Integration of historical maps and multi-temporal optical remote sensing data into a GIS system for studying the large Roman urban system expansion since the early twentieth century.

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Rome, the capital of the Italian Republic and the centre of Christianity, is at the same time an historical and modern city. On one hand its monuments and artistic heritage testify its strong historical identity. On the other hand, Rome is as well open to the future and sensitive to innovation. The urban agglomeration of Rome is one of the fastest-growing urban areas in the world, and this growth has unprecedented effects on both sprawl and population dynamics. The Eternal City is in fact characterized by a large municipal territory, for which some population shifts towards surrounding municipalities has produced and continues to produce an impressive increase in buildings.

The present analysis is based on our past studies, carried out since 1980. From 1980 to 2003 the Master Plan of Rome underwent numerous variations, as the result of a process that has been characterized by several steps that have progressively led to its adoption by the City Council. The population of Rome is now approximately amounting to 3,000,000 people.

During the Fascist era, the historical centre underwent heavy demolitions in order to favour the flow of traffic and isolate the monuments and archaeological areas, but that was to the detriment of many historical buildings of minor importance.

The urban area increased a lot within the time range 1900-1960, but Roman buildings were still within the Great External Road Ring (GRA). Between 1960 and 1980, the metropolitan area drastically increased within the belt of the GRA. Population growth peaked in the 1980s when part of the population started to settle outside the GRA.

Data analysis had demonstrated the urban expansion in the north-eastern quarter of the city. Urban developments have been detected in the south-eastern areas too, and these might increase urban pressure as well.
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-Methoodology-

This research was conducted to examine past and current effects of the urbanization process that occurred in the large Roman urban system and made use of multi-source and multi-temporal optical remote sensing (RS) data, collected between 1990 and 2013. These changes were then validated via Geographic Information System (GIS) techniques.

Evaluation of the urban growth for the area of Rome within the Great Circular Road (345.2 Km²)

The proposed approach with GIS geo-statistical methods was used to calculate an innovative index (AP Index) that was useful for monitoring the phenomenon of urban sprawl.

Density variation from 2002 to 2011 and API index application were used to produce a quantitative descriptive summary of the spatial arrangement of the different land uses, which allows to easily understand the environmental framework of the territory.

The overall density value for a specific land use x is: \[ \text{API}_x = \frac{\sum (C_i / S_i)}{S_x} \]

Where:
- \( \text{API}_x \) = Area Profile Index for the density class i and the land use x
- \( S_x \) = total area for the specific land use (x)
- \( C_i \) = number of cells in density class i
- \( S_i \) = total area cells
- \( S_t \) = total municipal area

The most noticeable of these patterns is urban expansion toward the north-eastern quarter of the city. In addition, urban developments are expected to emerge in the south-eastern areas, which are expected to increase urban pressure as well. It can be concluded that the general urbanization trend is still growing within the study area (internal to GRA). In particular, the constant increase in the urban density process is currently filling up the remaining gaps left by the sprawl phenomena previously occurred. Results indicate that in the timeframe 2002-2011, the land use classes were likely to turn into built-up areas. This can be also confirmed from the ISTAT data: in the last years, the demographic growth trend, after a sudden fall (-8.2), is actually growing from 2001, even if not much (+3.6).

Evaluation of the urban growth for the total area of the municipality of Rome (1287.2 Km²)

Evidence of urban sprawl

Mapping urban areas from space conference
ESA-ESRIN, 4-5 November 2015
Via G. Galilei, Frascati (Roma) - Italia