

Rill And Inter-Rill Erosion Measurements In Tarnii Valley, Eastern Romania, After Historical Rainstorm Events In September, 2007

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1. Abstract

Tarnii Valley is located in Tutova Rolling Hills, Eastern Romania, and was under conservation practices for more than forty years. During all that period, the study site behaved quite well, being almost permanently a field scale model of soil conservation by agro-technical practices for people from all around Romania (Figure 1). The territory seems to be marked like a paradigm by the former traditional way of exploitation, in long, narrow, up-and-down hill oriented small plots even after that long period of time (Figure 2). By using some new measurement techniques it was possible for the first time to verify that hypothesis. In the last four years, three major (low frequency – high intensity) rainstorm events have had a special impact in terms of rill and inter-rill soil erosion, by taking over in places the conservation works and resulting in spectacular erosion features (Figure 3). A huge number of individual rills within three contour stripcrops partially visible in figures 1, 2 and 3, by GPS equipment and resulted rill erosion data was compared with data acquired from runoff plots.



Figure 1 Tarnii Valley, Vranceanu area, a field scale model of conservation management

2. Material and method

Several techniques have been involved in order to assess the overall impact of those rainstorm events and, among them, the premiere use of ultimate GPS equipment proved to be a very useful tool, which conducted to the achievement of very interesting scientific results. The use of RTK GPS equipment (Figure 4), besides its accuracy and greater productivity if compared to theodolites or total stations has the advantage that measured points, polygons, etc. are already georeferenced. That means, successive measurements do not need monumented reference points, and rill-inter-rill paths can easily be compared after rainstorm events which trigger runoff. The professional GPS equipment involved was Magellan Thales Z-Max.Net with centimeter accuracy, which includes Magellan Mobile Mapper CE as controller, which can be used also as autonomous GPS with submeter accuracy. The field methodology consisted of contour measurement of every significant rill (wider than 30 cm and deeper than 15 cm) by Thales Z-Max.Net in RTK fine mode, within some different contour strips in Tarnii Valley, of different sizes ranging from 13 till 39 hectares, on the easterly looking hillside, the most

affected by rill erosion during the September 2007 historical rainstorm events. The longitudinal profile of each rill was measured by GPS equipment also in RTK mode, but the equipment was set to Auto by interval, so that a great number of points were measured in order to get geostatistical coverage of depths along the longitudinal profile. The contour strips mentioned were under conservation practices for more than 40 years, so that only the longitudinal profile of each rill was considered relevant for depth measurements.



Figure 2 Tarnii Valley during winter time when the waves of the old up-and-down hill oriented properties are still visible after 40 years of conservation management



Figure 3 Tarnii Valley after historical rainstorm event in September 5, 2007



Figure 4 Measurements of rill erosion by means of GPS equipment

The runoff plots which have a history of soil erosion monitoring since the '70s, were used also in this survey in order to validate the information gathered at field scale by GPS equipment. Runoff plots are located on the left hillside of the Upper Tarnii Valley. General features of this site are as follows: Latitude 46° 15' 50" N, Longitude 27° 37' 30" E, Elevation 218 m, Slope 12%, loamy textured mollisoloil. From the total of eight plots five of them are 100m² (25×4m with 1 m border areas between them) and the other two are 150m² (37.5×4m). Runoff collection was made in three calibrated recipients disposed in cascade. Six plots were cultivated with different crops as follows: corn, beans, soybeans, winter wheat, bromegrass. Two check plots of 100 and 150 m² were maintained like black fallow, always free of weeds.

3. Results

The conservation items on the easterly looking hillside of Tarnii Valley (Figures 1, 2 and 3), contour strip crops covered with alternating well or less protecting vegetation, talus of agroterraces covered with Bromegrass, forested shelter belts, earthen technological roads (contour or serpentine), behaved differently during rainstorm event in September 5, 2007, depending on their position on the slope and their intended conservation role. This conservation system had to withstand three major, historical, rainfalls within the last four years, which were characterized by the following parameters:

A. August 27, 2004

- total amount of rain: 75.9 mm / 24 hours, from which 75.4 mm/1.5 hours;
- maximum rain rate (intensity): a) 3.7 mm / min. (21.8 mm / 5.9 minutes); b) 2.07 mm / min. (17.51 mm / 7.9 min.).

B. May 6 – 9, 2005

- total amount of rain: 53.6 mm / 24 hours;
- maximum rain rate (intensity): 3.3 mm / min. (18.03 mm / 5.5 minutes).

C. September 5, 2007

- total amount of rain: 79 mm / 24 hours (over 120 mm / 24 hours in places);
- maximum rain rate (intensity): a) 2.97 mm / min.; b) 2.39 mm / min.

The most important characteristic of these rainfalls was the high rain rate, many times higher than the usual rainfalls in the area. The strip crops which were uncovered with protective vegetation at the time of the latest mentioned rainfall, were taken over by runoff coming sometimes from the top of the hill, and this was true mainly in the neighborhood of the serpentine earthen road and on the paths / lowland between the old up-and-down hill properties. The areas covered by alfalfa, Bromegrass, winter wheat, etc., did not show any sign of unusual erosion even though they were passed over by runoff coming from upland.

Three uncovered stripcrops with areas of 12.9 ha, 18 ha and 38.9 ha, located at different elevations on the slope, were selected in order to be surveyed from the point of view of rill-inter-rill erosion. The average width of these plots were: 98 m, 104 and 214 m respectively. Their location on the slope was: (1) on the mid slope, (2) close to the valley bottom, (3) upper third of the hillslope. The rills wider than 30 cm were measured

individually, while those narrower than 30 cm were grouped and assimilated with trapezoidal prisms. The results obtained within the three selected plots are illustrated in Table 1.

Table 1 Rill erosion estimated by GPS measurements in Tarnii Valley

Plot no.	Plot Area (ha)	Number of rills or group of rills	Area of measured rills (m ²)	Volume of measured rills (m ³)	Rill erosion (m ² /ha)	Rill erosion (m ³ /ha)	Rill erosion (tons/ha)
2	13	25	2356.19	516.08	182.7	40.0	52.0
1	13	22	3912.14	1023.99	303.3	79.4	103.2
3	26	55	9881.65	2346.19	383.0	90.9	118.2

By analyzing the data in table 1, and if we have in mind (1) the fact that most of the rills appeared particularly in the neighborhood of the serpentine road and large areas at the other ends of the stripcrops remained practically unaffected by rill erosion, (2) location on the slope, and (3) the 3rd plot has a doubled width (slope wise) it seems that the greatest rill erosion appeared on mid slope. The largest amount of rill erosion from the 3rd plot, close to the top of the hill, is abnormal because that plot has a doubled width if compared with the other two.

Table 2 Measured values of soil losses on runoff plots from Perieni after rainfall from September 5, 2007

Plot no.	Crop	Runoff (m ³ /ha)	Soil losses (To/ha)
1	Soybeans (100m ²)	204.0	0.988
2	Winter wheat – stubble (100m ²)	169.5	1.795
3	Corn (100m ²)	229.0	3.591
4	Brome grass (100m ²)	1.2	0.001
5	Bean (100m ²)	172.0	1.751
6	Black fallow (100m ²)	245.5	81.612
7	Black fallow (150m ²)	155.8	124.826
8	Winter wheat – stubble (150m ²)	182.7	2.344

Table no. 2 illustrates the soil losses measured on standard runoff plots. As expected, the best crop that offered a very good protection of soil against erosion can be noticed on the plot No. 4 cultivated by Brome grass where both runoff and erosion had the lowest values because at that time soil was completely covered by vegetation. On cultivated plots, runoff values ranged between 169.5 m³/ha for winter wheat – stubble (100m²) and 229.0 m³/ha for corn, while erosion had a minimum value of 0.988 to/ha on the plot cultivated by Soybeans and a maximum value of 3.591 to/ha on the plot with corn. The highest amount of soil losses has been measured on Black fallow where the values of 124.826 To/ha for the plot with 150 m² and 81.612 To/ha for the plot with 100 m² and were registered like records in the last two decades.

4. Conclusions

- ❖ Rill erosion after historical rainfall in September 5, 2007 appeared mainly in the neighborhood of earthen technological serpentine road and on the paths / lowlands between the old up-and-down hill properties;
- ❖ Rill erosion amounts depend on local slope and location on the hillslope;
- ❖ High intensity (≥ 180 mm/hour) – low frequency (one in one hundred years) rainstorms, have the tendency to become more and more frequent in the last years, and may trigger rill-inter-rill erosion which overcomes the conservation systems which behaved very well during more than forty years;
- ❖ The use of RTK GPS equipment in estimation of rill erosion, besides its accuracy and greater productivity, has the advantage that measured points, polygons, etc., are already georeferenced. That means, successive measurements do not need monumented reference points, and rill-inter-rill paths can easily be retrieved after successive rainfalls which trigger runoff.

5. References

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