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High resolution remote sensing data and environmental data for the classification of a square in Rome, Italy

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Abstract

The goal of work is to characterize and quantify the vehicles, with a synoptic vision. With data from the very high resolution Pléiades Neo sensor captured in a public space (square) of the city of Rome, the object-based image analysis (OBIA) method is applied. Traffic flow data expressed as equivalent vehicles/hour and relating to the peak hour of the winter weekday morning, made it possible to calculate the total polluting emissions expressed in g/h, indicative of local air quality conditions in the two study areas. The results achieved, while needing further checks on other areas of study, they have highlighted the validity of method and its large-scale reproducibility for support in urban planning. The work with a multidisciplinary character intends to offer a starting point for reflection on the use of spaces public places of historical architectural value, which over the centuries have seen the conditions worsen accessibility and usability for people of different age groups

1. Introduction

In this work, with a multidisciplinary and original approach, using high spatial resolution satellite data acquired in a public space of the city of Rome, respectively Square Mazzini (Figure 1), we apply a method that will allow:

- validate the usefulness of the data coming from the very high resolution Pléiades Neo sensor for the characterization and quantification of the different vehicles present (parking and transit);
- understand the dynamics of use and reflect on the critical issues in progress, through the results obtained from the processing integrated with punctual data on punctual traffic;
- present an analysis technique that can be reproduced on a large scale which, through the synoptic vision, can help reflect on the use of our heritage of historical architectural value and which can become a valid support for urban planning, aimed at environmental sustainability, preparatory to the development of new technologies and methodologies;
- offer food for thought as well as stimulate and carry on the discussion on the use of public spaces, especially in squares.

Figure 1. Study area , Square Mazzini, Rome, Italy

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2. Method

The images used for this study were delivered with geometric processing and with radiometric processing, they have the characteristics indicated in the Table 1, 2.

Table 1. Pléiades Neo data characteristics

Bande	Lunghezza d'onda (μm)	Risoluzione (m)
Deep Blue (VIS)	0,4 – 0,5	1,2
Blue (VIS)	0,45 -0,52	1,2
Green (VIS)	0,53 – 0,59	1,2
Red (VIS)	0,62 -0,69	1,2
Bande (NIR)	0,7 – 0,75	1,2
Neear Infrared (NIR)	0,77- -0,88	1,2
Pancromatico (VIS)	0,45-0,8	0,3

Table 2. Pléiades Neo data characteristics

Altitude Km	Fligh Date	Flight Time
620	16 october 2021	10:06:55

The workflow used is typical of Deep Learning (DL) and other supervised automatic DL approaches. In this case a combination of DL functionality within eCognition Developer and OBIA was used to detect cars with only optical data. In the first phase, some samples were collected for the recognition of cars and buses. The samples were identified in various areas of the image and chosen in different contexts, shapes and colors to guarantee a very high level of variables [Mohammad, 2019; Arch, 2017].

In the second phase of the work, the central phase, it was necessary to generate a Convolutional Neural Networks (CNN) model of DL and train it using the previously collected samples. Subsequently, the model was validated targeting new image data (other areas) [De Maria et al., 2021]. Once validated following the verification of good accuracy, the model was used in production mode and applied to new data. Finally, some samples have been added for the recognition of buses and articulated buses of ATAC (public transport of Rome). Figures 3 and 4 show the results obtained by processing the data with the DL - CNN in eCognition

Figure 2. OBIA-based object detection flowchart

2.1. Traffic flow data

To support the calculations, data on the traffic flow were used (data provided by the Mobility Office of the Municipality of Rome).

Starting from the data on the traffic flow expressed as equivalent vehicles/hour and relating to the peak hour of the winter weekday morning, the following simplifications were made: the category of cars for private transport was considered as the only component of the traffic flows.

As a function of the flows then broken down by power supply category respectively; petrol, diesel, LPG, hybrid, CNG (methane), electric and by environmental class (from Euro 0 to Euro 6), a calculation was made of the emissions for the pollutants: nitrogen dioxide (NO_2), nitrogen monoxide (NOx), Atmospheric particulate less than or equal to 10 μm (PM10) and less than or equal to 2.5 μm (PM2.5) (by power supply category and expressed in mg/h).

3. Results

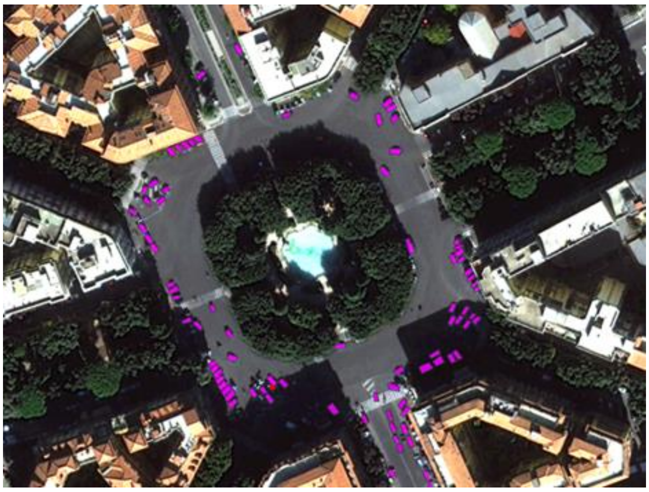

Figure 3. Rome Piazza Mazzini. The processing highlights the cars present in the study area in pink

Figure 4. Rome, Square Mazzini. The processing highlights the total emissions g/h calculated from the traffic flow data

Table 3. Processing results

Square	Car	Car parked	Bus	Total
Square Mazzini	11	78	-	89

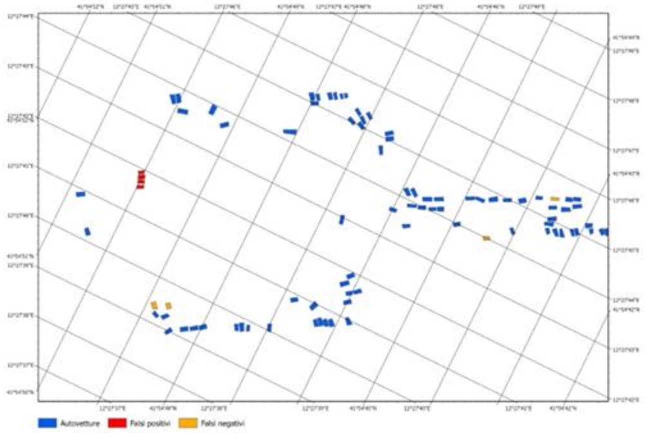

Figure 5. Square Mazzini confusion matrix. The processing shows correctly identified cars in blue, false negatives in yellow (not correctly identified) and false positives in red (wrongly classified as cars)

4. Discussion

The processing of the remote sensing data of Square Mazzini (16,600 m^2) confirms that the asphalted surface destined for traffic corresponds to almost 2/3 of the square and of this, approximately 25% is occupied by car parks located at the edges of both the square and the flowerbed central, delimiting the carriageway to a single direction of travel (Figure 3,4). The processing results in 78 parked cars and 11 in the lane. Although the presence of trees that delimit the central area, shelter from noise, absorb part of the greenhouse gases produced by cars and mitigate the heat island, the square does not offer the ideal conditions to be used appropriately by the inhabitants, declining it towards a condition of residuality. Figure 4 summarizes with the colors the presence of traffic coinciding with the trend of emissions, this reaches the maximum values (red) in the stretch of the square that goes from street Luigi Settembrini towards street Mazzini, discouraging the use of the space central.

In order to have a view that is not limited to just the moment of the acquisition of 16 october 2021, at 10.06, the integration with the data relating to car flows in the study area allows us to have a broader view. The rush hour of traffic in the square is between 7-10 and between 12-13 with a peak between 8-9. The analysis of the data relating to the flows of equivalent vehicles/hour quantifies an average value of 532 vehicles/hour, with maximum peaks at the end of via Settembrini on the square equal to 1132 vehicles/hour [Piano della Mobilità Sostenibile, 2021].

The presence of traffic and the effects due not only to pollution but also to noise represents a powerful obstacle to the usability and perception of the central space, discouraging pedestrian mobility towards the central garden, impoverishing the "social" potential of the central public space.

It would be desirable that the municipal administrations listen to and adapt to these new needs and give a new life to public spaces by equipping them adequately. From a practical point of view, it means making them accessible and usable by people with different needs and abilities. Of course, it is not always easy or obvious to give meaning and functions to historic squares, to make sure that they become places at the service of the community, or to implement effective regeneration strategies over time. The redevelopment interventions should at least try to give (or restore) a role of public space also through the integration of urban facilities that invite users to use them. For example limiting traffic or with slow-moving vehicular traffic where cars adapt to pedestrians and not vice versa, with safe routes and crossings, quality collective equipment such as benches to sit on, games for children, spaces for animals, temporary exhibitions , outdoor entertainment organizations that foster relationships and social relationships and contribute to the construction of a sense of belonging [Lauria, 2017].

5. Conclusion

Through the use of high-resolution remote sensing data from the Pléiades Neo sensor, in this work we have validated the utility of the OBIA method for the characterization and quantification of the different vehicles present (parking and transit); in a square of historic value in Rome. Furthermore, the integration with traffic data has made it possible to identify some critical issues and make a series of considerations on the use of public space.

The method, which can be reproduced on a large scale, once developed and validated in other places, in fact, can be used for environmental audits related to motorized and non-motorized activities, the presence of tourists, the sense of safety and environmental comfort, and more generally to study social phenomena, through the latest high-resolution remote sensing data, in order to inform the decision-making process.

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