STUDY ON FACTORS THAT INFLUENCE WATER EROSION ON AGRICULTURAL LAND - REVIEW

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Abstarct. Soil erosion is a global threat to the natural resources and is particularly responsible for reduction in crop yield due to reduction in land productivity and storage capacity of multipurpose reservoirs due to continuous siltation (Rupesh Jayaram Patil, 2018). Soil erosion is process of soil loss. Particularly from the surface, but sometimes a large mass of soil may be lost, as in landslides and riverbank erosion. Soil erosion processes are mainly caused by two mechanisms: raindrop impact and surfacewash resulting fromwater in excess of infiltration (Ellison, 1947). Soil erosion is determined by a number of factors such as: relief, climate, soil and solidification rock, vegetation. Soil erosion is a natural process, occurring over geological time, and most concerns about erosion are related to accelerated erosion, where the natural rate has been significantly increased by human activity. Soil erosion poses severe limitations to sustainable agricultural land use, as it reduces on-farm soil productivity and causes the accumulation of sediments and agro-chemicals in waterways (Boardman et al., 2007).

Keyword: soil erosion, water, factors affecting

THE PROCESS OF SOIL EROSION BY WATER

Soil erosion is a global threat to the natural resources and is particularly responsible for reduction in crop yield due to reduction in land productivity and storage capacity of multipurpose reservoirs due to continuous siltation. Accelerated soil erosion has adverse economic and ecologic impacts. The assessment of the risk of soil erosion can be helpful for land evaluation in the region where soil erosion is the major threat to sustained agriculture, as the soil is the basis of agriculture production (Rupesh Jayaram Patil, 2018).

Erosion is manifested with high intensity on sloping lands erosion is manifested with high intensity on sloping lands and on sandy lands by the action of water or wind, if they are not protected by a compact vegetation mat, consisting of grassy vegetation or forest (Parichi, 2007; Measnicov, 1987). Soil erosion is the detachment, entrainment and transport (and deposition) of soil particles caused by one or more natural or anthropogenic erosive forces (rain, runoff, wind, gravity, tillage, land levelling and crop harvesting) (Terrence *et al*., 2002; Edward, 2013; Klaus et al., 2010; Jondal *et al*., 2011; Boardman et al., 2006, Krishna, 2014; Thorpe *et al*., 2011; Beatriz Aguilar Alinquer, 2013).

The action of the two agents, water and wind, increased by human intervention as a farmer. By destroying forests, clearing pastures and hayfields on steep slopes and thin soils, as well as using irrational methods for cultivating sloping land, human has inadvertently intervened to trigger soil erosion and thereby increase its fertility (Parichi, 2007).

Ionescu, 1925 soil erosion is considered one of the greatest calamities of agriculture; research began with observations on the phenomenon and field experiments on runoff plots in different river basins, based on which relationships were established between erosion and factors involved in this process and established the average annual rate of erosional degradation and its variations on different pedological processes and cultural systems. The data obtained were used to calculate the universal formula of soil erosion, to establish the admissible annual soil losses (maximum 5-6 t / ha), to zoning the total specific erosion on agricultural lands, as well as to establish the crop losses due to erosion (Staicu, 1943, Moțoc, 1956, 1963, 1982, 1987, Moțoc et al., 1975, 1992, 1995, Luca, 1970, 1972, Teodorescu et al., 1988).

Water erosion is caused by water – water that comes in rain and runs off the land as overland flow or streamflow. At the initial stage, soil particles are detached from aggregates by the impact of falling raindrops or flowing water, which is followed by transport of the detaches particles by runoff water. Runoff water laden with suspended particles also detaches more soil particles in its way across the surface.

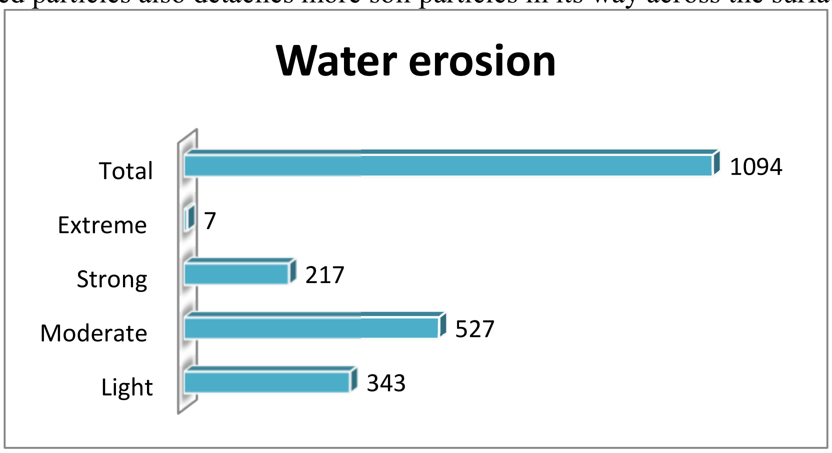


Fig. 1. Extent of human-induced soil degradation by erosion (million hectares)
Lenght: somewhat reduced productivity which can be restored by local farming systems. Moderate: greatly reduced productivity which can be restored by use of structural measures such as terracing and contour banks. Strong: land cannot be reclaimed at farm level, restoration requires major engineering works. Source: (Oldeman, 1994)

It is estimated that about 1.960 M ha of land are prone to erosion, which represents about 15 % of the Earth′s total land area, of which 50% is severely eroded and much of that is being abandoned. On-site effects of water erosion include soil loss and loss of organic matter as well as nutrients (10 mm topsoil loss equals to 350 kg ha-1 N, 90 kg ha-1 P and 1000 kg ha-1 K). Other on-situ effects are surface sealing and soil compaction, exposure of roots, deformation of terrain, difficulty in tillage operations, exposure of subsoil, reduction in growth and yield of crops, loss of growing crops, decline in soil quality and reduced capability of ecosystems function Figure 1 (Khan Towhid Osman, 2014).

Soil erosion is process of soil loss. Particularly from the surface, but sometimes a large mass of soil may be lost, as in landslides and riverbank erosion. Soil erosion processes are mainly caused by two mechanisms: raindrop impact and runoff erosion resulting from water in excess of infiltration (Ellison, 1947).

RAINDROP EROSION

The characteristics of the rainfall have a significant effect on the magnitude of splash erosion. The other factors which affect this type of soil erosion are, the type of soil, land topography and the vegetative cover. The intensity of rainfall is dependent on the drop size, the number of drops per unit area and the duration of rainfall. The erosive capacity of the raindrop varies with the distribution of different sizes of the raindrop during the storm Figure 2 (Ghanshyam Das Ojha, 2008).

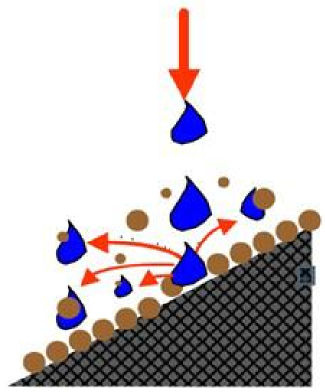


Fig. 2. The effect of raindrops falling on the soil
Source: http://www.romfiminvest.ro/documents/Controluleroziuniisolului.pdf

Fig. 3 Form raindrops
Source: http://books.google.ro/books?id=7UejVLCJZWAC&pg

This form of erosions is caused by raindrops hitting the soil aggregates in their fall. In torrential rains, the size of the raindrops increases, so it can reach a diameter of 6-8 mm Figure 3. As a result of the drops falling, the soil particle or aggregate breaks and once with the water, it is sprayed around the soil (Laflen *et al.*, 2000; Bryan *et al.*, 2006; Zekay, 2008; Measnicov, 1987).

The rate of raindrops is influenced by their shape, size and height, as well as wind, which usually accompanies torrential rains. The shape of raindrops depends on their size and can be almost spherical, with small drops with a diameter of less than 2.9 mm or with a flattened base at the bottom, with drops with a diameter of more than 2.9 mm. due to the kinetic force with which the air resistance acts. The speed of falling raindrops at the time of impact (final speed), depending on their diameter, has values between 5 m / s for drops with a diameter of 1.25 mm and 9.5 m / s for drops with a diameter of 5.0 mm (Budiu et al., 1996). A raindrop has a kinetic energy at the moment of impact, almost 1,000 times higher than the same amount of water that flows to the surface of the ground in the form of a continuous canvas (Budiu et al., 1996).

When raindrops come in contact with a flat ground, it develops an energy that entraines the soil particles, dissolves them, divides them into finer particles, thus reducing the volume of the pores and causing the threshing process, especially when the soil does not have a continuous protective layer. The soil becomes less permeable to water and air. On a sloping ground, under the action of raindrops, a large amount of soil is transported from upstream to downstream, because the splash is mostly 70-80%, downstream and only 20-30%, upstream, depending on the slope of the terrain and the angle of fall of raindrops. Soil erosion is maximum when raindrops fall at an angle of 45^0 to the horizontal (Budiu et al., 1996).

RUNOFF EROSION

After the stoppage of rainfall on standing water, the sediment form starts settling down by following the Stokes low. The finer soil particles settle at the end, which in turn block the pore spaces of the soil surface and reduce its infiltration rate capacity. The direct impacts of raindrops also reduces the infiltration rate by breaking the capillaries of the soil surface. This reduction in infiltration rate, increases the runoff rate from the land surface Figure 4 (Ghanshyam Das Ojha, 2008).

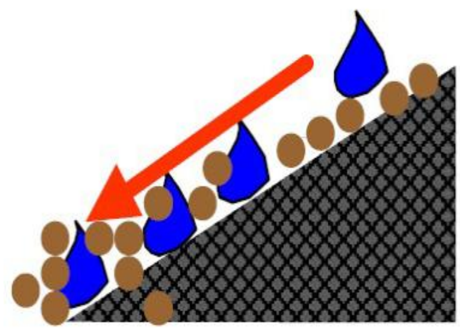
a)   b)

Figure 4. Erosion caused by surface water runoff

Source: a. http://www.google.ro/search?q=scurgerea+apei+eroziune&hl=ro

b.www.romfiminvest.ro

With an increase in the steepness of the land slope, the flow velocity of the runoff increases along with an increase in the tractive force of runoff. The increase in tractive force is proportional to the square of the velocity, and it scrapes the soil particles from the land surface with a force that increases in the same proportion. The volume on the sediment transported by runoff is proportional to its volume, and the intensity of detachment of soil particles is dependent on the chemical and physical properties of the soil (Ghanshyam Das Ojha, 2008). This type of erosion is known as rill erosion when the runoff is initially concentrated into small channels (rill) and gully erosion when the rills converge tor form large channels (gullies). In the third and final step of erosion, soil is deposited when water comes to rest or decreases in speed (Gordon B. Bonan, 2002).

Table 1

Factors affecting the erosivity of rainfall

Amount	Intensity	Terminal velocity	Drop size
• More rain results in more erosion although this correlation depends on rainfall intensity. • Amount of the rain is a function of duration and intensity of rain. • Measurement of the amount of rain is influenced by the type, distribution and installation protocol of the rain gauges. • Height of rain gauges and wind drift affect measurement. • Available measured data are only point estimates of a large area	• Intensity is the amount of rain per unit of time (mm h^{-1}). • Intensity is normally<70mm h^{-1} in temperate regions, but it can be as high as 150 mm h^{-1} in tropical regions. • Intense storms are often of short duration. • Intensity is directly correlated with erosion. • The more intense the rain, the greater is the soil erosion. • Many erosion models use kinetic energy based on rain intensity. • Intensity is obtained from daily rain gauges with charts and computerized systems.	• Reindrop acceleration its velocity until the air resistance equals the gravitational force, and then it falls at that constant velocity, also known as terminal velocity • Raindrop can strike the soil at a speed as high as 35 km h^{-1} and displace soill particles as far as 2 m in horizontal and 1 m in verticl direction. • Terminal velocity increase with increase in raindrop size. • Foster falling large raindrops have more erosive power than smaller drops. • Raindrops of 5 mm in diameter have a terminal velocity of about 9m s^{-1}.	• Size of raindrops can range between 0.25 and 8mm in diameter, but those between 2 and 5 mm are common. • In intense storms, raindrop can be as large 8 mm. • While drop size increase with increase in rain intensity, it many decrease when intensities exceed 100 mm h^{-1}. • Drop- stain (use of absorbent paper with water-soluble dyes) and flour-pellet (collecting and drying drops in a container with flour) are methods user for measuring raindrop size distribution, along with radar and imaging techniques.

Source: (Humberto Blanco et al., 2008)

FACTORS AFFECTING SOIL EROSION BY WATER

Soil erosion is determined by a number of factors such as: relief, climate, soil and solidification rock, vegetation.

RELIEF

The relief shape or topography of the soil formation refers to the shape of the slope (slope of the angle, length of the slope). The shape of the slope, in profile, can be linear, convex, concave or stepped (Barbour *et al*., 2007; Budiu et al., 1996).

Almost 40% of the surface of the agricultural land fund in Romanian is located on lands with a slope greater than 5%, being affected, more or less, by erosion processes and 15.5% includes lands whose slope exceeds 20% and are highly exposed to erosion (Ailincăi et al., 1992). Depending on the degree of inclination of the slope, the angle of incidence of the sun's rays also changes.

The shape of the slope, it can be straight or linear, convex, concave and stepped. In the case of straight slopes, the erosion manifests itself uniformly over the entire surface, accentuating towards the base of the long slopes. In the convex-shaped slopes, the erosion is more pronounced in the downstream part, where the slope is higher, and in the concave ones in the upstream part (Parichi, 2007; Budiu et al., 1996; Keith Richardson *et al*., 2005).

The length of the slope also influences soil erosion. The higher it is, the more accentuated the soil erosion, due to the increase of the drainage speed by accumulating an increasing amount of water (Parichi, 2007).

Slope exposure also has an important influence on soil erosion. Thus, the slopes with southern and southwestern inclination are more exposed about 5-7 times to the erosion process than the northern, northeastern slopes (Budiu et al., 1996; Riedl et al., 1984).

CLIMATE

The climatic factors that influence water erosion are: air temperature, atmospheric precipitation, air humidity, wind, solar radiation (Ward *et al*., 2004; Wong *et al*., 2014; Nuttall, 2005; Balogh Walker, 1992; Brunner *et al* ., 2010; Nyanjom et al., 2004; Ali, 2011; Bojie Jonesbrunce, 2013; Irene Gomez Campos, 2003). Temperature can influence erosion through its variations, frost, thaw that affect the structure of the soil and chemicals favoring the decomposition of rocks. In spring, high temperatures contribute to melting snow and increasing the risk of soil erosion (Budiu et al., 1996; Luca et al., 2000).

Atmospheric precipitation can directly influence soil erosion by the action of raindrops and runoff that forms from melting snow. These are related to their intensity, quantity, duration and distribution (*Squires et al*., 2009; Laflen *et al*., 2000; Tayupania, 1993; Budiu et al., 1996).

Erosion caused by torrential rains is maximum when they coincide with the periods of soil preparation. Erosion caused by snow melt water is influenced by the duration of snowmelt; if the soil is frozen on the surface, as well as the exposure, inclination and length of the slope and the vegetation that covers the soil (Budiu et al., 1996).

Precipitation, in close connection with the terrain and the degree of vegetation cover, most influences soil erosion, water being the active agent of erosion, which displaces, disperses and transports soil particles, and the relief and vegetation are those that condition the movement of water, that is, the energy with which this water produces the process of erosion (Budiu et al., 1996).

Soil moisture. The soil has the property to sustainably retain a large amount of water which, in hydrophysical ratio, is represented by the field capacity for water, at the beginning of the rain, the infiltration capacity is depending on the difference between the water content of the soil and the field capacity, with the lower the soil moisture content, the more infiltration will increase. Later, the size of the infiltration is determined by the difference between the total porosity and the field capacity for water. The more water-free pores remain, the greater the infiltration (Parichi, 2007).

SOIL STRUCTURE AND COMPOSITION

The erosion process is influenced by some soil properties such as texture, structure, permeability, humus, calcium and sodium content (Velasco *et al*., 2009)

The texture of the soil represents the size of the different elementary particles that make up the solid part of the soil. The basic components of the soil texture are: sand, dust and clay, and the percentage in which they are at some point in the soil, ensures or not the resistance of the soil to erosion. If the rain is torrential, so significant amounts of water fall in a short time, the water and soil runoff is very strong due to the lack of cohesion of the sand particles (Dîrja, 2000).

Soil structure. It plays an important role in the process of water infiltration, so in terms of erosion by the way the particles are placed in structural formations and by water stability. It is better resistant to water erosion, ie soils with a grain-glomerular structure have an increased structural hydro stability, such as chernozems, cambic chernozems and alluvial clays, whose calcium and humus-saturated humus content is high (Parichi, 2007).

The condition of the land surface also influences runoff and erosion. Thus, in spring, the warming of the weather can cause the snow to melt quickly, especially on the southern slopes, the soil is still frozen, water cannot infiltrate into the soil, it drains to the surface and causes erosion. The crust that forms especially on the surface of clay soils by disintegrating aggregates reduces infiltration, increases runoff and erosion (Feiza et al., 2006).

The rock on which the soil formed determines the composition of the size of its particles and influences its resistance to erosion, because the one formed on hard rocks (conglomerates, sandstones, etc.) is a thin soil, which retains a smaller amount of water, infiltration is reduced and occurs erosion. amplified. Soils formed on crumbly rocks (loess, clay, sand, etc.) retain more water, are more permeable and runoff and erosion are lower. If erosion removes the soil and the bedrock reaches the surface, it is difficult to erode if it is hard rock and forms sills on the bottom of rivers and streams. Crumbling rocks erode more easily and rivers and streams are formed quickly. Sand and loess erode most easily, then limestone rocks and slightly harder clays and compact marks (*Hartge* et al., 1992).

Moţoc 1963, classify the soils from Romania into six classes, according to the relative value of erodibility, which is expressed by a coefficient whose values are between 0.6 and 1.2. Soil erosion increases inversely with infiltration and this depends, as shown above, on its texture as well as on the type of soil and its state of erosion.

VEGETATION

Natural and cultivated vegetation have a particularly important role in the soil erosion process, the more abundant the volume of plant mass, the better the protection offered to the soil. If the coefficient of soil protection by closed forests and meadows is considered equal to 1, on the land cultivated with corn, sunflower, this coefficient is only 0.2 - 0.4 (Parichi, 2007; Huybrechts et al., 1989). Vegetation controls soil erosion by means of its canopy, roots, and litter components; erosion also influences vegetation in terms of the composition, structure, and growth pattern of the plant community (Gyssels et al., 2005).

Hardwood and coniferous forests in the temperate zone, with their rich branches and foliage, intercept raindrops and retain 15-30% of rainfall. The water reached from the branches to the surface of the soil infiltration for the most part, because the ground is covered with leaves and decaying branches, forming litter and, together with the blanket of muscles that line the soil, absorb 4 - 5 times more water than their weight. It is estimated that 1 ha of forest retains 50 m3 of water in this way after each rich rain (Huygens *et al*., 2000). In a forest from Ivory Coast, located on a sloping terrain, an amount of soil of about 2 t / ha was lost annually by erosion and after its deforestation the amount of eroded soil reached 93 t / ha (Hurni, 1990). It is considered that the forest can protect the soil against erosion 3 - 4 times better than the meadow, 50 - 200 times better than weeding crops and 100 - 500 times better than the land without vegetation (Giurgiu ., 2001).

Grasslands and grassy lands. On meadows, perennial grasses and legumes protect the soil well against erosion. Plants intercept 0.1 - 0.2% of the amount of water in precipitation. It is estimated that in a hayfield, 70% of the water from precipitation infiltrates and only 20% drains to the surface and 10% evaporates, while in annual crops, only 30% infiltrates into the soil and 60% drains to surface (Eckelmann, 2006).

The good protection of the soil against erosion on meadows is due to the high density of plants and the rich foliar surface, which intercepts raindrops and does not allow them to disintegrate aggregates and reduce infiltration (Eppink, 1986).

The fasciculated roots of forage grasses improve the structure of the soil and thereby increase its permeability. On degraded meadows, where vegetation weakly protects the soil, surface runoff and erosion amplify greatly (Farahbakhshazada *et al*., 2008).

Agricultural crops - annual, biennial or perennial - more or less protect the soil against erosion, as their density and leaf area, per 1 m^2 of land, is higher or lower, in different phases of vegetation.. (Neamţu*,* 1996) shows that this foliar index of soil protection varies from 4.8 in maize to 27 in perennial grasses year II - V. The state of development of plants influences the degree of soil protection. Thus, in the climatic conditions in Romania, in June, when the plants are better developed, soil losses represent only 46% of the value of those produced in May. Soil works, the orientation of plant rows, etc. also influence soil losses through erosion.

Over the millennia, a natural balance of erosion has been established, but through inappropriate human intervention, in some areas, this balance has been broken, resulting in so-called accelerated erosion (Nedelcu et al., 2004).

This is due, in particular, to the excessive deforestation of forests, even in places where they protected the soil against erosion, landslide with high slope, degradation of grasslands by abusive grazing, application of inappropriate agrotechnics on the slopes (Onisie et al., 1999).

CONCLUSIONS

Soil erosion is a natural process, occurring over geological time, and most concerns about erosion are related to accelerated erosion, where the natural rate has been significantly increased by human activity. Soil erosion poses severe limitations to sustainable agricultural land use, as it reduces on-farm soil productivity and causes the accumulation of sediments and agro-chemicals in waterways (Boardman et al., 2007). Factors such as climate, topography, specific soil characteristics, land cover and management have important effects on both runoff and the process of soil erosion. Depending on these factors, average human-induced soil erosion rates, due to rill and inter-rill erosion, are typically between 1 and 26 t ha _1yr _1 for Mediterranean arable land (Tropeano, 1983; Kosmas et al., 1997) and between 0.5 and 7.8 t ha _1yr _1 for arable fields in northern Europe (Bollinne, 1982; Kwaad, 1994; Chambers and Garwood, 2000). On the other hand, soil formation is a slow process involving the breakdown of rock into small particles and the accumulation of organic matter. Compared with slow soil formation rates, soil can be regarded as a nonrenewable resource. These are compelling reasons for assessing and monitoring soil erosion and improving the way soils are managed (Boardman et al., 2006).

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