REMOTE SENSING OF THE FOREST TRANSITION AND ITS ECOSYSTEM IMPACTS IN MOUNTAIN ENVIRONMENTS

(FOMO)

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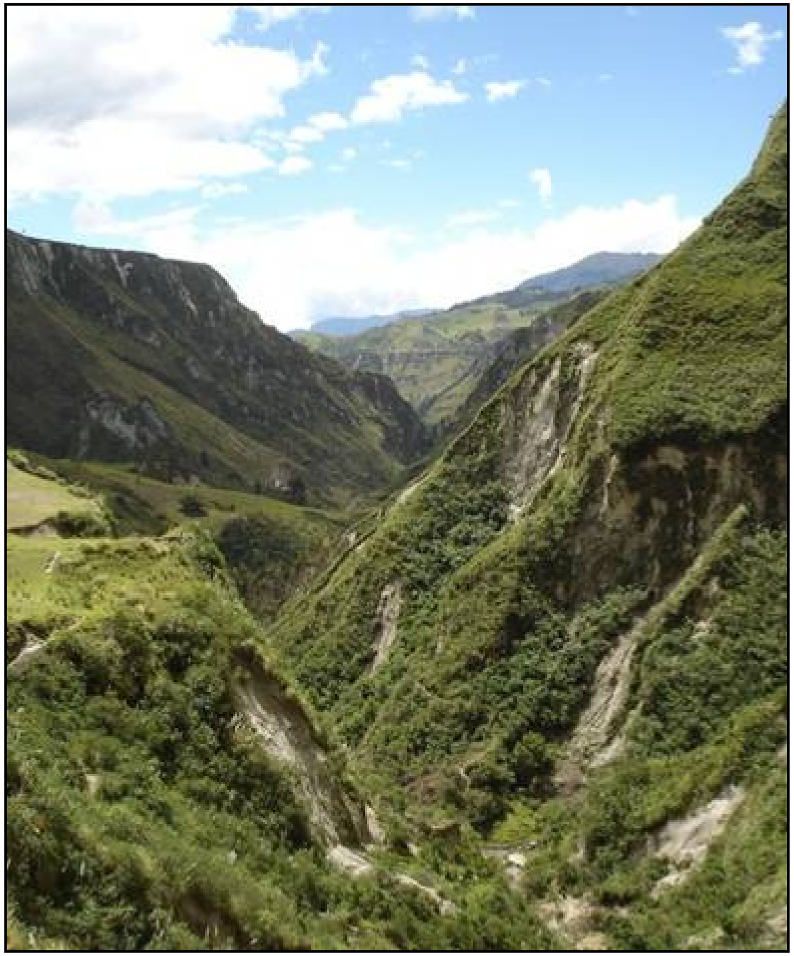
Outline of the presentation

1. Scientific context and aim of the project
2. Work Packages
3. Test sites
4. Preliminary results
5. Expected outcome



1. Scientific context and aim of the project

1.1. Context

- **Forest transitions** (from decreasing to expanding forest areas) are currently taking place in several countries.
- Generally associated with positive feedbacks on the provision of **ecosystem goods and services**.
- Land abandonment and forest recovery often on **marginal lands**, mostly **mountain environments**.
- **Remote sensing** in mountain environments: a **privileged tool but…**
- **Policy relevance** - Post-Kyoto REDD: **R**educing **E**missions from **D**eforestation and Forest **D**egradation in Developing Countries.

➔ Need for accurate & reliable **monitoring systems**.

1. Scientific context and aim of the project

1.2. Objectives

- To develop an optimal **preprocessing chain** to be used to detect forest transitions and to map their impact on ecosystem services
- To realize **Easy-to-use spatial tools** to:

  • distinguish **forest types** (primary, secondary, plantations) and **forest cover modifications** (degradation, clearing, afforestation, reforestation)

  • make accurate, spatially-explicit and timely estimates of **forest-cover changes**

  • estimate their impacts on **ecosystems services**

  • study **large areas** (semi-automated methods)

Forest transition in Xuan Lac

2. Work Packages

WP1: Data acquisition, preprocessing and correcti

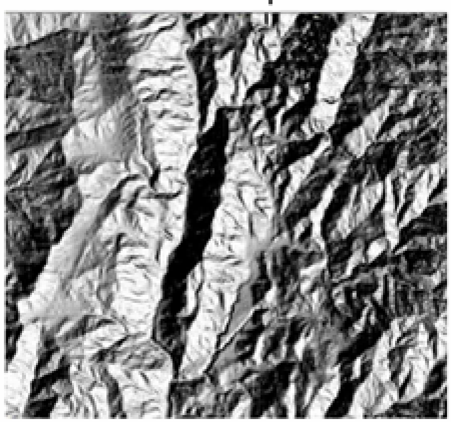
$$L_H = L_T \cos e / (\cos e \cos j)^k$$

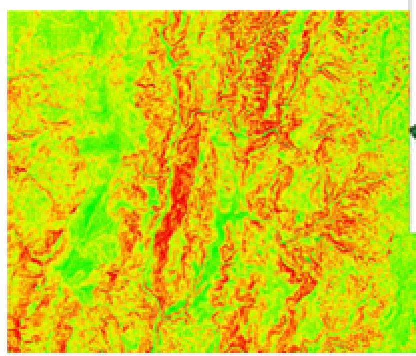
$$\cos j = \cos \theta \cos e$$

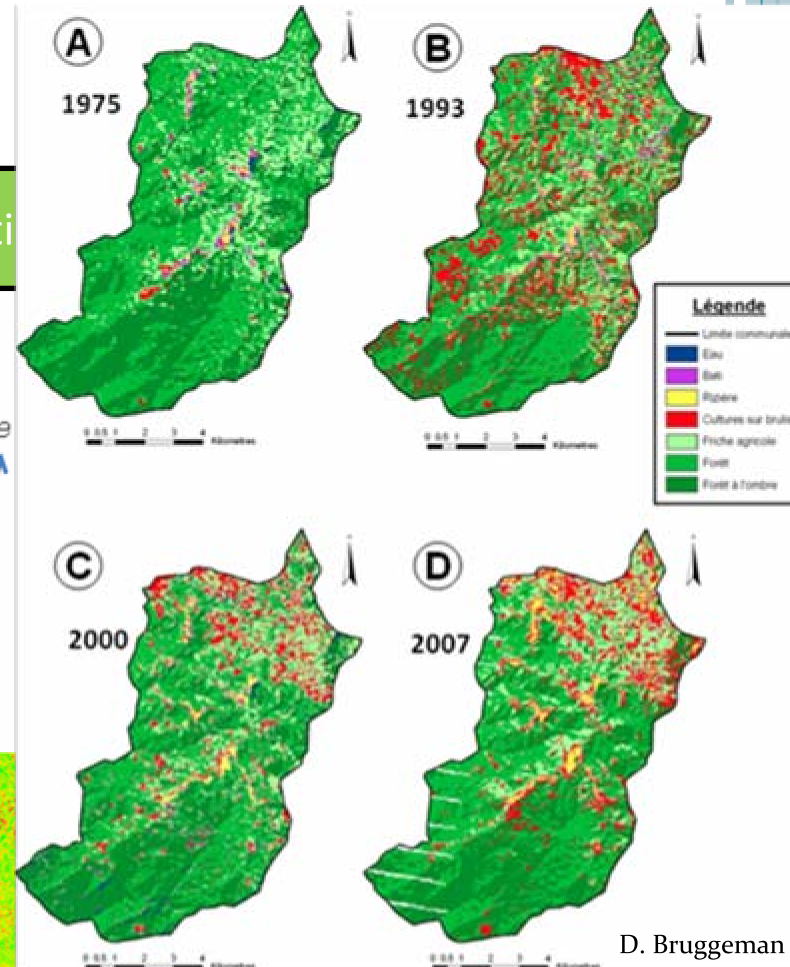
Illumination parameter

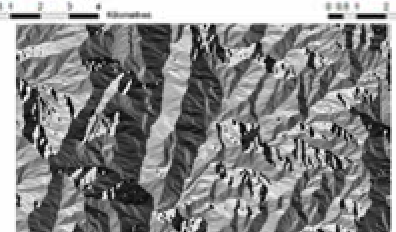
Solar zenith angle (metadata)

Slope angle







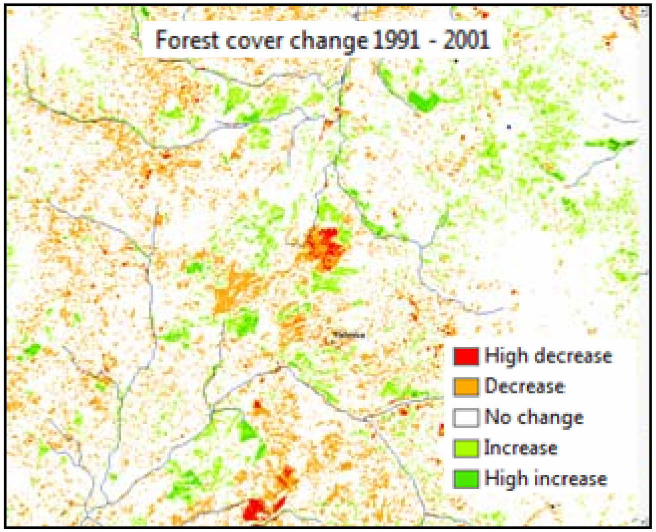


3. Test sites

- Different geographic contexts:
  - **Himalaya** (Bhutan)
    - Forest transition: policy intervention
    - Reforestation since **1980**
  - **Carpathians** (Central Europe):
    - Forest transition: decollectivization and globalisation since **1990**
    - Different pathways
  - **Northern Andes** (Ecuador)
    - Forest transition: socio-economic and demographic changes
    - **Very recently**: afforestation with Eucalyptus near urban centres

4. Preliminary results

4.1. Selection of study sites



➔ Availability of: - **RS data** (HR and VHR)
- **DEM**
- **Ancillary data**

➔ Catchment with **contrasting land use history** (in last 20 – 25 years)

➔ Catchment with similar bio-physical characteristics (climate, lithology…)

➔ Size of catchments

➔ Accessibility (field campaign)

4. Preliminary results

4.2. Correction for topographic effects

- Topographic effects can be so important that it may **overwrite** the weaker signal of the **forest transition** itself
- **Three levels of correction**:
  1. No preprocessing (stratified classification)
  2. Empirical correction methods
  3. Correction methods based on inverse modelling
- Preprocessing: labour and data-intensive. Often: lack of suitable input data (e.g., high quality DEM)

4. Preliminary results

4.2. Correction for topographic effects

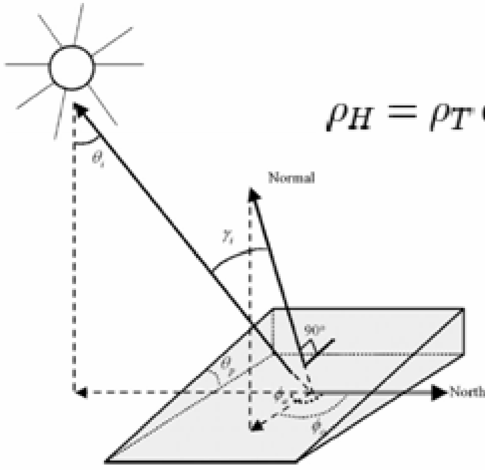
Empirical correction methods

Computation of the Incident angle (DEM)

Ex: Minnaert correction

$$\mathrm{IL} = \cos\gamma_i = \cos\theta_p \cos\theta_z + \sin\theta_p \sin\theta_z \cos(\phi_a - \phi_o)$$

➔ DEM requirement
➔ -1 (min illumination) < IL < +1 (max illumination)
➔ K parameter: describes the non-lambertian behaviour of the surface



$$\rho_H = \rho_T \cos\theta_p \left(\frac{\cos\theta_z}{\mathrm{IL}\cos\theta_p}\right)^{K_k}$$

Fig. 2 Angles involved in the computation of the IL.

Riano et al. (2003)

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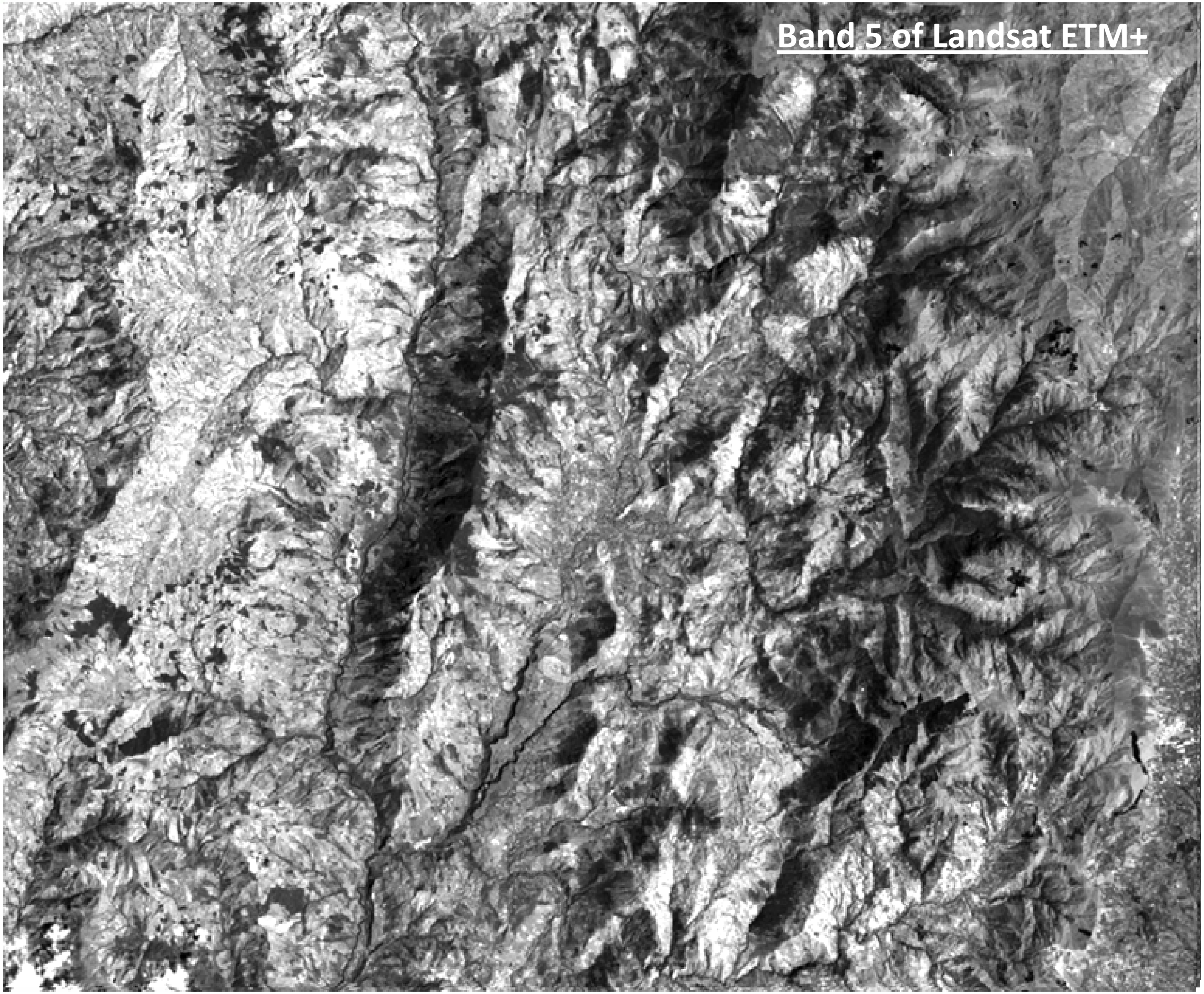
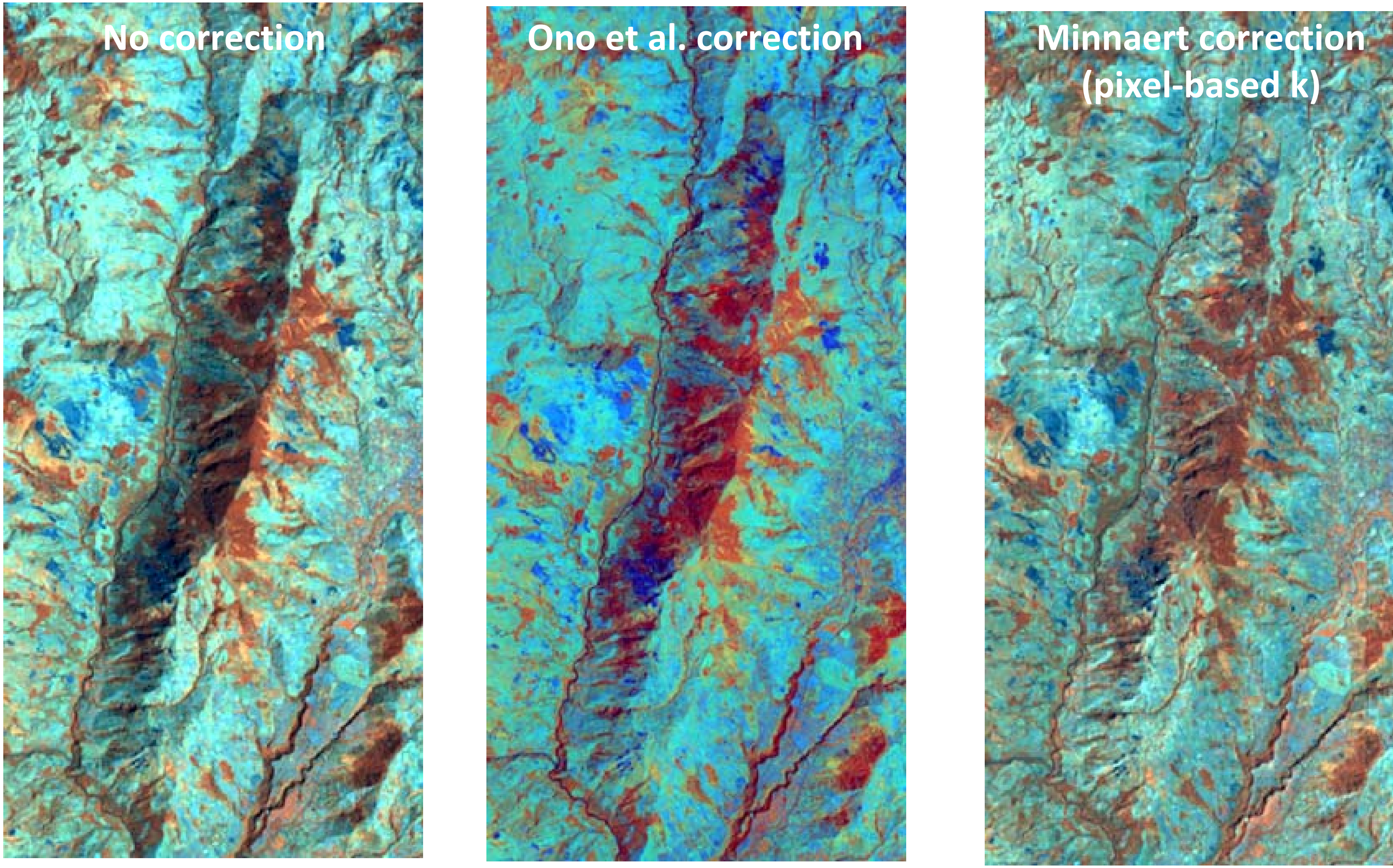


4. Preliminary results

4.1. Correction for topographic effects



FCC 457 of Landsat ETM+

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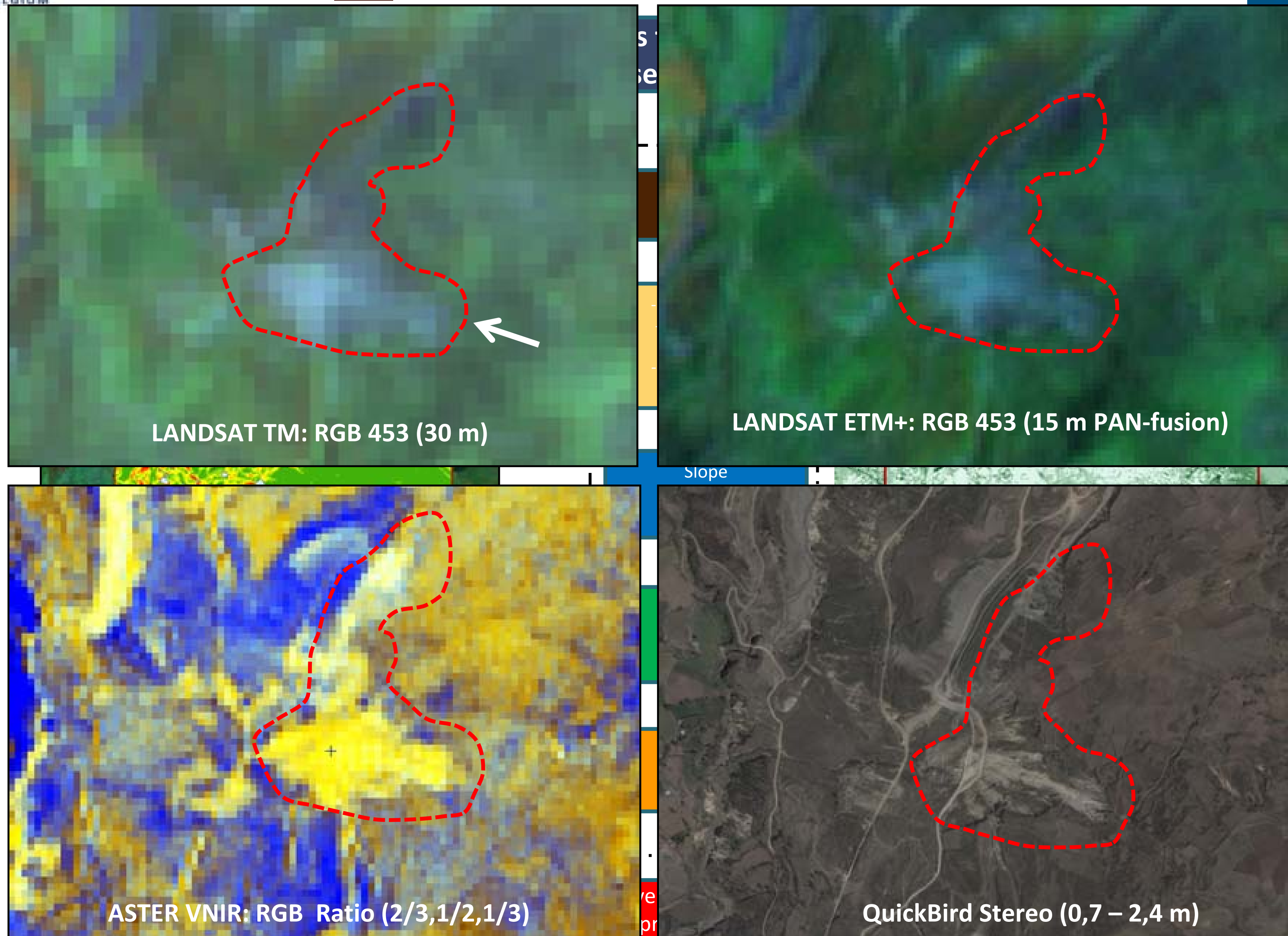
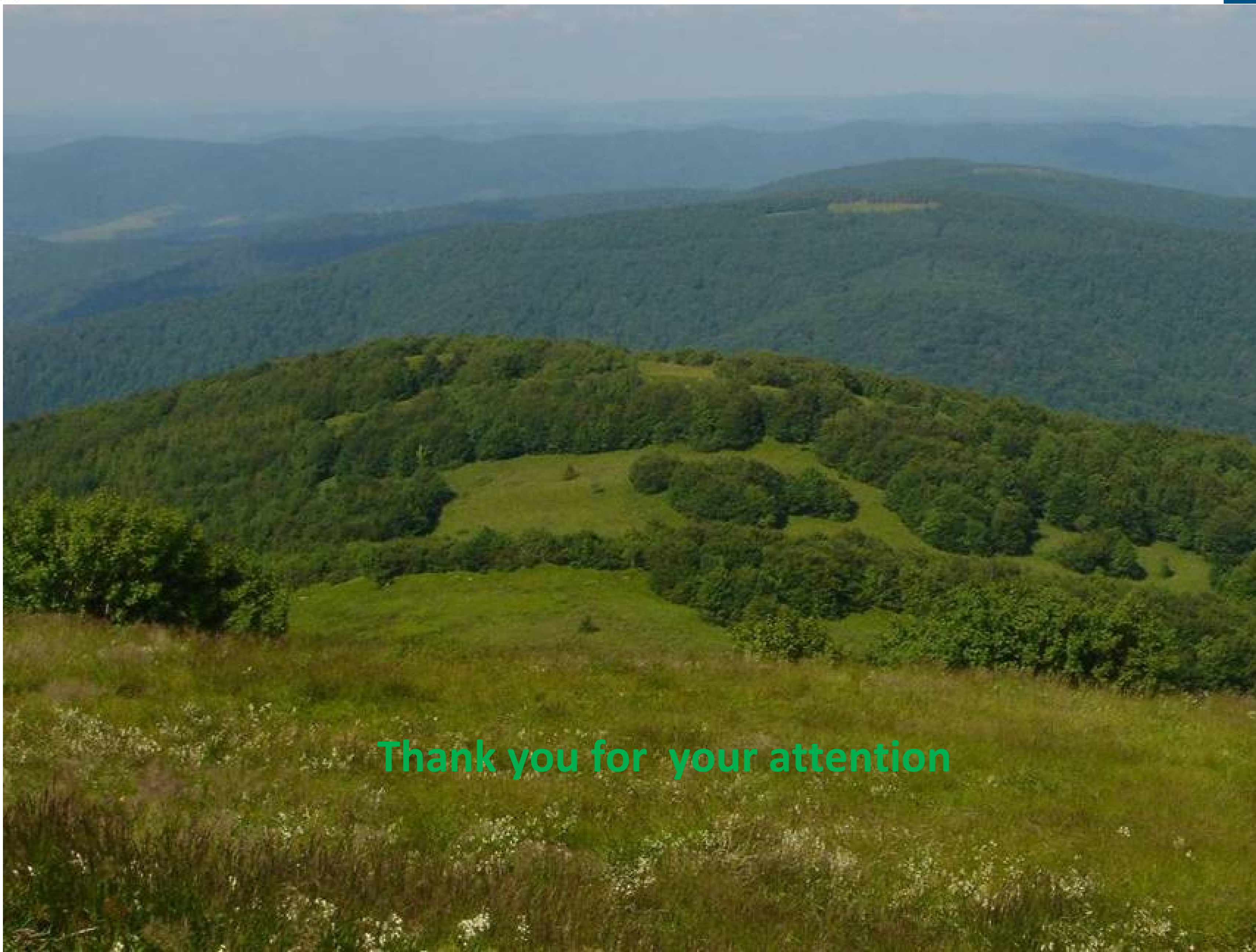


5. Expected outcome

- Scientific advance:
  - Benchmarking of preprocessing methods for **mountain environments** to monitor forest cover changes
  - **Trade-off** between model complexity and **limited data quality and availability**
  - Better insights on patterns and mechanisms of **forest transition** and its impacts on **ecosystem services**

- Applied science and policy:
  - **Robust tools** that enable **end users** (policy makers, nature conservation, water management) to:
    - Monitor forest transition
    - Link forest cover change with changes in ecosystem services
    - Quantify ecosystem services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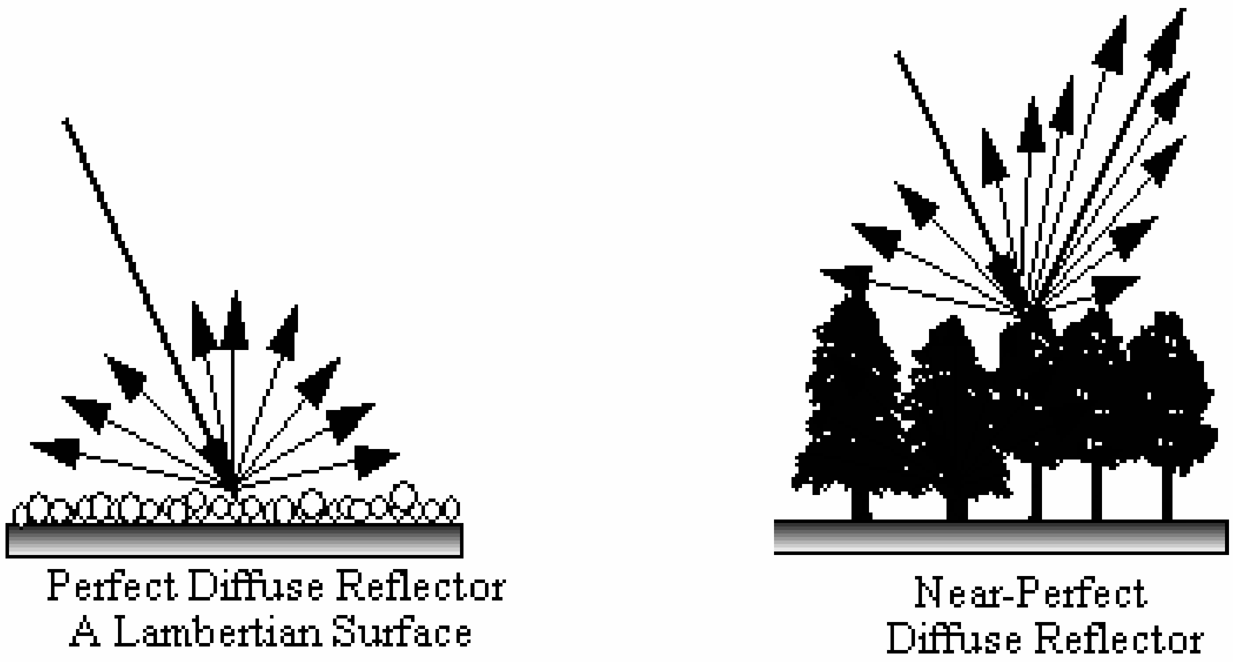


Often results in an overcorrection of the brightness since pixel in the shade still receive radiance due to diffuse skylight (Dengsheng et al., 2008)

K is an empirical coëfficient describing the reflection type. In the case of perfect Lambertian reflection k=1.

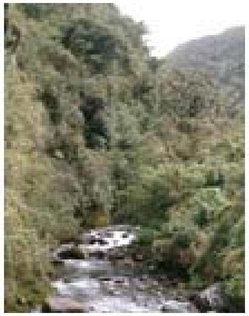
Ecosystem services

= benefits that people obtain from ecosystems (e.g. drinking water, food, hydropower; *Costanza et al. 1997; Daily et al., 1997; Millenium Ecosystem Assessment, 2005*)

Conceptual framework that is convenient for ecosystem management, that allows to 'valorize' natural capital.

Concepts are promoted by conservation groups: payment for environmental services






Landslide detection with High and Very High RS data

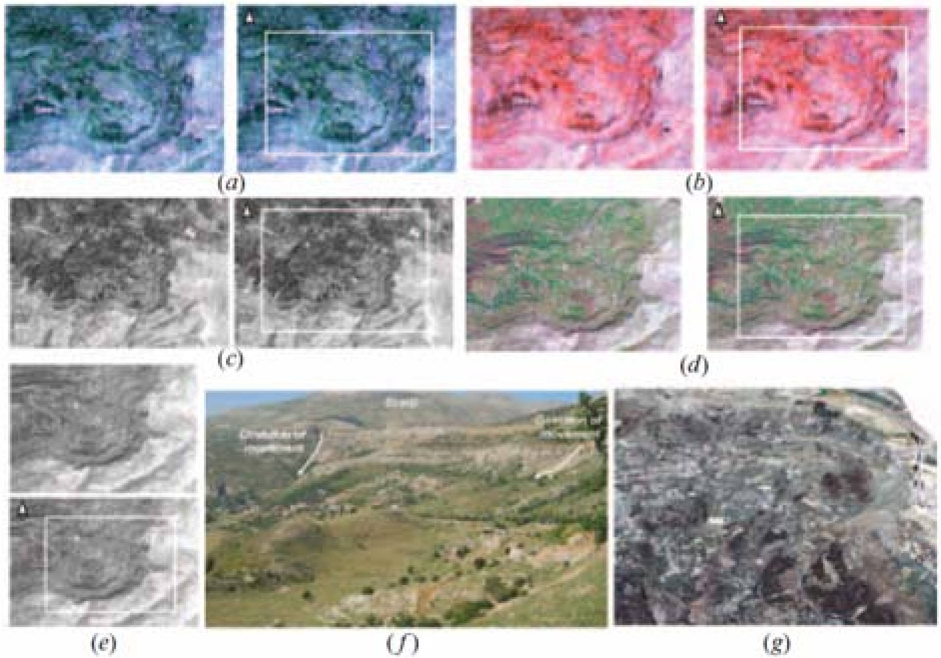


Figure 3. Large landslide of Hammana area (Mount Lebanon). (*a*) Landsat TM (3, 5, 7). (*b*) Landsat TM (4, 5, 7). (*c*) PCA of Landsat TM. (*d*) Pan-sharpened IRS + Landsat. (*e*) SPOT 4. (*f*) Photograph of the Hammana landslide. (*g*) 3D pan-sharpened IKONOS.

Abdallah et al., IJRS, 2007

Table 1. Relationships between image units' properties and the characteristics of landscape units in case of passive sensor.

Landscape units' properties	Image units' characteristics
Spatial distribution of ground pixels	2D shape 3D shape Micro-texture Macro-texture Neighborhood context
Slope angle	3D shape Albedo
Physico-chemical properties	Albedo Spectral signature

Metternich et al., 2004

Detection will be calibrated and validated with existing inventories of landslide data

Evaluate the sensitivity of the landslide detection to three levels of pre-processing of RS data & quality of ancillary data (WP1)