Aerial image use in the spatial variability analysis of degradation forms in North Eastern Romania

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Introduction

- Romania's transition process increased the human pressure on natural resources (soils, forests, and water bodies) and the probability of natural hazards occurrence (floods, landslides, lake plugging).

- There is a lack of up-to-date information on land degradation on a national level

Objectives

- spatial distribution of the degradation forms, within the specific conditions of Suceava Plateau in North Eastern Romania

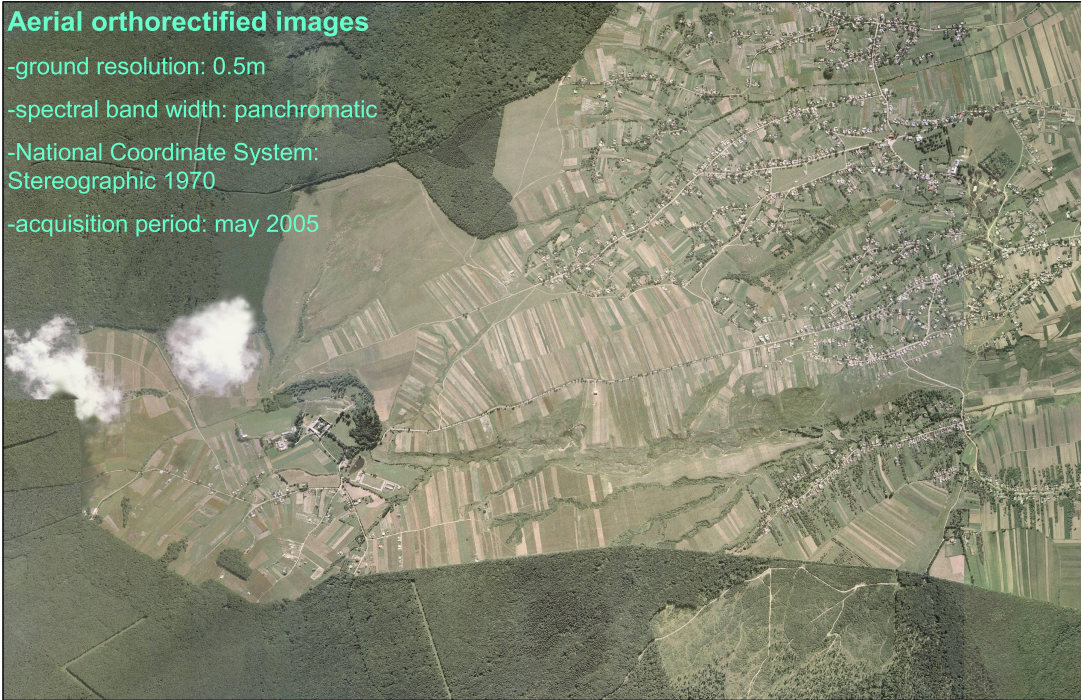- accuracy estimation in the land degradation mapping on the aerial orthorectified images

Study area

The Suceava Plateau

Total area: 3500 km2
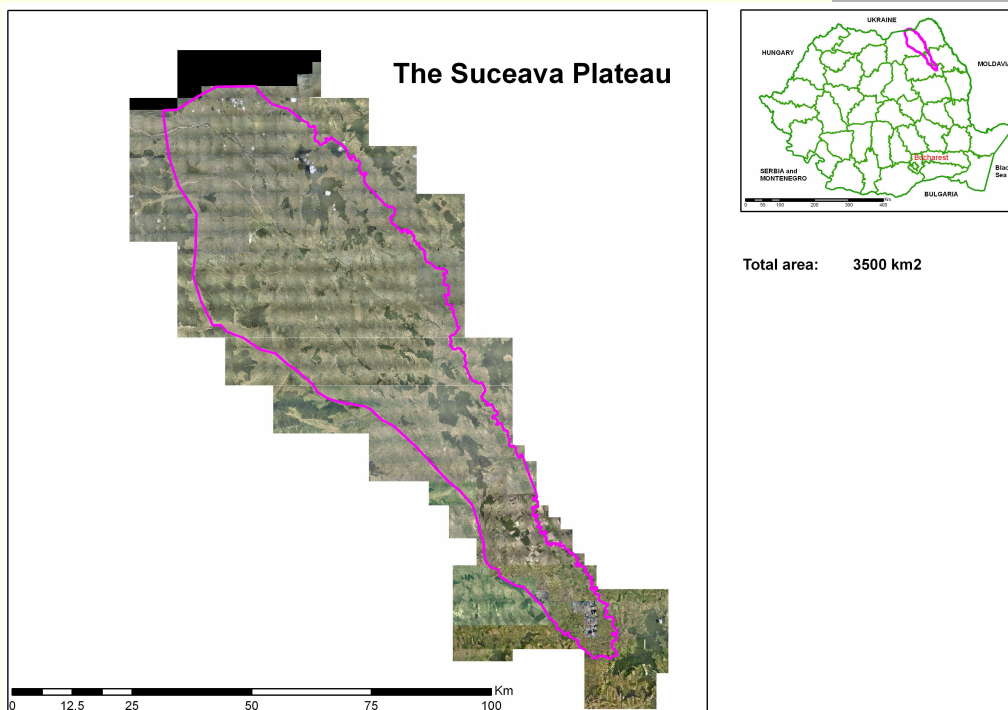
Materials

Aerial orthorectified images

-ground resolution: 0.5m

-spectral band width: panchromatic

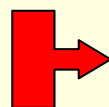-National Coordinate System: Stereographic 1970

-acquisition period: may 2005

Research Methods

- Ground inventory for photointerpretation keys
- Degradation forms delineation on aerial photos
- Model testing using GPS Ground Control Points

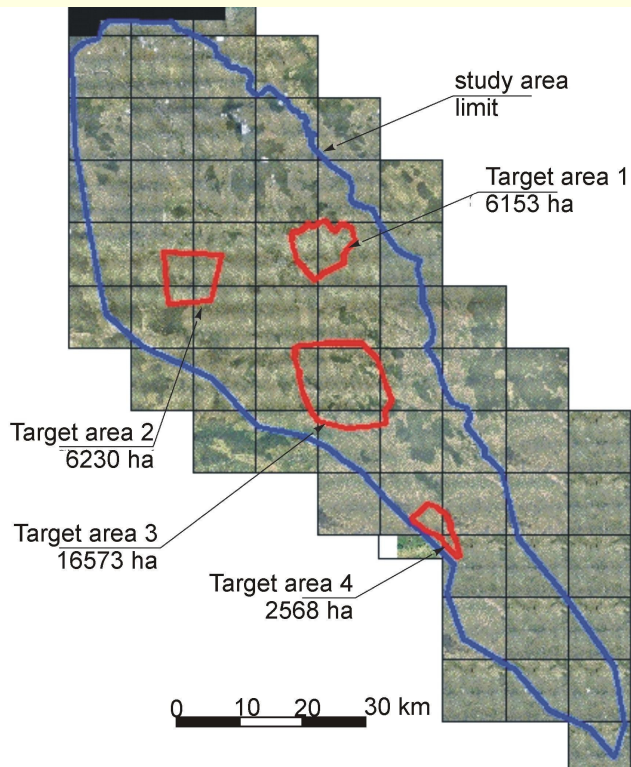**Land Degradation Mapping Model**

- Integration of geographic data and field information
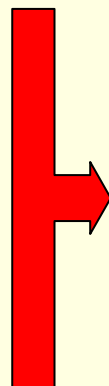
Land Degradation GIS Database

Target areas

- Four target areas chosen based on a preliminary land degradation mapping

- Target areas represent approx. 10% of the total study area

- Used for model assessment and detailed inventory of elementary degradation units

Elementary degradation units

- Erosion unit types:
    - *forested*
    - *origin*
    - *relatively stable banks*
    - *unstable banks*
    - *talweg*
    - *sheet erosion* (high intensity)
- Land displacements unit types:
    - *earth fall*
    - *sliding area*
    - *wet land*
    - *mud flow*
- Human induced degradations
    - *home waste deposits*
    - *industrial or mining refuse dump*

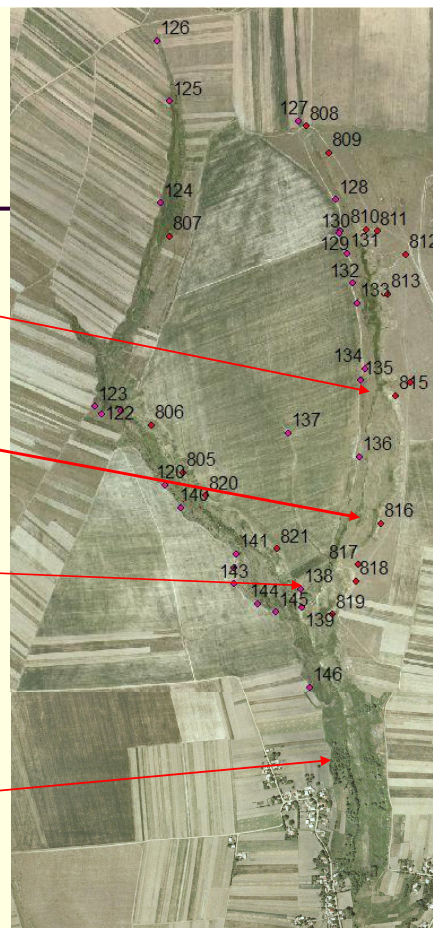# Ground inventory

-elementary erosion units

Unstable bank
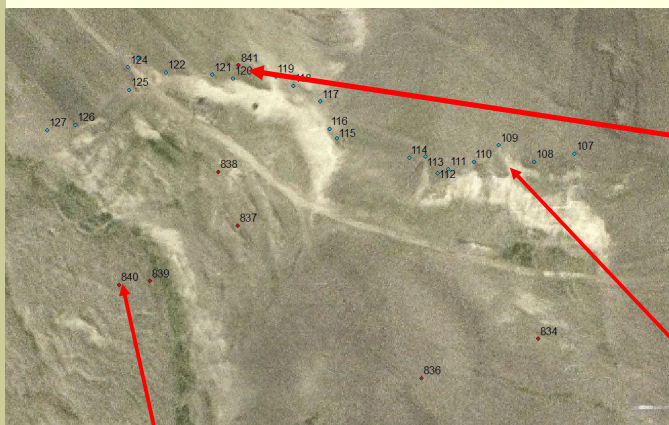Stable bank

Ravine Origin (secondary)

Confluence area

Forest vegetation coverage

Ground inventory – land displacements

Results: photointerpretation keys

Ditches

Identification: bright color, visible contrast against the surrounding areas, elongated form, no branches, rarely discharged in a permanent hydrological network, oriented on the highest slope
Mapping: - single forms are delineated based on its contour line; multiple forms are mapped as a unit for the same image texture

Ravines

Identification: - elongated, branched forms, discharged in the hydrological network, high contrast against the surroundings, larger than ditches, highly visible even at small scale
Mapping: - as an exterior contour line, surrounding the elementary units described below

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Results: photointerpretation keys

Ravines
Unstable banks

Identification: elements that frame the riverbed, with evident erosion forms, often earth fall or lateral early origins, with no wood vegetation, high contrast against undisturbed land
Mapping: - as a polygon, limited by the riverbed and the intersection with the undisturbed land; not evident on small ravines. The mapping should be done on a larger scale than in the case of ravine identification

Relatively stable banks

Identification: - elements that frame the riverbed without evident erosion or landslide, with herbaceous and/or forest vegetation, contrasting with the surrounding environment, contrast given by the different light incidence angle, with no lateral origins, sometimes with agricultural parcels
Mapping: - as a polygon, limited by the riverbed and the intersection with the undisturbed land; not evident on small ravines. The mapping should be done on a larger scale than in the case of ravine identification
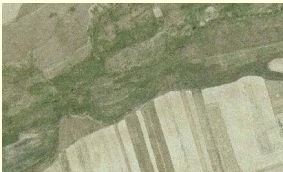
Results: photointerpretation keys

Land displacements
Land falls

Identification: - distinctive aspect on the image due to the apparent geological sublayer, often curved, with high humidity areas in the lower part
Mapping: - in the upper part according to the limit of the rupture, in the lower part following the intersection with the sliding mass

Mapping model validation

Possible error sources in land degradation mapping:

- Ortho rectification errors on aerial photos
  - verified by GPS control points (± 0.5 m, similar to ortophotoplan spatial resolution)
  - no significant differences between the external contour line of the degraded land in case of non-evolution forms
- Separation of elementary units
  - few difficulties in separating the stable/unstable banks of the ravines
  - possible errors in the classification of vegetation-covered areas on the ravine banks (low density of forest cover doesn't stop the erosion process)
- Sheet erosion – difficult to map in early stages

The general assessment showed a maximum error of ±1.2m

The mapping of the degradation forms and elementary units in the target area Preutesti
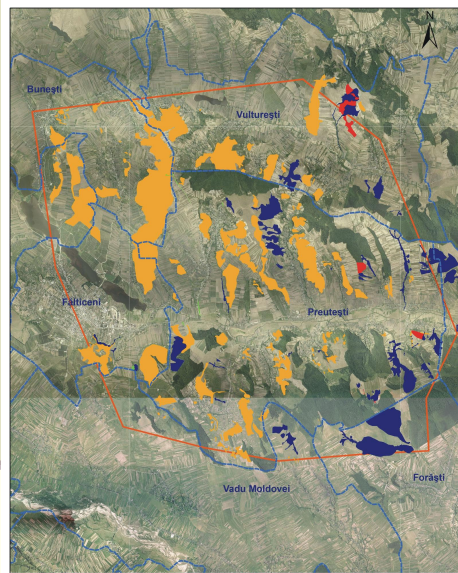
Harta formelor de degradare
din aria ţintă Preuteşti-Buneşti

Legenda

— Limite arii ţintă	**Preutesti**
- - - Limita UTA	**Forma de degradare**
	Deplasare
	Antropic
	Ogase
	Ravena
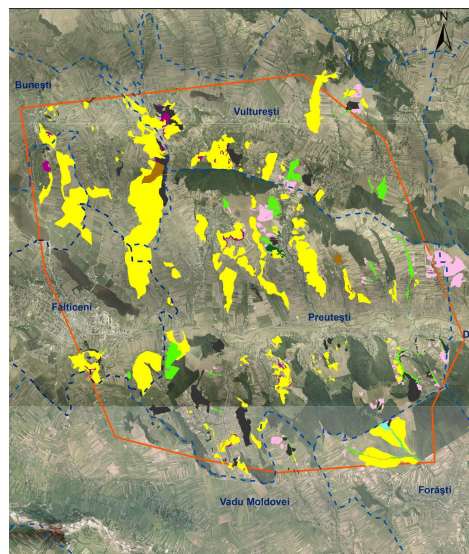
Harta unităţilor elementare de degradare din aria ţintă Preuteşti Buneşti
Legenda

Preutesti
Unităţi elementare

AV		H	R		ZS
C		MI	T		ZV
AI	CM	MS		- - -	Limita UTA
AM	CV	O	V	—	Limite arii ţintă

Preuteşti

Target area
16573 ha

Degradation
17 %

Degradation form	Total (ha)
human induced	67
ditches	14
ravine	1102
l. displacement	1657

The mapping of the degradation forms and elementary units - target area Ciprian Porumbescu
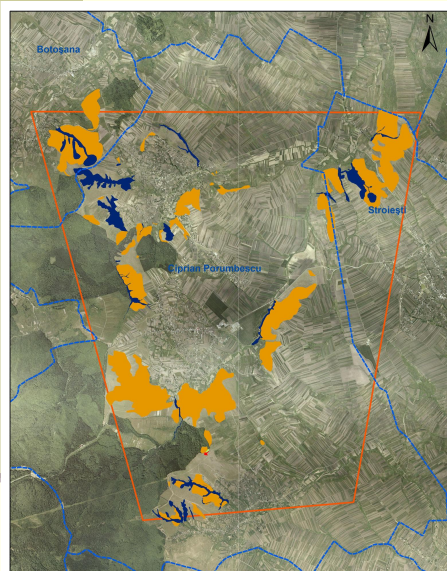
Harta formelor de degradare
din aria ţintă Ciprian Porumbescu

Legenda

Ciprian Porumbescu
Forma de degradare

Deplasare	Antropic	- - - Limita UTA
	Ogase	
	Ravena	
	— Limite arii ţintă	
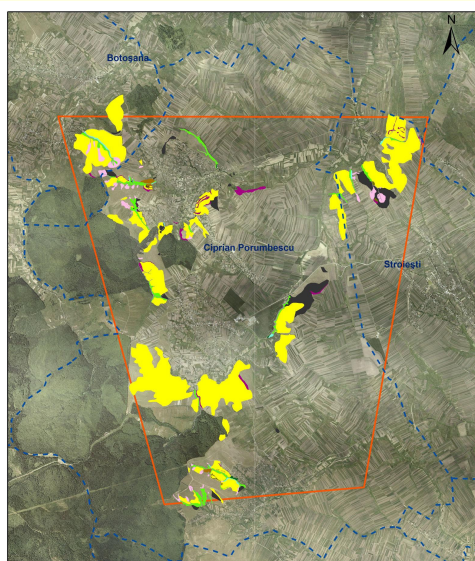
Harta unităţilor elementare de degradare din aria ţintă Ciprian Porumbescu
Legenda

Ciprian Porumbescu Unităţi elementare

AV	CV	MS	T		ZS
AI	C	H	O		ZV
AM	CM	MI	R	V	- - - Limita UTA
					— Limite arii ţintă

Ciprian Porumbescu

Target area
6230 ha

Degradation
15 %

Degradation form	Total (ha)
human induced	4
ditches	1
ravine	360
l. displacement	345

Land degradation forms - spatial distribution

Land Degradation Forms in the Suceava Plateau

Legend

- Human Induced Degradation
- Land Displacement
- Marsh Areas
- Ditches
- Ravines
- Superficial Soil Flow

0 3 6   12   18   24
Km
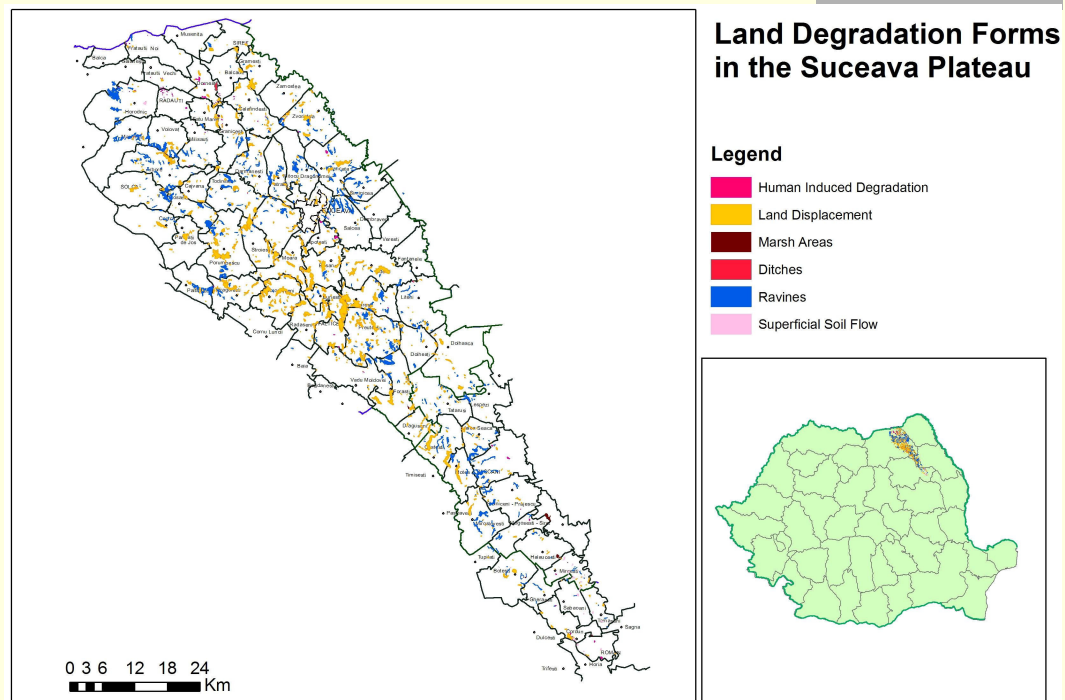
Degraded lands distribution on area classes

Legend:
- Land Displacement
- Superficial soil flow
- Human Induced Degradation
- Marsh Areas
- Ditches
- Ravines

Y-axis: Frequency (0, 100, 200, 300, 400, 500, 600, 700, 800)

X-axis: Area classes (ha) (0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, > 52)
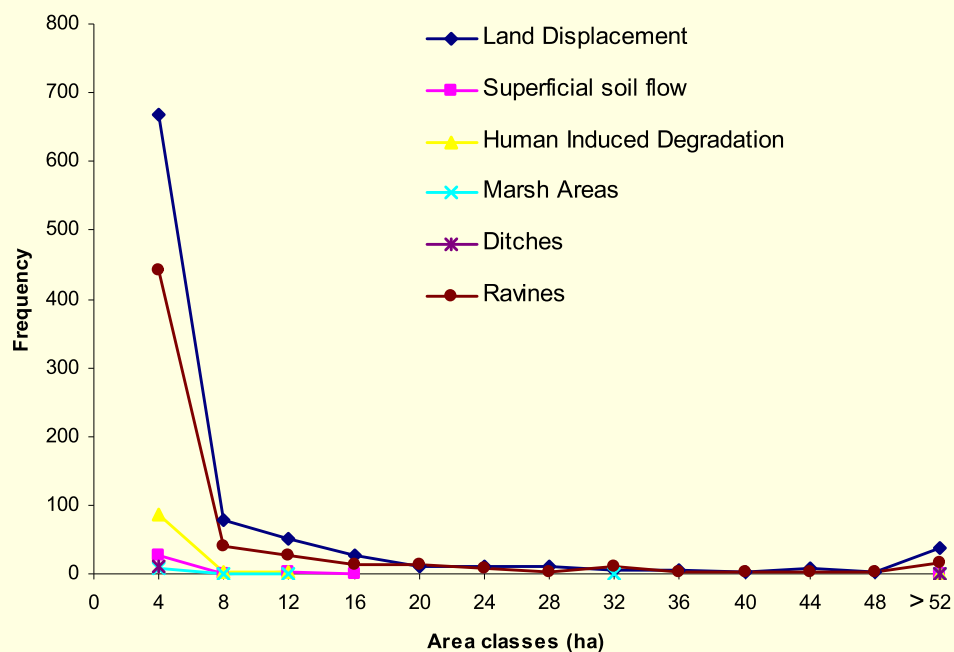
Degradation areas in the Suceava Plateau

Legend

Total land degradation area (ha)
- 0 - 17
- 18 - 49
- 50 - 79
- 80 - 104
- 105 - 122
- 123 - 157
- 158 - 212
- 213 - 289
- 290 - 442
- 443 - 772

Legend

Land Displacements (ha)
- 0 - 8
- 9 - 19
- 20 - 36
- 37 - 50
- 51 - 62
- 63 - 93
- 94 - 152
- 153 - 253
- 254 - 446
- 447 - 755

Legend

Ravines (ha)
- 0 - 3
- 4 - 11
- 12 - 25
- 26 - 46
- 47 - 63
- 64 - 84
- 85 - 116
- 117 - 157
- 158 - 199
- 200 - 304
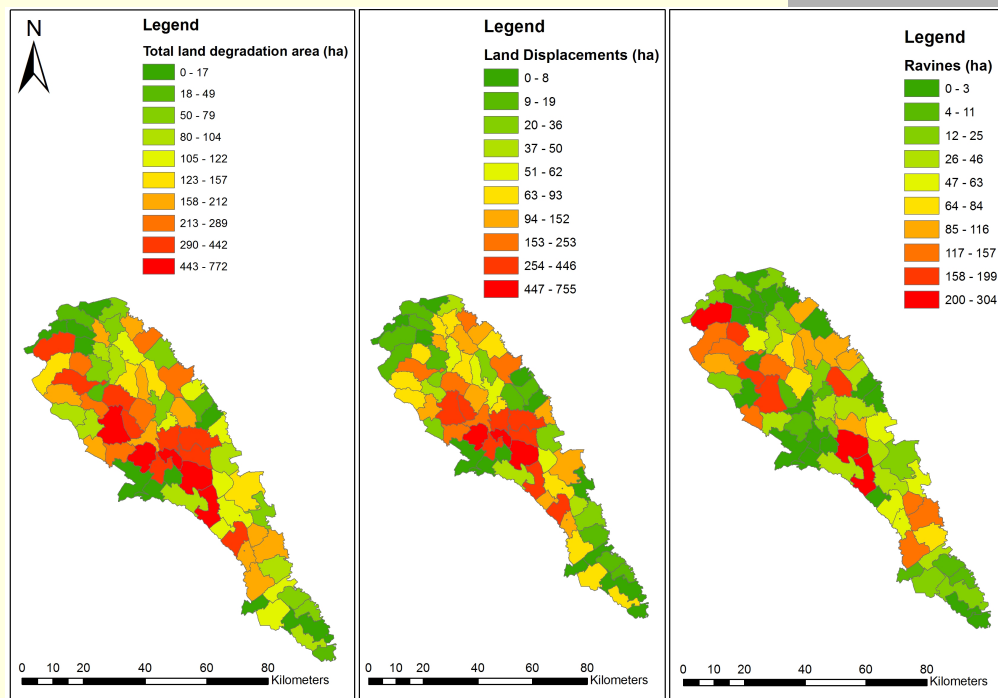
Degraded lands distribution on form coefficient classes

Legend: Land Displacement, Ravines, Ditches, Marsh Areas, Human Induced Degradation, Superficial soil flow, Total

Y-axis: Frequency

X-axis: Form coefficient ($m^2 m^{-1}$)
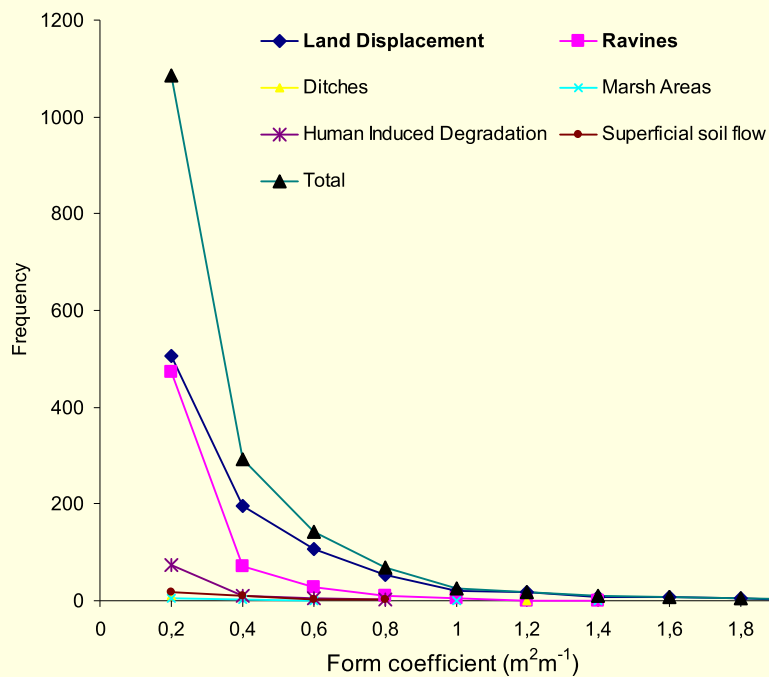
Discussions – model analysis

- existence of aerial orthorectified images, with guaranteed precision for degradation mapping technique,

- efficient ground control techniques (handheld GPS, ground photos),

- possible start point for a national up to date inventory of degradation phenomena

- exclusion of forest cover areas from the mapping activities

- static representation of a dynamic phenomena

- difficult to make an accurate characterization of areas with incipient *sheet erosion*

Discussions – external conditions

- the need of landscape management analysis in the context of bad practices related to uncertainties in land restitution

- the need to identify irrational use of agricultural systems

- increasing up to date data sets (aerial orthorectified images from LPIS European program, different maps)

- further use basis for *scientific and practical land degradation analysis:*

    - evolution assessments (1978 - 2008)

    - correlation of soil erosion to geology, soil type and DEM

    - support for *automatic soil erosion mapping* in multispectral images

- possible low impact on decision making processes due to stakeholders' lack of interest and political instability,

- image flaws (clouds, shadows, different incidence angle)

Conclusions

- The use of aerial photointerpretation in degradation mapping offers efficiency and satisfying accuracy in the analysis of phenomenon at broad scale level

- An accurate method of degradation mapping on the existing aerial images should include visual photointerpretation

- The aerial images database already exist and is periodically updated on a national level (Land Parcel Identification System – 5 year repeatability of the flight campaign)

- The resolution of the images is sufficient for an accurate delineation needed in the spatial analysis

- The results regarding incipient sheet erosion should be analyzed with caution due to the lack of image sensitivity in this case

- The detailed mapping on elementary degradation units offers important information for ecological rehabilitation purposes

Thank you!

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