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IDENTIFYING MAJOR CAUSES for GULLY EROSION in SLOPING OLIVE ORCHARDS by FIELD MAPPING

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1 Introduction

In the Mediterranean mountain areas of NW Syria, land degradation is a serious problem (Masri et al, 2005). Olive orchards dominate the landscape in 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. Low return to labour has resulted in livelihood insecurity, increased reliance on off-farm labour, and out-migration.

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 accelerated the rate of soil. Especially the replacement of mule tillage by the cheaper tractor tillage during the 1970's has caused an acceleration of the rate of land degradation. At the hills of Afrin District, the widespread presence of ephemeral and permanent gullies is a clear indicator of the severity of this problem. (Up-and-down) tractor tillage not only moves down sizable amounts of soil during every tillage run, but the consequent vertical furrows promote water-induced soil erosion and gully formation. Gullies are formed by concentrated surface runoff which acts as a cutting agent (Geyik, 1986). It is not exceptional to see that the parent material is surfacing, indicating a complete loss of the surface soil layer.

In recognition that gullies are mere *symptoms* of ongoing degradation rather than the cause of degradation itself (Stocking et al, 2001), the main focus of this study was to identify the causes of gully systems. Understanding these causes is an essential requirement for developing effective soil conservation strategies (Morgan , 1995). Other objectives were the mapping of gully systems, testing a methodology for meso-scale survey of gully systems, and capacity building of extension agents.

In the study area, there were two dominant soil types: red soils are usually formed on pure limestone (Luvisols on deeper soils, and Cambisols on more shallow soils), white soils are usually formed on clayey limestones or marls (Regosols or Cambisols).

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2 Methodology

First, the surveyors (from the Agricultural Extension Services, AES) were trained in processes, causes, recognizing symptoms and impacts of water erosion, with emphasis on gully systems. They were also briefed on the survey procedure and shown in the field how to identify and characterise active gully systems.

The field survey was conducted during the peak of the rainy season (between 22 and 25 February 2005). Six survey teams were formed, and each team was allocated a geographical area. Each field survey team was composed of two extensionists of the Syrian Agricultural Extension. The survey teams were supervised by a land management specialist of ICARDA. A4-size observation sheets and 1:25,000 maps of the area (i.e. an enlargement of 1:50,000 topographical maps) were provided. The surveyed gully systems were given sequential numbers.

The gully survey was based on four practical steps:

1. Identification of active gullies in the landscape.
2. Assessment of visual symptoms (gully depth and affected area).
3. Sketching the gullies on topographical maps and on the A4 format.
4. Identification in the field of probable main causes of gully formation. The following options were provided:
    - Concavity
    - Contour tillage
    - Up-and-down tillage
    - Water accumulation behind borders
    - Shallow soil
    - Degraded grazing areas
    - Drainage ditch, roads, paths, and villages
    - Earthen borders, stone ridges, and natural vegetation fences
    - Forest
    - Complex rugged area
    - Others

All the collected information was digitalized in a database and on a map. Finally, the possible causes of gully erosion were analyzed.

2. Results

2.1. Analysis of causes of gully system formation

The surveyors identified 583 main gully systems containing 1,004 gully sub-systems. The survey revealed that at least 3,989 ha (or 9%) of the total area of sloping olive orchards (or 45,000 ha) was affected by gully systems. The actual affected area might be higher, as some inaccessible areas could not be surveyed in the course of this rapid survey. This is an indication that this kind of erosion is a very substantial threat to olive productivity and sustainability.

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The survey showed that the average depth of the surveyed gullies is 16 cm, ranging from 5 to 42 cm. The three deepest gullies had a maximum depth of 60 cm. These three gullies were all caused by concave terrain and shallow soil. In addition they were located on white soil.

The frequencies of the causal factors identified for formation the gullies are shown at Figure 1. The three main casual factors are (in declining order): concave terrain, up-and-down tillage, and shallow soil. Terrain concavity is an inherent landscape factor, but by itself it is enough to cause gully systems. It is only when it is combined with other factors, that gully systems are formed (Fig. 2). It revealed that there are specific combinations of causes which occur very frequently. The mostly common combination is: concaved terrain with up-and-down tillage and shallow soils (21%).

The survey revealed differences in gully density related to the soil type. More gullies were formed in sloping areas with white soils, compared to similar slopes with red soils. This indicates that the red soil type is probably more resistant to gully erosion than the white soil type. White soils are formed on clayey limestone or marls and are more fragile and prone to water erosion.

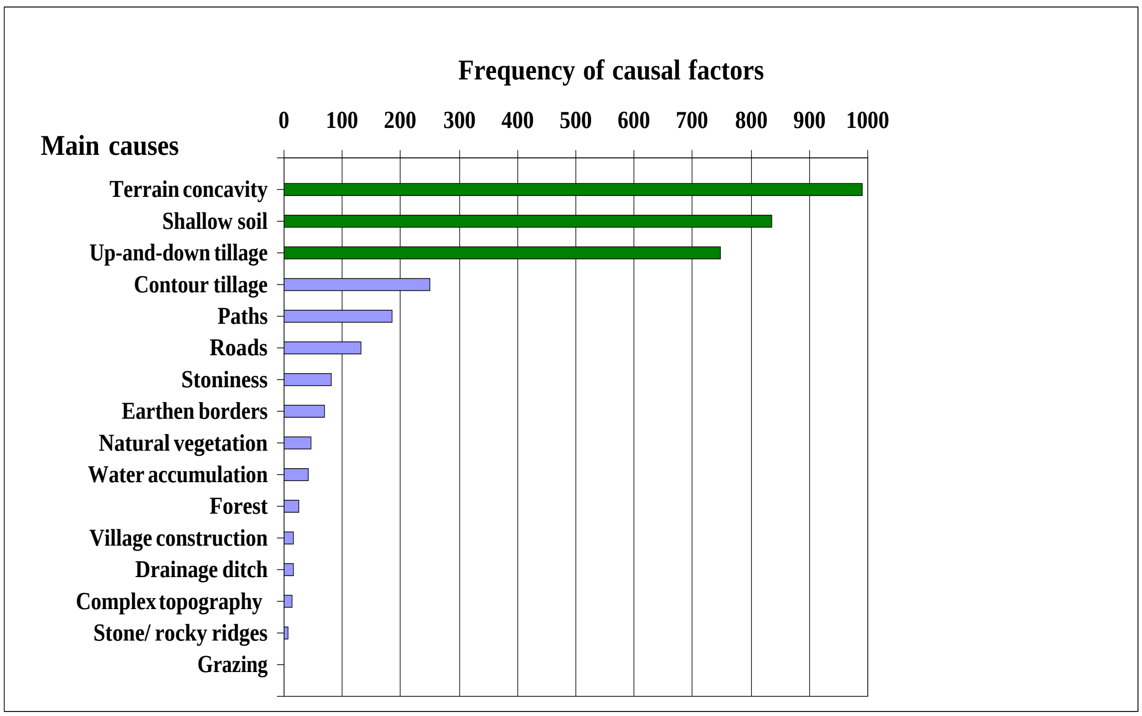

Figure 1. The frequencies of causal factors for formation of gully systems surveyed during February, 2005 in Afrin District, NW Syria.

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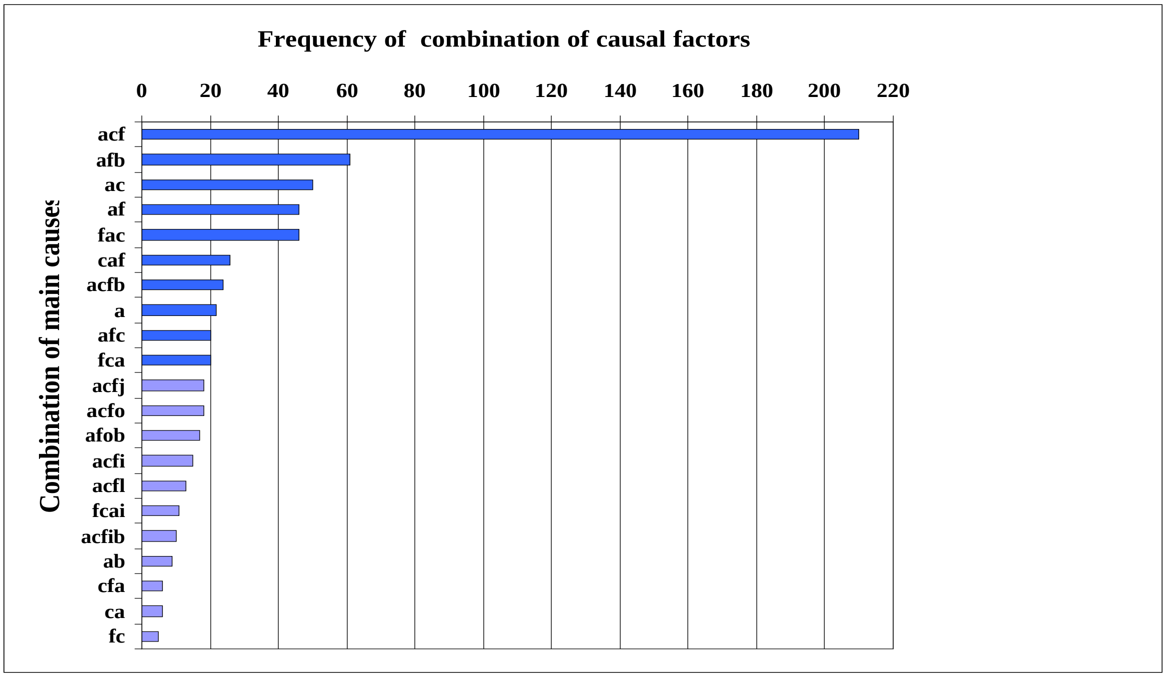

Concavity	contour tillage	Up-down till	Water accumulation	Shallow soil	Grazing	Drainage ditch	paths	roads	village	Forest
a	**b**	**C**	**d**	**f**	**g**	**H**	**i**	**j**	**k**	**l**

Figure2. The frequencies of combination of causal factors for formation of gully systems surveyed during February, 2005 in Afrin District, NW Syria.

2.2. Evaluation of methodology

The used methodology had some advantages and disadvantages:

Meso-level: This meso-level survey is a tool that fits between detailed plot experiment and detailed survey and large scale interpretation by remote sensing. The used tool identifies gully systems which cannot be observed by remote sensing, but goes beyond the anecdotal evidence of case studies.

It is rapid and effective: Six groups (12 extension staff) covered 45,000 ha during 5 days (i.e. 60 working days), or 750 ha/person/day.

Capacity building: Extension staff learned how to recognize symptoms, processes, causes and impacts of water erosion, with emphasis on gully systems and obtained field experience to observe and map active gully systems.

Subjectivity: Although all surveyors are trained together, there is a risk that similar cases are classified differently. Involvement of ICARDA specialists helped to reduce this problem.

Overlooked areas. Some remote areas were not accessible for survey.

4. Conclusion

Rapid and visual assessment of gully systems by the help of Agricultural Extension Services (AES) seems to be a valid approach for a quick assessment of the extent and causes of gully erosion.

The survey revealed that ephemeral and permanent gullies are very common at the target area. This highlights the need for sustainable land use and land management practices. Gully systems are caused by specific combinations of landscape factors, soil type, and land management practices. The development of reduced or conservation tillage practices and efficient and applicable land conservation systems would decrease the risk of gully formation.

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