SOIL EROSION FROM MODELLING TO MITIGATION: CAN CONSERVATION AGRICULTURE BE A SOLUTION?

Giampaolo Sarno - Regione Emilia-Romagna D.G. Agriculture
Francesca Staffilani - Regione Emilia-Romagna D.G. Environment

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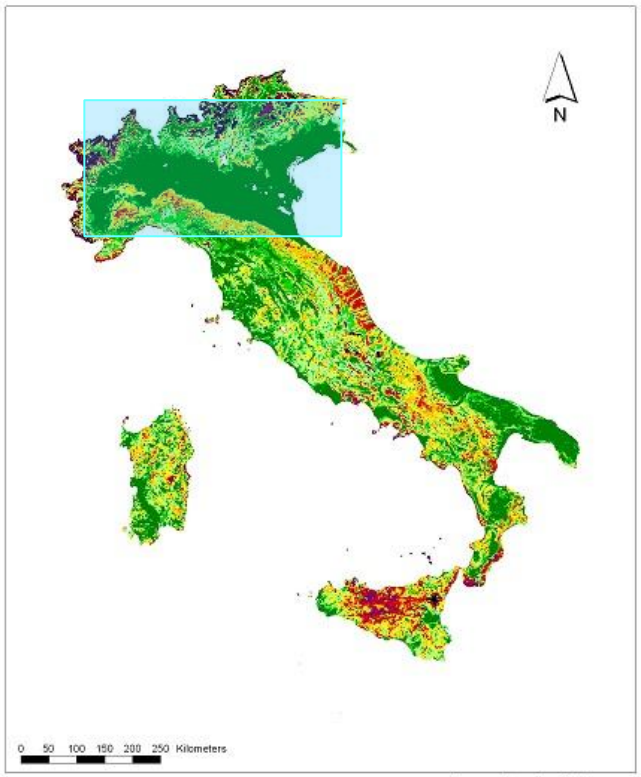
Life HelpSoil

SOIL EROSION RISK

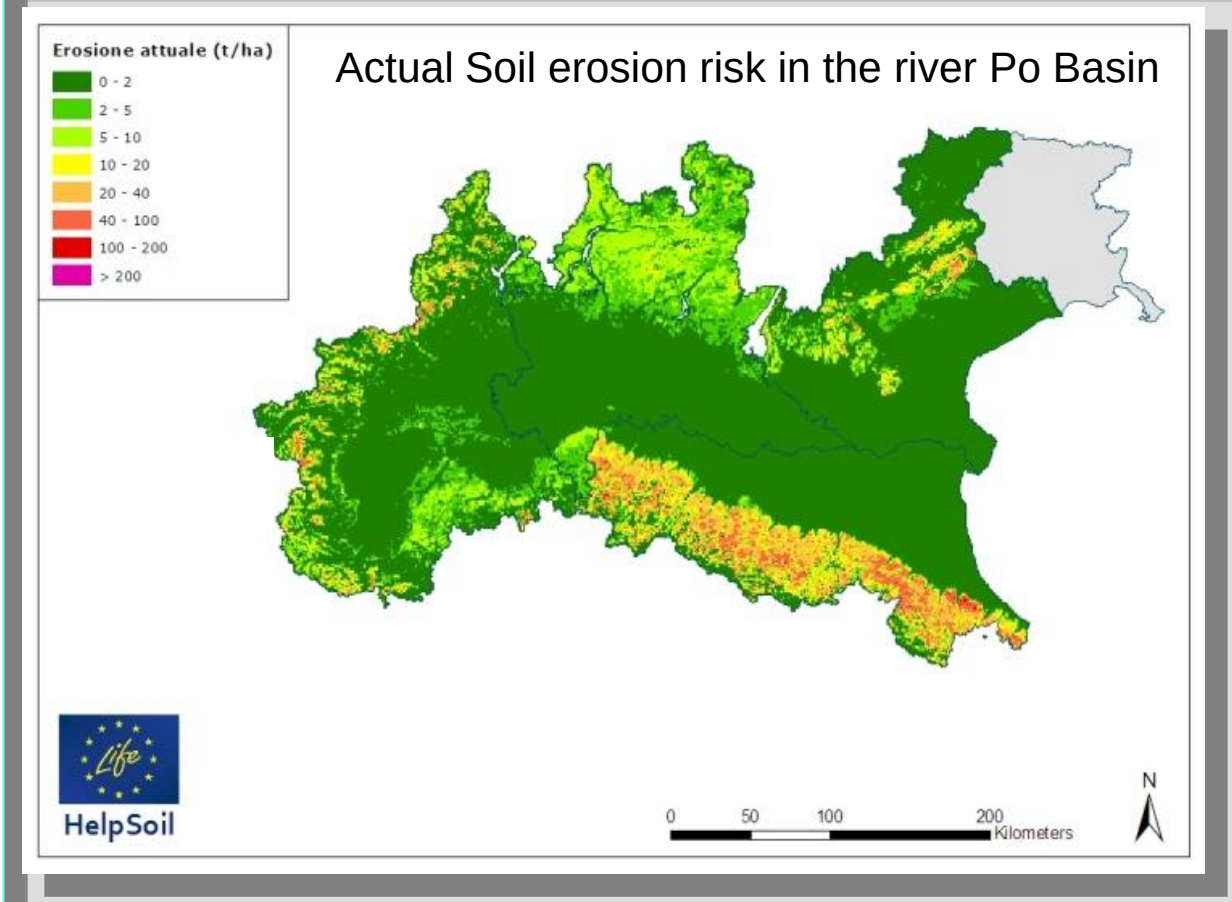


Actual Soil Erosion Risk Italy by Rill and Inter-Rill Erosion

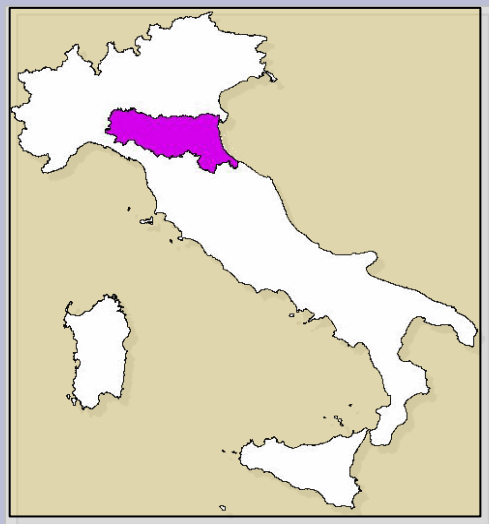
EUROPEAN SOIL BUREAU
EUROPEAN COMMISSION

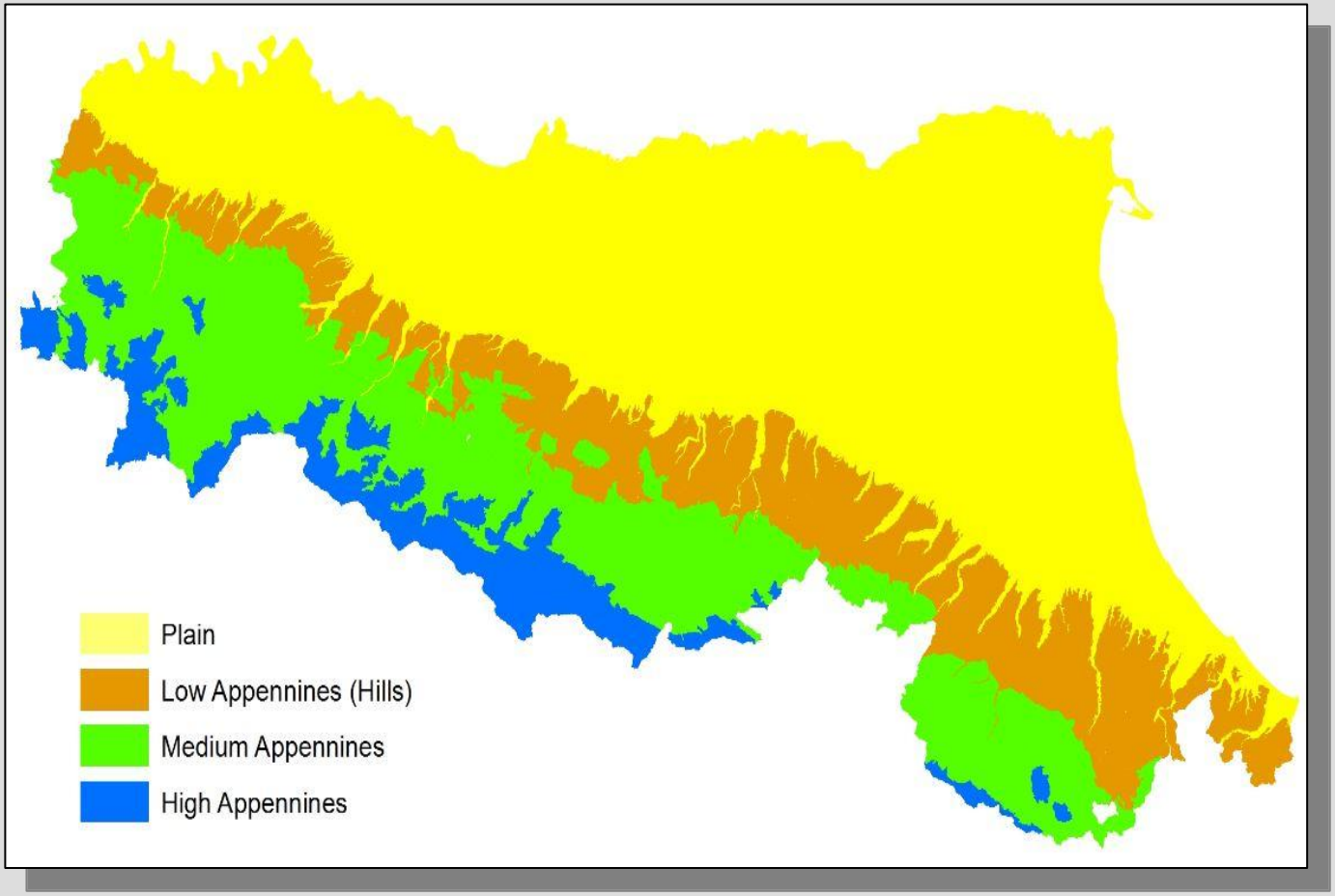
Approximate Soil Loss (t/ha/yr)

- 0 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 20
- 20 - 40
- > 40
- Rock outcrops



MORPHOLOGY OF EMILIA-ROMAGNA

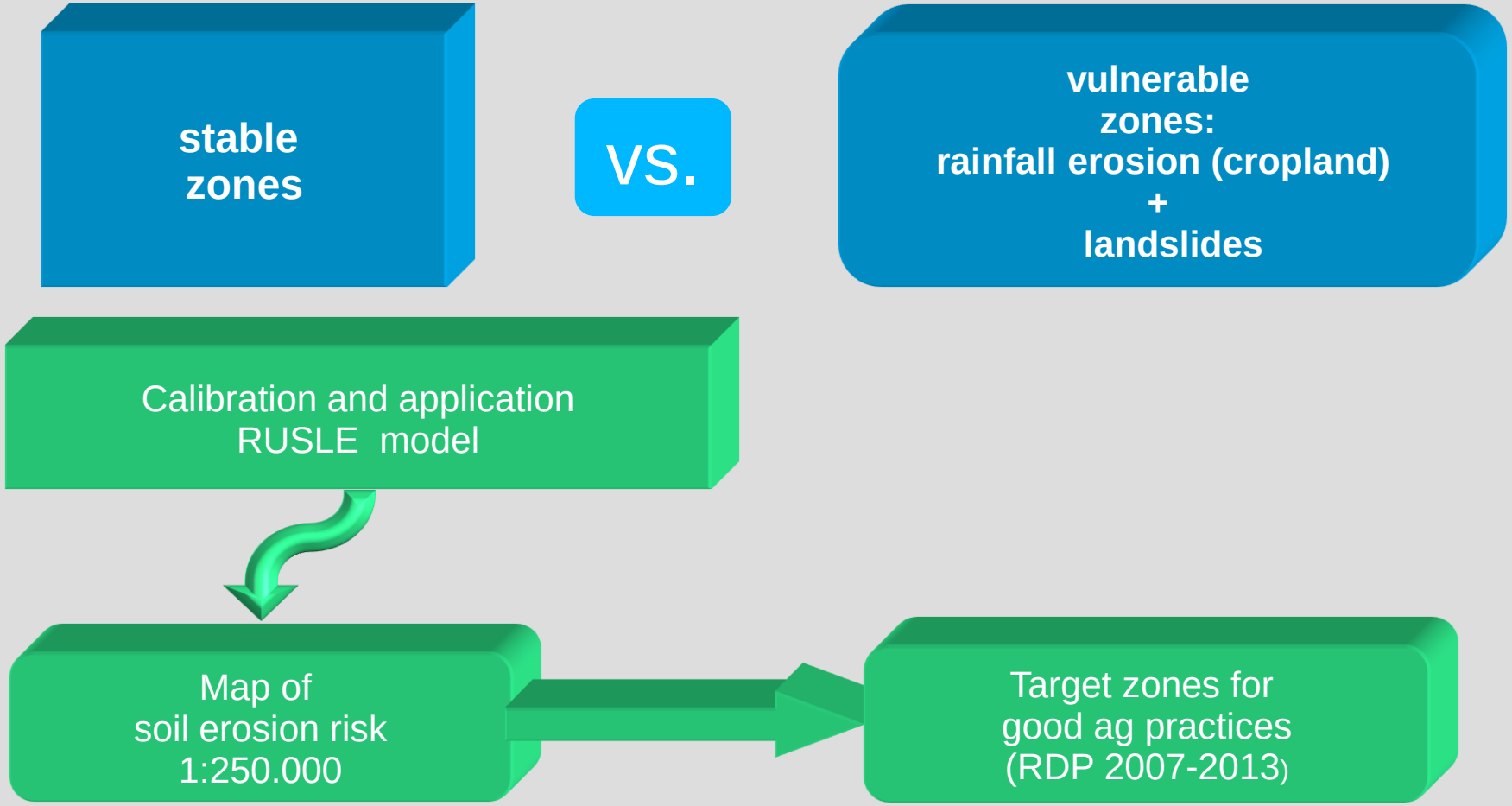




The Apennine chain covers half the total Area of the region

LAND VULNERABILITY: KNOWLEDGE AND MANAGEMENT stage 1

Constitutional instability of the geological substrate of the Apennine: analisys of effects



THE FACTORS OF RUSLE AT A REGIONAL SCALE

The RUSLE (Revised Universal Soil Loss Equation) model aims to evaluate soil erosion risk (*Wischmeier and Smith, 1978; rev. Renard et al., 1997*):

A = R * LS * K * C * P

A = Soil Loss ($Mg*ha^{-1}*y^{-1}$)

R = Rain Erosivity (function of rainfall intensity and duration)
EI = $0.11*P^{1.82}$, (*CNR-IRPI 2003)*

LS = Slope Lenght (estimation of topography effect, as sediment transportation capacity by run off)
$(FlowAccumul._{*} CellSize/ 22.13)^{0.4}{}_{*} ((\sin(Slope_{*} 0.001745)/0.09)^{1.4})_{*} 1.4$, (*Mitasova et al., 1996)*

K = Soil Erodibility (soil aptitude to be taken off by rain)
$K= 7.594[0.0034+0.0405 \exp[-0.5((\log(Dg)+1.659)/0.7101)^2]$, (*Renard et al. 1997)*

C = Soil Cover Factor
regional db, with crops, their distribution, timing of management (*RER, ARPA, CNR-IRPI, 2004)*

P = Support Practice Factor
estimation of effect of soil cover by crops and residues + agricultural practices

LAND VULNERABILITY: KNOWLEDGE AND MANAGEMENT

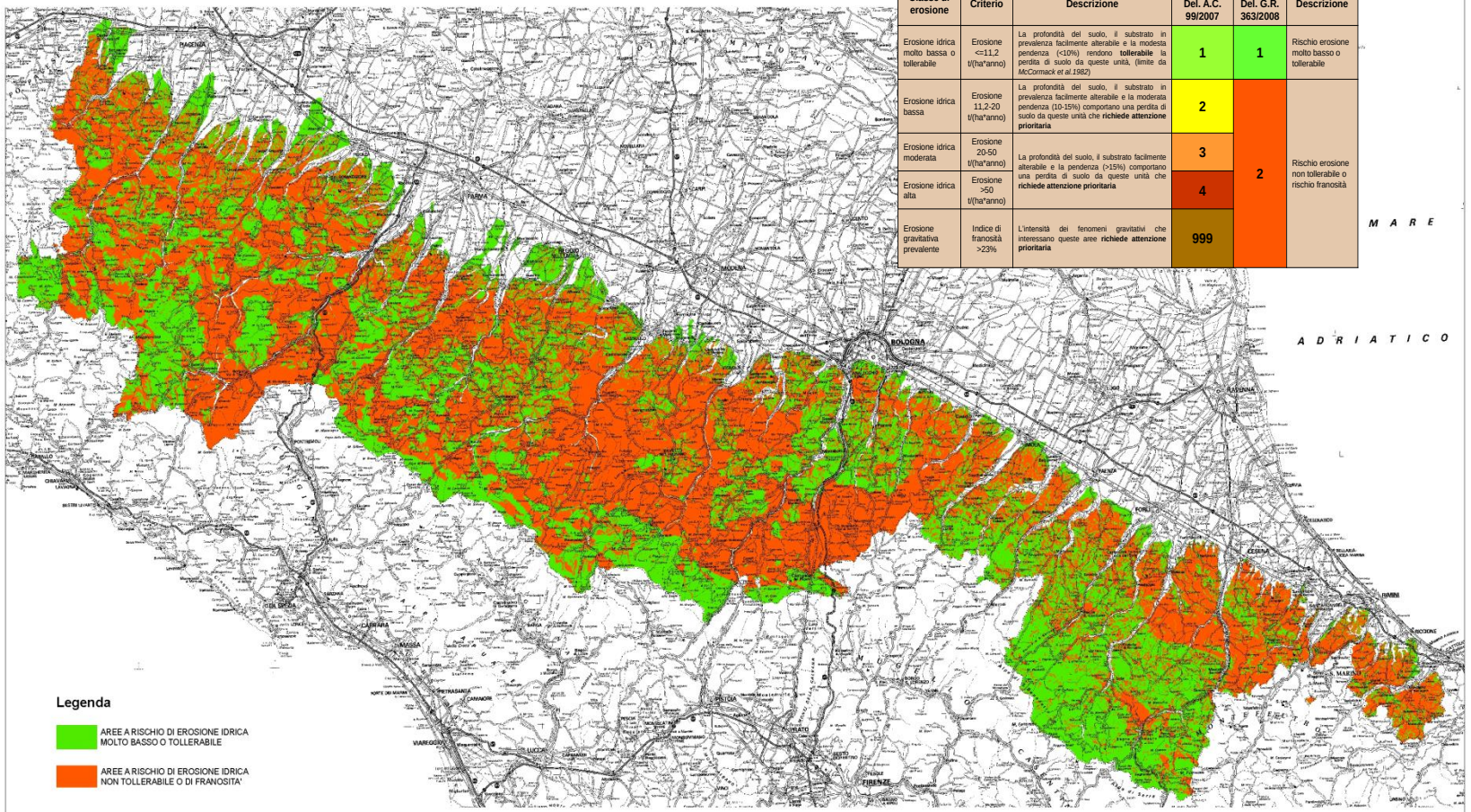
RegioneEmilia-Romagna

ACTUAL SOIL EROSION RISK (RAINFALL+ LANDSLIDES)

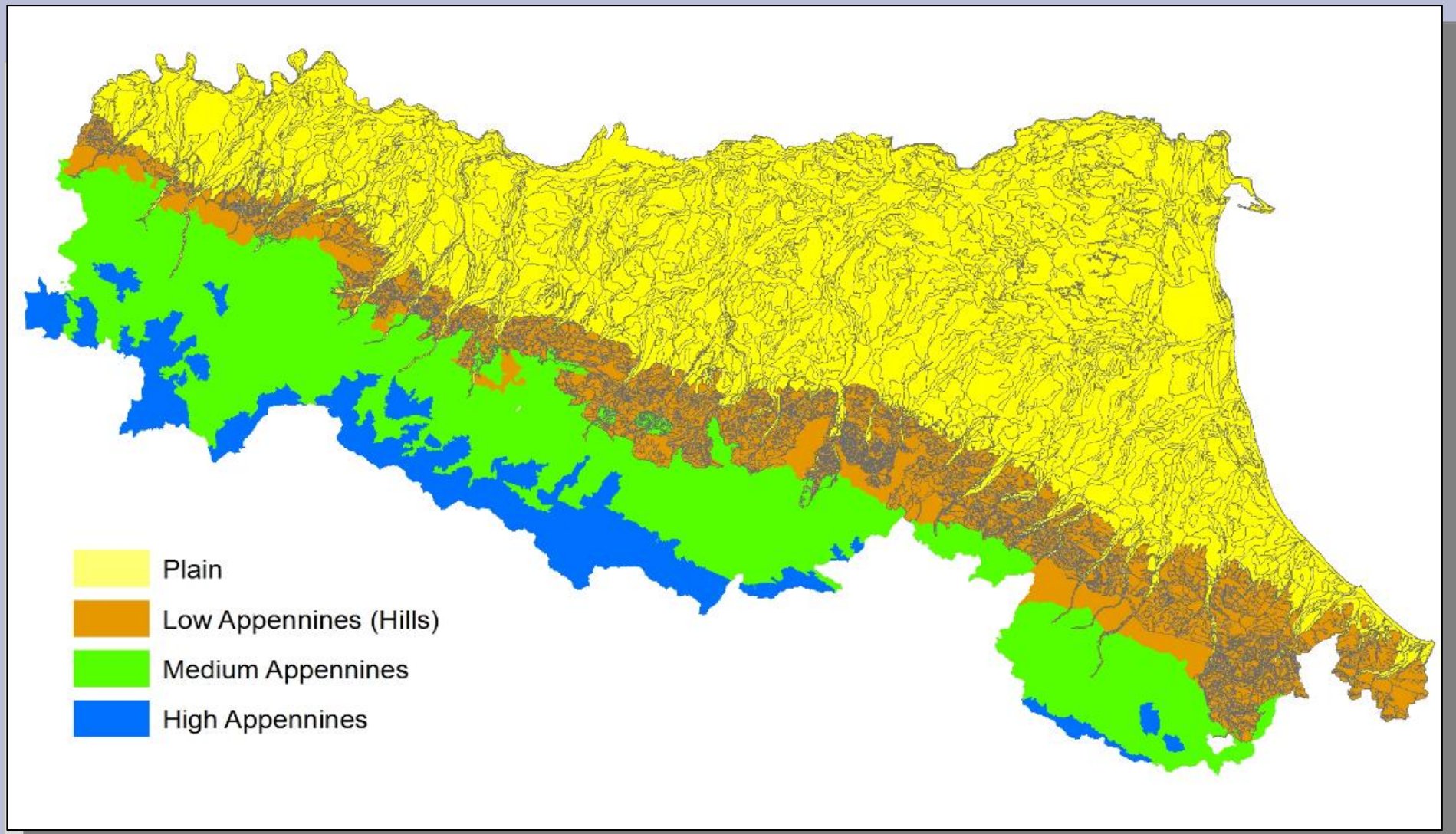
servizio geologico sismico e dei suoli

Secondo stralcio Programma Operativo dell'Asse 2 del PRSR 2007-2013

Classe di erosione	Criterio	Descrizione	CLASSI Del. A.C. 99/2007	CLASSI Del. G.R. 363/2008	Descrizione
Erosione idrica molto bassa o tollerabile	Erosione <=11,2 t/(ha*anno)	La profondità del suolo, il substrato in prevalenza facilmente alterabile e la modesta pendenza (<10%) rendono **tollerabile** la perdita di suolo da queste unità, (limite da *McCormack et al.1982*)	1	1	Rischio erosione molto basso o tollerabile
Erosione idrica bassa	Erosione 11,2-20 t/(ha*anno)	La profondità del suolo, il substrato in prevalenza facilmente alterabile e la moderata pendenza (10-15%) comportano una perdita di suolo da queste unità che **richiede attenzione prioritaria**	2	2	Rischio erosione non tollerabile o rischio franosità
Erosione idrica moderata	Erosione 20-50 t/(ha*anno)	La profondità del suolo, il substrato facilmente alterabile e la pendenza (>15%) comportano una perdita di suolo da queste unità che **richiede attenzione prioritaria**	3		
Erosione idrica alta	Erosione >50 t/(ha*anno)		4		
Erosione gravitativa prevalente	Indice di franosità >23%	L'intensità dei fenomeni gravitativi che interessano queste aree **richiede attenzione prioritaria**	999		



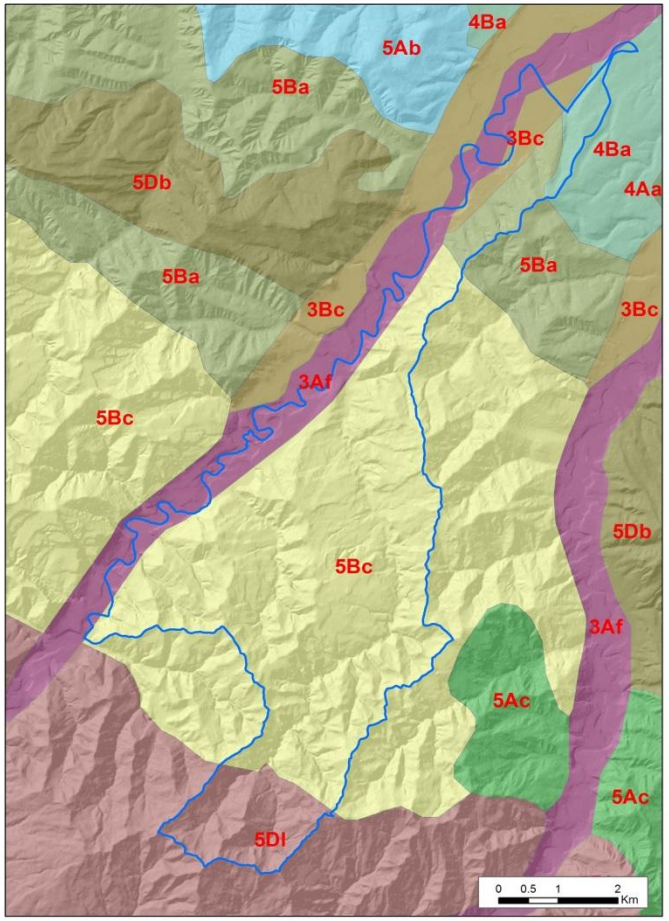
LAND VULNERABILITY: KNOWLEDGE AND MANAGEMENT stage 2

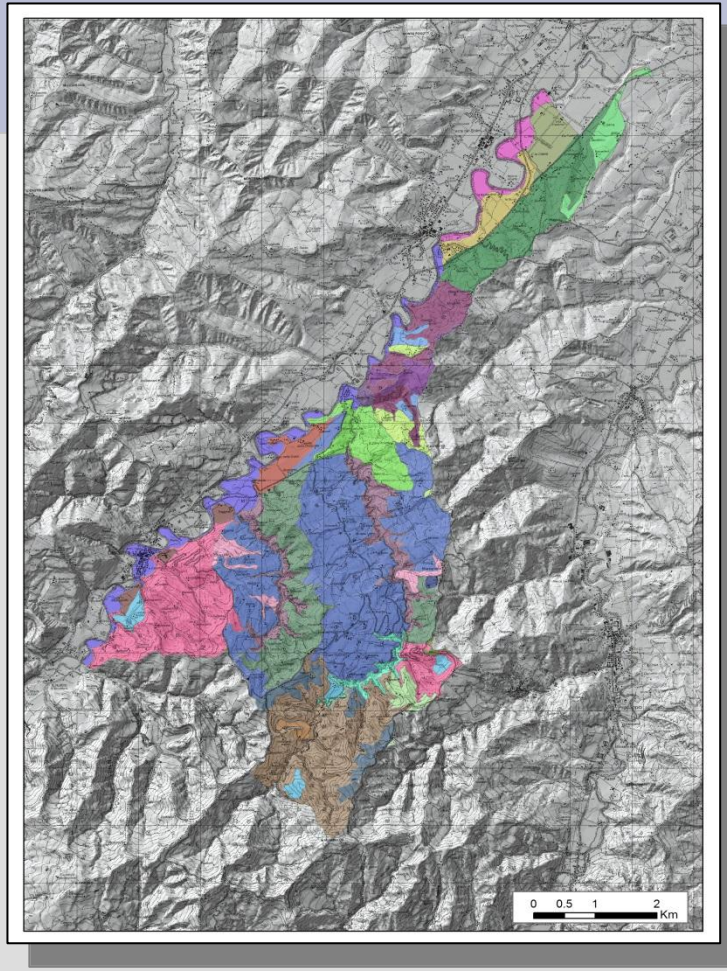


Soil map at scale 1:50.000 enlarged to most of regional hilly area (82%)

LAND VULNERABILITY: KNOWLEDGE AND MANAGEMENT stage 2

- Soil map at scale 1:50k enlarged to most of regional hilly area (82%)
- New application of RUSLE model: basin modelling.





Brasina creek Basin
1:250k > 6 Map Units, 12 Soil Units
1: 50k >19 Map Units, 50 Soil Units

RUSLE modelling
the Basin of Brasina creek

Description	
River basin	Brasina creek
Total area	3,408 hectares
Municipalities	Predappio, Dovadola, Castrocaro
altitude	50-700 m a.s.l.
ave. annual rain	800-1,500 mm
Geology	“Marnoso-arenacea”
Soils	Fine to coarse loamy family
Erosion evidence	Laminar flow - rills

RUSLE modelling
the Basin of Brasina creek

"K" factor modelling improved by consideration of SOM content (*Torri,1997*)

Simulations by means of the RUSLE model, applied at <u>basin scale</u>, identified:

- **32% of total basin area affected by erosion risk at high rate (>50 Mg*ha^{-1}*y^{-1});**
- **8% at a moderate level (20-50 Mg*ha^{-1}*y^{-1}).**

Further improvements: "C" AND "P" FACTORS

LAND USE IN THE BASIN OF BRASINA CREEK

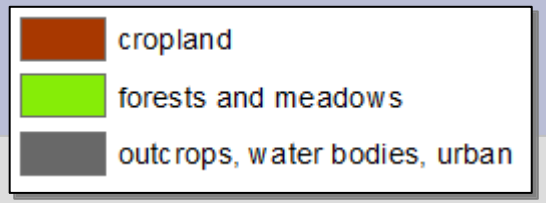
arable and horticultural crops with 44% represent the most relevant agricultural land use, followed by forest and meadows (representing 42% of the area).

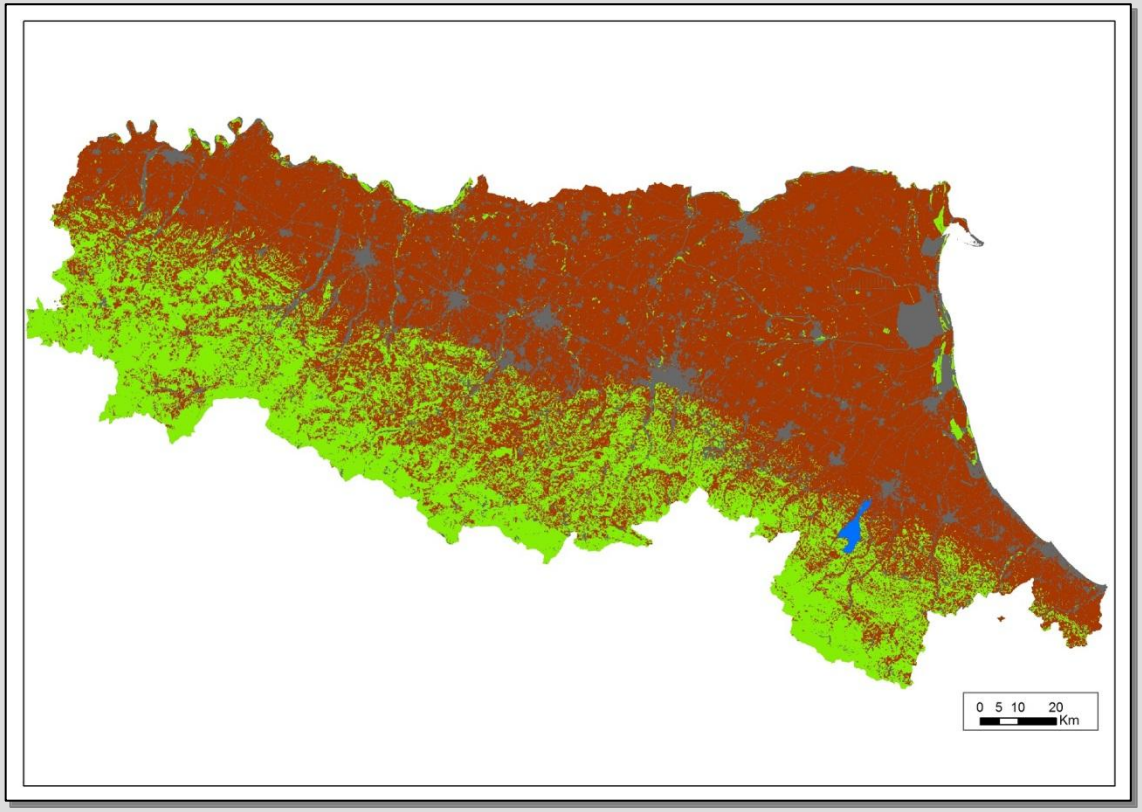
But arable crops and horticulture can be considered to be less effective in reducing the erosion risk.

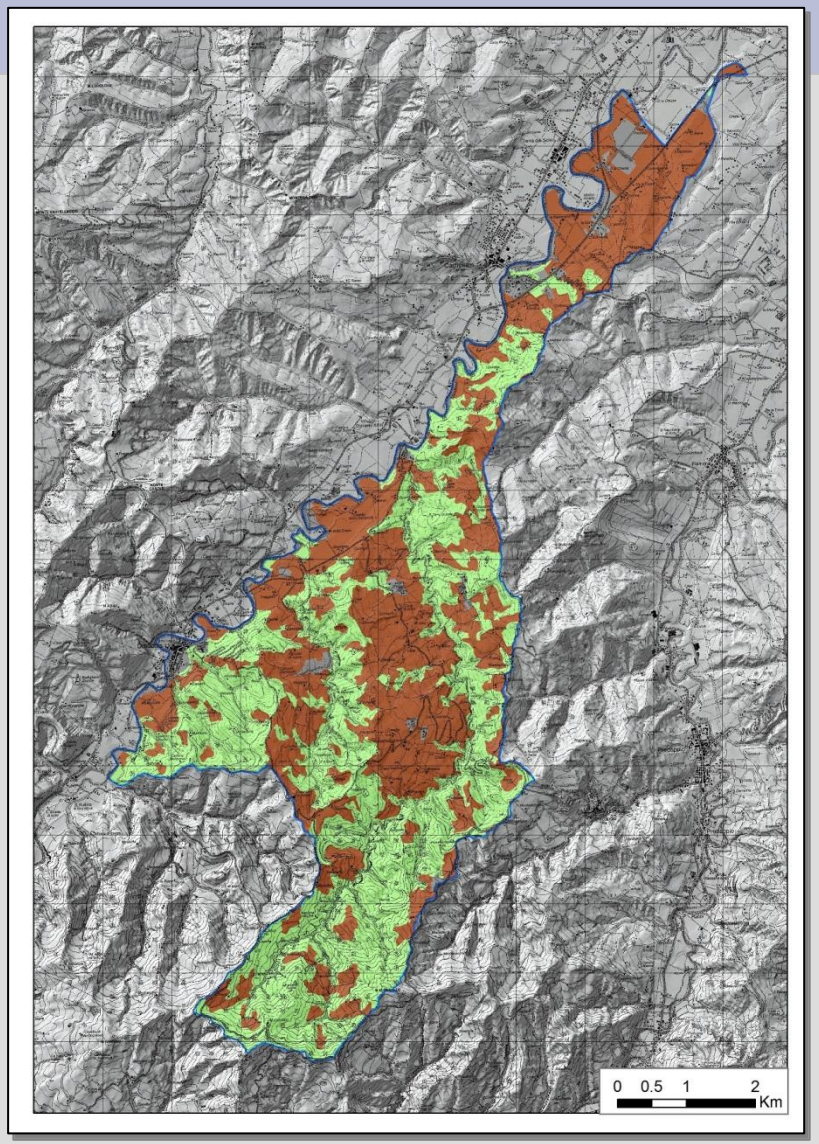
For these land use classes the vulnerability to erosion mainly depends on management practices:

- soil cover rate during rainy seasons,
- intercropping or grass cover for permanent crops,
- soil disturbance reduction (sod seeding)

LAND USE MAP: overview / focus







Agriculture in Apennine Hills

Hills of Emilia-Romagna (100<altitude<600 m a.s.l.) show very contrasting farming systems:

- **arable crops rotation,**
- **orchards and vineyards on permanent grass cover,**
- **livestock farming based on cereals-alfalfa cropping systems.**

These two latter can obtain a high level protection of topsoil against rain erosion, whilst arable rotations can result in huge soil losses (> 20 $Mg*ha^{-1}*y^{-1}$).

Conservation Agriculture: a new operation to reduce erosion risk in hilly cropland (RDP 2014-2020).

Improving soil quality - strengthening the adaptation to climate change through SUSTAINABLE TECHNIQUES OF CONSERVATION AGRICULTURE

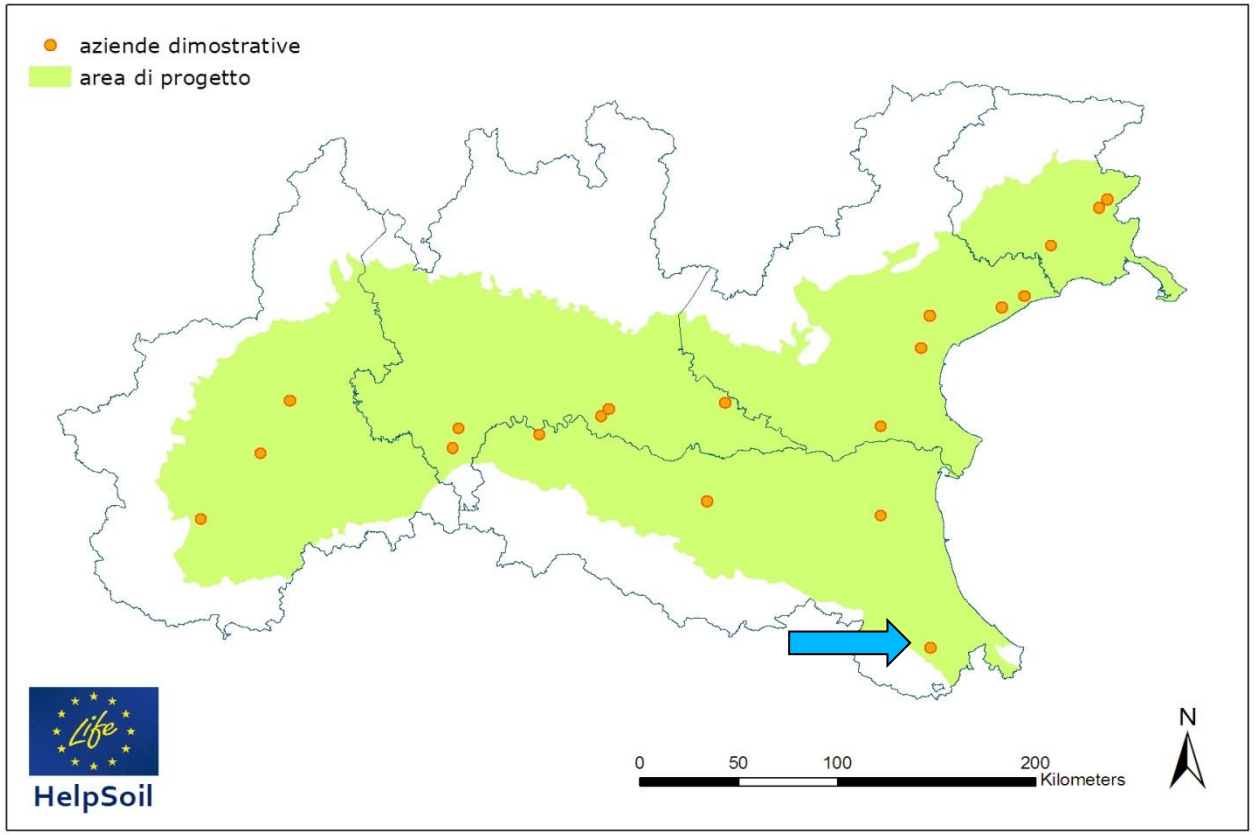
Conservation Agriculture (CA) is a production system based on a combination of 3 major principles:

- no inversion tillage and an overall reduction of soil disturbance, with preference for no-tillage;
- permanent maintenance of soil cover with crop residues or cover crops;
- plant species diversity or diversified crop rotations.

LIFE HelpSoil project

Objective: feasibility of CA, in association with some novel techniques, to achieve best soil management.

Focus: to strengthen the ecological functions of soils (carbon sequestration, increase of fertility and edaphic biodiversity, protection against erosion, water retention).



- **5 regions of the river Po plain (northern Italy)**
- **20 pilot farms**
- **4 pilot farms in Emilia-Romagna, 1 located on steep land**

CONSERVATION AGRICULTURE IN HILLY CROPLAND

“Gli Ulivi” pilot farm, represents the typical agriculture of Apennine Hills.

Total area: 300 hectares

Cropland area: 140 hectares

Cropping system: cereals, livestock feed and vineyards.

Basin: Brasina creek where RUSLE erosion model, as above described, has been testing.

Altitude: 295 - 420 m a.s.l.

Morphology: long, wavy, 10-40% slopes with predominant East orientation

Soils' parent material: pelithic-arenaceous rock-bed at 90-100 cm depth.

Soils: medium-textured, calcareous, with frequent Ca-carbonates concentrations, from moderately deep to deep.

CONVENTIONAL vs. CONSERVATION AGRICULTURE

ARABLE CROP
RAINFED
ROTATION

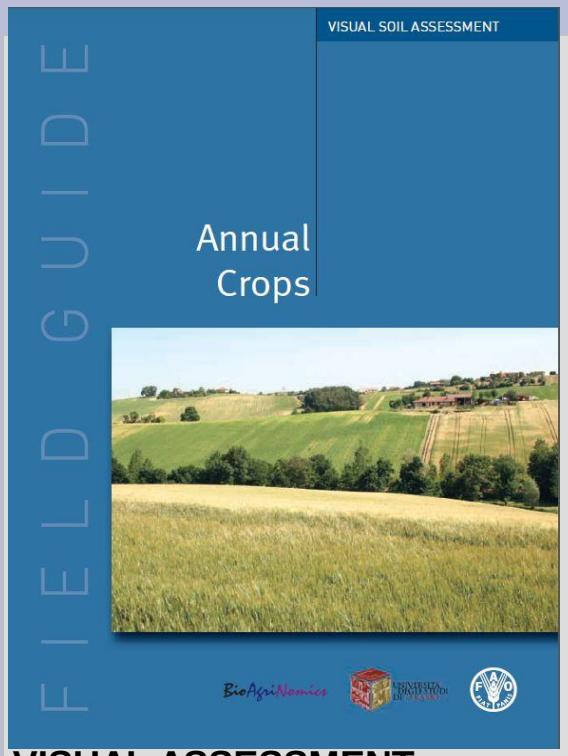
Alfalfa (4 years) –
Winter Wheat –
W. Barley

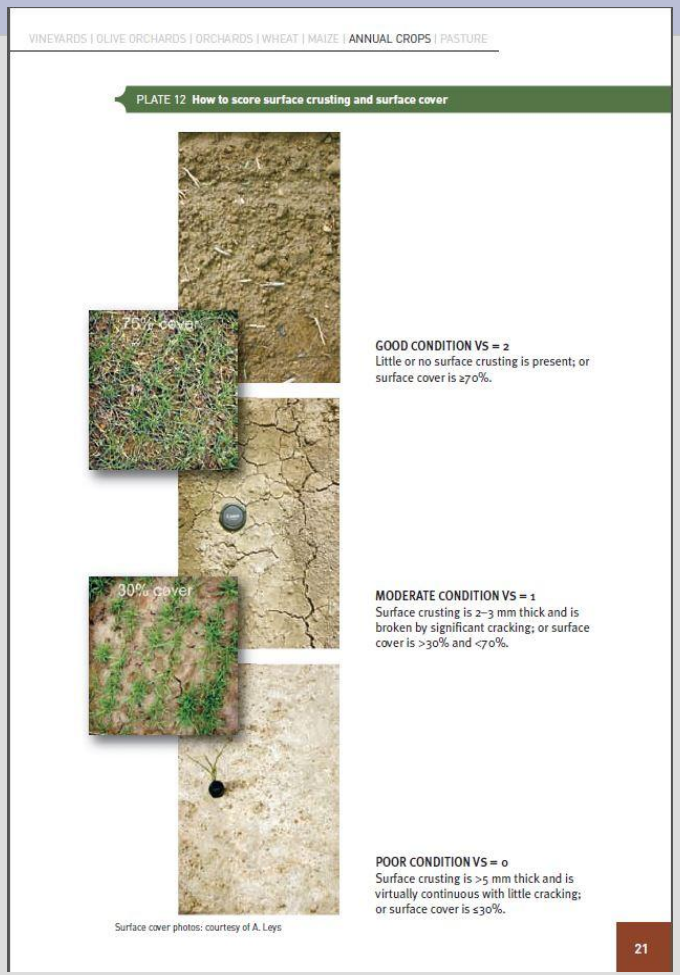
CONVENTIONAL MANAGEMENT
plowing (30-40 cm depth)
rotary harrow (1+ passages)
sowing machine
cereal straw harvested

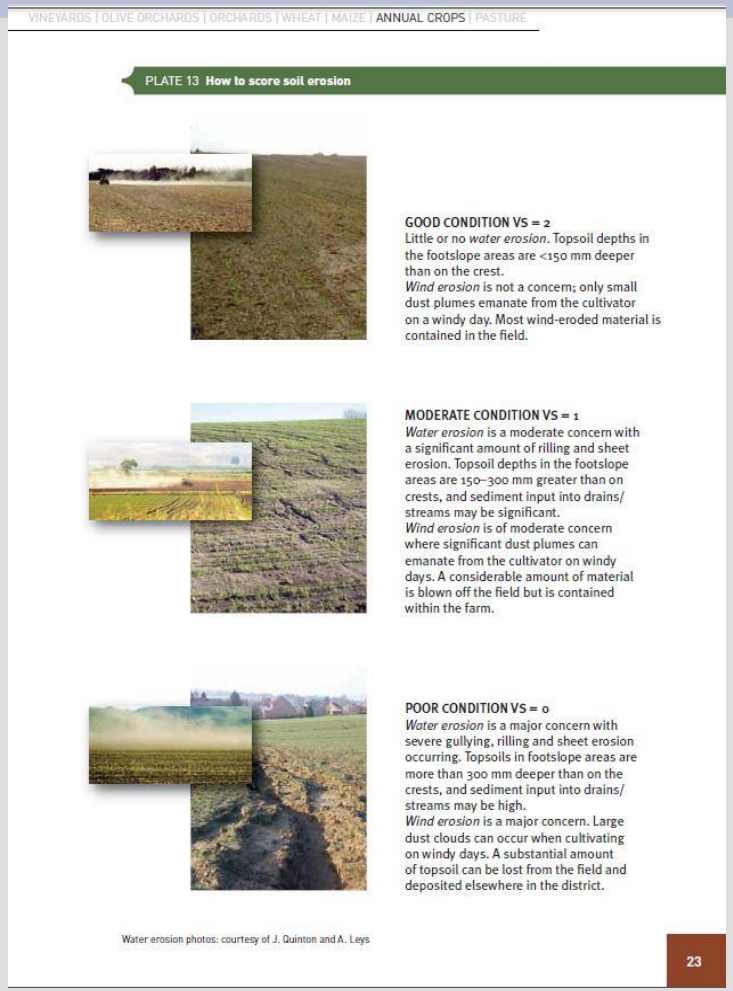
vs.

CONSERVATION MANAGEMENT
sod seeding
crop residues mulch
weed control / living mulch

CONVENTIONAL vs. CONSERVATION AGRICULTURE (SURVEY of EFFECTS)







VISUAL ASSESSMENT

- soil cover
- soil erosion + regional soil survey manual
- photo shots
- GPS-referenced plots

VISUAL SOIL ASSESSMENT

conventional

conservation

VISUAL SOIL ASSESSMENT

conventional: 40% soil cover
low sheet erosion

conservation: 60% soil cover
no erosion