SCIENTIFIC PAPERS

Series E

LAND RECLAMATION, EARTH OBSERVATION & SURVEYING, ENVIRONMENTAL ENGINEERING

Volume II

University of Agronomic Sciences
and Veterinary Medicine of Bucharest
Faculty of Land Reclamation
and Environmental Engineering

SCIENTIFIC PAPERS

Series E

LAND RECLAMATION, EARTH OBSERVATION & SURVEYING, ENVIRONMENTAL ENGINEERING

Volume II

2013
BucharesT

PUBLISHERS:

University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania - Faculty of Land Reclamation and Environmetal Engineering
Address: 5 9 Marasti Blvd., District l, Zip code 011464 Bucharest, Romania
Phone: + 40 213 1830 75, E-mail: conference@fifim.ro, Webpage: www.fifim.ro

CERES Publishing House
Address: 1 Piața Presei Libere, District l, Zip code 013701, Bucharest, Romania
Phone: + 40 21 317 90 23, E-mail: edituraceres@yahoo.com, Webpage: www.editura-ceres.ro

To be cited: Scientific Papers. Series E. LAND RECLAMATION, EARTH OBSERVATION & SURVEYING, ENVIRONMENTAL ENGINEERING, Vol. II, 2013

ISSN 2285-6064 ISSN-L 2285-6064

International Database Indexing: ULRICH'S PERIODICALS DIRECTORY.

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THE NITROGEN REGIME AND MOBILITY OF SOME TRACE ELEMENTS IN ARABLE SOILS LOCATED NEAR THE TAILING PONDS IN THE WEST PART OF BAIA MARE

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Abstract

Depression of the Baia Mare is known like an area strongly affected by the mining activities performed here the centuries.These activities have generated important polluted areas, which even today, are subject directly to the pollutant impact. This paper presents the results of research conducted in the experimental plots, located near the tailing ponds, from the west part of Baia Mare. The chemical analyses conducted at the beginning of the study showed a small content of the total nitrogen, a high content of micro nutrients – copper, manganese and zinc, and specific pollutant – lead, and acidic reaction of the soil. Differentiated fertilisations applied, does not demonstrates that this fact affect the mobilization and accessibility of the four metals and indicating therefore, the possibility to be translocated in the throphic chain soil-plant-human. The study demonstrates the needs to implement urgent measures for environmental remediation of these soils to restore agricultural capacity of these soils.

Key words: *fertilizations, micronutrients, nitrogen, specific pollutants, tailing ponds.*

INTRODUCTION

The forced industrialization of our country in the last century, including the strong development of activities in the ferrous ore mining and processing fields in Baia Mare depression has left a strong imprint on the environment. Studies show that large areas of land in this area are polluted. The most heavily polluted areas are occupied by the mine tailings dumps, including their adjacent surfaces (SNR-SS, 2006).

After 1989, through the implementation of the Land Law, while the economic decline and the population migration from urban to rural were taking place, newly regained lands began to be utilized for subsistence agriculture. Although, in most cases, there are no studies regarding the suitability of land in heavily polluted areas, these lands are cultivated every year with maize, potato, triticale and other economic useful plants (Muntean, 2012).

THE RESEARCH AREA

The ultimate goal of our research is to establish appropriate agro-technical measures for sustainable agriculture, in order to obtain our goal we have chosen for the experiments two rectangular plots with an area of approx. 600 m^2 located upstream and downstream of the three dams: Sasar, Remin and Aurul. This site is located in the west of Baia Mare depression plain, on the estate of the villages Sasar (S) and Bozanta Mare (B), at an average altitude of 170 m (Figure 1).

Figure 1. The geographic localization of the experimental area (Source: www.google.earth)

As we can see in the figure above, the experimental area is located on the first terrace of the river Sasar, the soil of this area falling within the following soil types:

- Stagnosol-typically strong stagnosols, clay, eluvial materials medium carbonated/non-carbonated clays, moderately compacted soil arable-Lot for the upstream;
- Distric gleyosol, strongly gleyed, clay, eluvial materials carbonated/non-carbonated clay, arable soil, for the downstream.

MATERIALS AND METHODS

Each batch has been parceled into 3 equal areas, one of which was the witness surface and the other two were fertilized as follows: one with chemical fertilizer (calcium) and one with organic fertilizer, manure. In 2011 agricultural plots were cultivated with maize, the Pioneer PR 38A-24 sort, and in 2012 we have planted a potato crop, variety Labadie.

To establish the baseline concentrations of micronutrient elements of the soil we have taken samples in the late March of 2011, when the soil temperature exceeded the critical threshold of 5°C. The last soil samples have been collected in October 2012. The soil sampling has been performed according to standard STAS 7184/1: 1984-Soils, Sampling for Soil Survey and agrochemicals. The harvesting has been done at a depth of 0-40 cm in new polyethylene bags. The samples have been labeled and transported immediately to the laboratory for analysis. The protocol lift of soil samples is highlighted in the following figure (Figure 2).

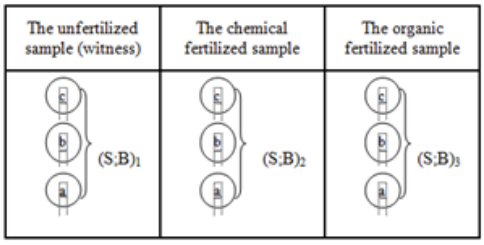

Figure 2. The sampling protocol

The soil reaction (pH) was determined in aqueous solution according to standard analysis STAS 7184/13: 2001- Soils, Determination of pH. The determination of macronutrients-nitrogen was performed according to standard ISO 11261-2000-Soil quality, Determination of total nitrogen, Kjedhal modified method.

Determining the form of pseudo-total trace elements of interest (copper, zinc, cadmium and lead) soil samples were processed according to standard ISO 11466:1999-Soil quality. Extraction of trace elements soluble in water, as total metals was determined according to the standard ISO 11047:1999-Soil quality. Determination of cadmium, chromium, cobalt, copper, lead, manganese, nickel and zinc in aqua regia soil extracts using Atomic absorption spectrometric method in Flame and electro thermal. For determining the availability of transfer through food chains, the metal concentration was determined according to the Soil Survey Methodology develop (MESP), simultaneous extraction method combined with a solution of 0.01 M EDTA-CH3COONH4 1N at pH = 7.0. Appropriate concentrations of micronutrients were also determined by atomic absorption spectrometry graphite furnace technique.

The interpretation of the results was performed in accordance with Order 756/1997,the approved legislation on environmental pollution assessment, i.e. Annex 1: Reference values for trace elements in soil chemical for use sensitive soils (Ordin 756,1997) and with the ICPA (ICPA, 1987).

RESULTS AND DISCUSSIONS

After analyzing the soil samples collected, we have obtained the following results:

The determinations regarding the **soil reaction** revealed that these soils are mainly moderately acidic and weakly acidic (Kabata-Pendias, 2006, Muntean, 2012), such as shown in Table 1.

Table 1. Values of the soil reaction in the batch upstream (S1-S3) and downstream group (B1-B3)

Sample code	2011		2012	
	Before seeding	After harvest	Before seeding	After harvest
S1	5.16	5.23	5.20	5.18
S2	5.42	5.46	5.53	5.33
S3	6.05	5.88	5.73	5.80
B1	5.80	5.68	5.85	5.72
B2	6.41	6.30	6.26	6.25
B3	5.85	5.70	5.68	5.80

The total content of nitrogen in the samples taken shows small and medium concentration, the gap values determined in 2011 - 2012, 0099 - 0119% for the group being downstream and upstream 0113 - 0150% for the group. The annual average values for each plot of the experimental groups are shown in Table 2.

Table 2. Annual average concentration of total nitrogen in the experimental lot

Annual medium values of the total nitrogen,%		
Samples code	**2011**	**2012**
S1	0.118	0.113
S2	0.138	0.138
S3	0.148	0.150
B1	0.104	0.099
B2	0.102	0.104
B3	0.115	0.119

The content of potentially toxic trace elements reveals that all their mobile forms for soil exceeding normal values provided by applicable law as follows:
-the determined concentrations for copper show exceptionally high supplies, the recommended value (20 mg/kg dry. dried) is being surpassed at least 4.5 times for the downstream lot and 52.4 times in the upstream lot:

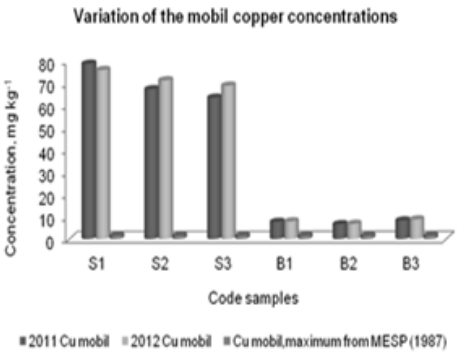

Figure 3. The mobile forms of copper concentrations

-the indicate zinc concentrations determined reveal high supplies, the recommended value (100 mg / kg dry. dried) being surpassed at least 7.1 times for the downstream lot and at most 31.5 times for the upstream lot;

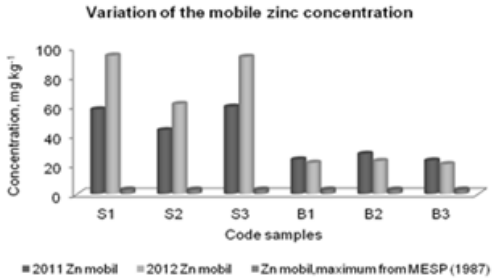

Figure 4. The mobile forms of zinc concentrations

-the manganese concentrations indicate a high supply, the recommended value (900 mg / kg dry. Dried) being surpassed at least 4.0 times for the downstream lot and 6.1 times for the upstream lot;

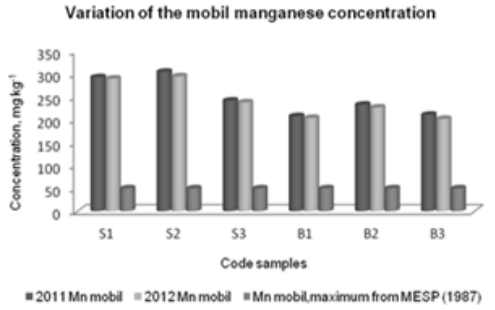

Figure 5. The mobile forms of manganese concentrations

-the concentrations determined for lead due show the exceeding of the recommended amount (20 mg / kg dry. dried) in both lots. This element shows the maximum overtaking in the samples taken upstream-6.6-8.3 times the normal amount indicated in Annex 1 of Order no. 756/1997 for sensitive use of soils

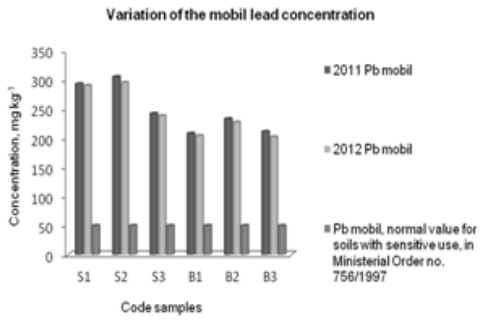

Figure 6. The mobile forms of lead concentrations

The Pearson correlations calculated using the Pearson function in Microsoft Office Excel application, of the concentrations of trace elements show negative correlations in the following order: The Mn > Pb > Zn.

CONCLUSIONS

The results show that:

-the adjacent lands soils in from the western tailings of Baia Mare show significant concentrations that exceed the rules laid down by legislation in force;

-the reaction of the soils is mostly acidic for both groups and the concentration of total nitrogen, essential macro nutrient in plant development is low for both groups;

-the concentrations of trace elements in mobile form presents high values in both groups, but especially in the lots located upstream the tailings dams;

-the lead pollution of this area is significant even if industrial processes have taken steps to protect the environment and have reduced or ceased their activity.

REFERENCES

Kabata-Pendias Alina, Mukherjee B. Arun, 2007. Trace Elements from Soil to Human, Editura Springer, Berlin.

Muntean A., Rusu T., Coman M., 2012. Macro and micronutrients in the arable soils strong anthropogenic, in west area of Baia Mare city. Scientific Bulletin of North University of Baia Mare, XXVI no.1, 143-148.

Rusu, T., 2005. Agrotehnica, Editura Risoprint, Cluj Napoca, Colectia Agraria.

***Metodologia studiilor pedologice (MESP), 1987, vol. I – III, ICPA, Bucuresti.

***Ordinul nr. 756/1997 – pentru aprobarea Reglementari privind evaluarea poluarii mediului, Anexa nr. 1 – Valori de referinta pentru urme de elemente chimice în sol.

***Publicatiile Societatii Nationale Romane pentru Stiinta Solului, 2006. Ghidul Aplicatiilor celei de-a XVIII-a Conferinte Nationale pentru Stiinta Solului, vol. 1, Cluj-Napoca, pg. 156-163.

EARTHQUAKE EFFECTS: THE IMPACT ON BUILDINGS AND ENVIRONMENT

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Abstract

The direct shaking effects as damage or collapse of buildings, bridges, elevated roads, railways, water towers, water treatment facilities, utility lines, pipelines, electrical generating facilities and transformer stations, are not the only hazard associated with earthquakes, other secondary effects, that are caused by earthquakes, most often a result of strong shaking, such as landslides, soil liquefaction, fires, floods etc. have also played an important role in destruction produced by earthquakes. These effects mean short-term (immediate) or long-term impacts. Depending on the vulnerability of the affected community, large numbers of people may be homeless in the aftermath of an earthquake. The estimating of all hazards is very important in order to get how are changed the life and the environment after an earthquake. The paper present some aspects related to this subject, what are some effects of earthquakes on the natural and built environments, why do buildings collapse in earthquakes, how we can make buildings more resistant to earthquakes etc.

Keywords: *earthquake, vulnerability, damage, strengthening works*

1. INTRODUCTION

Earthquake damages depend on what area is hit. If an unpopulated area is struck, there will not be loss of life or property, but there will be only some effects on environment. If it hits a big city, there may be many injuries and very severe damages.
The negative effects of earthquakes include, but are not limited to, the following: shaking and ground rupture, landslides, fires, soil liquefaction, floods, tsunami, human impacts etc.
Over time, it was found that the real dangers to people are being crushed in direct shaking effects as collapsing building and then what is very important from some secondary effects as drowning in a flood caused by a broken dam or levee, getting buried under a landslide, or being burned in a fire.
Usually, earthquake fatalities are dominated by shaking-related causes, while secondary effect-induced fatalities are dominated by landslide deaths. From the earthquake records, the fire and liquefaction tend to contribute more to structural and financial losses rather than fatalities.

2. WHAT EFFECT DID THE EARTHQUAKE HAVE ON THE BUILDINGS AND LIFELINE SYSTEMS?

2.1. How earthquakes affect buildings

For economic reasons, building codes permit buildings to be damaged by the infrequent severe earthquakes that may affect them, but prevent collapse and endangerment of life safety. For buildings that house important functions essential to post-earthquake recovery, including hospitals, fire stations, and emergency communications centres etc., all codes adopt more conservative criteria that are intended to minimize the risk that the buildings would be so severely damaged they could not be used for their intended function.
Failure of the ground and soil beneath buildings is also a major cause of damage.
Several important characteristics of buildings affect different the performance during an earthquake (Figure 1):

- *natural period* - it becomes a problem if the period of the ground is the same as that of a building on the ground
- *damping* - connections of non-structural elements such as partitions, ceilings, and exterior walls can dampen a building's vibration
- *ductility* - using materials, primarily steel, the structure will bend or deform before it will fail
- *stiffness* - less rigid building elements have a greater capacity to absorb several cycles of ground motion before failure, in contrast to stiff elements, which may fail abruptly and shatter suddenly during an earthquake
- *drift* – some limits are often imposed on drift so a building is not designed to be so flexible that the resulting drift or swaying during an earthquake causes excessive damage; if the level of drift is too high, a building may pound into the one next to it
- *building configuration* - determines the ways in which seismic forces are distributed throughout the building (an L, T, H-shaped building will experience increased stress at the point where the wings of the building meet; torsion forces on these buildings can cause one wing to rotate around the other)
- *soft-story* - creates a discontinuity of strength and stiffness; the first floor is the most highly loaded, so a soft-story to the first floor possibly causing column failure or can cause the building to collapse

a. b. c.

Figure 1. Negative performance during an earthquake due to some characteristics of buildings (a. pounding between two buildings because large drifts [1]; b. soft-story [2]; c. Lizeanu building, Bucharest – soft storey effect - March, 4, 1977, ICCPDC-INCERC photos)

2.2. How Earthquakes Affect Lifeline Systems - Transportation lifelines, Water distribution systems, Natural gas systems, Electric power systems, Sewer and wastewater systems etc.

The extensive damage and disruption to lifeline systems appear as deformed rail lines, tilted container cranes, and cracked wharf piles, catastrophic collapse of major bridge structures (which can led to a significant loss of life, and a big total repair cost, traffic delays and delays in the transportation of goods vital to the economy), cracking of distribution systems pipes etc. (Figure 2- b. this was particularly likely where the road crossed areas of softer, wetter ground, where the shaking was stronger and lasted longer; c. below one intersection a subway station collapsed, leaving the road above to sink unpredictably for months until it could be excavated)

a. b. c.

Figure 2. a. Railroad Damage [3]; b. from a report by J.-P. Bardet at USC and others at Gifu Univ.; Large sections of the main Hanshin Expressway toppled over [4]; c. from a report by J.-P. Bardet at USC and others at Gifu Univ. [4]

3. WHAT EFFECT DID THE EARTHQUAKE HAVE ON THE ENVIRONMENT?

The different types of seismic waves produce several different effects on the natural environment that also can cause tremendous damage to the built environment (buildings, transportation lines and structures, communications lines, and utilities). The negative effects of earthquakes include landslides, soil liquefaction, floods, fires, tsunami, and human impacts.

3.1. How earthquakes produce landslides and liquefaction

Occasionally large landslides can be triggered by earthquakes. Careful consideration should be made before place a building in a location that could be affected by a landslide. During an earthquake, a landslide can block the exits to the firehouse, and, while the fire equipment will be blocked inside, the town will suffer from fires caused by the earthquake (Figures 3, 4, 5).

Figure 3. a. Landslide produced by earthquake - Conchita, 1995 [5]; b. Landslide produced by earthquake - El Salvador, 2001 [6] c. Landslides produced by Anchorage earthquake near a school building - Alaska, 1964 [7]

Figure 4. Damage due to soil liquefaction and permanent settlement [8]

Strong ground motion during an earthquake can cause water-saturated, unconsolidated soil to act more like a dense fluid than a solid; this process is called liquefaction. Liquefaction occurs when a material of solid consistency is transformed, with increased water pressure, in to a liquefied state. Water saturated, granular sediments such as silts, sands, and gravel that are free of clay particles are susceptible to liquefaction. If the soil beneath it suddenly behaved like a liquid, a building would happen to shift, tilt, rupture, or collapse.

Figure 5. It is showed how buildings can topple when soil assumes the properties of a liquid and loses its bearing capacity [8]

Ground Failure

Strong ground motion is also the primary cause of damages to the ground and soil upon which, or in which, people must build. These damages to the soil and ground can take a variety of forms: cracking and fissuring and weakening, sinking, settlement and surface fault displacement.

One of the most important types of ground failure is known as liquefaction. Liquefaction takes place when loosely packed, water-logged sediments at or near the ground surface lose their strength in response to strong ground shaking. Liquefaction occurring beneath buildings and other structures can cause major damage during earthquakes.

Ground Sliding

Strong ground motion is also the primary cause of damages to the ground and soil upon which, or in which, people must build. These damages

to the soil and ground can take a variety of forms: cracking and fissuring and weakening, sinking, settlement and surface fault displacement.

Ground Tilting

Sometimes, due to earthquake, there is tilting action in the ground. This causes plain land to tilt, causing excessive stresses on buildings, resulting in damage to buildings.

Differential Settlement

If a structure is built upon soil which is not homogeneous, then there is differential settlement, with some part of the structure sinking more than other. This induces excessive stresses and causes cracking.

3.2. How earthquakes produce floods

An earthquake can rupture (break) dams or levees along a river. The water from the river or the reservoir would then flood the area, damaging buildings and maybe sweeping away or drowning people.

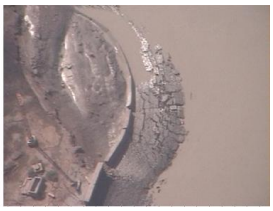

Figure 6. a. A tsunami floods over the breakwater protecting the coastal city of Miyako – Japan 2011 [9]; b. Earthquake-related failure of the breakwater in the Navlakhi port in 2001[10]

3.3. How earthquakes produce fires

The fires produced by earthquakes can be started by broken gas lines and power lines, or tipped over wood or coal stoves. It will be a serious problem if the water lines that feed the fire hydrants are missed or broken (Figure 7).

a. *b.*

Figure 7. a. School building after a fire produced by earthquake in 2004, India [11]; b. The destruction of lifelines and utilities made it impossible for fire-fighters to reach fires started by broken gas lines. Large sections of the city burned, greatly contributing to the loss of life [12];

3.4. How earthquakes produce faults

We saw in the previous unit that ruptures along fault planes or zones sometimes reach the surface. If a building stands on a fault line, little can be done to protect it during an earthquake. It is extremely important to select sites for new buildings that are away from known fault surface traces (Figure 8).

Figure 8. Ground failure near the building school, Duzce -1999 (INCERC photo)

3.5. How earthquakes produce tsunamis

During an earthquake, seismic waves can produce powerful ocean waves. These waves tend to be very deep, with long distance between the peaks. In deep water there may be no noticeable evidence of the tsunami at the surface. However, when the wave enters shallow waters, the energy is forced to the surface and produces a tall wave that travels at high speed and moves far inland. Seaside communities are usually ravaged twice—first, when the water crashes in from the sea and, second, when the water recedes and carries loose objects out to sea. Though tsunamis are not as common as earthquakes, they can cause much more damage.

Figure 9. The effect of a tsunami from March 11, 2011 Japan [13]

3.6. How earthquakes can induce a disasters chain

The formation of the disaster chain requires certain conditions and a certain correlation between the disasters. The disaster chains induced by an earthquake can cause great destruction and costing many lives so it's very important to analyze their patterns and spatial distribution in order to prevent possible disaster consequences. A model of such a chain of disasters assumes also the calculation of occurrence probabilities of all disasters which could appear.

A possible disasters chain is presented in Figure 10.

According with scheme presented in Figure 10, total effects F, can be computed applying the following expression

$$F = f(s_i, x_i) + f(s_i, r_i) + f(x_i, y_i) + f(s_i, x_i, r_i) + f(s_i, x_i, y_i) + f(s_i, y_i, r_i) + f(s_i, r_i, y_i) \quad (1)$$

where, *Initial cause = $f(s_i)$; Direct effect on natural environment = $f(s_i, x_i,)$; Direct effect on built environment $f(s_i,r_i)$; Secondary effects = $f(x_i, y_i)$; Effect 1 = $f(s_i, x_i, r_i)$; Effect 2 = $f(s_i, x_i, y_i)$; Effect 3 = $f(x_i, y_i, r_i)$; Effect 4 = $f(s_i, r_i, y_i)$; s_i – seismic movement; x_i – slope gradient, lithology, elevation; r_i – seismic response of the buildings, bridges, etc.; y_i – existing a flood prediction or warning system for fire*

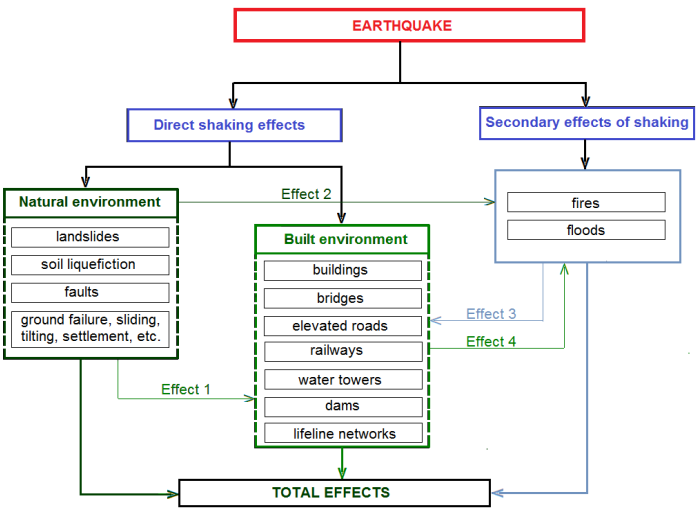

Figure10. A possible disasters chain, with a conditional probabilities analysis

4. CONCLUSIONS

Buildings aren't the only things to fail under the stresses of seismic waves. Often unstable regions of hillsides or mountains fail. In addition to the obvious hazard posed by large landslides, even non-lethal slides can cause problems when they block highways they can be inconvenient or cause problems for emergency and rescue operations. There are maps for seismic risk, for landslide features which delineate potential slope-stability problem areas, in condition of earthquake incidence or not, all these would be important for a common disaster preparedness plan. Knowing more about the direct or indirect effects of earthquakes helps us to understand the mitigation steps that must be taken to protect a community from a seismic event.

The presented images in this study show the effects on the built environment as a result of the occurrence of earthquakes and they can be found in the civil engineering university programs, although most of them are taken from other earthquakes produced in recent decades.

Based on this study can draw lessons and adapted for Vrancea earthquake characteristics and then can be entered into the university curricula as design examples of works from civil engineering and built environmental protection field.

To remember is that if a future Vrancea earthquake, the data should be collected in a short time because they can lose over time by intervention to restore the environmental equilibrium.

Taking into account that the seismic events occur at intervals of a few decades, we can not afford to lose all the seismic data that can be used after in the research and design field, as well as educational material in the university.

REFERENCES

1. http://world-housing.net/uploads/100907_064_22.jpg
2. http://pubs.usgs.gov/dds/dds-29/web_pages/sf.html
3. http://cse.ssl.berkeley.edu/img/earthquakes/Railroad.gif
4. http://crack.seismo.unr.edu/ftp/pub/louie/class/100/effects-kobe.html
5. http://earthquake.usgs.gov
6. http://en.wikipedia.org/wiki/2001_El_Salvador_earthquakes
7. http://earthquake.usgs.gov/earthquakes/states/events/1964_03_28_pics.php
8. http://en.wikipedia.org/wiki/File:Liquefaction_at_Niigata.JPG
9. http://www.oregonlive.com/environment/index.ssf/2011/12/despite_an_unusual_run_of_gian.html
10. http://www.geerassociation.org/GEER_Post%20EQ%20Reports/Bhuj_2001/ReconFlight.html
11. http://www.ndmindia.nic.in/School%20Safety%20Draft_Series1.0.pdf
12. http://crack.seismo.unr.edu/ftp/pub/louie/class/100/effects-kobe.html
13. http://www.allvoices.com/contributed-news/8445028/image/74979871-japan-tsunami-2011-exclusive-photos
14. http://training.fema.gov/emiweb/is/IS8A/pdf/is8a-unit4.pdf

POST CLOSURE MONITORING OF ENVIRONMENTAL WORKS CONDUCTED IN VADU PASII AREA, BUZAU COUNTY

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Abstract
In terms of physico – geographical conditions Vadu Pasii area is located in the lower basin of the Buzau River, crossing the northern Buzau Plains. Morphologically, it is located in the minor riverbed of Buzau River and it is included in the Site of Community Importance ROSCI 0103 Lunca Buzaului. Ecological works were completed in 2009 and had, among many others, the purpose of protecting the wild flora and fauna of the Natura 2000 protected area Lunca Buzaului. According to the structure of the scientific work, in 2011 land works have been started off, along with a monitoring program, spread out over four seasons, designed with the purpose of monitoring and evaluating the conservation status of the species and habitats for which the Lunca Buzaului Natura 2000 site has been designated , together with other species and habitats installed here after the rehabilitation works came to an end. This paper is barely a part of a more ample research program focused on the impact of mining exploitations in the Vadu Pasii area, identifying pollution sources and studying the way revegetation works are being made in pasture's case, respectively the aquifer basin planning work.

Keywords*: sustainable development, exploitations works, ecological restoration, monitoring.*

INTRODUCTION

The best known definition of sustainable development is certainly the one given by the world commission on environment and development (WCED) in its report "Our common future", also known as the Brundtland Report (1987): "sustainable development is development that aims to satisfy present needs without compromising the ability of future generations to satisfy their own needs ".
Sustainable development aims and tries to find a stable theoretical framework for decision making in any situation concerning a man – environment report type, whether it is the natural environment, the economic environment or the social environment.
Thus, the goal of this study is to serve as "a solution to the ecological crisis caused by intense industrial exploitation of resources and continuous environmental degradation."
The main idea of this study suggests the following: mining activities are to be carried out as far as possible within strong anthropized areas (areas where mining objectives were abandoned without executing environmental remediation works, in areas where vegetation has been degraded by overgrazing, or areas where arboreal vegetation was grubbed etc.) and the achievement of efficient ecological restoration programs at the end of mining works, and also during their operation, consisting of certain flora species plantings in the area where the mine is located, which may become a suitable ecosystem for animal species to inhabit.
This material shows how a mining objective can be done (a gravel pit) in a strong anthropized area, and subsequent operational period, the way in which this mining objective is closed and transformed into a favourable ecosystem for wildlife species development, characteristic for areas protected by the European legislation, in this case the Site of Community Importance "ROSCI 0103 Lunca Buzaului".
During the first step, for the study to prove successful, it was necessary to analyze several types of gravel pits in order to identify that specific type of pit which best substantiates the basic ideas on which this study was built on.
Therefore, a mining objective has been identified (gravel pit) in a strong anthropized area, within a protected area. Taking into account that from the mining operations will result aquatic basins, it is possible, since the

actual work period, to create an ecosystem that can lay the foundation upon which various animal species, characteristic for the protected area above, to develop.
The holder of the mining objective analysed in this material is S.C. LAFARGE AGREGATE BETOANE S.A., which in the last two years has run an ample biodiversity monitoring program in cooperation with the University of Agronomic Sciences and Veterinary Medicine of Bucharest, students of it and consulting companies, outside of Vadu Pasii village, Buzau County.
It was found that the operator of the gravel pit carries on ecological works annually in areas where resources (sand and gravel) are exhausted, consisting of water basins slope geometrization, soil covering of emersed areas and sowing them, planting of reed curtains, namely arboreal species characteristic to protected area "ROSCI010 Lunca Buzaului".
The second stage of the study was represented by the monitoring program, conducted in order to observe and identify the species of migratory birds that arrived on the lakes resulted from mining operations, and other site-specific fauna species characteristic to the Site of Community Importance "ROSCI010 Lunca Buzaului".
The observation zone has a total area of approx. 100 ha, of which, at present, only 22 ha are affected by mining works, the remaining area being part of an active exploitation license. On the other hand, the monitoring work has been carried out in areas of the minor riverbed of the Buzau River, respectively on a distance of approx. 3 km downstream of the railway bridge Vadu Pasii.
In the Site of Community Importance "ROSCI010 Lunca Buzaului" are ongoing monitoring programs for flora and fauna species, a program initiated by the Ecological University of Bucharest (designated custodian of the site), with the aim of developing the site management plan.

MATERIALS AND METHODS

In the monitoring work there was initially consulted the existing bibliography, was made desk research consisting of analyzing information collected from documents (data on the last condition, current location) and consultation with local stakeholders. The information on the characteristics of ecosystems, landscape and environmental factors specific to the region and the characteristics of the local community were taken during field trips.
For population evaluation of the species were used both qualitative and quantitative methods.
For bird species was used their freely observation and optical instruments binoculars 10 x 50. The main goal of this method was to identify species on the surface and in the vicinity of the exploitation beaches.
The cartographic method consisted in identifying plant associations and territories of birds nesting in the area under study. The method uses estimated results in surface sampling to calculate density populations in larger areas or certain types of habitats of a region. In this study were used the counting techniques of the method.
For some species, "standard" methods of reviewing the nesting populations, and cartographic methods did not provide sufficient information. For this particular cases, it has been used a method that consists in direct bird counting, followed by noting on an observation sheet the species and the number of individuals identified.

RESULTS AND DISCUSSIONS

The physico-geographical characteristics of the area are: Relief. Vadu Pasii commune is located at the North West of Râmnic Plains, also occupying Buzau Valley with its terraces and meadows on the left, at the contact between the glacis and Râmnic Plains (Romanian Geography, 1972 -1979).
Underground resources. The commune's basement has natural gas and the Buzau River's and the Calnau River's bed offer aggregates - sand and gravel (Mutihac V., L. Ionesi 1974).
The vegetation is specific to the steppic region. On the slopes of the valleys and on parts of the meadow we meet the following species: Blackthorn, Dog Rose, Fescue, Couch Grass and Wormwood. The meadow vegetation includes grasslands that consist of different species of Graminaceae and clumps composed of Willow, Wicker, Alder and Poplar. Besides

these, in wetter places, we meet Sedge species, Bulrush and Reed. (Calinescu R. 1969).

The fauna. Animals are characteristic for steppes and silvosteppes, represented primarily by mammal rodents. Birds found in the area are: Quail, Partridge, Skylark. In Buzau River we meet endangered species of fish, due to irrational fishing and water pollution (Calinescu R. 1969).

The dominant soils in this area are medium leached chernozem. In Calnau and Buzau meadows are alluvial soils. (Ielenicz Michael, 2007)

Climate. The commune is part of the temperate - continental climate with influence of the Eurasian steppes. The average annual temperature is 10.6 º C, with annual rainfall of 522.8 mm. Summers and winters are relatively long and springs and autumns are short. In most of the summer humidity is negative. Absolute minimum was recorded in January 1942 (-29 º C) and the absolute maximum in august 1951 (39.6 º C). (Ielenicz Michael, 2007).

Data on objective recognition: Vadu Pasii exploitation perimeter is located in the extravillan of Vadu Pasii village, Buzau County, and in terms of physico – geographical conditions, the area is located on the lower course of the river Buzau, in a floodplain terrace on the left bank of the valley, crossing the Northern area of Buzau Plain. In this sector the minor riverbed has a width between 50 and 250 m, and in the major riverbed the river created meanders with large radius of curvature, which affects lower terrace banks. Absolute altitudes of minor riverbed are between 74.0 m and 75.0 m, and in the lower terrace of the left bank, between 78.0 and 82.0 m. In the left bank at approx. 600 m, is the upper terrace (inter-field), with altitudes of up to 105.0 m.

The operator is currently running mining works in a strong anthropized area. Most spontaneous vegetation in the area was severely degraded by overgrazing.

Since taking over the site, SC LAFARGE AGREGATE BETOANE S.A. conducted a series of environmental rehabilitation works on an area of 22 hectares, consisting of filling excavation, with irregular distribution, made in previous years. After this step, the surfaces were cover with soil horizon and then grassed and fertilized. This area received an agricultural use, respectively pasture.

In the water basins area were conducted works of slope geometrization, so they should be stable for a long term, planting reed curtains, to set up a habitat for the development of site-specific fauna species of "ROSCI010 Lunca Buzaului". These curtains also act to protect basin banks against erosion processes exerted by waves of 50 cm.

In order to achieve some habitat types characteristic for the area, and suitable for fauna development, the operator intends to perform ecological works, consisting of planting tree species such as: *Populus alba, Fraxinus excelsior, Salix alba, Alnus glutinosa*.

Monitoring of fauna and flora within the perimeter Vadu Pasii:

Monitoring works were conducted during four seasons in the gravel pit from Vadu Pasii in order to observe and identify migratory bird species in the lakes resulted from mining, and related areas of Buzau riverbed of away approx. 3 km downstream of the railway bridge Vadu Pasii. A large surface area of observation was chosen to determine an approximate existing population of *Spermophilus citellus*. To determine the species observed which could not be recognized and identified in the field, we turned to specialized literature, the Biodiversity Management Plan (BMP) and documentation held by the operator of gravel pit for the Vadu Pasii. Following the field trips were identified following types of habitats:

Figure no. 1 - Mesotrophic lakes and ponds with emersed vegetation of *Typha sp* (Rush). and *Phragmites communis* (Reed), and abundant submersed vegetation of *Myriophyllum sp*. (Water milfoil);

Figure no. 2 - Sand and ballast beaches with hygrophile vegetation of *Carex sp*. (Sedge);

Figure no. 3 - Mixed dense thickets with *Eleagnos angustifolia* (Russian olive) and *Tamarix ramosissima* (Saltcedar)

Figure no. 4 - Bush vegetation developed on the island created by the deposition of sediments from the railway bridge base, consisting of species of *Hippophae rhamnoides* and *Salix sp*., supplemented by various species of herbaceous plants.

Figure no. 5 - Steppic meadows with *Cynodon dactylon* (Devil's grass), *Onopordum acanthium* (Cotton thistle) and *Poa sp.* (Meadow-grass);

Figure no. 6 - Degraded lands due to uncontrolled and illegal disposal of waste, with poor vegetation, herbaceous.

Species identified: Of the plant species found, *Elaeagnus angustifolia* and *Tamarix ramosissima* are invasive. Among shrubs, the species with the highest abundance is *Crataeugus monogyna*. Less numerous are *Salix sp*. and *Hippophae rhamnoides*. Grasslands are populated by *Carduus nutans*, *Verbascum sp., Taraxacum officinale, Poa sp., Cynodon dactylon* and *Botriochloa ischaemum*. Vegetation is dominated by *Typha sp*. and *Phragmites australis* and the submersible by *Littorelletea uniflorae.*

Figure no. 7 – Plant species identified

Of fauna species identified (total 23), most are birds, which was the reason for the field visits: observation and identification of species of migratory birds that arrived on the lake resulted from operations and on the portion of river which crosses the territory held by the operator.

Figure no. 8 – Fauna species identified

So, a number of 36 individuals belonging to *Cygnus olor* were counted, including 4 juveniles and 53 to *Fulica atra*, of which only two juveniles. In the damaged area and immediately downstream of the tubes bridge were observed more specimens of *Galerida cristata* (total 4). Also, there were a lot of holes in the banks of the lake, made by birds (*Riparia riparia* and *Hirundo rustica*). Downstream of the tubes bridge over the Buzau River representing the technological road of the analyzed area was found an individual of the species *Ardea cinerea*, one of the *Ardea alba* and a covey of over 30 birds - *Columba livia* and a group of Black-headed Gulls - *Chroicocephalus ridibundus*. (12 individuals). Also common species are present such as *Pica pica*, *Corvus frugilegus*, *Passer domesticus*, *Parus sp.*, *Columba livia*, *Streptopelia decaocto*.

From discussions with fishermen encounter were obtained evidence that on the lake are other birds but they could not be observed on field visits, such as *Limosa limosa* and *Alcedo atthis*. Also, fishermen said they saw numerous individuals of Dice snake (*Natrix tessellata*) and European pond turtle - *Emys orbicularis*. There were a lot of holes observed specific to sand lizard (*Lacerta agilis*) scattered throughout the area. Among amphibians, *Rana sp.* is present both on the main lake and in ponds and small mesh, and *Bufo viridis* occupies especially holes dug in the bottom of the lake shore - marked on the map in green (there were at least 10 individuals encounters, both in the water, on shore, in their holes and hidden through the vegetation with *(Typha sp.)*.

Figure no. 9 – Holes in the bottom of the lake shore - marked on the map in green and Bufo viridis.

As for mammals, going upstream from the lake, on the meadow were identified Ground squirrel holes especially on the road. Locals also confirms that on downstream meadow, stretching on the left bank of Buzau river are many gopher - *Spermophilus citellus* - and can be seen most often near the dam that borders the water canal.

Figure no. 10 - Ground squirrel holes

CONCLUSIONS

A total of 6 types of ecosystems have been identified and mapped, all common. Of the species identified (37): - *Spermophilus citellus* is present in the standard form as mammal species listed in Annex II of Council Directive 92/43/EEC; - *Emys orbicularis* is listed in Annex II of Council Directive 92/43/EEC; - *Salix sp., Verbascum sp., Hippophae rhamnoides, Lacerta agilis* and *Natrix tessellata* are listed in the standard form of the site ROSCI0103 Lunca Buzaului under "Other important species of flora and fauna".- *Elaeagnus angustifolia* and *Tamarix ramosissima* are invasive species; - The remaining species are classified as "least concern" on the Red List of endangered species IUCN (International Union for Conservation of Nature).

Regarding the invasive species forming thickets and tall shrubs, it is considered that an effective and inexpensive method of controlling and limiting their spread is the encouraging of locals to exploit them as a source of wood for household heating. Also, according to the locals, hares and foxes have sheltered here, probably because it is a relatively isolated area, as the dense and thorny vegetation acts as a natural barrier.

Moreover, given the invasive potential of the Ground squirrel species, the existing fox population would act as a controling factor and prevent their possible overpopulation. During field visits no fox specimen has been met and the large number of Ground squirrel holes could not allow an effective assessment of population. Therefore, a campaign to collect this data is considered to be very useful for completing the biodiversity management plan for the area.Through the grazing activity of the sheep and goats herds of the locals (from which there are complains about the meadows being barely enough to satisfy the feeding needs of the livestock), the existing ecosystems remain to a certain steady state. However, in the present state (not enough pasture to support the relatively large number of animals) overgrazing is a potential threat to the integrity of the ecosystem.

It is also recommended to keep the lake banks in their current form so that they will allow the population of Emys orbicularis to further develop and consolidate the existing population.

Given the results of the monitoring program, it can be concluded that the mining activity can be done while still respecting the principles of sustainable development, namely industrial exploitation of mineral resources with low impact on the environment, therefore being an activity involving economic growth and quality environment protection.

ACKNOWLEDGEMENTS

This research work has been carried out with the support of S.C. LAFARGE AGREGATE BETOANE S.A.

REFERENCES

Calinescu R. (1969) - Romanias Biogeography, Scientific and Encyclopedic Publishing House, Bucharest.

Interpretation manual of Natura 2000 habitats in Romania, 2008 Gafta Dan & John Owen Mountford (Risoprint Cluj-Napoca).

Habitats from Romania, 2005 Doniţă Nicholas et al. (Editura Tehnică Silvică Bucuresti).

Popular Republic of Romania Flora, 1952, E.I. Nyarady et al. (Editura Academiei Republicii Populare România).

A manual of Ornithology, 1896, Winfrid A. Stearns (Printed at The Atlanta University Printing Office, Atlanta GA).

Irimus I.A. (2003) - Physical Geography of Romania, Book of Science Publishing House, Cluj-Napoca.

Mutihac V., Ionesi L. (1974) - Geology of Romania, Technical Publishing House Bucharest.

Advanced Technologies for monitoring and management of natural resources exploitation of highly vulnerable to natural disasters CEEX Tammer no. 754/2006.

IUCN Red List of threatened species (International Union for Conservation of Nature).

xxx (1983-1991) - Geography of Romania, Vol-IV, Romanian Academy Publishing House, Bucharest.

INFLUENCE OF CLIMATE AND VEGETATION ON STRUCTURES FOUNDED ON EXPANSIVE CLAYS

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Abstract

Shrinking and swelling behaviour of expansive clays in response to water content change is a worldwide problem. It is one of the most usually geotechnical behaviour that causes a lot of damages to buildings. Expansive soils have the property to modify their volume when moisture changes in relation with temperature, precipitation and vegetation. The paper aimed to determine the shrink-swell behaviour of three different types of expansive clays from Australia, UK and Romania related to the vertical ground movement.

Keywords*: climatic conditions, expansive clay, ground movement, vegetation.*

INTRODUCTION

Expansive soils causes serious problem on civil engineering structures due to its tendency of swelling when it is in contact with water and shrinks when they dry out. In rainy seasons this soils imbibe water and swell, and in droughty seasons on evaporation of water, they shrink. This alternate swelling and shrinkage causes distress in many civil engineering structures like buildings, farms, deposits, etc.
Expansive soils contain the clay mineral montmorillonite with claystones, shales, sedimentary and residual soils. The expansive nature of the clay is less near the ground surface where the profile is subjected to seasonal and environment changes (Agrawal&Gupta, 2011).
An aspect in studying expansive and shrinkable clays is the establishing of certain criteria for the recognition of the soils capable of producing the degradation from this point of view. It was found that besides the specific nature of the soils, there must be fulfilled several conditions related to the existence and action of certain external factors as: vegetation and climatic conditions (Antonescu, 1959).
Semi-arid climates promote desiccation, while humid climates promote wet soil properties. A semi-arid climate can be described as a climate that has periods of rainfall followed by periods of no rainfall.
Vegetation depletes moisture from soil through transpiration and cause accumulation of moisture areas denuded of vegetation.

MATERIALS AND METHODS

In order to analyze the influence of climate and vegetation on structures founded on expansive clays, we used a number of experimental studies from the professional literature. These studies were analyzed according to Romanian standard in force NP 126/2012.
The analyzed studies track the variation of vertical ground movement for three expansive soils from Australia, UK and Romania.
The study achieved in Newcastle (Australia) by Fityus, Smith and Allman, indicates the vertical ground movement in relation with climatic prescriptions based on minimum and maximum daily temperature and total monthly rainfall over a period of 7 years (from Winter of 1993 to Summer of 2000).
Driscoll, Crilly and Chown studied the vertical ground movement for a plot in Chattenden (UK), in relation with existing vegetation and after the trees felling over a period of 12 years (from 1988 to 2000).
In Romania, the ground movement was studied by Antonescu, for a plot in Baleni, in relation

with prescriptions of rainfall over a period of 9 months (from January to September of 1952).
In this study cases were located landmarks on the ground surface and at several depths from the ground surface: 0.5 m, 1.0 m, 1.5 m, 2.0 m, 2.5 m, 3.0 m and 4.0 m.

RESULTS AND DISCUSSIONS

The characteristics and specific properties of the soils represent essential factors in establishing the possibilities of soils to produce degradations. Soils with important swelling and shrinkage behaviour are formed of montmorillonite clays with a rich content of fine particles, under 2μm (more than 50%).
Antonescu (1959) studied the characteristics of the vegetal soil layer at the surface of the ground. This study showed that the dangerous zone for foundations is limited to horizons A and B of the soil, rich both in organic material (hummus) and in very fine particles (especially horizon B).
In expansive soil areas, the soils are generally stiff, and the change of lightly loaded structures cracking due to settlement is more common. However, there are many cases where heavy cracks have appeared in the basement walls that were not caused by foundation heaving but by earth pressure exerted on the wall, generally compounded by seepage pressure. Diagonal cracks that develop below windows and above doors are a strong indication of swelling movement (Chen, 1975).
The most obvious identifications of damage to buildings are doors and windows that get jammed, uneven floors, cracked foundations, floors, masonry walls and ceilings. Moreover, different crack patterns mean different causes for different foundation materials. Oftentimes, cracks due to shrinkage and expansive clay usually run from corner towards adjacent opening and are uniform in width or v-shaped, wider at the top than the foundation wall (Lucian, 2008).
The weight of the structure has a significant impact in suppressing or levelling out the differential ground profile which result from the moisture changes in the soil alone. Swelling movements are often largely suppressed because the wet swelling soil has a relatively low stiffness. Cases of damage due to cyclic movements appear to be less common than those due to either swelling or shrinkage although there are some reports of extensive damage, such as roadway and ground movement due to seasonal climate changes, and severe cracks because of swelling during rainy periods and shrinkage during dry periods. Climatic conditions, wet seasons followed by warm and dry seasons are most favourable to cyclic movements. Foundation movements for different structures founded on expansive soils are reflected as cracks (Mansour, 2011).

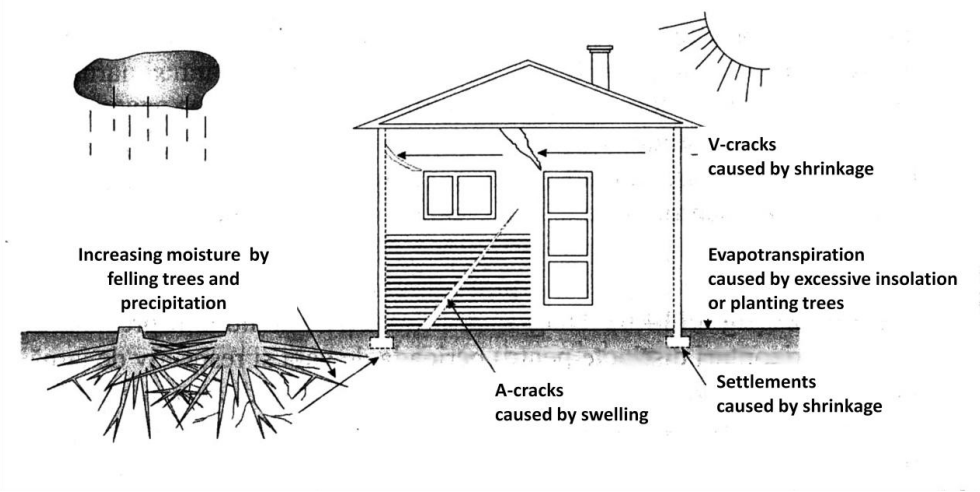

Figure 1. Effects of vegetation and insolation on buildings (NP 126 quoted by Ivasuc, 2012)

Andrei (1967) showed that the climate conditions from our country produce swelling and shrinkage to depths of 2 – 2.5 m. Because of this, are affected rural buildings; these buildings are founded at small depths of 1 -1.5 m and they transmit low pressures to foundation soil.

DAMAGE CAUSED BY VEGETATION

A common feature shared by homeowners in general is to plant trees and shrubs close to the foundation. Due to the highly expansive nature of the soil, the trees and shrubs have significantly affected the soil conditions around and under some houses resulting into differential swell of foundation and structural distress in a form of wall cracking, windows/door sticking and slab cracking (Lucian, 2008).

The vegetation existent in the zones with damaged constructions constitutes an important factor contributed to the releasing the damages; the most perceptible influence is that of evergreen shrubs which by abundant transpiration dries the soil and produces cracks. Around the trees which are planted close to the buildings water is absorbed; in general poplars, elms and oaks absorb the greatest quantities of water.

Damage to foundation in expansive soils commonly results from tree growth. This occurs in two principal ways – physical disturbance of the ground and shrinkage of the ground by removal of water. Physical disturbance of the ground caused by root growth is often seen as damage to pavements and broken walls. Vegetation induced changes to water profiles can also have a significant impact on other underground feature, including utilities – pipes (Jones&Jefferson, 2011).

Expansive soils problems typically occur due to water content changes in the upper few metres (2 – 5 m; the depth of the active zone could have important variation in correlation with climate conditions), with deep seated heave being rare. The water content in these upper layers is significantly influenced by climatic and environmental factors and is generally termed the zone of seasonal fluctuations or active zone as shown in Figure 2 (Nelson&Miller, 1992).

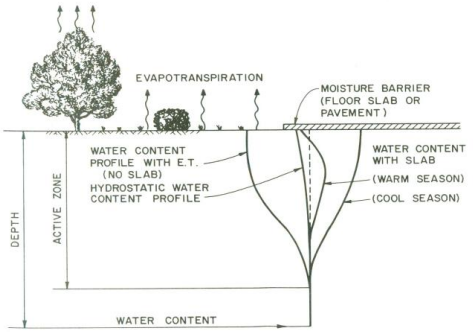

Figure 2. Water content profiles in the active zone (Nelson&Miller, 1992)

Tree roots will grow in the direction of least resistance and where they have the best access to water, air and nutrients. Trees will tend to maintain a compact root system. Paving of previously open areas of land, such as building of patios and driveways, can cause major disruption to the soil water system. If the paving cuts off infiltration, many trees will send their roots deeper into the ground or further from the trunk in order to source water. The movement of these tree roots will cause disturbance of the ground and will lead to the removal of water from a larger area around the tree. Problems occur when houses are situated within the zone of influence of a tree such in Figure 3 (Jones&Jefferson, 2011).

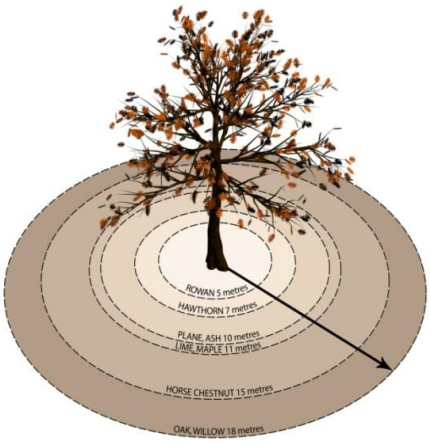

Figure 3. The zone of influence of some common UK trees (Jones&Jefferson, 2011)

Crilly and Driscoll (2000) and Driscoll and Chown (2001), based on an experimental study in Chattenden - UK, showed that ground movements are produced due seasonal fluctuation and vegetation (Figure 4).

If vegetation is involved, it produces a characteristic seasonal pattern of foundation movement: subsidence in the summer reaching a maximum usually in September, followed by upward recovery in the winter.

If it is occurring, there is no need to try to demonstrate shrinkable clay or desiccation as no other case produces a similar pattern – soil drying by vegetation must be involved (unless the foundations are less than 300 mm).

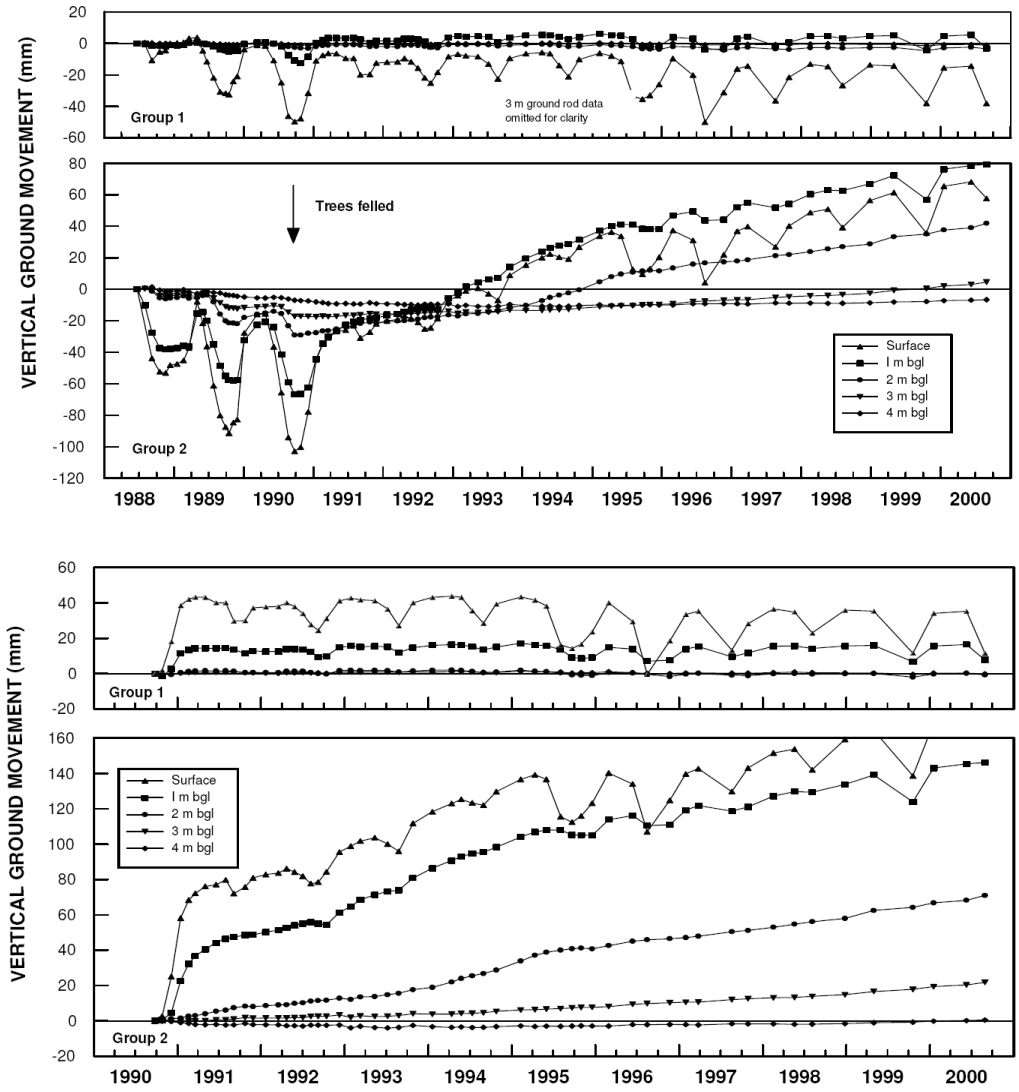

Figure 4. Examples of ground movements due seasonal fluctuation, Chattenden – UK. The upper plot shows results obtained since the first movements in June 1988. The lower plot shows an enlarged scale with results obtained since the trees were felled. Group 1 is remote from tree and group 2 near the trees (Crilly&Driscoll, 2000; Driscoll&Chown, 2001)

DAMAGE CAUSED BY CLIMATIC CONDITIONS

Important swellings and shrinkages are produced when the soil is submitted to an important moisture variation all over the year. The seasonal moisture variation decreases with the depth.

Antonescu (1959) showed that the maximum moisture range is about 20% at 0.4 m, 10% at 1.2 m and decreases under 5% from 1.8 m below.

Changing water content may be due to seasonal variation (often related to rainfall and the evapo-transpiration of vegetation), or brought about by local site changes such as leakage from water supply pipes or drains, changes to surface drainage and landscaping or following the planting, removal or severe pruning of trees or hedges, as man is unable to supply water to desiccated soil as efficiently as a tree extracted it through its root system. During a long dry period or drought a persistent water deficit may develop, causing the soil to dry out to a greater depth than normal, leading to long-term subsidence. This is why expansive problems are often found in arid and semi-arid environments (Jones&Jefferson, 2011).

In Romania, the depth to which the contraction cracks are developed is 1.5 – 2.0 m; and the climate is rather dry with precipitations of 500 – 700 mm/year, with mild winters and hot summers. Damages are reduced during the years with rainy summers.

Fityus, Smith and Allman (2004), based on an experimental study in Newcastle (Australia), showed important aspects of expansive soils sites including the magnitude and variability of changes in water content (produced by temperature and rainfall) and ground movement, at various depths (Figure 5).

A full assessment of climatic effects including rainfall, drainage, temperature and evapo-transpiration is beyond the scope of the experimental study made in Newcastle.

In Romania, Antonescu (1959) studied the ground movement behaviour in relation with precipitation (Figure 6). In this study were located landmarks at 0.5 m, 1.0 m, 1.5 m, 2.0 m and 2.5 m from the ground surface. Study was carried out from January to September; were recorded variations of vertical displacement for each depth and for each landmark.

It was noticed that ground movements decreases with depth, below 2.5 m are no longer significant displacement registered.

The influence of vertical ground movements related to precipitation receives a personal interpretation based on studies performed by Antonescu (1959), and it was materialized on diagrams in figure 6.

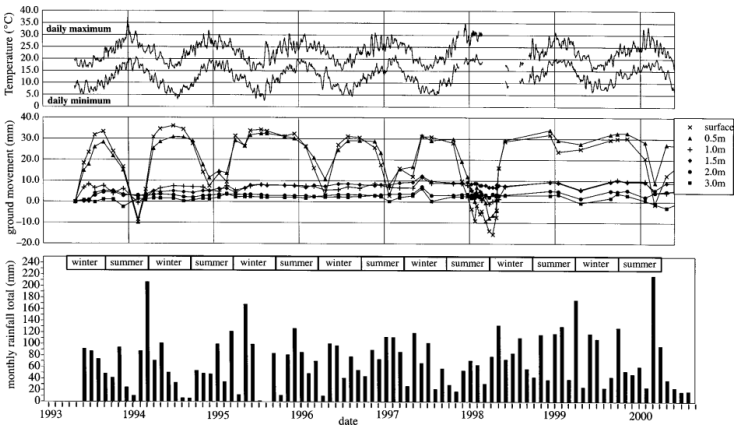

Figure 5. Comparison of local daily temperature, rainfall and ground movement at Newcastle field site (Fityus, Smith&Allman, 2004)

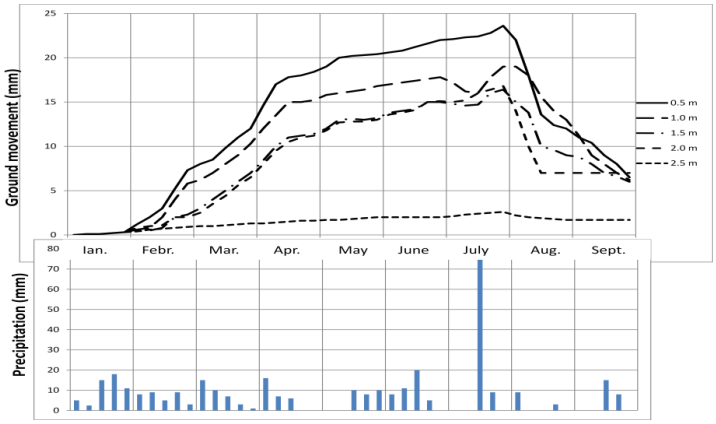

Figure 6. Ground movement in relation with precipitation at Baleni field site (personal interpretation after Antonescu, 1959)

CONCLUSIONS

Vertical soil movement is a function of soil depth, soil water content, rainfall, insolation and vegetation.

Rainfall appears to have an effect on short-term ground movement.

Many structural damages originate from insufficient foundation started by the swelling soils.

The slight, moderate and severe categories of damages are based on crack size and pattern.

Expansive soils are one of the most significant ground related hazards found globally.

REFERENCES

Agrawal V., Gupta M., 2011. Expansive soils stabilization using marble dust. International Journal of Earth Sciences and Engineering, 06, Vol. 4, 59-62.

Andrei S., 1967. Apa in pamanturile nesaturate. Editura Tehnica, Bucuresti.

Antonescu I.P., 1959. Contributii la studiul pamanturilor argiloase, cu umflari si contractii mari. Institutul de Studii si Cercetari Hidrotehnice, Bucuresti.

Chen F.H., 1975. Foundation on expansive soils. Elsevier Scientific Publishing Co., New York.

Crilly M.S., Driscoll R.M.C., 2000. The behaviour of lightly loaded piles in swelling ground and implications for their design. Proceedings of the Institution of Civil Engineers: Geotechnical Engineering, 143, 3-16.

Driscoll R.M.C., Chown R., 2001. Shrinking and swelling of clays. Problematic soils symposium, Nottingham, 53-66.

Fityus S.G., Smith D.W., Allman M.A., 2004. Expansive soil test site near Newcastle. Journal of Geotechnical and Geo-environmental Engineering, 686-695.

Ivasuc Tatiana, 2012. Identificarea terenurilor dificile de fundare. Raport de cercetare nr. 1, Bucuresti

Ivasuc Tatiana, Manea Sanda, Olinic E., 2012. Studii de laborator privind imbunatatirea pamanturilor argiloase. A XII-a Conferinta Nationala de Geotehnica si Fundatii, Vol. 1, Ed. Politehnium, Iasi, 107-117.

Ivasuc Tatiana, 2012. Seawater influence on the behaviour of the expansive clays. Land Reclamation, Earth Observation&Surveying, Environmental Engineering - Scientific papers, Series E, Vol. 1, Bucharest, 105-108.

Jones L., Jefferson I., 2011. Manual series. C5 – Expansive soils. Institution of Civil Engineering, London.

Lucian C., 2008. Doctoral thesis – Geotechnical Aspects of buildings on expansive soils in Kibaha, Tanzania. Stockholm.

Mansour E., 2011. Master of science in civil engineering thesis – Swell pressures and retaining wall design in expansive soils. Ohio

Nelson J.D., Miller D.J., 1992. Expansive soils: Problem and practice in foundation and pavement engineering. John Wiley and Sons Inc., New York.

Siminea Ioana, 1986. Teza de doctorat – Contributii la studiul starii si comportarii maselor de pamant. Institutul de Constructii. Bucuresti.

Siminea Ioana, 2006. Geotehnica si fundatii. Ed. Bren, Bucuresti

*** NP 126/2012 – Normativ privind fundarea constructiilor pe pamanturi cu umflari si contractii mari. Bucuresti

EFFECT OF SELENIUM AND MOLYBDENUM CONTENT IN RHIZOBOXES ON ELEMENT UPTAKE OF MAIZE AND SUNFLOWER

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Abstract

Selenium and molybdenum are essential trace elements.
Considering the characteristics of selenium and molybdenum, our research had the following purposes for both elements:
Considering Se the uptake of selenium was investigatein maize and sunflower seedling, moreover the different effect of two selenium species (selenite and selenite) for the examined plants (a monocotyledon (maize, Zea mays L.) and a dicotyledon (sunflower, Helianthus annuus L.)).
Considering Mo on the one sidedue to increasing level of molybdenum treatment, the concentrations of changes of Mo was investigated in maize and sunflower seedlings. On the other sidewe thought it is important to follow the concentration of this element because it plays prior role in nitrate reduction and operation of nitrate reductase. So we would have liked to prove in laboratory circumstances that there is a close relation between molybdenum supply and nitrate reduction: nitrate content of plants can be reduced by supporting their physiological molybdenum demand.
In our experiments for selenite 0 (control), 1, 10 and 100 mg kg^{-1} selenium concentrations, forselenate0, 0.1, 1 and 10 mg kg^{-1} selenium concentrations, while for molybdenum doses 0, 30, 90, 270 mg kg^{-1} were applied.
According to our results it is obvious that concentration of selenium and molybdenum in seedlings significantly was increased due to selenium or molybdenum treatments. Examining roots and shoots of experimental plants separately we found higher selenium and molybdenum content in roots than in shoots. It indicates more intensive selenium and molybdenum uptake (selenium and molybdenum mobility) and high molybdenum content shows nitrate accumulation of shoots under the given experimental circumstances.

Keywords: *maize, molybdenum, rhizobox, selenium, selenite, selenate, sunflower.*

INTRODUCTION

Selenium (Se) is an essential micro-nutrient, particularly in an animal and a human body. Se is a vital component of antioxidant system of organism. Deficiency of selenium is connected with emergence of many diseases among others the heart and vascular system one and the tumorous diseases. Its contradiction derives from above given concentration dangerous to plants and human too. In the periodical system, selenium has the narrowest tolerance concentration range that is essential and toxic contents are close to one another.

Selenium content of a plant is determined by the species of the plant, it‘s developmental state, selenium supply of soil and the type of selenium species (Lteif et al., 2005). A plant can uptake only the biology available element species from the environment (Chengyi et al., 2005). Selenium bonded to the organic part of the soil is not mobile and this selenium is available to a few indicator plants only. These plants are Se-transformers, which are excellent Se-source for the others plants after their wither (Kádár, 1998). The average content of selenium in plants is 0.01-2 μg kg^{-1} (Kovács et al., 1998). The inorganic selenium is transformed into organically bonded selenium by plants, hence it becomes uptakeable selenium for a human body (Bankhofer, 1994). The selenium content is the largest in the roots generally and smaller

in a young root, in a leaf, in a stalk and the smallest in a grain, which is a special filtering system in a plant (Kádár, 1995).

Certain plants are capable to rich selenium content in their organism, these plants are named as accumulators (Robb and Pierpoint, 1983). The vast majority of plants are not Se-accumulator, but those are Se-sensitive (Terry et al., 2000).

Molybdenum (Mo) as an essential trace element has an important role in nitrogen metabolism.

Comparing the amounts of microelements occurring in soil we can state that molybdenum is in small quantities in soils, however, it is enough for most of cultivated plants (Zimmer and Mendel, 1999). Average molybdenum content of soils is 0.25-5 mg kg^{-1} (Schulte, 2004). In soils molybdenum occurs in minerals and bound to iron and aluminum hydroxides (Fontes and Coelho, 2005).

Under pH 6 soils bind molybdenum rather strongly, therefore in acidic soils molybdenum deficiency can occur easily (Aubert and Pinta, 1977). Molybdenum uptake from basic soils is much more considerable due to the fact that its solubility in contrast to most of the microelements is more increased in basic conditions, so exchange of molybdenate ions of sorption complexes with hydroxide ions of soil solution is probably more intense. Availability of molybdenum can be improved most by raising of hydroxide ion content of soil solution (Berger and Pratt, 1965).

Plants are much more sensitive to molybdenum deficiency than to excess. In case of insufficient molybdenum supply sugar content and intensity of photosynthesis decrease, biosynthesis of ascorbic acid is restrained, therefore eg. C-vitamin content of leaves may decrease to the quarter of normal level (Wang et al., 1999). Growth of these plants slows down, leaves turn pale, although blooming is disturbed. Signs of deficiency appear mostly on central and older leaves. Color of leaves is yellowish, leaf margins may be twirled and chlorosis between leaf veins is frequent (Bambara and Ndakidemi, 2010; Zaijun et al., 2005; Schulte, 2004).

Molybdenum demand of different plants is not equal. Papilionaceous plants (soy bean, pea, bean, alfalfa) accumulate much more molybdenum than others and distribution of it is not constant in plant parts. According to Szalai (2006) there is much more molybdenum in seed than in vegetative organs. Higher molybdenum demand of papilionaceous plants is in connection with the presence of Rhizobium bacterium on their roots. These bacterium need molybdenum to fix nitrogen since the enzyme catalyzing this process called nitrogenase contains molybdenum ((Williams and da Silva, 2002; Gupta et al., 2011; Loch and Nosticzius, 1992).

Certain plants (eg. cauliflower, cabbage, spinach, lettuce and tomato) are especially sensitive to molybdenum deficiency thus they can be used as indicator plants (Katyal and Radhawa, 1983; Duval et al., 1991).

Appropriate molybdenum supply is necessary not only because of avoiding different deficiency symptoms but because the fact that molybdenum has a key function in nitrate reduction as the cofactor of nitrate reductase(Berks at al., 1995; Yaneva et al., 1996; Tunçeli and Türker, 2004). In lack of molybdenum nitrate reductaselooses its activity, nitrate reduction declines resulting in the accumulation of nitrate.

Molybdenum is essential for plants and animals as well. It is a component of several enzymes and enzyme systems contributing to appropriate operating of cells and growth (Reilly, 1991).

Our attention to the harmful effect of nitrate was drawn by the appearance of methaemoglobinaemia, what leads to anaemic disease or in worst case to death by suffocation of infants. In case of methaemoglobinaemia nitrate is reduced to nitrite in the ventricle. Nitrite transforms haemoglobin to methaemoglobin by oxidising central Fe^{2+} ion to Fe^{3+} making it unable for transporting oxygen. Methaemoglobin can be found at lower level (0.5-3.0%) also in blood of healthy people not causing any abnormal symptoms up to 10%, but over it cyanosis may occur and over 25% increasing pulse rate and short breathing can be observed (Knowles et al., 1989). Methaemoglobin concentration over 50% may cause death by suffocation. These present the importance of optimal operating of nitrate reductase, which demands optimal amount of molybdenum.

MATERIALS AND METHODS

A monocotyledon (maize, *Zea mays L. cv Norma SC*) and a dicotyledon (sunflower, *Helianthus annuus L. cv Arena PR*) were chosen for our research studying selenium and molybdenum moreover nitrogen speciesin its root and shoot parts,separately.

The concentration of selenium and molybdenum were analyzed in root and shoot, furthermore in soil samples. Beside molybdenum concentration,the change of NO_3-N, NO_2-N and NH_4-N concentration was also observed since the nitrate reduction processwas also examined in the rhizobox experiment applied different molybdenum levels.

Maize and sunflower plants were grown in the climate room of Institute of Crop Science, Department of Agricultural Botany and Crop Physiology where environmental conditions were regulated: 65-75% relative humidity (RH), 25/20 ºC temperature periodicity (day/night), 220 µE m^{-2} s^{-1} light intensity, 16 hours/8 hours light/dark period.

After disinfection seeds were germinated between moistened filter papers, stimulated geothropically at 22 ºC. Seedlings with 2-3 cm coleoptils were placed into rhizoboxes (Photos 1-2.).

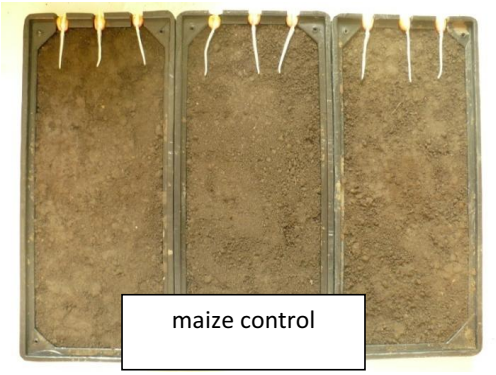

Photo 1: Maize seedlings grown in rhizobox (control)

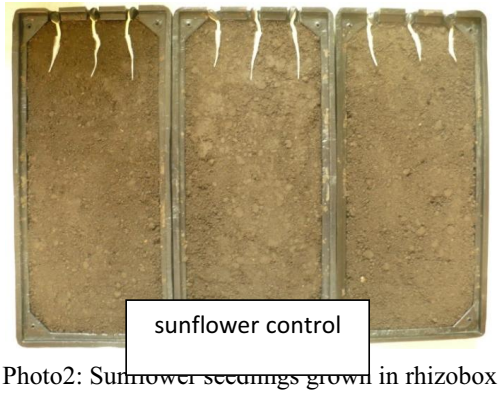

Photo2: Sunflower seedlings grown in rhizobox (control)

Experiments carried out in rhizoboxes:

Advantages of experiments carried out in rhizoboxes are that growing and daily growing rhythm of roots of maize can be followed up moreover also possible phytotoxic symptoms of roots resulting from increasing molybdenum dose can be seen.

Calcareous chernozemsoil type from Látókép Experimental Station of University of Debrecen was applied for our studies.

Composition of the applied soil can be seen in Table 1. Parameters correspond with the ones of soil used in experiment of Nagy et al. (2010), there was no NPK fertilization.

In our experiments in the case of selenite 1, 10 and 100 mg kg^{-1} selenium concentrations (Photos 3-4.), in the case of selenate 0.1, 1 and 10 mg kg^{-1} selenium concentrations were applied, furthermore there was also control (Ø) treatment. Molybdenum doses (Photos5-6.)were as follows: Ø (control), 30, 90, 270 mg kg^{-1}. Selenium was applied in the form of selenite ($Na_2SeO_3.5H_2O$) (Fluka, Buchs, Switzerland) and selenate (Na_2SeO_4) (Sigma-Aldrich, Steinheim, Germany) dissolved in ultrapure water. The applied molybdenum salt ($(NH_4)_6Mo_7O_{24}.4H_2O$) was dissolved in distilled water. The required concentrations were calculated for selenium and molybdenum. Each treatment was applied in three repetitions and in calcareous chernozem.

Table 1: Parameters of soil applied in the experiments carried out in rhizoboxes

Depth	0-0.3 m
pH (KCl)	5.71
pH (H_2O)	6.58
Soil texture category	loamy clay
Total water-soluble salt	0.015 %
$CaCO_3$	0.202 %
Humus	3.54 %
KCl-soluble NO_3-N+NO_2-N	8.04
AL-soluble P_2O_5	199 mg kg^{-1}
AL-soluble K_2O	451 mg kg^{-1}
AL-soluble Na	332 mg kg^{-1}
KCl-soluble Mg	176 mg kg^{-1}
KCl-soluble SO_4^{2-}-S	6.04 mg kg^{-1}
KCl-EDTA-soluble Cu	5.79 mg kg^{-1}
KCl-EDTA-soluble Zn	7.9 mg kg^{-1}
KCl-EDTA-soluble Mn	262 mg kg^{-1}

Before placing soil into the rhizoboxes, moistened filter paper was placed onto the bottom of boxes, thus steady water uptake of plants was ensured. After putting seedlings into the prepared soil, side plastic wall of rhizoboxes were covered by black foil. Plants were gheothropically stimulated so roots grew along the plastic wall of box making it possible to follow growing of roots.
Weight of rhizoboxes and length of roots were measured daily and also evaporated water was added each day.

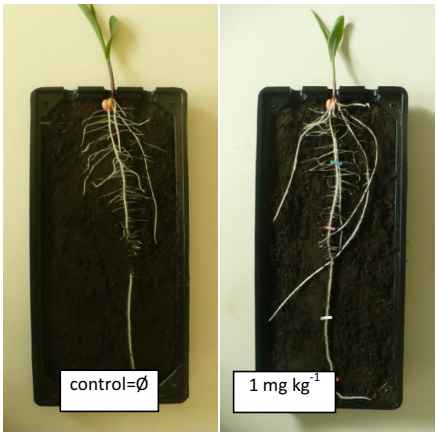

Photo 3.Maize in rhizoboxes, selenite treatments (control and1mg kg^{-1} selenium)

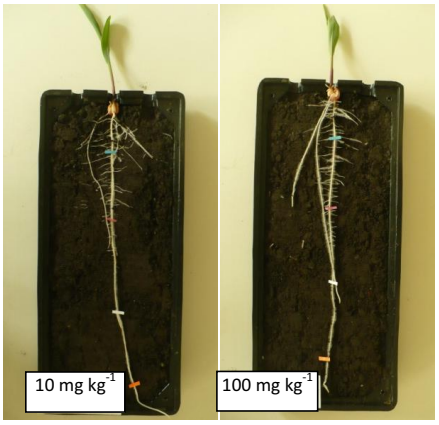

Photo 4.Maize in rhizoboxes, selenite treatments (10 and 100 mg kg^{-1} selenium)

Photo 5.Three replicates of the control Mo treatment, sunflower in rhizoboxes

Photo 6.Three replicates of the 90 mg kg^{-1} molybdenum treatment, sunflower in rhizoboxes

Finishing experiment plants grown in rhizobox were dried at 85 ºC to constant weight and weighed by analytical balance (OHAUS) after cooling them to room temperature.

After drying and homogenization samples were subjected to HNO_3-H_2O_2 wet digestion (Kovács et al., 1996). 1 g (±0.01 g) sample was measured. After adding 10 cm^3 cc. HNO_3 they were predigested for a night. Next day the samples were digested by LABOR MIM OE 718/A digestion instrument: 45 min at 60 ºC; then 90 min at 120 ºC (after addition of 3 cm^3 30% H_2O_2). After cooling they were filled up with deionized water to 50 cm^3, mixed by shaking and filtered through FILTRAK 388 type filter paper. Also blank experiment was done.

Concentrations of elements were determined by inductively coupled plasma optical emission spectrometry (ICP-OES) (Perkin Elmer OPTIMA 3300 DV) and inductively coupled plasma mass spectrometry (ICP-MS) (Thermo Elemental X7). Setting and measuring parameters correspond with the ones applied by Puskás-PresznerandKovács(2009).The interfering polyadducts were eliminated by the use of collisional cell technique (CCT) in kinetic energy discrimination (KED) mode (Szebeniet al., 2011). For selenium the 196.026 nm, while for molybdenum the 202.031 nm wavelengths in inductively coupled plasma optical emission spectrometerand two different selenium isotopes (^{78}Se and ^{80}Se) and three different molybdenum isotopes (^{95}Mo, ^{96}Mo and ^{98}Mo) were used in inductively coupled plasma mass spectrometer for analysis of selenium and molybdenum concentrations in plant and soil samples.

NO_3-N, NO_2-N and NH_4-N concentration of plant samples were determined by FIAstar 5000 Analyzator.

Statistical analysis:

Experimental data were evaluated by bivariate general linear model (GLM), which is a combination of analysis of variance and linear regression analysis. Statistical analysis was done by SPSS 13.0.

RESULTS AND DISCUSSIONS

Experiments with selenium:

The selenium concentrations of shoots and roots of maize and sunflower plants are shown in Tables 2-3., where the plants were grown in rhizoboxes and in different selenium levels of contaminated soil. The elongation of roots of applied plants cultivated in a rhizobox was retarded and the differentiation of the lateral roots was moderate also.

*Table 2.Se concentration (mg kg^{-1}) of maize and sunflower in rhizobox as a result of selenite treatment (***: 0.1% level of significance)*

	Se concentration			
Selenite	**Maize**		**Sunflower**	
Treatments	**Shoot (***)**	**Root (***)**	**Shoot (***)**	**Root (***)**
Ø	0.736±0.248	0.339±0.04	0.282±0.163	0.12±0.034
1	4.54±0.19	3.10±1.40	3.81±1.64	7.11±0.61
10	5.85±0.15	11.6±1.0	1.93±0.93	13.8±2.7
100	32.8±4.6	162±15	10.3±0.9	341±21

The higher the selenium level in the soil the higher the selenium concentration in a plant sample. The same selenate concentration caused much higher selenium content in a plant sample then the same selenite concentration produced.

*Table 3.Se concentration (mg kg^{-1}) of maize and sunflower in rhizobox as a result of selenate treatment (***: 0.1% level of significance)*

	Se concentration			
Selenate	**Maize**		**Sunflower**	
Treatments	**Shoot (***)**	**Root (***)**	**Shoot (***)**	**Root (***)**
Ø	0.736±0.249	0.339±0.04	0.282±0.163	0.120±0.034
0.1	13.1±1.6	3.9±0.1	13.9±2.0	8.47±0.37
1	213±43	42.7±5.7	209±39	33.6±3.0
10	570±50	837±163	213±46	258±62

The maize and the sunflower plants have taken up comparatively small quantity of selenium from the control soil, however the higher selenium treatments showed much higher selenium concentration both in the shoot and in the root also. It is established that the roots of the maize and the sunflower have taken up two times concentration of selenium then of the

shoots. It is assumed that the transport into the shoot was retarded.

In the case of phytoremediation of soil contaminated by selenium it is important to know what amount of selenium can be taken up by a plant from a contaminated soil, hence what duration is needed to eliminate the selenium contamination.

Table 4.shows the ratios between the selenium contents of shoots in the lowest (control) and in the largest treatments of maize and sunflower in the rhizoboxes (soil).

Table 4. Ratios and the selenium concentrations of selenite and selenate treatments in maize and sunflower

	monocotyledons (maize)	**dicotyledons (sunflower)**
selenite treatment:	45X (0.736 and 32.8 mg/kg)	41X (0.249 and 10.3 mg/kg)
selenate treatment:	775X (0.736 and 570 mg/kg)	859X (0.249 and 215 mg/kg)

The concentration values of plant shoots in parentheses are the selenium contents of the lowest, i.e. control (Ø) and the largest selenite (which is 100 mg/kg), and selenate (which is 10 mg/kg) treatments.
On the basis of Table 4.the largest selenite treatment (100 mg/kg selenium) caused approximately 40-50 times increment in selenium concentration, while the applied largest selenate treatment (what was only 10 mg/kg selenium) resulted approximately 800-900 times increment in selenium concentration of the shoot. This means, the selenium uptake applying selenate is much better approximately (200 times) greater than the uptake of selenite by a monocotyledon (eg. maize) or a dicotyledon (eg. sunflower).

Experiments with molybdenum:

In Figure 1. change of molybdenum concentration in shoots and roots of maize and sunflower seedlings depending on the molybdenum treatment is shown.

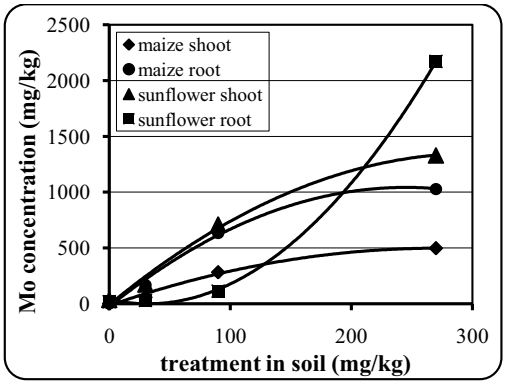

Figure 1: Molybdenum concentration of shoots and roots of maize and sunflower seedlings grown in rhizoboxes

Considering Figure 1.themaize and sunflower seedling took up small amount of molybdenum from control soil. Molybdenum concentration was low in shoot and root as well but owing to molybdenum treatments increase was observed. Kádár (1995) came to similar results during his microelement-load field experiment set on calcareous chernozem soil. According to his result load caused extremely high molybdenum accumulation in maize and sunflower, however excepting control treatment there was only inconsiderable difference between molybdenum content of organs above and under the surface. These data show us that in our research a more intensive concentration growth occurred. Furthermore a higher increase of molybdenum concentration was observed in the case of sunflower as a dicotyledon shoot and root as well.
Molybdenum treatments had effects also on N-forms. NO_3-N content of maize and sunflower shoots was variable (Tables 5-6.), the lowest and the highest molybdenum treatment in maize experiment served the highest values (Table 5.). Comparing these results to the maize experiment of Kádár et al. (2000) differences can be found. In their experiment in case of ammonium-paramolybdenate a definite increase of NO_3-N concentration occurred. We suppose that N added in the form of ammonium had been nitrified by that time and this increased supply was reflected by the leaves. Concentration of NH_4-N grew in shoots in compliance with increasing molybdenum

concentration, which indicated a definite connection between molybdenum treatments and more intensive nitrate reduction.

The effect of increasingmolybdenum treatments increased the measuredNO_3-N concentration in theshoots androots of sunflower seedlings, and the NH_4-N concentration did not show a similar tendency, which indicated that thenitrate reductasesystem capacity was not unlimited, saturated, which led to the accumulation of nitrate (Table 6.). This is a kind of protective reaction of the plant (sunflower), because in this way prevents the accumulation of toxic ammonia, while non-toxic nitrate is selected into vacuoles for the plant, thus the ammonia temporarily is excluded from the metabolism.

Table 5: Nitrate- (NO_3-N), nitrite- (NO_2-N) and ammonium-nitrogen (NH_4-N) concentration(mg kg^{-1}) of shoots of maize seedlings grown in rhizoboxes in case of different molybdenum doses (mg kg^{-1})

Mo-treatment	NO_3-N	NO_2-N	NH_4-N
control	41.5	0.424	237
30	0.736	0.681	331
90	8.44	0.102	308
270	214	1.51	401

Table 6: Nitrate- (NO_3-N), nitrite- (NO_2-N) and ammonium-nitrogen (NH_4-N) concentration (mg kg^{-1}) of shoots of sunflower seedlings grown in rhizoboxes in case of different molybdenum doses (mg kg^{-1})

Mo-treatment	NO_3-N	NO_2-N	NH_4-N
control	73.3	0.040	647
30	173	0.040	446
90	313	0.445	547
270	899	0.382	549

In the root of maize and sunflower seedlingsthe capacity of nitrate reductase was higher, asowing to the effect of increasingmolybdenum treatments, the measured NO_3-N concentration was increased in the root of maize and sunflower also (Tables 7-8.), moreover the NH_4-N concentration of sunflower was also increased (Table 7.), while in the maize it was decreased (Table 6.). A major part of the absorbed nitrate was reduced to ammonium that linking to glutamic acid took part in amino acid synthesis through transaminating reactions and thus in protein synthesis.

On the basis of our results, thereis obvious close relation among the molybdenum level, NO_3-N absorption and nitrate reduction. The system is finely controlled, ammonium is not able to accumulate in tissues.

High concentration of free ammonium cytotoxic because infiltrating in the energizing (mainly mitochondrial) membranes acts as disconnecting factor that is depolarises the membrane without synthesizing ATP. Since plants didn‘t show toxic symptoms we suppose that there was enough glutamic acid for absorbing ammonium. From these we conclude that citric acid cycle that is the part of dehidrogenating phase of respiration serving carbon skeleton of glutamic acid was also active. All these refer to intensive metabolism in which role of molybdenum was confirmed by our experiments too. Establishments set in relation with shoot are relevant also in case of maize roots, which means nitrate reductase activity of roots and shoots were roughly equal in experiment carried out in rhizobox (Table 7.).

As a result of our experiments it can be concluded that molybdenum plays an important role in reduction of nitrate.

Table 7: Nitrate- (NO_3-N), nitrite- (NO_2-N) and ammonium-nitrogen (NH_4-N) concentration (mg kg^{-1}) of roots of maize seedlings grown in rhizoboxes in case of different molybdenum doses (mg kg^{-1})

Mo-treatment	NO_3-N	NO_2-N	NH_4-N
control	35.5	0.040	280
30	15.8	0.040	334
90	15.8	0.459	333
270	134	2.84	200

Table 8: Nitrate- (NO_3-N), nitrite- (NO_2-N) and ammonium-nitrogen (NH_4-N) concentration (mg kg^{-1}) of roots of sunflower seedlings grown in rhizoboxes in case of different molybdenum doses (mg kg^{-1})

Mo-treatments	NO_3-N	NO_2-N	NH_4-N
control	15.6	0.040	443
30	50.3	0.040	507
90	162	1.76	544
270	285	3.66	824

CONCLUSIONS

The consumption of selenium sources of natural products, such as whole-grain cereals, wheat germ, brown rice, nuts, sesame seeds, soy and garlic, not in any case provides enough amount of selenium for human-input, especially if the soil is lack of selenium. In many European countries the soils contains quite low selenium. Therefore, selenium supplementation becomes necessary in these areas, and where people are proven to suffer from selenium deficiency. Today, the number of patients which are lack of selenium is decreasing, so selenium supplementation seems to be inevitable. One way you can replace the selenium, that a selenium salt (selenite or selenate) is added into the soil for the cultivated plants. One of the problems with the supply of adequate selenium to the plants in most cases do not show well defined deficiency symptoms among selenium deficient growing conditions.

In order to produce healthy food, therefore it may be appropriate to monitor selenium contents of soils and the crops.

In our experiment in soil (in rhizoboxes) the effect of selenium supply was studied in a monocotyledon (maize) and a dicotyledon (sunflower) plants among controlled conditions. In the experiments the dose was calculated and added as selenium in selenite form (concentrations: Ø, 1, 10, 100 mg kg^{-1}) and in selenate form (Ø; 0,1; 1; 10 mg kg^{-1}). On the basis of our results the selenium content of plants was increased significantly by the effect of selenium treatments. This increase of selenium concentration was more intensive by the effect of selenate treatment than by the effect of selenite treatment applying the same level of treatment. The selenium concentration of shoot and root samples was analyzed respectively. Se content was higher in roots than in shoot samples in the case of maize and sunflower as well. This shows that the selenium accumulation in roots was more intensive than in shoots of the applied plants among the applied conditions.

The rhizobox experiment can not be performed in selenium free environment, since the control soil contains also certain amount of selenium. Despite this, the sunflower plant could uptake only a relatively small amount of selenium from control soil. However, the maize has got more selenium from the control soil then the sunflower and it continued to increase as a result of the selenate treatments. This difference is explained by the difference nutrient uptake mechanism of the two types of plant (maize and sunflower).

In conclusion it can be stated that it is extremely important for proper selenium content in soil. Considering the selenium content of a soil, although the presence of selenium is important for the plants, however too high concentration is a serious threat to the plants, animals and humans. Owing to the relatively high tolerance of maize and sunflower to selenium they can be applied for phytoremediation of selenium-contaminated areas, which is an environmentally friendly and relatively inexpensive method of decontamination of a soil, however it is time consuming activity.

The uptake of molybdenum by two experimental plants (maize and sunflower) was examined with increasing molybdenum concentration; moreover the effect of molybdenum supplying was also investigated on the process of nitrate reduction. Examination of the relationship between the molybdenum supplying and the nitrate reduction was also investigated, as the presence of molybdenum which has key role of nitrate reduction to enzyme activity of nitrate reductase is essential. In the absence of molybdenum the process of the nitrate reduction will be slow down and this results the accumulation of nitrates in the plant.

In our rhizobox experiment, molybdenum was not added to the control treatment of soil, furthermore the molybdenum concentrations of the other treatments were as follows: 30, 90, 270 mg kg^{-1}.

On the basis of our results it seems that as a result of Mo-treatments, the content of molybdenum in the plants has increased substantially. This increase of sunflower seeds was more intensive, than of the maize. Analyzing the plant parts (eg. root and shoot) separately, the concentration of molybdenum in the root of maize was higher than in the shoot of maize, however only in the case of the largest sunflower treatment (270 mg kg^{-1})

resulted higher molybdenum concentration in the root.

The Mo treatments influenced by various forms of nitrogen. In those cases when the Mo treatments reduced the roots NO_3-N content and increased the NH_4-N concentrations, then more intensive nitrate reductase activity was postulated. The examples were also found for those NO_3-N concentration of the root and shoot increased by the influence of molybdenum treatments, but those were not followed higher NH_4-N concentration in the examined plants, which according to our assumption this phenomenon is explained by a kind of defense mechanism of the plant.

Based on the results of the attempt, we found clear evidence that there is a close correlation between the molybdenum supply of the plants and the reduction of nitrate.

Knowing this fact, in the case of intensive addition of NO_3-N, we have to take the original molybdenum concentration in the soil into consideration, moreover if the free molybdenum concentration in the soil does not reach the plant's physiological needs (that is approximately 0.01 μM Mo) into account also. If it is true then a micro-nutrient fertilizer containing molybdenum is reasonable to add into the soil. To ensure adequate supply of Mo the nitrate content in the leaf and root vegetables can be reduced, to produce and to consume healthier raw materials and foods.

ACKNOWLEDGEMENTS

The publication is supported by the TÁMOP-4.2.2/B-10/1-2010-0024 project. The project is co-financed by the European Union and the European Social Fund.

REFERENCES

Aubert H., Pinta M.: 1977. Trace elements in soils. Elsevier Scientific Publishing Company, 55-61.

Bambara S., Ndakidemi P.A.: 2010. The potential roles of lime and molybdenum on the growth, nitrogen fixation and assimilation of metabolites in nodulated legume: A special reference to Phaseolus vulgaris L., African Journal of Biotechnology, 8:2482-2489.

Bankhofer H.: (1994) Bio-szelén. Golden Book Kiadó, Budapest.

Berger K. C., Pratt P F.: 1965. Advances in secondary and micronutrient fertilization. In: McVicka M. M. Bridger G. L. Nelson L. B. (eds), Fertilizer technology and usage. Soil Science Society of America, Madison, Wisconsin, USA, 287-340.

Berks B. C., Ferguson S. J., Moir J. W. B., Richardson D. J.: 1995. Biochim.Biophys.Acta - Bioenergetics, 1232:97.

Chengyi Z., Ren J., Xue C., Lin E.: (2005) Study on the relationship between soil selenium and plant selenium uptake. Plant and Soil. 277:197-206.

Duval, L., More E., Sicot: A.: 1991. Observations on molybdenum deficiency in cauliflower in Brittany.ComtesRendus de I Academic d Agriculture de France, 78:27-34.

Fontes R. L. F., Coelho H. A.: 2005. Commun. Soil Sci. Plant Anal., 36:2367–2381.

Gupta U. C., Srivastava P. C., Gupta S. C.: 2011. Role of Micronutrients: Boron and Molybdenum in Crops and in Human Health and Nutrition. Curr.Nutr. Food Sci., 7:126-136.

Kádár I., Koncz J., Gulyás F.: 2000. Mikroelem-terheléshatása a kukoricaösszetételéreés a talajkönnyenoldhatóelemtartalmárakarbonátoscsernozjo mon.AgrokémiaésTalajtan, 49:205-220.

Kádár I.: 1995. A talaj-növény-állat-ember táplálékláncszennyeződésekémiaielemekkelMagyarorszá gon.KörnyezetvédelmiésTerületfejlesztésiMinisztérium MTA TalajtaniésAgrokémiaiKutatóIntézete, Budapest.

Kádár I.: 1998. Szelénforgalma a talaj-növényrendszerben. [In: Cser M. Á. ésSziklai-László I. (szerk.) A szelénszerepe a környezetbenésegészségvédelemben.] Frag Bt., Budapest.

Katyal J. C., Randhawa N. S.: 1983. Micronutrients (molybdenum).FAO Fert.Plant Nutr. Bull., 7:69-76.

Knowles R. G., Palacios M., Palmer R. J. M., Moncada S.: 1989. Formation of nitric oxide from L-arginine in the central nervous system: a transduction mechanism for stimulation of the soluble guanylatecyclase. Proc. Natl. Acad. Sci., 86:5159-62.

Kovács B., Győri Z., Prokisch J., Loch J. and Dániel P.: 1996. A study of plant sample preparation and inductively coupled plasma emission spectrometry parameters. Communications in Soil Science and Plant Analysis, 27(5-8):1177-1198.

Kovács M., Turcsányi G., Siller I., Engloner A.: 1998. A Se előfordulásaMagyarországnövénytársulásaiban. 85. [In: Cser M. Á. ésSziklai-László I. A szelénszerepe a környezetbenésegészségvédelemben.] Frag Bt., Budapest.

Loch, J., Nosticzius, Á.: 1992. Agrokémiaésnövényvédelmikémia.MezőgazdaKiadó, Budapest.

Lteif A., Bashour I., Nimah M. and Darwish R.: 2005. Selenium Levels in Beqaa Valley in Lebanon. In: Lee et al., Plant Nutrition for Food Security, Human Health and environmental Protection. Tsinghua University Press, Beijing, China.

Nagy K., Lévai L., Kovács B.: 2010. A szelénellátáshatása a kukoricaésnapraforgónövényekre.Növénytermelés, 59:61-84.

Puskás-Preszner A., Kovács B.: 2009. Molibdén-kezeléshatásaszabadföldikísérletben a növényifelvételreés a talajmolibdénfrakcióira.AgrártudományiKözlemények. Debrecen, 36:117-122.

Reilly C.: 1991. Metal contamination of food. Elsevier Science Publisher Ltd., 225-229.

Robb D. A., Pierpoint W. S.: (1983) Metals and micronutrients: uptake and utilization by plants. Academic Press. London.

Schulte E. E.: 2004. Soil and Applied Molybdenum. Understanding Plant Nutritients.Produced by Cooperative Extension Publications, University of Wisconsin -Extension.

Szalai I.: 2006. A növényekélete.Ahogyan ma látjuk I. NemzetiTankönyvkiadóZrt., Budapest.

Szebeni A., VargaL., Kovács B., TolvajGy. And Zalatnai A.: (2011) Microanalytical Determination of Trace Elements from Liver Biopsy Materials of Patients with Chronic Diffuse Liver Diseases with Different Ultrasound Attenuation, Liver Biopsy, Hirokazu Takahashi (Ed.). ISBN: 978-953-307-644-7, InTech. http://www.intechopen.com/articles/show/title/microanalytical-determination-of-trace-elements-from-liver-biopsy-materials-of-patients-with-chronic

Terry N., Zayed A. M., Desouza M. P., Tarun A. S.: (2000) Selenium in higher plants. Annual Review of Plant Physiology and Plant Molecular Biology. 51:401-432.

Tunçeli A, Türker A. R.: 2004. Solid-Phase Extraction and Spectrophotometric Determination of Molybdenum(VI) in Soil and Plant Samples as a Mo(V)-Thiocyanate Complex Microchim. Acta 144:69-74.

Wang Z. Y., Tang Y. L., Zhang F. S.: 1999. Effect of molybdenum on growth and nitrate reductase activity of winter wheat seedlings as influenced by temperature and nitrogen treatments. J. Plant Nutr. 22(2):387-395.

Williams R. J. P., da Silva J. J. R. F.: 2002. The involvement of molybdenum in life. Biochemical and Biophysical Research Communications, 292:293-299.

Yaneva I., Mack G., VunkovaRadeva R, Tischner R.: 1996. Changes in nitrate reductase activity and the protective effect of molybdenum during cold stress in winter wheat grown on acid soil. Journal of Pant Physiology 149:211-216.

Zaijun L., Yuling Y., Jian T., Jiaomai P.: 2005. 9-(2,4-dihydroxyphenyl)-2,3,7-trihydroxyl-6-fluorone as analytical reagent for spectrophotometric determination of molybdenum in plant tissues, Journal of Food Composition and Analysis, 16:561-569.

Zimmer W., Mendel R.: 1999. Molybdenum metabolism in plants. Plant Biol. 1:160-168.

MINERAL BALANCE IN FOOD - A FOOD QUALITY, ANIMAL WELFARE AND ENVIRONMENTAL ISSUE

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Abstract

Data over 20 to 40 years showed historical decline in the mineral content of food and feed plant from USA and UK rising questions on the evolution of the environment quality and its implication on human and animal wellbeing. Although the "intensive varietal improvements of vegetable crops for high yield and improved nutritional quality are primary breeding objectives of various national and international programs little attention have been paid to below threshold concentrations of pollutants in soils, such as Cd, which may significantly influence the mineral concentrations in vegetable crops and pasture plants. Over the years the mineral status of pasture and feed crops were found to be insufficient for a balanced nutrition of farm animals and to support high yields of produces of animal origin. Therefore feed supplements are provided to farm animals,, however it is unclear how these practices support animal welfare and are generating a healthier food.

A survey of the mineral status of foods of animal and plant origin marketed in the Bucharest areas, mineral status of milk produced in farms near Bucharest and pot experiments for lettuce plants(2001-2003) were conducted between 2008 and 2012.The aim of the survey and experiments were to bring into light information on the mineral status of food for the population leaving in the Bucharest area and to better understand how the environment quality is influencing the mineral balance in food and the wellbeing of humans and animals.

Keywords**: **food, minerals, survey.

INTRODUCTION

Devare et all (2011) mentioned that ―minerals are the basic spark-plugs in the chemistry of life, on which the exchange of energy in the combustion of foods and building of living tissues depend". Metals present in the body in trace concentrations carry out a large number of enzymatic reactions. Thus their deficiency or overdose can cause severe disorders in different metabolic pathways. The minerals are interrelated with each other, as well as being linked with the metabolism of proteins, carbohydrates, fats, and vitamins.

Cunningham et al, 2005 and Mayer, 1997 observed historical declines (for data over 20 to 40 years) in the mineral content of food from USA and UK (i.e. K in potatoes from 650mg/100g in 1948 to 450mg/100g in 1991 and to 380mg/100 in 2000).

Much effort have been put into the identification of the pathways of potentially toxic metals such as Cd and Pb in the food chain and for the characterization of their influence on plants development and toxicity too. Moreover a large number of studies were developed to quantify the effects of the accumulation of potentially toxic metals in humans and animals. In 2010 the JECFA (Joint FAO/WHO Expert Committee on Food Additives**)** reviewed its previous evaluation of cadmium accumulation in humans. As a result, the JECFA withdrew its previous PTWI (provisional tolerable weekly intake_ of 7 µg/kg b.w. and established a provisional tolerable monthly intake (PTMI) of 25 µg/kg body weight (b.w). The JECFA concluded that the tolerable dietary intake should be expressed as a monthly value because of the long half-life of cadmium. This PTMI corresponds to a weekly intake of 5.8 µg/kg b.w. The dietary cadmium exposure (µg/kg b.w. per day) that equates to a concentration of 5.24 µg cadmium/creatinine in urine (break

point) was estimated to be 1.2 μg/kg b.w. per day at the 5th population percentile, 0.8 and 1.8 μg/kg b.w. per day, corresponding to the break point CI 4.94-5.57 μg cadmium/g creatinine in urine, respectively. The JECFA used the lower bound of 0.8 μg/kg b.w. per day as critical dietary intake to account for particularly susceptible individuals to ensure that 95 % of the population will maintain urinary cadmium levels with 95 % probability below 5.24 μg cadmium/g creatinine, i.e. ~~-b~~elow the point at which renal pathology is indicated by increased B2M levels" (FAO/WHO, 2011).

Although the effect of minerals on cadmium accumulation in organisms is well documented the balance of minerals in the human diet was not taken into account for the previous calculations.

.Worldwide ~~-in~~tensive varietal improvements of vegetable crops for high yield and improved nutritional quality are primary breeding objectives of various national and international programs'' little attention have been paid to below threshold concentrations of pollutants in soils, such as Cd, which may significantly influence the mineral concentrations in crops and thus the total mineral intake for humans.

Several food nutritional value databases are available worldwide among which the USDA Nutrient Data Laboratory, Health Canada and the Danish Food Composition Databank (Department of Nutrition, National Food Institute, Technical University of Denmark). The Canadian Nutrient File database published by Health Canada is a database that reports up to 150 nutrients in over 5807 foods. This database provides entries on values for nutrients such as vitamins, minerals, protein, energy, fat etc, which are updated periodically

The usefulness of such databases stems from several issues such as the need for considering the risks of excessive nutrient intakes and establishing upper levels of intake where data exist regarding risk of adverse health effects. The activity for reviewing components and measuring concentrations of food components that may not meet the traditional concept of a nutrient but are of possible benefit to health, or an indicator of animal welfare (Tudoreanu et.al 2011) and environmental quality status is another important aspect in food mineral concentrations monitoring.

Usually database refers to food produced in a specific country (USA, Canada, UK, Denmark, etc). The main entries to these databases are generally grouped in proximate such as water, energy, protein, total lipid (fat), ash, carbohydrate, sugars (total), fiber; minerals such as Ca, Fe, Mg, P, K, Na, Zn, Cu, Mn, Se, Cr, Ni, I. Other components which are represented in the databases are vitamins, lipids and other components such as alpha and beta carotene, lycopene, Caffeine, theobromine etc. However the databases are very different due to difference in food groups' information and data offered by food group.

Moreover the presence of information on micronutrients total concentrations will provide valuable data for studies on population's heath consuming traditional foods. For some population categories the consumption of high quantities of traditional foods such as common beans (*Phaseolus vulgaris* L.) is very common. It has been reported that *Phaseolus vulgaris* L. may also produce negative dietary effects such as interference with micronutrient absorption, protein digestibility or glucose metabolism (Doria et al., 2012). Therefore information on micronutrients concentrations in food may be valuable to scientist studying the link between clinical pathology and mineral nutrition as well, and might generate the reconsideration of the provisional tolerable monthly intake for toxic metals such as Cd and Pb.

MATERIALS AND METHODS

Between 2008 and 2012 were analyzed over 800 samples of food commodities which were considered having the highest acceptability and to be most frequently bought such as: bread, meat, meat products, eggs, milk and milk products, legumes vegetables, fruits and drinks (wines, beer and soft drinks) including water, were All the samples were bought from the Bucharest local markets and supermarkets. In all sample the total concentration of 24 minerals was measured. The total mineral concentrations were analyzed by ICP OES and ICP-MS.

For the dairy products 1ml of milk or yogurt was digested in a microwave oven as described by (Gerber et al, 2008). A Thermo XS series2 ICP-MS spectrometer was used for the total minerals concentration analyses in meat, fish and beverage samples. The operating conditions for Thermo XS series 2 ICP-MS were: Sample uptake 40s; Washout 60s; Runs 3; Sample uptake;: 0.7 l/min; Sampling depth 15mm; Sampler 1.0mm, Ni Skimmer 0.4, Ni; Internal standard 103Rh; Neb. 1,9 bar; Spike recoveries from 80% to 110%. All operating conditions were optimized to yield the highest signal/ background ratio for ^{9}Be, ^{115}In, ^{230}U, ^{556}Fe, ^{209}Bi, ^{140}Ce, ^{156}CeO, ^{75}As, ^{27}Al. Prior to analysis each sample was spiked with the internal standard (Rh). The dilution factor for each sample is 10. All elements were determined against external calibration using synthetic standard acid multielemental standard (24 elements MS standard MERCK). Four standards were prepared by dilution containing 1ppb, 10ppb, 100ppb and 1000ppb of the 24 elements. The accuracy of the calibration was assessed by using reference materials such as NIST SRM 1546 and SRM1577b.

Milk, yogurt, eggs and bread were analysed by ICP-OES spectrometry (Thermo series). The operating conditions were 27.12 MHz, Rf=1.5 Kw, Ar flow 14 l/min, integration time 5-3 sec, Spectral range 200-800 nm. Theree standars were used 0.001ppm, 0.1ppm şi 50ppm from The standars were obained from a merck standard of 1000mg/l containing: Al, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Ga, K, Li, Mg, Mn, Ni, Pb, Se, Sr, Te, Tl and Zn.

A pot experiment to test the mineral status of letuce plants cultivated on subtrates containig Cd was conducted. The experiment and sample analyses were describe in details elsewere (Tudoreanu, 2004).

RESULTS AND DISCUSSIONS

The international food nutritional value database do not always include the concentrations of potentially harmful elements such as Cd, Pb, however some databases (the Danish database) included the concentrations of Cr and Ni and other elements concentrations such as Pb, Cd and Al (The British diary database). The three international databases mentioned in this paper (table 1) do not contain information on Sr concentrations in foods. The analyses conducted include micro and macronutrients as well as potentially harmful minerals such as Cd and Pb as well as Sr and Co. We believe that a clear picture of the influence of the mineral content of foods on human health may be found only if data on major nutrients (micro and macro nutrients) are known in relation to the potential harmful elements concentrations. (Tudoreanu et al. 2011). The impact on human health of these foods will also be influenced by overall quantity of each food groups in the daily diet.

Cobalt is an essential trace mineral that is a constituent of vitamin B12 and which plays a cofactor role for making the thyroxine hormone. Another mineral which is less studied as possible micronutrient is Ni. Nickel is associated lately with vitamin C. and also has been linked to skin allergies or dermatitis.**lit** is also thought to be a factor in hormone, lipid and cell membrane metabolism. Insulin response is increased after ingesting nickel, which may be related to its activation of enzymes associated with the breakdown or utilization of glucose.

However a very few international database gives information on the total concentration of Ni and no database gives information on Co in food and feed

Table 1. Comparison between the available data on minerals concentrations in foods which are available from international food databases and from the Romanian survey data.

USDA National Nutrient Database for Standard Reference, Release 24 [..]	*Food Danish Composition Databan [..].*	**2008-2012 survay (Bucharest markets)**
Ca	Ca	Ca
Fe	Fe	Fe
Mg	Mg	Mg
P	P	P
K	K	K
Na	Na	Na
Zn	Zn	Zn
Cu	Cu	Cu
Mn	Mn	Mn

USDA National Nutrient Database for Standard Reference, Release 24 [..]	*Danish Food Composition Databan [..].*	**2008-2012 survay (Bucharest markets)**
Se	Se	Se
-	I	Cr
-	Cr	Ni
-	Ni	Co
-	-	Sr
-	-	Al
-	-	Cd
-	-	Pb

Data obtained on milk and yogurt during the survey (mean values) are presented in table 2.
Although many food nutritional value databases are available none of them is offering information on microelements such as Co and B.

Table 2. Mean value of survey data for the period 2009-2012 for yogurt, milk, fish (carp trout and pike), pork meat and white bread samples.

Element	Yogurt (ppm) wet weight	Milk (ppm) wet weight	Fish (ppb) wet weight	Pork (ppm) wet weigh basis	Whitebread (ppm) dry weight
Li	0.00546	<0.001--	527.03	<0.001	-<0.001-
Be	0.00004	<0.001-	-<0.001	<0.001	<0.001-
B	0.33367	0.278	348.74	<0.001	<0.001-
Mg	6.122	3.695	<0.001	25.782	0.711
Al	0.40988	0.0862	660.377	<0.001-	0.572
Cr	0.01325	0.0186	35.547	-<0.001	<0.001-
Mn	0.02385	0.01385	136.767	0.0278	0.0134
Fe	503.0244	0.0634	611.450	0.795	0.0705
Co	0.00221	0.00072	4.644	<0.001-	<0.001-
Ni	0.01596	0.0218	21.224	<0.001-	<0.001-
Cu	246.92406	0.0631	654.727	0.178	0.0061
Zn	900.80057	0.2711	470.173	1.376	0.045
Se	0.02727	0.0058	2.254	0.086.	<0.001
Sr	0.04879	0.0256	69.519	-	0.05
Cd	0.00584	0.0136	277.82	0.063	<0.001
Pb	0.048962857	0.0507-	58.063	0.02	<0.001
Ba	0.07434	<0.001-	<0.001-	<0.001	<0.001
Tl	0.00002	-<0.001	<0.001-	<0.001	<0.001
Bi	0.001927571	-<0.001	-<0.001	<0.001	<0.001

Strontium was present in brine cheese, eggs from local traditional private farms, and in root vegetables but not in honey (Tudoreanu et.al., 2012), however further investigations are needed to elucidate the source of its presence and the level; that were detected.
Milk from cows farmed near Bucharest showed a large variability in minerals among individuals and the mineral decline in Ca or other elements were related to the individual pathology (table 3).
Usually mastitis is associated with reduced intake or quality of grass or silage; unpalatable herbage (reduced intake on certain paddocks, sometimes associated with high quality but low fiber). An adequate diet containing sufficient Vitamin E and Se and Zn reduce the incidence of subclinical mastitis in some deficient herds For dairy cows apart from hypomagnesaemia, mineral deficiency may cause poor milk yield, and occasionally deficiency of P, Na, Cu, Se, I or Co may be involved too. If the levels of Cu, Se, I, Zn, Co or P are low in blood samples there are risks of developing mastitis.
Letuce (Brasiliana cv) plants cultivated on substrates containing below threshold total cadmium concentration (1ppm dry weight) had a significant decrease of total mineral content after 45 days from planting although they had the total Cd concentration in leaves largely below the maximum admissible limit (table 4).
These results are supporting the ideas developed by the open letter of Cheryl Long (1999), the Senior Editor of Organic Gardening (Rodale Press), addressed to USDA Secretary Dan Glickman who raised the question : ―Is Chemical Farming Making Our Food less Nutritious? ―(James and Phillip, 2000) . The letter mentioned two studies which show that the vitamin and mineral content of American and British food appear to be declining. One of these studies (Mayer 1997) ―compared British data over a fifty year period ―significant reductions" in the levels of minerals in fruit and vegetables and questioned if modern agriculture could be responsible for the reduction" (James and Phillip, 2000).
The Diminishing Nutritional Values of Australian Grown Fruit and Mineral nutritional value of vegetables comparison between1948 and 1991 by the C.S.I.R.O.

showed a clear decline in mineral concentrations too. A survey of minerals in Australian food have been conducted for the period 1990-2000 . In 2001 Australian media reports (Patty 2001, Moynihan 2001) raised questions about whether or not nutrient levels in Australian horticultural produce are declining due to changing soil conditions and horticultural practices.

Up to date no attempt was made to generate complex data on the total diet mineral nutritional value and on the implication of minerals and potentially toxic metals on health

Table 3. Mineral content of milk from dairy cows farmed near Bucharest

Element	Mean concentration (mg/l)	Median concentration (mg/l)	Std Err Mean (mg/l)	Upper 95% Mean (mg/l)	Lower 95% Mean (mg/l)	Min (mg/l)	Max (mg/l)	FAO/ OMS (mg/l)
Ca	1058.00	1074.83	47.61	1157.02	959.01	601.571	1487.582	1250
K	1449.96	1563.89	55.48	1565.25	1334.88	673.554	1711.532	1300-1500
Fe	2.89	1.62	0.75	4.46	1.33	0.31	14.90	0,5
Cu	0.77	0.23	0.34	1.48	0.06	0.11	6.60	600
Li	0.24	0.12	0.09	0.43	0.05	0.06	1.80	
Mg	139.27	133.30	6.47	152.75	125.80	70.00	227.70	90-240
Mn	0.05	0.03	0.01	0.07	0.03	0.00	0.16	10-40
Na	541.49	438.40	72.54	692.34	390.63	269.60	1759.50	350-500
Pb	0.33	0.31	0.03	0.40	0.26	0.05	0.69	20-80
Cd	0.06	0.04	0.017	0.10	0.02	0.01	0.40	1-20
Co	0.15	0.14	0.01	0.18	0.11	0.00	0.33	0,4-1,1
Se	0.43	0.44	0.04	0.52	0.34	0.00	0.81	
Sr	0.41	0.37	0.03	0.47	0.34	0.24	1.00	
Zn	3.847	3.84	0.16	4.19	3.50	2.35	5.35	3-5

Table 4. Minerals and cadmium concentration in leaves of Brasiliana lettuce plants, after 45 from planting. Daily mean temperature: 22C to 39C. In brackets the standard error. Values from each row followed by the same letter are not significantly different for α =0.05 (all pairs Tukey –Kramer and Each pair Student‘s tests). No comparison between values from different rows can be made. T1, T3. T10 are treatments of the substrate.

Treatment Element	Control	T1 (1ppm added Cd in the substrate)	T3 (3ppm added Cd in the substrate)	T10 (10ppm added Cd in the substrate)	ANOVA p value
Cd (ppm DW)	0.4800 b (0.0500)	0.5775 b (0.0594)	2.4025 b (0.2050)	7.3400 a (1.1766)	0.0001
Ca (% DW)	1.3150 a (0.0050)	1.2000 a (0.0385)	0.9425 b (0.0201)	1.1525 a (0.0815)	0.006
K(% DW)	8.4500 a (0.4500)	6.1250 b (0.5297)	7.4750 b (0.3816)	5.1750 a (0.2393)	0.002
P (% DW)	0.6100 a (0.0700)	0.4000 b (0.0244)	0.3325 c (0.0246)	0.4825 d (0.0540)	0.009
Cu (ppm DW)	6.3000 a (0.5106)	4.9500 a (0.0500)	3.9500 c (0.0500)	5.0750 b (0.4714)	0.003
Mg (% DW)	0.4000 a (0.0011)	0.3300 a (0.0070)	0.2670 c (0.0110)	0.3600 ab (0.0160)	0.0003
Mn (ppm DW)	42.5000 (2.5000)	39.2500 (2.5290)	34.5000 (0.9574)	41.2500 (5.4371)	0.18
Fe (% DW)	631.500 (106.50)	917.250 (281.54)	661.500 (34.71)	937.500 (257.69)	0.69

CONCLUSIONS

The survey conducted between 2008 - 2012 on food commodities from local Bucharest markets revealed that Sr, Co and Ni concentration in foods as well as Cd, Pb, concentrations should be taken into consideration for food surveys and food nutritional value databases as they may influence the metabolism of other minerals. . Data from the xperiments conducted on lettuce plants in 2001-2003 showed that there

is a clear decline of minerals concentration in plants gorn on substrates containing less than 1ppm of total cadmium concentration in soil (1ppm wet weight). Unfortunately historical databases on minerals concentrations and potentially toxic metals in food of animal and vegetal origin are not available in Romania. However many valuable data exists from Romanian published research before 1990 but their collection and organization in historical food database is a costly and time consuming activity. However during the last decade many Romanian publications reported mineral content of locally produced food all over Romanian. Comparison of food mineral nutritional value data from the Bucharest region with data from other Romanian areas will be a valuable tool in evaluating the trends in the evolution of the environment quality and to identify the influence of food and feed quality on human and animal welfare.

REFERENCES

Cunningham JH, Milligan G., Trevisan L. 2004. Minerals in Australian fruits and vegetables – a comparaison of levels between the 1980‘s and 2000. Food Standards Australia, New Zealand

Doria E., Campion B., Sparvoli F., Tava A., and Nielsen E. (2012). Anti-nutrient components and metabolites with health implications in seeds of 10 common bean (*Phaseolus vulgaris* L. and *Phaseolus lunatus* L.) landraces cultivated in southern Italy. Journal of Food Composition and Analysis Volume 26, Issues 1–2, May–June 2012, Pages 72–80

Duizer L.M, James B., Corrigan V.K., Feng J, Hedderley D.I. and Haker F.R.(2011). Use of a panel knowledgeable in material science to study sensory perception of texture. Journal of texture Studies nr. 42 p 3009- 3011

Gerber N, Brogioli R, Hattendorf, B., Scheeder M.R.L., Wenk C., and Gunther D. (2009) Valability of selected trace elements of different meat cuts determined by ICP-MS and DRC-ICPS . Animal. 3:1, pp166-172 Print ISSN 1843-5246; Electronic ISSN 1843-5386

Hartkopp, H.B., Hess Ygil, K., Hels, O.H.:Danish (2008). .Food Composition Databank, revision7. Department of Nutrition, National Food Institute, Technical University of Denmark

James W. L. and Phillip B. 2000 . Are Depleted Soils Causing a Reduction in the Mineral Content Of Food Crops?. Annual Meetings of the ASA/CSSA/SSSA, Nov 5-9, 2000, Minneapolis MN.

Mayer, A-M. (1997). Historical changes in the mineral content of fruits and vegetables: a cause for concern?. p. 69-77 In W. Lockeretz, (ed). Agriculture Production and Nutrition: Proc. Sept 1997. Tufts University.

1. Moynihan, R. (2001). The value of the vegetable – the debate over the declining nutrients in fruits and vegetables. Australian Financial Review, 21 July 2001, p 25

Patty, A. (2001). Test for goodness. Fruits and vegetables in the spotlight. Daily Telegraph, 13 October, p 12

Saxholt, E., Christensen, A.T., Møller, A. Hartkopp, H.B., Hess Ygil, K., Hels, O.H.: (2009).The official Danish Food Composition Database

Tudoreanu L.(2004). Cercetari cu privire la acumularea cadmiului si influenta acestuia asupra plantelor de salata. Teza doctorat.(USAMVB).

Tudoreanu L., Codreanu M, Crivineanu V, Goran Gh. (2012*)*.The Quality of Romanian Honey Varieties - mineral content and textural properties. Bulletin UASVM Agriculture, 69(2)/

Tudoreanu L., Codreanu M, Goran Gh, Crivineanu V. (2011). Plant-animal models for heavy metals accumulation in agricultural systems. Simpozionul FMVB Iasi. Lucrarii stiintifice Medicina Veterinara .vol 53(12), ISSN 1454-7406

Tudoreanu L., Codreanu MD, Crivineanu V, Goran GV, (2011), Modeling heavy metals transport and accumulation in plat-animal systems, Ed. Printech.

***Danish Food Composition Databank,(2008) revision Department of Nutrition, National Food Institute, Technical University of Denmark. 2008.

***International Food Composition Tables Directory. United Nations University. International Network of Food Data Systems (INFOODS).

DOES WELFARE OF DAIRY COWS AFFECT QUALITY OF MILK AND DAIRY PRODUCTS?

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Abstract

The paper presents a non-systematic review about the relationship between welfare of dairy cows and quality of milk that they produce; the best demonstrated links are the effects of mastitis and oxidative stress on composition, shelf life, sensory and technological characteristics of milk and milk products. These evidences explained how specific aspects of animal welfare affected specific aspects of milk quality. Further interdisciplinary efforts should be made, in the light of the new strategy of the European Commission on animal welfare, new knowledge and emerging disciplines; welfare of dairy cows should be evaluated at farm level by a widely agreed protocol using outcome-based animal indicators; how and how much the animal welfare, measured in such way, affects the quality of milk should be studied by very large surveys and carefully designed experiments.

Keywords: *animal welfare, dairy cows, milk quality, dairy products*

INTRODUCTION

Worries about animal welfare are often associated with expectations about quality of animal products. Two of the main reasons of concern about welfare of dairy cows are that husbandry has become more and more intensive and that genetic selection for production traits could have side effects on animal reactivity. There is a widespread perception that unhappy and sick cows produce bad milk; however a direct relation between animal welfare and food quality is not easily demonstrable because ―food quality" and ―animal welfare" are, both, very complex concepts**.**

Food quality includes food security and safety, nutrition, sensory and others attributes related with product differentiation. Consumers' ability of processing information about quality is limited because some attributes of food quality can not be evaluated by visual perception or by experience. Considering the consumers' ability to distinguish it, foods traits have been classified into search, experience or credence attributes (Caswell and Mojduszka, 1996 cited by Olynk et al. 2010). An attribute is considered as a search attribute if consumers are able to identify its quality before purchase through either inspection or research; the quality of an experience attribute can be determined only after purchasing and consuming the product; a credence attribute is classified as one for which quality could not be assessed even after the product was purchased and consumed (Olynk et al. 2010). For livestock products, animal welfare is often a credence attribute; a crucial challenge for researchers is to produce data and tools allowing to transform most of food quality attributes from credence attributes to search ones.

Public awareness on animal welfare has been growing worldwide; in Europe, the concern for livestock welfare has resulted in political movement and regulations of the care of farm animal. More recently, the leading role of the market in driving development of animal friendly methods of production has received big attention and the public awareness is beginning to influence directly farm practices.

So far, one of the main obstacles on the way to a characterization of the products in relation to the animal welfare has been the difficulty of measuring it by feasible and objective methods based on scientific data. Over time, many protocols have been proposed for the assessment of welfare in

dairy farms and many resources have been spent to choose the best and give them a scientific basis. Now, there is a general agreement on the fact that very effective direct measurements (i.e., outcome-based animal welfare indicators) are available and must be used.

Recently, the European Commission adopted a new four-year strategy (2012-2015) (Commission Communication to the European Parliament, the Council and the European Economic and Social Committee, http://ec.europa.eu/food/animal/welfare/actionplan/docs/aw_strategy_19012012_en.pdf).

The new strategy aims to further improve the welfare of animals in the European Union and produce a simplification of the EU legislation on animal welfare, allowing more flexibility and less costs of compliance. A better enforcement is also expected as consequence of a more systematic approach and more transparency.

The new strategy will be based on the use of outcome-based animal welfare indicators. The EFSA Scientific Opinions on the development of welfare indicators (EFSA, 2012) will be taken into account.

Even there are growing evidences that an higher animal welfare could be economically convenient for farmers, one of the problem that must be considered is that improving animal welfare can increase cost of products; thus one question is if the people will accept higher prices for more friendly animal products.

Pala and Atakisi (2012) showed that sensory perception of different level of animal welfare by tasting yogurt was strengthened when sensory input was supported with information provided on animal welfare; they suggest that friendly animal products should be advertised and labeled clearly to increase consumer sensory acceptance and willingness.

Science on willingness to pay for animal welfare in dairy production (WTPD) is still in its infancy (Carlucci et al. 2009; Napolitano et al. 2008; Napolitano et al. 2010; Elbakidze e Nayaga, 2012); thus, experiments and surveys on WTPD don‘t give yet consistent results, being different in methods and showing differences across products. However, we can assume a higher WTPD if the animal welfare attributes will be associated with higher quality of products.

Aim of this review is to analyze the experimental evidences of a link between welfare of dairy cows and the quality of milk that they produce.

MATERIAL AND METHODS

A computerized literature research was carried out to update an existing archive of published reports about relationship between animal welfare and quality of milk and dairy products.

The keywords ―milk quality", ―yogurt" and ―cheese" were combined trough the Boolean operator ―and" with the keywords ―animal welfare" or ―animal wellbeing" on PubMed to find out scientific article published for the last five years. Additionally, some cross-references mentioned in the selected articles were checked and retained if relevant.

Then, a non-systematic review of selected number of articles has been conducted to highlight the state of the art on this topic.

RESULTS AND DISCUSSION

Many aspects of animal welfare have been demonstrated to affect the milk quality: sickness, oxidative stress, cognitive stress, nutritional stress and environmental stresses.

Sickness

The best demonstrated link of milk quality with health of cows is the effect of mastitis on composition and physical characteristics of milk and milk products (Barbano et al 1997; Barbano et al 2006).

Milk produced during mastitis is characterized by a higher somatic cell count (SCC); mastitis induces increased proteolysis, lipolysis, and free fatty acids content (Table 1).

The increased proteolysis is, partially, due to increased activity of plasmin. Since 1995, Ballou et al., through an investigation into the bulk milk of 200 farms ranked on the basis of the SCC, showed that the level of plasmin (PL) in milk is higher for farms with higher SCC. Plasmin is a protease, part of a complex protease-protease inhibitor system that exists in milk in its inactive zymogen form,

plasminogen that can be converted into active PL by plasminogen activators (Grufferty and Fox, 1988). The proteolysis induced by PL can have both positive or negative effects on the texture and the flavor of dairy products (Ismail and Nielsen, 2010) depending on the degree of hydrolysis and the type of product; proteolysis in cheese during ripening results in texture modifications, pH increase through NH_3 formation and the production of flavor compound (Fox et al., 1993); thus, a certain degree of protein‘s hydrolysis contributes to develop the consistency and flavor you want; in pasteurized or sterilized milk, excessive proteolysis is undesirable because reduce the shelf life and may lead to develop bitter off-flavors (Ma et al., 2000) due to the accumulation of small peptides.

Table 1. Demonstrated effects of mastitis on milk and dairy products

Effect on the animal physiology	**Effects on milk characteristics**	**Negative consequeces on quality of milk and dairy products**	**References**
Accumulation of leukocytes produced by the cow‘s immune system at the infection site (udder)	Increased cell somatic count; increased activity of non-plasmin proteases (somatic cell protease)	Reduction of shelf life of fluid milk due to accumulation of small peptides developing bitter and astringent off-flavors Increase in rennet coagulation time and reduction in curd firming rate.	Ma et al., 2000 Politis and Ng-Kwai-Hang 1988
Increased tight junctions permeability	Increased plasmin activity	Reduction of shelf life of fluid milk due to accumulation of small peptides developing bitter and astringent off-flavors Increase in rennet coagulation time and reduction in curd firming rate.	Ma et al., 2000; Ismail and Nielesen S.S., 2010. Politis and Ng-Kwai-Hang 1988.
	Reduced de novo synthesis in the udder. Increased leakage of blood components into the udder	Lower concentration of calcium, lactose, casein and fat Higher concentration of sodium, chlorine and serum protein	Kitchen 1981; Stelwagen, 1999; Delamaire and Guinard-Flament, 2006.
Increased susceptibility of milkfat substrate to lipase activity?	Increased lipolysis	Reduction of shelf life of milk and yogurt due to increased free fatty acids content leading to rancid off-flavors.	Ma et al., 2000; Shipe et al 1978; Fernandes et al., 2007.

The variations of the content of plasmin and plasminogen in milk are, partially, related to changes in the tight junctions (TJ) permeability; TJ are the intercellular junctions of the secretory cells of the mammary gland. In healthy udders, during lactation, the mammary epithelial TJ limits permeability and exchanges between milk and blood; when a pathogenic microorganism penetrates in the teat canal irritates and invades the mammary tissue, causing an inflammatory response with partial or complete breaking of TJ and increase of permeability of epithelium. In such conditions, *de novo* synthesis of milk components in the udder is reduced and the influx of the blood components into the milk is increased; there is an increased transfer of plasminogen from blood plasma to milk where it is activated to plasmin. The same thing happens in situations of stress and at the end of lactation.

Moreover, when the TJ become leaky, calcium, lactose, casein and fat contents are reduced in milk, while concentrations of sodium, chlorine and serum proteins increase (Kitchen 1981; Stelwagen, 1999; Delamaire and Guinard-Flament, 2006).

However, during mastitis, also a contribution of non-plasmin proteolitic activity from somatic cells, especially phagocitic leukocites (polymorfonucleocytes and macrophages) occurs. These cells contain active proteases; when milk SCC is maintained elevated (1

million cells/ml or more) their contribution becomes significative.

When SCC is high also lipolysis is high and affects negatively taste and technological properties of milk. Lipases catalyse hydrolytic release of free fatty acids from triglycerides causing a flavour defect in fluid milk described as ―rancid" (Shipe et al 1978).

Increased lipolysis in yogurt (Fernandes et al., 2007) and lower yield in cheeses (Politis and Ng-Kwai-Hang 1988) have been also reported as consequences of mastitis.

Oxidative stress

Oxidative stress is the result of an imbalance between prooxidants processes and antioxidants processes.

Tissues of animals under oxidative stress show an excessive production of free radicals; free radicals are compounds with an unbalanced electronic structure that gives them a great reactivity towards organic constituents and cellular structures; for this characteristic, free radicals are involved in a large number of redox reactions and are formed continuously, along the energy metabolism, contributing to the adaptation of an organism to the environment; however an excess of free radicals is harmful, can alter cellular structures and reduce the effectiveness of the immune system cells.

Diseases, bacterial, viral infections and any situation of stress, such as improper handling of animals, extreme cold and heat stress, excessive dietary levels, unbalanced diets stimulate the production of free radicals.

In cows, oxidative stress is frequent during the first three weeks after calving; the intensive metabolism observed during this period is accompanied by an increase in the amount of reactive oxygen species. While the effects of oxidative stress on the characteristics of the meat is well known, less is known about the relationship between oxidative status of the body (evaluated by the oxidative status of blood) and oxidative status of the milk; it is not yet clear to what extent the direct effect of oxidative stress is reflected in the milk in terms of greater content in oxidized compounds or lower content of antioxidant molecules. However, Andrei et al. (2011) reported a value of glutathione peroxidase higher in mastitic milk than in normal milk. Moreover, was clearly demonstrated that grazing affects oxidative status of milk; Pizzoferrato et al., (2007) proposed a parameter (DAP or degree of antioxidant protection) able to distinguish milk and cheese from grazing and zero-grazing animals; they found a discrimination between goat‘s milk and cheese produced from different feeding systems and concluded that cholesterol was highly protected against oxidative reactions when the herbage was the only feed or was dominant in the goat diet but they also suggest that grazing allows goats to select their favorite herbage and plays a key role in improving animal welfare and milk composition.

Cognitive stress

Mammary epithelial permeability is under hormonal control with glucocorticoids involved for maintenance and formation of mammary TJ. Stelwagen et al. 2000, demonstrated a damage to the integrity of the TJ with consequent increase in mammary epithelial permeability as a result of stress caused by social isolation.

Nutritive stress

One of the most critical moments for the welfare of dairy cattle is the *postpartum*. The negative energy balance, typical of the early stage of lactation, causes changes in milk fat that become particularly rich in polyunsaturated fatty acids resulting from the mobilization of body reserves; the oxidation of these fats can cause unwanted taste.

Environmental stress

Environmental stressors, such as those due to climate changes, housing and interaction with humans have effect on welfare of cows and udder physiology.

Effect of hot stress on welfare of dairy cows (Speroni et al. 2006) and milk composition (Malacarne et al., 2003) has been studied for long time, worldwide. Reduction of milk protein percentage has been observed by several authors. Bernabucci et al. (2002) showed that the reduction of milk protein content observed in the summer was due to the reduction in the casein content (α_s-casein and β-casein) and suggest that these changes might explain the alteration in cheesemaking properties of milk commonly observed during

summer.

There is a general assumption that high standards of cow comfort and the management of clean cows improve milk quality. Some studies have made associations between clean housing, clean cows, satisfactory beds and lower bulk tank somatic cell counts and lower incidence of mastitis (Barkema et al., 1998; Barkema et al., 1999; Ward et al. 2002).

Stress and microbial endocrinology

It is well known that **s**tress enhances the likelihood of infection; classic explanation for this fact is that activation of the sympathetic nervous system under stress leads to the release of neuroendocrine mediators, which may impair innate and adaptive immunity; however, a new discipline, microbial endocrinology, is giving an important role to the bacteria within the ruminant digestive tract to better understanding the mechanisms by which stress influences the pathogenesis of infectious disease (Freestone et al. 2008); Freestone and Lyte (2010) showed that enteric pathogens have evolved systems for directly sensing stress hormones by demonstrating that exposure of enteric pathogens to physiological concentrations of stress hormones can result in increases in growth and changes in expression of virulence factors such as adhesins and toxins. These findings are promising a new approach to better understand how stress influences ruminant physiology and products.

CONCLUSIONS

Relationship between welfare of dairy cows and quality of milk was demonstrated by several authors for many years; the best demonstrated links are the effects of mastitis and oxidative stress on composition, shelf life, sensory and technological characteristics of milk and milk product. In which extent oxidative status evaluated by blood is related to oxidative status of milk should be better studied; effect cognitive stressors on milk quality should be better investigated.

More generally, further interdisciplinary efforts should be made, in the light of the new strategy of the European Commission on animal welfare, new knowledge and emerging disciplines; welfare of dairy cows should be evaluated at farm level by a widely agreed protocol using outcome-based animal indicators; how and how much the animal welfare, measured in such way, affects the quality of milk should be studied by very large surveys and carefully designed experiments.

REFERENCES

Andrei S., Matei S., Fit N., Cernea C., Ciupe S., Bogdan S., Groza I.S. 2011. Glutatione peroxidase activity and its relationship with somatic cell count, number of colony forming units and protein content in subclinical mastitis cows milk. Romanian Biotechnological Letters, Vol.16, No.3: 6209-6217.

Abeni F., Calamari L., Calza F., Speroni M., Bertoni G., and Pirlo G. 2005. Welfare Assessment Based on Metabolic and Endocrine Aspects in Primiparous Cows Milked in a Parlor or with an Automatic Milking System. J. Dairy Sci. 88:3542-3552.

Abeni F., Terzano M.G., Speroni M., Migliorati L., Cappelletti M., Calza F., Bianchi L. and Pirlo G. 2008. Evaluation of Milk Enzymes and Electrolytes, Plasma Metabolites and Oxidative Status in Twin Cows Milked in an Automatic Milking System or Twice daily in a Conventional Milking Parlor. J. Dairy Sci. 91:3372-3384.

Barkema, H.W., Schukken Y.H.,. Lam T.J.G.M, Beiboer M.L., Benedictus G., Brand A.1998. Management practices associated with low, medium and high somatic cell count in bulk milk. J Dairy Sci 81: 1917-1927.

Barkema, H.W., J.D. Van der Ploeg, Y.H. Schukken, T.J.G.M. Lam, G. Benedictus, A. Brand. 1999. Management style and its association with bulk milk somatic cell count and incidence rate of clinical mastitis. J Dairy Sci 82:1655-1663.

Ballou, L. U., Pasquini, M., Bremel, R. D., Everson, T., Sommer, D., 1995. Factors Affecting Herd Milk Composition and Milk Plasmin at Four Levels of Somatic Cell Counts. J. Dairy Sci., 78,10, 2186- 2195.

Barbano D.M., Verdi R.J., Saeman A.I., Galton D.M., Rasmussen R.R., 1987. Impact of mastitis on dairy product yield and quality. 26th NMC Annual Meeting Proceedings. National Mastitis Council, Inc. Arlington, VA, 132.

Barbano, D. M., Ma, Y. Santos M. V., 2006. Influence of Raw Milk Quality on Fluid Milk Shelf Life. J. Dairy Sci. 89,(E. Suppl.):E15–E19.

Bernabucci U., Lacetera N., Ronchi B. and Nardone A. 2002. Effects of the hot season on milk protein fractions in Holstein cows. Anim. Res. 51: 25-33.

Carlucci A, Monteleone E, Braghieri A, Napolitano F. 2009. Mapping the effect of information about animal welfare on consumer liking and willingness to pay for yogurt. J. Sens. Stud.; 24:712–730.

Delamaire, E., and Guinard-Flament J. 2006. Longer milking intervals alter mammary epithelial

permeability and the udder‘s ability to extract nutrients. J. Dairy Sci. 89:2007–2016.
Elbakidze L., Nayga RM Jr. 2012. The effects of information on willingness to pay for animal welfare in dairy production: application of nonhypothetical valuation mechanisms. J Dairy Sci.; 95(3):1099-107.
European Food Safety Authority (EFSA), Panel on Animal Health and Welfare (AHAW),Parma, Italy. Scientific Opinion on the use of animal-based measures to assess welfare of dairy cows1EFSA Journal 2012; 10(1): 2554-2635.
Fernandes A.M., Oliveira C.A.F., Lima C.G., 2007. Effects of somatic cell counts in milk on physical and chemical characteristics of yoghurt. Int. Dairy J. 17, 111-115.
Fox P.F., Law P.L., MacSweeney L.H., Wallace J., 1993. Biochemistry of cheese ripening. In Cheese: Chemistry Physics and Microbiology, Vol.1 General Aspects. P.F. Fox ed. Chapman & Hall, London UK. Page 389-438.
Freeston P.P, Sandrini SM, Haigh RD, Lyte M. 2008. Microbial endocrinology: how stress influences susceptibility to infection. Trends Microbiol. 16(2):55-64.
Freestone P and Lyte M. 2010. Stress and microbial endocrinology: prospects for ruminant nutrition. Animal 4 (7): 1248-57.
Grufferty M.B., Fox P.F.,1988. Milk alkaline proteinase. J. Dairy Res., 55: 609-630.
Ismail B., Nielesen S.S., 2010. Invited review: Plasmin protease in milk: Current knowledge and relevance to dairy industry. J. Dairy Sci. 93: 4999-5009.
Kitchen B., 1981. Review of the progress of dairy science: Bovine Mastitis: Milk compositional changes and related diagnostic tests. J. Dairy Res., 48, 167-188.
Malacarne M., Fossa E., Sandri S., Tosi F., Summer A. & Mariani P. 2003. Seasonal variations of milk quality in Parmigiano-Reggiano cheese manufacture on a period of 10 years. EAAP Technical Series No7. "Interactions between climate and animal production", pp: 100.
Ma Y., Ryan C., Barbano D.M., Galton D.M., Rudan M.A., Boor K.J., 2000. Effects of somatic cell count on quality and shelf-life of pasteurized fluid milk. J. Dairy Sci. 83, 264-274.
Napolitano F, Pacelli C, Girolami A, Braghieri A. 2008. Effect of information about animal welfare on consumer willingness to pay for yogurt**.** J. Dairy Sci.; 91:910–917.
Napolitano F, Braghieri A, Piasentier E, Favotto S, Naspetti S, Zanoli R. 2010. Cheese liking and consumer willingness to pay as affected by information about organic production. J. Dairy Res.*;* 77:280–286.
Pala, A., Atakisi, G. 2012. Effects of animal welfare on sensory acceptance scoring of yogurt. Journal of Applied Animal Research, Volume 40, N.4, pp. 305-310.
Pizzoferrato L., Manzi P., Marconi S., Fedele V., Claps S. and Rubino R. 2007. Degree of Antioxidant protection: A parameter to trace the origin and quality of goat's milk and cheese. J. Dairy Sci. 90: 4569-4574.
Politis I., Ng-Kwai –Hang K.F., 1988. Effects of somatic cell counts and milk composition on cheese composition and cheese making efficiency. J. Dairy Sci. 71, 1711-1719.
Olynk N.J., Tonsor G.T., and Wolf C.A. 2010. Consumer Willingness to Pay for Livestock Credence Attribute Claim Verification. Journal of Agricultural and Resource Economics 35(2):261–280
Shipe W.F., Bassette R., Dean D.D., Dunkley W.L., Hammond E.G., Harper W.J., Kleyn D.H., Morgan M.E., Nelson J.H., and Scanlan R.A. 1978. Off Flavors in milk: Nomenclature, Standards and bibliography. J. Dairy Sci.61:855-869.
Speroni M., Pirlo G. and Lolli S. 2006. Effect of Automatic Milking Sistem on Milk Yield in a Hot Environment. J.dairy Sci. 89:4687-4693.
Stelwagen, K., Farr V. C., and McFadden H. A. 1999. Alteration of the sodium to potassium ratio in milk and the effect on milk secretion in goats. J. Dairy Sci. 82:52–59.
Stelwagen, K., Hopstert H., Van der Werf J.T.N. and Blokhuis H.J. 2000. Short Communication: effects of Isolation Stress on mammary Thigh Junction in lactating dairy cows. J. Dairy Sci.83:48-51.
Ward, W.R., Hughes J.W.,. Faull W.B,. Cripps P.J, Sutherland J.P. and Sutherst J.E.. 2002. Observational study of temperature, moisture, pH and bacteria in straw bedding, and fecal consistency, cleanliness and mastitis in cows in four dairy herds. Vet Rec. 151:199-206.

WHEY UTILIZATION FOR PRODUCTION OF BACTERIOCIN AND PROBIOTIC PREPARATIONS

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Abstract

Batch productions of nisin by Lactococcus lactis subsp. lactis CECT 539 and pediocin by Pediococcus acidilactici NRRL B-5627 were firstly investigated in MRS broth and in both deproteinized diluted (DDW) and concentrated (DCW) whey. Although both strains produced the higher amounts of biomass and bacteriocin titres on MRS broth, the productions on DDW were higher than on DCW. Therefore, the following experiment was focused on the optimization of the composition of DDW medium, by using factorial experiments and empirical modelling to study the effects of total sugar (lactose), nitrogen (glycine), phosphorous (KH_2PO_4) and buffer (potassium hydrogen phthalate–NaOH) concentrations on nisin and pediocin productions. The increase in buffer concentration led to a decrease in the production of both bacteriocins, and the supplements with lactose, glycine and KH_2PO_4 did not improve nisin and pedicoin productions.

Therefore, in an attempt for increasing bacteriocin production in DDW medium, both L. lactis CECT 539 and Ped. acidilactici NRRL B-5627 were grown in DDW media supplemented with lactose and four different nitrogen sources. Glycine and NH_4Cl were not good nitrogen sources, but the use of high concentrations of yeast extract and Casitone highly stimulated the production of both bacteriocins.

Since the use of these two complex nitrogen sources could be very expensive for bacteriocin production at a high scale, the production of bacteriocins and antibacterial factors by the two lactic acid bacteria was studied in DDW media by using re-alkalized fed-batch fermentations. These fermentations were mainly characterized with higher biomass and bacteriocin productions compared with the batch process in DDW medium and with the production of mixed acid metabolites (acetic acid, butane-2,3-diol and ethanol).

We also studied the fermentation kinetics of kefir grains CIDCA AGK1 on unbuffered and buffered DDW medium. In these studies, the highest levels of free biomass, lactic acid and acetic acid were obtained in the buffered medium. Subsequently, the effect of nitrogen and phosphorous supplementation on free biomass, lactic acid and acetic acid was studied in buffered DDW medium using factorial experiments and empirical modelling. Finally, the effect of agitation and aeration on the production of the three variables was studied by using the optimized DDW medium obtained in the latter experiment.

Keywords: *lactic acid bacteria, nisin, pediocin, kefir grains, probiotics, whey.*

INTRODUCTION

Cheese whey, which is a by-product of the dairy industry, contains usually high levels of lactose (about 50 g/L), low levels of nitrogen compounds and small amounts of vitamins and minerals (González, 1996; Guerra et al ., 2001). This effluent has been widely used for various bioproductions, such as organic acids, single-cell protein, enzymes, ethanol (González, 1996), bacteriocins (Guerra et al., 2001; Guerrae t.al., 2007; Fajardo, et.al., 2008) and probiotic preparations for animal feed (Guerra et.al 2007; Fajardo, et.al., 2008).

Nisin and pediocins are bacteriocins produced respectively by *Lactococcus lactis* and *Pediococcus* strains (organisms generally recognized as safe (GRAS)) (Guerra et al., 2001). Both bacteriocins exhibit a broad spectrum of antibacterial activity against Gram-positive spoilage and pathogenic bacteria present in foods such as *Listeria monocytogenes*, *Enterococcus faecalis*, *Staphylococcus aureus* and *Clostridium perfringens* (Bhunia et. al., 1988; Fajardo, et al., 2008). Both bacteriocins have proved to be effective food biopreservatives because they are innocuous, sensitive to digestive proteases and they do not produce changes in

the organoleptic properties of the foods. Since both bacteriocins in combination with other stress inducing processes (such as heating, freezing, acid treatment, chelating agents, high hydrostatic pressure and electroporation) can also be effective against Gram-negative or resistant Gram-positive bacteria (Kalchayanand,et al., 1992; Kalchayanand, Sikes et al., 1994; Fajardo, et al., 2008), there is a considerable interest in using them in current and potential applications in the veterinary and pharmaceutical areas.

Probiotics are living microorganisms that once ingested by humans and animals in sufficient numbers, can beneficially influence the health of the host (Salminen et al., 1998; Bogovič-Matijašić et al.j, 2004). The mode of action of probiotics is strain and host-dependent and may include the modulation of the host intestinal microbiota, modifications of the structure and function of the intestinal epithelium and stimulation of the immune response by activation and regulation of mucosa-associated and immune system responses (Gardiner et al., 2004;).

In recent years, some probiotic preparations, containing high concentrations of viable cells and antimicrobial substances, have been assayed as additives in animal feed as an alternative to the use of antibiotic growth promoters (Abe, et al 1995; Guerra et al., 2007; Fajardo, et al., 2008). This is basically due to the emergence of resistant bacteria and resistance genes as a consequence of the use of these latter compounds (Aarestrup, 2005). These antibiotic-resistant bacteria can spread among animal species and be transmitted to humans by food of animal origin (Abe et al., 1995; Tortuero,et al., 1995; Aarestrup, 2005).

Some lactic acid bacteria (LAB) strains (e.g. strains of the genus *Bifidobacterium*, *Lactobacillus*, *Pediococcus*, *Streptococcus* and *Enterococcus*) have proven to be effective in prevention or treatment of some diseases in humans and animals (Gardiner et al., 1999; Bogovič-Matijašić et al., 2004; Ohashi et al., 2004; Anadón et al., 2006), due to their adhesion capability to gut intestinal epithelial cells and their ability to produce antibacterial products (mainly organic acids and bacteriocins) (Bogovič-Matijašić et al., 2004; Sablon, et al.,, 2000; Guerra,et al.,2007). However, there are discrepancies in the results obtained because more often such effects were not significant, except when the animals are challenged with selected pathogenic strains or in gnotobiotic animals (Bogovič-Matijašić et al., 2004) and in other cases administration of LAB have shown no effects (Gardiner et al., 1999).

For an effective application as additives in animal feed, a potential probiotic strain must be: i) non-pathogenic and non-toxic, ii) beneficial to the host in some way after consumption, iii) amenable to industrial scale cultivation, vii) able to produce high amounts of antimicrobial substances with antagonistic activity against noted pathogenic bacteria and/or viruses, iv) able to attach to the gut epithelial tissue, v) able to colonise and persist within the gastrointestinal tract, vi) able to survive passage through the gastrointestinal tract, and viii) stable during preparation and storage of the carrier feed (Berg, 1998; Fajardo, et al., 2008).

The use of cheaper culture media (*e.g*. wastes from food industry) and an efficient cultivation method could be an appropriate alternative to produce probiotic culture highly concentrated at a low production cost (Guerra and Pastrana, 2003; Guerra et al 2007; Fajardo et al., 2008b; Guerra et al., 2010). Considering that substantial amounts of whey are available free, or commercialized at very low cost by local dairy of Galicia, the use of this waste as culture medium could provide a profitable substrate for production of probiotic culture concentrates. This approach allows an effective reduction of the initial chemical oxygen demand (COD) of the whey (Guerra et al., 2001; Guerra and Pastrana, 2003) and the recycling of this waste in production of probiotic culture concentrates (Guerra and Pastrana, 2003; Guerra, Fajardo and Pastrana, 2007; Fajardo,et al.,2008b; Guerra et al., 2010). With regard to the cultivation method, a fed-batch technique based on periodical re-alkalizations of the culture medium has proved to be effective for enhancing biomass and antimicrobial products synthesis by some LAB in different culture media (Cabo, et al., 2001; Guerra and Pastrana, 2003; Guerra, Fajardo and Pastrana, 2007; Guerra et al., 2010; Fajardo et al

Guerra, 2008b). In fact, the concentrations of biomass and antibacterial products obtained in these cultures were higher than those obtained in the corresponding batch cultures on the same culture media.

Taking into account the large number of microorganisms (LAB, acetic bacteria and yeast) present in the kefir grains, as well as the variety of bioactive products than can be produced by them (Farnworth, 2005), the use of kefir grains as a starter culture in whey fermentation could be more advantageous than the use of a single LAB. This approach could allow the production of a more concentrated probiotic product containing a larger number and variety of microorganisms and products than those with a single LAB. In addition, in vitro and animal trials have shown kefir and its constituents to have anticarcinogenic, antimutagenic, antiviral and antifungal properties (Farnworth, 2005).

Although the stability of the microbiota present in the kefir grains is maintained when it is preserved and cultivated under appropriate conditions (Simova et al., 2002), several studies indicate that the balance and presence of species and strains depends on both the kefir origin and process conditions (Garrote et al., 1998). It is therefore crucial to know the possible deleterious effects that the operation mode can produce on the microbial populations and consequently, on the quality and stability of the fermented product, which are two essential requirements for the marketing of the product. However, only a few studies deal with the study of the effects of the process and culture conditions on the fermentation kinetics of whey by kefir grains (Schoevers and Britz, 2003; Koutinas et al., 2005; Tramšek and Goršek, 2008).

For these reasons, the main purpose of this work was to give an overview on the use of whey and different fermentation strategies for the production of antimicrobial compounds (mainly bacteriocins, lactic acid and acetic acid) and probiotic preparations with two LAB (*Lactococcus lactis* subsp. *lactis* CECT 539 and *Pediococcus acidilactici* NRRL B-5627) and with kefir grains CIDCA AGK1.

EXPERIMENTAL

All experimental details about strains, culture conditions, analytical determinations and statistical analysis were taken from our previous works (Guerra and Pastrana, 2001a; 2001b; Guerra et al., 2001; Guerra,et al., 2007; Fajardo et al., 2008; Fajardo et al., 2008a).

RESULTS AND DISCUSSION

1. Whey fermentations

1.1. Whey fermentation with lactic acid bacteria

The production of bacteriocins (nisin and pediocin) and probiotic preparations by *L. lactis* subsp. *lactis* CECT 539 and *Ped. acidilactici* NRRL B-5624 was assayed in culture media prepared with both concentrated (DCW) and diluted (DDW) whey. The composition (g/L) of the DCW medium was, total sugars, 48.11; proteins, 5.02; total nitrogen, 1.05 and total phosphorus, 0.43. The composition (g/L) of the DDW medium was, total sugars, 20.54; proteins, 2.04; total nitrogen, 0.45 and total phosphorus, 0.25.

Although the results (**Figures 1 and 2**) showed that the DDW medium without supplementation is capable of promoting the growth of the two lactic acid bacteria (LAB), the productions of nisin (23 BU/mL) and pediocin (58 BU/mL) obtained (Guerra et al., 2001) were respectively lower than those produced in MRS broth by the strains CECT 539 (50 BU/mL) and NRRL B-5624 (493 BU/mL) (Guerra and Pastrana, 2001a). This observation suggested that DDW medium lacks of some nutrient necessary for biomass and bacteriocin production. Therefore, we studied the effects of supplementation with glycine (as nitrogen (N) source), KH_2PO_4 (as phosphorous (P) source) and lactose (as carbon (C) source) on nisin and pediocin synthesis by strains CECT 539 and NRRL B-5624 in whey. Since the pH was found to be an important variable in bacteriocin production (Guerra and Pastrana, 2001a; Guerra et al., 2001), the effect of the concentration of the buffering (B) agent (Potassium hydrogen phthalate–NaOH) was

included in this study, which was carried out by using a 2^4-full factorial design with four replicates of the central treatment (Guerra et al., 2001). The experimental ranges selected for each variable were between 0-0.1 M (in case of B), 26-48 g/L (in case of C), 0.43-7.55 g/L (in case of N) and 0.27-1.56 g/L (in case of P).

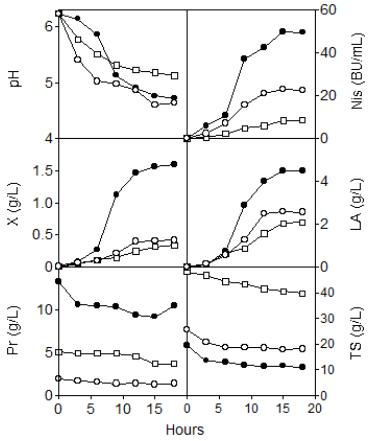

Figure 1. Batch fermentations of *L. lactis* CECT 539 on MRS broth (black circle), DDW medium (white circle) and DCW medium (white square). Nis, nisin; X, biomass; LA, lactic acid; Pr, protein; TS, total sugars.

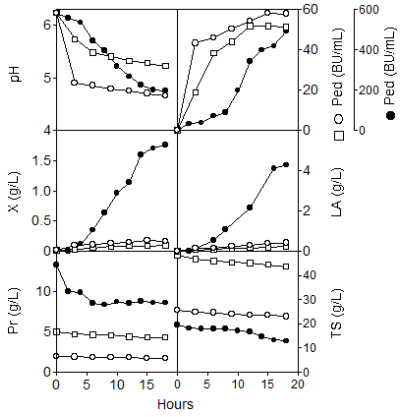

Figure 2. Batch fermentations of *Ped. acidilactici* NRRL B-5627 on MRS broth (black circle), DDW medium (white circle) and DCW medium (white square). Ped, pediocin; X, biomass; LA, lactic acid; Pr, protein; TS, total sugars.

The results obtained showed that the supplementation with lactose, glycine and KH_2PO_4 and the use of a buffering agent did not improve the productions of nisin and pediocin by *L. lactis* CECT 539 and *Ped. acidilactici* NRRL B-5624 in DDW medium (**Figure 3**).

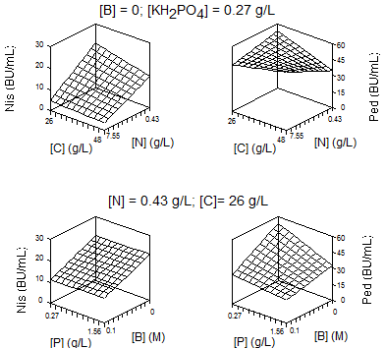

Figure 3. Response surfaces showing the effect of the concentrations of lactose (C), glycine (N), KH_2PO_4 (P) and the buffering agent (B) on nisin (Nis) and pediocin (Ped) production by *L. lactis* CECT 539 and *Ped. acidilactici* NRRL B-5627 in DDW medium.

For this reason, in a following step, our group investigated the effect of different nitrogen sources (glycine, NH_4Cl, yeast extract and Casitone) on nisin and pediocin production in batch cultures in DDW medium (Guerra and Pastrana, 2001b). In this study, both the amino acid and the inorganic salt were not good nitrogen sources for bacteriocin production. However, enhanced concentrations of nisin (59 and 74 BU/mL) and pediocin (185 and 195 BU/mL) were obtained when the whey was supplemented with casitone or yeast extract, respectively (**Figure 4**). However, this approach could be uneconomic for a high-scale bacteriocin production due to the high cost of the complex nitrogen sources in comparison with the low cost of whey.

The results obtained in the above batch cultures (Guerra et al., 2001; Guerra and Pastrana, 2001b) showed that low carbon source concentrations and high pH drops are needed for stimulating bacteriocin production. These observations were taken into account to develop the re-alkalized fed-batch fermentations, in which the DDW medium was used as a fermentation medium instead of the DCW medium. In addition, the fed-batch fermentations were carried out without pH control, allowing the pH to freely drop from its initial value until the 12 h of fermentation, justly when the nutrients (sugars, nitrogen,

phosphorous) utilization, cell growth and bacteriocin production stopped (Guerra et al., 2001).

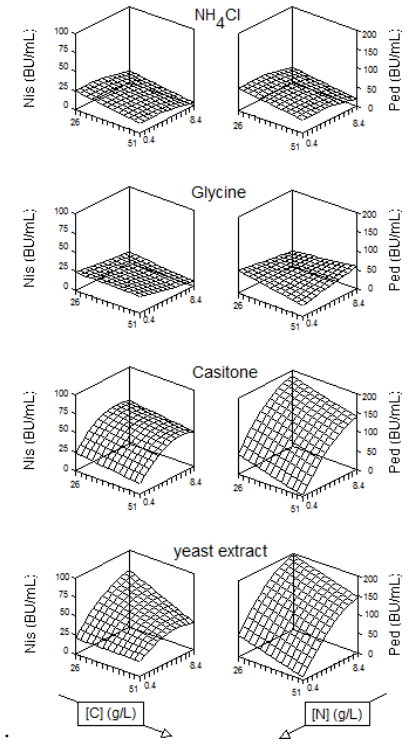

Figure 4. Response surfaces showing the effect of the concentrations of lactose (C) and four nitrogen (N) sources on nisin (Nis) and pediocin (Ped) production by *L. lactis* CECT 539 and *Ped. acidilactici* NRRL B-5627 in DDW medium.

Re-alkalized fed-batch fermentations (Guerra and Pastrana 2003; Guerra et al, 2005) were carried out in a 6 L bench top fermentor (New Brunswick Scientific, New Jersey) with a 4 L working volume of medium at controlled temperature (30ºC), agitation (200 rpm) and aeration flow rate (0.5 L/h). Fermentations were initiated as a batch fermentation without pH-control during the first 12 h of culture. Then, a sample of 100 mL was taken from the fermentation medium to perform analytical determinations. After determining the total sugars concentration in the sample withdrawn, the medium was re-alkalized up to a set pH of 7.0 with 5 M NaOH. The necessary volumes of feeding substrates to restore the initial total sugars concentration (~ 20 g/L) in the fermentation medium were calculated by applying mass balance equations for the total sugars around the fermentor. In these equations, the volumes of NaOH added to the fermentor in each re-alkalization cycle were taken into account. These sampling, feeding and re-alkalization strategies were repeated every 12 h until the strains were unable to bring about the decrease of pH.

In the re-alkalized fed-batch culture of *L. lactis* in DDW medium (fermentation 1), the fermentor was fed with a mixture of a 400 g/L concentrated lactose and DCW medium (Guerra and Pastrana 2003). In case of *Ped. acidilactici* (fermentation 2) (Guerra et al., 2005), the DDW medium was supplemented with a 2% (w/v) yeast extract (DDWYE2 medium) due to the negligible growth observed during the batch culture in DDW medium (Guerra et al., 2001), in contrast with the exuberant growth observed in the same culture medium supplemented with varying concentrations of yeast extract (Guerra and Pastrana, 2001b). In this re-alkalized fed-batch fermentation, the fermentor was fed with a mixture of a 400 g/L concentrated glucose and DCW medium supplemented with 2% (w/v) yeast extract (DCWYE2 medium). The inoculum in the re-alkalized fed-batch cultures consisted in 2% (v/v) of a 12-h culture in DDW medium (in case of *L. lactis*) or DDWYE2 medium (in case of *Ped. acidilactici*).

In the *L. lactis* re-alkalized fed-batch culture (**Figure 5**), the accumulated concentrations of biomass (3.5 g/L) and nisin (125 BU/mL) (Guerra and Pastrana, 2003), were respectively 2.2 and 2.5 times higher than those obtained on MRS broth (1.6 g/L and 50 BU/mL) (Guerra and Pastrana, 2001a). In this culture, the nitrogen source seemed to be consumed in two steps and consequently, biomass concentration displayed two exponential growth phases and two nonexponential growth phases. In addition, biomass concentration stopped when the cultures reached a low nitrogen concentration, even though the carbon source levels were still sufficiently available. These observations suggested that the nitrogen source was the

growth limiting substrate for *L. lactis* CECT 539 in this re-alkalized fed-batch fermentation.

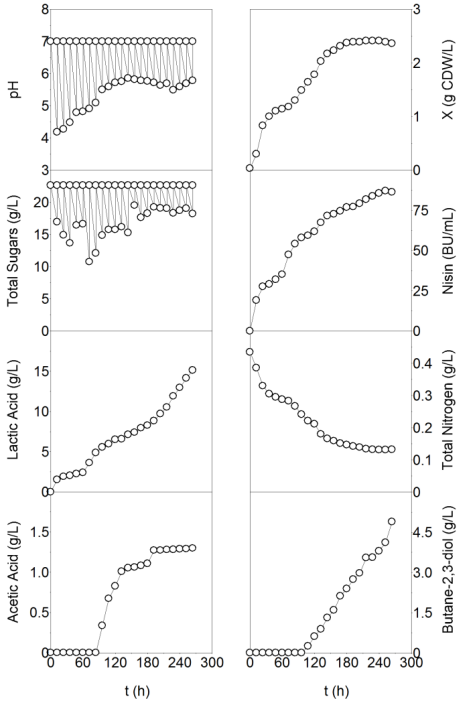

Figure 5. Re-alkalized fed-batch culture of *Lactococcus lactis* subsp. *lactis* CECT 539 in DDW medium with feeding with DCW medium and a 400 g/L concentrated lactose. X: biomass.

Taking into account the organic acids production, there were an initial homolactic phase (first 84-h of incubation) in which, only lactic acid was produced) followed by a second mixed acid fermentation phase (84 h to the end of the cultivation), in which lactic acid, acetic acid and butane-2,3-diol accumulated in the medium. The active period increased from 12 h in batch cultures to 264 h in the re-alkalized fed-batch culture.

In the re-alkalized fed-batch culture of *Ped. acidilactici* NRRL B-5627 (**Figure 6**), the concentrations of biomass (6.57 g/L) and bacteriocin (518 BU/mL) (Guerra et al., 2005) produced were respectively, 3.7 and 1.05 times higher than those levels obtained on MRS broth (Guerra and Pastrana, 2001a). However, in this case, a mixed acid fermentation phase was observed from the start of the fermentation, and increased concentrations of lactic acid, acetic acid and ethanol accumulated in the culture medium. The active period increased from 15 h in batch cultures (Guerra et al., 2001) to 240 h in the re-alkalized fed-batch culture (Guerra et al., 2005).

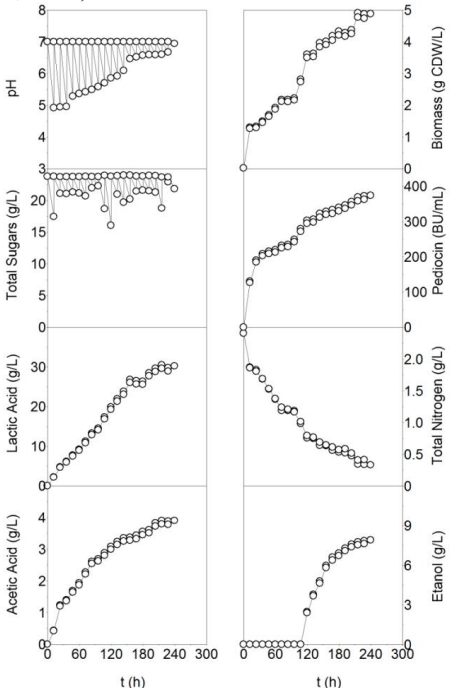

Figure 6. Re-alkalized fed-batch culture of *Pediococcus acidilactici* NRRL B-5627 in DDWYE2 medium with feeding with DCWYE2 medium and a 400 g/L concentrated glucose.

Taking into account the high concentrations of biomass and antimicrobial metabolites produced in the re-alkalized fed-batch cultures in whey, the following experiment was focussed on the evaluation of highly concentrated and viable probiotic culture (probiotic preparations) of four LAB (*Ped. acidilactici* NRRL B-5627, *L. lactis* CECT 539, *Lactobacillus casei* CECT 4043) as additives in animal feed. The results obtained showed that the use of the three potentially probiotic strains as additives in animal feed, stimulated the growth of post-weaning piglets and reduced coliform counts in the faeces of the animals. This indicated that these LAB could be suitable strains for widespread use in the pig industry (Guerra, Fajardo, et al., 2007).

1.2. Whey fermentation with kefir grains

In the last years, our research group has been focused on the study of the kinetic of the batch fermentation of whey by kefir grains CIDCA AGK1 (Fajardo et al., 2010). The cultures were carried out in 250 mL Erlenmeyer flasks containing 50 mL of deproteinized whey medium on a rotary shaker with shaking at 200 rpm at 30 ºC for 80 h. A culture on skimmed milk (–Hacendado", Spain) obtained from a local supermarket, was carried out in the same conditions as those used in the culture on whey, to obtain data for comparisons.

The initial composition of the skimmed milk (in g/L) used was: lactose, 60.0; proteins, 35.0; phosphorous, 0.12 and initial pH, 6.8. Whey was obtained from a local dairy plant (–Queserías Prado", Lugo, Spain) with the following mean composition (in g/L): lactose, 34.7; reducing sugars, 24.8; proteins, 11.5 and initial pH, 4.86. Before being used as culture medium, whey was deproteinized as described previously (Guerra et al., 2001) and a final protein concentration of 5.0 g/L was obtained. The deproteinized whey was adjusted to pH 6.5 and sterilized at 121 ºC for 15 min.

The pre-inoculum in both cultures was prepared by transferring 0.5 g of kefir grain into 50 mL of skimmed milk (–Hacendado") and incubated for 24 h at 30 ºC with agitation at 200 rpm. An aliquot (1 mL) of this preculture and 0.5 g of the kefir grains were used to inoculate the deproteinized whey medium or skimmed milk (Fajardo et al., 2010). Samples were withdrawn at intervals during the incubation to perform the analytical determinations.

The results obtained in this assay are shown in **Figure 7**. Although the initial pH of whey was initially adjusted to 6.5 with 2N NaOH, it decreased to a value of 4.86 after medium sterilization, and then the culture was started at this pH level. Then, the culture pH dropped to 4.0 during the first 4 h of incubation and remained constant afterwards.

In this culture, the dry weight of the grain (GDW) increased only slightly during the incubation. Free biomass production (as cell dry weight, CDW) reached its highest level (2.0 g/L) after 24 h of fermentation, remained constant until the 60 h, and then began to fall, when relatively high concentrations of lactose (17.0 g/L) remained in the medium. Thus, this growth cessation could be due to the exhaustion of nutrients (the sources of nitrogen and phosphorus) or any essential micronutrient for biomass production, or due to the low pH levels (below 4.0) achieved in the culture medium.

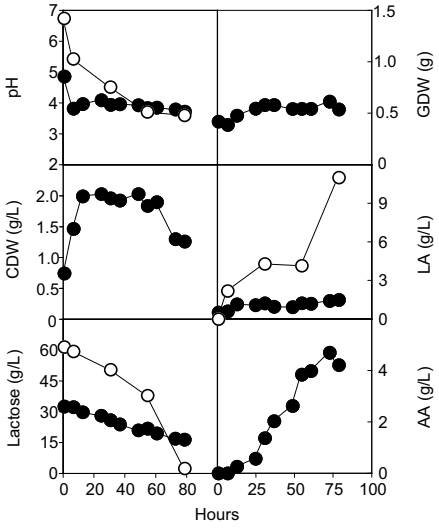

Figure 7. Kinetics of the batch fermentation of kefir grains CIDCA AGK1 on unbuffered whey (closed symbols) and skimmed milk (open symbols). CDW: cell dry weight of free biomass, AA: acetic acid, LA: lactic acid, GDW: grains dry weight.

Production of acetic acid (4.3 g/L) was only detected in whey, probably due to the metabolic activity of acetic bacteria or the development of an early heterolactic fermentation as a result of nutrient limitation due to low nitrogen content in the deproteinized whey medium. This behaviour has been observed before in other cultures with *L. lactis* CECT 539, *Ped. acidilactici* NRRL B-5627 and *Lactobacillus casei* subsp. *casei* CECT 4043 on whey (Guerra and Pastrana, 2003; Guerra et al., 2005; Fajardo, et al., 2008).

Determination of biomass in the milk culture was not possible due to the high amount of material precipitated after performing the centrifugation of the medium. As expected, lactic acid concentration in milk (11.0 g/L) was 7 times higher than in whey (1.5 g/L). This was probably due to the fact that milk

contains a higher concentration of nutrients (sources of carbon, nitrogen, phosphorus, vitamins, etc.) than the whey medium. Consumption of lactose in milk (59.0 g/L) was also higher than that in whey (16.1 g/L) during the whole fermentation period.

In general, the differences observed between the productions obtained in milk and whey could be related to the different initial media composition, initial pH levels (6.8 in milk, and 4.86 in whey) and pH evolution. According to Poolman and Konings (1988), the amino acid or peptide transport, which is one of the growth-rate-determining steps, depends on the culture pH. For *L. lactis* and *L. cremoris* strains, the optimum pH value for amino acid transport varied between 6.0 and 6.5, decreasing rapidly at higher and lower pH values (Poolman and Konings, 1988). In addition, a low nutrient consumption and consequently, a low biomass production by *Lact. casei* CECT 4043 (Fajardoet al, 2008) and *Ent. faecium* CECT 410 (Guerra et al., 2010) was observed in batch cultures in whey when the media reached a pH value below 5.0. In both cases, the observed reduction in the growth was related not only to a limitation in nutrient transport, but also to the exhaustion of some essential micronutrients (vitamins or minerals) or amino acids in the medium (Hofvendahl, et al, 1999; Fajardo et al 2008; Guerra et al., 2010).

In order to verify if the low initial pH and the low pH levels reached in the medium during fermentation affected the fermentation kinetic of kefir grains in whey, a new culture was performed with a whey medium buffered to an initial pH of 6.5 with 0.10 M potassium hydrogen phthalate-NaOH. The fermentation conditions were the same as in the previous culture.

The results obtained (**Figure 8**) showed that the pH dropped from its initial level of 6.5 to a value of 5.4 during the first 12 h of fermentation and remained almost constant afterwards. This fact did not affect the growth of the grains, because the final GDW obtained was similar to that of the previous culture. However, the productions of biomass (4.4 g/L) and lactic acid (6.2 g/L), as well as the lactose consumption (25.4 g/L) were higher than those obtained in the unbuffered whey medium, showing the positive effect of pH control on these variables.

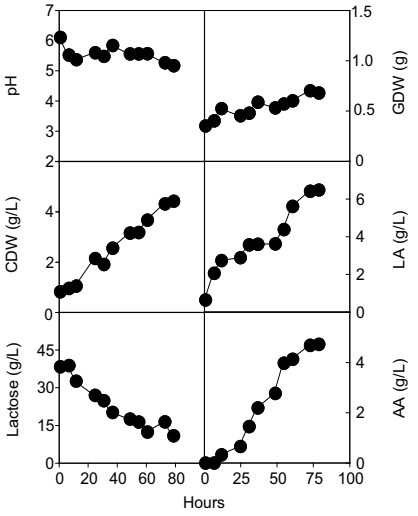

Figure 8. Kinetics of the batch fermentation of kefir grains CIDCA AGK1 on whey buffered at initial pH of 6.5 with 0.10 M potassium hydrogen phthalate–NaOH. Notations are as in Figure 7.

Surprisingly, acetic acid production reached the same final level as in the previous fermentation (Figures 7 and 8). Since the pH values never dropped below 5.0, it could be considered that a limitation of nutrients uptake and consequently the shift from homolactic to heterolactic fermentation did not occur in the culture in buffered whey. Thus, it is reasonable to suppose that the accumulation of acetic acid in this culture was probably due to the increase of the metabolic activity of the acetic bacteria present in the kefir grains.

After clarifying the positive effect that the initial pH and its evolution produced on the production of biomass and lactic acid, the following experiment was focussed on the optimization of the composition of buffered whey medium.

Since the carbon source is not completely consumed during the fermentations (see **Figures 7** and **8**), it could be considered that the initial lactose in the whey medium (~ 35 g/L) is suitable for the growth of the microbial population present in the kefir grains. For this reason, in the following experiment, the whey was supplemented with

phosphorus (P) and nitrogen (N) sources, whose concentrations in this medium are lower than those of the complex culture media such as milk or MRS medium (Guerra and Pastrana, 2001a). With this experiment, the production of free biomass, lactic acid and acetic acid after N and P supplementation could be studied in buffered whey without nutrient limitation.

Thus, a central composite design (Akhnazarova and Kafarov, 1982; Box et al, 1989) based on two levels and two variables was used to study the effect of the initial concentrations of total nitrogen and phosphorous on free biomass production and product (lactic and acetic acid) synthesis on buffered whey. The design consisted of 13 experiments with four (2^2) factorial points, four axial points to form a central composite design with $\alpha = 1.267$ and five centre points for replication (**Table 1**)

.Table 1. Experimental domain and codification of the variables in the study on the effect of the nitrogen (N) and phosphorous (P) sources on production of free biomass and product formation by kefir grains CIDCA AGK1 on buffered whey.

Codified values	Natural values	
	N (g/L)	P (g/L)
-1.267	0.00	0.00
-1	2.32	0.21
0	11.01	1.00
1	19.70	1.79
1.267	22.00	2.00

Those concentrations corresponding to the buffered whey medium (initial pH = 6.5) without supplements were taken as the inferior levels ($\alpha = -1.267$) for the N and P variables. To reach the superior limit ($\alpha = 1.267$), the media were supplemented with the sources of phosphorus (K_2HPO_4) and nitrogen (a mixture of bacteriological peptone, meat extract and yeast extract) to obtain the same concentrations as in the MRS medium. This approach would provide, *a priori*, an increase in the production of free biomass and antimicrobial substances (Guerra and Pastrana. 2001b; 2002).

Results were analyzed by Experimental Design Module of the Statistica software package (Statistica 5.1 for Windows computer program manual; StatSoft Inc. Tulsa, OK, USA, 1996). The Student's *t*-test was employed to check the statistical significance of the regression coefficients. The Fisher's *F*-test for analysis of variance (ANOVA) was performed on experimental data to evaluate the statistical significance of the models.

Table 2 shows the experimental matrix, as well as the corresponding results for the productions of free biomass (CDW), lactic acid (LA) and acetic acid (AA) and the final pH reached in the cultures. As can be observed, the final pH values obtained in the cultures were from 4.41 to 4.64. Therefore, the effect of this variable on the metabolic activity of the microbiota present in the kefir grains appeared to be not significant.

The corresponding analysis of variance (ANOVA) of each empirical model obtained along with the values of the determination coefficient (R^2) and the adjusted determination coefficient are presented in **Table 3**. In each case, the equations obtained for CDW, LA and AA productions were highly significant in Fisher's *F*-tests ($\alpha < 0.05$) applied to the quotients total error/experimental error and lack of fitting/experimental error. In addition, the higher values of R^2 obtained (0.847 or higher) indicated that the fitted models could explain at least 85 % of the total variation in the responses. These facts indicate that the quadratic models were appropriate to fit and describe satisfactorily the experimental data.

After eliminating the non-significant coefficients, the corresponding empirical equations obtained for CDW, LA and AA productions as a function of the concentrations of N and P, in coded units, were:

$$\text{CDW (g/L)} = 5.70 + 0.56 \cdot N + 0.56 \cdot P - 0.61 \cdot P^2$$

$$\text{LA (g/L)} = 8.84 + 0.75 \cdot N + 1.02 \cdot P - 0.99 \cdot P^2$$

$$\text{AA (g/L)} = 22.06 + 1.76 \cdot N + 2.77 \cdot P - 6.91 \cdot N^2 \quad (3)$$

Table 2. Experimental concentrations of free biomass (CDW), lactic acid (LA), acetic acid (AA) and final pH values reached in the buffered whey media supplemented with different concentrations of N and P according to the experimental matrix defined in Table 1.

Codified values		Natural values		Response variables			
N	P	N (g/L)	P (g/L)	LA (g/L)	AA (g/L)	CDW (g/L)	Final pH
1	1	19.70	1.79	10.02	20.35	6.27	4.45
1	-1	19.70	0.21	8.20	15.96	5.16	4.41
-1	1	2.32	1.79	7.99	12.73	5.15	4.56
-1	-1	2.32	0.21	6.36	9.57	4.09	4.53
1.267	0	22.00	1.00	8.99	9.47	6.46	4.64
-1.267	0	0.00	1.00	7.79	10.50	5.01	4.64
0	1.267	11.01	2.00	8.40	23.92	5.40	4.55
0	-1.267	11.01	0.00	5.29	14.09	3.97	4.54
0	0	11.01	1.00	9.06	22.02	5.72	4.51
0	0	11.01	1.00	9.20	23.02	5.91	4.45
0	0	11.01	1.00	8.54	20.02	5.49	4.55
0	0	11.01	1.00	9.20	24.02	5.91	4.48
0	0	11.01	1.00	8.54	22.02	5.49	4.48

Table 3. Significance analysis of the proposed models for the free biomass (CDW), lactic acid (LA) and acetic acid (AA) production. SS: Sum of Squares; df: degrees of freedom; QM: Quadratic Means; E: total error; Ee: Experimental error; LF: Lack of Fitting.

	CDW (g/L)			LA (g/L)			AA (g/L)		
QME/QMEe	0.50			2.15			2.96		
F ($\alpha = 0.05$)	$F^9_4 = 6.00$			$F^9_4 = 6.00$			$F^9_4 = 6.00$		
QMLF/QMEe	0.10			3.07			4.52		
F ($\alpha = 0.05$)	$F^5_4 = 6.26$			$F^5_4 = 6.26$			$F^5_4 = 6.26$		
R^2	0.969			0.882			0.847		
Adjusted R^2	0.959			0.842			0.800		
	SS	df	QM	SS	df	QM	SS	df	QM
Model	6.34	3	2.11	16.67	3	5.56	323.88	3	107.96
Error	0.20	9	0.02	2.24	9	0.25	58.55	9	6.51
Exp. error	0.18	4	0.04	0.46	4	0.12	8.80	4	2.20
Lack of fitting	0.02	5	0.00	1.78	5	0.36	49.75	5	9.95
Total	6.55	12	0.55	18.91	12	1.58	382.44	19	0.028

Table 4. Experimental conditions to study the effect of aeration, agitation and inoculum size in the kinetic behaviour of whey fermentation by kefir grains CIDCA AGK1.

Series	Erlenmeyer flask volume (mL)	Medium volume (mL)	Inoculum	Agitation speed (rpm)
1	250	50	0.5 g of kefir grain 1.0 mL of fermented milk	200
2	250	100	1.0 g of kefir grain 2.0 mL of fermented milk	200 (0 - 24 h), 0 (24 - 48 h), 200 (48 - 72 h), 0 (72 - 96 h)
3	150	90	0.9 g of kefir grain 1.8 mL of fermented milk	0

The significant coefficients for the quadratic term P^2 in models (1) and (2), and the quadratic term N^2 in model (3), imply the existence of optimum values for P and N inside the experimental domain for CDW, LA and AA. For CDW and LA productions, the coefficient for the quadratic term N^2 was found to be non-significant and the linear term N had a positive coefficient. For AA production, a non-significant value was obtained for the quadratic term P^2 and the linear term P had a positive coefficient.

Therefore, the optimum value of N for CDW and LA productions was located in the maximum level (N = 22.0 g/L) assayed for this independent variable. In case of AA production, the optimum value of P was also located at its maximum value (P = 2.0 g/L).
The response surfaces obtained according to the three above models showed that the productions of CDW, LA and AA were highly influenced by both the phosphorus and nitrogen source concentrations (**Figure 9**).

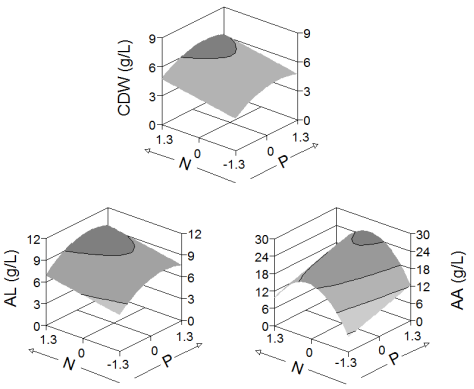

Figure 9. Response surfaces showing the effect of the nitrogen and phosphorous sources on the batch production of free biomass (CDW), lactic acid (LA) and acetic acid (AA) by kefir grains CIDCA AGK11, during 96 hours, on whey buffered at initial pH of 6.5 with 0.10 M potassium hydrogen phthalate–NaOH.

Thus, the optimum concentrations of CDW (5.7 g/L), LA (10.0 g/L) and AA (25.7 g/L) were obtained for N = 22.00 g/L and P = 1.36 g/L, for N = 22.00 g/L and P = 1.41 g/L and for N = 12.12 g/L and P = 2.00 g/L, respectively. These optimum concentrations of CDW, LA and AA were higher than those (4.5, 5.5 and 5.2 g/L, respectively) obtained in the previous experiment. This indicates that there was not nutrient limitation in the cultures on buffered whey supplemented with the complex nitrogen sources and K_2HPO_4, and consequently, the metabolic activity of both the acetic and lactic acid bacteria was favoured.
Taking into account that in the fermentation processes, other variables such as the agitation, aeration and inoculum size have a marked influence on the evolution of the fermentation process (Cabo et al., 2001; Pérez and Guerra, 2009), the following experiment was focused on the study of the effect of these independent variables on CDW and product formation (as response variables) by kefir grains in supplemented buffered whey.
The results obtained in the previous experiment showed that the optimum values for the response variables were obtained for different concentrations of the nitrogen and phosphorus sources. Therefore, the following experiment was carried out by supplementing the buffered whey with the mean concentrations of N and P (18.71 and 1.59 g/L, respectively) that provided the optimum CDW, LA and AA concentrations.
The culture conditions defined for this experiment are shown in **Table 4**. In this study, different Erlenmeyer flask volume/medium volume relationships were used to ensure different levels of aeration in the culture media.
The results obtained (**Figure 10**) showed that the evolution of the culture pH was not affected by changes in agitation, inoculum size and aeration. In addition, the different agitation and aeration strategies had a poor influence on the production of lactic acid, but there was a slight stimulation of production of ethanol and acetic acid in the static conditions (third series).

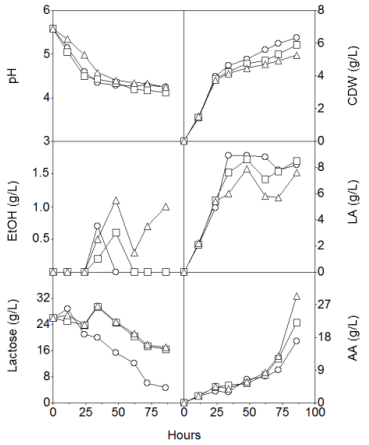

Figure 10. Kinetics of the batch fermentations of kefir grains CIDCA AGK1 on buffered whey supplemented with N and P sources (for more details see the text). The symbols correspond to the series 1 (○), series 2 (□) and series 3 (Δ). EtOH: ethanol. Notations are as in Figure 7.

On the other hand, the continue agitation favoured the consumption of the carbon source, since a concentration of lactose below 4.0 g/L was obtained in the culture carried out at a constant agitation speed of 200 rpm. Since in this culture, the production of lactic acid and acetic were respectively similar and lower, than those of the other two series, it is reasonable to suppose that the higher amounts of lactose consumed in the first culture was mainly used for biomass production. In fact, the final concentration of CDW obtained in the first series (6.32 g/L) was higher than those obtained in the second (5.88 g/L) and third (5.27 g/L) series (**Table 1** and **Figure 10**).

Ethanol production was slightly higher in the static culture (series 3) than in the other two fermentations. However, in the series 1 and 2, ethanol concentration dropped to zero before the end of the cultivations (**Figure 10**). The disappearance of ethanol in these cultures could be due to its assimilation as carbon source by the acetic bacteria to produce acetic acid (Nanda et al., 2001; Sueki, et al, 2005).

These promising results indicated that whey could be used a profitable substrate for production of highly concentrated probiotic cultures to be used as additives in animal feed.

REFERENCES

Aarestrup, F. M. 2005. Veterinary drug usage and antimicrobial resistance in bacteria of animal origin. Basic and Clinical Pharmacology and Toxicology, 96, 271-281.

Abe, F., Ishibashi, N., and Shimamura, S. (1995). Effect of administration of bifidobacteria and lactic acid bacteria to newborn calves and piglets. Journal of Dairy Science, 78, 2838-2846.

Akhnazarova, S., and Kafarov, V. (1982). Experiment optimization in chemistry and chemical engineering. (1st ed.). Moscow, MIR.

Anadón, A., Martínez-Larrañaga, M.R., and Martínez, M. A. (2006). Probiotics for animal nutrition in the European Union. Regulation and safety assessment. Regulatory Toxicology and Pharmacology, 45, 91-95.

Berg, R.D. (1998). Probiotics, prebiotics or 'conbiotics'?. Trends in Microbiology, 6, 89-92.

Bhunia, A. K., Johnson, M. C., and Ray, B. (1988). Purification, characterization and antimicrobial spectrum of a bacteriocin produced by *Pediococcus acidilactici*. Journal of Applied Bacteriology, 65, 261-268.

Bogovič Matijašić, B., S. Stojkovic, J. Salobir, S. Malovrh, and Rogelj, I. (2004). Evaluation of the *Lactobacillus gasseri* K7 and LF221 strains in weaned piglets for their possible probiotic use and their detection in the faeces. Animal Research, 53, 35-44.

Box, G. E. P., Hunter, W. G., and Hunter, J. S. (1989). Estadística para investigadores. (2nd ed.). Barcelona, Reverté, (Chapter 5).

Cabo, M.L., Murado, M.A., González, Mª.P., and Pastoriza, L. (2001). Effect of aeration and pH gradient on nisin production. A mathematical model. Enzyme and Microbial Technology, 29, 264-273.

Fajardo, P., Fuciños, C., Méndez, J., Pastrana, L., and Guerra, N. P. (2008). Performance and intestinal coliform counts in weaned piglets fed a probiotic culture (*Lactobacillus casei* ssp. *casei* CECT 4043) or an antibiotic. Journal of Food Protection, 71, 1797-1805.

Fajardo, P., Fuciños, C., Pataro, A., Rodríguez, I., Fuciños, P., Estévez, N., et al. (2010). Producción de cultivos potencialmente probióticos a partir de lactosuero. In A. Gomez-Zavaglia (Ed.), Aspectos probióticos y tecnológicos de las bacterias lácticas (pp. 127-163). La Plata, Argentina, Universidad Nacional de La Plata.

Fajardo, P., Fuciños, C., Rodríguez, I., Pastrana, L., and Guerra, N. P. (2008a). Cheese whey utilization for bacteriocin production. In M. E. Cerdán, M. I. González-Siso, and M. Bacerra (Eds.), Advances in cheese whey utilization. Kerala, India, Transworld Research Network.

Fajardo, P., Rodríguez, I., Pastrana, L., and Guerra, N. P. (2008b). Production of a

potentially probiotic culture of *Lactobacillus casei* subsp. *casei* CECT 4043 in whey. International Dairy Journal 18, 1057-1065.

Farnworth, E. R. (2005). Kefir-a complex probiotic. Food Science and Technology Bulletin, 2, 1-17.

Gardiner, G. E., Casey, P. G., Casey, G., Lynch, P. B., Lawlor, P. G., Hill, C., et al. (2004). Relative ability of orally administered *Lactobacillus murinus* to predominate and persist in the porcine gastrointestinal tract. Applied and Environmental Microbiology, 70, 1895-1906.

Gardiner, G., Stanton, C., Lynch, P. B., Collins, J. K., Fitzgerald, G., and Ross, R. P. (1999). Evaluation of cheddar cheese as a food carrier for delivery of a probiotic strain to the gastrointestinal tract. Journal of Dairy Science, 82, 1379-1387.

Garrote, G. L., Abraham, A. G., and De Antoni, G. L. (1998). Characteristics of kefir prepared with different grain: milk ratios. Journal of Dairy Research, 65, 149-154.

González, M.I.G. (1996). The biotechnological utilization of cheese whey, a review. Bioresource Technology, 57, 1-11.

Guerra, N. P., and Pastrana, L. (2001a). Modelling the influence of pH on the kinetics of both nisin and pediocin production and characterization of their functional properties. Process Biochemistry, 37, 1005-1015.

Guerra, N. P., and Pastrana, L. (2001b). Enhanced nisin and pediocin production on whey supplemented with different nitrogen sources. Biotechnology Letters, 23, 609-612.

Guerra, N. P., and Pastrana, L. (2002). Nisin and pediocin production on mussel-processing waste supplemented with glucose and five nitrogen sources. Letters in Applied Microbiology 34, 114-118.

Guerra, N. P., and Pastrana, L. (2003). Enhancement of nisin production by *Lactococcus lactis* in periodically re-alkalized cultures. Biotechnology and Applied Biochemistry, 38, 157-167.

Guerra, N. P., Fajardo, P., and Pastrana L. (2007). Fed-batch pediocin production on whey using different feeding media. Enzyme and Microbial Technology, 41, 397-406.

Guerra, N. P., Fajardo, P., Fuciños, C., Rodríguez, I., Alonso, E., Torrado, A., and Pastrana, L. (2010). Modelling the biphasic growth and product formation by *Enterococcus faecium* CECT 410 in re-alkalized fed-batch fermentations in whey. Journal of Biomedicine and Biotechnology, 2010, 1-16.

Guerra, N. P., Fajardo, P., Méndez, J., Cachaldora, P., and Pastrana, L. (2007). Production of four potentially probiotic lactic acid bacteria and their evaluation as feed additives for weaned piglets. Animal Feed Science and Technology, 134, 89-107.

Guerra, N. P., Fajardo, P., Torrado, A., López, C., and Pastrana, L. (2005). Fed-batch pediocin production by *Pediococcus acidilactici* NRRL B-5627 on whey. Biotechnology and Applied Biochemistry, 42, 17-23.

Guerra, N. P., Fajardo, P., Torrado, A., López, C., and Pastrana, L. (2005). Fed-batch pediocin production by *Pediococcus acidilactici* NRRL B-5627 on whey. Biotechnology and Applied Biochemistry, 42, 17-23.

Guerra, N. P., Rua, M. L., and Pastrana, L. (2001). Nutritional factors affecting the production of two bacteriocins from lactic acid bacteria on whey. International Journal of Food Microbiology, 70, 267-281.

Hofvendahl, K., van Niel, E. W. J., and Hahn-Hägerdal, B. (1999). Effect of temperature and pH on growth and product formation of *Lactococcus lactis* ssp. *lactis* ATCC 19435 growing on maltose. Applied Microbiology and Biotechnology 51, 669-672.

Kalchayanand, N., Hanlin, M. B., and Ray, B. (1992). Sublethal injury makes Gram-negative and resistant Gram-positive bacteria sensitive to the bacteriocins, pediocin AcH and nisin. Letters in Applied Microbiology, 15, 239-243.

Kalchayanand, N., Sikes, T., Dunne, C.P., and Ray B. (1994). Hydrostatic pressure and electroporation have increased bactericidal efficiency in combination with bacteriocins. Applied and Environmental Microbiology, 60, 4174-4177.

Koutinas, A. A., Athanasiadis, I., Bekatorou, A., Iconomopoulou, M., and Blekas, G. (2005). Kefir yeast technology: scale-up in SCP production using milk whey. Biotechnology and Bioengineering, 89, 788-796.

Nanda, K. Taniguchi, M., Ujike, S., Ishihara, N., Mori, H., Ono, H., and Murooka, Y. (2001). Characterization of acetic acid bacteria in traditional acetic acid fermentation of rice vinegar (Komesu) and unpolished rice vinegar (Kurosu) produced in Japan. Applied and Environmental Microbiology, 67, 986-990.

Ohashi, Y., Umesaki, Y., and Ushida, K. (2004). Transition of the probiotic bacteria, *Lactobacillus casei* strain Shirota, in the gastrointestinal tract of a pig. International Journal of Food Microbiology, 96, 61-66.

Pérez, R., and Guerra, N. P. (2009). Optimization of amylase production by *Aspergillus niger* in solid-state fermentation using sugarcane bagasse as solid support material. World Journal of Microbiology and Biotechnology, 25, 1929-1939.

Poolman, B., and Konings, W. N. (1988). Relation of growth of *Streptococcus lactis* and *Streptococcus cremoris* to amino acid transport. Journal of Bacteriology, 170, 700-707.

Sablon, E., Contreras, B., and Vandamme, E. (2000). Antimicrobial peptides of lactic acid bacteria, mode of action, genetics and biosynthesis. Advances in Biochemical Engineering/Biotechnology, 68, 21-60.

Salminen, S., Deighton, M. A., Benno, Y., and Gorbach, S. L. (1998). Lactic acid bacteria in health and disease. In S. Salminen, and A. von Wright (Eds.), Lactic acid bacteria, microbiology and functional aspects (pp. 211-253). New York, Marcel Dekker Inc.

Schoevers, A., and Britz, T. J. (2003). Influence of different culturing conditions on kefir grain increase. International Journal of Dairy Technology, 56, 83-187..

Shu, Q., F. Qu, and Gill, H. S. (2001). Probiotic treatment using *Bifidobacterium lactis* HN019 reduces weanling diarrhoea associated with rotavirus and *Escherichia coli* infection in a piglet model. Journal of Pediatric Gastroenterology and Nutrition, 33, 171-177.

Simova, E., Beshkova, D., Angelov, A., Hristozova, T., Frengova, G., and Spasov, Z. (2002). Lactic acid bacteria and yeasts in kefir grains and kefir made from them. Journal of Industrial Microbiology and Biotechnology, 28, 1-6.

Sueki, M., Kobayashi, N., and Suzuki, A. (2005). Continuous acetic acid production by the bioreactor system loading a new ceramic carrier for microbial attachment. Biotechnology Letters, 13, 85-190.

Tortuero, F., Rioperez, J., Fernandez, E., and Rodriguez, M. L. (1995). Response of piglets to oral administration of lactic acid bacteria. Journal of Food Protection, 58, 1369-1374.

Tramšek, M., and Goršek, A. (2008). Analysis of growth models for batch kefir grain biomass production in RC1 reaction system. Journal of Food Process Engineering, 31, 54-767.

STUDIES FOR RURAL DEVELOPMENT PROGRAMME ELABORATION IN THE CRISURI BASIN

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Abstract
The studied area has a potentially favourable rural agricultural economy whose recovery is increased by the environmental characteristics whose annual growth does not meet the requirements of agricultural technology. The analysis of the natural factors has resulted in determining the stress level imposed upon the crops, which can lead to human intervention so that the environmental conditions should match the farming conditions. For this purpose, we should develop facility improvement programmes and appropriate measures.

Key words: *lack of humidity, limiting factors, risk factors, rural development, water catchment area*

INTRODUCTION

The vast majority of rural economic activities are conducted outdoors, under the direct effect of environmental conditions, where climate variability influences the physiological processes of the plants, the growing conditions of the animals, and the work of those involved in conducting such business processes (Maracineanu, 2003).
However, in order to take place under optimum conditions, each category of activities requires certain environmental conditions, most of them depending on the climate. The increased climate variability of the recent decades, characterized by extreme events, is a natural limiting factor for the rural activities taking place in the natural environment, especially in large spaces. Besides this direct influence, the climate influences the other environmental factors such as soil quality and evolution, the hydrological and hydro-geological regime, and land degradation processes due to heavy rain, high temperatures and strong winds.

MATERIALS AND METHODS

Located in the western part of Romania, the Crisuri water catchment area is bordered by the Somes basin to the North and North-east, the Mures basin to the East and South, and the Republic of Hungary to the West (figure 1), i.e. between 47°06' and 47°47' north latitude, and 20°04' and 23°09' east longitude. It includes the following main rivers: Barcau, Ierul, Crisul Repede, Black and White Cris, which are gathered two by two on the territory of Hungary, forming one course that confluences with the Tisa. Most of the Crisuri water catchment area is in Bihor County (Pop, 2005).

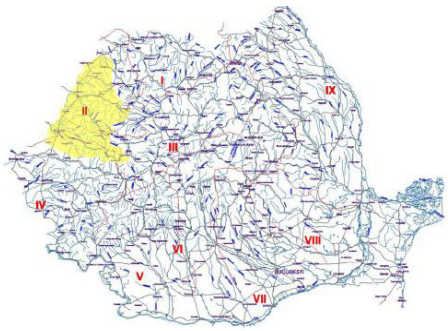

Figure. 1 Crisuri water catchment area

This area has a valuable potential for rural development, as it is supported by natural conditions which often present a development in time that does not fully satisfy the specific needs of the different categories of rural activities, particularly the exploitation of arable land. Sustainable development cannot be designed only based on the protection of

agricultural natural resources, soil and water, plus the specific biological resources of cropped plants. The protection of the agricultural natural resources and the best use of the biological resources require a better correlation between the environmental offer and the optimal conditions of resource protection and capitalization through the most suitable ameliorative techniques (Constantin, 2006).

For the study area, we analyzed the climatic risk factors and the limitations of soil quality. The assessment of the climatic factors as risk factors was made by using various types of climate classifications whose comparative results allowed conclusions with practical effects. For a more realistic assessment of how climate affects rural capitalization, we used several climate classifications that are used worldwide in specialist studies (Dogaru, 2012).

Soil and land degradation result from the poor management applied to those two complex systems considered in interaction: the natural ecosystem and the social system human. The soil is considered degraded when its specific qualities are reduced, and shows a process of decline due to its misuse by the human factor. The assessment of soil degradation in the study area was based on studies conducted by the OSPA (Office of Pedological and Agrochemical Studies) Bihor.

RESULTS AND DISCUSSIONS

The six methods of processing the raw climate data highlighted the stable character of the climate in the Crisuri Plain, and also the tendency to become a more arid climate - Table 1. Thus, according to the Martonne index, the Lang precipitation factor and the ICPA classification, the climate became more arid in the last decades, a trend which reduced the amount of water that precipitations made available for the crops. The significant water deficit required more extensive technological interventions, such as irrigation and the use of more resistant plants in order to preserve the water reserves in the soil to a greater extent.

Table 1 Comparative climatic indices of Crisuri water catchment area

Climatic index		Calculation period			
		1896-1955	1990-1999	2000-2009	Class limits
Gorczynski Index	value	84	79	84	> 34 Continental
	Climate type	continental	Continental	continental	
Martonne Index	value	31	31.6	28.6	25-30, moderately arid; 30-35, sub-moist
	Climate type	Sub-moist	Sub-moist	moderately arid	
Lang Precipitation factor	value	60.0	50.9	54.2	56-180, semiarid area; 21 – 55, Arid area
	Climate type	Semiarid area	Arid area	Arid area	
Martonne-Gottman Index	valoare	32.9	30.8	32.5	30-59 Moist climate
	Climate type	Moist climate	Moist climate	Moist climate	
Thornthwaite humidity global index	value	-1.8	22.0	9.0	
	Climate type	Sub-dry		Sub-moist	0 ÷-20 Sub-dry 0-20 Sub-moist
ICPA clasification	value	I_b=82mm,i_h=114%, i_a=32	I_b=88,8mm,i_h=116%, i_a=32	I_b=16mm,i_h=97%, i_a=28	
	Climate type	Overflow, moderate overflow	Overflow, moderate overflow	Overflow, low overflow	

Tables 2 and 3 highlight the modification of the annual precipitation production rate and average air temperature may indicate the development tendency of climate. Therefore, the last four decades considered for the comparative study, 1970 - 2010.

Table 2 Frequency of average annual precipitation in the study area

Annual precipitations, mm	Frequency (number %) per decades			
	1970-1979	1980-1989	1990-1999	2000-2010
1000 - 700	2 / 20	1 / 10	4 / 40	2 – 20
700 - 600	1 / 10	5 / 50	1 / 10	4 - 40
600 - 500	3 / 30	2 / 20	1 / 10	1 -10
500 - 400	4 / 40	2 / 20	2 / 20	2 / 20
400 - 300	-	-	2 / 20	1 - 10

Table 3 Frequency of average annual air temperatures in the study area

Air temperature, °C	Frequency (number/ %) per decades			
	1970-1979	1980-1989	1990-1999	2000-2010
≥ 12	-	-		2 / 20
12 - 11	-	-	3 / 30	3 / 30
11 - 10	8 / 80	7 / 70	4 /40	4 / 40
10 - 9	2 / 20	3 / 30	3 / 30	1 / 10

During the 40 years, a trend developed, i.e. the production of a lower volume of annual rainfall since the decade 1990-1999. At the same time, the share of rainfall of 700 mm/year was maintained at the range of 10% - 40% of annual rainfall for each decade. There was a clear tendency of reduction in the annual rainfall, i.e. 500-600 mm/year, from 40% in the decade 1970-1979 to 10% starting with the decade 1990-1999. Also, low precipitations have occurred since the same decade, i.e. between 300 and 400 mm/year (Dogaru, 2012).

The dynamics of the annual average air temperatures showed a consistent trend of increasing annual average temperatures, from 10°C and 11°C to values higher than 12°C; thus, starting with the decade 2000-2010, they accounted for 20%. The average annual temperatures between 10°C and 11°C decreased from 80% to 40% which modified the thermal regime of the area.

These conclusions supported the interpretation of the climatic indices based on which the evolutionary trend of climate towards aridity is considered.

The forms and processes of land and soil degradation result in decreased soil productivity to a greater or lesser extent, depending on the number and intensity of the manifest restrictive factors. They are caused by natural factors (parent rock, climate, landforms, biotic factor and water) or human activity (agricultural or industrial), table 4. Water excess, fluid erosion and landslides, salt and acid excesses in the soil are risk factors for agriculture. There is another risk that can be added to these, i.e. the exploitation of the compacted soils or the soil with low nutrient content.

Table 4 Factors limiting the land productive capacity in Bihor County

Degradation process	Affected area, ha	
	Total	Arable
Permanent humidity excess in soil	148,983	89,390
Water erosion	43,234	31,561
Landslides	2,263	1,358
Excessive frame at ground surface	8,743	2,620
Salt land, of which:	38,549	11,565
- highly alkaline	822	482
Secondary compaction of soil due to inadequate tillage (plough sole)	-	-
Primary compaction of soil	-	-
Crust formation	-	-
Low reserve - very low humus in soil	312,689	229,211
Strong and moderate acidity	140,886	94,098
Providing poor and very poor mobile phosphorus	159,067	96,150
Providing low nitrogen	203,947	156,829
Pollution by wind-carried substances	-	-
Soil damaged by excavation	-	-
Soil covered with waste and solid waste	-	-
TOTAL	**1,059.2**	**996**

Data Source: Office of Pedological and Agrochemical Studies - Bihor 2011

CONCLUSIONS

- The increased climate variability in the recent decades, characterized by extreme events, is a natural limiting factor for the rural activities taking place in the natural environment;
- The Crisuri water catchment area has a valuable potential for rural development, supported by the natural conditions which often present developments in time that do not fully satisfy the specific needs of the different categories of rural activities, particularly the exploitation of arable land.
- By processing the climatic data and interpreting the results, we found the stable character of the Cris Plain climate and also its tendency to become a more arid climate;
- The tendency of climate evolution was assessed as the change in the production frequency annual precipitation and average air temperature for a period of four consecutive decades, and showed an evolution towards aridity.
- The forms and processes of land and soil degradation were caused by natural factors (parent rock, climate, landforms, biotic factor, water) or human activity (agricultural or industrial), among which the following were dominant: the permanent humidity excess in the soil, low reserve - very little humus in the soil, providing low nitrogen and mobile phosphorus, strong and moderate acidity.

ACKNOWLEDGMENTS

This paper was prepared with support provided by the research conducted for the elaboration the thesis of Mr. Dogaru Neculai, PhD candidate, in the major field of intervention 1.5 "Doctoral and postdoctoral studies in support of research". The identification number of the POSDRU Contract is 107/1.5/S/76888.

REFERENCES

Ambrus A., 2008. Environmental factors in the Euro-region Bihor-Hajdu – Bihar; influence on the health of the population. PhD Thesis. University of Oradea, University of Debrecen

Constantin E., 2006. Rural Development, Bren Publishing House

Dogaru N., 2012 - Scientific Report No.2, Description of natural area in the study area, USAMV, FIFIM, Bucharest

Maracineanu Fl., Nistreanu M., Constantin E., 2003. Rural development, policies and strategies. Ceres Publishing House

Pop Gr., 2010. Definition, limits and regionalization Western Hills and Cris Plain, Studia UBB, Geographia, L, 1, Publishing House, Cluj Napoca.

www.hydrop.pub.ro/bpcap1-2. – Water catchment area in Romania

vest.ro/Despre noi. Agentia de Dezvoltare Regională Nord-Vest/RegiuneaTransilvania de Nord/Prezentare regiune.html

LANDSCAPE AND IRRIGATION DESIGN OF GREEN SPACES IN RURAL AREAS OF CANDESTI PLATEAU. CASE STUDY. PICIOR DE MUNTE VILLAGE, DAMBOVITA COUNTY

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Abstract

This paper aims to present the results of researches conducted in the Cândesti Plateau between 2009 and 2012 concerning the design and execution of the landscaping and irrigation works of green spaces. This kind of works was mandatory to be done in this area, having as final objective the improvement of the environment quality and the residents' access to an enjoyable recreational space. As specific methods we used data collection in the geographical area, measuring and interpreting information regarding the climatic and pedagogical condition, soil geology, vegetation, hydrology, ground water and social conditions. To define the values of the irrigation elements we have used "the soil water balance method". We have obtained results regarding the optimal landscape solution, the average values of the irrigation elements and technical elements of the irrigation systems. Therefore, during the planning, scheduling design and execution of the green areas landscaping and irrigation works, all crucial data must be considered in order to determine one or several best and legally, technically and economically-feasible solutions.

Key words*: irrigation, landscape design, green spaces, environment.*

INTRODUCTION

The development of green spaces constitutes a major and indispensable chapter in the evolution of urban and rural development, both globally and nationally for Romania, being treated as a long-term national strategy for improving the environmental quality in populated areas (Chiper, 2012).

The quality and the long life of landscaping may be enhanced through use of competitive procedures and technology and through sound land use according to the type of landscape and the incident of the pedoclimatic area.

Green area watering is a requisite regenerating practice aiming to manage the necessary water for plants to grow and for the landscape to be maintained fully and constantly operational and aesthetically balanced according to its intended purpose (Cimpeanu et al., 2002).

The objectives of the study consisted in the landscaping design and operation of an irrigation system for a public green space which has been properly laid out in Picior de Munte locality and is functional in terms of equipment and has general positive effects on the social life of inhabitants in the area. This park must provide a playground and recreational area under safe conditions for children, its settlement being well chosen because it is located near the locality's kindergarten and school.

On the other hand, the installation of the irrigation system must allow the watering in optimum and economic quantities of the seeded vegetation and lawn and according to the irrigation elements set up for the studied location: Cândesti Piedmont, Picior de Munte locality.

MATERIALS AND METHODS

During the research, many working methods, which have been deemed efficient, have been applied by consulting the specialty bibliography at international and national level in order to achieve the objectives proposed by the conducted study. Specific methods have been applied depending on the objectives followed for the natural background research, the settlement of the irrigation elements in order to design the landscaping in the proposed location and the analysis of the technical landscaping solution in parallel with the

determination of the technical watering elements which are necessary for the design and operation of the site.

Regarding the natural background, research has been conducted in order to obtain results on geographical, pedoclimatic, social and economic conditions in the studied area. The annual and multiannual climatic data measured by the National Meteorological Administration in Târgoviste station has been collected, being monthly interpreted for the average air temperature, rainfall, wind speed and relative air humidity (ANM, 2008).

It was necessary to determine and calculate the irrigation elements for the watering rate, irrigation rate, watering time, watering periods, watering number.

To calculate the landscape irrigation, *"The Soil Water Balance Method has* been applied (Jinga et al., 2009; Grumezea et al., 2005).

The method has been established for the growing season of component ecosystems, i.e. April 1 to September 30 for lawn, trees and shrubs and April 15 to September 30 for herbaceous flowers.

Thus, according to the method presented by Jinga in 2009, using the hydrologic balance equations for the growing season, the monthly and annual irrigation water demand has been determined by the following general formula:

$$\text{“}\sum_m = ETRO - P_v - A_f - (R_i - R_f) \quad (m^3/ha)$$

where:

- $\sum m$ - is the annual demand (irrigation rate) of irrigation water in m^3/ha;
- ETRO - optimal real evapotranspiration or total water consumption during the growing season through the plant transpiration and evaporation at the soil surface of an ecosystem, cultivated in a soil moisture which ensures the viability and normal development of plants, in m^3/ha;
- P_v - useful amount of rainfall during the growing season to ensure 80%, in m^3/ha;
- A_f - water input of underground water, in case of the closed circuit balance (Rota de Jos), in m^3/ha;
- R_i - soil water reserve at the beginning of the growing season, in m^3/ha;
- R_f - soil water reserve at the end of the growing season, in m^3/ha."

To determine the technical watering elements necessary to design and operate the landscape, a series of essential data has been considered for the application of the general design principles of irrigation systems observing: the form and size of surfaces to be irrigated, the component vegetation, the irrigation water demand, the water supply and its hydrodynamic parameters (pumping height, provided water flow and pump flow), the diagram and the optimal irrigation solution (in the studied case by sprinkling plants, column elbows and valves water losses, watering equipment operating parameters, namely sprinklers: sprinkler operating pressure, net flow, pluviometry, watering radius and angle of action, judicious division of irrigated areas into watering areas depending on the sprinklers parameters, available flow and water pipe pressure, determining the operating time in area control units supplied by valves, in order to supply the determined watering rates by the soil water balance method (Water Management Committee of the Irrigation Association, 2010).

RESULTS AND DISCUSSIONS

This area has climate, pedological, geographical and social features, forms of relief specific to piedmont plateau, the determined vegetation being diversified and specific to Subcarpathian areas. Hydrogeology is correlated to hydrology and geology and the area is influenced economically, socially and demographically by the urban centres nearby (Găesti, Titu, Târgoviste and Pitesti).

Based on the pedogeological structure of the predominant soil in the area determined by the cartographic study, hydrophysical indications of the soil could be determined depending on the active layer thickness (Table 1) and the watering rates determined for the three studied ecosystems.

Table 1. The hydro-physical indices of soil in Cândesti Plateau, Picior de Munte village

Ecosystem	Vegetation	Thickness of the active layer of soil (H)	Bulk density (Da)	Wilting factor (CO)		Field water capacity (CC)		Active moisture range (IUA=CC–CO)		Minimum Floor of Humdity (p.min)	
		(m)	(t/m^3)	% gr.	m^3/ha	% gr.	m^3/ha	% gr.	m^3/ha	% gr.	m^3/ha
Flowers	15.04-31.09	0,40	1,31	8,40	550,00	27,80	1821,00	19,40	1271,00	21,33	1397,33
Trees and shrubs	01.04-31.09	0,75	1,33	9,50	895,67	27,53	2456,00	18,03	1560,33	21,52	1935,89
Turf (lawn)	01.04-31.09	0,75	1,33	9,50	895,67	27,53	2456,00	18,03	1560,33	21,52	1935,89

The monthly average rainfall quantity during the growing season in Cândesti Piedmont, namely in Picior de Munte locality has been calculated considering the multiannual monthly values measured in Târgoviste meteorological station by the National Meteorological Administration and made available based on the convention between it and the Faculty of Land Reclamation and Environmental Engineering in Bucharest. They are presented according to the multiannual monthly average values during 1980-2010 (Table 2).

Table 2. The multiannual monthly averages and useful rainfalls during the growing season in Cândesti Plateau, Picior de Munte village

$P_v = 10\delta P$ unde δ=0,76							
Month	**April**	**May**	**June**	**July**	**August**	**September**	**Total**
No. of days in a month	30	31	30	31	31	30	-
mm/month	52,7	70,9	91,8	86,2	77,4	52,3	431
mm/day	1,8	2,3	3,1	2,8	2,5	1,7	-
δ	0,76	0,76	0,76	0,76	0,76	0,76	-
Useful precipitation (P_v) (m^3/ha)	400,5	538,8	697,7	655,1	588,2	397,5	3.278

The irrigation elements necessary to design and operate the irrigation systems for green spaces in Cândesti Piedmont, Picior de Munte locality for the three types of studied ecosystems are presented in Table 3.

Table 3. The summary of the irrigation regime elements in Cândesti Plateau, Picior de Munte village

No. crt.	Crop	Watering norm (m^3/ha)		Watering month date	No. of watering	Irrigation norm (m^3/ha)	
		Nett	Gross			Nett	Gross
1.	**Flowers**	339	400	15.IV; 02,12.V; 04.VI; 01.VIII; 01,14.IX	7	2373	2800
2.	**Trees and shrubs**	601	650	02.VI; 01,13.VII; 06.VIII	4	2404	2600
3.	**Turf (lawn)**	601	650	02.V;09.VI ; 07.VII; 11.VIII ; 01.IX	4	2404	2600

In order to provide viable solutions for the responsible and efficient operation of the irrigation system it is necessary to present the technical landscaping design (planting plan) and implicitly the constructive solution of the irrigation systems in the studied areas.

The park project and execution were done based on the *"National program for environmental quality improvement by establishing green spaces in localities"* provided for in GEO 59/2007 (OUG 59/2007)" and implied:

- setting up green spaces by planting dendrological material consisting of trees, shrubs, green fences and establishment of lawns;
- installation of an automatic irrigation system which is operational throughout the entire landscape surface;
- installation of a functional lighting system with photovoltaic panels;
- establishment of a rectangular fountain;
- installation of street furniture: benches, trash bins and chess tables;
- installation of a playground for children;
- construction of ecologic stone alleys;
- park endowment with ecological toilets;
- landscape fencing with wooden fence.

Thus, considering the pedoclimatic conditions of the area, the following have been designed and executed:

- plantation of small, average and high size vegetation resistant to contaminants and adapted to the climatic conditions of the studied area according to the plan presented in figure 1 and centralized in table 4, namely 111 deciduous trees, 24 rooted trees and 49 shrubs;
- settlement of 1073 m^2 of lawn by grass seeding (*mixture of Lolium perenne, Poa pratensis* and *Festuca arundinacea*);
- automatic irrigation system for landscapes 1073 m^2 .

Table 4. Plants used in green spaces landscaping of the Picior de Munte village

No. Crt.	Type / Species	Pieces	No. Crt.	Type / Species	Pieces
Deciduous tree			**Resinous trees**		
1.	*Acer negundo*	4	**8.**	*Picea pungens*	14
2.	*Acep platanoides*	19	**9.**	*Pinus nigra*	10
3.	*Catalpa bignonioides*	71	**Deciduous shrub**		
4.	*Fraxinus excelsior*	8	**10.**	*Cotoneaster dammerii*	13
5.	*Platanus acerifolia*	2	**11.**	*Ligustrum ovalifolium*	18
6.	*Prunus cerasifera*	5	**12.**	*Spiraea vanhouttei*	10
7.	*Rhus typhina*	2	**Resinous shrubs**		
			13.	*Juniperus horizontalis*	8

The irrigation system designed and executed for providing the necessary quantity of water on the green spaces in Picior de Munte locality consists of a PEHD-type polyethylene pipe assembly (High-density polyethylene) with a rated diameter of Φ32 mm, connections between pipes made of polyethylene fittings with pressure seal PN10, dripping hose, solenoid valves DV/DVF Series and rotor-type sprinklers 5004 series 5000 / 5000 Plus / 5000 Plus PRS Rotors, equipped with MPR-25 nozzles, rotary multijet with nozzles RN Series Nozzle, spray (UNI-Spray™ Series) and nozzles VAN Series (Rainbrid.com).

The operation of this equipment is provided by a programmable controller TBOS provided with 14 stations, equivalent to the number of areas. The watering schedule memorized by the program consists in setting up the start hour, the watering duration in an area and the sequence for each solenoid valve of the irrigation system (area).

For the irrigation system to operate under optimum conditions, it has been divided into 13 different areas which are individually connected to a water source supplied from an average depth borehole (25 m), provided with a submersible pump. The water supply must provide the calculated water flow which is necessary for the system operation to a proper pressure (3.2 m^3/h, 35 mca).

Figure 2 presents the water flows related to the area supplied by the system‘s solenoid valves, the dimension and location of the water supply pipes to sprinklers and their types.

Figure 3 presents the way of covering the space with irrigation systems depending on the sprinkler, type of nozzle, radius and angle of action of sprinklers.

The operation of the designed irrigation system involves the administration of a watering rate of 650 m^3/ha, namely a water volume of 70 m^3/landscape (1073 m^2), in 5 stages (consecutive days), 5 hours each, according to the watering schedule presented in table 3. Concurrently, the duration of those stages represent the sum of the individual operating times which is supplied by each solenoid valve of the system.

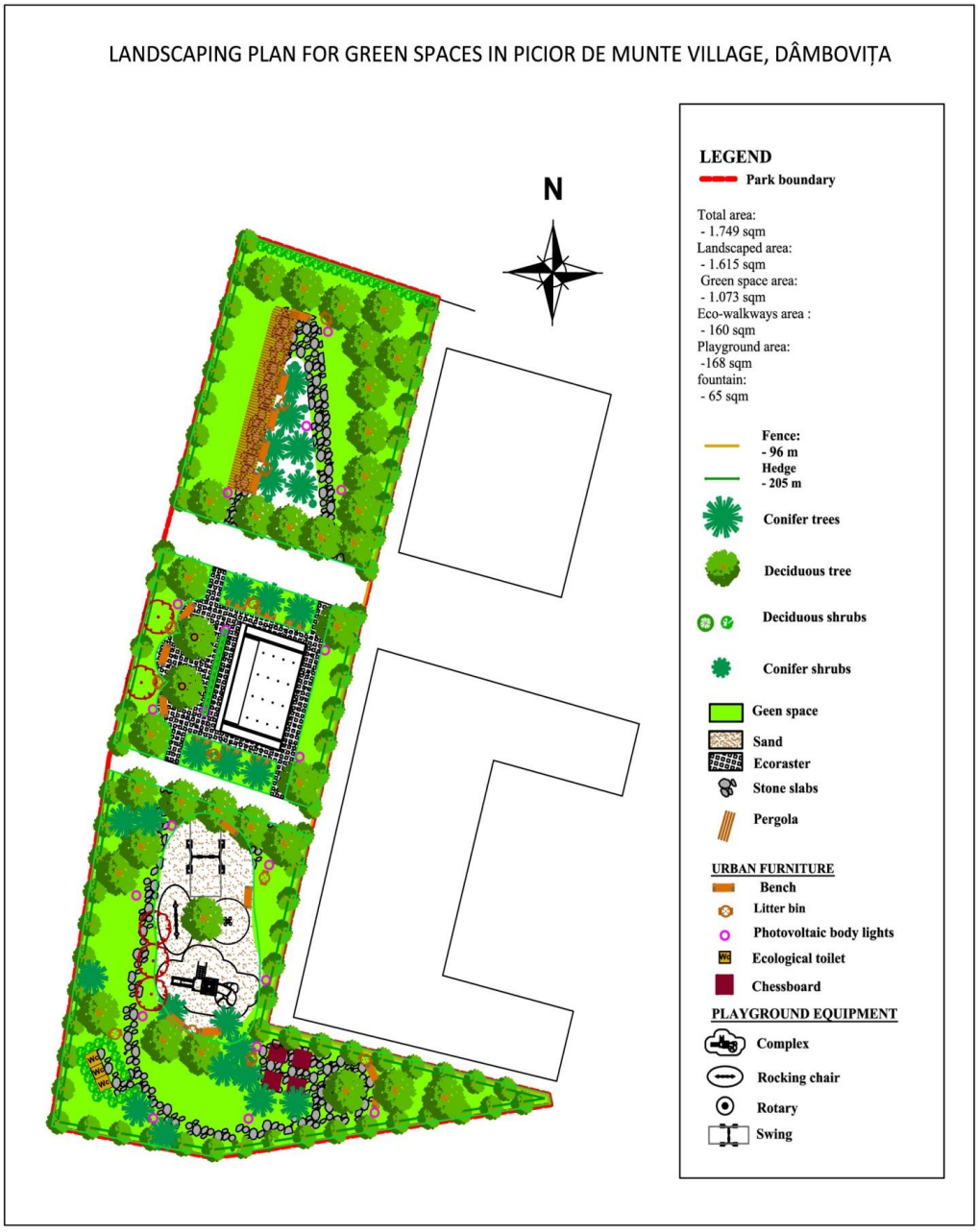

Figure 1. Landscaping plan for green spaces in Picior de Munte village, Dâmboviţa

Thus, in order to best operate the irrigation system an operating time has been established for the solenoid valves so that they can provide the sprinklers‘ operation at the parameters specified in tables 4 and equal to the operating time of the type of sprinkler which is a predominant component of the wing, as seen in the above-mentioned table

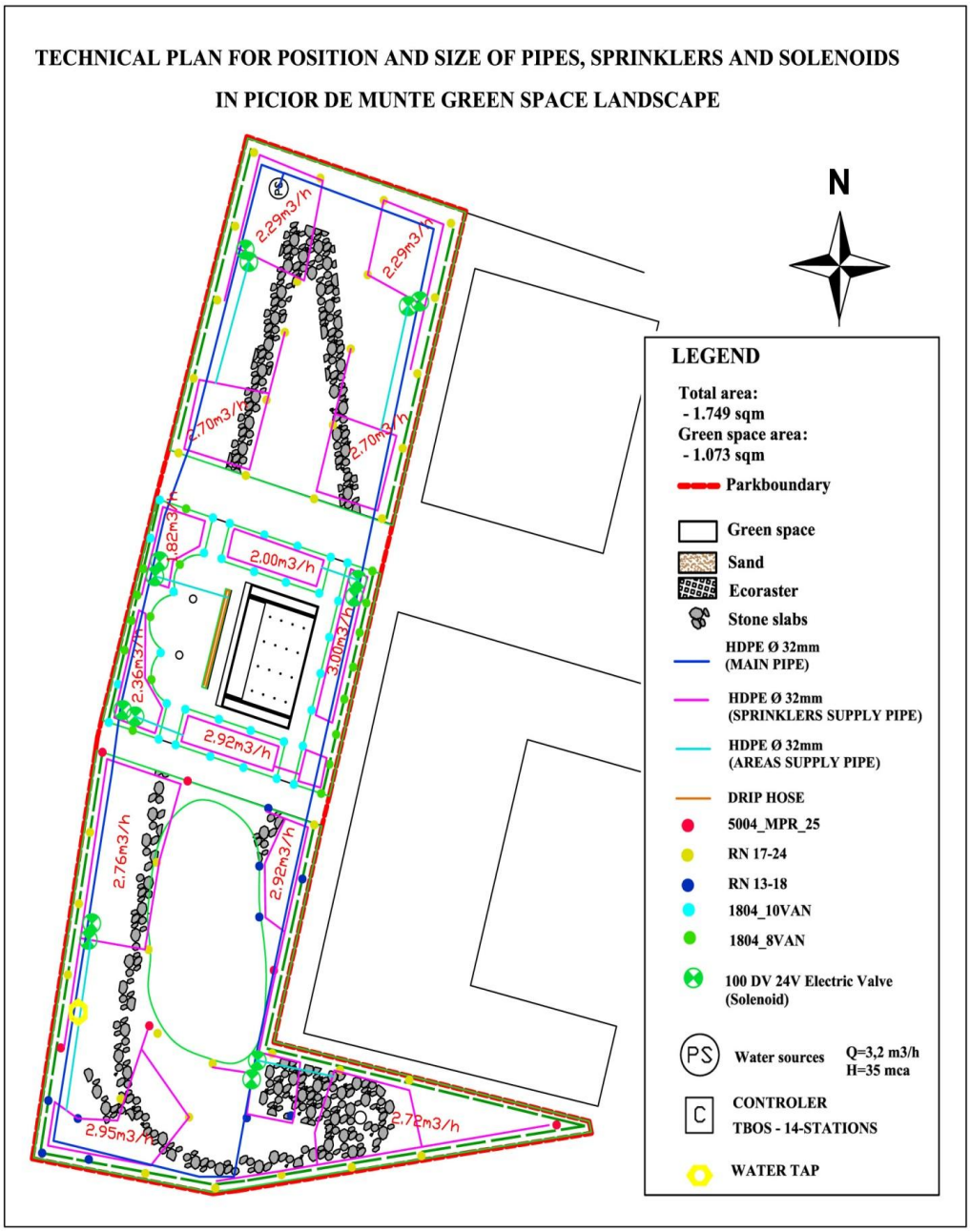

Figure 2. Technical plan for position and size of pipes, sprinklers and solenoids in Picior de Munte green space landscape

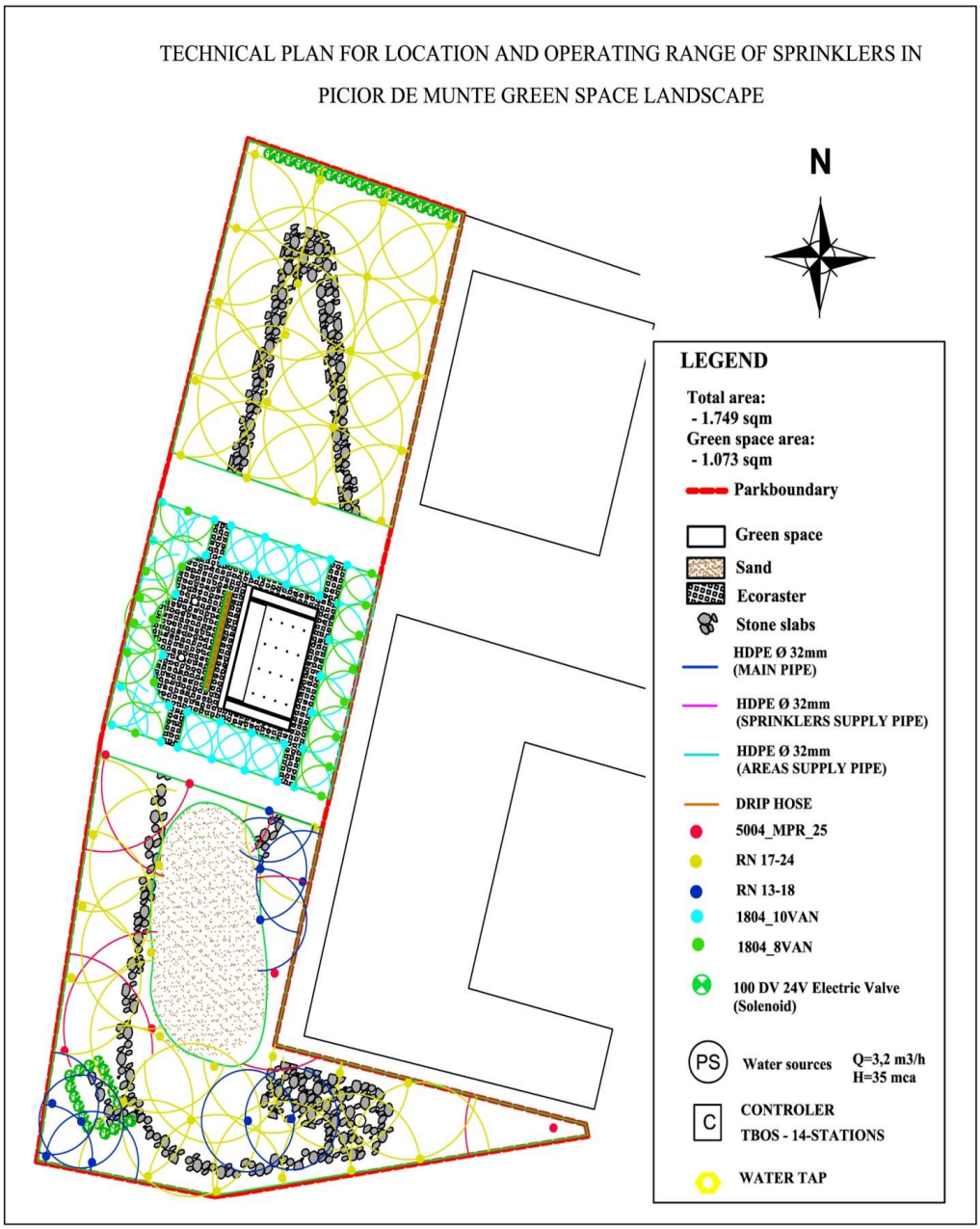

Figure 3. Technical plan for location and operating range of sprinklers in
Picior de Munte green space landscape

CONCLUSIONS

The benefits of the automatic irrigation system installation works related to the green spaces established in Picior de Munte locality, in Cândesti Piedmont are multiple and consist in the sustainable and aesthetic operation of green spaces (resistant to dryness and water deficit), namely saving resources (financial, human, water, energy) by optimizing the watering program depending on the plants' water demand and the allocation of the determined irrigation rates**.**

The balance of irrigation system installation costs, namely 3.7%, is less in relation to the total costs of the green space establishment works; instead the benefits resulted from its establishment and optimum operation are important, exponentially reducing the risk of compromising the viability of plants during dryness and alteration of park's aesthetics and operation.

The landscaping works, such as all public or private sustainable utility investments must be treated as the normal performance of the stages for fulfilling and implementing a project.

The stages must be structured and approached during the planning, programming, designing, noticing, executing, accepting and operating phases of the fulfilled investments.

REFERENCES

Administraţia Naţională de Meteorologie, 2008. Clima României. Editura Academiei Române.

Chiper A.M., 2012. PhD Thesis „Research studies to improve quality of the environment through landscaping and irrigation". University of Agronomical Science and Veterinary Medicine of Bucharest, Faculty of Land Reclamation and Environmental Engineering.

Cîmpeanu S., Plesa I., Ene A., 2002. Proiectarea lucrărilor de irigaţie, desecări – Drenaje si combaterea eroziunii solului. Editura Relal Promex, Bucuresti.

Emergency Ordinance no. 59 as of June 20, 2007 on the instauration of the National Program for the environmental quality improvement by establishing green spaces in localities.

Grumezea N., Kleps C., 2005. Amenajările de irigaţii din România. Editura Ceres.

Jinga I., Cîmpeanu S., Niţu O.A., 2009. Irigaţii, desecări, combaterea eroziunii solului. Irigarea culturilor. Editura USAMV-Bucuresti.

Water Management Committee of the Irrigation Association, 2010. Turf and Landscape Irrigation, Best Management Practices. Available on-line at: http://www.irrigation.org.

http://www.rainbird.com.

SUSTAINABLE AGRICULTURE- ROMANIA CASE-STUDY; NEW AREAS FOR RESEARCH

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Abstract

This paper identifies new areas regarding research on sustainable agriculture, assessing the status on sustainability (environmental-social and economic aspects) of the Romanian agriculture sector. The agricultural land reform has influence on agricultural sustainability, as it led to land fragmentation, as the efficiency was not a primary concern.
To understand better the sustainability, case studies can increase knowledge of the ecological importance of certain agricultural management practices and can also draw attention to rural development, to other socio-economic factors. The environmental awareness of farmers, measured by means of agri-environmental indicators is an important aspect to be assessed.
The types of crops, including those that compete to food (i.e. biomass to biofuel) and the degree of fragmentation of land parcels are important factors to be considered. Also, the marginal land, and contaminated one are additional factors to research, as well as areas for policy investigation.

Keywords: *agri-environmental indicator, land reform, sustainability;*

INTRODUCTION

The agriculture sector is the primary employer of the world's poor. As such, agriculture is an important part of any country, particularly developing economies. There are many benefits to the local, rural economy by the expansion of the agricultural sector. On the production side, upstream benefits include farm demand for inputs and services, while downstream benefits include food processing, storage, and transportation. On the consumption side, the increased disposable income of rural household's results in increased demand for goods and services in the local, rural economy (Meijerink&Roza2007). Yet, despite the importance of agriculture to economic development, many countries continue to neglect their agricultural sector. One such country where the agricultural sector has been neglected is Romania. Having once been considered the breadbasket of Europe, agricultural production in Romania is regularly at the lowest in Europe. This paper intends to illustrate the importance of agriculture to the development of the Romanian economy and provides suggestions for public policy that would encourage growth of the agricultural sector in Romania. In addition, the need for further research is underlined.

This paper is an effort to identify the ideas, practices and policies that constitute our concept of sustainable agriculture. The main reason is to clarify the research agenda, as well as priorities, and to suggest to others practical steps that may be appropriate for them in moving toward sustainable agriculture. Because the concept of sustainable agriculture is still evolving, the intention of the paper is not as a definitive or final statement, but as an invitation to continue the dialogue.

Sustainable agriculture integrates three main goals - environmental health, economic profitability, and social and economic equity.

Making the transition to sustainable agriculture is a process. For farmers, the transition to sustainable agriculture normally requires a series of small, realistic steps.

Finally, it is important to point out that reaching toward the goal of *sustainable* agriculture is the responsibility of all participants in the system, including farmers, labourers, policymakers, researchers, retailers, and consumers. Therefore, there is need for

specific strategies for realizing these broad themes or goals, especially in Romania where land is so fragmented. The strategies may be grouped according to three separate though related areas of concern: Farming and Natural Resources, Plant and Animal Production Practices, and the Economic, Social and Political Context (EC, 2010; Nastase*et al*., 2009).

How sustainable is the development of agriculture in Romania?

Economists have focused on viewing the economy and the environment as a single interlinked system with a unified valuation methodology (Dasgupta, 2007). Therefore, the strategy of development must be a strategy of sustainable development.

The goal of the National Sustainable Development Strategy of Romania is to connecting this country to a new development philosophy adopted by the European Union and widespread in the world - sustainable development. Romania, as EU Member State, subscribes the EU sustainable development strategy. EU Sustainable Development Strategy 2006 (EU Council, 2006) presents a coherent and unified plan on how the EU will more effectively meet the challenges of sustainable development. The Romanian agricultural sector needs to be integrated in this broader strategy. Realizing this objective is a real chance for Romanian agriculture in order to increase the competitiveness on the EU market, valorising in this manner its agricultural potential.

MATERIAL AND METHODS

Research on Sustainable Agriculture

Innovations and technological advances

Not only is the agricultural sector expected to produce adequate food, fibre, and feed, and contribute to biofuels to meet the needs of a rising global population, it is expected to do so under increasingly scarce natural resources and climate change. Growing awareness of the unintended impacts associated with some agricultural production practices has led to heightened societal expectations for improved environmental, community, labour, and animal welfare standards in agriculture.(Brooks, & Loevinsohn, 2011; Bran et al., 2011).

Several topics of research and projects were undertaken by Romania after the EU accession (2007). For instance, the project "Informed and experienced for sustainable agriculture" (supported by the European Commission), deals with improving the availability of information and consultative capacities of the social partners in the field of agriculture, active participation in working life for sustainable agriculture. Within the project, National Guidelines and Recommendations will be prepared, relating to information and consultation in agriculture unions.

A prerequisite for ensuring sustainable agriculture and rural development is the design and implementation of appropriate and well-targeted policies that take into account the interactions between macro-economic, agricultural and other sectorial policy concerns at national and regional levels. The mobilization of adequate financial resources as well as the skills and appropriate tools that are often lacking is crucial for the effective implementation of these policies.

The CEI (Central-European Initiative) encourages and supports activities and projects aiming at meeting the standards and criteria set by the acquiscommunautaire, thus strengthening the competitiveness of the farming and agri-food sector.

Funding opportunities

With its EU accession in 2007, Romania has gained access to much needed financing alternatives in agriculture; the main sources of funding are the direct payments and those through the National Program for Rural Development. The proper use of the financing for the farming sector could trigger a more competitive Romanian agriculture, the increase in the number of jobs in rural areas, as well as the sustainable development of rural areas (Ministry of Environment, 2008).

New areas for research

More research is needed, in order to contribute to a deeper understanding of sustainable agriculture and rural development. Thus, focus is need to draw a more comprehensive picture of the rural economy through integrating various determinants of rural development and several methodologies, which allows the evaluation of linkages and interaction effects.

Decreasing soil fertility implies decreasing yields over time and hence lowers the real incomes of already poor farmers even further. Sustainability in agricultural production depends on various interdependent aspects that require integrated analytical approaches to address the complexity involved. Smallholder production of food crops in poor countries is particularly vulnerable to hazards that are related to (i) production technologies as well as (ii) factor and commodity markets. The former aspect includes appropriate input use and land management, while the latter particularly considers rural labour markets, intermediate input markets, and commercial output markets. Al these topics can constitute further research areas.

For instance, in this context, a project may focus on three crucial aspects, namely (i) institutional and other determinants to foster the degree of commercialization of agricultural small-scale produce, (ii) alternative occupational choices in rural labour markets with respect to agricultural and non-agricultural employment, and (iii) biophysical aspects concerning soil-conserving production technologies. The main hypothesis is that all three aspects need to be addressed sufficiently and simultaneously in order to promote sustainable smallholder agricultural production that is able to contribute to overall economic growth and development and, consequently, to food security.

As methodology involved, this kind of research follows an interdisciplinary approach, which combines several methodologies within economic and social sciences**.**

Other research additional topics may be constituted of: energy; air; soil; election of site, species and variety; diversity; soil management; efficient use of inputs; consideration of farmer goals and lifestyle choices, etc.

The Economic, Social & Political Context

In addition to strategies for preserving natural resources and changing production practices, sustainable agriculture requires a commitment to changing public policies, economic institutions, and social values.

Food and agricultural policy**.** New policies are needed to simultaneously promote environmental health, economic profitability, and social and economic equity. For example, commodity and price support programs could be restructured to allow farmers to realize the full benefits of the productivity gains made possible through alternative practices.

Land use**:** conversion of agricultural land to urban uses is a particular concern, as rapid growth and escalating land values threaten farming on prime soils.

Labour**:** in many parts of the world, the conditions of agricultural labour are generally far below-accepted social standards and legal protections in other forms of employment.

Rural Community Development**:** rural communities are currently characterized by economic and environmental deterioration. Many are among the poorest locations in the nation. The reasons for the decline are complex, but changes in farm structure have played a significant role.

Consumers and the Food System: consumers can play a critical role in creating a sustainable food system. Through their purchases, they send strong messages to producers, retailers and others in the system about what they think are important (EC, 2010;IESA(2012).

Agri-environmental indicators

As presented in COM(1999) "Directions towards Sustainable Agriculture", the reforms undertaken as part of Agenda 2000 provide a powerful impetus for the integration of environmental concerns into agriculture policy. The Commission, Member States, local authorities and agricultural and rural communities now have a considerable range of instruments at their disposal to achieve sustainable agriculture.

Appropriately developed agri-environmental indicators will be particularly important in improving transparency, accountability and ensuring the success of monitoring, control and evaluation. This will contribute significantly to the effectiveness of policy implementation and will feed into Global Assessment processes.

Member States may use agri-environment programmes to protect or enhance the environment beyond good farming practice. Furthermore, while the CAP (Common Agriculture Policy) is a common European policy, Agenda 2000 recognises that the diverse nature of the farmed environment across Europe means that the policy has to be applied

in a decentralised way. Agenda 2000 has made a strong effort to correct the most apparent negative environmental effects of the old CAP by providing Member States with a range of instruments, including indicators.

However, in Europe, much of the valued rural environment is the product of agriculture and is dependent on it. Appropriate farming systems help to preserve landscapes and habitats as well as a range of conditions favourable to beneficial environmental processes. Some of these processes can be summarised below:

Relationship: Processes Pollution of environment: build-up of nitrate and other mineral residues, pesticide residues, salination, ammonia and methane emissions.

Depletion of environmental resources: inappropriate use of water and soil, destruction of semi-natural and natural land cover.

Preservation and enhancement of the environment: creation/preservation of landscapes, habitats, land-cover, preservation of genetic diversity in agriculture, production of renewable energy sources.

Potential for certain types of agricultural activity to make a significant contribution to environmental objectives should not be underestimated, particularly within a favourable policy context. The production of biofuels can, for example, make an important contribution to combating climate change. Under these subject areas, about thirty actual indicator shave been selected for short-term development while more than twenty indicators will need further refinement in a medium/longer term. For instance, some indicators to address agri-environmental issues of relevance to policy-makers are:

Agricultural nutrient use
Agricultural pesticide use
Agricultural water use
Agricultural land use and conservation
Agricultural soil quality
Agriculture and water quality
Agricultural greenhouse gases
Agriculture and biodiversity
Agriculture and wildlife habitats
Agricultural landscape
Farm management
Farm financial resources

Socio-cultural issues in relation to agriculture.

The OECD has developed its own database but most of the indicators developed will rely on existing figures at national level or new uncollected data. For three indicator areas (nutrients, pesticides, green house gases), it is considered that data collection and indicator measurement are already well advanced and being refined. The other areas still require further development.

Indicators for assessing environmental integration.

At present, a partial set of indicators can be established to monitor the integration of environmental concerns into agricultural policy (UN, 2007). This set will evolve as the indicators are improved and completed. There are, however, areas in which the definition of operational indicators remains a major challenge. This is particularly the case for farm management, beneficial processes, landscapes, global habitat stock and biodiversity and landscape diversity. For these, appropriate indicators need to be defined on the basis of the considerable information that is currently available.

RESULTS AND DISCUSSIONS

A more sustainable agriculture seeks to make the best use of nature‘s goods and services as functional inputs. It does this by integrating natural and regenerative processes, such as nutrient cycling, nitrogen fixation, soil regeneration and natural enemies of pests into food production processes. It minimises the use of non-renewable inputs (pesticides and fertilizers) that damage the environment or harm the health of farmers and consumers. It makes better use of the knowledge and skills of farmers, so improving their self-reliance. In addition, it seeks to make productive use of social capital - people‘s capacities to work together to solve common management problems, such as pest, watershed, irrigation, forest and credit management.

Governments have an important role in ensuring that sustainable agriculture options are available, adaptable and affordable for farmers. This, in turn, will require a broad set of actions. First, sustainable agriculture to achieve food security needs to be an explicit component of countries‘ national development strategies,

including the identification of financial resources to expand rural infrastructure and support services to small-scale agricultural producers. A holistic, cross-sectorial approach should consider trade-offs and build on synergies between sectors and objectives.

Second, there is a need to substantially expand resources for agricultural research and development and for the adaptation of technology to local conditions, with an explicit focus on meeting the needs of small-scale farmers, including women.

Third, new forms of public-private partnerships, including with civil society organizations, need to be identified to expand the provision of public goods in rural areas.

Fourth, the institutions responsible for service provision in rural areas (including education, and research and development/R&D) will need to undergo radical reform to make them responsive to the needs of small-scale rural producers through direct participation and consultation between small-scale producers and relevant stakeholders.

Finally, international commitment steward food security need timely delivery and must be aligned to national development strategies. The international community can also contribute to a global agenda for food security and environmental sustainability through reform of agricultural subsidies, including to biofuels, in countries of the Organisation for Economic Co-operation and Development (OECD); elimination of non-tariff barriers to food trade; increased investment in agricultural R&D; new payments for environmental services to small farmers in developing countries; and effective regulation of commodity futures markets.

Some questions for the future investigation, including research will be:

- What policy measures are being undertaken to improve the environmental situation in the agricultural sector?
- What improvements in farming practices are taking place?
-To what extent have beneficial environmental processes such as habitat preservation increased and harmful processes such as pollution decreased?
- What is the effect on the state of the environment?
- To what extent have specific objectives been met?

As regards policy measures and farming practices, the key source of information will come from the monitoring of rural development, market and environmental policies. However, this will remain dependent on the coverage of these policies and the willingness of member states to collect the appropriate information. The indicator set outlined above could be adapted to reflect the broader concerns of the strategy and its specific objectives. A monitoring framework for further development is proposed below.

Another important step is bringing agri-environmental concerns closer to the citizen.

The development of agri-environmental indicators presents a particular opportunity to engage citizens in both rural and urban areas. Alongside improved competitiveness, the multifunctional role of agriculture and the growth of publicly remunerated environmental services will play a large part in ensuring the viability of many rural areas. It is therefore important for society in general to understand the issues at stake and, indeed, the quality and diversity of Europe's rural environment.

The agri-environmental indicators are meant to address precise questions related to agricultural driving forces, pressures and benefits, the state and the impact on habitats and biodiversity as well as agri-environment policy responses. The indicators will help understand how regional farming patterns are developing. They will help assess whether policy or production changes pose risks to the conservation of the environment, or, if they are contributing positively to the preservation and enhancement of environmental resources.

The role of agriculture in maintaining the landscape and semi-natural rural environment is increasingly reflected in a range of initiatives such as the European Landscape Convention (ELC) and the Pan European Biological and Landscape diversity strategy (PEBLDS). The site specificity of agricultural activities fits closely with growing concerns about sustainable development and landscape quality at a very local level expressed in Local Agenda 21.

CONCLUSIONS

Several things are now clear with respect to sustainable agriculture:
The technologies and social processes for local level sustainable agriculture are well-tested and established;
The social and institutional conditions for spread are less well-known, but have been established in several contexts, leading to very rapid spread in the 1990s;
The political conditions for the emergence of supportive policies are least well established, with only a very few examples of real progress.
The past decade has seen considerable global recognition of the need for policies to support sustainable agriculture. Sustainable agriculture clearly does not yet have all the solutions, but great progress has been made in recent years. With further explicit policy and institutional support, particularly through national policy reforms, these benefits to food security and attendant improvements to natural, social and human capital could spread to much larger numbers of farmers and rural people in the next decade.
Sustainable agriculture therefore needs to reflect productive, environmental and social functions.
While considerable work has been undertaken in the development of indicators, many gaps still remain. These gaps exist at a number of levels in data, the construction of indicators, but above all in the existence of appropriate indicators that reflect key policy issues. It is therefore necessary to compare the "policy" coverage of existing indicator work with the key issues and questions identified during investigation and assessment.
If a lesson were to be drawn, it would be on the need to develop and implement integrated policies and strategies for agricultural and rural development, which incorporate socio-cultural, economic and environmental objectives in a balanced way. Such policy development is most effective if done in close interaction between governmental authorities, the private sector including farmer organizations, and representatives of civil society, including environmentalists.

ACKNOWLEDGEMENTS

I would like to thank to the Organising Committee of this event who invited me to speak, particularly to Prof. Ana Virsta and Prof. Stefana Jurcoane. I do not have an agronomical background, but being involved in researching alternative fuels, I came across to this field and now it became a hobby. However, I have been involved in sustainability for more than 10 years, and I find the topic of sustainable agriculture extremely important and challenging for Romania. In addition, I am interested in identifying new areas of research on this topic, which is an interdisciplinary field.

REFERENCES

Bran, M. Paicu, C.E. & Dobre, I. (2011) –The Management of Regional Biodiversity – Forest Potential", *Review of International Comparative Management*, 12(2), 282-292
Brooks, S. and M. Loevinsohn (2011)*Shaping Agricultural Innovation Systems Responsive to Food Insecurity and Climate Change*. Background paper for the WESS 2011.
COM (1999) *Directions towards Sustainable Agriculture*; Brussels, 27.01.1999 COM (1999) 22 final
COM, (2000).*Communication from the Commission to the Council and the European Parliament* - Indicators for the integration of environmental concerns into the common agricultural policy COM/00/0020 final
Dasgupta, P. (2007). –The idea of sustainable development", *Sustainability Science*, 2(1), 5-11
European Union Council (2006).*Strategy of Sustainable Development of the European Union*, Bruxelles
European Commision, (2010).*Agricultural and Rural Development*An analysis of the EU organic sector; Brussels, 2010
Informed and Experienced for Sustainable Agriculture_IESA(2012).Enhancing the information and consultation capacity of the social partners in sector of *Agriculture for active participation in working life for sustainable Agriculture*; VS/2012/003/0305
Meijerink, G. & P. Roza. (2007). The role of agriculture in development. *Markets, Chains and Sustainable Development Strategy and Policy* Paper, no. 5.Stichting DLO: Wageningen. Available at: http://www.boci.wur.nl/UK/Publications/
Ministry of Environment and Sustainable Development (2008).*National Strategy of Sustainable Development of Romania,* NSDS 2013-2020-2030 , Bucharest, 2008
Nastase, M., Cretu, A. &Stanef, R. (2009).*Effects of Global Financial Crisis*,Review of International Comparative Management, 10(4), 691-699
United Nation (2007).*Indicators of Sustainable Development: Guidelinesand Methodologies* — Third Edition

APPLICATION TECHNIQUES OF FERTIGATION

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Abstract

Advances in micro-irrigation techniques have facilitated greater adoption of the application of fertilizers to crops through irrigation water; the technique is termed as fertigation. Fertigation is used extensively in commercial agriculture and horticulture and is starting to be used in general landscape applications as dispenser units become more reliable and easy to use. Some irrigation systems offer the ability to use high-frequency fertigation likes drip irrigation systems. Irrigation and fertigation system design, soil type, crop stage, chemical type, fertigation time and irrigation water quality are important parameters for an appropriate fertigation. Fertilizer application techniques are also an important factor in achieving success. All techniques for incorporating a chemical with the irrigation water create a specific level of chemical concentration during irrigation. The various techniques may be classified into three main groups. These are; (i) gradual decrease of chemical concentration, (ii) constant level of chemical concentration, (iii) intermittent chemical concentration. In this article, the methods and equipments of fertigation and some research results of the fertigation frequencies on crops are presented.

Keywords: *fertigation, application techniques, injection, fertigation frequency*

INTRODUCTION

Fertigation is basically to supply fertilizers via irrigation water to the crops (Cetin and Tolay, 2008). This- a modern agro-technique, provides an excellent opportunity to maximize yield and minimize environmental pollution (Hagin et al., 2002) by increasing fertilizer use efficiency, minimizing fertilizer application and increasing return on the fertilizer invested. In fertigation, timing, amounts and concentration of fertilizers applied are easily controlled.

Thus, fertilizers are delivered through the irrigation water. The use of fertigation enables for highly accurate nutrient supply to plants. A small and frequent application of fertilizers, in the exact amounts that meet crop requirements, increase the efficiency of nutrient uptake and minimizes nutrient loses. However, using fertigation requires careful management and many factors must be taken into consideration.

The application of fertilizers is highly site-specific, depending on soil type, climatic conditions and water quality. Fertilizer demand in intensive plant production systems is particularly variable, changing rapidly during the season and the year and even within day and night. The nutrient requirements of annual crops is very much dependent on the biological stage of growth, varying from seeding to harvest, and likewise in orchard crops from vegetative to fruiting periods (Kafkafi and Tarchitzky, 2011).

Some of the basic advantages of fertigation are that efficiency of nutrient utilization is excellent, distribution of fertilizer is uniform, micro-nutrients and soil conditioners can be very effectively applied and poor quality irrigation water can be used (Anonymous, 2013a). Thus, fertigation ensures the fertilizer will be carried directly to the root zone. Amounts and timing of fertilizer application can be precise. Studies have shown that compared to broadcast applications, dramatically less fertilizer needs to be used to achieve similar growth and yield due to direct application to root zones when using fertigation. When using fertigation combined with scheduling of irrigation there may be savings of up to 50 percent of the amount of water is used, compared to a fixed irrigation schedule. Dependent on soil type, leaching of nutrients into the ground water can be reduced. Fertigation allows for increased flexibility at reduced rates of fertilizer timed more closely to tree demand. Compared to broadcast

application of fertilizer, fertigation of phosphorus and potassium allows rapid movement into the root zone.
Although the fertigation is a modern agro-technique for irrigated agriculture, there are some disadvantages. Fertigation using drip-irrigation or micro-irrigation is very sensitive to clogging, nutrient content in the used wastewater might vary and difficult to predict, it may require expert design and installation and not all parts and materials may be available locally.
In addition, uniformity of application depends on uniform water distribution. Poor system design, plugged lines and emitters means poor distribution. Fertilizer amounts cannot be varied to suit individual tree requirements. Only soluble forms of fertilizer can be used. Soil acidification is a significant problem with the use of any acid fertilizers regardless of application method particularly in poorly buffered soils, and low pH soils. This problem is intensified with drip irrigation. Some nutrients are leached readily, particularly nitrogen, boron and sometimes potassium particularly in coarse textured soils. Roots are generally restricted to areas close to the emitter. A smaller root volume may result in uptake difficulties for non-fertigated non-mobile nutrients, such as copper whose uptake is dependent on root length.

APPLICATION of FERTIGATION

Application Methods

There are two main methods of fertigation as quantitative (i) and proportional (ii). When using fertigation, fertilizers solutions are prepared in advance in stock tanks and the solution is then injected into the irrigation water. The most common fertigation methods to do so are the quantitative method and the proportional method.

The quantitative method (i) is commonly used in soils. In this fertigation method, the grower first decides how much fertilizer to be applied per area (e.g. kg/ha). This quantity of fertilizer is then delivered through the irrigation system. The proportional method (ii) is mostly used in soil-less media and sandy soils. In this method a defined quantity of the stock solution is injected into each unit of water flowing through the irrigation system (e.g. l/m^3, mg/l)
Depending on the methods of fertigation, application methods may use given below (Anonymous, 2013b).

1. Continuous application: Fertiliser is applied at a constant rate from irrigation start to finish. The total amount is injected regardless of water discharge rate.
2. Three-stage application : Irrigation starts without fertilisers. Injection begins when the ground is wet. Injection cuts out before the irrigation cycle is completed. Remainder of the irrigation cycle allows the fertiliser to be flushed out of the system.
3. Proportional application : The injection rate is proportional to the water discharge rate, e.g. one litre of solution to 1000 litres of irrigation water. This method has the advantage of being extremely simple and allows for increased fertigation during periods of high water demand when most nutrients are required.
4. Quantitative application : Nutrient solution is applied in a calculated amount to each irrigation block, e.g. 20 litres to block A, 40 litres to block B. This method is suited to automation and allows the placement of the nutrients to be accurately controlled.
Different application methods of fertizers in fertigation are given in Fig. 1. (Manor et al., 1983).

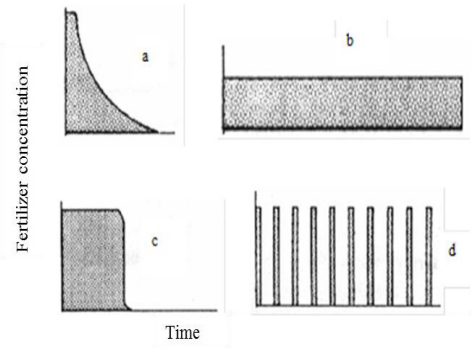

Figure 1. Decreasing nutrient concentration depending on time (a), fixed concentration during irrigation (b), fertigation in a part of irrigation (c) and equal and fixed quantities application of fertigation for same irrigation intervals (d) (Manor et al., 1983).

On the other hand, the selection of the correct injection equipment is just as important as the

selection of the correct nutrient. Incorrect selection of equipment can damage parts of the irrigation equipment, affect the efficient operation of your irrigation system or reduce the effectiveness of the nutrients.
The three usual methods of injection are (Anonymous, 2013b):

1. Pressure differential injection: A pressure differential tank system is based on the principle of a pressure differential being created by a valve, pressure regulation, elbows or pipe friction in the mainline, forcing water through a bypass pipe into a pressure tank and out again, carrying a varying amount of dissolved fertiliser. Advantages are very simple to operate; a stock solution does not have to be premixed, easy to install and requires little maintenance, changing fertiliser is easy and ideal for dry formulations. Disadvantages are concentration of solution decreases as fertilizer dissolves, leading to poor placement of nutrients, requires pressure loss in main irrigation line, tank must be able to withstand irrigation line pressure and proportional fertigation not possible, limited capacity, accuracy of application is limited and determined by volume rather than by proportion.
2. Suction injection: Suction of fertiliser through the intake of the pump is a common method of application and is the simplest method. The pumping unit develops a negative pressure in its suction pipe (unless the suction is flooded). This negative pressure can be used to draw fertiliser solutions into the pump. A pipe or hose delivers the fertiliser solution from an open supply tank to the suction pipe. The rate of delivery is controlled by a valve. This connection must be tight to prevent air entry into the pump. Another hose or pipe connected to the discharge side of the pump can fill the supply tank with water. A high-pressure float valve can be used to regulate this inflow into the tank. If necessary the system can be automated with a direct-acting solenoid valve. For multiple block usage, two or more tanks can be set up in series and operated when required. Advantages of this injection are very simple to operate; a stock solution does not have to be premixed, easy to install and requires little maintenance, ideal for dry formulations and low cost. Disadvantages are concentration of solution decreases as fertiliser dissolves, placing most of the nutrients below the effective root zone if tank is operated when irrigation is commenced. Proportional fertigation is not possible unless several tanks are used, limited capacity, danger of suction air entering the pump unless all fittings are airtight, risk of corrosion of pump bowl. Flushing the system is necessary and risk of contamination of water supply if chemicals flow back down suction pipe when pumping unit stops. A check valve is necessary and automation is difficult.
3. Pump injection: This is the most common method of injection of fertiliser into irrigation systems. Injection energy is provided by electric motors, impeller-driven power units and water-driven hydraulic motors. The pumps are usually rotary, gear, piston or diaphragm-type which deliver fertiliser solution from the supply tank into the pressurised mainline. This method can be very accurate. Pumps are generally not simple in design and can include a number of moving parts, so wear and breakdown are more likely. The three systems available are electric injection pumps, piston-activated pumps and diaphragm-activated pumps. Piston-activated and diaphragm-activated pumps are both hydraulic injection pumps; these dominate the fertigation market at present. Electric injection pumps include single or multiple piston, diaphragm, gear and roller pumps. Advantages are simple and effective, relatively easy to install and maintain, either proportional or quantitative fertigation is possible, no pressure loss in the main irrigation line, suitable for high head systems and automation is relatively easy. Disadvantages are pumps must develop a minimum mainline pressure to operate, need electric power source to operate and injection rate not easily adjusted.

Injection Equipments

Several techniques have been developed for applying fertilizers through the irrigation systems and many types of injectors are available on the market. There are two main techniques: the ordinary closed tank; and the

injector pump. Both systems are operated by the system‘s water pressure.
The injector pumps are mainly either Venturi type or piston pumps. The closed tanks are always installed on a bypass line, while the piston pumps can be installed either in-line or on a bypass line (Anonymous, 2013c).

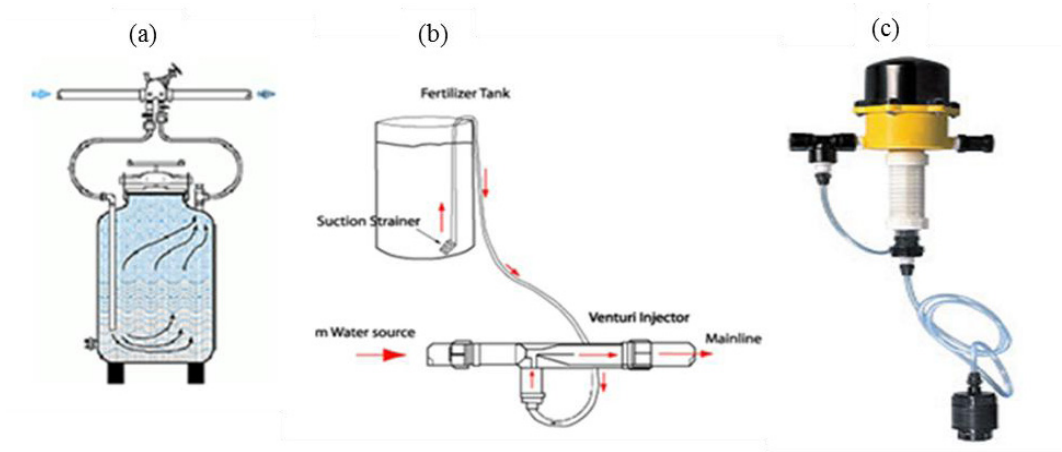

Figure 2. Different injection equipments for fertigation. Fertilizer (closed) tank (a), venturi system (suction) and a hydraulic pump (c)

1. Fertilizer (closed) tank: This is a cylindrical, epoxy coated, pressurized metal tank, resistant to the system‘s pressure, and connected as a bypass to the supply pipe of the head control. It operates by differential pressure created by a partially closed valve, placed on the pipeline between the inlet and the outlet of the tank. Part of the flow is diverted to the tank entering at the bottom. It mixes with the fertilizer solution and the dilution is ejected into the system (Fig. 2a). The dilution ratio and the rate of injection are not constant. The concentration of fertilizer is high at the beginning and very low at the end of the operation. However, this apparatus is still in service on a very small scale in some countries because of its low cost and easy manufacture. A by-pass fertilizer tank is the simplest way to apply fertilizers through the irrigation water. Injection of the fertilizer is not proportional to the water discharge rate. As the dilution ratio and rate of injection are not constant, fertilizer concentration is high at the beginning and decreases as irrigation progresses.

2. Venturi type : This is based on the principle of the Venturi tube. A pressure difference is needed between the inlet and the outlet of the injector. Therefore, it is installed on a bypass arrangement placed on an open container with the fertilizer solution. The rate of injection is very sensitive to pressure variations, and small pressure regulators are sometimes needed for a constant ejection. Friction losses are approximately 1.0 bar. The injectors are made of plastic in sizes from to 2 inches and with injection rates of 40–2 000 litres/h. They are relatively cheap compared to other injectors (Fig. 2b).

3. Piston pump : This type of injector is powered by the water pressure of the system and can be installed directly on the supply line and not on a bypass line (Fig. 2c). The system‘s flow activates the pistons and the injector is operated, ejecting the fertilizer solution from a container, while maintaining a constant rate of injection. The rate varies from 9 to 2 500 litres/h depending on the pressure of the system and it can be adjusted by small regulators. Made of durable plastic material, these injectors are available in various models and sizes. They are more expensive than the Venturi-type injectors.

CONCLUSION

Fertigation is affected by different crop species and growing stages, different environmental conditions (soil, climate etc) and growing media. Modern fertigation should be able to regulate quantity applied, duration of applications, proportion of fertilisers and starting and finishing time.

In fertigation, one-third of phosphorus and approximately one-fourth of the nitrogen are, basically, incorporated into soil before planting. The remaining fertilizer, which contained nitrogen, phosphorus, potassium and some minor elements, is applied by fertigation every one or two irrigation cycles (Cetin and Tolay, 2008).

In application of the fertigation, a pressure differential is created by throttling the water flow in the control head and diverting a fraction of the water trough a tank containing the fertilizer solution (Sne, 2006). This application is commonly used because it is cheap and simple. The other equipments, venture system and pumps, are also used depending on precision application and cost of these.

The effects of application of fertigation on crops are different depending on using equipment, practical application, crop species, soil and climate conditions. Kırda et al.(1997) stated that there were no significantly differences on continuously and discontinuously application of nitrogen in greenhouse for tomatoes. Thompson et al. (2003) found that there was no any significant effects of application frequency of nitrogen by fertigation on broccoli yield. However, the application frequency of fertigation increased yield and nutrient elements uptake by crops under the soilless (perlite) conditions (Silber et al.,2003). This is very important for the media which has lower nutrient concentration. In addition, Fernandes et al.(2003) stated that daily application of fertigation increased the crop yield compared to weekly application for water melon. İbrahim (1992) determined that fertigation applied for each 2 days increased the crop yield compared to the application for 15 days. On the other hand, total N uptake was appreciable higher with increasing N rate and with more frequent than with less frequent fertigation for tomatoes (Badr and Abou El-Yazied, 2007). Fertigation of P at any rate also resulted in more available P compared to soil applied treatment (Shedeed et al., 2009).

Considering the results on fertigation, the effects of the applications of fertigation are different on crops depending on climatic and environmental conditions, and methods of applied. Although the fertigation is a modern agro-technique, it needs more data and information and multi-disciplinary works such as soil fertility, plant nutrient, plant physiology and irrigation.

REFERENCES

Anonymous, 2013a. Fertigation Overview. http://www.ameriturf.com/images/fertigation/Fertigation (available 16.02.2013)

Anonymous, 2013b. Horticultural fertigation - techniques, equipment and management. http://www.dpi.nsw.gov.au/agriculture/resources/water/irrigation/crops/publications/fertigation (Available 16.02.2013)

Anonymous, 2013c. Pressurized Irrigation Techniques. Chapter 16: Fertigation. (ftp://ftp.fao.org/docrep/fao Available: 16.02.2013)

Badr, M.N., Abou El-Yazied, A.A., 2007. Effect of Fertigation Frequency from Subsurface Drip Irrigation on Tomato Yield Grown on Sandy Soil. Australian Journal of Basic and Applied Sciences, 1(3): 279-285

Cetin, O, Tolay, I., 2008. Fertigation: Fertilizing together with irrigation water. HASAD Publishing, ISBN: 978-975-8377-69-5, İstanbul, p. 160.

Fernandes, A.L.T., Rodrigues, G.P., Testezlaf, R., 2003. Mineral and organomineral fertirrigation in relation to quality of greenhouse cultivated melon. Scienta Agricola. Vol. 60, No:1, 149-154

Hagin, J., M. Sneh, and A. Lowengart-Aycicegi. 2002. Fertigation – Fertilization through irrigation. IPI Research Topics No. 23. Ed. by A.E. Johnston. International Potash Institute, Basel, Switzerland.

Ibrahim, A., 1992. Fertilization and irrigation management for tomato production under arid conditions. Egyptian Journal of Soil Science. 32(1): 81-96

Kafkafi, U., Tarchitzky, J.,2011. Fertigation. A Tool for Efficient Fertilizer and Water Management. International Fertlizer Industry Association (IFA), International Potash Institute (IPI), Paris, France, ISBN 978-2-9523139-8-8

Kırda,C., Baytorun, N., Tanriverdi, C., Derici, R.,Zapata,.F., Topcu, S., 1997. Continuous and intermittent application of fertilizers to decrease residual nitrogen fertilizer in greenhouse soils planted to tomatoes. Volume VI, Fertilizer and water quality

Water management, salinity and pollution control towards sustainable irrigation in the Mediterranean Region CIHEAM, International Conference, Valenzano, Bari, Italy,-22-26-September-1997, 37-50

Manor, S., Lowengart, A., Brum, M., Hazan, A., Bar, I., Geva, S., 1983. The technology of chemigation: Uniformity of Distribution in the Irrigation. 3rd International Conference on Irrigation, 3-6 October, 1983, Tel-Aviv, Israel.

Shedeed, S.I., Zaghloul , S.M., Yassen, A. A., 2009. Effect of Method and Rate of Fertilizer Application under Drip Irrigation on Yield and Nutrient Uptake by Tomato Ozean Journal of Applied Sciences 2(2), 139-147

Silber, A., Xu, G., Levkovitch, I., Soriano, S., Bilu, A., Wallach, R., 2003. High fertigation frequency: the effects on uptake of nutrients, Water and Plant Growth.

Thompson, T.L., White, S.A., Walworth, J., Sower, G.J., 2003. Fertigation frequency for subsurface drip-irrigated broccoli. Soil Science Society of America Journal. 67 (3), 910-918.

AGRICULTURE IN TERMS OF EUROPEAN UNION STRATEGY FOR DANUBE DELTA ADOPTION

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Abstract:

This paper shows how the adoption of the EU strategy for the Danube will affect agriculture in areas along the river and the main objectives of the strategy for agriculture. Among the Danube's states, Romania has the largest area in the Danube basin, Danube strategy aims a macro-regional development and is also an action plan for the river areas and neighbouring countries. The people from the Danube delta have a way of life unchanged for centuries and agriculture remains a vital sector for the Danube region. Farmers will need support for adopting and maintaining systems and agricultural practices that will contribute to achieving the strategy's objectives for the environment and climate changes.

Keywords **:** *Danube Strategy, agriculture, sustainable development, co-operation, objective*

INTRODUCTION

Danube, the second largest river in Europe, covers about 2850 km, linking the Black Forest to the Black Sea, across ten countries and has tributaries from other four countries.
An ideal location for placement of hydroelectric power plants, a pan-European transport corridor and a refugee for the rarest species in Europe - the pressures on the river are often in conflict with each other and political changes in the region also influenced the way the difficulties are dealt.
Following the example of the EU Strategy for Baltic Sea, which was the first macro-regional approach, the EU strategy for the Danube was based on stakeholder efforts in the region, allowing them to create a region where all 115 million people to enjoy security, prosperity and equal opportunities. (Dobrescu Emilian M., Popovici Vlad – European Institute from Romania, 2010)
EU Strategy for the Danube is a model of regional cooperation at European level. (Romanian Government, 2010)

MATERIAL AND METHOD

Strategy - a tool for integration and better use of EU funds - is also a political innovation and a new stage in EU regional policy. The EU Strategy's principles are solidarity and cooperation.
Strategy is EU's commitment towards job creation, sustainable and inclusive growth. It supports sustainable growth aimed at reducing energy consumption, increased usage of renewable energy, and upgrading transport sector by streamlining and improving its environmental impact and also ecological tourism. The EU Strategy helps to eliminate internal market barriers and improve the business environment.

RESULTS AND DISCUSSIONS

Among the Danube states, Romania has the largest area, part of the Danube Basin and the Danube Delta, which is the second largest wetland in Europe.
Regarding the course of the Danube in Romania, we can mention the following: it flows through 4 development regions, 12 counties with 25 municipalities and 56 cities, growth poles such as Constanţa and Craiova or development poles such as Brăila and Galaţi. The counties in the Danube region represent 30, 1 percent of Romania and 33, 8 percent of Romania's population. The socio-economic situation of the Danube region is the result of several factors including, demographic factors, level of education and training, remunerations

and unemployment, the overall level of economic activity and economic structure by sector, activity level and promotion of SMEs (Small and Medium Enterprises), the local taxation, foreign investments, etc.

The Strategy for the Danube Region is a macro-regional development and is an action plan for areas and countries close to the river and also for Romania. In addition to the sustainable development of the micro-region, the strategy aims to the nature protection, the protection of the landscapes and cultural heritage. (Romanian Government, 2010)

For Romania, the consolidation of the Danube's cooperation is a priority taking account of the potential for sustainable development of the region and we want to contribute at making the Danube a backbone of the European area as part of the Rhine-Main-Danube corridor. (Debates at The First Annual Forum of the EU Strategy for the Danube Region, 27-28 November 2012, Regensburg, Germany)

The problems we face are numerous and the dimensions of regional cooperation are multiple: transport, energy, tourism, agriculture and environment.

The economic and social development of the Danube region must be a sustainable development, which respects the European legislation regarding the environmental protection.

Romania supports this approach given that manages most of the climate change's reserves and the need to protect villages against natural disasters and national parks in the Danube region are extremely important aspects and need to be considered in the current strategy.

The Strategy's projects can be financially supported by developing strong synergies between different EU policies: cohesion, transport, tourism, agriculture, fishing, social and economic development, energy, environment, neighbourhood and development policies.

The people that live in the Delta have a way of life unchanged for centuries. Human implantation allowed discrete survival of the Delta's amazing ecosystems.

The great expanse of water explains the small number of inhabitants. Fishing is a constant of human activity in the region. The continuous usage of reed and bulrush is another branch of human activity. In some banks people practice plant culture and on others are green lands for livestock.

The navigation on Danube's arms and the transportation on its channels are other concerns of the inhabitants.

Agriculture remains a vital sector for the Danube Region, which includes 5, 07 million hectares of agricultural areas - arable land, pastures, meadows, and orchards, representing 34, 5% of total national agricultural areas.

In the developing regions which include the counties in the Danube region, namely South East, South Walachia and South-West Oltenia, the agriculture, hunting and fishing have a higher share than the regional Gross Domestic Product (GDP) share of agriculture in Gross Domestic Product of Romania.

The development of hydraulic structures and those for the recovery of water along the Danube basin were related to the economic development and thus protecting settlements and population.

Flood protected areas were expanded and under the protection of dams was developed a stable agriculture, and manufacturing centres, buildings for agricultural products, households.

Over the years and especially lately, changes occurred in dams profile (and the land of their foundation), and some portions of the dams were weakened because of erosion, which could lead to their collapse and flooding in the remaining unprotected areas.

The policy focused on the Danube embankment to reduce the risk of flooding and to provide the land for agriculture, led to a dramatic decrease of fish stocks. Embankment at the same time reduced the sediment carried by the Black Sea, thus changing the landscape of the Delta and increasing the risk of shore erosion.

Sustainable exploitation of living aquatic resources by practicing rational fishing is necessary for improving quality of life in fishing communities, conservation and restoration of fish stocks, improving and professionalizing the workforce and creating alternative occupational opportunities.

Supporting the sustainable development of fishery and improving quality of life in these areas, creating opportunities for alternative incomes for residents in the fishery areas, developing the specific infrastructure, training

of qualified personnel, ensuring the equipment for exploitation and manufacturing and encouraging the formation of partnerships, are important actions in the new Strategy.

The Danube Region is an ecosystem of interlinked and interdependent, providing invaluable environmental goods and services (food, fibber and fresh water, adjusting the quantity of water in a given territory and soil protection).

In this region there are the largest wild areas of Europe, which offers essential ecological health of the European environment as a whole. Industrial development, deforestation and pollution put hard pressures on the region.

The proposed actions to be taken include: implementation of bumper strips along the river to capture nutrients, usage of latest technologies for treating hazardous waste sites, helping restore wetlands as a way to increase flood protection and implementation of protected areas network.

A common theme through the whole process, proved the need to promote efficient use of resources to an intelligent sustainable and favourable growth for the inclusion of EU agriculture and rural areas, in line with Europe 2020.

It became more pronounced the market orientation of agriculture, while ensuring for producers an income support, also the integration of environmental requirements and the strengthen support for rural development as integrated policy for rural development across the European Union.

At the same time, agriculture and rural areas are invited to intensify their efforts to achieve the ambitious goals of climate change and energy and the implementation of the biodiversity strategy.

Farmers together with the foresters are the main managers of the land and they will need support for adopting and maintaining agricultural systems and practices that contribute to the achievement of particular environmental and climate changes, because the provision of public goods is not reflected in market prices. It will be essential to maximize the diversified potential of rural areas, contributing to inclusive growth and cohesion.

In the past 20 years there has been register a significant improvement in the quality of the Danube‘s water. Appropriate treatment of waste water in all communities, usage of detergents without phosphates, agricultural production to protect water resources and fish bypass channels in hydropower and other dams - all this will have an important role.

The measures give the river more space, creating additional wetlands and protecting biodiversity. Therefore the balance of land usage is restored, no longer used exclusively for cultivation, but also as meadows and stock rising. Overall economic impact is in the benefit of agriculture and increases opportunities for nature tourism and recreation activities. (x x x - Inforegio Panorama magazine no. 37, 2011)

It is strongly highlighted the multifunctional role of agriculture in terms of food security, employment in rural areas, ensuring a fair standard of living for farmers and mitigation of climate changes effects.

EU Strategy for the Danube Region provides the European agricultural model, characterized by viable exploitation structures close to the market, along with rural development and environmental protection. Are needed measures to be taken to support agriculture producers to adapt to the consequences of climate change because these changes will influence the variability and size of agricultural production and livestock.

Particularly, the EU Strategy for the Danube River is focused on developing recess agricultural and nutriment production and also ecological and traditional products in those areas where there are favourable conditions. It will be needed measures to protect the name of Romanian products, recipes and cooking procedures on European Union's and third countries single market, in compliance with food safety and appropriate promotion of food safety.

Part of the new sustainable approach on river engineering includes river restoration, rebuilding at the same time the connection between the Danube and tributaries whose course are now discontinued. These conditions, similar to natural ones, protect and establish new habitats for flora and fauna, creating a more attractive environment for all river users.

The strategy provides a framework for sustainable cooperation actions targeting these issues, and others. For the strategy to succeed,

however, is that people in the region need to take actions in the Strategy, in order to build a sustainable future for themselves and their children. Preparation of large projects in the Danube area has accelerated lately as witnessed by the many conferences.

At Regensburg, Germany, was held the first Annual Forum of the EU Strategy for the Danube Region, an event attended by local government representatives in the Danube region. Discussions at the forum focused on issues such as building the future of the Danube Region, improved environmental adaptability, perspectives, energy modern Danube region, a basin sustainable tourism and environmental assets, innovative action Danube successful businesses, promoting delegation, skills and overall growth and modern governance in the Danube area. (Debates at The First Annual Forum of the EU Strategy for the Danube Region, 27-28 November 2012)

Another example is the Danube Financial Dialogue - II edition (23-24 January) that took place in Belgrade, Serbia. The event turned out big enough financial perspectives of the EU project covering the entire macro-region lying within the 14 states. In this dialogue discussed and agreed with the delegates of the Danube countries and representatives of the European Commission and the European Union to organize a forum dedicated to Bucharest Danube macro-region strategy. (Debates at the Danube Financial Dialogue – 2nd Edition, 23 – 24 January 2013, Belgrade, Serbia)

CONCLUSIONS

Danube Strategy projects are financially supported through structural funds allocated for 2007-2013 and the support of the European Investment Bank (EIB) and European Bank for Reconstruction and Development (EBRD), both as project preparation and implementation.

Looking at the strategy in terms of regional development perspective, it is the framework that can ensure the overcome of regional disparities, being created at an opportune moment, and the beginning of the end of the current programming period and start training for 2014-2020. Strategy may change the way we approach regional development. Thus within the framework of this project by collecting projects and existing results, we can draw the lessons from the current period at regional level and make proposals for the future.

By adopting the Macro – Strategy for the Danube Region we can fill the development gaps between the European countries, including Romania.

The Danube Strategy is an important step towards simplification current funding and supports efforts to absorb European funds already committed to finance investment projects.

A Romanian regional policy rooted in reality with new and healthy institutions can bring new life line of our convergence towards the European Union. (Forum dedicated to the World Water Day and World Meteorological Day, Bucharest, 2013)

REFERENCES

x x x - Inforegio Panorama magazine no. 37 (Spring edition): EU Strategy for the Danube Region. United efforts in approaching the common challenges, 2011

Dobrescu Emilian M., Popovici Vlad – European Institute from Romania, 2010, Strategy and Policy

Debates at The First Annual Forum of the EU Strategy for the Danube Region, 27-28 November 2012, Regensburg, Germany

Debates at the International Conference –Strategy for the Danube Region – present and future", 2011, Bucharest

Debates at the Danube Financial Dialogue – 2nd Edition, 23 – 24 January 2013, Belgrade, Serbia

Forum dedicated to the World Water Day and World Meteorological Day, Bucharest, 2013

Studies SPOS 2012, Study no. 3 - Romania and the EU Strategy for the Danube Region. Process, implementation and priorities (bilingual edition), , Bucharest

Romanian Government, 2010, European Union Strategy for the Danube Region (brochure)

Action Plan of the Strategy for the Danube region, 2010

STRENGTHENING OF BUILDINGS BY SEISMIC BASE ISOLATION. PROS AND CONS FOR APPLYING THE STRENGTHENING METHOD TO BUILDINGS LOCATED IN BUCHAREST

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Abstract

At present, earthquake engineering can take advantage, among others, of the modern consolidated technique, namely "seismic base isolation". Base isolation is a technique that is easily enforceable in the case of buildings or other structures of new building, but it can also be used for the "strengthening" of already existing buildings. This technique has been often used with success, first in New Zeeland and USA, and now also in Italy, Japan, and other countries. The main objective of paper is to analyze the dynamic response of base isolation system under specific local seismic conditions. Local seismic conditions were established on the base of Vrancea earthquake records obtained during strong Vrancea earthquakes in 1977, 1986 and 1990. As results of this analysis at the end of paper are presented pros and cons for applying the strengthening methods to buildings located in Bucharest. The most important aspect is that high amplifications are present in response spectra of relative displacements at long periods. For this seismic local condition are very difficult to design an effective base isolation system.

Keywords: *seismic action, response spectra, strengthening works, seismic base isolation*

1. INTRODUCTION

The increasing demand for safe and comfortable buildings, together with the worldwide huge public and private housing programs currently in progress in high seismic areas, call for use of new industrialized construction systems.
Earthquake engineering can take advantage, among others, of two modern but consolidated techniques as seismic isolation and energy dissipation. The seismically isolated structures make use of devices, called seismic isolators, which are placed between the part to be protected and that from which protection is necessary.
When using rubber isolators, dissipation is achieved by mixing additives to the rubber compound – High Damping Rubber Bearings – HDRBs – or by inserting lead plugs or silicone fluids in the isolators, when it is desired to obtain damping values larger than 15%. It is also possible to install some dampers in parallel to the isolators, usually low damping.

In Eurocode 8 is emphasized that the structure shall be designed to withstand the seismic action with 10% in 50 years arrival probability without collapsing.
For example of seismic isolated structure in Figure 1 is presented University of Basilicata, Potenza which was first Italian isolated ~~–s~~chool" in 1995. For that scope were used 221 High Damping Rubber Bearings.

Figure1.University of Basilicata, Potenza (Martelli, 2008)

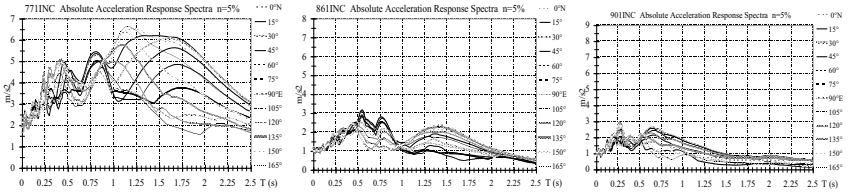
2.SEISMIC HAZARD OF BUCHAREST CITY

About 10% of the population of Romania is living in In City of Bucharest where more than 90% of the life losses occurred during the destructive earthquake of 1977.03.04. Unfortunately, during that earthquake, a single strong motion record was obtained in Bucharest at ground level.(the development of the strong motion network after 1978, due essentially to the generous aid provided by US/AID) made it possible to obtain, during following strong earthquakes, more valuable instrumental information. Among the absolute acceleration response spectra determined for various records, concerning various sites and events, the results obtained for the 1977.03.04 record of Bucharest – INCERC (upper plots of left column of Fig. 2) are obviously the most severe, due to:

a) High peak spectral values, exceeding 0.6 g;

b) Long dominant oscillation periods, exceeding 1.0 s, which involved high peak values of relative displacement response spectra.

The examination of the various processing data as response spectra makes it possible to remark following facts:



a. 1977.03.04 b.1990.05.30 c.1990.05.31

Figure 2. Response spectrum of accelerograms recorded in Bucharest – INCERC (INC)

- The transfer function derived for the case of considering a single layer (plot up left) corresponds obviously to the analytical solution;
- increasing gradually the number of layers considered leads to a gradual increase of the fundamental period characterizing the transfer function;
- the shape of the transfer function changes considerably when the number of layers considered changes; a certain tendency to stability of the transfer function shape appears in case one considers more than four layers (when the interface with stronger contrast at a depth of 600 m, after the fourth layer, is exceeded);
- in case one considers a deep geological package, one remarks that the transfer function has several main peaks of comparable importance, which means that, the spectral characteristics of ground motion will be determined primarily by the features of the input disturbance;
- the peaks of the transfer function (numbered leftwards) in case of considering all eight layers, up to a depth of 2800 m, present an interesting correspondence with instrumental data at hand: the first peak (period: ~ 5.7 s) corresponds fairly to the dominant periods of some 6 s, observed for records of remote earthquakes and to the frequencies of 0.15 … 0.2 Hz; the fourth peak (period: ~ 1.5 s) corresponds fairly to the main spectral peak for the 1977 event; the last important peak to the left (period: ~ 0.7 s) corresponds fairly to the main spectral peaks for the 1986 and 1990 events respectively.
- the stability of the oscillation periods corresponding to the transfer function peaks is obvious; this represents an explanation of the tendency to stability put to evidence by the sequence of response spectra at hand;

3. BASE ISOLATION SYSTEMS

In practice, the principle of Seismic Isolation is that of shifting the fundamental period (= reciprocal value of the frequency) of a building (Fig. 3) using the installation of

devices with a low horizontal stiffness between foundation and building (Fig. 4).

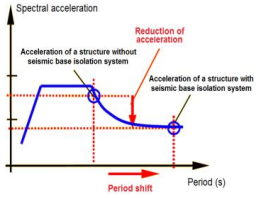


Figure 3. Response spectrum

Figure 4 below shows the effects of seismic movements on both a non-isolated and an isolated structure. Many non-isolated buildings have fundamental periods of 0,2-0,5 sec, especially old buildings with lowest height regime, i.e. the same fall within the typical range of high spectral acceleration (i.e. where the maximum energy content of the response spectrum is concentrated). Thus, the non-isolated buildings undergo resonance that results in dramatic amplification of ground accelerations within the structure as well as large inter-storey displacements. In the case of an isolated building, the fundamental period is shifted into an area with lower spectral accelerations.

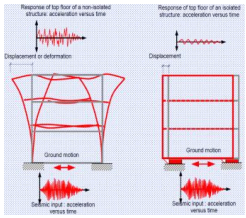


Figure 4. Displacements and deformations of a non-isolated and of an isolated structure

Resonance effects can be avoided and the building moves smoothly without showing appreciable structural deformations (Dragomir, 2008).

The four fundamental functions of aseismic isolation system are: 1.Transmission of vertical loads; 2.Allowance of displacements on the horizontal plane; 3.Dissipation of substantial quantities of energy and 4. Assurance of self-centring. These functions can be realized by so called *isolators* and *dampers*. The first function means that the isolation system acts as a conventional bearing system i.e. transfers vertical loads in the intended location from the superstructure to the substructure. The second function produces uncoupling between foundation and superstructure and thus reduces transmitted forces or the amount of mechanical energy, which is essentially the same. The uncoupling allows horizontal flexibility of the structure. The dissipation of energy limits relative displacement of the isolated structural mass and provides better structural control with bigger safety for the structure. The purpose of the self-centring capability requirement – return of the structure to former neutral mid position - is not so much to limit residual displacements at the end of a seismic attack, but rather, prevent cumulative displacements during the seismic event. Self-centring assumes particular importance in structures located in close proximity to a fault, where earthquakes characterized by highly asymmetric accelerograms are expected. It should be noted that energy dissipation and self-centring capability (sometimes referred to as restoring force) are two antithetic functions and their relative importance depends primarily on the case under examination.

In Figure 5 it can see the general installation of isolation system with High Damping Rubber Bearings.

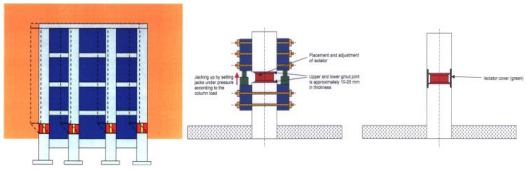


Figure 5. General installation of isolation system

The concept of the energy approach (1) reduces effectively the energy induced into the structure (Ei) by ground motion through its foundations. The amount of the structurally stored energy (Es) has to be as low as possible to avoid damages. Therefore

the value of the dissipated energy (Ed) must be great.

$$E_i \leq E_s + E_D = (E_e + E_k) + (E_h + E_v) = \\ = \oint -m\ddot{x}dx \quad (1)$$

where, Ee = elastic strain energy; Ek = kinetic energy; Eh = energy dissipated by hysteretic or plastic deformation; Ev = energy dissipated by viscous damping; m = mass of isolated structure x_G = absolute ground displacement.

The amount of the structurally stored energy (Es) has to be as low as possible to avoid damages. Therefore the value of the dissipated energy (Ed) must be great. The energy part Eh out of Ed due to plastic deformation of the structure has to be kept low, as this way of energy dissipation causes structural yielding and cracks.

The drastic increase of the value of the energy of viscous phenomena (Ev) is the final opportunity to control the energy balance of the structure. It should be pointed out that (Ev) is associated with the response forces (F) that depend only on the velocity (v) through a constitutive law.

4. RESULTS AND DISCUSSION

The use of *base isolation systems(BIS's)*may be highly beneficial, yet it requires a considerable investment, not only in financial terms, but also in terms of specific technology and, ultimately, in terms of specific know-how.

A factor of highest specific importance is represented by an appropriate consideration of the seismic conditions at the sites where *BIS's* are intended to be used. The information at hand shows that accepting without a kind of specific, qualified, control the provisions of codes specifying design seismic action for usual buildings may lead in case of use of *BIS's* to considerable errors and, consequently, to over conservative protection or to coarse under design. The concern for the seismic conditions represented the bulk of this paper.

A geographic zone requiring highest attention in relation to earthquake protection, due to the severity of seismic conditions, combined with the importance and vulnerability of elements at risk, is represented by the City of Bucharest, extended to some of its surroundings (which are, by the way, planned to develop quite soon like an extended urban area).

The differences between the seismic conditions at different sites inside this area are of secondary importance. It turns thus out that the results of analysis of seismic conditions for a certain site are significant for a wider area. This enrightens the organization of in depth analysis of site conditions for some reference site, investing considerable scientific, technical and financial resources, since the results will be to a high extent valuable for a wider area, i. e. for a lot of other sites. A pilot study deserves therefore to be organized for a reference site (Sandi and Borcia, 2008).

5. CONCLUSION

The most important aspect is that high amplifications are present in response spectra of relative displacements at long periods. For this seismic local condition are very difficult to design an effective base isolation system.

The results of analyses performed by *Sandi and Borcia in 2008* put to evidence the modification of dominant periods of ground motion from one event to the other, as well as the potential of occurrence, for very strong earthquakes, of ground motions having dominant periods longer than those observed for the event of 1977.03.04, raises special problems of seismological nature.

The need to anticipate dominant periods for earthquakes of very high magnitudes, in the range of $M_{GR} \in (7{,}5 \ldots 7{,}7)$, for which the rupture length would considerably exceed the value of about 60 km of 1977.03.04, is thus raised.

REFERENCES

Sandi H., BorciaI.S. (2008) On the verification criteria for base isolation systems, under the conditions of Romania. Proceedings of International Symposium on ―Modern systems for mitigation of seismic action", Bucharest, Romania.

Martelli A., (2008). Anti-seismic systems: State of the art of development and application, Proceedings of International Symposium on ―Modern systems for mitigation of seismic action", Bucharest, Romania.

Dragomir C.S. (2008). Influence of dynamic amplification on seismic response of masonry buildings. Doctoral Thesis, Technical Universityof Civil Engineering in Bucharest.

ASSESSMENT OF STRUCTURAL DAMAGES USING NON-DESTRUCTIVE AND SEISMIC INSTRUMENTATION METHODS. CASE STUDY OF AN EDUCATIONAL BUILDING IN BUCHAREST

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Abstract

All European countries are rich of pre-code buildings and there is also a considerable number of residential masonry buildings in the rural areas. In Romania, where over 60% of the territory and population are exposed to the Vrancea earthquakes, there are many pre-code reinforced concrete and masonry buildings. This type of buildings should be strengthened in accordance with the European and National Codes in force (EC8-Part 3 and P100- Part 3). According to paragraph 2.2.4., the "additional measures" of the Code of Building Seismic Design, indicative P100-1:2006, it is recommended to investigate the buildings with recording equipment for the seismic action parameters. The objective of the paper is to present a series of non-destructive methods used to assess damages of an educational building in Bucharest. The non-destructive testing of the concrete structures yields valuable information for the engineers when investigating problems and can reveal unanticipated or hidden damages. The repair of the structure is guided by the results of the testing. The building presented in the paper was designed as masonry structure with reinforced concrete cores and erected during 1950s with BS+GF+3storey height regime. In accordance with the technical report, building damages were evaluated. For this purpose, non-destructive and seismic instrumentation methods were used. Non-destructive methods are based on auscultation, ultrasound and percussion with Schmidt hammer, and the seismic instrumentation methods are based on the GEODAS-12USB equipment with adequate software. Evaluations are useful for both the seismic risk analysis of the inspected building and the design of the strengthening interventions. The prevention or determination of the earthquake effects was done by practical measures. It was understood that the increase in mass and stiffness was not always beneficial. The role of geometry was equally important in earthquake engineering and there were cases when reshaping might prove advantageous, especially when using advanced technologies available on the European market.

Keywords: *educational building, non-destructive tests, seismic instrumentation, structural assessment.*

INTRODUCTION

Earthquakes are the only unpredictable and the most destructive actions of all the natural catastrophes that can change the fate of people and their goods in a few seconds. In Romania, where over 60% of the territory and population are exposed to the Vrancea earthquakes, as there are many pre-code reinforced concrete and masonry buildings.

This type of buildings should be strengthened in accordance with the European and National Codes in force as EC8-Part 3 and P100-Part 3. According to paragraph 2.2.4.,"additional measures" in the Code of Building Seismic Design, indicative P100-1:2006, it is recommended to investigate the buildings with recording equipment of seismic action parameters.

The objective of the paper is to present a series of non-destructive methods used to assess damages of an educational building in Bucharest which is presented in Fig. 1. The non-destructive testing of the concrete structures yields valuable information for the engineers when investigating problems and can reveal unanticipated or hidden damages. The repair of the structure is guided by the results of the testing.

The old masonry and RC buildings, most of them with irregular plan and elevation, have suffered damage from the past seismic actions.

Making them safe is an important requirement for the owners and certainly urgent for the authorities.

The paper presents the authors' research on old building structures and proposes an original concept of evaluation for this type of building. The results on dynamic characteristics of these buildings obtained by seismic instrumentation with seismic data acquisition system are presented.

According to the Code P100-1:2006, asymmetric structures have no appropriate seismic shape; they have disadvantageous distribution of volumes, masses and stiffness.

Figure 1. Horticulture Faculty building within UASVM Bucharest, *BS+GF+2storeys+A*, located on 59 Mărăsti Blvd.

The irregularities and asymmetry of the structures cannot be avoided. They evolve from functional reasons in plan and technologic ones in height. This type of structures is also mentioned in the Eurocode 8 by the Principles of conceptual design, as follows: structural simplicity, uniformity and symmetry, redundancy, strength and bidirectional stiffness, strength and torsion stiffness, the effects of horizontal shear walls of the adequate floors and foundations.

According to the modern approach of preparedness, post-seismic interventions should be clearly foreseen and properly planned in order to avoid additional damages and fatalities, as well as save what has remained worth for further use. Post-seismic interventions should be designed and organised according to the provisions of the ISO13822:2001 (Dragomir and Calin, 2012). The clause 7.4 regarding the plausibility of interventions should be carefully considered.

General data on the building

The Horticulture Faculty is located in the complex of U.A.S.V.M. Bucharest. Its design and building were carried out in 1951-1952, which means that the building is approximately 60 years old. The Faculty building, shown in Figure 2, includes study spaces for education (lecture halls, classrooms, and laboratories), circulation spaces (corridors, stairways), faculty offices for the teaching staff, toilets and a terrace in the attic.

Access to the building is made through the main entrance located on the north facade or the secondary located in the western end of the building. The upper landings of the building can be reached by the central staircase next to the main entrance or the south-west wing of the building. Subsequently, the project for the external metal staircase was implemented in 2001; it is located in the southeast wing of the building that provides access to the attic through an outside terrace.

Figure 2. Main facade of Horticulture Faculty building

The plans show a building with five functional levels, BS+GF+3S+A, roughly rectangular in

shape with dimensions 82.90 x 14.38 m; adjacent to these forms, on the south side there is a building which houses the largest lecture hall (Bpa), also with a basement and ground floor level of approximately 20.00 x 30,00 m in size. The built area is approximately 1625 m^2 and the surface area about 6840 m^2. The floor height is as follows: basement - 3.00 m, ground floor - 4.64 m, 1st floor - 4.64 m, 2nd floor - 4.84 m and the toilet walls in the attic - 2.40 m. The upper cornice height is 15.26 m, and 16.30 m from the average land height.

Given the irregular shape and size of the building plan, the building was divided into two distinct wings through an expansion joint of 2.00 cm. The section of the main entrance and lecture hall area was named B1, and the other was called B2.

Data on the construction system

The two sections, B1 and B2, differ structurally as follows:

- Section B1 has a structure consisting partly of load-bearing brick walls and partly of concrete pillars supporting the monolithic reinforced concrete floors;
- Section B2 has a structure consisting of load-bearing brick walls supporting the monolithic reinforced concrete slabs.

The masonry walls are at least 37.50 cm in thickness and may reach 50.00 cm in the lower levels or the structural elements of high loads, although normally the load-bearing walls have been reinforced with monolithic reinforced concrete.

Masonry is made of solid red, C100 double pressed bricks and lime-cement mortar equivalent to class M10. The separating walls are made of brick, being 12.5 cm or 25.00 cm in thickness, and mostly coincide with the positions of the floor beams made of monolithic reinforced concrete.

According to the expertise of PRINCER Ltd registered under no. 1131/1993, the following characteristics were similar to the building materials used: C100 bricks, M10 mortar cement, R28 Concrete (120 daN/cm2), current class C12/15 according to NE012-2007 and OB37concrete steel.

Data on the foundation system

A geotechnical study was conducted together with the technical expertise of Building A – Rector‘s Office. As the Horticulture Faculty is close to this building, it shares the same data on the soil foundation characteristics.

The geotechnical study states that the foundation ground is based on clayey sand. This layer is lower in quality than the active clay layer that has contractile properties specific to the area, which resulted in the past damage in some buildings (e.g., the students‘ bedrooms required expertise and consolidation, performed by Prof. Aurel Beles).

The carrying capacity of the soil at the standard depth of 2.00 m is 280 kPa. Groundwater has been found at a depth of -9.20 m, with no wide variations as to affect the building foundation. The geotechnical study does not mention water damage to the concrete.

From experience we can say that this type of structure foundations, made between 1950 and 1952, consists in continuous soles of simple and reinforced concrete under the structural brick walls and insulated foundations under the reinforced concrete pillars (Dragomir, 2010).

Structural damages

The two wings of the building show cracks and fissures caused by the earthquake on March 4, 1977 and reactivated by the 1986 and 1990 earthquakes. There have been no interventions in the building structure during its approximately 60 years of service.

The following images present both the wrong reinforcement, even for the 50s, and the rusty spots on the reinforcement surface of the pillar located in the semi-basement. The picture below shows that the central pillar has the behaviour of simple concrete.

The two wings of the building are irregular in shape and their eccentricities between CG and CR highly exceed the standard values. The effects of their eccentricities are worsened by the geometric irregularities.

Figure 3. Western facade damaged outside load-bearing brick wall


a. Damage to the expansion joint b. Joint damage between the projection hall and Bpa lecture hall


c. Damaged concrete pillar in the semi-basement d. Plaster-stripped areas for non-destructive testing

Figure 4. Main structural damages of the Horticulture Faculty building

Figure 4a shows that the 2.00 cm expansion joint plays no role as a seismic point since the two wings collided with each other, probably due to their different rigidity (different structural systems) particularly since the two wings have large heights (approx. 16.00 m). It was found that the metal bars supporting the outer load-bearing walls and the roof of the Bpa lecture hall were not protected against corrosion.

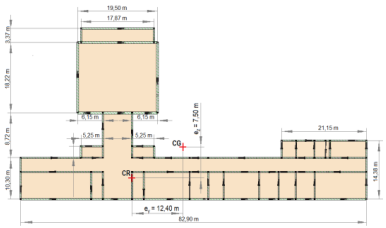

Figure 5. General plan of Horticulture Faculty (wings B1 and B2 with no expansion joint)

The plan shape of the wings is irregular, showing symmetrical discontinuities, ins and outs, resulting in additional pressure. The values presented in the figure above, and detailed in Appendix A, show that the Horticulture Faculty building plan does not comply with the regularly conditions imposed by both P100-1: 2006 Code and SR EN 1998.

The major structural damages of the building are shown in Figure 4.

MATERIALS AND METHODS

The clause 4.4.3 of the P100-1/2006 Code establishes conditions for assessing structural regularity both in plan and vertically. To calculate the relative position of the two intrinsic centres, centre of gravity - CG and centre of rotation – CR, calculations have been performed using the computer program AUTODESK ROBOT (Figure 5 and 6). In order to solve this problem, one of the consolidation solutions is to divide the building into sections building by a seismic joint that separates the large lecture hall. This results in two buildings with approximately rectangular shapes. The design will focus on each wing separately, and the spatial computing models validated by micro-seismic measurements will aim to achieve the safety level required by the codes.

RESULTS AND DISCUSSIONS

The recording of the dynamic parameters was performed in September 2012, with the micro-seismic data acquisition equipment, GeoDAS 12-USB, BUTTAN SERVICE, Japan, endowed with 12 channels. Spatial structure speed was recorded in different locations, in the three main directions NS, EW and vertical Z, measured in mm/s. The processing of the

recording by using specialized software resulted in the Fourier spectra. From these spectra we extracted the values corresponding to the fundamental period of vibration for the two transverse and longitudinal directions of the building.

For temporary seismic instrumentation, we used four tri-axial sensors placed in different directions. The resulting values indicated

a. B1 wing shape b. B2 wing shape

Figure 6. Eccentricities according to the two orthogonal directions

approximately the same values of their own periods, a shown in the table below.

Table 1. Natural oscillation periods measured for the building on two horizontal directions

Data	Event	Direction	
		T	L
24.09.2012	Micro-seismic	034.0.40	0.28

Comments:

1. The fundamental oscillation periods for the two horizontal directions ranged between 0.28 and 0.40 s, thus defining average rigidity structures. Analysing the response spectra recorded for the four earthquakes: March 1977, August 1986, May 1990 and October 2004 (see annex C), amplification peaks can be observed between 0.30 and 0.40 s (0.40 s in 1986 and 0.30 s in 1990). This dynamic amplification can be one of the causes for the recorded damages.
2. All the speed values were much lower than the threshold required, i.e. 5 mm / s as the vibration standard in the buildings, which means that there are no comfort-related problems.

In order to validate the results obtained by temporary seismic instrumentation, we present the fundamental periods of some existing buildings with a reinforced concrete frame (Figure 7) or load-bearing walls of masonry (Figure 8) analysed by the INCERC Bucharest researchers in Bucharest at different time periods (Dragomir, 2013).

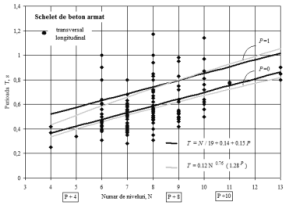

Figure 7. Values of own vibration periods for reinforced-concrete framed structures

Based on the results obtained were calibrated two regression models: linear and nonlinear (UBC format, Eurocode). The exponent 0.76 determined for the reinforced concrete frame structures was close to the value specified by the UBC 0.75 and Eurocode EC8.

For the Horticulture Faculty, the calculation formula for the fundamental vibration period of the two wings led to the following values:

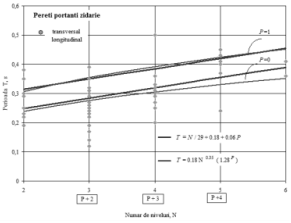

Figure 8. Values of own vibration periods for load-bearing brick wall structures

- for reinforced-concrete framed buildings, as wing B1:

$$T = 0{,}12N^{0.76} => T_{N=4} = 0{,}34\ s\ si\ T_{N=5} = 0{,}40\ s \quad (1)$$

- for brick-wall structured buildings, as wing B2:

$T = 0,18N^{0.35} => T_{N=4} = 0,29\ s\ si\ T_{N=5} = 0,31\ s$ (2)

The values obtained by the formulae determined by INCERC ranged from 0.29 to 0.40 s. In conclusion, we can state that the values were validated for the vibration periods recorded in the Horticulture Faculty, as determined by the temporary seismic investigation conducted in September 2012.

CONCLUSIONS

Following the analysis of the existing plans and the technical expertise performed until the present, and as the result of the visual inspection and calculations carried out for this study on the overall behaviour of the Horticulture Faculty, we have identified some deficiencies in the design and structure of the building.

The two wings separated by the expansion joint have different strength structures and there are no reinforced concrete pillars at the intersection of the load-bearing brick walls for strengthening these areas;

The building has an irregular shape in plan and elevation and the expansion joint is damaged, which means that the two buildings clashed in the earthquakes that occurred over the past 60 years. Therefore, the expansion joint has failed to fulfil the function of seismic joint;

There are no double walls or double poles in the expansion joint and covering the area of the largest lecture hall (Bpa) with metal trusses of approximately 20.00 m in opening and the absence of a rigid washer element in the roof structure, which would uniformly distribute the seismic action to all the structural elements if an earthquake occurs.

Under these circumstances, the failure to comply with the provisions of the code P100-1:2006 is evident for the seismic design of the buildings. The safety levels deriving from the new requirements are lower than the ones that were previously recorded by the 1993 expertise (cf. P-100-92, Standard for the seismic design of houses, social and cultural, agricultural and industrial buildings) because the different definitions of the seismic hazard: IMR = 50 years for P-100-92, and IMR = 100 years for P100-3/2008, which leads to higher values in the latter requirement and hence the lower values of the safety level.

In addition, the requirements imposed by the Standard P100-3/2008 for calculating the indicator (R3) (R_{3i}>0.5). These restrictions eliminate the capacity contribution of the active structural walls, while the standard P-100-92 is unconditionally considered the contribution of all walls.

To conclude, it is considered imperative to consolidate the building of the Horticulture Faculty. In addition to the building solutions presented in Expertise no. 1131/1993, building systems based on composite materials can be adopted in various forms which can be applied on one or on both sides of the wall. The solution is present among the consolidation measures included in P100-3:2008. In this case, the shear force capacity of the masonry wall plated with composite materials is given by the contribution of the composite material and the masonry.

The advantages of this type of intervention for the Horticulture Faculty are the following: good mechanical properties of the composite materials; the light weight composite materials generate permanently low loads on the structure; reduced thickness of the plating layers; structural intervention does not alter the original appearance; intervention is reversible as the materials can be removed from the structure if they fail to comply with the long-term performance levels that have been initially established.

ACKNOWLEDGEMENTS

The authors would like to thank the staff of the Seismic Risk Assessment Laboratory, INCERC Bucharest Branch of the National Institute for Research and Development for Constructions, Urban Planning and Sustainable Spatial Development.

REFERENCES

***Technical Report no. 1131/1993 developed by PRINCER SA.

Dragomir C.S., 2013. Damage assessment of buildings. Case study of an educational building, International Conference on Urban Earthquake Engineering, March, 2013, Japan

Dragomir, C.S. Calin, M.C., 2012. Dynamic response parameters and damage assessment of educational building located in earthquake prone area, Proceedings of the 15th World Civil Earthquake Engineeering in Lisbon, Portugal.

Dragomir, C.S., 2010. Seismic monitoring of architectural heritage building rehabilitation, Proceedings of the 14th European Conference on Earthquake Engineering, Ohrid, Republic of Macedonia.

RESEARCH UPON LANDSLIDES AT MOSOROASA, VALCEA COUNTY

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Abstract:
Landslides are a major degradation form of the natural environment with significant economic and social problems that affect all areas of earth slopes. In Romania, these processes are more intense in the Curvature Sub-Carpathians from Vrancea County to Vâlcea County. This paper presents the causes and forms of mass movements on slopes and customizes these problems for a slide area at the Olanesti river basin.

Keywords*: land degradation, shifting land masses, geological deposits, climatic indicators, digital terrain model highlighting*

INTRODUCTION

More than 80% of the Romanian territory has medium to high risk of landslide, the highest risk area being the Carpathian Mountains curvature, which also includes Valcea County.
From the viewpoint of deep erosion, Vâlcea County occupies the fourth place in Romania, and from the viewpoint of landslides, it ranks first. At present, the total ground area affected by these active phenomena in Vâlcea is 38.720 hectares. Out of this, 13.200 hectares are affected by surface erosion, 3.700 hectares by landslides and 21.820 hectares by deep erosion.
The research area is placed on the South-western side of the Mosoroasa Hill at Olanesti, with a 15-18% North East – South West slope; a 385 m long landslide occurred on the slope, 90 m far from the drainage divide, to the thalweg of the Mosoroasa Valley. The landslide front is 91.5 m in its maximum width (Rosulescu S.D., 2011).

MATERIALS AND METHODS

From the geomorphological point of view, the area is placed on the South-West side of the Mosoroasa Hill, close to the summit. The Hill is part of the morphostructural unit known in literature as –Getic Depression", which extends to the Southern part of the Southern Carpathians, reaching Bals-Slatina.

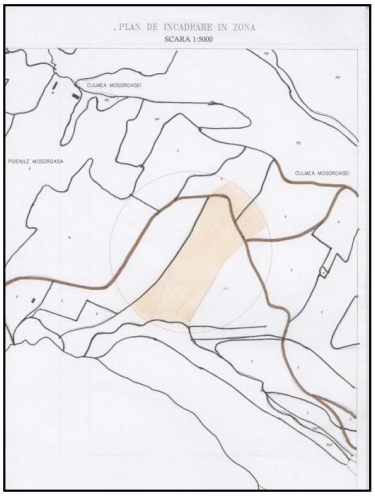

Figure 1 Study area position

The landslide has affected the slope from the hill summit to the Mosoroasa stream which runs from East to West and is a left tributary of the Olănesti River. Landslides are also present on the Southern part of the stream, where the ground area has a South-East to North-West direction. The main factor triggering the landslide is the high precipitations level, which has resulted in reducing the resistance parameters of the layers that form the slope covering (Rosulescu S.D., 2011).
From the geological point of view, the deposits that are currently forming belong exclusively to the Eocene (set out in monocline) and the Quaternary Period. These formations, whose total depth reaches 2000 m, are formed of two conglomerate horizons separated by a loamy

one: on the upper side, the quaternary covering of variable depths (2-15 m0, formed by the degradation of the main rock; the fixed consolidated rock deposits represented by Eocene formations consisting in two conglomerate horizons separated by a sandy, grey and rough clay package, figure 2.

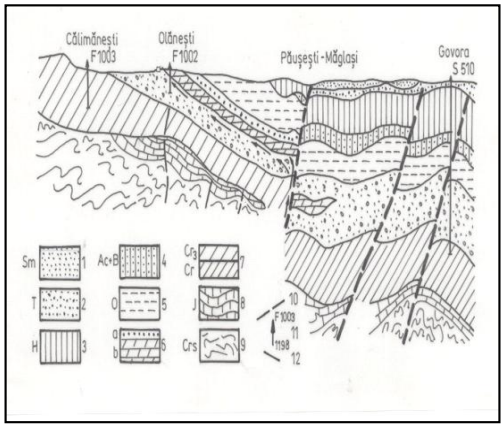

Figure 2 Transversal geotechnical profile through the study area

The geological profile on the NE-SW direction shows the presence of eight layers, as follows:

(1) Vegetal soil;
(2) Yellowish, plastic, running dust;
(3) Sandy, yellowish, plastic, running dust;
(4) Clayish, grey-blackish dust up to -1.60 m, grey-yellowish in the rest, plastic, running;
(5) Blackish, running mud;
(6) Clayish, light and yellowish sand, with grey films;
(7) Clayish, grey, plastic, consistent dust;
(8) Dust with $CaCO_3$, grey, plastic, rough, with yellowish slate films;

The climate of the Mosoroasa region is temperate continental of the transition continental climate subtype, with the following parameters: the annual average temperature is 10.2°C, the absolute low temperature is -31°C, the absolute high temperature is 40.6°C, the annual average precipitations are 750-800 mm/year.

The climatic indexes determined according to the climatic classification made by ICPA (National Research and Development Institute for Soil Science, Agro-Chemistry and Environment) allow a more complete assessment of the climate effect on the environment;

- Balance index (Bi);

Bi = P – ETp = 707.3 – 680.0 = 27.3 mm.

- Hydro-climatic index (Ih) :

$$Ih = \frac{P}{ETp} \cdot 100 = \frac{707.3}{680} \cdot 100 = 104\%$$

- Aridity index (Ia):

$$Ia = \frac{P}{T+10} = \frac{707.3}{10.2+10} = 35 \cdot$$

These climatic indexes show that the Mosoroasa landslide belongs to the low excess climatic class of the excess area. Thus, there is mainly a more humid climate in the area, which favours slope ground degradation processes by erosion and landsliding.

From the **hydrological** point of view, the following parameters of slope running were calculated for the Mosoroasa area:

- the annual average volume of flowing water (V):

$V = b \cdot H \cdot S$ (m^3)

where:

b – average flowing coefficient
H – annual average precipitations, m
S – water collecting surface, m^2

$V = 0.88 \cdot 0.7 \cdot 35.000 = 21.560$ m^3/year

The result of the above calculations shows that a flowing volume of 21.560 m^3/ year or 0.6 m^3/ m^2/ year is reached on the landslide surface of Mosoroasa throughout a year.

- The slope flowing debit (Q):

The precipitations registered on the 8th of March 2010 were considered, characterised by an intensity of i=0.02 mm/min.

$Q = 167\ i \cdot Ks \cdot S$ (l/s)

Where:

i – Rain intensity, mm/min
Ks – Flowing coefficient
S – Water collecting surface, ha

$Q = 167 \cdot 0.02 \cdot 0.6 \cdot 3{,}5 = 7.0$ [l/s]

The debit flowing on the landslide surface in the case of moderately intense precipitations (0.02 mm/min) is 7.0 [l/s].

These data indicate that precipitations are the main factor which maintains the landslide process development.

The Mosoroasa landslide monitoring took place from 2009 to 2011, when topographic measurements were performed, geomorphology was analysed in progress, while intervening

with a soil mass modelling in order to render the sliding-proposed changes visible.

The monitoring of the sliding progress by topographic measurements started by identifying/planting benchmarks in the fixed areas, as well as on the slide mass surface. Collecting data by topographic elevation helped obtaining the ground quotas and allowed the comparison with the previous measurements in order to indicate the ground mass time and space movement (Manea S., 2009).

Topographic measurements were performed using a 3D laser scanner in the research area, in a region traditionally mentioned and characterised from the topographic point of view. At present, the 3D laser scanning technology represents a specific method of determining the scanned objects' positions and correlating the photographic information with topographic information. This technology allows the user not only to determine surfaces, volumes, quotas or other topographic information, but also to correlate this information with the ground aspect, the vegetation covering, etc. Using the scanner processing software, the interest items are highlighted by the user who can design the digital pattern of the ground and then highlight the upper or lower slopes, as well as other interest items, figure 3.

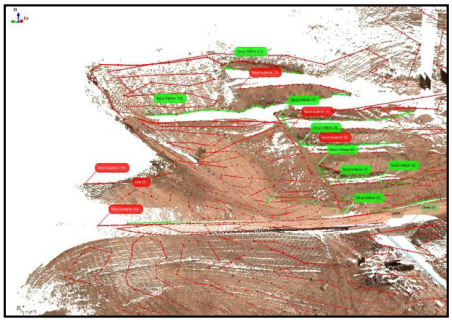

Figure 3 Digital pattern of the ground by highlighting the upper and lower slope with the help of 3D scanning

RESULTS AND DISCUSSIONS

The study concerning the Mosoroasa landslide progress was based on the topographic elevation of the ground mass from one year to another. For this purpose, topographic points were placed on the satellite image of the study area (figure 2), both on the sliding surface and benchmark positions on the determined ground. The image allowed us to determine precisely the current use categories of the ground which are different from the area cadastral plan. One can notice that the sliding area was used as pasture and was laterally bordered by two afforested areas eroded by the low tree density.

The landslide progress map, edited at a 1:500 scale (figure 3), indicated the position of the points topographically elevated, the corresponding quotas, as well as several infrastructure elements: the Păusesti–Măglasi–Mosoroasa communal road and the overhead power line, both items being degraded by landslide.

The digital processing of the topographic elevations resulted in the progress plan with level curves of 0.25 m in equidistance (figure 4). This offered the possibility to elaborate longitudinal and transversal profiles through the ground, in order to determine the ground volume moved during the landslide between two successive measurements.

Figure 4 Situation plan with level curves

We hereby present an example (figure 5), i.e. a longitudinal profile through the landslide axle that has a slight thalweg form.

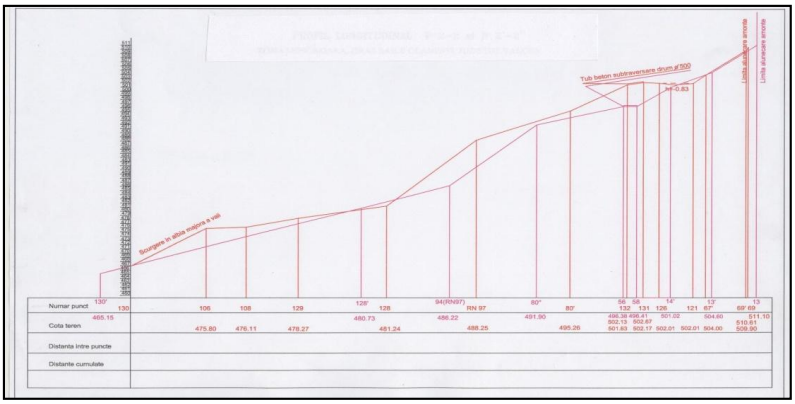

Figure 5 Longitudinal profile sliding

By processing and interpreting the profile data, we can conclude that the ground volume moved during a year was approximately 0.69 m^3/ year on the thalweg line of the ground mass sliding.
In parallel with the classic ground elevation, a modern method was used for more detailed research related to the landslide evolution, i.e. the 3D scanning of the research area. The final image of the sliding ground is presented in fig. 6, which provides the possibility to visualize and analyze the micro relief forms of the sliding mass, which favours the establishment of several punctual improvement techniques.

CONCLUSIONS

The landslides of the Olănesti hydrographic basin, the Mosoroasa region, affect the two slopes of the stream with the same name, following the intense erosion produced on the valleys of the region, which has destabilised the slope basis.
The triggering factor of the mass movement processes are the precipitations falling during the cold period of the year. The degradations produced by the slope slide result in a direct negative impact on the road and electric infrastructure, as well as the constant use of the lands.
The evaluation basis of the improvement techniques is represented by the slide progress dynamic research by using the periodic topographic monitoring.
Preliminary research shows that, from 2010 to 2012, the landslides at Mosoroasa moved an average ground volume of 0.63 m^3/ year.

REFERENCES

Manea Sanda, 2009 – Assessing the risk of sliding slopes. Publishing House Conspress
Rosulescu S.D., 2011- Studies and research on natural conditions specific areas addressed in research, Scientific Report No. 2, USAMV Bucharest
Rosulescu S.D., 2011- Experimental results on evolution processes and environmental reconstruction of landslides, Scientific Report No. 3, USAMV Bucharest
*** - Geotechnical study. Landslide in Mosoroasa Valey, Olanesti, Valcea County. Project nr.4990/2010, S.C.BEFAC Ltd Rm.Vâlcea
*** - Economic and social development strategy of the village Păusesti Maglasi, Valcea County. European Project Consulting, 2010
http://valceaturistica.ro

PEDOLOGICAL AND GEOTEHNICAL ANALYSIS OF LANDSLIDES AREA AT CORNU, PRAHOVA COUNTY

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Abstract

The research performed as part of this topic resulted in a modern methodology for geological risk management triggered by natural and/or anthropic phenomena occurring at Cornu, Prahova county. The methodology was applied in the area and consisted of risk identification, analysis, evaluation and monitoring in order to reduce or limit theit negative impact on the community life, environmental factors and natural habitat.

Keywords*: environmental factors, erosion, geological risk, landslides*

INTRODUCTION

From the administrative viewpoint, the area under study is located at Cornu, the north-western part of Prahova county, about 7 km far from Campina. The place is on the left side of the Prahova river, and can be reached by D.N.1 Ploiesti Brasov, 40 km north of Ploiesti.
Accessibility to the location under study is easy, owing to the well maintained roads. The area belongs to the South Carpathians, morphologically situated in a hilly region.
The area consists in slopes of various expositions and slopes strongly divided by valleys, mostly of torrential nature.
The overall relief aspect is strongly rugged, its elements being dominated by extremely non-uniform slopes. Micro-relief is characterized by the presence of landslides, which provides a precarious equilibrium to the area.
The adjacent slopes are steep and have numerous fault faces which eventually trigger landslides and even collapses on small areas.
On small areas, there are spontaneous bushes which maintain a fragile equilibrium of the small areas with high slippage potential.
In the Land Resources register, the land is recorded as agricultural land (degradation-affected pasture and grassland) and as non-agricultural land (exploitation roads, marshes, bushes and non-yielded land).
The specific degradation processes of the area include landslides, permanent moisture excess and deep erosion.
The area belongs to the Prahova river basin which bounds the western part of the location. The area under study is bounded by the Campinita creek in the North.

MATERIALS AND METHODS

The fieldwork was carried out between 08/11/2010 and 15/11/2010. In general, the geotechnical investigation consisted of advancement of three (3) boreholes, as F1, F2 and F3. The F1 borehole was located outside the slope, on the stable upper land, being used as control; F2 and F3 boreholes were placed within the landslide. The three drillings were performed on a NW– SE alignment.
The boreholes were generally advanced to depths between 4 and 7 m, using a drilling unit equipped with continuous flight augers, soil sampling and soil testing equipment. Within each borehole, disturbed samples were recovered at depth interval of 0,75 m using conventional split spoon sampling equipment. During the drilling, the stratigraphy within each borehole was examined. Observations of the groundwater level were also noted in the open boreholes.
Following the drilling, the boreholes were backfilled with the excavated material.

Representative samples of the various soil strata encountered at the locations were taken in Soil Science Laboratory of the University of Agricultural Sciences and Veterinary Medicine for further examination. Laboratory testing for this investigation comprised of routine moisture content determination and grain size analysis. Also, we had calculated plasticity, consistency and pore indexes.

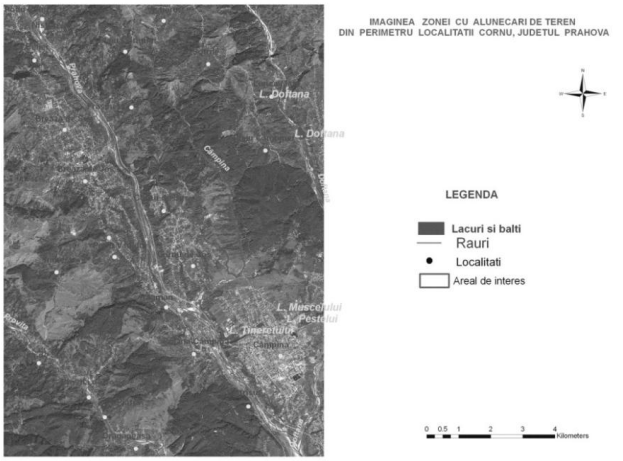

Figure 1. Cornu, Prahova county, orthophotomap

RESULTS AND DISCUSSIONS

METEOCLIMATIC CONSIDERATIONS

Climate is characterized by annual average temperatures of 9^0C. The annual amplitude is 21.5^0C, as January is the coldest month (-1.9^0C) and July the warmest month (19.6^0C).

According to multi-annual average data, first frost occurs on 6 October, while the last one can occur on 30 April. The average length of no-frost days is 175.

The number of frosty days (below 0^0C) is 115.6 days, while the number of days with highest temperature (over 25^0C) is only 74.7. The number of hot days (temperatures over 30^0C) is 15.7.

The number of cloudy days is 108.4, the cloudiest month being June (14.2 days). Sunshine duration is 2136.4 hours.

Concerning the rainfall, the annual average amount is 779 mm. at the Câmpina station. The rainiest month (June) consists in an average of 80 mm in the plains and about 100 mm in the hilly region. The month of lowest rainfall is February, with an average of 35-50 mm.

The annual average potential evapotranspiration is 640 mm, the highest values being registered in June (112 mm), July (128 mm) and August (114 mm).

Water excess is registered in six months of the year, the annual amount being 140 mm. The months with the highest water excess are January, February and March (over 30 mm each).

Northeastern winds are predominant but the Prahova hilly regions are sheltered, with slight intensifications towards the valleys and lanes.

Based on these overall climatic features, various topoclimates are manifest, determined mainly by the diverse geographical structure. Local temperature inversions in the large valleys and depressions result in early autumn and late spring frosts. Air flow from the mountain to the plain is recorded on the valley bottoms.

The climatic aggressiveness coefficient k is a constant which depends on the geographic position and is used for the prognosis of multi-annual average volume soil losses.

The value of the climatic aggressiveness coefficient corresponding to the location is k

=0.14 (k=0.08-0.16). The number of the pluvial intensity area is z=7 (z=1-19) .

Table 1. Average annual and monthly temperatures and rainfalls registered at Campina meteorological station

Monthly	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
T (^{0}C)	-2.3	-0.5	3.4	9.3	14.4	17.7	19.7	19.1	14.8	9.7	4.8	0.2	9.2
P (min.)	41.2	40.6	38.6	57.9	96.7	115.3	97.1	78.9	58	53.3	54.7	467	779

Table 2. Maximum rainfall layer of different probabilities

Maximum rainfall layer in 24 hours (mm) with ensurance				
0.50%	1%	5%	10%	20%
101	95	80	73	66

PEDOLOGICAL CONSIDERATIONS

Data to obtain

a. Soil genetic type
b. Textures and erosion degrees
c. S factor value
d. Degradation types

Information sources

Data writing method

a. Soil genetic type

The soil of the area is brown forest. It evolves as podzol under the influence of the humid climate.

Bedrock could be of crystalline or sedimentary origin; generally, the formation rocks do not contain carbonates and are relatively permeable.

Rainfalls exceed evapotranspiration, especially in winter and spring, determining a trans-percolation hydric regime resulting in soil salt leaching.

These soils have the following profile:

Ao – El – Eb – Bt – D or C.

Ao horizon – grey brown color, slightly structured.

Bt horizon – different from Ao horizon in color, structure and important clay accumulation; the color gradually lightens to the base, towards the D horizon.

D horizon – rock generally leached by carbonates; carbonates are present in some cases, especially if the initial rock is carbonated.

C horizon – can be absent or occurs at relatively high depths.

The fertility level of the soils decreases as the podzolic and pseudo-gleyey processes intensify. In this case, the soil ability to provide the plant with useful nutrients decreases significantly and the soil conditions (reaction, temperature, aeration) worsen.

Pseudo-rendzinic soils occur together with brown soils. Dark meadow soils also occur in the slight depression or slight slope zones. Proluvial soils are formed at the slope base.

Pseudo-rendzinic soil features:

- Specific horizons – Am – AmD – D
- Clay content – 4-7%
- pH in H_2O, pH = 7.0
- nitrogen, potassium: well-stocked
- $CaCO_3$ content: 3.2 % (AmD), 16.2 % (D)
- fertility: medium.

Dark meadow soil features:

- Specific horizons – Am (W) – Bv (W) – Bv – D
- Clay content – 4-10%
- pH in H_2O, pH = 6÷7
- nitrogen, potassium: well-stocked
- $CaCO_3$ content: -
- Aerial-hydric regime: imperfect (soils used as pastures and grassland).

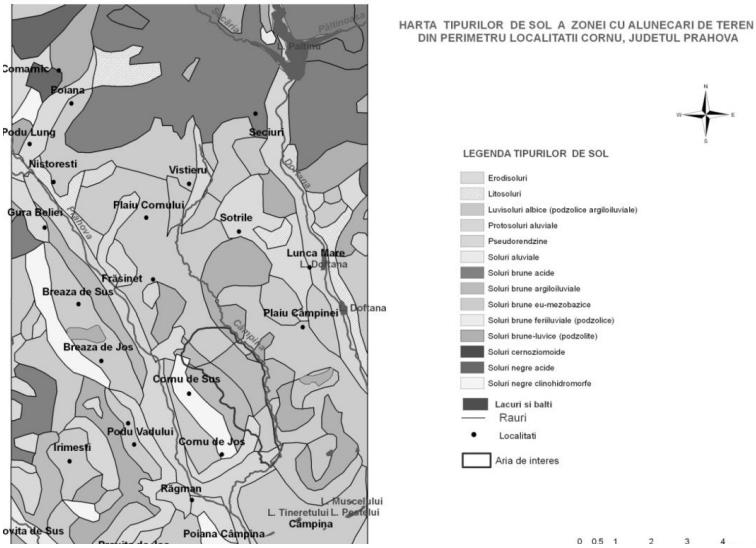

Figure 2. Map of soil geography with soil type distribution at Cornu

b. Textures and erosion degrees

The soils are characterized by medium textures, with favorable chemical features and fertility, rich in clay and nitrogen, with well-stocked phosphorus and middle-stocked potassium.

As part of the area under study, the following soil units are identified:

Table 3. Analytical data – podzolic brown forest soil

Horizon	Ao	El	EB	Bt	D
Depth –cm	0-9	9-27	30-50	63-83	140-160
Clay % <0.002 mm	21.2	24.1	31.4	42.7	35.5
Clay % <0.01 mm	34.4	37.8	44.5	53.3	47.2
Humus (%)	5.24	1.71	1.14	-	-
Ntotal (%)	0.22	0.08	0.08	-	-
Horizon	Ao	El	EB	Bt	D
pH in H_2O	5.16	4.9	5.24	5.48	6.74
Gv (g/cm^3)	1.35	1.50	1.50	-	-
Pt (%)	48	43	44	-	-

U.S. 1 – pseudo-gleyey, brown soil

U.S. 2 – medium pseudo-gleyey, slight podzolic, brown soil

U.S. 3 – pseudo-gleyey, medium podzolic, brown soil

U.S. 4 – skeleton, brown soil

U.S. 5 – medium eroded, brown soil

U.S. 6 – slightly moderate podzolic, brown soil

U.S. 7 – moderately eroded, pseudo-gleyey, slightly moderate podzolic, brown soil

U.S. 8 – pseudo-gleyey, strongly eroded, brown soil

U.S. 9 – moderately eroded, slight skeleton, dark-brown forest soil

U.S. 10 – complex of strongly eroded soils

U.S. 11 – locally strongly-excessively eroded, brown soil

U.S. 12 – moderately eroded, dark-brown soil, with strongly eroded soils in area with stable slips

U.S. 13 – complex of eroded pseudo-rendzinis soils, with excessively eroded soils eroded ones in area with temporary stabilized landslides

U.S. 14 – complex of podzolic brown soils, dark-brown pseudo-gleyey, pseudo-gleyey, moderately and excessively-strongly eroded soils, with quasi-stabilized landslides
U.S. 15 – complex of dark-brown podzolic soils, pseudo-gleyey, excessively-strongly eroded
U.S. 16 – complex of strongly eroded dark-brown soils, with semi-stable slips
U.S. 17 – dark-brown forest soil, slight podzolic one, pseudo-gleyey, medium eroded, with many slightly deep crevasses
U.S. 18 – lands affected by deep erosion (active or under activation crevasses)
U.S. 19 – brown pluvial soil, pseudo-gleyey, slight skeleton into depth
U.S. 20 – complex of colluvial brown soils, eroded, into valley, locally
U.S. 21 – consolidated natural outlets pseudo-gleyey soils
See below the plan including the soil map
Pedologic risk factor, S:
Depending on the soil groups (soil type, texture, erosion degree) found in are under study, the S erosion factor has the following values: 0.8; 1.0; 1.2.

Degradation types :
Depending on the soil degradation type and degree, soil units were included into pedo-ameliorative groups.
Group I – non-eroded, pseudo-gleyey soils: U.S. 1, 2, 3, 4, 19, 20 – S = 83 ha
Group II – moderately eroded soils E1: U.S. 5, 6, 7, 9 – S = 156.25 ha
Group III – strongly eroded soils E2: U.S. 8 – S = 56.7 ha
Group IV – excessively eroded soils E3: U.S. 10, 11 – S = 34.6 ha
Group VI – complexes of erosions into area with stable slips: U.S. 14, S = 146.7 ha
Group VII – eroded soil complexes affected by quasi-stabil U.S. 15, 16 – S = 5.7 ha
Group VIII – soils affected by erosions into depth
Sub-group VIII A – natural consolidated outlets, U.S. 21 – S = 2.0 ha
Sub-group VIII B – active and under activation crevasses, U.S. 17, 18 – S = 65.0 ha

The landslide test was performed on a slope of high relief energy, on the right upper side of the ramified ravine. The whole area was affected by first and second-degree landslides which were firstly produced at the contact between the basic rock and the covering delluvial formations, and subsequently in the delluvial deposits.
The ground had an irregular aspect, being partly covered by herbs and partly by thistles and shrubs. The second-degree slips had an obvious ‗crock skin' aspect. The first-degree slips were detrusive and produced starting from the upper part of the slope.
In the F1 drilling area, the land was stable, the first slip occurring at approximately 10.00 m downstream.
In the drilling area and the right flank of the ravine, the first-degree slip had the first severance of about 4.00 m in height, the land being organized into three major terraces. Delapsive slides of low extension subsequently occurred in the ravine flank. Counterslip areas were identified in the bermes, where rainfall water accumulated resulting in vegetation typical for excessively moist areas.

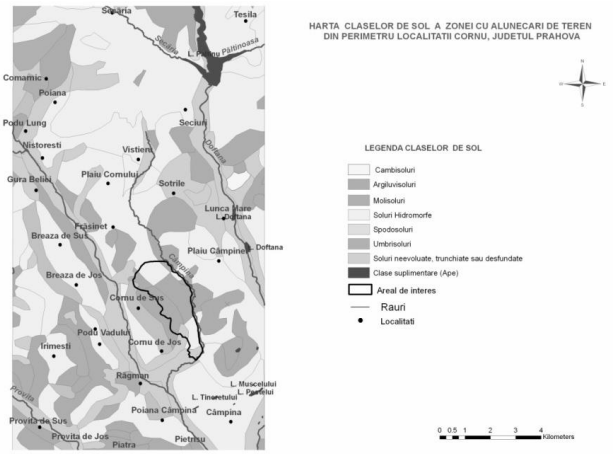

Figure 4. Map of soil classes at Cornu

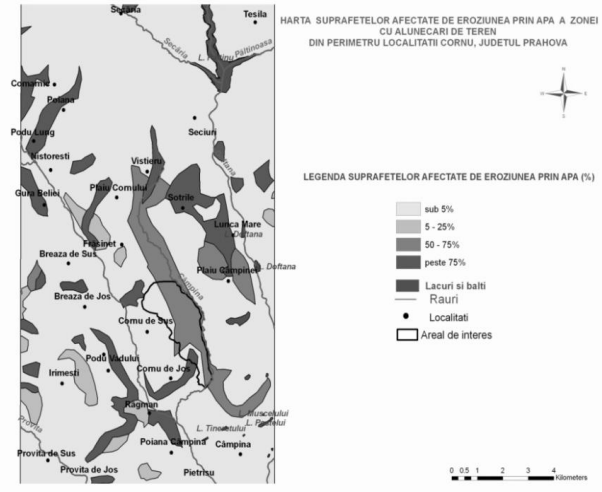

Figure 5. Erosion map of Cornu

Cracks and fissures were identified on the surface of the whole slipped mass. In time, they lead to new phenomena of instability.

Drilling F2 was placed on a first-degree slip while F3 on a semi-stable, second-degree slip.

The factors leading to slip production were linked to the high energy of the slope, the petrographic nature of the delluvials in relation to both the marl rock and infiltration water at the contact between the cover formation and the basic rock. The same causes led to the formation of the previously mentioned crevasse which, although presently consolidated by gabions, it is under evolution, with an unfavorable impact on the overall stability.

From the base to the upper part of the slope, a cobblestone road was identified, sustained by earthwork and consolidation by wattle fences. The works were partially compromised due to water infiltration, previous slips and the petrographical nature of the delluvials.

The work depth was conditioned by the interferance with the slope plan and basic rock.

The unitary profiles of the drillings present land stratification and the physical-mechanical features of the interfering land.

The F2 borehole was especially equipped for slope measurements.
Based on the results obtained from the F1, F2 and F3 boreholes, the following stratification is presented:
-*F1 borehole*:
0.00 – 2.70 m clay, yellow-brown at the base, plastic-consistent hard, with grey interferings in upper part;
2.70 – 3.50 m dusty clay, yellow, plastically hard, with small gravel and angular elements of shale rocks;
3.50 – 4.70 m clayey sand, brown, with small-big gravel at the base, with angular elements of shale rocks;
4.70 – 7.00 m gravel, with clay-dusty sand binder, with boulders at the base.No water.
- *F2 borehole*:
0.00 – 2.20 m clay, yellow-brown at the base, plastically hard, with rare small gravel in the base;
2.20 – 3.10 m clay, grey-brown, plastically hard, stratified, with brown clay interfering with vegetal residues and gravel in the base;
3.10 – 4.00 m marl clay, grey, hard.
NH_s = 3.10 m (infiltration)
- *F3 borehole*:
0.00 – 1.40 m clay, yellow-brown, plastically hard;
1.40 – 3.80 m clay, grey, yellow in the upper part, hard;
3.80 – 4.00 m marl clay, grey, hard.
NH_s = 2.30 m (infiltration).
As noticed, the F2 and F3 boreholes emphaisezed two land categories:
- lands belonging to the moving earth;
- lands placed under the slope plan, unaffected by the movement.
The landslide is basically represented by superficial delluvial deposits and the stable land is represented by the basic marl rock, the slip occurring at the contact between the two formations.
The table below presents the main features of the lands located over and below the slip plan, expressed as extreme values:

Table 4. Lands over and below the slip plan

Geotechnical feature of lands from F2 and F3 boreholes	**Lands – over slip plan*)**	**Lands – below slip plan*)**
Plasticity index, **Ip**	35.7 – 43.3	36.8 – 42.3
Moisture, **w (%)**	14.3 – 24.8	13.0 – 16.1
Consistency index, **Ic**	0.81 - >1	>1
Volume weight, **γ(kN/m^3)**	19.7 - 21.3	19.7
Porosity, **n(%)**	27.8 – 41.8	41.8
Pore index,**e**	0.38 – 0.72	0.72
Saturation degree, **Sr**	0.92 – 1	0.92
Internal fricton angle , **ϕ_{uu}(kPa)**	28^o – 36^{o}30‘	12^0 45‘
Cohesion, **c_{uu}(kPa)**	79 - 112	42.00

**) The position of the slip plan was orientative; it could not be directly established by slope measurements, but only estimated based on the land nature and modification of the geomechanical features in certain depths.*

CONCLUSIONS

In the F1 drilling area, the land was stable, the first slip occurring at about 10 meters downstream.
In the area of the drillings and the right side of the ravine, the first-degree slips have the first detachment step of 4 meters in height, the land being organized on three major terraces. On their background, delapsive reduced slips took place in the ravine side. At the bermes level, counterslip areas were identified, where rainfall water accumulated leading to vegetation specific to humid areas.
Cracks and fissures were identified on the whole cover of the slip mass which, in time, results in new instability phenomena.

One can ascertain that the F2 drilling was placed on a first-degree slip, while the F2 drilling was placed on a semi-stable, second-degree slip.

The samples taken from the drillings, which led to the establishment of the physical-mechanical properties of the land, corresponded to the direction of land movement on the slope.

At the date of drilling, underground water was found in two drillings, F2 and F3, at 3.10 m and 2.3 m depth, respectively. Water occurred as infiltration, probably on the slip direction. Underground water was not found in the F1 drilling.

REFERENCES

- Montgomery C.W., 2011. Environmental Geology. Wm.C. Brown Publishers, Dubuque;
- Varnes D.J., 1984. Landslide hazard zonation: A review of principles and practice. Paris;
- Ioniţă A.A., 2013. Managementul riscului geologic asociat fenomenelor natural si antropice din perimetrul localitatii Cornu, judetul Prahova. USAMV. Bucuresti;
- Florea N., 1989. Metodologia elaborarii studiilor pedologice, Bucuresti;
- Florea N., 1978. Generalizare dupa harta solurilor, ICPA, Bucuresti;
- Puiu St., 1980, Pedologie, Ceres, Bucuresti;
- Stanciucu M., 2010. Investigatii geotehnice in situ, ed. Universitatii din Bucuresti, Bucuresti.

FLOODS TRANSIT THROUGH HYDROTECHNICAL WORKS IN RIVERBEDS

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Abstract

The reservoirs are water management works that modify watercourses flow regime by retaining a part from their stock and sending it towards the downstream at lower flows. In this paper a front lake has been considered and its effect on the maximum flow in the riverbeds has been numerically simulated. Numerical simulation was performed using the NEPERM software. This software is based on the Saint-Venant equations, knowing that the water discharge from the reservoir is performed by a bottom discharge and a spillway. Boundary conditions of simulation were represented by tributary flood characteristics in the reservoir and wasteways operating characteristics. The results of the software are hydrographs of flows and levels in cross sections.

Keywords: *flood, front lake, Saint-Venant equations, numerical simulation*

INTRODUCTION

Frontal accretions are made by crossing the minor and the major riverbeds of the water courses, and are designed to change the temporal regime of the medium and high water courses to mitigate flood waves and/or satisfaction with water of uses. The main components of the frontal accumulation in relation with the functions of mitigate the flood waves are: lake basin, dam, surge of high waters. In this paper a front lake has been considered and its effect on the maximum flow in the riverbeds has been numerically simulated with the NEPERM software, which was developed by PhD. Eng. Dan Marinovici [1] and it is based on the Saint - Venant equations.

MATERIAL AND METHOD

It was considered a frontal accretion lake with an impermanent operating regime, respectively the variation of the water level in the dam section, knowing that the water from the accretion is drained, through a bottom drain and a hydraulic ram. Attenuation in accretion was made with the model of non-permanent movement. The gradually non-permanent and varied movement of the currents with free level is described by the system of differential equations with partial derivate:

$$\frac{\partial \omega}{\partial t}+\frac{\partial Q}{\partial s}=0$$

$$\frac{\partial}{\partial s}(z+\frac{v^2}{2g})+\frac{1}{g}\frac{\partial v}{\partial t}+I=0$$

where which "I" represents the hydraulic gradient $I=Q^2/K^2$. These written equations with variables Q represents flow and z – the free level of a water surface are known as equations Saint – Venant.

$$B\frac{\partial z}{\partial t}+\frac{\partial Q}{\partial s}=0$$

$$\frac{\partial z}{\partial s}+\frac{1}{g\omega}\frac{\partial Q}{\partial t}+\frac{2Q}{g\omega^2}\frac{\partial Q}{\partial s}-\frac{Q^2}{g\omega^3}\frac{\partial \omega}{\partial s}+\frac{Q^2}{K^2}=0$$

To solve the system of equations, the initial conditions must be known, which can have the following form:

$t = 0$; $Q = Q(s)$ (flow distribution along the river); $z = z(s)$ (free level of water surface).

And the limit (boundary) conditions:

$s = 0$; $Q = Q(t)$ (upstream flood wave hydrograph);

$s \in (0, l)$; $Q = Q(z)$ (water discharge characteristic of a frontal accretion lake);

$Q_{av} = Q_{am} \pm q$ (Continuity equation), in which q represent the inflow or outflow from the river (a tributary or a side accretion lake);

$s = l$; $Q = Q(z)$ (limnimetric key in cross section or water discharge characteristic of a front accretion lake).

These are nonlinear hyperbolic equations, with variable coefficients which cannot be analytically integrated in this form. But one can find approximate solutions of this differential equation system for some particular situations, if upon the phenomenon that it describes are made a number of simplifying assumptions. Best results are obtained by numerical integration of the equation system, being previously transformed in equations with finite differences. The results obtained in this way are acceptable and can be used in practice.
The front accumulation can be located in downstream profile of calculation sector or on the way.
The flood wave hydrograph from the upstream cross section it consists by characteristics such as $Q_{\max}$, T_{cr}, T, γ.

$$Q = Q_{\max}\left(\frac{t_1 - t_1^{'}}{T_{cr} - t_1^{'}}\right)^{\left(1-\frac{t_1^{'}}{t_1}\right)\frac{1-\gamma}{\gamma}} \cdot \left(\frac{t}{t_1}\right)^{\frac{1-\gamma}{\gamma}};$$

$t \in [0, t_1]$

$$Q = Q_{\max}\left(\frac{t - t_1^{'}}{T_{cr} - t_1^{'}}\right)^{\left(1-\frac{t_1^{'}}{t_1}\right)\frac{1-\gamma}{\gamma}} \quad ; \quad t \in [t_1, T_{cr}]$$

$$Q = Q_{\max}\left(\frac{t_2^{'} - t}{t_2^{'} - T_{cr}}\right)^{\frac{1-\gamma}{\gamma}\cdot\frac{t_2^{'}-t_2}{T-t_2}}$$

; $t \in [T_{cr}, t_2]$

$$Q = Q_{\max}\left(\frac{t_2^{'} - t_2}{t_2^{'} - T_{cr}}\right)^{\frac{1-\gamma}{\gamma}\cdot\frac{t_2^{'}-t_2}{T-t_2}} \cdot \left(\frac{T - t}{T - t_2}\right)^{\frac{1-\gamma}{\gamma}} \quad ;$$

$t \in [t_2, T]$

Where $t_1 \approx (0{,}90 \div 0{,}95)T_{cr}$, $t_2 \approx T_{cr} + (T_{cr} - t_1)$,
$t_1^{'} \approx (0{,}95 \div 0{,}99)t_1$
$t_2^{'} \approx t_2 + (0{,}01 \div 0{,}05)(t_2 - T_{cr})$.

For the example are considered the characteristics of the flood influx in the barrier lake:

- Duration T = 48 hours;
- Growth duration : Tcr = 16 hours;
- Maximum flow : Qmax = 350 m³/s;
- Form coefficient: γ = 0,25.

The operating characteristics of the high water evacuators are:

- Bottom drain: ω = a x b = 3 x 3 = 9 m², flow coefficient μ = 0,56;
- For hydraulic ram: level of the hydraulic ram z_{cr} = 148 mdM, flow coefficient m=0,40.

Were given seven transverse profiles in upstream of the dam, inclusively the section of the dam, describing the lake section. The cross sections are described by a number of points for which are registered the cumulated levels and the distances for the minor river bed, respectively the major riverbed. Also it is required the limnimetric key and the upstream hydrograph.

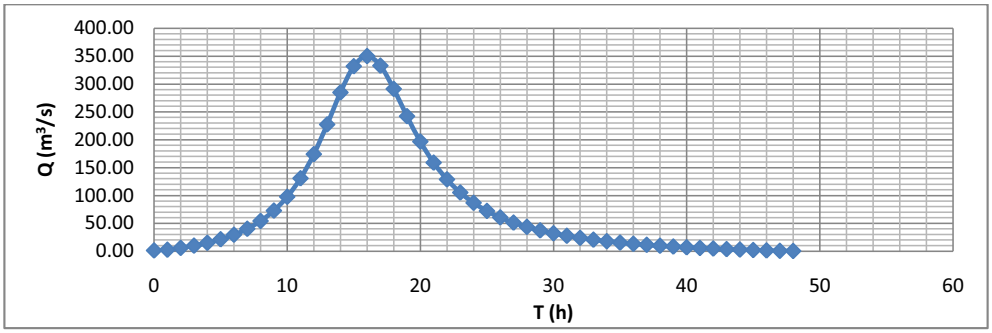

Fig. 1. The upstream hydrograph

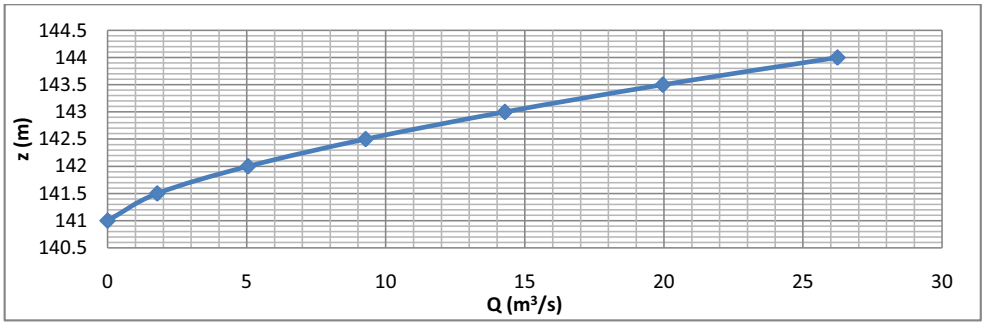

Fig. 2. The limnimetric key for bottom drain 0-3 m

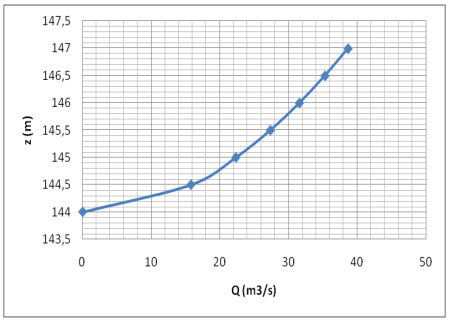

Fig. 3. The limnimetric key for bottom drain 3-5 m

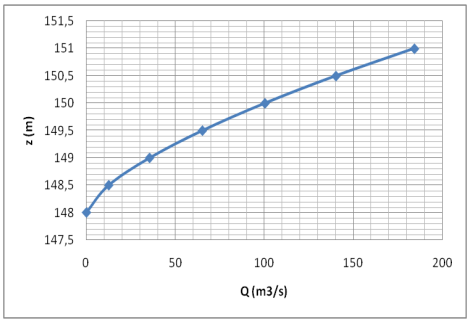

Fig. 4. The limnimetric key for overflow 5-8 m

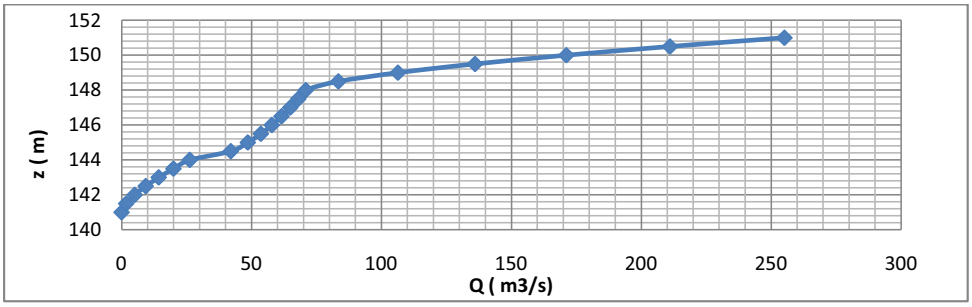

Fig. 5. The total limnimetric key

RESULTS AND DISCUSSIONS

Hydraulic calculations were performed in non-permanent movement and by numerical integration of the differential equation and of the movement results the hydrograph of the flows and of the levels in the transverse profiles.

Therefore, by evaluating the two hydrographs, was determined the mitigation level of a flood in a frontal barrier lake with an impermanent operating regime, respectively the variation of the water level in a dam section.

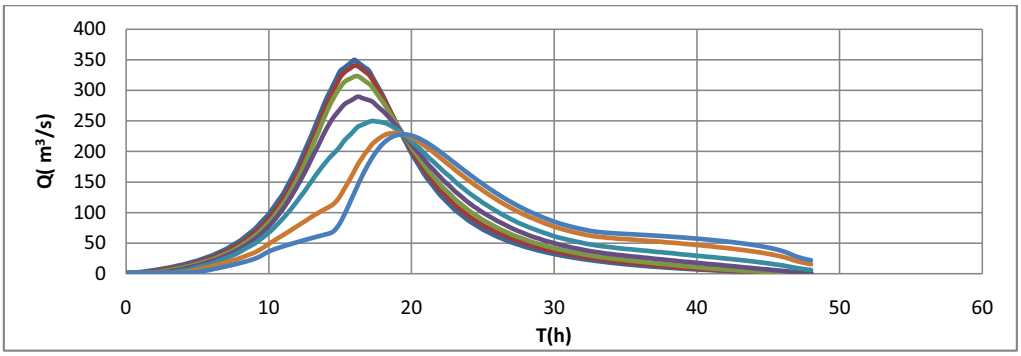

Fig. 6. The flows hydrographs

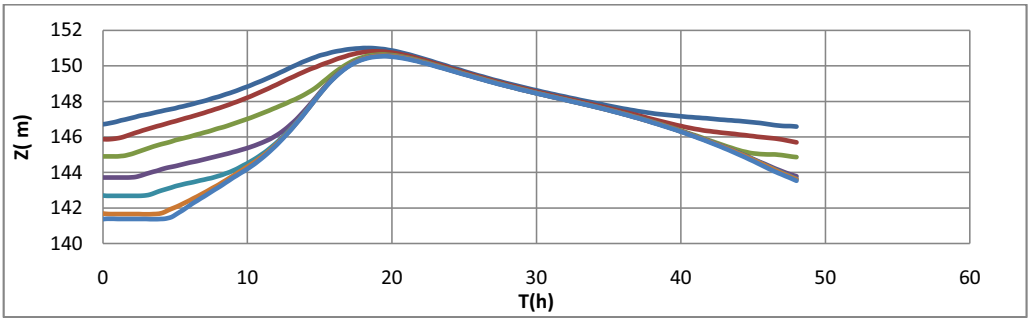

Fig. 7. The levels hydrographs

CONCLUSIONS

By evaluating those two hydrographs, easily it can be observed the influence of a frontal accumulation lake and how it modifies the watercourses flow regime by retaining a part from their stock and sending it towards the downstream at lower flows, according to the flood protection needs.

REFERENCES

Hâncu S., 1985. Applied Hydraulics, Numerical simulation of non-permanent movement of fluids. Technical Publishing, Bucharest

Marinovici D., Burghilă D. Analytical expression of the flows hydrographs for singular flood waves. 2008., Scientific Bulletin – E Series XLVI. Land Reclamation, Environment Engineering, Terrestrial Measurements, 197-200.

RAINFALL-RUNOFF MODELLING OF THE DROBOTFOR WATERSHED USING GIS-BASED SCS-CN METHOD

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Abstract

The Drobotfor basin is situated in the eastern part of Tutova Colinas, in the Bacau County and it is tributary of Zeletin River. The watershed drains a land area of 87.61 sq. km and is characterized by an elongated shape on north-south direction. It has a length of 32.3 km with differences regarding height and relief fragmentation of each sector and a maximum width of 4.25 km in the inferior sector. The land is heavily degraded, especially by erosion. The high torrential degree in the basin denotes the possibility of concentration large amounts of water from rainfall with thunderstorm fallen character with great importance in the area of modelling of the relief. In this study, using a GIS-based approach, the SCS-CN method has been applied to the Drobotfor watershed in order to peak runoff rates for a uniform rainfall. There have been taken into consideration the relevant spatial and hydrological characteristics.

Keywords: *GIS, SCS-CN, Runoff depth, Curve Number*

INTRODUCTION

The hydrological behaviour of a basin is provided for the morphometric characteristics of the drainage basins. Using multivariate statistical analysis help in establishing correlations between the morphometric parameters and the key hydrological variables such as, the catchment area, the time of concentration, the shape of the unit hydrograph, and discharge (Bardossy, 2002). Although these morphometric parameters provide information for hydrological modelling, it, however, must be well defined and able to be derived from the available data using standardized techniques (Willemin, 2000). Unless there is reliable and accurate data about rainfall, the determination of surface runoff will be problematic. The localized meteorological station always fails to provide an accurate coverage of climatic parameters.

This paper aims at determining the runoff using Soil Conservation Service method (SCS) for a rainfall in a small watershed. The method was developed mainly for small watersheds for which only daily rainfall and watershed data are ordinarily available. Simple methods for predicting runoff form watersheds are important in hydrological modelling and they are used in many hydrologic applications, such as flash flood estimation and water resources.

The SCS-CN method is an event-based model developed by the USDA Soil Conservation Service. A curve number (CN) is a land cover index for a given land and soil type to determine the amount of rainfall that infiltrates into the ground and the amount that becomes runoff for a specific storm event (USDA, 1986). The SCS-CN method is the most common technique for estimating storm runoff volume. Many watershed models, including the USDA Agricultural Research Service (ARS) SWAT model, incorporate this method for determining runoff despite some of its limitations including: no explicit accounting for the effect of antecedent moisture conditions, difficulty in separating storm runoff from the total discharge hydrograph, and peak runoff rate is not obvious (Mihalik, et al., 2008).

MATERIALS AND METHODS

GIS and Watershed Characterization

Geographical Information System (GIS) offers a variety of techniques to automatically extract hydrological variables from high-quality digital elevation models (DEMs), such

as flow direction and watershed delineation (El-Magd, et al., 2010).

The version of GIS used in this study was ArcGIS 9.3. Spatial data layers (aerial photography, hydrology, hypsography, soils, topography, and digital elevation models) were collected from a number of sources.

All data sets were projected to the same coordinate system (Stereo 70) and integrated to provide a vector topographic coverage that could be interpolated to a raster digital elevation model (DEM) for use in the runoff modelling. In addition to topography, the hydrology, hypsography, and soils data were each transformed into layers for the GIS to form the datasets useful for delineating and modelling the watershed.

The layers were processed using ArcHydro. ArcHydro is a set of data models and tools that operates within ArcGIS to support geospatial and temporal data analyses. ArcHydro is used to delineate and characterize watersheds in raster and vector formats, define and analyse hydrologic networks, manage time series data. It consists of two key components:

- ArcHydro Data Model
- ArcHydro Tools

These two components, together with the generic programming framework, provide a basic database design and a set of tools that facilitate the analyses often performed in the water resources arena. ArcHydro is intended to provide the initial functionality that can then be expanded by adding to its database structures and functions required by a specific task or application (ESRI).

Soil Conservation Service Curve Number Method

The Soil Conservation Service Curve Number (SCS-CN) method was originally developed to predict direct runoff volumes for given rainfall events and it is documented in the National Engineering Handbook, Sect. 4: Hydrology (NEH-4) (SCS, 1956, 1964, 1971, 1985, 1993, 2004). It soon became one of the most popular techniques among the engineers and the practitioners, because it is a simple but well-established method, it features easy to obtain and well-documented environmental inputs, and it accounts for many of the factors affecting runoff generation, incorporating them in a single CN parameter (Soulix, et al., 2012). The main weaknesses reported in the literature are that the SCS-CN method does not consider the impact of rainfall intensity, it does not address the effects of spatial scale, it is highly sensitive to changes in values of its single parameter, CN, and it is ambiguous considering the effect of antecedent moisture conditions.

The SCS-CN method was originally developed as a lumped model and up to this date it is still primarily used as a lumped model. In natural watersheds, however, spatial variability with regard to the soil-cover complex is inevitable. The method is based on calculating runoff form rainfall depth,

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} \quad (1)$$

where: Q = direct surface runoff in mm,
P = storm rainfall in mm, and
S = potential maximum retention

The potential retention S is expressed in terms of the dimensionless curve number (CN) through the relationship:

$$S = 25.4\left(\frac{1000}{CN} - 10\right) \quad (2a)$$

In the English metric system (with Q and S in inches) the following definition should be used:

$$S = \frac{1000}{CN} - 10 \quad (2b)$$

The runoff CN is an empirical parameter corresponding to different soil-vegetation-land use combinations.

The SCS-CN method only forecasts the quantity of runoff formed in any point of the catchment but does not model the flow routing or the distribution of runoff through time. Because of this reason the requirements of the method are quite low, only the rainfall depth and an empirical parameter CN are mandatory. The CN value can be obtained from the hydrologic soil group, land-use and moisture conditions of the soil, the last two values being more important. Water infiltration capacity of the soil was classified by the USDA-SCS into four classes called hydrologic soil groups. Every type of soil has a Hydrologic Soil Group (HSG) that indicates

an infiltration capacity and a rate of water transmission through the soil (USDA- NRCS 2007). The four types of HSGs are presented in table 1.

Table 1. Classification of hydrologic soil groups (USDA-NRCS 2007)

HGS	Characteristics of the hydrologic soil group and infiltration rates
A	Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Infiltration rate > 7.62 mm/h
B	Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures. Infiltration rate 3.81 - 7.62 mm/h
C	Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Infiltration rate 1.27 - 3.81mm / h
D	Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have clay textures. Soils in this group may have high shrink-swell potential, a water table or a water impermeable layer close to the surface. , infiltration rate from. Infiltration rate 0 - 1.27 mm/h.

Table 2. CN coefficient values (Drobot, 2007)

Land Use		CN value for Hydrologic Soil Groups			
Code	**Description**	**A**	**B**	**C**	**D**
1	Urban continuous areas	85	89	92	98
2	Urban discontinuous areas	77	85	90	95
3	Industrial and commercial units	81	88	91	93
4	Transportation networks	83	89	92	93
5	Airports	80	85	88	93
6	Ore extraction areas	80	85	88	93
7	Waste dump	80	85	88	93
8	Construction areas	80	85	88	93
9	Urban green spaces	48	66	76	82
10	Facilities for recreation and sports	51	68	79	84
11	Non-irrigated arable	67	78	85	89
12	Irrigated arable	67	78	85	89
13	Paddy fields	67	78	85	89
14	Vineyards	46	67	78	83
15	Orchards	43	65	76	82
16	Pastures	49	69	79	84
17	Complex agriculture	67	78	85	89
18	Agricultural land with an important percentage of natural vegetation	52	69	79	84
19	Agro-forester lands	52	69	79	84
20	Deciduous forests	42	66	79	85
21	Coniferous forests	34	60	73	79
22	Mixed forests	38	62	75	81
23	Meadows	49	69	79	84
24	Subalpine bushes and shrubs	49	69	79	84
25	Scrubs-forests transition areas	45	60	73	78
26	Beaches, dunes	63	77	85	88
27	Rock	77	86	91	94
28	Dispersed vegetation areas	72	82	83	87
29	Peat (turf)	30	58	71	78
30	Water	-	-	-	-

The HSG values are based on the intake and transmission of water under the conditions of maximum yearly wetness (thoroughly wet) and are valid for unfrozen soil. The land cover and land-use are used in conjunction with these HSGs in order to obtain the final value of the Curve Number (CN) parameter. The CN values for different land-use and soil types can be found in table 2.

RESULTS AND DISCUSSIONS

Case Study

The Drobotfor basin is situated in the eastern part of Tutova Colinas, in the Bacau County and is a tributary of Zeletin River. The watershed drains a land area of 87.61 sq km and is characterized by an elongated shape on north-south direction. It has a length of 32.3 km with differences regarding height and relief fragmentation of each sector and a maximum width of 4.25 km in the inferior sector. Its most import subbasin is Pojorata, strongly asymmetric with a length of 10 km and a maximum width of 2.16 km.

The land is heavily degraded, especially by erosion. The high torrential degree in the basin denotes the possibility of concentration large amounts of water from rainfall with thunderstorm fallen character with great importance in the area of modelling of the relief. Along the river are situated a number of localities. The watershed incorporates among agricultural and forested lands, meadows and pastures, vineyard and orchards. The soils are dominated by moderately to somewhat well-drained with sandy clay loam textures on most of the agricultural areas and poorly-drained with sandy clay loam textures in the southwest and northeast.

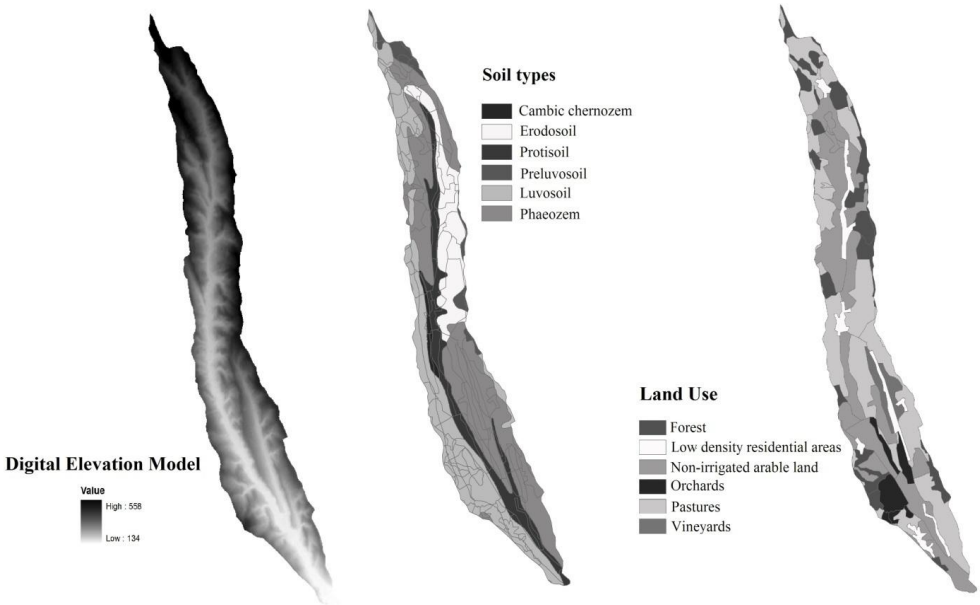

Figure 1. Input layers

The detailed land use map, shown in Figure 1, was analyzed to determine the area of each identified land use. The map was also used to compare impervious to pervious land cover within the watershed, for subsequent rainfall-runoff assessment.

Watershed and subwatershed boundaries were created using ArcHydro Tools and are shown in Figure 2. Boundaries were developed using the enhanced DEM, and flow directions. These boundaries were developed to allow for

calculations to be made using the SCS-CN method.

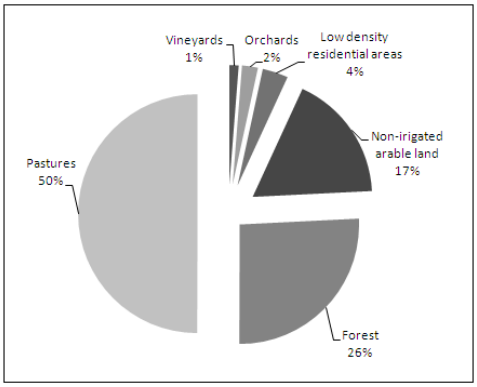

Figure 2. Land uses

Using ArcHydro we have obtained the flow direction grid in witch the values in the cells indicate the direction of the steepest descent from that cell.

Catchment Grid Delineation is a function that creates a grid in which each cell carries a value (grid code) indicating to which catchment the cell belongs. The value corresponds to the value carried by the stream segment that drains that area, defined in the stream segment link grid. Adjoint Catchment is a function that generates the aggregated upstream catchments from the "Catchment" feature class (Figure 3). For each catchment that is not a head catchment, a polygon representing the whole upstream area draining to its inlet point is constructed and stored in a feature class that has an "Adjoint Catchment" tag (ESRI, 2002).

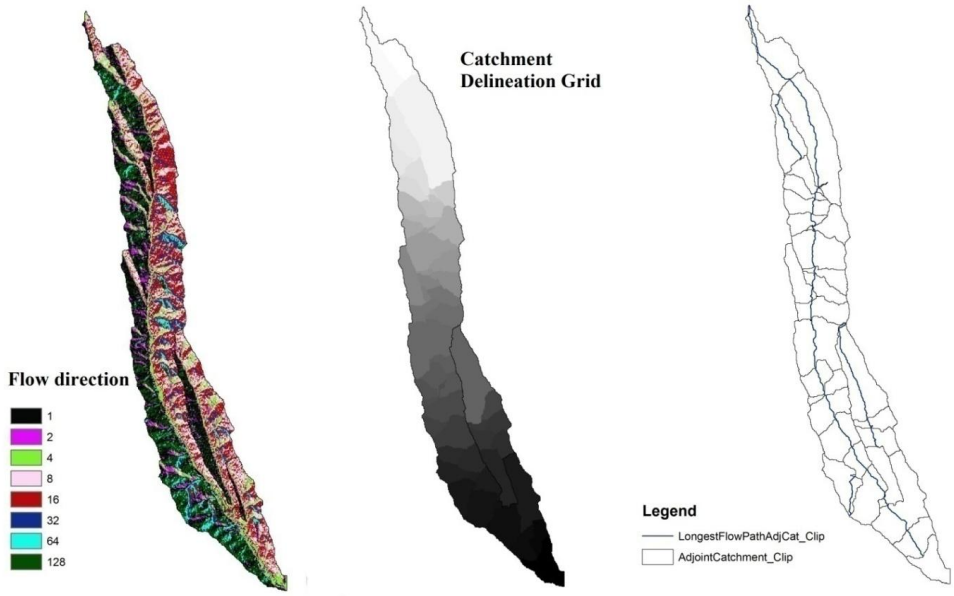

Figure 3.Layers resulted from ArcHydro

Analysing digital terrain data, HEC-GeoHMS transforms the drainage paths and watershed boundaries into a hydrologic data structure that represents the drainage network. The program allows users to visualize spatial information, watershed characteristics, perform spatial analysis, and delineate subbasins and streams. Working with HEC-GeoHMS through its interfaces, menus, tools, buttons, and context-sensitive online help allows the user to expediently create hydrologic inputs for HEC-HMS (US Army, 2013). The two layers, the land-use and hydrological groups of soil have been united for assigning each HGS a land-use and using Table 2 CN was calculated. HEC-GeoHMS creates automatically a grid with the CN (Figure 4).

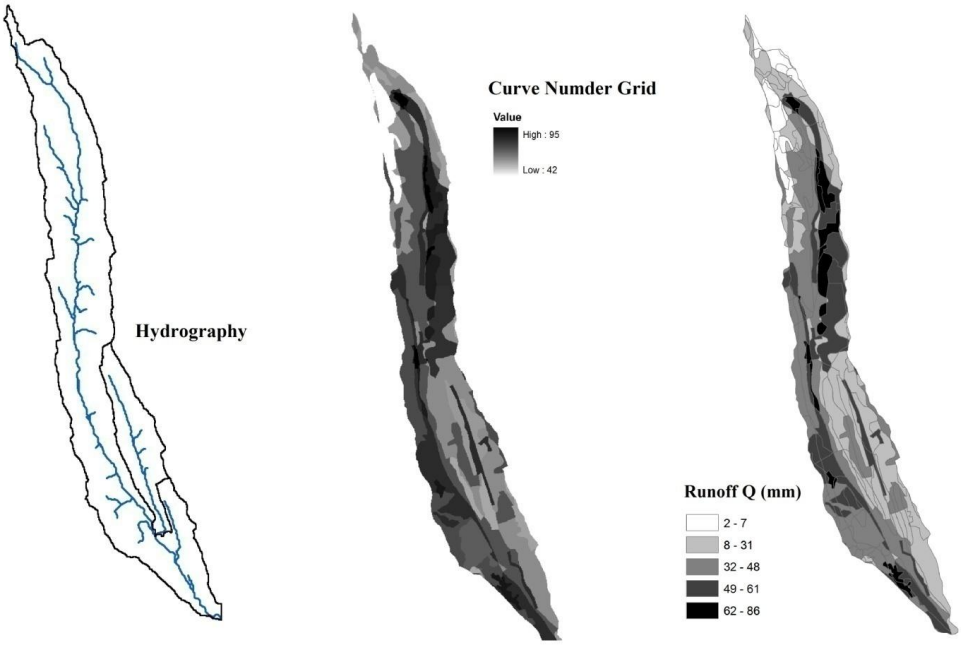

Figure 4. Layers resulted from HEC-GeoHMS

Applying the formula for runoff (eq. 1) for a uniform rainfall of 100 mm it will result a layer for the runoff.

CONCLUSIONS

This study focused on Drobotfor watershed, which is located near the Stanisesti village, evaluated the commonly used rainfall-runoff model (SCS-CN) for predicting direct surface runoff. This study makes use of a detailed land use map and tests the above mentioned model within an elongated torrential basin.
Results on runoff simulations made in the study may provide initial insights into hotspots and ecologically sensitive areas within the Drobotfor watershed. The study provided an initial background for identification of the runoff source areas and many of the parameters (in particular GIS spatial data) necessary for characterizing the watershed, which will be used for further hydrological modelling of water management in the basin.

REFERENCES

Bardossy A., Schmidt F., 2002. GIS approach to scale issues of perimeter-based shape indices for drainage basins. Hydrol. Sci. J., 47, 931-942.
Drobot R., 2007. Metodologia de determinare a bazinelor hidrografice torențiale în care se află așezări umane expuse pericolului viiturilor rapide.
El-Magd I.A., Hermas E. and El Bastawesy M.,2010. GIS-modelling of the spatial variability of flash flood hazard in Abu Dabbab catchment, Red Sea Region, Egypt. The Egyptian Journal of Remote Sensing and SpaceSciences. 13, 81-88.
ESRI, 2013. ArcGIS Resources
Mihalik E.N., Levine N.S. and Amatya D.M., 2008. Rainfall-Runoff Modeling of the Chapel Branch Creek Watershed using GIS-based Rational and SCS-CN Methods. ASABLE
Soulix K.X., Valiantzas J.D., 2012. SCS-CN parameter determination using rainfall-runoff data in heterogeneous watersheds – the two-CN system approach. Hydrol. Earth Syst. Sci. 16, 1001-1015.
US Army Corps of Engineers – http://www.hec.usace.army.mil/software/hec-geohms/
USDA, 1986. Technical Release 55: Urban Hydrology for Small Watersheds
Willemin J.H., 2000. Hack's law: sinuosity, convexity, elongation. Water Resour. Res., 36, 3365-3374.

MODIFIED OF POWER PLANT ASH FOR REMOVAL OF HEAVY METAL IONS FROM SOIL

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Abstract

In the last years, modified ash has been researched for a variety of agricultural and environmental applications. Modified ash can is used as soil conditioners, amendments, remediation agents in contaminated soils with heavy metal ions. In this paper, the different methods modification of ash with KOH was studied. Ash from thermal power plant and modified ash were used for removal of heavy metal ions from soil. The ash and the modified ash were characterized by microstructure (electronic microscopy SEM), chemical and mineralogical composition (EDAX, XRD diffraction, FT-IR). According to the XRD results, it was proven that the form of modified ash was K-chabazite. The determination removal capacity of heavy metals ions from soil was performed by atomic absorption.

Keywords: *ash, characterization, heavy metal, soil.*

INTRODUCTION

Ash is waste produced by burning coal in power plant. According to the report of American Coal Ash Association in agriculture, wasteland reclamation and civil engineering purposes use 32% of the fly ash, 30% of the bottom ash, 94% of the boiler slag and 9% of flue gas desulfurization sludge (American Coal Ash Association, 1998). Many experiments and studies on the effect and potentiality of ash as an amendment in agricultural applications have been conducted by various agencies, research institutes at dispersed locations all over the world (Basu et al., 2009). Soil properties as influenced by fly-ash application have been studied by several authors for utilizing this waste as an agronomic amendment (Ciocinta et al., 2012; Desmukh et al., 2000; Nidhi, 2003; Inam, 2007a, 2007b). Researchers have noted other beneficial effects of the application of ash soil systems: it improves soil and water retention in the treated zone, the texture of the soil; it reduces the bulk density of the soil, the crust formation, the consumption of other soil amelioration agents such as fertilizers or lime and it can decrease the mobility and availability of metal in the soil (Pandey and Singh, 2010).

The initial studies have proposed diverse hydrothermal activation methods to modified power plant materials from ash. All the methodologies proposed are based on the dissolution of Al Si-bearing ash phases with alkaline solutions NaOH or KOH (Park et al., 2000; Querol et al., 2002; Criado et al., 2007; Rios et al., 2009; Harja et al., 2012a, 2012b; Kowenje et al., 2010; Rosales et al., 2012; Ryu et al., 2006). There are some examples of the direct application of these materials in which it does not require any pre-treatment to develop the required functionality such as its use in agriculture, as an adsorbent for heavy metals.
In this study we characterized the ash and modified power plant ash by different technique, such as microstructure (electronic microscopy SEM), chemical and mineralogical composition (EDAX, XRD diffraction, FT-IR).

MATERIALS AND METHODS

Methods of analysis

In this study was synthesized 1 material based on power plant ash by hydrothermal treatment at 90^0C, 2M of KOH, corresponding to a ratio s/L of 1:3.

The chemical and the mineralogical characterizations were done with the VEGA TESCAN for SEM analysis, EDAX with QUANTA 3D - AL99/D8229 and FT-IR analysis was determined using a DIGILAB FTS 2000 (Harja et al., 2013).

RESULTS AND DISCUSSIONS

Adsorbents characterization

SEM and EDAX analysis

From figure 1 it can be observed that the particles of ash are spherical with different sizes and the modified material presents new crystals due to the hydrothermal treatment. From figure 2 it can be seen that the K content increased because the ash was treated with 2M of KOH solution.

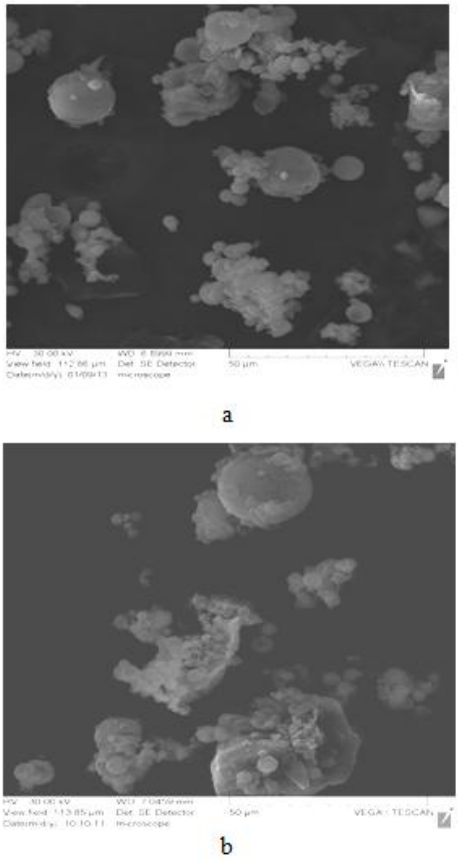

Figure 1. SEM analysis for ash (a) and modified ash (b)

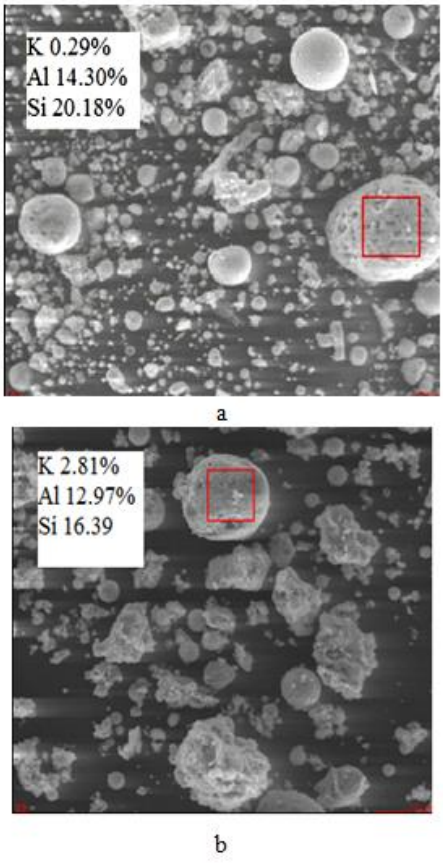

Figure 2. EDAX analysis for ash (a) and modified ash (b)

FT-IR analysis

From Fig. 3 it can be observed the different wavelengths are presented in the case of modified ash.

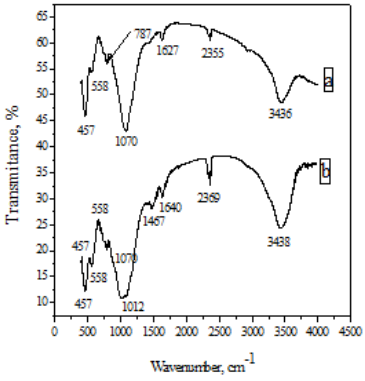

Figure 3. FT-IR analysis for ash (a) and modified ash (b)

The spectrum of materials, from Figure 3 illustrates the presence of absorptions at 457, 558, 787, 1070, 1640 and 2355 and 3436 cm^{-1}. The amorphous aluminosilicate samples showed a broad band centered at around 1070 cm^{-1} that corresponded to Me–O–Me (where Me is either Si or Al that is tetrahedrally coordinated) (Harja et al., 2013). The band at 787 and 558 cm^{-1} are due to the Me–O–Me symmetric stretching. The band at 457 cm^{-1} is assigned to the Si–O–Al symmetric bending modes. The FTIR band at 787 cm^{-1}, that can be assigned to the amorphous precursor of zeolite (Izidoro et al., 2012a, 2012b; Shigemoto et al., 1995; Rasouli et al., 2012)), not appear at modified material, because this material presented a high degree of crystallization. The band at 1640 cm^{-1} has been associated with the characteristic bending mode of water molecules. (Musyoka, et al., 2012).
It can observe that modified material presented a pick at 1467 cm^{-1}, which corresponding of K-chabazite zeolite, fact confirmed of XRD analysis.

CONCLUSIONS

For modified power plant ash we worked by direct hydrothermal treatment at 90^0C, 2M of KOH solution, ratio s/L:1-3, 4h time of contact.

From SEM images it can be seen that the new crystals were deposited on the surface of ash particles due the hydrothermal treatment.

Ash has Si/Al ratio in the range of 1.2 -1.4, which proves that is a good source to synthesized materials.

From FT-IR analysis shows that different wavelengths are presented in the case of modified power plant ash.

This type of new material can be used for retain heavy metal ions from soil.

ACKNOWLEDGEMENTS

This paper was realized with the support of POSDRU "Postdoctoral School in Agriculture and Veterinary Medicine", ID 89/1.5/S62371, project funded by the European Social Found and Romanian Government and This paper was performed with the support of Posdru Cuantumdoc "Doctoral studies for European performances in research and inovation" ID79407 project funded by the European Social Found and Romanian Government.

REFERENCES

American Coal Ash Association, 1998. Coal combustion product (CCP) production and use. Alexandria, VA: ACAA; http://www.acaa-usa.org

Basu M., Pande M., Bhadoria P.B.S., Mahapatra S.C., 2009. Potential fly-ash utilization in agriculture: A global review. Progress in Natural Science, 19, 1173–1186.

Ciocinta, R.C., Harja, M., Bucur, D., Rusu, L., Barbuta, M., Munteanu, C. 2012. Improving soil quality by adding modified ash. Environmental Engineering and Management Journal, 11, 297–305.

Desmukh A., Matti D.B., Bharti B., 2000. Soil properties as influenced by fly ash application. Journal of Soils Crops, 10, 69–71.

Harja M**.,** Bucur D., Cimpeanu S. M., Ciocinta R. C. 2012b. Conversion of ash on zeolites for soil application. Journal of Food, Agriculture and Environmental, 10, 1056-1059.

Inam A., 2007a. Use of fly ash in turnip (Brassica rapa L.) cultivation. Pollution Resource, 26, 39–42.

Inam A., 2007b. Response of methyl to nitrogen and fly ash supplemented as a source of nutrients. Pollution Resource, 26, 43–47.

Izidoro J. C., Fungaro D.A., dos Santos F., Wang S.B. 2012a. Characteristics of Brazilian coal fly ashes and their synthesized zeolites. Fuel Processing Technology, 97, 38–44.

Izidoro J.C., Fungaro D.A., Wang S.B. 2012b. Zeolite synthesis from Brazilian coal fly ash for removal of Zn2+ and Cd2+ from water. Advanced Materials Research, 356–360, 1900–1908.

Musyokaa N., Petrik L., Hums E., Baser H., Schwieger W. 2012. In situ ultrasonic monitoring of zeolite A crystallization from coal fly ash, Catalysis Today, 190, 38– 46

Nidhi J., 2003. Looks the ways to utilize fly ash. Down Earth, 12, 1–5.

Synthesis of zeolite adsorbents by hydrothermal treatment of PFA wastes: A comparative study. Minerals Engineering, 13, 831–842.

Pandey V.C, Singh N., 2010. Impact of fly ash incorporation in soil systems. Agriculture, Ecosystems & Environmen, 136, 16–27.

Park M., Choi C. L., Lim W. T., Kim M. C., Choi J., Heo N. H., 2000. Molten-salt method for the synthesis of zeolitic materials: I. Zeolite formation in alkaline molten-salt system. Microporous and Mesoporous Material, 37, 81-89.

Querol X., Moreno N., Umana J. C., Alastuey A., Hernandez E., Lopez-Soler A., Plana F., 2002. Synthesis of zeolite from coal fly ash: An overview. Coal Geology, 50, 413 -423.

Rasouli M., Yaghobi, N., Hafezi, M., Rasouli, M. 2012. Adsorption of divalent lead ions from aqueous solution using low silica nano-zeolite X. Journal of

Industrial and Engineering Chemistry, 18, 1970–1976.

Rosales E., Pazos M., Sanromán M. A., Tavares T. 2012. Application of zeolite-Arthrobacter viscosus system for the removal of heavy metal and dye: Chromium and Azure B. Desalination, 284, 150–156.

Ryu T. G., Ryu J. C., Choi C. H., Kim C. G., Yoo S.J., Yang H.S., Kim,Y.H. 2006. Preparation of Na-P1 zeolite with high cation exchange capacity from coal fly ash. Journal of Industrial and Engineering Chemistry, 12, 401–407.

Qiu W., Zheng Y. 2009. Removal of lead, copper, nickel, cobalt, and zinc from water by a cancrinite-type zeolite synthesized from fly ash. Chemical Engineering Journal, 145, 483–488.

Shigemoto N., Sugiyama S., Hayashi H., Miyaura K. 1995. Journal of Materials Science, 30, 5777-5582.

REGARDING ROMANIA-UKRAINE CROSS-BORDER MANAGEMENT OF THE CONTAMINATED SITES WITH OIL PRODUCTS

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Abstract

Nowadays, we assist to an intensification cooperation in an economically, socially and environmentally between Ivano-Frankovsk Region of Ukraine and Maramures region from Romania. So, in this actual context the management of the cross border area is a necessity and benefice for the whole region. The paper presents some results of the project from ENPI Cross-border Cooperation Programme 2007-2013, "RoUaSoil: Romania-Ukraine cross border area-The Management of the Contaminated Sites with Oil Products", applicant Technical University Cluj-Napoca, North University Centre Baia Mare. The specific objectives of the project are to inventory, study and analysis the sites polluted with oil products within the cross-border area and to plan the cleanup by developing solutions using depollution and fertilization technologies.
Partial results obtained during the project concludes that it can create modern databases with electronic processing, with common denominator for different states but sharing the same natural resources and it can prepare information materials useful for various domains, from the environmental impact assessment studies to ecological education activities.

Keywords*: cross-border area, sites polluted with oil, depollution*

INTRODUCTION

The soil, a dynamic and extremely complex system, which is permanently evolving in time and space. The soil characteristics have been changed by athropic pollution. Monitoring the polluted areas reveals the dynamics migration of the pollutant, the accumulative and regenerative soil capacity and also its historical -genetics evolution (Florea, 2009).
Nowadays, we are justified to conclude that soil degradation has an impact on several areas of common interest such as groundwater, surface water, biodiversity, food security and health. Protection measures relating to soil must therefore be taken into account, both the characteristics of the pollutant and soil's ones, the conditions under which it "lives", and soil protection policies must be integrated in environmental policies.
In their turn, environmental policies should have as a final term ecosystem protection and strengthening cooperation between resource users from different domains of activity (Coman, 2009).
We are currently witnessing an enchanted cooperation in economic, socio-cultural and environmental protection from Ivano-Frankivsk region from Ukraine and Maramures region from Romania. In this context, integrated border area becomes a necessity and benefits all Euro-regions (Raport Proiect RoUaSoil, 2012).

RESEARCH PURPOSE

For future actions on ecological restoration of polluted sites, in accordance with EU Directives and laws of the Member States, it is very important to establish what the polluted areas are, and of course, their geographically, physically and chemically characteristics (Rusu et al., 2009)
The regeneration plans, set according to the specific situation of contamination, should provide to regional and local public authorities detailed information on which they can develop strategies for the purpose of ecological reconstruction and development. Intensifying and deepening cooperation on environmental, social and economic domain between Ivano-Frankivsk region from Ukraine and some regions from EU border like as Maramures, from Romania and Szabolcs-Szatmár-Bereg,

Borsod-Abaúj-Zemplén, from Hungary wants to be strengthened through concrete activities starting from academia.

RESEARCH AREA

Establishment of polluted areas with oil products in adjacent cross-border region Maramures from Romania and region Ivano-Frankivsk from Ukraine, as we can see in Figure 1.

The project RoUaSoil also develops "CBC Regional Network" by extending the 3th previously mentioned regions of Hungary.

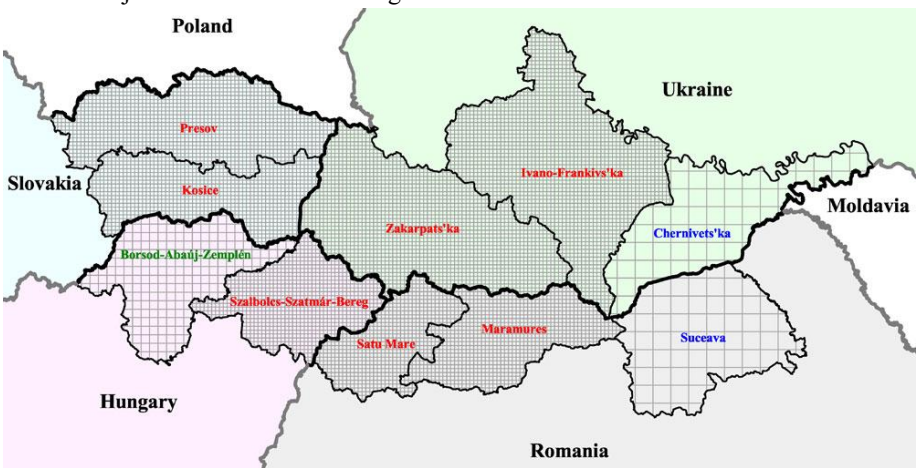

Figure 1. The cross-border region Maramures (RO) - Ivano-Frankivsk (UA)
(source: www.infocooperare.ro)

MATERIALS AND METHOD

Inventory, monitoring and analysis of sites contaminated with petroleum products from cross-border area between Maramures and Ivano-Frankivsk is a complex activity that respects traditional research protocols from environmental sciences including the following:

- theoretical documentation- with mapping phase,
- field phase- especially sampling and adaptation to specific conditions,
- data processing stage using the environmental informatics system.

Briefly, these stages can be managed using specific elements of optimal environmental informational systems (Figure 2).

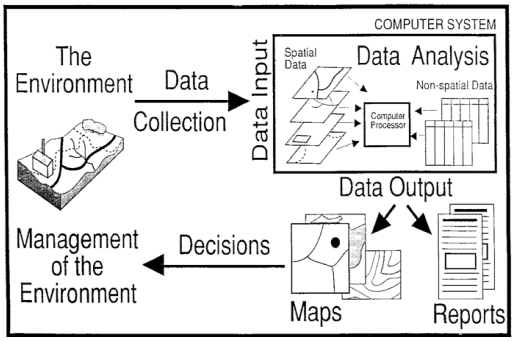

Figure 2. A specific way for getting information and knowledge using common environmental info-interactive applications or EISs(source: Cioruţa B. & all, 2012)

In the documentaries phase information from the responsible authorities have been used, polluted sites were estimated close by train stations, oil stations from socialist period, closed military bases, overground and underground deposits, companies with registered polluted areas and lands affected by technical accidents.

Figure 3. The perspective of getting multidisciplinary information and knowledge using as EISs the GIS products (source: Cioruța B. & all, 2012)

By collecting information from the field with the help of the local authorities, owners, managers and direct observation, other polluted sites have been tracked down, but non-inventoried yet. (Rusu et al., 2009; Cioruta et al., 2012). For polluted sites is envisaged, in the first phase, setting their geometric characteristics and in final stage, based on physico-chemical analyses, to determine the intensity of their pollution. Based on the estimated boundaries, it is important to follow the limits of the polluted areas which, as we know, varies with geomorphologic conditions, lithology and drainage; the form of the area, including degree of compaction or sifting; smooth contour polluted, altitude and exposition for relief of these sites; site boundaries and distance to the nearest sensitive use area, or household / farm.

All these cartography indicators are needed to be evaluate from full environmental impact of people communities. Also, they are required in the monitoring and evaluation of financial remediation costs (Florea, 2009).

RESULTS AND DISCUSSIONS

Database of contaminated sites with petroleum products from Maramures and Ivano-Frankivsk will be supported from regional governments, regional authorities to design studies for remediation and their reinstatement in business. Estimated results are to develop two maps of contaminated sites, one for Maramures County and one for Ivano-Frankivsk region. For the Romanian side, this map is presented as follows (Raport Proiect RoUaSoil, 2012).

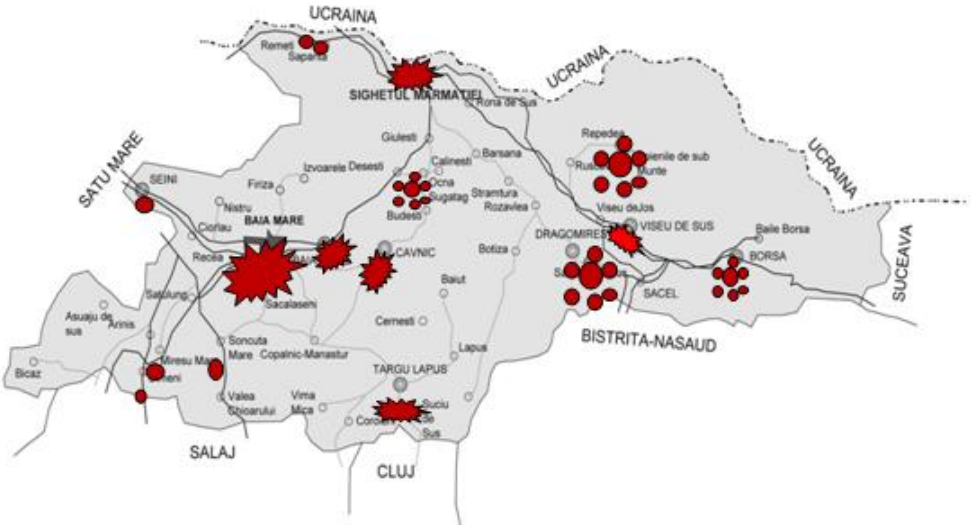

Figure 4. Estimated results for the Maramures County contaminated sites

CONCLUSIONS

Partial results obtained during the project „RoUaSoil: Romania-Ukraine cross border - The Management of the Contaminated Sites with Oil Products", concludes that:

- this type of projects may intensify and deepen cooperation between institutions from different fields of activity, the aim being a healthier living environment;
- it can create modern databases with electronic processing, with common denominator for different states but sharing the same natural resources;
- it can extend networking cross-border cooperation with other regions like Szabolcs Szatmár-Bereg, Borsod-Abaúj-Zemplén (Hungary) and Košice (Slovakia);
- it can prepare information materials useful for various domains, from the environmental impact assessment studies to ecological education activities.

REFERENCES

***Raport intermediar Proiect "RoUaSoil: România-Ucraina gestionarea transfrontalieră a siturilor contaminate cu produse petroliere", 2012-2014.

Cioruța B., Coman M., 2012. Studying Environmental Problematics And Hazards By Interactive Applications (Sephia) , Studia Ambientum, nr 1/2013, Cluj-Napoca

Coman M., 2009: Management ecologic, Editura Risoprint, Cluj-Napoca

Florea N. 2009: Pedodiversitate si Pedociclicitate, Bucuresti

Rusu T. et al., 2009. Metode de cercetare ale solului si plantei, Editura Risoprint, Cluj-Napoca

USAMVB CAMPUS INVENTORY AND SURVEYING USING 3D GIS TECHNOLOGIES

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Abstract

GIS – Geographical Information System is currently the most used tool for analyzing and presenting spatial digital data of various sources. This paper aims to present the use of 3D GIS for properties inventory for the Campus of USAMVB. The used sources were provided by local authorities and public institutions, and consist of plans and topographic maps, orthophotos and cadastral plans. This article is focused on the application of GIS tools in the process of data processing for the needs of campus information. The data was processed as follows: digitizing maps and data extraction from orthophotos by image interpretation, field data collection, GIS database design and implementation, a 3D analysis and a virtual reality model demonstration. It will be presented the three-dimensional data acquisition and the modelling and reconstruction method for objects with realistic visualization. Obtained data from the output maps will be for users more friendly, more readable, more recent and accessible. Through the web interface will be easier for the users to get the required information.

Keywords: *3D modelling, GIS, database, USAMVB campus*

INTRODUCTION

GIS is currently the most widely used tool for the analysis and presentation of spatial data from various sources. This paper aims to present the possibilities and benefits of using 3D GIS for properties inventory and easy retrieval of information about this. It will talk about the strategy and the priorities need to be applied in land and construction using, making it a valuable document like an administrative and technical tool of local authorities related to urban management and development of the area. 3D GIS technology arose from the need to facilitate the analysis of complex operation for which the existing systems does not offer any possibility or need for increased consumption or difficult procedures (M.Doru, 2012). The 3D GIS systems is the only solution that can be solved rationally, intelligently and effectively the problems related to terrestrial resources, facilitating the processing and the analysing of spatial data from conventional sources(maps and topographical plans) and sources that involves advanced technologies(satellite images and GPS). Thus, GIS systems, integrating databases containing location information with decision support facilities are a fundamental aid in the management of any complex organization, the applicability of this application is virtually unlimited because the vast majority of human activities had as important feature the localization and spatial analysis. In this case, because exists available data, the application can be created for any geographical or administrative problem, thereby providing objectivity in presenting information. This can make predictions of a phenomenon in space and time because the level of detail the data is high and the decision-making process is increased and improved, offering advanced visualization, analysis and generating tools for surfaces (M.Doru, 2012). 3D GIS are also very useful to visualize large three-dimensional data sets from many points of view, or creating a realistic perspective images in raster and vector data over a surface. Thus, I present the basics of this technology and the first steps in implementing a GIS to be a starting point for future developments that serve different purposes.

MATERIALS AND METHODS

The software used is ArcGIS for Desktop, version 10.1. To represent the study area and its integration into GIS, I have created a type of database called "file geodatabase". This can be done from the Catalog in ArcCatalog or the Catalog window in ArcMap. Inside it I created several feature classes, defined as homogeneous collections of spatial objects of same type of geometry and common set of attribute columns. These are represented by "buildings", "paths", "green spaces" and "recreation areas". The cartographic support was an orthophoto from 2009 for Bucharest (Figure 1), geo-referenced in Stereo 1970 national coordinate system.

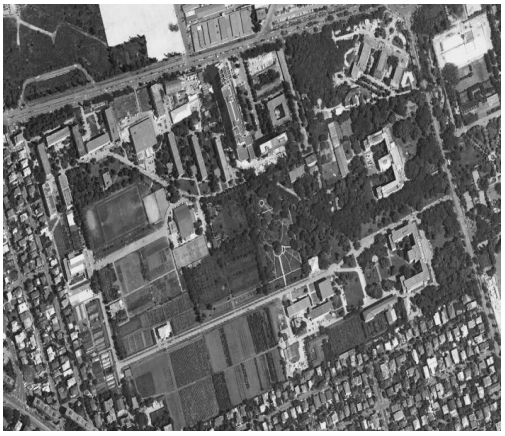


Figure 1. Study area location

Building roofs were vectorised and to match the real model there have been displaced by the footprint. Paths, green spaces and recreational areas have been vectorised polygon. To ensure spatial continuity between vectors obtained by digitizing it was created a topological data structure with the "must have gaps" rule, to not exist empty spaces. Topology allowed identification of all digitization errors and has corrects them, so the whole set of data is currently in topologically correct. For creating digital terrain model (Figure 2) it were vectorised 257 elevation points from the topographic plans (1:2000 scale) on Bucharest, and on this basis was created by interpolation, using the Anudem interpolation method implemented in ArcGis for Desktop program, Spatial Analyst extension at Topo to Raster tool, which is the representation of continuous elevation of the topographic surface.

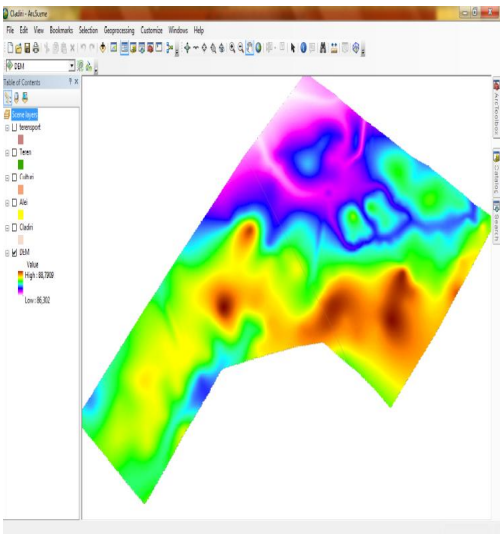


Figure 2. Digital elevation model

Geodatabase was created in ArcCatalog and for 3D visualization and editing was used ArcScene application from ArcGis for Desktop software package. This collection of data was overlapped to the terrain model and for 3D visualization it was changed the vertical exaggeration value from 0 to 5. Changing vertical exagere factor is required where elevation differences are too small to be perceived by the human eye. Polygons that represent buildings were extended vertically by an amount equal to their height, and the building height was estimated from the number of floors of each building. The number of floors was mapped in the field and the buildings were positioned on the digital elevation model, same with each spatial object that was positioned spatially on that model. The height of digitized spatial object (except buildings) was mapped on the ground and the extrapolated for similar items (for example: a power pole was measured and all that poles gained the same amount of height). To create textures I used Google Sketch-Up program that allows shooting in the field of spatial objects and the reproduce them in 3D (Figure 3). The footprint of each object was exported from ArcGis and imported in

Sketch-Up; here was processed and it was generated a 3D model which in turn was imported into ArcScene.

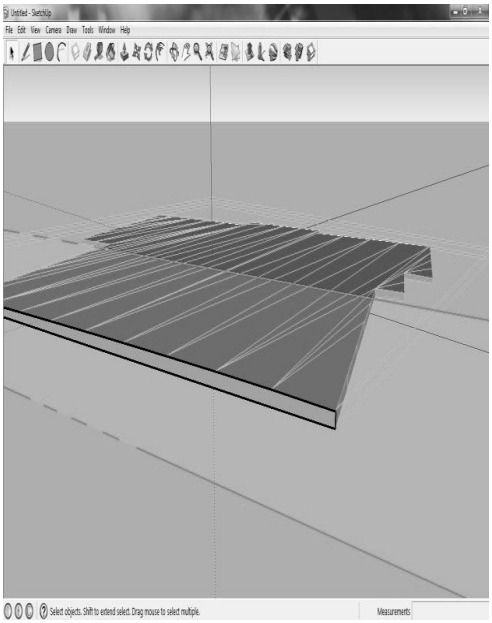


Figure 3. Edit building using Google Sketch Up

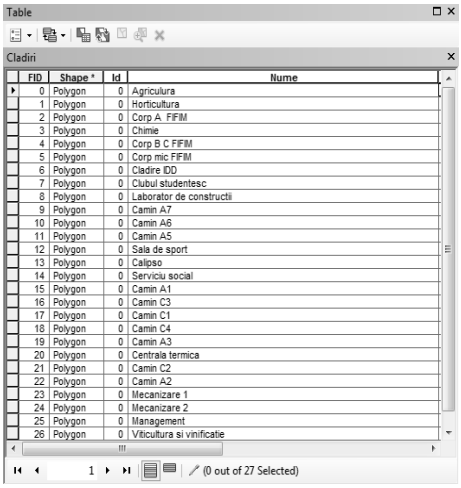
For buildings this procedure was performed for each building, but for the other elements it was performed only a few times. Trees and infrastructure elements with similar appearance were created one time only and then copied like symbol in ArcScene. FIFIM building was further processed, so the whole building was digitized in detail, it was digitized every room and access element separated and symbolized corresponding to the texture collected in the field.

RESULTS AND DISCUSSIONS

For USAMVB campus were digitized 257 elevation points of which was interpolated the digital elevation model. It was obtained a number of digitized buildings equal with 27 (Figure 5) and a number of green spaces and recreational spaces equal with 31. (Figure 4)

Figure 4. 3D view of USAMVB campus

Based on it, the user can query the 3D spatial object and find information about it. Information about 3D objects from USAMVB campus can simply be learned by 3D query of each spatial object or by making SQL queries (for example: all trees of green spaces or all the administrative buildings of the USAMVB campus).



Table

Cladiri

FID	Shape *	Id	Nume
0	Polygon	0	Agricultura
1	Polygon	0	Horticultura
2	Polygon	0	Corp A FIFIM
3	Polygon	0	Chimie
4	Polygon	0	Corp B C FIFIM
5	Polygon	0	Corp mic FIFIM
6	Polygon	0	Cladire IDD
7	Polygon	0	Clubul studentesc
8	Polygon	0	Laborator de constructii
9	Polygon	0	Camin A7
10	Polygon	0	Camin A6
11	Polygon	0	Camin A5
12	Polygon	0	Sala de sport
13	Polygon	0	Calipso
14	Polygon	0	Serviciu social
15	Polygon	0	Camin A1
16	Polygon	0	Camin C3
17	Polygon	0	Camin C1
18	Polygon	0	Camin C4
19	Polygon	0	Camin A3
20	Polygon	0	Centrala termica
21	Polygon	0	Camin C2
22	Polygon	0	Camin A2
23	Polygon	0	Mecanizare 1
24	Polygon	0	Mecanizare 2
25	Polygon	0	Management
26	Polygon	0	Viticultura si vinificatie

1 (0 out of 27 Selected)

Figure 5. Attribute table for buildings

The Identify tool allows you to see the attributes of your data and is an easy way to learn something about a location in a map (Figure 6). Clicking the Identify tool on a location inside a data frame will present the attributes of the data at that location. When identifying features with the Identify tool, the attributes are presented in a feature-by-feature, layer-by-layer manner in the Identify window.

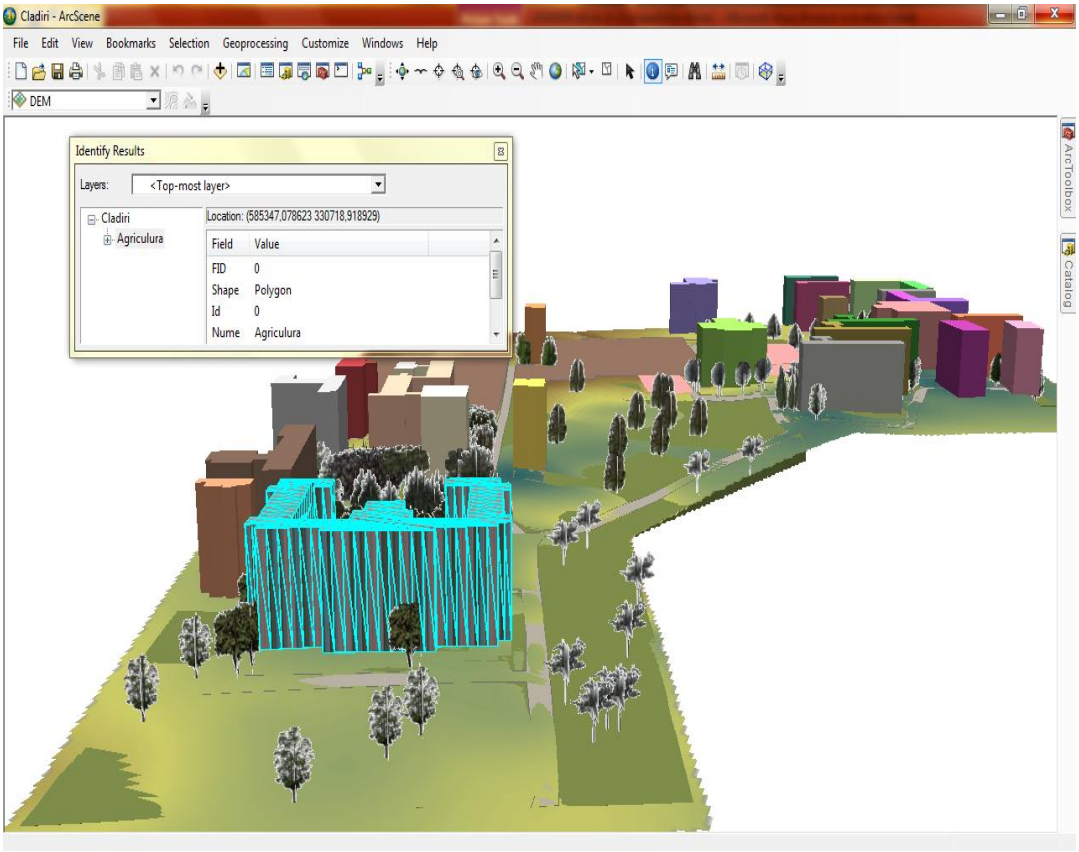


Figure 6. Query of Agriculture building

Analyze GIS data in three dimensions using geo-processing tools, and use interactive tools (such as the 3D Measure tool) in a 3D view to solve problems that can‘t be solved in 2D. The application provides several ways to measure a distance or an area of a polygon in terms of some factors such as slope and land using. The Measure tool lets you draw on the map to measure lines and areas (Figure 7). You can use this tool in several ways. For example, you can draw a line or polygon on the map and get its length or area, or you can even click directly on a feature and get measurement information. Using this function, you can create distance and direction raster and compute the least-cost or shortest path from a chosen destination to the source point. The measurement reflects the projection of the 3D data onto the 2D surface, and does not take into account the curvature of the earth. If the data frame is using a geographic coordinate system and the display units are linear, the measurements are geodesic by default.

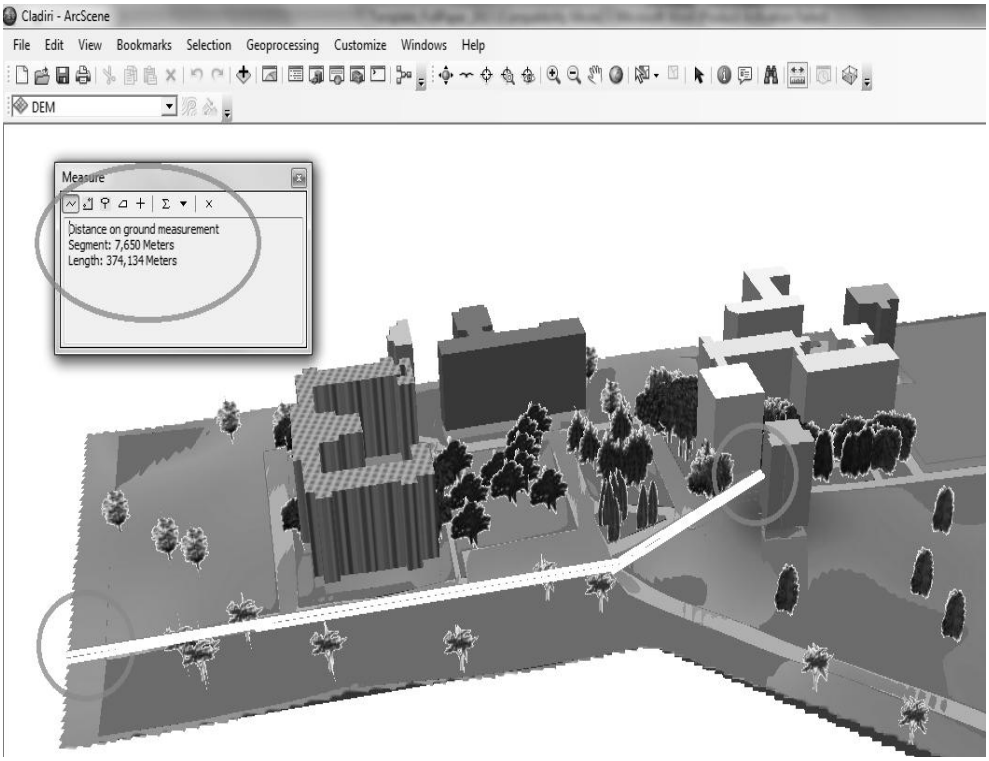


Figure 7. Measure a distance in the scene

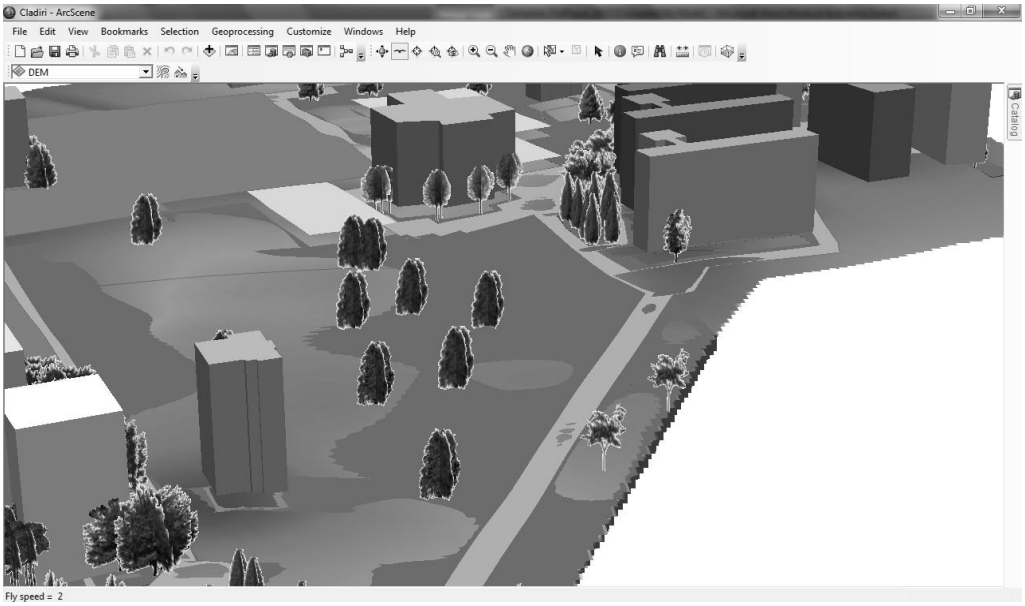


Figure 8. Flying through a scene

The Fly tool is used in ArcScene to fly through a scene (Figure 8). The speed is relative and goes from negative numbers (backward) to positive numbers (forward). Sometimes these speeds need further tuning.

CONCLUSIONS

Using virtual reality provides a better understanding of surrounding space and better support for decision-making. The time required to achieve 3D models is significantly higher than for achieving 2D models, but the amount of obtained information is considerably higher. These results can contribute in the design of a 3D city modelling software and can indicate the benefits of integrating 3D city models in working processes of communities. Making decision requires information as well as exploration. With analysis and design tools, information can be used to make decisions.

Exploration will support both the process of finding (user looks for specific information) and discovering information (user doesn‘t know what is looking for).

Analysis aims at enriching the available information by computing specific measurements (e.g. the area of a parcel) or solving specific problems (e.g. compute the shortest route from point A to point B).

Finally, the design process starts from an exploration and analysis process

REFERENCES

Mocanu A.M., 2009. Baze de date spatiale. Analiza, dezvoltarea si proiectarea unui GIS.

ArcGIS for Desktop Help

Google Sketch Up Help

Mihai D., 2012. The use of geographical information systems and LIDAR technology in the field of archaeology, Vol. I, Scientific Papers, Series E.

Mihai D., 2012. Suport de curs sisteme informationale geografice, an II.

SPORADIC CADASTRE, SYSTEMATIC CADASTRE

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Abstract

Cadastre is a system of registering land properties based on a cadastral plan, ownership documents and a fair tax system. To achieve general cadastre is a desideratum even since 1991, starting with the Law 18, regarding the retrocession of the farm land. When Law 7/1996 was released the achieving of cadastre was taken into account also. The cadastral registration has 2 types now: sporadic and systematic There are similarities and differences related to technical procedures and legal documents registration between the two types .

Keywords *: cadastral sector, owner, parcel, parcel limit.*

INTRODUCTION

The cadastre permanently raised particular interest from the government as its objective is the correct system property and tax records. A professional achieved cadastre should not have even one square meter without an owner. In this way, double taxation on land or occupation of land without a real property right could be avoided. Modern cadastre has been achieved for the first time by Austrian Empire, in the northern Italy, during XVIth century. It has been extended and ended to other provinces of the Empire later. Because at that time there was no official reference ellipsoid, the cadastre was repeated several times, each time improving surface quality determination. In time, the tools also evolved so that the measurements became more precise. The german type cadastre is based on a cadastral plan having all parcels highlighted.

Each parcel has attached a topographical number, unique on an administrative territory. Besides the cadastral plan, for each parcel there are documents proving ownership. Thus, there is a direct connection between the cadastral plan and the ownership documents records. This cadastre is usually called The Cadastre Registry system. Each owner, at the moment of registration in „The Cadastre Registry" obtains a proof of registration. He/ She can also request a land book extract proving ownership which could help him/ her in various occasions. A cadastre system was also inserted in other countries but in a different way. For example, French system is based on the transcriptions - inscriptions registry which does not localise the land very precise. There are highlighted only some identification elements: name of the place where it lays, the owner, the neighbours, etc. This system is weaker and allows multiple trades of the land more easily. As there is not a plan to annex the property act, confusions and malevolence could appear. It is very easily to show someone a land you pretend to trade and this is placed elsewhere actually. Such acts have occurred in Southern Romania after 1990, quite often. It was purchased land in an area where land is actually another area. A land was bought in the area, when in fact the land was situated in another area (Paunescu C.et al., 2012).

In Romania there were both ways of property registration: Austrian type and French type. Austrian type has been implemented in areas occupied by the Empire, respectively Banat, Ardeal and Bucovina. In the rest of the territory there was French type registration.

MATERIALS AND METHODS

As it is known from history, lands, especially farm land, have been owned by important land owner or by the church. Alexandru Ioan Cuza has done the first farm land reform and gives land to peasants. In 1920 the peasants participating in war have been allotted. The

major reform has been done in 1946 when farm lands were given to the peasants.

Whereas the agricultural production did not correspond to the area allotted to agriculture and to what Soviet Union imposed, IAS (State Farm Institute) and CAP (Agricultural Production Cooperative) have been created. Each land owner has been forced to enter the land owned in a CAP. From this moment the property registering system has been destroyed. Only the land in built-up area of private owners has remained certain, the land that is part of outside built-up area belongs to a single owner. In Ardeal, The Cadastre Registry of Austrian type has been maintained till the collectivisation.(CESAR Project).

After that the cadastre registries were not updated (no modifications were operated). The registration has been preserved in the city, and there to malfunction. For example, houses and multi-dwelling units were built on a large built-up area land. The land has been split, but not very accurate, so real position to a topographical number we‘re not known very well.Taking into account facts presented above, the issue of land restitution to former owners has been acutely discussed in 1990. Of course, there was very difficult to position exactly, especially on plain area, where natural details do not exists. Hence, a lot of confusions were created. Also, measurements were made with a compass of 2 meters opening (capra), which resulted in large errors. The plans were worked on scale 1:5000. It must be taken into account that the parcel widths were small, thus, hard to represent them on this scale. Another problem was represented by official‘s ambiguity which changed the surfaces to be given back during the law application. Thus, they started with 10 hectares for each owner, than changed to 50 hectares and in the end they gave back the entire surface. From here there were titles, returned surfaces overlapping, etc.

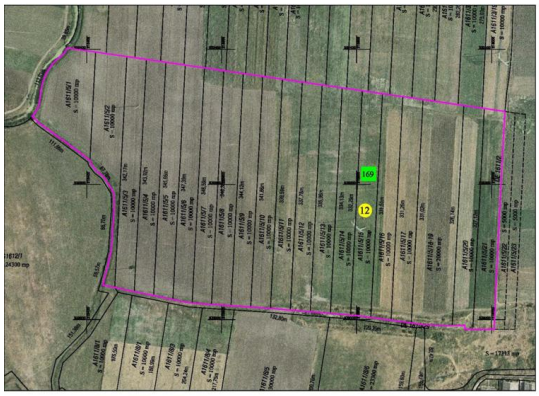

Figure 1. Added distances measured using compass are not equivalent to the perimeter

Distances measured with compass were never correctly reduced to horizon, to Stereographic plan 1970. In this way, added distances of the ends parcels never equal the perimeter of the „field”. The employees that applied property laws did not have required qualifications. Even though in some localities specialists were employed, they had to work under pressure and demands expressed by the Mayor and Commission for the implementation of property laws. Moreover, the laws of property have not been completed in any city because of these technical and legal issues. Besides, political factor interfered. The commissions for the implementation of property laws have worked in their favour, meaning that they have returned the land themselves first, sometimes the best locations, giving the others what was left.

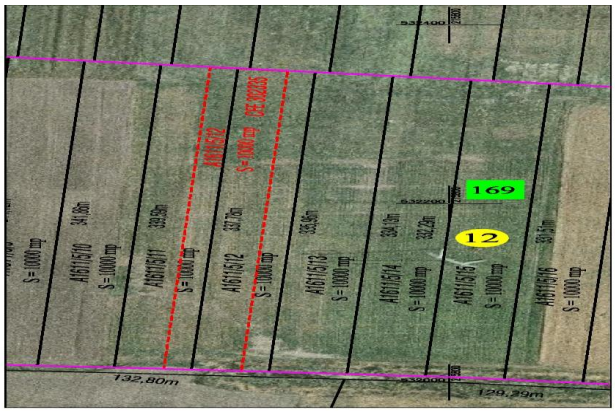

Figure 2. Faulty positioning of some parcels in plains

Each Mayor, as headof the commission for the implementation of property laws tried to solve his personal and his family issues, then, if time permitted, those of citizens. Newly elected mayors came up with the idea to solve their own and those of their families land related issues. Thus, they cancelled old parcel plans and ordered new one, modifying titles, property acts. From these reasons each locality situation is very difficult regarding the cadastral plan. Meanwhile the National Agency for Cadastre and Land Registration (N.A.C.L.R.) started first projects related to general cadastre, as it was named in the law. In Romania the cadastre was legalised by Law 7/2006, which stated achieving general cadastre in Romania.Only in 1999, July has been applied this in practice but applied to the specific Romanian situation. Thus, in areas where Cadastral Registry did not exist, offices affiliated to law courts were opened for registering properties. Though, it was not made a unitary cadastre on a territory, but a sporadically registration, piece by piece. The pieces are not next to each other, they are somewhere inside administrative territory. Even more, it was allowed to make this cadastre in local coordinate system. Parcel placing was not connected to anything in reality, especially in the plains, where there are not natural or artificial landmarks.

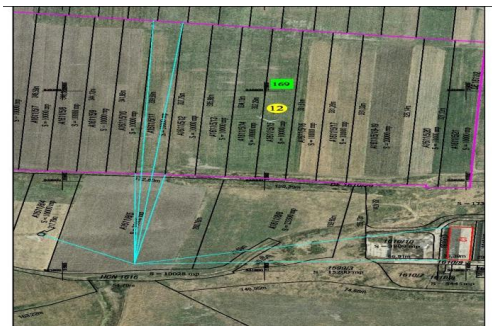

Figure 3. Positioning in local system with correct localisation in plan

Determination of parcels position became mandatory in Stereographic coordinate system 1970 and it has been created a database with all registered parcels on each administrative NACLR started a project of achieving systematic cadastre on administrative territory. territory since 2007. NACLR took over Cadastral Registry, where cadastral files had to be submitted, shortening and improving the way of property registering.

Thus, a group of 19 localities was bided and followed by another group of 31 localities.

RESULTS AND DISCUSSIONS

To achieve systematic cadastre assumes collaboration of four entities: N.A.C.L.R, Office of Cadastre and Land Registration (O.C.L.R.), City Hall, and contractor. Theoretically, it should be only three entities as N.A.C.L.R. and O.C.L.R. have the same interests (O.C.L.R. is subordinate to N.A.C.L.R.), but many times they have totally different opinions. The contract is signed only between two of the four entities, so two of them have no contractual liabilities and cannot be held responsible. There are also a lot of data to be collected from municipalities and to collaborate with municipalities depends on the pleasure of the Mayor and officials at City Hall. There are no penalties for City Hall‘s delays in order to accomplish the cadastral plan or collaboration to collection of ownership documents. Many times O.C.L.R. has a different opinion regarding the achieving the parcel plan, type of ownership documents, etc. For these reasons the contractor is forced to compromise to finish the job.

We further present several issues encountered during achieving systematic cadastre in the following localities: Saschiz (Mures County), Moara (Suceava County) and Arad (Arad County).

Thus, we will present a situation where although a land owner exists it was registered as unknown owner. The current owner bought the land from the previous owner. This person had an inheritance document from his parents and the termination of the joint tenancy with the other heirs. The current owner presented as proof of property the following documents: a legalised copy of the purchase agreement, certificate of inheritance, former owner‘s termination of joint tenancy (legalised copy) and simple copy of title of property of the former owner‘s parents. The Registrar from the Cadastral Registry refused to register the land on the name of current owner due to missing title of property of former owner‘s parents in original form or legalised copy. For this reason on that particular parcel we had to register it as unknown owner. Of course the owner made appeal, but the appeal was dismissed on same grounds. It should be noted that the title of property is original in the archives of O.C.L.R. and it could have been verified by them immediately.

The major issue is represented by titles of property which have different kind of errors. The most difficult errors are those related to areas and identification of parcels and field. Thus, the title is issued for the land situated in one place but the owner has it in another place. Also there is another owner where the title was issued.

CONCLUSION

It should be welcome the N.A.C.L.R. initiative to start achieving the systematic cadastre at Administrative Units for the first localities and steps they take to realise this work across the territory of Romania. Development projects with European funding infrastructure projects are basically held in place by lack of tabulation, the unknown real owners. Property titles are just some informative records. Meanwhile things have evolved: land was sold based on handmade purchase agreement, position of parcels have been changed through mutual agreement, owners died, etc. All these changes are updated and registered in the Cadastral Registry. One more aspect must be mentioned, the payment of agricultural subsidies. As specified above, the position of parcels has been changed.

When payments are checked, they are checked after property titles not the place where they work the land. For this reason, a farmer declares a certain crop but during verification something else is found to be cultivated.

Conclusion: systematic cadastre should continue for entire country.

ACKNOWLEDGEMENTS

This article was carried out with the support ofSC C&C TOPOEXIM.

REFERENCES

Paunescu, C, Ciuculescu, IC, IE Bărbusoiu, 2012, Considerations for Achieving Systematic Cadastre, Alba Iulia Symposium
CESAR Project.

STUDY ON DISTANCE REDUCTION IN PROJECTION PLAN IN CADASTRE

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Abstract

Distance reduction is a very important operation for cadastral and topographic works. Reduced distances are used both for determination of support network points and determination of detailed points. The formulas for distance reduction should be used correctly, otherwise can lead to very large positioning errors. For these reasons overlapping of parcels measured for tabulated can occur. Apparently the overlapping are real, but actually they are virtual overlapping, due to incorrect usage of formulas.

Keywords: *coordinate, reduced distance to projection plan, stereographic projection 1970.*

INTRODUCTION

The cadastre is a registry system of property and has 3 components: technical, legal and commercial. The technical component refers to positioning the perimeter points on a plan or space which define a property. Positioning is defined on projection plan used on national or local level. The projection plan used in Romania is Stereographic 1970. Stereographic 1970 projection is a conform projection. There is also a plan perspective azimuthall projection on secant plan which has polar coordinate projection at the point Q_o on a coordinate Bo=46° and Lo=25° East Greenwich. The projection has been adopted on September 1971 when the Decree 305 „regarding surveying, topographic, photogrammetric and cartographic activity" was released. As a reference surface was adopted Krasovski ellipsoid. The advantage of this projection is representation of the entire country on a single plan. The zero deformation circle has a 201.718 m radius and represents the intersection between the secant plan and ellipsoid.

The origin of the rectangular coordinate axes is the point Q_o, x-axis is directed northward and y-axis eastward. As is known, linear deformations are negative inside the zero deformation circle and positive outside in this projection.

Reduced distance formula in Stereographic projection plan 1970 has the form:

$$D_{ppr} = D_E + D_E \frac{x_m^2 + y_m^2}{4R_o^2} + D_E \frac{\Delta x^2 + \Delta y^2}{48R_o^2}$$

where:

- D_{ppr} is reduced distance to Stereographic projection plan 1970;
- D_E is reduced distance to ellipsoid;
- x_m, y_m is the average coordinates of base measuring heads in Stereographic system 1970;
- Δx, Δy is the difference between coordinates of the measuring base in 1970 Stereographic system;
- R_o is the average Earth radius.

x_m, y_m and Δx, Δy are calculated in the first stage approximately, based on reduced distances to ellipsoid. Influence of approximation is under a millimeter. (Paunescu C.et al., 2012)

Figure 1. Distance deformations in Stereographic 1970 (Iosif Gh., 2012)

MATERIALS AND METHODS

In Romania the specialists used a lot planimetric total stations for determining the position of points of detail. GNSS receivers are usually used for topographic support grid points and coordinates determined on WGS′84 ellipsoid are later transformed to Krasovski ellipsoid and to Stereographic 1970 using TRANSDAT software provided free by the National Agency for Cadastre and Land Registration (NACLR). As I stated above, detailed points define the perimeter of properties.

At present, the property registration, with few exceptions, is made through sporadic cadastre. Thus, each property is separately measured, based on owners directions, plot plans, boundary elements (if any) and on documents of ownership.

The file is submitted to the Office of Cadastre and Land Registration and receives permission for registering or if some items do not match, they require clarification. Also, if the plan is not good, technical or juridical is rejected.

Over a period of time, the neighbor of the already registered parcel will want to register his own parcel. He will contact an authorized person and will go through the same steps. Most times, when submitting work to OCLR there is found an overlapping with the neighbor or between the 2 properties remains a free strip (they do not fit perfectly). Overlapping or distance has a certain value. When these values are in a tolerance or precision measuring existing old network, a meeting between parties takes place and the limit of the new registered property is aligned to the old one.

Often, the differences are great and then start problems regarding the drawing the technical documentation up.

The first issue brought up is how link the geodetic network to the Stereographic system 1970. Each specialists who carried out the technical work realised the link in a certain way. Either GNSS receivers and then transformed with TRANSDAT, either by direct binding to geodetic network points (retro-intersection, traverse, network compensated by the method of least squares, and so on).

The second problem is how as determined perimeter points. If these are materialized on ground (corner of fence, natural or artificial detail) it should be checked the location of the measurement. For example, a concrete wall, 40 centimeters thick, can be measured by each authorized specialist on the property measured. In this way creates a gap of at least 40 centimeters because it can be added the errors due to transmission network.

But the most serious problem is related to how reduce the distance to the projection plane. Most experts work with total station directly in coordinates. It is not wrong, but to obtain correct coordinates the reduced distance used by total station must be correctly calculated. Usually setting the Stereographic plan is considered sufficient. Or, even worse, a reducing coefficient of 0.99975 is inserted, which is totally wrong. This coefficient is valid only in central point of projection, as shown in Figure 1.
Another option is to insert a valid coefficient for the entire county. It is also wrong, because, as shown also in Figure 1, most counties have large differences in distance correction throughout the county.
Alternatively, also wrong, is to use simple formula to reduce the distance on the horizon:

$$D_0 = D_i \cos\alpha = D_i \sin z$$

Where:

- D_0 is the horizontal distance;
- D_i is the slope distance (measured);
- α is slope angle;
- z is the zenith angle. None of the above solutions is scientific valid.

The only one valid is formula 1 which takes into account the elements of Stereographic projection system 1970.

RESULTS AND DISCUSSIONS

Given the above, I selected from Figure 1 data related to gap distance / km for counties where using an improper formulation can lead to serious positioning errors.
Basically there is an error of principle, respectively the use of formulas that do not lead to a correct result.
Each expert pretends to respect the correct formula. Unfortunately, using formula 2 was possible on very small surfaces only topographic surveys.

No.	County	Reduced distance using formula (2.1) [m]	Reduced distance using formula (1.1) [m]	Difference /1000 m [cm]
1	Timis Est	1000	999.99	-0.1
	Timis Vest	1000	1000.615	+61.5
	Total difference county Timis			+61.6
2	Dolj Nord	1000	999.938	-6.2
	Dolj Sud	1000	1000.303	+30.3
	Total difference county Dolj			+36.5
3	Ialomita Vest	1000	999.92	-8.1
	Ialomita Est	1000	1000.318	+31.8
	Total difference county Ialomita			+39.9

The table presents an example of distance differences resulting from the application of incorrect formulas. Given the currently used tools, precision it offers, it is inexcusable to use formulas that provide solutions for measurements made with classic instruments. Using incorrect formulas leads to serious positioning errors and overlapping of parcels in cadastre.

CONCLUSIONS

We conclude from Table 1 that there is a 61.6 centimetres/100 meters difference between the 2 distances in Timis County. If measured distances is greater than 1000 meters, the error increases proportionally with distance. This situation is viable when large areas, spanning several kilometers, are measured.

Calculating errors induced in area could conclude that the minimum error per hectare is 246. 4 square meters. Minimum error occurs

when the hectare is a perfect square of sides of 100 meters. In the worst case, that is one side of 10 meters and one is 1000 meters, the error area is 622.16 square meters.

There are data that put a warning on how reduced distances are calculated to project plan. In fact, during data verification at OCLR, the expert should provide raw data measured, respectively the slope distance and vertical or zenith angle, height of the tool and the height at which to target. In this way, the distanced used for coordinate determination can be verified.

Long-time agreed that the total station and GNSS receivers replace both classic instruments and computer programs. If classic instruments replacement is valid there is not available the replacement of data processing programs. Without a carefully examination of how the total station reduces distances we cannot trust the resulting data, or the coordinates (positioning).

ACKNOWLEDGEMENTS

This article was carried out with the support of SC C&C TOPOEXIM.

REFERENCES

Iosif Ghe. Vasile C., vol. XLII 2012/2
Moldoveanu Constantin - Geodesy. Getting Physical and Ellipsoidal Geodesy, Positioning, MatrixRom Publisher 2002
Paunescu Cornel - Geodesy Course - Surveying, University of Bucharest, 2001
Paunescu C, Paunescu V, Anton CA, - Comparative Study on Obtaining Coordinates for Areas Distant from Zero Strain Circle Stereographic System 1970 - Alba Iulia Symposium 2012

PLATFORM FOR GEOINFORMATION IN SUPPORT OF DISASTER MANAGEMENT

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Abstract

Efficient analysis and interpretation of satellite imagery can contribute to rapid mapping for disaster management. Earth observation capabilities from national, European and international community actors are used to respond to major disasters around the world, for humanitarian aid and security. Satellite derived information needs to be used in combination with additional data to be presented in a proper geospatial context for the work of civil protection agencies and relief organizations. When disasters happen, reliance is placed on any type of geoinformation that might be available in a short period of time. The paper presents the main goal to be achieved by implementing the project Platform for GeoInformation in Support of Disaster Management (GEODIM) under the frame of PCCA 2012 Programme, coordinated by the National Meteorological Administration of Romania, University of Agronomical Sciences and Veterinary Medicine being a partner. The GEODIM project is focused to develop a downstream emergency response service for contributing to current disaster and risk management approach based on Earth observation data. The service will enable socioeconomic benefits for Romania in terms of future decisions on disaster and risk management policies by providing decision makers with better, more complete, timely and reliable information.

Keywords: *downstream emergency response service, Earth observation, remote sensing, satellite image.*

INTRODUCTION

According to the United Nations Office for Disaster Risk Reduction (UNISDR), more than 2.9 billion people were affected and more than 1.2 million people were killed around the world by disasters that occurred from 2000 to 2012 (UNISDR, 2013).At present, approximately 60% of the world's natural disasters arefloods, but recent scientific studies show that, in the future,global climate changes might increase the incidence of this phenomenon (Niculescu et al., 2010).Europe is also facing severe floods almost every year. The European Commission (EC) decided to establish the European Flood Alert System (EFAS) in order to reduce the catastrophic effects of the floods. The system is developed by the Joint Research Center (JRC) together with national flood forecasting centers and meteorological services. EFAS provides not only flood warning information (covering up to 10 days in advance) but it also offers useful information for disaster management during the ongoing flood events (EFAS, 2005). Directive 2007/60/EC represents an European initiative that aims to reduce and manage the risks that floods pose to humans, environment, and economic activity (Directive, 2007).

Romania has been severely affected by floods many times in the recent past. According to the statistics, there are over one million hectares of floodplain and more than 900,000 people living in areas with high risk of flooding, while more than 88,000 households could be flooded at any time. Most frequently, thefloods occurred on the Siret, Danube and Prut rivers (Dana et al., 2011). Starting with 2005, the floods have been monitored with the support of the International Charter "Space and Major Disasters" and the Copernicus Emergency Management Service (GMES EMS) developed by EC.

In this context, a local emergency response service called GEODIMwill be implemented in Romania. The service will contribute to the

current disaster and risk management approach, based on Earth observation data. It will use the current emergency response services provided by the International Charter, Copernicus EMS and UN-SPIDER, but it will complement them with a downstream component that offers value-added and validated products for each disaster management phase (GEODIM, 2013).

MATERIALS AND METHODS

All the emergency response services that are currently operational provide space-based vital information to the countries affected by natural or man-made disasters. All of them address emergency situations that occur at global level. Generally, the activation steps are quite similar. In the case of a disaster situation, the national authorized user contacts one of the emergency response services in order to trigger the service. Detailed information in terms of location, type of the disaster, extent, date of occurrence must be completed in the activation form. Further on, the emergency service identifies the most suitable satellite missions that are available and might acquire useful remote sensing data. In the same time, archive satellite images are also identified for the area of interest. The service processes all the data and deliversspace-based products to the user that triggered the service.

Presently, the International Charter"Space and Major Disasters" has more than 10 years of activity and more than 300 activations in case of different emergency situations (earthquakes, fires, floods, landslides, oil spill, tsunamis) that occurred in nearly 100 countries. The members of the International Charter are space agencies and space system operators (Charter, 2000).

Copernicus – the European Earth Observation Programme (former called GMES - Global Monitoring for Environment and Security)is coordinated and managed by EC. It consists of three main components: services (land, marine and atmosphere monitoring, security, climate change emergency, management), the in-situ component and the space component (future Sentinel missions).The European Environment Agency (EEA) manages the in-situ component while the space component is operated by the European Space Agency (ESA). Presently, the Mapping component (rush mode and non-rush mode) of the Emergency Management Service (EMS) is operational (GMES EMS, 2013).

The United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) has the following mission: "Ensure that all countries and international and regional organizations have access to and develop the capacity to use all types of space-based information to support the full disaster management cycle". In addition to the other emergency management services, UN-SPIDER also focuses on capacity-building. The platform has several permanent offices and a network of Regional Support Offices - RSOs (UN-SPIDER, 2010). One of these offices is hosted by the Romanian Space Agency and it is managed in close cooperation with the National Meteorological Administration and also the University of Agronomic Science and Veterinary Medicine Bucharest (ROSA, 2013).

GEODIM will be designed as a value-added service that covers all the phases of a disaster, namely preparedness, prevention, emergency response, and recovery. It will gather all the puzzle pieces consisting in services provided by the International Charter, GMES EMS, UN-SPIDER under a unique Romanian emergency response downstream service. GEODIM will strengthen the expertise of the Romanian experts both when operating specific actions for local disaster events and when assisting other countries as an UN-SPIDER Regional Support Office (GEODIM, 2013).

RESULTS AND DISCUSSIONS

A data center containing archive and newly acquired satellite imagery, in-situ data, and different types of useful ancillary data, all stored in geodatabases, will be established for the downstream service. Moreover, the center will also incorporate improved satellite image processing algorithms that will be adapted for each disaster type. The cartographic products will be created in the Romanian language for ensuring their use also by people who know only the mother tongue. This will broaden and facilitate the use of maps, especially in crisis situations where time is critical and rescue actions are required (GEODIM, 2013).

The analysis and modelling of the risks in order to enable the responsible authorities to take

precautions measures to reduce the incidence of a disaster and its amplitude are of particular importance because past experiences show that floods affect mostly the same areas.
For example, the Piscu village was flooded both in 2005 (Figure 1) and 2010 (Figure 2). The very high resolution satellite images allow the assessment of the damages at the level of the households. The maps are very useful for intervention and rescue actions.

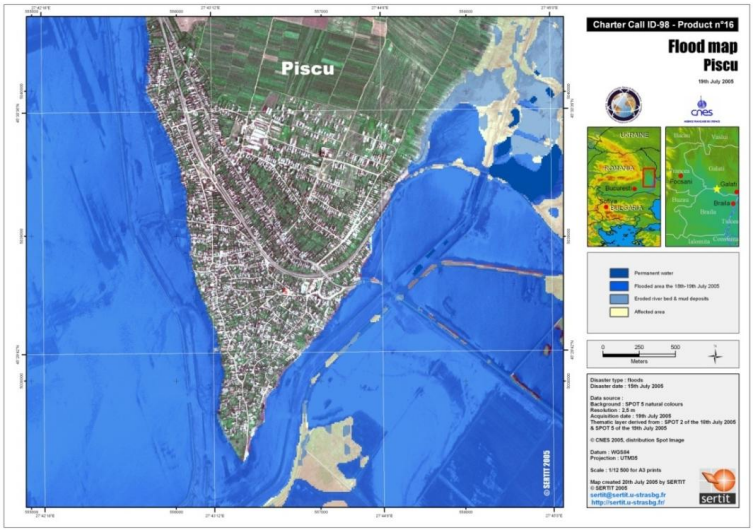

Figure 1.Floods on the Siret River, Piscu, Galati County. Disaster map derived from a satellite image acquired by SPOT 2 on July 19, 2005. International Charter Space and Major Disasters, © SERTIT 2005

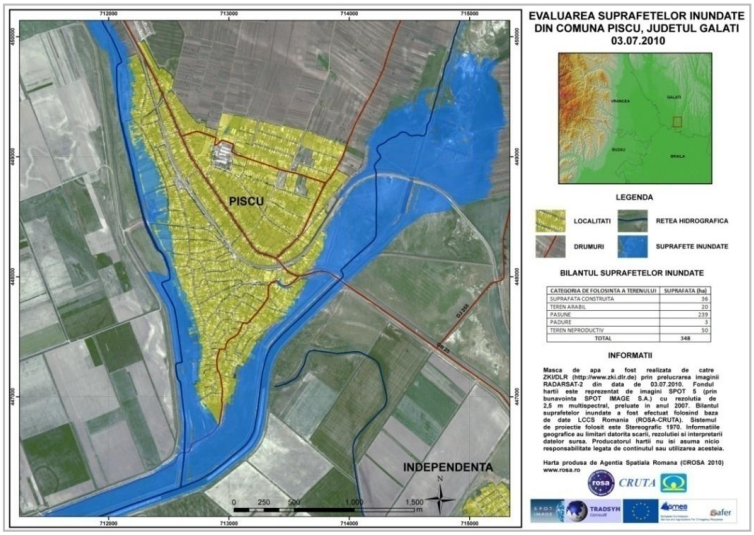

Figure 2.Floods on the Siret River, Piscu, Galati County. Disaster map derived from a satellite image acquired by RADARSAT-2 on July 3, 2010.GMES Emergency Response Service, © ROSA ANM 2010

CONCLUSIONS

The information obtained through the analysis and processing of satellite images is essential in the management of the emergency situations. Moreover, the integration of in-situ collected data improves the quality and content of the disaster crisis maps.

The downstream emergency response service will target information products that are agreed by the user community and defined based on current technology and Earth Observation data based on users' requirements. Thus, GEODIM will provide value-added products through disaster maps (printed and electronic), graphics and written reports that offer a clear and objective perspective concerning the dimension of disasters and their effects on infrastructure, agriculture, human settlements, etc. The service will also incorporate improved and newly-developed algorithms in order to generate more accurate and complex products.

The service will enable socioeconomic benefits for Romania in terms of future decisions on disaster and risk management policies by providing decision makers with better, more complete, timely and reliable information.

GEODIM will enable a better coordination between the institutions involved in crisis management that in turn will increase the efficiency of the disaster management actions. Consequently, the service will lead to human and material losses reduction and in the same time to an improved protection of the citizens.

In the same time, Romania will significantly strengthen its capabilities in disaster and risk management and will offer high quality assistance as a Regional Support Office within the UN-SPIDER emergency response service.

In conclusion, GEODIM will provide an operational and validated service that will help the responsible authorities to use the space-based products during all stages of the crisis management cycle (preparedness, prevention, response, recovery), as a support for their decision-making actions. The establishment and implementation of this downstream service would represent an absolute first performance for Romania, fitting the current European policies and trends related to the Copernicus Downstream Services that are an extension of the Emergency Management Core Service.

ACKNOWLEDGMENTS

This study has been carried out under the "Platform for Geoinformation in Support of Disaster Management (GEODIM)" scientific project financed by the Executive Agency for Higher Education, Research, Development and Innovation Funding. GEODIM (ID PN-II-PT-PCCA-2011-3.2-0575) was submitted within the Partnerships Programme as a Joint Applied Research Project in the domain of Space and Security. The partnership is led by the National Meteorological Administration and it includes Romanian Space Agency, Advanced Studies and Research Center, University Politehnica of Bucharest, and the University of Agronomic Science and Veterinary Medicine – Bucharest.

REFERENCES

Charter, 2000: International Charter "Space and Major Disasters". http://www.disasterscharter.org/web/charter/home (accessed March 2013).

Dana, I., Badea, A., Moise, C., Olteanu, V. G. and Irimescu, A., 2011. Space Based Maps in Support of Disaster Management Actions in Romania, Proceedings of ISPRS Geoinformation for Disaster Management (Gi4DM), 2011, Antalya, Turkey, p. 1

Directive, 2007: Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the Assessment and Management of Flood Risks, Official Journal of the European Union, L 288/27, EU, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:288:0027:0034:EN:PDF (accessed April 2011).

EFAS, 2013: European Flood Alert System, Floods Portal, Joint Research Centre, EC. http://floods.jrc.ec.europa.eu/ (accessed March 2013).

GEODIM, 2013: Platform for Geoinformation in Support of Disaster Management, Introduction and Objecives. http://geodim.rosa.ro/ (accessed March 2013).

GMES EMS, 2013: Global Monitoring for Environment and Security - Emergency Management Service, EC. http://portal.ems-gmes.eu/(accessed March 2013).

Niculescu, S., Lardeux, C., Güttler, F., and Rudant, R.-P., 2010.Multisensor Systems and Flood Risk Management.Application to the Danube Delta Using Radar and Hyperspectral Imagery. Revue Télédétection, 9(3-4), p. 271-288.

ROSA, 2013: UN-SPIDER Office in Romania. http://www.rosa.ro/index.php/en/2009/181-onu-spider-in-romania.html (accessed March 2013).

UN-SPIDER, 2010: United Nations Platform for Space-based Information for Disaster Management and Emergency Response. http://www.un-spider.org/, (accessed April 2011).

UNISDR, 2013: Disaster Statistics, Disaster Impacts 2000-2012, United Nations Office for Disaster Risk Reduction. http://www.unisdr.org/we/inform/disaster-statistics (accessed March 2013).

CULTURAL HERITAGE SURVEYING EXPERIENCES OF COMITATO ITALIANO FOTOGRAMMETRIA ARCHITECTTONICA SUMMER SCHOOL 2011

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Abstract

This paper reports the experiences of the second edition of an international, educational programme named "Summer School 2011". The Summer School 2011 was held by the Comitato Italiano Fotogrammetria Architettonica, in Italy. The main goals of that educational programe were:
(a) to develop the thinking about the importance of cultural heritage preservation,
(b) to emphasize the potential of application of LASER scanning techniques to the surveying of cultural heritage sites. The Summer School involved five professors and seventeen professionals and students not only from Italy (8), but also from Brazil (7), Turquey (2), Venezuela (2), and Romania (3). The technical backgrounds of the participants were the areas of remote sensing, architecture, digital photogrammetry, civil engineering, and surveying. The Summer School had an itinerant programe, starting from the city of Noci, located in Puglia, Southern Italy, and going down into the Puglia province, by visiting the community of Laterza, and the cities of Lecce and Bríndisi. The methodology for developing the technical and cultural programe was divided into three main parts:
(a) a theoretical part held by technical presentations;
(b) the "on-site" presentations and descriptions of the cultural and historical highlights of the objects of interest;
(c) the demonstrations and controlled practice of LASER scanning surveying work.
This paper also reports the results of the surveying of the following historical sites:
(a) The " Cantina Spagnola" cavern;
(b) The "Tempio di San Giovanni al Sepolcro" site, a catholic church located in Brindisi, Italy.
The most relevant conclusion of this multicultural, international programe was to spreading the thinking about cultural heritage inventory techniques, sought to be fundamental for maintaining the historical records of a country. In this direction, the Laboratory of photogrammetry of The Rio de Janeiro State University, in Brazil, has started a joint technical project with the Laboratory of Comitato Italiano Fotogrammetria Architettonica toward the surveying of two historical sites located in the State of Rio de Janeiro:
(a) the ruins of a city in the southern part of the State, named "São João Marcos";
(b) the headquarters of the Rio de Janeiro State government, named the "Palácio da Guanabara". The results of that international technical cooperation are also included.

Keywords: *Architectonic Photogrammetry, Archaeology, Cultural Heritage, LIDAR, Surveying*

INTRODUCTION

Motivation

In 2010 the Laboratory of Architectonic Photogrammetry of Comitato Italiano Fotogrammetria Architettonica, in Italy, developed an international, short-term educational programe named –Scuola Estiva" or Summer School. The main goals of that educational programe were:
(a) to develop the thinking about the importance of cultural heritage preservation;
(b) to emphasize the potential of application of close-range digital photogrammetry, and remote sensing techniques to the surveying of cultural heritage sites. Those techniques encompass LASER scanning, close-range photogrammetry, termography, and ground-penetrating RADAR.

Goals and Overview

This paper aims to presenting the main results of the second edition of Summer School,

named –*Summer School 2011*".
The written work is organized into 6 sections, including this introductory part. Section 2 describes the technical programe of Summer School 2011, the methodology used in the surveying, including the description of the sites chosen. Section 3 summarizes the results of the surveying and post-processing work. Section 4 concludes this paper. The references and acknowledgements are also presented in Sections 5 and 6, respectively.

MATERIALS AND METHODS

THE SUMMER SCHOOL PROGRAMME

Description and focuses

The scope of this second edition of Summer School educational programe was: –*New Technology and Cultural Heritage Protection: Remote Sensing and Architectonic Survey*". In such a context, the focuses of this short-term instructional programe were:
(a) to develop the thinking about the importance of cultural heritage preservation, and;
(b) to emphasize the potential of application of state-of-the-art techniques and equipments to the surveying of cultural heritage sites. This short-term educational programme was held form September 5th till September 10th. It had an itinerant schedule, starting from the city of Noci, located in Puglia, Southern Italy, and going down into Puglia province, by visiting the community of Laterza, and the cities of Lecce and Bríndisi.
The Summer School involved two invited teachers, one from Brazil and other from Romania; ten Italian teachers and technicians, from both public and private support organizations; and seventeen professionals and students not only form Italy (8), but also from Brazil (7), Turkey (2), Venezuela (2), and Romania (3). The technical backgrounds of the participants were the areas of remote sensing, architecture, digital photogrammetry, civil engineering, and surveying.

The Cultural Heritage Recording

There are many possibilities for recording cultural heritage objects. Close-range photogrammetry techniques, for instance, are commonly used. This technique uses both film and digital, small and medium-format cameras. LASER-scanning devices are being developed along the time, are becoming more popular, and are getting higher accuracies and lower scanning times along the time. Termography is also a very promising field of research for cultural heritage diagnosis and recording. Close-range or ground-penetrating RADAR scanners and similar devices are useful for underground searching for archaeological and historical signs and sites. Those techniques above mentioned can be used together with GNSS and other topographic devices to give georeference for cultural and historical sites and objects. Furthermore, those surveying and recording techniques are non-invasive. This characteristic makes a big difference when compared with invasive techniques. This characteristic increases the potential of applications of non-invasive techniques for historical and cultural heritage surveying and recording. The key concept, however, is not only centered the use of those devices and techniques but also in the thinking about the necessity of recording for preservation of the cultural heritage of a society or Nation.

The First Edition of Summer School

The *Scuola Estiva* educational programme had its first edition in 2010, by an initiative of the Laboratory of Architectonic Photogrammetry of the Politecnico di Bari, and by the financial support of both public and private Italian institutions. In its first edition, a Brazilian, undergraduate student in Cartographic Engineering attended to that programme. As a result of his participation in that educational programme, he is finishing his final project on an historical site in the Southwestern region of the State of Rio de Janeiro, in Brazil. This site is named –The São João Marcos ruins". That site has its historical relevance due to the XVIII century, the colonial period of Brazil, and remaining as an important city in that epoch, until the construction of a dam for water service for the city of Rio de Janeiro. The point that needs to be stressed is the fact that the Brazilian student learned not only how to recording an historical site, but also the thinking about the importance of cultural and historical heritage surveying for preservation. One of his results are presented in this paper.
The general approach adopted for developing the technical and cultural programme of

Summer School 2011 was to divide the programme into three main parts:
(a) a theoretical part held by technical presentations; (b) –on-site" presentations and descriptions of the cultural and historical highlights of the objects of interest, and;
(c) demonstrations and controller practice of recording and surveying by close-range photogrammetry, LASER scanning, GNSS georeferencing, and ground-penetrating RADAR.

Description of the Historical Sites Chosen

The Region of Puglia, Southern Italy The rocky habitat is a very important cultural aspect of Puglia, it represents a heritage of diverse artistic culture, architectural, historical, linguistic and devotion of the people who settled there, traces of which can be traced back to the remote Neolithic and in the Middle Ages (IX-XII century).
The rocky habitat has taken a central role in relations between East and West. The geomorphological features of Puglia favored the development of a substantial building rock, as local people took advantage of the rock to housing needs and the creation of places of worship. An interesting feature that characterizes the constructions rock is the creation of villages that were built into the rock cliff along the ravines and the blade, next to water courses and major communication routes. Within these settlements, the houses do not have exceptional interest of the architectural and artistic. The churches, however, are an important cultural heritage, not because of the architectural simplicity with which they were built (dug into the rock), but rather for the elegance of the paintings.
The area of Taranto in the area overlooking the Ionian Sea and the region of Puglia, called "Alta Murgia", preserve the most significant traces of this phenomenon, thanks to the geological feature of its territory, mainly consisting of blades and widespread ravines and karst features.

The city of Laterza

The City of Laterza is characterized by a considerable rocky area between the sanctuary of Mater Domini and the ravine.
The deep ravine Laterza is 200 meters, 500 meters wide and 12 Km long. The ravine Laterza, located approximately at latitude 400 38' N and longitude 160 48' E is at the center of the district of ravines (60 ravines surveyed between Matera and Grottaglie), the ravine Laterza was formed millions of years ago and reveals the human presence, as attested by archaeological finds from as early as the eleventh century B.C.
Figure 1 shows a low-oblique, aerial view of the city, and is tought to be self-explanatory.

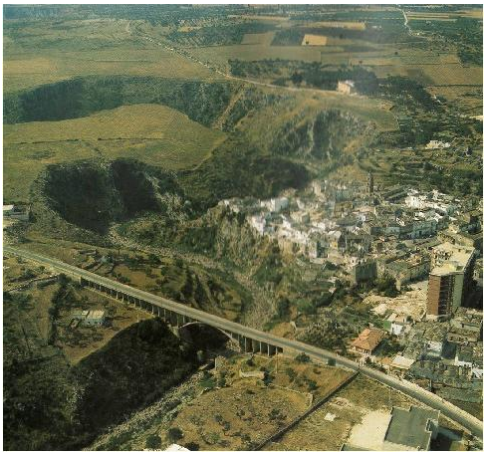

Figure 1 A low-oblique aerial view of the city of Laterza

The human settlement of this area is evident from the testimonies of underground funerary furnishings and tools of flint and bone found in this area. These elements demonstrate the presence of a population of Balkan origin. The population settled in these places between the third and second millennium BC, giving rise to the Eneolithic civilization of Laterza. Behind the ravine Laterza were surveyed 30 rock churches carved into the tufa rock, located mainly along the blades. Among these, the cave church "Spanish Wine", the cave church of San Giorgio and the Rock Church of Christ the Judge.

The Cantina Spagnola

The Cantina Spagnola in Laterza known by the common name of "the cave of Mammuécce" is one of the most significant settlements of the city of Laterza, for the uniqueness of its kind, formed by the variety of its decorations and sculptures.
The –Cantina Spagnola" is located in the center of the blade of the city of Laterza, on the right side, below the plateau where there are the caves of San Pietro, near the bridge leading to

the town of Ginosa. This underground has undergone several changes of intended use as is apparent from a reading of architectonic sites: from its use as a church, then as a meeting place of the ~~"n~~obility Laertina" use as a place of grain storage and recovery of sheep, and finally as a millstone for the production of oil. The plan of the building is irregular with uneven walls, but all painted. Three steps allow the entrance to the hypogeum, which is not dug over a unit time and that can be divided into three rooms.

The first environment that is very simple has the presence of two wells of irregular shape and two meters deep for the storage of grain and wine. In the left side of this small room is a wall of "tompagno", performed to divide the cave from another adjoining room. Arouse great attention a carved mask (once there were two masks, one was stolen), the mask is formed in low relief and is an expression of apotropaic masks used on the entrance gates of the residences feature with merely superstitious. A large arch, composed of blocks of tufa, introduces and reinforces the turn in the other room that looks quite irregular. In fact there is a difference at the floor and ceiling, most likely because of different times of the excavation.

The left wall, with the presence of a niche, and the remains of an ancient altar and a seat, is the clearest evidence of the use of the cave as a church, because the altar is oriented to the east according to the canons of Christian churches. (Bongermino, 1993).

The right wall of this space is largely occupied by a mill built at the beginning of the century, while an interesting fresco is on the rest of the wall. This fresco called "The Mother's Son" in which there is a richly dressed woman flanked by two men who hold out their hands.

The third room, placed in the bottom of the cave, is bounded by a partition, painted with two gates built into the original excavation (now there are three openings, the centre opened in recent times most likely to allow the animal shelter).On the left side of this partition is the sculpture in high relief with the inscription "CAVALLO DI RISPETTO ", horse parts, a factor that has made people believe that to some that the cave was used as a place to change horses. Of particular attention to the decoration within this environment represented by a dozen priests vestments and objects of worship, these were popular in the decoration of ceramics of Laterza.

The Tiempio di S. Giovanni al Sepolcro

The church of *S. Giovanni al Sepolcro* is located in the city of Brindisi, southern Italy. It is a building of Romanesque style and was built around the XI century. Although tradition has it that the building was built by Boemondo, but the most accepted hypothesis that the building connected to the "*~~O~~rdine cavalleresco dei Templari*".

The medieval city of Brindisi is a major port for boarding in the Holy Land, so the presence of temple architecture is justified in this sense as a place to welcome the pilgrims and the Knights Templar themselves from Northern Europe reached from the port Brindisi holy places. The temple of "~~S~~an Giovanni al Sepolcro" is a circular building. The plan interior stirrup-shape formed by two concentric circles of columns reminiscent of the Holy Sepulchre of Jerusalem, is supported by eight columns from the stem smooth with fine capitals with acanthus leaves alternating with cubic capitals, the original vaulted roof has been replaced by the current one in wood.

Frescoes on the walls with images of saints dating from the twelfth and fifteenth centuries, including the "Deposition" dated to the early '300. The main portal, with a marble architrave surmounted by a spire porch is supported by two columns resting on lions. The sculptures are reminiscent of the medieval model of Bestiarium among the themes represented: the Nereid, the fight between bull and lion, the griffin, the deer are decorative elements used in all Mediterranean areas since remote antiquity, and from there subsequently exported throughout Europe.

The São João Marcos Ruins (Brazil)

The ruins of the archaeological of São João Marcos are located in the south-western part of the State of Rio de Janeiro, Brazil, in the county of Rio Claro, approximately at latitude 220 48' S and longitude 440 02' W. The major part of the ruins are the former foundations of buildings, bridges, roads, and remaining of the main church, The city was constructed in 1739, around a chapel built in the honour of São João Marcos. The city has prospered by the time of its construction mainly due to coffeeplantation

and market. In fact, according to historical records, São João Marcos was one of the most rich and populated cities in the Rio de Janeiro State, by the colonial period. (Serra, 2011).

With the ending of the coffee plantation and market the city of São João Marcos completely lost its economical importance. In 1938 it was attached to the city of Rio Claro, and two yearslatter, it was destroyed by a presidential decree. Theoretically, the order for destroying the city of São João Marcos was justified by the construction of the dam of Ribeirão das Lajes, for water supplying for the city of Rio de Janeiro. After dam filling, however, only a small part of the ruins was flood. This fact has permitted the foundation of the first Brazilian archaeological urban park.

The Guanabara Palace (Brazil)

This beautiful construction was built in the city of Rio de Janeiro in 1853 and was formerly used as a private home until 1860, when it was purchased by the Brazilian Imperial family.

The building suffered its first restoration in 1864, for hosting the Princess Isabel. In 1908 the Brazilian military republican government took it and gave its actual name of "*Palácio da Guanabara*". In 1960 The *Palácio da Guanabra* became the headquarters of the Rio de Janeiro State government. In 2009 the palace had its domes, roofs, and gardens completely rebuilt, aimed to recovering its original appearance, and the colour of its façades. (Araújo, 2012).

Equipment Used

LASER Scanners

Generally speaking LASER scanner equipments consist in a LASER beam assembled with optical, mechanical, and electronic components and parts. The major parts of LASER scanners are:

(a) a LASER-ranging device, which range varies from 2.0m to 1,400m or more; (b) a scanning mechanism; (c) hardware components for measuring and recording main and auxiliary data, like inclination sensors, laser plummet, and compass, and; (d) software components for configuration of data acquisition and for data post-processing.

Optionally LASER scanners devices can be integrated to a GNSS receiver and or antenna, and to a digital, small-format photographic camera. LASER scanners are becoming more common in many surveying and recording applications. In fact, there are many possibilities and prices for terrestrial, industrial or close-range LASER scanner devices for recording cultural heritage objects. Figures 2 to 4 show the LASER scanners used in Summer School 2011.

Figure 2 The RIEGL VZ1000 LASER Scanner assembled with a digital photographic camera

Figure 3 The Topcon Faro Focus 3D LASER Scanner

Figure 4 The Trimble GS200 LASER Scanner

Figure 5 The FLIR 660 thermal infra-red imaging camera

Table 1 below shows a summarized fact sheet about the LASER scanners used in Summer School 2011:

Table 1 Some facts about LASER scanners used

EQUIPMENT	FACTS
RIEGL – VZ1000	• Maximum distance of operation: 1,400 meters; • Has inclination sensors, a laser plummet, and a compass; • Can be integrated to a GNSS receiver with antenna; • Can be integrated to a digital, small-format photographic camera.
TOPCON – Faro Focus3D	• Maximum distance of operation: 120 metres; • Has an automated leveling system; • Has a digital, small-format photographic camera of 70 Mpixels integrated to the system.
TRIMBLE - GS200	• Maximum distance of operation: 350 metres; • Has a digital, small-format photographic camera integrated to the system.

Thermal Imaging Camera

Thermal, infra-red cameras show temperature differences in structures and objects. For instance, the thermal measurement of building façades and walls is based upon temperature differences of the interior of the building, the outside temperature, and the temperatures of the façades. Thermal imaging cameras help preserving cultural heritage, by measuring the temperatures inside and in the structure of ruins and ancient façades, thus permitting to detect water infiltration and other defects. Figure 5 shows a FLIR 660 thermal imaging camera.

RESULTS AND DISCUSSIONS

The *Cantina Spagnola* Surveying

Figure 6 below illustrates one of the practical results achieved in the Summer School 2001. It is the result of a 3D LASER scanning, where one can clearly see (figure 7) some historical paintings in one of the walls inside that cave. This surveying was performed by a RIEGL-VZ1000 LASER scanner. The recording time interval of the LASER profiling was about one hour for four shooting stations and point clouds acquired consist of approximately 23 million points.

Figure 6 – A Panoramic photography of the Cantina Spagnola in Laterza, Italy

Figure 7 Detail of the rendering of a photographic image over a LASER Scanning Surveying of a wall inside the "Cantina Spagnola"

The "*Tempio di San Giovanni al Sepolcro*" Surveying

Figure 8 illustrates the Surveying of the entrance of the *Tiempio di S. Giovanni al Sepolcro,* in Bríndisi, Italy.

Figure 8 The LASER Scanning Surveying of the Tempio di San Giovanni al Sepolcro, in Bríndisi, Italy

Figure 9 illustrates an overview of a rendering of the photographic images over the 3D LASER scanning This surveying was also performed by a RIEGL-VZ1000 LASER scanner. The post processing software used was the RIEGL Riscan Pro.

Figure 9 A rendering of photographic pictures over the 3D LASER Scanning Surveying of the Tempio di San Giovanni al Seplocro, in Brindisi, Italy

Figure 10 shows a photographic image of the interior of the *"Tempio di San Giovanni al Seplocro"*. One can observe the *capitellos* in the upper part of the columns.

Figure 10 The LASER Scanning Surveying of the Location of the Tiempio di S. Giovanni al Seplocro, in Bríndisi, Italy

Figure 11 depicts 3D model of one of the *capitellos* shown in the upper part of the columns. The 3D model was also generated by the post processing software used was the RIEGL Riscan Pro.

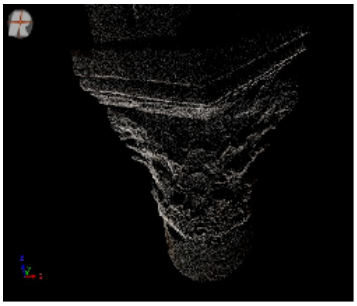

Figure 11 The 3D LASER Scanning Surveying of a capitello inside the Tempio di San Giovanni al Seplocro, in Brindisi, Italy

The *São João Marcos Ruins* Surveying

The surveying work of the city of São João was concentrated on the ruins of its main church. We used the Topcon Faro Focus 3D LASER Scanner for that purpose. We performed 13 LASER scanner positions around the ruins of the main church. Two scanning were performed in each station: one with low precision and high horizontal angle, and the other with high precision and low horizontal angle. The clouds of 3D points were post-processed, merged, and visualized by the SCENE post-processing and visualization software.

Figure 12 shows a photography of the ruins of the main church. One can notice in the upper-left part of this picture one of the stations of the LASER scanner used.

Figure 12 The ruins of the main church of the city of São João Marcos, located in the State of Rio de Janeiro, in Brazil

The *Palácio da Guanabara* Surveying

Figure 13 depicts an oblique, photographic colour view of the main façade of the Palácio da Guanabara. It is worth mentioning that this picture was taken in February, 2012, rather after the conclusion of the restoration work of the building, in 2011.

Figure 13 An oblique, close-range photographic image of one of the main façades of the Palácio Guanabra

The surveying work of the *Palácio da Guanabara* focuses not only on the LASER scanning of the main façade of that building, but also in the using a thermal infra-red imaging camera. Figure 14 depicts the results of the imaging with the using The FLIR 660 camera. One can notice the colour of one the main dome (in red), indicating the difference in temperature of this part of the building, if compared with the walls, for instance. This image permits the analyst to conclude the differences between the material used in the dome (a metallic cover structure) and in the walls, that have a green-toblue colour aspect, thus indicating lower temperatures. For example, in the pointing cross depicted in the upper-left part of the thermal image, one have the temperature of 35.8 0C.

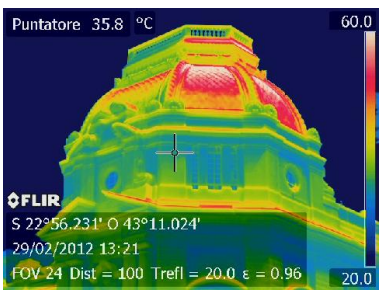

Figure 14 - An image taken by the FLIR 660 of the domes of the Palácio da Guanabara

CONCLUSIONS

The combination of LASER scanner, digital photographic and/or infra-red thermal cameras, and GNSS data can provide photo-realistic 3D reconstruction of objects and scenes, thus leading to an effective cost/benefit recording and surveying technique for cultural and historical heritage inventories. Not only inventories can be made. These techniques could be extended to many industrial and civil engineering applications in benefit of the society in general.

The most relevant conclusion of this multicultural, international programme Summer School 2011 was to spreading the thinking about cultural heritage inventory techniques, sought to be fundamental for maintaining the historical records of a country.

ACKNOWLEDGEMENTS

The authors would like to express their gratefulness to the public and private sponsors and collaborators of the Summer School 2011 for their financial, infrastructure, and technical support, without which this work would not be feasible.

Special thanks are due to the following persons:
(a) to Mr.Daniele Bartolucci from GEOTOP-TOPCON for using of the FARO Focus 3D, in the surveying of the "Tempio di San Giovanni al Sepolcro" at Brindisi;
(b) to Ms.Mariana Silveira, for cession of two pictures for illustrating this work.

REFERENCES

Araújo, J. 2012. Palácio Guanabara. O Prelo, ano IX nº 29 pp.15-22.

Bongermino R. 1993, *Storia di Laterza*, Congedo Editore, Galatina, pp. 251-254.

Dell'Aquila C. 1989, *Laterza Sacra*, Taranto Amministrazione Provinciale, Taranto, pp. 279-281.

Dell'Aquila C. 1998, *La cantina Spagnola nell'insediamento rurale di Laterza,* Rotary Intenacional.

G. Carito, *Brindisi nuova Guida*, 1993

Dell'Aquila C., Dell'Aquila F., Lenti E.1975, *Contributo alla conoscenza dell'insediamento rupestre laertino: la Cantina Spagnola*, in *L'Eremitismo in Puglia*, Adda, Bari , pp. 81-98.

Fonseca C.D.1988, *Civiltà delle grotte: Mezzogiorno rupestre*, Edizioni del Sole, Napoli.

Organização MV Serra, São João Marcos: Patrimônio e Progresso. Cidade viva, Rio de Janeiro, 2011.

R. Jurlaro, *Storia e cultura dei monumenti brindisini*, 1976

NEW CLOSE-RANGE PHOTOGRAMMETRIC TECHNOLOGIES

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Abstract

The work suggests the theoretical and practical experience of three international summer schools which propose to promote the new geomatics technologies, very useful for students and specialists, to solve many civil engineering works in many domains. A complete approachment of analytical and digital photogrammetric methods using CAD systems, combined with laser scanning and other non-destructive research techniques of remote sensing has the purpose of finding the best solution for surveying, inventorying, monitoring, restoration and conservation of space-objects. The benefit of combination of close-range photogrammetric methods with others geomatics and geophysics researches is that it provides a solid technical documentation of a space-object as a basis for technical rehabilitation or restoration planning, a total inventory, both quantitative and qualitative. In the framework of the photogrammetric complex process, the work refers to the computer representation techniques of space object obtained by photogrammetric methods for the processing of thematic data interpretation and their mathematical modeling. There are presented new 3D acquisition and processing procedure to map RGB, thermal IR and near infrared images (NIR). The combination and fusion of different data sources allows the generation of 3D thermal data useful for different purposes such as localization, visualization, and analysis of anomalies in contemporary architecture.

Keywords: *Architecture, Geomatics, Laser scanning, Photogrammetry, Surveying.*

INTRODUCTION

The Close-Range Photogrammetry (CRP) relies on the reconstruction of the object simultaneously from several images from different and best possible perspective to ensure a suitable geometry of intersecting rays. (A. Behrens, C. Lasseur, D. Mergelkuhl).

By definition, close-range photogrammetry is meant to be when the distance (range) from the camera to the object of interest can be from 1 m to aprox.300 meters. (J.R. Watson)

The ever-expanding areas of application of close-range photogrammetry can be grouped into three major areas: architectural photogrammetry, biomedical and bioengineering photogrammetry (biostereometrics) and industrial photogrammetry.

CRP is an accurate, cost effective technique of collecting measurements of real world objects and conditions, directly from photographs. Digital Photogrammetry utilizes digital images to obtain accurate measurements and geometric data of the object or area of interest, in order to provide spatial information for engineering design, spatial surveys or 3D modeling.

The benefits of CRP over other field procedures are purported to be: increased accuracy, complete as-built information, reduced costs, reduced on-site time for small and large projects.

Industrial CRP has been described by Meyer (1973) as *"application of photogrammetry in building construction, civil engineering, mining, vehicle and machine construction, metallurgy, ship building and traffic, with their fundamentals and border subjects, including the phases of research, planning, production engineering, manufacture testing, monitoring, repair and reconstruction. Objects measured by photogrammetric techniques may be solid, liquid or gaseous bodies or physical phenomena, whether stationary or moving, that allow of being photographed"*.

Another new technology which is combined very well with CRP techniques is **Terrestrial Laser Scanning (TLS)** which provides highly accurate, three-dimensional images enabling designers to experience and work directly with real-world conditions by viewing and manipulating rich point-clouds in CAD software. By sweeping a laser beam over a scene or object, the laser scanner is able to

record millions of 3D points. These X,Y,Z measurements can be imported into CAD or 3D application software and displayed on a computer monitor as a point cloud of points which has photographic qualities portrayed in one-color, gray-scale, false-color or even true color. Since all laser scan points are 3D, the files can be viewed, navigated, measured and analyzed as 3D models.

Another new technology use **Close-Range Panorama Photogrammetry** which realizes accurate 3D documentation with high resolution 360° panoramic images. [2]

Figure 1 - FODIS panorama camera together with a tablet PC for camera control and image storage.

Panoramic cameras with Linear Array CCD have been originally built for purely imaging purposes, but they also have a high potential for use in high accuracy measurement applications. Panoramic cameras have the advantage of high information content with giga-pixel format size and 360° field of view. *"Viewing 360° images is a natural way for the human being to perceive an space-object environment. The ability to process data directly from 360° high resolution panorama RGB images makes the workflow extremely intuitive, natural and realistic"* (Jafar Amiri Parian, 2012).

Terrestrial applications might also exploit findings and achievements of IR sensors that have been used for many years in satellite and airborne applications. The use of infrared (IR) sensors is today a fundamental tool in many close-range and terrestrial applications.

A new 3D acquisition and processing procedure to map **RGB**, **thermal IR** and **near infrared images (NIR)** on a detailed 3D model of a building was presented in Figure 2, *Remote Sensing Journal,*(Alba M.I,Barazzetti L, 2011).

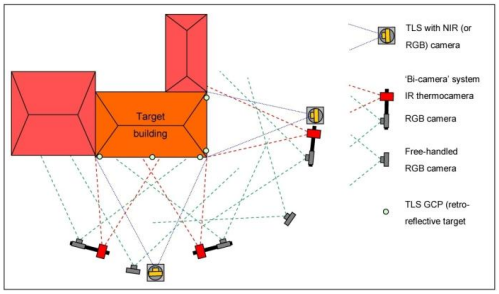

Figure 2. Example of data acquisition process for mapping IR/NIR/RGB images on a 3D model of a building.

The combination and fusion of different data sources allows the generation of 3D thermal data useful for different purposes such as localization, visualization, and analysis of anomalies in contemporary architecture.

Near infrared cameras (NIR) are sensitive to the wavelengths in the range 0.75 μm < λ < 1.4 μm and are usually used for the analysis of vegetation.

Infrared thermography (IRT) is mostly used as a preliminary investigation tool, a direct survey of the shape, materials and their damages is necessary to know the real state of the surface to analyze. Now, Infrared Imaging Techniques are used for the analysis of space-object and for buildings especially.

Thermal scanning of a structure allows one to collect information regarding technological elements, shape, physical characteristics of materials, and state of decay. Different kinds of defects affecting building structures can be detected by the analysis of surface temperature, submitted at particular boundary conditions.

Another relative new technology is UAV (Unmanned Aerial Vehicles) photogrammetry which opens various new applications in the close range domain, combining aerial and terrestrial photogrammetry, but also introduces low-cost alternatives to the classical manned aerial photogrammtery.

UAV Photogrammetry is a new terminology, introduced in 2009 by Henri Eisenbeiss from Institute of Geodesy and Photogrammetry ETH Zurich, which describes photogrammetric measurement platforms, which operate as either remotely controlled, semi-autonomously, or autonomously, all without a pilot sitting in the platform, and the photogrammetric processing

of UAV images. The broad definition covers balloons, kites, gliders, airships, rotary and fixed wing UAVs with the capability for photogrammetric data acquisition in manual, semi-automated and automated flight mode.
The main research in the photogrammetric community should focus more on the integration of the sensors like camera units and LiDAR (Light Detection and Ranging) system as well as the communication with navigation and control unit. It is important also to develop a multi spectral micro sensor concentrated on the use of mini and micro UAVs in agricultural applications.

Figure 3 - Overview of various UAV systems. [10]

These kinds of UAVs (shown in the Figure 3) are more depending on weather and local conditions, since these systems are difficult to control on a predefined path. In addition, most of them are not stabilized, which complicates the hovering on a position.
For the integration of different sensors on the same UAV, the exterior orientation has to be known and therefore the accuracy of the various sensors implemented into the platform has to be investigated.
In the last years, UAV/UAS are used for archaeological applications and cultural heritage documentation, monitoring of hazards, environmental and agricultural applications etc.

MATERIALS AND METHODS

The present paper use the theoretical and practical experience accumulated in three years of international summer schools, held in Italy, organized by Pietro Grimaldi from the *Politecnico di Bari*, based on various simulation models for the period 2010-2012 and which have had the purpose to promote the new geomatics and geophysics technologies, very useful for students and specialists, to solve many civil engineering works in many domains.
I have used also the previous expertise and applications in many projects of analogical, analytical and digital photogrammetry in Romania.

RESULTS AND DISCUSSIONS

A simple question is *–which camera should be used or purchased when applying CRP to the Earth Sciences"*? (ISPRS 2010)
There is not a simple answer, because project requirements should always dictate the design of any measuring system, which should include camera selection.
In 2010, the photogrammetric data acquisition was made with three digital cameras Nikon D1X calibrated before and mounted on an aluminum steel ruler of 2,000 mm.
Camera positions were chosen according to the best available photogrammetric configuration rules, and system used is shown in the Figure 4 (designed by Italian firm Menci Software).

Figure 4 -Three professional digital cameras Nikon D1X

Sometimes, mathematically a number of factors complicate the terrestrial photogrammetric modeling (camera positions and orientations are irregular; multiple exposures from the same station; uncalibrated cameras; not fixed lens; each photo has a different focus setting; local reference system). Terrestrial photogrammetry often use DLT (Direct Linear Transform) as a way of linearising the collinearity equations, to get a linear transformation between image space and object space coordinates, and get camera parameters from image measurements.

We used a minimum of six non-coplanar control points in XYZ coordinates.

Almost all non-topographical projects use *Bundle adjustment solutions,* with the object coordinates and the camera stations as unknowns. Simple rules which are to be observed for close range photography with non-metric cameras have been written, tested and published on the CIPA-Symposium in Sofia, in 1988. They are called the "3x3x3 Rules", because they are structured in three items, with three sub-items each, for simple photogrammetric documentation of architecture

3 geometric rules:
- Prepare control information,
- Multiple photographic all-round coverage,
- Take stereo-pairs for stereo restitution.

3 photographic rules:
- Keep a constant camera‘s interior geometry,
- Select homogeneous illumination,
- Select a stable and large format camera.

3 organizational rules:
- Make proper sketches,
- Write proper protocols,
- Don‘t forget the final check.

In the field of surveying and mapping, accuracy and reliability of measurement tools are the key of success.

If we know the conditions for the photogrammetric project (type of camera, type of instrument, which systematical errors will be modeled, mathematical models used, adjustment method/software used, etc.) then we can make experience-based predictions of the RMS error in the final result.

Laser scanning for inside and outside objects was made with Terrestrial Laser Scanner *Leica Scan Station 2* (shown in the Figure 5) and a number of marks uniform distributed on building corners were used to register scans captured. The check points used are in the same ground coordinate system used for external orientation of photos.

For fusion digital photogrammetric data with laser scanning data, it‘s very important to have the same coordinate system. So, for each point from the cloud corresponding to image pixel we know the space coordinates (X, Y, Z), the intensity and the three color components (RGB). In that way we can assign the corresponding image pixel for each space point from the cloud.

Figure 5 - Terrestrial Laser Scanner *Leica Scan Station 2*

Finally the main advantage of 3D images obtained after fusion is that moving the mouse on the 3D image, on line 3D coordinates for pixels are displayed on the computer screen. We can extract point coordinates from the image and we can interpolate space coordinates between pixels using interpolation algorithms.

The accuracy of 3D images depends mainly on the accuracy of the points cloud used and the ground pixel size of the images.

The new SLR (Single-Lens Reflex) cameras can be equipped with CCD (Charge-Coupled Device) or CMOS (Complementary Metal Oxide Semiconductor) and these sensors have a pixel size of a few micrometers, and thermal cameras have pixel size between 30 and 50 μm. Digital SLR cameras tend to give better results than compact digital cameras. The number of megapixels is important with high resolutions providing more information, but if the lenses are of low quality, images will lack sharpness and clarity whatever the resolution. Digital SLR cameras are generally equipped with higher quality lenses than compact cameras and therefore give better results. In addition, digital SLR cameras normally provide more controls for image capture, so tend to be more versatile and hence capable of tackling more diverse problems (Chandler et al, 2003). Such cameras also offer the best high ISO performance - this allows working indoors without the need for a tripod or flash or to stop down aperture for increased depth of field.

The main advantages of SLR cameras are:

- the possibility of changing lenses in order to cope with several camera-object distances;
- the availability of large formats for CCD (or

CMOS) sensors that allow one to capture large views of the object and to improve the image block geometry.

A calibrated SLR camera can be used in applications with a precision required of 1:100,000 [4].

Key stages which allow for accurate spatial measurement using digital cameras must be:

- Test-field calibration to derive an approximate lens model;
- Provide sufficient control for restitution and providing independent checks;
- Obtain images for object recording using a convergent image pair configuration with an overlap of 90-95%. If multiple image pairs are combined to mosaics, an appropriate overlap between adjacent convergent pairs can be 5-10%;
- Spatial measurement using digital photogrammetry, including automated DEM acquisition.

For example, the photogrammetric surveys of historic and art monuments can be grouped in three major categories: rapid and relatively simple surveys, accurate and complete surveys, and very accurate surveys.

Rapid and relatively simple surveys are used in preliminary studies for restoration and improvement, in inventory work, and in the study of the history of art. Stereometric cameras and other small format photogrammetric cameras are used extensively, together with normal case stereo plotters. Plotting is generally at a scale of 1:100.

Accurate and complete surveys are used for systematic documentation of architectural heritage. Plotting scale is generally 1:50, while the details are mapped at 1:20 or 1:10. Large-format metric cameras with long focal lengths are preferred in this type of work in view of the accuracy requirements and the sizes of buildings surveyed. The recently developed wide-angle cameras having focal lengths ranging between 100 - 150 mm are particularly suitable for this class of photogrammetric surveys. Such surveys are conducted in conjunction with restoration and consolidation projects. The highest possible accuracy is needed for these purposes and, depending on the needs, the final outputs of the survey can be in the form of plans, cross-sections, elevations and profiles.

Very accurate photogrammetric surveys are needed for highly refined studies. Accuracy requirement is generally in the order of ±1 mm and in some cases ± 0.1 mm. The study of sculptures in monuments and the assessment of the evolution in the surface of defaced stones, in support of chemical and physical investigations into the ~~"d~~isease of the stone" require this very high accuracy.

For example, two different kinds of sensors are used in IR thermo-cameras. The most largely adopted technology is based on thermal detectors, which feature has a sensitivity in the order of ±0.1 K. Currently, cameras with sensor size inferior to 320 × 240 pixels are used for analyses in building maintenance practice. Larger sensors are also available (up to a size of 1280 × 960 pixels), although at an absolutely different cost.

In the *Remote Sensing Journal 3, 2011*, there are presented three possible combined systems tested before for close range data acquisition:

- ~~"B~~i-camera" system, including a Nikon D80 SLR (3,872×2,592 px, f = 20 mm) and an IR Thermocamera AVIO (320 × 240 px, resolution 0.08 K; FoV 26° × 19,6°, IFOV 1.4 mrad, f = 74 mm);
- ~~"B~~i-camera" system, including a Nikon D80 SLR and an IR Thermocamera NEC H2640 (640×480 px, resolution 0.03 K; FoV 21.7° × 16.4°, IFOV 0.6 mrad, f = 50 mm);
- TLS Riegl LMS-Z420i integrating a SLR camera Nikon D100 (3,008×2,000, f = 20 mm) to gather RGB or NIR images.

IRT is a non-destructive and non-contact technique based on the measurement of the heat energy and its conversion into an electrical signal which is turned into a thermal digital image by a microprocessor. As is well known from [3], the maximum emitted electromagnetic wavelength (λ_{max}) of an object is inversely proportional to its absolute temperature (T):

$$\lambda_{max} = 2897.8 / T$$

This means that in the field of building analysis, the detection of temperatures is required in the range between −20 °C and 100 °C, corresponding to emitted maximum wavelengths ranging from 7.7 μm to 11.4 μm. As a result, the sensors to be adopted must be able to work in the Long Wave IR spectrum. [3]

CONCLUSIONS

The use of CRP technology is growing in such fields as: architecture, automobile construction, mining engineering, agriculture, machine constructions, objects in motion, shipbuilding, structures and buildings, traffic engineering, aerospace medicine, anthropometry, child growth and development, dentistry, marine biology, neurology, orthodontics, orthopedics, pediatrics, physiology, prosthetics, radiology, criminology, insurance, etc.

The efficiency of IRT as a non-destructive technique is well documented in many fields of engineering to support restoration or conservation projects and treatments. In civil engineering and architecture, IRT can be successfully used as an alternative to conventional inspection technologies, especially for the detection of subsurface defects and hidden structures in wide areas. IRT is often complemented by other non-destructive techniques such as GPR or sonic measurements.

The integration between photogrammetry, terrestrial laser scanning, and IR thermography allows to optimize mapping of thermal anomalies, to ascertain their location, and to improve the geometric resolution of the final textured 3D model. For the better evaluation of the defect extension allows to prioritize the conservation plan and the modality of the maintenance activity. Furthermore, the released graphic documentation consists of orthoimages that can support the preliminary projects for the conservation plan.

The application of NIR images in building analysis is innovative. NIR images can be easily used to texture 3D models if a low-cost camera is integrated to a terrestrial laser scanner, but we need in the future to understand better the response of construction materials in the NIR spectrum.

Comparative with the traditional aerial photogrammetry, UAV systems can operate autonomously. The coordinates in the flight planning are frequently defined relative to the start point, which allows flight planning independently from existing maps and coordinate systems. Using UAVs it is possible to fly closer to objects than with manned systems and the capability of using UAVs in unaccessible and dangerous areas, and the improvements in the data processing, open up new applications in photogrammetry.

ACKNOWLEDGEMENTS

This work was carried out with the support of University of Agronomic Sciences and Veterinary Medicine. The author thanks USAMV/FIFIM Bucharest that he will have the possibility to present these new close-range photogrammetric technologies used for reconstruction of initial image of space-object elements, theoretically shown above, and applied for students in the next International Summer School, which will be open at USAMV/FIFIM Bucharest in September 2013.

REFERENCES

Alba M.I, Barazzetti L., Scaioni M., Rosina E. and Previtali M., Mapping Infrared Data on Terrestrial Laser Scanning 3D Models of Buildings, 2011.

FOVEX Measure3D – a revolutionary solution for fast CAD modeling directly in RGB images, 2012, www.fovex.com

Luhmann, T.; Ohm, J.; Piechel, J.; Roelfs, T. Geometric Calibration of Thermographic Cameras. In Proceedings of the ISPRS Commission V Mid-Term Symposium „Close Range Image Measurement Techniques‟, Newcastle upon Tyne, UK, 2010.

Maas, H.G.; Hampel, U. Photogrammetric techniques in civil engineering material testing and structure monitoring. *Photogramm. Eng.Remote Sensing* 2006.

Popescu G., The Advantage of Holo-Photo-grammetric Methods Combined with the Remote Sensing Techniques for 3d Modelling of the Space Object Elements, International Symposium CIPA, Sinaia 1993.

Popescu G., Tendinţe privind prelucrarea interactivă a observaţiilor fotogrammetrice, combinate cu alte tehnici moderne de detecţie, Simpozion naţional Actualităţi si perspective, Bucharest, 2008.

Popescu G., Mihai D., New geomatics applications, 18th Congress of International Federations of Private Detectives, Bucharest, 7 - 9 December 2012.

Redaelli, V.; Caglio, S.; Gargano, M.; Ludwig, N.; Rosina, E. The Surfaces of Contemporary Architecture: Characterization of Clinker by IRT. In Proceedings of the 11th International Workshop on Advanced Infrared Technology and Applications AITA-11, L‟Aquila, Italy, 7–9 September 2011.

Staiger R., Terrestrial Laser Scanning Technology, Systems and Applications, 2nd FIG Regional Conference Marrakech, Morocco, 2003.

Eisenbeiss H., UAV Photogrammetry, Institut für Geodäsie und Photogrammetrie ETH Zurich, 2009

APPLIED GEOMETRY IN MICROECONOMICS. RECENT DEVELOPMENTS

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Abstract

Recently, B.Y. Chen (Chen, 2011, 2012 (1)) studied some geometric properties of h-homogeneous production functions with applications in microeconomics. The class of production functions includes many important production functions in microeconomics; in particular, the well-known generalized Cobb-Douglas production function, widely used in economics to represent the relationship of an output to inputs, and the ACMS production function, also known as the Armington aggregator are production functions.
In (Mihai and Sandu, 2012), the authors continued the study of geometry of h-homogeneous production functions by considering the minimality property of the production hypersurface and also the minimality of a production surface corresponding to a quasi-sum production function of 2-variables.
In (Chen, 2012 (2)), B. Y. Chen classified h-homogeneous production functions with constant elasticity of substitution.
In this paper we make a survey of recent results on production functions obtained by B.Y. Chen, especially from (Chen, 2011), and also recall the results obtained by the first author in (Mihai and Sandu, 2012).
In this note, we consider examples of known production functions and verify by concrete calculations some of the previous results. We study production surfaces by considering their constant Gauss curvature. Also, we calculate the mean curvature for some particular production function of two-factors.

Keywords: *h-homogeneous production function, perfect substitute, production hypersurface, quasi-sum production function.*

INTRODUCTION

The production function is one of the key concepts in the economic field. A *production function* is a non-constant positive function, specifying the output of a firm, an industry or even entire economy for all combinations of inputs.

There is a very important class of production functions that are often analyzed in both microeconomics and macroeconomics; namely, *h-homogeneous production functions.*
A function f of a multiple variables $x_1, x_2, ..., x_n$ is a *h-homogenous function* (or *homogenous of degree h*) if

(1.1) $f(tx_1, tx_2, ..., tx_n) = t^h f(x_1, x_2, ..., x_n)$,

for any given positive constant t and some constant h, where h is the *degree* of f.
A *h-homogenous production function* is a production function homogenous of degree h (a h-homogenous production function). This class of production functions includes many important production functions in microeconomics, such as the Cobb-Douglas production function and the generalized Cobb-Douglas production function, the ACMS production function and the generalized ACMS production function. For details about the production functions and their history, please see (Cobb and Douglas, 1928), (Douglas, 1976), (Filipe and Adams, 2005), (Mishra, 2010).

One denotes by $Q = f(x_1, x_2, ..., x_n)$ a h-homogenous production function. If $h > 1$, the function exhibits increasing return to scale; if $h < 1$, it exhibits decreasing return to scale; if $h = 1$, it exhibits constant return to scale. A homogenous function of degree *1* is often called *linearly homogenous*.

Cobb and Douglas (Cobb and Douglas, 1928) defined a *2*-factor production function (CD *production function*) of the form

(1.2) $Y = bL^kC^{l-k}$,

where L represents the labor input, C is the capital input, b the total factor input and Y the total production. Douglas was looking for a function which estimates the relationship of an output to inputs of the workers and capital.

A *generalized CD production function* is of the form

(1.3) $Q(x) = bx_1^{\alpha_1}x_2^{\alpha_2}\dots x_n^{\alpha_n}$,
$x = (x_1, x_2, \dots, x_n) \epsilon \boldsymbol{R}_+^n$,

with b a positive constant and α_i, $i\epsilon\overline{1,n}$, non-zero constants. The function Q is homogenous of degree $h = \sum_{j=1}^{n} \alpha_j$.

Arrow, Chenery, Minhas and Solow (Arrow, Chenery, Minhas and Solow, 1961) defined another *2*-factor production function called the *ACMS – production function*,

(1.4) $Q' = F[aK^r + (1-a)L^r]^{\frac{1}{r}}$

where Q' is the output, F is the factor productivity, a is the share parameter, K, L are the primary production factors, $r = \frac{s-1}{s}$ and $s = \frac{1}{1-r}$ is the elasticity of substitution.

There is also a *generalization of ACMS production function* as follows:

(1.5) $Q'(x) = b(\sum_{i=1}^{n} a_i^{\rho} x_i^{\rho})^{\frac{h}{\rho}}$,
$x = (x_1, x_2, \dots, x_n) \epsilon \boldsymbol{R}_+^n$,

where a_i, b, h, ρ are constants, b, $h > 0$, $\rho < 1$ and a_i, $\rho \neq 0$.

For each production function $Q = f(x_1, x_2, \dots, x_n)$ it is possible to define a non-parametric hypersurface of an Euclidean $(n+1)$–space $\boldsymbol{E}^{n+1}$ endowed with the canonical euclidian structure,

$x \cdot y = x_1y_1 + x_2y_2 + \dots + x_ny_n + x_{n+1}y_{n+1}$,
$x = (x_1, x_2, \dots, x_{n+1})$,
$y = (y_1, y_2, \dots, y_{n+1})$, $x, y \epsilon \boldsymbol{E}^{n+1}$,

given by

$L = (x_1, x_2, \dots, x_n) = (x_1, x_2, \dots, x_n, f(x_1, x_2, \dots, x_n))$.

L is called a *production hypersurface* (Chen, 2011). If $n=2$, then L is a *production surface*.

Chen in (Chen, 2011) studied geometric properties of h-homogenous production functions via their corresponding production hypersurface. Geometric properties of CD and ACMS-production hypersurfaces and their generalizations were proved in (Chen, 2011), (Vîlcu and Vîlcu, 2011), (Glen, 2011).

A production function Q is called *quasi-sum* (Chen, 2012 (2), (3)) if there are continuous strict monotone functions $h_i : \boldsymbol{R}_+ \to \boldsymbol{R}$, $i\epsilon\overline{1,n}$ and there exist an interval $I \subset \boldsymbol{R}$ of positive lenght and a continuous strict monotone function $F : I \to \boldsymbol{R}_+$ such that for each $x\epsilon\boldsymbol{R}_+^n$ we have $h_1(x_1) + \dots h_n(x_n) \epsilon I$ and

(1.6) $Q = f(x_1, x_2, \dots, x_n) =$
$= F(h_1(x_1) + \dots + h_n(x_n))$.

The quasi-sum production functions are related to the problem of consistent aggregation (Aczel, 1996). The generalized CD production functions (1.3) and the ACMS production functions (1.4) are examples of quasi-sum production functions. A quasi-sum product function is *quasi-linear* if at most one of $F, h_1, \dots, h_n$ in (1.6) is a non-linear function.

Let M be a hypersurface in $\boldsymbol{E}^{n+1}$. For general references on the geometry of hypersurfaces please see (Chen, 1973).

Recall the following notations on M: ξ is the *unit normal* at M; g is the *metric tensor*, having the coefficients $g_{ij} = g\left(\frac{\partial}{\partial x_i}, \frac{\partial}{\partial x_j}\right)$ with (g^{ij}) the *inverse matrix* of (g_{ij}); dV is the volume element; h_{ij} are the coefficients of the second fundamental form h; H is the mean curvature vector; G is the Gauss-Kronecker curvature.

In (Chen, 2011, 2012 (1), (2)) B. Y. Chen gives the known formulas for the previous quantities. More precisely, the following statements hold:

Proposition 1.1 (Chen, 2011, 2012 (1), (2)) For the production hypersurface M of $\boldsymbol{E}^{n+1}$, defined by

(1.7) $L(x_1, \dots, x_n) = (x_1, \dots, x_n, f(x_1, \dots, x_n))$,

with $Q = f(x_1, x_2, \dots x_n)$ a h-homogenous production function and $w = \sqrt{1 + \sum_{i=1}^{n} f_i^2}$ where $f_i = \frac{\partial f}{\partial x_i}, i = 1, \dots n$, we have:

(1.8) $\xi = -\frac{1}{w}(f_1, \dots . f_n, -1)$,

(1.9) $g_{ij} = \delta_{ij} + f_i f_j$, where $\delta_{ij} = \begin{cases} 1, if\ i = j \\ 0, if\ i \neq j \end{cases}$ is the Kronecker symbol.

(1.10) $dV = \sqrt{g_{ij}}\, dx_1 \wedge ... \wedge dx_n = w dx_1 \wedge ... \wedge dx_n$,

(1.11) $g^{ij} = \delta_{ij} - \frac{1}{w^2} f_i f_j$,

(1.12) $h_{ij} = \frac{1}{w} f_{ij}, where\ f_{ij} = \frac{\partial^2 f}{\partial x_i \partial x_j}$,

(1.13) $H = \frac{1}{n} \sum_{j=1}^{n} \frac{\partial}{\partial x_j} \left(\frac{1}{w} f_j \right)$,

(1.14) $G = \frac{\det(h_{ij})}{\det(g_{ij})} = \frac{1}{w^{n+2}} \det(f_{ij})$.

We point out the geometric interpretation of the geometric quantities from above.

The *Gauss-Kronecker curvature* measures how far is a hypersurface for being flat. When *n = 2*, the Gauss-Kronecker curvature is simply called the *Gauss curvature*, which is an intrinsec invariant (depends on the surface M only). A surface of null Gauss curvature is a *flat surface*.

The *mean curvature vector H* measures the tension received by the hypersurface from the ambient (Euclidian space). A hypersurface of null mean curvature is *minimal*. Of all hypersurfaces with a given boundary, *the minimal one* has maximum volume.

2. RECENT RESULTS ON *h*-HOMOGENEOUS AND QUASI-SUM PRODUCTION FUNCTIONS

A production function is a *perfect substitute* (Chen, 2011) if it is *1*-homogeneous (linearly homogeneous) which takes the form

(2.1) $Q(x_1, x_2, ..., x_n) = \sum_{i=1}^{n} a_i x_i$,

for some non-zero constant $a_1, ..., a_n$.

A perfect substitute with inputs capital and labour has the property that the marginal and average physical products of both capital and labour can be expressed as functions of the capital-labour ratio alone (see (Chen, 2011)).

Denote by $\boldsymbol{R}_+ = \{t \in \boldsymbol{R},\ t > 0\}$ and by $\boldsymbol{R}_+^n = \{(x_1, x_2, ... x_n) / x_1, x_2, ... x_n > 0\}$.

B. Y. Chen proved geometric characterization for a *h*-homogeneous production function to have constant return to scale or to be a perfect substitute.

Theorem 2.1 (Chen, 2012(3)) Let $Q = f(x_1, ..., x_n)$ be a homogeneous production function of degree $d \neq 0$. Then the production hypersurface of Q has null Gauss-Kronecker curvature if and only if either

i) the production function has constant return to scale, or
ii) the production function is of form:

$$f(x_1, ..., x_n) = \left(x_1 \phi\left(\frac{x_2}{x_1}, ..., \frac{x_n}{x_1} \right) \right)^d,$$

where $\phi(u_1, ..., u_{n-1})$ is an *(n-1)*-input function satisfying the homogeneous Monge-Ampère equation: $\det(\phi_{ij}) = 0$.

Theorem 2.2 (Chen, 2011) A *h*-homogeneous production function with more than two factors is a perfect substitute if and only if the production hypersurface is flat.

Theorem 2.3 (Chen, 2011) A two-factor *h*-homogeneous production function is a perfect substitute if and only if the production surface is a minimal surface.

The following corrolaries were proved.

Corollary 2.4 (Chen, 2011) The generalized Cobb-Douglas production function has constant return to scale if and only if the production hypersurface has null Gauss-Kronecker curvature.

Corollary 2.5 (Chen, 2011) The two-factor Cobb-Douglas production function has constant return to scale if and only if the production surface is flat.

Corollary 2.6 (Chen, 2011) The production hypersurface of the generalized Cobb-Douglas production function with more than two factors is always non-flat.

Similar results have been obtained for ACMS production functions:

Corollary 2.7 (Chen, 2011) The ACMS production function has constant return to scale if and only if the production hypersurface has null Gauss-Kronecker curvature.

Corollary 2.8 (Chen, 2011) The ACMS production function with more than *2*-factors is a perfect substitute if and only if the product hypersurface is flat.

In (Chen, 2012(1)) B. Y. Chen obtained a necessary and sufficient condition for a quasi-sum production function to be quasi-liniar and completely classified quasi-sum production functions whose production hypersurfaces have vanishing Gauss-Kronecker curvature.

Theorem 2.9 (Chen, 2012(1)) A twice – differentiable quasi-sum production function with than two-factors is quasi-liniar if and only if its production hypersurface is a flat space.

Theorem 2.10 (Chen, 2012(1)) Let *f* be a twice-differentiabl quasi-sum production function. Then the production hypersurface of *f* has vanishing Gauss-Kronecker curvature if and only if up to translations, *f* is one of the following:

a) $f = ax_1 + \sum_{i=2}^{n} \varphi_i(x_i)$, with a non-zero constant and $\varphi_2, \dots \varphi_n$ are strict monotone functions;
b) $f = F(a_1x_1 + a_2x_2 + \sum_{i=3}^{n} \varphi_i(x_i))$, where a_1, a_2 are non-zero constants and $F, \varphi_3, \dots, \varphi_n$ are strict monotone functions;
c) f is a generalized Cobb-Douglas function given by $f = \vartheta x_1^{\alpha_1} \dots x_n^{\alpha_n}$ for some non-zero constants ϑ, $\alpha_1, \dots, \alpha_n$ satisfying $\sum_{i=1}^{n} \alpha_i = 1$;
d) $f = \left(\sum_{i=1}^{n} a_i x_i^{\frac{\varepsilon-1}{\varepsilon-2}}\right)^{\frac{\varepsilon-2}{\varepsilon-1}}$, where a_i, ε are constants with $a_i \neq 0$ and with $\varepsilon \neq 1,2$;
e) $f = a \cdot ln(\sum_{i=1}^{n} b_i e^{r_i x_i})$ for some non-zero constants a, b_i, r.

For quasi-sum production function with *2*-factors the following corollary was given:

Corollary 2.11 (Chen, 2012(1)) Let *f(x, y)* be a twice-differentiable quasi-sum production function. Then the production surface is a flat surface if and only if, up to translations, f is one of the following:

a) a quasi-liniar production function;
b) *f* is a Cobb-Douglas function, i.e. $f = ax^r y^{1-r}$ for some non-zero constant *a, r* with $r \neq 1$;
c) f is an ACMS function given by $f = \left(ax^{\frac{\varepsilon-1}{\varepsilon-2}} + by^{\frac{\varepsilon-1}{\varepsilon-2}}\right)^{\frac{\varepsilon-2}{\varepsilon-1}}$, with $\varepsilon \neq 1,2$;
d) $f = a\ ln(be^{rx} + ce^{sy})$, for some non-zero constants *a, b, c, r, s*.

In (Mihai and Sandu, 2012) the following characterization of *h*-homogenous production functions, by considering the minimality of the corresponding production hypersurface, was obtained.

Theorem 2.12 (Mihai and Sandu, 2012) A *h*-homogenous production function which is a perfect substitute has minimal corresponding production hypersurface.

The converse of this result is partially true.

Theorem 2.13 (Mihai and Sandu, 2012) A *h*-homogeneous production function whose corresponding production hypersurface is minimal is not always a perfect substitute.

Also, in (Mihai and Sandu, 2012) the minimality of the corresponding production surface of a *2*-factor twice differentiable quasi-sum production function was studied. The authors obtained the following:

Theorem 2.14 (Mihai and Sandu, 2012) Let $f(x_1, x_2) = (x_1, x_2, F(h_1(x_1) + h_2(x_2)))$ be a twice-differentiable quasi-sum production function. Then:
a) If *F*, h_1 and h_2 are all linear functions, the corresponding production surface is minimal.
b) If h_1 and h_2 are linear functions, then the minimality of the corresponding production surface implies that *F* is also a linear function and we have again case a).
c) If *F* is a linear function, then the minimality of the corresponding production surface implies that h_1 and h_2 are non-linear

functions (i.e. f is a quasi-linear quasi-sum productions function).

3. NULL GAUSS CURVATURE OF KNOWN PRODUCTION FUNCTIONS

Let us first consider the two-factor Cobb-Douglas production function

(3.1) $f(x_1, x_2) = \beta {x_1}^{\alpha_1} {x_2}^{1-\alpha_1}$,

where β is a positive constant and α_1 is a non-zero constant.

Denoting by $a(x_1) = \beta {x_1}^{\alpha_1}$ and by $b(x_2) = {x_2}^{1-\alpha_1}$, we have:

$$\dot{a}(x_1) = \beta\alpha_1 {x_1}^{\alpha_1 - 1},$$
$$\ddot{a}(x_1) = \beta\alpha_1(\alpha_1 - 1){x_1}^{\alpha_1 - 2}.$$

$$\dot{b}(x_2) = (1-\alpha_1){x_2}^{-\alpha_1},$$
$$\ddot{b}(x_2) = (1-\alpha_1)(-\alpha_1){x_2}^{-\alpha_1 - 1}.$$

Recall

$$f_1 = \frac{\partial f}{\partial x_1},$$

$$f_2 = \frac{\partial f}{\partial x_2},$$

$$f_{11} = \frac{\partial^2 f}{\partial {x_1}^2},$$
$$f_{22} = \frac{\partial^2 f}{\partial {x_2}^2},$$
$$f_{12} = \frac{\partial^2 f}{\partial x_1 \partial x_2}.$$

Then it follows that

$$f_{11}f_{22} - {f_{12}}^2 =$$
$$= \beta\alpha_1(\alpha_1 - 1){x_1}^{\alpha_1 - 2}{x_2}^{1-\alpha_1} \cdot$$
$$\cdot \beta {x_1}^{\alpha_1}(1-\alpha_1)(-\alpha_1){x_2}^{-\alpha_1 - 1} -$$
$$-(\beta\alpha_1 {x_1}^{\alpha_1 - 1})^2[(1-\alpha_1){x_2}^{-\alpha_1}]^2 =$$
$$= \beta^2\alpha_1^2(\alpha_1 - 1)^2 {x_1}^{2(\alpha_1 - 1)}{x_2}^{-2\alpha_1} -$$
$$-\beta^2\alpha_1^2(\alpha_1 - 1)^2 {x_1}^{2(\alpha_1 - 1)}{x_2}^{-2\alpha_1} = 0.$$

So, *k=0*, according to the formula (1.14), where k is the Gauss curvature.

Now, we consider the two-factor ACMS production function given by

(3.2) $f(x_1, x_2) = (a_1x_1 + a_2x_2)^h$.

The partial derivatives of (3.2) with respect to x_1, x_2 are the following:

$$f_1 = h(a_1x_1 + a_2x_2)^{h-1}a_1,$$
$$f_2 = h(a_1x_1 + a_2x_2)^{h-1}a_2,$$
$$f_{11} = h(h-1){a_1}^2(a_1x_1 + a_2x_2)^{h-2},$$
$$f_{22} = h(h-1){a_2}^2(a_1x_1 + a_2x_2)^{h-2},$$
$$f_{12} = h(h-1)a_1a_2(a_1x_1 + a_2x_2)^{h-2}.$$

Then we get

$$f_{11}f_{22} - {f_{12}}^2 =$$
$$= h^2(h-1)^2{a_1}^2{a_2}^2(a_1x_1 + a_2x_2)^{2(h-2)} -$$
$$-h^2(h-1)^2{a_1}^2{a_2}^2(a_1x_1 + a_2x_2)^{2(h-2)}$$
$$= 0.$$

Then the Gauss curvature k is zero, according to (1.14).

The calculations from this section agree with the theoretical results of Chen (Chen, 2011).

4. PRODUCTION FUNCTIONS WITH CONSTANT GAUSS CURVATURE

In this section we investigate two-factor production functions which have constant Gauss curvature *k*.

It follows from (1.14) that

$$\frac{f_{11}f_{22} - f_{12}^2}{(1 + f_1^2 + f_2^2)^2} = k,$$

using the same notations as in the previous sections for the partial derivatives of first and second order.

Then we obtain

(4.1) $f_{11}f_{22} - f_{12}^2 = k(1 + f_1^2 + f_2^2)^2$.

By having in mind the examples from the Section 3, it is natural to consider the case when the production function has separable variables, i.e, f is of the form:

$$f(x_1, x_2) = a(x_1)b(x_2)\ .$$

Then

$$f_1 = \dot{a}(x_1)b(x_2),$$
$$f_2 = a(x_1)\dot{b}(x_2),$$
$$\Rightarrow$$
$$f_{11} = \ddot{a}(x_1)b(x_2),$$
$$f_{12} = \dot{a}(x_1)\dot{b}(x_2),$$

$$f_{22} = a(x_1)\ddot{b}(x_2).$$

Thus, (4.1) can be rewritten as

(4.2)

$$\ddot{a}(x_1)b(x_2)a(x_1)\ddot{b}(x_2) - \dot{a}^2(x_1)\dot{b}^2(x_2) = \\ = k[1 + \dot{a}^2(x_1)b^2(x_2) + a^2(x_1)\dot{b}^2(x_2)]^2.$$

Case (i): $a(x_1) = constant$ or $b(x_2) = constant$.

For example, $a(x_1) = q = constant\ (\neq 0)$. From (4.2) we get

$$0 = k[1 + q^2\dot{b}^2(x_2)]^2.$$

Therefore we obtain $k = 0 \rightarrow$ case studied by Chen (flat surface) or $\dot{b}^2(x_2) = -\frac{1}{q^2}$ impossible!

Case (ii): $a(x_1) \neq constant$ and $b(x_2) \neq constant$.

Suppose that *a* and *b* are linear functions:

- $a(x_1) = a_1x_1 + a_2,\ a_1 = \dot{a}(x_1) \neq 0$ (because $a(x_1) \neq constant$);
- $b(x_2) = b_1x_2 + b_2,\ b_1 = \dot{b}(x_2) \neq 0$ (because $b(x_2) \neq constant$).

In this case, $\ddot{a}(x_1) = \ddot{b}(x_2) = 0$ and from (4.2) we obtain:

$$-a_1^2b_1^2 = k[1 + a_1^2(b_1x_2 + b_2)^2 + \\ +(a_1x_1 + a_2)^2b_1^2]^2.$$

$$\Rightarrow$$

$k < 0$ and

$$\sqrt{-\frac{1}{k}} = \frac{1}{a_1^2b_1^2} + \\ \frac{(b_1x_2 + b_2)^2}{b_1^2} + \frac{(a_1x_1 + a_2)^2}{a_1^2}.$$

The last relation is equivalent with

$$\underbrace{\frac{(a_1x_1 + a_2)^2}{a_1^2} + \frac{1}{a_1^2b_1^2} - \sqrt{-\frac{1}{k}}}_{function\ of\ x_1} = \\ = \underbrace{-\frac{(b_1x_2 + b_2)^2}{b_1^2}}_{function\ of\ x_2}$$

which implies that $a_1 = 0$ & $b_1 = 0$, in contradiction with $a_1 \neq 0$ and $b_1 \neq 0$.

Then $a(x_1)$ and $b(x_2)$ cannot be linear functions.

Case (iii): Now, suppose that *a* is a linear function of x_1 and we don't know anything about *b*:

$$a(x_1) = a_1x_1 + a_2.$$

From (4.2) we get

$$-a_1^2\dot{b}^2(x_2) = k[1 + a_1^2b^2(x_2) + \\ +(a_1x_1 + a_2)^2\dot{b}^2(x_2)]^2.$$

$$\Rightarrow$$

$k < 0$ and

$$1 + a_1^2b^2(x_2) + (a_1x_1 + a_2)^2\dot{b}^2(x_2) = \\ = \sqrt{-\frac{a_1^2\dot{b}^2(x_2)}{k}}.$$

Because we are in the case $b(x_2) \neq constant$, i. e. $\dot{b}(x_2) \neq 0$, we can divide the previous relation by $\dot{b}(x_2)$:

$$\underbrace{(a_1x_1 + a_2)^2}_{function\ of\ x_1} = \\ = \underbrace{\frac{1}{\dot{b}^2(x_2)}\sqrt{-\frac{a_1^2\dot{b}^2(x_2)}{k} - 1 - a_1^2b^2(x_2)}}_{function\ of\ x_2}.$$

$$\Rightarrow$$

$a_1 = 0$

$$\Rightarrow$$

$a(x_1) =$ constant, case already studied.

It follows that the case of constant Gauss curvature reduces to the case of null Gauss curvature.

5. THE MEAN CURVATURE OF KNOWN *2*-FACTORS PRODUCTION FUNCTIONS

i) By using symbolic computation in MathCad version 14, we have obtained the following expression for the mean curvature vector of the two-factor Cobb-Douglas production function

$$f(x,y) := a\,x^{b}\,y^{1-b},$$

with *a* a positive constant and *b* a non-zero constant.

$$\frac{d}{dx} f(x,y) \to a\cdot b\cdot x^{b-1}\cdot y^{1-b}$$

$$f1(x,y) := \frac{a\cdot b\cdot x^{b-1}}{y^{b}}$$

$$\frac{d}{dy} f(x,y) \to -\frac{a\cdot x^{b}\cdot(b-1)}{y^{b}}$$

$$f2(x,y) := -\frac{a\cdot b\cdot x^{b}}{y^{b+1}}$$

Remember

$$w := \sqrt{1 + f1(x,y)^2 + f2(x,y)^2}.$$

Then, in our case:

$$w \to \sqrt{\frac{a^2\cdot b^2\cdot x^{2\cdot b}}{y^{2\cdot b+2}} + \frac{a^2\cdot b^2\cdot x^{2\cdot b-2}}{y^{2\cdot b}} + 1}$$

$$g1(x,y) := \frac{f1(x,y)}{w}$$

$$g1(x,y) \to \frac{a\cdot b\cdot x^{b-1}}{y^{b}\cdot\sqrt{\frac{a^2\cdot b^2\cdot x^{2\cdot b}}{y^{2\cdot b+2}} + \frac{a^2\cdot b^2\cdot x^{2\cdot b-2}}{y^{2\cdot b}} + 1}}$$

$$g2(x,y) := \frac{f2(x,y)}{w}$$

$$g2(x,y) \to -\frac{a\cdot b\cdot x^{b}}{y^{b+1}\cdot\sqrt{\frac{a^2\cdot b^2\cdot x^{2\cdot b}}{y^{2\cdot b+2}} + \frac{a^2\cdot b^2\cdot x^{2\cdot b-2}}{y^{2\cdot b}} + 1}}$$

Denoting by *h1(x,y)* and *h2(x,y)* the partial derivatives of *g1* with respect to *x*, respectively *g2* with respect to *y*, from the relation (1.13) we have that *H(x,y)* is the mean average of *h1(x,y)* and *h2(x,y)*.
The final value of *H(x,y)* is:

$$H(x,y)\ \text{simplify} \to \frac{a\cdot b\cdot x^{b-2}\cdot\left(b\cdot x^2 + b\cdot y^2 + x^2 - y^2\right)}{2\cdot y^{b+2}\cdot\left(\frac{a^2\cdot b^2\cdot x^{2\cdot b}}{y^{2\cdot b+2}} + \frac{a^2\cdot b^2\cdot x^{2\cdot b-2}}{y^{2\cdot b}} + 1\right)^{\frac{3}{2}}}$$

It follows that *H* cannot be zero, because it is obviously that the denominator cannot be zero (*b* cannot be in the same time *1* and *-1*).

ii) By using symbolic computation in MathCad version 14, we have obtained the following expression for the mean curvature vector of the two-factor ACMS production function

$$f(x,y) := (a\cdot x + b\cdot y)^{h},$$

where *a*, *b* and *h* are non-zero constants.

We write below the final result, the denominator of the mean curvature *H(x,y)* is:

$$(a\cdot x + b\cdot y)^{h}\cdot h\cdot\left(a^2 + b^2\right)\cdot(h-1).$$

It follows that *H=0* if and only if *h=1*.

If *b=1-a*, i.e when we consider the original ACMS production function (see Arrow K. J., Chenery H. B., Minhas B. S., Solow R. M., 1961), the denominator of the mean curvature *H(x,y)* is:

$$h\cdot(h-1)\cdot\left(2\cdot a^2 - 2\cdot a + 1\right)\cdot(y + a\cdot x - a\cdot y)^{h-2}$$

For this example, *H=0* if and only if *h=1*.

Then, we have proved by straightforward calculations that the production surfaces corresponding to usual *2*-factors production functions are not minimal.

This fact means that we cannot get similar results from the view-point of minimality as those obtained by Chen about Gauss curvature (flatness) (for example Corrolary 2.5 from Section 2).

AKNOWLEDGEMENTS

The first author's work was supported by the strategic grant POSDRU/89/1.5/S/58852, Project *Postdoctoral programme for training scientific researchers*, cofinanced by the European Social Found within the Sectorial Operational Program Human Resources Development 2007 – 2013.

REFERENCES

Aczel J., G. Maksa G., 1996, Solution of the rectangular m x n generalized bisymmetry equation and of the problem of consistent aggregation, J. Math. Anal. Appl. 203, 104 – 126.

Arrow K. J., Chenery H. B., Minhas B. S., Solow R. M., 1961, Capital Labour substitution and economic efficiency, Rev. Econom. Stat. 43(3), 225 – 250.

Chen B. Y., 1973, Geometry of Submanifolds, M. Dekker, New York.

Chen B. Y., 2011, On some geometric properties of h-homogeneous production functions in microeconomics, Kragujevac J. Math. 35(3), 343 – 357.

Chen B. Y., 2012(1), A note on homogeneous production models, Kragujevac J. Math. 36(1), 41-43.

Chen B. Y., 2012(2), On some geometric properties of quasi-sum production models, J. Math. Anal. Appl. 392(2), 92–199.

Chen B. Y., 2012(3), Classification of h-homogeneous production functions with constant elasticity of substitution, Tamkang J. Math. 43(2), 321–328.

Cobb C. W., Douglas P. H., 1928, A theory of production, Amer. Econ. Rev. 18, 139 – 165.

Douglas P. H., 1976, The Cobb-Douglas production function once again: its history, its testing and some new empirical values, Journal of Political Economy 84(5), 903 – 916.

Filipe J., Adams G., 2005, The estimation of the Cobb Douglas function, Eastern Econom. J. 31(3), 427 – 445.

Glen G. E., 2011, A geometric perspective on the generalized Cobb-Douglas production functions, Appl. Math. Letters 24, 777 – 783.

Mihai A., 2006, Modern Topics in Submanifold Theory, Editura Universităţii din Bucuresti.

Mihai A., Sandu M., 2012, The use of the h-homogeneous production functions in microeconomics. Modelling challenges, Revista Economica Suppl. 1, 465-472.

Mishra S. K., 2010, A brief history of production functions, The IUP Journal of Managerial Economics 8(4), 6 – 34.

Vîlcu A. D., Vîlcu G. E., 2011, On some geometric properties of the generalized CES production functions, Appl. Math. Comp. 218, 124 – 129.

A SURVEY AT THE POPULATION OF URZICENI, IALOMITA TO DETERMINE THE PROBLEMS FACING THE CITY IN TERMS OF SUSTAINABLE DEVELOPMENT

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Abstract

Creating a population survey in the city of Urziceni, Ialomita County, to determine the problems facing the locality, the perspective of sustainable development was seen as a tool for testing the perception of people towards the development of the city of Urziceni and future orientation its development.
The main objectives of the survey were: measuring people's satisfaction regarding public services,measuring level of living standard, optimism for the future and identifying the most important problems of the studied area in the opinion of its citizens.
Finally, it was established the development needsaccording to the citizen's needs.

Keywords*: citizens, problems, survey, sustainable development, Urziceni*

INTRODUCTION

The concept of sustainable development stands for all forms and methods of socio-economic development, which foundation is firstly represented by a balance between the socio-economic systems of the natural elements (Manoliu and Ionescu, 1998).
The sustainable development means and tries to find a stable theoretical framework for decisions in any situation where such a report as man / environment is to be found, be it environmental, economical or a social one.
Increased attention to environmental is the basis of the sustainable development of Urziceni (Platon, 1997).
Developing such strategies on the environment is a complex process involving various technical analysis, coordination and cooperation between the participants in this action, such as economic, industrial employers' associations, local civic organizations, local officials and the public
Creating a population survey in Urziceni city, Ialomita County to determine the problems facing the locality perspective of sustainable development was seen as a tool for testing the perception of people towards the development of Urziceni and its future development orientation.
Among the most important objectives are the following:

-measuring people's satisfaction regarding the standard of living and optimism for the future of the area
-measuring people's satisfaction with public services and opportunities in the area
-identifying the most important problems of the area in terms of its members.

MATERIALS AND METHODS

The sample used to interview was a probabilistic one for the adult population of the municipality (Newport, 2007).
The selection of subjects was made using lists dating from 2008.
The interview was face to face at subjects' home.
The sample structure consisted of persons selected according to the following criteria:

- Age of persons
- Sex of persons
- Working place.

The sample structure consisted of 53.14% males and 46.86% females.
The age structure of the sample was 43.43% of people in the age group up to 44 years old and 56.57% of people in the age group of over 45 years old.

RESULTS AND DISCUSSIONS

In terms of opinion about the living standard of the inhabitants of the locality, 83.42% are dissatisfied with the standard of living in town, a percentage of 16.57 of the respondents are satisfied with the standard of living in the city.
It is noteworthy that most of the inhabitants, about 83.42%, are not satisfied with the level of living. Some of these, 1.71%, are not satisfied with the standard of living, and the majority of 81.71% is not so happy with the standard of living.

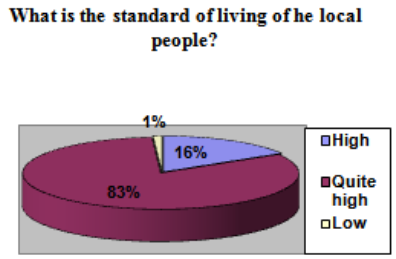

Figure 1. The standard of living of the local people

Although, overall, people are dissatisfied with the standard of living of the city, more than half, about 53.71%, of the respondents believe that the area is more developed than other areas of the country.
Corroborating the two questions above, although the vast majority is dissatisfied with the standard of living, that at the same timethey believe that the area is more developed than others in the country, lead to the idea that they would not change their residence in order to work in another area.
Be noted that there were people who believed that their city is as developed as others, is 46.29%.

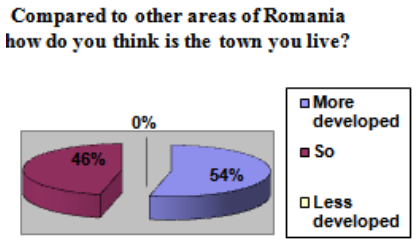

Figure 2.Thecompared between Urziceni and other areas of Romania

Regarding the level of development of the city, it was found that 94.86% of the respondents considered that city would be developed in five years.
No respondent believed that the localitywould be less developed in five years; instead there were people who believed that the town would be as developed in the next 5 years (5.14%) as it is now.

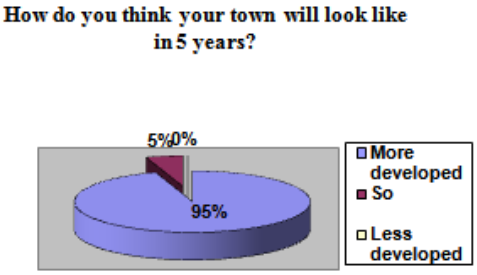

Figure 3. How the town will look like in 5 years

Overall, in terms of living standards, the inhabitants of Urziceni consider that they have a low standard of living and I think in the next five years the situation will be better, considering that poverty is present in all country.
Related to local roads it is found a large percentage, about 56% of the neither satisfied nor dissatisfied with the state of roads in the area, who consider that it could be better, and a percentage of 85.71% of the satisfied state of city sidewalks.

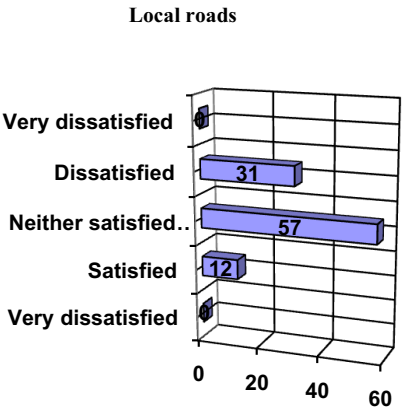

Figure 4.The state of local roads

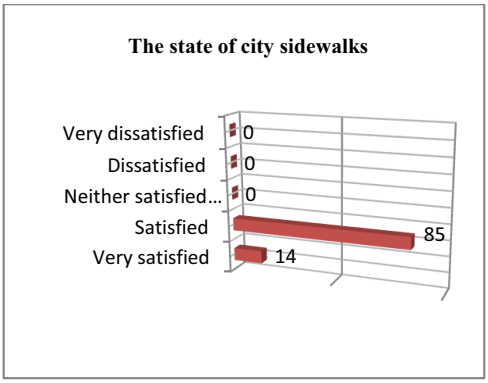

Figure 5. The state of city sidewalks

Regarding health services, all respondents are satisfied or very satisfied with health services in the city, namely 86.29% of people are happy and 13.71 very pleased, especially after the opening of the new Municipal Hospital in 2012.

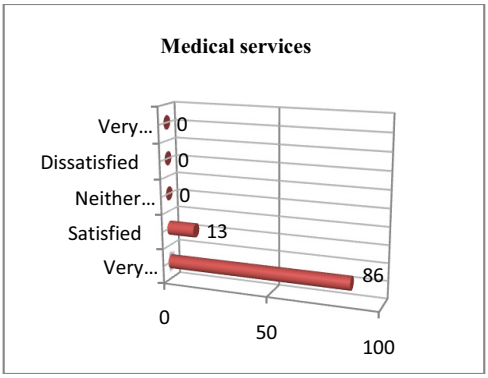

Figure 6.Thecitizens'opinion over the medical service

Regarding the visibility of the work of The City Hall, 82% of respondents mentioned some works done by The City Hall in the recent years.

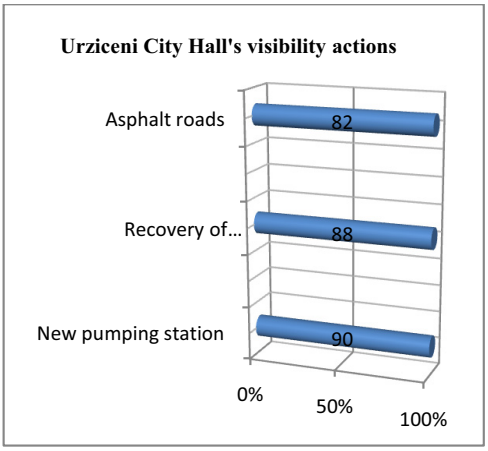

Figure 7.Urziceni City Hall's visibility actions

Thus, 82% mention asphalt roads, 88% recovery of wastewater sewers and 90% construction of a new pumping station for drinking water.

Most of those who mentioned projects undertaken by the Municipality are satisfied with these projects.

Only a minority of respondents, i.e. 4% could not mention any project undertaken by the Municipality.

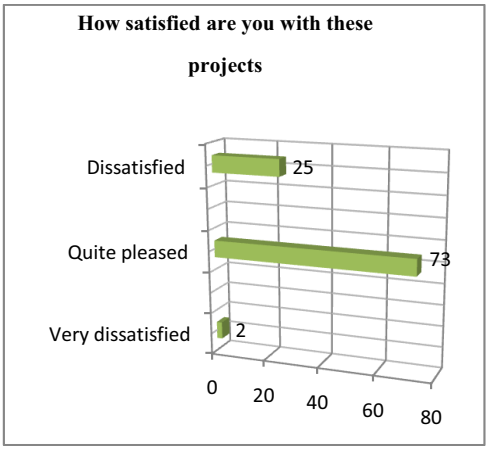

Figure 8. How satisfied are the citizens with these projects

In terms of city inhabitants of Urziceni the most important issues are:

- paving streets in the north part of the city (85%)
- achieving a rainwater sewerage system (75%)
- job creation (87%)
- construction of classrooms for students (70%)
- restoration and reopening of cinema city (60%).

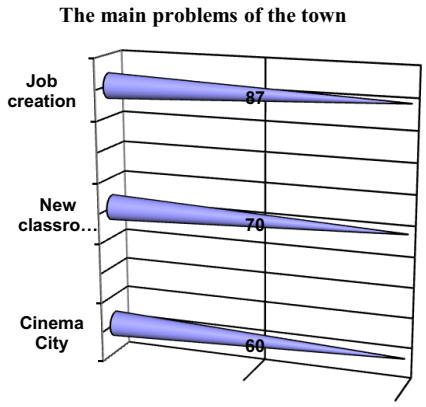

Figure 9.The main problems of the town

Interviewees noted that it is difficult to find a new job in town especially in the current situation.

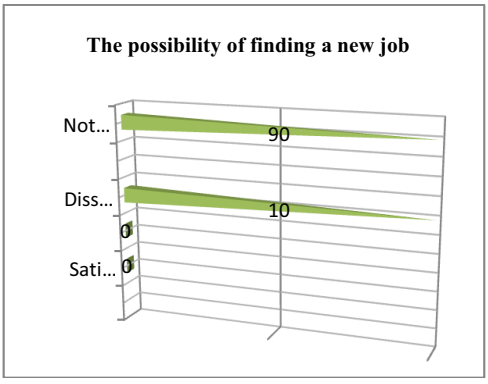

Figure 10. The possibility of finding a new job

CONCLUSIONS

Urziceni City members are dissatisfied with the standard of living of the city, but the majority, means 53.71% of the people, consider their city is more developed than other areas of the country.

Regarding the visibility of the activity of the Municipality, about 82% of the members of the city mention little involvement done by the City Hall in recent years.

In terms of city inhabitants in satisfactions the most important issues are:

- paving the streets of the northern part of the city (85%)
- construction a rainwater sewerage system (75%)
- job creation (87%)
- construction of classrooms for students (70%)
- restoration and reopening of a cinema city (60%).

Even if they had the opportunity, the inhabitants of Urziceni city would not be willing to change their jobs with another.

REFERENCES

ManoliuM., Ionescu C., 1998. Sustainable development and environmental protection, Bucharest, H.G.A. Publishing House, 25-27

Matei C., Buleandra Al., Geacu S., Barbu I, 2006. The Monograph of Urziceni, Slobozia, 20-30.

National Institute of Statistics, Statistical Yearbook 2011

Newport F., 2007. How importants are the polls, ALL Publishing House, 15-20

PlatonV, 1997. Environmental protection and economic development, Didactic and Pedagogic Publishing House, 79-81

Rotariu T., Ilut P., 1997. Sociological investigation and survey, Polirom Publishing House, 40-50