

AN INDEX MONITORING THE SENSITIVITY TO DESERTIFICATION:ESPI

*A. Duro, V. Piccione, M.A. Ragusa
R.V. Rapicavoli, V. Veneziano*



Évora Portugal, February 2-5 2016



Desertification Risk: Introduction



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SPEAKER: M.A. Ragusa
maragusa@dmi.unict.it



Desertification is land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities.



It is a detrimental process that brings about a gradual and an unnoticed reduction in the productive capacity of land over a period of years (Kannan, 2012)



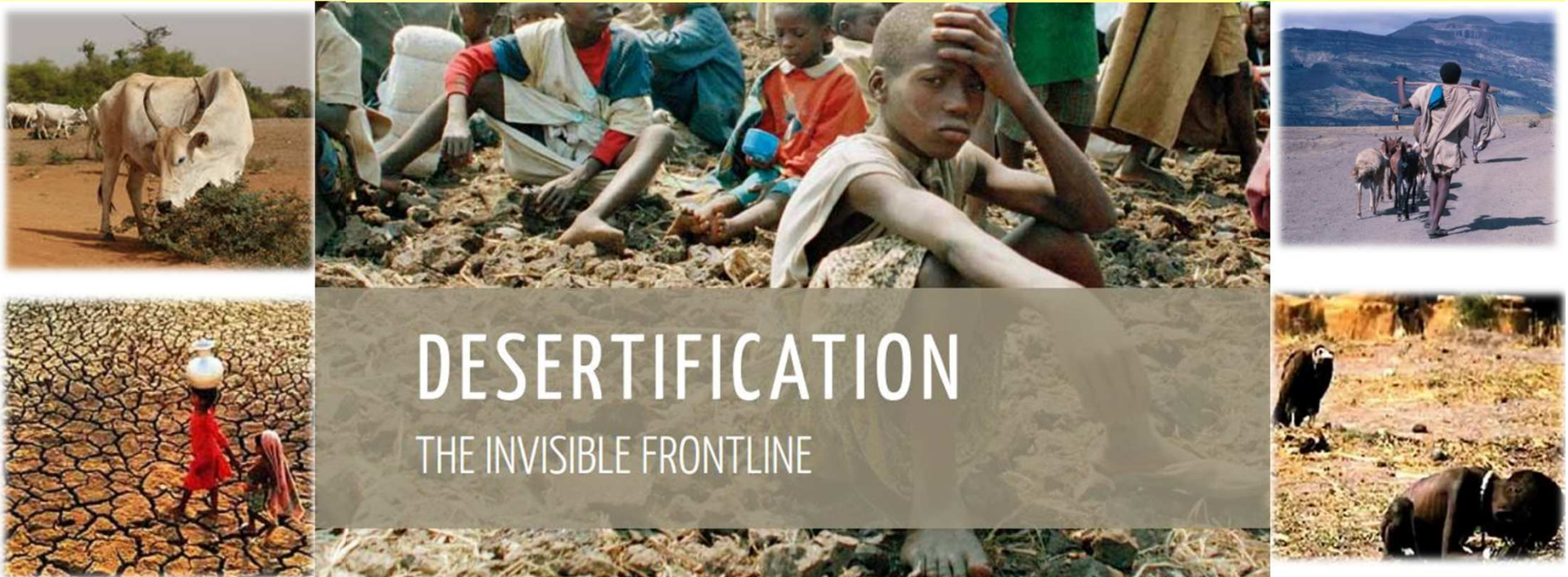
Is a global phenomenon of land degradation which reduces the natural potential of the ecosystems and makes rural populations vulnerable to food shortages, to changes of weather and natural disasters.



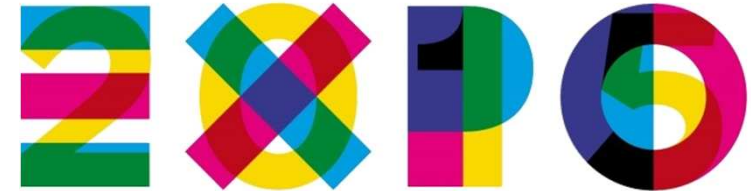
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maragusa@dmi.unict.it

As confirmed by UN, desertification is to consider the most serious emergency in recent decades, impacting the socio-economic conditions of millions of people living in the drylands, which account a significant part of the Earth.



The costs of desertification are most often measured in terms of loss productivity, which includes the reduced crop yields, grazing intensities, etc. Secondary costs are the loss of ecosystem services and ecological functions that affect the very sustainability of the planet (Sherbinin, 2002).



CONFERENCE ON DESERTIFICATION

Auditorium in to the Italia building, Expo Milan August 26, 2015

The dry areas cover more than 41% of land area



There are approximately 2 billion people

72% of drylands fall in developing countries

Poverty and aridity are highly correlated



EUROPE: HIGH RISK FOR 20 MILLION HECTARES OF LAND



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maragusa@dmi.unict.it



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21% of the country is at risk of desertification



41% of the South



58% Molise

57% Puglia

55% Basilicata

70% Sicilia

Sardegna, Marche, Emilia Romagna, Umbria, Abruzzo e Campania between 30 and 50%

«Impressive numbers that tell of a dramatic problem which is discussed very little»

Mauro Centritto, Director of the Institute for the exploitation of wood and tree species CNR



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maragusa@dmi.unict.it



Desertification Risk: Methodology



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maragusa@dmi.unict.it

METHODOLOGY

European research project



MEDALUS (Mediterranean Desertification And Land Use) to identify *Environmentally Sensitive Areas (ESAs)* through a multifactor approach based on both a general and a local knowledge of the environmental processes acting.



DETAILS OF INFORMATION

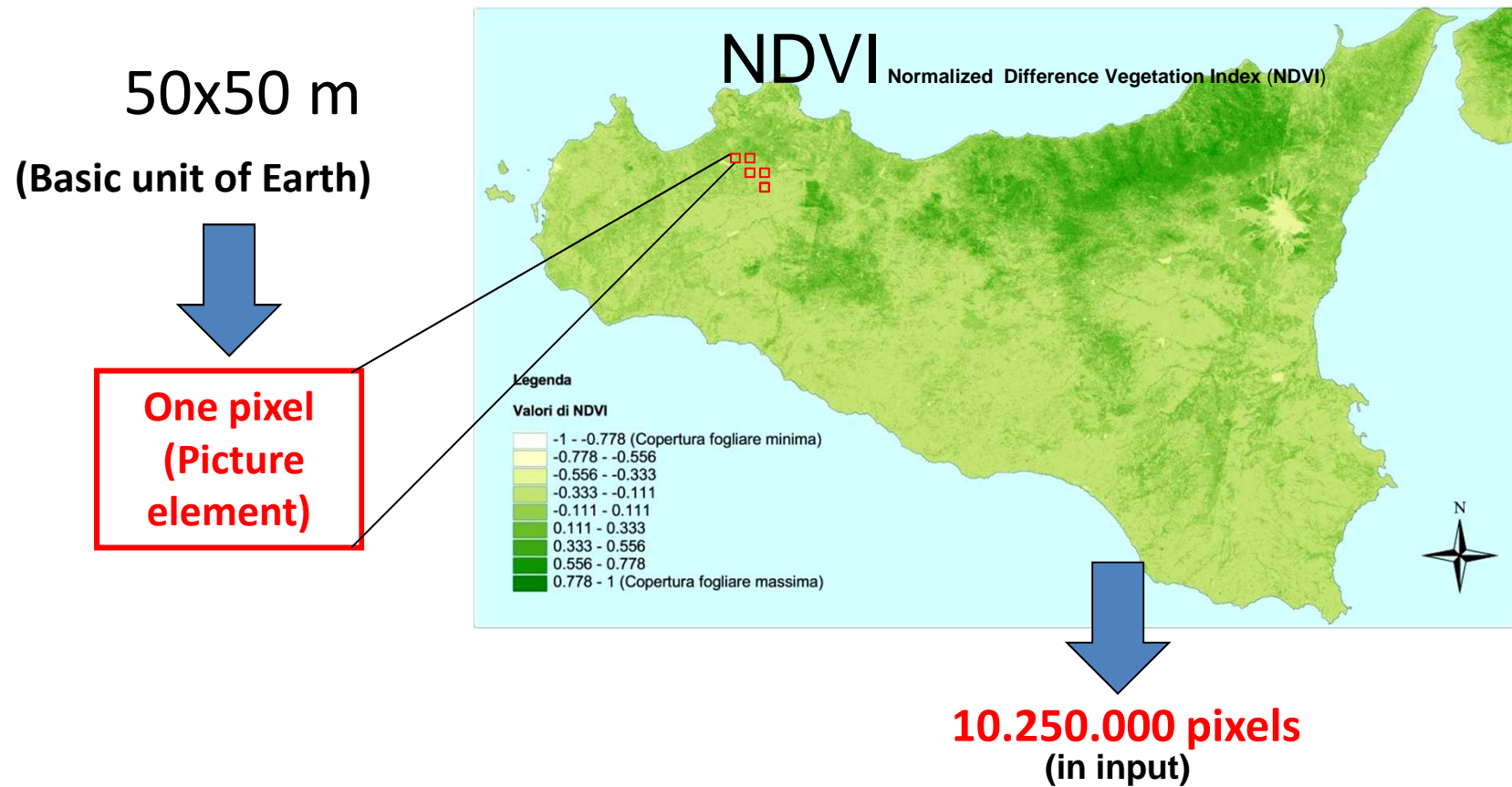


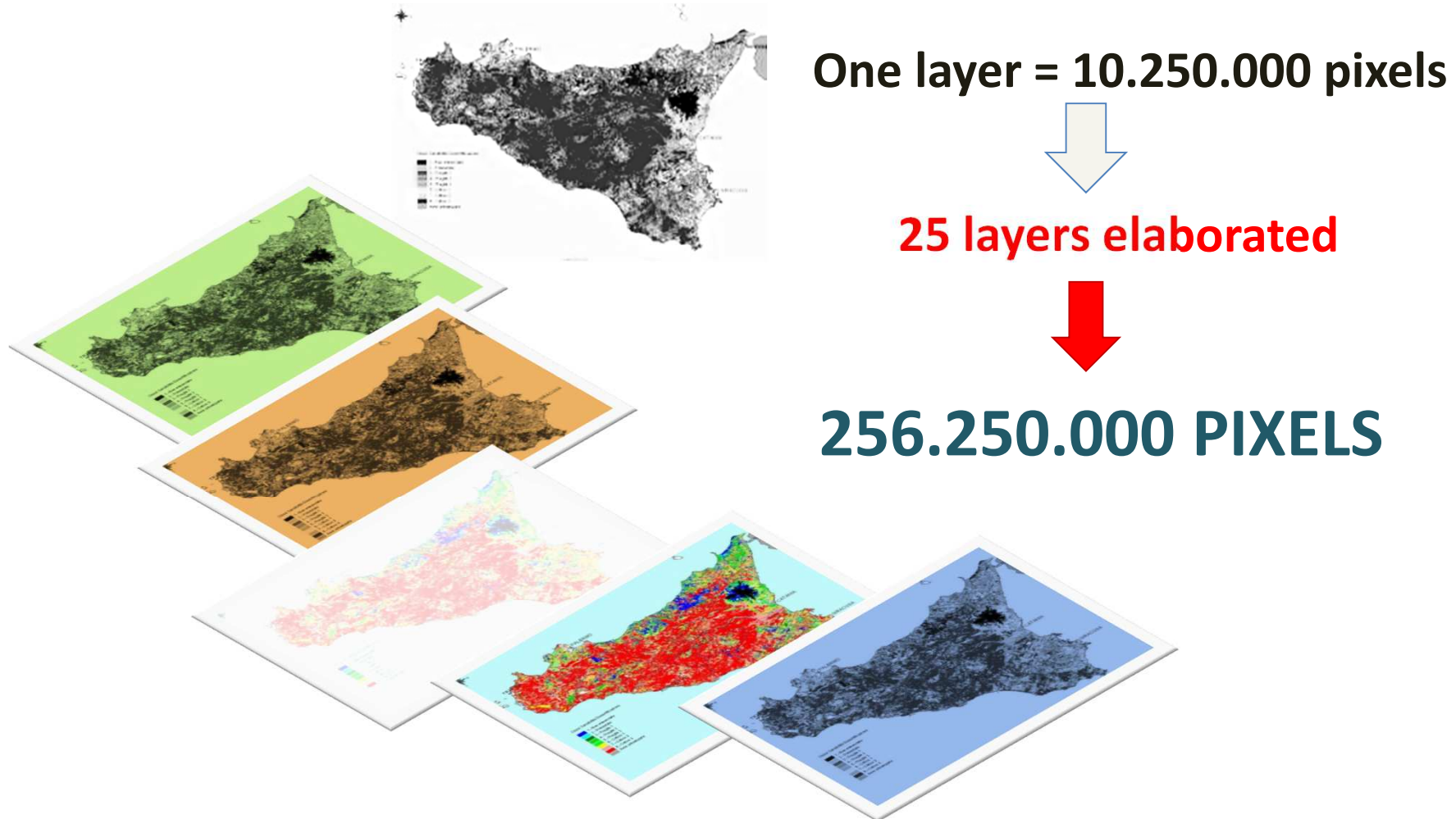
Image in output raster



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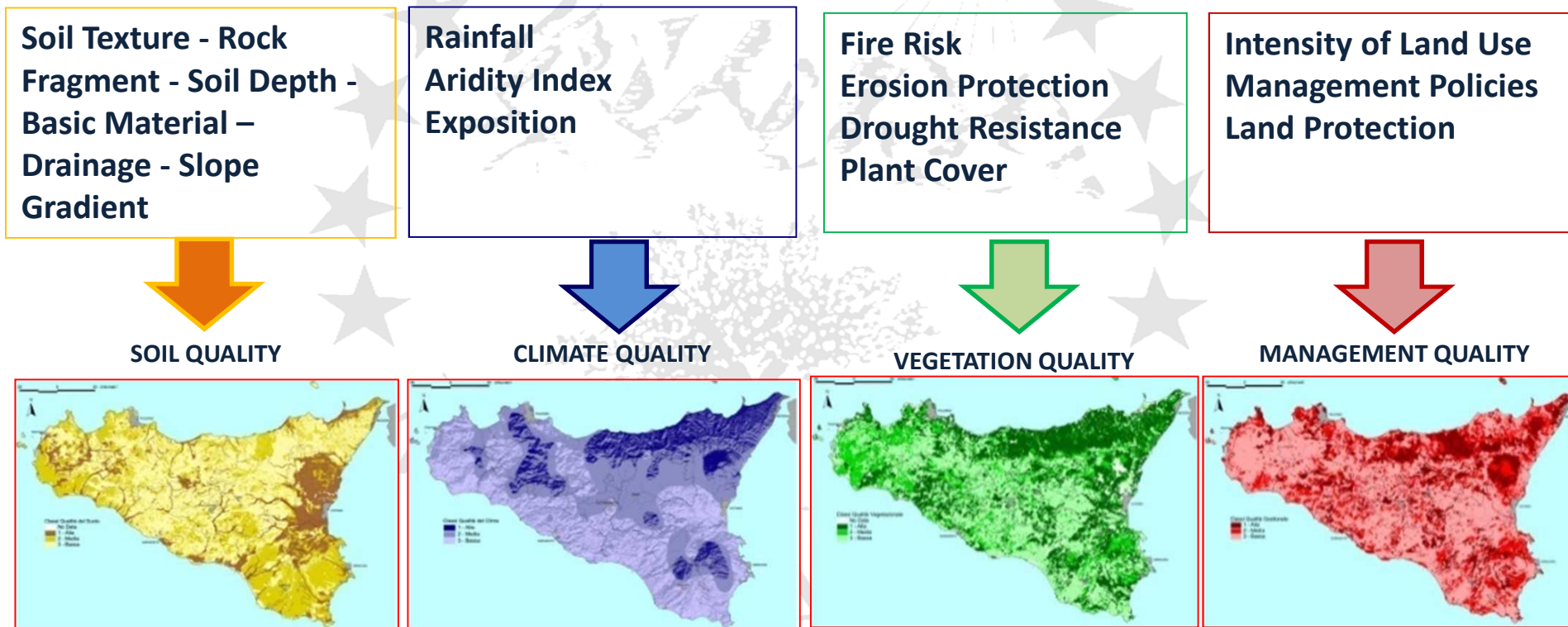
DATABASE



MEDALUS PROTOCOL

Parameters are used for the definition and mapping of the ESAs to desertification

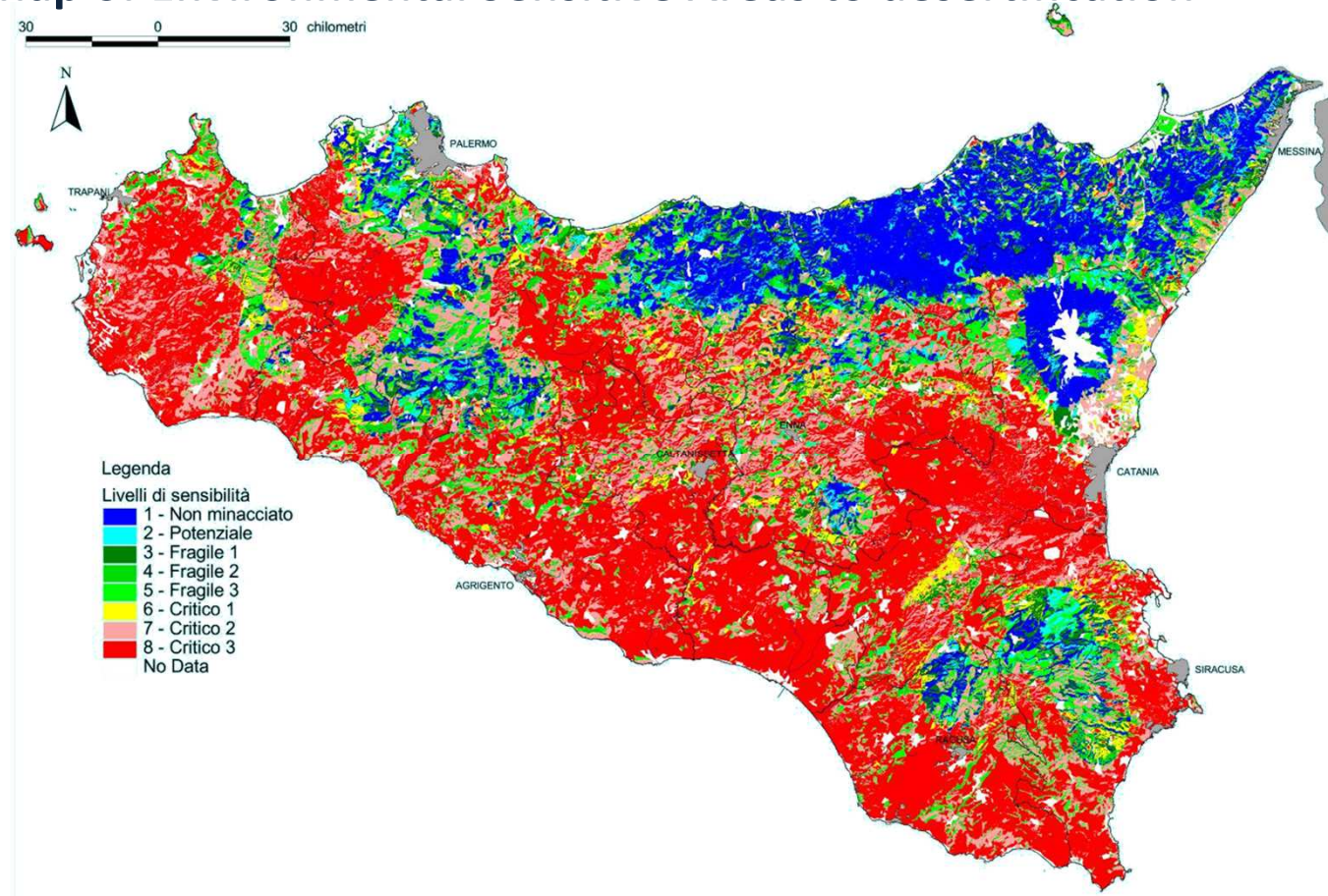
KEY INDICATORS OF DESERTIFICATION AT THE ESA SCALE



4 CATEGORIES

MEDALUS PROTOCOL

Map of Environmental Sensitive Areas to desertification



MEDALUS LEGEND

Map of Environmental Sensitive Areas to desertification

ESAI	Type	Subtype	Characteristics
< 1,17	NON AFFECTED	N	Areas not subject and not susceptible to desertification
1,17 – 1,22	POTENTIAL	P	Potential risk areas, where are necessary policy and planning precise and concrete.
1,23 – 1,26	FRAGILE	F 1	Areas with very steep to steep, moderately fine-textured, stony to slightly stony, moderately deep to deep, well drained soils formed mainly on marble, schist, ultrabasic materials.
1,27 – 1,32		F 2	
1,33 – 1,37		F 3	
1,38 – 1,41	CRITICAL	C 1	Areas with mainly very steep, moderately fine-textured, stony, shallow to moderately deep, mainly well drained soils formed on marble, limestone.
1,42 – 1,53		C 2	
> 1,53		C 3	





Desertification Risk: Sicily






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maragusa@dmi.unict.it

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RECENT WORKS

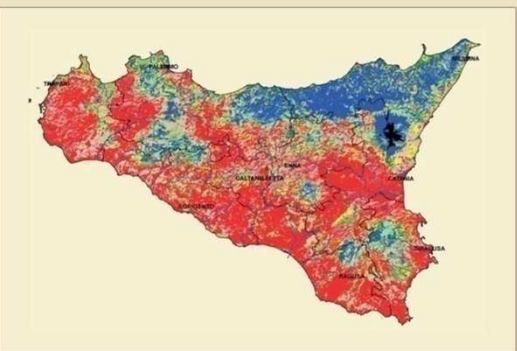




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 Università degli Studi di Catania
 Laboratorio di Cartografia Dipartimento di Botanica Università di Catania

Direttore CUTGANA Concetto Amore
 Responsabile Progetto Archimede Angelo Messina

RISCHIO DESERTIFICAZIONE REGIONE SICILIA

V. Piccione, V. Veneziano, V. Malacrino & S. Campisi



PALERMO, 2009

Università degli Studi di Catania



CUTGANA
Centro Universitario per la Tutela e la Gestione degli Ambienti Naturali e degli Agroecosistemi

Direttore CUTGANA
Concetto AMORE – Dipartimento di Scienze Geologiche - Università degli Studi di Catania

Progetto ARCHIMEDE - Centro Polifunzionale per lo sviluppo sostenibile, finanziato dalla Regione Siciliana Assessorato Industria, Dipartimento Industria, a valere sulla misura 3.15 - sottosezione C Potenziamento delle infrastrutture e laboratori esistenti PTT n°11: Enna: Turismo tra archeologia e natura

Responsabile del Progetto ARCHIMEDE
Angelo MESSINA – Dipartimento di Biologia Animale - Università degli Studi di Catania

Unità Operativa Monitoraggio Cambiamenti Ambientali del Progetto ARCHIMEDE
Coordinamento: Vincenzo PICCIONE, Giorgio SABELLA, Fabio VIGLANISI
Collaboratori U.O.: Antonio ALICATA, Elena AMORE, Fabio BRANCA, Giuseppe MESSINA, Ettore PETRALIA

Responsabile del Laboratorio di Cartografia – Dipartimento di Botanica Università degli Studi di Catania
Vincenzo PICCIONE
Afferenti Laboratorio
Vincenzo VENEZIANO - Dottorando in Biologia ed Ecologia Vegetale in Ambiente Mediterraneo – Università degli Studi Catania - Italy
Vincenzo MALACRINO - Dottore di Ricerca in Ingegneria Agroforestale e dell'Ambiente - Università degli Studi Mediterranea di Reggio Calabria - Italy

Ben Gurion University of the Negev, Israel
Gideon ORON - Environment Water Resources The Institute for Desert Research Kiryat Sde-Boker, Israel
Savatore CAMPISI - The Jacob Blaustein Institute for Desert Research Zuckerberg Institute for Water Research (ZWIR) Sde Boqer Campus, Israel

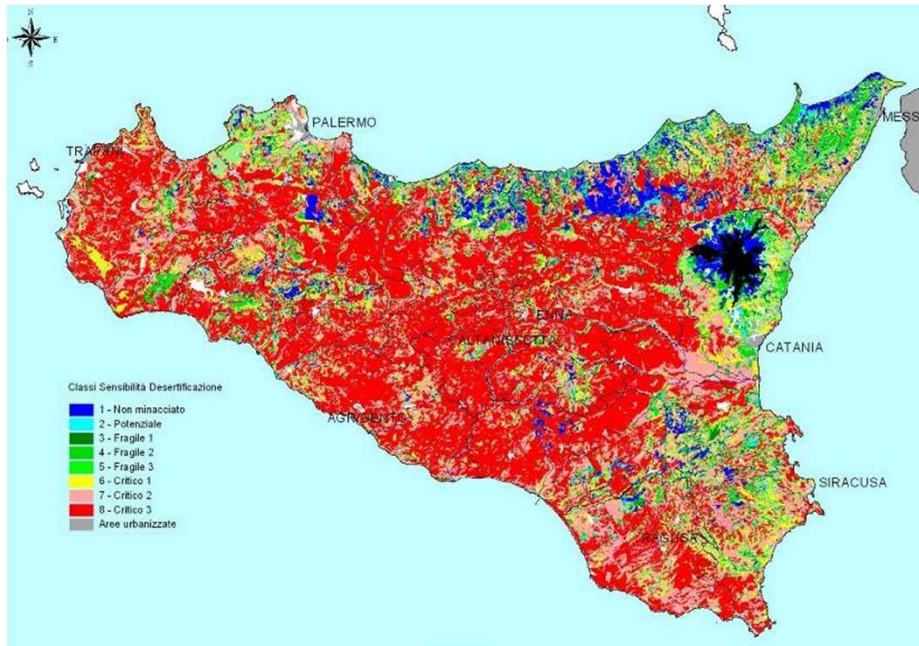
Collaboratori aggregati all'Unità Operativa Monitoraggio Cambiamenti Ambientali del Progetto ARCHIMEDE
Nunzia Aiello – dott.ssa in Scienze Biologiche - Università degli Studi di Catania
Fabiana Berardo - dott.ssa in Scienze dell'Ambiente e della Natura - Università degli Studi del Molise
Concetta Simona Buccheri - dott.ssa in Scienze Naturali - Università degli Studi di Catania
Sebastiano Calgiore - dott.re in Scienze Naturali e dott.re in Scienze per la Tutela dell'Ambiente e delle sue Risorse - Università degli Studi di Catania
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Caterina Cuscunà - dott.ssa in Scienze Naturali - Università degli Studi di Catania
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Alessio Laudani - dott.re in Scienze Naturali - Università degli Studi di Catania
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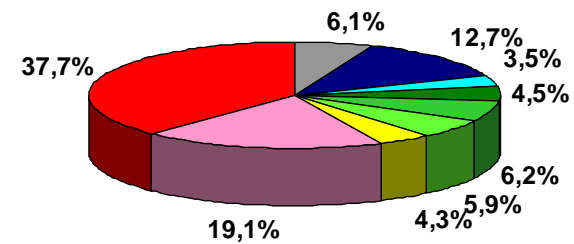
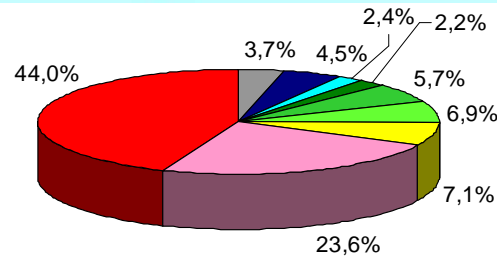
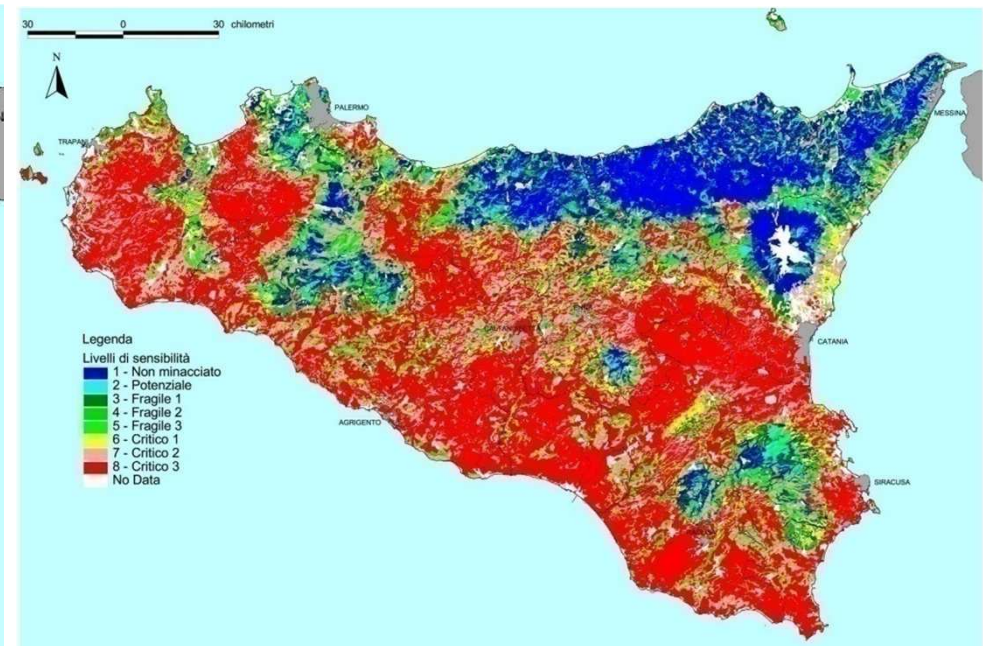



Map of Environmental Sensitive Areas to desertification

First half of the 20th century





Second half of the 20th century



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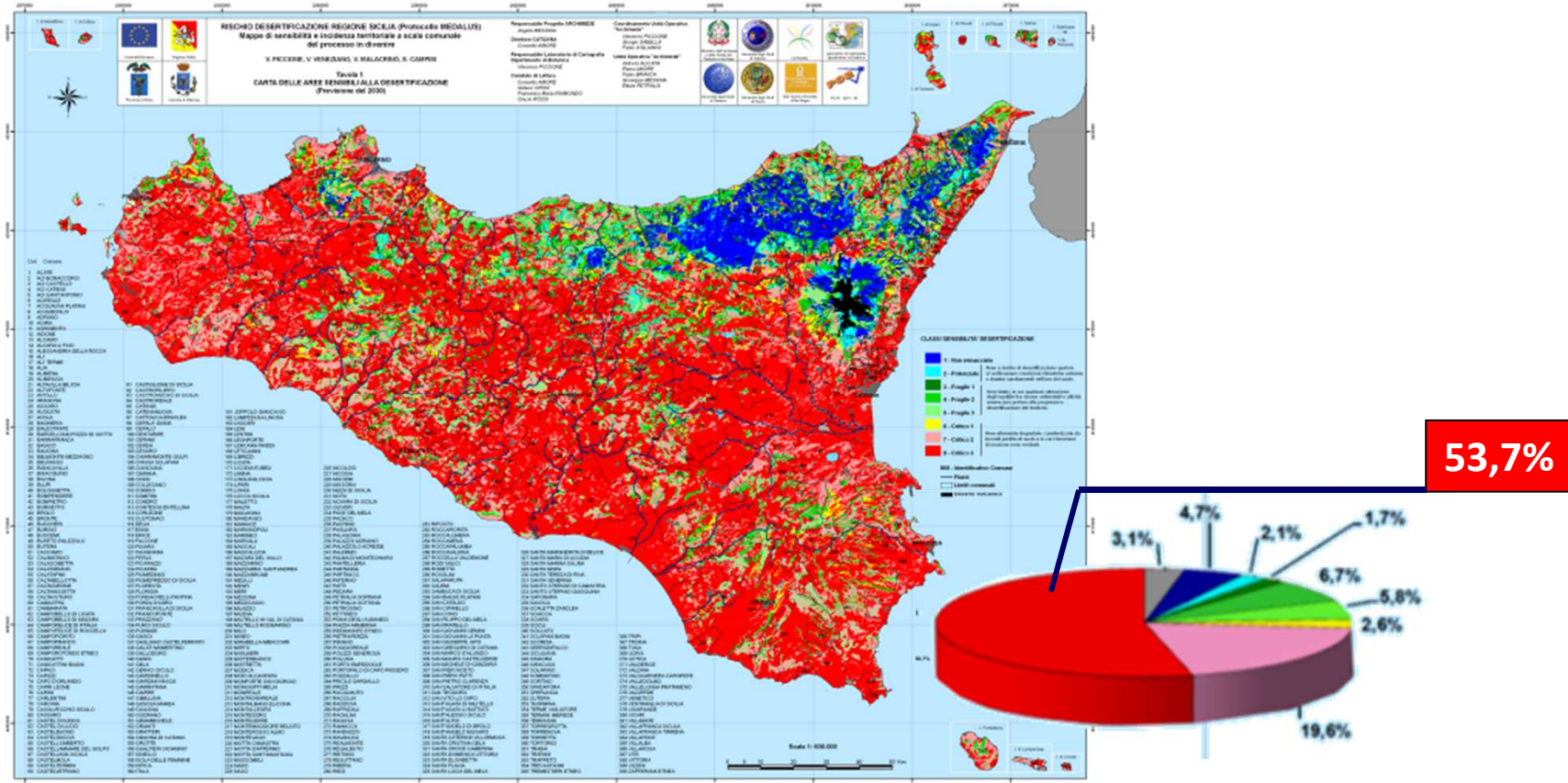


YEAR	DYNAMIC GIS MODEL	STATISTICS MODEL WINTERS
2030 compared with average 1951-1990	 + 1,4°C	 - 27%



SIMULATION OF SCENERY ON DESERTIFICATION RISK BASED ON CLIMATE CHANGE

Sensitive Areas of Desertification – expectation 2030



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Desertification Risk: Municipalities of Sicily



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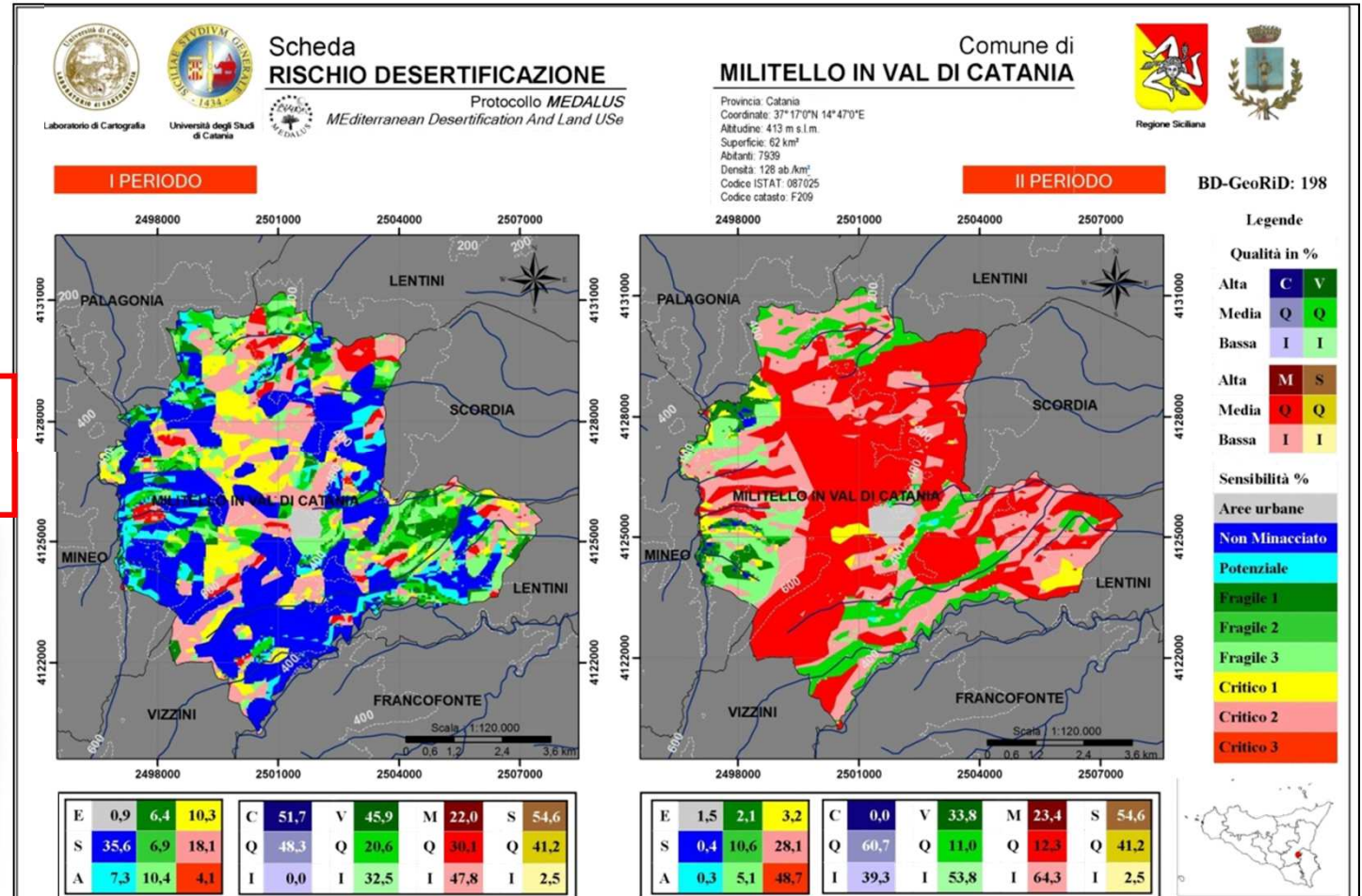
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MILITELLO IN VAL DI CATANIA



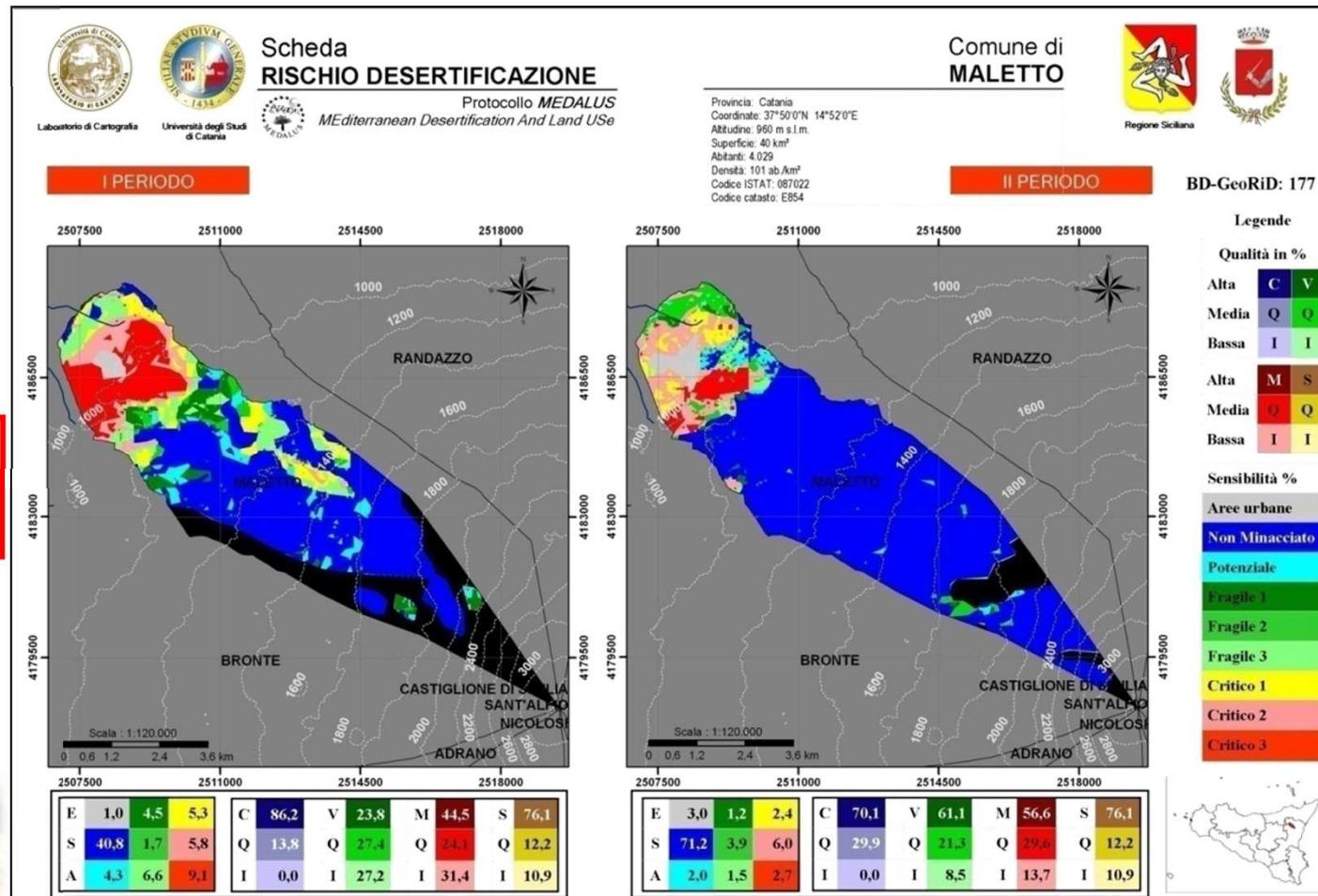
**EXAMPLE OF
WORSENING**



MALETTO



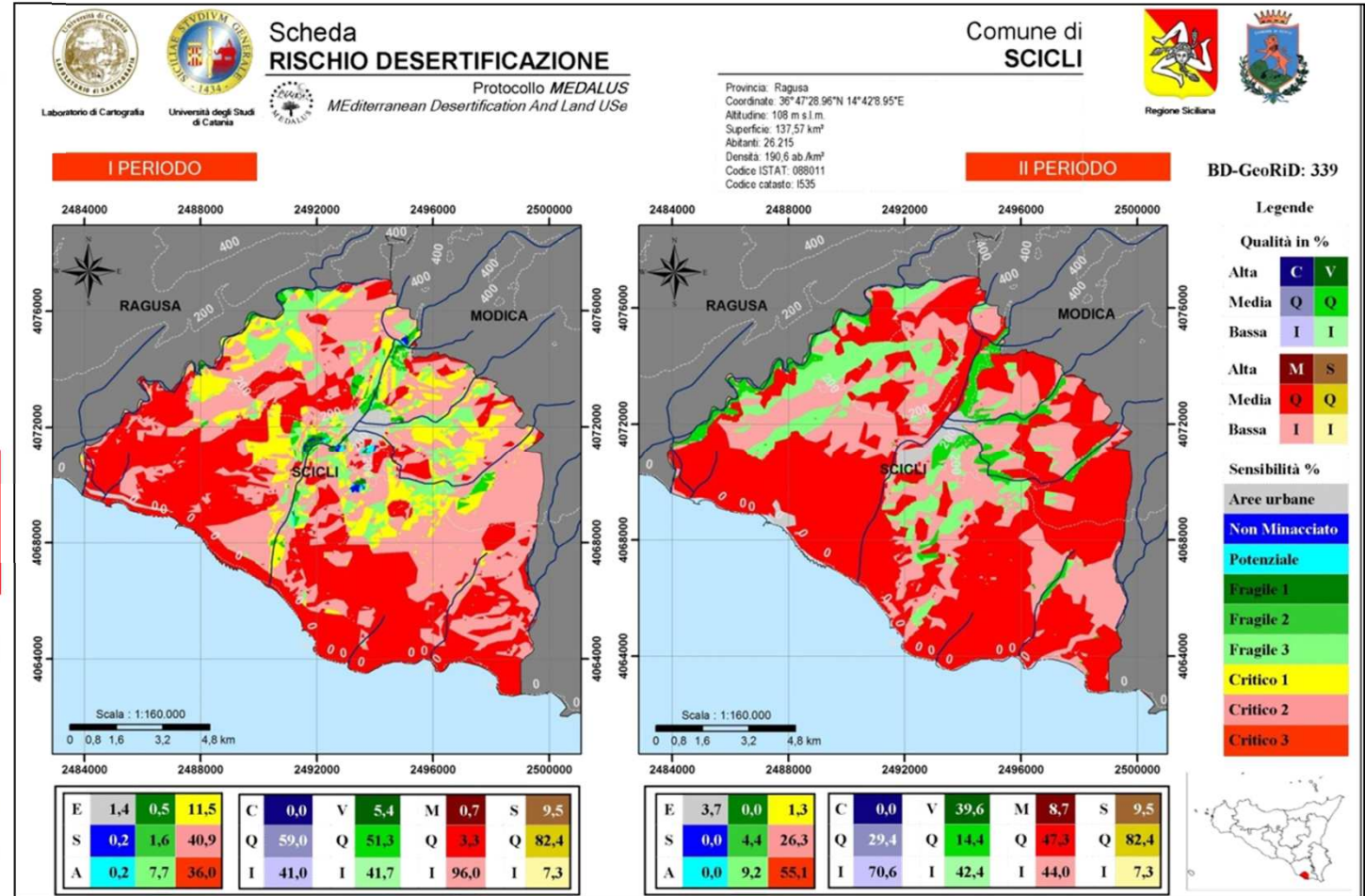
**EXAMPLE OF
STABILITY**



SCICLI



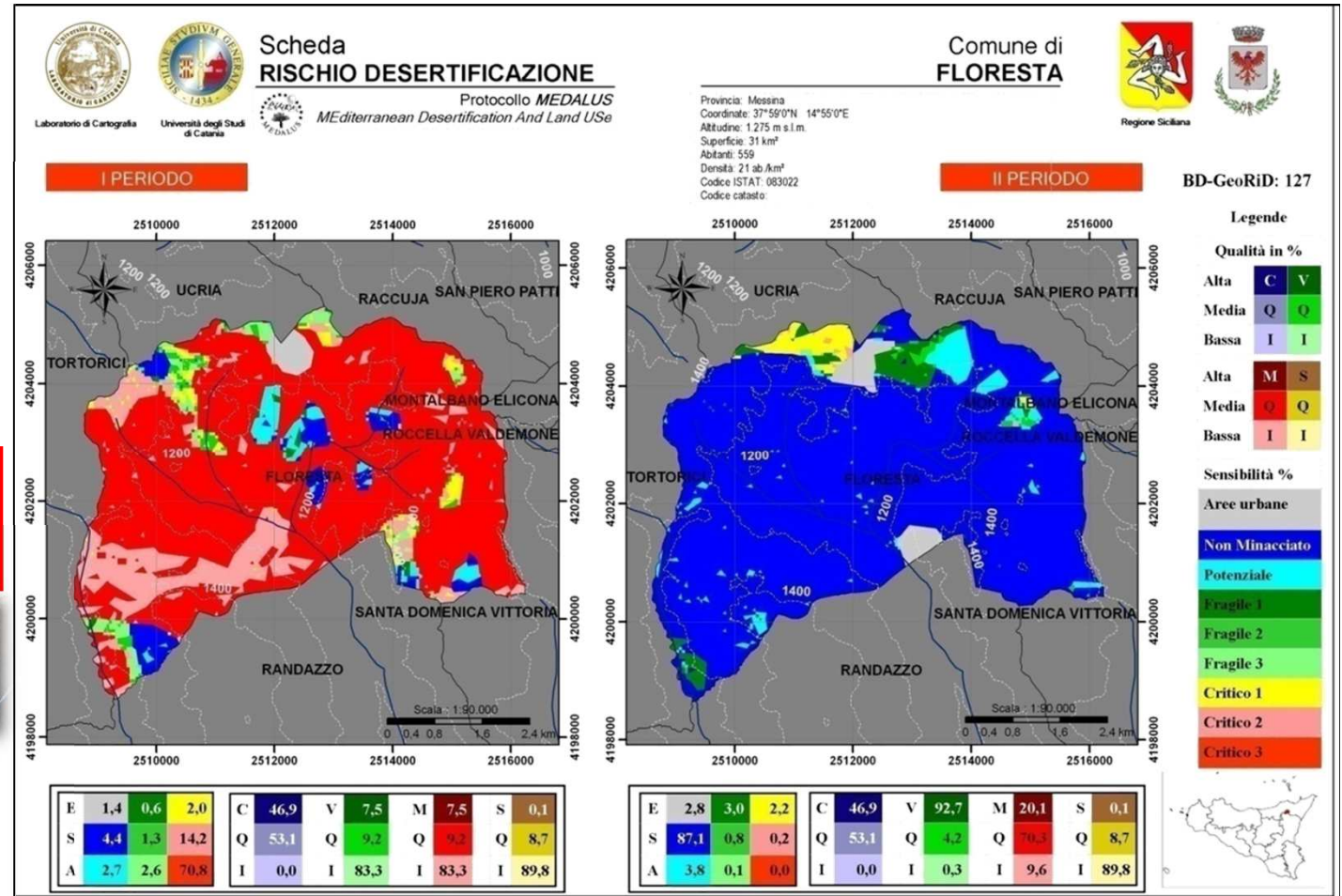
**EXAMPLE OF
STABILITY**



FLORESTA



**EXAMPLE OF
IMPROVEMENT**





<http://www.gioenia.unict.it/>

Vincenzo Piccione, Vincenzo Veneziano, Andrea Piccione
 [Progetto geodatabase rischio desertificazione in Sicilia (4 - SR)
 Caratterizzazione bi-temporale dei territori comunali della provincia di Siracusa*]
 Project geodatabase desertification hazard in Sicily (4 - SR)
 Bi-temporal characterization of the municipalities in the province of Syracuse
 Bollettino dell'Accademia Gioenia, 2011, Vol. 44, n. 373, FP55 - FP148 [ABSTRACT] [PDF]

Vincenzo Piccione, Vincenzo Veneziano, Andrea Piccione
 [Progetto geodatabase rischio desertificazione in Sicilia (6 - AG1)
 Caratterizzazione bi-temporale di territori comunali della provincia di Agrigento*]
 Project geodatabase desertification hazard in Sicily (6 - AG1)
 Bi-temporal characterization of the municipalities of the province of Agrigento
 Bollettino dell'Accademia Gioenia, 2012, Vol. 45, n. 374, FP97 - FP130 [ABSTRACT] [PDF]

Vincenzo Piccione, Vincenzo Veneziano, Andrea Piccione
 [Progetto geodatabase rischio desertificazione in Sicilia (10 - CT3)
 Caratterizzazione bi-temporale di territori comunali della provincia di Catania*]
 Project geodatabase desertification hazard in Sicily (10 - CT3)
 Bi-temporal characterization of the municipalities of the province of Catania
 Bollettino dell'Accademia Gioenia, 2012, Vol. 45, n. 374, FP271 - FP313 [ABSTRACT] [PDF]

Vincenzo Piccione, Vincenzo Veneziano, Andrea Piccione
 [Progetto geodatabase rischio desertificazione in Sicilia (11 - PA1)
 Caratterizzazione bi-temporale di territori comunali della provincia di Palermo*]
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 Bi-temporal characterization of the municipalities of the province of Palermo
 Bollettino dell'Accademia Gioenia, 2012, Vol. 45, n. 374, FP271 - FP313 [ABSTRACT] [PDF]

Vincenzo Piccione, Vincenzo Veneziano, Andrea Piccione
 [Progetto geodatabase rischio desertificazione in Sicilia (12 - PA2)
 Caratterizzazione bi-temporale di territori comunali della provincia di Palermo*]
 Project geodatabase desertification hazard in Sicily (12 - PA2)
 Bi-temporal characterization of the municipalities of the province of Palermo
 Bollettino dell'Accademia Gioenia, 2012, Vol. 45, n. 374, FP314 - FP356 [ABSTRACT] [PDF]

Vincenzo Piccione, Vincenzo Veneziano, Andrea Piccione
 [Progetto geodatabase rischio desertificazione in Sicilia (13 - PA3)
 Caratterizzazione bi-temporale di territori comunali della provincia di Palermo*]
 Project geodatabase desertification hazard in Sicily (13 - PA3)
 Bi-temporal characterization of the municipalities of the province of Palermo
 Bollettino dell'Accademia Gioenia, 2012, Vol. 45, n. 374, FP357 - FP399 [ABSTRACT] [PDF]

Vincenzo Piccione, Vincenzo Veneziano, Andrea Piccione
 [Progetto geodatabase rischio desertificazione in Sicilia (15 - ME2)
 Caratterizzazione bi-temporale di territori comunali della provincia di Messina*]
 Project geodatabase desertification hazard in Sicily (15 - ME2)
 Bi-temporal characterization of the municipalities of the province of Messina
 Bollettino dell'Accademia Gioenia, 2012, Vol. 45, n. 374, FP443 - FP484 [ABSTRACT] [PDF]

Vincenzo Piccione, Vincenzo Veneziano, Andrea Piccione
 [Progetto geodatabase rischio desertificazione in Sicilia (16 - ME3)
 Caratterizzazione bi-temporale di territori comunali della provincia di Messina*]
 Project geodatabase desertification hazard in Sicily (16 - ME3)
 Bi-temporal characterization of the municipalities of the province of Messina
 Bollettino dell'Accademia Gioenia, 2012, Vol. 45, n. 374, FP485 - FP522 [ABSTRACT] [PDF]

Vincenzo Piccione, Vincenzo Veneziano, Andrea Piccione
 [Progetto geodatabase rischio desertificazione in Sicilia (17 - ME4)
 Caratterizzazione bi-temporale di territori comunali della provincia di Messina*]
 Project geodatabase desertification hazard in Sicily (17 - ME4)
 Bi-temporal characterization of the municipalities of the province of Messina
 Bollettino dell'Accademia Gioenia, 2012, Vol. 45, n. 374, FP523 - FP565 [ABSTRACT] [PDF]





Desertification Risk: The mitigation role of parks



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maragusa@dmi.unict.it

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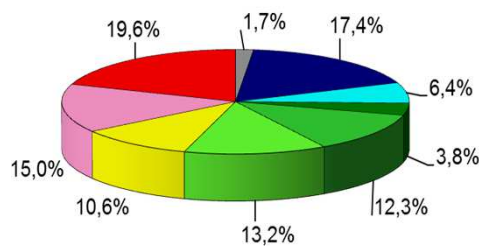
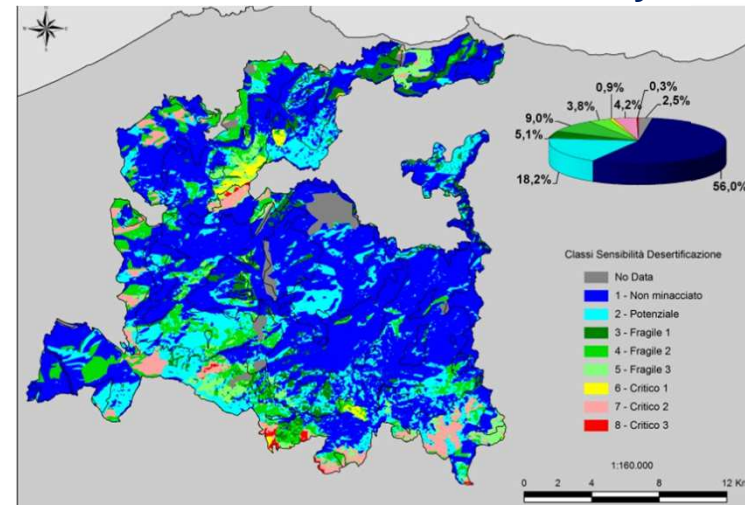
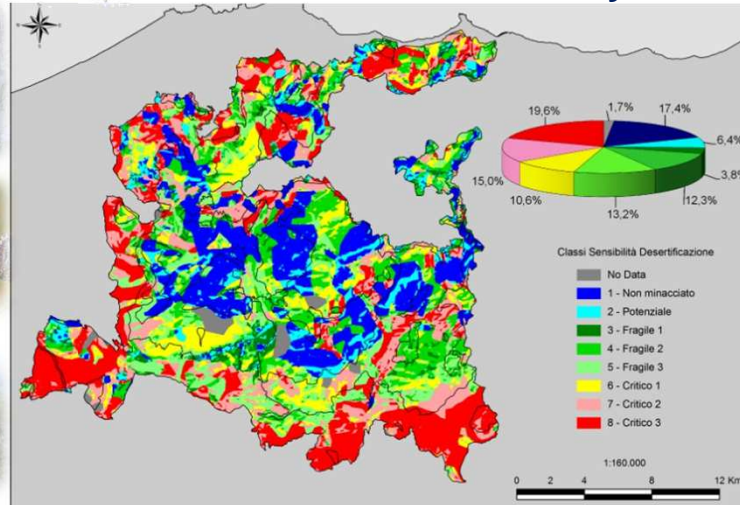
Desertification Risk Madonie Park



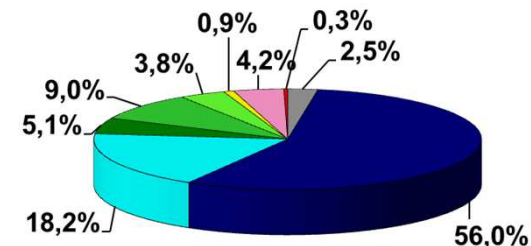
Extension
39.941 ha

First half of the 20th century

Second half of the 20th century



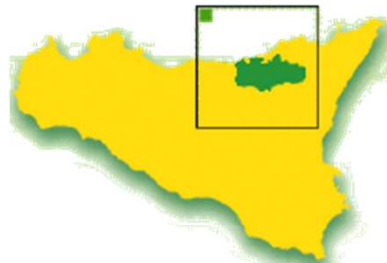
Classes ESA
Non affected
Potential
Fragile1
Fragile2
Fragile3
Critical1
Critical2
Critical3



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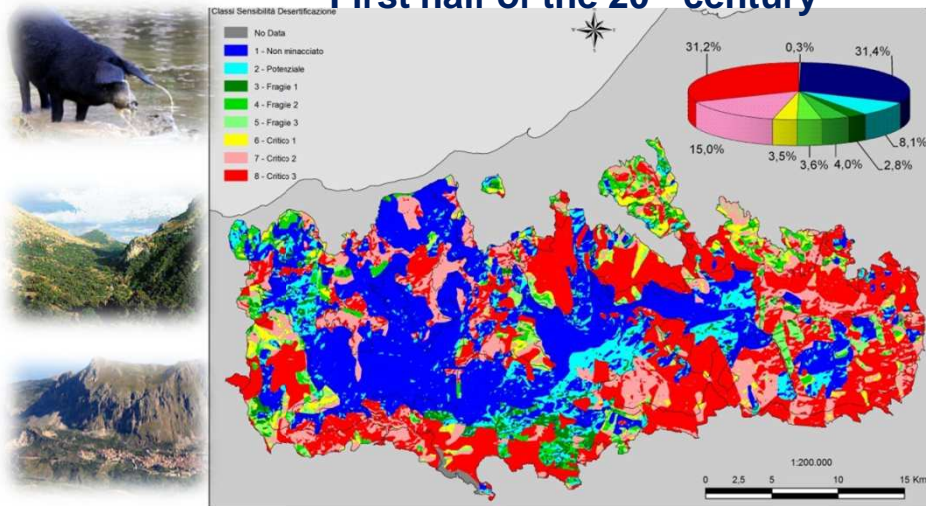
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Desertification Risk Nebrodi Park

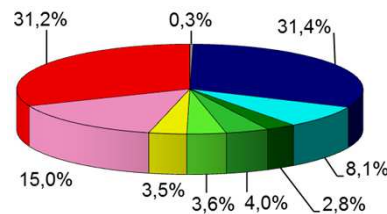
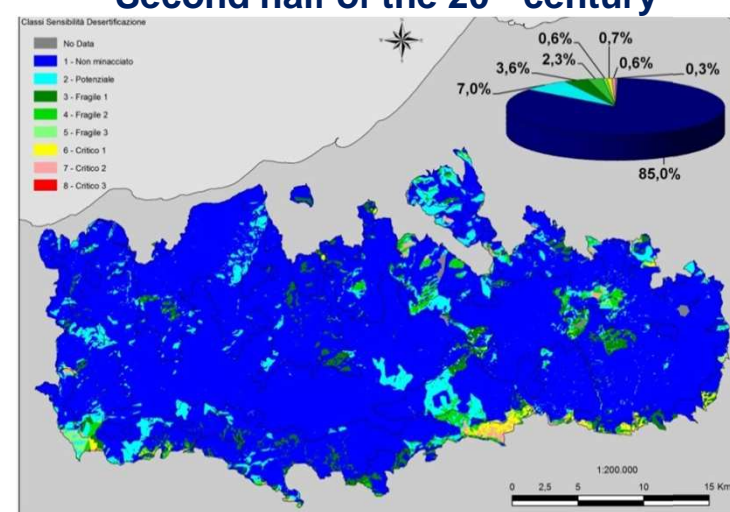


Extension
85.687 ha

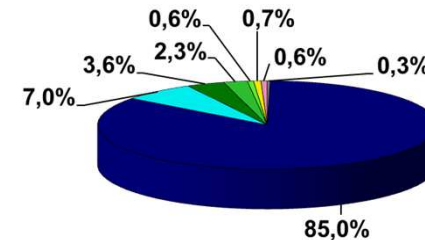
First half of the 20th century



Second half of the 20th century



Classes ESA
Non affected
Potential
Fragile1
Fragile2
Fragile3
Critical1
Critical2
Critical3



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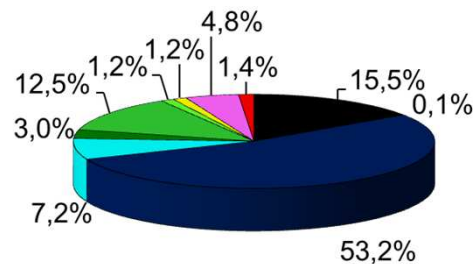
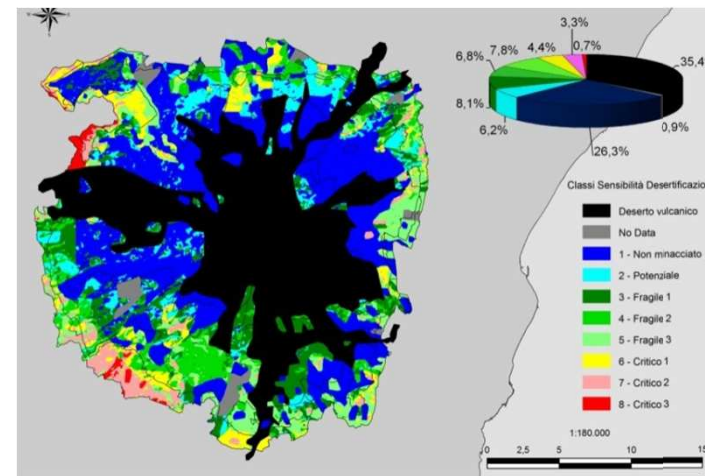
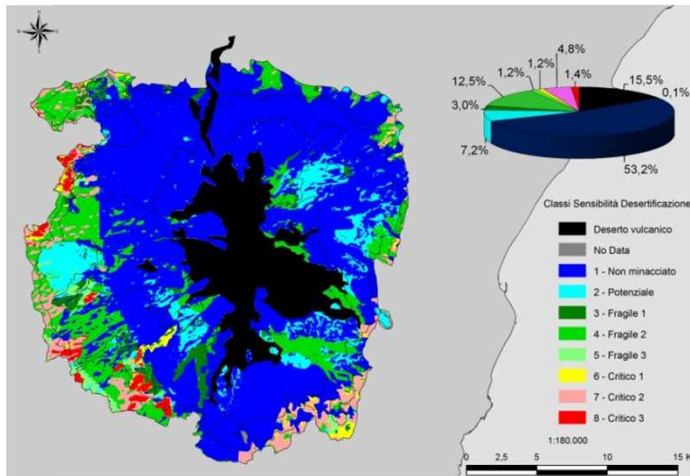
Desertification Risk Etna Park



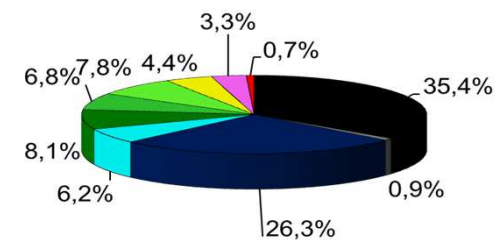
Extension
58.367 ha

First half of the 20th century

Second half of the 20th century

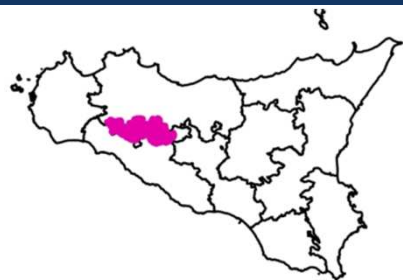


Classes ESA
Non affected
Potential
Fragile1
Fragile2
Fragile3
Critical1
Critical2
Critical3



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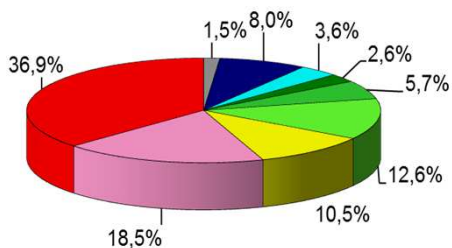
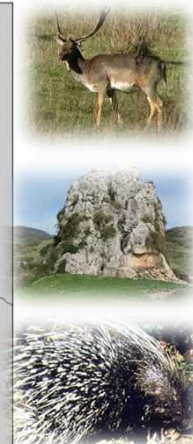
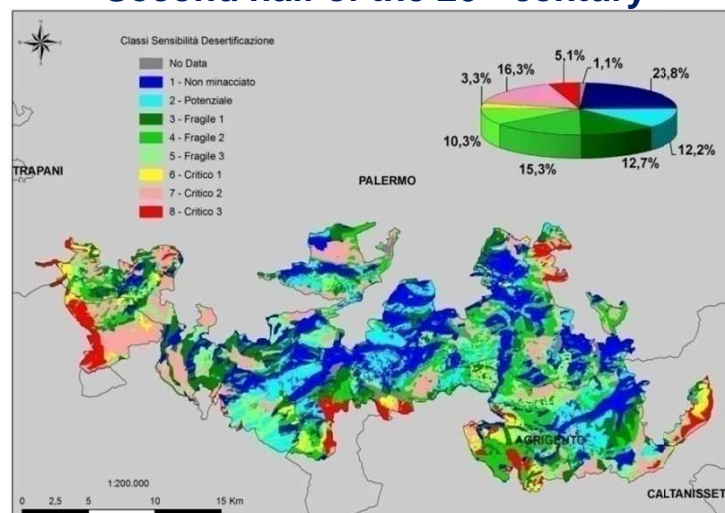
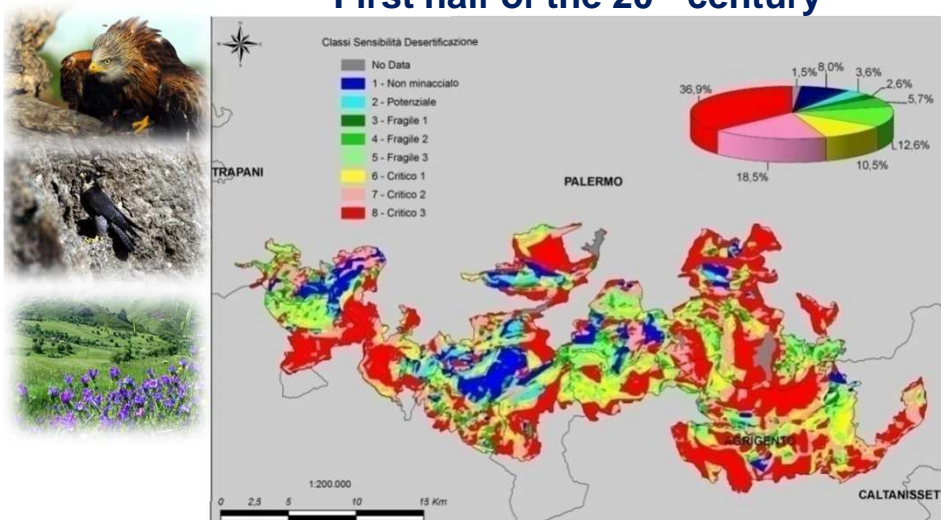


Extension
43.687 ha

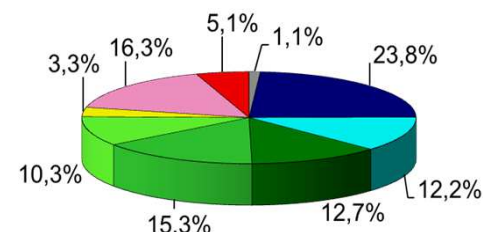
Desertification Risk Sicani Park

First half of the 20th century

Second half of the 20th century



Classi ESA
Non affected
Potential
Fragile1
Fragile2
Fragile3
Critical1
Critical2
Critical3



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maragusa@dmi.unict.it

Variations of Sensitive Areas to Desertification in Sicilian's Parks



Classi ESA	Variations Nebrodi Park	Variations Madonie Park	Variations Etna Park	Variations Sicani Park
Non affected	+ 53,6%	+ 38,6%	+ 26,9%	+ 15,8%
Potential	- 1,1%	+ 11,8%	+ 1,0%	+ 8,6%
Fragile	- 3,9%	- 11,4%	- 3,4%	+ 17,4%
Critical	- 48,4%	- 39,8%	- 1,0%	- 41,2%



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maragusa@dmi.unict.it



Desertification Risk: The mitigation role of wooded areas



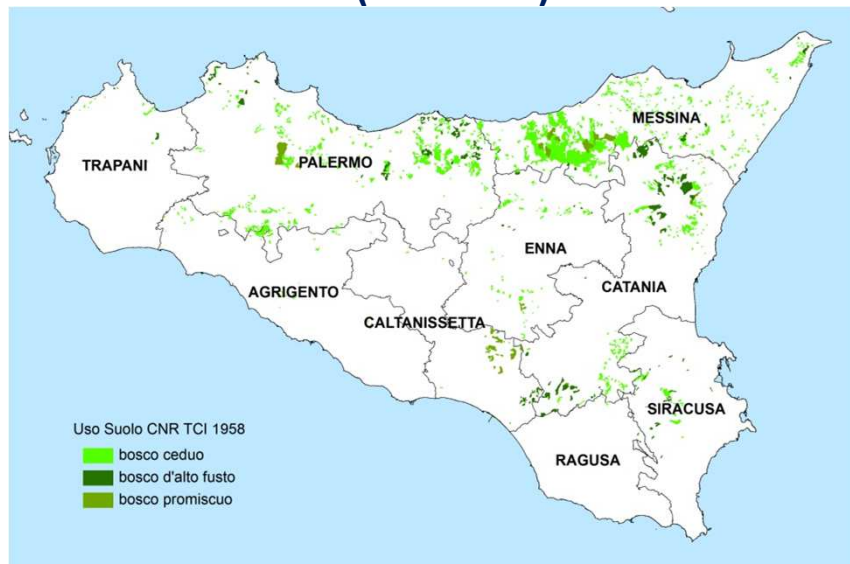
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maragusa@dmi.unict.it

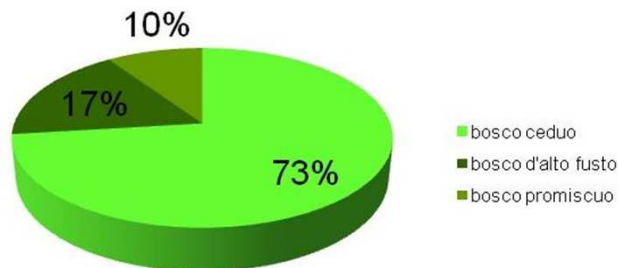
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WOODED AREAS

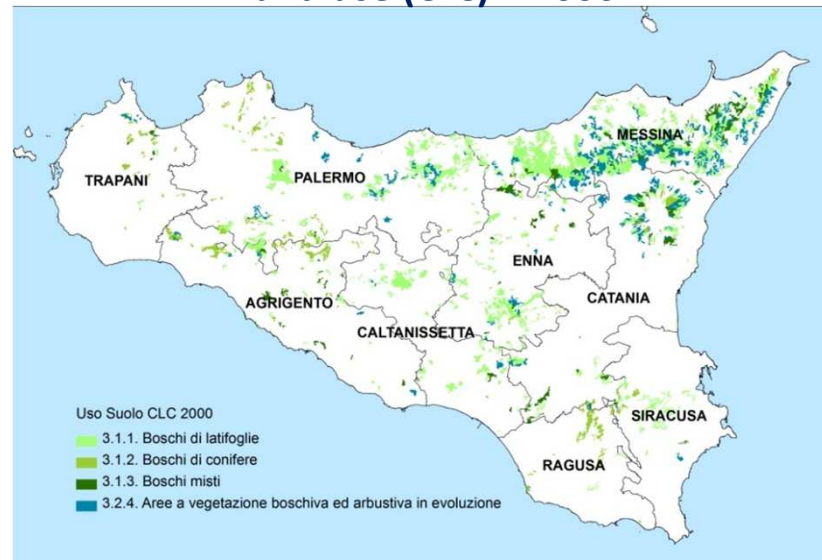
Land use (CNR – TCI) – 1958



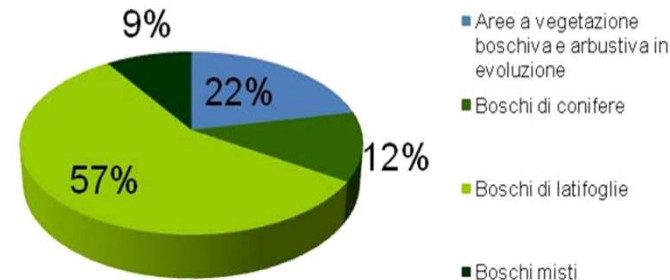
Wooded Areas 4,5% - 113.227 ha



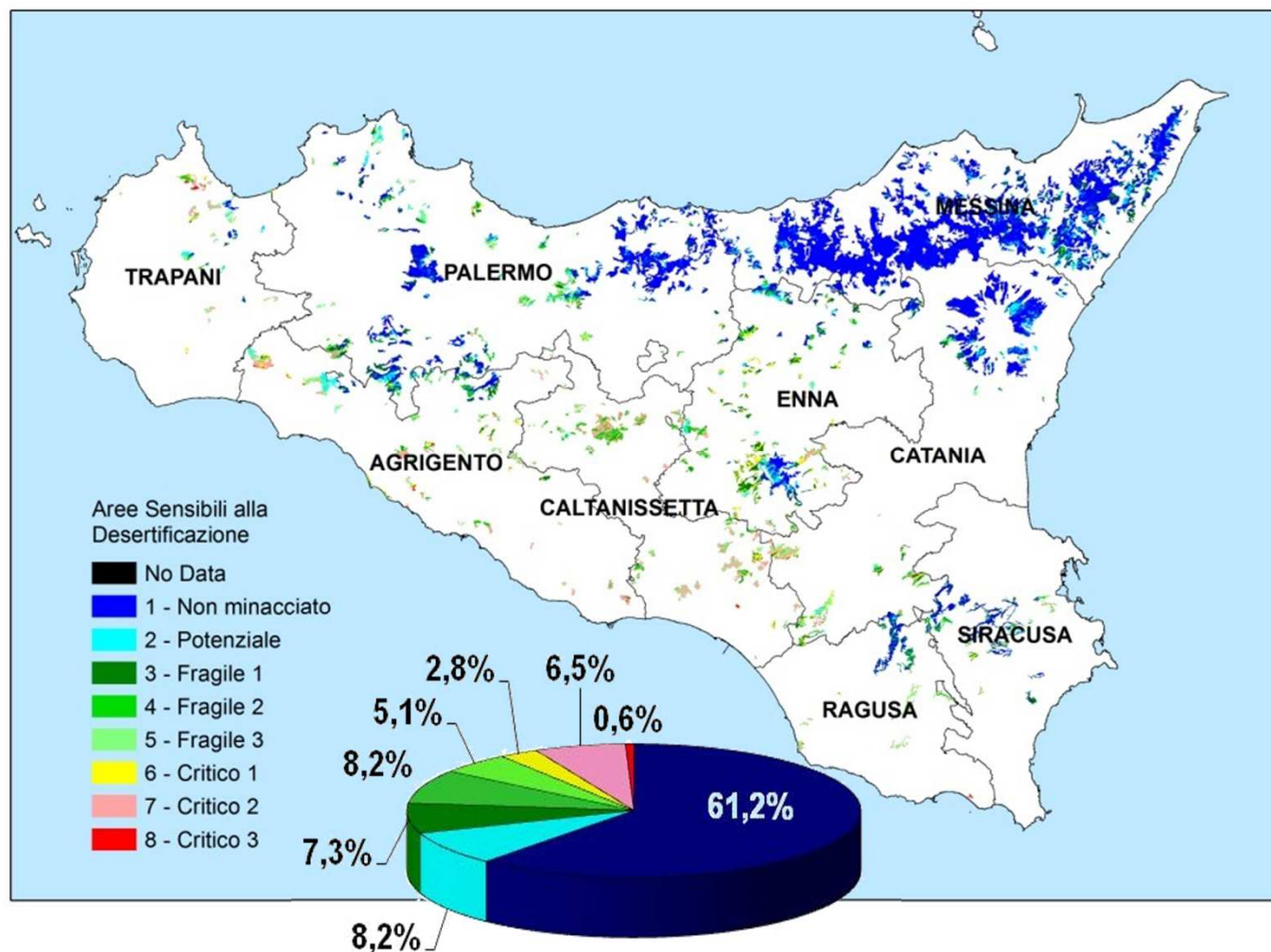
Land use (CLC) – 2000



Wooded Areas 9,6% - 244.022 ha



Desertification risk on wooded areas (end of the 20th century)



CHANGES ON WOODED AREAS

from the beginning of the last century to today

Change extension woods

 Reduction -17,4%

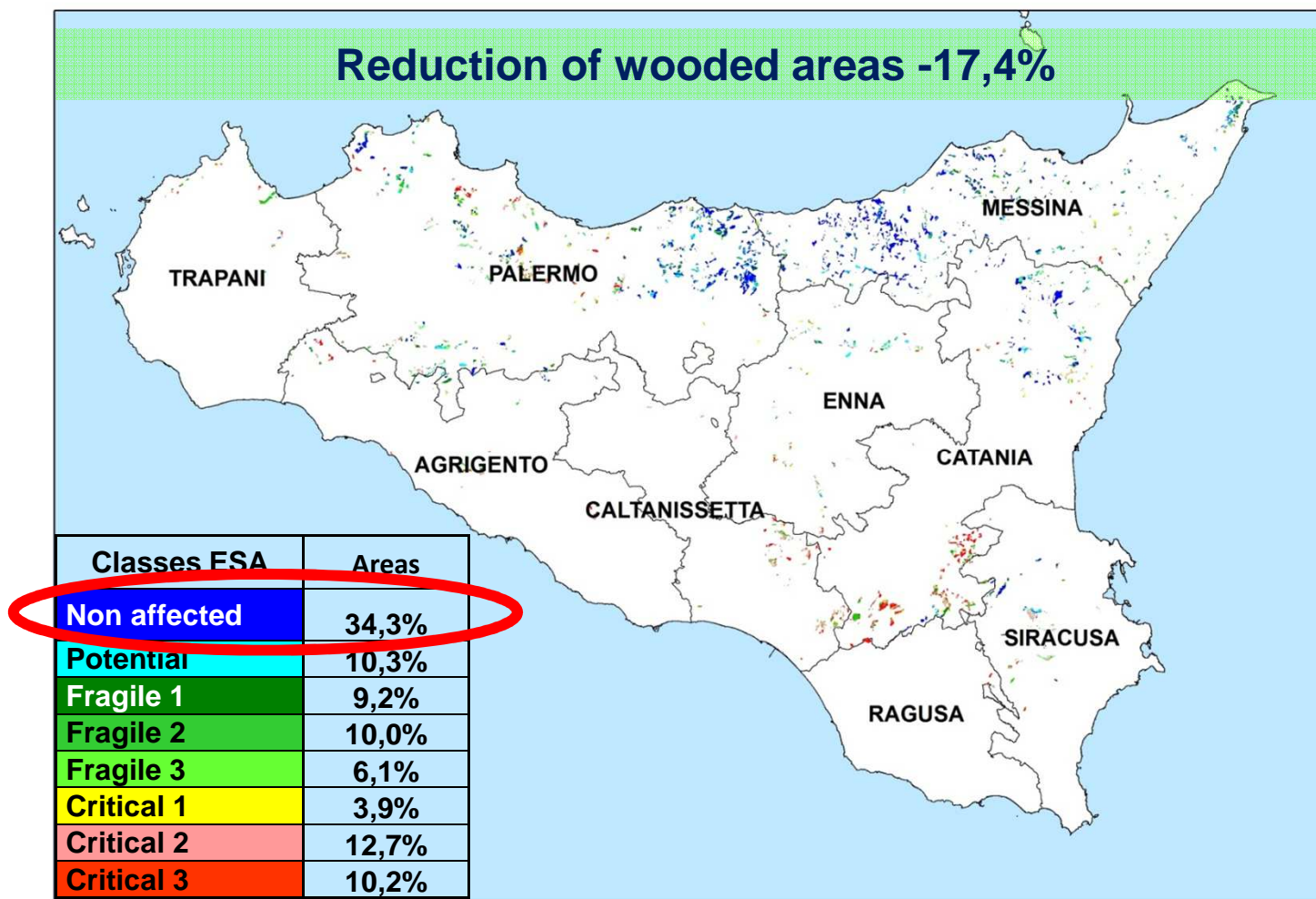
 Unchanged 21,0%

 Increase +61,6%

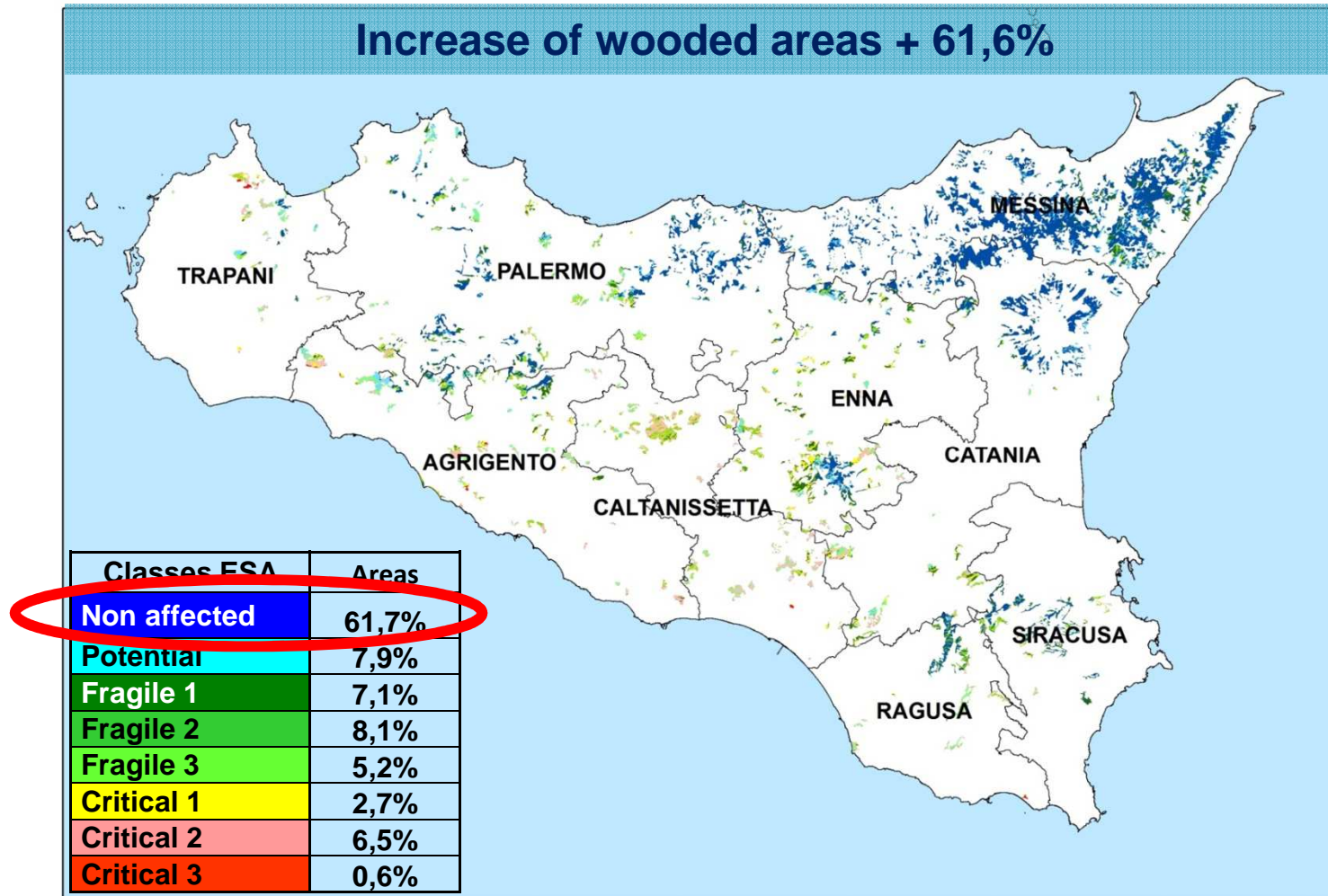
Increase of wooded areas ha 130.795



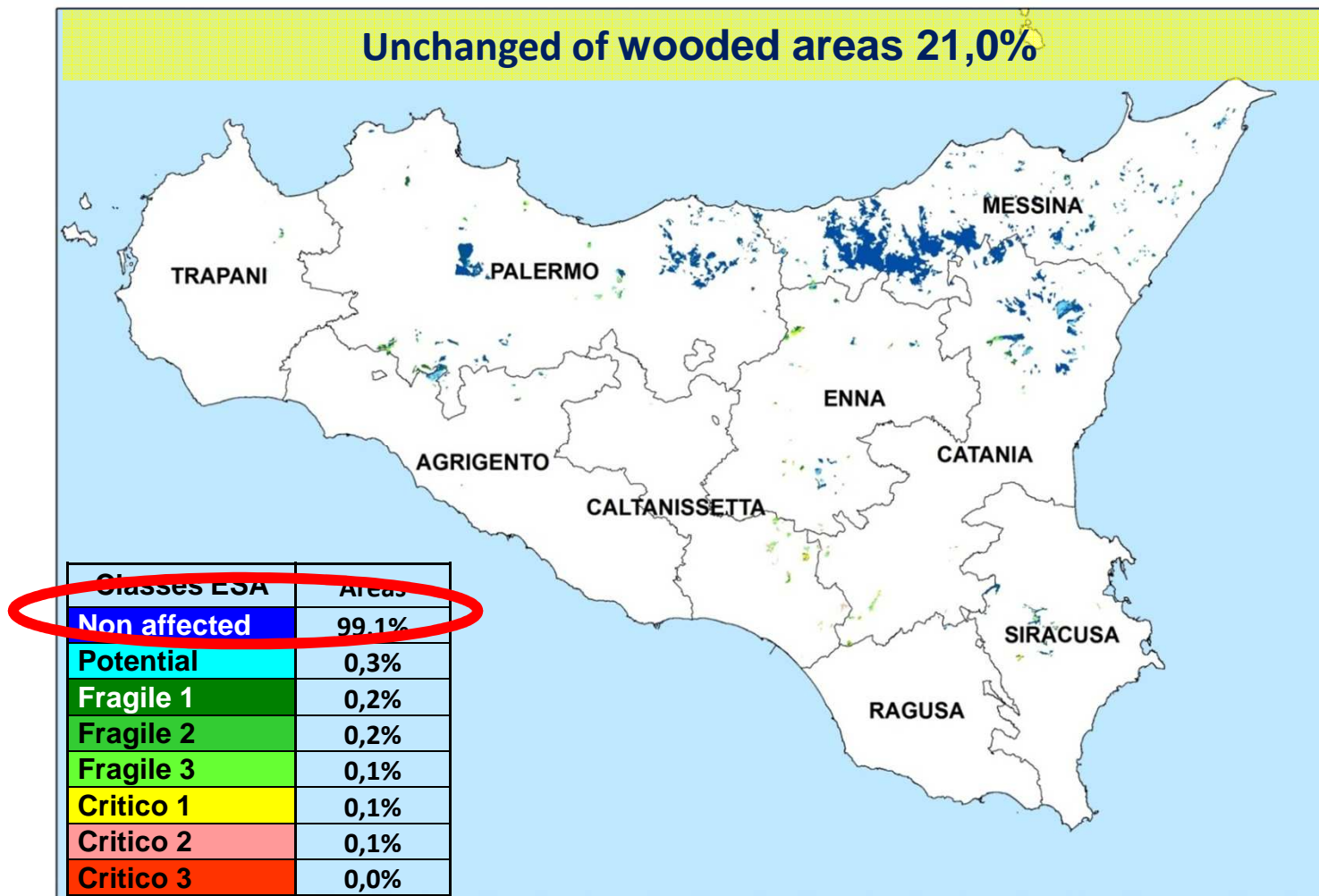
ROLE OF WOODED AREAS ON MITIGATION OF RISK DESERTIFICATION



ROLE OF WOODED AREAS ON MITIGATION OF RISK DESERTIFICATION



ROLE OF WOODED AREAS ON MITIGATION OF RISK DESERTIFICATION





International action to deal with the advance of deserts

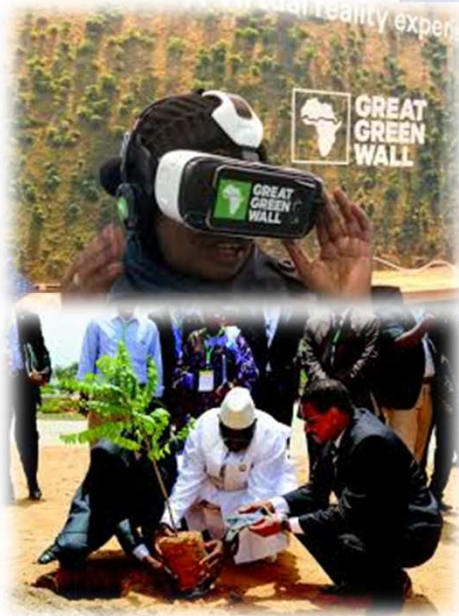
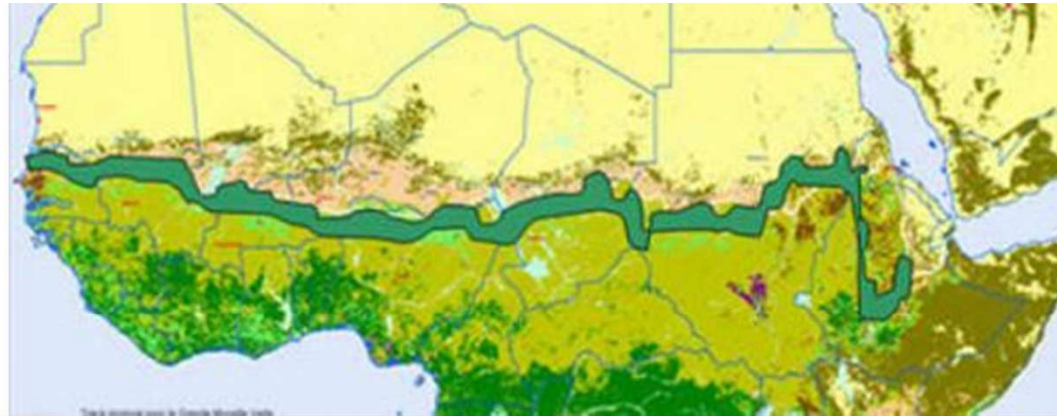


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SPEAKER: M.A. Ragusa
maragusa@dmi.unict.it

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THE GREAT GREEN WALL OF AFRICA



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SPEAKER: M.A. Ragusa
maragusa@dmi.unict.it

THE GREAT GREEN WALL OF CHINA



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SPEAKER: M.A. Ragusa
maragusa@dmi.unict.it



Desertification Risk: monitoring



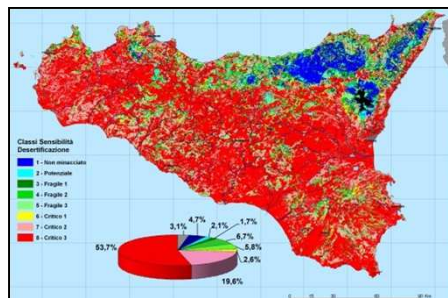
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maragusa@dmi.unict.it

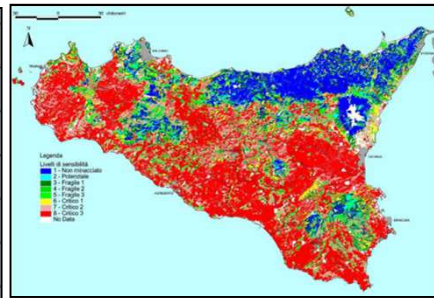
41

LIMITATIONS OF THE MEDALUS METHODOLOGY

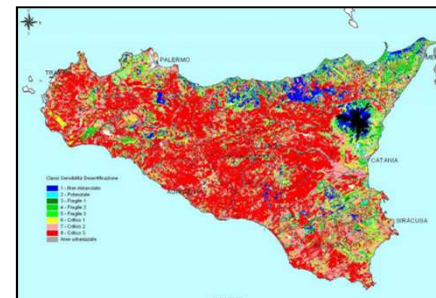
Objective difficulties in comparing risk areas in the different time and / or space



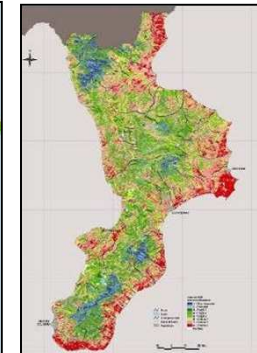
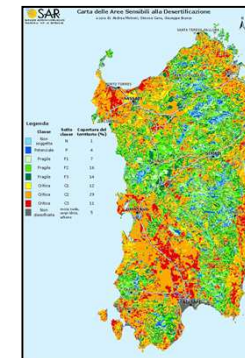
1931-60



1961-90



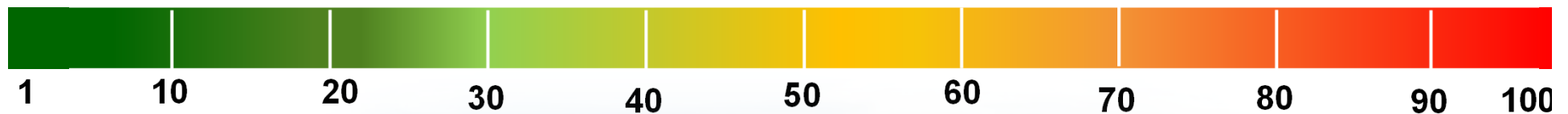
Expectation 2030



It does not allow to create an environmental sensitivity index
There isn't a unique and numerical parameter
It is possible to compare only between pictures

NEW ESPI: ENVIRONMENTALLY SENSITIVE PATCH INDEX

Overall assessment of the global sensitivity to desertification of an area, regardless of its extension (country, region, province, municipality, river basin, etc.)



An Index capable of give, in a scale 1–100, the global sensitivity to desertification in a territorial context

It gives possibility of producing ranking and easy comparison of different areas and different periods



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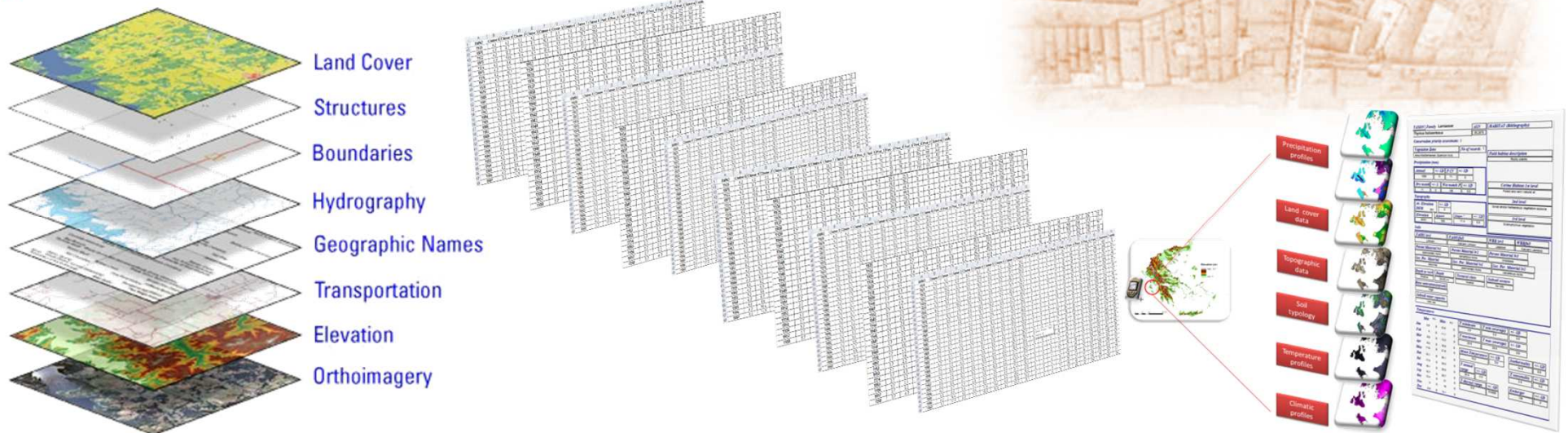
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maragusa@dmi.unict.it

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POTENTIALITY OF ESPI INDEX

Rankings immediately understandable

Update, flexibility and efficient thanks to the use of Geographic Information Systems (GIS)



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maragusa@dmi.unict.it

POTENTIALITY OF ESPI INDEX

INSTRUMENT FOR THE APPLICATION OF DECISION-MAKING STRATEGIES FOR THE MAINTENANCE OF
TERRITORY



MONITORING OF LAND AND ENVIRONMENT



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SPEAKER: M.A. Ragusa
maragusa@dmi.unict.it

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APPLICATIONS OF ESPI INDEX

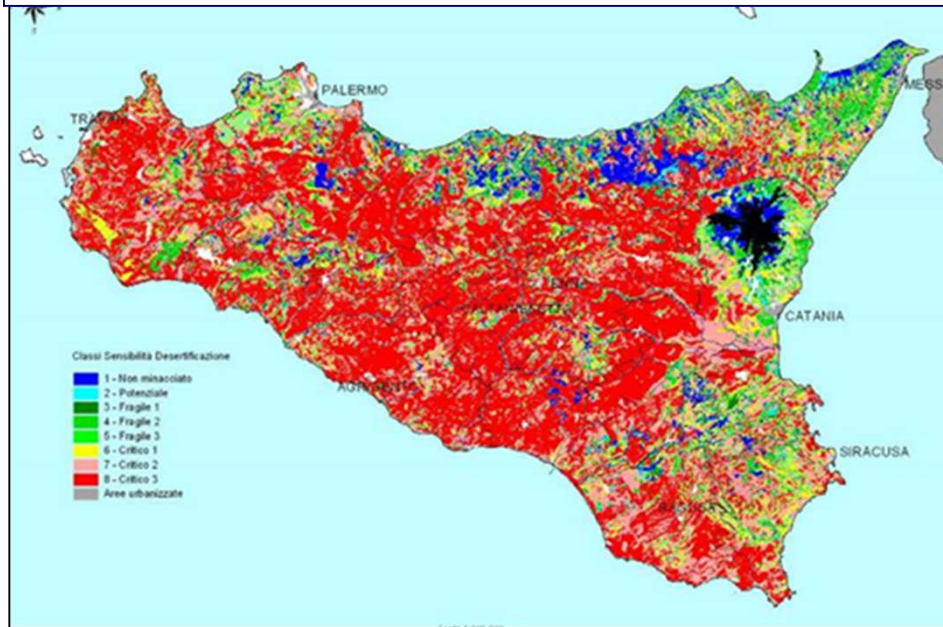
Qualitative and quantitative environmental
monitoring

Regional planning

Instantaneous quality control of a territory

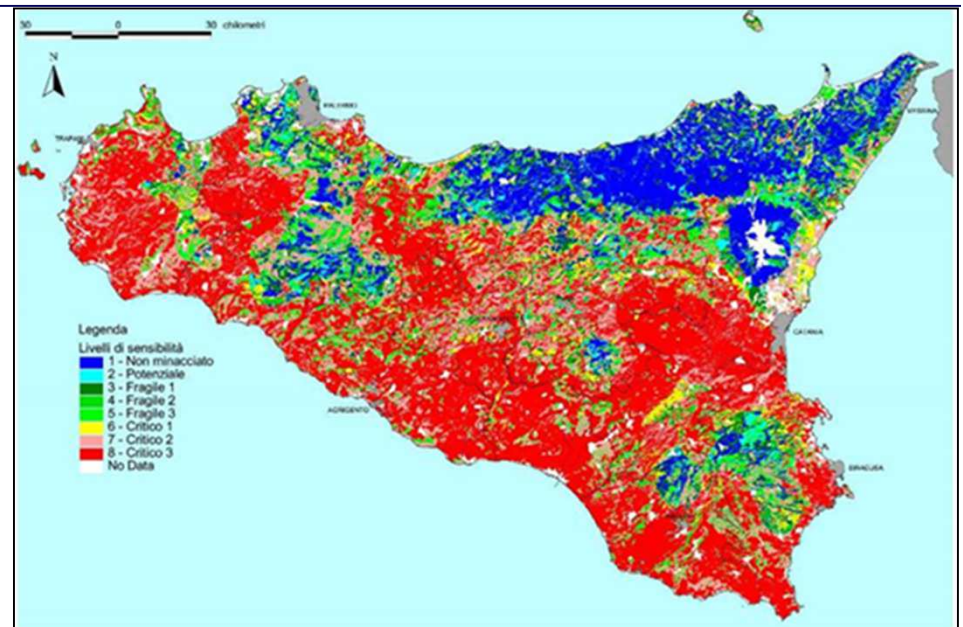


Comparison between Sensitive Areas of Desertification I and II half of XX century



I half of 20 th century

$ESPI_{med} = 72,6$



II half of 20 th century

$ESPI_{med} = 65,8$

YEARS MEANINGFUL

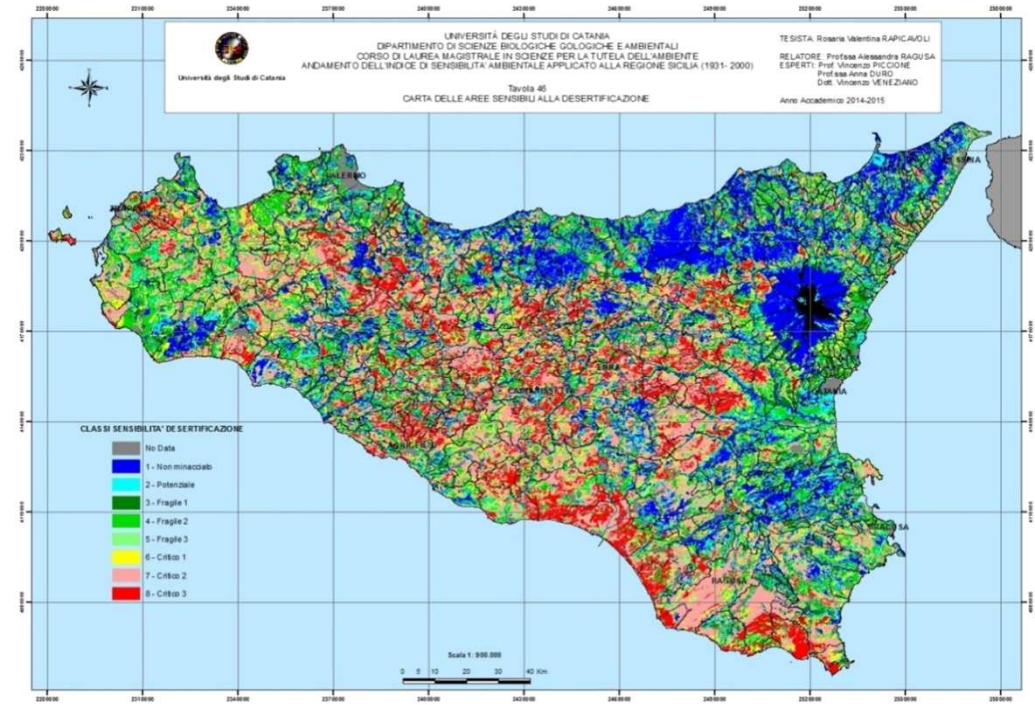
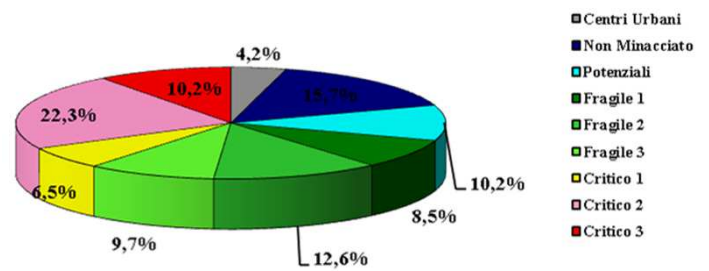
1976 YEAR WITH LESS SENSITIVITY DESERTIFICATION RISK

BEST CONDITIONS

1976							
Subtype	Range of ESAI	Σp	Σv	$\Sigma v/\Sigma p$	ESAI	I	F
	0	424545	0	0	4,2	0	
Mn	< 1,17	1605994	1781628	1,11	15,9	17,60	1,74
P	1,17 - 1,22	1047258	1251807,9	1,20	10,3	12,37	2,02
F1	1,22 - 1,26	892155	1106622	1,24	8,8	10,93	2,12
F2	1,26 - 1,32	1273812	1642571	1,29	12,6	16,23	3,64
F3	1,32 - 1,37	1005529	1354694	1,35	9,9	13,38	3,45
C1	1,37 - 1,41	649056	902619	1,39	6,4	8,92	2,50
C2	1,41 - 1,53	2286715	3357096	1,47	22,6	33,16	10,57
C3	> 1,53	1041122	1655759	1,59	10,3	16,36	6,07
Σ		10226186	13052798	10,63	101	128,95	32,12
	average			1,33			
	max			2,05			
	min			0,81			

ESPI 57,5

ESPI = 57,5



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maragusa@dmi.unict.it

YEARS MEANINGFUL

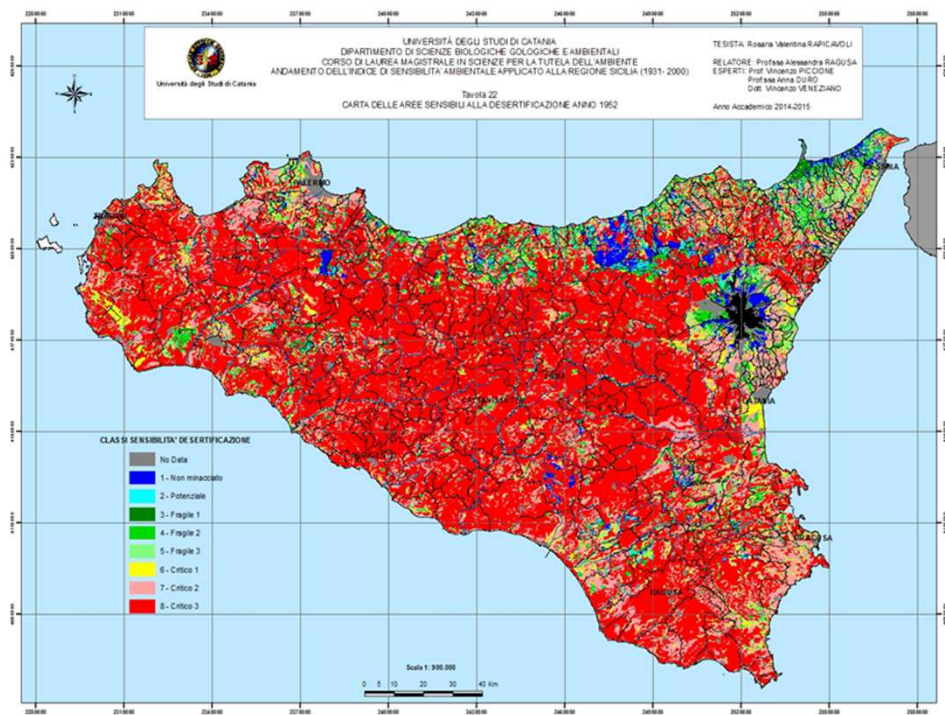
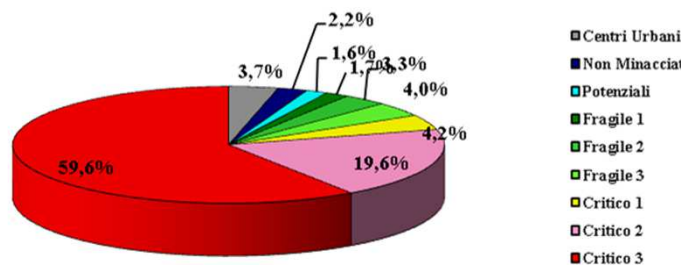
1952 YEAR WITH HIGHER SENSIVITY DESERTIFICATION RISK

WORST CONDITION

1952							
Subtype	Range of ESAI	Σp	Σv	$\Sigma v/\Sigma p$	ESAI	I	F
	Q	375232	0	0	3,7	0	
Mn	<1,17	225146	349229	1,11	2,2	2,46	0,24
P	1,17- 1,22	162662	194557,8	1,24	1,8	1,92	0,32
F1	1,22- 1,26	175506	217669	1,24	1,7	2,15	0,42
F2	1,26- 1,32	336576	434938	1,29	3,3	4,30	0,97
F3	1,32- 1,37	407990	549651	1,35	4,0	5,43	1,40
C1	1,37- 1,41	421953	589000	1,39	4,2	5,81	1,64
C2	1,41- 1,53	1993998	2939682	1,47	19,7	29,04	9,34
C3	>1,53	6023767	10220149	1,70	59,5	100,96	41,46
Σ		10122700	15393875	10,75	100	152,07	55,78
	average		1,34				
	max		2,26				
	min		0,85				

ESPI 80,8

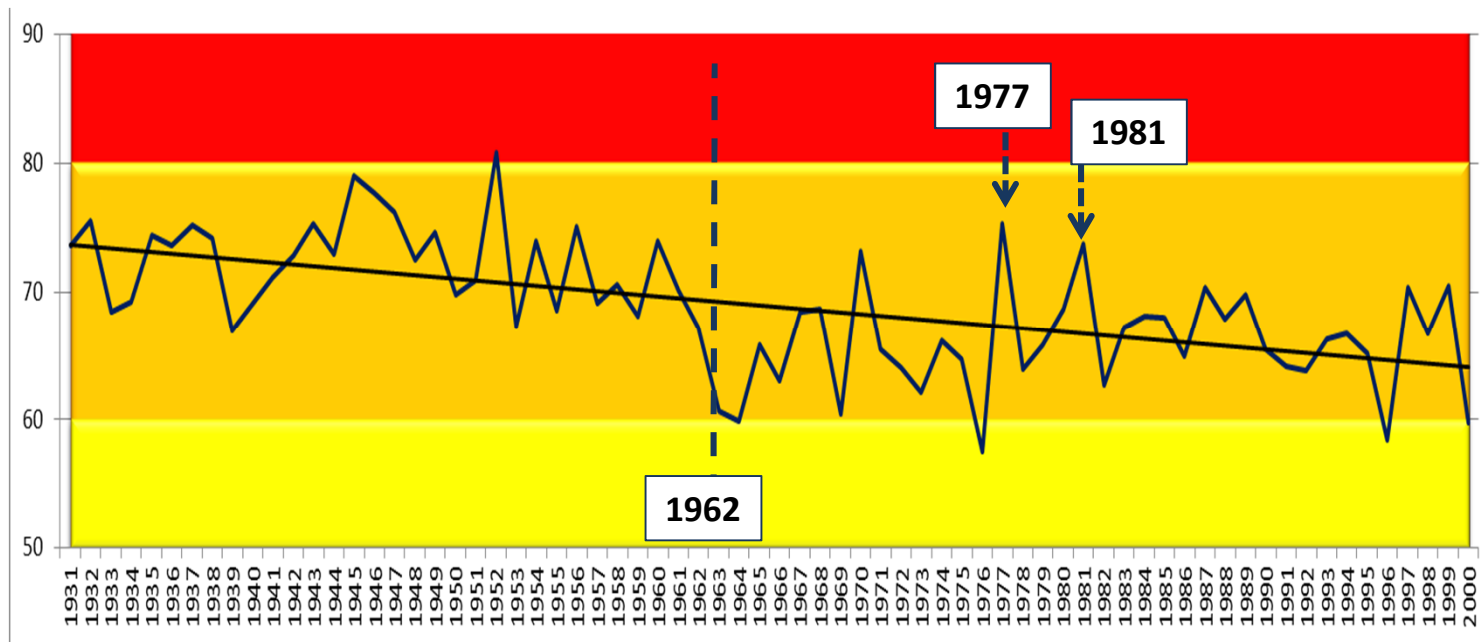
ESPI = 80,8



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maragusa@dmi.unict.it

CHRONOLOGICAL ORDER OF ESPI INDEX IN SICILY (1931 – 2000)



DESERTIFICATION RISK IS FALLING FROM 1931 TO 2000



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maragusa@dmi.unict.it

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Desertification Risk: Climate in Sicily

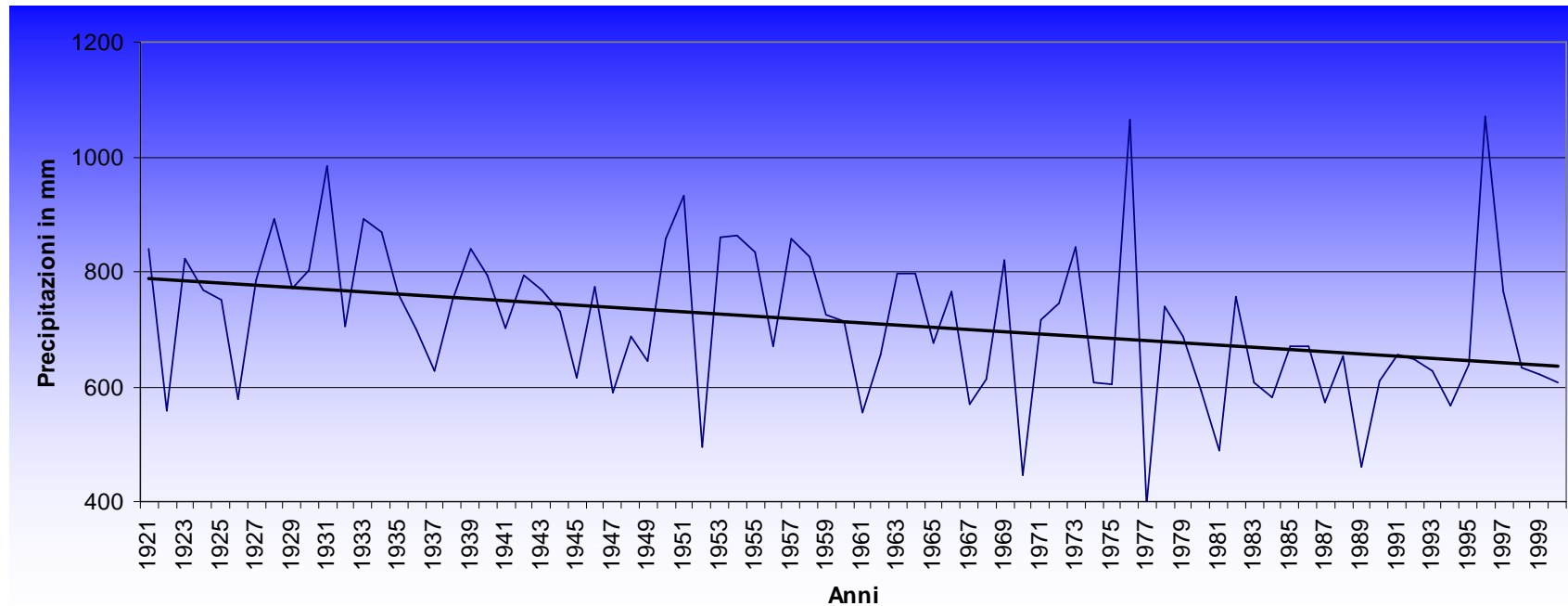


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SPEAKER: M.A. Ragusa
maragusa@dmi.unict.it

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Annual rainfall : SICILY REGION



Regional average from 1921 to 2000 = 713 mmc

Annual averages

Val max = 1071 mm

Val min = 393 mm

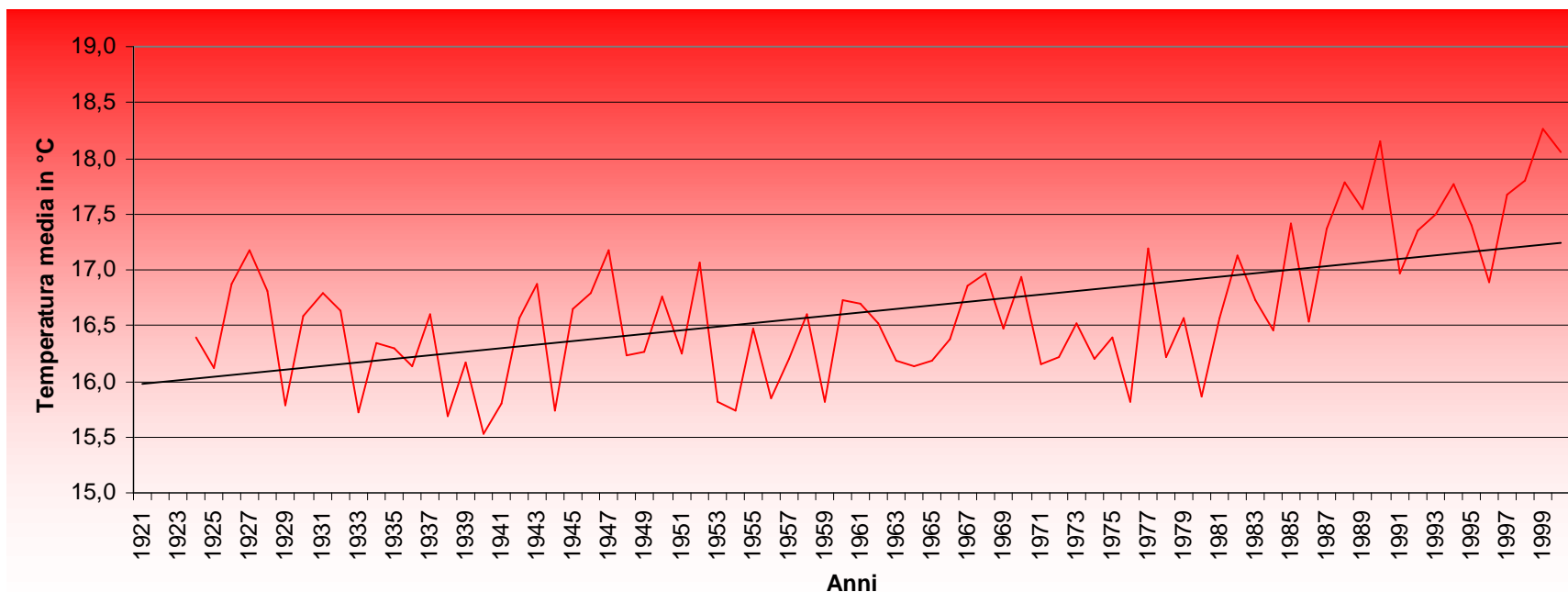


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maragusa@dmi.unict.it

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Annual average temperatures : SICILY REGION



Regional average from 1921 to 2000 = 16,6 °C

Annual averages

Val max = 18,3 °C

Val min = 15,5 °C

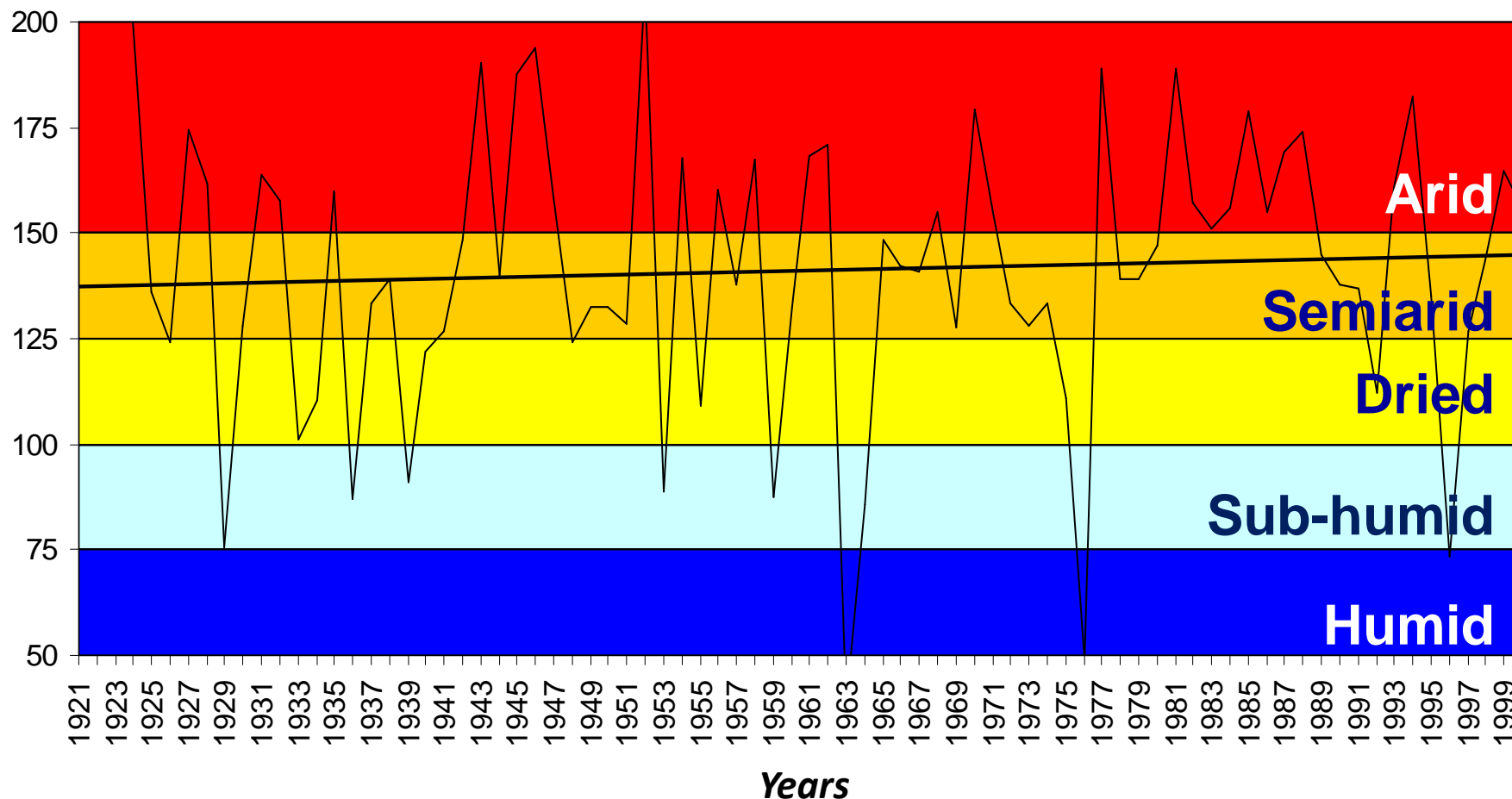


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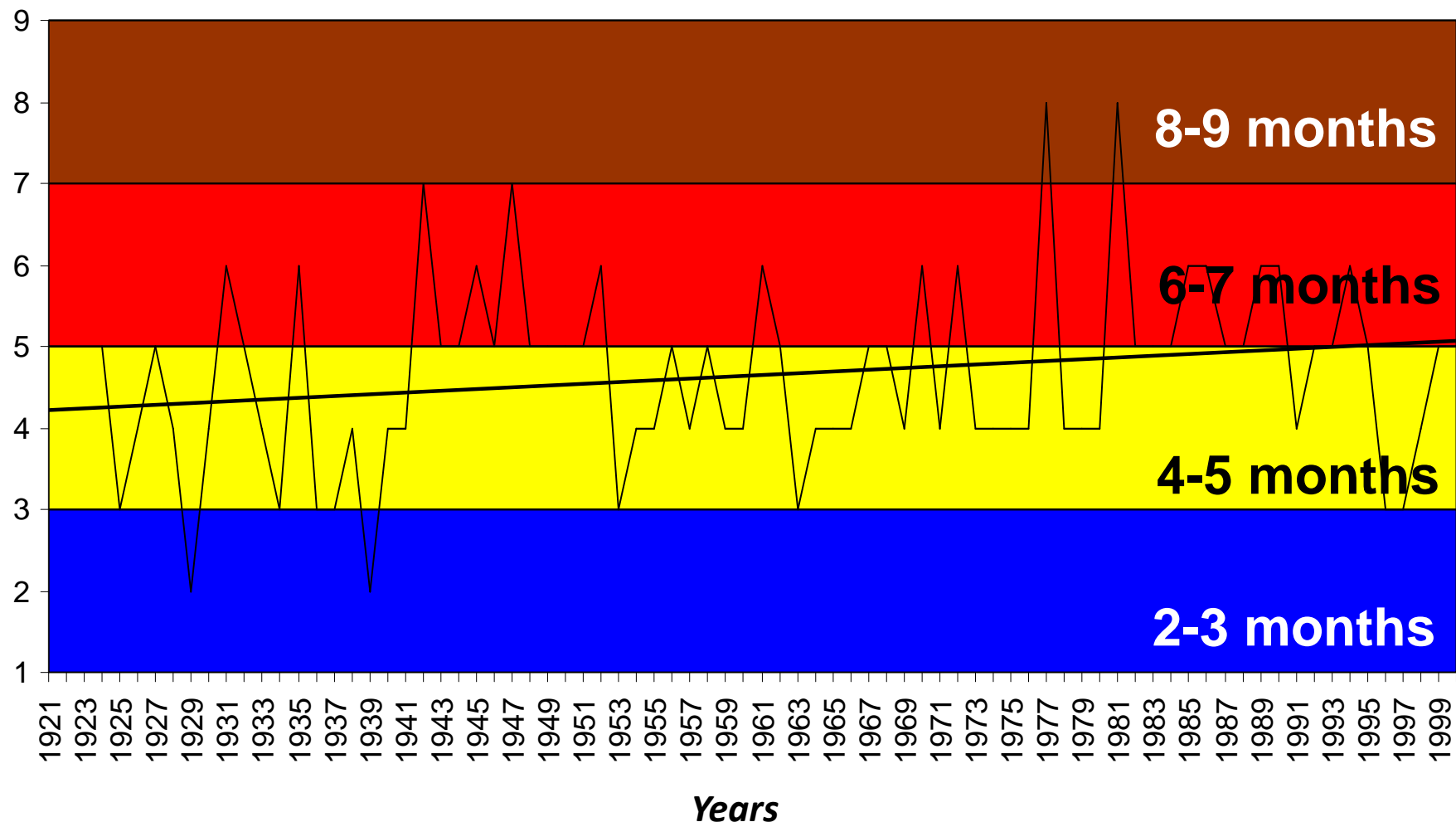
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maragusa@dmi.unict.it

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ANNUAL TREND HUMIDITY - INTENSITY IN SICILY



ANNUAL TREND HUMIDITY - DURATION IN SICILY



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maragusa@dmi.unict.it

CHRONOLOGICAL ORDER OF ESPI - CQI INDEX IN SICILY (1931 – 2000)

