# PROTECTION OF HILL LAKES THROUGH EROSION CONTROL WORKS

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## ABSTRACT

Soil erosion has a great impact on reservoirs, owing to sedimentation and the degradation of water quality. There are made erosion and sediments effluence differentiation in a watershed with erosion control works and same watershed without erosion control works. The comparative analyze of these tow situation, with erosion control works and same watershed without erosion control works, set of some conclusions.

The erosion is reduced under acceptable limits; a proper cultivation structure mixed with erosion crop system reduced erosion and sediment effluence; a good erosion control works capitalized efficiently rainfall, surface runoff are reduced; an adequate reclamation of outlet network reduces gully erosion; ensemble of land reclamation (cultivation structure, erosion crop system, erosion control works on outlet network) reduces erosion and sediment effluence with 23%.

## RESEARCH LOCATION

The Cuibul Vulturilor reservoir, located in Eastern Romania in the watershed of the Tutova River, flowing through the Tutova Hills, at 34.5 km from the source, provides a part of the water necessary for the population of Bârlad city.

The reservoir was formed along with the erection of an earth dam (17 m in height and 843 m long at crest) with a central weir and a laterally spillway on the right bank. In 1978 it was taken into exploitation, with the following planned characteristics (from Normal Retention Level): available water volume – 9,500,000 m³, dead storage capacity – 300,000 m³, annual sedimentation ratio – 10,000 m³.

According to annual mean sedimentation ratio in this reservoir yearly enter about 221,430 m³ sediments but from the area located in the vicinity of the reservoir enter about 98,755 m³ sediments that mean 65 % from all sediments step in the reservoir in one year. From these volume of sediments that provide from the area located in vicinity of the reservoir 13.1 % provide from the hill slopes and 86.9 % provide from the watersheds.

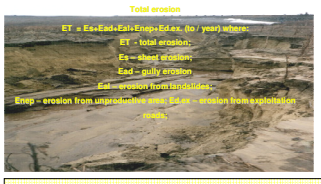
This value show that the contribution of the watersheds located in vicinity of reservoir direct overflow in the reservoir is the most important quantitative in comparative with the hill slopes.

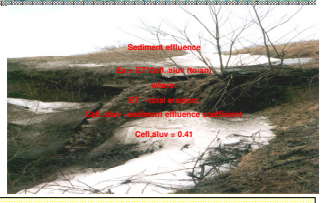
## RESULTS

•In the vicinity of Cuibul Vulturilor reservoir there is the watershed Cârjăoani a valley gully. From this watershed about 1872 hectares it was proposed to appropriate an erosion control works, with ought changing the land use (Table 1), through an adequate crop structure, erosion control measure and erosion control works on the outlet network for showing the effect of these works on the sedimentation process.

•Before reclamation: Crop structure - straw cereals 38 % / cultivator plants 62%; non erosion measure up and down cultivating; the outlet network with ought erosion control works.

•After reclamation: Crop structure - straw cereals 68 % / cultivator plants 24 % / yearly leguminous plants 8 %; erosion measure – contour, split and strip farming, banquet terraces; the outlet network (three zone from the upstream to downstream) first zone 7 working (earth dam 4-5 m in height), second zone 6 working (earth dam 5-6 m in height), third zone without working.




For erosion calculation, in both cases relationship used it where:

Es = K*S*C*Cs*L0.3*I1.4 (to/ha/an) where: K – rainfall aggressively, S – soil erodabillity coefficient, C – crop structure coefficient, Cs – crop cultivating system efficiently coefficient, L –slope length, I – slope land;

Ead =Vs*Sad (m3/an) where: Vs – sediment volume transported in active sector, Sad – stretched active area;

Eal = Eal*Sal; where: Eal was calculated with USLE equation consider that the surface of landslide like an area with ought vegetation, Sal – stretched active area;

Enep = Enep *Snep unproductive area are considered like an area with ought vegetation;

Ed.ex = Ed.ex*Sd.ex; road area are considered like an area with ought vegetation (at road or level

Table 1

Land use and homogeneous calculation area from smallwatersheed Cârjăoani

| Land use | Area (ha) Before improvement ha | % | After improvement ha | % | Homogeneous calculation area (nr.) |
|---|---|---|---|---|---|
| Arable | 1237.44 | 66.10 | 1237.44 | 66.10 | 51 |
| Pastures | 302.60 | 16.16 | 302.60 | 16.16 | 24 |
| *TOTAL agriculture area* | *1540.04* | *82.27* | *1540.04* | *82.27* | *75* |
| Forestry | 207.90 | 11.11 | 207.90 | 11.11 | 27 |
| Constructions | 62.65 | 3.35 | 62.65 | 3.35 | 1 |
| Unproductive | 61.75 | 3.30 | 61.75 | 3.30 | 3 |
| Total | 1872.00 | 100.00 | 1872.00 | 100.00 | 106 |

Table 2

Erosion and sediments effluent from Cirjaoani watershed

| Erosion forms | Erosion: Before improvement to | to ha | % | After improvement to | to ha | % | Sediments effluent: Before improvement to | to ha | % | After improvement to | to ha | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sheet erosion, whom: | 30581 | 17.5 | 100 | 6725 | 3.8 | 22 | 12538 | 7.2 | 100 | 2759 | 1.6 | 22 |
| from arable | 27562 | 22.3 | 100 | 5506 | 4.5 | 20 | 11300 | 9.1 | 100 | 2260 | 1.8 | 20 |
| from pasture | 3008 | 9.9 | 100 | 1112 | 3.7 | 37 | 1233 | 4.1 | 100 | 456 | 1.5 | 37 |
| from forest | 11 | 0.1 | 100 | 11 | 0.1 | 100 | 4.4 | 0.0 | 100 | 4.4 | 0.0 | 100 |
| from gully erosion | 541 | 8.8 | 100 | 324 | 5.3 | 60 | 222 | 3.6 | 100 | 133 | 2.2 | 60 |
| from roads | 0.3 | 0.1 | 100 | 0.3 | 0.1 | 100 | 0.1 | 0.0 | 100 | 0.1 | 0.0 | 100 |
| TOTAL | 31123 | 17.2 | 100 | 7054 | 3.9 | 23 | 12760 | 7.0 | 100 | 2892 | 1.6 | 23 |



There are tow determination case and from both case there are tow characteristic moments

Case t< tc moments t and t+Δt

Case t>tc moments tc and t

where:

t- time from beginning of the runoff through the end of rainfall

tc - concentration time on slope

Δt – time when the height of runoff remain constant after the rain finished

Table 3

Height of runoff from 10% assurance in Cirjaoani watershed

hs = hrain-hi-hr

Where:

hs- height of runoff

hrain - height of rain

hi – heigt of infiltration

hr – height of retention

| | 00-05 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Before improvement | | | | | | | | | | | | |
| hs(mm) | 8.50 | 10.00 | 11.50 | 12.50 | 12.75 | 12.75 | 12.25 | 11.75 | 10.00 | 8.50 | 8.25 | 8.00 |
| After improvement | | | | | | | | | | | | |
| hs(mm) | 5.75 | 6.50 | 9.50 | 9.75 | 10.00 | 9.50 | 9.00 | 8.00 | 7.00 | 6.50 | 6.50 | 6.00 |
| Debitmax(l/s) | 11.8 | 15.0 | 17.8 | 22.0 | 21.6 | 25.5 | 26.6 | 29.8 | 30.0 | 31.2 | 31.3 | 25.3 |

Table 4

Maximum flood discharge on going out section of Cârjăoani watershed

*Flood discharge are calculated at tow case and tow moments*

*Cases:*
*t< tc and t < tc*

*Moments:*
*t and t+Δt*

*where:*

*t - time from beginning of flow to finish of rain*
*tc - concentration time of slope flow*
*Δt – time when the height of flow on slope is maintained constant*

| Time | 10 | | 20 | | 30 | | 40 | | 50 | | 60 | | 70 | | 80 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Case | t>tc | t<tc | t>tc | t<tc | t>tc | t<tc | t>tc | t<tc | t>tc | t<tc | t>tc | t<tc | t>tc | t<tc | t>tc | t<tc |
| Moment | t | t+Δt | t | t+Δt | t | t+Δt | t | t+Δt | t | t+Δt | t | t+Δt | t | t+Δt | t | t+Δt |
| Qba | 0.10 | 4.54 | 1.00 | 12.59 | 2.28 | 16.64 | 3.72 | 19.39 | 4.62 | 19.76 | 5.18 | 19.33 | 5.05 | 17.46 | 4.61 | 15.76 |
| Qas | 0.05 | 3.09 | 0.17 | 4.04 | 0.87 | 9.20 | 1.23 | 9.60 | 1.61 | 9.99 | 1.59 | 8.84 | 1.51 | 7.78 | 1.28 | 6.38 |

## CONLUSIONS

-The comparative analyze of these tow situation, with erosion control works and same watershed without erosion control works, set of some conclusions:

-The erosion is reduced under acceptable limits (17.2 m³/ha without erosion control works relative to 3.9 m³/ha with erosion control works);

-A proper cultivation structure mixed with erosion crop system reduced erosion and sediment effluence with 20%;

-A good erosion control works capitalized efficiently rainfall, surface runoff are reduced with 11-30%;

-An adequate reclamation of outlet network reduces gully erosion with 60%;

-Ensemble of land reclamation (cultivation structure, erosion crop system, erosion control works on outlet network) reduces erosion and sediment effluence with 23%.

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