



Active Deformation Areas (ADA) tools

U-Geohaz Training
Athens, 03/06/2019



“This work has been funded by the European Commission, Directorate-General Humanitarian Aid and Civil Protection (ECHO), through the project U-Geohaz (UCPM-2017-PP-AG -783169).”



<https://u-geohaz.cttc.cat/>

MAIN TARGET

Providing maps, based on **Sentinel-1 6-days ground deformations monitoring**, to assess continuously the **potential impact of geohazard activity** to urban areas and critical infrastructures and to be used as key inputs to **support early warning**.



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MAIN TARGET

Providing maps, based on **Sentinel-1 6-days ground deformations monitoring**, to assess continuously the **potential impact of geohazard activity** to urban areas and critical infrastructures and to be used as key inputs to **support early warning**.



OPERATIONAL PRODUCTS



<https://u-geohaz.cttc.cat/>

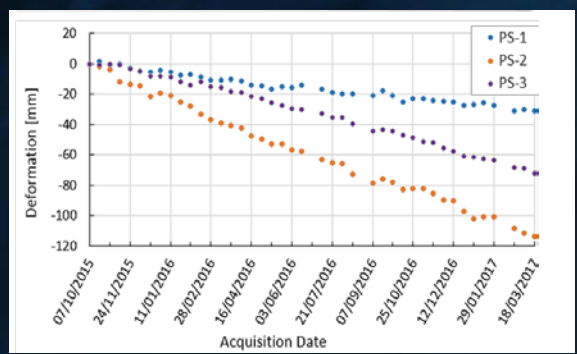
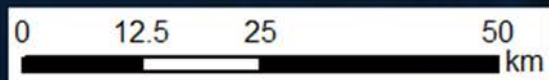
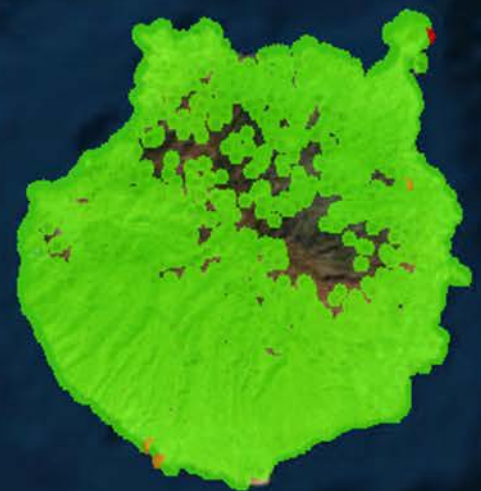
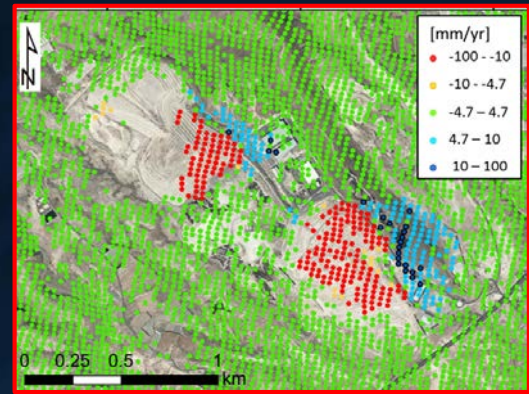
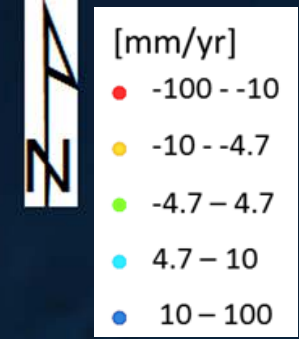
- ***Processing***

- ***Post processing: provide simplified products for not expert users***



Sentinel-1 for regional to local risk prevention and assessment

- Spatial-temporal activity characterization
 - 6-days monitoring





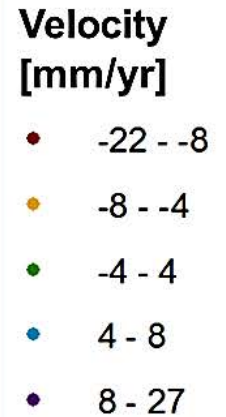
Is it operational?

Analysis and interpretation: difficult and time consuming

1. Geometric limitations of SAR acquisition

2. Spatial and temporal noise

3. Huge amount of information



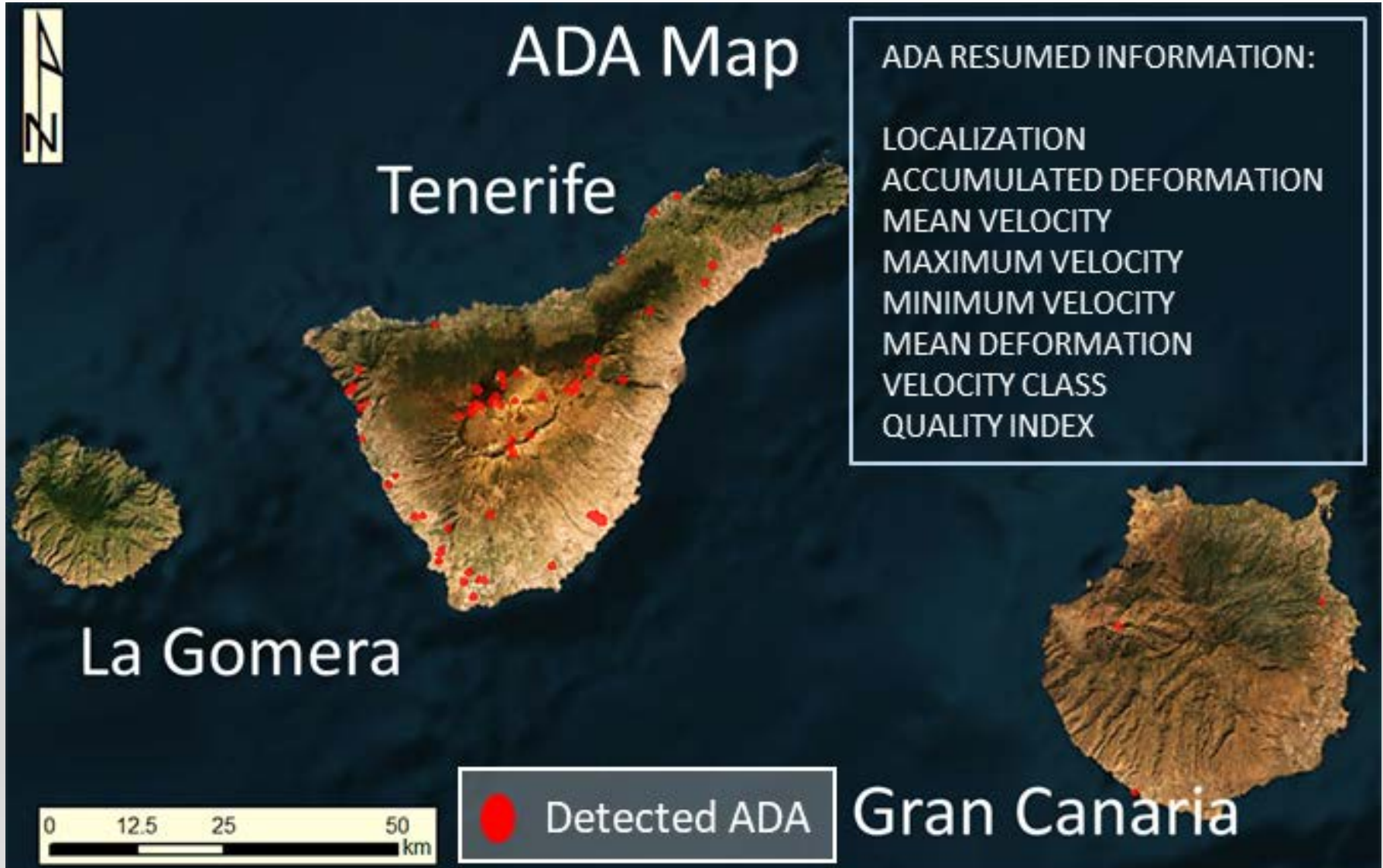
Total land area around 5.000 km²



Is it operational?

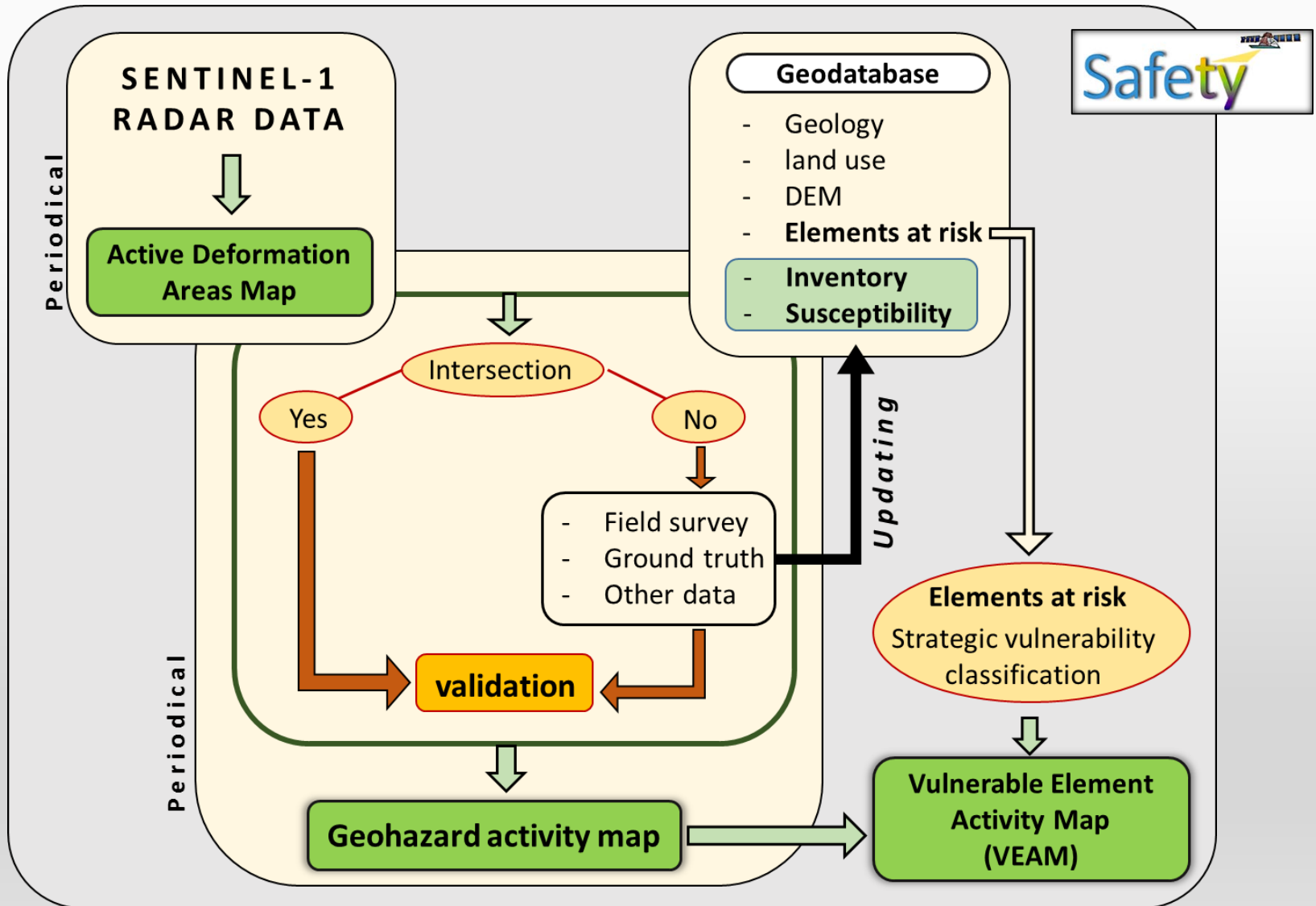


ADA MAP: automatic Active Deformation Areas extraction



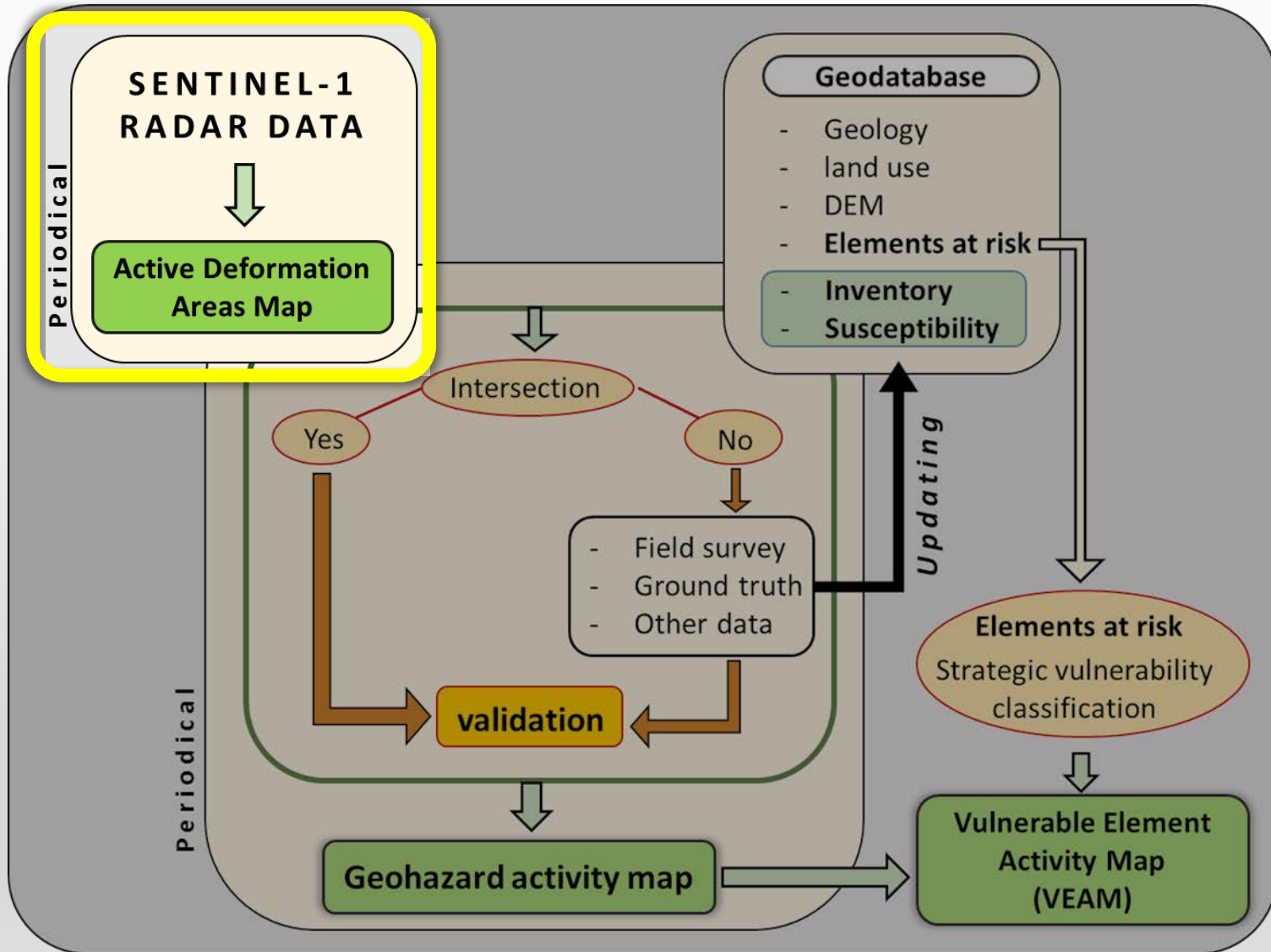


ADA map as input for further assessment



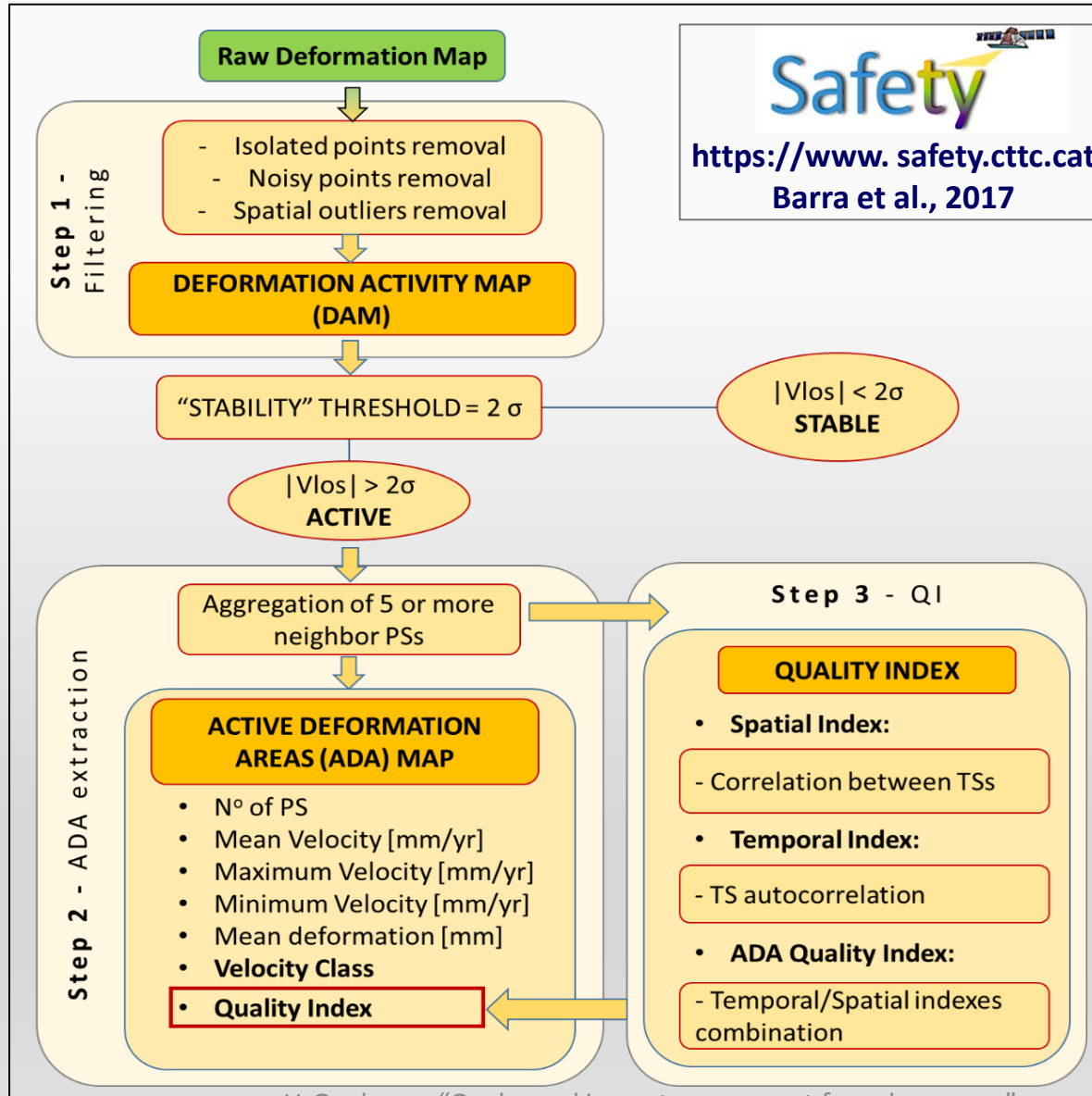


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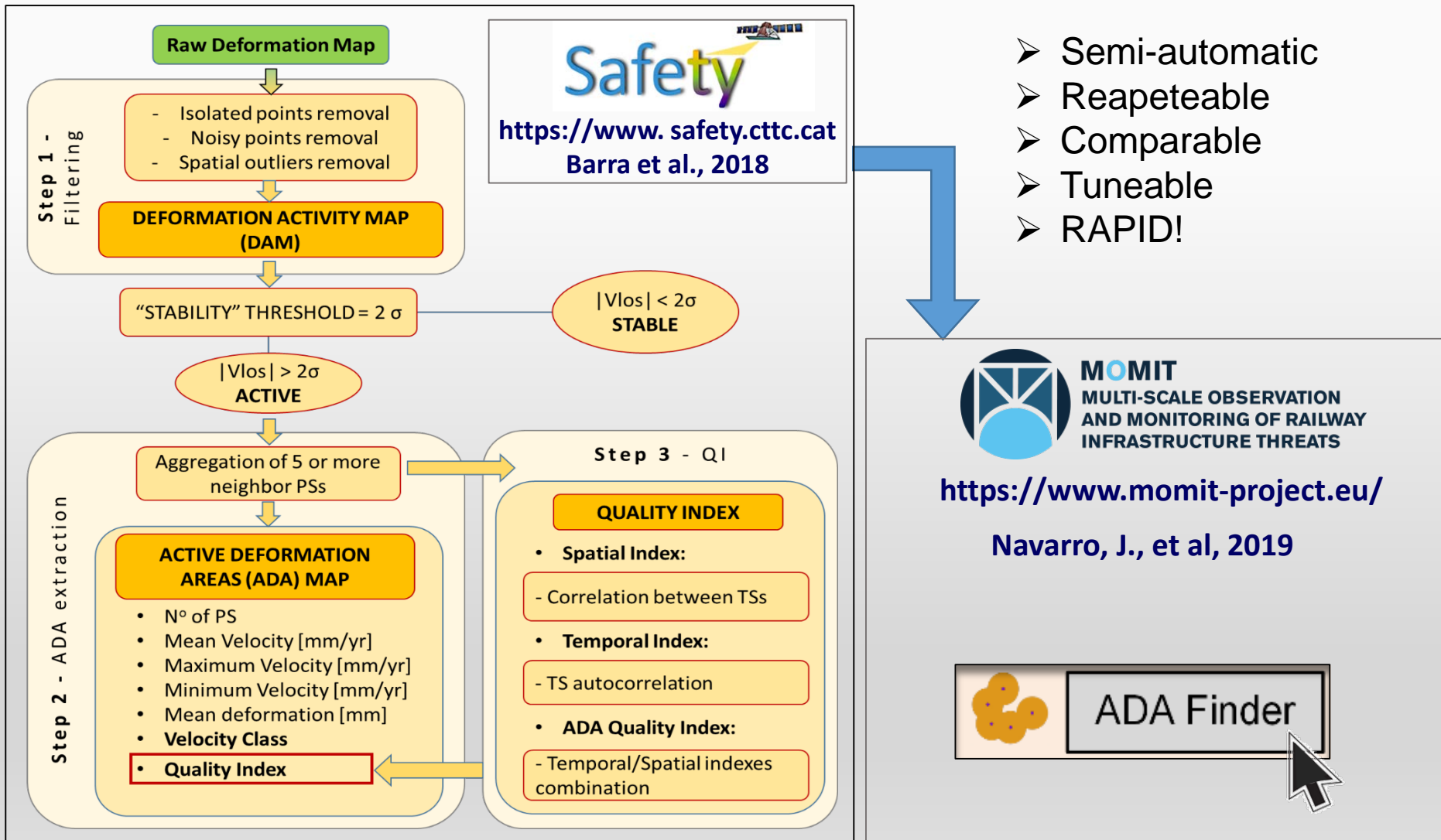


Developed methodology





Developed methodology



- Semi-automatic
- Repeatable
- Comparable
- Tuneable
- RAPID!



<https://www.momit-project.eu/>

Navarro, J., et al, 2019





Developed methodology

PSI_Row_Deformation_Map.shp



Filtering



Extraction



Deformation_Activity_Map.shp

Active_Deformation_Areas.shp



ADA finder - Find Active Deformation Areas

Input shapefile with raw deformation data ...

Read map for the input shapefile with raw deformation data ...

(Optional) input shapefile with AOI boundaries ...

Output shapefile with ADA data ...

Output shapefile with point data ...

Isolation distance (m)

Minimum size of non-isolated clusters

Factor for stdev filter

Threshold for velocity class 1 (mm)

Clustering radius (m)

Minimum ADA size

of values to compute the mean of the deformation

PS subset to write

- Non-isolated (moving or stable) PSs inside ADAs
- All non-isolated PSs
- All moving non-isolated PSs
- Non-isolated (moving or stable) PSs inside ADAs
- Non-isolated, moving PSs inside ADAs

Log messages



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- Non-isolated (m)
- Non-isolated, m

Log messages

Quit Load options file Save options file Go

Isolation distance (m)	<input type="text" value="80.0"/>
Minimum size of non-isolated clusters	<input type="text" value="2"/>
Factor for stdev filter	<input type="text" value="2"/>
Threshold for velocity class 1 (mm)	<input type="text" value="10.0"/>
Clustering radius (m)	<input type="text" value="40.0"/>
Minimum ADA size	<input type="text" value="5"/>



Methodology

- The velocity threshold
- Deformation Activity Map (DAM)
 - ADA extraction
 - Quality Index (QI)



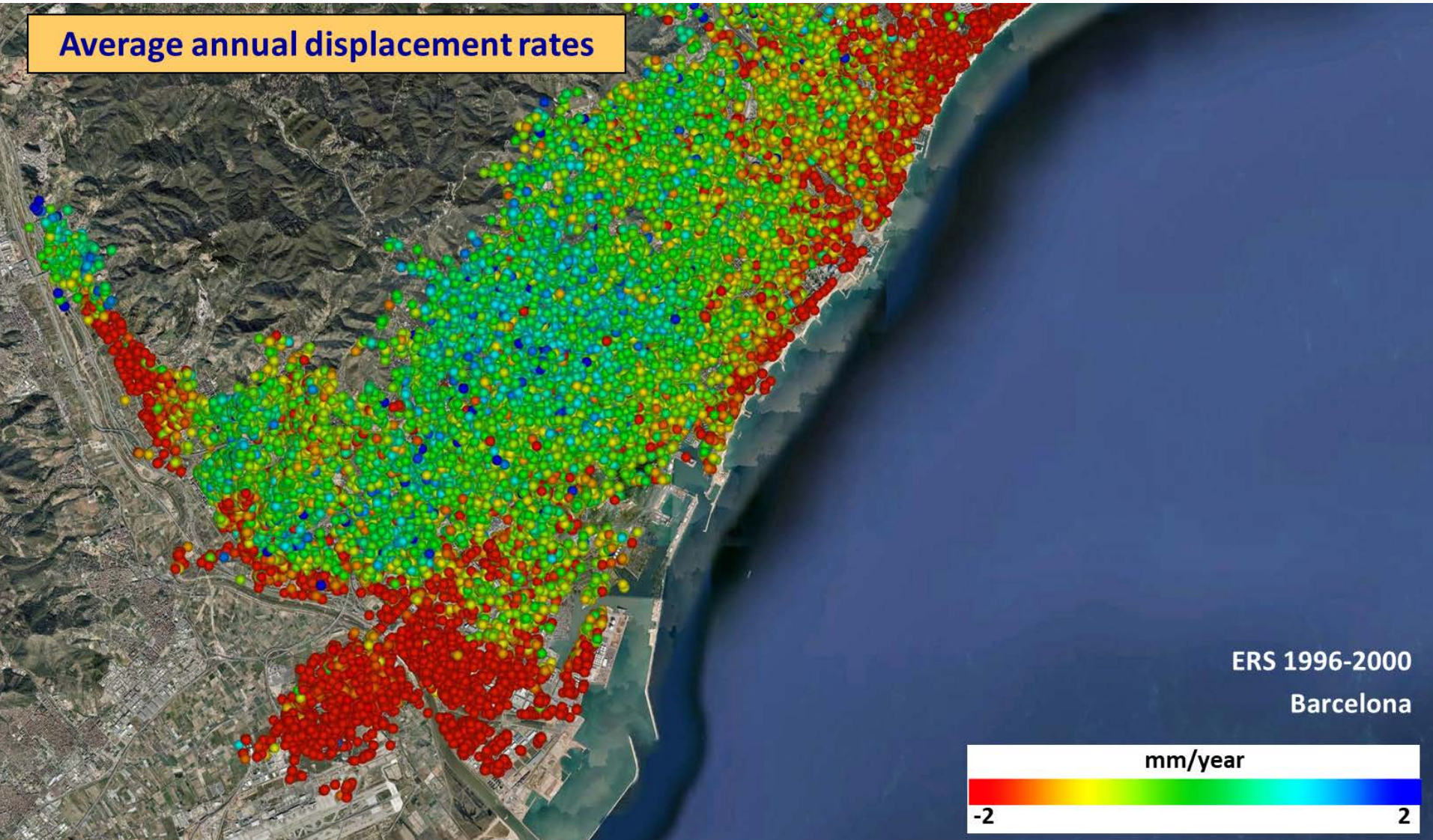
Methodology

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The velocity threshold

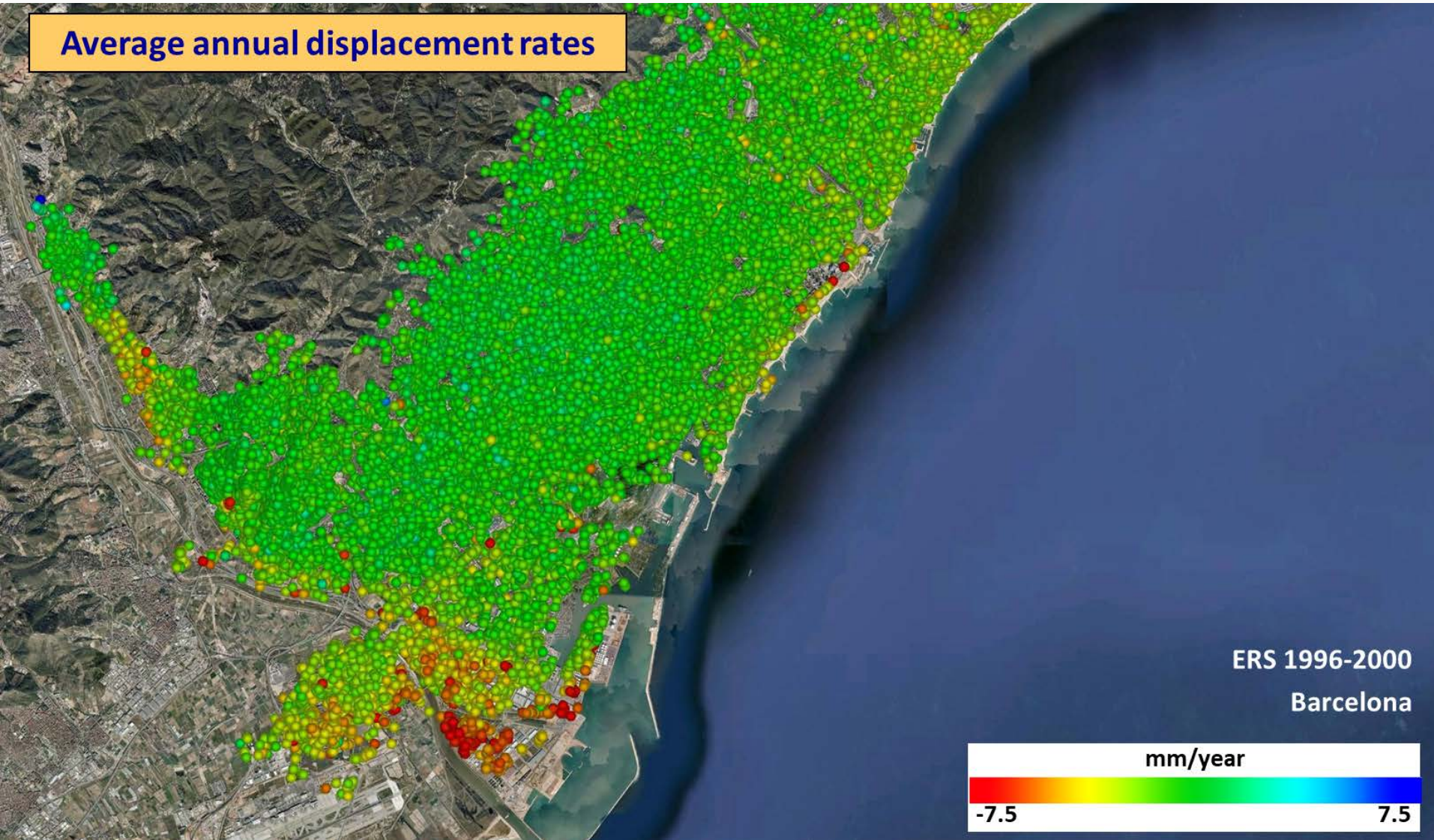
Average annual displacement rates





The velocity threshold

Average annual displacement rates



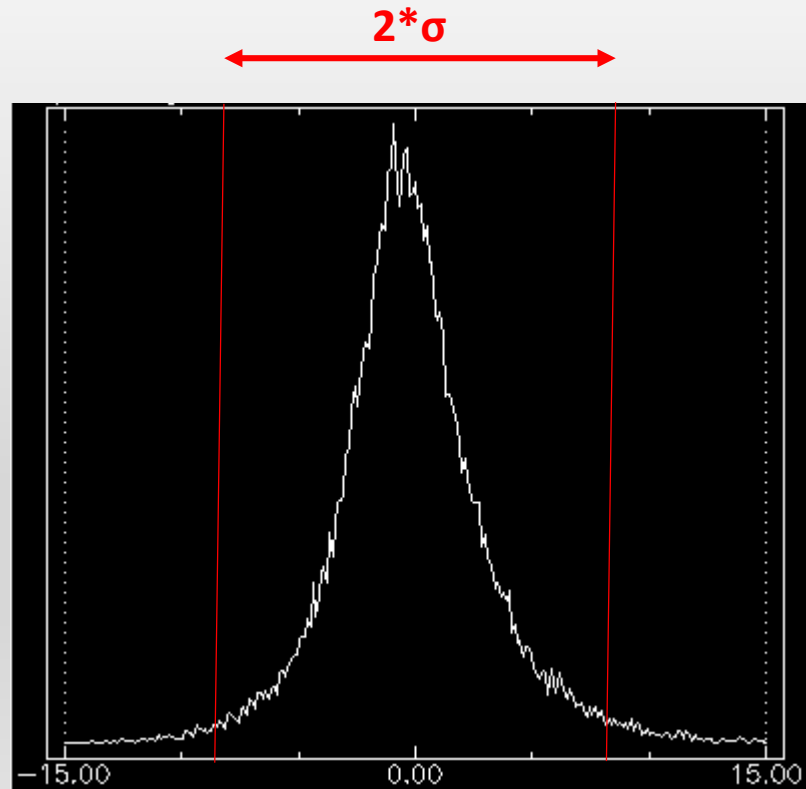


Velocity threshold

It represent the general **noise level (sensitivity)** of the Row Deformation Map (RDM).

It is evaluated as **N times** the standard deviation (σ_{map}) of the RDM velocity values.

ASSUMPTION: at a REGIONAL SCALE the majority of the points falls in a stable area





The velocity threshold

In LOS direction!!!

DETECTED / NOT DETECTED DEFORMATION

❑ A point with a $|v| > \text{Velocity threshold}$ is classified as ACTIVE

❑ A point with a $|v| < \text{Velocity threshold}$ is classified as GREEN:

it can be stable as well as instable point with a not detectable movement



ADA finder - Find Active Deformation Areas

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of values to compute the mean of the deformation

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- Non-isolated (m)
- Non-isolated, m

Log messages

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Quit Load options file Save options file Go



Methodology

- The velocity threshold
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 - ADA extraction
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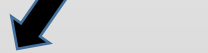


Developed methodology

PSI_Row_Deformation_Map.shp

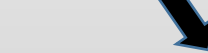


Filtering



Deformation_Activity_Map.shp

Extraction



Active_Deformation_Areas.shp



Filtering Of the Row Deformation Map

Reduce the spatio-temporal noise and improve the **readability** and the **reliability** of the map.



Filtering

Row Deformation Map



- Isolated points removal
- Spatial outliers removal



DEFORMATION ACTIVITY MAP (DAM)



Filtering

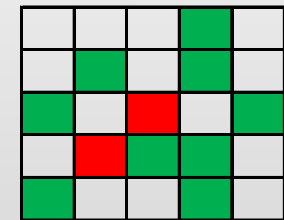
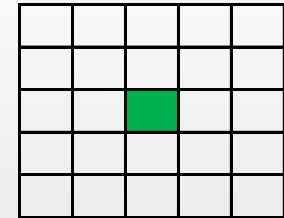
Row Deformation Map



- Isolated points removal
- Spatial outliers removal



DEFORMATION ACTIVITY MAP (DAM)



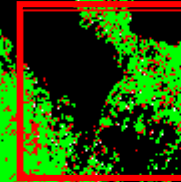
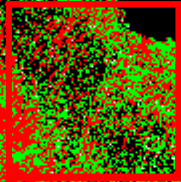
 PS with $|v| > 2\sigma$

 PS with $|v| < 2\sigma$

Filtering example

1.010.787 points

920.361 points

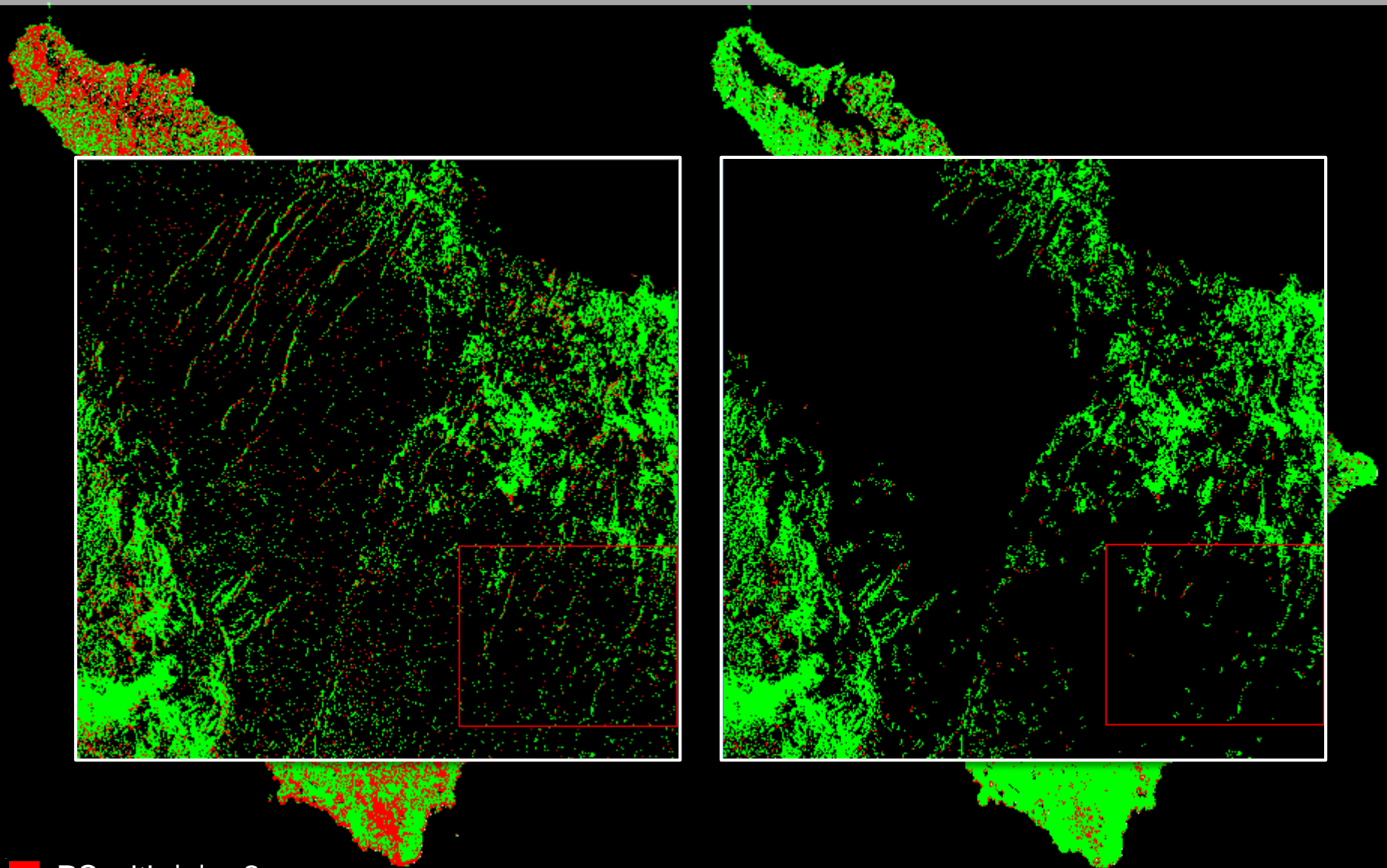


90.426 (9%) removed points

■ PS with $|v| > 2\sigma$

■ PS with $|v| < 2\sigma$

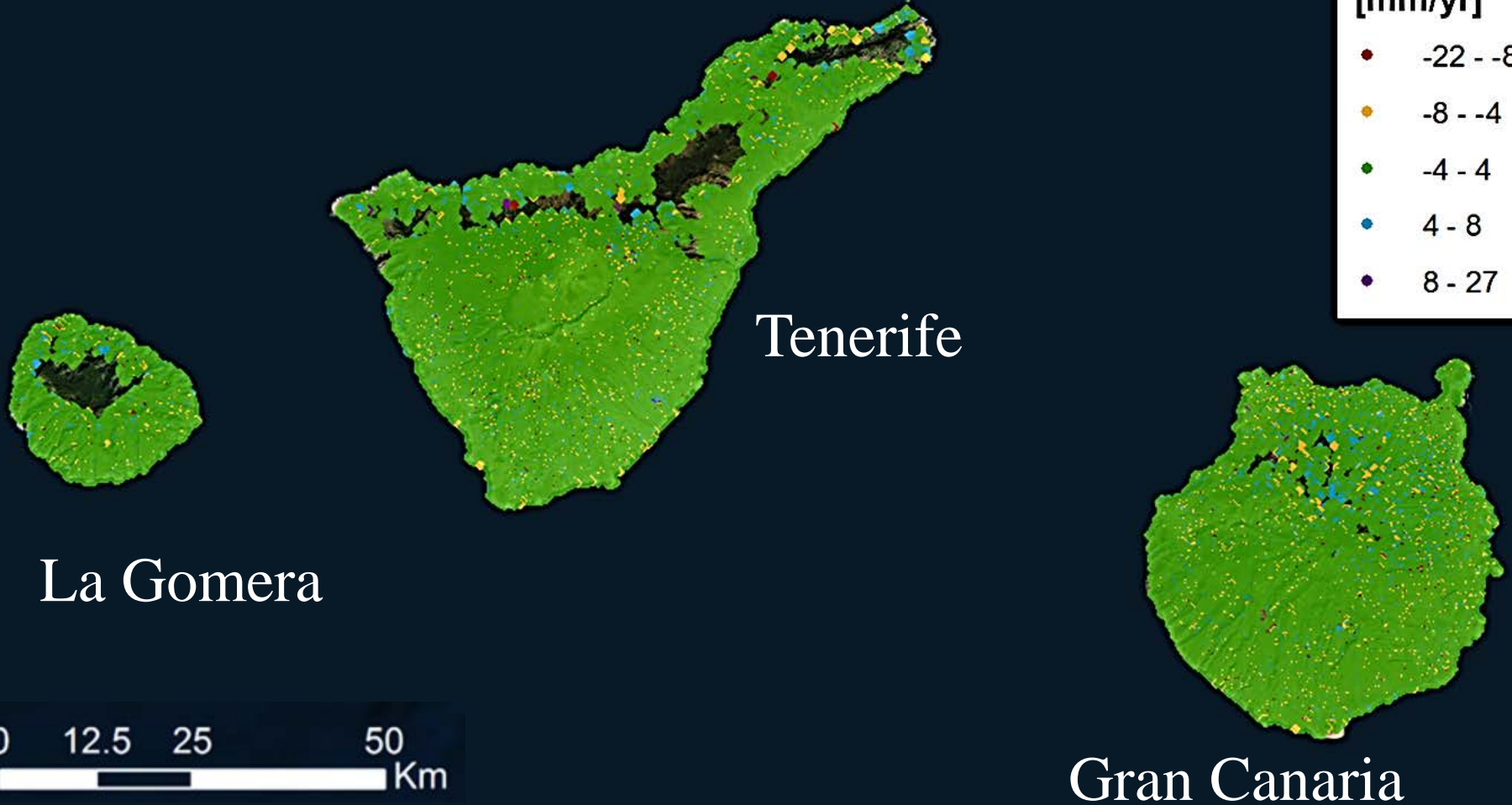
Filtering example



■ PS with $|v| > 2\sigma$

■ PS with $|v| < 2\sigma$

Canary Islands: before filtering (Row Deformation Map)

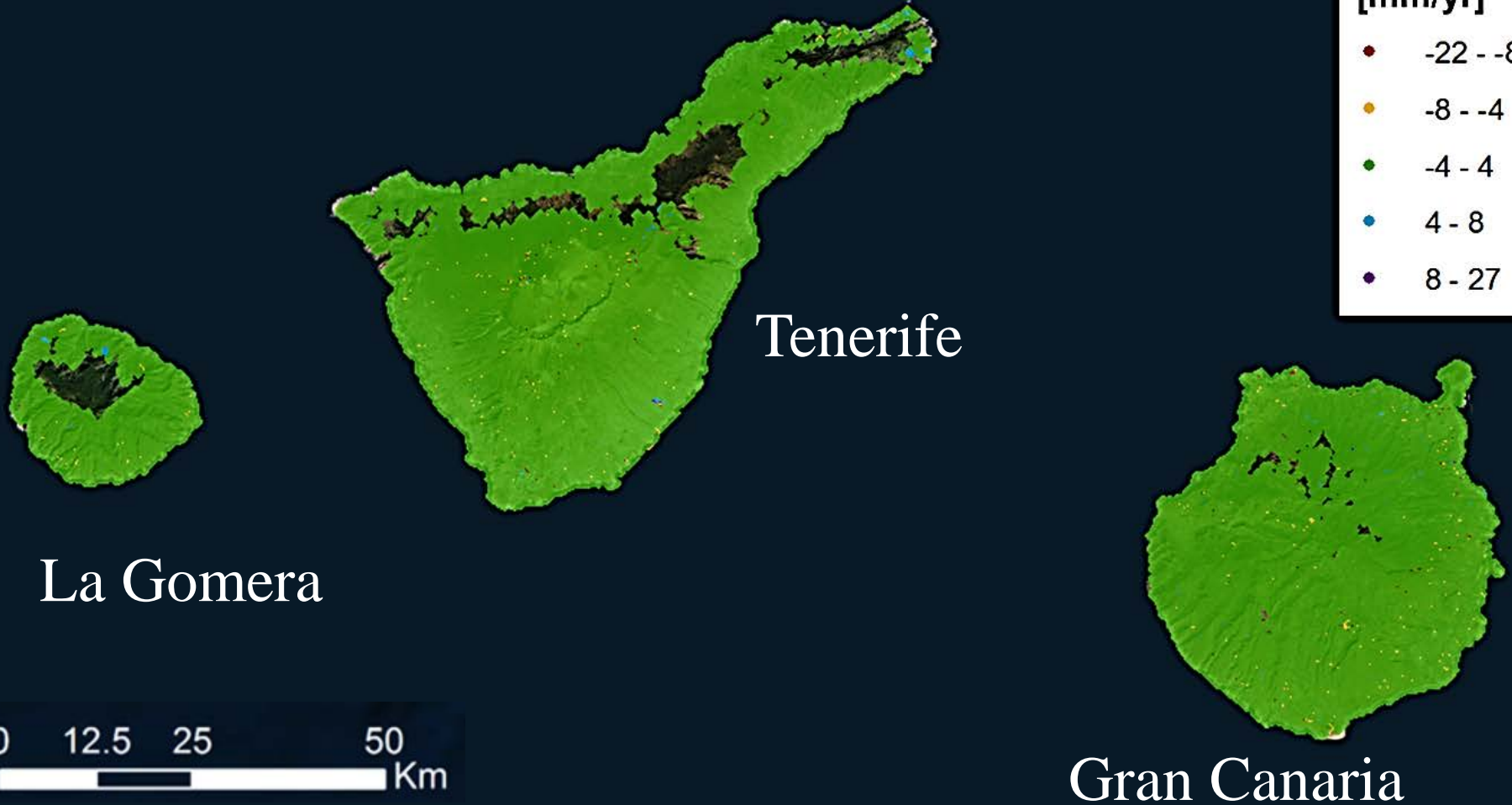




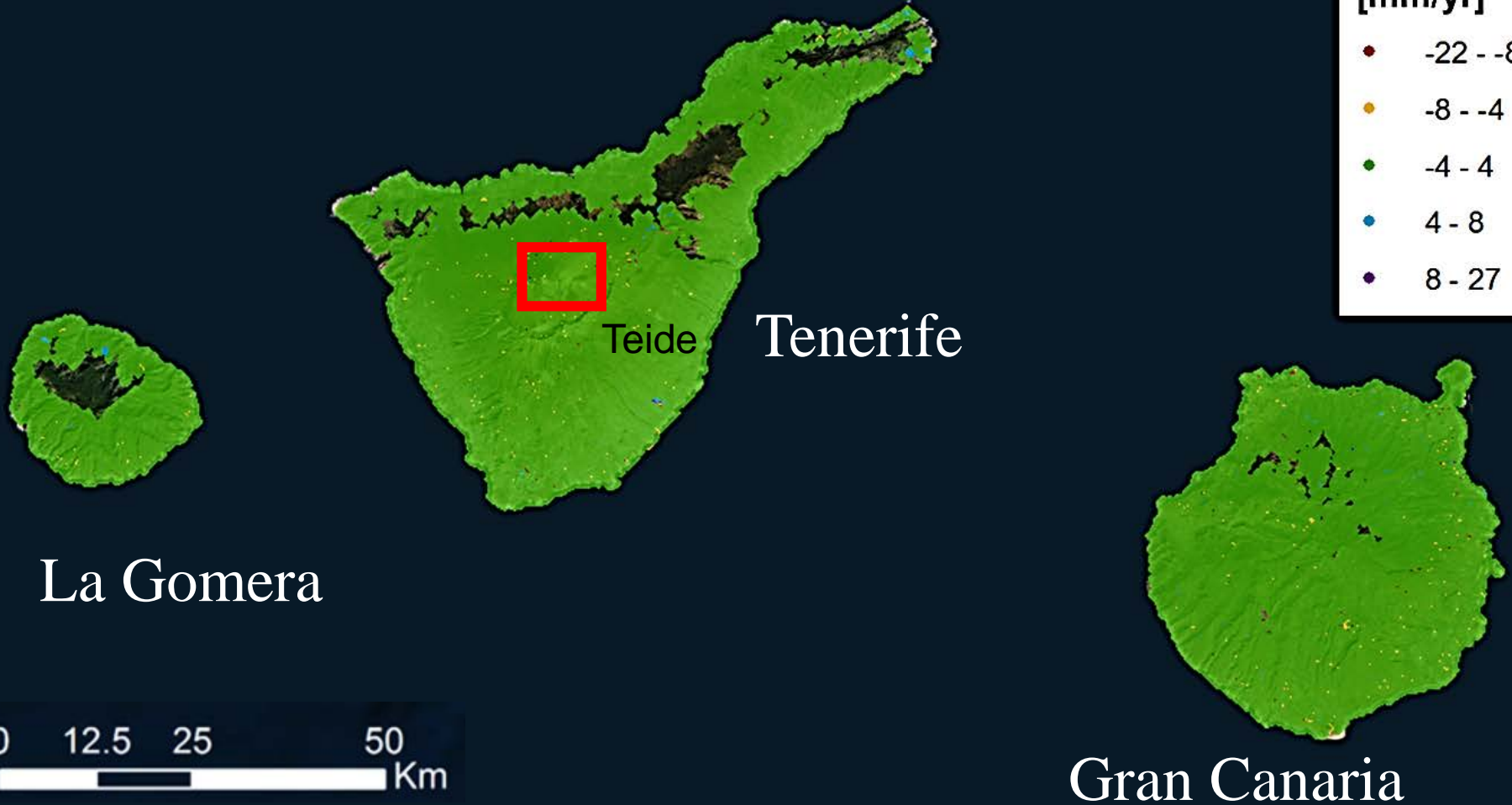
Filtering example



Canary Islands: after filtering (Deformation Activity Map)



Canary Islands: after filtering (Deformation Activity Map)

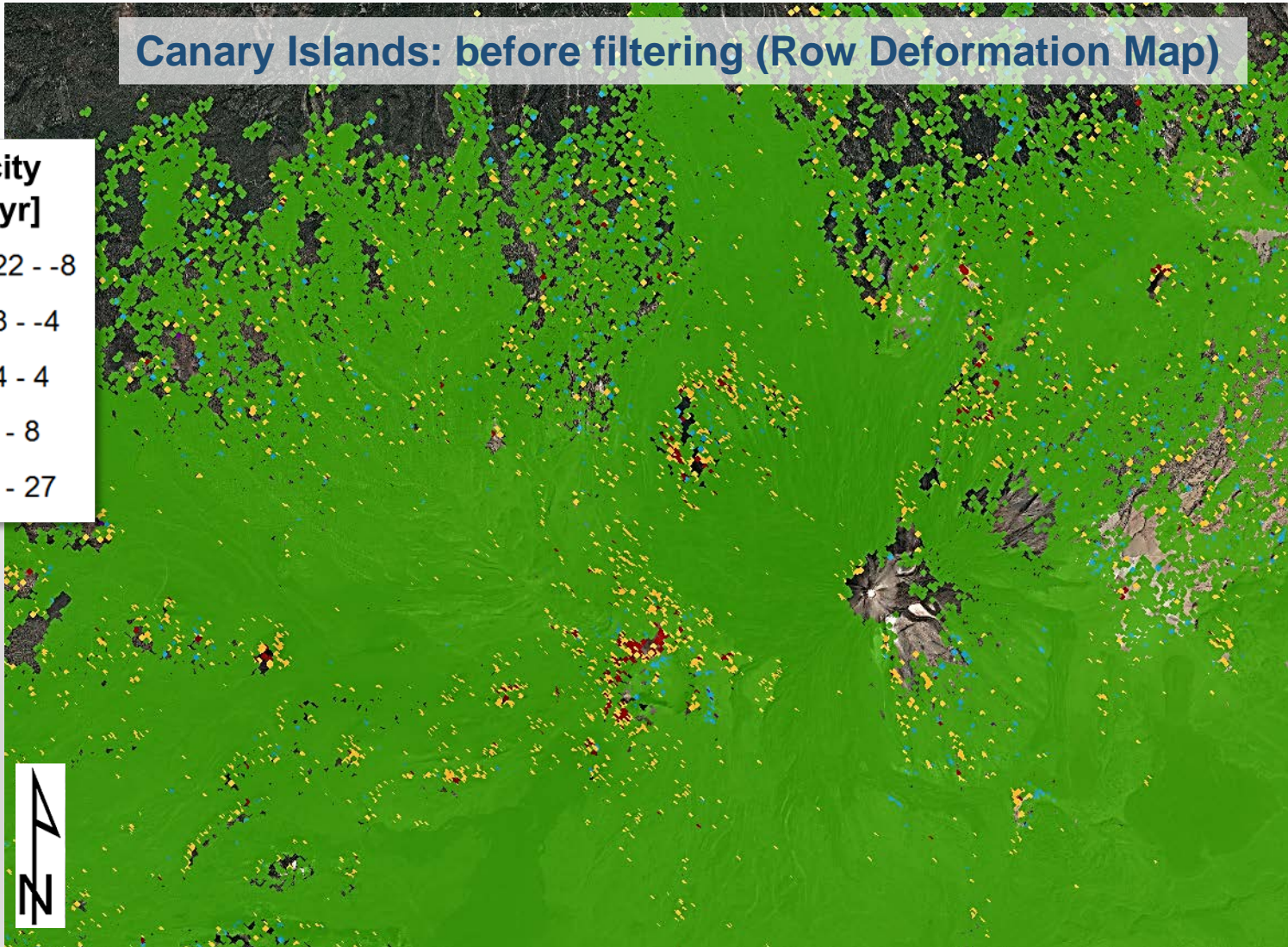


Filtering example

Canary Islands: before filtering (Row Deformation Map)

Velocity
[mm/yr]

- -22 - -8
- -8 - -4
- -4 - 4
- 4 - 8
- 8 - 27



Teide zone: after filtering (Deformation Activity Map)

Velocity
[mm/yr]

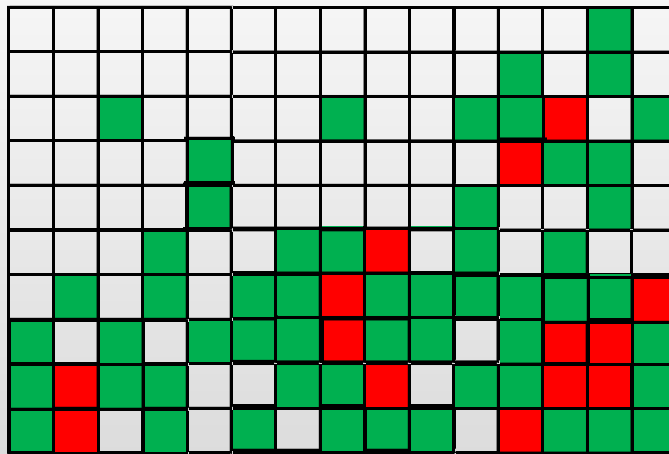
- -22 - -8
- -8 - -4
- -4 - 4
- 4 - 8
- 8 - 27







Filtering

PARAMETERS TO CHOSE: area of influence (ray)

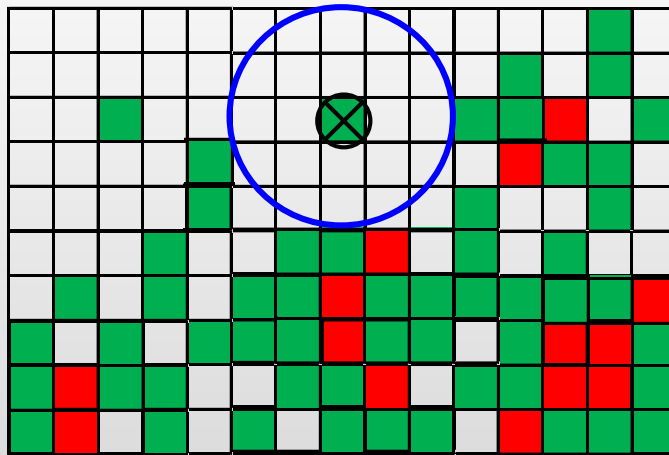
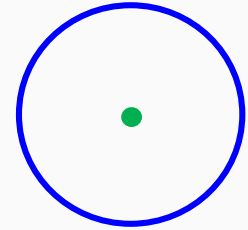





-  PS with $|v| > 2\sigma$
-  PS with $|v| < 2\sigma$



Filtering

PARAMETERS TO CHOSE: area of influence (ray)

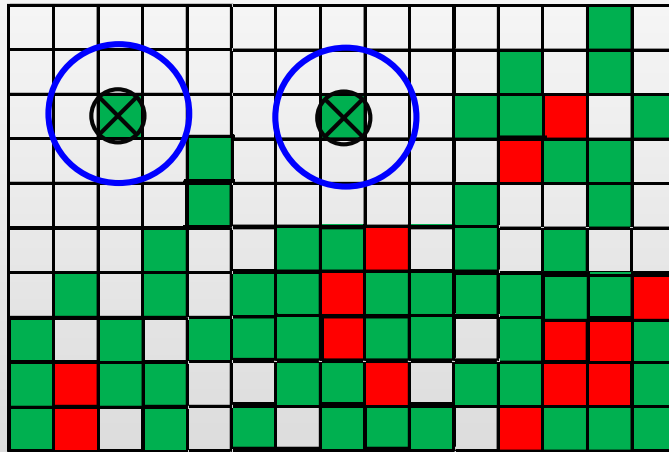
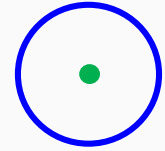





-  PS with $|v| > 2\sigma$
-  PS with $|v| < 2\sigma$
-  Filtering PS elimination



Filtering

PARAMETERS TO CHOSE: area of influence (ray)

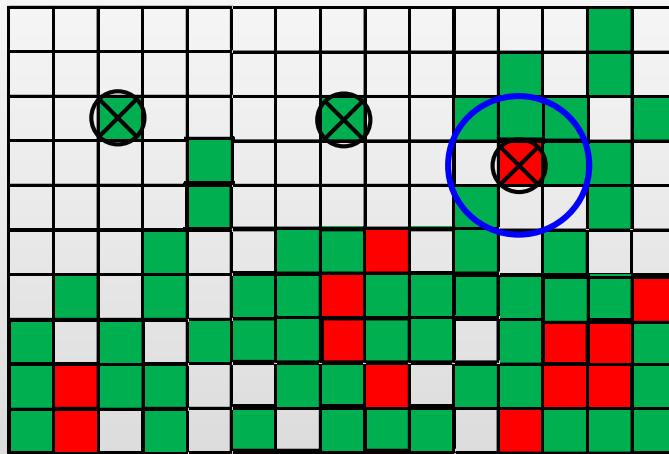





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Filtering

PARAMETERS TO CHOSE: when is it outlier?

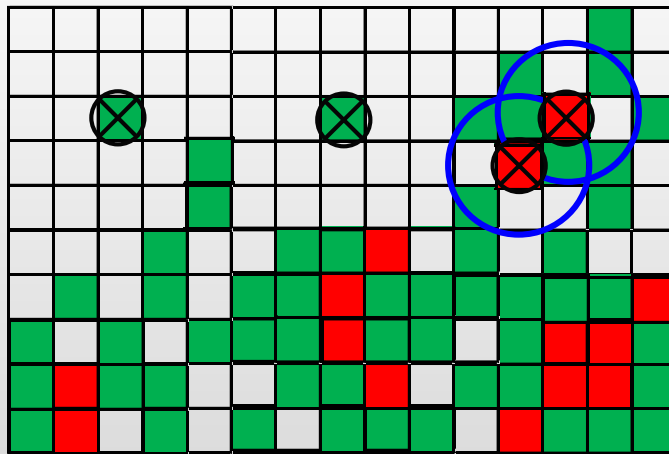





-  PS with $|v| > 2\sigma$
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Filtering

PARAMETERS TO CHOSE: when is it outlier?



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-  Filtering PS elimination



ADA finder - Find Active Deformation Areas

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Output shapefile with ADA data ...

Output shapefile with point data ...

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Minimum size of non-isolated clusters	<input type="text" value="2"/>
Factor for stdev filter	<input type="text" value="2"/>
Threshold for velocity class 1 (mm)	<input type="text" value="10.0"/>
Clustering radius (m)	<input type="text" value="40.0"/>
Minimum ADA size	<input type="text" value="5"/>

of values to compute the mean of the deformation

PS subset to write

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- All non-isolate
- All moving non
- Non-isolated (
- Non-isolated,

Log messages

Quit

Load options file Save options file Go

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Log messages

Quit Load options file Save options file Go

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Methodology

- The velocity threshold
- Deformation Activity Map (DAM)
 - ADA extraction
- Quality Index (QI)



ADA extraction

Rapid identification of the most reliable and significant active deformation areas at a **regional scale**.

The ADA map has to represent a clear input to be validated and integrated with other data (e.g., geohazard inventories, ground truth information, etc.) in order to determine the nature of the deformation and thus to generate the **Geohazard Activity Map**.

- Rapid
- Automatic
- **Clear**

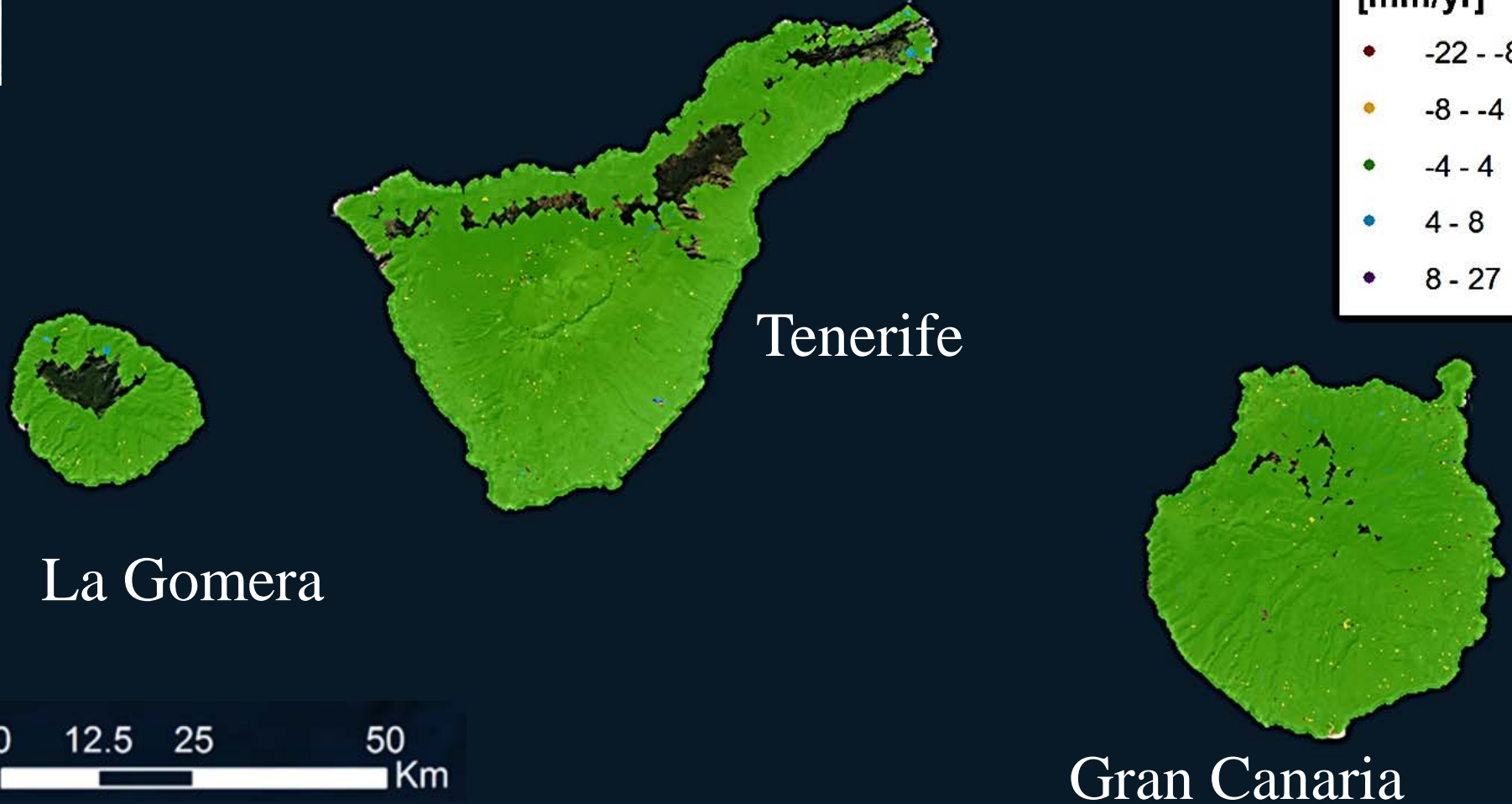


ADA extraction

Canary Islands: after filtering (Deformation Activity Map)

Velocity
[mm/yr]

- 22 - -8
- 8 - -4
- 4 - 4
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Active Deformation Areas



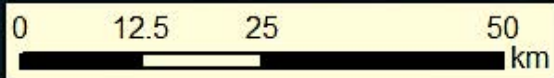
ADA Quality Index (QI)

- 1 - Reliable ADA
- 2 - Reliable ADA - Each TS needs to be analyzed
- 3 - Reliable ADA - TSs cannot be exploited
- 4 - Not Reliable

Tenerife

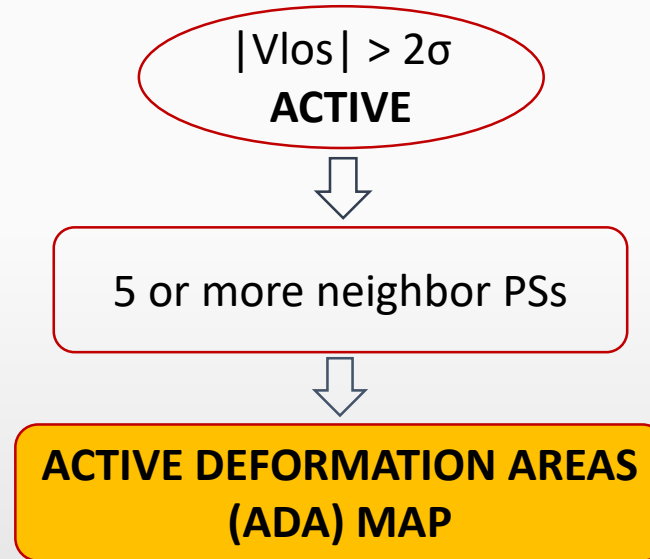
La Gomera

Gran Canaria





ADA extraction

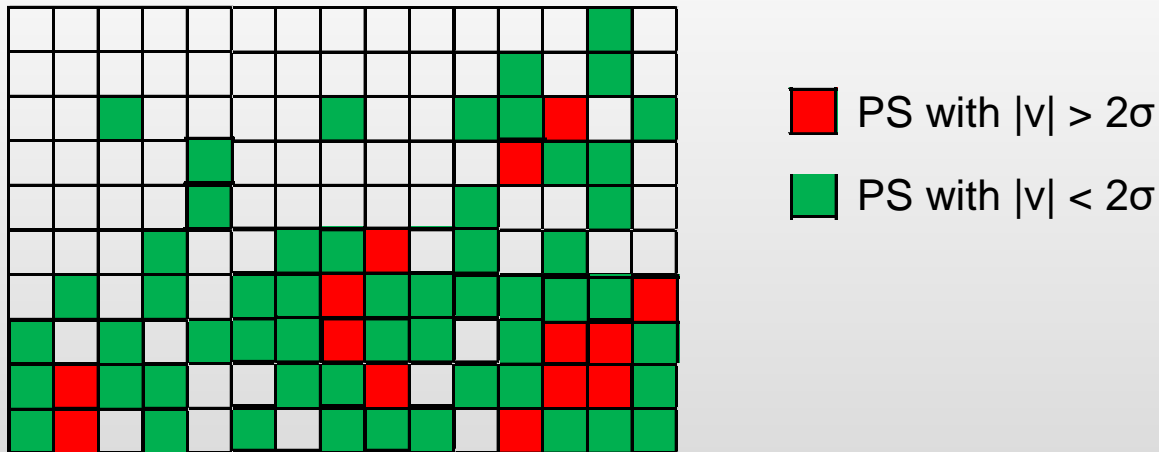


- N° of PS
- Localization
- Accumulated deformation
- Mean Velocity (Absolute value) [mm/yr]
- Maximum Velocity (Absolute value) [mm/yr]
- Minimum Velocity (Absolute value) [mm/yr]
- Mean deformation [mm]
- **Velocity Class**
- **Quality Index**



ADA extraction

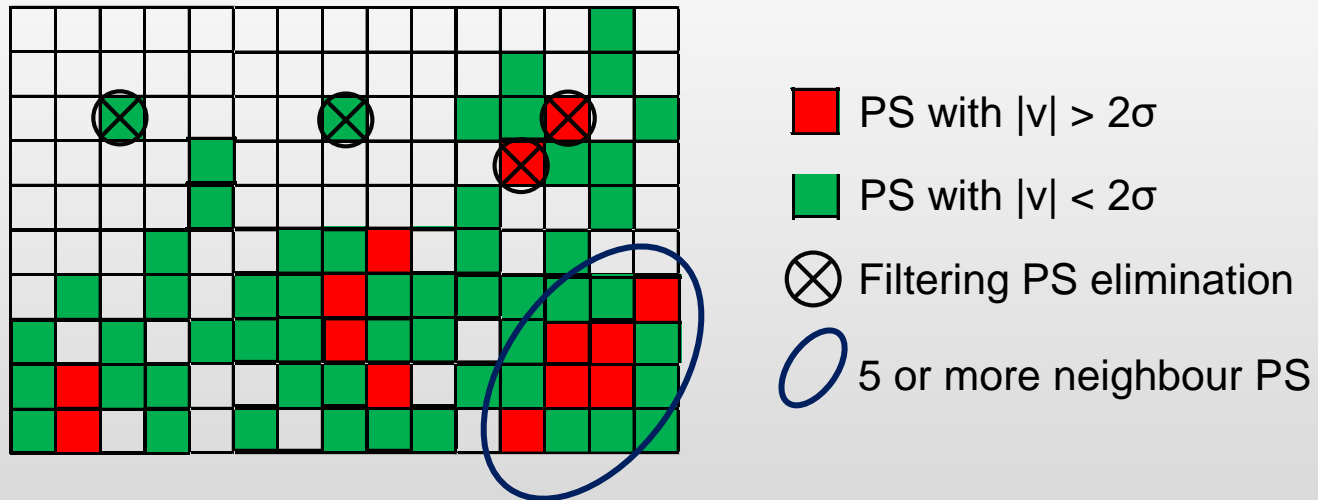
ADA: 5 or more neighbor Active PSs





ADA extraction

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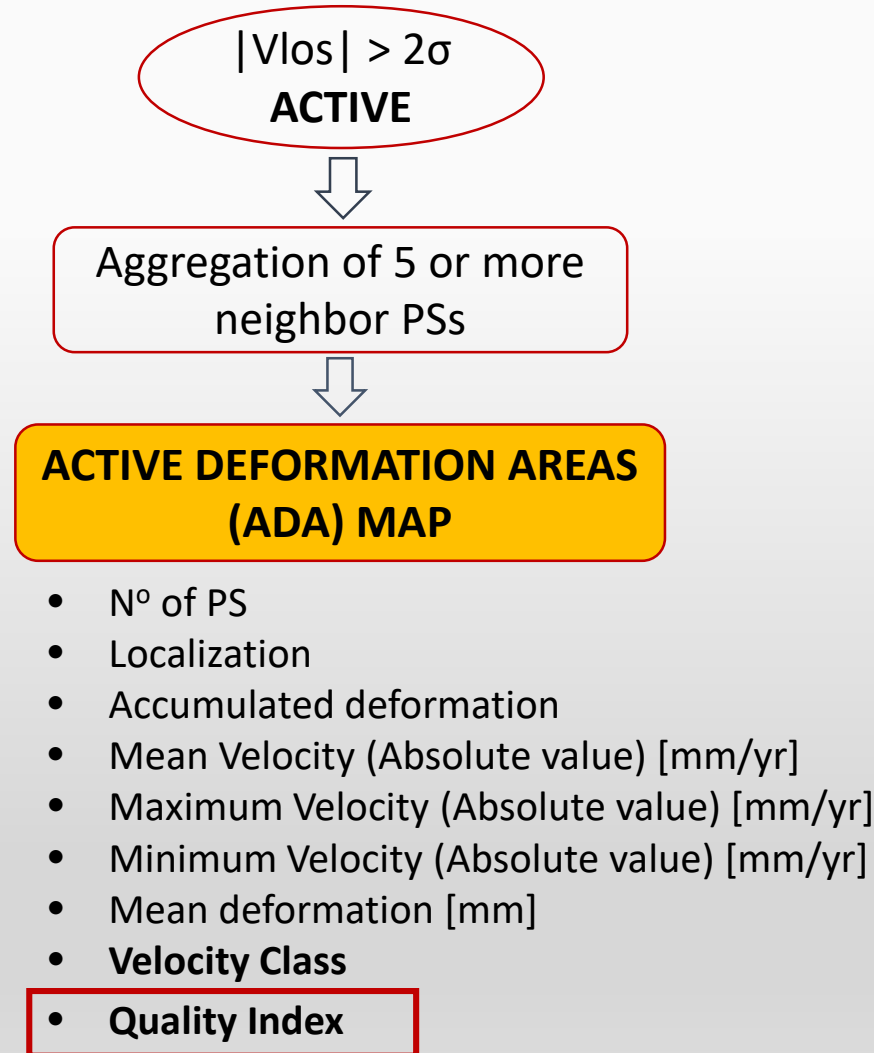
Log messages

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ADA extraction





ADA attributes

ADA_ID	N_APS	X_MEAN	Y_MEAN	VEL_MIN	VEL_MEAN	VEL_MAX	VEL_CLASS	DEF_MEAN	TNI_CLASS	SNI_CLASS	QI_CLASS
90	21	397038.6111428...	4067338.328904...	3.10000000000	6.36190476190	17.50000000000	1	-17.04166666667	2	3	3
105	21	400181.7795714...	4070513.039095...	8.80000000000	13.00952380952	17.70000000000	1	-29.79761904762	1	1	1
106	184	400378.8425760...	4071231.547722...	3.10000000000	4.36250000000	8.00000000000	0	-15.99198369565	4	3	4
108	59	400614.0010847...	4070991.309813...	3.30000000000	6.72711864407	10.20000000000	1	-24.25042372881	3	2	3
109	30	400755.1626333...	4070866.962066...	3.10000000000	5.07666666667	10.90000000000	1	-16.57833333333	4	3	4
111	24	400841.4264583...	4070292.227875...	4.00000000000	6.36250000000	8.50000000000	0	-19.50937500000	2	2	2
113	30	401031.1970333...	4066555.956466...	3.70000000000	11.20666666667	26.10000000000	1	-45.70500000000	1	2	1
123	37	402252.1083783...	4070252.996108...	3.10000000000	4.92432432432	10.20000000000	1	12.34662162162	2	1	1
145	20	407082.8583000...	4072212.585649...	3.10000000000	3.96000000000	6.90000000000	0	10.63750000000	4	4	4
168	24	409527.8651249...	4072973.912874...	3.10000000000	3.44583333333	4.30000000000	0	3.50416666667	4	3	4
174	35	409723.9331714...	4071316.480885...	3.10000000000	4.22285714286	6.80000000000	0	8.18571428571	4	4	4
182	24	410058.6554166...	4072208.354291...	3.20000000000	4.13333333333	6.20000000000	0	13.51250000000	4	3	4



ADA attributes

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106	184	400378.8425760...	4071231.547722...	3.100000000000	4.362500000000	8.000000000000	0	-15.99198369565	4	3	4
108	59	400614.0010847...	4070991.309813...	3.300000000000	6.72711864407	10.200000000000	1	-24.25042372881	3	2	3
109	30	400755.1626333...	4070866.962066...	3.100000000000	5.07666666667	10.900000000000	1	-16.57833333333	4	3	4
111	24	400841.4264583...	4070292.227875...	4.000000000000	6.362500000000	8.500000000000	0	-19.50937500000	2	2	2
113	30	4010...	4070...	3.100000000000	5.07666666667	10.900000000000	1	-16.57833333333	1	2	1
123	37	4022...	4070...	3.100000000000	5.07666666667	10.900000000000	1	-16.57833333333	2	1	1
145	20	4070...	4070...	3.100000000000	5.07666666667	10.900000000000	1	-16.57833333333	2	3	3
168	24	4095...	4070...	3.100000000000	5.07666666667	10.900000000000	1	-16.57833333333	4	4	4
174	35	4097...	4070...	3.100000000000	5.07666666667	10.900000000000	1	-16.57833333333	1	1	1
182	24	4100...	4070...	3.100000000000	5.07666666667	10.900000000000	1	-16.57833333333	4	4	4
									4	3	4
									3	2	3
									4	3	4



Methodology

- The velocity threshold
- Deformation Activity Map (DAM)
 - ADA extraction
 - Quality Index (QI)



Temporal Noise Index

Autocorrelation coefficient ($\rho_{t,t-1}$)

For each PS of the ADA the first order autocorrelation ($\rho_{t,t-1}$) of its TS is evaluated. The first order autocorrelation allows evaluating the temporal noise degree for both linear and nonlinear deformation trends. The autocorrelation coefficient ranges from 0 to 1, where 0 means the prevalence of noise over the deformation trend

<i>Med (ρ)</i>	Class
<0.53	4
0.53–0.70	3
0.70–0.84	2
>0.84	1



Spatial Noise Index

To evaluate the spatial consistency of the detected ADA, i.e., to quantify how the PSs composing an ADA evolve with a similar trend.

We assume that all the TSs of the same ADA belong to the same deformation phenomena. Thus, we expect different magnitude of the detected movements, but a spatial correlation between their temporal evolutions.

<i>Med(ρ)</i>	Class
< 0.53	4
0.53–0.7	3
0.7–0.84	2
> 0.84	1



ADA Quality Index

		Spatial Noise Class			
		1	2	3	4
Temporal Noise Class	1	1	1	2	4
	2	1	2	3	4
	3	2	3	3	4
	4	4	4	4	4

Class 4: not reliable ADA TS

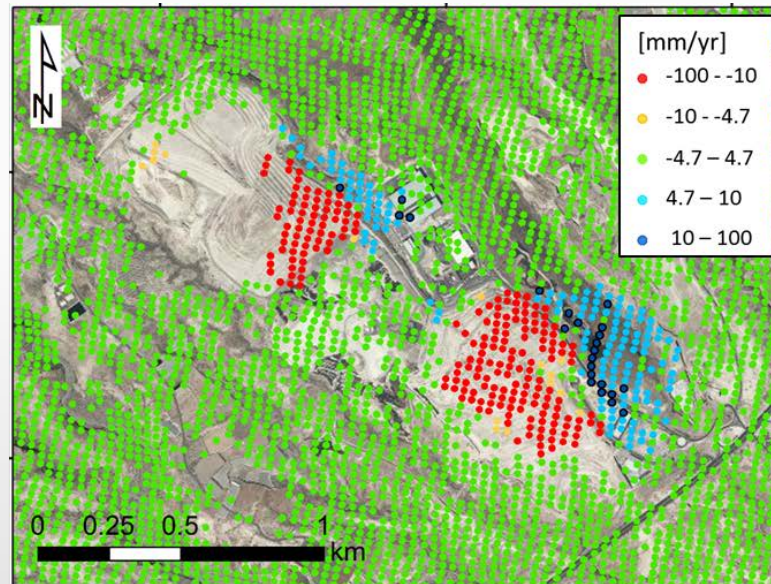
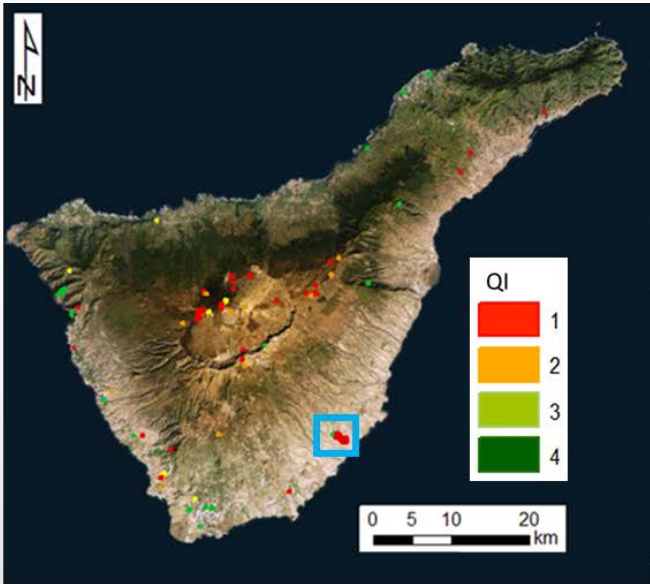
Class 3: reliable ADA but TS that cannot be exploited

Class 2: reliable ADA, but a further analysis of the TS is recommended

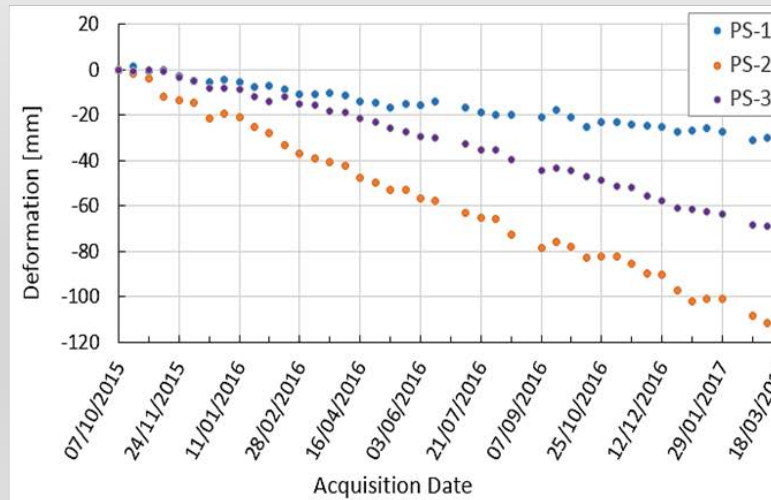
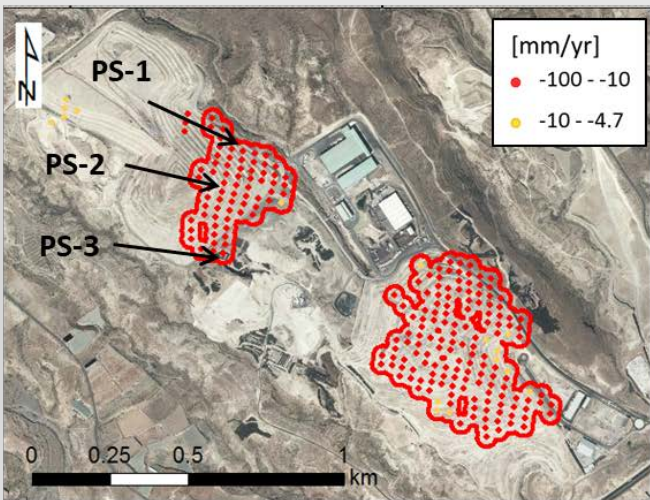
Class 1: reliable ADA and TS



Example 1

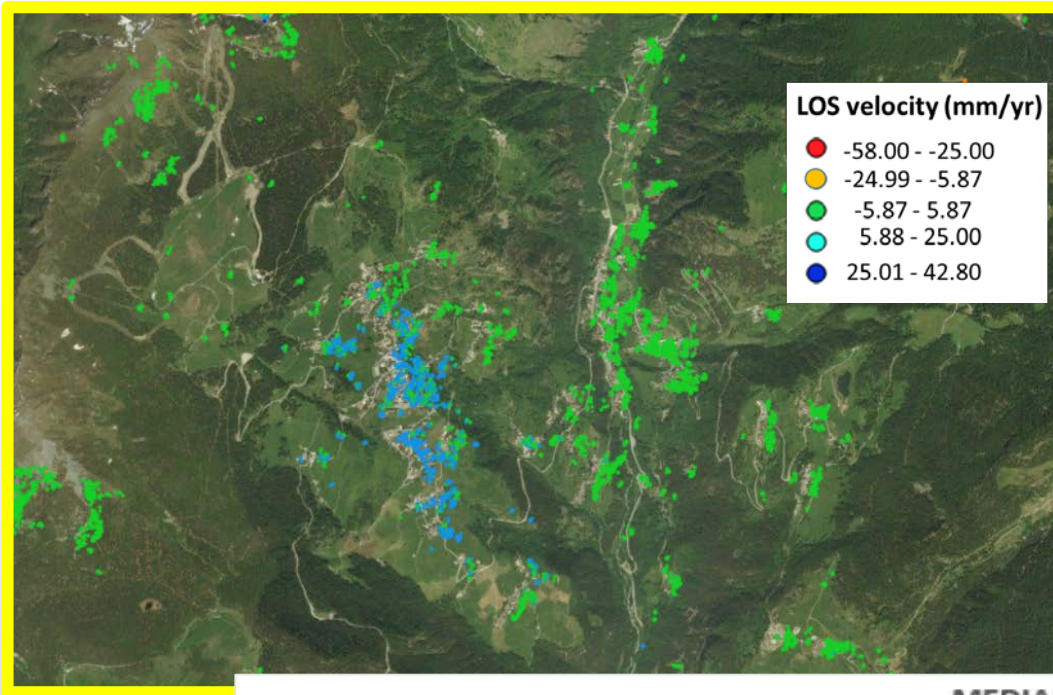


TNI= 1
SNI= 1
QI= 1

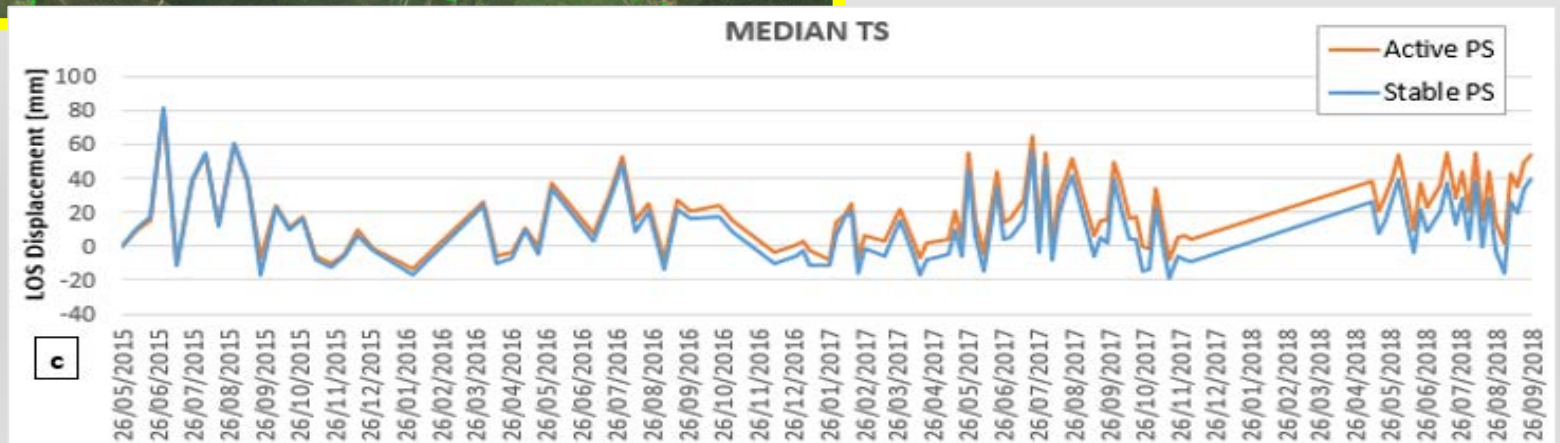




Example 2: before atmosphere filtering

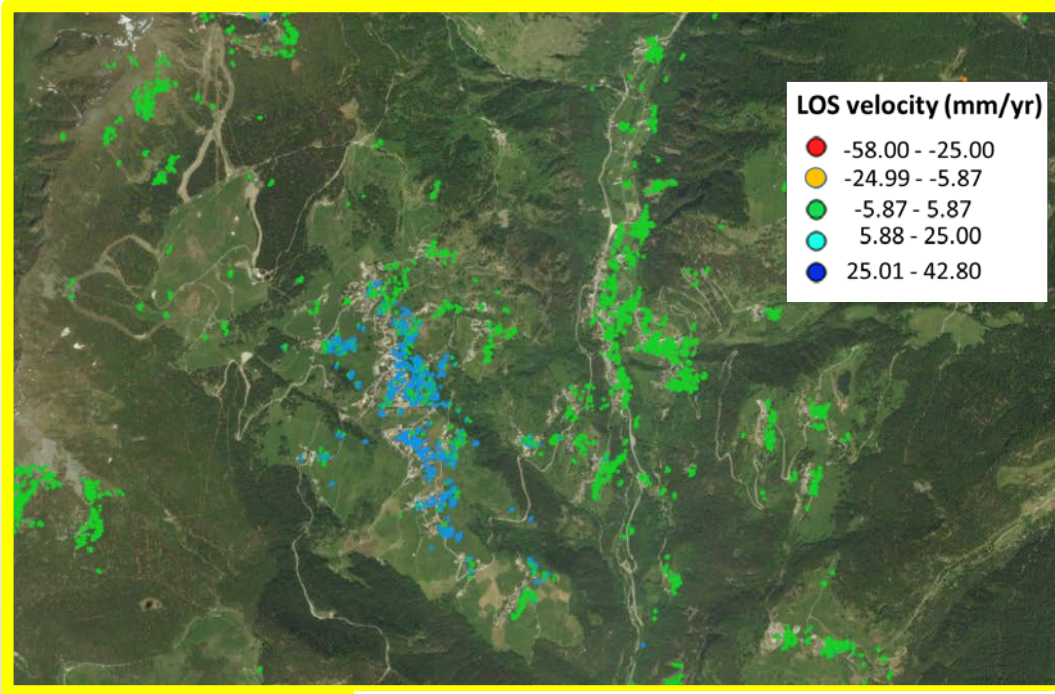


TNI= 4
SNI= 1
QI= 4

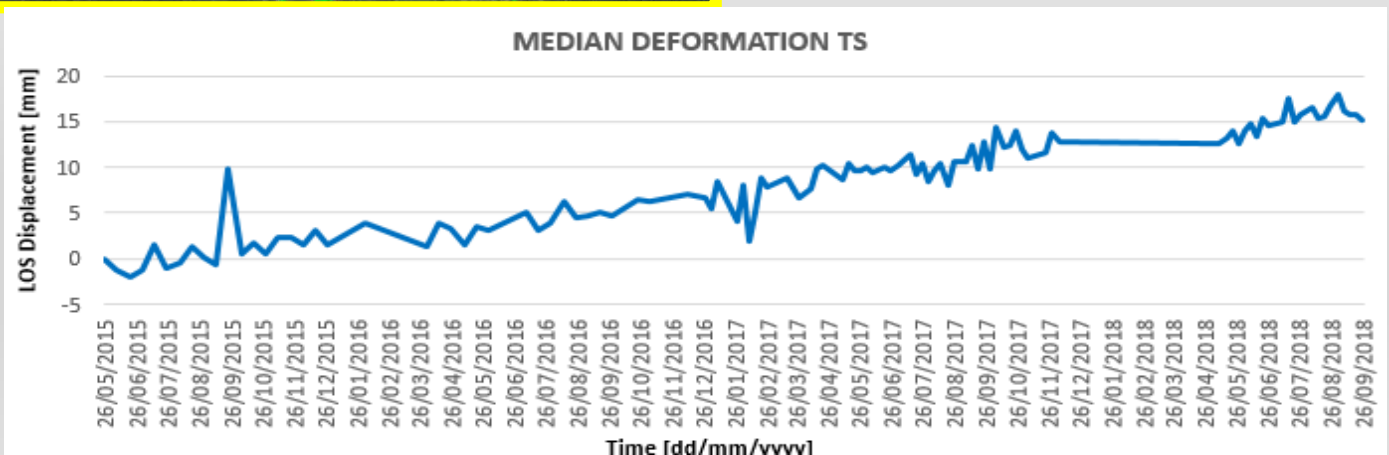




Example 2: after atmosphere filtering

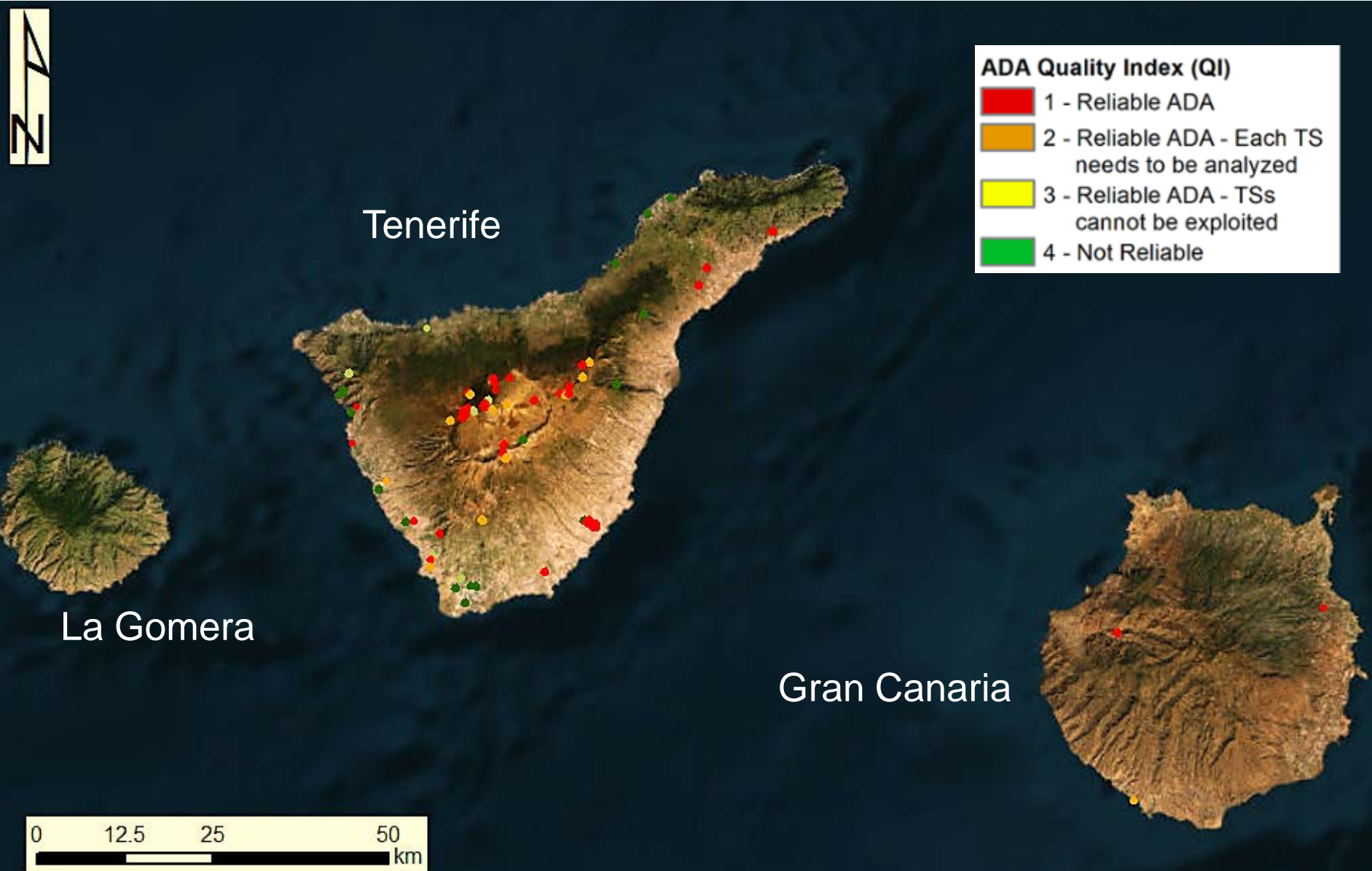


TNI= 1
SNI= 1
QI= 1





ADA Time Series Quality Index





ADA Finder

Questo PC > Unità USB (E:) > training > ADAFinder >

Nome	Ultim
platforms	13/0
ADAFinder.exe	28/0
ADAFinder_cmd.exe	28/0
ADAFinder_default_configuration.op	16/1
ADAFinder_points_read_write_map.op	10/1
concr140.dll	09/0
dump_dbf_header.exe	10/1
MOMIT_technical_note_ADAFinder docu...	29/0
msvc140.dll	09/0
Qt5Core.dll	23/0
Qt5Gui.dll	25/0
Qt5Widgets.dll	25/0
vccorlib140.dll	09/0
vcruntime140.dll	09/0

ADA finder - Find Active Deformation Areas

Input shapefile with raw deformation data	d_deliverable/SHP/Aosta_int2ima_3ok.shp	...
Read map for the input shapefile with raw deformation data	iverable/ADA/ADAFinder_points_read_writ	...
(Optional) input shapefile with AOI boundaries		...
Output shapefile with ADA data	ond_deliverable/ADA/ADA_Aosta3_del.shp	...
Output shapefile with point data	ond_deliverable/ADA/DAM_Aosta3_all.shp	...
Isolation distance (m)	40	
Minimum size of non-isolated clusters	2	
Factor for stdev filter	1.5	
Threshold for velocity class 1 (mm)	10	
Clustering radius (m)	20	
Minimum ADA size	5	
# of values to compute the mean of the deformation	4	
PS subset to write	All non-isolated PSs	▼

Log messages

```
Standard deviation of the velocity: 3.913237
Removing isolated points.
Removing stable points.
Removing clusters with too few points.
Looking for ADAs.
Building polygons with ADA's circular areas of influence.
Computing ADA data.
Writing the output ADA polygons (shp).
Writing the output ADA attributes (dbf).
Project file found:
  F:/00_Projects/00_ECHO/02_UGEOHAZ/01_Processing/01_Valle_Aosta/01_Descending/
  02_second_deliverable/SHP/Aosta_int2ima_3ok.prj
successfully copied to
  F:/00_Projects/00_ECHO/02_UGEOHAZ/01_Processing/01_Valle_Aosta/01_Descending/
  02_second_deliverable/SHP/ADA_Aosta3_del.prj
Successful completion.
```

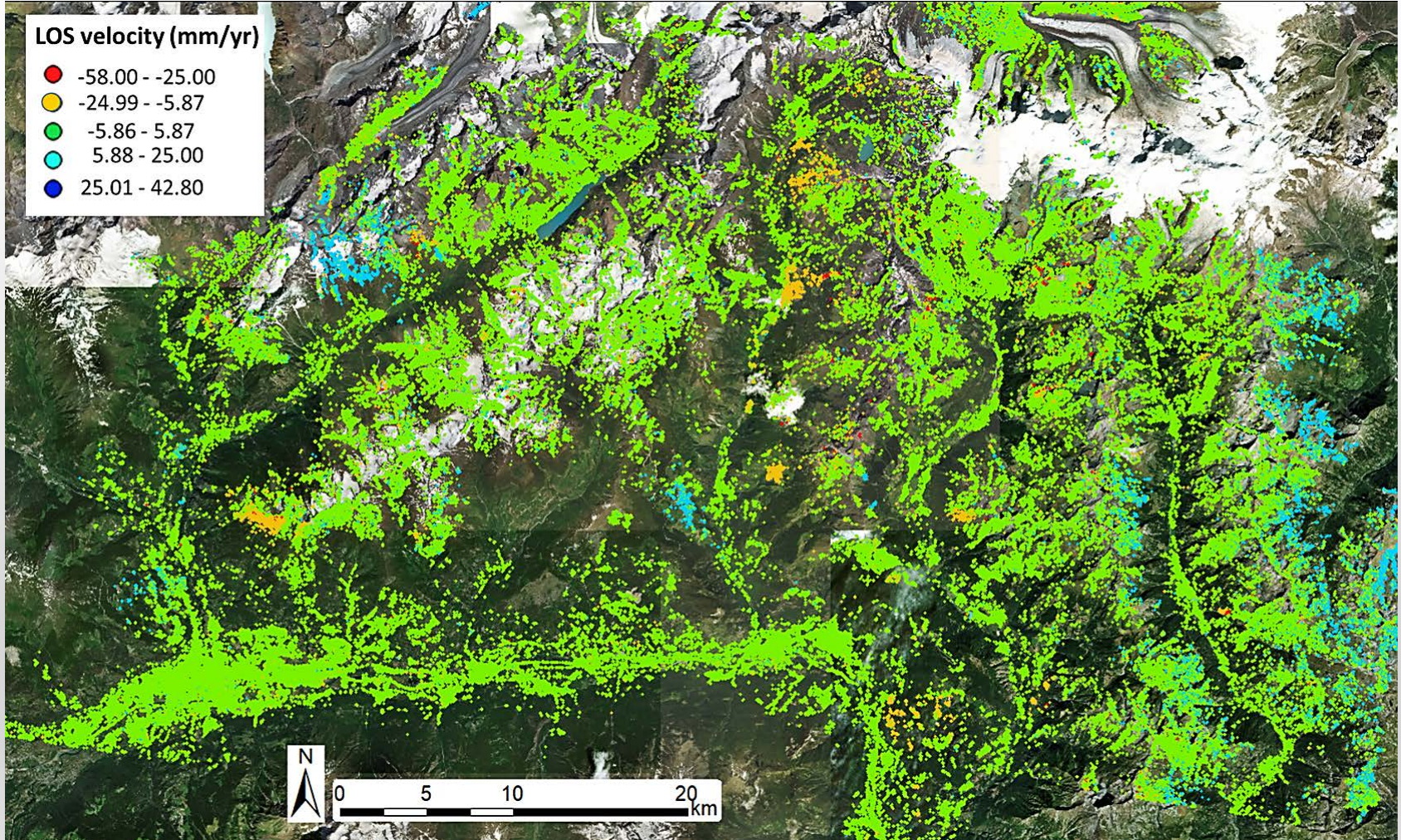
Buttons: Cancel, Load options file, Save options file, Go



ADAFinder Input shapefile



ADA MAP: automatic Active Deformation Areas extraction

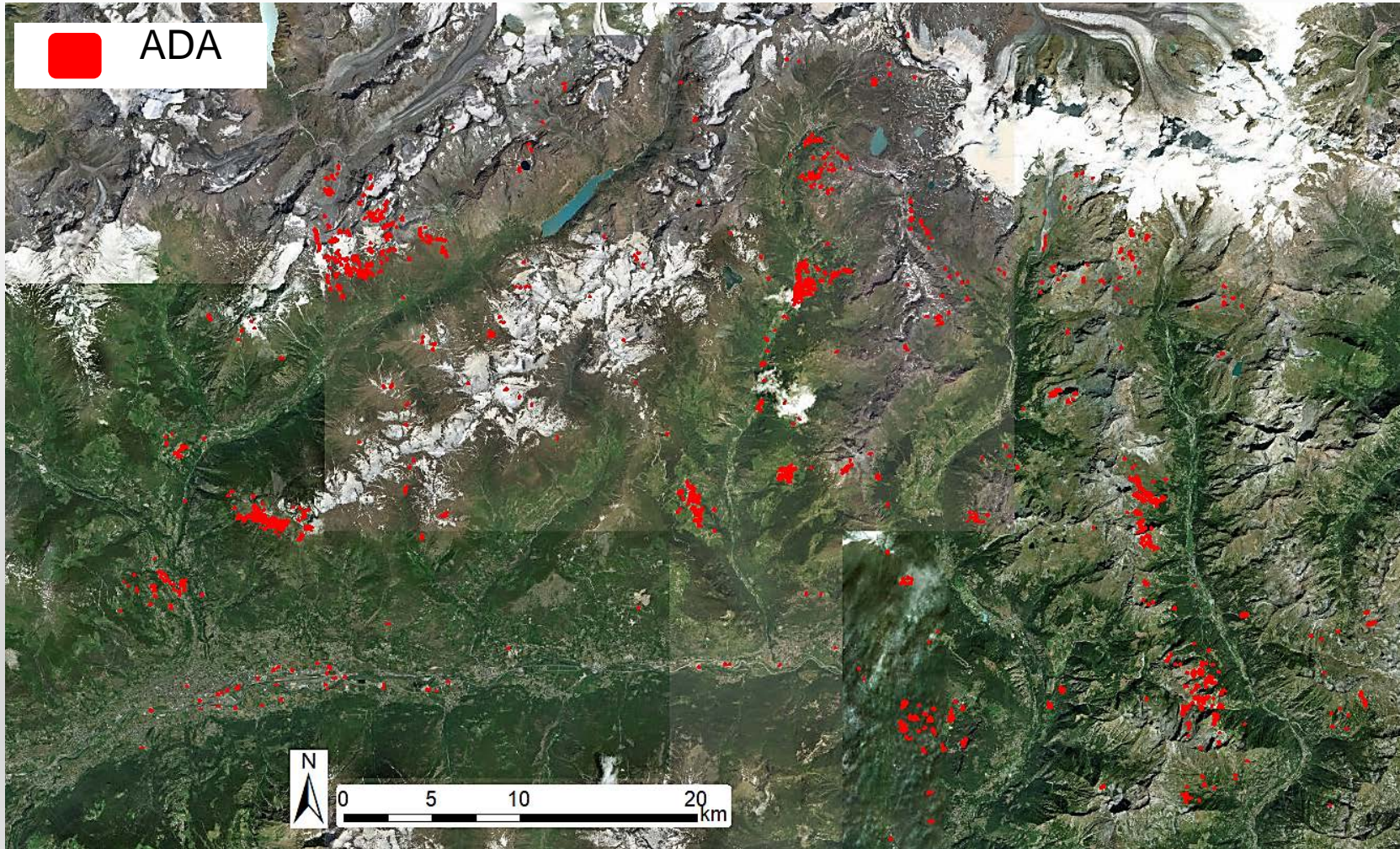




ADAFinder output shapefile



ADA MAP: automatic Active Deformation Areas extraction

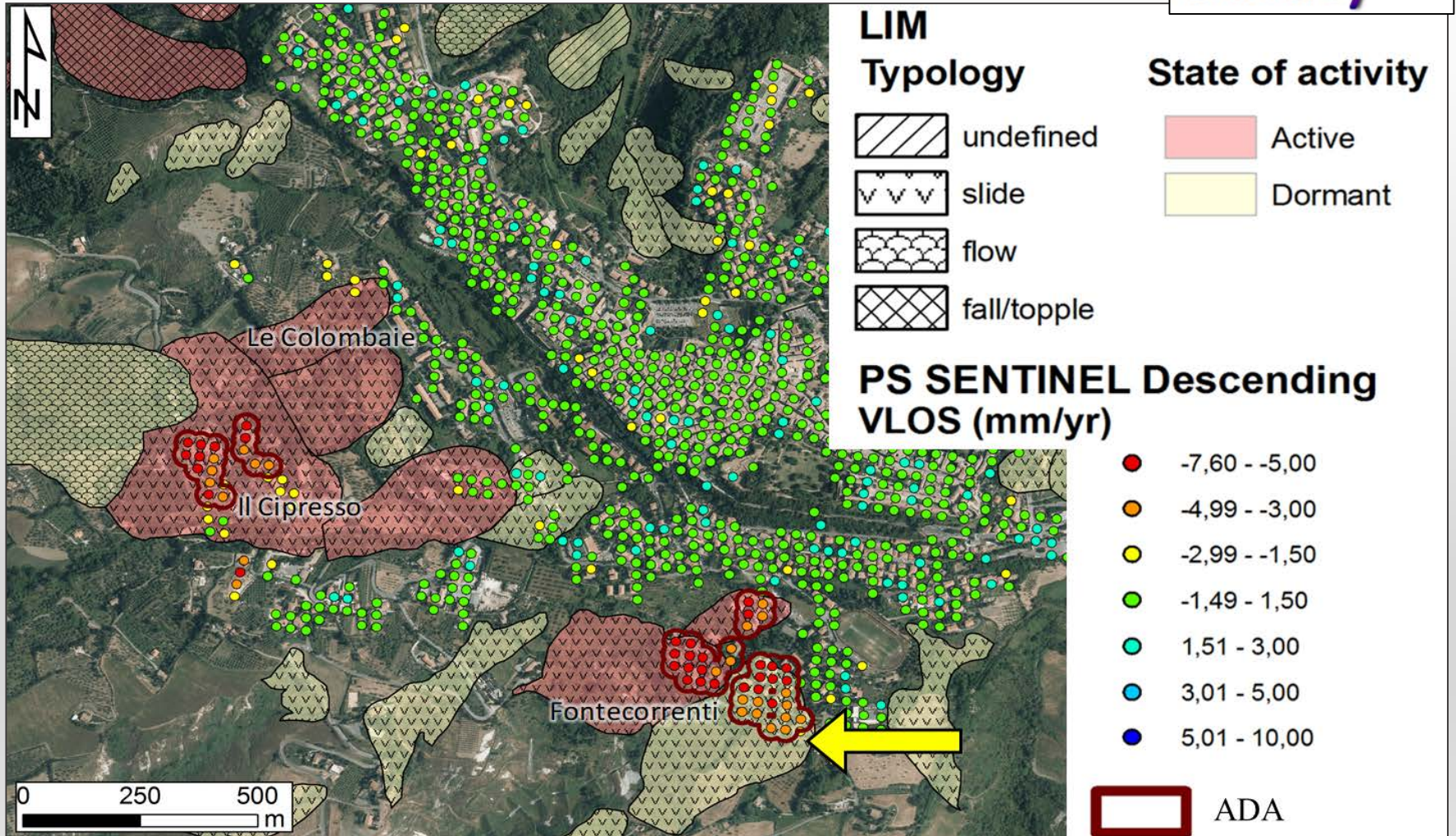




ADA + other data: interpretation and assessment

Example 1: Landslide inventory map

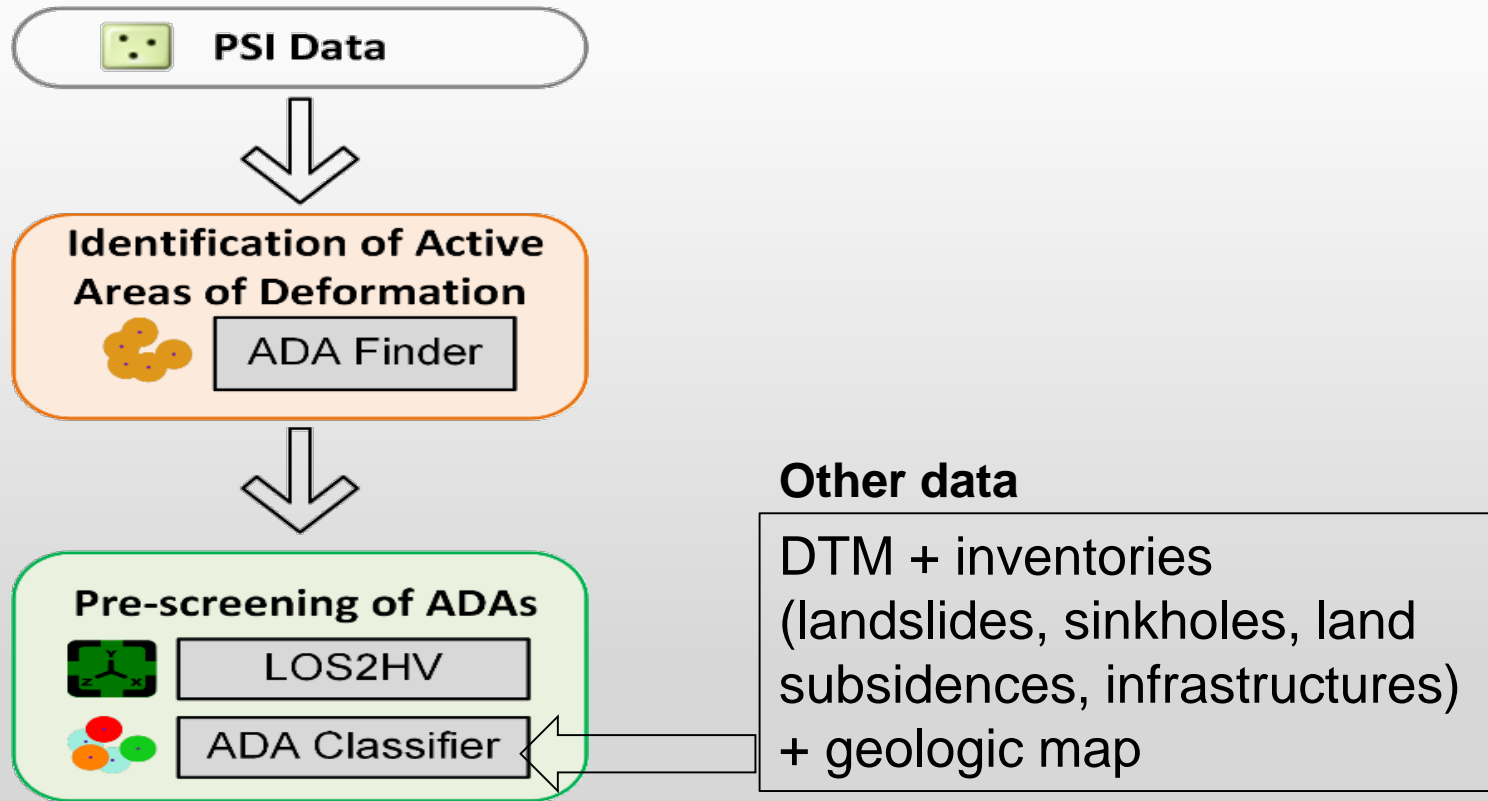
Volterra (Italy)





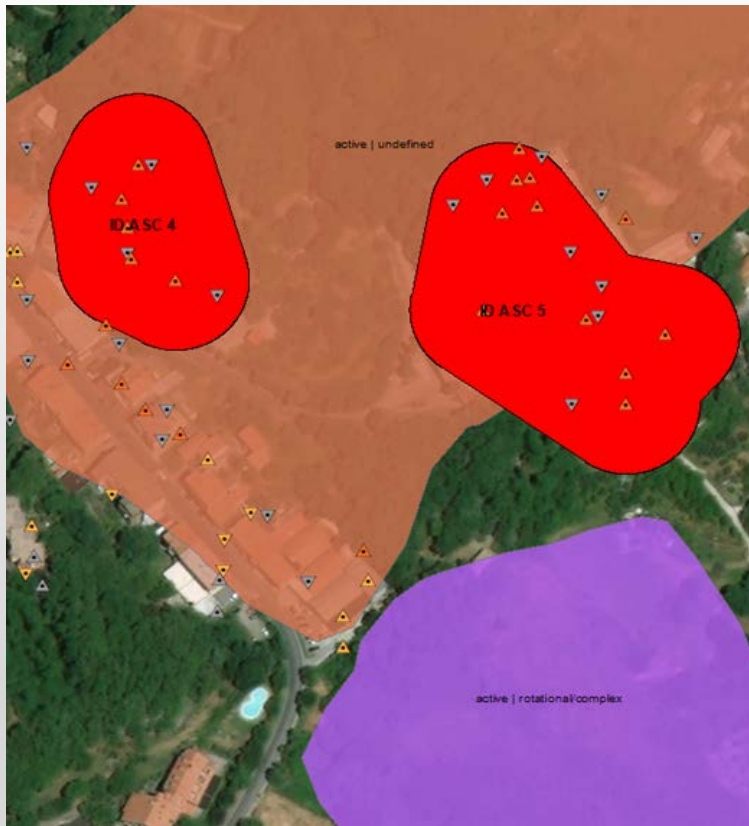
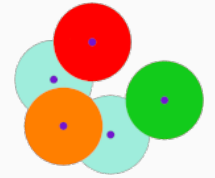
ADA Classifier:

Automatic preliminary assessment of the phenomena





ADA classifier



Target

Classify the ADAs. Up to 6 phenomena:
landslide, sinkhole, subsidence, constructive settlements, expansive soils & temperature effects.

Input

ADAs (from ADAfinder) + DTM + inventories for landslides, sinkholes, land subsidences, infrastructures + geologic map + horizontal displacement map (los2hv).



ADAClassifier - Classification of Active Deformation Areas

Options

Files

Log messages

Input ADA polygons
(MANDATORY)

varro/Desktop/03_1 Input/ADAs_ASC_5m_poly.shp

...

Input ADA points
(MANDATORY)

varro/Desktop/03_1 Input/ADAs_ASC_5m_point.shp

...

Input Digital Terrain Model header
(OPTIONAL)

anavarro/Desktop/03_1 Input/DEM/header_DTM.op

...

Input landslides inventory
(OPTIONAL)

anavarro/Desktop/03_1 Input/LANDSLIDES_AOI.shp

...

Input sinkholes inventory
(OPTIONAL)

...

Input subsidences inventory
(OPTIONAL)

...

Input infrastructures inventory
(OPTIONAL)

t/Infrastructures_Railway_Stations_UrbanCLC.shp

...

Input geologic inventory
(OPTIONAL)

arro/Desktop/03_1 Input/GEOLOGY_AOI_CODES.shp

...

Input geologic inventory read map
(ONLY if the geologic inventory is set)

arro/Desktop/03_1 Input/geologic_map_readmap.op

...

Input horizontal displacements map
(OPTIONAL)

3_1 Input/LoS2HV_Horizontal_10m_merge_poly.shp

...

Output classified ADAs
(MANDATORY)

:/Users/janavarro/Desktop/03_1 Input/OUTPUT.shp

...

Quit

Options Files

LANDSLIDE classification thresholds

% of intersection with landslide inventory Slope (deg) Horizontal displacement velocity

SINKHOLE classification thresholds

% of intersection with sinkholes inventory % of intersection with saline / carbonate soils Horizontal displacement velocity

LAND SUBSIDENCE classification thresholds

% of intersection with subsidences inventory % of intersection with quaternary unconsolidated sediments Slope (deg)

CONSTRUCTIVE / CONSOLIDATION SETTLEMENTS classification thresholds

% of intersection with infrastructures inventory Determination coefficient (inverse exponential fit)

EXPANSIVE SOILS classification thresholds

% of intersection with expansive lithologies Determination coefficient (sinusoidal fit)

TEMPERATURE EFFECTS classification thresholds

% of intersection with infrastructures inventory Determination coefficient (sinusoidal fit)

Log messages

Quit

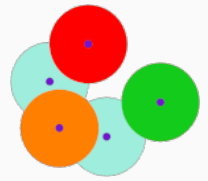
Load options file

Save options file

Go



ADA classifier

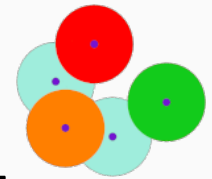


6 different algorithms, one per phenomenon to test

ID type 1 (Landslide)					
Is the percentage of intersection of the ADA	Yes	Landslide			
	No	Slope > Th2		Yes	Potential new landslide
with the landslide inventory > Th1?			Horizontal displacement > Th3?	No	Not a landslide
		Slope < Th2?	Not a landslide		
ID type 2 (Sinkhole)					
Is the percentage of intersection of the ADA with the sinkhole inventory > Th4?	Yes	Sinkhole			
	No	Saline carbonate rock/soil > Th13(1).	Horizontal displacement > Th5?	Yes	Not a sinkhole
		Other lithologies	Not a sinkhole		



ADA classifier



6 different algorithms, one per phenomenon to test

ID type 3 (Land subsidence)

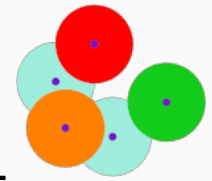
Is the percentage of intersection of the ADA with the subsidence inventory > Th6 ?	Yes	Land subsidence		
	No	Quaternary unconsolidated sediments > Th13(2) .	Yes	Slope > Th7 Not land subsidence
				Slope < Th7 Possible land subsidence
	No	Not land subsidence		

ID type 4 (Constructive settlements – consolidation settlements)

Is the percentage of intersection of the ADA with the infrastructures (building, embankment, bridge, etc.) inventory > Th8 ?	No	Not constructive settlements		
	Yes	The Pearson coefficient measuring the fit of the time series and an inverse exponential function is > Th9 .	Yes	Consolidation process.
No			Not consolidation process	



ADA classifier

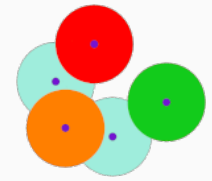


6 different algorithms, one per phenomenon to test

ID type 5 (Expansive soils)				
Is the percentage of intersection of the ADA with elements identified as potentially expansive lithologies in the geologic inventory > Th13(3) ?	No	Not expansive soils		
	Yes	The Pearson coefficient measuring the fit of the time series and an sinusoidal function is > Th10.	No	Not expansive soils
			Yes	Potential expansive soil
	ID type 6 (Temperature effects)			
Is the percentage of intersection of the ADA with the infrastructures (building, embankment, bridge, etc.) inventory > Th11?	No	Not expansive soils		
	Yes	The Pearson coefficient measuring the fit of the time series and an sinusoidal function is > Th12.	No	Not thermal effects
			Yes	Potential temperature effects



ADA classifier



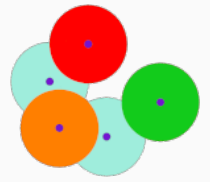
	Landslides	Sinkholes	Subsidences	Settlements	Expansive soils	Temperature effects
DTM	✓		✓			
Horizontal components	✓	✓				
Landslides inventory	✓					
Sinkholes inventory		✓				
Subsidences inventory			✓			
Geologic inventory		✓	✓		✓	
Infrastructures inventory				✓		✓

Table 2: Data versus available classification subprocesses.

-1: not classified
0: NO
1: Potential
2: YES



ADA classifier



-1: not classified
0: NO
1: Potential
2: YES

SNI_CLASS	QI_CLASS	EXPSOIL	LANDSLIDE	SETTLEMENT	SINKHOLE	SUBSIDENCE	THERMALEFF
1	1	0	0	2	0	0	0
1	1	0	0	0	0	0	0
1	1	0	0	0	0	1	0
1	1	0	0	0	0	1	0
1	1	0	1	0	0	0	0
1	1	0	1	0	0	0	0
1	1	0	0	0	0	0	0
1	1	0	0	0	0	0	0
1	1	0	0	0	0	1	0
1	1	0	2	0	0	0	0
1	1	0	0	0	0	1	0
1	1	0	0	0	0	0	0

Options Files

LANDSLIDE classification thresholds

% of intersection with landslide inventory Slope (deg) Horizontal displacement velocity

SINKHOLE classification thresholds

% of intersection with sinkholes inventory % of intersection with saline / carbonate soils Horizontal displacement velocity

LAND SUBSIDENCE classification thresholds

% of intersection with subsidences inventory % of intersection with quaternary unconsolidated sediments Slope (deg)

CONSTRUCTIVE / CONSOLIDATION SETTLEMENTS classification thresholds

% of intersection with infrastructures inventory Determination coefficient (inverse exponential fit)

EXPANSIVE SOILS classification thresholds

% of intersection with expansive lithologies Determination coefficient (sinusoidal fit)

TEMPERATURE EFFECTS classification thresholds

% of intersection with infrastructures inventory Determination coefficient (sinusoidal fit)

Log messages

Quit

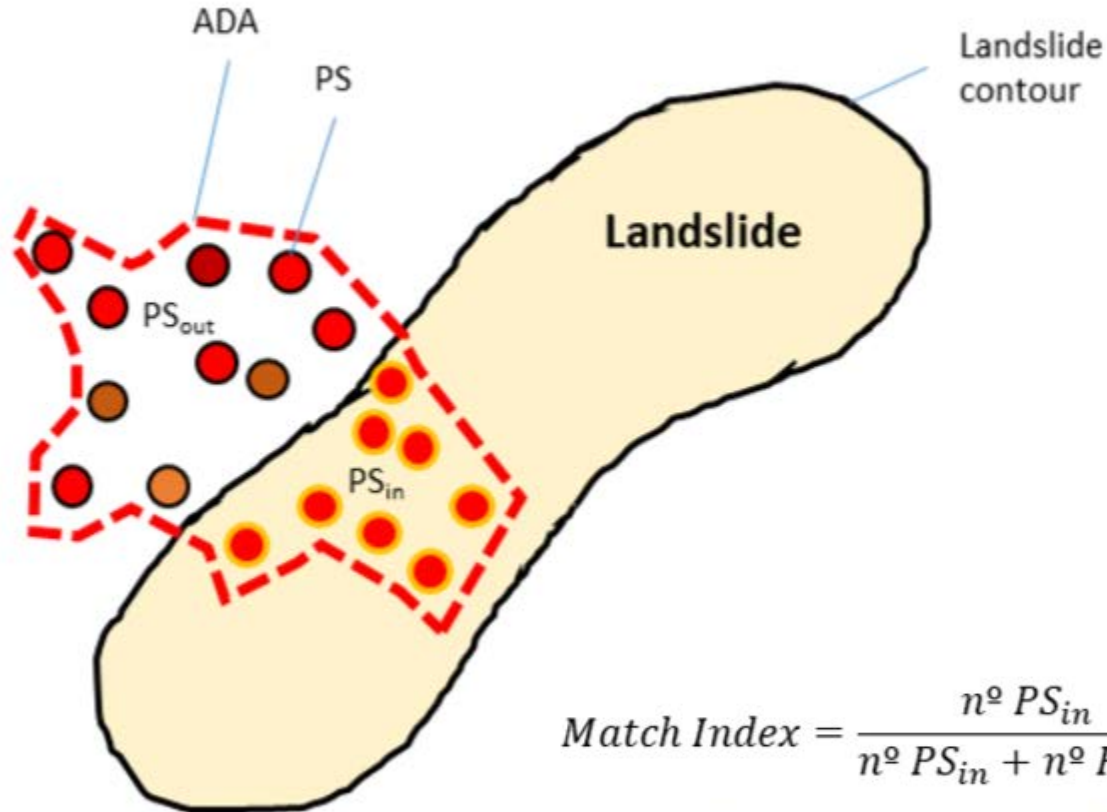
Load options file

Save options file

Go



Example fo Intersection with an Inventory

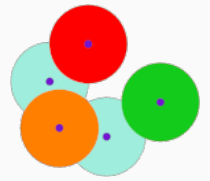


$$\text{Match Index} = \frac{n^{\circ} PS_{in}}{n^{\circ} PS_{in} + n^{\circ} PS_{out}} \times 100$$

Figure 4-1 – Description of the Match Index (MI).



ADA classifier



6 different algorithms, one per phenomenon to test

ID type 1 (Landslide)					
Is the percentage of intersection of the ADA with the landslide inventory > Th1 ?	Yes	Landslide			
	No	Slope > Th2		Yes	Potential new landslide
			Horizontal displacement > Th3 ?	No	Not a landslide
		Slope < Th2 ?	Not a landslide		
ID type 2 (Sinkhole)					
Is the percentage of intersection of the ADA with the sinkhole inventory > Th4 ?	Yes	Sinkhole			
	No	Saline or carbonate rock/soil > Th13(1).	Horizontal displacement > Th5 ?	Yes	Not a sinkhole
		Other lithologies	Not a sinkhole		



LOS2HV



los2hv - Line Of Sight to Horizontal & Vertical

los2hv - Line Of Sight to Horizontal & Vertical

Input shapefile with PSs (ascending)	F:/tools/adaclassifier_los2hv/dataset
Input shapefile with PSs (descending)	F:/tools/adaclassifier_los2hv/dataset
Input file with ascending PSs read map	F:/tools/adaclassifier_los2hv/dataset
Input file with descending PSs read map	F:/tools/adaclassifier_los2hv/dataset
Output shapefile with horizontal components	F:/tools/adaclassifier_los2hv/dataset
Output shapefile with vertical components	F:/tools/adaclassifier_los2hv/dataset
Grid spacing (m)	250
Output mode	Polygons
Look angle, ascending (rad)	0.35
Azimuth angle, ascending (rad)	0.2
Look angle, descending (rad)	1.05
Azimuth angle, descending (rad)	0.2

Input shapefile with PSs (ascending)	F:/tools/adaclassifier
Input shapefile with PSs (descending)	F:/tools/adaclassifier
Input file with ascending PSs read map	F:/tools/adaclassifier
Input file with descending PSs read map	F:/tools/adaclassifier
Output shapefile with horizontal components	F:/tools/adaclassifier
Output shapefile with vertical components	F:/tools/adaclassifier
Grid spacing (m)	250
Output mode	Polygons

Log messages

```

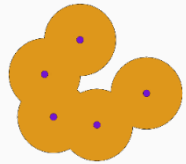
Reading file with PSs (ascending)
Unable to open the shapefile (.shp) with ascending PSs.
Reading file with PSs (ascending)
Reading file with PSs (descending)
Cataloging PSs (ascending)
  Total number of cells found: 29426
Cataloging PSs (descending)
  Total number of cells found: 29426
Intersecting both catalogs.
  Total number of common cells: 29426
Computing horizontal & vertical components.
Writing horizontal components (polygon shp).
  
```

Log messages

```

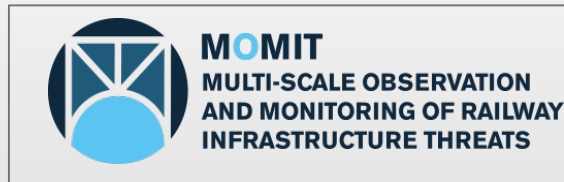
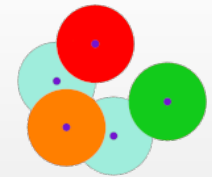
Reading file with PSs (ascending)
Unable to open the shapefile (.shp) with ascending PSs.
Reading file with PSs (ascending)
Reading file with PSs (descending)
Cataloging PSs (ascending)
  Total number of cells found: 29426
Cataloging PSs (descending)
  Total number of cells found: 29426
Intersecting both catalogs.
  Total number of common cells: 29426
Computing horizontal & vertical components.
Writing horizontal components (polygon shp).
  
```

Quit



Thank you!!

<https://u-geohaz.cttc.cat/>



<https://www.momit-project.eu/>



<http://safety.cttc.cat/>

Contacts: anna.barra@cttc.cat oriol.monserrat@cttc.cat