Chapter 16
Integration of Satellite Remote Sensing Techniques and Landscape Metrics to Characterize Land Cover Change and Dynamics

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ABSTRACT

One of the most relevant applications of Remote Sensing (RS) techniques is related to the analysis and the characterization of Land Cover (LC) and its change, very useful to efficiently undertake land planning and management policies. Here, a case study is described, conducted in the area of Avellino (Southern Italy) by means of RS in combination with GIS and landscape metrics. A multi-temporal dataset of RS imagery has been used: aerial photos (1954, 1974, 1990), Landsat images (MSS 1975, TM 1985 and 1993, ETM+ 2004), and digital orthophotos (1994 and 2006). To characterize the dynamics of changes during a fifty year period (1954-2004), the approach has integrated temporal trend analysis and landscape metrics, focusing on the urban-rural gradient. Aerial photos and satellite images have been classified to obtain maps of LC changes, for fixed intervals: 1954-1985 and 1985-2004. LC pattern and its change are linked to both natural and social processes, whose driving role has been clearly demonstrated in the case analysed. In fact, after the disastrous Irpinia earthquake (1980), the local specific zoning laws and urban plans have significantly addressed landscape changes.

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INTRODUCTION

Identify and map Land Cover (LC) is a fundamental topic in Remote Sensing (RS), especially in the case of studies concerning its spatial and temporal change (Change Detection). In fact, RS is the main source of a wide range of environmental information about landscape and its changes, which is essential for an effective sustainable land planning and management. RS data, opportunely processed and elaborated, can give a strong effort in change detection tasks, monitoring the differences of LC at different times (Singh, 1989). The processing of multi-temporal image dataset, by means the integration of RS and GIS techniques, can allow to analyse and to identify the changing pattern of LC during a long time period and, as a result, to understand the changes within the area of interest. Is well known that the development of the urban areas is able to transform landscapes formed by rural into urban life styles and to make functional changes, from a morphological and structural point of view (Antrop, 2000; 2004). Historically, urban development (driven by the population increase) and agriculture are competing for the same land: cities expansion has typically take place on former agricultural use. Just to mention some data, the amount of land consumed by urban areas and associated infrastructure throughout Europe was about 800 $km^2 \cdot year^{-1}$ between 1990 and 2000 (EEA, 2006).

MATERIALS AND METHODS

Description of the Study Area

The study here presented has been conducted in the area of the Province of Avellino, in the Campania region (Italy). This area is characterized by many small towns and villages scattered across the Province. Its capital city, Avellino, is one of the only two towns having a population over 20,000. Avellino (40°5'55"N 14°47'23"E, 348 m a.s.l., 42 km NE of Naples, Total population: 52,700) is situated in a plain called "Conca di Avellino" (Figure 1) and surrounded by mountains: Massiccio del Partenio (Monti di Avella, Montevergine e Pizzo d'Alvano) on NO and Monti Picentini on SE.

Due to the Highway A16 and to other major roads (S.S. 7 and S.S. 7bis), Avellino also represents an important hub on the road from Salerno to Benevento and from Naples.

Avellino has suffered from seismic activity throughout its history and was struck hard by the disastrous Irpinia earthquake of 23 November 1980. Measuring 6.89 on the Richter Scale, the quake killed 2,914 people, injured more than 80,000 and left 280,000 homeless. Towns in the province of Avellino were hardest hit and the Italian Government spent during the last thirty years around 30 billions of Euro on reconstruction. Consequently to the earthquake and to regulate the reconstruction activities, several specific acts, decrees, zoning laws and ordinance have been issued: the first one was the Law n. 219/1981, that entrusted the urban planning to the damaged Municipalities, under the coordination of the Campania Region. From 2006 the urban planning issues of Avellino and neighbour areas are regulated by two instruments: P.I.C.A. (Italian acronym that stands for Integrated Project for Avellino City) and P.U.C. (Urban Plan for Avellino Municipality). In this framework, the analysis has concerned the Conca di Avellino area (extended 57,398.48 ha), in consequence of its particular location: a plain between the two natural protected areas: Regional Park of Partenio (14,870 ha) and Regional Park of Picentini Mountains (62,200 ha).

Land Cover Classification and Change Detection

To study and analyse LC changes, a multi-temporal set of remote-sensed data (Yuan et al., 2005; Lucas, 2007) related to the area of interest has been used. This dataset included aerial photos (1954, 1974 and 1990 surveys carried by "Istituto Geografico