REGIONAL ASSESSMENT OF GULLY SYSTEMS IN A HILLY OLIVE-ORCHARD DOMINATED LANDSCAPE

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1. Introduction

Olive orchards dominate the land use at the hills of Afrin area, and olive oil represents the most important cash income source for rural communities in this area. However, olive yields in many orchards have been decreasing steadily over the last 20 years (Hoorelbeke, 2006).

The major reason for the yield decline is the severe land degradation taking place in this region. Deforestation, expansion of olive production into steeper areas, and inappropriate land management practices, accelerated the rate of soil erosion. Especially the replacement of mule contour tillage by the cheaper up-and-down tractor tillage during the 1970's was very detrimental. Tractor tillage not only moves down sizable amounts of soil during every tillage run, but also the consequent (mostly) vertical furrows stimulate water-induced soil erosion.

The widespread presence of rills and gullies during the rainy season is a clear indicator of the severity of this problem. It is not exceptional to see that the parent material is surfacing, which indicates that a complete loss of the surface soil layer. However, gully systems are mere symptoms of ongoing degradation rather than the cause of degradation itself (Stocking et al., 2001). In order to facilitate the development of an effective soil conservation strategy for olive-dominated hill landscapes, the main focus of this study was to assess the severity of gully systems and to increase the understanding of the causes of gully system development.

2. Methodology

The first survey took place during the peak of the rainy season (February-March 2005) before the spring tillage. The gully survey was based on four sequential steps: (1) locating active gullies in the landscape and indicating them at a topographical map of the area (scale 1:25,000); (2) sketching the gully system; (3) measurement and visual assessment of the gully system and the affected areas; and (4) identification in the field of the most likely main causes of the gully system.

During the peak of the next rainy season (February-March 2006), selected gully systems were described in more detail in order to develop a gully typology. The surveyors attempted to cover representative areas of Afrin District in terms of topography, soil type and land use (use was made of an Agro-ecological zoning map). The framework for analysing gully systems in the field was based on identifying the causes for runoff generation, runoff concentration and sedimentation. In addition, landform, land use (including land cover and land management) and gully morphology (size, branching) were assessed by GPS, field measurements and visual assessments. At the end of each description, the group surveyors brainstormed on the preliminary gully type and potential soil conservation measures. When the gully system database was completed in Excel, a final typology was built and parameters for each type were identified.

The team surveyors consisted out of a land management expert of ICARDA and 14 trained staff from the Agricultural Extension Services of Afrin District.

3. Results and discussion

3.1. Major causes of gully systems in an olive orchards-dominated landscape

For the whole target area (120,000 ha) the surveyors identified 583 main gully systems. This revealed that at least 3,989 ha (or 9%) of the total area of sloping olive orchards (or 45,000 ha) were affected by gully systems.

Three main causes are (in declining order): concave terrain, up-and- down tillage, and shallow soil (see Figure 1). Terrain concavity is an inherent landscape factor, but by itself it is not enough to cause gully systems. It is only when concavity is combined with other factors, that gully systems are formed. We found that specific combinations of causes occur very frequently. The most common combination is: concave terrain with up-and-down tillage and shallow soils (21% of the total surveyed gully systems).

The survey revealed differences in gully frequencies related to the soil type. More gullies were formed in sloping areas with white soils (formed on clayey limestone or marls, which are more fragile and prone to water erosion- Regosols or Cambisols), compared to similar slopes with red soils (soils formed on pure limestone- Luvisols on deeper soils, and Cambisols on more shallow soils). This indicates that the red soil type is probably more resistant to gully erosion than the white soil type.

Furthermore, use of GIS and remote sensing will help to specify factors relevant to identifying areas at risk of soil erosion and will result in a provisional methodology for identifying hot spots of current and potential rill and gully erosion.

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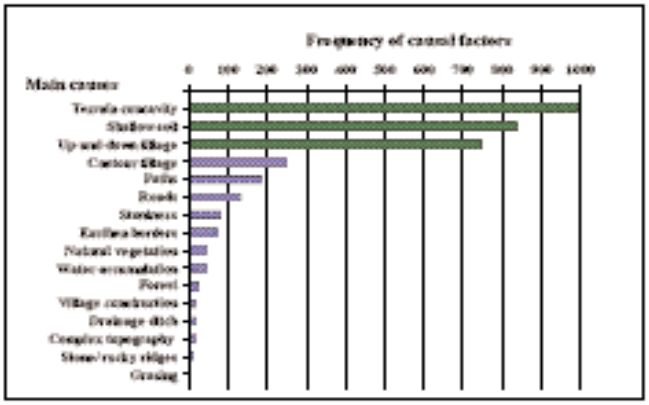

Fig. 1. The frequencies of causal factors for formation of gully systems in the hills of Afrin District, NW Syria (based 2006 winter survey).

3.2. A gullies typology for an olive orchard dominated landscape

Based on the dominant causes, eight types of gullies were identified: road gullies, barrier gullies, shallow soil gullies, forest gullies, long-slope gullies, tillage-furrows gullies, tractor gullies, and plan-concavity gully systems.

Road, barriers, tillage-furrows, shallow soil, and long slope gullies occur very frequently. Plan concavity, forest gullies, are less common, while the tractor gullies are the least frequent. However, road and barrier gullies associated with shallow soils and tillage furrows gullies are the most common types of gullies system.

3.3. Implications of gully typology survey for soil and water conservation (SWC)

Categorization of gully typology and their causes may help to identify proper remedies to decrease the risk of gully system formation. In this context, main feasible actions for controlling the different gully system types are suggested (see Table 1).

4. Conclusions

- Field surveying of gully systems is a valid approach to quickly assess the occurrence, severity and causes of gully erosion systems in an area of 1200 km^2.
- The formation and development of the gully system on Afrin's olive orchards were not caused by single factors, but it are specific combinations of landscape factors, soil type, and land management practices which make them happen.
- Most frequent types of gullies are road, barrier, shallow soil, and long slope gully systems.
- Expansion and mechanization in olive production over the hill slopes are the likely drivers of accelerated water erosion over the recent decades.
- Identification of cause-effect for gully system formation will help to identify effective SWC strategies that will decrease the risk of gully formation.

Table 1. Main feasible actions for controlling gully system formation

Gully types	Main causes	Remediation action
Barrier	Concentrated flows	- Effective barriers (thick barriers + close gaps, e.g. by using olive prunes).
Road	Runoff generating & concentration	- Diversion channels to safe drainage paths
Shallow	Saturated overland flow	- Diversion channels - No or late tillage - Roughen soil surface??
Tillage furrows	- Up-down tillage furrows	- Sturdy contour furrows - Contour buffer strips
Forest	- Concentration flows - Tillage step at top of orchard	- Sturdy contour furrows - Safe drainage path
Long slope	- Accelerated flows - Shallow soil	- Diversion channels - Late tillage - Roughen soil surface - Contour buffer strips
Plan concavity	- Concentrated flow due to topography-	- Diversion channels - Retard flows
Tractor path	- Tracks path generating flows	- Mule tillage - Roughen soil surface - Avoid tractor paths perpendicular along the contour

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