University of Zagreb
Faculty of Geodesy

Geospatial Monitoring of Green Infrastructure by Means of Terrestrial, Airborne and Satellite Imagery (GEMINI)

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Introduction

▸ Green infrastructure (GI) is a network of natural and semi-natural areas, features and green spaces in rural and urban areas that collectively provide society sustainable, healthy living environment.

▸ 2/3 Europe population live in urban areas.

▸ GI provides various benefits such as:

 ▸ environmental (air pollutants, land quality),

 ▸ social (health and human well-being, green cities, tourism and recreation opportunities),

 ▸ adaptation and mitigation to climate change (heat island).

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Project GEMINI

- GEMINI – Geospatial Monitoring of Green Infrastructure by Means of Terrestrial, Airborne and Satellite Imagery.
- GEMINI is a scientific project funded by the Croatian science foundation
- Project holder
  - Faculty of Geodesy, University of Zagreb
- Partner institution
  - Croatian Forest Research Institute
- Principal investigator
  - Prof. Dr. Damir Medak
- Time period: 2017-2021
- New positions: 1 postdoctoral, 1 doctoral scholarship

Study area

▸ The study area is the urban area of the city of Zagreb, Croatia.

▸ Focus is on protected green areas inside the city:

    ▸ Medvednica Nature Park,

    ▸ Park Maksimir,

    ▸ Botanical garden,

    ▸ Lenuzzi's green "horseshoe".
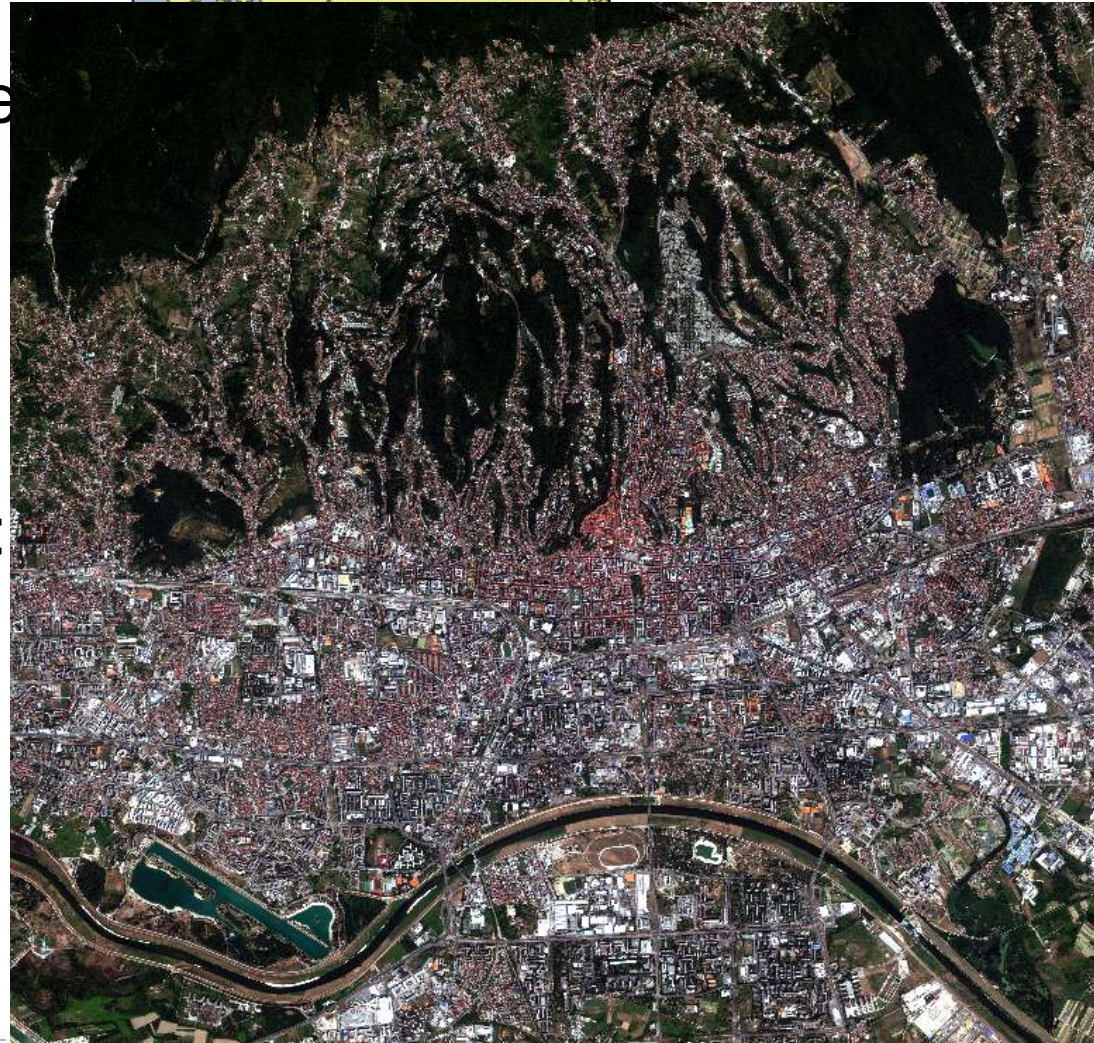
Data types for GI monitoring

▸ **Satellite imagery**

 ▸ All available imagery from free satellites such as Sentinel, Landsat, etc.

 ▸ Selected imagery from WorldView 1, 2 and 3 satellites

▸ **UAV aerial imagery**

 ▸ Multispectral and thermal data (images and videos) collected from UAV

▸ **Terrestrial ground data and measurements**

 ▸ Multispectral and thermal data (images and videos) collected from automotive vehicle

 ▸ Ground measurements, e.g. data from meteorological stations and other sensors – for acquisition system calibration

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RS methods for GI monitoring

▸ Sharpening of multispectral channels with the panchromatic channel.

▸ Fusion of satellite imagery (large coverage area but a low resolution) with UAV and terrestrial imagery (medium and small coverage area but a high-resolution).
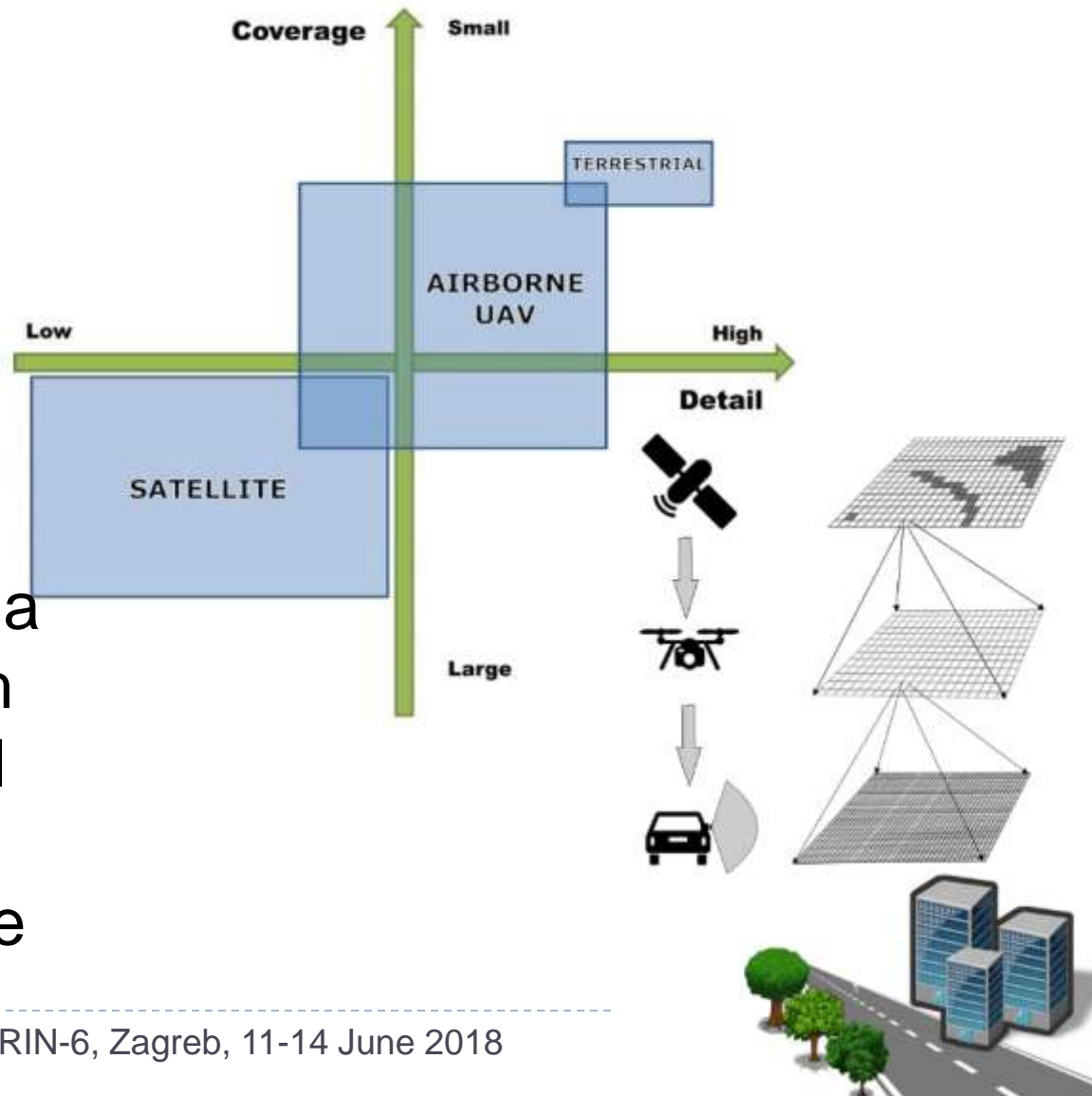
Geospatial tools and software

▸ Calibration and integration of various sensors data and geospatial analysis on project GEMINI are based on open source tools.

▸ The following tools are:

 ▸ GRASS GIS, SAGA GIS and Quantum GIS – for data pre-processing, the implementation of remote sensing methods (segmentation, vegetation indices, feature mapping, classification), data fusion, and geospatial analysis;

 ▸ R – for imagery pre-processing, data fusion and statistical computing;

 ▸ Python – for development and implementation of novel methods for data calibration and fusion;

 ▸ GeoServer, PostGIS – for database development, geospatial data analysis;

 ▸ MultiSpec, ImageJ and similar programs – for image processing, classification and analysis.

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Current GEMINI project status

Free and commercial satellite imagery collecting
Multi-sensor system for autonomous GI monitoring

Current status

- **Free satellite imagery collection**
  - Sentinel 2, Landsat 8
- **Commercial VHRSI**
  - WorldView-2 for 2011, 2012, 2013 (summer) and 2016 (winter)
  - WorldView-2, 3 and 4 for 2014 till now
  - PlanetScope
  - RapidEye
- **UAV**
  - Multi-sensor system for autonomous GI monitoring
  - Home build design and development

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Multi-sensor system for autonomous GI monitoring

- ▸ **Design and development UAV**
  - ▸ Carbon X8 – coaxial frame, open source (OS) flight controller (pixahawk), 3-axis gimbal + OS controller board, accurate GNSS receivers, RTK GNSS base + rover, 25-30 min flight time.
- ▸ **Obtaining optimal sensors for image acquisition**
  - ▸ VIS camera (RGB), NIR camera (B, G, R, red edge, near-IR), thermal camera
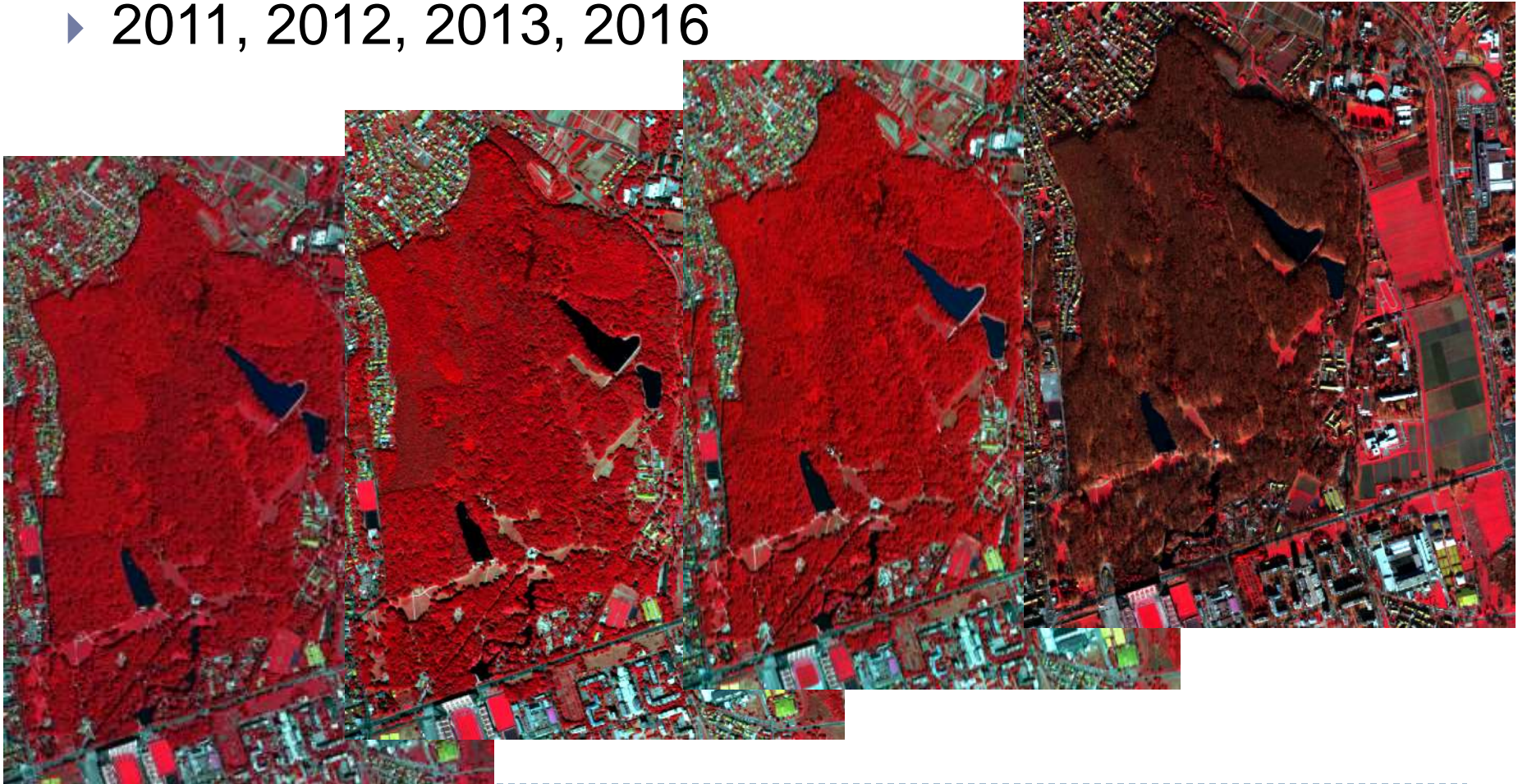- ▸ **Sensor calibration and fusion (future)**

Bundek (recreation zone)

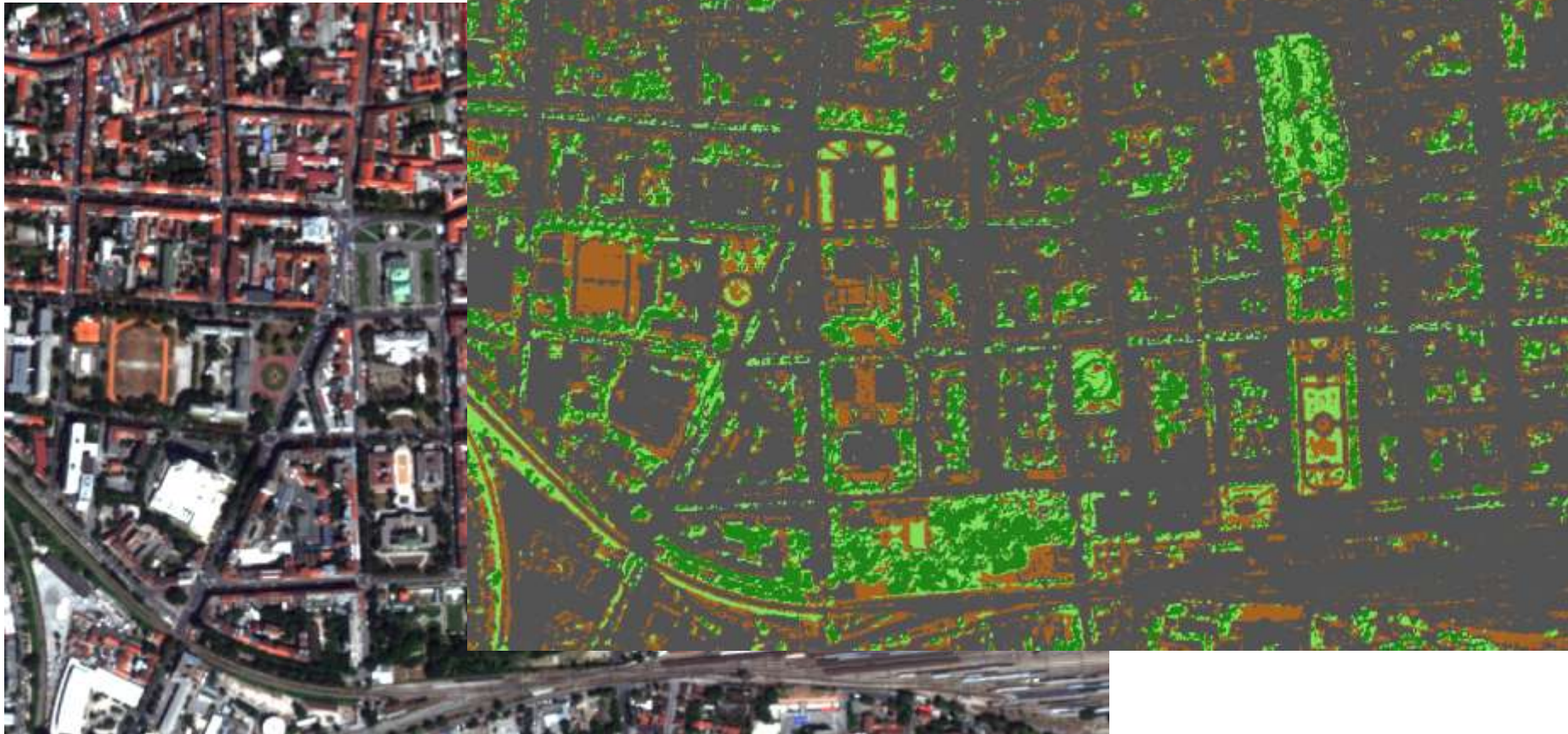- WorldView-2 „true color" composite
- 2011, 2012, 2013

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Park Maksimir (recreation zone)

- ▸ WorldView-2 „false color" composite
- ▸ 2011, 2012, 2013, 2016

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Urban green infrastructure detection

▸ Zagreb center – WorldView-2, supervised classification

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Dissemination

- Homepage: http://gemini.geof.hr
- Published papers

  - Gašparović, Dobrinić, Medak (2018): Spatial accuracy analysis of aerial and satellite imagery of Zagreb // Geodetski list

  - Gašparović, I., Gašparović, M., Medak (2018): Determining and analysing solar irradiation based on freely available data: A case study from Croatia // Environmental Development

  - Gašparović, Seletković, Berta, Balenović (2017): The Evaluation of Photogrammetry-Based DSM from Low- Cost UAV by LiDAR-Based DSM // Seefor – South-East European Forestry

  - Gašparović, Medak, Miler (2017): Geospatial monitoring of green infrastructure – case study Zagreb, Croatia // 17th SGEM 2017

  - Župan, Frangeš, Šutalo (2017): Vegetation index and forest analysis in the Republic of Croatia // 17th SGEM 2017

  - Gašparović, Jogun (2017): The effect of fusing Sentinel-2 bands on land-cover classification // International Journal of Remote Sensing

  - Rumora, Miler, Medak, Majić, Pilaš (2017): Vegetation detection using video data // SCERIN-5

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Conclusions

▸ The importance of protected GI areas is continuously growing.

▸ To preserve them for future generations is necessary to implement a concept of sustainable development in their management.

▸ The GEMINI project enables development of new methods and systems for monitoring the urban GI.

▸ UAV-based remote sensing offers great possibilities to acquire field data for GI monitoring within the urban areas in a fast and easy way.

▸ Future analysis will be of great importance in fields such as forestry, arboriculture, urban and geospatial science.

Lenuzzi's green "horseshoe" in center of Zagreb, Croatia

Thank you for attention

Prof. Dr. Damir Medak (dmedak@geof.hr)

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