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USE OF REMOTE SENSING IN SOIL DEGRADATION

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I. INTRODUCTION

Data processing and satellite images are a useful tool for the study of land degradation. We have selected images from different sensors to analyze some cases of erosion and loss of soil quality: pollution, loss of organic matter (fire, deforestation), salinization, sealing, erosion and hydromorphic process. The sensors used for this type of study are the average spectral and spatial resolution (embarked in Landsat, Spot, Aster, EO, etc. satellites), high temporal resolution (embarked in MODIS, NOAA, etc. satellites) and radar satellites (embarked in Envisat, ERS, etc. satellites).

Some areas have been selected, located in Spain, Hungary and Brazil, to study the main degradation processes.

II. MATERIAL AND METHODS

The software used for the analysis of these images is ERDAS Imagine 2010. All images were georeferenced to UTM coordinates and have spatial, radiometric and spectral enhancements. These enhancements allow a better visualization of the images. The most useful enhancements in soil degradation studies are:

- Convolution filter of high pass
- Histogram equalization
- Band combinations (visual and infrared channels)
- Normalized Difference Vegetation Index (NDVI)
- Principal components
- Detection of changes

III. RESULTS AND DISCUSSION

The main results are:

1. **Pollution**: the best band combinations to detect toxic waste (analyzed in Kolontar, Hungary) are those that combine visible and infrared channels. If the pollution affects vegetation it is also possible to realize cartography of the affected formations. However, if chemical contamination is due to a particular toxic element it can be detected only by hyperspectral sensors that detect the high contents of pollutants (Pb, Cu, As, etc.).

2. **Loss of organic matter**. It is due to three factors: fires, deforestation and changes of use of soil. The soils affected by fires and their capacity for regeneration have been studied from images Landsat (TM) and Digital Elevation Model (DEM) in Guadalajara, Spain. The thermal bands provide information on the soil temperature. The visible and infrared bands allow the evaluation of the affected area. The loss of biomass can be calculated from the NDVI.

We have selected images of the TM and ETM + sensors to study deforestation and changing land use in the Amazon jungle. The images from different dates have been processed to obtain a new image showing the changes. The loss of forest has been very large over the past 20 years due to the construction of road infrastructure, urban expansion and extension of agricultural activity.

3. **Salinization**: the use of satellite imagery for mapping saline soils is complicated, because the salts are not always reflected on the surface and have great diversity. The spectral signatures of saline soils show very high digital values, allowing them to be differentiated from other soils and land use. The higher spectral values correspond to soils with salt efflorescence on the surface and the lower spectral values to soils affected by hydromorphic processes. To study this process an area of Castilla La Mancha with numerous salt lakes and soils affected by salinization has been selected. Natural and anthropogenic changes in water levels in a semiarid climate with high evaporation cause salts to rise to the surface. The presence of salts on the surface during the summer and halophyte vegetation allow the areas affected by salinity to be distinguished, although there are many problems with detecting salts that retain large amounts of moisture.

4. **Soil sealing**: this process often affects the most fertile soils, since historically many populations settled in the valleys of the rivers. Many floodplains are used for road infrastructure and buildings. Spot images were analyzed in the metropolitan area of Madrid in 2005 and 2010. Soils sealed by buildings are detected in the images by their shapes and gray tones: dug-up soils in which building has not yet commenced have very white tones. Comparing the two dates one can see the rapid development of sealing due to the construction of new residential neighbourhoods.

5. **Erosion**: badlands processes are analysed in two sectors of the Community of Madrid from SPOT imagery. To detect the badlands it is recommended to use spatial and radiometric enhancement (convolution filters, histogram equalization), which can highlight the eroded areas. These images have been superimposed on the digital terrain model, to show the soils affected by erosion. These soils have irregular spatial patterns, closely linked to the development of river dendritic networks.

6. **Hydromorphic** soils: a sector of La Mancha (Spain) at the confluence of the Riansares and Ciguela Rivers is selected to locate areas prone to flooding. These areas are difficult to map by traditional methods due to the flatness of the terrain and low erosive capacity of rivers. The appropriate selection of dates allows one to accurately delineate the areas affected by flooding. The image obtained by principal components is the one that best identifies the surface flooding in very dark tones (wetlands, floodplain and flood other areas). This region of La Mancha presents greater risk of flooding due to the presence of low permeability clay deposits.

IV. CONCLUSION

In conclusion remote sensing provides valuable information for understanding the processes of soil degradation. The use of sensors with channels in the visible and infrared spectrum has been successful in studies of contamination, organic matter loss, salinization, sealing soils, erosion and hydromorphic processes.