
North	0,011	0,0695	0,667
Center	0,0087	0,053	0,411
South	0,013	0,0485	0,494
average	*0,0109*	*0,057*	*0,524*
MAC, ultraolig.	*0,005*	*0,2*	*1,0*

We notice the same situation in the case of the seasonal repartition. The concentration of total mineral nitrogen and the phytoplankton biomass integrate St. Ana Lake in the cleanest group, which is the ultraoligotrophic group. The total phosphorus makes problems again. The lake's water in autumn integrates into the oligotrophic group, due to the value of 0,0088 mg/l, and in the summer the situation worsens, being degraded to mesotrophic group with a value of 0,0138 mg/l.

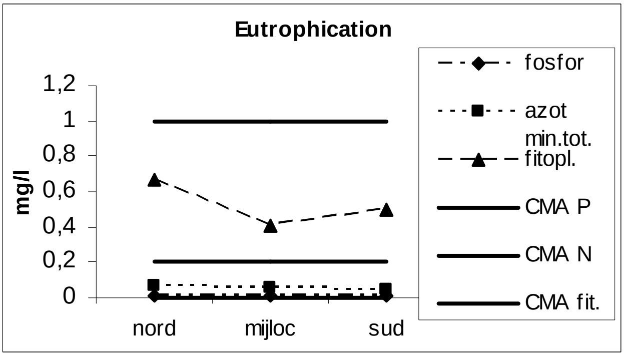

Fig. 4. Eutrophication

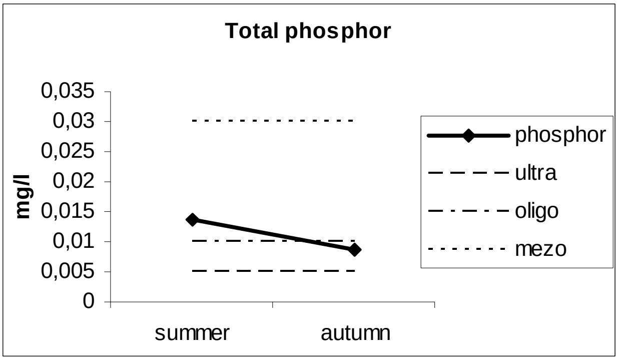

Fig. 5. Total phosphor

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THE ANALYSIS OF FLOODING RISK IN BAHLUI BASIN

IONUȚ MINEA[1]

ABSTRACT. The Analysis of Flooding Risk in Bahlui Basin. The hydrographic network developed in the south-central part of the Moldavian Plain, in the area between Prut and Siret rivers, is represented mainly by the basin of Bahlui. Although the basin is over 80% hydrotechnically managed (there are over 150 reservoirs larger than 5 hectares, tens of square kilometers of dammed or drained areas and so on), in some extreme situations (as in August 2005 or July 2008) a series of inundations occurred, affecting settlements and agricultural terrains, with damages estimated to over 2 million lei. The analysis of the flooding risk has been conducted based on the techniques offered by Geographical Informational Systems (digital elevation model realized after 1:25000 topographic maps or 1:5000 topographic plans, vectorial strata representing elements of the natural or modified landscape) and by remote sensing (aerial photos). To exemplify the methodology used in the study of flooding risk in Bahlui basin, we have chosen two areas affected by this phenomenon: the town of Târgu Frumos (the confluence area between Bahlueț and Rediu) and Lungani area (on the valley of Goești brook).

Keywords: *flood risk, GIS, vectorial analysis*

1. INTRODUCTION

The hydrographic network developed in the south-central part of the Moldavian Plain, in the area between Prut and Siret rivers, is represented mainly by the basin of Bahlui. Although the basin is over 80% hydrotechnically managed (there are over 150 reservoirs larger than 5 hectares, tens of square kilometers of dammed or drained areas and so on), in some extreme situations (as in August 2005 or July 2008) a series of inundations occurred, affecting settlements and agricultural terrains, with damages estimated to over 2 million lei.

2. CONDITIONS FOR FLOODS AND INUNDATIONS OCCURRENCE

Having in view the climatic characteristics from the south of the Moldavian Plain in what regards maximum precipitations quantities in 24 hours (these exceed at the local meteorological stations 100 l/m^2, table 1), combined with the low forestation degree of Bahlui basin upstream Podu Iloaiei, we may appreciate that flood waves may reach in exceptional conditions a level of 2-3 m on Bahlui or its tributaries.

An analysis at the level of the occurrence probability for the annual maximum precipitation quantities in 24 hours reveals the fact that at the main meteorological stations and rainfall gauges from Bahlui basin the maximum values enter the 1 - 5% probability.

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Table 1

Annual maximum 24 hours precipitation quantities 24 de ore with different occurrence probabilities

Probability %	Bârnova	Iasi	Podu Iloaiei	Cotnari	Tg. Frumos
0.01%	361.3	261.5	213.9	144.5	190.1
0,1	281.9	204.2	167.4	119.5	150.3
1	202.1	146.7	120.8	93.2	109.9
5	145.5	105.9	87.6	73.7	80.7
10	120.9	88.1	73.2	64.7	67.9
20	95.5	69.9	58.4	55.1	54.6
50	61.2	45.1	38.3	40.5	35,7
80	41.8	31.1	27.0	30.4	24.0
95	33.6	25.2	22.2	24.1	18.5
99	31.0	23.4	20.7	20.8	16.3
99.9	30.3	22.8	20.2	18.8	15.5
Maximum quantity of precipitations in 24 hours for the observation period	**167,9**	**136,7**	**128,2**	**83,6**	**112,8**

The maximum precipitation quantities in 24 hours in the area on the analyzed basin are generally determined by the local, frontal and orographic dynamic convections that may occur during the whole year, and by thermal convection, manifested mainly during the warm season (*Mihăilă,* 2002). Usually, the highest precipitation quantities in 24 hours in this region occur during the summer months, when air has a high capacity of retaining water vapors and when atmospheric fronts that go from the Atlantic over Europe on a general west – east direction have at their back humid and relatively unstable air masses, frequently affected by local thermo-dynamic convections which reaches maximum values in this period.

The highest values of precipitation quantities in 24 hours were generally measured in summer months, varying from 167.9 mm at Bârnova (on September 7th 1989, Fig.1) and 65.3 mm at Victoria (in a marginal area of the basin, measured on June 7th 1975) (*Sfîcă, Minea* 2006).

Similar conditions have occurred in the night of July 24-25, 2008, when in the west-central part of the basin, at Târgu Frumos, were measured 135 l/m^2 during less than 24 hours, and in the northern part of the basin, at Pârcovaci, 125 l/m^2. In the marginal area of the basin, towards Siret valley, at Pascani, were measured 125 l/m^2, and at Lespezi and Siretel over 100 l/m^2. In the central-eastern part of the basin, the precipitation quantities were lower, yet still significant: 50 l/m^2 at Iaşi meteorological station. More, on the maps produced by the National Meteorology Agency during July 24-25, could be observed a precipitation nucleus of over 150 l/m^2 on Siret valley downstream Roman, very close to the southwestern limit of our basin. Based on these information was created a map of the rain's isohyetes during July 24-25, 2008, at the level of the entire basin, in which can be seen that the areas affected by large precipitation quantities are those from the south-western part.

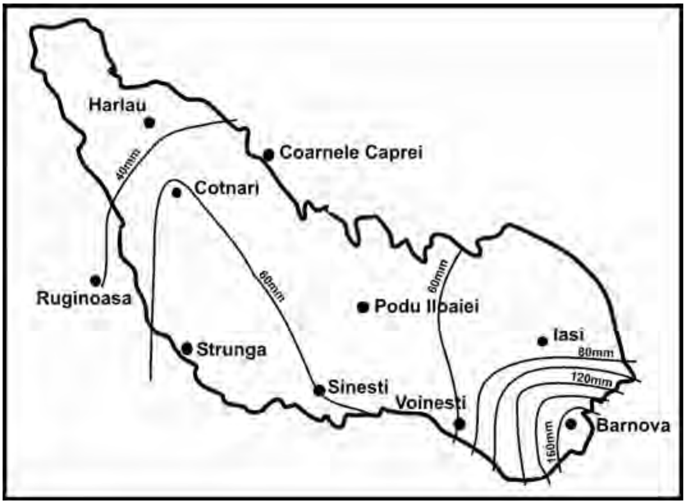

Fig. 1. Isohyets of the September 6-7, 1989 rain in Bahlui basin

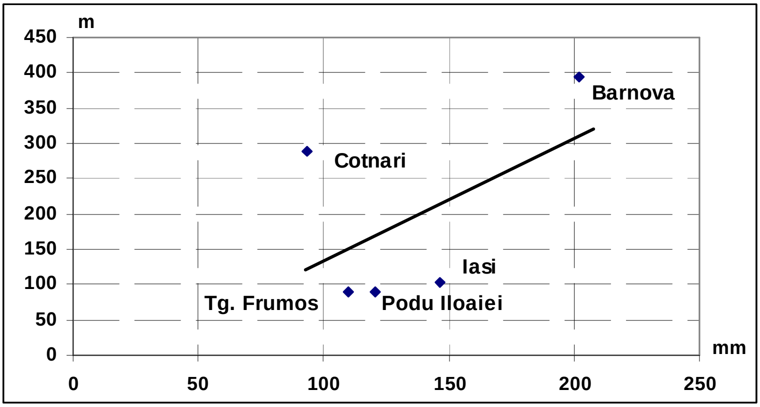

Fig. 2. Correlation between the maximum precipitations in 24 hours with a 1% occurrence probability and the altitude of the meteorological stations and precipitation gauges from Bahlui basin

The data from the hydrometric observations conducted at Târgu Frumos hydrometric station have indicated an exceeding of the flooding elevation of over 20 cm (Table 2).

Table 2

Data from the observations conducted at Târgu Frumos hydrometric station at 00.60 hours (July 25th 2008)

River	Hydrometric station	Protection levels (cm)			Values on July 25th, 2008, 00.60 hours	
		CA	CI	CP	Q(mc/s)	Level(cm)
Bahluet	Tg. Frumos	100	150	250	8.40	170

*after D.A.Prut

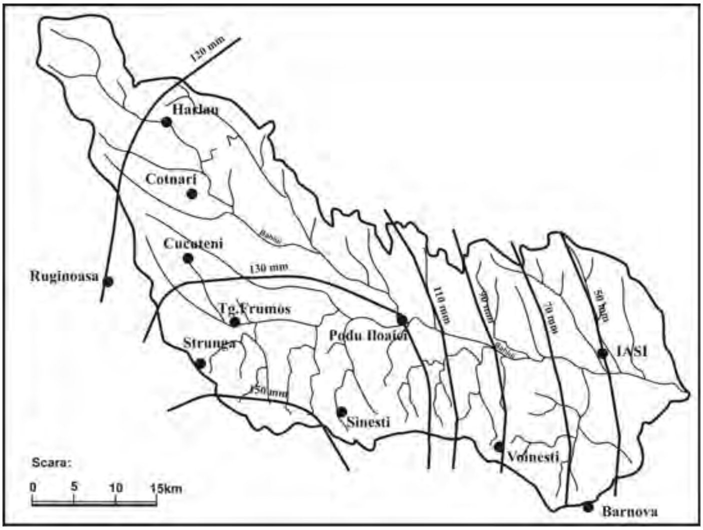

Fig. 3. Isohyets of the rain from July 24-25, 2008, in Bahlui basin

In the morning after these high precipitation quantities fell was realized a terrains survey for the identification of the areas affected by the flood. Even if in certain areas it was difficult, have been identified three important sectors affected by the flood from the night of July 24-25, 2008. A first area was in Lungani township, where a complex of local factors, the flood from Bahlueț valley and the remu effect induced by the raise of water level from Podu Iloaiei lake, have led to the flooding of Goeşti brook lower valley, of 7 households from the right bank of the brook at almost 80-100 m from its floodplain (Fig. 4., left). A second area was identified in the region of Târgu Frumos, where the dam from Rediu brook was affected on a length of 30 meters, being flooded two dammed sectors nearby and the lower part of the town (Central Station area) (Fig.4., right). There have been affected 15 households, the flooded area being larger than 25 hectares. The third identified area has been north-west of Târgu Frumos, in the region of Giurgeşti village, where due to a dam break 180 households remained isolated.


Fig. 4. The effects of the July 24-25, 2008 flood on Bahlueț valley in the area of Lungani (left) and Târgu Frumos (right)

3. THE ANALYSIS OF THE FLOODING

For a closer to reality evaluation, have been conducted a series of simulations, with the purpose of evidencing the floodable areas, either in the case of such flood waves or in the case of smaller ones, which due the morphologic features of this basin in certain sections may lead to their blocking (cut and fills along the river, bridges). The spontaneous blocking during floods in certain sections may lead to the occurrence of ,,lakes" that flood the upper stream sectors.

Departing from the principle HAZARD+VULNERABILITY=RISK, we considered necessary the creation of vectorial strata that would evidence the hydrologic risk and the vulnerability, so that later by over-imposition to obtain the map of the areas exposed to flooding risk (*Ursu et.al.*, 2008).

The evidentiation of the floodable areas has been possible by simulating a few floods based on the digital elevation model, realized after the 1:25000 topographic maps or 1:5000 plans, vectorial strata representing elements of the natural or anthropic landscape) and remote sensing (aerial photos), according to the above mentioned methodology. A first example is given for Lungani township, located in the lower course of Goeşti brook, right tributary of Bahlueț upperstream Podu Iloaiei lake.

After simulating the formation of such a dam, were evidenced a series of areas exposed to flooding risk, situated mainly in the newly built sector of Lungani (Fig.5). In the bellow graphics are presented the terrain surface flooded at different dam heights. We may observe that the surface increases at low dam levels till the floodplain is filled, after this moment the flooding area increasing being slow (Fig.6). Obviously, this fact will be reflected and on the rhythm of flood affected households.

For Târgu Frumos the situation is much more severe. After the rains felt in the night of July 24-25, 2008, the area of the dam on Rediu river (right tributary to Bahluet) has been affected on a 30 m length. This situation led to the flooding of two dammed areas and of the low region along the railway station. According to the estimations, have been affected about 25 hectares and 20 households. Our survey conducted the morning following this extreme hydrologic phenomenon reached another conclusion. In this sense we used and the simulations conducted based on the digital elevation model (Fig.7 and 8.).

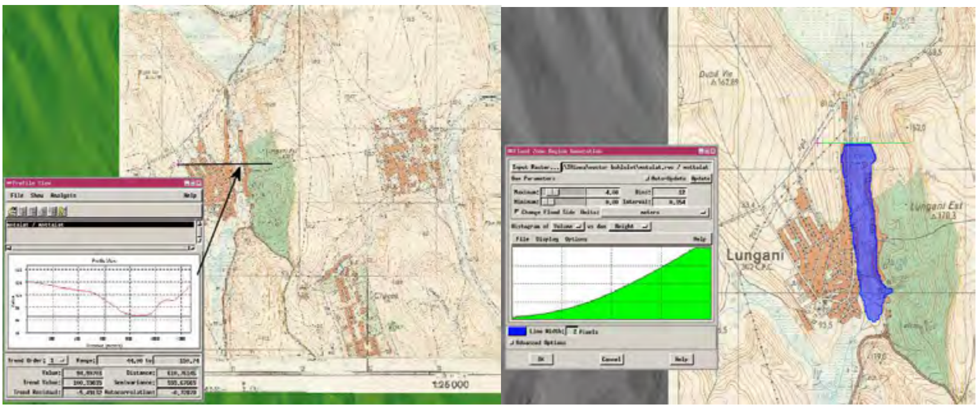

Fig. 5. The choice of the section that presents conditions for the spontaneous formation of a dam during the flood (left) and the flooded sectors in the case of a dam of 4 m height (right) in the case of Lungani

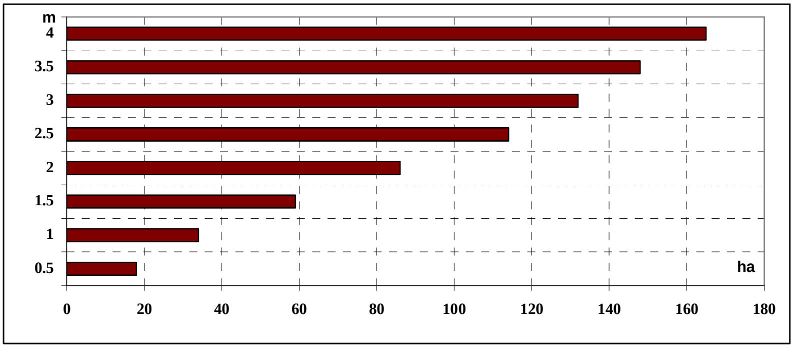

Fig. 6. The surfaces (ha) flooded at different heights of the dam at Lungani

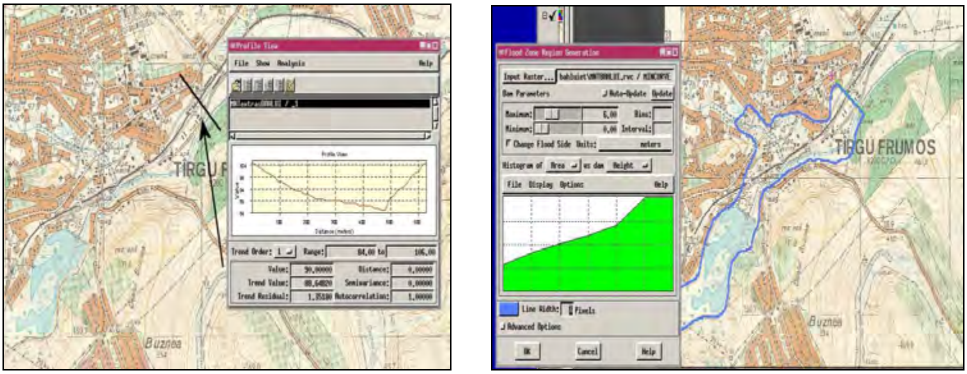

Fig.7. The choice of the section that presents conditions for the spontaneous formation of a dam during the flood (left) and the flooded sectors in the case of a dam of 6 m height (right) in the case of Târgu Frumos

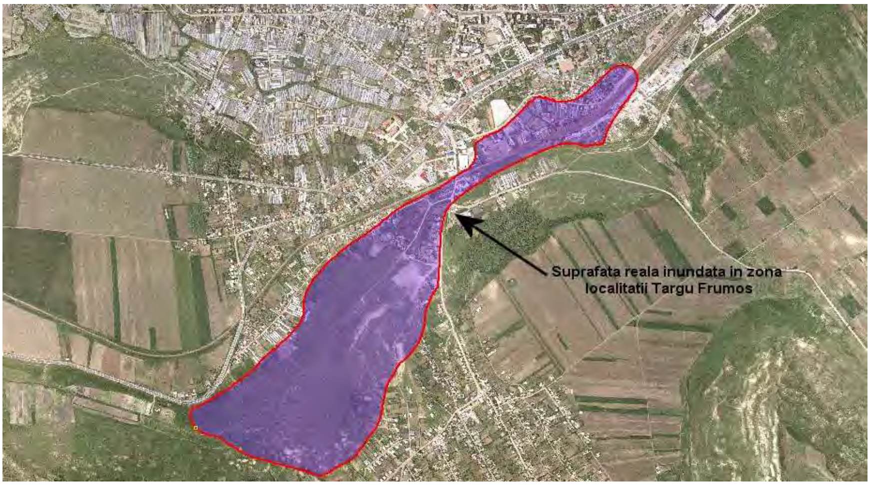

Fig. 8. The real surface flooded near Târgu Frumos after the flood from the night of July 24-25, 2008

In the conditions of a 6 meters dam simulation in the area of Târgu Frumos railway station was obtained a flooded perimeter of 12.2 km and a surface of 115 ha. The limits identified on the field and then drawn on aerial photos have evidenced a flooded perimeter of 6.1 km length and 85 ha surface, three times larger than that reported by the local authorities. According to some information from the locals, approximately the same surface has been flooded in August 2005, situation that implies a much more detailed analysis in what regards the management of the hydrologic risks that should be conducted by the local authorities.

4. CONCLUSIONS

According to our analysis, we may draw the following conclusions:

- even if Bahlui basin is 80% hydrotechnically managed, a series of extreme rainfall events (maximum precipitations in 24 hours of over 130-150 l/m^2) may generate local floods and inundations with serious effects;

- for a better evaluation of these extreme hydrologic phenomena, may be realized a series of simulations based on the proposed GIS methodology, yet in correlation with field surveys, so as to avoid wrong estimates (in what regards the flooded surface and the flooding causes);

- the local morphologic features of some sections from this basin may lead to runoff blocking during floods, fact that may lead to the occurrence of "lakes" that flood the upper stream sectors, situation similar to that from Lungani;

- a series of hydrotechnical improvements from the basin need to be dimensionally reconditioned so as to be able to face extreme situations that may generate disastrous effects (for example the dam from Târgu Frumos).

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WATER AND AIR POLLUTION IN COPSA MICA AND ITS IMPACT ON THE BIOTIC COMPONENT AND HUMAN HEALTH

RÉTI KINGA-OLGA[1], CORPADE ANA-MARIA[2], CS. HORVÁTH[3]

ABSTRACT. Water and Air Pollution in Copsa Mica ans its Negative Impact on the Biotic Component and Human Health. The pollution negative effects of the 80's maximal industrialization period on the biotic component and on human health still represent an acute problem for the locality itself and for its neighbouring areas. Among the principal pollutants inducing major risks (46 and 131 times more than the maximum allowable values at lead and cadmium) for the living community we could mention: metallic bismuth, stibium, zinc ammonium sulphate, carbon black, stibium trisulphate, sulphure dioxide, sulphate acid, cadmium etc. The presence of these substances determined genetical mutations or extinctions to plants and animals, human affections as the chronic saturnism (acute lead intoxication), the skin cancer, problems on children development as anemia, growing-up and bone development difficulties and a generally reduced staturo-ponderal growth.

***Keywords**: Copsa Mica, pollution, negative impact, human health, heavy metals*

1. INTRODUCTION

Air and water (Tarnava Mare River) quality in Copsa Mica town has changed significantly along with the industrialization and urbanization process in the last century 80's, with serious implications both on the environmental elements and on human health.

Air pollutants are substances (particles in suspension or aerosols) that should not be present within air composition under normal conditions and which, emitted in ther air, determinate a nocive effect on environment and humans according to their concentration and lifetime. The emitted air pollutants get dispersed through atmospheric vertical and horizontal movements and thus affect all the other natural and human-made factors in town. Wthin the air pollution in the urban area of Copsa Mica, an overriding weight belongs to the stationary sources (industrial and combustion processes), succeeded by the mobile ones (road and rail transportation means), while the pollution natural sources could only exceptionally determine significant atmospheric pollution.

The main pollution sources responsible for the negative impact on the environmental components are the two industrial plants (chemical industry and non-ferous metallurgy) on the Copsa Mica industrial platform: Carbosin S.A. and Sometra S.A.

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Carbosin S.A. produced till 1994 (when it is completely closed) chemical products as carbon black, methyl methacrylate and polimethacrylate, formic acid, nitric acid, sodium sulphate, ammonium sulphate, in 1992, the territorial area affected by this industrial unit's pollution being 20 km long and 5-6 km wide.

Sometra S.A., with a non-ferous metallurgy profile, has produced: metallurgical zinc, electrolithic lead, zinc powders, cadmium, bismuth, stibium, sodium antimonate, stibium trisulphure, zinc sulphate, sulphuric acid. The main pollutants aggressing atmosphere, pedosphere and all the other environmental factors are: harmful metals powders (Pb, Zn, Cd), harmful metal oxides (SO_2, CO and NO_2), volatile arsenic compounds and small quantities of chlorine.

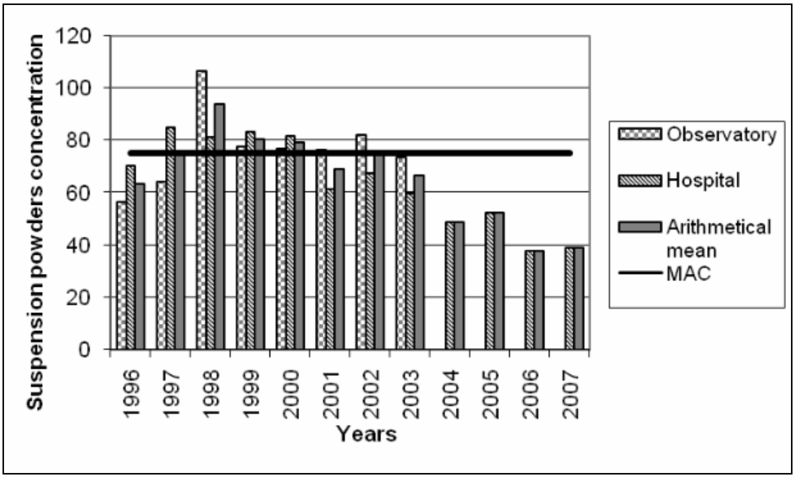

Fig. 1. Amount of suspension powders in the air above Copsa Mica

The air quality monitoring in Copsa Mica was undertaken by two industrial-type stations:

- ***Observator (observatory),*** located 1500 m far from the Sometra S.A. industrial unit, with 24 hours prelevations for suspension powders, metals from suspension powders, weekly (precipitations) or montlhy samples (sedimentable powders or metals in sedimentable powders);

- ***Spital (hospital),*** located 500 m far from Sometra S.A., with 24 hours prelevations for SO_2, suspension powders, metals from suspension powders.

Among the monitored pollutants, we have followed the evolution of heavy metals amount (Pb and Cd) in suspension powders. As regarding the suspension powders, the maximal pollution was registered in 1998 and in its coming up period, up to 2003, when, because of the reduction/ceasing of the industrial activities, the pollution intensity decreased.

As regarding lead amount in the air, it should be mentioned that the maximal admissible limits were exceeded in each and every year, including 2007. The same situation was encountered in the case of cadmium, the registered amounts in many situations significantly surpassing the allowable concentration. This heavy metals pollution of the air above the Copsa Mica locality has irreversible repercussions on the quality and health of the biotic and human component, determining some chronic affections and the 10 years decrease of life expectancy in comparison with the country's average.

As a result of the urban and industrial development and of fertilizers and pesticides use in agriculture, the quality of Tarnava Mare River, Copsa Mica sector, was deeply affected through changes in the physico-chemical and bacteriological composition.

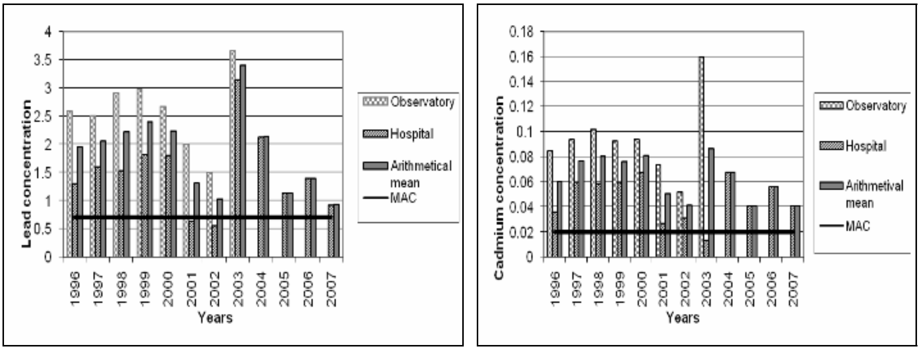

Fig. 2. Amount of lead and cadmium in the air above Copsa Mica

In the established control sections, the following indicators are measured: pH, CCO-Mn, NH_4, O_2, chlorides, fixed residue, sulphates, calcium, magnesium, sodium, nitrites, nitrates, cyanides, phenols, iron, chromium, copper, zinc, cadmium, suspensions, durity. Because Copsa Mica lacks a water control section, we have processed the data measured at the section located upstream Medias and provided by Romanian Waters Administration, Targu-Mures branch office. Among the analyzed indicators, we have pointed out those which, by exceeding the maximal admissible values, determined water quality damages within Copsa Mica areas and implicitely the includance of the river sectors into inferior quality categories. These indicators are: nitrites, phenols and zinc. As regarding lead and cadmium, they were not monitored. The graphics show that phenols and nitrites have exceeded each and every year the maximal admissible concentration for the first water quality category and even for the second one. This type of pollutants is induced by agro-zootechnical activities in the analyzed locality or in the upstream ones.

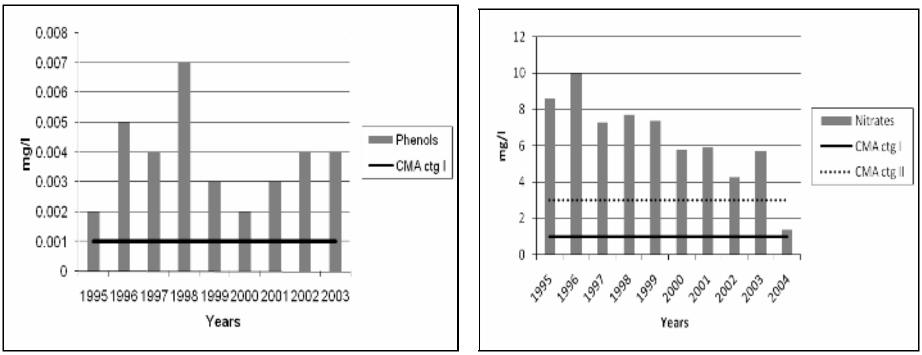

Fig. 3. Phenols and nitrates concentration in Tarnava Mica River water at upstream Medias sampling station

As regarding zinc concentration, it is supplied by the unproper management of the technological and pluvial waters on the town's industrial platform, and, once coming into contact with the watercourse, it determined the highest amounts after 2000, with exceedings of the maximum admissible concentration.

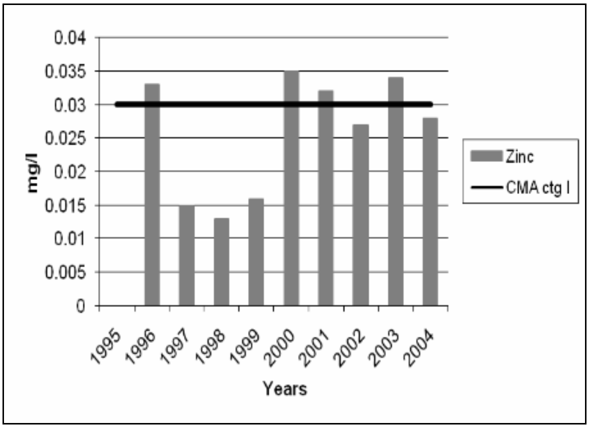

Fig. 4. Zinc concentration in Tarnava Mica River water at upstream Medias sampling station

Air and water (Tarnava Mare River) pollution in the locality of Copsa Mica represented the major source of the biotic component and human health quality damaging. As a consequence, we have tried to determinate the "cause" – "effect" - type relations.

2. POLLUTION IMPACT ON THE BIOTIC COMPONENT

None of the human actions was more dangerous and more environmentally unfriendly than pollution, because it modifies life conditions in discordance with the biologic systems features. Plants were not prepared to survive and reproduce under pollution conditions, their normal development requiring normal ecosystemic parameters.

Within the Copsa Mica area, pollutants from industrial activities and from road and rail traffic influence the agricultural and forest vegetation both directly, through fine depositions on plants surface, and indireclty, through propagation of the soil pollution to plants.

As a consequence of pollutants deposition on plants, the chlorophyll assimilation is reduced by the occlusion of their stomatal pores. The imissions from the polluted areas induces physical and chemical reactions that determine biochemical and physiological changes in the main vital processes (photosynthesis, hydric regime, breathing, growth and development) mirrored in some morphopatologic modifications.

The solid emissions from the dispersion chimneys are represented by lead, zinc, copper, cadmium, under the form of oxides and sulphates. In contact with atmospheric water vapors or with dew particles on the plants, they give birth to chemical compounds with very negative effects on the vegetal cell.

In the following charts and tables, the heavy metals accumulation rates (Pb, Zn, Cd, Cu) at two vegetal species in Copsa Mica area, surveying year – 1996.

When analyzing the two charts, the conclusion is that heavy metals accumulation rate in plants significantly exceeds the concentrations registered in the control samples. In the case of lead and zinc, the values are 10 times above the normal considered values, at cadmium 5 times, while at copper twice. It has also to be mentioned that, today, the heavy metals concentration in plants has significantly decreased, but the negative consequences of the aggressive pollution are still being felt.

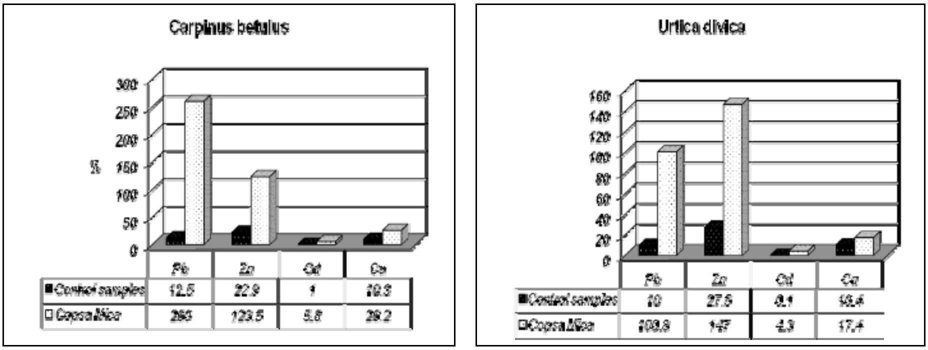

Fig. 5. Heavy metals accumulation rate: Pb, Zn, Cd, Cu at Carpinus betulus and Urtica divica genera

Ash and *smoke*, under the direct action of light, turns into a photochemical oxidizing smog that determines negative impacts on vegetation as growth delays, untimely leaves falling off, crown thinning, reduced blossoming and fruit weight

Nitric oxides (NO_x) are hardly absorbed by plants, the only entering way being the stomates. Even if these substances do not determine an occlusion of the stomatal pores, they contribute up to 80% to the photosynthesis reduction.

It is evident that pollution (especially the atmospheric pollution) affected vegetation and determined the development in Copsa Mica area of an unorganized phytocenosis that lack self-regulation possibilities. In other words, the local vegetation almost disappeared, while the surviving one suffered irreversible changes.

3. POLLUTION IMPACT ON HUMAN HEALTH

In Copsa Mica, the pollution effects were also felt in human health that strongly depends on the pollutants harmfulness, number, concentration or lifetime. As a result of a direct action on the human body, a lot of effects might appear. According to the exposure periods that are necessary for inducing health problems, the effects could be classified as follows: *immediate (acute)* – exposure to pollutants high concentrations; *chronic* – exposure during a long period; *tardive* – exposures of hundreds of years

If mentioning the characteristic diseases during the massive pollution period, the following aspects are to be considered:

- During 1977 and 2001, the most frequent diseases were lead and cadmium poisoning (chronic saturnism), saturnine encephalopathy, radial nerve paralysis, saturnine colic, anemia, conjunctivitis, breathing problems (Muntean 20084;
- At children between 0 and 14 years, intelligence quotient deficits, acute and chronic anemia, nephropathies, somatic-functional dysfunctions were noticed;
- Decrease of the local life expectancy with 10 years in comparison with the country's average;
- Increased morbidity at the two industrial units' employees, due to some professional diseases as tuberculosis, acute respiratory infections, skin diseases, ulcers.

A direct relation may be established between air pollution (above the industrial platform, on the one hand, and above the entire locality, on the other) and population health in Copsa Mica town. The most dangerous pollutants with effects on human health are the systemic-harmful pollutants **(Pb, Cd)**, each of them affecting a specific compartment of the human body (lead the blood components – hemoglobin and red-cells, while cadmium affects kidneys and liver). Lead may accumulate in bones and it could be only partially eliminated through urine, motions, saliva or transpiration. The chronic exposure to cadmium particles may cause pulmonary emphysem, its inhalation or chronic ingestion could determine kidneys dysfunctions (tubular or glomerular dysfunction, alteration of urine concentration capacity, decreased insulin clearance).

The **non-ferrous heavy metals** do not loose their harmful features in combination with other substances, but on the contrary, there are some heavy metals organic compounds that increase in harmfulness if compared to the original source.

4. CONCLUSIONS

The relation between the atmospheric and hydric pollution in Copsa Mica town and the decrease of the human and biotic components health is indisputable. Both the direct and indirect negative effects of the industrial activities on human health was pointed out by the high rate of the employees mortality, by delays in the physical and mental development of children, by the reduction of life expectancy with 10-15 years in rapport to the country's average, by heavy metals accumulation in the natural or cultivated vegetation or by the replacement of the initial vegetation with a "black desert".

All these dysfunctions should be rapidly fixed through an efficient collaboration between all involved actors (the industrial unit, the Environmental Protection Agency, local administration, NGOs). The solutions stand in pollution reduction, rehabilitation projects, improvements in life quality and human health and a proper environmental education.

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