University “Sv. Kiril i Metodij” –Skopje -
Faculty of Forestry, Dept. of Land and Water,
Skopje, Macedonia

GLOBAL WARMING, CLIMATE CHANGES and EROSION PROCESSES

Erosoin monitoring

Presenter: Ivan Blinkov

GLOBE - Ohrid, Macedonia June 2010

THE GLOBE PROGRAMME

Ivan Blinkov, PhD, full professor

University "Ss. Cyril and Methodius" - Skopje

<u>Permanent:</u> Faculty of Forestry – Dept. Land and Water

<u>Part-time:</u> Interdisciplinary studies of Environmental engineering

Age – 49

Civil Status – Married, 1 daughter

<u>Education:</u>

BSc – Forestry ; MSc, PhD - Forest Environment > Natural hazards > Watershed management

Teaching: ***Land and Water related courses,***

Leader of MSc group: ***Management of Land and Water in Mountainous ecosystems***

Membership: ***WASWC; Alliance21 GAOF, MES, BIOEKO …***

-<u>Professional achievements:</u>

2 textbooks, 3 internal scripts

author of chapter in monograph "Soil Erosion in Europe"

40 domestic projects

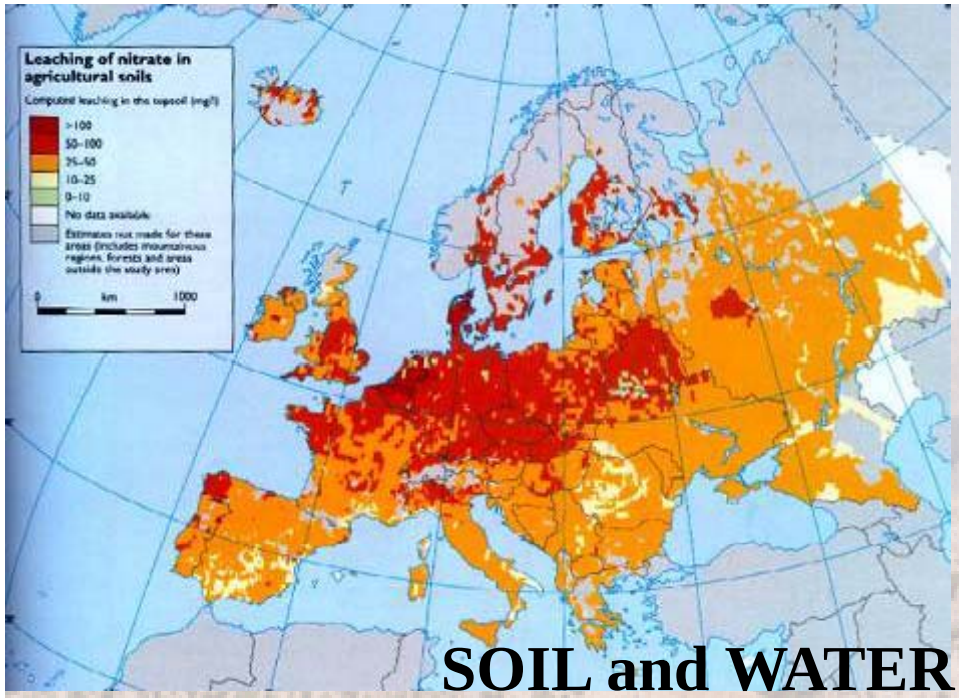
10 scientific domestic projects

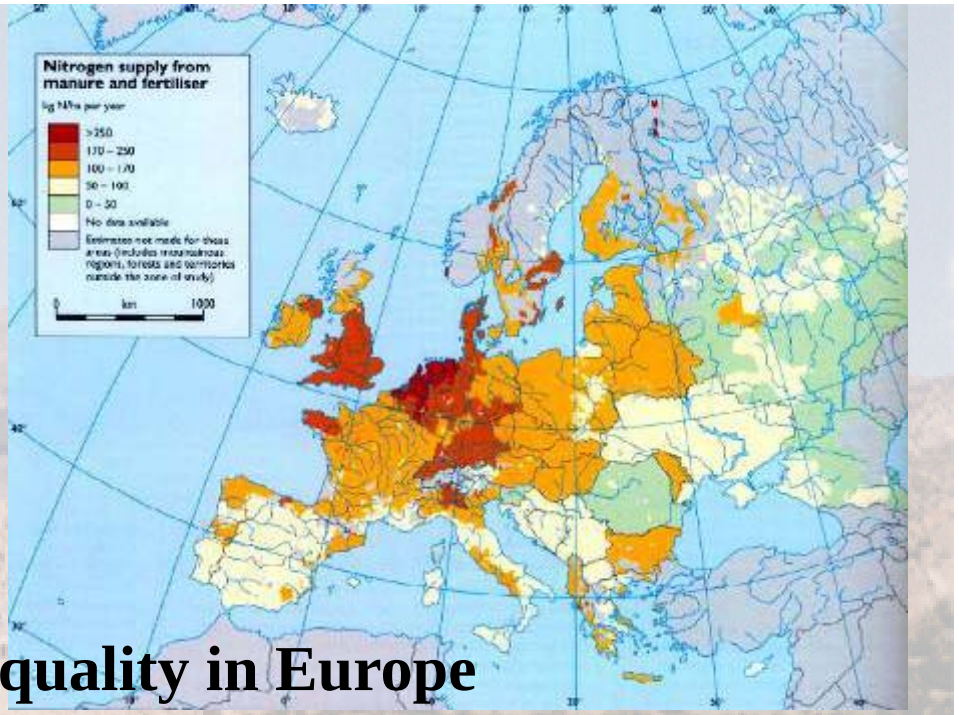
10 International projects

60 published papers on international conferences

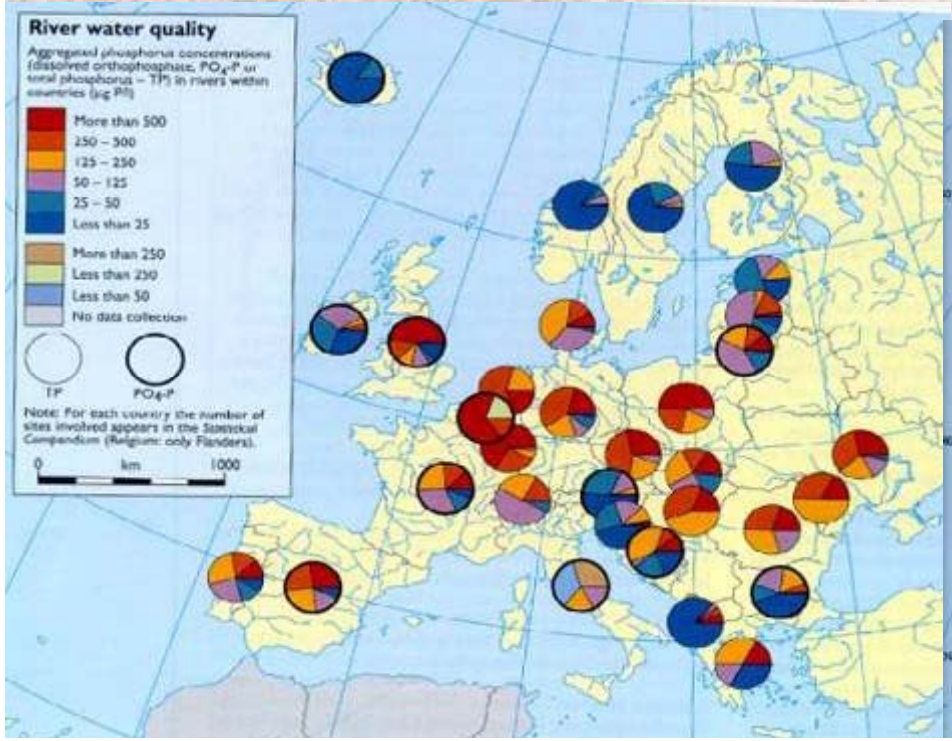
Reviser on scientific conferences, scientific journals, domestic projects

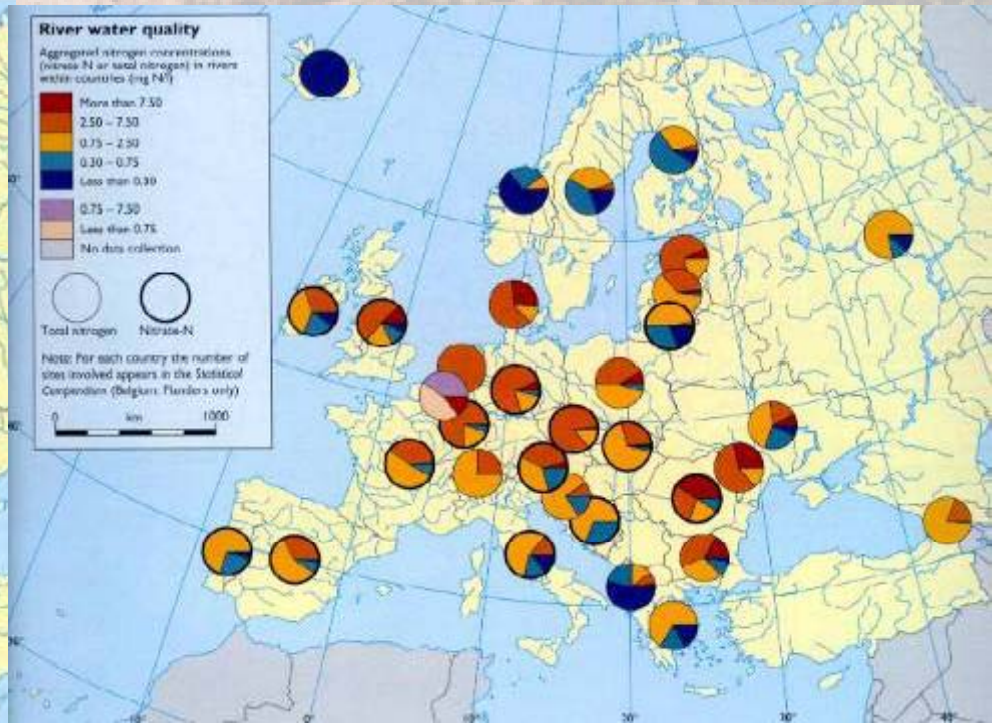
Member of Expert council of the Minister of environment





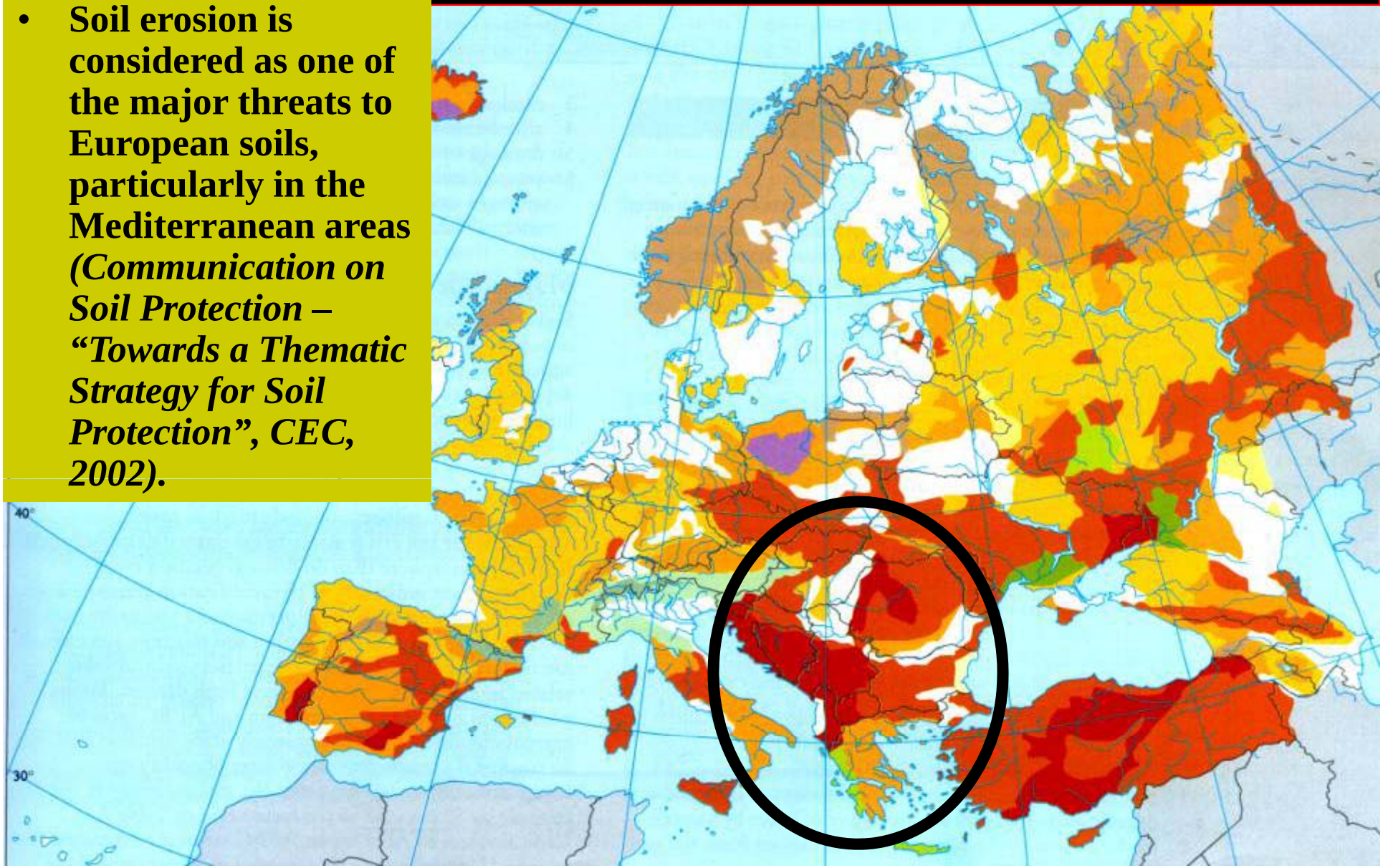
SOIL and WATER quality in Europe





WATER EROSION MAP - EUROPE

- **Soil erosion is considered as one of the major threats to European soils, particularly in the Mediterranean areas *(Communication on Soil Protection – "Towards a Thematic Strategy for Soil Protection", CEC, 2002).***



- *"The threat of nuclear weapons and man's ability to destroy the environment are really alarming. And yet there are other almost imperceptible changes -*

  I am thinking of the exhaustion of our natural resources, and especially of soil erosion - and these are perhaps more dangerous still, because once we begin to feel their repercussions it will be too late."

  - *(p144 of The Dalai Lama's Little Book of Inner Peace: 2002, Element Books, London)*

- *Erosion is a gravity driven process that moves solids (sediment, soil, rock and other particles) in the natural environment or their source and deposits them elsewhere.*

- *It usually occurs due to transport by wind, water, or ice; by down-slope creep of soil and other material under the force of gravity; or by living organisms, such as burrowing animals, in the case of bioerosion (a combined definition).*

- *Excessive erosion can produce trouble such as ecosystem damage, loss of soil and receiving water sedimentation*

- *Coupled with naturally occurring erosive rainfalls or windstorms makes erosion a huge environmental issue. This occurs in both agricultural/farming areas as well as the natural environment.*

Erosion processes and forms

Depend on the agent, erosion processes are classified as:

1 - water erosion processes,
2 - wind erosion processes and
3 - abrasive erosion processes.

Water erosion process are classified as follow:

- **a) Pluvial erosion** (raindrop and rainsplash erosion)
- - sheet erosion:
- - mixed erosion with appearance of small rills and gullies and sheet erosion including appearance of shallow landslides,
- - deep erosion: deep rills, gullies (U-shaped, V-shaped, W-shaped),

- **b) Fluvial erosion** (stream channel erosion)
- - torrent erosion,
- - river erosion;

Specific erosion processes are as follow:

- karst erosion,
- glacial erosion
- avalanche erosion
- landslides,
- landfalls,
- rock weathering,
- rock falls

- All these processes produce erosive material that is subject of down-slope or downstream transport and are deposed somewhere.

Erosion damages

The effects of erosion impact two places,
on-site (where the soil has become detached), as well as
off-site (where the eroded soil goes).

- **- “on-site” damages**
- loss of topsoil and nutrients,
- disturbance of the hydrological regime,
- landscape changes

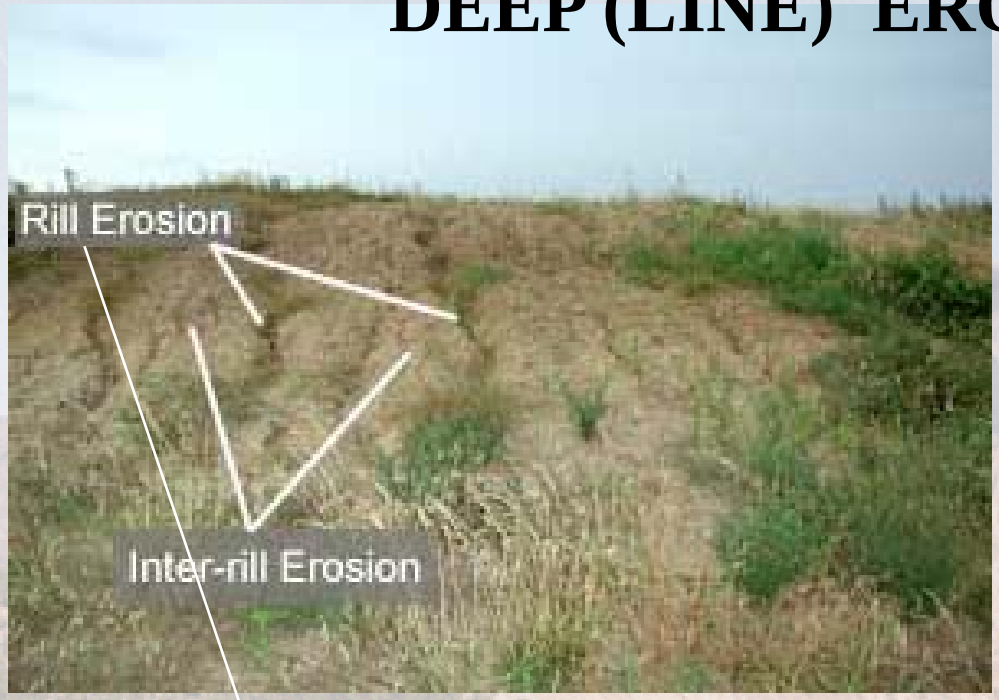
- **- “off-site” damages**
- flash flooding,
- siltation of the reservoirs and land in the downstream sections,
- soil halomorphism,
- soil and water pollution.

RAIN DROP

Saturated soil >>>>

Sheet erosion

DEEP (LINE) EROSION



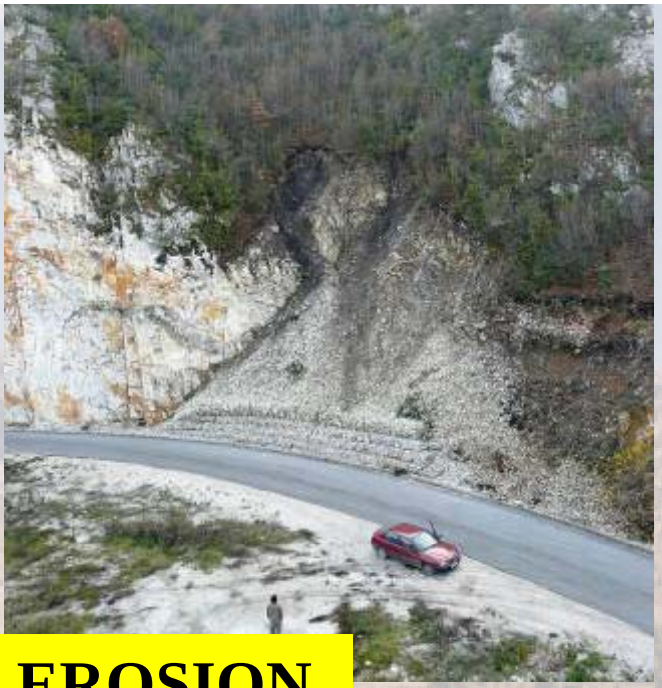
Gully erosion

U – gully

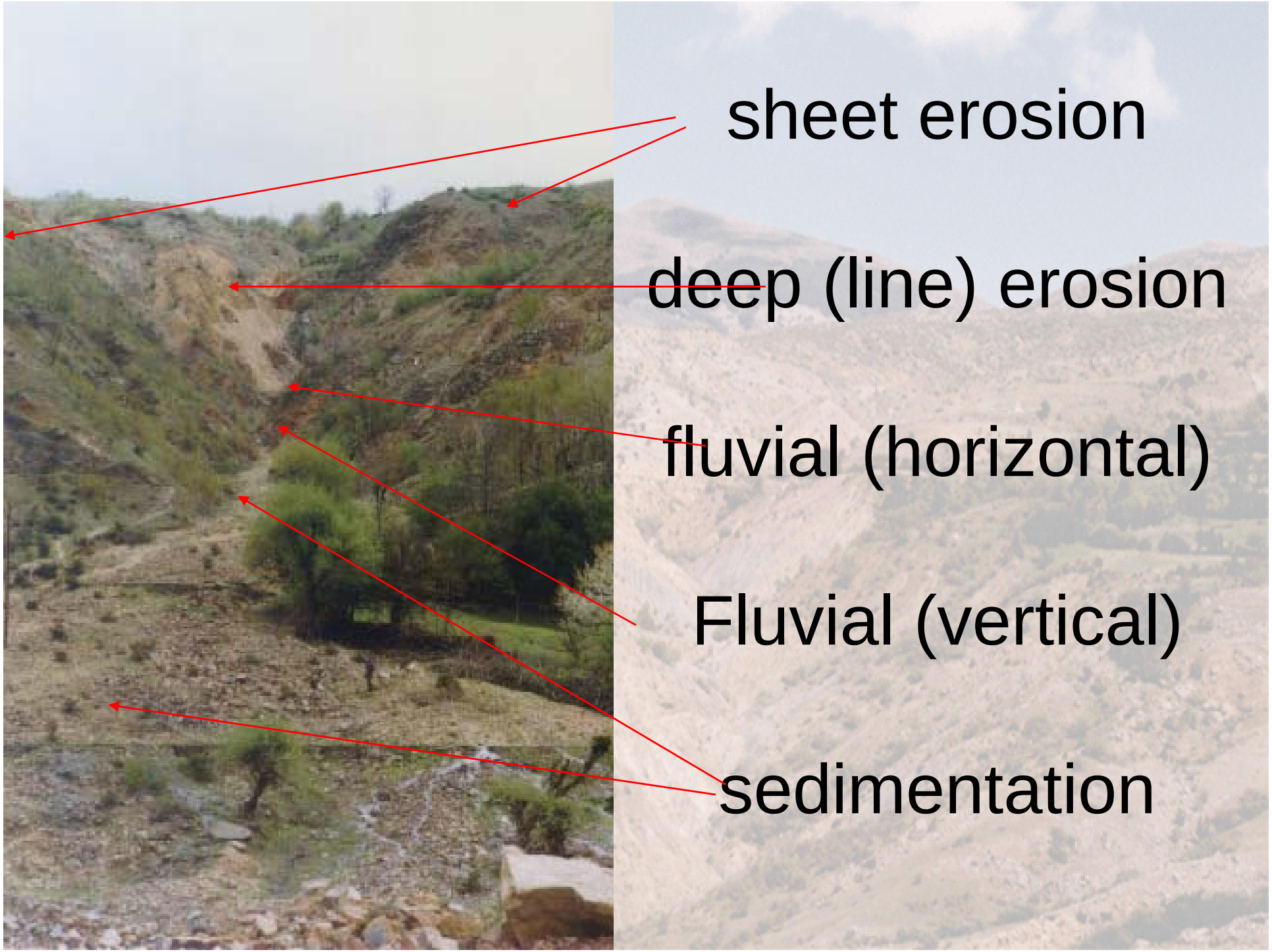
V – gully

W-shaped gully

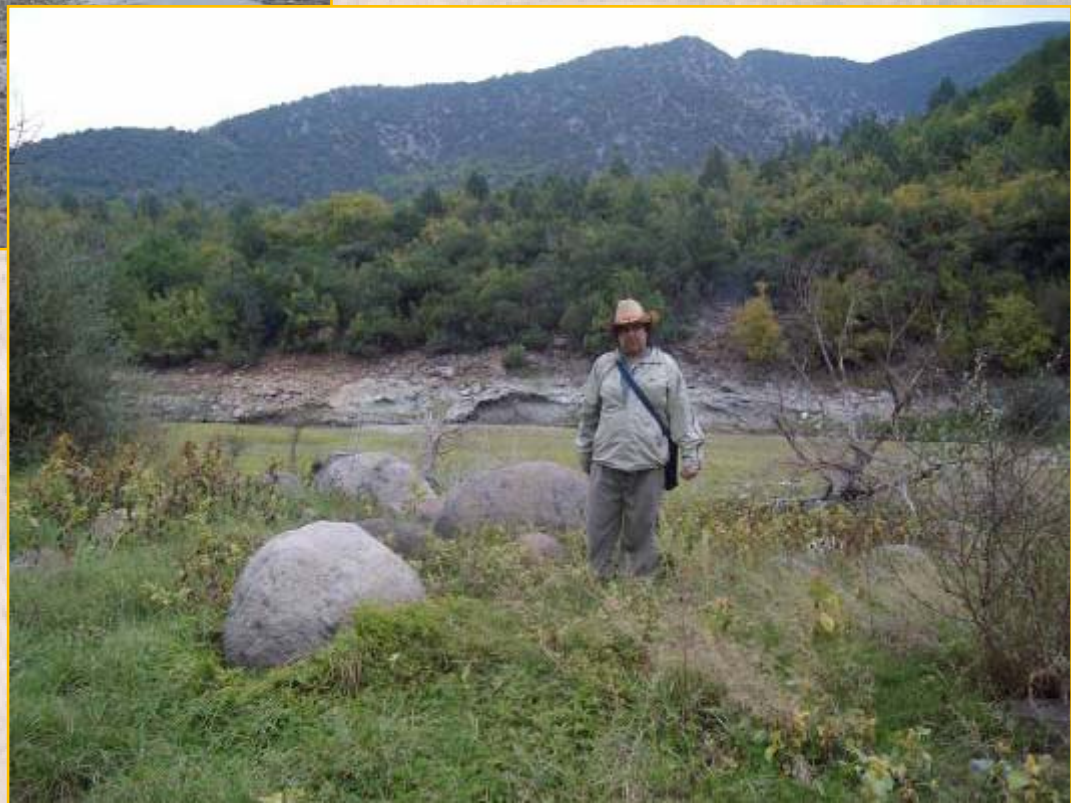
FLUVIAL EROSION



ROAD CONSTRUCTION and EROSION


sheet erosion
deep (line) erosion
fluvial (horizontal)
Fluvial (vertical)
sedimentation

Sedimentation



Blastica River

Mouth to Tikves reservoir

Blue colored water

Brown colored water

RESERVOIR KOZJAK

Timjanik - Negotino Landslide

LANDFALL Landslide - (MK)

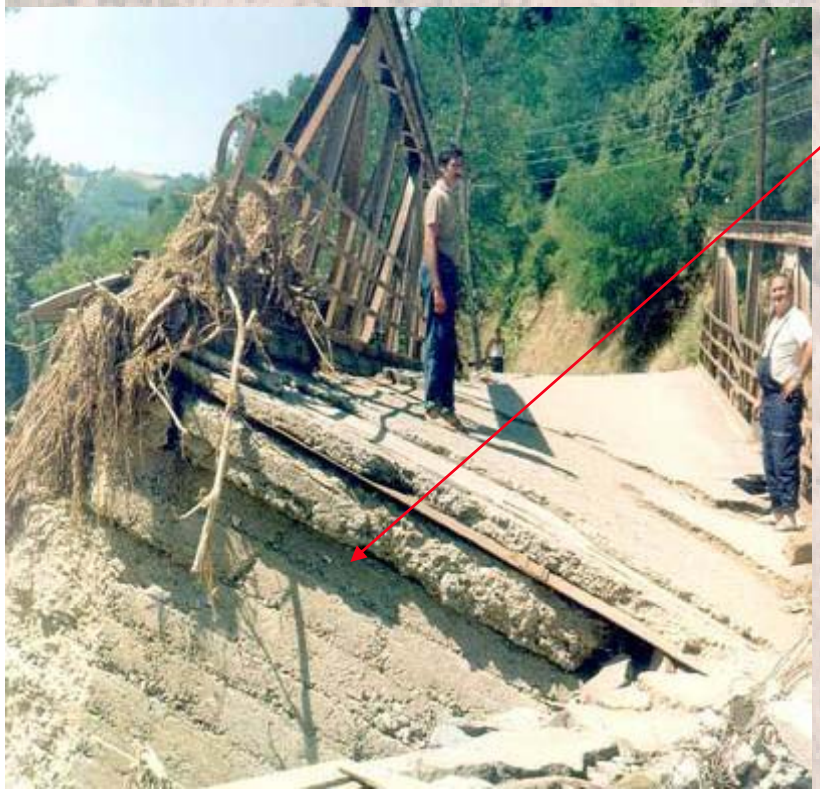
Sopishte

Rostushe

The Biggest landfall/landslide on the BALKAN

Damage from bombing
in SERBIA

Damages from
torrent flash floods

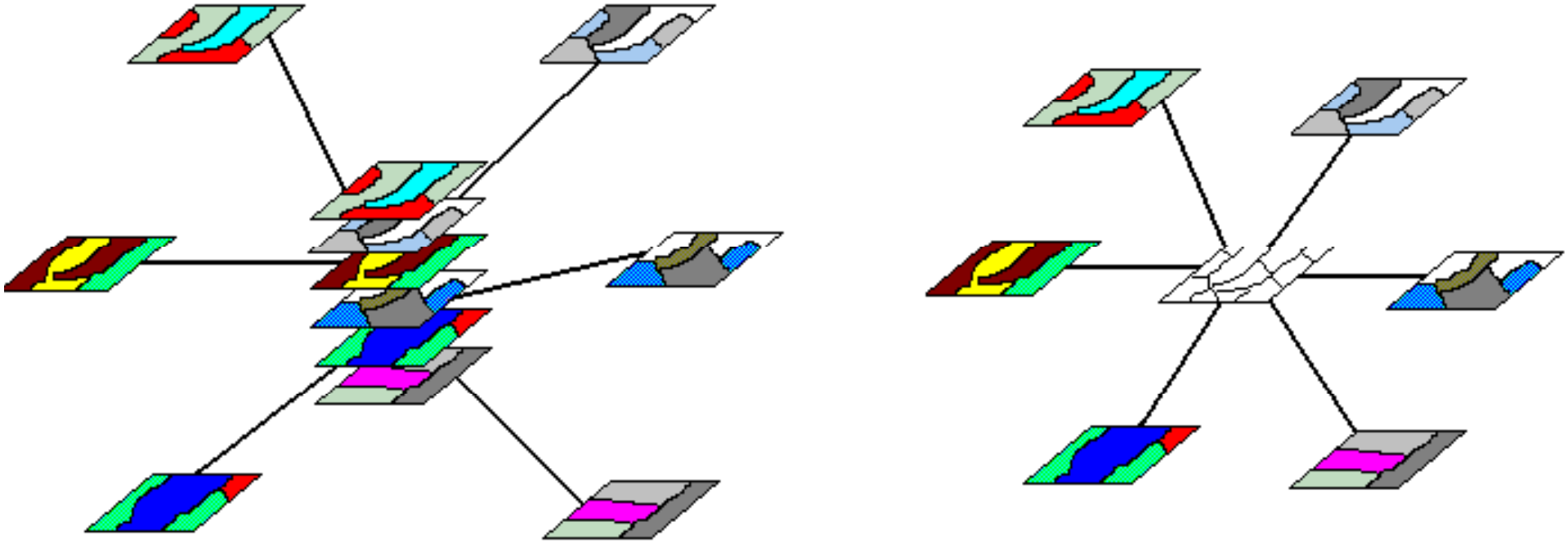


17 killed, 175 injured

a

FLASH FLOODS Damges - MKD

EROSION FACTORS



CLIMATE ELEMENTS (RAINFALLS..)

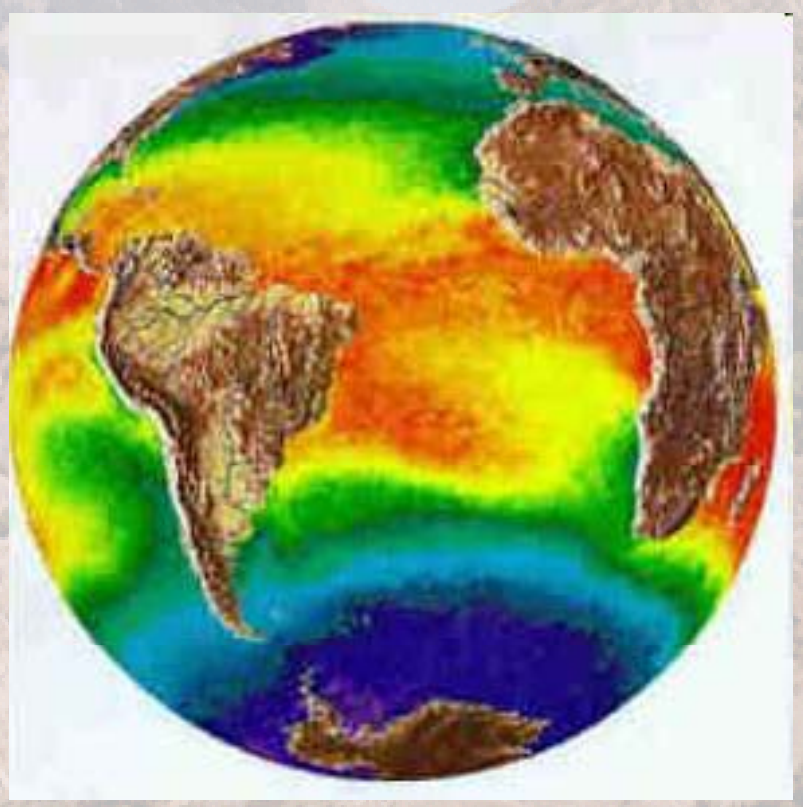
RELIEF ELMENTHS

SOIL/ROCK characteristics

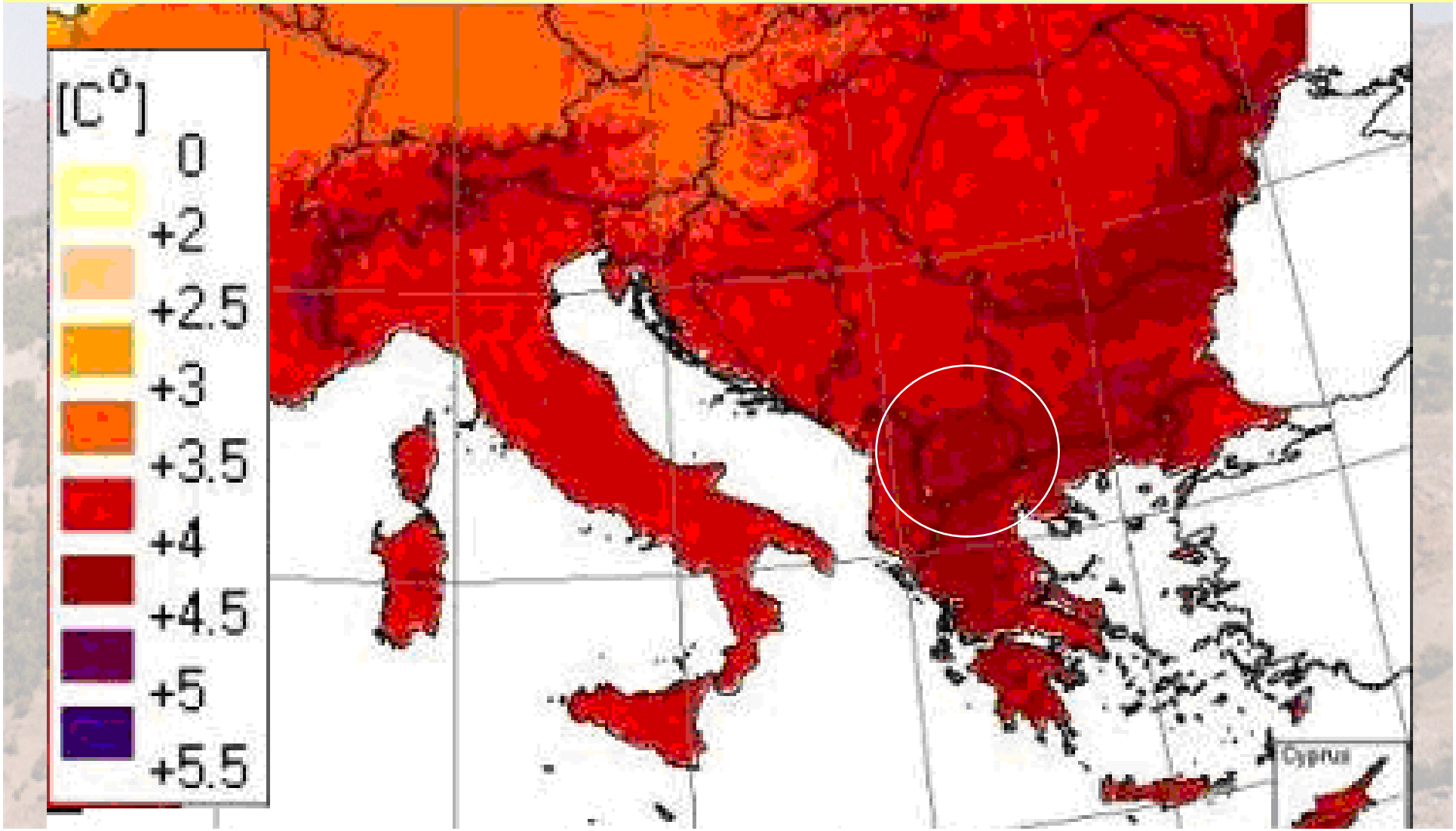
LAND COVER/USE

HUMAN ACTIVITIES

Global Warming & Climate Changes impact on erosion factors



Map 1. Change in mean annual temperature by the end of this century
(figure 1 in the Green Paper about Adaptation)
Absolute change in mean annual temperature between control period 1961-1990 and 2071-2100, under the IPCC SRES scenario A2.
Data from EC-funded project Prudence

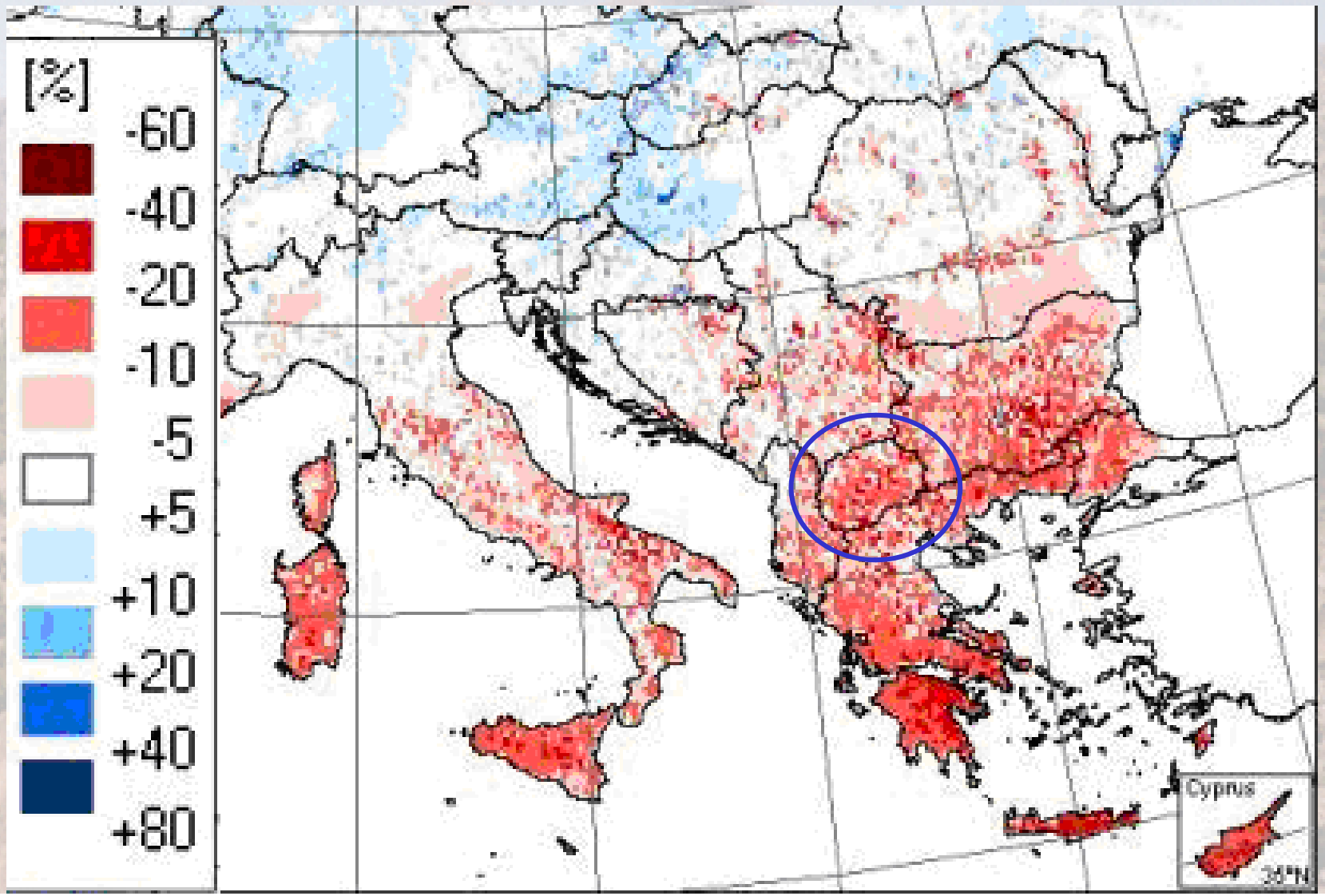


Map 2. Change in mean annual precipitation by the end of this century

(figure 2 in the Green Paper about Adaptation)

Relative change in mean annual precipitation between control period 1961-1990 and 2071-2100, under the IPCC SRES scenario A2.

Data from EC-funded project Prudence



Climate change means more heavy rain

- Climate change will lead to an increase in heavy rainfall events across most of the world.
- The study suggests that precipitation in extreme events will increase by about 6% for every 1.8 degree rise in global temperature. A global temperature increase of anywhere from 2 to 11 degrees is expected by 2100.
- Some of the most notable dangers of the additional rainfall include flooding and soil erosion.
- ***http://www.usatoday.com/tech/science/environment/2009-08-21-climate-change-rain_N.htm***

- **Global warming** is expected to lead to a more vigorous hydrological cycle including more frequent high intensity rainfall.
- These rainfall changes along with expected changes in temperature, solar radiation, and atmospheric CO_2 concentration will have significant impact on erosion rates.

- The potential for global climate changes to increase the risk of soil erosion is clear, but the actual damage is not.

Climate changes and Soil

- Climate change and its impacts — increases in temperature, changing precipitation patterns, floods, droughts — will not only affect us but may also affect how soil provides these services.

- Soil drought >>> destroying of soil characteristics (soil conective elemenths evaporate) >>>> increase of erosion vulnerability

Climate change – Land cover changes

CC – changes of vegetation distribution

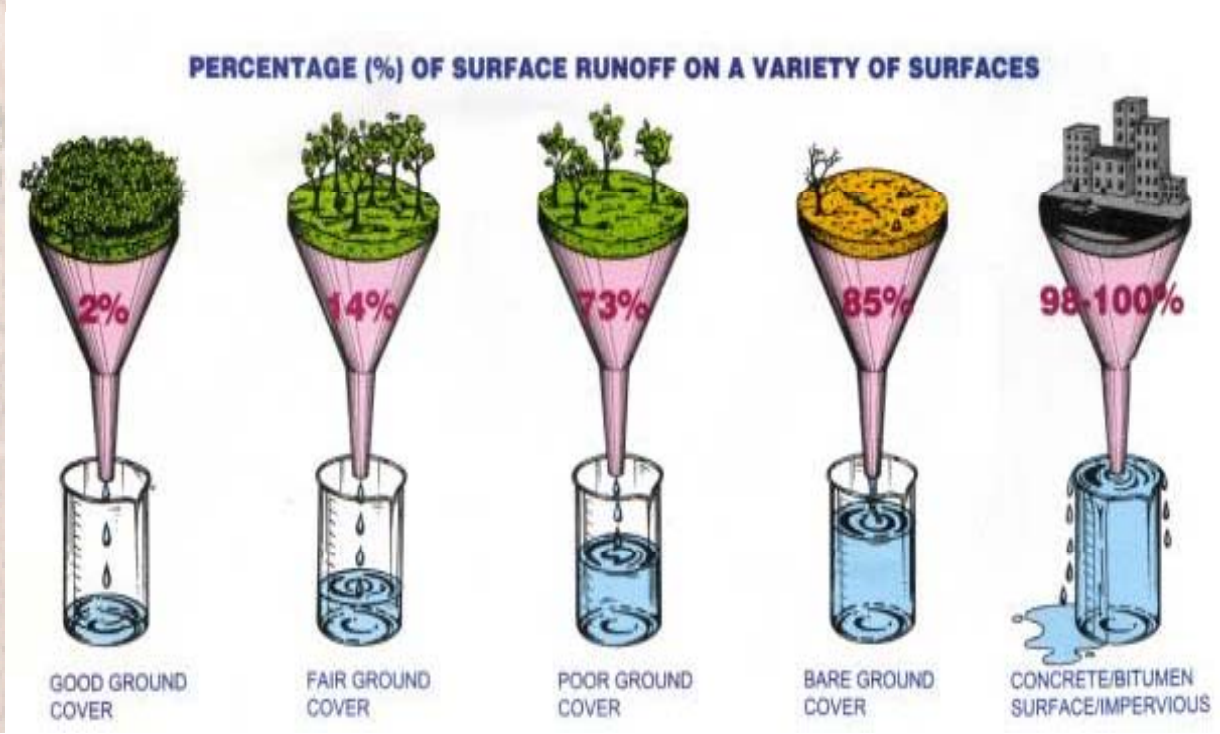
- some species go on higher altitude

- Conversion of vegetation

- termosclerophyle species occupy habitats

- possible decrease of coverness

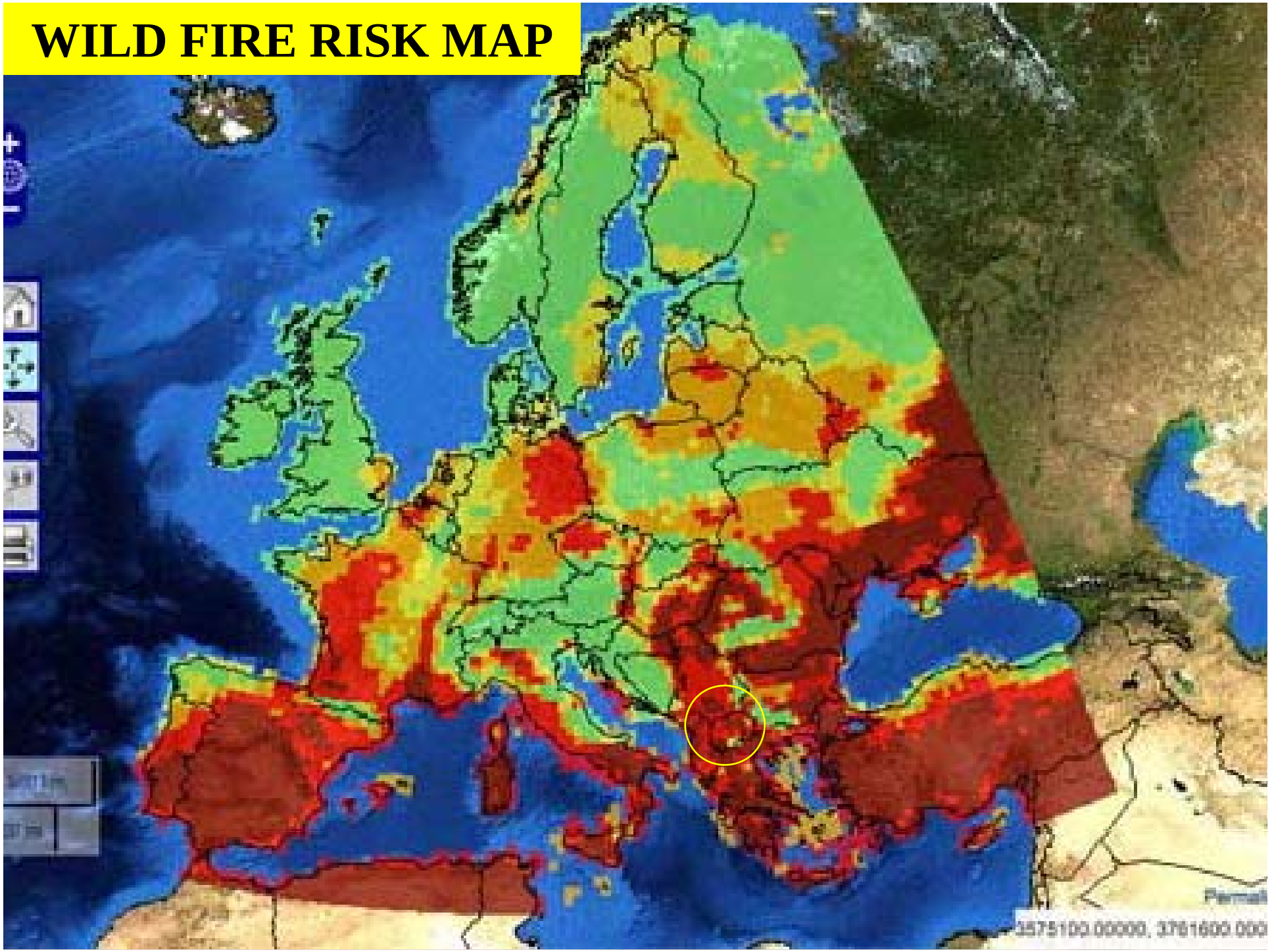
Radical changes as a result of increased frequency of wild fires



FOREST FIRES DISTRIBUTION

Satellite image – 25 July 2007

WILD FIRE RISK MAP



Chained hazard - what-if scenario

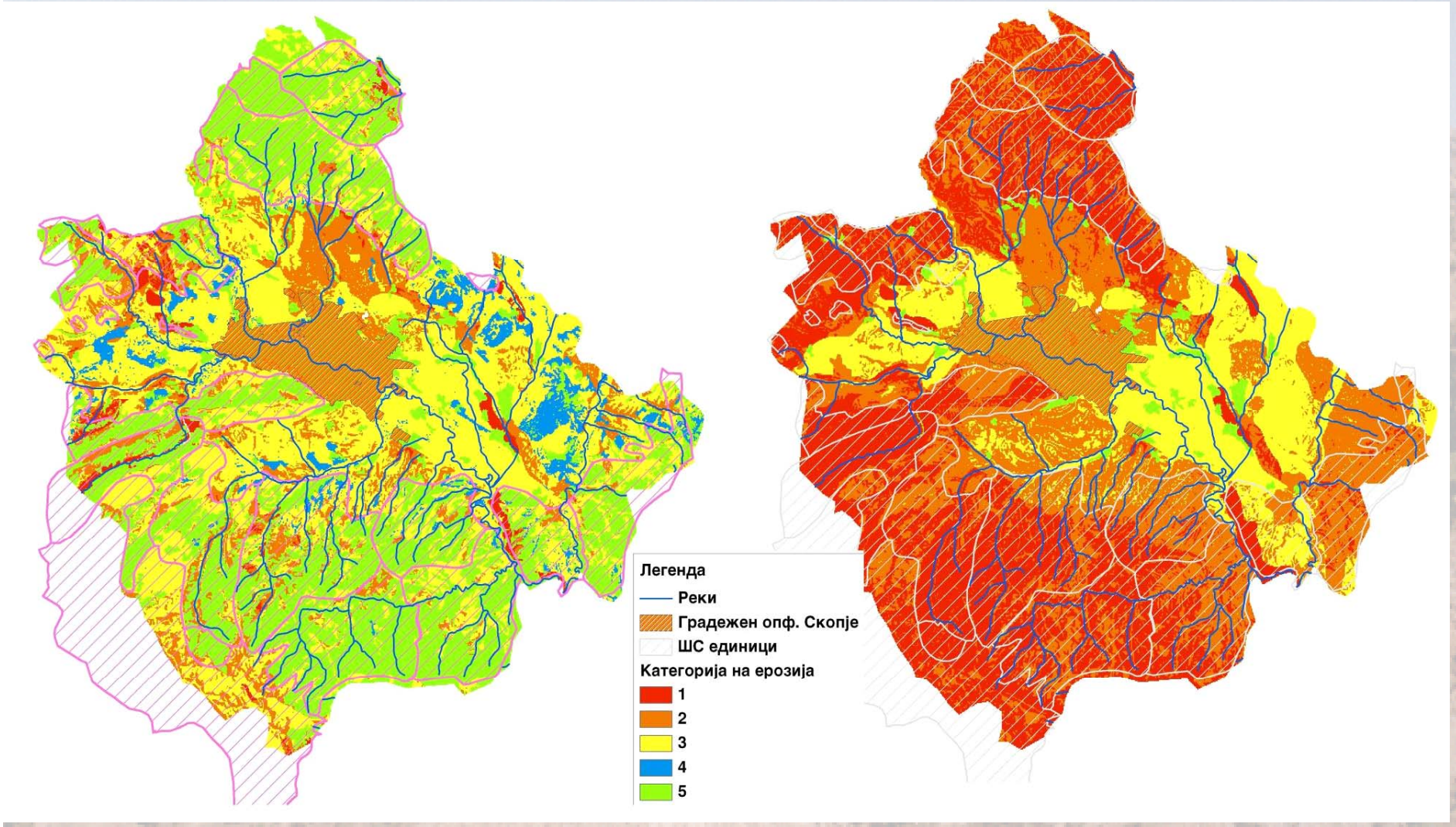
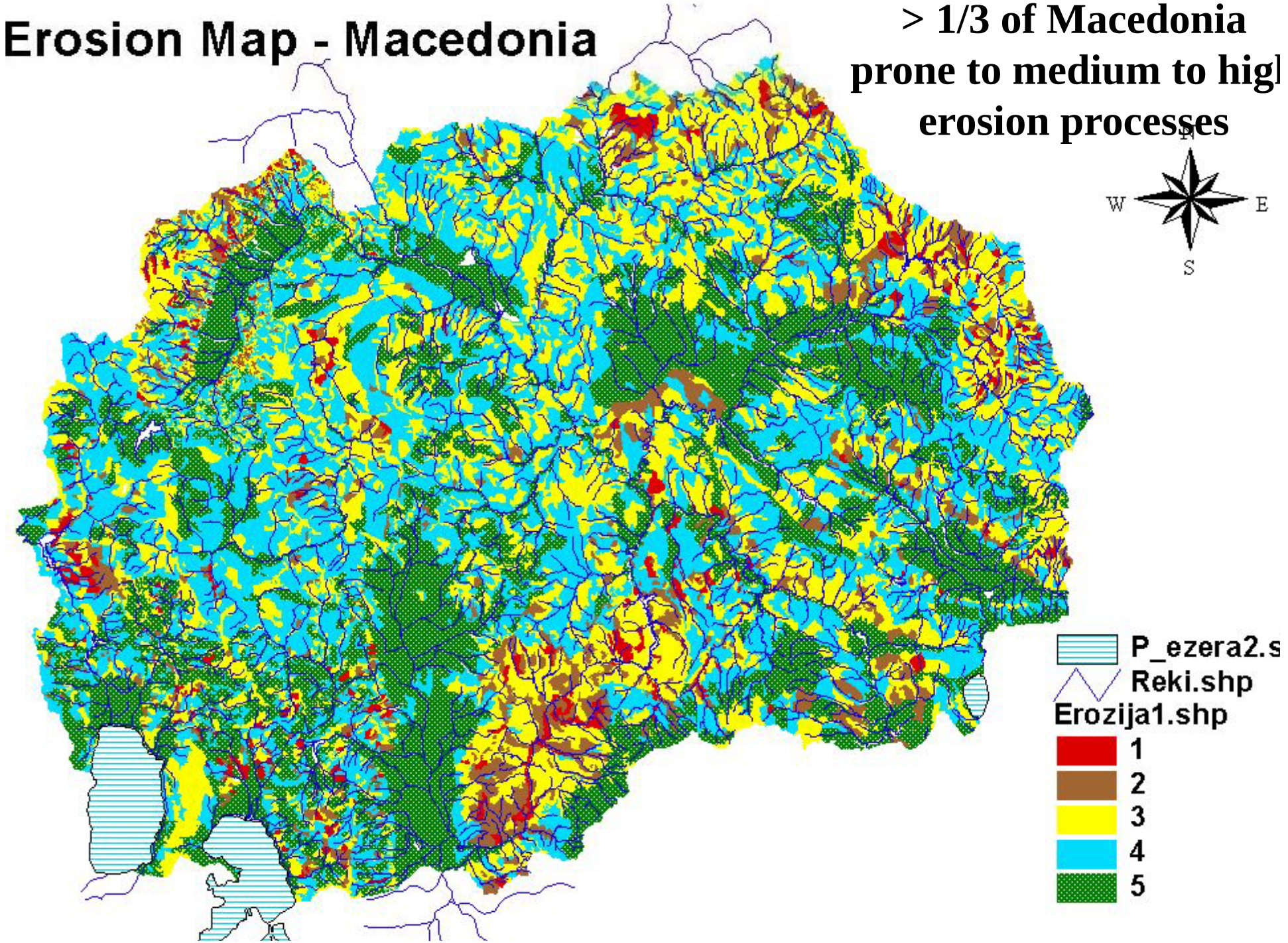


Figure 8. Actual and potential erosion risk (in a case of mass forest fires:

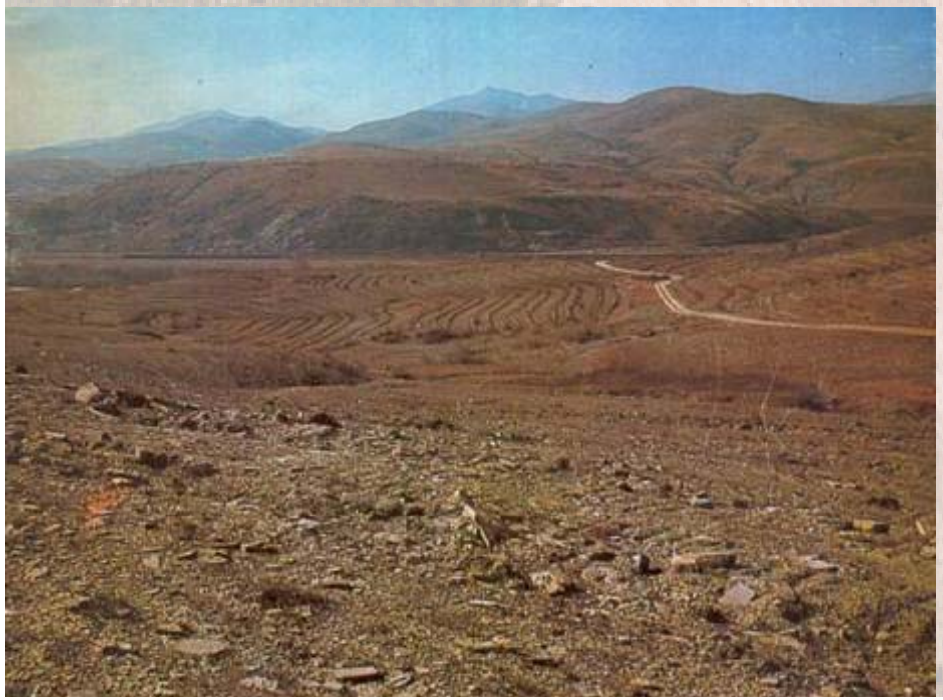

Erosion Map - Macedonia
> 1/3 of Macedonia
prone to medium to hig
erosion processes
N
W
E
S
P_ezera2.s
Reki.shp
Erozija1.shp
1
2
3
4
5

DEGRADED AREA

Central Macedonia

Extremely dry area - Eroded area >>>> desertification

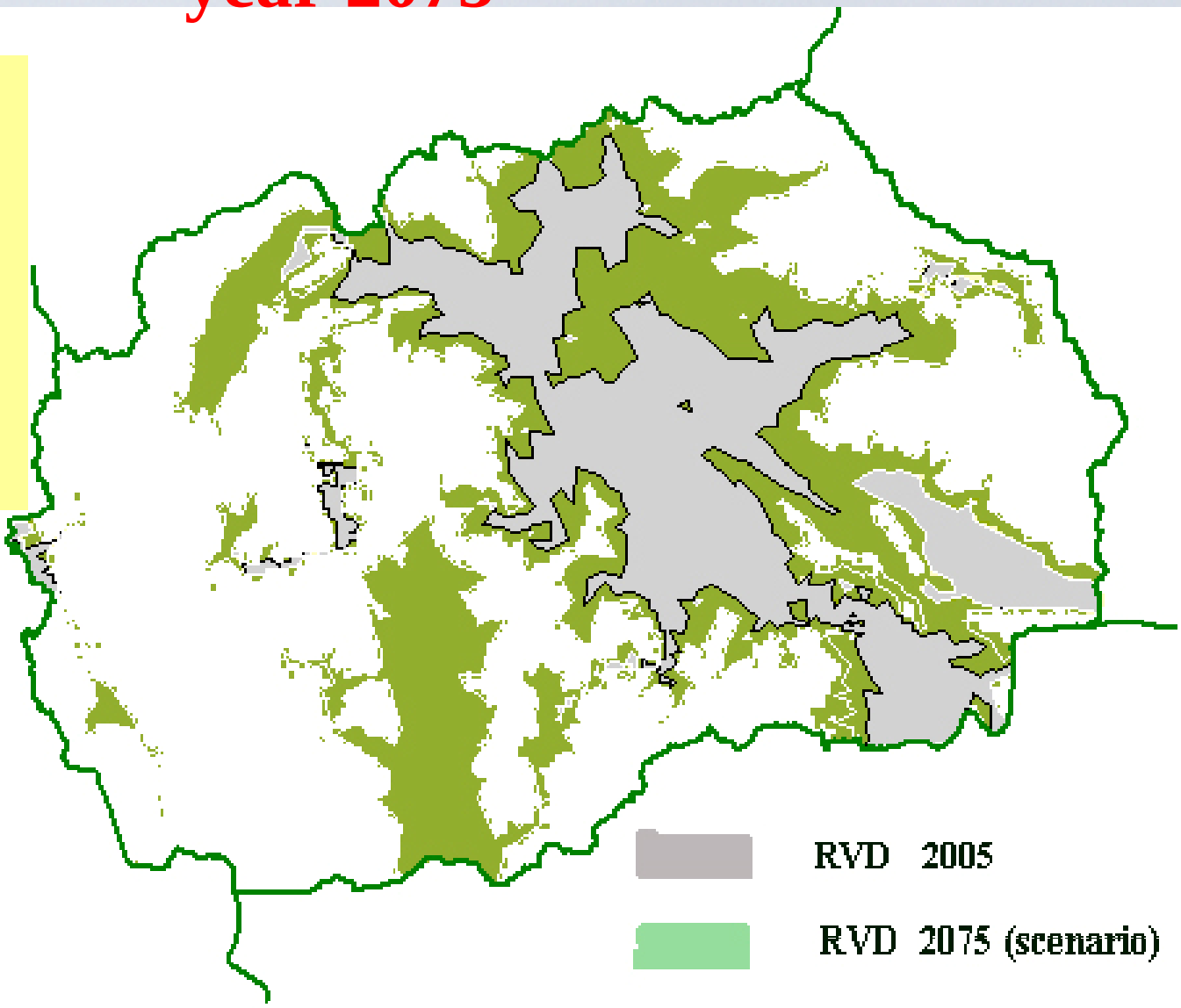
Central Macedonia



Scenario IS92 for Climate Changes – year 2075

precipitation
decrease up to -25%

summer temperature
increase +2,5ºC



Region Vulnerable to DESERTIFICATION in Macedonia

- Climate changes will impact all other erosion factors except the relief characteristics.
- - climate elements (frequency of heavy rainfalls..)
- - soil characteristics
- - land cover

- All these will result in increase of erosion risks.

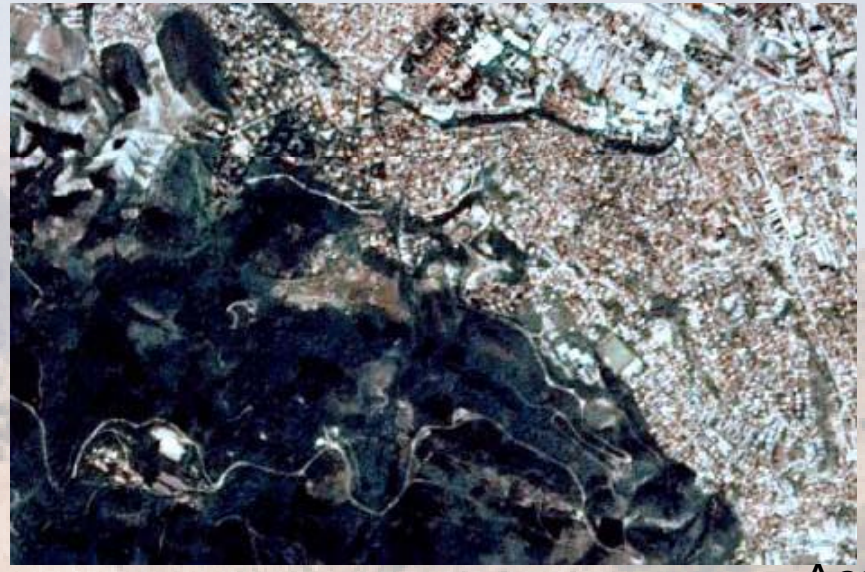
EROSION MONITORING

- Erosion monitoring in fact erosion measurement could be carried out through various methods. The type of method depend on that what kind of erosion process we intend to monitor.

- Erosion monitoring could be on-site or off-site of the process occurring.

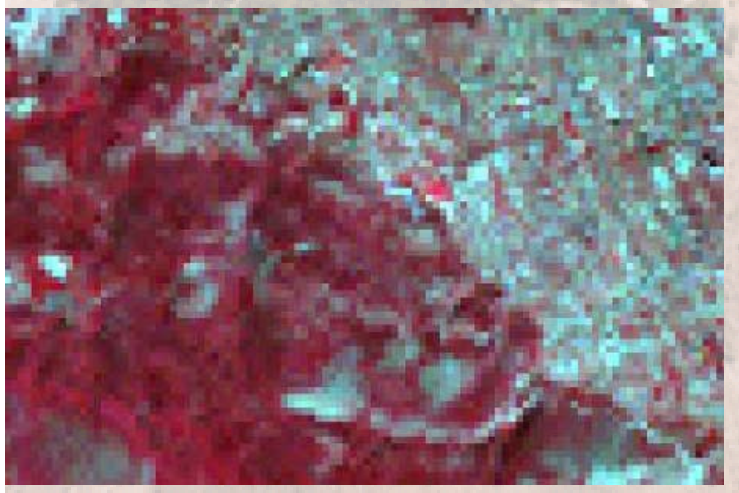
Aerial photos and satellite images

Using expert judgment method could be derived the areas with high erosion risk. (*subjective method, need experience*)



Ikonos (4m)

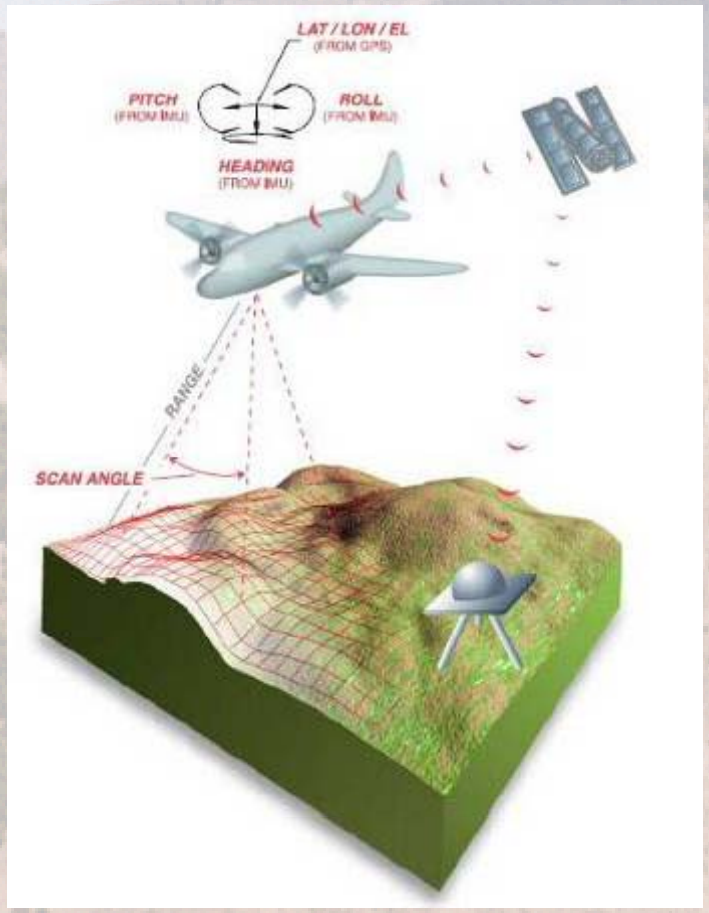
Landsat (30m)

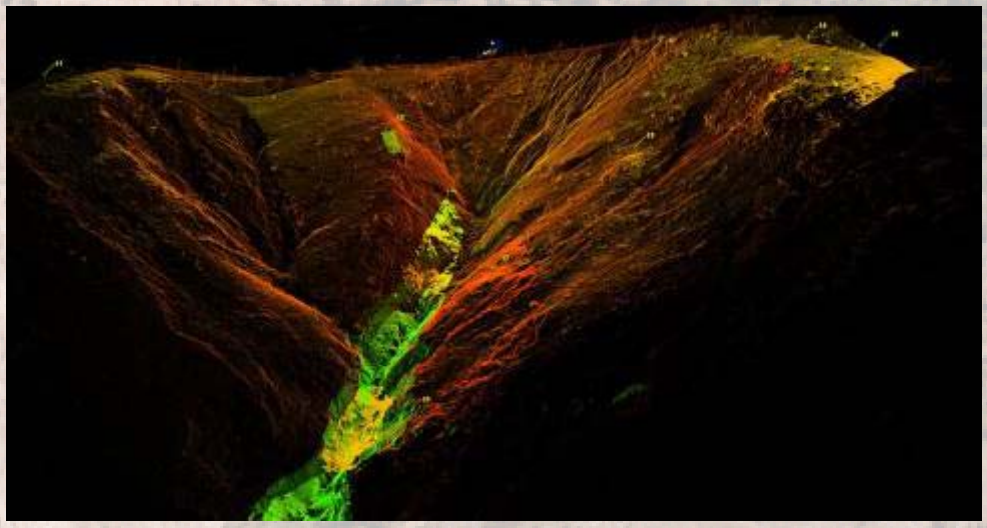


Aerial photo (0.5m)

Good approach for pre-assessment or for preparation for field work

LiDAR (Light Detection And Ranging)





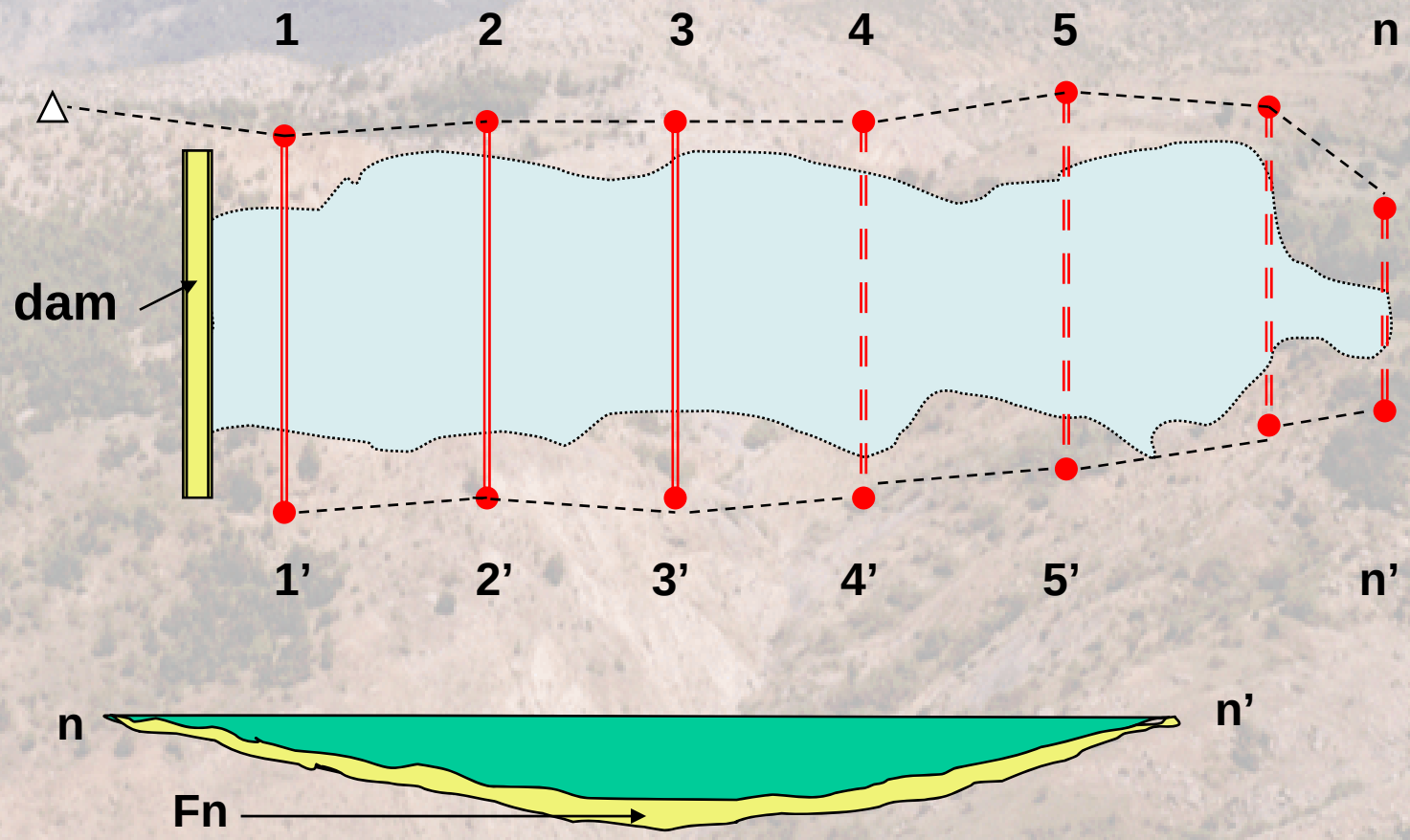
Direct measuring of deposed material

- Direct measuring on the hydrometric stations shows erosion intensity in the upstream part of the catchment. According to the methodology bed load is not a subject of measuring on this type of station.
- Measuring of erosion on experimental catcments that represent any small catchment is common practice in the world, but it is expensive and not in use in Macedonia.

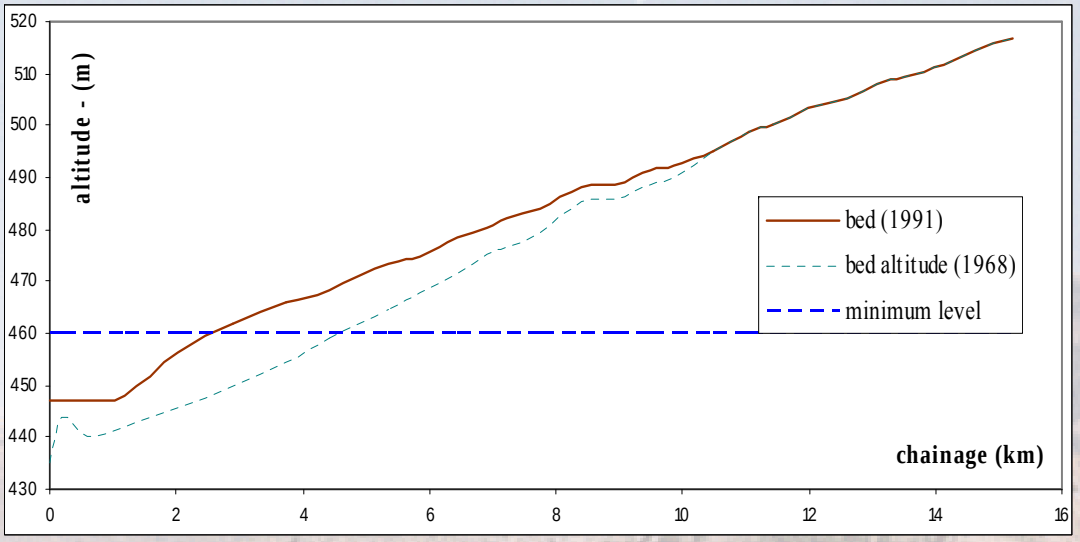
- Direct measuring of the deposed sediment into the reservoir is a useful method. The quantity of deposed sediment into the reservoir is useful information for water management experts to plane available water resources. Besides, it is a sign for the erosion intensity on the reservoir

Sediment measuring methodology

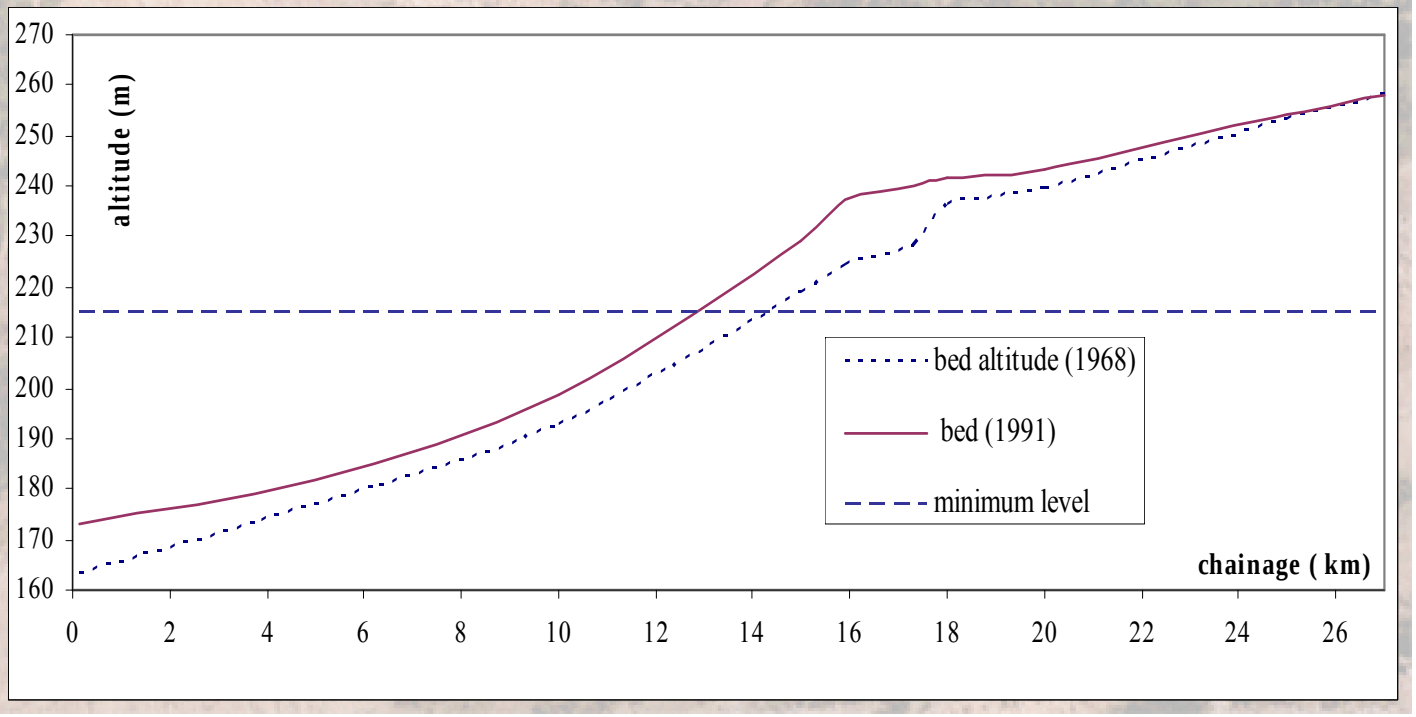
polygonal points ; cross profiles ;



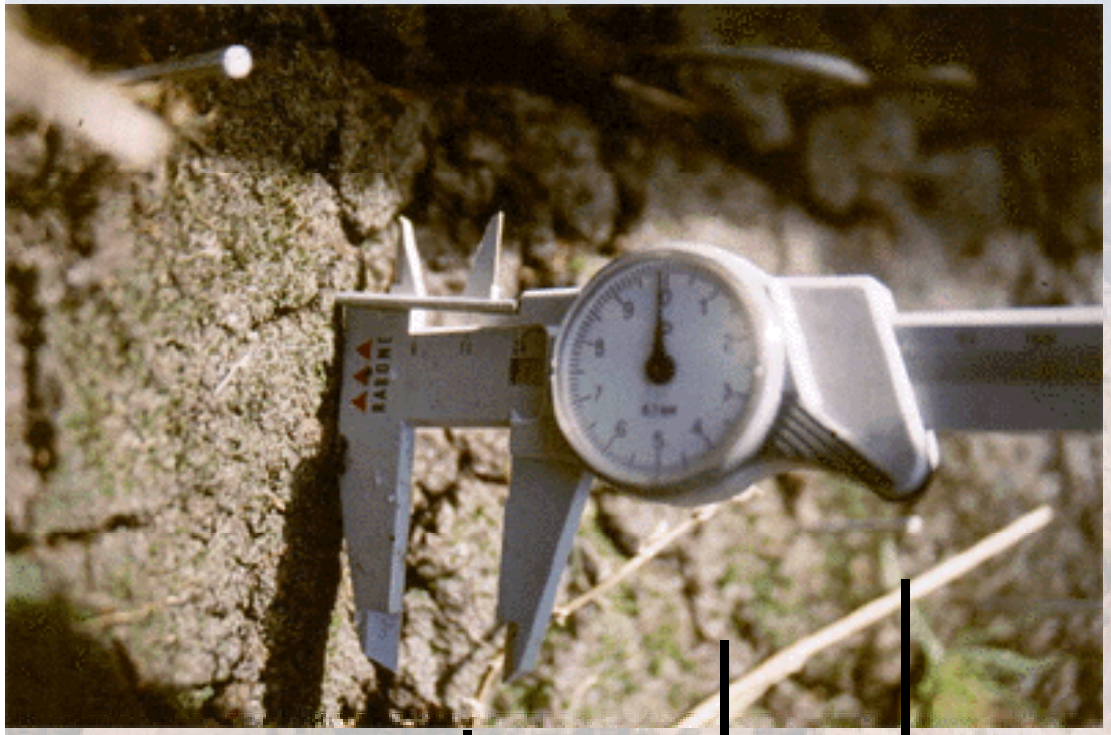
Long profile – reservoir Kalimanci

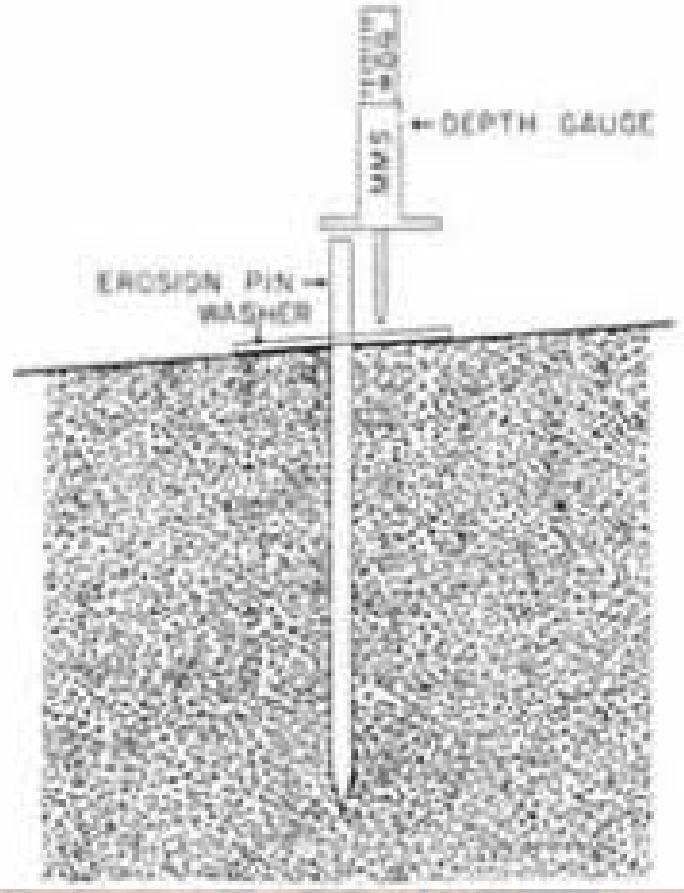


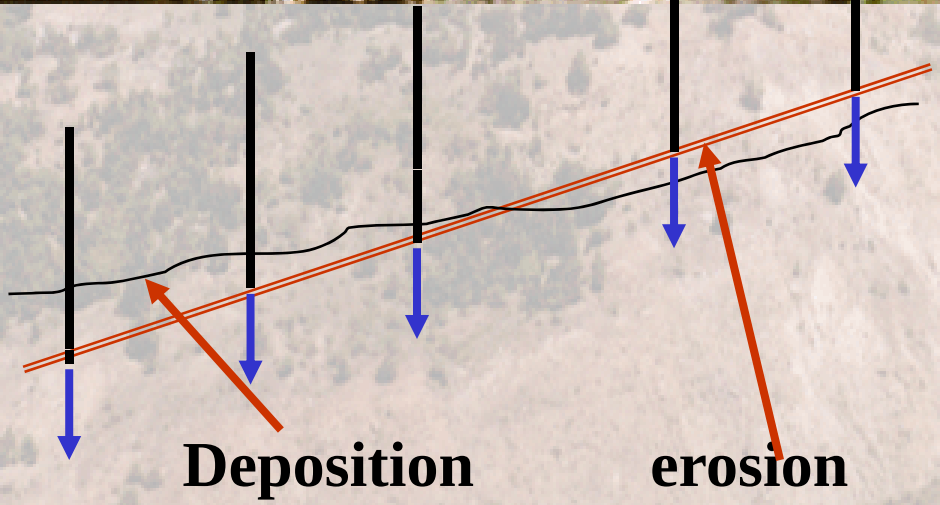
Long profile – reservoir Tikves



Erosion Pins

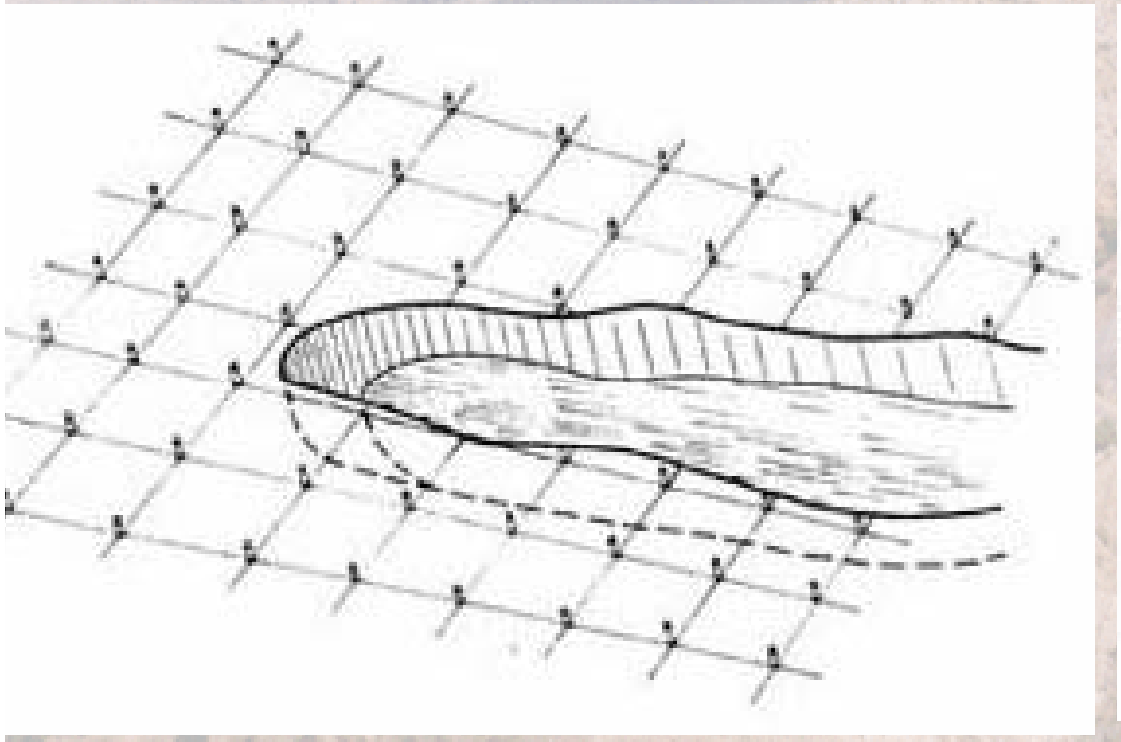


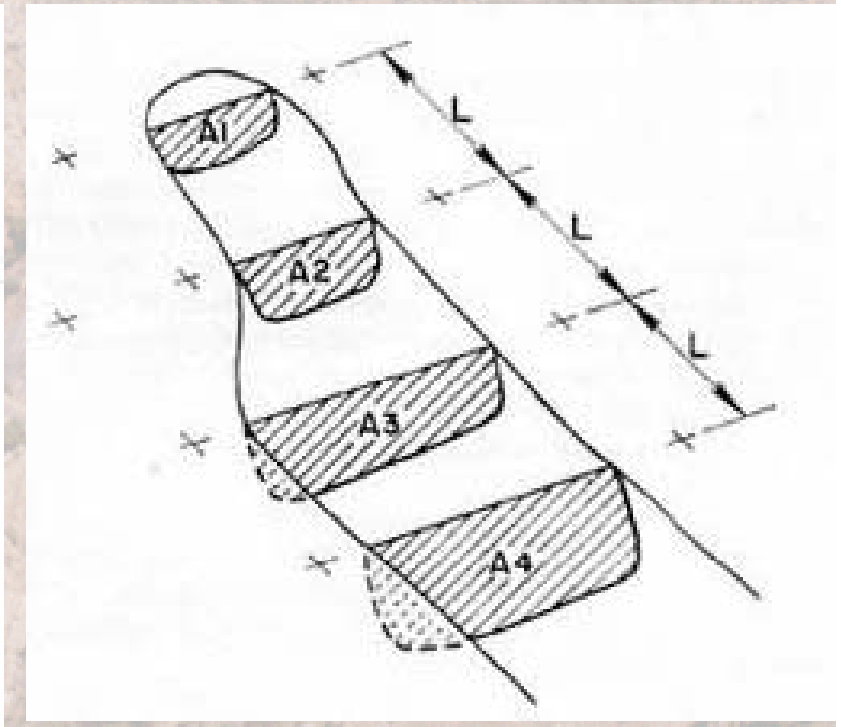




- Pins should be set into the soil up to the referent point. Monitor from time to time control the pins and noticed level of the soil expressed in [mm].

System of pins for measuring gully





Pins with sensors (PEEP) for monitoring streambank erosion

Erosion monitoring plots

- The most appropriate method for monitoring of sheet erosion processes is through monitoring on erosion plots set on the terrains with different conditions (slope, exposure and land cover).

- The erosion plots have standard dimensions and shape and could be:
  - square shaped having an area of 100 m2 (according to Gavrilovic)
  - rectangle shaped according to Wischmeyer (dimension 22,1x1,87m = 41,327m2).

On the end of the plot is set into the soil a totalizer (barrel) Runoff water and sediment is collected into the barrel.

The other solution is the barrel to be perforated with aim to collect only sediment.

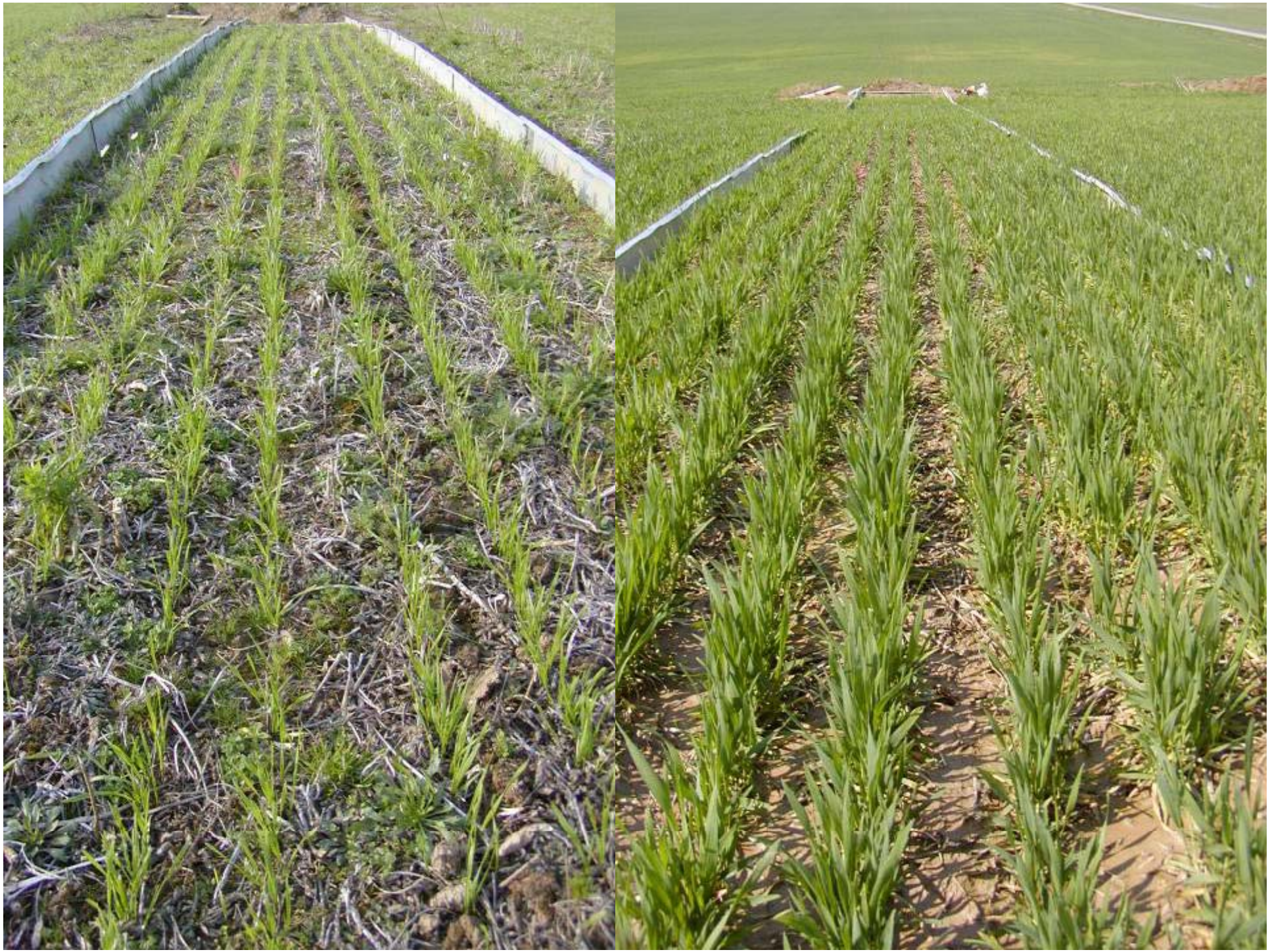
Wishmeyer type

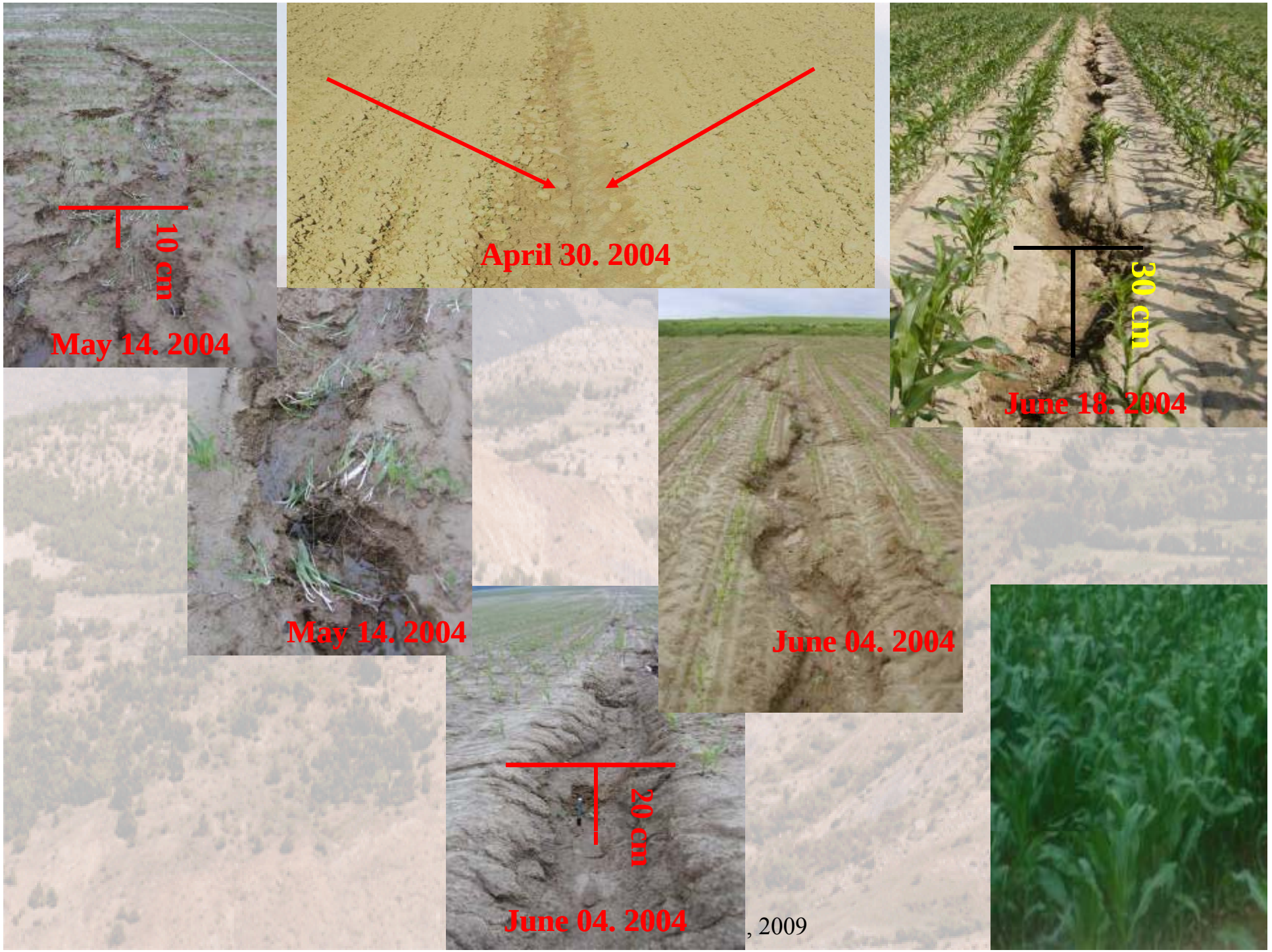
Gavrilovic type

- Should be established at least pair of plots with all same characteristics except one:
- - various crop
- - various tillage or irrigation technique
- - various slope or exposure
- - various soil type
- - various land cover type (forest, grassland , bareland)
- - burned or unburned area etc.

Run off on check (black fallow) and up and down tillage and planting direction

Run off on no-tillage and perpendicular tillage and planting direction

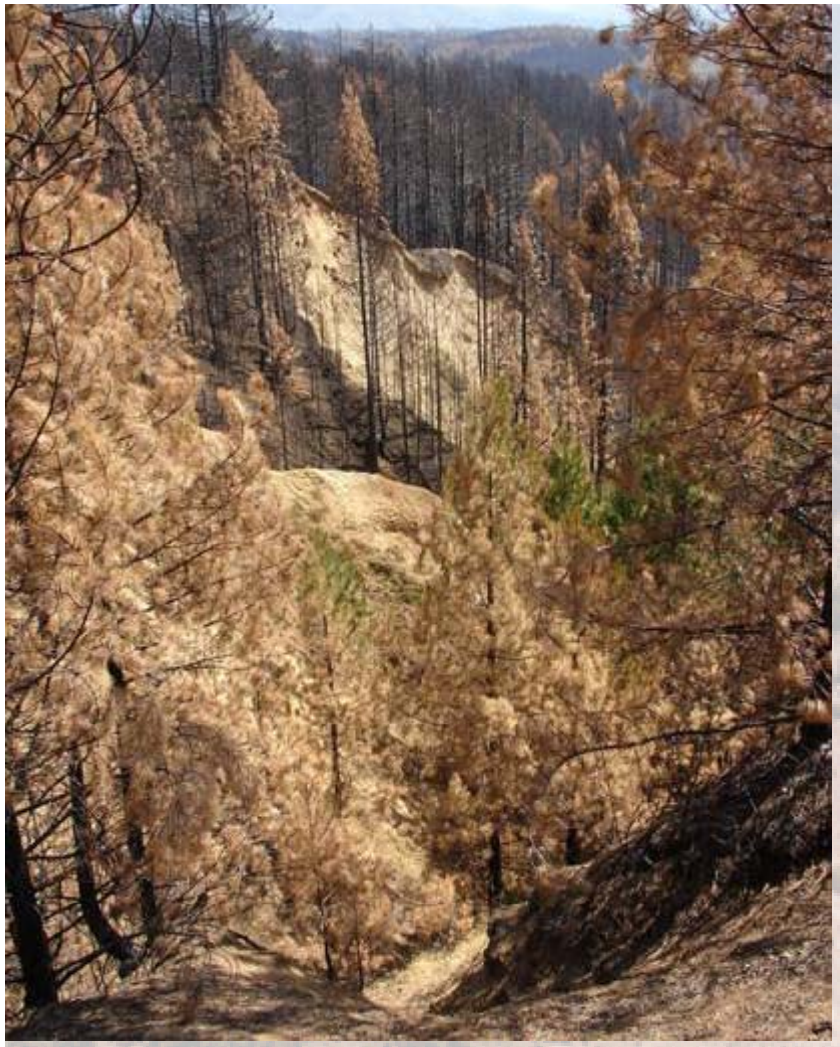



10 cm
May 14. 2004
April 30. 2004
30 cm
June 18. 2004
May 14. 2004
June 04. 2004
20 cm
June 04. 2004

, 2009

Burned area - forest


ОПИТНО
ПОЛЕ
ЦФС
18/04/2009



Irregular shaped plot - simulate small gully

Needed material for 1 plot

- Can – 20 cm (height) x 50 m (length)
- 1 or 2 barrels (200 liters)
- 1 plastic tube for inflow from the first to the second barrel
- 3 menzuras (1 liter volume)
- 1 liter color and brush (to write down lines – decimeters or 5 cm line into the barrel

To avoid runoff from the surrounding,

plot should be fenced (metal fence) and small ditch around the plot should be dig.

- After taking samples filling of the barrels

What to do!

- The methodology is simple: monitor noticed the level of water into the barrel.
- Then mix the fluid into the barrel and collect 3 samples of 1 liter. The monitor pour off the liquid from the bottle in 1 liter menzuras and leave it 48 hours. Sediment will be deposed down and that monitor noticed the level of sediment.
- Then, the sediment could be used for laboratory analysis (N, P, K, pH , CaCO3). Could be estimated annual soil loss and annual nutrients losses.

Estimation - Results

- Concentration of sediment - [%]
- total volume of the fluid (liter = dm^3)
- Volume of the sediment [dm^3]

- Total weight of the fluid [gr]
- Weight of the sediment [gr]
- *(need additional activities – filtration of the sediment using paper filters, drying up the sediment (usually 105^oC) and later measuring weight using precise weighingmachine).*

Possible additional laboratory analysis

- Mechanical composition
- Content of nutrients in the sediment (N, P, K…)
- Carbonates; organic matter

All results should be expressed on annual level.

Simple Addition of separate results

(note: 1 result = arithmetic mean value of 3 samples)

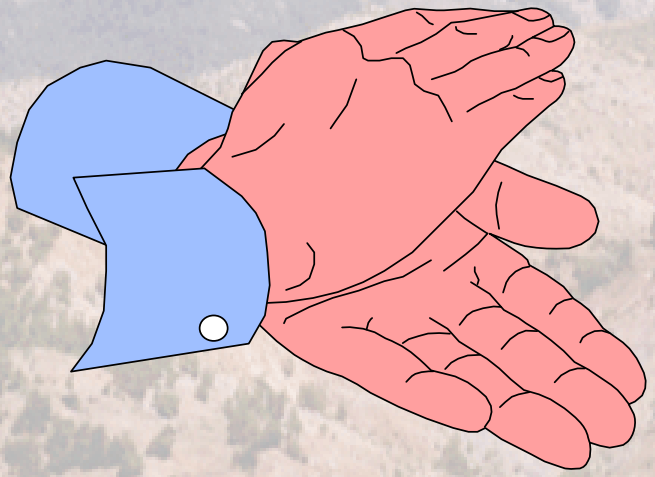
Annual values

- - annual soil loss [m^3, m^3/ha ; t ; t/ha]
- - humus and nutrient loss [t ; t/ha]
- - annual total runoff – m^3/ha;

if we compare results with rainfall measuring >> we could:

- - analyse influence of rainfall intensity on runoff
- - estimate runoff coefficient (ratio between runoff rainfalls and total rainfalls)

Благодарам на вниманието



Thank you for your attention