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S U M A R

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HYDROTECHNICS

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THE ECOLOGICAL REHABILITATION OF MOUNTAIN LAKES

BY

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Abstract. The paper analyzes the rehabilitation of natural mountain lakes tourist purposes. The mountain area of Romania has mountain lakes with high tourism potential. The introduction of mountain lakes in organized tourist circuit involves the application of hydro-technical works of rehabilitation. These works must be designed and implemented in accordance with the conditions imposed by the environment. The paper presents a case study for the rehabilitation and construction of a mountain lake in the North of Moldova (Iezer Lake, in Obcina Feredeului). The lake was formed by the slipping of a hillside that has blocked a mountain river. The lake was stocked in time with a series of engineering control to adjust the level and flow. The Iezer Runnel produced floods have affected the safety of the spillway and of the earth dam. The space tourist area planning requires the rehabilitation of hydrothenic constructions in compliance with the conditions imposed by the natural area of the site. The works include the reconstruction of earth dam, part of the tower to maneuver and the spillway of the waters. The Lake is a potential source of trout. Lake rehabilitation will follow the development of its fisheries.

Keywords: mountain lake; dam; fishing; tourism; rehabilitation.

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1. Introduction

In the mountains of Romania there are a number of natural lakes, which gives a particularly nice area and tourist attraction. The natural Lakes of mountains from Romania has known and visited for tourism and fishing.

Some of the lakes has included in the regional units operating record (water basin administrations).A particular situation presents the lakes form by sliding the slopes (*i.e.* Red Lake in the Hăşmaşu Mountains). In the Carpathians in the northern Bucovina subunit, respectively embossed Obcina Feredeului is Lake Iezer. This lake is form by sliding of the slope which crossed the brook Iezer. Nature has made this one of the most beautiful places in the mountains. Iezer Lake has a high potential for tourism and fishing. The lake is subject to human impact particularly because of the easy access to the site. The absence of adequate control of tourism and economical activities contribute to environmental degradation in the lake.

In the last time there is a breakdown of some of the mountain lakes with area location. Ownership changes, lack of maintenance, disorganized exploitation of forests has contributed to the continuing degradation of mountain lakes. The existing legislation in the field of water and forest had been contributing to the degradation of mountain lakes.

Some mountain lakes were extended by building dams and levees to ensure the volume and level required. Lakes were equipped with hydraulic structures to adjust the level (intake tower) and discharge flood flows (spill-weir). The spatial design of the lake has been preserved as much as natural appearance. The materials used were ecological, so the environmental impact is minimized.

2. **Synthetic Elements on the Current State of the Lake**

Iezer Lake is a natural lake formed in a hollow mountain. The lake is located outside of village Sadowa, county Suceava. The Iezer Lake is located on the upper stream of creek (Runnel) Iezer. It is a left tributary of the river Sadowa. Altitude location of the lake is about 930 m. The lake is located at the intersection of 47°36'12" north latitude with the meridian 25°26'52" east longitude.

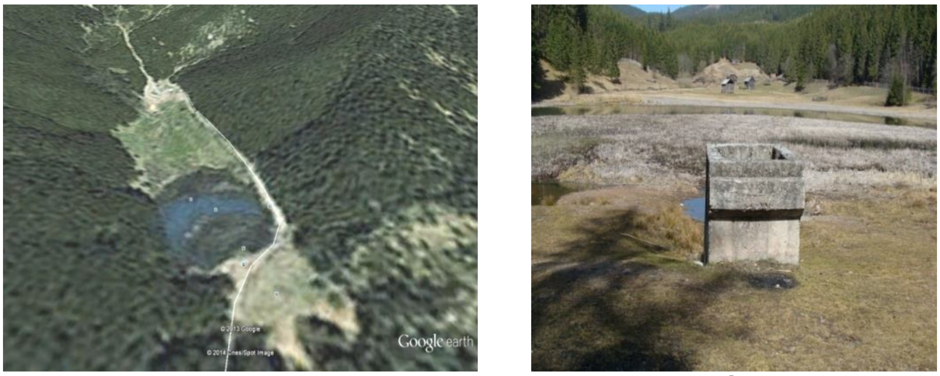
Iezer Lake is located in the Carpathians in the northern Bukovina relief subunit Obcina Feredeului, respectively. Geographically, the lake is located in the south-west of Obcina Feredeului Obcinele Feredeului under type alignment (1,364 m) and Poiana Prislop saddle (1,102 m). Geologically, the area belongs to the site folded sedimentary formations (flysch) of the Carpathians.

Lithology from point of view, the location's area is constituted mostly of Cretaceous-age deposits below. These are known as the "Black Shale fossil Series". In the area it can be found deposits of Cretaceous-upper. Lithological formations of the Lake Iezer have food consistency of Cretaceous age and a complex of pelitic sediments, clay-marl, and sandstone with siliceous, blackish intercalations of glauconitic very hard, over which is a relatively small thickness, clay striped.

From petrography point of view, the study area has a large variety and wide availability of plastic and loose formations, poorly, relative to the cohesive cemented detrital harsh. Facies alternation of soft and hard plastic presents a major role in lowering the field homogeneity. This has an influence on the stability of the slope.

Iezer creek path at 930 m elevation was a slip of the left slope. Slipping slope have been materialized by a threshold which closed down valley. Threshold earth became earth dam that form of Mountain Lake. Of slope sliding occurred upstream of the first issue that defined the final shape of the lake. Iezer Brook changed course and form a new bed right side boundary. Water Storage is basically a pond. Lake captures two streams/creeks short. The age of the lake is probably 4-5 centuries.

Riverbed slope limit Iezer is located right in the lake and in the Sulla Mappa of the lake has a depth less developed. Downstream natural threshold which serves as a dam and amended for this purpose be anthropogenic, the bed has a relatively small width but in-depth development of severe burns processes.



a *b*

Fig. 1 – Overview of Lake Iezer (year 2014): *a* – Google earth image; *b* – view year 2014.

The early 80s were built on the threshold of a land and a small tower spillway outlet. Making hydraulic structures transformed natural mountain lake in the systematic accumulation. Make the changes on the lake must respect the laws of operation of reservoirs. The floods of 2008 destroyed the great waters overflow and accumulation has again become a natural mountain lake.

The data obtained from studies of Lake show that its surface Iezer and volumes changed very much over time. The original surface of the lake was estimated at 4.5 on ... 5.0 ha. Surface gradually decreased due to silting up to 2.0 ha in 1981 arrived in 2009 to 1.63 ha in 2009 volumes of accumulated water was initially estimated at around 31,400 m^3. Initial maximum lake depth was 4.25 and ... 5.0 m.

2014 Lake Iezer handles only a small area in the centre of the site (a water surface of 0.75 [...] 1.0 ha). The situation is caused by damage to the spillway. Iezer stream fed pond just after free flowing downstream through the opening form on the brink of the earth. The lake and the surrounding area is of outstanding beauty. The lake is visited by locals and tourists. How unorganized operation causes degradation and visiting Lake Mountain

3. **Current Status of the Lake and Construction Related**

Mountain Lake Iezer had several owners during its lifetime. Before 1989 it was the property of the Romanian state. After 1989, the lake became the property of local authorities (town hall Ottomans are defeated). Lack of maintenance caused continuous deterioration of hydraulic structures. Disorganized exploitation of forests has led transport wood waste reservoir flood propagation. Flood produced in 2008 created a hole in the ground in the overflow threshold. In 2014 the survey was conducted on the structural and functional state of spatial components "Lake Iezer" [L., M., 2014]. The results show the following:

a) threshold based on the ground with the overflow barrier is broken in a length of 5 ... 10 m; higher volume of the lake was evacuated and Iezer creek flows downstream through the riverbed located next to the right side;

b) a large part of the lake (about 2/3 of the surface) is clogged with silt and wood waste;

a *b*

Fig. 2 – Overview of Lake Iezer (year 2014): *a* – right; *b* – left.

c) overflow of waters is degraded by baring the left abutment where Iezer creek made a new bed;

d) the spillway basin sink was totally degraded by the action of floods and lack of rehabilitation works;

e) tower outlet is clogged and degraded concrete structural frame; outlet tower installations were demolished;

f) drain pipe made of concrete is totally degraded and broken;

g) threshold function earth dam has an uneven canopy with variables. large share (0.50 ... 0.80 m) in length; upstream slope is uneven, eroded and is not protected from wave action;

h) road continues dam on the west side of the lake is uneven canopy and degradation of slope adjacent lake.

a *b*

Fig. 3 – Status dam components: *a* – threshold/dam of earth; *b* – pipe.

Hydraulic structures under endowment accumulation were not designed according to the standards of water management. The cause of structural failure of the building was non flow calculation and the minimum dimensions required by law. This category includes the spillway, energy sink drain pipe.

a *b*

Fig. 4 – Condition silting of the lake: *a* – surface-overview clogged to the dam; *b* – detail on the type of deposit.

Non-application of the rehabilitation of hydraulic structures 35 years old has triggered structural failure phenomena. Incorrect operation of state buildings influenced the lake. This situation was worsened in the past 10 years.

The absence of control of cutting trees on the slope worsened clogging the lake (deposition of waste wood). Structural and functional status of the lake and hydraulic structures requires the implementation of rehabilitation works.

4. Rehabilitation of the Lake and Hydraulic Structures

Using Iezer Lake as a tourist and economic way, it must be make more rehabilitation and development work. Rehabilitation of Lake Iezer must be designed in accordance with the conditions of the site. Works projects must not modify the natural characteristics of the environment. The natural appearance of the site area of the lake should be preserved and protected.

Rehabilitation applies to several objectives in the area of location of the lake. These objectives are: lake, hydraulic structures related to lake, access road, protection zone, buildings and operating facilities.

Rehabilitation of Lake Iezer consist of the following:

a) works by clogging the tank while lake deposited material;

b) correcting papers tank configuration to limit clogging phenomenon.

Rehabilitation of hydraulic structures are necessary to comply with the operating rules of the reservoir. Hydraulic structures rehabilitated are:

a) spillway to evacuate flood;

b) tower outlet to adjust levels in the lake;

c) drain pipe;

d) threshold function earth dam.

Part of the old hydraulic structures will be demolished (tower outlet, overflow and sink elements energy). Demolition materials are the type of concrete and stone. These will be used to make risbermei and the exhaust port.

The rehabilitation works will be carried out considering the actual data design and requirements standards. For Iezer river flows were calculated actual location section of the lake. The values used in the design calculation are shown in Table1. The water level in the lake corresponding flow calculation is shown in Table 2.

Table 1

Calculus Discharges

$Q_{p\%}$, [m^3/s]	$Q_{1\%}$	$Q_{2\%}$	$Q_{5\%}$	$Q_{10\%}$	$Q_{50\%}$
Values, [m^3/s]	26.0	20.5	14.0	9.50	0.045

Overflow of waters was calculated flow rate $Q_{1\%}$ = 26.0 sizing m^3/s and checked the flow $Q_{1\%}$ = 14.0 m^3/s.

Table 2

Levels and Calculus Discharges of the Exploitation Conditions

Q_p, [%]	1%	5%	NL_{exp}	L_{min}
H, [mdM]	930.06	929.63	928.70	928.25

NL_{exp} – normal level of exploitation; L_{min} – minimum level

Resulted in the spillway length of 10.50 m. Spillway new builds by extending the existing dam body. The flow of the overflow section is trapezoidal. The construction is made of reinforced concrete spillway. Access to the overflow channel has a trapezoidal shape and is protected by the concrete tiles.

The sink basin spillway was designed for the conditions of the field site. Construction of energy dissipation within the existing space and does not affect the environmental aspect. The energy dissipater comprises two buildings made as a fall in steps. Each step is a basin sink. The shape is rectangular with a width of 12.0 m. First basin sink has a height of 1.60 m, and the second 1.50,0 m. Energy dissipation is achieved with threshold water and a row of sinks teeth. Basin sink is made of reinforced concrete. After basin it continues with the hydraulic energy dissipation of protection stone below dam.

The intake tower was designed according to these works. Intake tower is a reinforced concrete building with a height of 6.50 m and a rectangular shape. The construction consists of two vertical rooms to adjust the level of the lake. Water enters the lake outlet tower and is discharged through the bottom drain. Access to the tower is made from the dam outlet with a walkway. The bridge is made of wood and metal to blend into the natural environment of the lake. Emptying the bottom square section was designed as 0.80 × 0.80 m galleries inside and outside 1.30 × 1.30 m Gallery is 17.0 m long drain and drain basin sink 2. The gallery is made of reinforced concrete.

Threshold produced by sliding down the left slope of the dam has function. Threshold was modeled by human actions and natural action. The rehabilitation of the break-down was cant of 0.5 [...] 1.00 m. The tower outlet fillings were made to turn down the slopes down to the threshold of a dam. Half the length threshold of land and North-East side of the lake there is a way. It was raised to achieve water depth in the lake, the dam area needed for the development of flora and fauna.

Upstream slope of the dam was protected by a concrete revetment in the form of tiles. Slope of the road, which is based on the dam was protected with stone pitching grouting. Stone pear preserves the natural appearance of the area. The collected works of clogging the lake has designed to create the required volumes for the movement, storage and water oxygenation. This work is done at the top of the pond and the area adjacent to the dam and road. Current water depth of 0.20 [...] 0.30 m must reach 1.00 [...] 1.50 m.

Role of perimeter dike road is rehabilitated through the rehabilitation of slope and canopy. Grassing the slope of the road in order to ensure stability to water. Channel slope road to recover contacts to collect rainwater. The channel waters discharged into the lake through a culvert pipes with diameter of 1.00 m. Subramanian construction using concrete Recovers and crushed stone.

The entrances of the river into the lake Iezer recover the works clogging. The exhaust stream after the lake was formed Iezer protection below stone dam and a canal connecting the bed. Channel does as a speaker to move from section to section risbermei bed. The channel is made of stone and concrete debris from old works.

All materials used in the rehabilitation works are ecological (stone, concrete, wood). Rehabilitation does not affect the natural environment during construction and the presence of site organization.

Iezer lake and the surrounding area must enter in the tourist circuit. Iezer lake has a high fishing potential. In the lake have made utilities to facilitate tourism and local economic activities.

5. Conclusions

Mountain Lakes is a gift of nature to people, so they must be conducted best living conditions and protection of the area of the site.

Iezer Lake is a mountain lake by slipping a release form that the current state has a state of degradation marked deterioration manifested by silting basin and hydraulic structures.

Mountain lake rehabilitation components should be performed based on works properly designed, with consideration of the parameters and river flow conditions imposed by Iezer and location.

Work planned to be undertaken includes the waters of the spillway outlet tower and a drain pipe with structural parameters under legislation.

Lake Iezer must be introduced in the tourism and economy by making suitable access roads and construction of utility specific to tourism.

Articles over 12 pages will be only by way of exception accepted, if the Editorial Staff considers them to be notably interesting and that reducing the number of pages would obstruct significant authors to fulfill their message.

REFERENCES

Băloiu V., *Wathershed Project and Watercourses*. Publ. Ceres, Bucharest, 1980.

Gâştescu P., *Lakes of R.P.R.* Publ. Romanian Academy R.P, Bucharest, 1963.

Hobjilă V., Luca M., *Complements on the Design and Expertise of Some Types of Hydrotehnical Construction.* Publ. CERMI, Iaşi, 2000.

Luca M., Tamaşanu F., *Restoration and Wathershed of Iezer Lake, Commune Sadova. Tehnical Project.* SC Polias-Instal, Iaşi, 2014.

Mîndrescu M., Iosep I., Cristea I.A., Forgaci D., Popescu D.A., *Lakes Iezer and Bolătău (Obcina Feredeului) –the Oldest Naturally Dam Reservoirs Formed by Sliding from Romania.* Univ. „Ştefan cel Mare", Suceava.

Rădoane M., Rădoane N., *Dams, Sediment Sources and Reservoir Silting in Romania.* Geomorphology, **71**, 112-125 (2005).

Ujvari I., *Geography of Romania's of Waters*. Publ. Scientific, Bucharest, 1972.

* * * *Regulation on Follow the Behavior, Operation and the Intervention Post-Use of Construction.* HGR 766/1997, Monitorul Official, Anul **IX**, nr. 352.

REABILITAREA ECOLOGICĂ A LACURILOR MONTANE

(Rezumat)

Se analizează reabilitarea lacurilor naturale montane în scopul turistic. Zona montană a României are o serie de lacuri cu potențial turistic ridicat. Introducerea lacurilor montane în circuitul turistic organizat implică aplicarea unor lucrări hidrotehnice de reabilitare. Aceste lucrări trebuie proiectate şi aplicate în concordanţă cu condiţiile impuse de mediul înconjurător. Lucrarea prezintă un studiu de caz pentru reabilitarea şi amenajarea unui lac montan din nordul Moldovei (Lacul Iezer, Obcina Feredeului). Lacul a fost format prin alunecarea unui versant care a blocat un râu montan. Lacul a fost dotat în timp cu o serie de construcţii hidrotehnice pentru reglarea nivelului şi debitului. Viiturile produse pe râul Iezer au afectat siguranţa deversorului şi a barajului de pământ. Amenajarea zonei ca spaţiu turistic necesită reabilitarea construcţiilor hidrotehnice cu respectarea condiţiilor impuse de zona naturală de amplasament. Lucrările prevăd reconstrucţia pragului de pământ cu rol de baraj, a turnului de manevră şi a evacuatorului de ape mari. Lacul este o sursă potenţială salmonicolă. Reabilitarea lacului va urmări şi amenajarea piscicolă a acestuia.

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INTEGRATED CONTROL OF NUTRIENT POLLUTION IN ACCUMULATION LAKES

BY

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Abstract. Nitrates and phosphates are found in the environment and their presence is normal. Loading beyond imposed limits determines nutrient pollution. Naturally nitrates (NO_3) and phosphates (PO_4) from water come from aquatic animal manure, soil forming lacustrine basin or aquifer specific decomposition of organic matter. Their surplus comes from human activities, from human waste and various industrial and agricultural sources.

Purpose: assessment of the environmental potential of heavily modified water bodies – accumulation lakes, by applying the "worst case" scenario.

Material and method: there were analyzed and monitored nutrient emissions from Prut – Bârlad basin. This is due both to point sources, including: urban wastewater, industrial and agricultural untreated, or to insufficiently treated and diffuse sources, such as livestock and fertilizer use.

Results: Of the 21 lakes monitored, there were recorded eight with good ecological potential, 11 with moderate ecological potential and two without compliance. The largest amount of nutrients (more than half) is due to agricultural activities. Nutrient pollution causes a number of risks: health, nature and biodiversity, agriculture and industrial activities.

Conclusions: nutrient pollution imposes the need to continue activities to promote awareness of the danger to the population as well as the simulation and

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evaluation of improvement measures when talking about water quality in line with European standards.

Keywords: nutrient pollution; water quality monitoring; ecological potential.

1. Introduction

Nitrogen and its compounds are indicators of pollution. Therefore, clean waters show a relatively high content of organic nitrogen and low levels of ammonia. However, in the case of polluted water this ratio is reversed (Varduca, 2000).

Nutrients are compounds of nitrogen and phosphorus (nitrates, nitrites, ammonium, organic nitrogen derived from harvest residues and other organic compounds and phosphates) found in the environment and whose presence is normal. Loading beyond accepted limits determines nutrient pollution.

Nitrates are stable forms of nitrogenous organic matter that can stimulate algal growth and thereby lead to water oxygenation. Their excessive presence stimulates eutrophication. Naturally, nitrates (NO_3) and phosphates (PO_4) from water come from aquatic animal manure, soil forming lacustrine basin or aquifer specific decomposition of organic matter. Their surplus comes from human activities, from human waste and various industrial and agricultural sources.

An essential role in the functioning of ecological systems is nitrogen. Biogeochemical nitrogen journey is determined largely by the organism’s activity, being of biological nature. The forms in which nitrogen is found differs depending on environmental conditions: gaseous, dissolved, or "solid" in organic matter.

In water, nitrogen cycle consists of a balance between nitrogen inputs and losses. Under normal oxygenation conditions, nitrogen is found mainly in the form of nitrates. This form, being in a dissolved state has a huge potential mobility and is directly assimilated by aquatic vegetation.

Another nutrient with an essential role in ecosystem functioning is phosphorus. In surface waters, phosphorus is found in the form of organic phosphorus, dissolved, and phosphorus fixed on alluvial particles.

Phosphorus presence in water is related to rainwater washing of fertilized fields with phosphate fertilizers and polluted with domestic wastewater from livestock units. Moreover, phosphorus presence is determined by the biochemical degradation of plant and animals, being one of the basic constituents of plant and animal organisms.

In practice is used the Redfield ratio to estimate the ratio between N and P (16:1), which is generally equivalent to water values of nitrate and phosphate. The derangement of nutrient quantities changes the ratio and thereby determines the biological alteration of ecosystem (planktonic biomass, species composition, and food web dynamics).

2. Theoretical Considerations

Water quality monitoring system tracks the following: classification of water quality indicators, the maximum allowable concentrations and standardized methods for their determination (Varduca, 1999).

Table 1
Types of Nitrogen and Phosphorus Analysis in Terms of Water Quality Monitoring

Indicators	Values admitted, according to Order 161/2006, corresponding to the five quality classes				
Ammonium	0.2 mg N/l	0.2 mg N/l	0.2 mg N/l	0.2 mg N/l	0.2 mg N/l
Nitrites	0.01 mg N/l	0.01 mg N/l	0.01 mg N/l	0.01 mg N/l	0.01 mg N/l
Nitrates	1 mg N/l	1 mg N/l	1 mg N/l	1 mg N/l	1 mg N/l
Total nitrogen	1.5 mg N/l	1.5 mg N/l	1.5 mg N/l	1.5 mg N/l	1.5 mg N/l
Orthophosphate	0.05 mg P/l	0.05 mg P/l	0.05 mg P/l	0.05 mg P/l	0.05 mg P/l
Total phosphorus	0.1 mg P/l	0.1 mg P/l	0.1 mg P/l	0.1 mg P/l	0.1 mg P/l

Nitrates and phosphates are an indicator that contributes to assessing the environmental potential of heavily modified water bodies - accumulation lakes. The ecological potential given by "nutrients" is obtained by applying the "worst case" principle. Also, in vulnerable or susceptible to nitrate pollution areas it is tracked the nitrate concentration, according to HG 964/2000.

3. Case Study

The hydrographic basin Prut-Bârlad consists of middle and lower basin of the river Prut, the Bârlad river basin and left affluents of the Siret river in Botoşani and Galați counties, with a total area of 20,267 km^2.

From the administrative point of view, hydrographic basin Prut - Bârlad occupies almost entirely Botoşani, Iaşi, Vaslui and Galați counties and partially Neamț, Bacău and Vrancea counties.

Prut river basin is located in the north east of the Danube basin, north west Tisza basin, Siret – west and Nistru – north and east. The total area is 27,500 km^2 , being developed on the territory of three countries: Ukraine, Romania and Moldavia.

Bârlad river basin, left affluent of Siret, is bounded in the north and east by the Prut river basin.

An important aspect is that Romania has been identified as a sensitive area to nitrate pollution.

Nitrates vulnerability quality assessment of the accumulation basin Prut – Bârlad was performed according to the Order no.161/2006 – Norms on surface water quality classification for the determination of the ecological potential of water bodies (National management plan, 2010).

Table 2

This Nitrates Vulnerability Quality Assessment of the Accumulation Basin Prut - Bârlad

Catchment	Accumulations	Ecological potential
Prut	5	Maximum
Bârlad	3	Maximum
Siret	1	Maximum

To reduce the potential for nitrate pollution in vulnerable areas are required the following:

a) the use of specific methods of sustainable agriculture and biological systems: fertilization plans that comply with the above conditions and fertilizer use on slopes, ground filled with water, flooded or covered with snow; crop rotation. Perennial legume crops (and annual) are preferred for improving nitrogen balance in the soil, the use of residual organic material derived from livestock (preferably solid composted ones) in combination with mineral fertilizers to provide nutrients for crops and conservation of soil fertility status. Doses of fertilizer to be applied are based on calculations of balance of nutrients in the soil in order to avoid overdose, especially in the case of nitrogen, both to reduce production costs, as well as environmental pollution;

b) disposal of animal wastes must follow certain rules in order to minimize pollution: its storage outside sensitive areas and away from water sources.

In Prut Bârlad basin, nutrient emissions are due both to point sources, including: urban wastewater, industrial and agricultural untreated or insufficiently treated and to diffuse sources, such as livestock and fertilizer use. In stagnant water bodies including accumulation lakes, nutrients lead to eutrophication. This phenomenon affects species composition, species biodiversity but affects water resources quality (Water quality bulletin , 2014).

In Prut Bârlad basin are identified the following point sources of pollution:

Human agglomerations, which have more than 2,000 population with wastewater collection systems with or without treatment plants and discharging water resources; agglomerations <2,000 are considered significant point sources if they have centralized sewerage system; human agglomerations with sewer system which does not have the ability to collect and purify the mixture of wastewater and storm water during periods of intense rainfall.

Table 3

Nutrient Discharges to Water Resources of the River Agglomerations in Prut-Bârlad Space

Categories of clusters / pollutants discharged	Total nitrogen (Nt) t/year	Total phosphorus (Nt) t/year
> 100,000	1,412.23	378,112
10,000–100,000	185,404	69,727
2,000–1.000	35,551	4,534
<2,000	–	–
Total	1,633.185	452.373

Industry by:

a) installations covered by the Directive on Integrated Pollution Prevention and Control - 96/61 / EC;

b) units discharging hazardous substances and / or priority substances beyond legislation;

c) other units discharging water resources and which do not respect legislation on water environmental factor.

Agriculture, through:

a) livestock farms that fall under the Directive on integrated pollution prevention and control - 96/61/EC;

b) farms discharging hazardous substances and/or priority substances beyond legislation;

c) other agricultural units with exhaust punctate that don't respect legislation on water environmental factor.

When referring to industry and agriculture, nutrient discharge into waters comes from the food industry, chemical industry, fertilizers, pulp and paper and from livestock farms. Thus in the following table sets nutrient discharges to water resources from industrial and agricultural sources.

Table 4

Nutrient Discharges to Water Resources from Industrial and Agricultural Sources in Hydrographic Basin Prut Bârlad

Industry/pollutants discharged	Total nitrogen (Nt) t/year	Total phosphorus (Nt) t/year
Industry	20,130	7,063
Other point sources	–	4,069

On the other side the main categories of diffuse sources of pollution from Prut – Bârlad hydrographic basin are:

Agglomeration/communities that have no wastewater collection systems or appropriate systems of collection and disposal of sludge from treatment plants and localities that have inappropriate landfills.

Agriculture, through: agribusiness farms which do not have adequate storage/use of manure, localities identified as areas vulnerable to pollution by nitrates from agricultural sources, units that use pesticides and does not comply with legislation, other agricultural units/activities can lead to significant diffuse emissions.

Diffuse pressures due to agricultural activities are difficult to quantify. Diffuse agricultural pressures affecting the quality of surface water, especially groundwater quality.

Industry by: deposits of raw materials, finished products, ancillary products, inappropriate waste storage, units producing diffuse pollution incidents, abandoned industrial sites.

At the Prut–Bârlad river basin was applied the MONERIS model (Modelling Nutrient Emissions in River Systems) to estimate emissions coming from sources of pollution, even if they are punctiform or diffuse.

If diffuse sources of pollution, water pollution load estimation is more difficult than for point sources taking into consideration the different ways of producing pollution. In addition to the punctiform release, MONERIS model considers several ways of producing diffuse pollution: atmospheric depositions, surface runoff, leaking drainage networks, soil erosion, groundwater flow and leakage from waterproof urban areas.

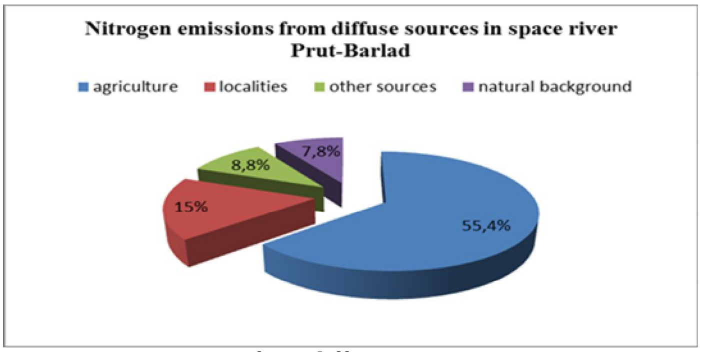

Fig. 1 – Nitrogen emissions from diffuse sources in space-river Prut–Bârlad.

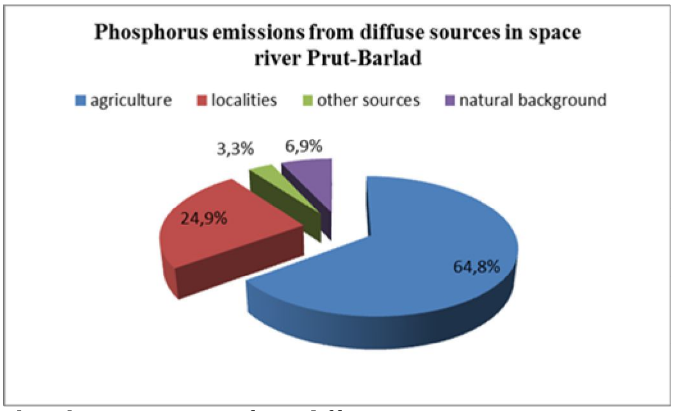

Fig. 2 – Phosphorus emissions from diffuse sources in space-river Prut–Bârlad.

From above we see that more than half of the nitrogen and phosphorus load emitted from diffuse sources are from agricultural activities.

4. Monitoring and Characterization of Water Status in Accumulation Lakes

Surveillance monitoring is to assess the status of all waters within the river basin and to provide information to: validate the impact assessment procedure, effective design of future monitoring programs, evaluating the long-term trend of variation from water resources, including due to the impact of anthropogenic activities.

Establishes operational monitoring of water bodies in the catchment that may not meet environmental objectives and the status of water bodies possible risk and assess any changes in the status of these water bodies. Operational program stops when water bodies reach at a good condition.

Table 5
Frequency of Monitoring in Reservoirs

Elements of quality	Frequent	
	Surveillance program	Operational program
Nutrients: nitrates, nitrites, ammonia, total nitrogen, total phosphorus, orthophosphate	4/year	4/year*

* monitoring frequency may become monthly or higher depending on the evolution process of eutrophication

Through application of water bodies delimitation criterion in the catchment area Prut–Bârlad can be identified a total of 46 water bodies - lakes, that represents 66 accumulation lakes. From these only 21 are monitored. The lakes monitoring is done in control sections: middle lake, barrage and water intake. The result is shown in the following table (Water quality bulletin, 2014).

Table 6
Ecological Potential of Accumulation in the Prut Bârlad Basin

H.B.	No. of monitored accumulation lakes	Repartition of accumulation lakes according the environmental potential consider			
		Maximum ecological potential	Good ecological potential	Moderate ecological potential	Without compliance
Prut	13	0	3	9	1
Bârlad	6	0	5	0	1
Siret	2	0	0	2	0
TOTAL	21	0	8	11	2

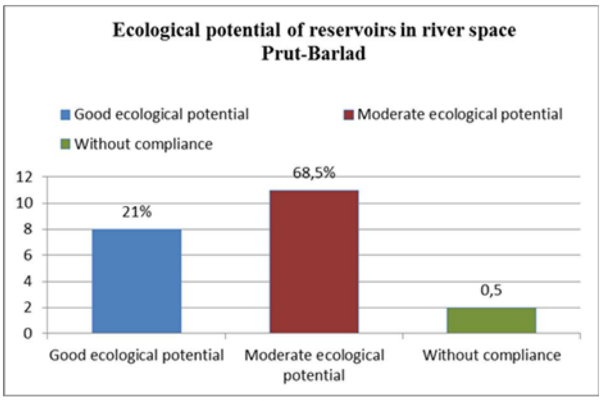

Fig. 3 – Ecological potential of reservoirs in river space Prut–Bârlad.

4. Conclusions

Table 7

Risks and Effects Caused by Nutrient Pollution

Risk type	Effects
Health	Contamination of drinking water Contamination of aquatic and terrestrial fauna
On nature and biodiversity	Eutrophication Sediment Contamination
On agriculture	Contamination of soil and crop irrigation
On industrial activities	Contamination of process and cooling water

Reservoirs pollution is a problem with consequences more or less serious on population. The effects of pollution are complex and varied, depending on the nature and concentration of substances.

Waters from river basin Prut–Bârlad are affected most by agricultural activities, industrial activities and wastewater discharges.

The objective is to analyze the water quality of lakes in the Prut Bârlad basin and also the simulation and evaluation of improvement measures to talk about water quality in line with European standards.

REFERENCES

Brezeanu G., Simon-Gruita A., *General Limnology,* 2002.

Varduca A., *Water Quality Protection*. Publishing *H*G*A*, Bucureşti, 2000.

Varduca A., *Integrated Monitoring of Water Quality*. Publishing *H*G*A*, Bucureşti, 1999.

* * * Order 161/2006

* * * HG 964/2000

* * * *Water Quality Bulletin*. “Romanian Waters” National Administration, 2014.

* * * *National Management Plan*. “Romanian Waters” National Administration, 2010.

CONTROLUL INTEGRAT AL POLUĂRII CU NUTRIENȚI ÎN LACURILE DE ACUMULARE

(Rezumat)

Nitrații şi fosfații se găsesc în mediul înconjurător iar prezența lor este normală. Încărcarea însă peste limitele acceptate determină poluarea cu nutrienți. În mod natural nitrații (NO_3) şi fosfații (PO_4) din ape provin din dejecțiile animalelor acvatice, din solul ce formează cuveta lacustră sau din descompunerea materiei organice specifice acviferului. Surplusul acestora provine din activitățile antropice, din dejecții umane şi din diverse surse industriale şi agricole.

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TECHNIQUES FOR COLLECTING, TRANSPORTATION AND DEPOSITING OF WASTE, TARCĂU, NEAMŢ COUNTY

BY

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Abstract. As we all know, Romania is facing environmental issues, particularly those relating to environmental management, very serious, namely: collecting, transportation and depositing waste in optimal conditions.

The human population considers waste deposits as a source of pollution for air, surface waters and soils and also changing the lands of biota near the deposits and not the least, optical and olfactory discomfort. These visions must be evaluated before the construction of deposits by the policy makers, for adopting the most effective methods of waste management. In this context, Fricke and Kölsch (2009) affirm that "in many countries it became increasingly difficult to find suitable locations for waste deposits that are accepted by the population."

Until the ‘70s, waste management was based on one method, known as depositing, which means the collecting and the actual depositing of waste (Lombrano, 2009). After a few years it began to be proposed, analyzed and adopted different strategies which had the purpose to obtain economic benefits.

Keywords: waste management; collecting, transportation and depositing.

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1. Introduction

Romania is facing problems related to environmental protection, particularly environmental management, namely: collecting, transportation and residue depositing in a properly way. If these activities are managed properly and correct, the environment and humans will not face with any kind of problems.

In Romania the waste management activity is based on OUG78/2000, which implements a series of directives of the Council of Europe.

Even if in Romania initiatives were started for recycling waste before 1989, in the context of the time gaps, action encountered resistance. Today the recycling is resumed, but the success of recycling waste is based on the possibility of sorting waste and that should start from the first phase by collecting in a separate way the recycled materials. (Bold & Mărăcineanu, 2006).

The case study for collecting, transportation and depositing of waste was performed on the entire area of the Tarcău territory, Neamț county (Fig.1).

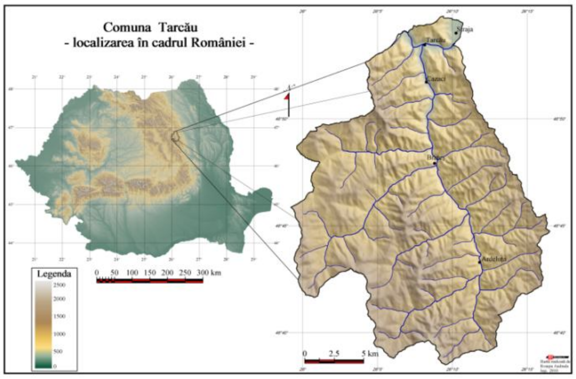

Fig. 1 – The localization map of Tarcău.

Fig. 2 – Bins along the main road at the entrance to Tarcău.

Fig. 3 – Waste dumped in the Tarcău river bed.

The collecting – transportation - depositing line describes the most important phase of the waste management process, through which they are removed from the community system and stored in a place where they are not affecting the system circuit in a negative way.

2. The Description of the Research Area

The suitable location for building a waste deposit is at the entry into Tarcău, near a furniture factory, known as SC Forestar SA Tarcău, because in this area is the population with the largest number of inhabitants of Tarcău, and from this statistic resulted that in this part are most waste products.

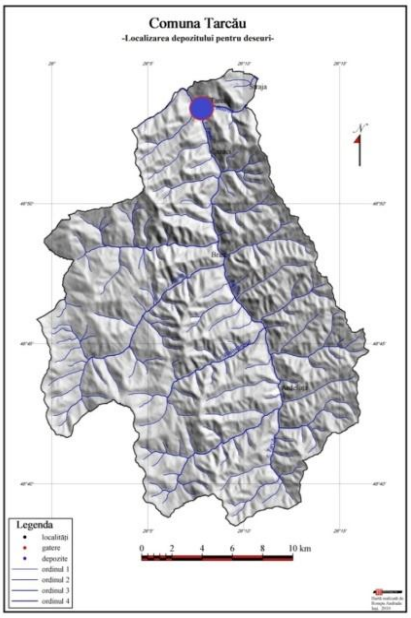

Fig. 4 – The localization map of the waste deposit.

2.1. Geological, Geomorphological, Pedological, Geotechnical, Hydrological and Biological Conditions

In terms of soil, the following types are found: typical eutricambosoil and entic alluviosoil. The typical eutricambosoils are characterized by physical properties, physical-mechanical, hydrophysical and good aeration and generally show no excess of water. Sometimes these soils are eroded, it appears necessary to apply appropriate measures to prevent and combat this harmful phenomenon by applying the method of terracing.

Alluviosoils are spread on the young landscape units, recent or current, formed under the influence of the river deltas. The alluviosoil is characterized by a reduced bioaccumulation, as a result of successive deposits of silt, which prevents the installation and vegetation growth.

From the geological point of view,the construction of the waste deposit requires technical methods to strengthen the south shore of the land because it has the prospect of sliding.

In terms of hydrological, the insulation for the waste deposit should be made carefully, applying special materials for retaining the leach, because the risk of pollution is very high in the vicinity of rivers.

The hydraulic slope of groundwaters from the studied enplacement, is directed to the river, with a perpendicular direction to its course. Ground waters are unevenly distributed, according to geological structure and climate conditions.

2.2. The Quality of Household, Street and Industrial Waste

All the residues from other activities (industry, agriculture, from constructions, streets and hospitals) that may occur in the territory must be analysed and for which are established possibilities for treatment and neutralization of these, along with household waste (waste balance).

In the Tarcău area there is resulting waste from constructions, streets, household and industry (Fig. 5). Industrial waste is the result of the technological process from installations for wood cutting (sawmill). All the debris that is resulting from this activity is not collected and organized properly and transported at the specific places for waste collecting.

Fig.5 – Logs cut and abandoned in the forests of Tarcău.

3. Collecting, Transportation and Disposal Of Household, Industrial And Street Wastes

3.1. Calculation of Storage Capacity

After following formula:

$$\mathrm{Cd} = \frac{nQ_0}{m}\left[1 + \frac{(n-1)k_0}{2}\right], \tag{1}$$

where: Cd – ability of the ramp for “years”, [m^3]; $Q_0 = Q_m + Q_s + Q_i$ total amount of waste in the first year; Q_m – average annual quantity of waste in the base year, [m^3/year]; Q_s – average amount of street waste, [m^3/year]; Q_i – the average amount of industrial waste, [m^3/year]; k_0 – growth coefficient in time for the quantity of household, street and industrial waste (annual value of 5%), $k_0 = 0.05$; n – the number of years for the function of ramp, n – 10-25 years; m – coefficient of compacting waste in storage.

3.2. The Amount of Residues - Calculating the Number of Bins Required for Collecting the Industrial and Industrial Waste

After following formula:

$$n = \frac{2Nz}{cv}, \tag{2}$$

where: n is the number of bins needed; 2 – l/person/day, the specific amount of waste produced by each inhabitant; N – the number of inhabitants subordinated to central waste collection (70% of total no. of people); z – maximum time between two collecting phases, days; v – bin volume, [L]; c – 0.8 filling coefficient of bin.

3.3. Calculating the Number of Vehicles Required for Transportation of Industrial and Household Waste

After following formula:

$$N = \frac{Q}{8pc}, \tag{3}$$

where: N is the number of vehicles (pieces); Q – total amount of household waste to be transported, [m^3]; p – the vehicle productivity, [m^3]; c – 2 coefficient of utilization of the deposit; 8 – number of hours worked per shift.

3.4. Productivity (p) of the Vehicle

After following formula:

$$p = \frac{G}{T}, \tag{4}$$

where: G is the vehicle loading capacity, [m^3]; T – duration of a journey, [h].

3.5. Total Number of Bins THAT ARE Discharged Into Vehicle in a Single Run

After following formula:

$$N = \frac{G}{VC} \text{ pubele}, \tag{5}$$

where: G is the vehicle load capacity, [m^3]; V – volume of bins (0.14 m^3); C – 0.8 bin filling coefficient (0.8,…,0.9).

After careful consideration of local conditions concrete proposals for disposal (neutralization) of residues must be made showing comparison of alternatives, taking into consideration the costs and ecological indicators.

4. Modes of Collecting Waste

4.1. Depositing

The waste deposit that is located near Tarcău is the one from Bicaz city but it was closed in 2009 (Fig. 6). The idea of building a new waste deposit here in Tarcău is required, one reason being the high interest for tourism in this area.

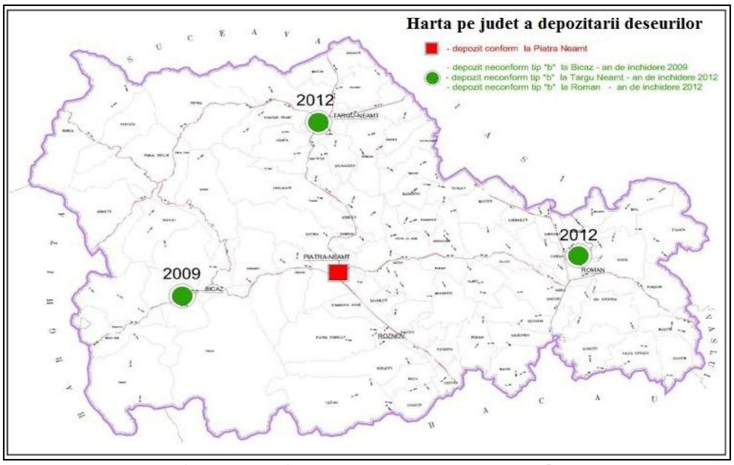

Fig. 6 – The map of Neamț county – waste depositing.

The location for the waste deposit will be chosen by taking into account the general town planning and urban planning area. Arrangements for reducing the visual impact caused by the location of a waste deposit is performed according to adjacent land use through: a) implementation of a vegetal curtain and if necessary to plant a vegetal curtain composed of several floors of trees and shrubs that breed fast; b) placing metal panels for commercials; c) grassing with grassy plants – gramineous - and planting resistant species at pollutants over the covered areas of the waste storage, which reached the final level to restore soil structure and biota, in parallel with the elimination of pollutants and gradual introduction of these lands in the natural landscape of the area.

4.2. Used Materials

a) For impermeabilization clays or other mineral materials are used with similar characteristics with the ones of clay and an artificial impermeabilization with geomembrane or other similar materials, which must provide a coefficient of permeability $K \leq 1 \times 10^{-9}$ m/s and physico-chemical conditions for the strength and stability that were required by the planner. Will be used smooth geomembrane at the foundation of the deposit and a rough geomembrane on slopes and for the final cover; b) For the separation of the drainage and impermeabilization layers from the deposit walls, will be used geotextiles with protective role; c) Drainage tubes used to drain the leachate must be made from polyethylene and must be provided with slits; d) Drainage section consists in a gravel layer with granules having the diameter between 16 and 32 mm.

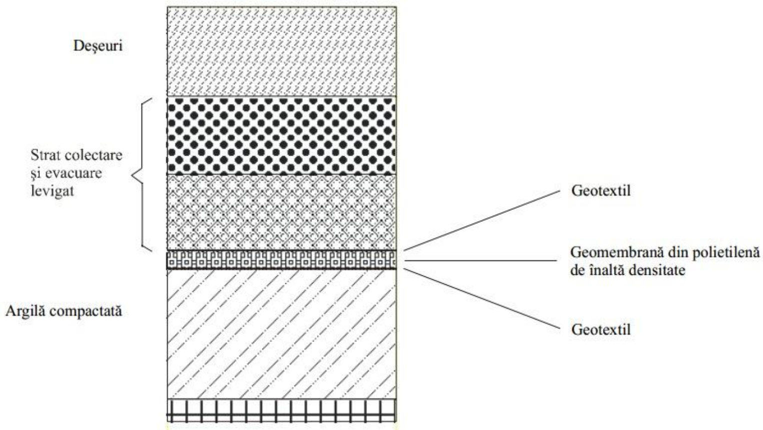

Fig. 7 – The scheme of the impermeabilization system from a waste deposit.

4.3. Built Barrier

Before beginning the construction of base impermeabilization, it must be proved that the usable materials comply with legal requirements. This phase is achieved by testing the behavior of the materials used in the fields where specific conditions are simulated from a waste deposit.

4.4. Requirements for Barrier Construction, Impermeabilization and Drainage System for Leachate

The base layer which is overlapped by the synthetic sealing layer must have the flatness tolerance of maximum 2.0,…,4.0 m. Geomembranes from the sealing layer from the bottom of the deposit must be protected against the mechanical pressure from the loading of waste. Protective layer may consist of geotextiles (polypropylene or polyethylene fiber) or a layer of fine-medium sand.

4.5. Pipes for Leachate Drainage

Drainage pipe network is built over sealing system of the base deposit. The system for collecting leachate: drainage layer for leachate, drainage pipes for leachate, pipes for intake leachate, manholes, pumping station, storage tank, pipe for leachate discharge (Fig. 8).

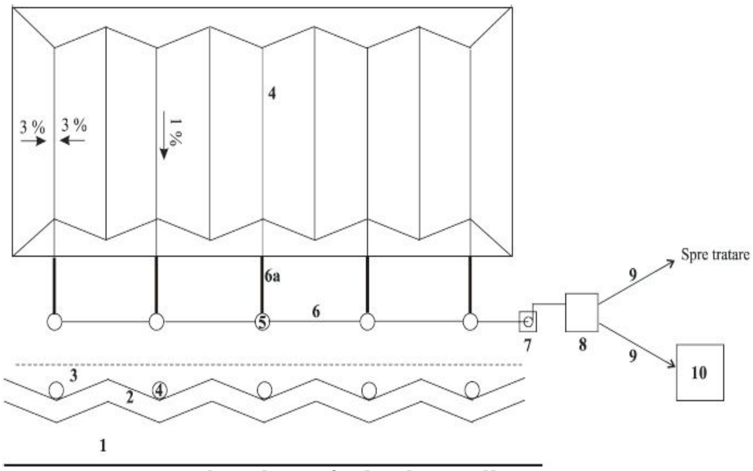

Fig. 8 – The scheme for leachate collecting system.

Where: 1 – geological barrier; 2 – impermeabilization; 3 – leachate drainage layer; 4 – leachate drainage pipe; 5 – tank for leachate; 6 – pipe for leachate intake; 6a – the area in which are placing the leak control systems; 7 – leachate pumping station; 8 – tank for leachate; pipe for leachate discharge.

5. Conclusions

Waste management objectives are to protect and improve the health of the population, protect the environment, maintaining the area of Tarcău clean and creating a proper aesthetics for this mountain region, conserve natural resources by supporting and implementing policies to reduce waste and recycle them.

For avoiding the danger of pollution, the waste deposit must be well equipped for environmental protection. The City Hall of Tarcău urgently needs to implement a waste management project if in this area the touristic development will increase and also the villagers need to have a healthy and civilized environment where to live.

REFERENCES

Bojoi I., Surdeanu V., *Considerations on the Basin Relief of Tarcău.* Works of the Biological, Geographical and Geological Research Station "STEJARUL" (extract), 1970.

Bold O.V., Mărăcineanu G.A., *Depositing, Treatment and Recycling of Waste and Materials.* Press Matrix Rom, 2006.

Bularda G., Bularda D., Catrinescu T., *Household, Street and Industrial Residues.* Press Technic, Bucharest, 1992.

Culic A., Petrescu M., *Waste Management and Legislation* (Part I and II). Press Efes, Cluj-Napoca, 2006.

Do Hung Thanh, *The Structural and Petrographic Relief of Tarcău Mountains Between Valley and Valley Damuc Tarcău.* Univ. of Bucharest, Faculty of Geography and Geology" Ph. D. Diss., 1974.

Fricke, K., Kolsch, F., *Waste Management in Low Inncome Emerge Countries.* The Role of Ecological Chemistry 243 in Pollution Research and Sustainable Development, 2009.

Gheorghiu C., *Geographic Dictionary of Neamț County*. Press Bucharest, 1895.

Giurgiu V., *Protection and Sustainable Development of Forests*. Society Forestry Progress. Press Graphic Art, Bucharest, (1995).

Malschi D., *Integrated Pest Management in Relation to Environmental Sustainability* (Part I). Ecological management of wheat pests, online manual, Cluj-Napoca, 2009.

Modoi O.C., Ozunu A., *Practical Applications of Solid Waste Management.* Press EFES, Cluj- Napoca, 2012.

Pietraru J., *Spoil Banks for Silt, Ash, Slag, Sterile and Household Wast.* Press Technic, Bucharest, 1992.

Ştefănescu M.F., *Monography of Tarcău.* Second edition, Press NONA, Piatra- Neamț, 1942.

* * * COUNCIL OF THE EUROPEAN UNION Brussels, *Green Paper of bio-waste management in the European Union* (8 dec.2008, To: Mr Javier SOLANA , Secretary General / High Representative), 19 decembrie 2008 (23.12) (OR. en) 17559/08.

* * * *County Waste Management Plan - Salaj County,* September 2009.

* * * National Agency for Environmental Protection – Neamț, request information on the status of environmental elements Tarcău , no. 5068 / 17.06.2011.

* * * National Regie of Forests – Romsilva - http://www.silvant.ro/

* * * Romanel Internațional Grup, http://www.forestar.ro/

TEHNICI PENTRU COLECTAREA, TRANSPORTUL ŞI DEPOZITAREA DEŞEURILOR, COMUNA TARCĂU, JUDEȚUL NEAMȚ

(Rezumat)

După cum bine ştim, România se confruntă cu probleme legate de protecția mediului, mai ales cu cele legate de managementul mediului, foarte grave şi anume: colectarea, transportarea şi depozitarea deşeurilor în condiții optime.

Populaţia consideră depozitele de deşeuri ca fiind o sursă de poluare a aerului, a apelor de suprafaţă, a solurilor, producându-se schimbări în biocenozele terenurilor din apropierea depozitelor şi nu în ultimul rând, disconfort vizual şi olfactiv. Aceste viziuni trebuiesc evaluate înaintea construirii depozitelor, de către factorii de decizie, în vederea adoptării metodelor cele mai eficiente de management al deşeurilor.

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HYDROLOGICAL MODELLING FOR THE FLOOD IN THE UPPER CATCHMENT OF THE GERU RIVER

BY

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Abstract. This paper analyzes the flood that occurred between 11th and 13th of September 2013 in the upper catchment of the Geru river. The flood was simulated using the program Mike by DHI with the Unitary Hydrograph Method. As input data, we used the precipitation measured at the Automated Hydrological Sensor Station Cudalbi and radar precipitations. We analyzed the importance of accuracy for input data on the simulation results and the direct influence of setting the proper time steps in achieving the simulated discharge hydrograph. It appears that radar precipitations used as input data lead to a discharge hydrograph with low errors for amplitude and phase of the runoff peak.

Keywords: hydrological modeling; rainfall; runoff; automatic station; radar.

1. Introduction

Appropriate river flow forecasting and estimation are the essential parameters to enable calculations of flood warning, drought forecasting and optimal operation of the reservoirs (Maryam Hafezparast *et al*., 2013).

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To evaluate surface runoff in small catchments that are homogeneous from the physico-geographical point of view, only the processes of rainfall transformation in runoff are modeled, without the study of flood routing through the riverbeds. In the formation of network discharges during high intensity rainfalls, the most important weight is held by surface runoff (Giurma, 2003).

These types of hydrological models only study the surface runoff component and assume that the parameters used are constant across the entire catchment, so they are models with global parameters. The models evaluate and then integrate the net rainfall. Evaluation of net rainfall is done through a series of mathematical models, of which the most widely used model is the model SSAR. Integration of net rainfall in surface runoff is performed using a weighted function, called *unit hydrograph* (Giurma, 2003).The *Unit hydrograph* function is the response of the catchment to a 1 mm net rainfall, uniformly distributed on the surface of the catchment and having the duration Δt; it is defined by the ordinates:

$$\text{U.H.}=\{u_i = u(i,\Delta t)\};\ i=1,2,\ldots\ldots,n_u, \quad (1)$$

where u_i is the ordinate of the unit hydrograph at the moment of time i; n_u is the number of ordinates taken into account, so that:

$$\sum_{i=1}^{n_u} u_i \approx \frac{1}{T} \quad (2)$$

where: T is the number of hours of time step Δt.

Mathematical modelling of rainfall-runoff process on the hillslopes, resulting in a runoff hydrograph in the closing section of a catchment can be achieved using MIKE by DHI software, which includes in the hydrological module Rainfall - Runoff, a unit hydrograph model (UHM) (DK-2970 2003). The UHM calculates excess rainfall and determines seepage losses by four methods:

a) the method using *SCS Curve Number* parameter to characterize the analyzed catchment from the perspective of existing soil type and land use patterns;

b) *the constant loss method* that sets an initial fixed value and a constant value during rainfall;

c) *the rational method* that describes infiltration as a proportional loss – *SCS method* which takes into account the *Curve Number*;

d) *SCS method generalized.*

Excess rainfall is routed to the river and transited through unit hydrograph method. The model divides the flood generating precipitation in excess rainfall (net rainfall) and losses (infiltration).

In accordance with the principle of superposition, UHM model determines a flow hydrograph corresponding to each step of computation time and excessive rain, according to the method of calculating the losses and then adds the flow generated in the previous step time (DK-2970 2011). The evolution of the runoff can be described in different ways:

i) *the triangular hydrograph SCS* method (*Soil Conservation Service of USDA*), which establish that the moment of occurrence of the maximum flow (peak hydrograph) is considered to be at half the duration of the rain, plus the duration between the nucleus of the rain and the peak of the runoff;

ii) *reduced SCS hydrograph* derived from a number of unit hydrograph with different sizes and locations associated with the catchment;

iii) *user defined hydrograph.* The module includes the possibility of establishing dimensionless hydrographs and facilities for setting up and managing databases with runoff hydrographs basins defined a priori by the user and recorded time series of precipitation and discharges.

During rainfall, a part of the total precipitation infiltrates into the soil, than the infiltration is evaporated or routed as base flow to the river bed, a long period after the end of the rainfall. Hence in event models as the present one, it is reasonable to describe the major part of the infiltration as loss. The amount of rain actually reaching the river (the total amount of rainfall less the los) is termed the excess rainfall.

The *SCS loss method* uses the parameter *AMC* for defining the antecedent moisture condition at the start of the storm. The model operates with three different antecedent moisture conditions namely:

- AMC = 1 Dry conditions close to wilting point.
- AMC = 2 Average wet conditions close to field capacity.
- AMC = 3 Wet conditions close to saturation.

Another parameter used by *SCS loss method* is the parameter *CN (Curve number),* which is a dimensionless coefficient whose value varies between 0 and 100. Setting the value of the parameter *CN* requires knowledge of certain specific factors basin: soil type, land use, hydrological conditions, antecedent moisture condition and existing impervious surfaces in the catchment.

To create a valid rainfall-runoff model using MIKE 11 software the following files are required:

a) time series file with the extension *dfs0 containing the precipitations;

b) file with the extension *rr11 which is the editor of the rainfall-runoff model;

c) file with the extension *sim11 which performs the hydrological simulation.

To run a hydrological model the following steps are required:

a) In the file *rr11, in the *catchment* option, the catchment parameters (name, hydrological model and catchment area) are set and then the characteristic parameters of the model are determined.

b) Link the meteorological data (rainfall) from the *dfs0 extension file as INPUT data in the *TIME SERIES* option;

c) Create a file with the extension *dfs0 with hydrological data (significant flow hydrographs registered at the hydrometric stations in the analyzed catchment);

d) Create the simulation file *sim11 where the option *Rainfall-runoff Model* is checked, the file *rr11 is uploaded, the simulation period is set, the path and name for the *Results* are chosen, the simulation is started.

e) The *Results* can be viewed in **MIKE View**.

The model can present the net rainfall and comparison of simulated and measured runoff hydrographs and accumulated volumes for the analyzed flood (Crăciun & Giurma, 2014).

2. Case Study

2.1. The Characteristics of the Analyzed Catchment

The model is applied to the upper basin of the river Geru located in Galati county, in the south of the area operated by the Basinal Water Administration Prut–Bârlad. The area of the river Geru catchment is 113.56 km^2 Geru (Geru River – 99.52 km^2 and Geruşiţa River tributary – 14.04 km^2). The river Geru is a right tributary of the river Suhu. The upper catchment was chosen for study. The downstream control section is Cudalbi hydrometric station, located at 22.53 km downstream. The confluence of the river Geruşiţa with the river Geru is located 5.25 km downstream from the spring of the river. The river Geruşiţa is a left tributary, with a length of 7.27 km and a 14.04 km^2 catchment.

The analyzed catchment is controlled by the hydrometric station located in the village Cudalbi. The daily transmitted data from the classic hydrometric station with vertical hydrometric surprise are doubled since August 2013 with hourly precipitation data from the AHSS (Automated Hydrological Sensor Station) established in the DESWAT program, implemented by the Water Basinal Administration Prut–Bârlad. Cultivated agricultural lands occupied the largest area in the catchment Geru (45%). As follows meadows (25%), rural localities 15%, and forests (15%). Fig. 1 presents distribution in percentages of land use in the upper catchment of the river Geru.

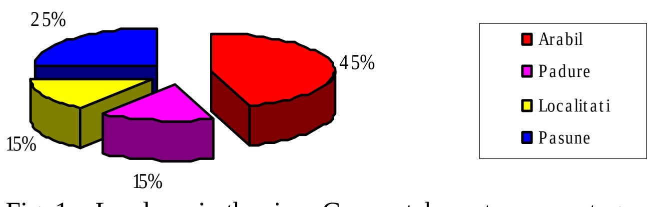

Fig. 1 – Land use in the river Geru catchment – percentages.

The catchment of river Geru shows very different soil types: river deposits, carbonate silts, colluvial soils, chernozem soils. Grey forest soils occur on the hillslopes and are formed of loess, sand and marl. Fig. 2 presents the textural classes of soils in the catchment of river Geru.

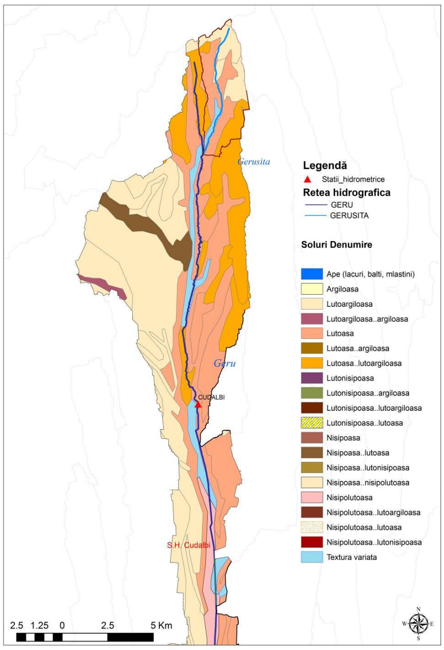

Fig. 2 – Cartograme of texture soils in the catchment of river Geru.

2.2. Significant Flood that Occurred in September 2013

Between 11th and 13th of September in the upper catchment of the river Geru large quantities of precipitation occurred. Following the rapid concentration of runoff on the hillslopes, in the reference period, the defense characteristic threshold DANGER was reached and exceeded on the river Geru (*Raport anual de sinteză…*, 2014) (Table 1).

Table 1

Exceedance of DANGER Defense Threshold at the Hydrometric Station Cudalbi

River	Hydrometric station	Maximum level cm	Maximum discharge m^3/s	Exceedance of DANGER defense threshold cm/date	Maximum hystoric level cm/Year
Geru	Cudalbi	358	118	+ 88 cm On 11th of September 2013, 23^{00}	358/2013

Rainfall that occurred between 11th and 13th of September 2013 generated a flow hydrograph with three peaks, with the following maximum discharges: 118.00 m^3/s recorded on 12/09/2013 23^{00}, then 75.30 m^3/s recorded on 13/09/2013 02^{20}, respectively 10.30 m^3/s recorded on 13/09/2013 10^{00}.

The flow hydrograph was extracted from the rating curve calculated by the Hydrology Department of the Basinal Water Administration Prut–Bârlad for the cross section of the river Geru at Cudalbi hydrometric station.

It appears that the flood that occurred 11th and 13th of September 2013 had a maximum discharge of 118.00 m^3/s that is very close to the peak of the flood with a 2% probability of exceedance, which is 120.00 m^3/s, established by the National Institute of Hydrology and Water Management, for the analyzed section.

2.3. Mike 11-UHM Simulations Performed with the Use of Rainfall Recorded at AHSS Cudalbi

To simulate the flood that occurred between 11th and 13th of September 2013 we used the hydrological model that was built in the project "Hazard and flood risk maps for the river Bârlad catchment".

The model included the river Geru and its tributary, the river Geruşiţa and it used the unitary hydrograph method the Rainfall – Runoff Module. The model was calibrated and validated for the flood which occurred in May 2008.

UHM parameters used in the model are shown in Fig. 3.

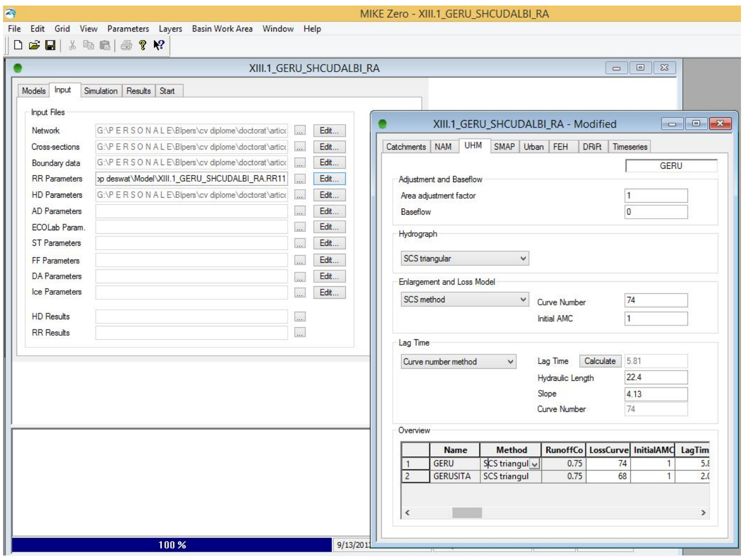

Fig. 3 – Setting the parameters for the model Mike 11-Unitary Hydrograph Method.

Triangular *method* was used to draw the hydrograph and *SCS method* was used to calculate the infiltration.

Mostly clay soil and clay loam, with low infiltration are spread in the river Geru catchment. The soils are classified in the *group C* of hydrological soils. For the analyzed catchment the *CN* (Curve Number) parameter was calculated by the weighted method established in TR - 55 (*Technical Release - 55*) by the *United States Department of Agriculture* (*Urban Hydrology*…, 1986). The method is applicable to small basins and *CN* parameter is calculated as a weighted average based on land use and *CN* intermediate surface corresponding to each surface. Table 2 presents the calculation of the weighted *CN* parameter with detail on both the river Geru and the tributary river Geruşiţa catchments.

Table 2

The Calculation of Weighted Coefficient CN for the Catchments

	Area of river Geru catchment = 99.52 km^2					
		Percentage of the catchment	**Intermediate area – km^2**	***CN* partial**	***CN* x area**	**CN**
Cultivated agricultural lands		**0.45**	**44.784**		**3486.88224**	**77.86**
Fallow	Bare soil	0.01	0.44784	91	40.75344	
Row crops	Straight row	0.01	0.44784	88	39.40992	
	Straight row + Crop residue cover	0.02	0.89568	85	76.1328	
	Contoured & terraced	0.10	4.4784	80	358.272	
	Contoured & terraced + Crop residue cover	0.20	8.9568	77	689.6736	
Small grain	Straight row + Crop residue cover	0.10	4.4784	80	358.272	
	Contoured & terraced	0.05	2.2392	78	174.6576	
	Contoured & terraced + Crop residue cover	0.31	13.88304	77	1068.99408	
Close-seeded legumes	Contoured & terraced	0.20	8.9568	76	680.7168	
Forrest		**0.15**	**14.928**		**992.712**	**66.50**
	Woods	0.30	4.4784	70	313.488	
	Brush	0.70	10.4496	65	679.224	
Localities		**0.15**	**14.928**		**1138.26**	**76.25**
	Open space (lawns, parks, etc.)	0.45	6.7176	74	497.1024	
	Streets and roads - gravel	0.05	0.7464	89	66.4296	
	Residential districts	0.50	7.464	77	574.728	
Meadow		**0.25**	**24.88**	**71**	**1766.48**	**71.00**
	***CN* for the river Geru catchment=74**					
	Area of river Geru□i□a catchment = 14.04 km^2					
Forrest		**0.75**	**10.53**		**705.51**	**67.00**
	Woods	0.40	4.212	70	294.84	
	Brush	0.60	6.318	65	410.67	
Meadow		**0.20**	**2.808**	**71**	**199.368**	**71.00**
Cultivated agricultural lands						
Row crops	Contoured & terraced + Crop residue cover	**0.05**	**0.702**	77	**54.054**	**77.00**
	***CN* for the river Geru catchment=74**					

For the initial moisture expressed by *AMC (Antecedent Moisture Condition)* parameter we used in first stage the value *1* specific to dry land, with humidity near the wilting coefficient.

The *Lag Time* parameter (the time interval between the rain nucleus upon reaching maximum flood flow) was calculated automatically by the software by selecting the Curve Number method formula developed by NRCS (*Natural Resources Conservation Services*, *USDA*), when provided values for hydraulic length, slope and *CN*.

The rainfall recorded by the AHSS Cudalbi with a 10 minutes time step is shown in Fig. 4.

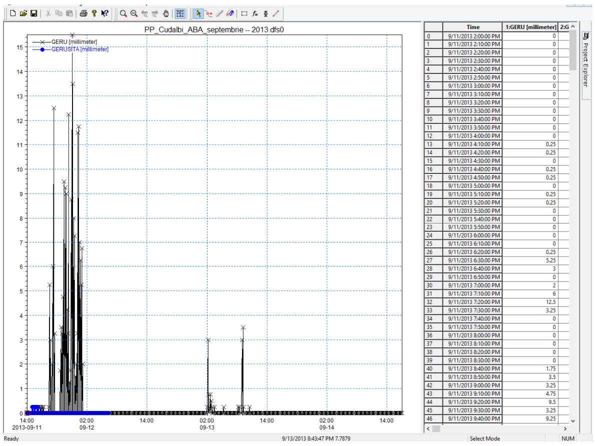

Fig. 4 – Precipitation recorded AHSS Cudalbi.

For simulation time step it was chosen the time step of 10 minutes, to coincide with rainfall recording accuracy. For the parameter *AMC* it was used the value *1* and for the parameter *area adjustment factor* it was also used the value *1*.The comparison between the hydrograph of the discharges measured at AHSS Cudalbi between 11th and 13th of September 2013 and the hydrograph of discharges simulated with Mike Unitary Hydrograph Method is presented in Fig. 5.

It is found that the maximum simulated discharge was 242.85 m^3/s (on 12th of September 2013 06^{00}), compared to the maximum measured discharge of 118.00 m^3/s (on 11th of September 2013 23^{00}), so the peak value is increased by 105 % and appears to show 7 hours later than the measured peak.

The simulated hydrograph does not capture the other 2 peaks recorded on 13th of September 2013, which means that there is a difference between the intensity of the rainfall produced in the catchment and the rainfall records from AHSS Cudalbi.

When using the value 0.71 for the parameter *area adjustment factor* in the setup menu for the parameters used for the simulation, it is found that the maximum simulated discharge is 120.10 m^3/s (12th of September 2013 06^{00}) compared to the maximum measured discharge of 118.00 m^3/s (11th of

September 2013 23^{00}), so the peak value is increased by 1.8 % and appears to show 7 hours later than the measured peak (Fig. 6).

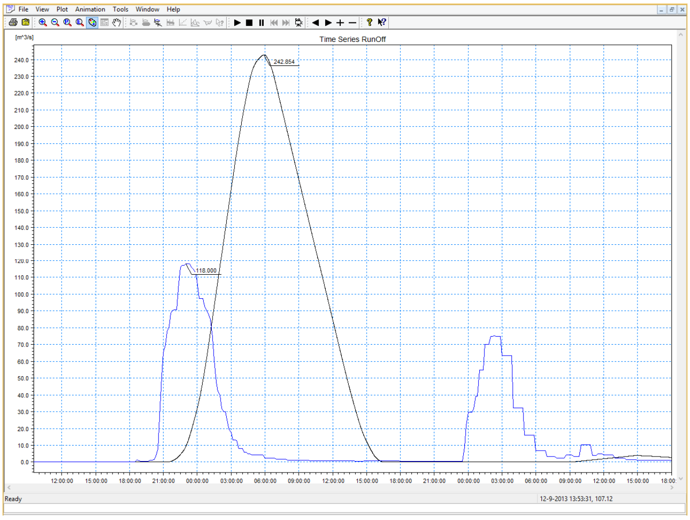

Fig. 5 – Discharges measured at AHSS Cudalbi and discharges simulated with Mike 11-UHM (AHSS precipitation, AMC = 1, area adjustment factor = 1, the simulation time step = 10 min.).

——— Discharges simulated with Mike 11-UHM;

——— Discharges measured at AHSS Cudalbi

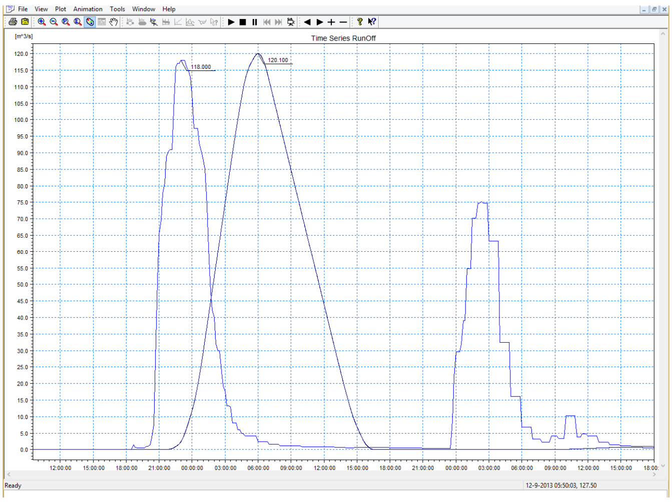

Fig. 6 – Discharges measured at AHSS Cudalbi between 11th and 13th of September 2013 and discharges simulated with Mike 11-UHM (AHSS precipitation, AMC = 1, area adjustment factor = 0,71, the simulation time step = 10 min.)

——— Discharges simulated with Mike 11-UHM

——— Discharges measured at AHSS Cudalbi

The comparison between measured and simulated discharges leads to the conclusion that it is possible that some of the precipitation may have occurred in the upper catchment and were not recorded by AHSS Cudalbi, but in fact contributed to the formation of the other two peaks of the surface runoff that were not captured by the simulated hydrograph.

2.4. Mike 11-UHM Simulations Performed with the Use of Radar Precipitation

Radar rainfall values were generated by *ROFFG (Romanian Flash Flood Guidanc*e) software system in ArcGIS module for determining the area affected by flash floods. ROFFG system is designed to provide information about the potential for flash flood of small catchments throughout Romania.

From the data processed by the system ROFFG we have used the product *Merged Map - Average Precipitation accumulated in an hour*, based on estimates of radar rainfall corrected by rainfall recorded at the automated stations.

For simulations using radar rainfall we have use the value *1* for the *area adjustment factor* parameter, because this kind of input data characterize the catchment with high accuracy and the input file describe the distribution of precipitation closely to the actual distribution. Radar rainfall radar with hourly frequency are shown in Fig. 7.

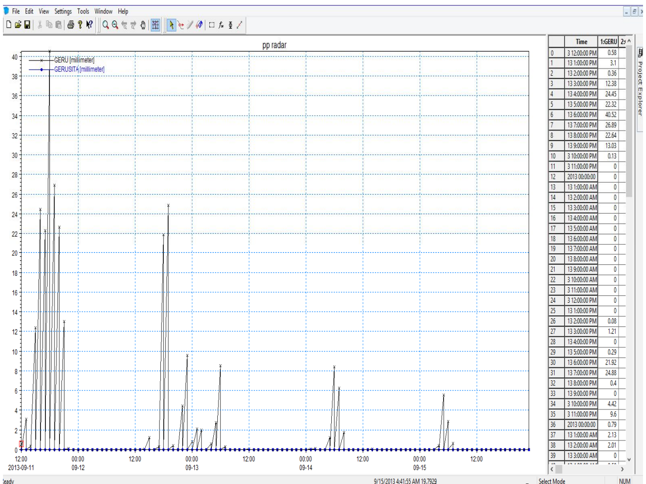

Fig. 7 – Radar precipitations recorded between 11th and 15th of September 2013.

In the *Simulation Result* tab we used a 10 minutes time step for the initial stage of the simulation.

Fig. 8 presents a comparison between the hydrograph of the discharges measured at AHSS Cudalbi between 11th and 13th of September 2013 and the hydrograph of discharges simulated with Mike 11 - Unitary Hydrograph Method, in terms of value *1* for *AMC* parameter and value 1 for *area adjustment factor*.

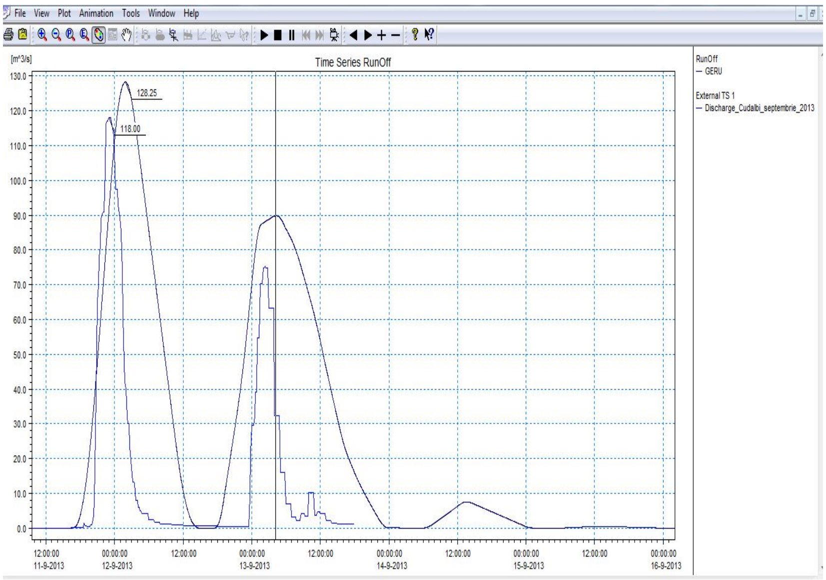

Fig. 8 – Discharges measured at AHSS Cudalbi between 11th and 15th of September 2013 and discharges simulated with Mike 11-UHM (radar precipitation, AMC=1, area adjustment factor=1, the simulation time step = 10 minutes).
Discharges simulated with Mike 11-UHM
Discharges measured at AHSS Cudalbi.

It is found that the first peak of the simulated discharge was 128.25 m^3/s (12th of September 2013 05^{00}), compared to the first peak of the measured discharge of 118.00 m^3/s (11th of September 2013 23^{00}), so the peak value is increased by 8.7 % and appears to show 6 hours later than the measured peak.

The second peak of the simulated discharge was 89.82 m^3/s (12th of September 2013 07^{16}), compared to the second peak of the measured discharge of 75.30 m^3/s (13th of September 2013 02^{20}), so the value is increased by 19 % and appears to show 5 hours later than the measured peak.

The third peak of the simulated discharge was 7.47 m^3/s (14th of September 2013 16^{30}), compared to the third peak of the measured discharge of 10.30 m^3/s (13th of September 2013 10^{20}), so the value is diminished by 27 % and appears to show 30 hours later than the measured peak.

The simulated hydrograph captures the shape of the measured hydrograph with all three discharge peaks with different phase and amplitude errors. The first peak of the hydrograph is captured with acceptable error amplitude and phase.

An hourly time step was chosen for the next stage of the simulation, in order to match the time step of the recorded precipitation used as input data. The simulated discharge hydrograph obtained from the hourly simulation step is shown in Fig. 9, in comparison with the measured discharge hydrograph at AHSS Cudalbi.

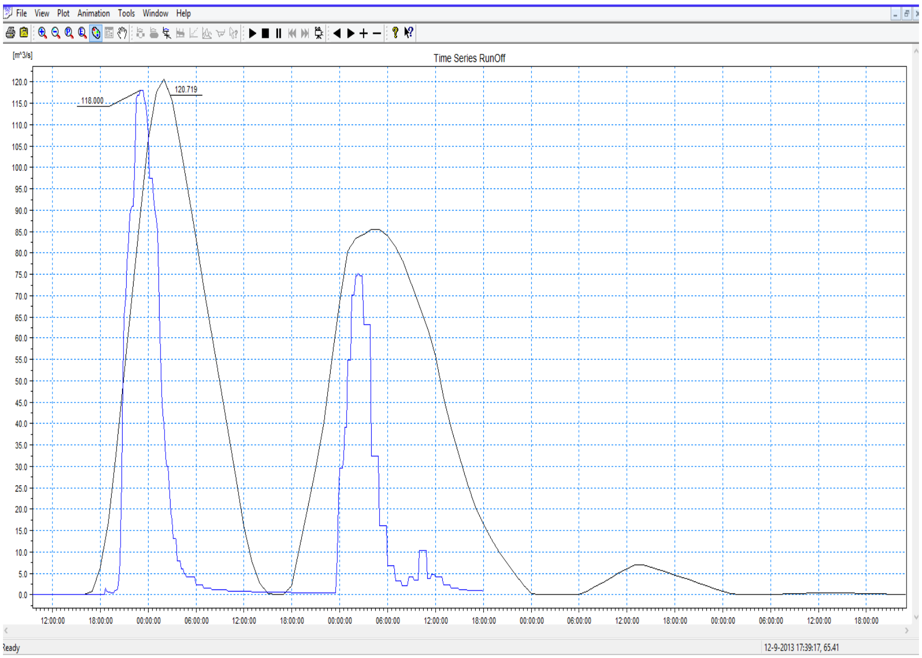

Fig. 9 – Discharges measured at AHSS Cudalbi between 11th and 15th of September 2013 and discharges simulated with Mike 11-UHM (radar precipitation, AMC=1, area adjustment factor = 1, the simulation time step = 1 hour).
Discharges simulated with Mike 11-UHM
Discharges measured at AHSS Cudalbi.

It is found that the first peak of the simulated discharge was 120.72 m^3/s (on 12th of September 2013 02^{00}), compared to the first peak of the measured discharge of 118.00 m^3/s (on 11th of September 2013 23^{00}), so the peak value is increased by 2.3 % and appears to show 3 hours later than the measured peak.

The second peak of the simulated discharge was 85.57 m^3/s (on 13th of September 2013 05^{00}), compared to the second peak of the measured discharge of 75.30 m^3/s (on 13th of September 2013 02^{20}), so the value is increased by 13.7 % and appears to show 2.5 hours later than the measured peak.

The third peak of the simulated discharge was 7.04 m^3/s (on 14th of September 2013 13^{00}), compared to the third peak of the measured discharge of 10.30 m^3/s (on 13th of September 2013 10^{20}), so the value is diminished by 31% and appears to show 26.5 hours later than the measured peak.

The comparison between the results obtained with 10 minutes time step and hourly time step highlights that the amplitude errors are smaller when the model uses for simulation the same time step for data input and results. However, phase errors remain at the same value, offset from the actual moments of the maximum discharges measured at AHSS Cudalbi.

6. Conclusions

This paper analyzes the flood that occurred in the upper catchment of the river Geru between 11th and 13th of September and the simulation results obtained with the use of MIKE 11 – Unitary Hydrograph Method. Precipitation measured by AHSS Cudalbi and radar precipitation were used as input data.

Different time steps for the simulation results were used, in order to analyze the importance of accuracy of the input data on the simulation results and the direct influence of setting the time steps in achieving a close match of the simulated discharge hydrograph with the measured discharge hydrograph.

It appears that the hydrological modeling that used radar precipitation as data input, leads to a discharge hydrograph with low amplitude and phase errors, compared to the measured discharge hydrograph.

The model can be used in the future to reproduce the floods in the analyzed catchment and to study the influence of physical and geographical characteristics of hillslopes.

The results obtained by hydrological modeling can be used as input in hydraulic modeling. Hydraulic modeling and the drawing of flood maps are performed in order to predict the development of a high risk flood event, obtain the potentially flooded areas, the water depth in certain locations on the analyzed river sector.

REFERENCES

Crăciun I., Giurma C.-R., *Hidrologie specială – Aplicaţii*. Edit. Performantica, Iaşi, 2014.

Giurma I., *Viituri şi măsuri de aparare*. Edit. Gh. Asachi, Iaşi, 64, 2003.

Maryam Hafezparast, Shahab Araghinejad, Sayed Ehsan Fatemi and Hanse Bressers, *A Conceptual Rainfall-Runoff Model Using the Auto Calibrated NAM Models in the Sarisoo River*. Hydrol Current Res., **4**, *1* (2013).

* * * *MIKE 11 – A modelling system for rivers and channels – User guide* – DHI – Agern Alle 5, DK-2970 Horsholm, Denmark, 2003.

* * * *MIKE 11 Reference Manual* - DHI water and environment, DK-2970 Horsholm, Denmark DHI, 2011.

* * * *Raport anual de sinteză privind activitatea de urmărirea comportării construcţiilor din patrimoniul Administraţiei Bazinale de Apă Prut – Bârlad în anul 2013,* Administraţia Bazinală Prut – Bârlad, 2014.

* * * *Urban Hydrology for Small Watersheds-Technical Release 55,* Natural Resources Conservation Services USDA, 1986.

MODELAREA HIDROLOGICĂ A VIITURILOR ÎN BAZINUL SUPERIOR A RÂULUI GERU

(Rezumat)

Se analizează viitura care a avut loc între 11 şi 13 septembrie 2013, în bazinul superior al râului Geru. Viitura a fost simulată cu ajutorul programului Mike prin DHI, cu metoda hidrografului unitar. Ca date de intrare, am folosit precipitațiile măsurate la stație hidrologică automată cu senzor Cudalbi şi precipitațiile radar. Am analizat importanța preciziei datelor de intrare pe rezultatele simulării şi influența directă în stabilirea etapelor corespunzătoare de timp în realizarea hidrografului simulat. Se pare că precipitațiile radar folosite ca date de intrare la un hidrograf de viitură prezintă erori mici pentru amplitudinea şi faza vârfului de scurgere a hidrografului.

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FEATURES OF THE SALINE SOILS AND VALORISATION BY TOLERANT CROP CULTIVATION TO THE SALINITY REWIU

BY

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Abstract. Saline soils are characterised by an excess in the amount of soluble salts and of Na that can be exchanged in the soil’s water. This surplus of salts changes the physical and chemical properties of the soil, therefore creating an environment that inhibits crop yields. Therefore, the accumulation of salts in the soil represents one of the main reasons for low levels of agricultural output.

At the moment, one of the most pressing global problems is overpopulation, which further highlights the issue of sustainable food production. As a result, in the last few years, greater emphasis has been placed on research and on finding ways to improve and manage this. To effectively tackle this problem requires that research into the physics (dynamics), chemistry and microbiology of saline soils is bolstered by the effective implementation of scientific discoveries and by sustainable management. This review investigates the taxonomy and characteristics of saline soils, the various problems they create for agriculture, and provides a summary of the body of research related to the level of salt tolerance of different plant species. In addition, this review highlights several promising salt tolerant crops (and strategies), such as forest-farming, horticulture, agroforestry (agro-sylviculture), or the cultivation of high-value medicinal plants.

Keywords: saline soils; salt tolerance; crops.

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1. Introduction

Land degradation, which can be considered as a decline in land quality or reduction in its productivity, is receiving increasing concern among global issues because of its impact on world food security and the quality of the environment (Eswaran *et al.*, 2001). Land degradation is a composite term and includes various physical and chemical processes. Soil salinity has remained one of the major and most widespread land-degradation problems for long time that substantially limits crop productivity

Salinity related land degradation is becoming a serious challenge for food and nutritional security in the developing world. As per FAO/UNESCO soil map of the world, a total of 953 million ha covering about 8 per cent of the land surface is suffering from salinity/sodicity (Szabolcs, 1971). Salt-affected soils are reported to comprise 42.3 per cent of the land area of Australia, 21.0 per cent of Asia, 7.6 per cent of South America, 4.6 per cent of Europe, 3.5 per cent of Africa, 0.9 per cent of North America and 0.7 per cent of Central America (El-Mowellhey, 1998).

2. The Classification and Characterization of Salinity Affected Soils

Salinity is a process where we have accumulation in soil with excessive quantities of sodium salts, calcium, magnesium, potassium, particularly accumulations of chlorides, sulphates, carbonates and bicarbonates, which give us a negative fertility soil (Eckelmann *et al.*, 2006). This accumulation of salts, especially sodium salts, it is the first physiological threat when we speak about ecosystem.

Excess of salts in a soil can bring drastic changes in some of the soils physical and chemical properties resulting in the development of an environment unsuitable for growth of most crops. Soils having salts in the solution phase and/or sodium ions (Na^+) on the cation exchange sites exceeding the specified limits are called salt-affected soils. Major captions in salt-affected soils are sodium (Na^+), calcium (Ca^{2+}), magnesium (Mg^{2+}) and to a lesser extent potassium (K^+). The major anions are chloride (Cl^-), sulphate (SO_4^{2-}), bicarbonate (HCO_3^-), carbonate (CO_3^{2-}) and nitrate (NO_3^-). These soils are generally divided into three broad categories: saline, sodic and saline-sodic.

The sodic soils have a higher proportion of sodium in relation to other cations in soil solution and on the exchange complex. Growth of most crops on sodic soils is adversely affected because of impairment of physical conditions, disorder in nutrient availability and suppression of biological activity due to high pH, exceeding even 10.0 in severe cases, and exchangeable sodium percentage of up to 90 per cent or so (Kanwar & Bhumbla, 1969). Salt solutions contain a preponderance of sodium carbonates and bicarbonates capable of alkaline hydrolysis, there by saturating the absorbing complex with sodium.

Thus, soil sodicity represents the combined effects of soil salinity as measured by the electrical conductivity (ECe) of an extract from a saturated soil paste (ECe) and soluble (Na^+) concentration relative to soluble divalent cation concentration in soil solution, *i.e.* sodium adsorption ratio (SAR), or as exchangeable sodium fraction (ESF) expressed as a percentage, *i.e.* exchangeable sodium percentage (ESP) (USDA Handbook 59..., 1954).

Saline-sodic soils, another category of salt-affected soils, are grouped with sodic soils because they share several characteristics and the management approaches required for both soil types are similar.

An ESP of 15 (SAR < 13) is generally considered the thres hold below which soils are classified as non-sodic, and above which soils are dispersive and suffer serious physical problems when water is applied (http://www.soils.org/ sssagloss/, 2006). However, considerable data exist on infiltration rates and hydraulic conductivities that show that sodic soil behaviour may occur at *ESP* values of less than 5 if ECe is lower than 4 dSm^{-1} (Thomsen *et al*., 1999).

Therefore, the principal factor determining the extent of the adverse effects of Na^+ on soil properties is the ambient electrolyte concentration in the soil solution, with low concentrations exacerbating the deleterious effects of exchangeable Na^+. The SAR has been widely used as a proxy for ESP within the range 0,...,40 (the ESP range which is most common in agricultural soils).

Therefore a soil having electrical conductivity of the saturated paste extract (ECe) ≥ 4 dS m^{-1} and sodium adsorption ratio SAR < 13 is called a saline soil. Soils having ECe < 4 dS m^{-1} and sodium adsorption ratio SAR ≥ ≥ 13 is are designated as sodic soils. If a soil has ECe ≥ 4 dS m^{-1} and sodium adsorption ratio SAR > 13 it is categorized as a saline-sodic soil (Table 1). Saline-sodic and sodic soils are generally bracketed together because similar amelioration practices are used for these soils.

Table 1

Classes Depending on the Variation Salinity Indicators SAR, ESP, pH and ECe

Type of soil	The property of soil			
	SAR	ESP	pH	ECe mS/m^{-1}
Non-saline, non-sodic	< 13	< 15	< 8,5	< 4
Saline	< 13	< 15	< 8,5	≥ 4
Sodic	≥13	> 15	> 8,5	< 4
Salin-sodic	> 13	> 15	> 8,5	≥ 4

Sodic soils are generally described in terms of the relative amounts of (Na^+) on the cation exchange complex, or in the soil solution, and the presence of accompanying levels of salinity. Thus, soil sodicity represents the combined effects of soil salinity, as measured by the electrical conductivity (ECe) of either an extract from a saturated soil paste or of soil to water suspensions of different ratios, and either the soluble (Na^+) concentration relative to the soluble divalent cation concentrations in the soil solution (*i.e.* the sodium adsorption ratio, SAR; eq. 1), or the exchangeable sodium fraction (ESF) expressed as a percentage of the cation exchange capacity (CEC), *i.e.* the exchangeable sodium percentage (ESP; eq. 2):

$$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}, \quad (1)$$

$$ESP = \frac{Na^+}{CEC} \times 100, \quad (2)$$

where: SAR is the sodium adsorption ratio, [cmol $kg^{+0.5}$]; ESP – the exchangeable sodium percentage, [%]; CEC – cation exchange capacity, [cmol kg^{-1}].

The exchangeable sodium percentage may also be calculated by replacing CEC in eq. 2 with the sum of exchangeable cations such as calcium, magnesium , potassium , sodium , and aluminum; in such a case, cation concentrations are expressed as mmolc kg^{-1} or cmolc kg^{-1} of soil (Thomsen *et al.*, 1999).

3. Problems Created in Agriculture

The crops on soils affected by salting plants is characterized by small, compared to what develop on the soils affected by salinity and/or alkalization. "Dwarfing" plant is the first visible effect of the action of soluble salts in agriculture.

Some of physical characteristics of saline soils, the classification as clay textural classes and clay-loam, bulk density wich are high values, the porosity values below 50% will adversely affect water retention capacity, permeability, aeration and report leakage/seepage water (Tanji, 1990).

Other features such as a high content of clay, which will swell strongly in the presence of water reduces their permeability for the water. Low permeability leads to stagnation of water in the soil and the soil surface, which is accompanied by a number of processes and transformations under anaerobic conditions. All these features makes it difficult for the cultivation of these soils and shortens the period in which you can perform agricultural work.

The high concentration in salt contents disrupts the quality of water and nutrients, plant metabolism, uptake by plants and soil biota. The water which contains a large amount of salt dissolved brought into contact with the plant cells, with protoplasmic mucous membrane, leads to reducing, shriveling and the loss of the cell viability. Plant physiology research is required for tolerant to salinity, for achieve the best results in the desalination of soil, remediation and to preserve these characteristics and for economic optimization.

4. The Degree of Tolerance of the Various Species of Plants to Salinity

Plant tolerance to salinity is their ability to resist on the effects of concentrated soluble salts in the root.

Salinity tolerant plants have a strongly ameliorative character. Through their ability to extract large amounts of soluble salts, especially Na^+ and Cl^- or $NaCl_2$ and to accumulate in the leaves. These plants contribute along with the other specific measures to improve salinity with provided it the removal yearly the whole mass of the vegetation .

Saline soils account for about 40 per cent of the world's salt-affected area (Maas & Hoffman, 1997). These soils are non-sodic, containing sufficient soluble salts to adversely affect the growth of most crop plants. The lower limit of saturation extract electrical conductivity (ECe) of these soils is conventionally set at 4 dS m^{-1} (at 25°C). Actually, sensitive plants are affected at half this salinity and highly tolerant ones at about twice this salinity (Sumner *et al*., 1998).

The salt tolerance of a crop is not an exact value It refects the ability of a crop to resist the adverse, non-specifc efects of excessive root zone salinity. Although the capacity of a crop to endure salinity cannot be stated in absolute terms, the relative crop responses to known salinities under certain conditions can be predicted.

Maas and Hofman (1977), proposed a linear response model to characterize crops regarding their salt tolerances. Two parameters obtained from this model are: (a) the threshold soil salinity (the maximum allowable soil salinity for a crop without yield reduction) and (b) the slope (the percentage yield decrease per unit decrease in salinity beyond the threshold salinity level).The data, presented in terms of ECe at 14 > C, serve only as a guideline to relative tolerances among crops. Absolute tolerances may vary and depend on climate, soil condition and cultural practices. The threshold and slope values obtained from the Maas-Hofman model can be used to calculate relative yield (*Yr*) for any given soil salinity exceeding the threshold level by using:

$$Yr = 100 - s(\mathrm{ECe} - \mathrm{ECt}), \qquad (3)$$

where: ECt is the threshold salinity level expressed in dS/m^{-1}; *s* – slope expressed in per cent in dS/m^{-1};
ECe - average electrical conductivity of the saturated soil paste extract of the root zone expressed as dS/m^{-1}.

The tolerances of crops to salinity are generally divided into four classes *i.e*. sensitive, moderately-sensitive, moderately-tolerant and tolerant (Akhtar *et al*., 1994). Generally, the threshold and linear slope for a crop remain within one class. Where the linear curve for a crop crosses division boundaries, the crop was classifed based on the tolerance at lower levels atwhich yield was commercially acceptable.

Bean (*Phaseolus vulgaris* L.), strawberry *Fragaria* *Ananassa Duch,* peas (*Pisum sativum* L.), lentil (*Lens culinaris*) are sensitive tolerance to salinity.

Soya (*Glycine max),* peanuts *(Apios Americana),* onion *(Allium cepa),* millet *(Pennisetum glaucum),* flax *(Linum usitatissimum),* garlic *(Allium sativum)*) are moderately- sensitive tolerance to salinity.

Indian Mustard *(Brassica juncea),* wheat *(Triticum aestivum),* sunflower *(Helianthus annuus),* barley *(Hordeum vulgare)* rise *(Oryza sativa)* and cotton (*Gossypium hirsutum*) are moderately- tolerant to salinity.

Canola (*Brassica napus L*.), sugar beet (*Beta vulgaris L*.), Rhodes grass (*Cynodon gayana),* Kallar grass *(Leptochloa fusca),* Bermuda grass *(Cynodon dactylon),* are tolerant to salinity.

Various approaches have been taken to improve the salt tolerance of these crops by introducing genes for salt tolerance into adapted cultivars, including screening of large international collections, extensive testing of selected cultivars under field conditions, conventional breeding methods and unconventional crosses with the crop-specific relatives. The aim has been to exploit variation in salt tolerance within a particular crop and its progenitors or close relatives to produce new cultivars with more tolerance than the existing cultivars.

Another issue in cultivating of soils affected by the salinity, is the choice of crops used as an amelioration tool, to resist the absence of oxygen when excessive irrigations are applied to leach salts from top soil to lower depths. Root zone salinity in conjunction with oxygen defciency greatly increases salt uptake compared with saline non-waterlogged conditions (West, 1978). This efect may cause failure in active transport and exclusion processes in the root membrane (Drew, 1993; West & Taylor, 1984; Dagar *et al*., 2004). There seems to be a need to evaluate salt tolerant crops for their resistance again hypoxia. The genotypes showing greater tolerances against the combined efects of salinity and hypoxia may be a better choice for soil amelioration. Thus genotypes of increased tolerances to salinity and hypoxia should be sought or developed through genetics and bioengineering processes. Use of suitable rotations of the salinity-hypoxia-tolerant crops during soil amelioration may help promote lowering of the watertable-leaching of salts and soil aggregation.

5. Promising Growing Crops on Saline Soils

Medicinal and Aromatic Species

Recent studies have shown that several medicinal and aromatic plant species have the ability to tolerate ambient levels of salinity in soil and irrigation water as well as to produce adequate biomass of economic value.

German chamomile (*Matricaria recutita L*.), also known as blue chamomile, produces in its leaves an essential oil with antispasmodic, expectorant, carminative, anthelmintic, sedative and diuretic properties. It is also used as a flavour in beverages and ice cream. It grows well on a range of soils in different parts of the world and can with stand saline conditions with soil salinity levels up to 12 dSm^{-1}.

Psyllium (*Plantago ovata Forssk.*), which is also known as blond white psyllium, produces seeds that are used commercially for the production of mucilage. The mucilage is obtained by mechanically grinding away the outer layer of the seed (often referred to as husk or psyllium husk). The milled seed mucilage is a dull white fibrous material that is hydrophilic. It is laxative and mainly used as a dietary fibre. The seeds are used as a demulcent and as a bulk laxative in the treatment of constipation, dysentery and other intestinal complaints. The species can withstand irrigation water salinity up to 8 dSm^{-1} without any loss of yield. Similarly, it maintains its yield up to soil pH of 9.2. It is considered as moderately tolerant to soil salinity (Patra & Singh,1998).

Palmarosa (*Cymbopogon martini* Roxb. Wats) is a perennial species with foliage rich in geraniol, which is a natural antioxidant. The oil from palmarosa is obtained by hydro-distillation of foliage and is used in perfumes, soaps and as tobacco flavour. Although the species requires well-drained soils, it performs well on saline soils with ECe levels in the range of 8 to 12 dSm^{-1} . Moderate levels of soil salinity (around $5dSm^{-1}$) even increase the herb and oil yields. Palmarosa can be grown successfully with high electrolyte waters with ECe levels of 16 dSm^{-1}.

Because of the high content of citral in essential oils present in its leaves, lemon grass (*Cymbopogon flexuosus* Nees ex Steud. Wats) has a strong lemon-like flavour. The citral isolated from its oil is used for the preparation of vitamin A, cosmetics, perfumes, detergents, soaps and fumigants. Lemon grass grows well on a range of soils; it can be raised successfully without reduction in herb and essential oil yield in soils with pH up to 9.5 and salinity levels of 10 dSm^{-1} (Gucci & Tattini, 1997). As compared to freshwater irrigation, its growth and yield are improved when irrigated with water of salinity up to 4 dSm^{-1}. However, its growth and yield start declining when irrigation water salinity reaches 8 dSm^{-1}.

Fruit Trees

Several fruit tree species have shown promising results under saline environments. Research on the response of fruit trees to salinity has been modest compared to that on field crops.

According to Maas and Hoffman (1977), date palm has the highest salinity tolerance among fruit trees.

One of the most promising fruit trees in saline environments is olive, which is a glycophytic species that avoids salinity stress essentially by salt exclusion (Husain *et al.*, 2004).

Guava can be grown on wet and moderately saline soils, but its growth suffers under sodic conditions. Rainfall and high humidity at ripening may damage the fruit skin. It is frost sensitive.

Agroforestry Systems

Many species of the multipurpose tree Acacia used for timber, pulp, fodder, fuel wood, shelterbelts, soil conservation and rehabilitation exhibit some degree of tolerance to salinity. Most research involving Acacia species in saline environments has been conducted in Australia and South Asia. In general, annual wood production of Acacia varies between 4 and 15m3 ha^{-1} in a 20-year period. This wood yield does not include the biomass removed due to lopping. Average annual forage (leaves) yield as dry matter is estimated around 5 t ha^{-1}. Some of the most popular Acacia species used for agroforestry and conservation purposes on saline soils include *Acacia stenophylla, A. nilotica, A. cyclops, A. ampliceps, A. tortilis and A. maconochieana.*

Mesquite species are considered as potential tree plantations for saline environments. A study conducted in Saudi Arabia showed that young (5–6 months old) mesquite trees survived soil salinity levels as high as 38 dSm^{-1} when irrigated with water of salinity up to 13,5dSm^{-1} (Singh & Anwar, 1985). The tolerance of the same species under highly alkaline conditions was also shown by Ahmed *et al*. (1990), reporting that the production decreased by only 25 per cent with an increase in pH from 8 to 10.5. Among the mesquite species, long thorn kiawe (P. juliflora (Sw.) DC.) is a small thorny tree that grows on soils of high alkalinity (*pH* up to 9.8) and intermittent flooding. Therefore, it can be used as an effective bio-drainage species.

6. Conclusions

The emerging evidence of the potential to a series of plants species that can be cultivated successfully in saline environments, provides opportunities for researchers, agricultural consultants and farmers to select appropriate cultural and combine these cultures to obtain maximum benefits.

Crop diversification and production systems based on plant species resistant to salinity, are likely to be the key to the future agriculture and economic. This is relevant for arid and semi-arid countries less developed, where most farmers cultivate salt-affected land and the resources are poor and the communities experiencing severely unemployment, poverty and migration implicitly male population.

Contemporaneity of requires that these soils become a useful resource with economic value and not just an environmental problem, so their use should be considered as an opportunity to move from subsistence agriculture to progressive agriculture, and for that the farmers should adopt information resulting from research.

REFERENCES

Ahmad N., Qureshi R.H., Qadir M., *Amelioration of a Calcareous Saline-Sodic Soil by Gypsum and Forage Plants.* Land Degradation and Rehabilitation, *2*, 277-284 (1990).

Akhtar *et al.*, *Combined Effect of Salinity and Hypoxia in Wheat Triticum aestivum L and wheat Thinopyrum amphiploids.* Plant and Soil, **166**, 47-54 (1994).

Dagar J.C., Tomar O.S., Kumar Y., Yadav R.K., *Growing Three Aromatic Grasses in Different Alkali Soils in Semi-Arid Regions of Northern India*. Land Degradation and Development, **15**, *2*, 143-151 (2004).

Drew, *Plant Injury and Adaptation to Oxygen Defciency in the Root Environment a Review*. Plant and Soil, **75**, 179-199 (1983).

Eckelmann W., Baritz R., Bialousz S., Bielek P., Carré F., Houšková,B., Jones J.A., Kibblewhite. R. J.A., *Common Criteria for Risk Area Identification According to Soil Threats*. Research report no. *20*, Soil Information Working Group (SIWG), European Soil Bureau Network, 2006.

El-Mowellhey N., Proc. of the Internat. Symp. on Sustainable Manage. of Salt Affected Soils in the Arid Ecosystem,Cairo, Egypt, 21–26 September 1997, 1–2, 1998.

Eswaran H., Ial R., Reich P.F., *Land Degradation*. An Overview Conf. on Land Degradation and Desertification, Thailand, Oxford Press, New Dehli, India, 2001.

Gucci R., Tattini M., *Salinity Tolerance in Olive*. Horticultural Reviews, **21**, 177-214 (1997).

Husain S., von Caemmerer S., Munns R., *Control of Salt Transport from Roots to Shoots of Wheat in Saline Soil*. Functional Plant Biology, **31**, 1115-1126 (2004).

Kanwar J.S., Bhumbla D.R., *Physico Chemical Characteristics of Sodic Soils of Punjab and Haryana and their Amelioration by the Use of Gypsum*. Agrokem,Talajatan, **18**, 315-320 (1969).

Maas E.V., Hoffman G.J., *Crop Salt Tolerance - Current Assessment*. J. Irrigation and Drainage Division, ASCE 103 (IRI), 115-134 (1977).

Patra D.D., Singh D.V., *Medicinal and Aromatic Crops, in Agrcultural Salinity Management in Salinity*. Edit. Central Soil Salinity Research Institute Karnal, 499-506, 1998.

Singh D.V., Anwar M., *Effect of Soil Salinity on Herb and Oil Yield and Quality of some Cymbopogon Species*. J. of the Indian Soc. of Soil Sci., **33**, 362-365 (1985).

Sumner M.E., Rengasamy P., Naidu R., *Sodic Soils: a Reappraisal, in Sodic Soil Distribution*. Manag. and Environ. Consequences, Oxford Univ. Press, NY, 3-17, 1998.

Szabolcs I., Eu*ropean Solonetz Soils and their Reclamation*. Edit. Akadémiai Kiadó, Budapest, 204, 1971.

Tanji, *Nature and Extent of Agricultural Salinity*. Agricultural Salinity Assessment and Management,Tanji KK (ed) Manuals and Reports on Engineering Practices No. *60*, American Society of Civil Engineers, New York, 1-17, 1990.

Thomsen *et al*., *Nitrogen Conserving Potential of Successive Ryegrass Catch Crops in Continuous Spring Barley*. Soil use, **15**, *3*, 195-200 (1999).

West, Taylor, *Response of Six Grape Cultivars to the Combined Efects of High Salinity and Rootzone Waterlogging*. J. of the American Soc. of Horticultural Sci. 109, 844-851 (1984).

West, *Water Use and Sodium Chloride Uptake in Apple Trees II the Response to Soil Oxygen Defciency*. Plant and Soil, **50**, 51-56 (1978).

* * * *Diagnosis and Improvement of Saline and Alkali Soils*. US Salinity Laboratory Staff, US Salinity Laboratory Staf, USDA Handbook 59 US Government Printing Offce Washington DC, 1954.

* * * *Internet Glossary of Soil Science*. Soil Science Society of America, Available at http://www.soils.org/sssagloss/, (2006).

CARACTERISTICI ALE SOLURILOR SALINE ŞI VALORIFICAREA ACESTORA PRIN CULTIVAREA PLANTELOR TOLERANTE LA SALINITATE – REWIU

(Rezumat)

Solurile saline se caracterizează printr-un exces al cantității totale de săruri solubile cât şi a cantității de Na^+ schimbabil din complexul adsorbtiv al solului. Acest exces de săruri duce la modificări ale proprietăților fizice şi chimice ale solului, rezultând astfel un mediu impropriu pentru creşterea culturilor, salinizarea fiind una dintre cauzele majore ale scăderii productivității agricole. În contextul actual, la nivel mondial, ne confruntăm cu problema suprapopulării planetei lucru ce aduce în prim plan şi problema siguranței alimentare. Astfel că în ultimii ani s-a pus accent pe cercetarea, ameliorarea şi managerierea acestora pentru obținerea randamentului maxim. Abordarea acestei probleme impune coroborarea cercetărilor solurilor saline din punct de vedere fizic, chimic, microbiologic cu efectuarea complexă a amendamentelor şi o abordare managerială durabilă. Acest review abordează clasificarea şi caracterizarea solurilor sărăturate , diferite probleme create în agricultură , sintetizează cunoştințele de cercetare avînd în vedere gradul de toleranță a diferitelor specii de plante la salinitate şi evidențiază câteva culturi promițătoare pentru cultivarea pe aceste soluri cum ar fi creşterea plantațiilor forestiere, horticultură, agrosilvicultura, creşterea plantelor de înaltă valoare medicinală.

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ANALYSIS OF THE PHENOMENON OF INFILTRATION IN THE DAMS OF EARTH DEGRADED

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Abstract. Earth dams changes over in time is the structural condition. The earth dams present substantial discrepancies of the constructive and hydraulic parameters in comparison with those initially design. Structural change determines the changing parameters of infiltration phenomenon. The phenomenon of infiltration evolves from laminar flow regime to the transition and turbulent. Changing the flow regime led to the emergence of the phenomenon of sufozie in the body of a dam. The results revealed new safety parameters of the high water discharge structure and suggested modernization solutions.

Keywords: dams; infiltration; phenomenon of sufozie.

1. Introduction

Climate actions and mechanical changes modify the structural and functional parameters, of the dams of earth, in time.

The political and economic changes, which occurred in Romania after 1989, have in some cases determined the partial modification of functions in some hydrotechnic systems. In this case, the hydrotechnic system undergoes

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new demands not initially taken into consideration, while designing. These modifications affect the safety of exploiting by introducing supplementary risk factors. The hydraulic expertise allows for an analysis of the way in which hydrotechnic constructions behave in the new exploitation circumstances. What results are the characteristics of the new hydraulic regime and, at the same time, an insight into the safety measures required while exploiting.

Analysis of infiltration is carried out based on the measurements and researches of land to construction of water projects in operation. In certain situations has not been respected the way of structuring the material in body of earth dams.

In other situations have been changed while the height of the water. All these have influenced the process of infiltration through the body of the dam. The infiltration phenomenon passed in the field of linear flow in nonlinear field. The result of the change of regime is represented by seeping the emergence of the phenomenon of suffuse. Structural degradation over time affects the stability of the dam. Application of structural rehabilitation measures requires analysis of infiltration through the body of the dam.

2. The Dam of Land Degraded. Case Study

In the analysis it was considered a dam of ground where the process of infiltration has been modified over time negatively. New regime parameters of infiltration have imposed reducing the level of exploitation. The stability of the dam was influenced by lifting the curve of infiltration. The phenomenon of seeping through the body of the dam caused the training fine material (clay and dust).

The analysed hydrotechnic system is located in Northern Romania. The accumulation was deigned with the purpose of reducing flood waves with a probability of overflowing of 1% and 0.1%, irrigation, fish farming and supplying with water a town.

The hydrographic basin corresponding to the accumulation measures 310 km^2. The hydrotechnic system started to be exploited in the year 1979. In the later years the hydrotechnic system underwent several structural and functional modifications.

The storage basin is achieved through a frontal dam with a heterogeneous structure executed with local materials. The construction parameters of the dam are (Fig. 1): maximum height – 14.0 m, width at the crest – 5.0 m, length – 2,160 m, average width of the road territory - 80.0 m etc.

The storage basins specific volumes are: on the total – 46.2 million m^3, accumulated – 39.86 million m^3 at the maximum level of exploitation (p = 1% and elevation 243.94 m of reducing flood waves 24.60 million m^3 etc. The calculus discharges are: $Q_{1\%}$ = 330 m^3/s of the design discharge and $Q_{0.1\%}$ = = 516 m^3/s of the verification discharge. The flow absorbed from the basin for the water supply is Q = 0.75 m^3/s.

The upstream facing of dam is described by two slopes and is protected by a layer of riprap (in the initial project the slope was of 1:3.5 and the protection realized out the concrete slab). The downstream facing of the dam with 1:2 and 1:3.50 slope, shows two berms with a width of 2.0 m, located at an elevation of 239.50 m and respectively 234.50 m. The downstream slope presents a drainage system.

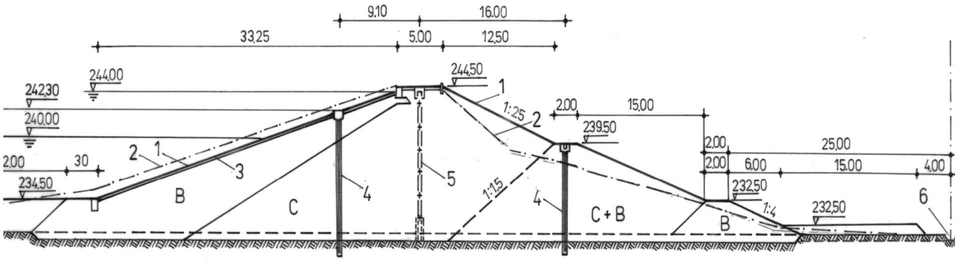


Fig. 1 – The transversal profile of the dam: *1* - the initial form;
2 - the present-day form; *3* - pitching of the concrete slab;
4- piezometer tubes; 5 - mark of depression; *6* - channel.

Fig. 2. – The downstream facing of the dam

After 30 years of exploitation, the dam shows a satisfactory functional status in what regards the structural integrity, its hydraulic response and its mechanical stability. After the year 1989, the functions of the hydrotechnic system were modified. At present, the achieved functions are: reducing the flood waves, water supplying of two towns, fish farming, tourist area, etc. Changing the initial function has determined, consequently, the designing and execution of several modifications in the dam's structure, as well as in that of the intake tower and execution of a supplementary intake tower.

The new conditions of exploitation have determined the maintaining of a raised retention level and the intense usage of the hydromechanics devices within the intake tower. At the same time, the hydrotechnic system has repeatedly undergone actions of an endogenous nature. These actions have led to a diminishing state of safety in exploiting the hydrotechnic system, especially of the earthen dam of the intake tower. The modification of the functioning conditions and the absence of corresponding constructions specific to earthen dams, now determine a decline in the safety of the exploitation (Fig. 2).

While exploiting the accumulation some important deficiencies have been noted, as a result of incomplete implementation of the execution design, of the interaction between the construction and the incorporating medium, of the action of the endogenous and exogenous factors, etc.

3. Research on Seepage Through the Dam Body

Theoretical and experimental studies have emphasized the following observations:

a) The dam presents a less slender transversal profile than which the design has specified.

b) Instead of the protective layer made out of concrete slabs of the upstream face of the dam there is a layer of riprap. As a result there is an active process of infiltration through the dam, with significant water loss from the storage basin. The infiltration current initiates and intensifies the internal erosion phenomenon.

c) The absence of waterproofing works of the dam has affected its stability, situation which has claimed imperatively a decline in the normal level of exploitation of the water in the storage basin.

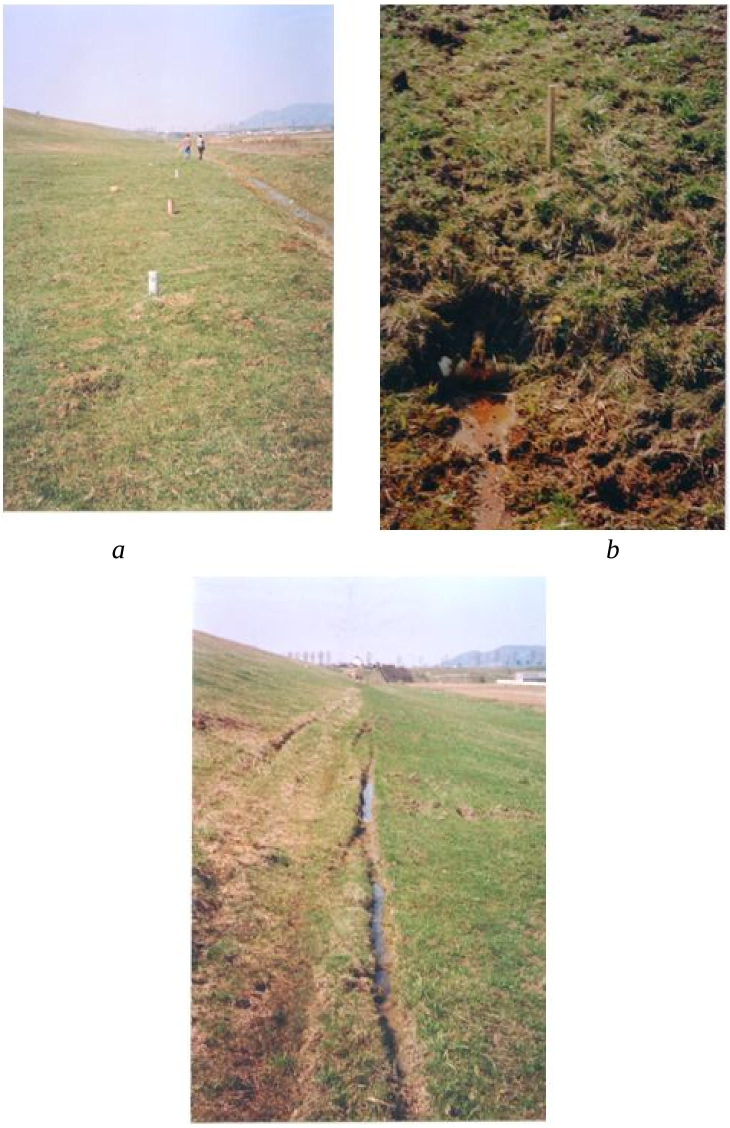
d) The drop-down curve rises to the surface at relatively high elevations on the downstream face of the dam, which affects its stability.

e) The internal erosion phenomenon and its effects in time have determined modification within the structure of the material within the dam's body.

f) The unequal subsidence of the emptying gallery at the old intake tower, with values up to 55 cm in its central area, due to the internal erosion phenomenon.

g) For normal pool level (NPL), boiling areas have been observed with ascending springs at the bottom of the collecting channel, but no dislodging of sold sediment.

h) The physical and chemical analysis of the water evacuated by relief well indicates the presence of clay, of the internal erosion phenomenon respectively. The reddish coloring of the evacuation channel of the infiltration waters confirms the existence of this phenomenon (Fig. 3). The absence of fine material in some relief well indicates that the internal erosion phenomenon is not permanent active.



a *b*

c

Fig. 3 – The effects of the phenomenon of infiltration over the dam: *a* – the relief well of the downstream facing of the dam; *b* – the fountainhead of the downstream face; *c* – the presence of water on the downstream face.

Field test have emphasized a relatively non-uniform stratification in the studied section of the dam. This stratification is made up two geological types: waterproof soils at the surface (dusty clay and argillaceous dust), under which lay cohesion less soils. The level of the underground water has been observed at depths of 1.60…4.80 m. This level is mostly located in the area of the waterproof formation at the surface. This shows the presence of a current under pressure located in the cohesion less deposits beneath the waterproof layer.

Researches conducted in the field have highlighted an intense sufozie process through the body of the dam (Fig. 4). This process is exemplified by the following structural and functional aspects:

a) in the body of the dam has been developed an active phenomenon of sufozie (involve material fine stream of water); this is determined by the structural hydraulic and causes;


a *b*

c

Fig. 4 – Marking of water transport loaded with fine material in the body of the dam: *a* – channel collectors; *b* – channel intersection node; *c* – channel.

b) the dam has not complied with the structuring of the layers of material;

c) the operation of the dam have not been observed water levels imposed by the project; the curve of infiltration was high on the downstream face of the dam;

d) the high level of water caused a hydraulic gradient that has exceeded a critical value; on certain sections of the dam appeared the phenomenon of sufozie;

e) the phenomenon of sufozie is highlighted by the transport of material from the body of the dam; this transport is uneven on the length of the dam;

f) the phenomenon of sufozie is marked on the ground by red clay components included in the body of the dam; water discharged by some downloading wells has the colour red on sections where there is present the phenomenon of sufozie;

g) on the downstream face of the dam water springs appeared; they show the appearance of flow paths in the body of the dam where no longer satisfied the law of linear filtration;

h) intense red colour of the water of the colourful grass of the downstream face of the dam in the mouth; it also has coloured in red pitching channels collecting water seeping.

For the calculus of the infiltration a computer programs has been used, compiled in Turbo Pascal, for homogeneous and heterogeneous dam (through the virtual method), with or without downstream waters, for drained dams.

The analysis of the infiltration process was carried out for the present day functional situations, as well as for the hypothesis of the rehabilitation and modernization of the dam. The verification was carried out in five different significant sections for calculus. New safety parameters for the dam corresponding modernization solution have resulted.

The analysed versions were the follwings:

Version 1: earthen dam with a drainage system, maximum level (p = = 1%, calculus insurance) with the subversion:

A – functioning drain of the downstream facing of the earthen dam;

B – blocked drain of the downstream facing of the earthen dam.

Version 2: earthen dam with a drainage system, maximum verification level (p = 0.1%) with the subversions:

A – functioning drain of the downstream facing of the earthen dam;

B – blocked drain of the downstream facing of the earthen dam.

Version 3: earthen dam with a central concrete/steel concrete diaphragm (the new design version), with maximum level and maximum verification level;

Version 4: earthen dam with a steel concrete screen (the design version).

The verification of the parameters of the infiltration phenomenon indicates a high diversity of values due to the heterogeneous composition of the filling materials and to the considered calculus hypothesis (Fig. 5). Even in the case of a functioning drain, there emerge situation in which the depression curve is in the close neighborhood of first berm and of the surface of downstream face of the dam, due to the characteristics of the material and the slender shape of the dam.

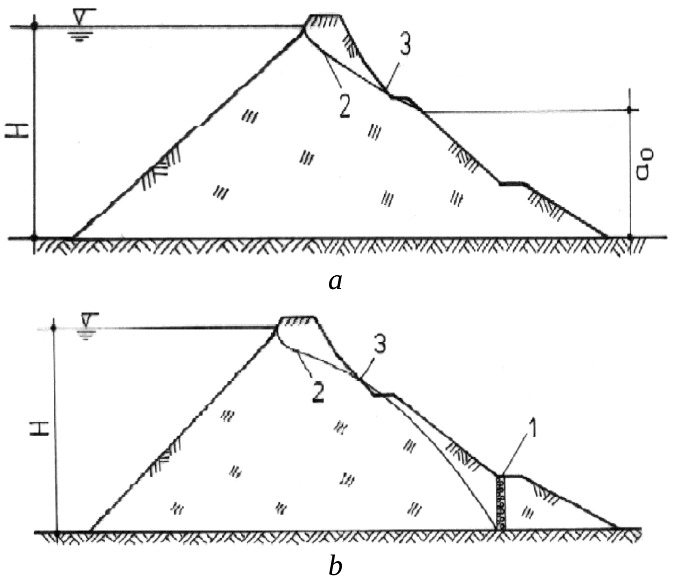


Fig. 5 – The position of the seepage curve in the maximum level hypothesis (p = 1%): *a* – blocked drain; *b* – functioning drain; *1* – drain; *2* – seepage curve; *3* – zone of the spring.

The analysis shows that the maximum level of infiltration through the dam is traced in calculus section *3* (near the first/initial intake tower, with the parameters of the material: k_{med} = 1.16 cm/s, ρ = 1.915,…,2.031 kg/m^3, ϕ = 8° 15…15° 35, C_{med} = 0.44…0.58 daN/cm^2). For the storage basin level with the calculus probability 1%, the maximum specific infiltrated flow is $q_{max} = 15 \times 10^{-8}$ m^3/sm, with the height of trickling downstream face of the dam of a_0 = 3.82 m (Fig. 2).

For the level with the calculus probability of 0.1%, calculus section **3** becomes the most strained, here the height of trickling downstream face of the dam of a_0 = 6.03 m is at its highest value and the depression curve intersects first berm. In the hypothesis of the blocked drain, the maximum specific infiltrated flow results in section **2**, with the value $q_{max} = 24 \times 10^{-8}$ m^3/ms. The means that a possible try to over-increase of the level of exploitation can determine the loss of the dam’s stability, due to the appearance of the springing phenomenon on the downstream slope at very high elevations (higher that 6.0 m).

General condition unsatisfactory structural and functional rehabilitation of the dam body was imposed. To stop the tide of infiltration was a vertical wall of reinforced concrete.

4. Conclusions

1. A partial or total modification of the initial functions of hydrotechnic system induces a series of new actions that can affect the safety in exploiting the system by inducing supplementary risk factors.

2. The special heterogeneous structure of the filling within the dam's body negatively influences its response to the infiltration waters, determining in some places mechanical erosion processes and scouring, even in the construction area and that of the incorporated equipment.

3. In the study case of the hearth dam, modifying the initial function, correlated with the absence of any waterproofing works undergone, led to the decrease in the normal retention level in order to avoid risking the dam's stability and loosing water from the storage basin.

4. The phenomenon of sufozie is developed in the body of the dam due to changes in the hydraulic gradient by using a higher level of water. The phenomenon is intense and affects the stability of the dam.

REFERENCES

Bartha I., Javgureanu V., Marcoie, N., *Hidraulica*. Vol. **2**, Edit. Performantica, Iaşi, 2004.

Carlier M., *Hydraulique générale et appliquée*. Edit. Eyrolles, Paris, 1972.

Crețu I., *Modele numerice pentru curgerea prin medii poroase*. Edit. Tehnică, Bucureşti, 1980.

Hobjilă V., Luca M., *Complemente privind proiectarea şi expertizarea unor tipuri de construcții hidrotehnice*. Edit. CERMI, Iaşi, 2000.

Marchidanu, E., *Hidrogeologia în ingineria construcțiilor*. Edit. Tehnică, Bucureşti, 1996.

Pietraru V., *Calculul infiltrațiilor*. Edit. Ceres, Bucureşti, 1987.

Prişcu R., *Construcții hidrotehnice*. Vol. **I**, Edit. Did. şi Pedag., Bucureşti, 1976.

Rațiu M., Constantinescu C., *Comportarea construcțiilor şi amenajărilor hidrotehnice*. Edit. Tehnică. Bucureşti, 1989.

Stematiu D., Constantinescu C., *Considerații privind analiza şi evaluarea riscului asociat barajelor*. Hidrotehnica, **43**, *5*, Bucureşti (1998).

* * * *Expertiză tehnică privind siguranța în exploatare a barajului Virşolț*. Contract de expertiză tehnică S.C. POLIASCAS S.A., Iaşi, 1997.

ANALIZA FENOMENULUI DE INFILTRAȚIE ÎN BARAJELE DE PĂMÂNT DEGRADATE

(Rezumat)

Pământul barajelor se modifică în timp şi mai ales îşi modifică starea structurală. Barajele de pământ prezintă discrepanțe substanțiale ale parametrilor constructivi şi hidraulici, în comparație cu cele inițiale de proiectare. Schimbările structurale determină parametrii de schimbare ale fenomenului de infiltrare. Fenomenul de infiltrare evoluează la regimul de curgere laminar, de tranziție şi turbulent. Schimbarea regimului de curgere a dus la apariția fenomenului de sufozie în corpul barajului studiat. Rezultatele au relevat noi parametri de siguranță ale structurii de evacuare a apei şi a sugerat soluții de modernizare.

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ISSUES ON THE SOIL POLLUTION DYNAMICS THROUGH EROSION RELATED PROCESSES AT "DEALUL BUJORULUI" VINEYARD, GALAȚI COUNTY

BY

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Abstract. The research conducted on the dynamics of the pollution process from non-punctiform sources of the slope lands took place at "Dealul Bujorului" vineyard, located in the S–E department of Covurlui plateau, Galaţi County.

The selection of this location is justified by the fact that the operation and maintenance of a vineyard plantation (20,…,30 years), in order to ensure the pest control protection, uses significant quantities of insecticide and fungicide products on an annual basis, and these products remain in the soil as residues.

Keywords: erosion; pollution; agricultural vineyard.

1. Introduction

Soil represents a receptor (basin) for pesticides, where these degrade or are gradually dispersed in the environment or are translated into plants, some of them persisting in the soil for many years.

The circulation of pesticides in the soil takes place in the form of solution, volatilization and mass transport, upon the migration of water or soil

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particles associated to the pesticide molecules, through discharge to the surface or by depth levigation on the soil profile.

The pesticide soil pollution generates unbalances, by impairing the physical, chemical and biological functions thereof. The removal of the pollutant is generally difficult and long-lasting. Through the erosion process the soil pesticide residues are mobilized and accumulate in the deposit areas of the material transported by the erosion discharges on the slope lands, and due to this fact it is considered that currently any system of actions and works forecasted for environment protection in the areas with erosion risk should take into consideration the involvement of erosion in the environment pollution process (soil, surface and underground water).

2. Location of Researches

Being aware that the persistence and degradation of these pesticide substances depend on the physical – chemical characteristics of the soil and on the climate conditions (temperature and humidity), the research was initiated within three experimental perimeters (with an average area of approximately 100 ha), regarding the status of pollution with products, under various pedo-climatic conditions (including long term drought) and specific anti-erosion systems (culverts – elevations, grassed bands, terraces).

The ecopedological factors and determinants of “Dealul Bujorului” vineyard can be characterized by:

- Annual average precipitations: 440 mm (max. 790 mm and min. 260 mm);
- Annual average temperature: 9.7ºC (max. 25.5ºC and min. –11.5ºC);
- High rain aggressiveness (ap = 1.03), frequency of torrential rain by i_{15} higher than 0.6 mm/min. represents 70.8%; the critical erosion season June 25 – August 25, position of the torrential core, mainly at the beginning of the rain;
- Hilly landscape, in the form of long interfluves and valleys approximately parallel on the NNS – SSW direction; absolute altitude of approximately 300 m, average slopes 10,…,15%;
- Predominant soils: alluvial clay black earth, impaired by erosional processes, characterized by:

a) medium and middle texture (sandy-clay and clay-sandy-clayish);

b) glomerular structure in the 0,…,30 cm layer; dark color in the upper horizon as a result of the balanced humus percentage;

c) water capacity in the field approximately 23.5%, with decreasing trend on the soil profile;

d) total porosity 47.4%, aeration porosity 14.6%, with decreasing trend on the soil profile;

e) apparent density 1.21,…,1.38 g/cm^3, with increasing trend as the depth increases, due to the higher compaction;

f) hydric regime obviously influenced by the physical characteristics of the soil: extremely good permeability for the water; level of the soil humidity higher in the 0,…,40 cm layer, compared to the water supply for the 40,…,100 cm layer.

g) pH between 7.30,…,8.30 and humus between approximately 2.50% in the 0,…,20 cm layer and 1.28% in the 40,…,60 cm layer.

3. Research Technique and Obtained Results

The soil samples were taken differently from the versant and anti-erosion arrangement manner: grassed bands (upstream and downstream); terraces with broad platform (upstream, downstream and witness). The soil samples were taken from a depth of 40 cm. Also, a soil sample was taken from the lower part of the versant (collovium) from the 0,…,20 cm horizon.

The soil samples were analyzed according to the A.O.A.C. method for the soil pesticides, and the results are set out in Table 1 and Fig. 1.

Please note that:

a) during the tests no active substances of the products used during the experiment for fight against grape vine blight and mildew were identified;

b) for the “DICAMBA” herbicide, the denomination (Table 1) was made in milligrams/kilogram

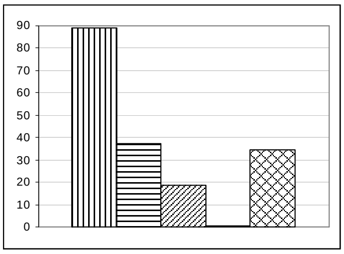
Table 1
Tests of the Soil Samples Residues

Compound/ sample (Micrograms/ kg)	Polygon I Upstream grassed bands	Polygon II Downstream grassed bands	Polygon I Upstream terraces	Polygon I Downstream terraces	Witness	Colluvium
α- HCH	89	37.5	18.7	–	34.4	–
γ-HCH	74.3	47.3	33.8	–	13.5	–
pp^{I}-DDE	40.9	64.6	38.8	–	–	–
pp^{I}-DDT	47.6	119.0	107.1	–	–	–
Dicamba	11.6*	8.7*	7.0*	5.6*	7.2*	5.0*

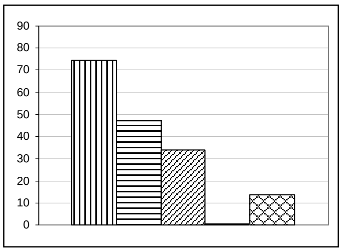
4. Conclusions

1. Due to the long-term remanence (14,…,15 years) of the organic-chloride products, these were found in the soil and grape vine leaves. The residues existing in the soil were: Aldrin, γ-HCH, α-HCH, by-products of DDT, traces of Dachtal and Chloroneb.

2. For the organic-chloride pesticides, the level of residues is within the normal ranges, the soil samples generally containing small quantities of α-HCH, γ-HCH, pp^{I}-DDE , pp^{I}-DDT.

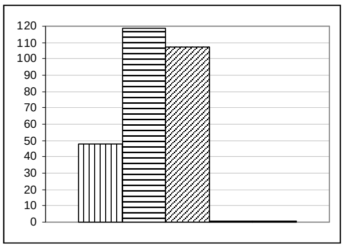


a) Sample: α-HCH

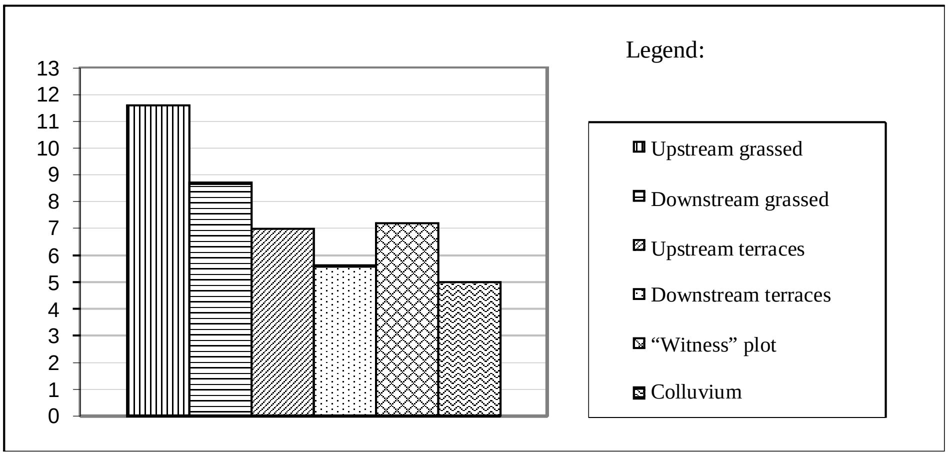


b) Sample: γ-HCH

c) Sample: pp^{I}-DDE



d) Sample: pp^{I}-DDT



e) Sample: **Dicamba**

Fig. 1 – Charts representing the residues content in the soil.

For instance, the quantity of α-HCH shows values between 89 micrograms/kg in sample 1 (upstream grassed bands) and 18.7 micrograms/kg in sample 3 (upstream terraces) and is nil in sample 4 (downstream terraces) and sample 6 (colluvium).

The content of pp^{I}-DDT is within normal ranges in samples 1, 2, 3 and is absent in samples 4, 5 and 6.

3. The residues originating from "DICAMBA" herbicide are found in significantly higher quantities compared to other ones; 11.6 mg/kg in sample 1 (upstream grassed bands) and 5.0 mg/ kg in sample 6 (colluvium). The explanation could consist of the fact that there existed a contribution from the neighboring areas, through the liquid discharges generated by precipitations or that due to the most recent use (compared to the soil sample taking moment), the disaggregation of the active substance was not fully completed.

4. Differentially, depending on the anti-erosion arrangement actions existing on the versants in order to preserve the ecopedological stability and certain ecopedological determinants, in the analyzed case we were able to show the existence of certain direct correlations, including with respect to the dynamics of residues from pesticides and nutrients. Thus, according to the data set out in Table 1, the content of residues is clearly lower in the downstream of grassed bands and terraces compared to the upstream thereof, due to the effect of such works intended for decreasing the erosion discharges on the versants.

One can consider that the amplification of the erosional process which generates the degradation of soil features also contributes to the degradation of active substances from the pesticides and the persistence of residues originating from them.

REFERENCES

Biali G., *Research on the Forecast of Erosion-Related Land Degradation on Large Areas, by Means of the Territory Information Systems Technique under the Specific Conditions in Romania*. Ph. D. Diss., "Gh. Asachi" Technical Univ., Iaşi, 2003.

Enache V., *Ecopedological Stability of Vineyard Lands in South Moldavia Through an Upgraded Technology on the Fight Against Soil Erosion and Diseases and Pest, with Low Pollution Degree*. "PAX Aura Mundi" Publishing house, Galați, 2004.

Enache V., *Research on the Ecological Implications of Erosion Processes at the Vineyard Plantations Located on Slope Lands in South Moldavia; with Reference to Dealurile Bujorului Vineyard, Galați County*. Ph. D. Diss., "Gh. Asachi" Technical University, Iaşi, 2004.

Popovici N., Gheorghiu E., Oancea E., *L'influence des quelques caracteritique du sol dans le vignoble Odobeşti, le departament Vrancea*. Bul. Inst. Politehnic, Iaşi, **XXV (XXIX)**, *1-4*, Section VI, 1979.

Răuță C. et al., *Prevention and Fight Against Soil Pollution*. Ceres Publishing house, Bucharest, 1989.

ASPECTE PRIVIND DINAMICA POLUĂRII SOLULUI PRIN PROCESE EROZIONALE ÎN POGDORIA „DEALUL BUJORULUI", JUD. GALAȚI

(Rezumat)

Cercetările întreprinse asupra dinamicii procesului de poluare din surse nepunctiforme de pe terenurile în pantă, s-au desfăşurat în podgoria „Dealul Bujorului", aflată în compartimentul de S–E al podişului Covurlui, jud. Galați.

Opțiunea pentru această locație se justifică prin faptul că în perioada de exploatare şi întreținere a unei plantații viticole (20 – 30 ani), în scopul protecției fito-sanitare se folosesc anual cantități semnificative de produse insecto-fungicide care se găsesc în timp în sol sub formă de reziduuri.