

Multimodal Remote Sensing: Bridging Forests, Fields, and Cities for a Sustainable Future



ACRS 2025

THE 46TH ASIAN CONFERENCE ON REMOTE SENSING
"Harnessing Remote Sensing for Global Sustainability and Innovation"
MAKASSAR - INDONESIA 27 - 31 OCTOBER 2025



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Francesco Pirotti PhD

Interdepartmental Research Center in Geomatics CIRGEO
University of Padova - Italy



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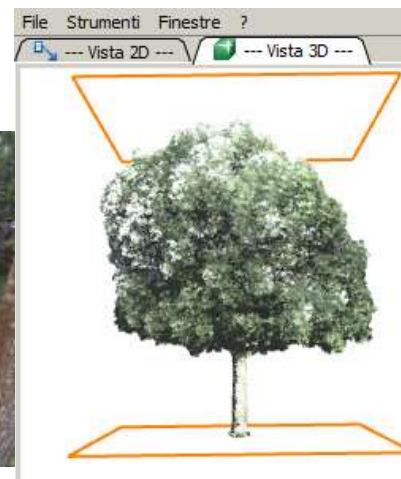
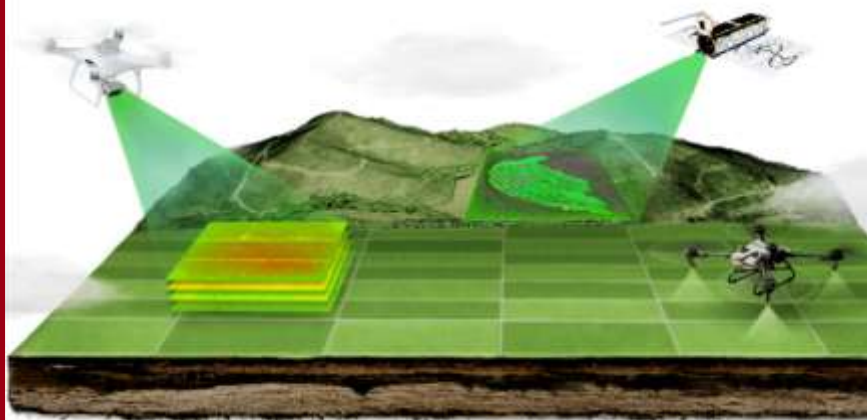
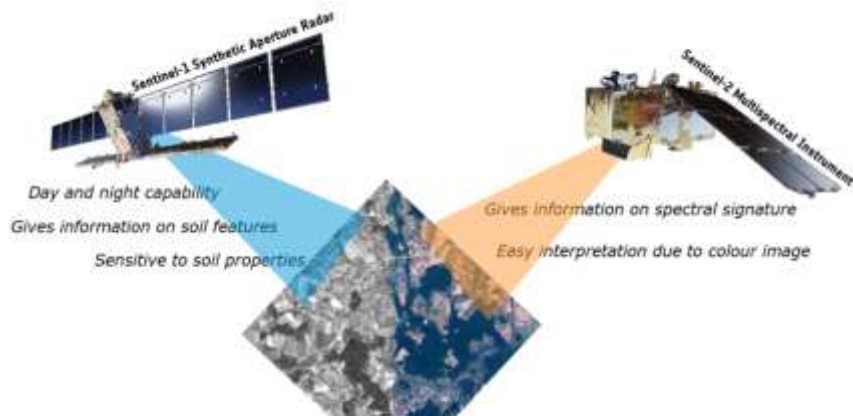


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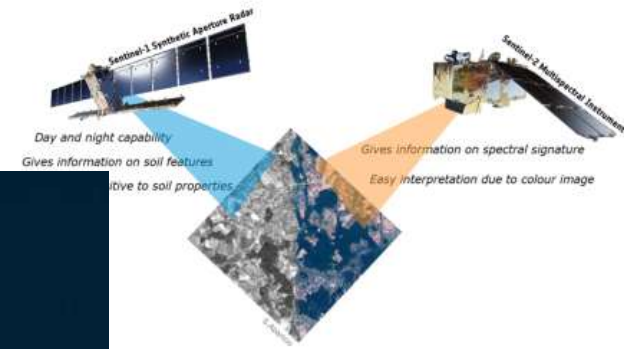
Multimodal Remote Sensing



Cortesy: DJI



Multimodal Remote Sensing



5,401 **Earth Observation** satellites

see also NASA World Wind SPACE BIRDS!!! <https://worldwind.arc.nasa.gov/spacebirds/about.html>

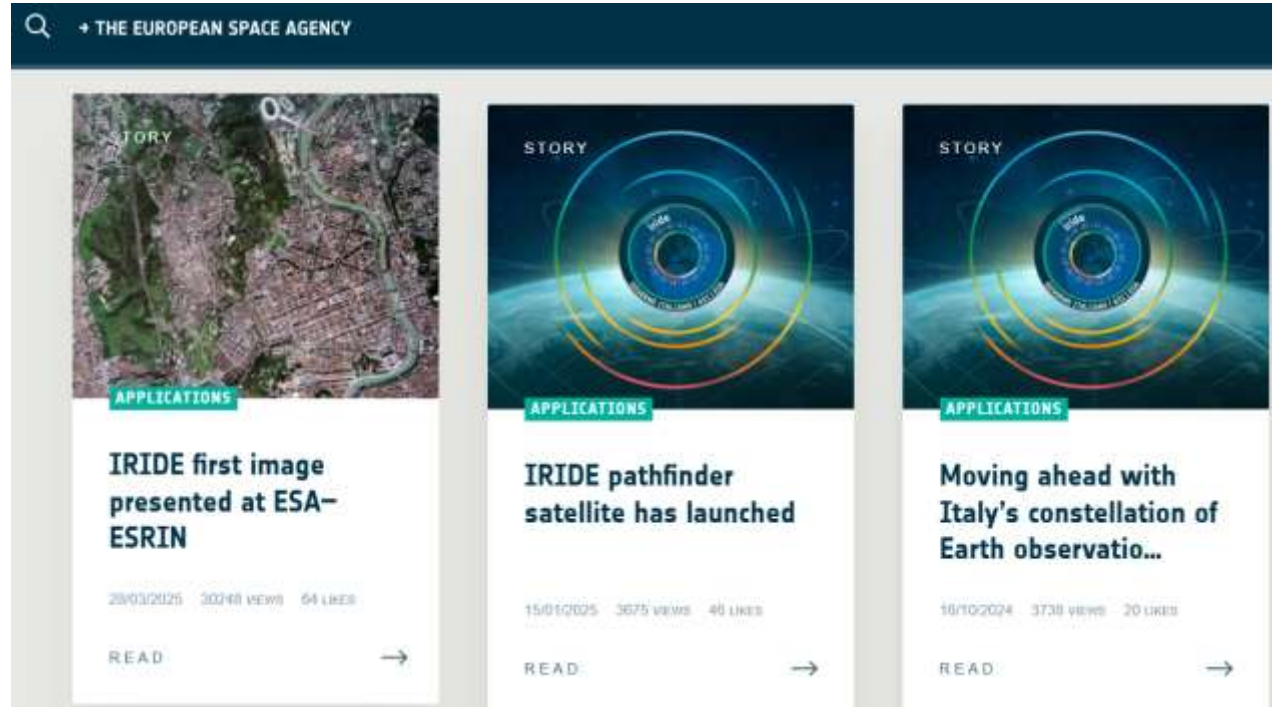


Multimodal Remote Sensing - IRIDE



- PLATiNO-Hyperspectral
- Hawk for Earth Observation HEO
- Nimbus SAR
- NOX SAR
- Nimbus VHR
- Eaglet II Optical

six sub-constellations
60+ vectors





Multimodal Remote Sensing - IRIDE



Source: E-Geos “Designed as a “constellation of constellations”, IRIDE is made up of several sub-constellations of satellites in low Earth orbit (LEO), known as the Upstream Segment, the operational infrastructure on the ground (Downstream Segment) and the services for the Italian Public Administration (Service Segment).”



Source: Planetek



Data access & ToS:

As open as possible, as closed as necessary?



Multimodal Remote Sensing



International Society of Photogrammetry
and Remote Sensing (ISPRS) - Educational
and Capacity Building Initiatives



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Multimodal Remote Sensing



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Remote Sensing data extraction:

Indices calculated from Harmonized data from Sentinel-2 and Landsat bands:

NDWI – Normalized Difference Water Index

$$NDWI = \frac{Green - NIR}{Green + NIR}$$

MSI – Moisture Stress Index

$$MSI = \frac{SWIR}{NIR}$$

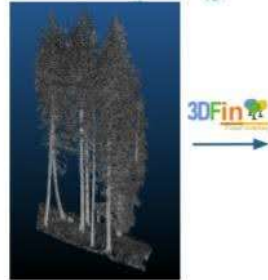
NDMI – Normalized Difference Moisture Index



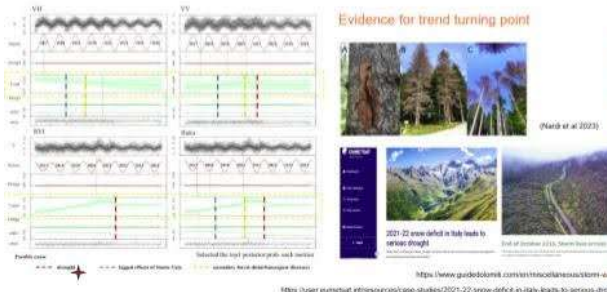
Site-specific data collection:

Tree stand parameters
from TLS point cloud

- Average tree height
- Average DBH (diameter at breast height)



Results: SAR-based anomaly detection



GROUP D -Water Balance Modelling & Remote Sensing

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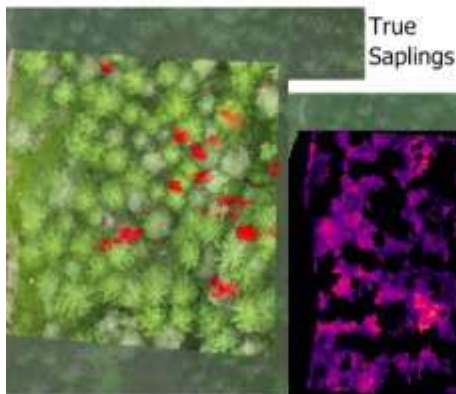
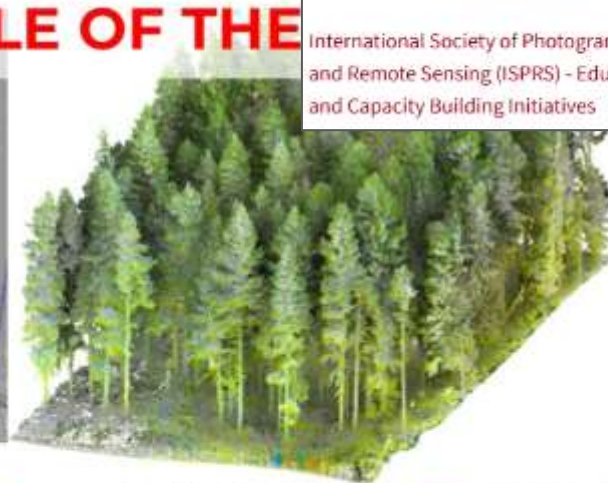
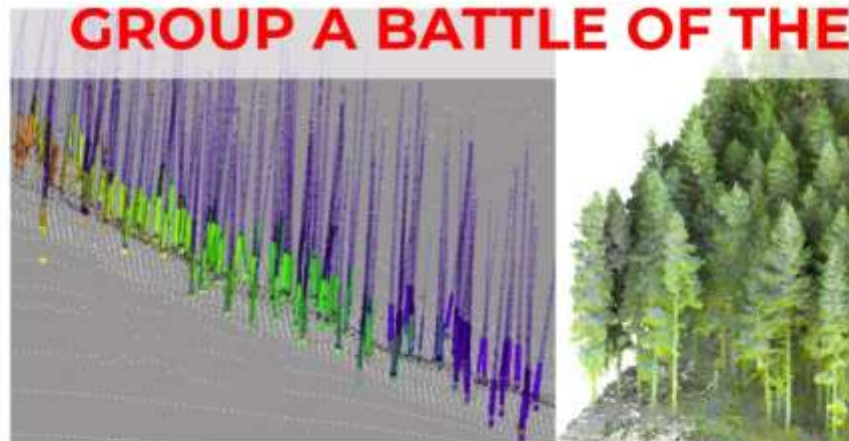
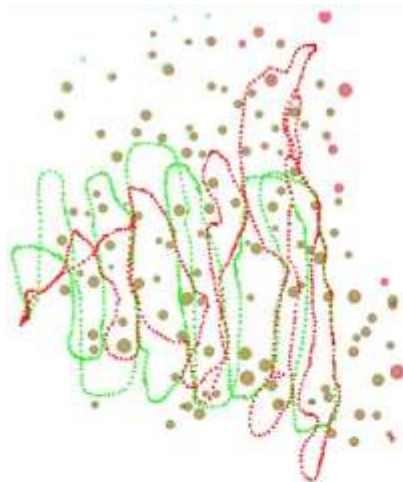
Multimodal Remote Sensing



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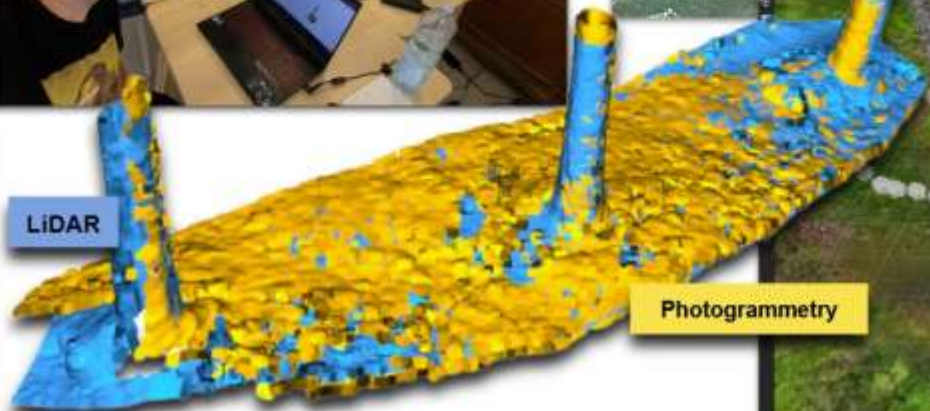
Multimodal Remote Sensing





Multimodal Remote Sensing

GROUP F - Photogrammetry and Nerf-Gaussian Sp



LiDAR

Photogrammetry





Multimodal Remote Sensing

VVV+ 3 V's (volume, velocity and variety)

BIG DATA!!!!



which to use? how?
data-fusion? AI?





Bridging Forests, Fields, and Cities

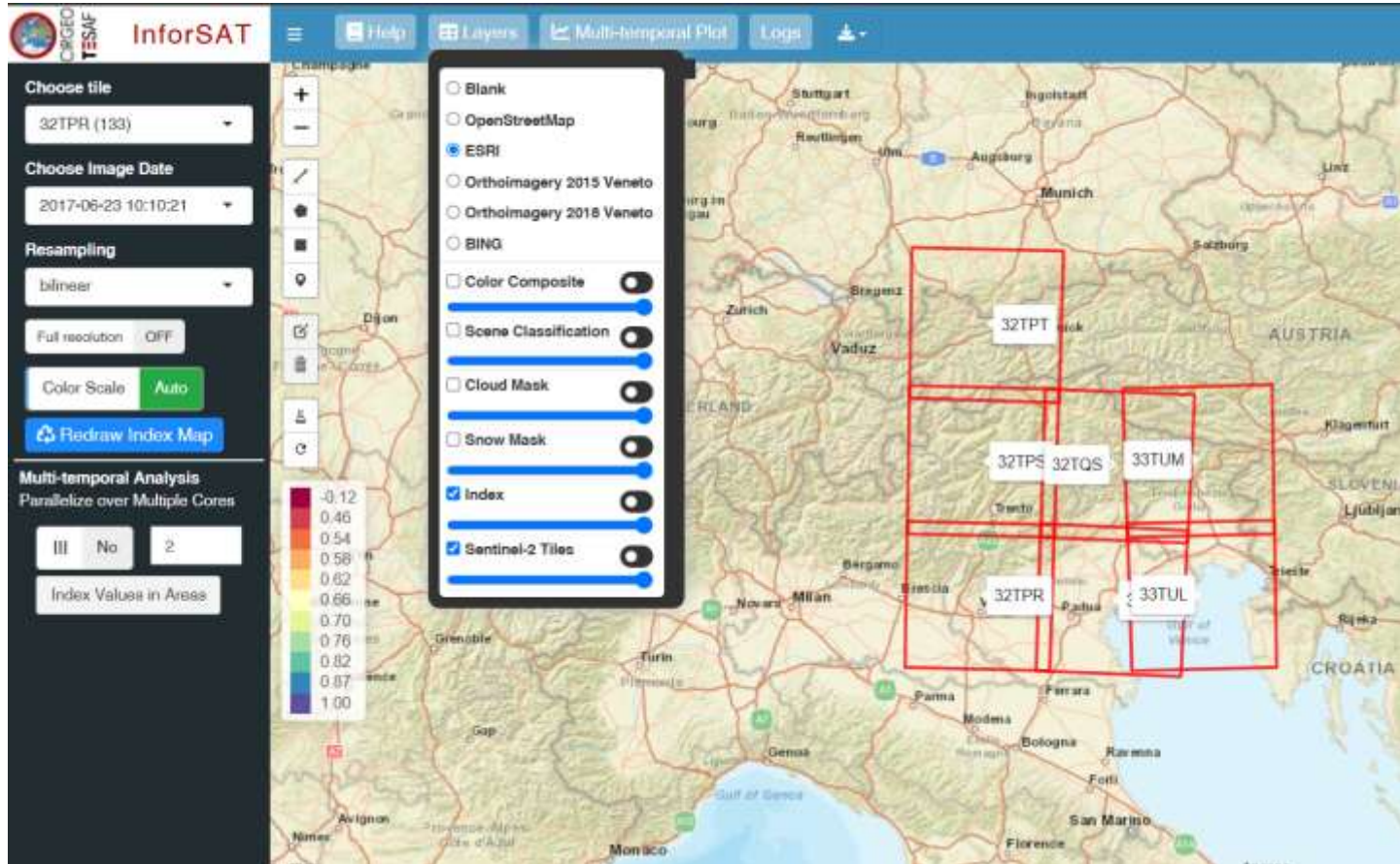


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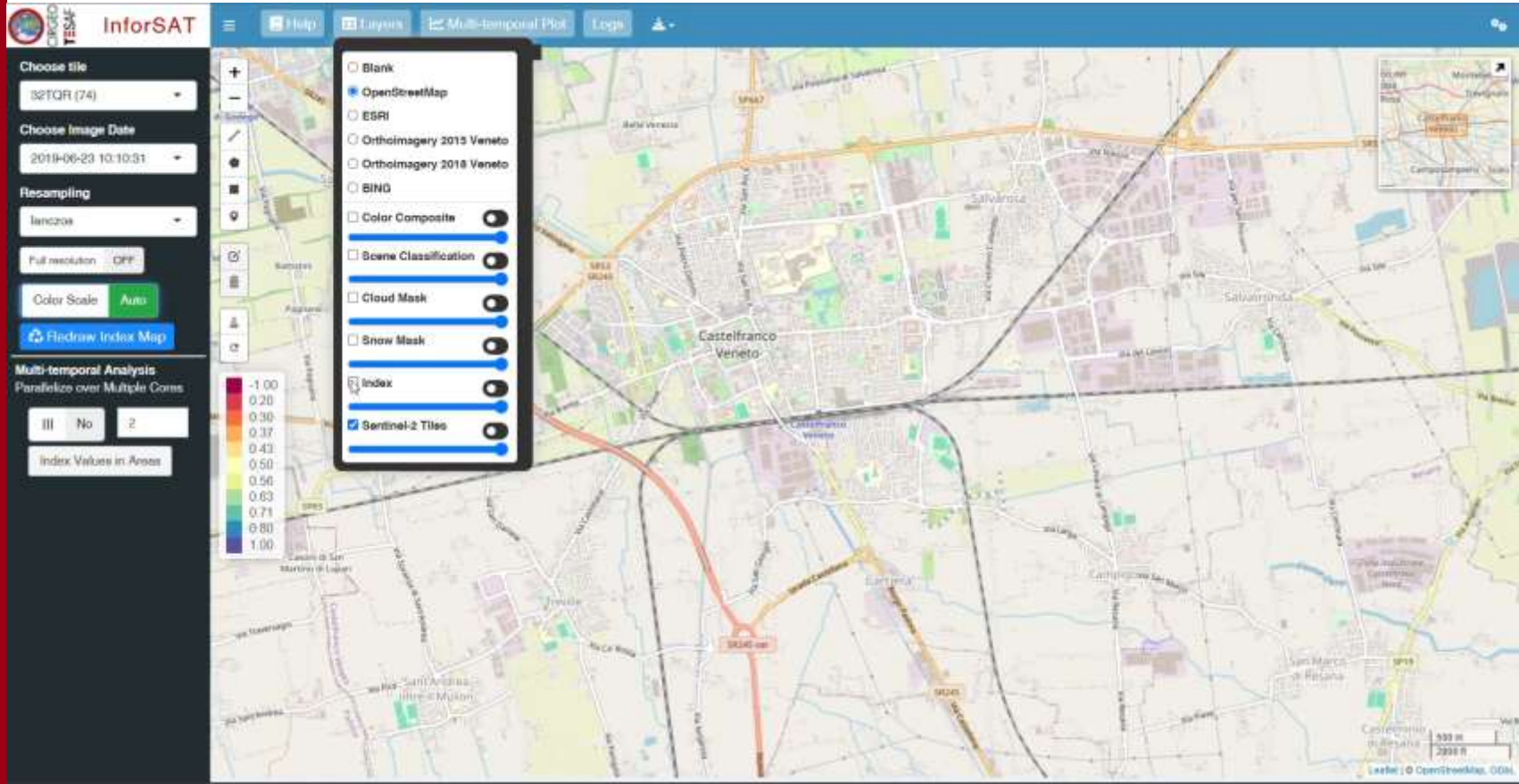


Bridging Forests, Fields, and Cities



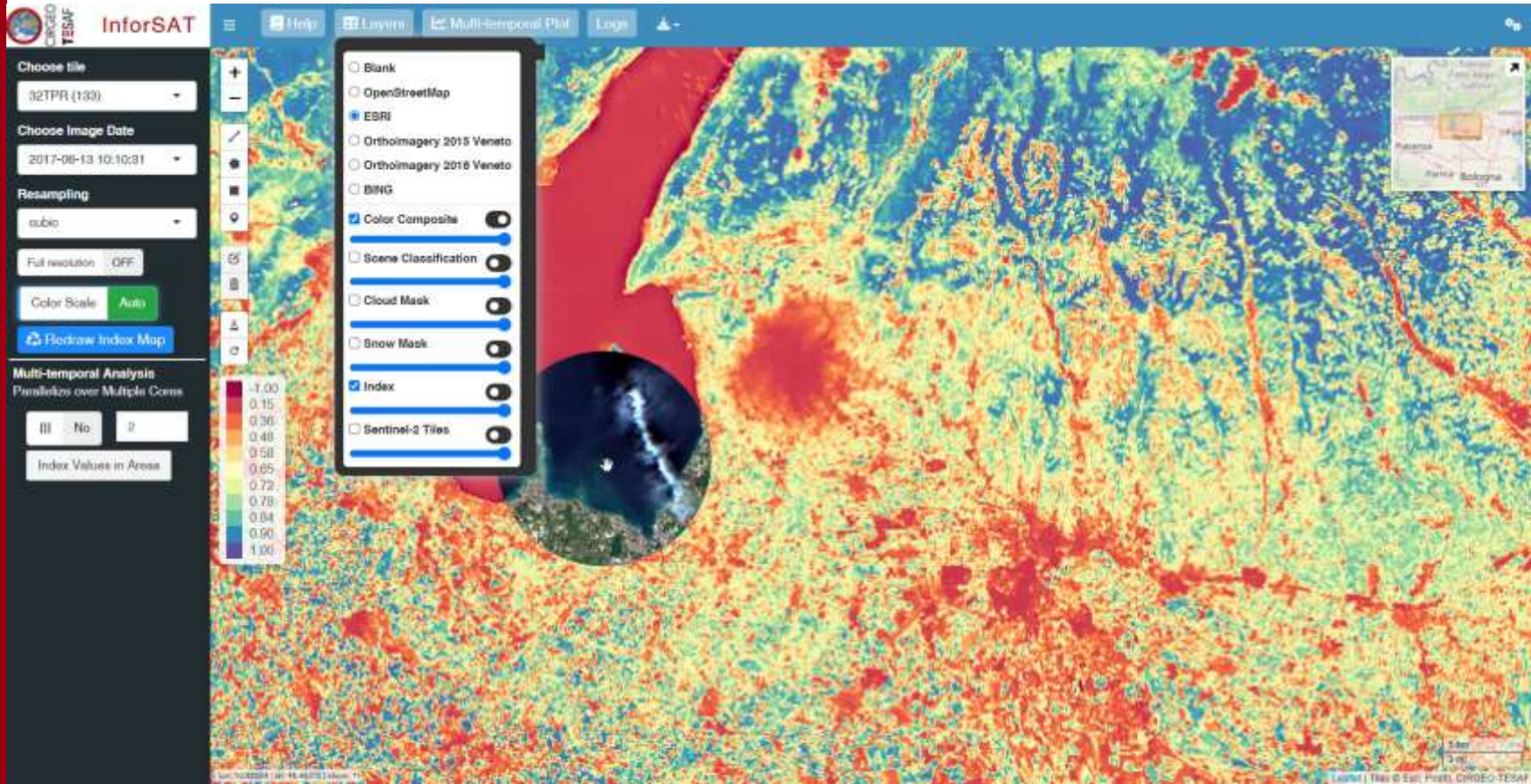


Bridging Forests, Fields, and Cities





Bridging Forests, Fields, and Cities





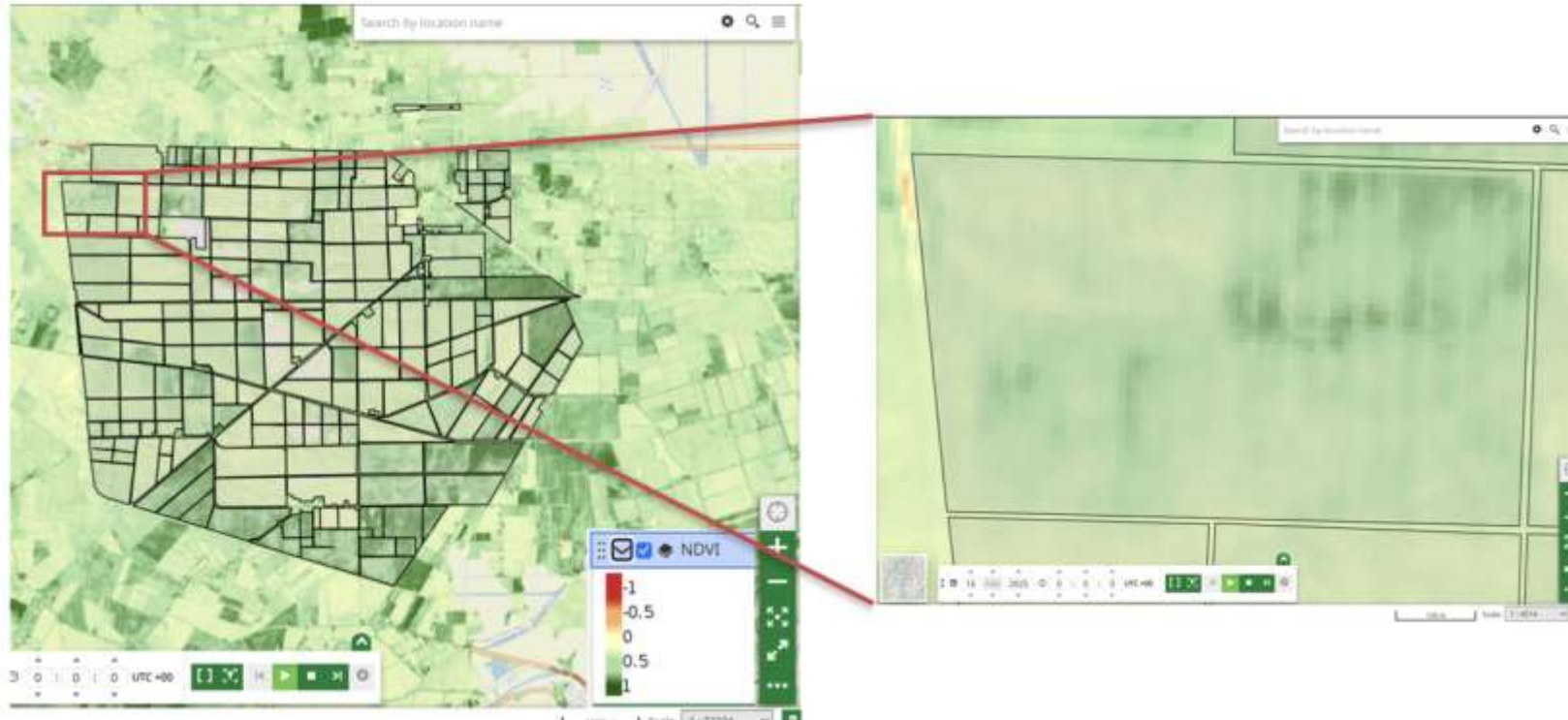
Bridging Forests, Fields, and Cities



«Eye in the Sky»

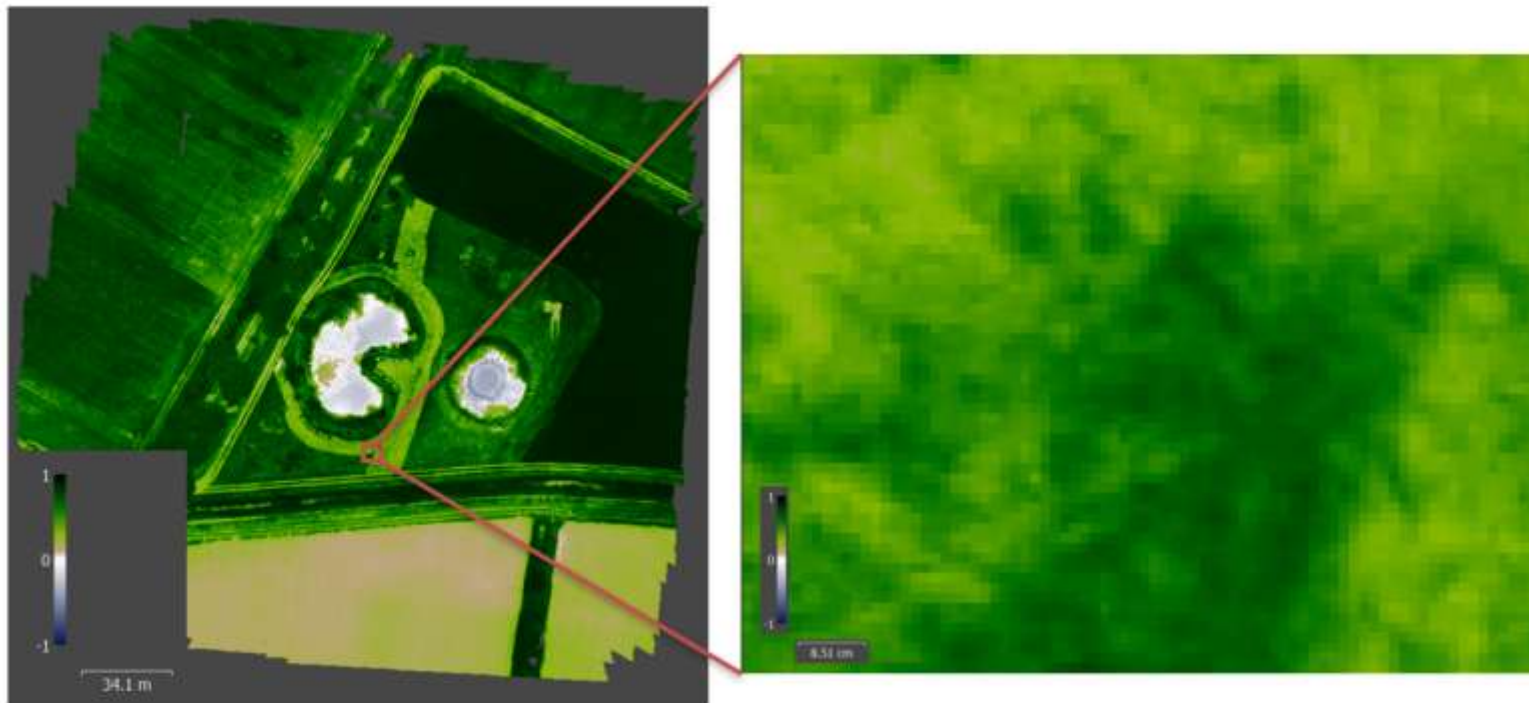
Bridging Forests, Fields, and Cities - Agro-forestry

Satellite offers repeatable data but **misses fine-scale** features.



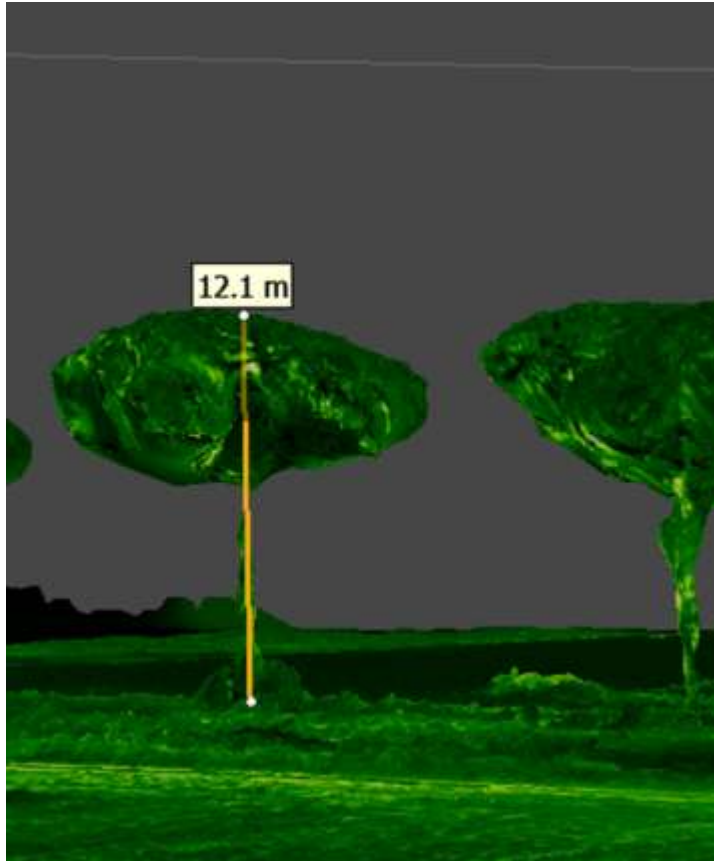
Bridging Forests, Fields, and Cities - Agro-forestry

**Close-range modalities add
centimetre geometry** → connectivity & habitat metrics.



Bridging Forests, Fields, and Cities - Agro-forestry

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gwlcloud_plot_broadleaved.cla - Excel

Start Einfügen Referenzdaten Formeln Daten Überprüfen Ansicht Hilfe Aktivität

Einlegen Experimente Format übertragen

Zeichnungsfläche

0.316079130078814

1 Total height (TH) of each tree (T). Diameter at breast height (DBH) of each tree (T). (x, y) coordinates (X and Y) of each tree (T).

2 This cloud has 40,341,500 millions points and its area is 434 m²

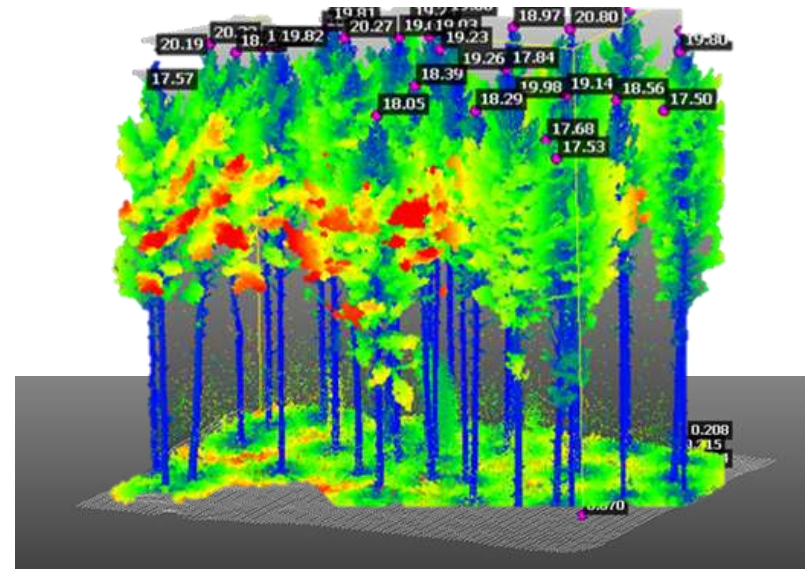
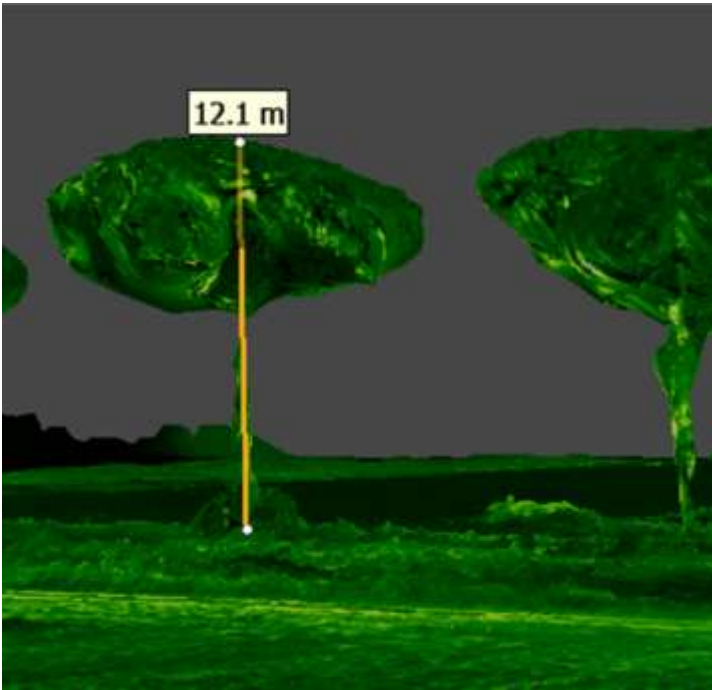
	TH	DBH	X	Y
T1	17.167	0.197102	-13.9101	-0.2209
T2	20.3205	0.516078	-11.431	-1.8992
T3	18.2155	0.194669	-12.2938	5.06638
T4	20.1857	0.222489	-11.6716	-3.6723
T5	17.72447	0.183212	-12.1386	7.54713
T6	18.18181	0.208042	-10.8137	9.83769
T7	18.81832	0.186815	-7.89078	0.181216
T8	20.06408	0.208348	8.811748	8.284156
T9	18.80796	0.237629	-7.23801	4.331112
T10	18.23617	0.214308	-6.17705	7.550064
T11	20.49278	0.294225	4.736438	0.184023
T12	18.99994	0.207967	-4.46789	10.23791
T13	19.8625	0.215444	9.122648	3.184797
T14	20.27189	0.231523	-4.32292	11.796905
T15	17.58086	0.114157	15.6529	3.8102
T16	18.66386	0.217709	-1.84471	8.75082
T17	18.09227	0.204762	-1.80767	8.156037
T18	17.35223	0.096022	10.06855	-6.87707
T19	17.6787	0.152181	8.198256	-3.55025
T20	18.56178	0.186541	8.812189	1.064095
T21	20.80499	0.292256	9.147265	1.600051
T22	18.96939	0.207641	-0.98874	9.487086
T23	19.98279	0.296736	6.881019	-3.37477
T24	19.22728	0.175048	-1.39403	3.702764
T25	18.0463	0.237578	-0.85405	-3.81756
T26	18.13846	0.23132	6.67913	-1.54579
T27	18.19283	0.198179	-0.74721	8.830281
T28	17.8394	0.138384	0.25838	6.117562
T29	18.29353	0.219418	3.050015	-2.517177
T30	18.25804	0.178629	1.897329	0.568786

Plot Metrics

Diagrams | X | Y | Sections | Q1Overall Quality (0-1) | Q1Outlier Probability | Q2Sector Occupancy | Q3Pine Inner Circle

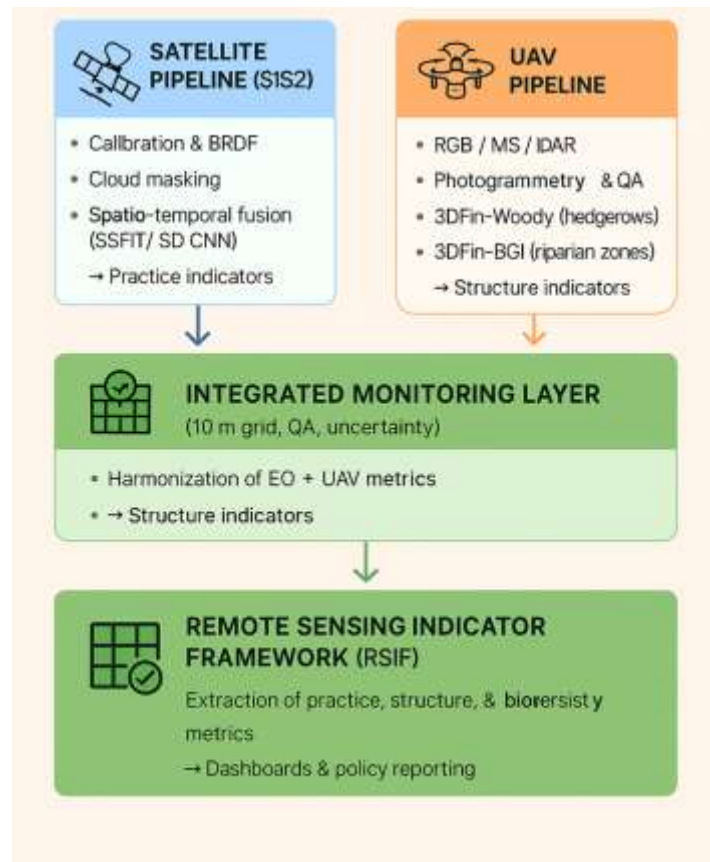
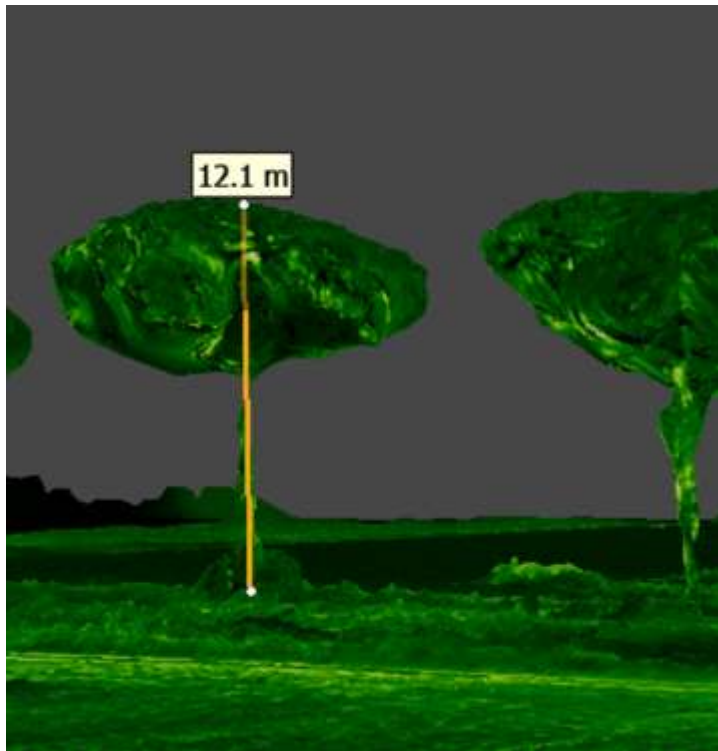
Enrico Magazzino - PhD candidate @UNIPD

Bridging Forests, Fields, and Cities - Agro-forestry



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Bridging Forests, Fields, and Cities - NbS



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 contact@varcities.eu

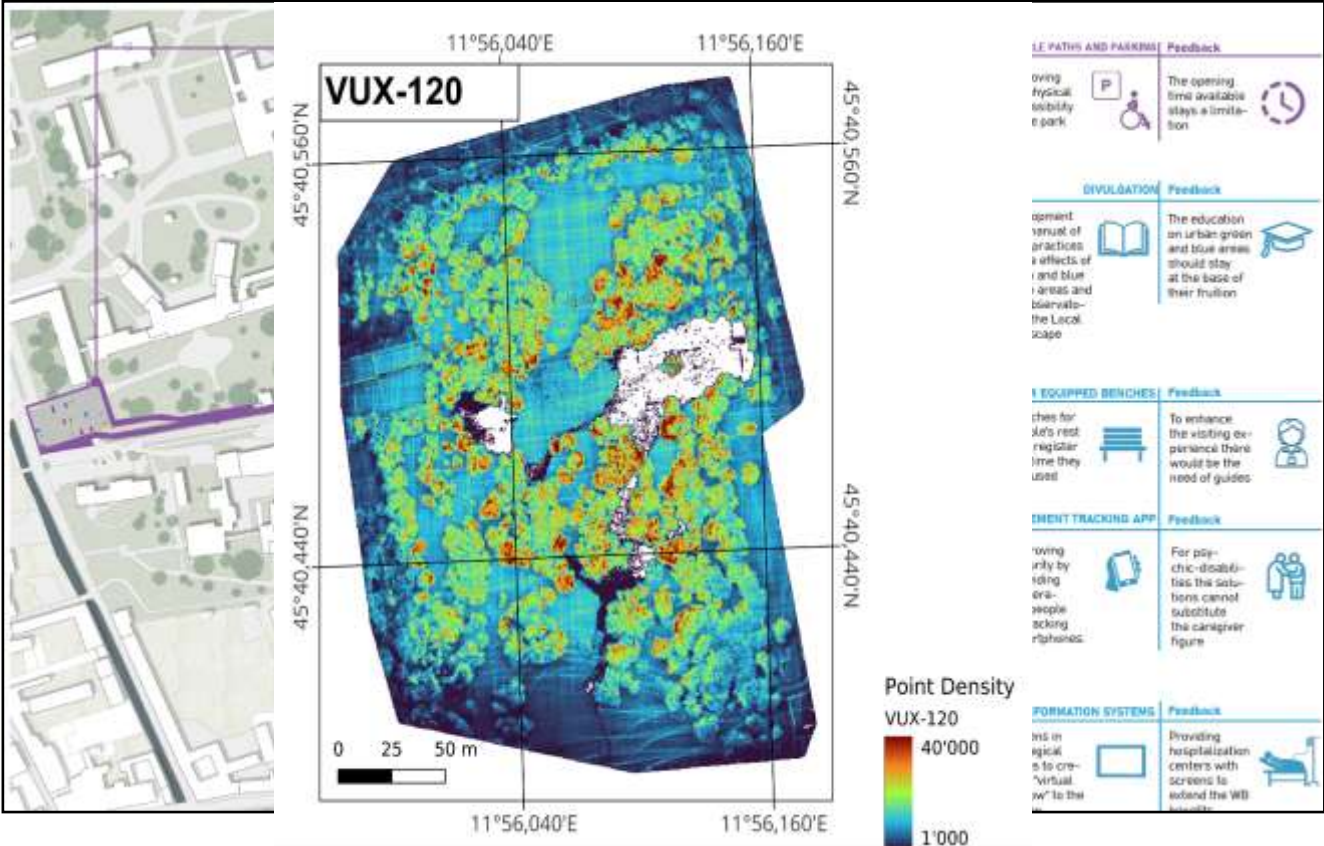
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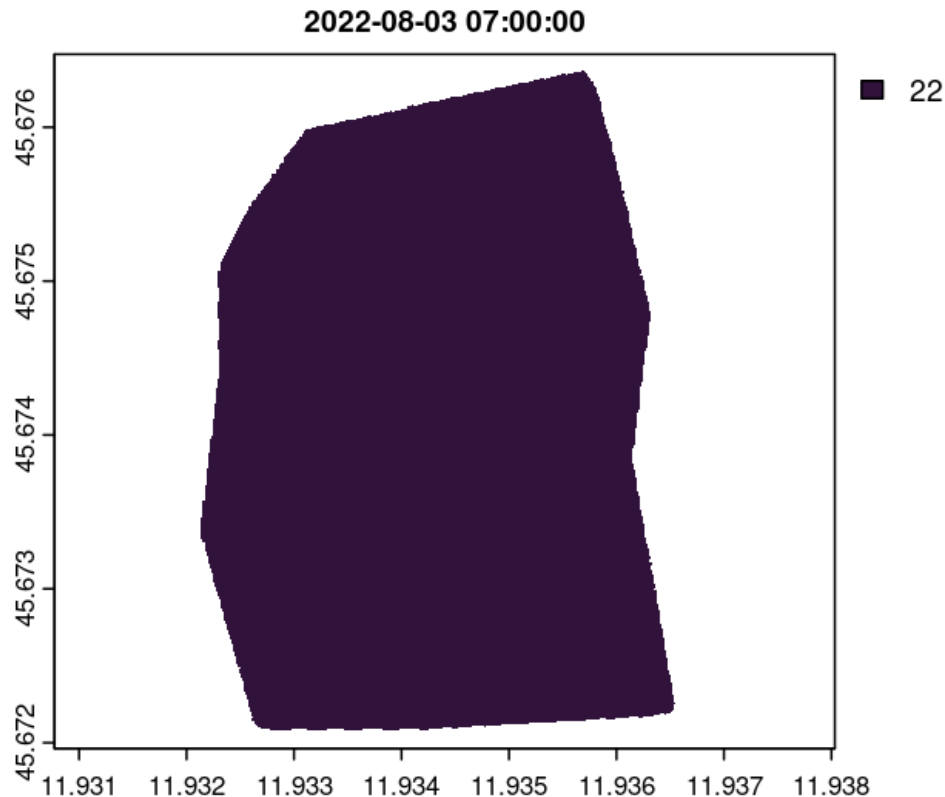
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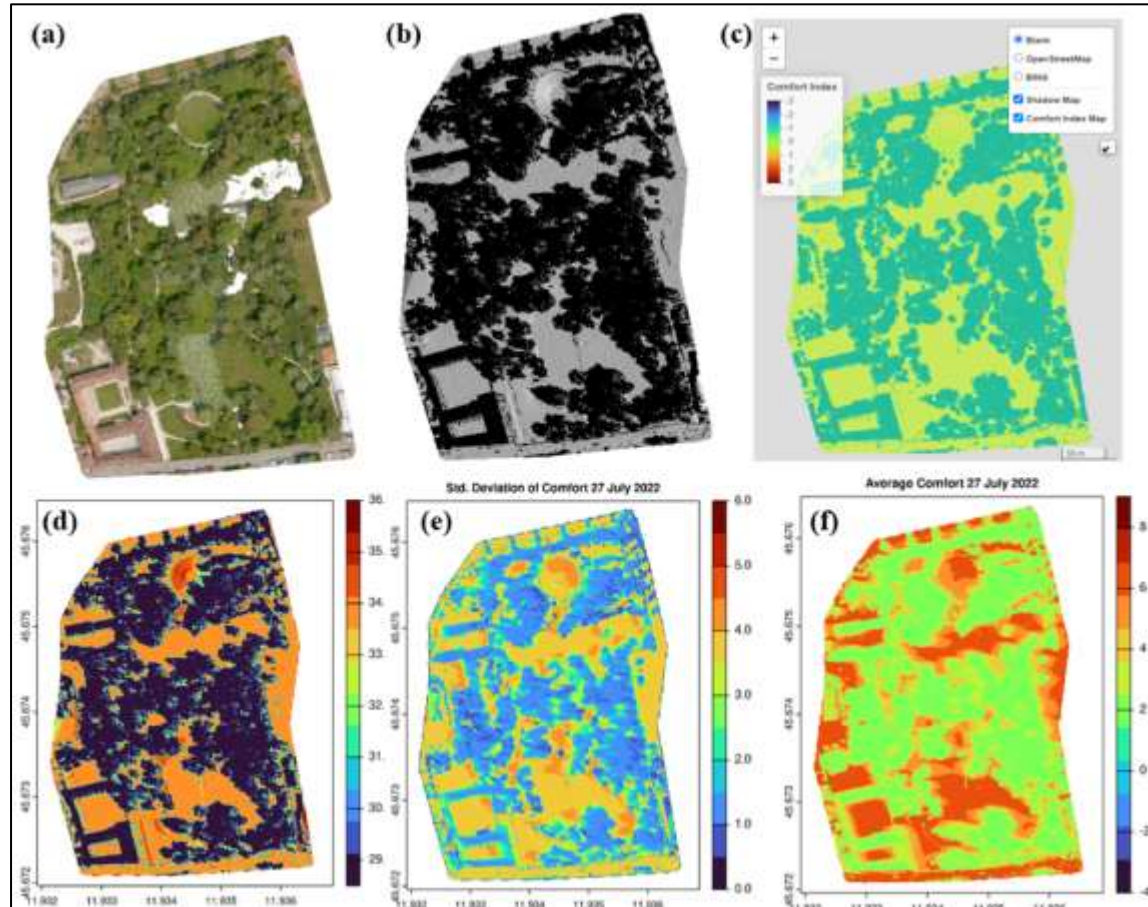
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MMRS: Bridging Forests, Fields, and Cities for a Sustainable Future - How?

Academy/Industry

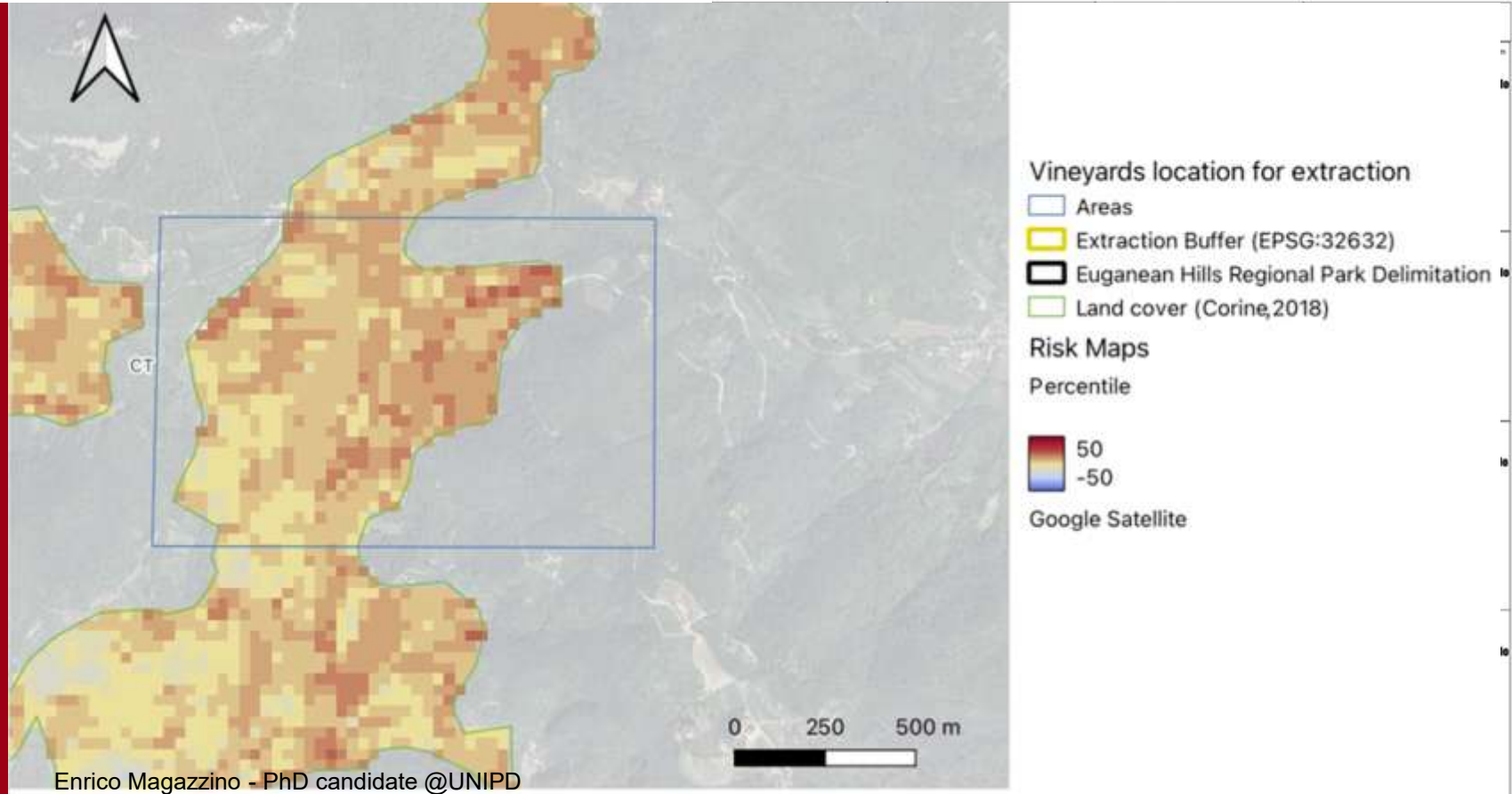
Downstream applications

TRL (close 2 market)

Open/Replicable



Sustainable Future - predict optimal crop variety - plan rotations - estimate yield and risk (insurance, market...)



Sustainable Future - risk modelling: protect cities and safeguard the environment

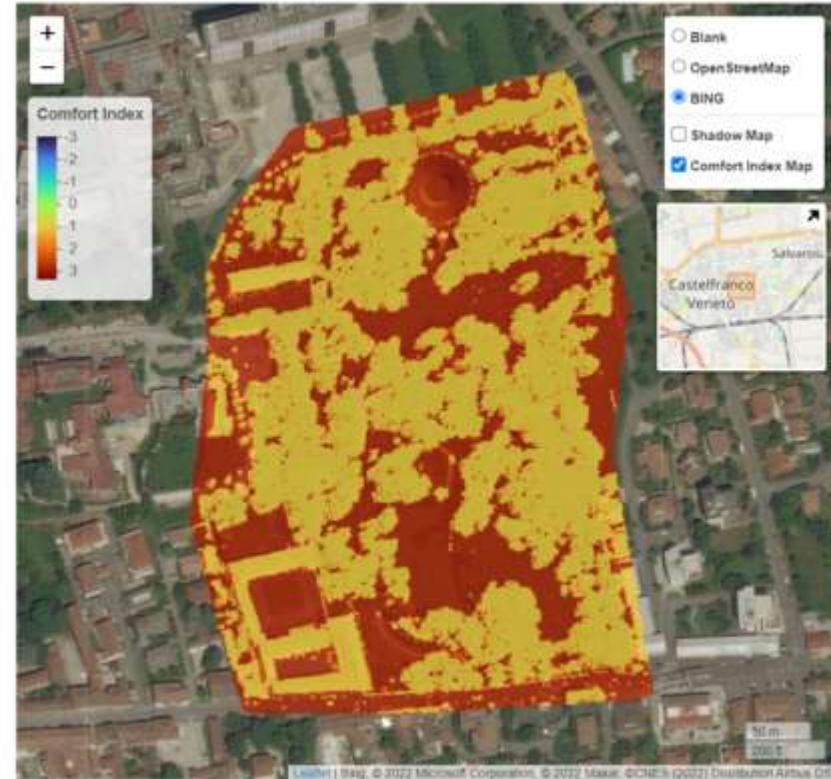
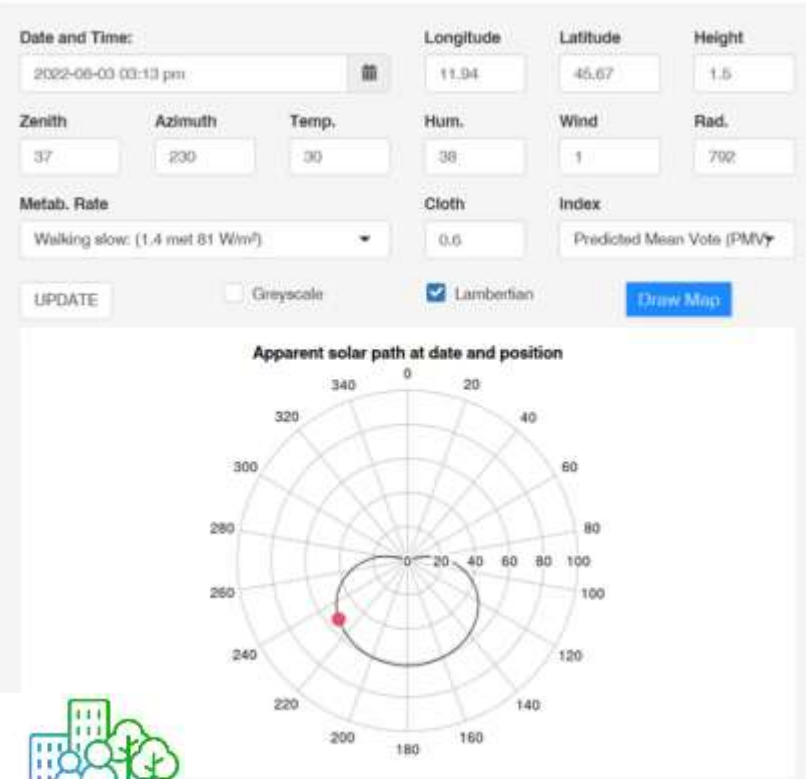


Sustainable Future - risk modelling: protect cities and safeguard the environment

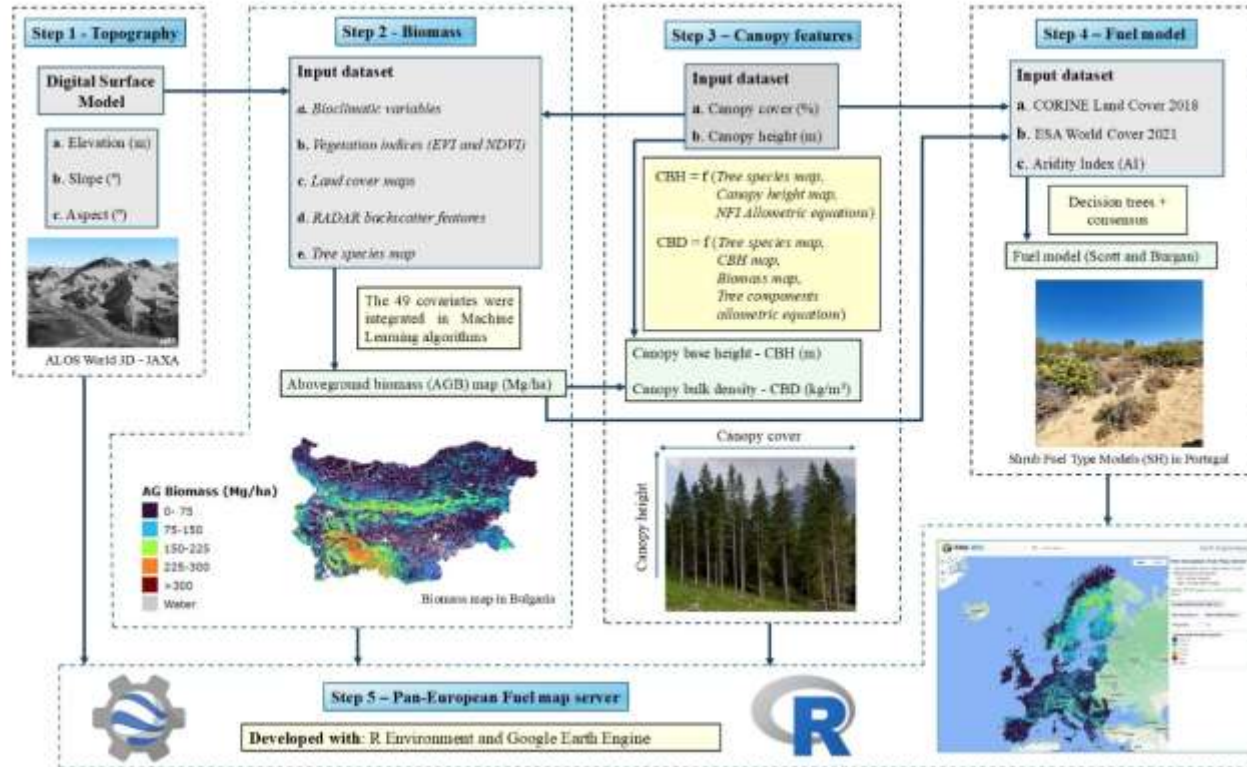
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Sustainable Future - risk modelling: protect cities and safeguard the environment



Sustainable Future - risk modelling: protect cities and safeguard the environment



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Earth Sensing Lab CIRGEO @UNIPD

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Thank you all for the great participation at the Earth Sensing Summer School 2025 - was not possible without you. Six assignments focusing on various geomatic topics, group-work, seminars, touching on InSAR, NeRF, GeoAI, urban 3d modelling and remote sensing for forests and ecology applications... and of course wonderful side activities. Keep tuned for more!

ISPRS - International Society for Photogrammetry and Remote Sensing

SIFET Società Italiana di Fotogrammetria e Topografia

Dipartimento Territorio e Sistemi Agro-Forestali

3DForEcoTech

ISPRS Students Consortium

Laboratorio di Geomatica - CIRCE @IUAV Università degli Studi di Padova

Centre of Studies and Activities for Space (CISAS) "G.Colombo" University of Padova

Centro Interdipartimentale di Ricerca di Geomatica Università degli Studi di Padova

E-FORESTER

IUFRO - International Union of Forest Research Organizations



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