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Review

Prevention of Rain Erosion on Sloping Terrains

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Abstract

The researches conducted worldwide have shown that a land deprived of vegetation is sensitive to degradation processes. Annually, eroded land area increase on average by 0.9%, while annual losses of topsoil are estimated at about 126 million tones. This interest in preventing of rain erosion is due to the consequences of this phenomenon on soil fertility and associated processes: reducing transport capacity of the river system, clogging lakes and socio-economic objectives, land and water pollution.

Keywords: topsoil degradetion, slope consolidation.

1. Soil degradation features and facts

Among processes affecting soil quality, erosion actually show the biggest interest, both in terms of damage and the affected areas [1, 5, 20, 26,39, 66, 83, 90, 96, 100, 101]. Erosion process is the most harmful, causing average annual loss of soil amounts of 18.1 t / ha in North America, 13.0 t / ha in Europe, 40 t / ha Asia and 100 t / ha in Africa [81].

In Europe, 12% of the area (about 115 million hectares) is affected in various degrees of water erosion, and 42 million hectares are affected by wind erosion [7, 8, 27, 28, 31, 45, 62, 86, 92, 93, 95, 102].

In Romania land cultivated on slopes occupies 43% of the country's agricultural land [6]. Among land uses, orchards are most affected (65.6%), followed by natural meadows (58.3%); and around 20% of total land uses are arable land and landslides [65]. The percentages of Romanian land located on the slopes, are as follows [10]: slope between 5.1 to 8.0% - 1,257,250 ha (17%); slope between 8.1 to 12.0% - 1,489,762 ha (21%); slope between 18.1 to 25% - 1,446,765 ha (20%); slope between 25.1 to 50% - 963.802 ha (13%); with a slope of more than 50% - 332.528 ha (4%).

Also the numerous experiments carried out at the national scale [66, 70, 71, 36, 98,12], led to the establishment of the soil tillage practices on sloping terrains, differentiated in terms of hydrological soil amelioration and anti-erosion management. Soil combating remains a matter of strict actuality issues of numerous studies and research [4, 40, 60, 87, 6, 73, 13, 52, 22, 47, 16, 52].

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2. The mechanism of soil erosion

Soil erosion includes removal (detachment and entrainment), transport and deposition of soil particles caused by one or more natural or human factors such as: rain water leaking on the slope, wind, gravity, and plowing [99, 85, 59, 34, 103, 41, 88, 61, 24, 42, 37, 21, 29, 84, 76, 105, 57, 78, 23, 22, 47, 5].

Rain erosion is one of the most significant forms of topsoil degradation [102] triggered by raindrops hitting the ground surface or water overland flow with (1) diffuse mottle and non directional mottling – sheet erosion, (2) diffuse mottle and linear mottling across the contour – rill erosion, (3) linear with dendritic or parallel pattern – gully erosion [77, 22, 14, 15, 32].

Rain erosion features includes detachment of soil particles and their transport by air, due to the kinetic energy they have when raindrops reach the topsoil [67, 80, 30, 55, 33, 43, 38, 25] (Fig. 1). This form of erosion occurs by hitting the soil aggregates by raindrops, in their fall. In torrential rain, there is an increase of the raindrops size up to 6-8 mm diameter.

Following the fall of drops, soil particle or aggregates break and once with water, soil is splashed around [46, 9, 104, 58].

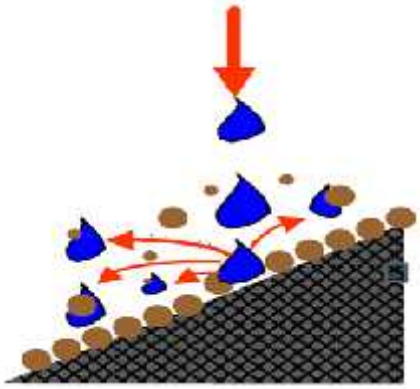


Figure 1. The effect of raindrops falling to the ground
Source: ttp://www.romfiminvest.ro/documents/Controluleroziuniisolului.pdf

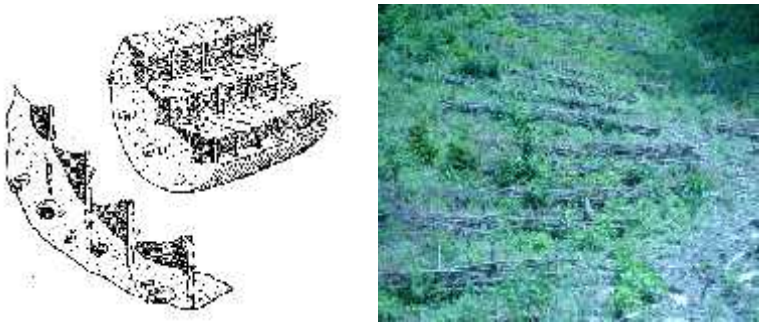
The water not entering in soil by infiltration during rain or snowmelt, on sloping terrains, will sum the surface runoffs. The overflow increases the flow energy particle capable of soil or rock coach.

The runoffs starts when the rain intensity or snowmelt speed exceeds the water infiltration and retention capacity of the small bumps on the surface of the land.

This erosion takes place in two phases: phase loosening material and particle transport, water uploading and solid material is dispersed through the impact of raindrops. Material transport occurs through dragging by leaps and suspended [11, 83, 77].

3. Classic and modern techniques for slope consolidation

Wattle fences are some works made by weaving thin branches with reinforcing a bed, hill or a slope degraded (Fig. 2). Wattle fences can be placed on one line - simple wattle fences or two rows – double wattle fences, from 0.50 to 1 m in height and the distance of 0.40 to 0.80 m between stakes



. b.

Figure 2. Wattle fences: a. application of the slope; b. a slope arranging with wattle fences
Source: a. https://www.crd.bc.ca; b www.google.ro/search?tbm=isch&q=cleionaje&

Gabions are quadratic or cylindrical boxes or cages with walls tied together with wire filled with rocks, concrete, or sometimes sand (Fig. 3). There are usually used two types: box gabion and cylindrical gabion.

a.   b.

Figure 3. Gabions: a. gabion structure; b. a slope arranging with gabion
Source: a. http://www.gabionbaskets.net; b. http://www.gabionindia.com

For structure strength of gabions is using concrete steel by 10 to 18 mm or galvanized steel bars, and for wire mesh used it is used galvanized wire from 3-4 mm which is filled with rough stone or boulders. Gabions are set directly in field.

Grasscrete (Fig. 4) is a system of reinforced concrete block paving, grassing cast on sites that allow the surface to be paved. It is a solution to harmonize with the natural environment, successfully used by architects in the UK, USA, Europe, China (Hong-Gong) and other countries, with a particular aesthetic effect in the urban landscape.

Resistance platform created draining properties of the system, together with a natural paved surface, make this system ideal for paving access roads, parking lots, highway service areas, and water streams.

  b.

Figure 4. Cellular paving with grass: a. application of the slope; b. a slope arranging
Source: a. http://www.terram.com; b. http://www.sustainablepavingsystems.com

Figure 5. Technology PratiArmati
a. consolidation of a slope using technology PratiArmati;
b. comparison between technology PratiArmati and traditional plant
Source: http://www.pratiarmati.it

PratiArmati (Fig. 5) is a environmentally friendly technology building slope against erosion.

Reinforce Prati technology uses a mixture of perennials (Gramineae, mushrooms and legumes). System radica can reach up to 5 m deep, has a very fast growth in 12 months can reach up to 2 m high radical density of more than 10 roots per cm^2 and can reach up to 50 roots after a year of seeding, the root system is thin with a diameter of between 0.1 and 3 mm and is homogeneous. The minimum tensile strength up to 205 Mpa roots (20.5 Kg / mm^2) [91].

Biodegradable nets (Fig. 6) are made up entirely of jute, jute cloth is biodegradable and recyclable degrade 2, 3 years old, so it is environmentally friendly.

Jute is recommended as an anti-erosion system on natural slopes, slope protection on sensitive soils against erosion phenomenon, also maintain soil moisture and increase water infiltration.

Jute acts as mulch for growing vegetation [19, 3, 94, 48, 44].

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a ***Figure 6.*** Nets biodegradable jute; a. application of the slope jute; b. detail jute
Source: a. www.hy-tex.co.uk / b. http://www.ecomerchant.co.uk

Organic fiber matrix (Soil guard) (Fig. 7) is a modern technique for stabilizing degraded land, is performed by the Research and Development department Weyerhaueser is an organic membrane that extends anti-erosion hydraulic seeding. Soil Guard System consists of wood fibers (poplar, pine, oak), mixed with a binding agent colloidal fluid and vegetables.

Hydraulic Application of allows a uniform spray mixture from a great distance and inaccessible areas.

Typical applications include residential lawns, golf courses, embankments, stabilizing water courses [54].

Geotextiles (Fig. 8) are permeable materials used in construction, and are textile products with technical uses.

Geotextiles is in the form of blankets or simple and resistant textile layers with thickness of 1 cm, a width of 3 m, 6 m and 10 m lengths escalators in large bales [18, 49, 35].

a.   b.

Figure 7. Soil Guard: a. application of the slope; b. fiber matrix
Source: a. [54]/ b. www.emeraldseedandsupply.com

a.   b.

Figure 8. Geotextiles: a. Application of the slope; b. geotextile roll
Source: a. http://your.kingcounty.gov/kcdot/roads/cip;
b. www.google.ro/search?q=geotextiles+roll&biw

Grass or woody vegetation is the most important factor for the protection and conservation of soils slopes. The role of vegetation is closely related to cover degree of development, having an overwhelming influence on soil protection through its direct or indirect, depending on the density, consistency and duration of protection. [71, 11].

Vegetation also has a favorable effect by retaining a portion of water from rainfall, reducing leakage and hence erosion. The root system of herbal and woody vegetation provide soil reinforcement profile on where it grows, thus increasing the soil aggregates and tear resistance and also washing - contributing to soil structure, it provides a good internal drainage [77].

The number of natural and cultivated plant species began to decline more and more, because it impoverishes soil erosion and sometimes accumulate toxic side products. Pair species must take into account the following aspects: during sowing and the area covered during the seasons aesthetically pleasing, high protection against water erosion, a large number of perennials [79]. The moment in which cover species are selected for stabilization of degraded land is very important to have an increase rapid root system to support soil [2].

Anti-erosion vegetation behavior differs depending on the characteristics and species, so are plants that offer very good protection against erosion and plants that provide little protection against soil erosion. The effects of vegetation on soil erosion led to the establishment of criteria and classification of vegetation, depending on the degree of protection that can provide on sloping land.

4. Conclusions

The main consequence of erosion is changing soil characteristics. Erosion affects the physical, chemical and biological soil. The erosion of arable horizon texture changes due to displacement and transport, in particular, fine particles of the solid phase of the soil. The texture changes but also because the erosion lower horizons are updated with size less favorable composition than that of plants grown with humus horizon [89].

Studies by Purnavel et al. (1994), about the degree of clogging accumulations basin "Tutova", shows that the annual rate of clogging of these facilities is very high (4.12%) compared to that in projects, estimating their removal in use after about 20 to 25 years. Simultaneously, surface waters are polluted with nitrates and especially phosphorus that cause eutrophication their items.

Research carried out in France, have determined that 2% of nitrogen and 3% of phosphorus fertilizer applied to crops are found in

shallow waters. At the country level, it is estimated that 40% of phosphorus pollution arises from agricultural activities [82]. Fertilizers N and P, like manure from livestock farms are likely to cause groundwater contamination. For example, the average amounts of nitrogen washing the inclined surfaces in France are between 20 and 40 kg / ha · year. At national level in aquifers reach on average 28 kg / ha · year [50, 63].

Regarding soil pollution and especially those located on the slopes on which crops are established intensively, nitrogen accumulation, especially mineral or organic pesticides cause repercussions on soil micro-flora [54, 64, 51, 74, 75].

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