DAMAGE MAPPING

Earthquake damage assessment at different spatial scales

Bignami Christian, Piscini Alessandro, Romaniello Vito

Earthquake damage assessment at different spatial scales

★ The activity concerns the development of algorithms and procedures in order to produce earthquake damage maps.

★ Maps are supplied both at single building and block of buildings scale.

★ The products can be derived by exploiting different types of satellite data, from SAR images to medium or high spatial resolution optical ones.

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• SCIENTIFIC RATIONALE

The satellite DAMAGE ASSESSMENT is based on change detection methods, capable of identifying the changes of the observed objects on two (or more) scenes acquired at different times (before and after a seismic event).
Change features are computed, derived from statistical analysis:

★ Kullback-Libler Divergence (KLD)

★ Mutual Information (MI)

★ Intensity Correlation Difference (ICD) → for SAR data

★ Normalised Difference Index (NDI) → for optical EO data

&

★ SAR polarimetric features + InSAR phase coherence → the latter re-evaluated with the advent short-term time revisit missions (satellite constellation).

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• OBSERVATIONAL INFRASTRUCTURE

Both Optical and SAR imageries can be used with a data fusion approach (or separately)

Satellite/sensor	type	systematic acquisition	Notes
Sentinel-1	SAR - Single Look Complex	SI	
Cosmo-SkyMed	SAR - Single Look Complex	Si	Background mission
TerraSAR-X	SAR - Single Look Complex	No	
Sentinel-2	Optical - L2	SI	
PRISMA	Optical - L2	Si	Background mission
VHR Opt (Quickbird, Worldview, GeoEye etc)	Optical - L2	No	

• TECHNOLOGICAL LABORATORIES

The procedures and algorithms are currently implemented on personal PCs

N/A

• INFRASTRUCTURE FOR DATA MANAGEMENT

Satellite/sensor	images / year	Storage [GB]
Sentinel-1	4 - 6	50
Cosmo-SkyMed	2 - 4	5
TerraSAR-X	2 - 4	5
Sentinel-2	4 - 6	10
PRISMA	2 - 4	10
VHR Opt (Quickbird, Worldview, GeoEyeetc)	1 - 2	5

The DAMAGE ASSESSMENT products occupy a few tens of MB each (mainly vector data).

• INFRASTRUCTURE FOR DATA PROCESSING

There is no dedicated *hardware* infrastructure: the algorithms are currently implemented on personal PCs

There are two main *damage assessment* algorithms:

1) FST (*Feature Stepwise Thresholding*)
2) NN-CD (*Neural Network - Change Detection*)

both suitable for optical & SAR *data fusion*

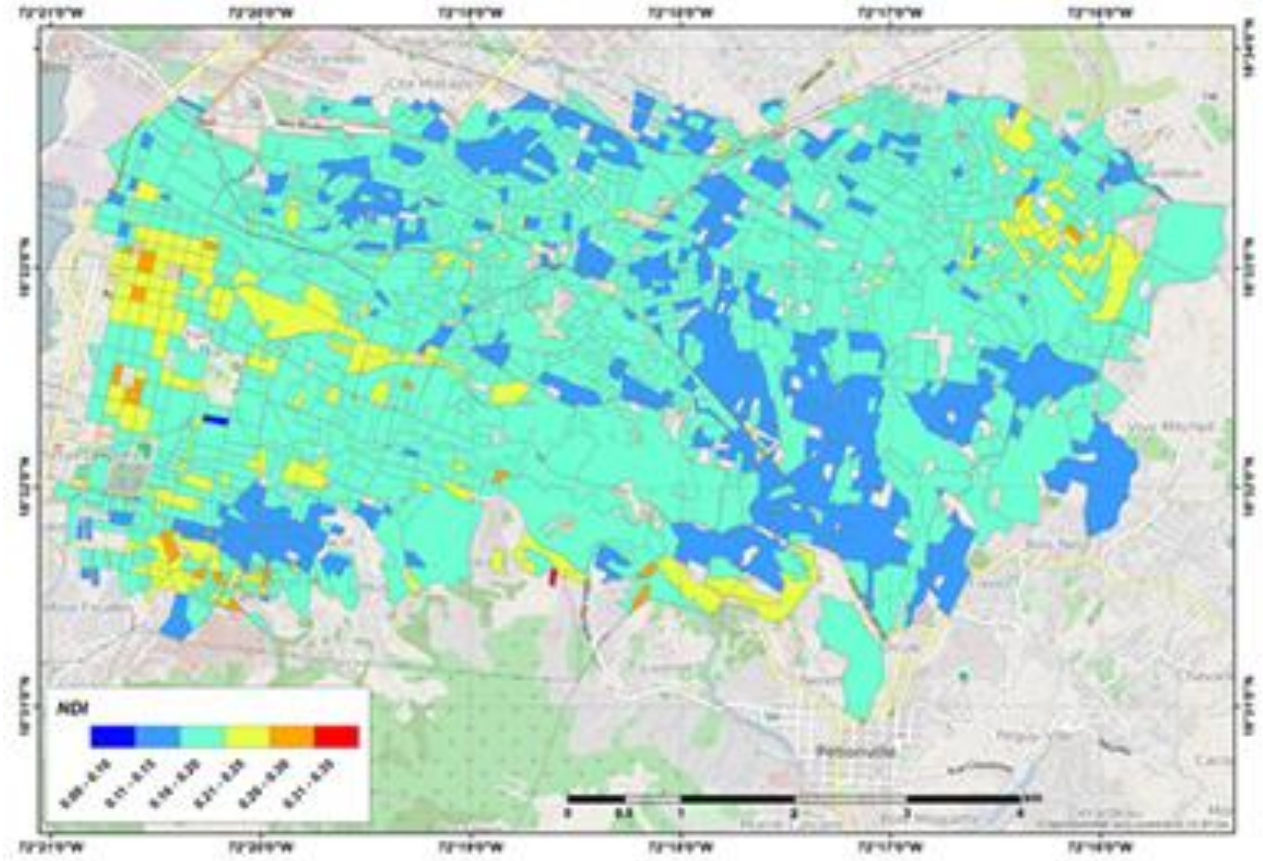
These codes require Matlab and ENVI-IDL *softwares*

• PROPOSED PRODUCTS (IN DEVELOPMENT)

Change Detection features:

OPTICAL
NDI (*Normalised Difference Index*)
KLD (*Kullback-Libler Divergence*)
MI (*Mutual Information*)

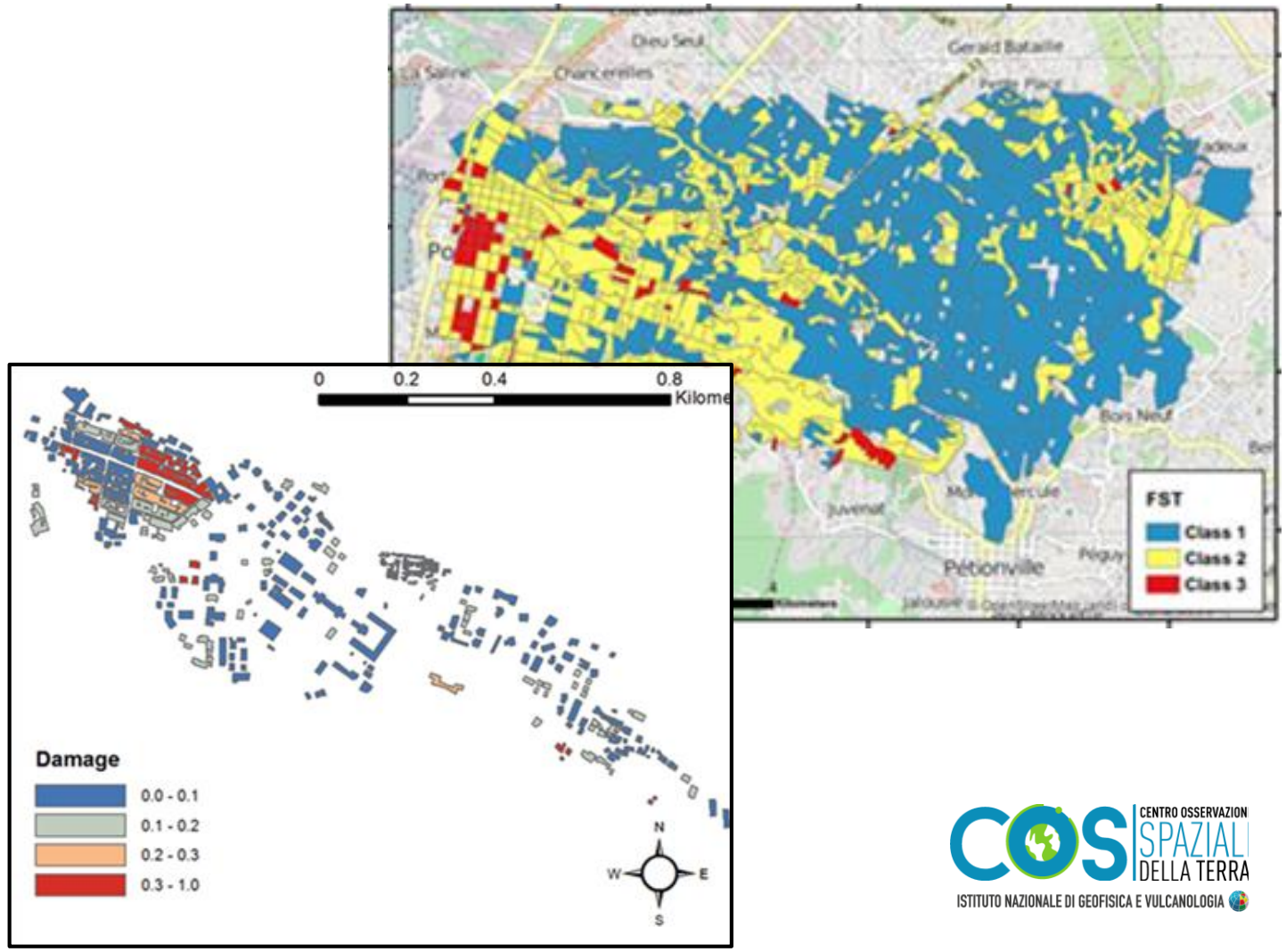
SAR
ICD (*Intensity Correlation Difference*)
KLD (*Kullback-Libler Divergence*)



• PROPOSED PRODUCTS (IN DEVELOPMENT)

Four Thematic Maps (products are under test/development - non-operational)

Product	Spatial resolution	Type
COLLAPSE RATIO damage map	building blocks	vector
Damage map to scale EMS98	single building	vector
semi-quantitative damage maps (high-medium-low)	building blocks	vector
"Change detection" indexes maps	sensor resolution	Raster



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• CURRENT DISTRIBUTION OF PRODUCTS

The products are made on *demand* and are not currently distributed

N/A

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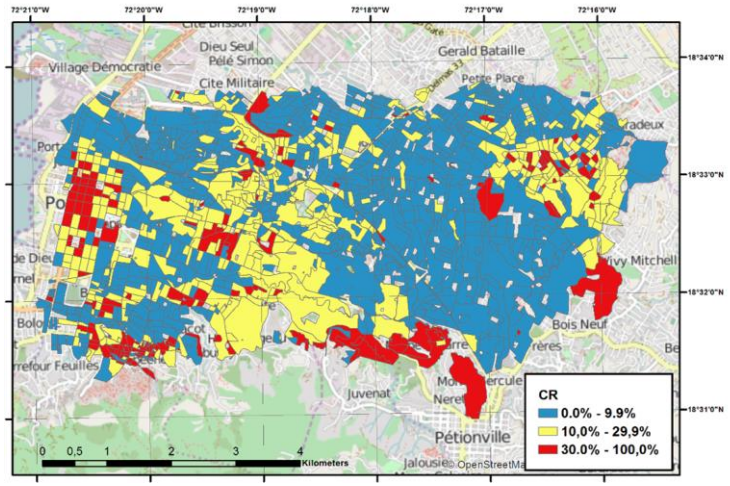
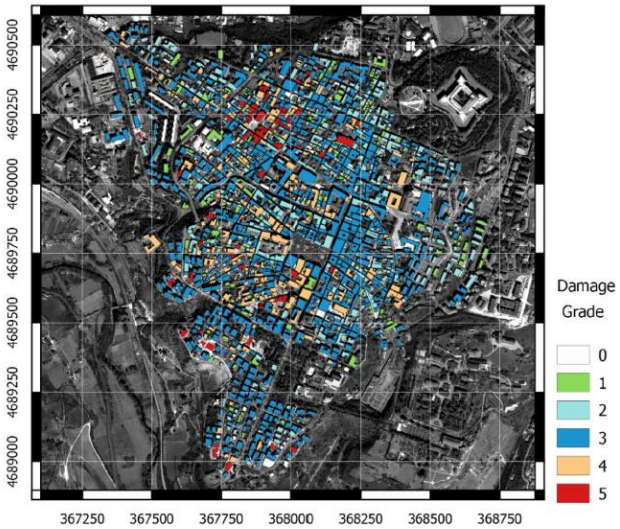
• PROGRAMS/PROJECTS OF REFERENCE

NO ACTIVE PROJECT

APhoRISM – Advanced PRocedures for volcanIc and Seismic Monitoring) → ***CONCLUDED!***

- ★ Volcanic theme….
- ★ Seismic theme: "The three years of activities have been focused on a deep screening of change detection methods with the objective to select the best performing damage proxy from EO data"





		INGV (D=5)	INGV (D<5)			
classifier	(D=5)	**29**	19	48	60.4%	*precision*
	(D<5)	45	**1574**	1619	97.2%	*Negative Predictive Value*
		74	1593	1667	*overall accuracy*	*Cohen's Kappa*
		sensitivity	*specificity*			
		39.2%	98.8%		96.2%	45.6%

➢ Romaniello, V., Piscini, A., Bignami, C., Anniballe, R., Stramondo, S., 2017. Earthquake damage mapping by using remotely sensed data: the Haiti case study. Journal of Applied Remote Sensing 11, 016042. https://doi.org/10.1117/1.JRS.11.016042

➢ Romaniello, V., Piscini, A., Bignami, C., Anniballe, R., Stramondo, S., 2016. A multisensor approach for the 2016 Amatrice earthquake damage assessment. Annals of Geophysics. https://doi.org/10.4401/ag-7185

➢ Piscini A., Romaniello V., Bignami C., Stramondo S., 2017. A New Damage Assessment Method by Means of Neural Network and Multi-Sensor Satellite Data. Applied Sciences 7, 781. https://doi.org/10.3390/app7080781

Multi-polarization C-band SAR imagery to quantify damage levels due to the Central Italy earthquake

in press

Emanuele Ferrentino[a], Ferdinando Nunziata[a], Christian Bignami[b], Laura Graziani[b], Alessandra Maramai[b] and Maurizio Migliaccio[a,b]

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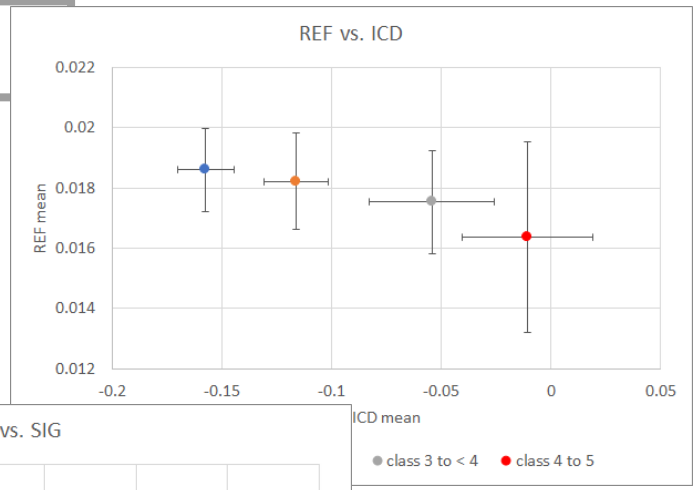
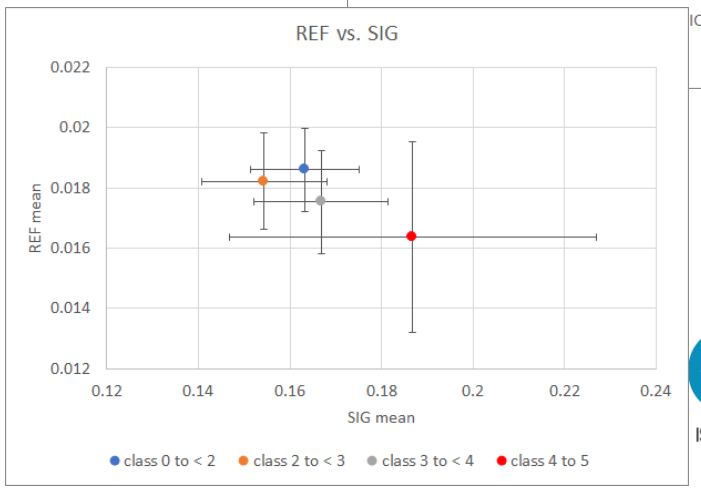
• TEAM AND AFFILIATIONS

Name and Surname	Contract	Department	MP/year
Christian Bignami	TI	ONT	1.5
Alessandro Piscini	TI	ONT	1.5
Vito Romaniello	TD	ONT	1.5

- Active partnership with the INGV macroseismic group
- We are working in partnership with the University of Naples Parthenope for the introduction of polarimetric data in the algorithms





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