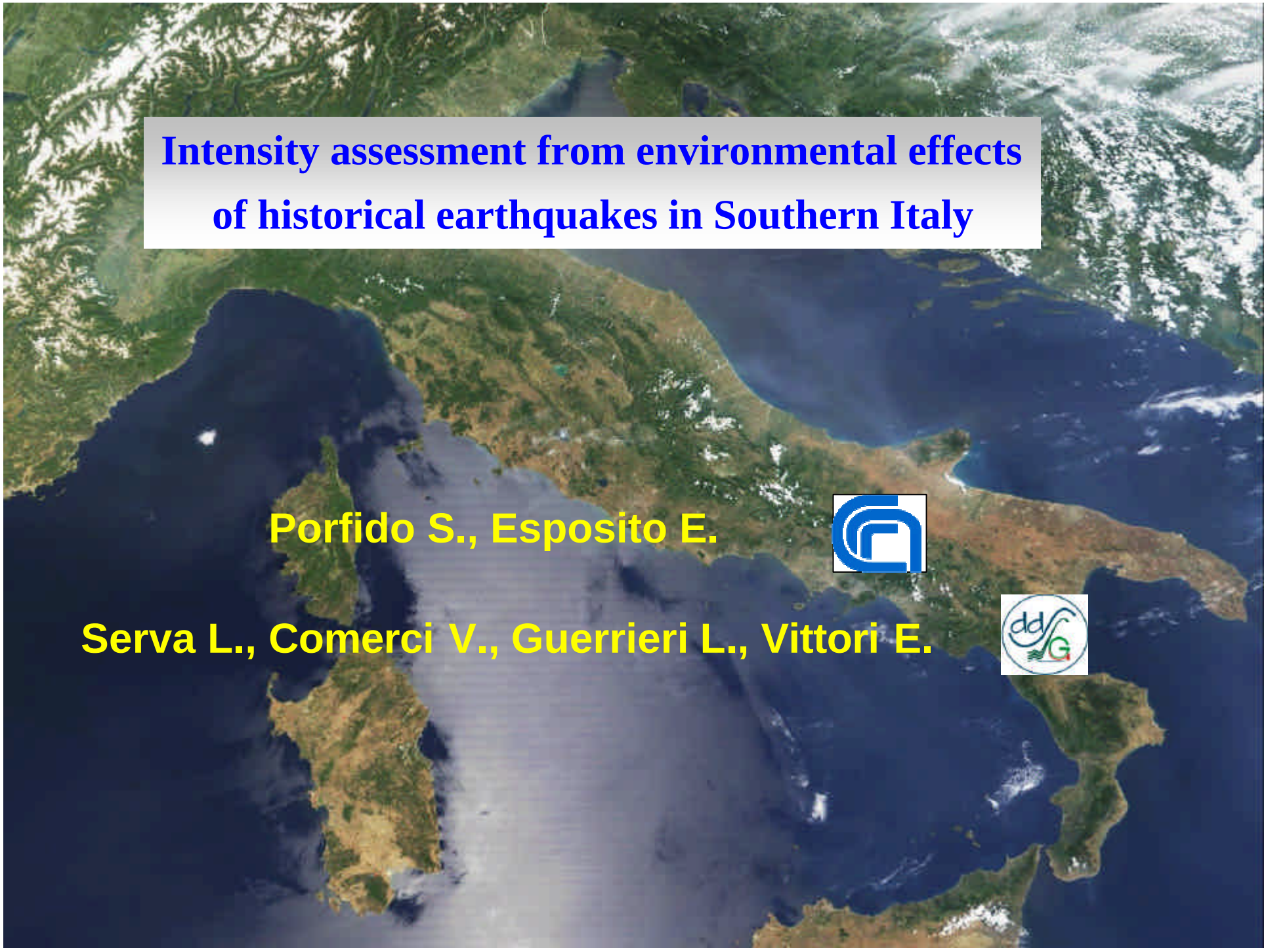


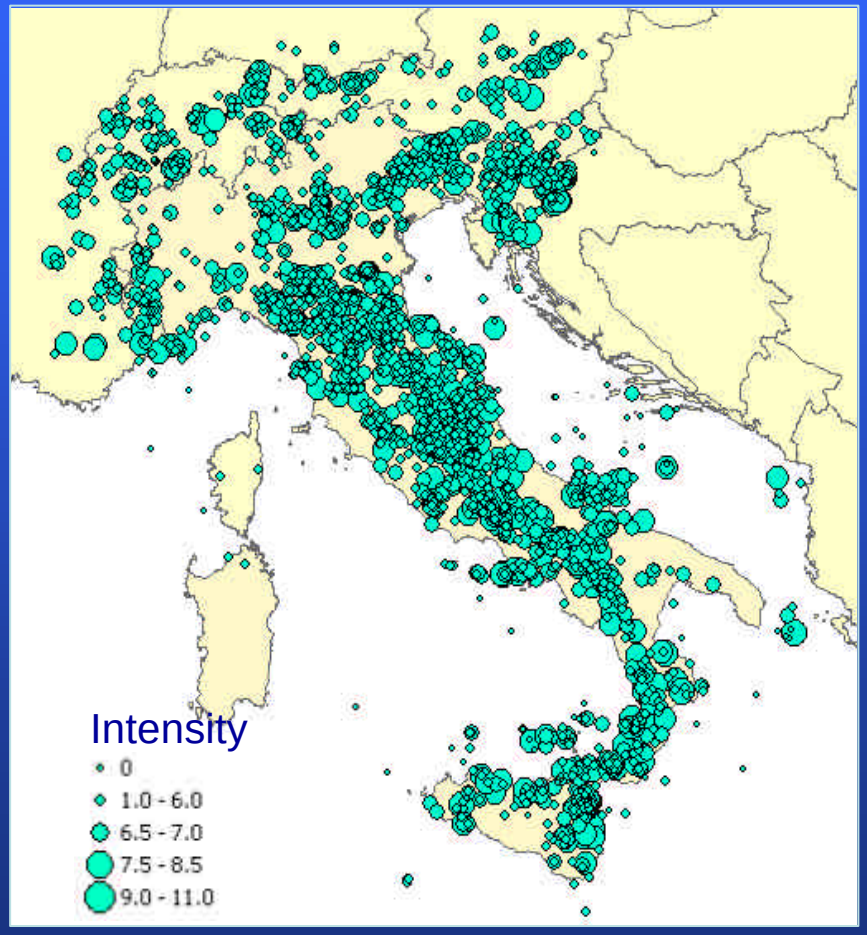
Intensity assessment from environmental effects of historical earthquakes in Southern Italy

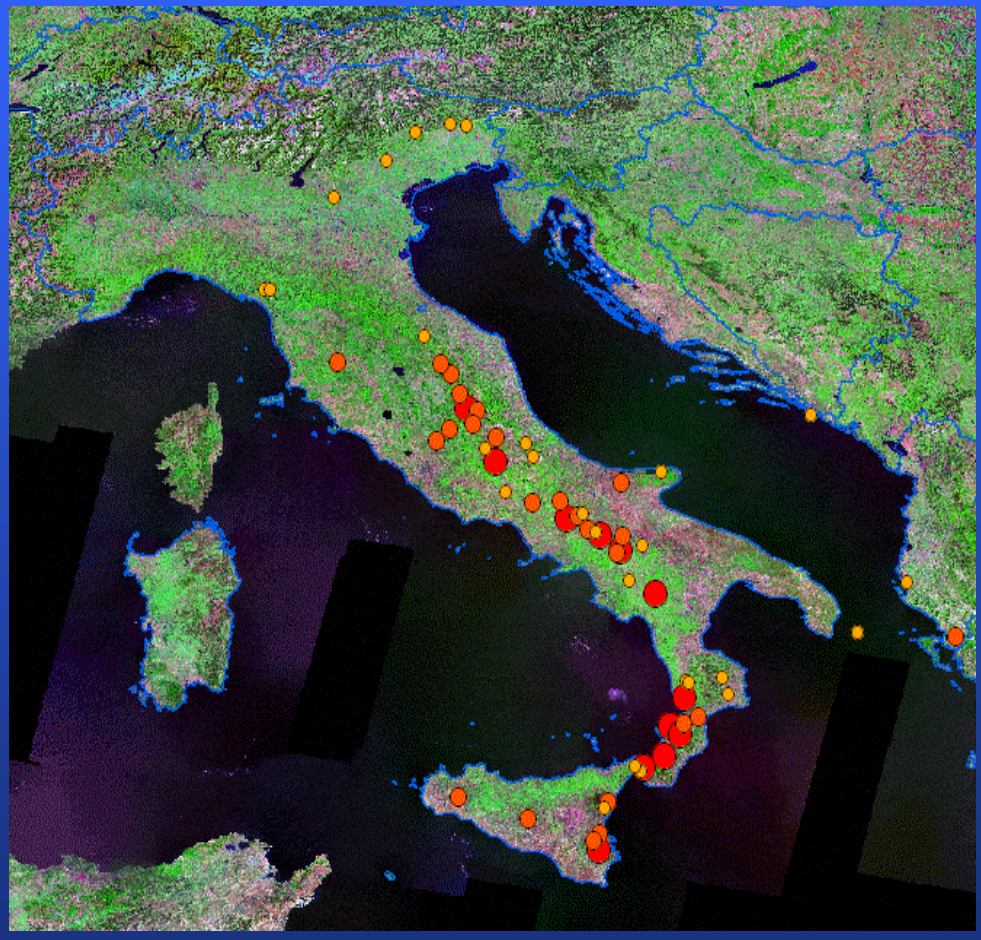
Porfido S., Esposito E.

Serva L., Comerci V., Guerrieri L., Vittori E.

To improve the ESI 2007 Scale, moderate-to-strong earthquakes, worldwide, are analyzed by various working groups, in order to compare the obtained intensity values with those assessed with conventional scales (MM, MCS, MSK, EMS, JMA). We present a contribution of Italian WG with a basic scope of reassess the historical events occurred in the same region by comparing environmental effects and damage-based intensity in order to contribute to reduce risk from environmental effects in earthquakes-prone areas.

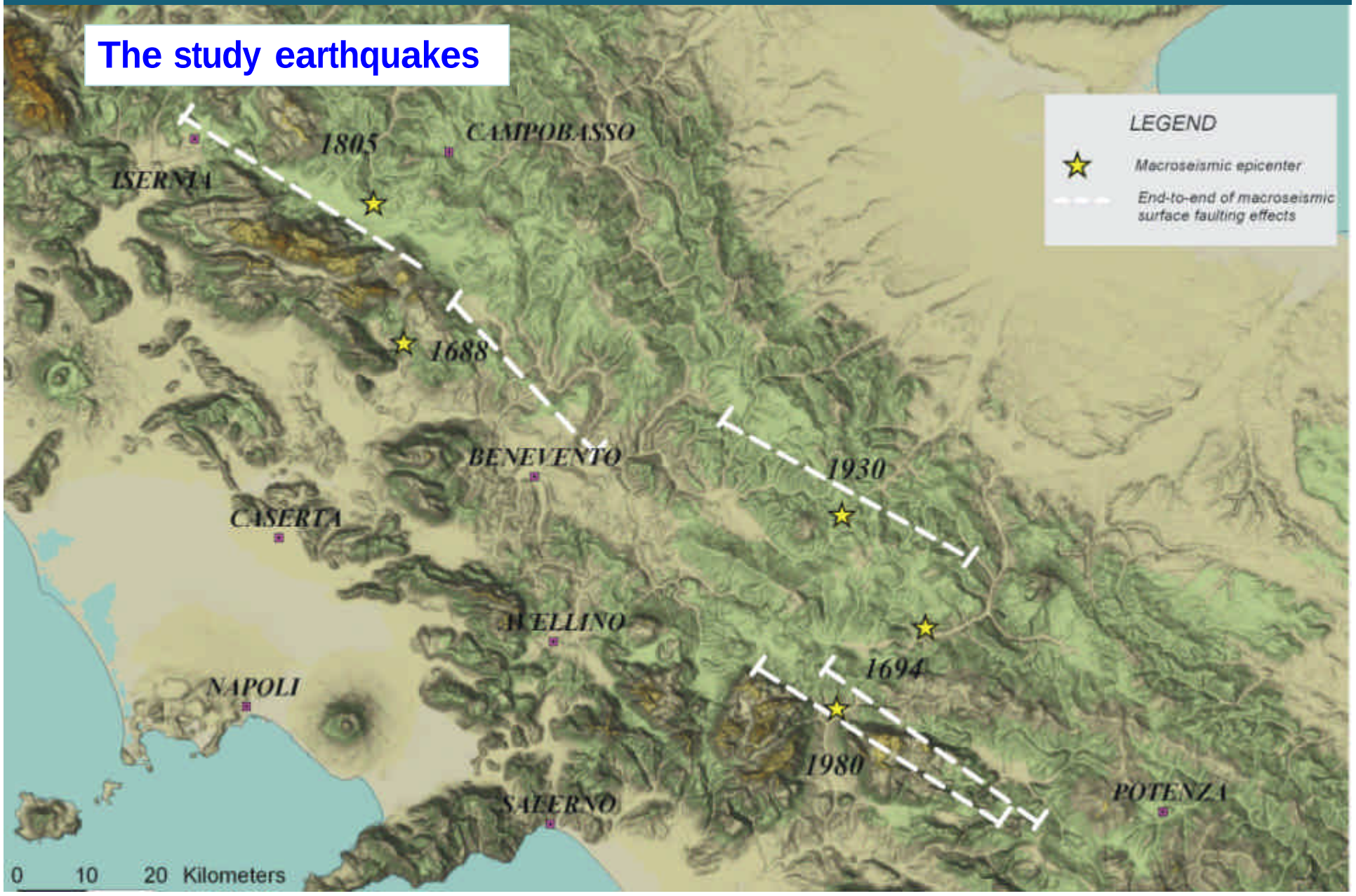
Historical earthquakes in Italy since Roman times





A huge database of historical earthquakes (time window larger than 2,000 yrs)
Macroseismic intensities up to XI degree MCS
Maximum expected magnitude slightly above 7

The study earthquakes



The study earthquakes

Date	Region	I MCS	M	Victims
1688	Sannio	XI	6,7	10,000
1694	Irpinia-Basilicata	X-XI	6,9	6,000
1805	Molise	X	6,6	6,000
1930	Irpinia	X	6,7	1,425
1980	Irpinia-Basilicata	X	6,9	3,000

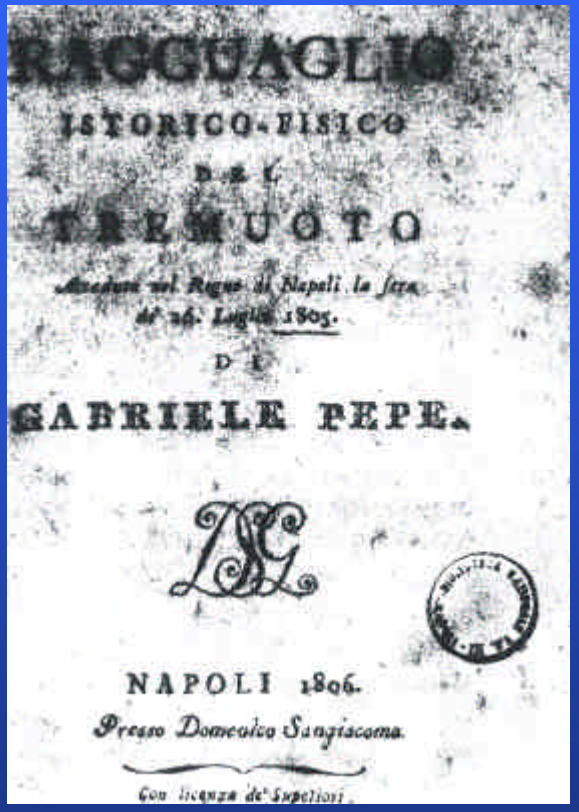
In this study, the ESI intensity scale is applied to a five events occurred in the Southern Apennines, one of the most seismic regions of Italy, to contribute to the world archive (EEE database) of coseismic geological effects under construction within the project The investigated earthquakes span in age from 1688 to 1980, with intensities between X and XI MCS (estimated magnitude 6.7-6.9). For each earthquake, the review of the original historical sources has permitted to construct an updated portrait of the type, distribution and size of the coseismic environmental effects

Methodology

1. **Analysis of historic sources, including completeness and reliability of the document within the historical context and source classification.**
2. **Classification of the coseismic environmental effects**
3. **Intensity assessment by using ESI 2007 scale**

Data Sources

Contemporary reports


RAGGUAGLIO
ISTORICO-FISICO
DEL
TREMUOTO
Accaduto nel Regno di Napoli la sera
de' 26. Luglio 1805.
DI
GABRIELE PEPE.
NAPOLI 1806.
Presso Domenico Sangiacomo.
Con licenza de' Superiori.

MEMORIA
SUL TREMUOTO
DE' 26 LUGLIO DEL CORRENTE
ANNO 1805.
DI
GIUSEPPE SAVERIO POLI
COMANDANTE DELLA R. ACCADEMIA MILITARE,
MEMBRO BRITTANNICO DELLA SOCIETA' R.
DE LONDRA, E SOCIO DI VARIE
ACCADEMIE.
NAPOLI MDCCCVI.
PRESSO VINCENZO ORSINO
Con pubblica Facoltà.

MEMORIA
SUL TREMUOTO AVVENUTO NEL CONTADO
DI MOLISE
Nella sera de' 26 Luglio dell' anno
1805.
Scritta dal Parroco
D. GIUSEPPE
CAPOZZI
Regio Accademico Napolitano.
IN BENEVENTO
Nella Stamperia del Sacro Seminario.
Con licenza de' Superiori.

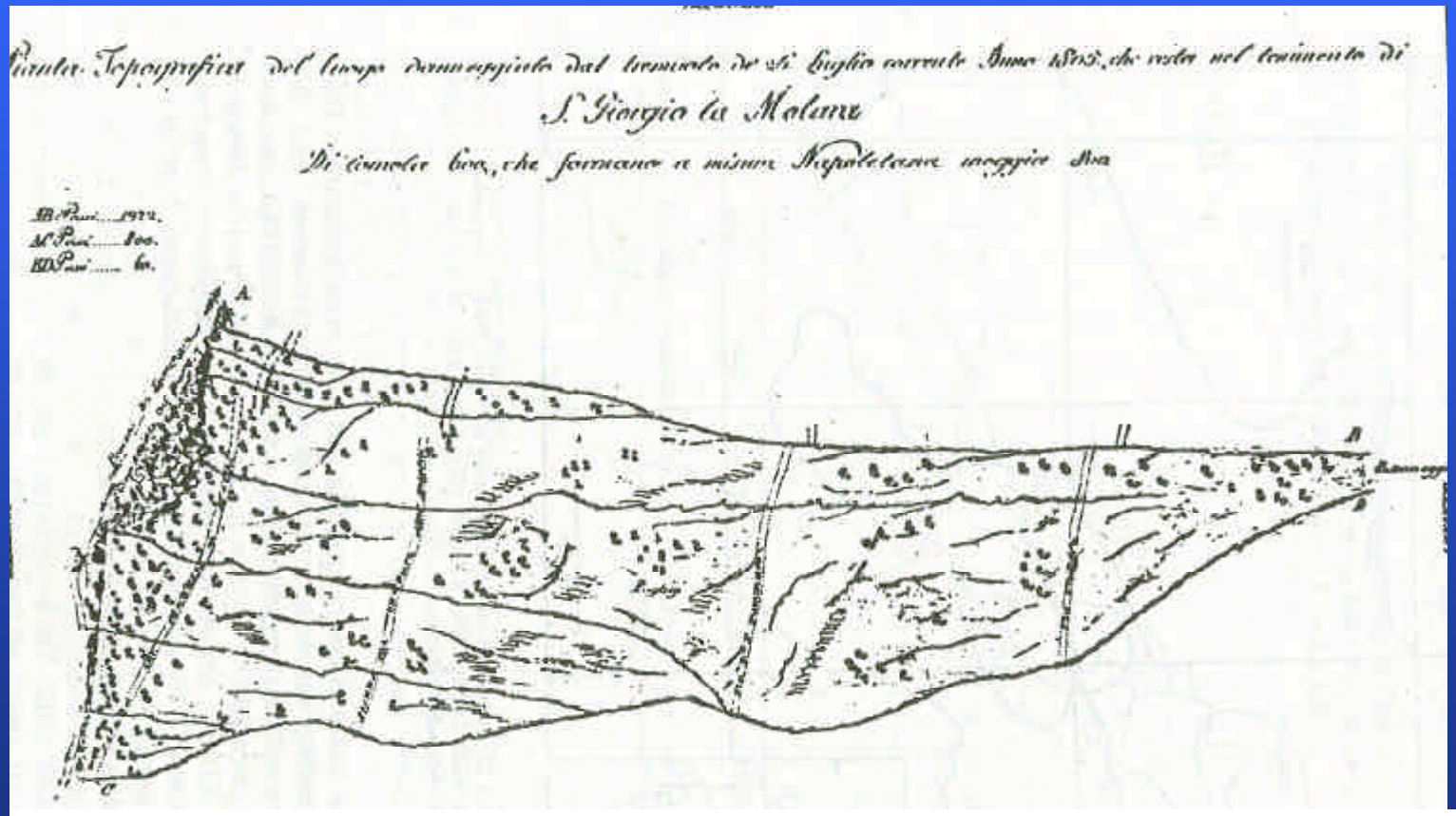
The main groups of sources are generally found in local documentary materials, administrative records, special studies, scientific reports, diaries, books and newspapers. They are available in record offices, libraries, public and private documentary collections, and parish archives throughout Europe.

The 1783 Calabria earthquakes, Sarconi (1784)

Another important type of source is the bibliographic one. It is generally divided into two main groups a) direct source - including text written by eyewitnesses, specific studies such as scientific literature, contemporary newspapers; b) indirect source – including texts written after the event by local authors, the scientific literature, etc.

Data Sources

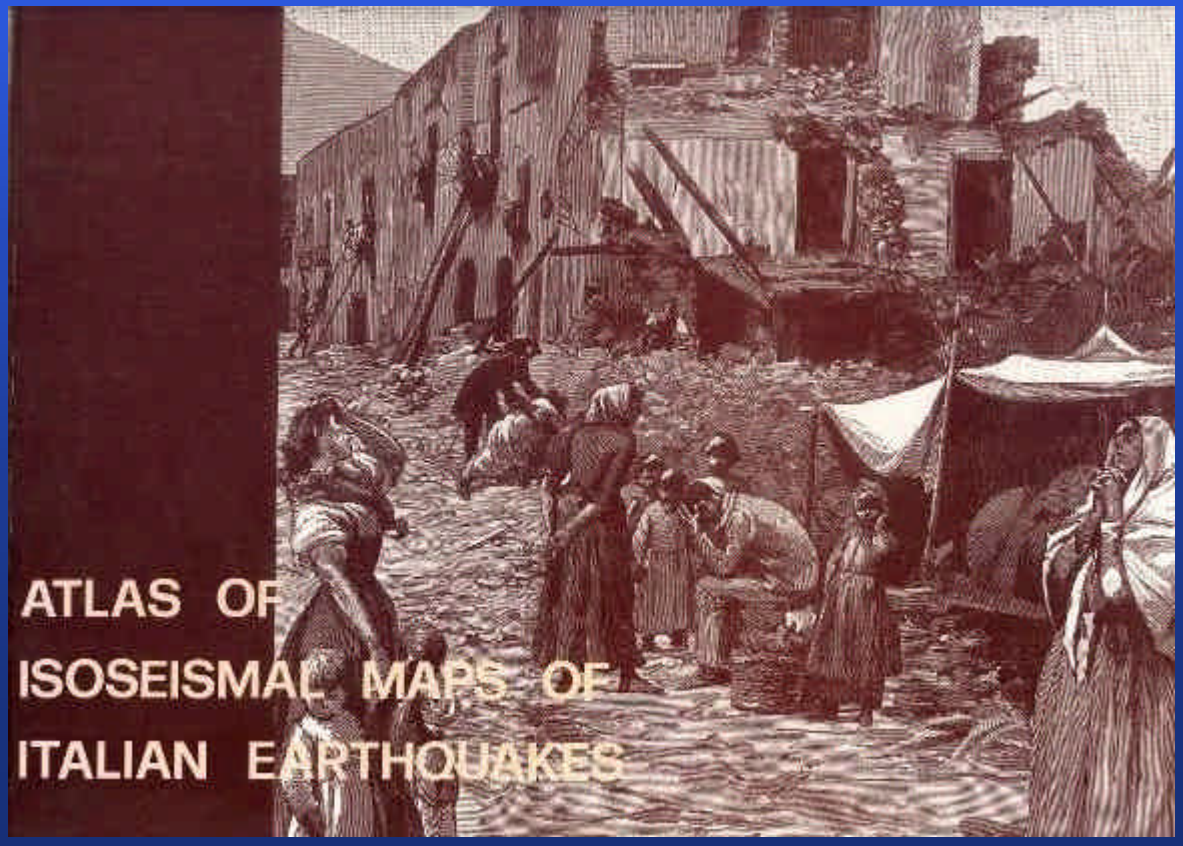
Contemporary maps



Marchese L. (1805) Map of landslides induced by the 1805 eq in S. Giorgio la Molara (Benevento district), drawn just after the event by an engineer for an official documentation .The document dated 1806 and located in State Archive of Naples, provides the precise location and dimension of landslide (3.7 km long , 1,5 km wide)

Data Sources

Scientific sources



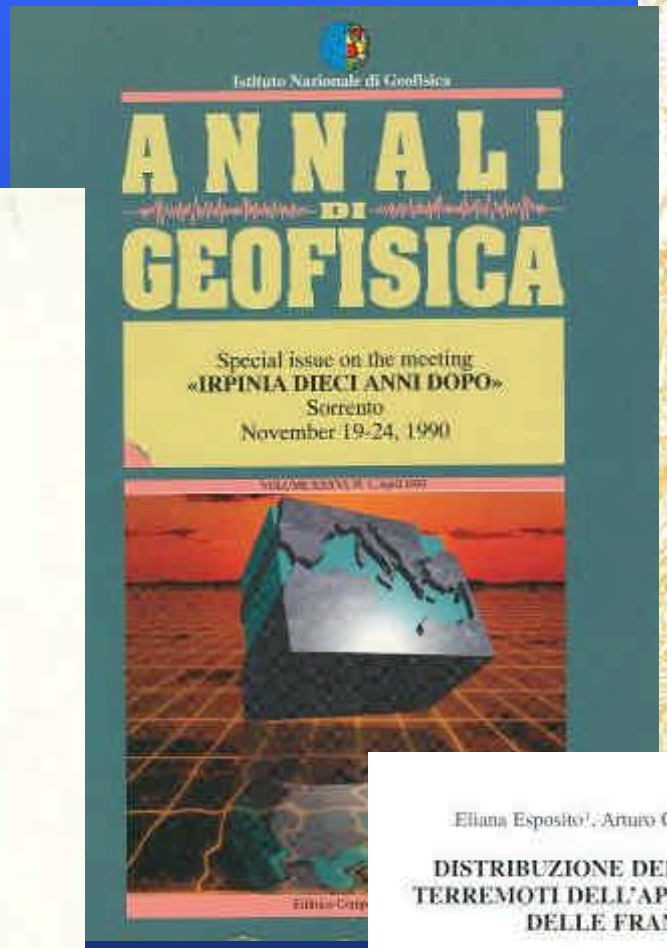
Data Sources

Scientific papers

VINCENZO COTECCHIA

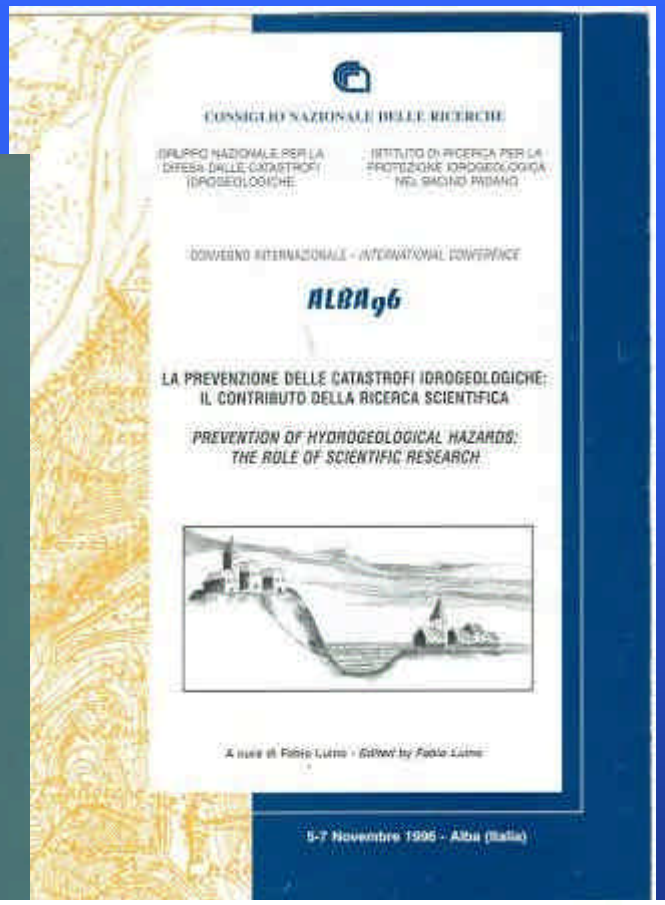
GROUND DEFORMATIONS AND
SLOPE INSTABILITY PRODUCED BY THE EARTHQUAKE
OF 23 NOVEMBER 1980 IN CAMPANIA AND BASILICATA

Reprint of
Proceedings of the International Symposium on
ENGINEERING GEOLOGY PROBLEMS IN SEISMIC AREAS
Bari, 1981 - Volume I


Istituto Nazionale di Geofisica

ANNALI
DI
GEOFISICA

Special issue on the meeting
«IRPINIA DIECI ANNI DOPO»
Sorrento
November 19-24, 1990


CONSIGLIO NAZIONALE DELLE RICERCHE

GRUPPO NAZIONALE PER LA DIFESA DALLE CATASTROFI IDROGEOLOGICHE

ISTITUTO DI RICERCA PER LA PROTEZIONE IDROGEOLOGICA
NEL BACINO PADANO

CONVEGNO INTERNAZIONALE - *INTERNATIONAL CONFERENCE*

ALBA96

LA PREVENZIONE DELLE CATASTROFI IDROGEOLOGICHE:
IL CONTRIBUTO DELLA RICERCA SCIENTIFICA

PREVENTION OF HYDROGEOLOGICAL HAZARDS:
THE ROLE OF SCIENTIFIC RESEARCH

A cura di Fabio Luino - *Edited by Fabio Luino*

5-7 Novembre 1996 - Alba (Italia)

Eliana Esposito[1], Arturo Gargiulo[2], Gianmaria Iaccarino[2] & Sabina Porfido[1]

DISTRIBUZIONE DEI FENOMENI FRANOSI RIATTIVATI DAI TERREMOTI DELL'APPENNINO MERIDIONALE. CENSIMENTO DELLE FRANE DEL TERREMOTO DEL 1980

[1]CNR-Gruppo Nazionale per la Difesa dai Terremoti, Via A. Vespucci 9, 80142 Napoli - ITALIA
[2]Università degli Studi di Napoli «Federico II», Dipartimento di Scienze della Terra, L.go S. Marcellino 10, 80138 Napoli - ITALIA

Data Sources

Eye-witness accounts

Methodology

1. **Analysis of historic sources, including completeness and reliability of the document within the historical context and source classification.**
2. **Classification of the coseismic environmental effects**
3. **Intensity assessment by using ESI 2007 scale**

For each considered earthquake, the original descriptions have been reviewed in order to point out effects on natural environment. This process has detected and localized coseismic environmental effects, and classifies them into two main types:

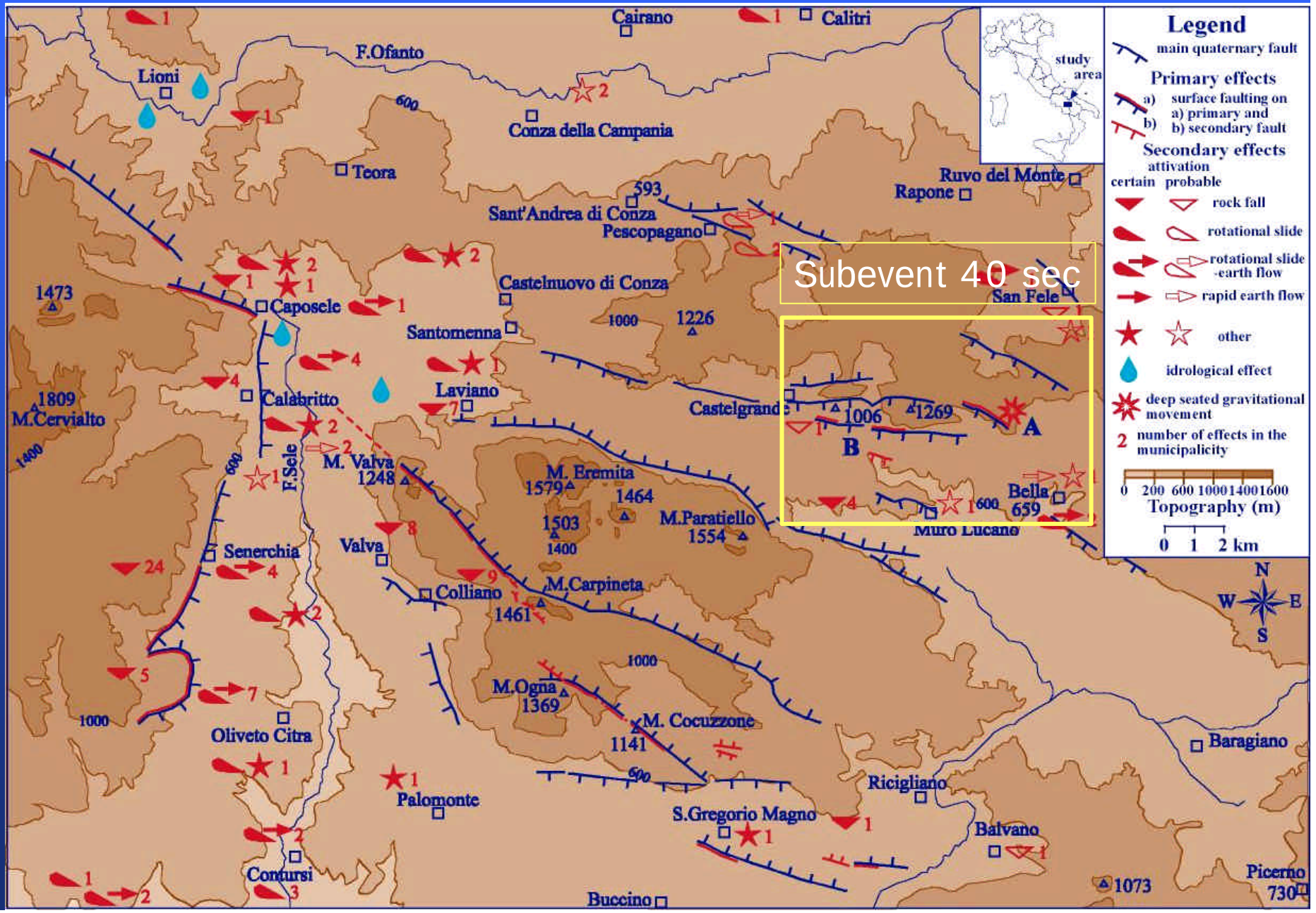
- **Primary**

  surface faulting (SF)

- **Secondary**

  slope movement (SM)
  ground crack (GC)
  ground settlement (GS)
  hydrological change (HA)
  anomalous seasurface wave (tsunami, TS)

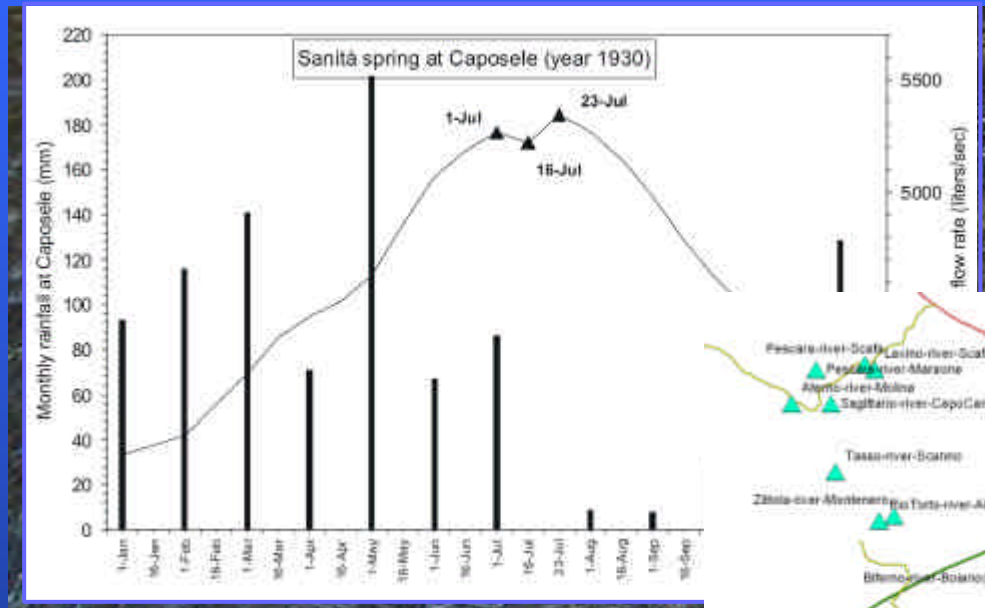
SURFACE FAULTING

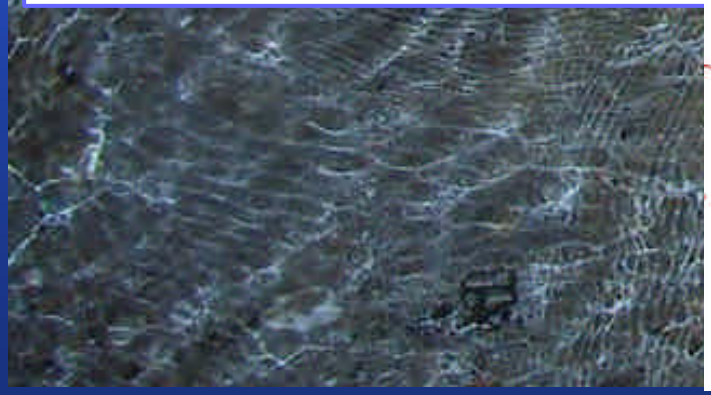

Legend
main quaternary fault
Primary effects
a) surface faulting on
a) primary and
b) b) secondary fault
Secondary effects
attivation
certain probable
rock fall
rotational slide
rotational slide -earth flow
rapid earth flow
other
idrological effect
deep seated gravitational movement
2 number of effects in the municipalicity
0 200 600 1000 1400 1600
Topography (m)
0 1 2 km
study area
Subevent 40 sec
A
B
Cairano
Calitri
F.Ofanto
Lioni
Conza della Campania
Teora
Ruvo del Monte
Rapone
593
Sant'Andrea di Conza
Pescopagano
Castelnuovo di Conza
San Fele
1473
Caposele
Santomenna
1000
1226
1809
M.Cervialto
Calabritto
Laviano
Castelgrande
1006
1269
F.Sele
M. Valva
1248
M. Eremita
1579
1464
M.Paratiello
1554
1503
Bella
659
Muro Lucano
Senerchia
Valva
Colliano
M.Carpineta
1461
M.Ogna
1369
M. Cocuzzone
1141
Oliveto Citra
Palomonte
Baragiano
Ricigliano
S.Gregorio Magno
Balvano
Picerno
730
1073
Buccino
Conursi
N
W
E
S

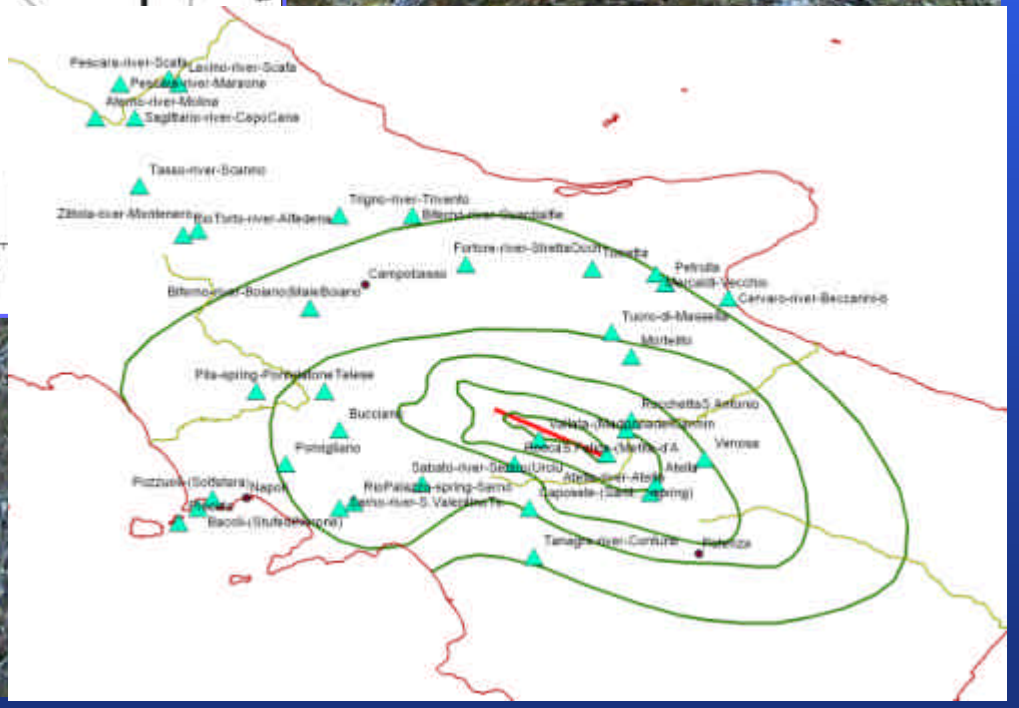
SLOPE MOVEMENTS

Caposele

46,000 cubic meters

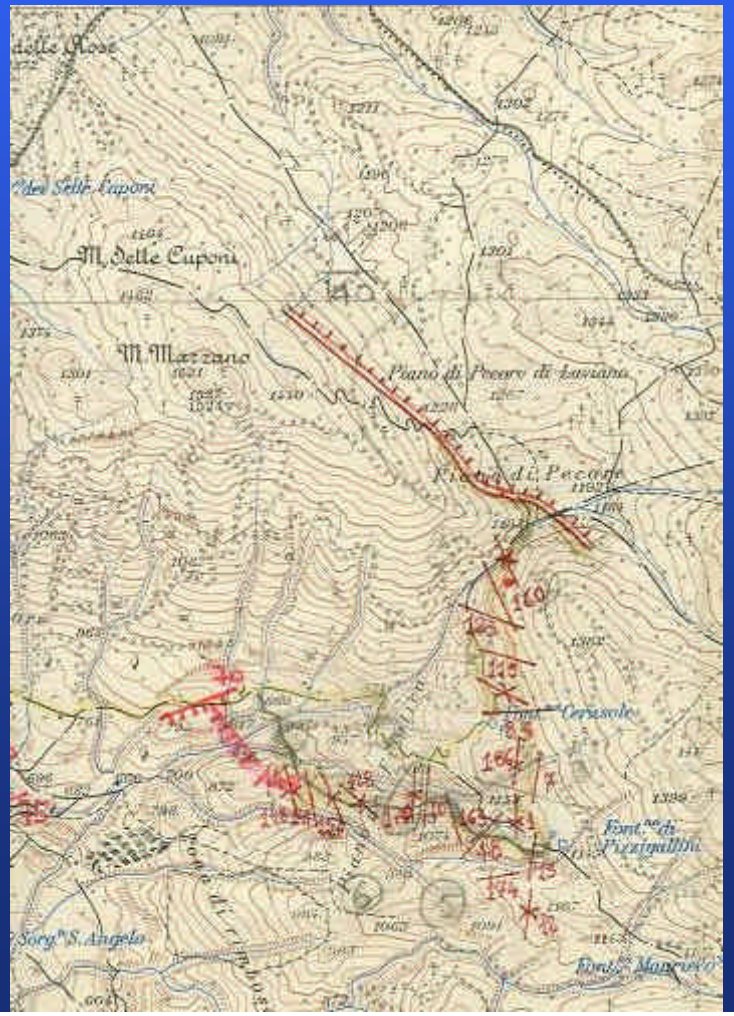




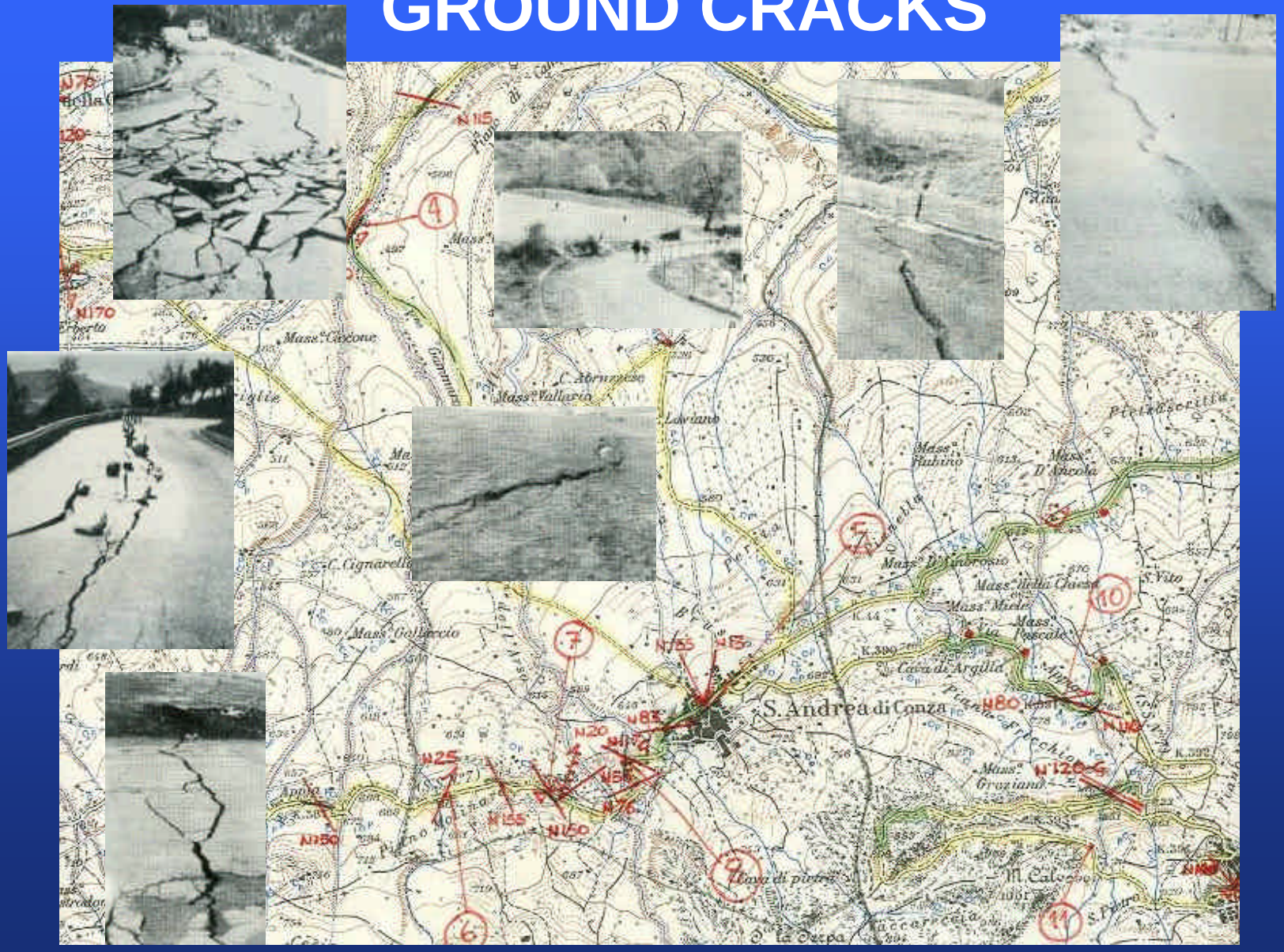


1930 Irpinia earthquake: hydrological changes recorded at the Sanità spring, Caposele (after Esposito et al., 2007)

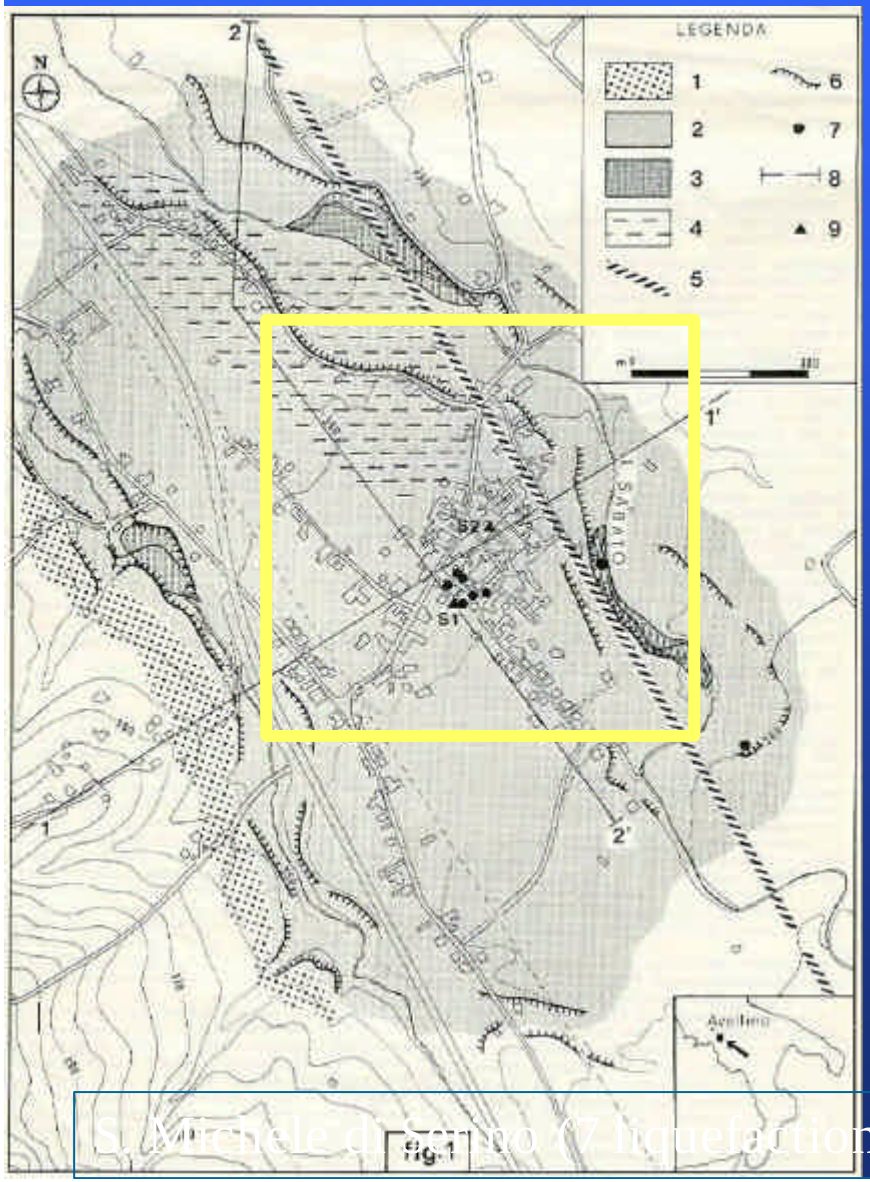
Aerial photographs and field surveys

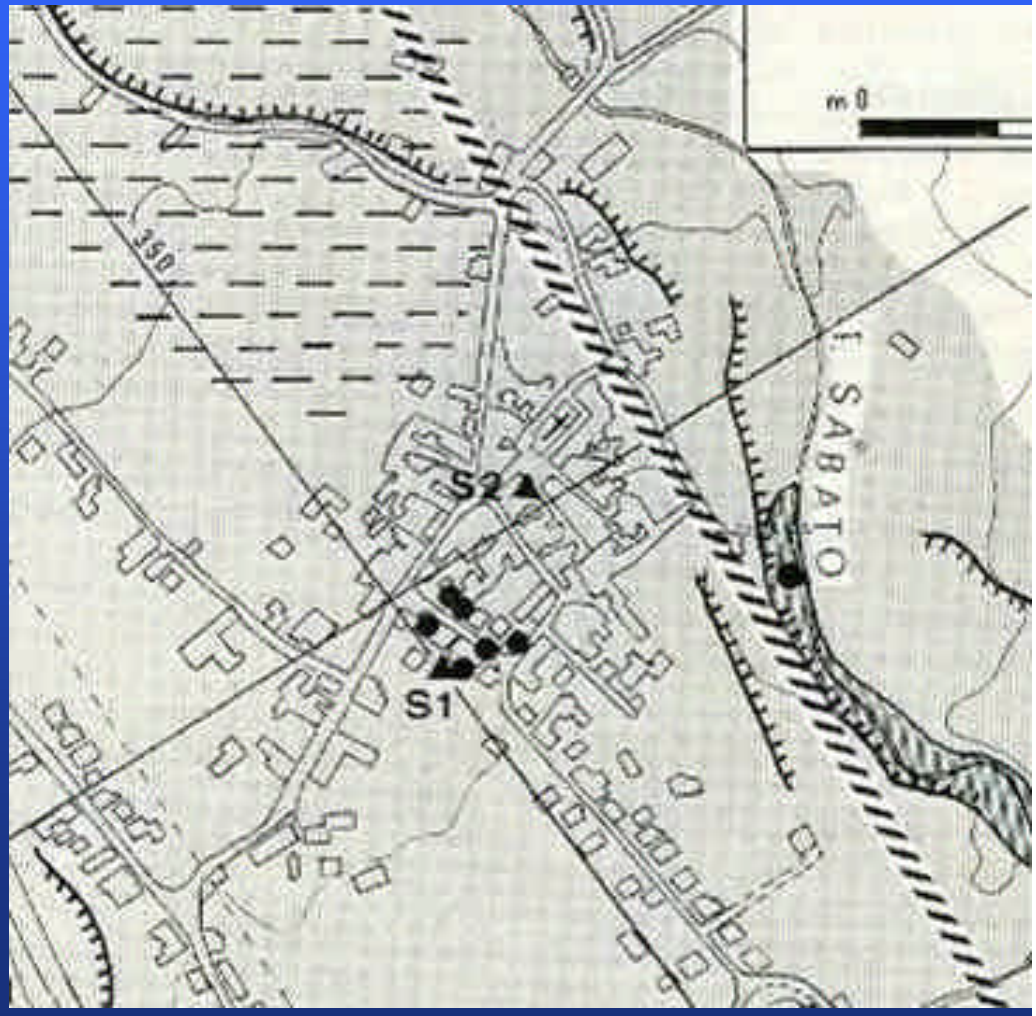


GROUND CRACKS



LIQUEFACTION PHENOMENA





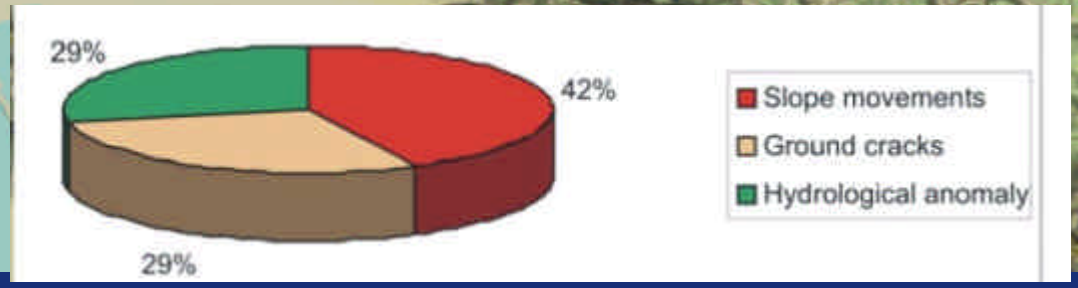
S. Michele di Serino (7 liquefaction phenomena near the Sabato River)

Methodology

1. **Analysis of historic sources, including completeness and reliability of the document within the historical context and source classification.**
2. **Classification of the coseismic environmental effects**
3. **Intensity assessment by using ESI 2007 scale**

5 June 1688, Sannio earthquake

Locality	Longitude	Latitude	Type of effect	Site distance	I_{MCS}	I_{EEE}
Alvignano	14,34E	41,24N	HA	19	9	8
Apice	14,90E	41,11N	HA	39	10	7
Atella	15,65E	40,88N	GC	105	8	7
Benevento	12,05E	44,15N	HA, SM	29	10	7
Cerreto sannita	14,55E	41,28N	HA, SM, GC	0	9	8
Montoro superiore	14,90E	41,11N	SM	59	8-9	7
Napoli	14,27E	40,86N	HA	57	7-8	7
Piedimonte d'Alife	14,37E	41,35N	HA, GC	15	9	8
Pomarico	16,54E	40,52N	SM, GC	190		7
San Giorgio la Molara	14,93E	41,27N	SM, GC	30	8-9	8
S. Lorenzello	14,54E	41,27N	SM	0	10	8
S. Lupo	14,63E	41,26N	SM	10	10	8
S. Marco de' Cavoti	14,88E	41,31N	SM, GC	26	8-9	8
Vico Equense	14,43E	40,66N	SM	70		5

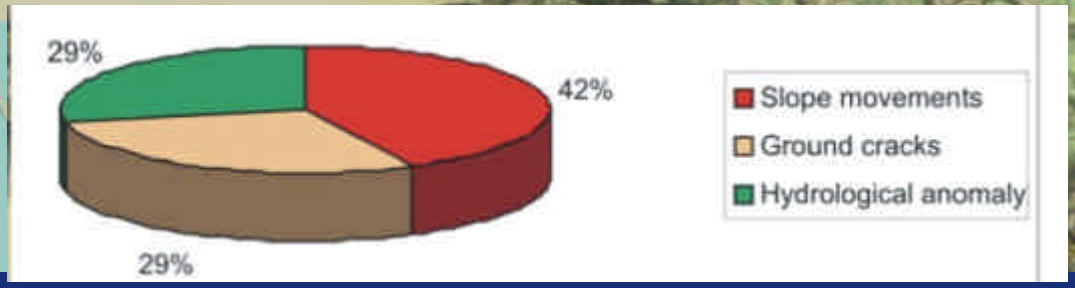


5 June 1688, Sannio earthquake

Locality	Longitude	Latitude	Type of effect	Site distance	I_{MCS}	I_{EEE}
Alvignano	14,34E	41,24N	HA	19	9	8
Apice	14,90E	41,11N	HA	39	10	7

ESI local intensities ranging between V and VIII have been assessed for 14 localities on the basis of secondary effects (42% slope movements, 29% ground cracks, 29% hydrological changes) occurred inside their territory. Based on recent scientific bibliografy (Nappi,2006-2007) it was possible to estimate the end-to end length of coseismic rupture zone (about 30 km).

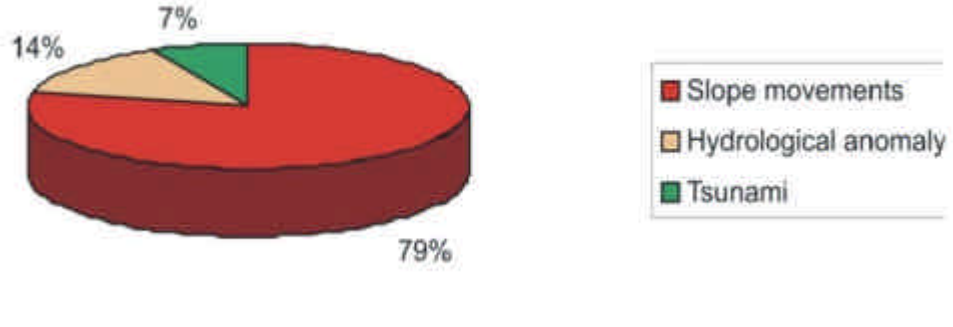
The epicentral intensity I_0 is based on primary and secondary effets. By using the ESI scale the epicentral Intensity is X, one degree lower than the corresponding MCS.



5 September 1694, Irpinia-Basilicata earthquake

EEE local intensity

Locality	Latitude	Longitude	Type of effect	Site distance	I_{MCS}	I_{EEE}
Bisaccia	41,01N	15,37E	SM	13	9/10	**8**
Brindisi	40,62N	17,94E	TS	216	5	**4**
Calitri	40,90N	15,43E	SM	0	10/11	**8**
Capua	41,10N	14,22E	SM	106	7	**5**
Colliano	40,72N	15,29E	SM	23	9	**8**
Napoli	40,86N	14,27E	SM	96	7	**7**
Ricigliano	40,67N	15,47E	SM	26	10	**8**
Sorrento	40,62N	14,37E	SM	94	7	**5**
Stigliano	40,40N	16,23E	SM	80	7	**6**
Teora	40,85N	15,25E	SF, SM	16	10/11	**10**
Tito	40,58N	15,67E	SF, SM, HA	40	10	**9**
Tricarico	40,62N	16,14E	SM, HA	68	8	**8**



5 September 1694, Irpinia-Basilicata earthquake

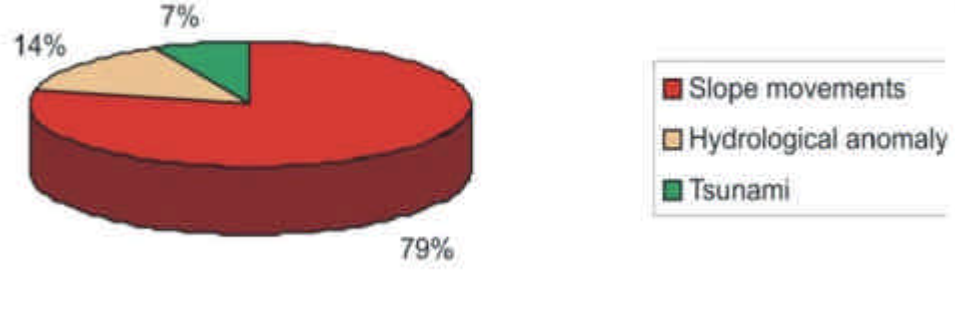
EEE local intensity

Locality	Latitude	Longitude	Type of effect	Site distance	I_{MCS}	I_{EEE}
Bisaccia	41,01N	15,37E	SM	13	9/10	8
Brindisi	40,62N	17,94E	TS	216	5	4
Calitri	40,90N	15,43E	SM	0	10/11	8
Capua	41,10N	14,22E	SM	106	7	5

The ESI macroseismic field from secondary effects (mostly slope movements) is composed by 12 local intensities between IV and X.

The length of macroseismic surface faulting is about 38 km.

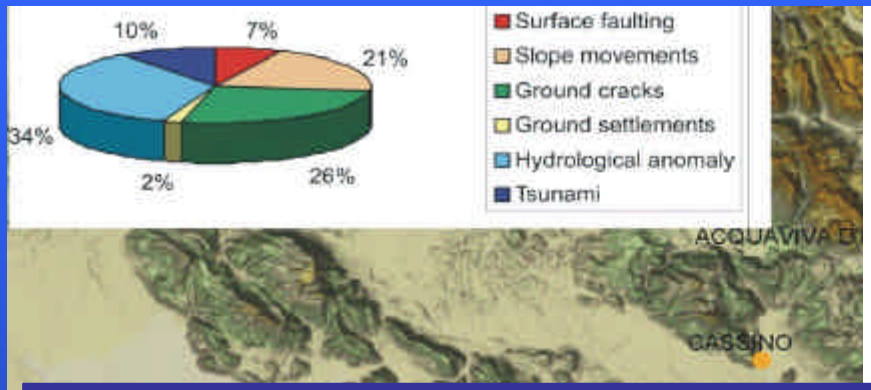
Even in this case the epicentral intensity based on the ESI scale is I0 = X, slightly lower than the corresponding MCS (I_0 = X-XI).



26 July 1805, Molise earthquake

Locality	Latitude	Longitude	Type of effect	Site distance	I_{MCS}	I_{ESE}
Acquaviva d'Isernia	41,67N	14,75E	SM	13	7	8
Agnone	41,8N	14,37E	HA	27	8	7
Alvignano	41,23N	14,33E	HA	31	7	7
Arienzo	41,02N	14,48E	HA	53	7	7
Bagnoli del Trigno	41,84N	14,47E	SM	18	7	7
Bojano	41,48N	14,47E	HA, GC	4	9	9
Caiazzo	41,18N	14,37E	HA	39	7	7
Campobasso	41,33N	14,4E	GC	13	9	>7
Cantalupo	41,31N	14,23E	GS	0	10	8
Capri	40,33N	14,55E	TS	110		5
Carovilli	41,42N	14,17E	SM	26	7	7
Cassino	41,48N	13,82E	HA	55	7	7
Castelfranco in Miscano	41,18N	15,5E	SM	54	7	7
Castelvenere	41,23N	14,53E	HA, GC	27	7	6
Cerreto sannita	41,28N	14,55E	HA, GC, SM	20	8	8
Civitanova del Sannio	41,65N	14,4E	HA, GC	13	8	8
Civitella Licino	41,32N	14,52E	GC	9	7	7
Dragoni	41,27N	14,3E	SM	26	6	7
Formicola	41,2N	14,22E	HA, GC	35	7	7
Frigento	41,01N	15,08E	HA	79	6	7
Gaeta	41,13N	13,34E	TS	85	5-6	5
Guardiaregia	41,26N	14,32E	SF	11	10	10
Isernia	41,58N	14,22E	HA, GC	9	9	7
Jelsi	41,31N	14,47E	SM	25	9	7
Lago del Matese	41,4N	14,42E	SF	14	7	10
Madonna dell'Arco	40,85N	14,37E	HA	70	7	6
Melizzano	41,15N	14,5E	HA, GC	35	7	7
Montagano	41,38N	14,4E	GC	19	7	7
Morcone	41,35N	14,67E	SF	14	8	10
Napoli	40,51N	14,15E	HA, TS	77	7	8
Pesche	41,62N	14,28E	SF	20	8	8
Piana di Monteverna	41,17N	14,33E	HA	39	7	7
Pietraroia	41,2N	14,32E	HA, SM	26	7	7
Ponza	40,53N	12,57E	TS	147	6	5
Ruviano/Alvignanello	41,2N	14,4E	HA	33	6	7
S. Elia a Pianisi	41,37N	14,87E	GC	31	7	6
Salcito	41,44N	14,3E	SM, GC	30	7	7
San Bartolomeo in Galdo	41,42N	15,02E	GC	23	7	7
San Giorgio la Molara	41,27N	14,92E	SM	27	7	8
San Lorenzello	41,27N	14,53E	SM	54	7	7
San Salvatore Telesino	41,27N	14,42E	GC	61	6	8
Santa Croce del Sannio	41,23N	14,43E	HA	24	7	6
Santa Maria del Molise	41,33N	14,22E	SM	12	7	6
Solopaca	41,18N	14,53E	HA, SM	35	8	8
Sorrento	40,37N	14,22E	TS	101	7	6
Telese	41,2N	14,52E	HA	34	7	7
Trivento	41,78N	14,55E	SM, GC	30	7	7
Ventotene	40,58N	13,52E	TS	122		5
Vesuvio	40,82N	14,42E	SM	60	7	6
Villamaina	40,97N	15,08E	HA	84	7	6

26 July 1805, Molise earthquake

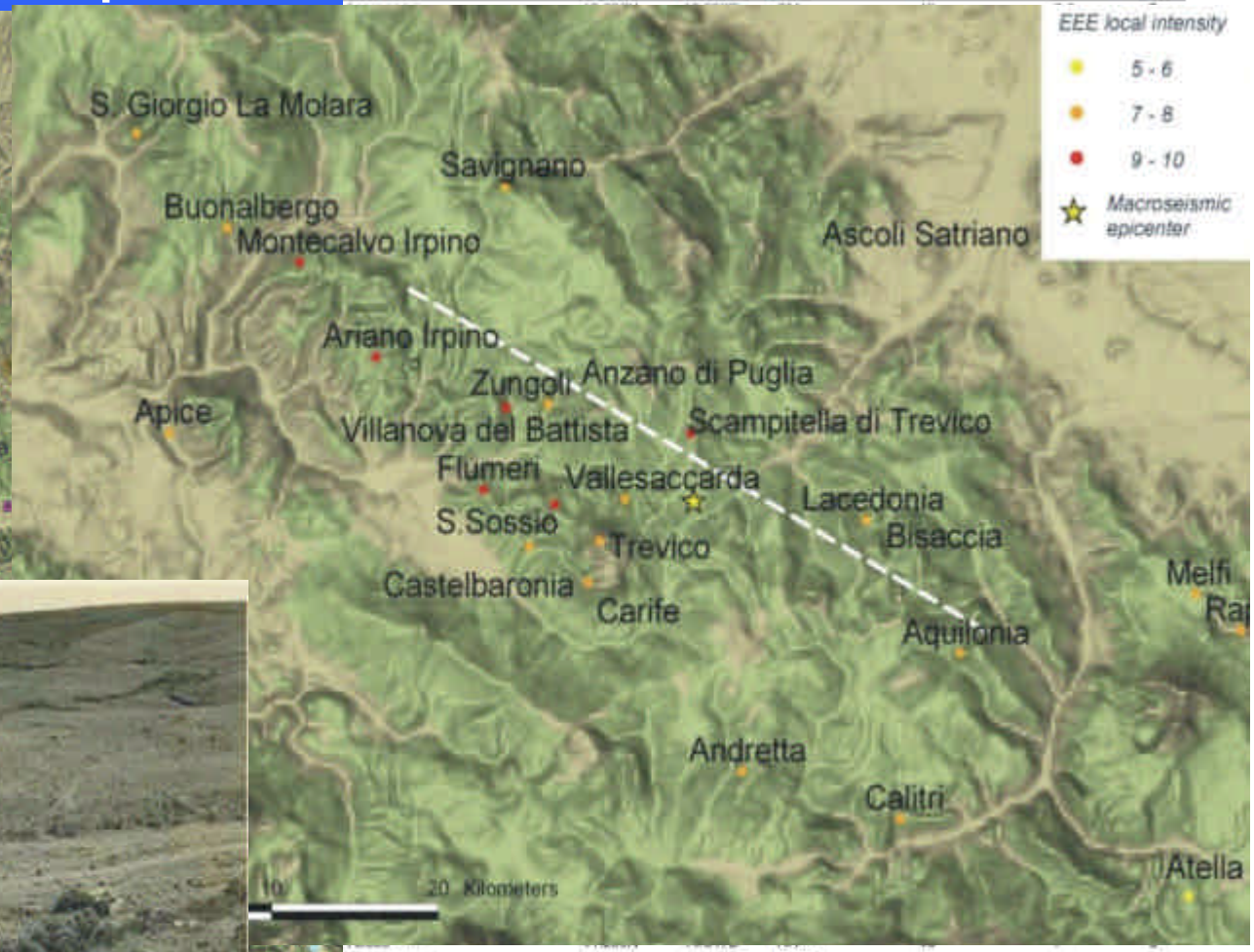


Locality	Latitude	Longitude	Type of effect	Site distance	I_{MCS}	I_{ESI}
Acquaviva d'Isernia	41,67N	14,75E	SM	13	7	8
Agnone	41,8N	14,37E	HA	27	8	7
Alvignano	41,23N	14,33E	HA	31	7	7
Arienzo	41,02N	14,48E	HA	53	7	7
Bagnoli del Trigno	41,84N	14,47E	SM	18	7	7
Bojano	41,48N	14,47E	HA, GC	4	9	9
Caiazzo	41,18N	14,37E	HA	39	7	7
Campobasso	41,33N	14,4E	GC	13	9	>7
Cantalupo	41,31N	14,23E	GS	0	10	8
Capri	40,33N	14,55E	TS	110		5
Carovilli	41,42N	14,17E	SM	26	7	7
Cassino	41,48N	13,82E	HA	55	7	7
Castelfranco in Miscano	41,18N	15,5E	SM	54	7	7
Castelvenere	41,23N	14,53E	HA, GC	27	7	6
Cerreto sannita	41,28N	14,55E	HA, GC, SM	20	8	8
Madonna dell'Arco	40,85N	14,37E	HA	70	7	6
Melizzano	41,15N	14,5E	HA, GC	35	7	7
Montagano	41,38N	14,4E	GC	19	7	7
Morcone	41,35N	14,67E	SF	14	8	10
Napoli	40,51N	14,15E	HA, TS	77	7	8
Trivento	41,78N	14,55E	SM, GC	30	7	7
Ventotene	40,58N	13,52E	TS	122		5
Vesuvio	40,82N	14,42E	SM	60	7	6
Villamaina	40,97N	15,08E	HA	84	7	6

A great number of effects on the natural environment has allowed assessment of an ESI intensity value (from V to X) for 50 localities in the near and far field area.

Along the Bojano fault system it was possible to measure the rupture length (40 km) and the maximum displacement (150 cm). Using the ESI scale, surface faulting parameters and the total areal distribution of landslides indicate I_0 = X in agreement with the equivalent MCS assessment.

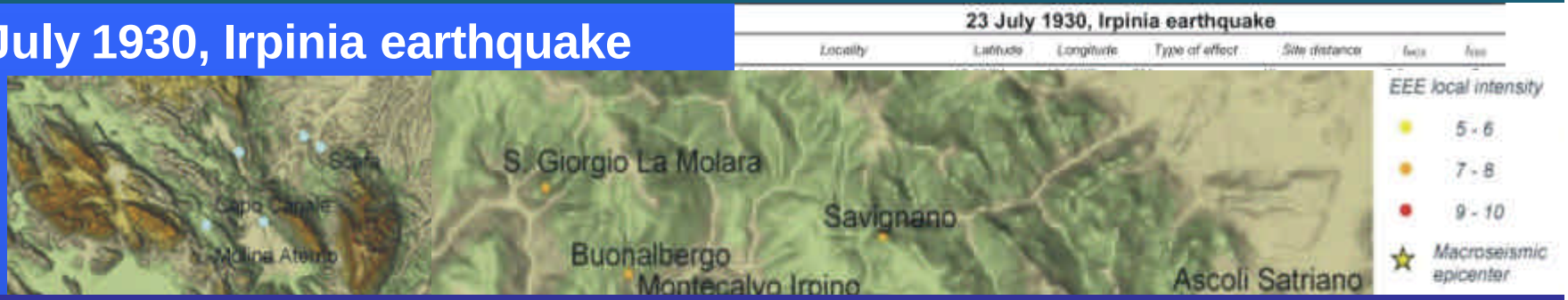
23 July 1930, Irpinia earthquake



23 July 1930, Irpinia earthquake

Locality	Latitude	Longitude	Type of effect	Site distance	I_{MCS}	I_{ESI}
Tocco Caudio	41.133N	14.617E	SM/GC	36	8	7
Torretta	41.617N	15.433E	HA	62	6	4
Trevico	41.050N	15.233E	SM/GC	1	8	8
Trivento	41.800N	14.567E	HA	86	5	4
Tuoro di Massella	41.400N	15.500E	HA	48	6	4
Vallata	41.033N	15.250E	SM/HA	2	8	8
Vallesaccarda	41.067N	15.250E	SM/GC	1	7-8	7
Venosa	40.967N	15.817E	HA	34	7	>4
Villanova del Battista	41.117N	15.167E	SF	2	10	10
Zungoli	41.117N	15.200E	GC/SM	5	8	7

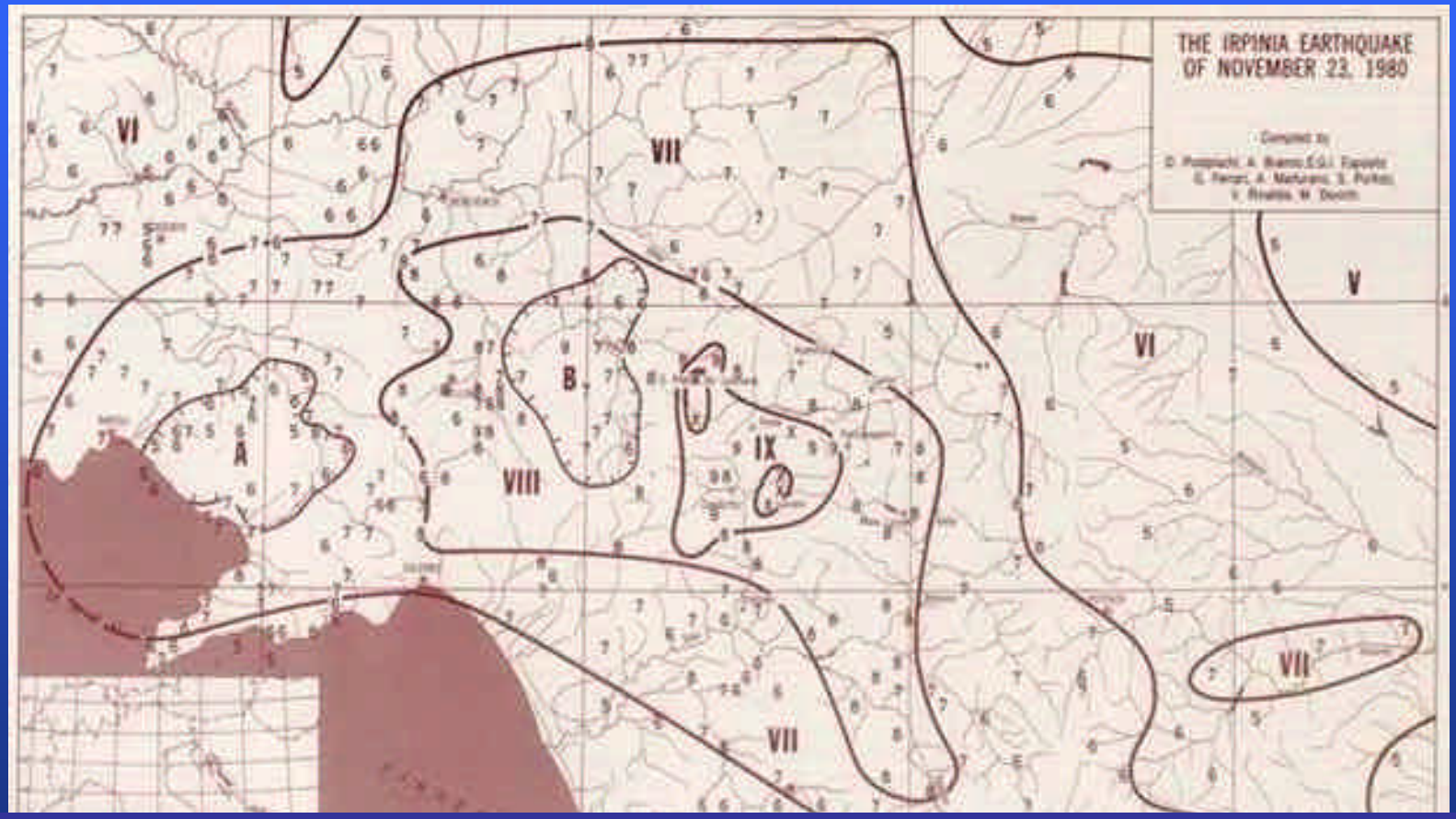
23 July 1930, Irpinia earthquake



Effects on natural environment are largely reported in the contemporary documents including geological reports.
Secondary effects, mainly hydrological changes and slope movements have supported the evaluation of ESI intensity values in more than 60 localities.
The macroseismic surface faulting can be estimated in the order of 38 km in length and 40 cm in maximum displacement. According to these data, ESI and MCS epicentral intensity values are coincident I_0 = X.

Tocco Caudio	41.133N	14.617E	SM/GC	36	8	7
Torretta	41.617N	15.433E	HA	62	6	4
Trevico	41.050N	15.233E	SM/GC	1	8	8
Trivento	41.800N	14.567E	HA	86	5	4
Tuoro di Massella	41.400N	15.500E	HA	46	6	4
Vallata	41.033N	15.250E	SM/HA	2	8	8
Vallesaccarda	41.067N	15.250E	SM/GC	1	7-8	7
Venosa	40.967N	15.817E	HA	34	7	>4
Villanova del Battista	41.117N	15.167E	SF	2	10	10
Zungoli	41.117N	15.200E	GC/SM	5	8	7

23 November 1980, Irpinia earthquake



This event was the strongest one of the last 30 years in the Southern Apennines. About 800 localities suffered damage, mainly in Campania and Basilicata regions. Casualties were ca. 3,000, and 10,000 people were wounded .

23 November 1980, Irpinia earthquake

Locality	Latitude	Longitude	Type of effect	Site distance	I_{MCS}	I_{ESI}
Acerno	40,44N	15,03E	SM	27	8	7
Aiano	41,23N	14,12E	SM	118	5	5
Andretta	40,55N	15,19E	SM, GC	17	7	8
Atella	40,52N	15,39E	SM	25	7	7
Auletta	40,33N	15,25E	SM	33	8	7
Avigliano	40,30N	15,43E	SM	32	6	7
Balvano	40,39N	15,3E	SM	20	8	7
Bella	40,45N	15,32E	SM, SF	16	8	8
Brienza	40,28N	15,37E	GC	40	7	8
Brindisi di Montagna	40,36N	15,56E	SM	55	6	7
Buccino	40,37N	15,22E	SF	12	8	8
Caggiano	40,34N	15,29E	SM	28	7	8
Calabritto	40,47N	15,13E	SM, HA, SF, GC	13	9	8
Calitri	40,53N	15,28E	SM	18	8	8
Campagna	40,39N	15,05E	SM	25	6	7
Capaccio	40,25N	15,04E	SM	48	6	7
Caposele	40,48N	15,12E	GC, GS, HA, SM	6	9	10
Carife	41,01N	15,12E	SM, GC	29	7	8
Cassano Irpino	40,52N	15,01E	HA	23	7	8
Castelfranci	40,55N	15,02E	SM, GC	30	7	8
Castelgrande	40,47N	15,25E	SM, GC, SF	6	8	8
Castelnuovo di Conza	40,48N	15,19E	SM, GC, SF	8	9	8
Chiusano San Domenico	40,55N	15,55E	SM	40	7	7
Colliano	40,43N	15,17E	SM	11	8	8
Contursi	40,38N	15,14E	SM, GC	23	8	7
Conza della Campania	40,41N	15,10E	SM, GC, GS	0	10	9
Frigento	41,01N	15,05E	SM, GC	33	6	7
Lago Laceno	40,59N	15,06E	GS	15	8	7
Laviano	40,46N	15,17E	SF, SM	0	10	9
Lioni	40,52N	15,1E	SM, GC, GS	15	10	8
Monte Corvino Pugliano	40,4N	15,55E	HA	24	7	8
Montecalvo Irpino	41,02N	15,02E	GS	44	7	7
Montella	40,8N	15,01E	HA	21	7	7
Muro Lucano	40,46N	15,29E	GS, SF, HA, GC, SM	11	8	9
Oliveto Citra	40,41N	15,13E	SM, GC, SF	21	7	8
Ottati	40,27N	15,18E	SM	37	7	7
Pago Veiano	41,14N	14,52E	SM	65	7	8
Palomonte	40,38N	15,17E	GC, SM	17	7	7
Pescopagano	40,9N	15,23E	GC, SM	5	9	8
Pisoniso	40,38N	15,38E	SF, SM, GC	40	7	8
Pontecagnano	40,38N	14,52E	GS	43	7	7
Rocca S. Felice	40,56N	15,09E	SM, GC, SM	24	8	8
Ruvo del Monte	40,5N	15,32E	SM, GS	25	8	8
Sacco	40,22N	15,22E	SM	44	6	6
San Fele	40,46N	15,32E	SM, GC	14	8	8
S. Angelo dei Lombardi	40,55N	15,1E	SM, GC	22	10	8
Santandrea di Conza	40,5N	15,22E	GC, SF	10	9	8
Satriano di Lucania	40,32N	15,38E	SM, GC, SF	30	6	8
Scafati	40,44N	14,31E	GS	30	6	7
Senerchia	40,42N	15,12E	SM, GC, SF	17	9	9
San Giorgio la Molara	41,16N	14,55E	SM, GS	63	7	8
Sicignano degli Alburni	40,33N	15,18E	SM	26	6	6
San Gregorio Magno	40,66N	15,40E	SF	20	8	10
S. Mango	40,57N	14,56E	SM, GC	20	9	8
San Marzano sul Sarno	40,48N	14,35E	GS	59	6,5	8
S. Michele di Serino	40,52N	14,51E	GS	33	8	6
Sicignano	40,49N	14,5E	SM, GC	43	8	8
S. Rufo	40,26N	15,27E	SM	40	7	8
Teora	40,51N	15,15E	GC	10	9	6
Tito	40,34N	15,4E	GC, SM	32	7	8
Torella dei Lombardi	40,56N	15,06E	SM	27	8	8
Vaglio Basilicata	40,39N	15,55E	SM	50	5	8
Valva	40,43N	15,15E	GC, SF, SM	10	8	7
Vietri di Potenza	40,35N	15,3E	GC, SF, SM	35	8	8
Villamaina	40,58N	15,05E	SM	25	8	8
Volturara Irpina	40,52N	14,54E	GS	28	8	7

23 November 1980, Irpinia earthquake

Locality	Latitude	Longitude	Type of effect	Site distance	×	I_{ESI}
Acerno	40,44N	15,03E	SM	27		7
Adano	41,23N	14,12E	SM	118	5	5
Andretta	40,55N	15,15E	SM, GC	17	7	8
Atella	40,52N	15,39E	SM	25	7	7
Auletta	40,33N	15,25E	SM	33	8	7
Avigliano	40,30N	15,43E	SM	32	6	7
Balvano	40,39N	15,3E	SM	20	8	7
Bella	40,45N	15,32E	SM, SF	16	8	8
Brienza	40,28N	15,37E	GC	40	7	8
Brindisi di Montagna	40,36N	15,56E	SM	55	6	7
Buccino	40,37N	15,22E	SF	12	8	8
Caggiano	40,34N	15,20E	SM	28	7	8
Calabritto	40,47N	15,13E	SM, HA, SF, GC	13	9	8
Calitri	40,53N	15,28E	SM	18	8	8
Campagna	40,39N	15,05E	SM	25	6	7
Capaccio	40,25N	15,04E	SM	48	6	7
Caposele	40,48N	15,12E	GC, GS, HA, SM	6	9	10
Carife	41,01N	15,12E	SM, GC	29	7	8
Senerchia	40,42N	15,12E	SM, GC, SF	17	8	8
San Giorgio la Molara	41,16N	14,55E	SM, GS	63	7	8
Sicignano degli Alburni	40,33N	15,18E	SM	26	6	6
San Gregorio Magno	40,66N	15,40E	SF	20	8	10
S. Mango	40,57N	14,56E	SM, GC	20	9	8
San Manzano sul Sarno	40,48N	14,35E	GS	59	6,5	8
S. Michele di Serino	40,52N	14,51E	GS	33	8	6
Sicignano	40,49N	14,5E	SM, GC	43	8	8
S. Rufo	40,26N	15,27E	SM	40	7	8
Teora	40,51N	15,15E	GC	10	9	6
Tito	40,34N	15,4E	GC, SM	32	7	8
Torella dei Lombardi	40,56N	15,06E	SM	27	8	8
Vaglio Basilicata	40,39N	15,55E	SM	50	5	8
Valva	40,43N	15,15E	GC, SF, SM	10	8	7
Vietri di Potenza	40,35N	15,3E	GC, SF, SM	35	8	8
Villamaina	40,58N	15,05E	SM	25	8	8
Volturara Irpina	40,52N	14,54E	GS	28	8	7

Numerous geological surveys of the area affected by this earthquake have provided a large amount of information on secondary effects, slope movements and ground cracks .It was possible to assess ESI lintensities to 66 localities (284 effects).

The amount of surface faulting (rupture length = 40 km; maximum displacement = 100 cm, and the total area distribution of slope movements (7400 km2) indicate I_0 = X, in good agreement with I_0 resulting from MSK scale.

CONCLUSIONS

The ESI scale is a contribution to intensity assessment taking in account the effects on the natural environment. It is not an independent tool for intensity assessment, it can provide independent estimates, but it is conceived to integrate and improve the intensity evaluations based on the classical macroseismic scales.

The environmental effects provide very important information for seismic hazard :

1) a more complete picture of the macroseismic field, based on the whole bulk of available information;

2) estimates of Io based on rupture length and offset;

3) useful data for land-use planning by revealing sectors of significant hazard also where no damage data are available.