TERRITORI APERTI

GIS Analysis of Territorial Fragility

Chiara Capannolo – Federico Eugeni

Università degli Studi Dell'Aquila – Dipartimento di Ingegneria Edile - Architettura

UNIVERSITÀ DEGLI STUDI DELL'AQUILA

COMUNE DELL'AQUILA

PARTNER

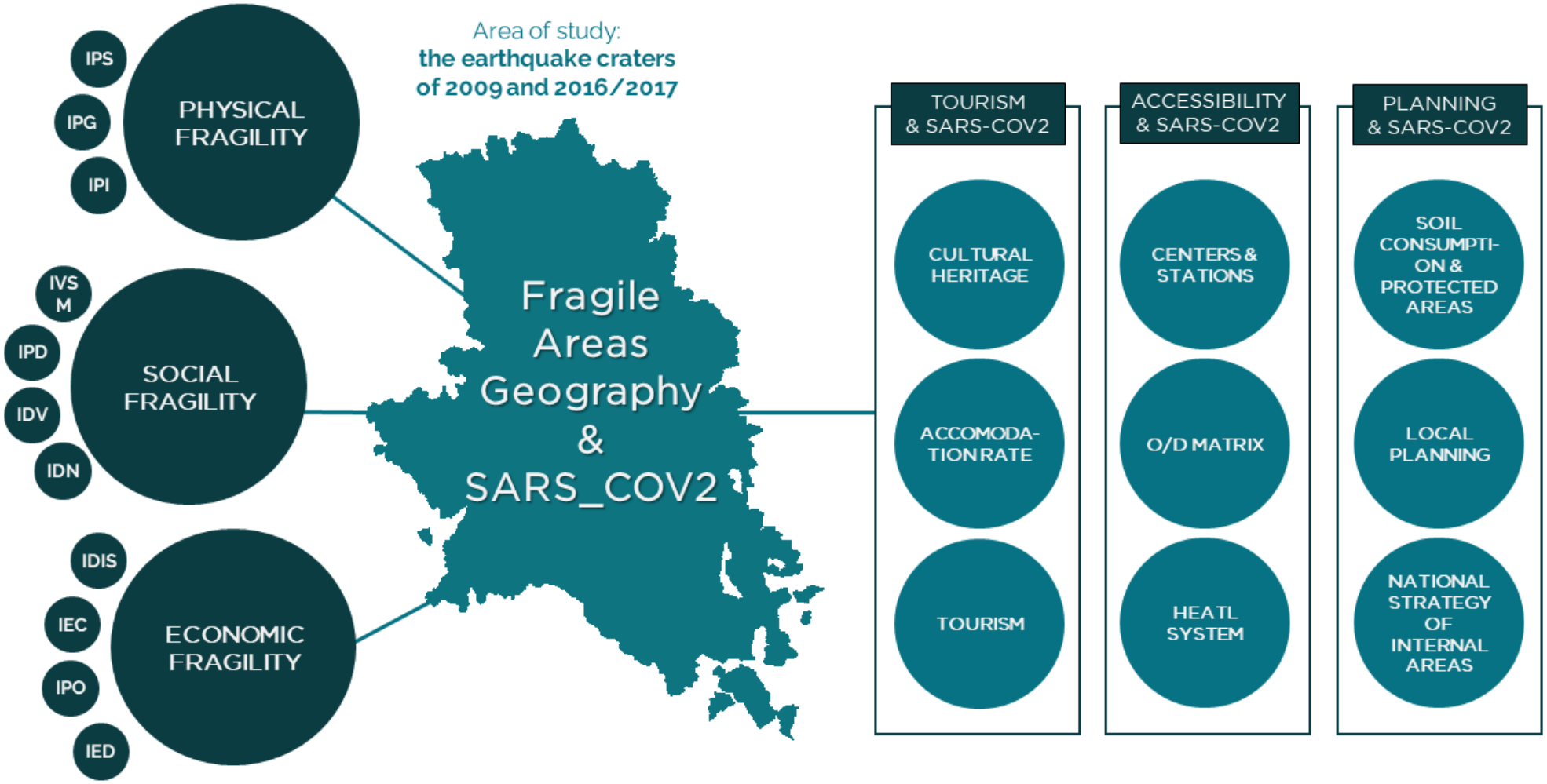
CNR-ISTI

USRA Ufficio Speciale per la Ricostruzione dell'Aquila

UNIVERSITA' DEGLI STUDI D'ANNUNZIO

CGIL CISL UIL

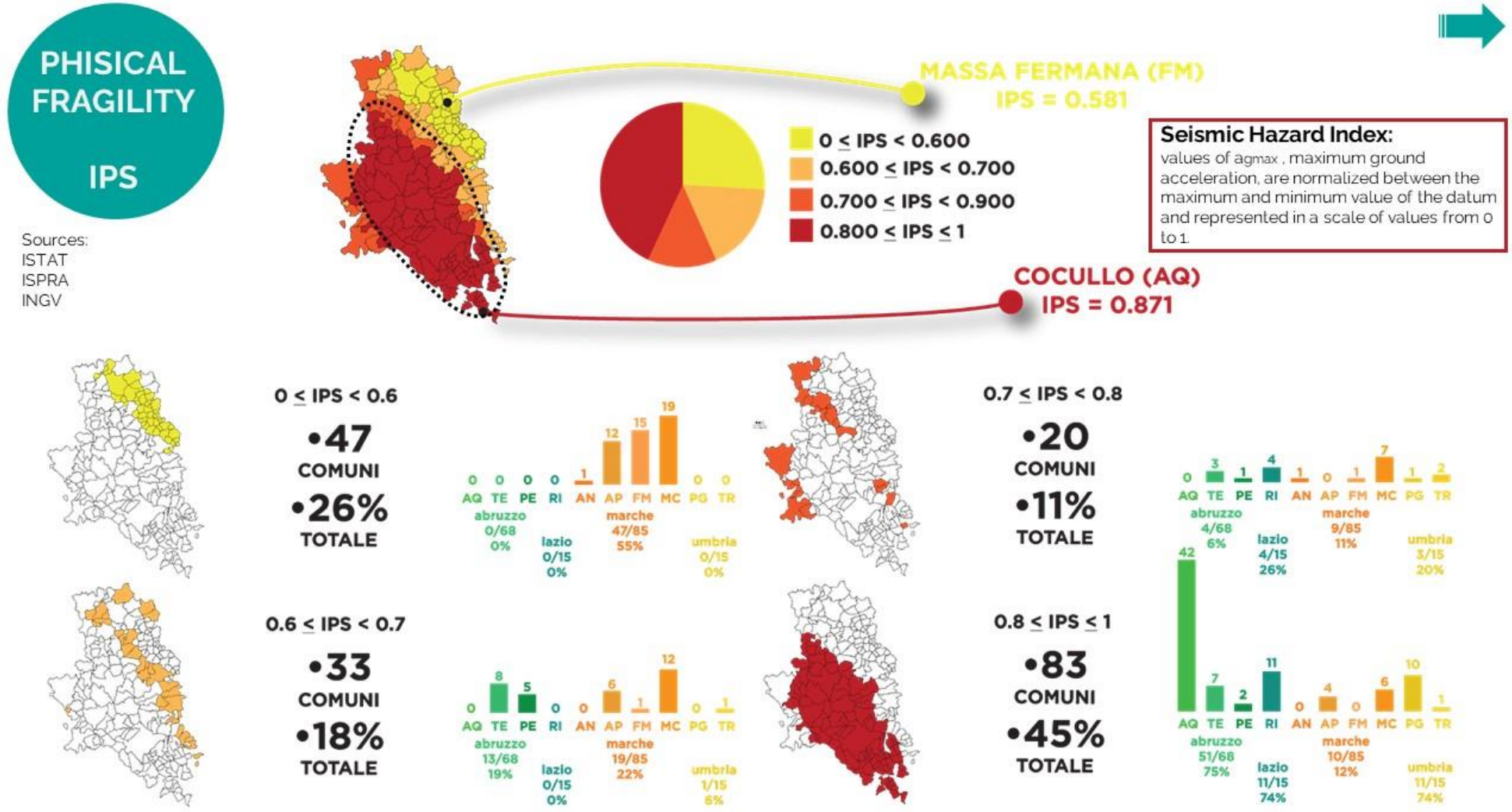
SARS-COV2 In Fragile Areas



Physical Fragility Index - IFF

Nr	Geografia/Lettura – Indice sintetico	Indice	Tipo di lettura	Formula	Range valori non norm. alla scala macroarea	Range valori non norm. alla scala nazionale	Rif. Bibliografico	Fonte Dati	Data agg.
1	PHYSICAL FRAGILITY *Physical Synthethic Index - IFF*	IPS – Seismic Hazard Index	Statistics	$\frac{A_{g_i}}{A_{g(50°perc)}}$	0.173 / 0.261	0.028 / 0.280	Elaborazione interna	ISTAT, INGV	2015
		IPG – Hydrogeological Hazard Index	Statistics	$\frac{S_{i(P_{idrog3-4})}}{S_i}\%$	0.00 / 36.8	0.00 / 97.5	Trigila A., Iadanza C., Bussettini M., Lastoria B., Barbano A. (2015) Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. Rapporto 2015. ISPRA, Rapporti 233/2015 (ISBN 978-88-448-0751-1)	ISTAT, ISPRA	2015
		IPI – Hydraulic Hazard Index	Statistics	$\frac{S_{i(P_{idr3-4})}}{S_i}\%$	0.00 / 77.23	0.00 / 100	Trigila A., Iadanza C., Bussettini M., Lastoria B., Barbano A. (2015) Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. Rapporto 2015. ISPRA, Rapporti 233/2015 (ISBN 978-88-448-0751-1)	ISTAT, ISPRA	2015

Physical Fragility – Seismic Hazard Index



Physical Fragility – Hydrogeological Hazard Index

Sources:
ISTAT
ISPRA

0 ≤ IPG < 0.100
0.100 ≤ IPG < 0.300
0.300 ≤ IPG < 0.500
0.500 ≤ IPG ≤ 1

BORBONA (RI)
IPG = 0.000

OVINDOLI (AQ)
IPG = 1

Hydrogeological Hazard Index:
percentage on the total extension of the municipality of the surfaces falling in HIGH and VERY HIGH Hydrogeological Hazard Areas. The percentage, normalized, varies between 0 and 1.

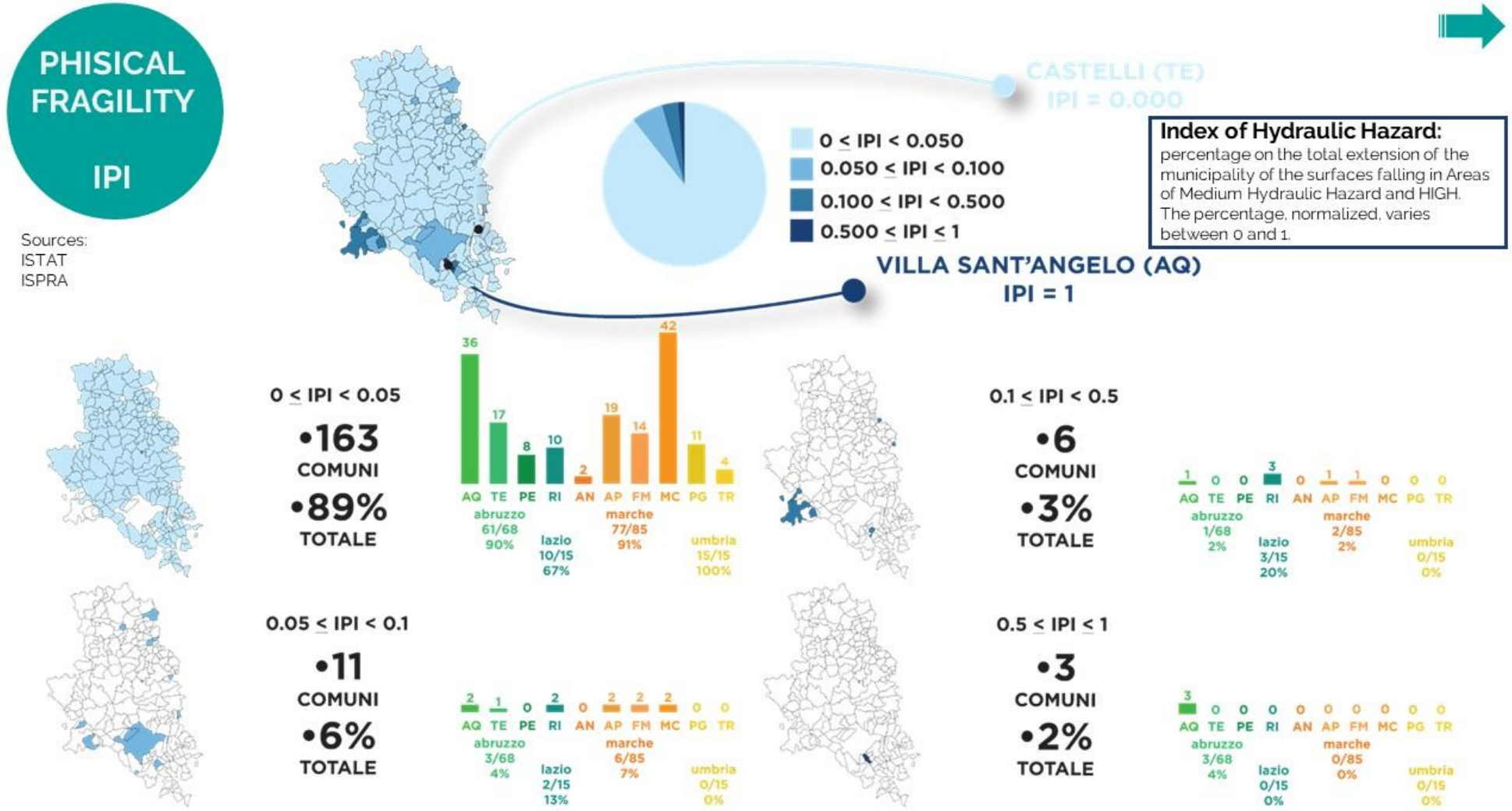
0 ≤ IPG < 0.1
•91
COMUNI
•50%
TOTALE

0.3 ≤ IPG < 0.5
•30
COMUNI
•16%
TOTALE

0.1 ≤ IPG < 0.3
•44
COMUNI
•24%
TOTALE

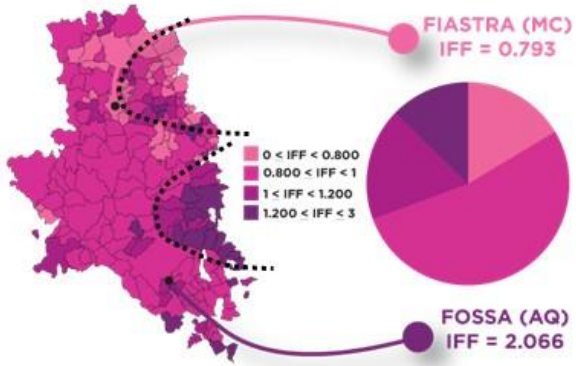
0.5 ≤ IPG ≤ 1
•18
COMUNI
•10%
TOTALE

Physical Fragility – Index of Hydraulic Hazard



Physical Fragility Index

Sources:
ISTAT
ISPRA
INGV



IFF

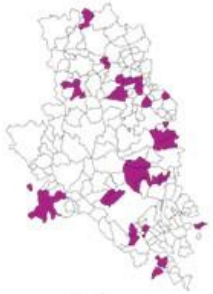
The Physical Fragility Index (**IFF**) is the combination of the previously described Indices (IPS, IPG, IPI).
The score attributed to the Index of Physical Fragility varies between 0 and 3, where 3 is the maximum value that overall indicates a greater fragility, at the physical level, of the territory. From the graphic representation it is clear that compared to all the municipalities of the Crater there is a clear difference between the physical fragility in the Abruzzo area, especially in Teramo, which has much higher values of IFF, mainly due to the combination of a very high Seismic Hazard (IPS) and Hydrogeological Hazard (IPG).

0 ≤ IFF < 0.8

•33
COMUNI
•18%
TOTALE

0.8 ≤ IFF < 1

•98
COMUNI
•54%
TOTALE



1 ≤ IFF < 1.2

•28
COMUNI
•15%
TOTALE

1.2 ≤ IFF ≤ 3

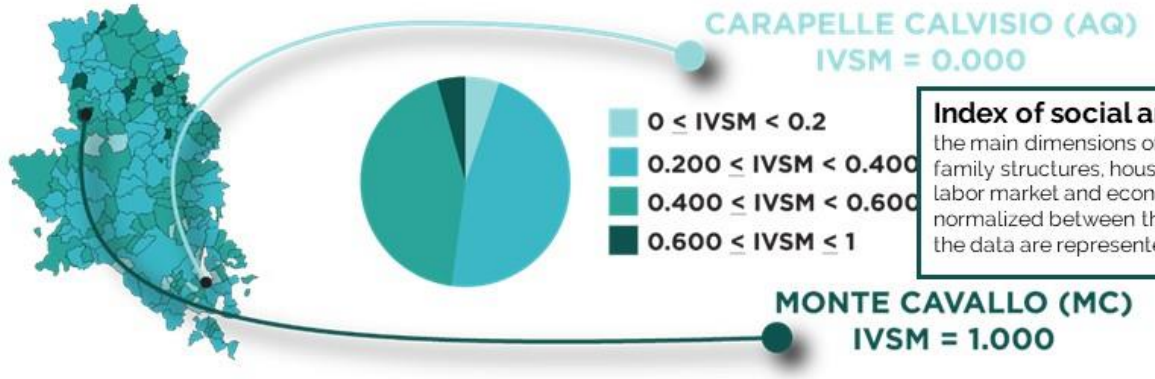
•24
COMUNI
•13%
TOTALE

Social Fragility Index - IFS

2	SOCIAL FRAGILITY *Social Synthethic Index - IFS*	IDA – Illiteracy index	Statistics	$\frac{P_{i,>6(analf.)}}{P_{i,>6}}\%$	0.00 / 4.80	0.00 / 30.1	--	ISTAT	2011
		TCP – Population Growth Rate	Statistics	$\mu e\left(\frac{P_{i,x+10}-P_{i,x}}{P_{i,x}}\%\right)_{x=1951}^{x=2041}$	-52.00 / +9.47		Elaborazione interna	ISTAT	2020
		IdV – Ageing Index	Statistics	$\frac{P_{i,>65}}{P_{i,(0-14)}}\%$	110.20 / 2766.70	0.00 / 2850	8mila Census	ISTAT	2011
		IdN – Birth Rate	Statistics	$\frac{N_{i,x}}{(P_{i,x-1}-P_{i,x})/2}‰$	0.00 / 11.07		Elaborazione interna	ISTAT	2011

Social Fragility – Illiteracy Index

Sources:
ISTAT



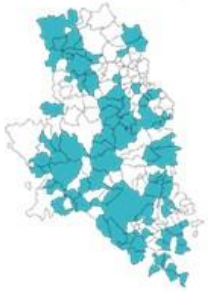
Index of social and material vulnerability:
the main dimensions of the data are level of education, family structures, housing conditions, participation in the labor market and economic conditions. The values, normalized between the maximum and minimum value of the data are represented on a scale between 0 and 1.

0 ≤ IVSM < 0.2

•12
COMUNI
•6%
TOTALE

0.4 ≤ IVSM < 0.6

•80
COMUNI
•44%
TOTALE



0.2 ≤ IVSM < 0.4

•82
COMUNI
•45%
TOTALE

0.6 ≤ IVSM ≤ 1

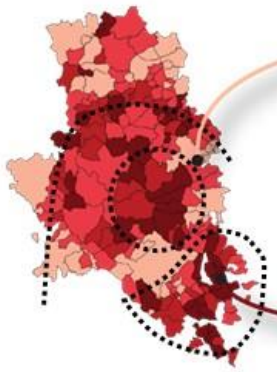
•9
COMUNI
•5%
TOTALE

Social Fragility – Population Growth Rate

SOCIAL FRAGILITY

IPD

Sources:
ISTAT



FOLIGNANO (AP)
IDP = 0.000

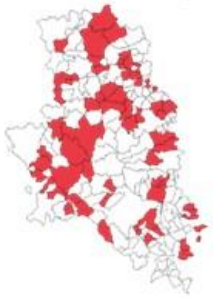
0 ≤ IDP < 0.300
0.300 ≤ IDP < 0.500
0.500 ≤ IDP < 0.600
0.600 ≤ IDP ≤ 1

Population dynamics index: median of the percentage change in population every 10 years from 1951 to 2051. Values, normalized between the maximum and minimum value of the percentage, are represented on a scale between 0 and 1.

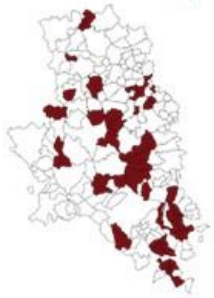
VILLA SANTA LUCIA DEGLI ABRUZZI (AQ) IDP = 1.000

0 ≤ IDP < 0.3
•36
COMUNI
•20%
TOTALE

0.5 ≤ IDP < 0.6
•40
COMUNI
•22%
TOTALE

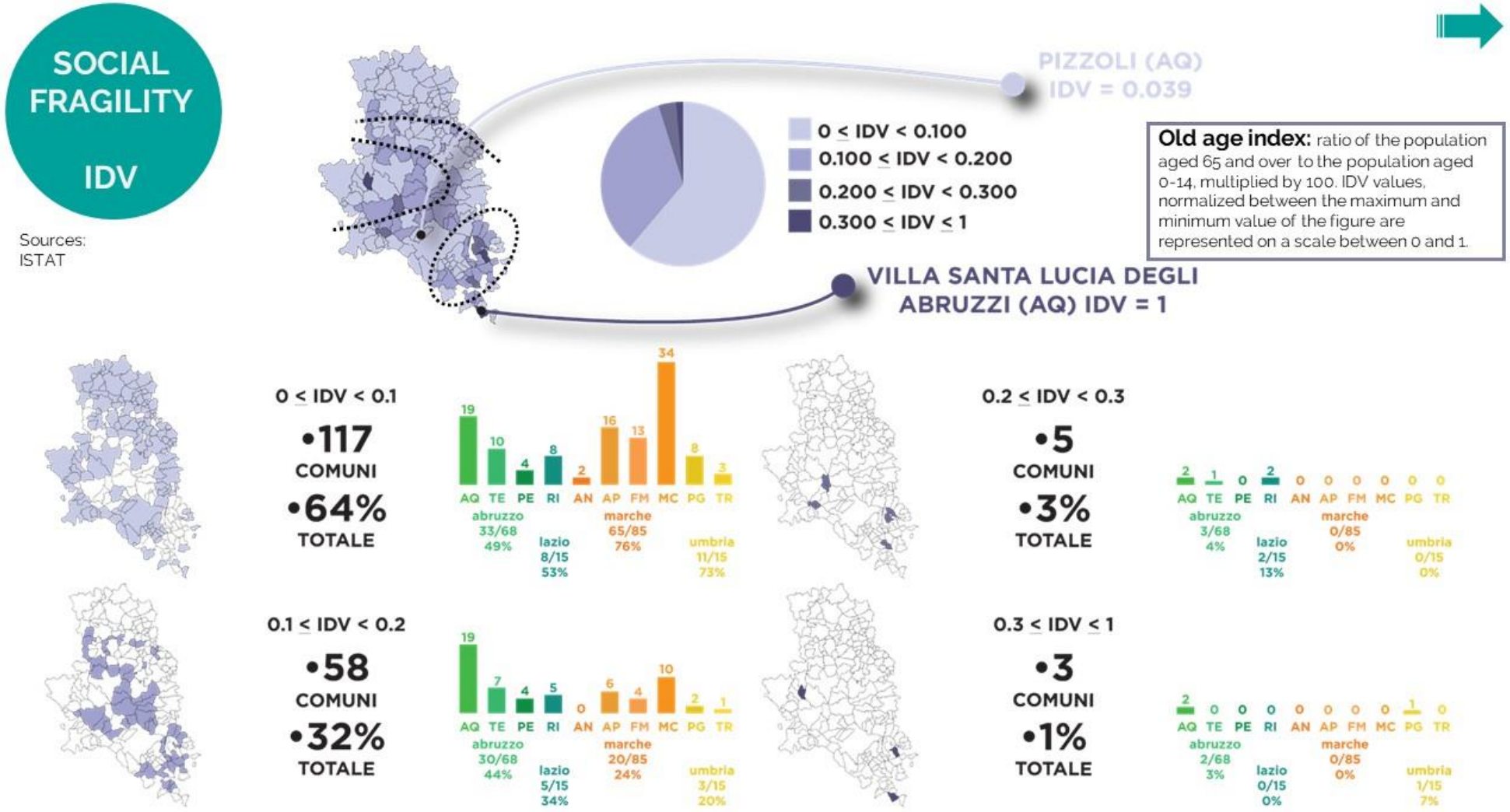


0.3 ≤ IDP < 0.5
•62
COMUNI
•34%
TOTALE

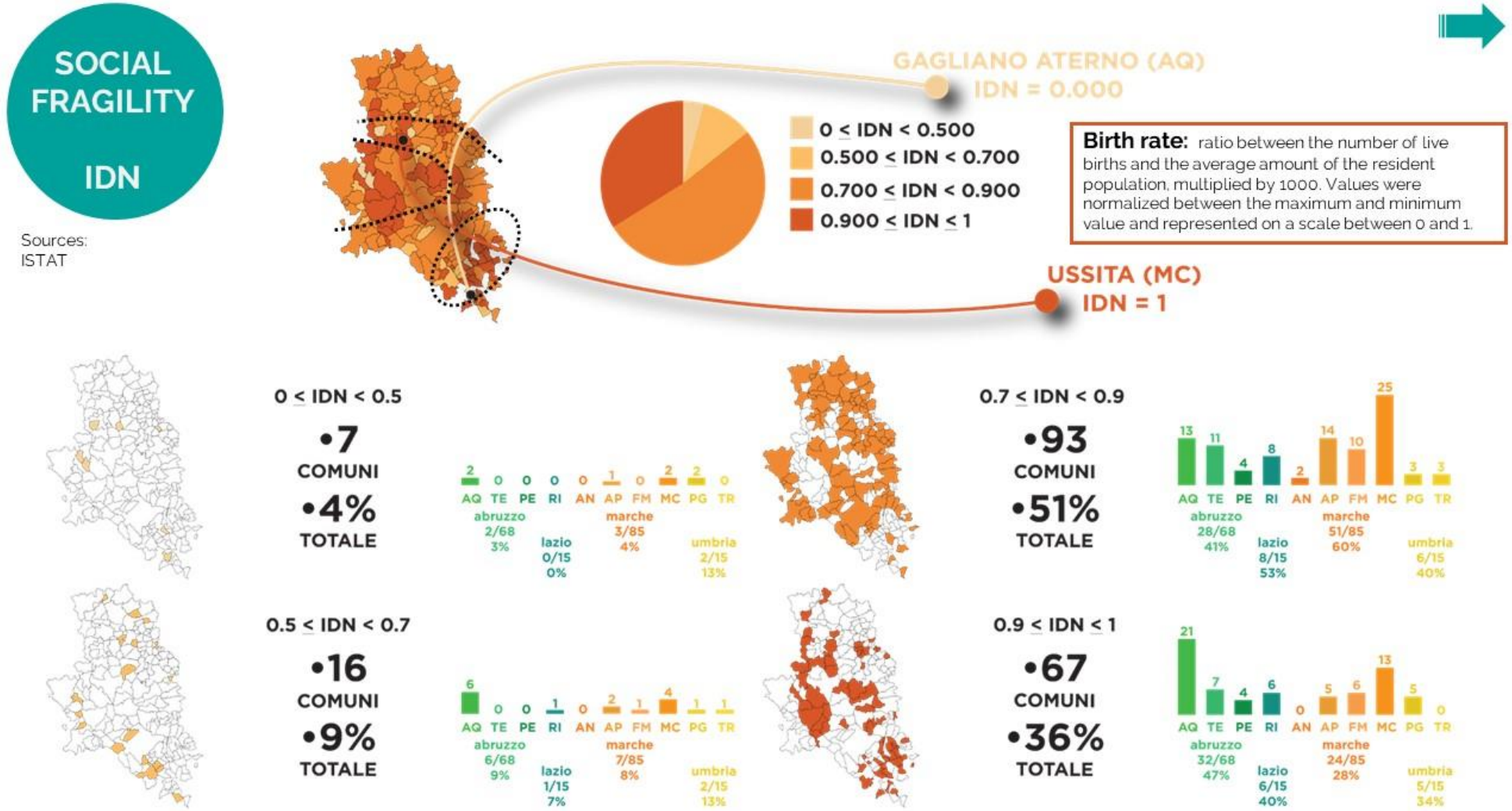


0.6 ≤ IDP ≤ 1
•45
COMUNI
•24%
TOTALE

Social Fragility – Ageing Index

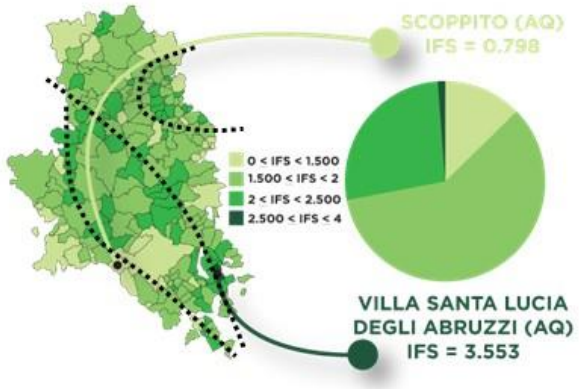


Social Fragility – Birth Rate



Social Fragility Index

Sources:
ISTAT



IFS

The Index of Social Fragility (IFS) is the combination of the previously described Indices (IVSM, IDP, IDV, IDN). The score attributed to the Social Fragility Index varies between 0 and 4, where 4 is the maximum value that overall indicates greater fragility at the social level of the territory.
The graphic representation shows how in the 183 municipalities of the earthquake crater there is a homogeneous distribution of the various levels of fragility. Most municipalities have medium and medium-high values of IFS.

0 ≤ IFS < 1.5

•28
COMUNI
•15%
TOTALE

2 ≤ IFS < 2.5

•49
COMUNI
•27%
TOTALE

1.5 ≤ IFS < 2

•105
COMUNI
•83%
TOTALE

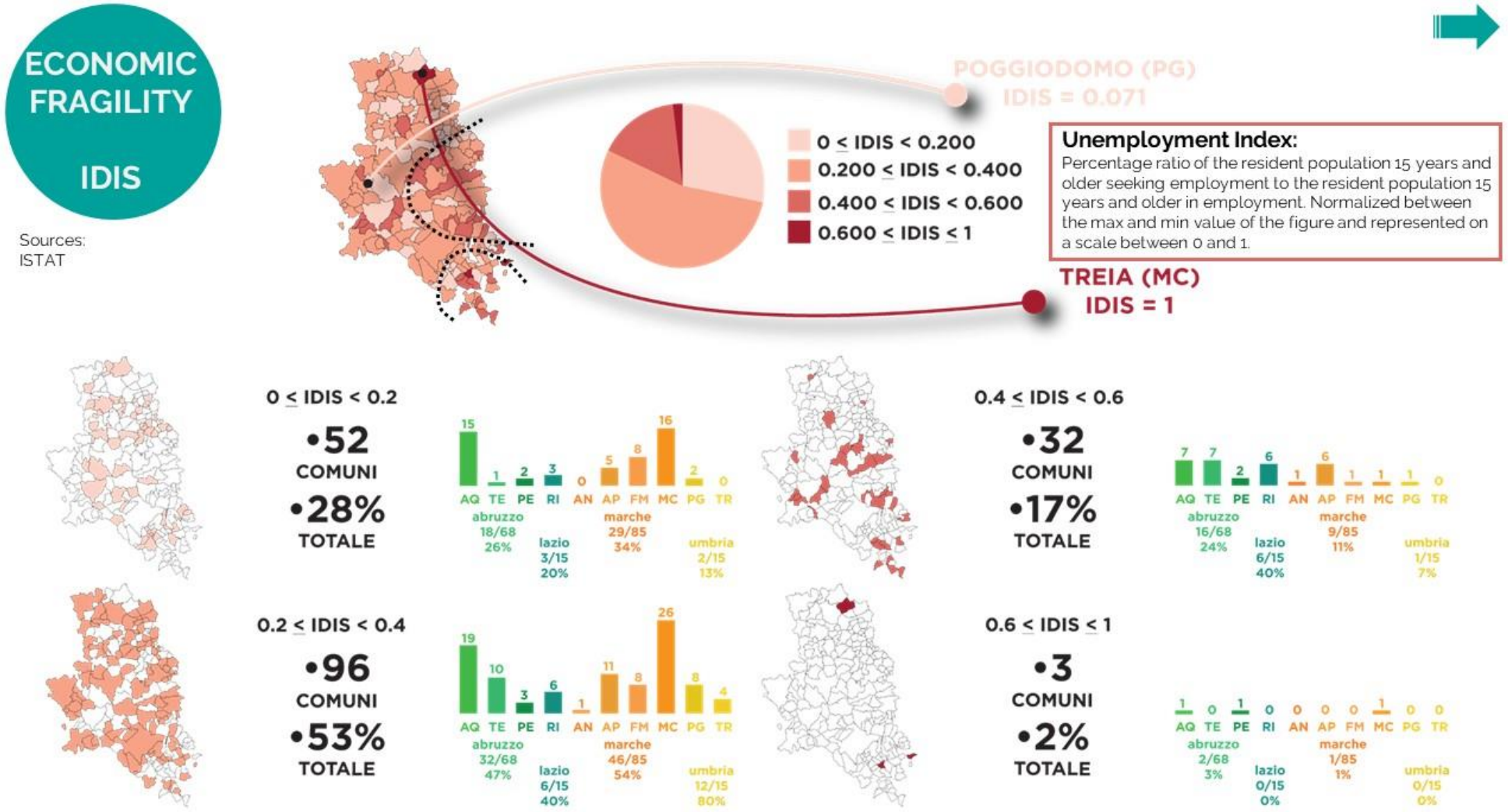
2.5 ≤ IFS ≤4

•1
COMUNI
•1%
TOTALE

Economic Fragility Index –IFE

3	ECONOMIC FRAGILITY *Economic Synthethic Index - IFE*	IDIS – Unemployment Index	Statistics	$\frac{P_{i,>15(dis)}}{P_{i,>15(attiva)}}\%$	2.00 / 26.50	0.00 / 42.20	8mila Census	ISTAT	2011
		IEC – Index of Economic Inertia*	Statistics	$\mu(z_{score})$: $\left(\frac{P_{i,agric.}}{P}\%\right)$; $\left(\frac{P_{i,manif.}}{P}\%\right)$; $\left(\frac{P_{i,comm.}}{P}\%\right)$; $\left(\frac{P_{i,serv.}}{P}\%\right)$;	-0.71 / +1.32	- 0.78 / 13.52	(PostMet 2015)	ISTAT	2011
		IPO – Poverty Index	Statistics	$\frac{P_{i,contr.(€>10.000)}}{P_{i,contr.}}\%$	20.13 / 56.72	*elab. propria	Direzione Studi e Ricerche Economico-Fiscali Ufficio di Statistica (2018) Statistiche sulle dichiarazioni fiscali. Analisi dei dati irpef. Anno d'imposta 2018.	ISTAT, MEF	2018
		IED – Digital Divide Index	Statistics	$\frac{P_{i,escl.}}{P_i}\%$	0 / 100	0 / 100	(PostMet 2015)	ISTAT, MiSE	2013

Economic Fragility – Unemployment Index

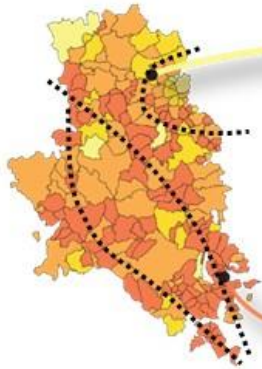


Economic Fragility – Index of Economic Inertia

ECONOMIC FRAGILITY

IEC

Sources:
ISTAT



0 ≤ IEC < 0.300
0.300 ≤ IEC < 0.500
0.500 ≤ IEC < 0.700
0.700 ≤ IEC ≤ 1

COLMURANO (MC)
IEC = 0.281

VILLA SANTA LUCIA DEGLI ABRUZZI (AQ) IEC = 1

Index of economic inertia: calculated from the average of the percentages of employees in agriculture, manufacturing, commerce and services over the total population. Obtained by normalizing between 0 and 1 the values obtained from the average.

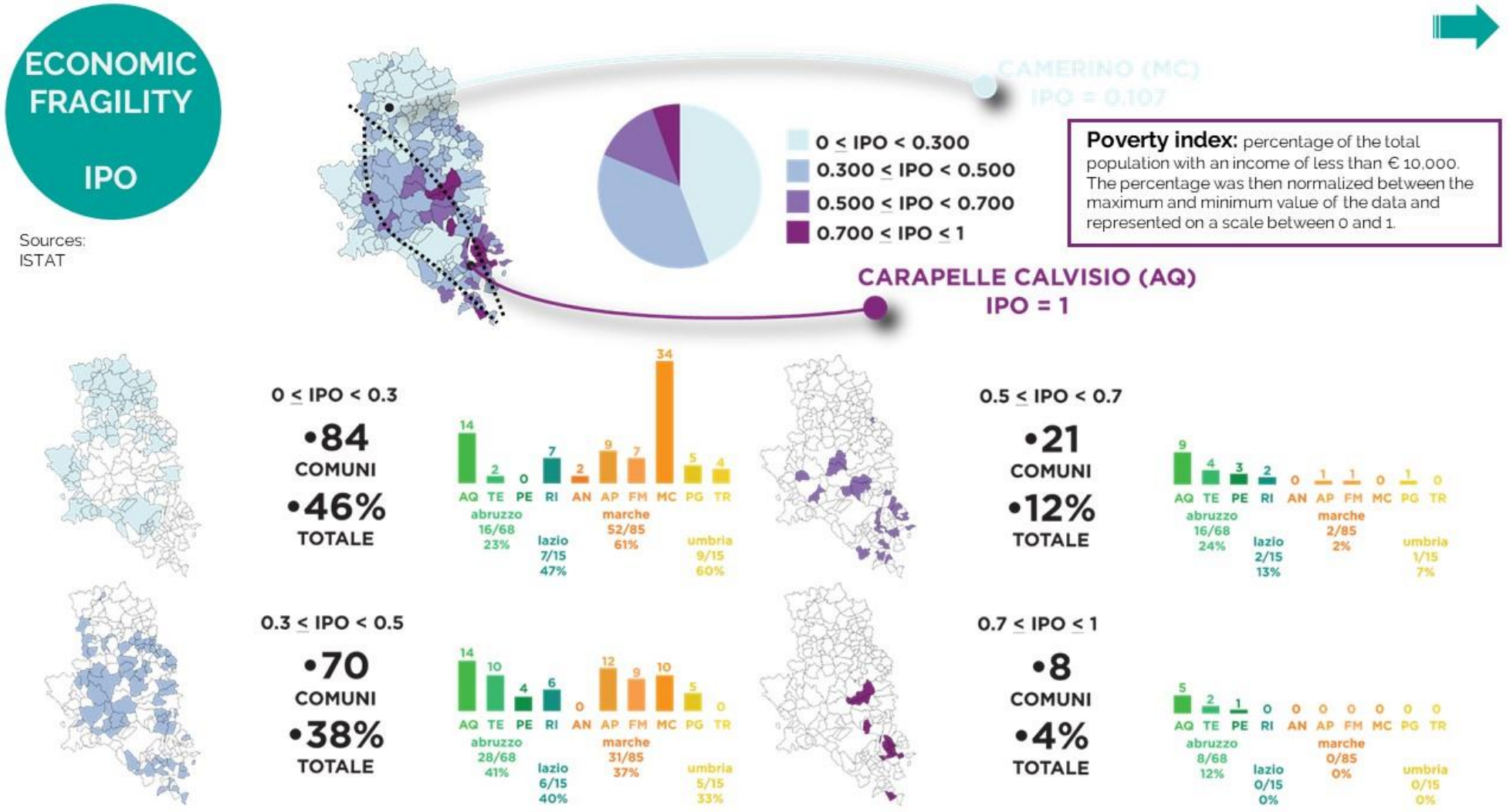
0 ≤ IEC < 0.3
•7
COMUNI
•4%
TOTALE

0.5 ≤ IEC < 0.7
•60
COMUNI
•33%
TOTALE

0.3 ≤ IEC < 0.5
•23
COMUNI
•12%
TOTALE

0.7 ≤ IEC ≤ 1
•93
COMUNI
•51%
TOTALE

Economic Fragility – Poverty Index

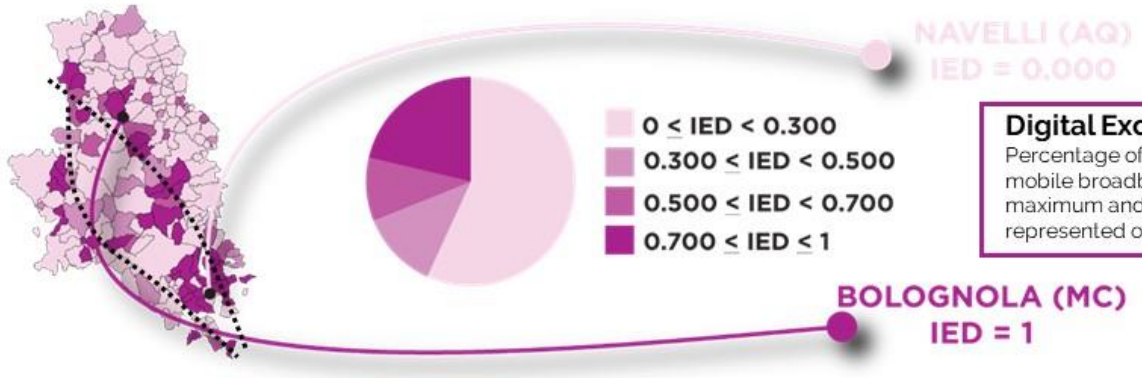


Economic Fragility – Digital Divide Index

ECONOMIC FRAGILITY

IED

Sources:
ISTAT



Digital Exclusion Index:
Percentage of population excluded from fixed and mobile broadband, also normalized between the maximum and minimum value of the figure and represented on a scale between 0 and 1.

0 ≤ IED < 0.3

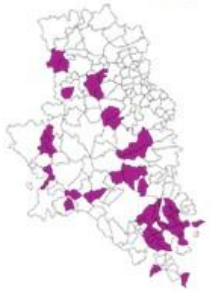
•107
COMUNI
•58%
TOTALE

0.5 ≤ IED < 0.7

•17
COMUNI
•9%
TOTALE

0.3 ≤ IED < 0.5

•18
COMUNI
•10%
TOTALE

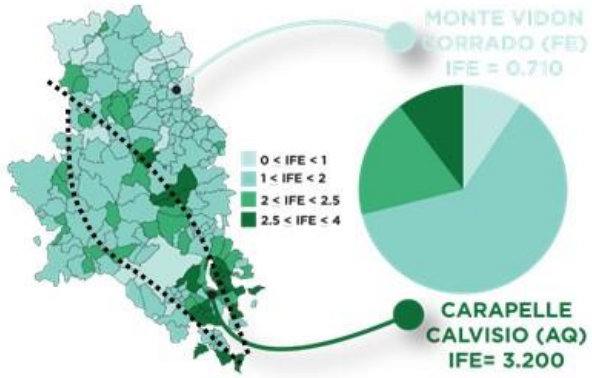


0.7 ≤ IED ≤ 1

•41
COMUNI
•23%
TOTALE

Economic Fragility Index

Sources:
ISTAT



IFE

The Index of Economic Fragility (IFE) is the combination of the previously described Indices (IDIS, IEC, IPO, IE).
The score attributed to the Index of Economic Fragility varies between 0 and 4, where 4 is the maximum value that overall indicates a greater fragility, at the economic level, of the territory.
From the graphical representation it can be seen that in the 183 municipalities of the Crater there is greater economic fragility in the municipalities of Abruzzo, in particular in the Teramo area and in the area east of the province of L'Aquila.On the contrary, also comparing the percentages with respect to the number of municipalities involved, the Marche region has lower values than the IFE, confirming the positive trend also found in the previous elaborations of the 85 municipalities involved.

0 ≤ IFE < 1

•19
COMUNI
•10%
TOTALE

2 ≤ IFE < 2.5

•32
COMUNI
•18%
TOTALE

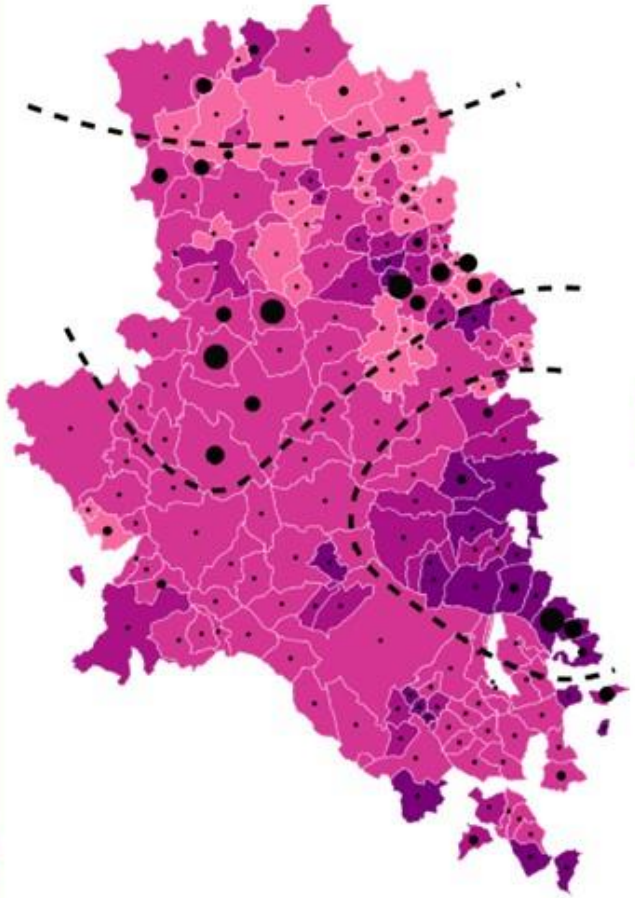
1 ≤ IFE < 2

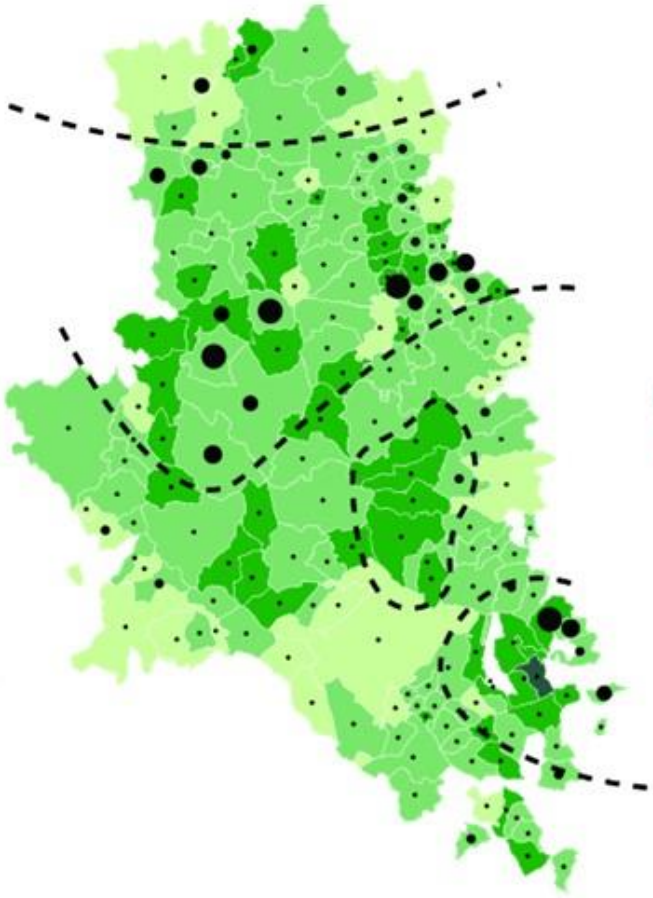
•114
COMUNI
•62%
TOTALE

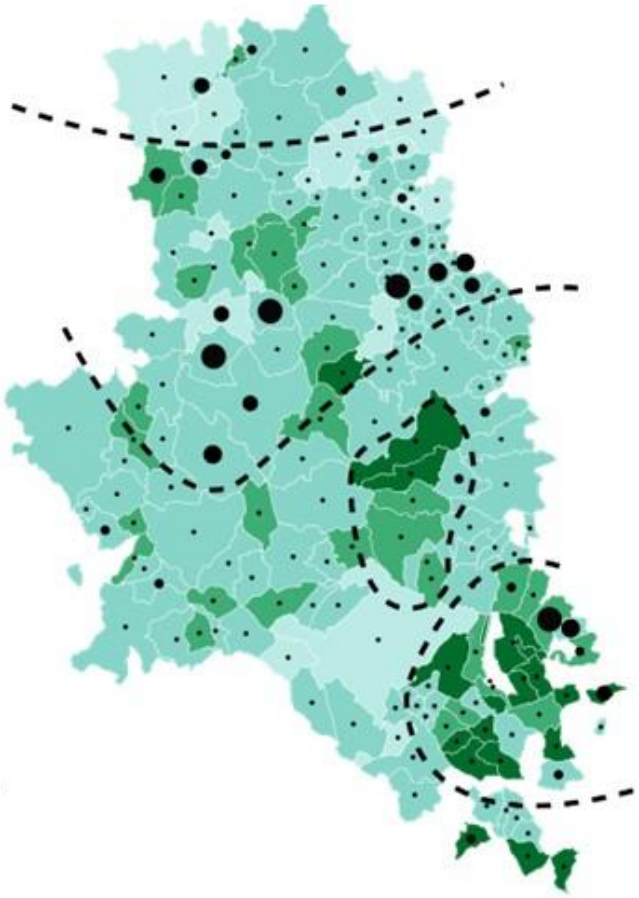
2.5 ≤ IFE ≤ 4

•18
COMUNI
•10%
TOTALE

OVERLAY BETWEEN SARS_COV2 & FRAGILITY SYNTHETIC INDEXES







POSITIVE DENSITY_DPOS_SarsCov2 _updated to 08|26th: pos/inhab

- 0% < DPOS < 1%
- 1% < DPOS < 2%
- 2% < DPOS < 3%
- 3% < DPOS < 4%
- DPOS > 4%

DEFINITION OF THE PHENOMENON

PHYSICAL FRAGILITY INDEX_IFF

- 0 < IFF < 0.800
- 0.800 < IFF < 1
- 1 < IFF < 1.200
- 1.200 < IFF < 4

SOCIAL FRAGILITY INDEX_IFS

- 0 < IFS < 1.500
- 1.500 < IFS < 2
- 2 < IFS < 2.500
- 2.500 < IFF < 4

ECONOMIC FRAGILITY INDEX_IFE

- 0 < IFE < 1
- 1 < IFE < 2
- 2 < IFE < 2.500
- 2.500 < IFF < 4

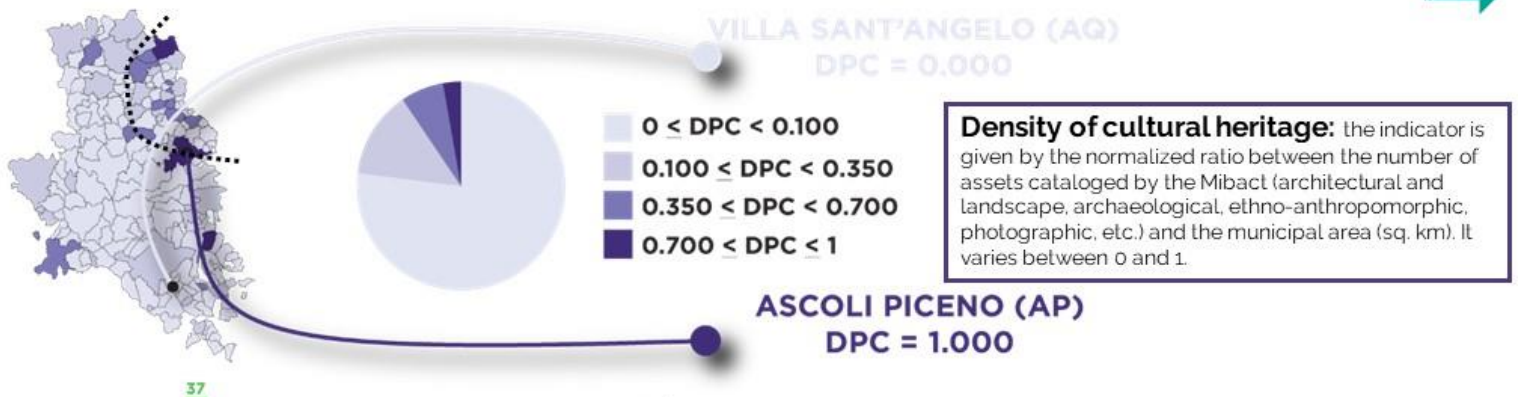
Tourism

4	TOURISM	IDPC – Cultural Heritage Density	Statistics	$\frac{BC_{i,}}{S_i} * 10.000$	0.00 / 2154.13	*elab. propria		ISTAT, MIBACT	2013
		TFR – Receptive Function Rate	Statistics	$\frac{SR_i}{(P_i * S_i)} * 10.000$	0.00 / 988.30	0.00 / 391568.4		ISTAT, MIBACT	2011
		IDV – Density of Visitors	Statistics	$\frac{V_{i,x}}{S_i} * 10.000$	0.00 / 495	*elab. propria		ISTAT, MIBACT	2013

Tourism – Cultural Heritage Density

TOURISM

Sources:
ISTAT
Mibact



Density of cultural heritage: the indicator is given by the normalized ratio between the number of assets cataloged by the Mibact (architectural and landscape, archaeological, ethno-anthropomorphic, photographic, etc.) and the municipal area (sq. km). It varies between 0 and 1.

0 ≤ DPC < 0.100

•142
COMUNI
•77%
TOTALE

0.350 ≤ DPC < 0.700

•13
COMUNI
•7%
TOTALE

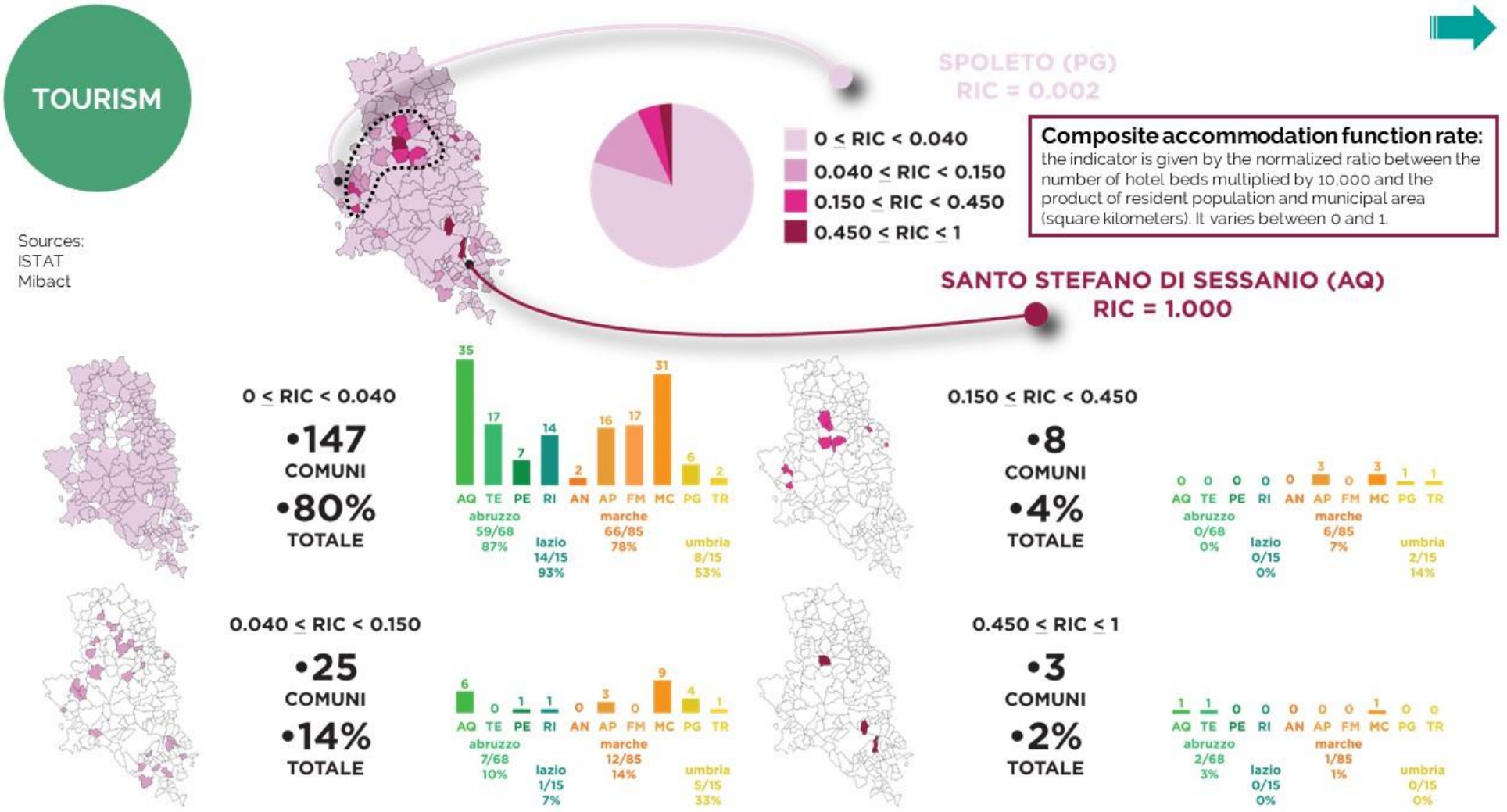
0.100 ≤ DPC < 0.350

•25
COMUNI
•14%
TOTALE

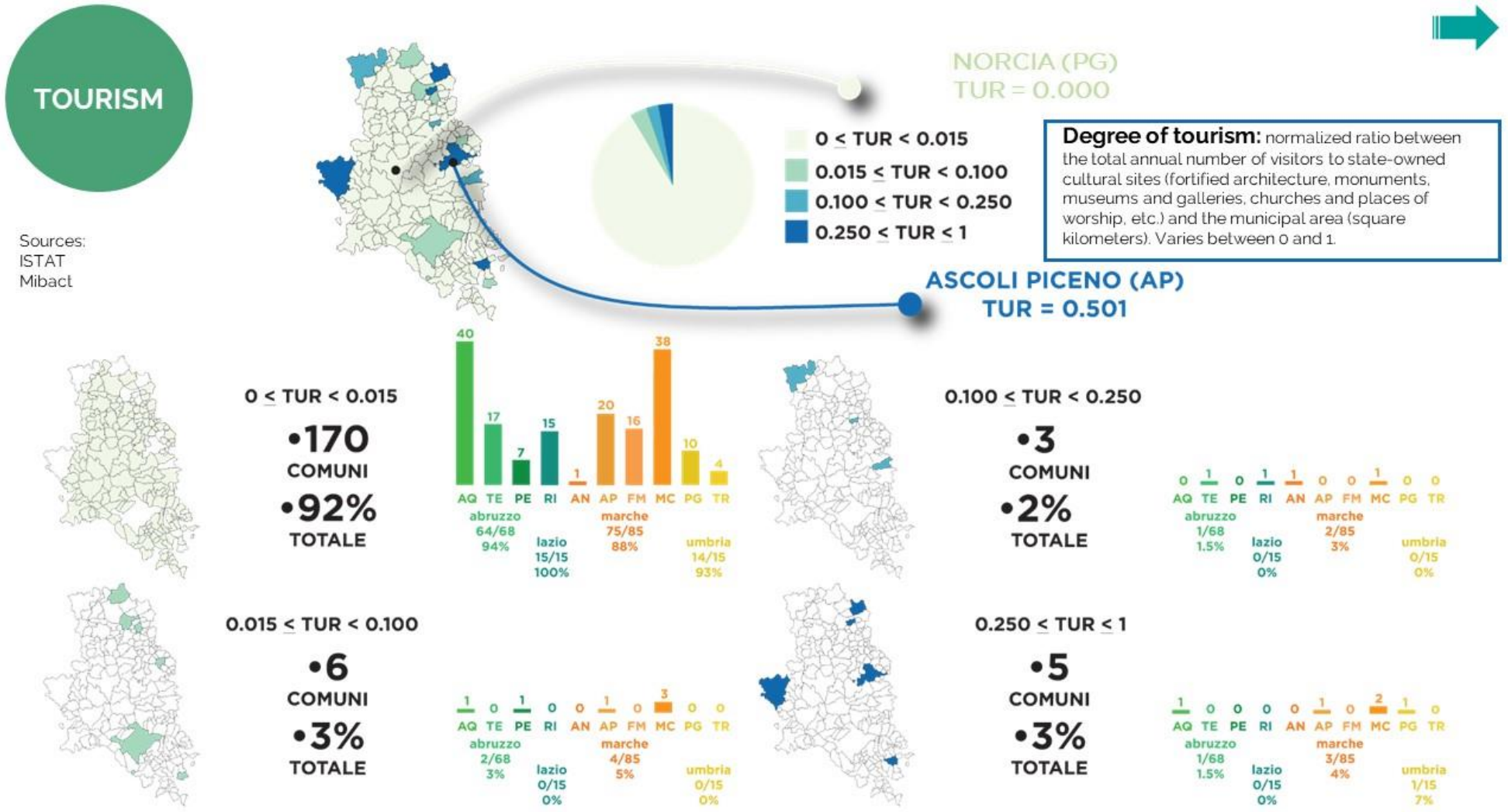
0.700 ≤ DPC ≤ 1

•3
COMUNI
•2%
TOTALE

Tourism – Receptive Function Rate



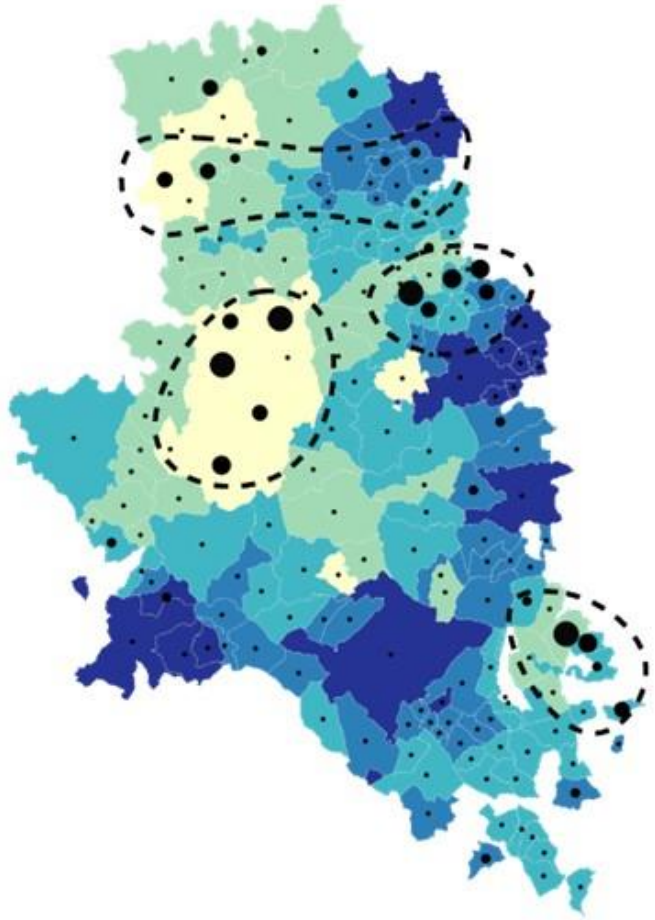
Tourism – Density of Visitors

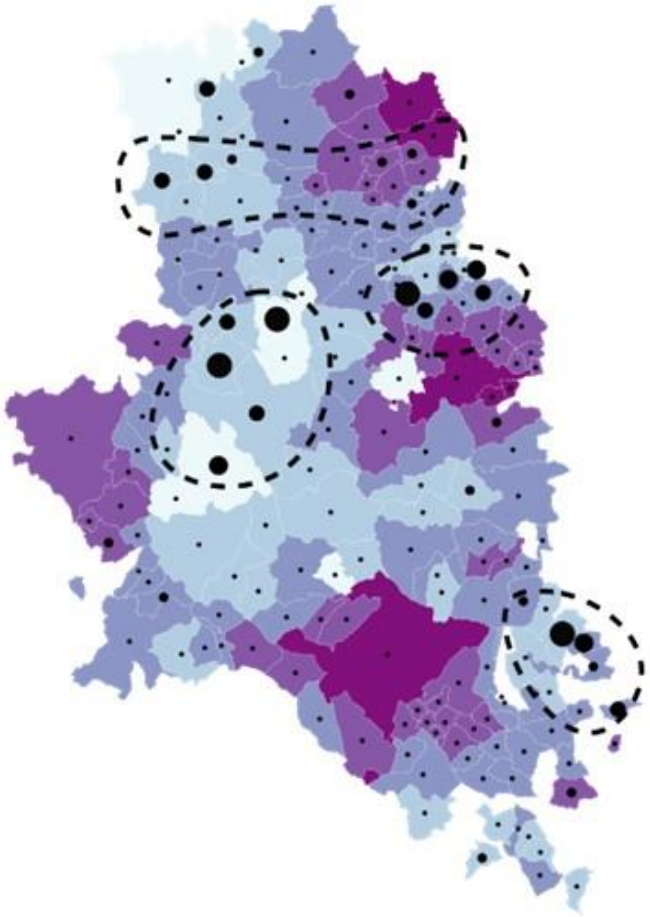


Accessibility

5	ACCESSIBILITY	IAC – Center Accessibility index	Statistics	Calculated using a sampling function of the isochrones in which the centroid of the municipality is located	0 / 4	0 / 4		ISTAT	2013
		IAS – Stations accessibility index	Statistics	Calculated using a sampling function of the isochrones in which the centroid of the municipality is located	0 / 4	0 / 4	(PostMet 2015)	ISTAT	2013
		Infrastructure Network	Territorial	--	--			OSM	
		Matrix O/D	Territorial	--	--			ISTAT	
		Accessibility to the Health Care System	Territorial	--	--		--	OSM, MDS	

OVERLAY BETWEEN SARS_COV2 & ACCESSIBILITY INDEXES





POSITIVE DENSITY_DPOS_SarsCov2 _updated to 08|26th: pos/inhab

- 0% < DPOS < 1%
- 1% < DPOS < 2%
- 2% < DPOS < 3%
- 3% < DPOS < 4%
- DPOS > 4%

DEFINITION OF THE PHENOMENON

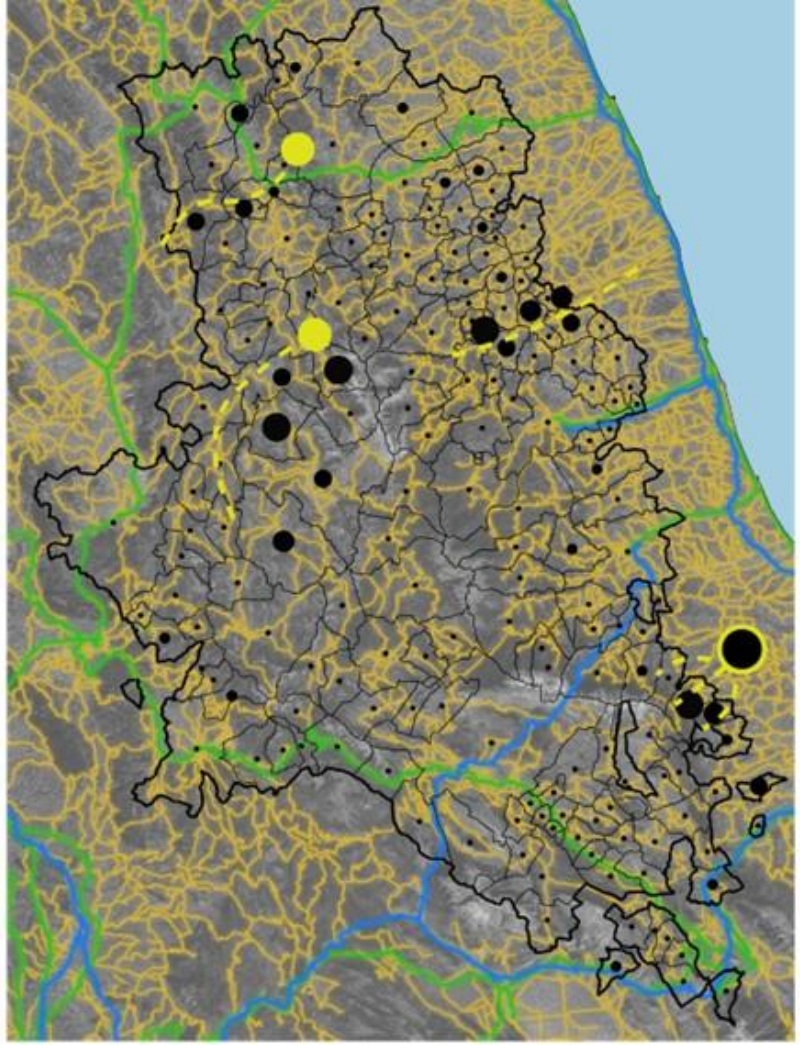
CENTERS ACCESSIBILITY INDEX

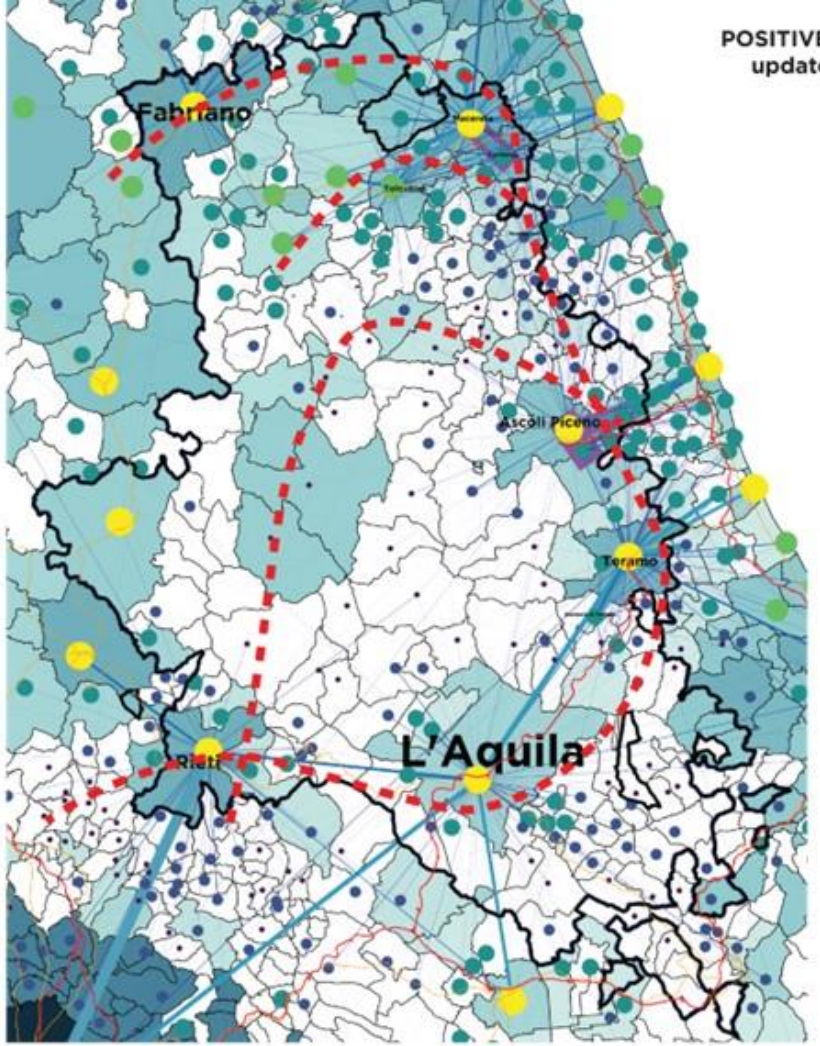
- 0
- 1
- 2
- 3
- 4

STATIONS ACCESSIBILITY INDEX

- 0
- 1
- 2
- 3
- 4

OVERLAY BETWEEN SARS_COV2 & O/D MATRIX





POSITIVE DENSITY_DPOS_SarsCov2_updated to 08|26th: pos/inhab

- 0% < DPOS < 1%
- 1% < DPOS < 2%
- 2% < DPOS < 3%
- 3% < DPOS < 4%
- DPOS > 4%

DEFINITION OF THE PHENOMENON

INFRASTRUCTURES

- RAILWAY
- HIGHWAY
- REGIONAL HIGHWAY
- COUNTY ROAD
- TANK
- TERMINAL

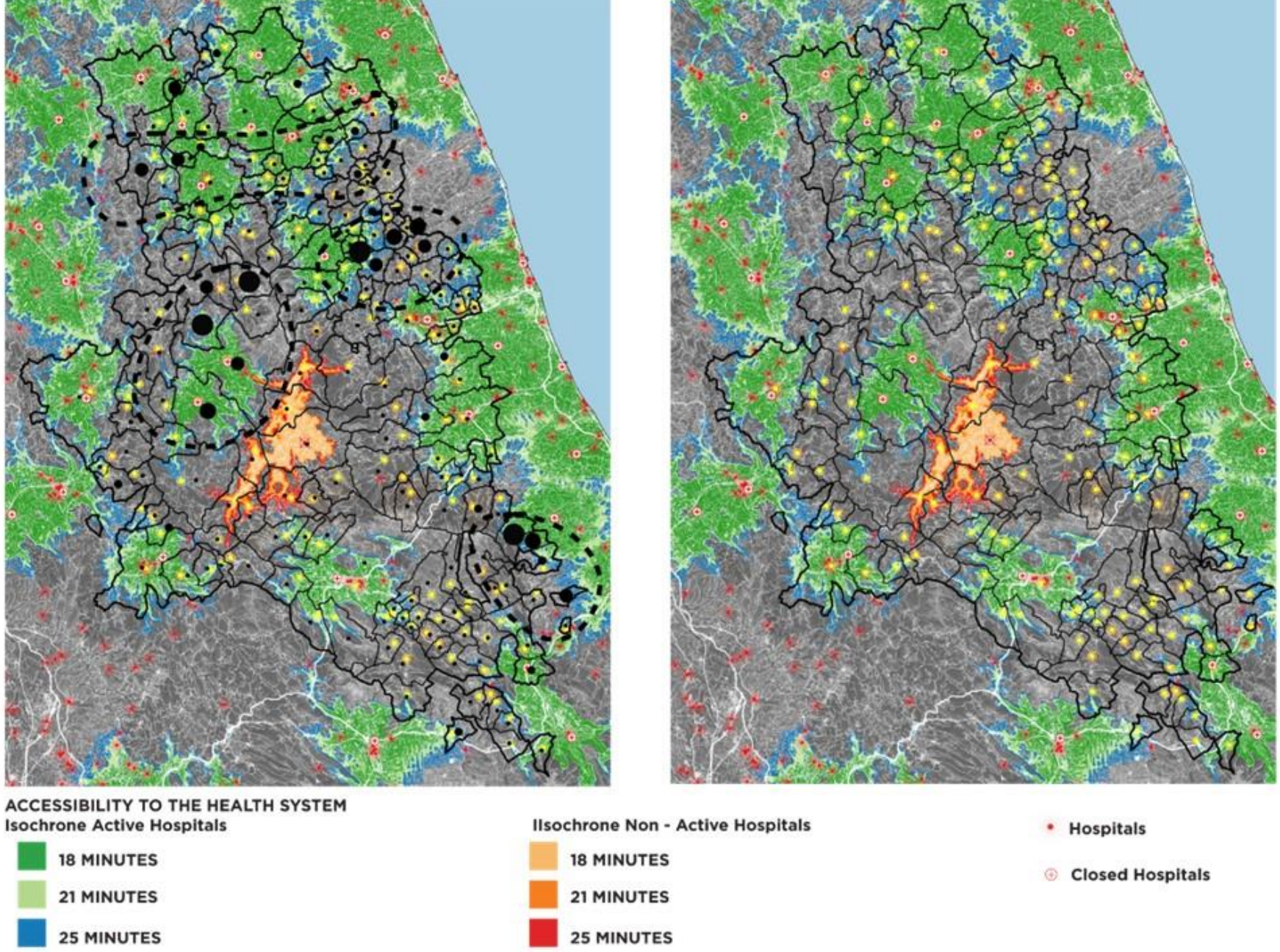
STUDY AND WORK FLOWS

- 1 - 65
- 65 - 256
- 256 - 555
- 555 - 1125
- 1125 - 2668

CLASSIFICATION OF THE MUNICIPALITY

- A - POLO
- B - INTERMUNICIPAL POLE
- C - BELT
- D - INTERMEDIATE
- E - PERIPHERICAL

OVERLAY BETWEEN SARS_COV2 & HEALT SYSTEM



Planning

6	PLANNING	Soil Consumption Rate and Protected Areas	Statistics		181.20 / 4398.40	0 / 17097.40	--	ISPRA, MATTM	2015
		Local Planning	Territorial	--	--		--	INU	
		Inland areas	Territorial	--	--		--	ACT	

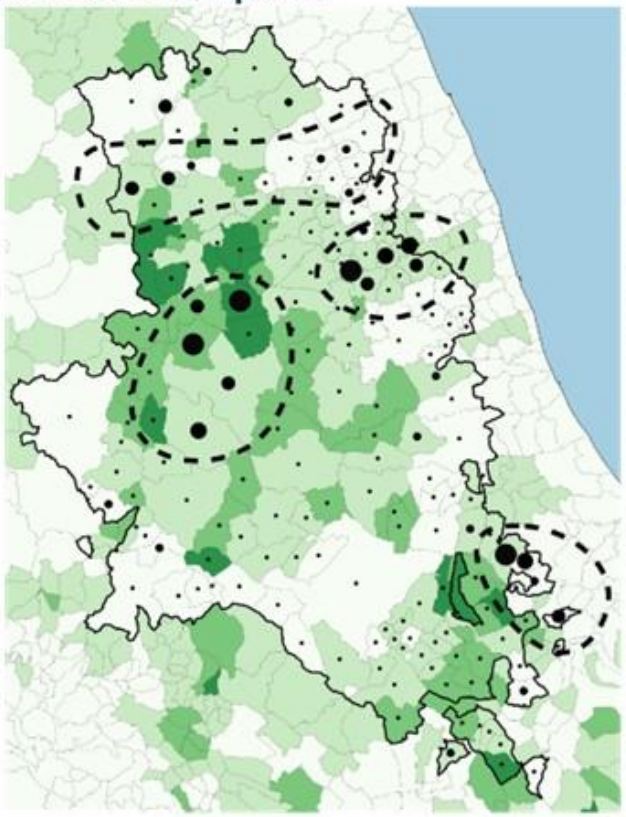
OVERLAY BETWEEN SARS_COV2 & PLANNING

POSITIVE DENSITY_DPOS_SarsCov2 _updated to 08|26th: pos/inhab

- 0% < DPOS < 1%
- 1% < DPOS < 2%
- 2% < DPOS < 3%
- 3% ≤ DPOS < 4%
- DPOS > 4%

DEFINITION OF THE PHENOMENON

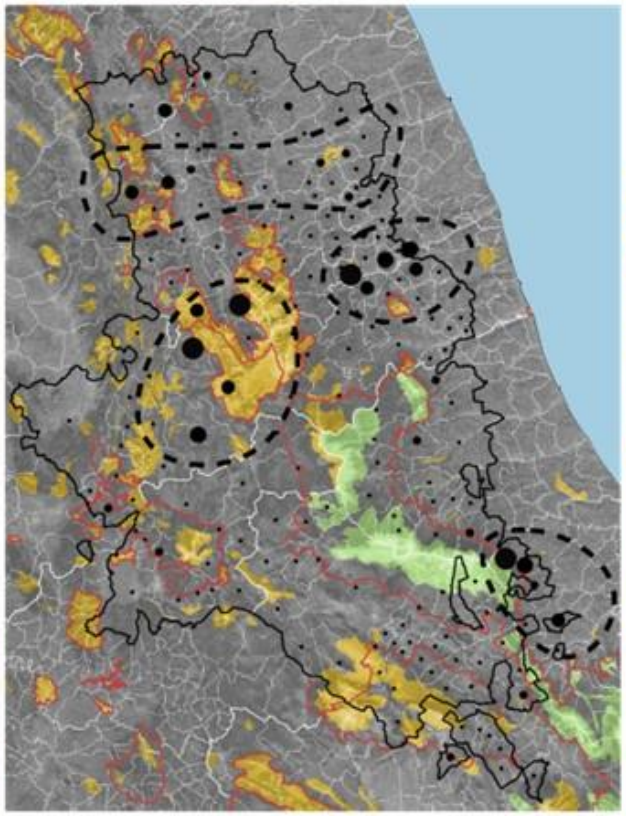
SARS-COV2 & Soil Consumption



SOIL CONSUMPTION (m²/inhab)

- 0 - 675
- 675 - 1380
- 1380 - 2773
- 2773 - 6191
- 6191 - 17097

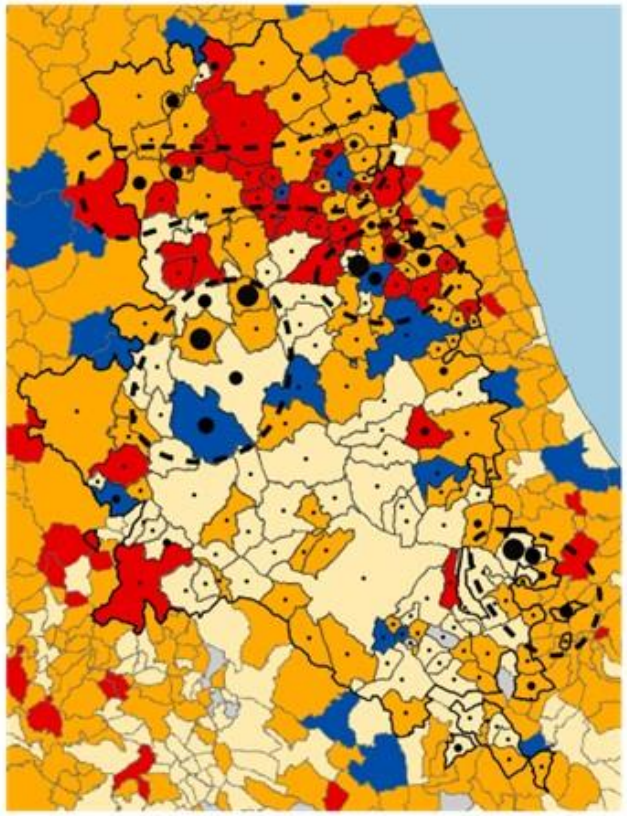
SARS-COV2 & Protected Areas



PROTECTED AREAS

- SITES OF COMMUNITY INTEREST (SIC)
- SPECIAL AREAS OF CONSERVATION (ZSC)

SARS-COV2 & Local planning



LOCAL PLANNING - Year of approvation

- NO PLANNING
- BEFORE 1955
- 1955 - 2010
- 2010 - 2014
- POST 2014

Conclusions

The first results described, allow us to highlight some phenomena in terms of critica issues:

- A persistent **isolation** of the territories that present **a high fragility**, not only related to physical infrastructures but also to digital or telecommunications infrastructures, made even more evident with the analysis of the distribution of Sars-Cov-2.

- The **fragility of the system of relations** between the territories of the crater that in project terms will require a system of governance and alliances that will necessarily have to face the territorial rebalancing to ensure accessibility and therefore the use, for example tourism, developing the **integration** of fragile contexts with the strong ones.

- The **gap** that characterizes the system of **territorial and proximity services**, which leaves open important questions such as health.

References

- Barbano, A. et al (2012). Proposta metodologica per l'aggiornamento delle mappe di pericolosità e di rischio - Attuazione della Direttiva 2007/60/CE relativa alla valutazione e alla gestione dei rischi da alluvioni (Decreto Legislativo n.49/2010). Manuali e Linee Guida ISPRA, 82/2012.
- Clementi, A. (1999). Infrastrutture e Progetti di Territorio. Palombi Editori. Roma.
- Cusimano, G. & Mercantanti, L. (2018). La strategia europea delle macroregioni. Opportunità e criticità. Geotema, 57, 8-17.
- Di Ludovico, D. & Di Lodovico, L. (2020). The Regional Management Risk Plan. Knowledge, scenarios and prevention projects in a regional context. International Journal of Disaster Risk Reduction. Vol. 45, 1-13. Doi: https://doi.org/10.1016/j.ijdrr.2019.101465.
- Di Ludovico, D. & D'Ascanio, F. (2019). European cross-scale spatial planning and Territorial Frames in the Italian Median Macroregion. European Planning Studies. Vol. 27, 1369-1390. Doi: https://doi.org/10.1080/09654313.2019.1581729.
- Di Ludovico, D. & Properzi, P. (2019). Smart Land e processi di sviluppo delle Aree Interne. In: (a cura di) Pignatti L., Rovigatti P., Angelucci F., Villani M., Territori fragili / Fragile territories. Paesaggi_Città_Architetture / Landscapes_Cities_Architecture. 672-679, Roma: Gangemi Editore.
- Di Ludovico, D. & Properzi, P. (2015). Governo del Territorio - Progetti di Territori. In: Italia mediana. una macroregione, strategie, piani e paesaggi, Di Ludovico, D. & Properzi, P. (a cura di). Verdone Editore. Castelli (TE).
- ISS (2020). Epidemia COVID-19. Aggiornamento nazionale (appendice): 18 agosto 2020. Istituto Superiore della Sanità. In: https://www.epicentro.iss.it/ (Ultimo accesso 25.08.2020).
- Mächtle, B. & Eitel, B. (2013). Fragile landscapes, fragile civilizations - How climate determined societies in the pre-Columbian south Peruvian Andes. Catena, N. 103, 62-73. Doi: https://doi.org/10.1016/j.catena.2012.01.012.
- Medici, F. et al (2019). Monitoraggio dei LEA attraverso la cd. Griglia LEA - Metodologia e Risultati dell'anno 2017. In: http://www.salute.gov.it/imgs/C_17_pubblicazioni_2832_allegato.pdf (ultimo accesso 30.10.2020)
- Moroni, S. (2007). La città del liberalismo attivo. Diritto, piano, mercato. CittàStudi. Torino.
- PostMetropoli (2015). Atlante dei territori post-metropolitani. In: http://www.postmetropoli.it/ (ultimo accesso: 14.10.2020)
- Sabel C.F (2013). Esperimenti di nuova democrazia. Tra globalizzazione e localizzazione, Armando Editore, Roma.
- Trigila, A. et al (2018). Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio. Edizione 2018. ISPRA, Rapporti 287/2018.
- Vinci, I. a cura di (2010). Pianificazione strategica in contesti fragili. Alinea Editrice. Firenze.

Thanks for your attention.